Serpent River Watershed
Cycle 5 (2015 to 2019)
State of the Environment Report

Prepared for:
Rio Algom Limited and Denison Mines Inc.
Elliot Lake, Ontario

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March 2021

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EXECUTIVE SUMMARY

Uranium mining was undertaken in the Elliot Lake area of north-eastern Ontario for approximately forty years, from the late 1950s to the mid-1960s and again from the early 1970s until the early 1990s when most of the mines ceased operations. In total, there are twelve decommissioned mining operations: Quirke [Quirke I and Quirke II], Panel, Denison, Spanish-American, Can-met, Stanrock, Stanleigh, Milliken, Lacnor, Nordic, Buckles, and Pronto. All the tailings management areas (TMAs) discharge to the Serpent River Watershed (SRW), except Pronto which discharges to the north shore of Lake Huron. As the operations are closed, the TMAs are in the long-term care and maintenance phase that includes effluent treatment, source and watershed monitoring and TMA maintenance. The long-term care and maintenance of these sites is the responsibility of the licensees Rio Algom Limited (RAL) and Denison Mines Inc (DMI). 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.

As part of the decommissioning and closure process, RAL and DMI developed a focused and integrated performance monitoring network. The current comprehensive monitoring and management strategy clearly defines and delineates the purpose for all monitoring activities through three integrated programs: the TMA Operational Monitoring Program (TOMP), the Source Area Monitoring Program (SAMP), and the SRW Monitoring Program (SRWMP).

The objective of this Cycle 5 SRW State of the Environment (SOE) 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 SRW relative to TMA sources. The report focusses on data from January 2015 to December 2019 (five years), and incorporates older data in the assessment of trends and historical conditions.

In-Basin Quality (TOMP)

Surface water quality at TOMP stations was generally at or near EIS-predicted levels for Cycle 5 data (2015 to 2019). At most TMAs, surface water quality has continued to improve in recent years (2003 to 2019) based on decreasing concentrations of radium-226, sulphate, and uranium, as well as increasing pH levels. However, at Stanrock and Denison TMAs, concentrations of barium and radium 226 in surface water have increased slightly since 2003. Also at Denison TMA, pH has slightly decreased. Decreasing pH in the Denison TMA 1 basin was likely 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 relatively small and pH within the TMA remains neutral, achieving the PWQO prior to treatment at station D-1.

Pore water and groundwater quality have also generally improved over time for most TMAs, except for pore water at Stanrock TMA and groundwater at one of the Quirke TMA stations. Stanrock TMA pore water quality has remained similar or deteriorated over time, whereas groundwater quality has generally improved. Concentrations of acidity, iron, and sulphate were increasing in the TMA upgradient of Dam A (pore water station PN-STP3-P); however, acidity and sulphate were decreasing, and iron did not show a trend in groundwater downgradient of Dam A (station BH91-SG1A). For Quirke TMA, improving trends were noted for pore water quality at all stations and for groundwater quality stations downgradient of the Main Dam and Dam G-2, and downgradient of and closest to Dam K1 (station 95QW-5). Further downgradient of Dam K1, groundwater concentrations of iron and sulphate were increasing. The difference in trends observed at station 95QW-5 relative to upgradient may reflect the slower flushing of contaminants further downgradient of TMA Cell 14, particularly in deeper sampling depths. In 2019, pore water pH at all depths achieved the EIS predicted levels (only applicable to Stanrock and Quirke TMAs), except for the shallowest horizon (<3 m) at Stanrock TMA.

Overall, the TOMP surface water, pore water, and groundwater data indicated that the TMAs were performing as expected.

TMA Discharges and Seepages (SAMP)

Primary mine discharges contribute the majority of chemical loadings to the receiving environment. Although trends of increasing concentrations or decreasing pH were observed at many of the mines, concentrations typically either improved or remained relatively unchanged over time, effluent continued to achieve discharge criteria, and concentrations were frequently below (or above for pH) receiving environment SRWMP benchmarks. At Stanrock (DS-4), Stanleigh (CL-06), Denison (D-2, D-3), and Quirke (Q-28) TMA principal discharge locations, effluent pH showed slight decreasing trends. Also at these stations and at Panel TMA (P-14), barium concentrations increased from 2003 to 2019. Changes in pH and barium concentrations likely reflected treatment efficacy. In all cases, effluent barium concentrations were below toxicity thresholds, and pH remained circumneutral. Within the May Lake sub-watershed, barium and radium-226 concentrations increased at the Stanleigh TMA (CL-06) in response to refractory radium and initial treatment of increased barium chloride additions. Since the introduction of ex-situ barite (XSB) treatment at the Stanleigh effluent treatment plant in 2018, both radium-226 and barium concentrations have decreased. Within the Quirke Lake sub-watershed, iron concentrations increased in the primary discharges at both the Denison (D-2 and D-3) and Quirke (Q-28) TMAs from 2003 to 2019, though iron concentrations in the Quirke discharge (Q-28) appear to have declined since 2013. In addition to increased iron concentrations, there was a small but significant increase in manganese concentrations at

SAMP station D-3. Although concentrations of manganese and iron increased, concentrations remained below the SRWMP benchmarks. At Pronto TMA, since 2003 there has been a slight increase in the concentration of radium-226 at SAMP station PR-01, although concentrations remain well below the discharge criterion (0.37 Bq/L) and below the SRWMP benchmark of 0.469 Bq/L.

Effluents from the TMAs have been consistently non-lethal to *Daphnia magna* and rainbow trout, with no mortality reported in semi-annual acute toxicity tests, except for effluent from Stanleigh, Quirke, and Panel TMAs, which each had one or two *D. magna* toxicity tests toxicity tests that exhibited minimal mortality. Reproduction of *Ceriodaphnia dubia* was not affected by exposure to 100% effluent from any of the TMAs over the 2015 to 2019 period, except for one sample each from Stanrock, Quirke, Panel, and Milliken. However, the IC25 values (effluent concentration causing 25% inhibition relative to control organisms) for each of these samples was substantially higher than would be expected in the diluted receiving environments, and therefore effects to these invertebrates would not be expected in the receiving environment.

Direct seepage releases from the TMAs to the receiving environment occur in the Quirke Lake sub-watershed and Elliot Lake sub-watershed. Generally, seepage concentrations have been improving since 2003 at all seepage monitoring locations, except for increasing uranium concentrations at station D-9 (Denison TMA) and station P-02 (Panel TMA), increasing barium concentrations at ECA-398 (Quirke TMA), and some evidence of slightly higher radium-226 concentrations at station WL-4 (Nordic TMA) in 2018 and 2019. Despite increasing trends at these seepage locations, barium and radium-226 concentrations remained below SRWMP benchmarks. The only discharge location where pH has remained low (i.e., below 5) is the seepage from the historical Quirke II mine (station ECA-398). While metal concentrations tend to be highest and pH lowest in these seepage sources compared to the primary mine discharges, their loads to the receiving environment are low compared to primary discharges and background (upstream) loads.

Watershed Conditions (SRWMP)

The improvements within the TMAs and at the TMA discharges were reflected in the downstream receiving environment. Within the SRW, annual mean water concentrations (2015 to 2019) were less than SRWMP benchmarks for all substances, except for mean iron concentrations at station D-6 in 2018 and 2019. For individual samples, all concentrations of barium, pH, radium-226, and uranium in water were less than (or greater than for pH) the SRWMP benchmarks. Water metal concentrations at station D-6 (Cinder Lake outlet, downstream of Denison TMA 1) exceeded the iron, manganese, and sulphate benchmarks in four, three, and one out of 20 samples, respectively. At station Q-09 (Serpent River, downstream of Quirke TMA and Denison TMA 1), sulphate concentrations marginally exceeded the SRWMP in one out of 20 samples.

Water quality trends indicated that SRW water quality has generally improved or remained stable since 2003, with a couple exceptions in the May Lake sub-watershed. Within the May Lake sub-watershed, barium concentrations were observed to increase significantly over time at the three SRWMP stations SR-06 (McCabe Lake outlet, downstream of Stanleigh TMA), DS-18 (Halfmoon Lake outlet, downstream of Stanrock TMA), and SR-15 (May Lake Outlet, downstream of Stanrock and Stanleigh TMAs). Increasing trends were also shown for iron at station DS-18 and radium-226 at station SR-06. Contrary to these increasing trends, from 2018 to 2019 there was a drop in radium-226 concentrations at station DS-18, as well as in both barium and radium-226 concentrations at stations SR-06 and SR-15. The increases in barium and radium-226 at station SR-06 were associated with refractory radium-226 and treatment trials at the Stanleigh TMA ETP in 2015 and 2016. The lower concentrations of barium and radium-226 observed in 2018 and 2019 reflect the effectiveness of the XSB treatment. Notably, concentrations of barium, iron, and radium-226 remained well below the SRWMP benchmarks at these three SRWMP stations. Also at these SRWMP stations, sulphate and uranium concentrations decreased significantly, indicating continued improvements in water quality. Loadings of barium, sulphate, and uranium at the outlet of Halfmoon Lake (SRWMP station DS-18) were similar to those measured upstream (SAMP station DS-4), whereas loadings of iron and radium-226 were higher. This was potentially indicative of flushing of historical deposits as overlying water quality improves.

Sediment quality and benthic invertebrate community (BIC) structures were assessed in four mine-exposed lakes: May Lake (downstream of Stanrock and Stanleigh TMAs), McCabe Lake (downstream of Stanleigh TMA), Nordic Lake (downstream of Lacnor/Nordic TMAs) and Quirke Lake (downstream of Spanish-American, Denison, Quirke, Panel, and Stanrock TMAs). Four reference lakes were also monitored. In 2019, mean sediment concentrations of metals and radium-226 in most mine-exposed lakes exceeded the upper limit of background or Lowest Effect Level (LEL) benchmarks (i.e., barium in McCabe and Quirke lakes, cobalt, nickel, radium 226 in all lakes, manganese in McCabe and Nordic lakes, and uranium in all lakes except May Lake). However, in no instance did sediment concentrations exceed a Severe Effect Level (SEL) for nickel, radium-226, or uranium[1], or the lake-specific dose-based benchmarks for radium-226. Temporally, there have been few significant changes

[1] Barium and cobalt do not have applicable provincial sediment quality guideline (PSQG) or Thompson et al. (2005) LEL or SEL values. The upper limit of background concentrations for iron and manganese were higher than the PSQG LEL and SEL.

in sediment chemistry over the past 20 years, consistent with slow deposition rates in the watershed. In McCabe Lake, radium-226 concentrations in sediment decreased in 2019 relative to 2009. In Quirke Lake, sediment concentrations of iron, manganese, and nickel were significantly higher in 2019 compared to 1999 (manganese, nickel) and 2004 (iron). These higher concentrations were likely due to increased TOC concentrations and proportion of clay particles, which have been shown to accumulate metals in sediment. Nonetheless, mean iron and manganese concentrations were less than the upper limit of background concentrations, and nickel concentrations were slightly above the upper limit of background concentrations but well below the SEL. The BIC from both the mine-exposed and reference lakes in the SRW continued to be dominated by chironomids, as is typically the case for deep lake sediments. Some improvements in mine-exposed communities were noted over time (i.e., increased organism densities in May Lake and McCabe Lake), whereas other lakes were already similar to reference (Nordic Lake) or unchanged from previous study years (Quirke Lake). Temporal CAs indicated that community structure has been changing over time in the mine-exposed lakes as conditions improved.

Public Dose

The estimated radiation dose to the public associated with the closed Elliot Lake mine sites in the SRW was updated using the most up-to-date radiochemistry data and surveys of residents. The total dose for an adult from Elliot Lake (including background dose), was calculated to be 0.035 mSv/a. Of this, 0.026 mSv/a was attributable to background, while the incremental dose was 0.01 mSv/a. Overall, the public dose of approximately 0.01 mSv/a (after removal of background) was well below the incremental public limit of 1 mSv/a and the dose constraint of 0.3 mSv/a.

Summary

The TMAs are performing well and reflecting improving conditions, with parameters meeting EIS predictions, effluents achieving discharge criteria, and low to no effects in acute and sublethal toxicity testing of effluents. The SRW is responding to these improvements as demonstrated by surface water quality consistently achieving the SRWMP benchmarks, with few exceptions. SRW water quality has improved more rapidly than sediment and benthic invertebrates. The estimated radiation dose to the public associated with the closed Elliot Lake mine sites in the SRW was well below the public dose limits.

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ACRONYMS AND ABBREVIATIONS

AECB – Atomic Energy Control Board

ANOVA – Analysis of Variance

BCWQG – British Columbia Water Quality Guideline

BIC – Benthic Invertebrate Community

Bq/day – Becquerels per Day

Bq/L – Becquerels per Litre

CA – Correspondence Analysis

CAB – Cellulose Acetate Butyrate

CALA – Canadian Association for Laboratory Accreditation

CCME – Canadian Council of Ministers of the Environment

CGVD28 – Canadian Geodetic Vertical Datum of 1928

CNSC – Canadian Nuclear Safety Commission

CofA – Certificate of Approval

CSA – Canadian Standards Association

DFO – Department of Fisheries and Oceans

DQA – Data Quality Assessment

DQO – Data Quality Objectives

DMI – Denison Mines Inc

EC – Environment Canada

ECA – Environmental Compliance Approval

ECD – Effluent Collection Ditch

EDF – Environmental Design Flood

EIS – Environmental Impact Statements

ELRFS – Elliot Lake Research Field Station

ETP – Effluent Treatment Plant

GLP – Good Laboratory Practice

GPS – Global Positioning System

HDPE – High Density Polyethylene

IBMP – In-Basin Monitoring Program

ICP-MS – Inductively Coupled Plasma Mass Spectrometry

JRG – Joint Review Group

Kg/day – Kilograms per Day

K-M – Kaplan-Meier

LIMS – Laboratory Information Management System

LPL – Lowest Practical Level

LRL – Laboratory Reporting Limit

masl – Metres Above Sea Level

MCT – Measures of Central Tendency

MECP – Ministry of the Environment, Conservation and Parks

MNRF – Ontario Ministry of Natural Resources and Forestry

MNDM – Ontario Ministry of Northern Development and Mines

MOD – Magnitude of Difference

MOE – Ontario Ministry of the Environment

MOL – Ontario Ministry of Labour

OCM – Annual Operating, Care and Maintenance

OECD – Organisation for Economic Co-operation and Development

OMOEE – Ontario Ministry of the Environment and Energy

PCAF – Perdue Central Analytical Facility

PMP – Probable Maximum Precipitation

PSQG – Provincial Sediment Quality Guidelines

PWQO – Provincial Water Quality Objective

QA/QC – Quality Assurance / Quality Control

RAL – Rio Algom Limited

SAMP – Source Area Monitoring Program

SCC – Standards Council of Canada

SOE – State of the Environment

SOP – Standard Operating Procedures

SRC – Saskatchewan Research Council

SRW – Serpent River Watershed

SRWMP – Serpent River Watershed Monitoring Program

TMA – Tailings Management Area

TOC – Total Organic Carbon

TOMP – TMA Operational Monitoring Program

WSC – Water Survey of Canada

WQG – Water Quality Guideline

XSB – *ex situ* barite

1 INTRODUCTION

1.1 Sites and Program History

Uranium was mined in the Elliot Lake area of north-eastern Ontario for approximately forty years. The former Elliot Lake mines are generally located within the Serpent River Watershed (SRW), which is located between Sudbury and Sault Ste. Marie, Ontario. The watershed drains a land area of 1,376 km^2 and flows southward into Serpent Harbour at the North Channel of Lake Huron. The SRW is a chain-lake system containing more than 70 lakes.

The Elliot Lake 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 SRW (Quirke [Quirke I and Quirke II[2]], Panel, Denison, Spanish-American, Can-met, Stanrock, Stanleigh, Milliken, Lacnor, Nordic, and 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 in Sheriff Creek (adjacent to the Milliken mine); these sites are included within the areas licensed by the Canadian Nuclear Safety Commission (CNSC).

Final decommissioning and closure of the Quirke, Panel, Denison, Stanrock and Spanish-American properties was undertaken between 1992 and 1996. The Stanleigh, Lacnor, Nordic, and Pronto were decommissioned from 1997 to roughly 2000 and, in the case of Stanleigh, was not final 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 management. All TMAs discharge to the SRW, 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 (RAL) and Denison Mines Inc. (DMI).

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 CNSC, and/or a Certificate of Approval (CofA) from the Ontario Ministry of the Environment (MOE[3]). As part of the environmental approvals for the closure and decommissioning plans, RAL

[2] Quirke I production occurred from 1956 until mining activities were suspended in 1961, at which time the mine was flooded. In 1968 the Quirke Site reopened, and the Quirke II mine was developed (RAL 1993).

[3] The MOE is now known as the Ministry of the Environment, Conservation and Parks (MECP).

Table 1.1: Elliot Lake Mines - Operating History, Size, and Cover Type

Site [a]	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 [b]	23.1	flooded
Nordic/Buckles [c]	Jan 1957 - Jul 1968	1997-1999	12.0	117.3	vegetated
Pronto	Aug 1958 - 1970	1999 2001	4.4 [d]	47	vegetated
Quirke [e]	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

Note: Table adapted from Table 5.2.2 of CNSC 2002.

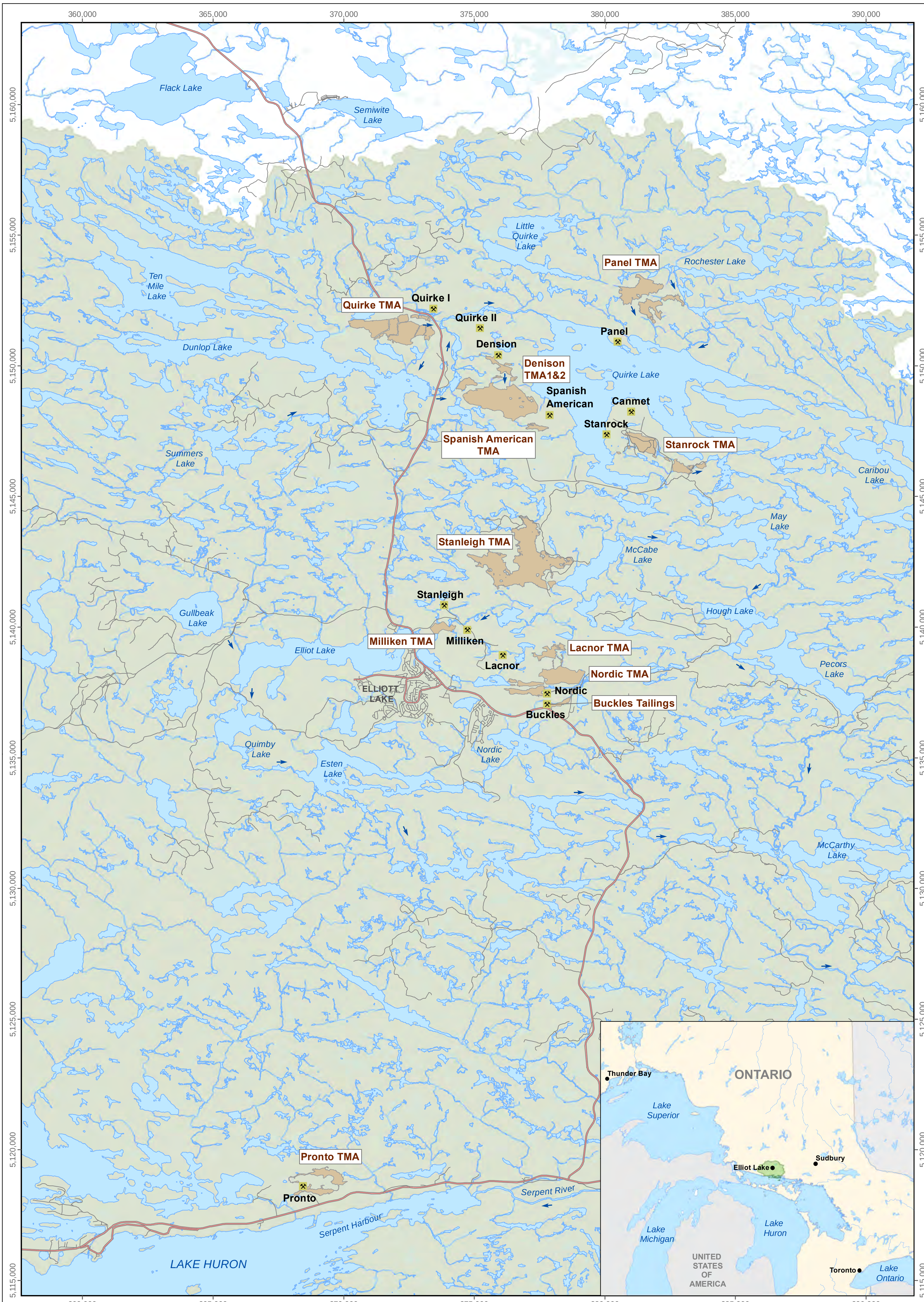
[a] Denison Mines Inc. owns the Denison, Canmet, and Stanrock properties and Rio Algom Limited owns the Quirke, Panel, Spanish-American, Lacnor, Nordic, Milliken, Stanleigh, and Pronto properties.

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

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

[d] Includes 2.1 Mt of uranium tailings and 2.3 Mt of copper tailings.

[e] Quirke I production occurred from 1956 until mining activities were suspended in 1961, at which time the mine was flooded. In 1968 the Quirke Site reopened, and the Quirke II mine was developed (RAL 1993).



LEGEND

- Mine Site
- Tailings Management Area (TMA)
- Serpent River Watershed

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

0 2.5 5 10 km

N W E S

Map Projection: UTM Zone 17 NAD 1983
Data Source: Reproduced under licence from Her Majesty the Queen in Right of Canada, Department of Natural Resources Canada. All rights

Date: March 2021
Project 197202.0041

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Figure 1.1

Document Path: C:\Users\MLaPalme\Trinity Consultants, Inc\BHP - 197202.0041 - Cycle 5 SOE\4 - GIS\Cycle 5 Report\19-41 Figure 1.1 Serpent River Watershed and Location of Former Mines.mxd and DMI 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 (Beak 1999b). A companion program, the In-Basin Monitoring Program (IBMP), was also developed to assess the health risks to biota potentially feeding at each of the aquatic and vegetated TMAs (Beak 1999a). 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 CofAs 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 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 first 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 was first implemented in January 2003, concurrent with the SAMP.

The rationalization process used to design the monitoring programs for the Elliot Lake mine sites resulted in 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[4]). The study designs have modified over time, with review and approval from the JRG. Data for each program are

[4] The JRG is a multi-stakeholder committee composed of representatives from the CNSC, Department of Fisheries and Oceans (DFO), Environment Canada (EC), MECP, 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 reviewing study design reports and interpretive reports for the TOMP, the SAMP, and the SRWMP.

reported annually. In 2008, RAL and DMI prepared a State of the Environment (SOE) report (Minnow 2009c) which assessed the 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 receiving environment (SRWMP). The first SOE report captured data collected from the inception of the four programs (IBMP, TOMP, SAMP, and SRWMP) to the end of 2006 (Minnow 2009c). Based on the findings of the SOE report, the IBMP was discontinued after 2006, as it had provided sufficient information to achieve its original objective. After this, the remaining programs have been reported on both annually and on a five-year cycle in SOE reports. The study designs are also reviewed on the five-year cycle. Changes are summarized in Table 1.2.

Since its inception, the SRWMP has retracted both in scope and spatially, based on established acceptability criteria and dramatic improvement in water quality and biological indicators. At the beginning in 1999, more than twenty lakes and interconnecting channels were incorporated into the monitoring program and included far-field monitoring areas, which were further downstream from the immediate receiving environment. Currently, the SRWMP is focused on the near-field receiving environments and reference locations. Water quality is monitored downstream of all lakes that receive mine discharge as well as at reference areas, and sediment quality and benthic invertebrate communities (BIC) are monitored in the first lake downstream of the mine discharge (McCabe, May[5], Quirke, and Nordic lakes) as well as reference lakes (Dunlop, Ten Mile, Summers, and Semiwite lakes). Generally, these water quality, sediment quality, and BIC monitoring lakes are large, deep lakes with retention times that range from approximately 1 to 4 years (Table 1.3). Water quality within these lakes has improved dramatically since closure and now achieves SRWMP benchmarks for the protection of fish and aquatic life (see Section 2.2.3). However, sediment deposition rates in these receiving lakes are very slow (i.e., 1 cm every 13.6 years to 1 cm every 32 years; Minnow 2013), thus changes in surficial sediment chemistry and particle size, and therefore changes to the BIC residing in these sediments are also expected to be slow. Reflecting this slow deposition rate, the frequency of sediment quality and BIC monitoring was reduced from every five years to every ten years, with monitoring having been conducted in 1999, 2004, 2009, and 2019. The SRWMP also initially included fish abundance, fish health, and fish tissue chemistry monitoring components, which were monitored in Cycle 1 (1999). Based on the findings of Cycle 1, in Cycle 2 (2004)

[5] May Lake is not the first lake downstream of the mine discharge, but rather receives mine discharge from Stanrock and Stanleigh TMAs, via McCabe Lake and Halfmoon Lake (Figure 2.1). Halfmoon Lake was monitored in Cycle 1 (1999) and Cycle 2 (2004); however, it could not be compared to the other deeper lakes in the SRWMP program, and, due to its size, did not represent a key depositional habitat. Furthermore, the BIC did not demonstrate mine-related impacts (Minnow and Beak 2001). May Lake was accepted as the replacement to Halfmoon Lake, as it receives water from Stanrock TMA, is located immediately downstream of Halfmoon Lake, and is comparable in surface area and depth to other SRWMP lakes (Minnow 2019).

Table 1.2: Summary of Changes to the Elliot Lake Monitoring Programs (IBMP, TOMP, SAMP, and SRWMP) and Associated Documents

Cycle	Report Title	Year	Period Covered	Descriptions of Changes to the Monitoring Programs within Each Cycle
Cycle 1	Serpent River Watershed Monitoring Program Framework Document	1999	historical monitoring data	**IBMP, TOMP, SAMP, and SRWMP** were developed based on program objectives and existing monitoring data collected over the period of operations and decommissioning.
	In-Basin Monitoring Program Report	1999		
	Serpent River Watershed and In-Basin Monitoring Program – Implementation Document	1999		
	Serpent River Watershed Monitoring Program -1999 Study	2001	1999 to 2000	
	In-Basin Monitoring Program for the Uranium Tailings Areas - 1999 Study	2001		
Cycle 2	Overview of Elliot Lake Monitoring Programs and Source Area Monitoring Program Design	2002	2000 to 2004	**Changes only SRWMP** most associated with optimization after first cycle of program was complete: • monitoring substances reduced to mine indicator parameters (barium, cobalt, DOC, iron, manganese, radium-226, selenium, silver, sulphate and uranium); • addition of two lake reference stations (Summers and Semiwite lakes) and 3 stream reference areas (SR-16, SR-17 and SR-18); • removal of shallow lakes for sediment and benthic sampling (Westner, Grassy, Halfmoom, Upper Cinder and Horne lakes); • removal of some stream sediment and benthic stations (D-15, SC-03 and SR-07); • removal of Depot Lake and Serpent Harbour; addition of May Lake; • the transfer of some SRWMP stations to SAMP or TOMP (N-12, ECA-131, P-11, MPE and Q-23); and • fish health assessment eliminated based on performance, fish community assessment added for McCabe Lake and fish tissue monitoring reduced in scope based on performance.
	TMA Operational Monitoring Program Design (TOMP)	2002		
	Cycle 2 Study Design – Serpent River Watershed and In- Basin Monitoring Programs	2004		
	Serpent River Watershed Monitoring Program: Cycle 2 Interpretive Report	2005		
	Serpent River In-Basin Monitoring Program: Cycle 2 Interpretive Report - 2004 Study	2005		
	Serpent River Watershed State of the Environment	2009		
Cycle 3	Monitoring Framework For Closed Uranium Mines Near Elliot Lake	2009	2005 to 2009	**IBMP** eliminated based on objectives of program being achieved. **TOMP and SAMP:** • removal of silver, selenium based on performance and removal of conductivity based on redundancy with sulphate; and • DOC, hardness and flow added at selected stations. **SRWMP:** • removal of selenium and sliver based on performance; • removal of station SR-12, ELO, SR-09, SR-15, SR-02, SR-03, SR-11, P-01, QL-01 and SR-16 and SR-17 based on performance; • monthly monitoring frequency reduced to quarterly; • sediment and benthic monitoring removed from Whiskey, Evans and Cinder lakes based on redundancy; • depositional streams (Q-20, D-6, SR-06, M-01 and SR-08) based on very high natural variability masking results; and • fishing in McCabe Lake and fish tissue monitoring eliminated based on performance.
	In Basin Monitoring Program, Cycle 3 Study Design	2009		
	Serpent River Watershed Monitoring Program: Cycle 3 Study Design	2009		
	Source Area Monitoring Program Revised Study Design	2009		
	Tailing Management Area Monitoring Program (TOMP) Revised Study Design	2009		
	Serpent River Watershed State of the Environment Report	2011		
Cycle 4	Cycle 4 Study Design For the SRWMP, SAMP and TOMP	2014[a]	2010 to 2014	Minor changes to **TOMP** and **SAMP**. **SRWMP**: • elimination of reference stations SR-05, P-222 and SR-14; • removal of cobalt as substance for monitoring, addition of DOC; • far-field lakes removed from the program (Hough, Pecors, and McCarthy); • removal of Rochester Lake as a sediment and benthic reference area; and • reduction in benthic and sediment sampling to 1/10 years based on measured deposition rates.
	Serpent River Watershed Cycle 4 State of the Environment	2016		
Cycle 5	Cycle 5 Study Design For the SRWMP, SAMP and TOMP	2019	2015 to 2019	**TOMP, SAMP, and SRWMP**: • improved approach to trend analysis of surface water quality using the non-parametric seasonal Kendall test. **SRWMP**: • improved approach to calculate benchmark upper limit of background water quality values have previously been calculated based on the upper 95th percentile of values collect across all five years (rather than annual means); • use of a Serpent River Watershed site-specific dose-based radium-226 benchmark for assessment of water quality; • addition of a lake-specific dose-based radium-226 benchmark for assessment of sediment quality; and • sediment and benthic monitoring removed from Elliot Lake based on improvements in water quality, negligible mine-related sediment toxicity, and gradual improvement in benthic invertebrate communities.

[a] Study Design was submitted to CNSC and JRG in 2014 but reissued with agency comments in 2016.

Notes: IBMP = In Basin Monitoring Program. TOMP = Tailings Management Area Monitoring Program. SAMP = Source Area Monitoring Program. SRWMP = Serpent River Watershed Monitoring Program.

Table 1.3: Characteristics of Mine-exposed and Reference Lakes in the Serpent River Watershed

Type	Lake	Mine Discharges and SRWMP Relevance	Surface Area (ha)	Mean Depth (m)	Maximum Depth (m)	Volume (M m^3)	Average Outflow (m^3/sec)	Approximate Retention Time (months)
Reference	Dunlop Lake	Sediment and BIC monitoring lake, also receives seepage from Quirke TMA. Outlet is a SRWMP water station (D-4).	1,100	9	55	101	2	19
	Semiwite Lake	Sediment and BIC monitoring lake.	310	13	36	39.1	-	-
	Summers Lake	Sediment and BIC monitoring lake.	233	14	53	32.2	-	-
	Ten Mile Lake	Sediment and BIC monitoring lake.	932	31	117	300	0.45	150
Mine-exposed	Cinder Lake	Receives seepage from Denison TMA. Outlet is a SRWMP water station (D-6).	42	10	24	4.15	-	-
	Elliot Lake	Discharge and seepage from Milliken and Stanleigh TMAs (via Sheriff Creek) and seepage from Nordic TMA (via Horne Lake/Westner Lake).	615	17	38	96	2	18
	Evans Lake	Seepage from Quirke TMA. Outlet is a SRWMP water station (Q-20).	30	16	37	4.7	0.014	10.5
	May Lake	Discharge from Stanrock TMA via Halfmoon Lake and discharge from Stanleigh TMA via McCabe Lake. Outlet is a SRWMP water station (SR-15). SRWMP sediment and BIC monitoring lake.	318	14	47	45.5	0.48	12
	McCabe Lake	Discharge and seepage from Stanleigh TMA. Outlet is a SRWMP water station (SR-06). SRWMP sediment and BIC monitoring lake.	180	9.3	25	16.8	0.48	12
	Westner Lake	Seepage from West Arm of Nordic TMA. Flows to Horne Lake which discharges to Elliot Lake. Outlet is a SRWMP water station (SC-01).	38	-	-	-	-	-
	Nordic Lake	Discharge from Nordic TMA. Outlet is a SRWMP water station (SR-08). SRWMP sediment and BIC monitoring lake.	122	9	26	11	0.55	8
	Quirke Lake	Discharge and seepage from Denison TMA, Quirke TMA, and Panel TMA, as well as seepage from Stanrock TMA. Outlet is a SRWMP water station (SR-01). SRWMP sediment and BIC monitoring lake.	2,100	39	104	800	5.8	54

Notes: "-" = data not available. TMA = tailings management area. SRWMP = Serpent River Watershed Monitoring Program. BIC = benthic invertebrate community.

fish monitoring focussed on fish tissue chemistry and fish community in one lake (McCabe) where abundance had been low. Fish monitoring for the SRWMP was discontinued after Cycle 2, as fish monitoring for McCabe Lake was conducted separately as part of Environmental Compliance Approval (ECA) commitments, and because fish tissue concentrations were well below conservative consumption benchmarks (Minnow 2009b).

The Cycle 4 SOE reported on TOMP, SAMP, and SRWMP data collected from 2010 to 2014. This report indicated that the TMAs were performing well in terms of meeting EIS predictions and reflecting improving conditions. The SRW was responding to these improvements, with water quality responding (improving) more rapidly than sediment and benthic invertebrates. The public dose estimates indicated that the upper bounds of public dose were below the public dose limits. Based on the findings of the Cycle 4 SOE report and feedback from the JRG, revised TOMP, SAMP, and SRWMP study designs were submitted in April 2019 (Minnow 2019) and approved in March 2020 (Appendix V). Currently, water quality data from the TOMP, SAMP, and SRWMP are reported in monthly (TOMP and SAMP), quarterly (SRWMP), and annual reports as well as in each 5-year SOE report, while sediment quality and benthic invertebrate community data from the SRWMP are reported on a 10-year cycle within alternating 5-year SOE reports. This Cycle 5 SOE report presents the finding of the TOMP, SAMP, and SRWMP at the closed DMI and RAL mines in Elliot Lake from 2015 to 2019.

1.2 Project Objectives and Approach

The objective of this Cycle 5 SOE Report is to integrate recent monitoring data (2015 to 2019) from the TOMP, SAMP, and SRWMP to provide an assessment of TMA performance and the conditions in the downstream SRW relative to TMA sources[6]. To achieve this objective, several goals were identified:

- Assess TMA performance relative to discharge criteria as well as performance objectives and predictions made in the EIS;
- Evaluate mine sources (TMA releases) in terms of concentrations and loads to the SRW and near-shore Lake Huron, and use trend analysis to assess temporal changes;
- Assess water quality conditions within the receiving environment relative to TMA sources and consider concentrations relative to background concentrations, water quality guidelines for the protection of aquatic life, and EIS predictions, as well as assess temporal changes through trend analysis;

[6] While this report focuses on data collected from January 1, 2015 to December 31, 2019, historical and longer term data have been considered in the assessment of temporal trends and for comparison to EIS predictions.

- Assess impacts to the receiving environment based on sediment quality and benthic invertebrate community structure, and evaluate temporal trends; and
- Provide an assessment of public dose implications associated with mine source areas 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).

This SOE report summarizes the conditions at each of the TMAs based on the TOMP and SAMP water quality monitoring data collected from 2014 to 2019, and also summarizes conditions within the near-field receiving environment based on water quality data collected from 2014 to 2019 and on sediment and benthic invertebrate community data collected in 2019. Within this SOE report, the TOMP, SAMP, and SRWMP water quality data have been grouped by sub-watersheds so that multiple sources to the receiving environment may be collectively compared and considered (Sections 3 to 7). The SRWMP sediment quality and benthic invertebrate community data are presented separately to allow for a more integrated assessment of data (Section 8). The current estimated radiation dose to the public is summarized in Section 9. The estimated public dose was updated in 2020 based on fish tissues collected in 2019 and on site-specific surveys of residents conducted in 2016 (EcoMetrix 2020, Appendix V).

2 METHODS

2.1 Water Quality

2.1.1 Overview

Water samples were collected under the TOMP, SAMP, and SRWMP, with 10, 24, and 128 stations monitored, respectively (Tables 2.1, 2.2, and 2.3). Under these programs several types of water samples were collected:

- Influent and effluent samples at TMA treatment plants (TOMP and SAMP);
- Samples collected to support ETP treatment and reagent application (TOMP);
- Surface water samples within basins (TOMP), at discharge points including seepages (TOMP and SAMP), and within the SRW and mine-exposed and reference stations (SRWMP);
- Pore water within TMA basins (TOMP); and
- Groundwater outside of TMAs (TOMP).

Station locations, monitoring frequency, and monitoring variables were dependent on the program objectives and station type (Tables 2.1, 2.2, and 2.3) as described in the Cycle 5 SOE Study Design (Minnow 2019).

2.1.2 Data Collection

2.1.2.1 Field Monitoring and Sampling

Water quality monitoring for the TOMP, SAMP, and SRWMP was conducted by DMI for both the DMI and RAL sites as part of the ongoing care and maintenance of the closed mines under contract to RAL (Figures 2.1 and 2.2). Monitoring was conducted according to standard operating procedures (SOPs) for TMA elevation determination, *in situ* measurements, flow measurements, quality control, as well as collecting samples of surface water, pore water, and groundwater for water chemistry and/or toxicity testing (Table 2.4; Appendix A).

Water samples were collected in High Density Polyethylene (HDPE) bottles according to SOPs that codified all aspects of the sample collection, including how sample bottles were rinsed in the field, how sample water was drawn into bottles, and the temperature at which the collected samples were stored (Table 2.4; Appendix A). The SOPs also ensured that the laboratory submissions, data entry, and data validation were consistent with the objectives of these programs, regulatory requirements, and industry standards (Table 2.4; Appendix A).

Table 2.1: Cycle 5 TOMP Stations, Parameters, and Monitoring Frequencies

TMA	TOMP Stations	Station Type/Purpose	Parameters and Monitoring Frequencies[a]														
			Elevation	Flow	Acidity	Barium	Cobalt	Iron	Manganese	pH	Radium-226	Sulphate	Uranium	Conductivity	TSS	Lime or NaOH Consumption	Barium Chloride Consumption
Stanrock	DS-2[d]	Basin performance (primary), ETP operations	-	D	Q	Q	Q	Q	Q	M	M	Q	Q	-	-	M	M
	DS-3[d]	ETP operations	-	-	-	-	-	-	-	D	-	-	-	-	-	-	-
	DS-4[d]	Effluent	-	W[b]	-	M[b]	M[b]	M[b]	M[b]	W	W	M	M[b]	-	W	-	-
	DS-1[d]	Additional pH control, radium monitoring	-	W	-	-	-	-	-	W	Q	-	-	-	-	-	-
	DS-6[d]	Additional pH control	-	W	-	-	-	-	-	W	-	-	-	-	-	-	-
	DS-5	Seepages and surface water internal to TMA	-	Q	-	-	-	-	-	Q	-	-	-	Q	-	-	-
	BH91-SG2(A,D)	Pore water	-	-	A	-	-	A	-	A	-	A	-	-	-	-	-
	BH91-SG1A, BH98-16A, BH98-15A, BH91-SG3(A,B)	Groundwater	-	-	A	-	-	A	-	A	-	A	-	-	-	-	-
Stanleigh	CL-04[d]	Basin performance (primary), ETP operations	W	D	Q	Q	Q	Q	Q	M	M	Q	Q	-	-	M	M
	CL-05[d]	ETP operations	-	-	-	-	-	-	-	D	-	-	-	-	-	-	-
	CL-06[d]	Effluent	-	W[b]	-	M[b]	M[b]	M[b]	M[b]	W	W	M	M[b]	-	W	-	-
	SGW-3, SGW-5	Groundwater	-	-	A	-	-	A	-	A	-	A	-	-	-	-	-
Denison	D-1[d]	Basin performance (primary), ETP operations	W	D	Q	Q	Q	Q	Q	M	M	Q	Q	-	-	M	M
	D-25	Basin performance (secondary)	-	-	S	-	-	S	-	S	S	S	-	-	-	-	-
	D-22[d]	ETP operations	-	-	Q	Q	Q	Q	Q	W	M	Q	Q	-	-	-	M
	D-3[d]	Effluent	-	W[b]	-	M[b]	M[b]	M[b]	M[b]	W	W	M	M[b]	-	W	-	-
	D-2[d]	Effluent	-	W[b]	-	M[b]	M[b]	M[b]	M[b]	W	W	M	M[b]	-	W	-	-
	BH91-D1(A,B), BH91-D3(A,B), BH91-DG4B, BH91-D9A	Groundwater	-	-	A	-	-	A	-	A	-	A	-	-	-	-	-
Spanish-American	ECA-128	Basin performance (primary)	M[c]	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	-	-	-	-
Quirke	Q-05[d]	Basin performance (primary), ETP operations	W	D	Q	Q	Q	Q	Q	M	M	Q	Q	-	-	M	M
	Q-03[d]	ETP operations	-	-	-	-	-	-	-	W	-	-	-	-	-	-	-
	Q-04P[d]	ETP operations	-	-	-	-	-	-	-	D	-	-	-	-	-	-	-
	Q-28[d]	Effluent	-	W[b]	-	M[b]	M[b]	M[b]	M[b]	W	W	M	M[b]	-	W	-	-
	Q-29	Perimeter monitoring	W	W[c]	-	-	-	-	-	-	-	-	-	-	-	-	-
	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)	Pore water	-	-	A	-	-	A	-	A	-	A	-	-	-	-	-
	QPW1-(1,4,8); 95QW-3(A,C,D); 95QW-4, 95QW-5(A,D)	Groundwater	-	-	A	-	-	A	-	A	-	A	-	-	-	-	-
Panel	P-13[d]	Basin performance (primary), ETP operations	W	D	Q	Q	Q	Q	Q	M	M	Q	Q	-	-	M	M
	ECA-349[d]	ETP operations	-	-	-	-	-	-	-	D	-	-	-	-	-	-	-
	P-14[d,e], P-36d,e	Effluent	-	W	-	M[b]	M[b]	-	M[b]	W	W	M	M[b]	-	W	-	-
	P-15	Perimeter	-	-	-	-	-	-	-	-	-	-	-	M	-	-	-
	P-21	Basin performance (secondary)	M[c]	-	S	-	-	S	-	S	S	S	-	-	-	-	-
	P-16A, P-20, P-31	Groundwater	-	-	A	-	-	A	-	A	-	A	-	-	-	-	-
Lacnor/Nordic	L-03	Basin performance (primary)	M[c]	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	-	-	-	-
	N-17	Basin performance (primary), ETP operations	-	D	Q	Q	Q	Q	Q	M	M	Q	Q	-	-	M	-
	N-18	ETP operations	-	-	-	-	-	-	-	D	-	-	-	-	-	-	-
	N-19	Effluent	-	W	-	M	M	M	M	W	W	M	M	-	W	-	-
	N-22	Basin performance (secondary)	-	M[e]	S	S	S	S	S	S	S	S	S	-	-	-	-
	ECA-132	Basin performance (secondary)	M[c]	M[c]	S	S	S	S	S	M[c]	S	S	S	-	-	-	-
	NWPH	Basin performance (secondary)	-	M[c]	S	S	S	S	S	S	S	S	S	-	-	-	-
	ECA-131, N-20	Basin performance (secondary)	-	-	Q	Q	Q	Q	Q	Q	Q	Q	Q	-	-	-	-
	CPW	Basin performance (secondary)	M[c]	M[c]	S	S	S	S	S	M[c]	S	S	S	-	-	-	-
	UW7-(2,4,6); UW9-(1,2,3)	Pore water	-	-	A	-	-	A	-	A	-	A	-	-	-	-	-
	M-12-(1,3,6,9); M-13-(1,3,6,9); M-14-(1,3,6,9); 95N-4(A,B); 95N-7(A,B); 95N-11; 95N-12(A,B); 95N-13(A,C,E); 95N-14(A,B,C); 95N-16(A,C,E); 95N-17(A,B,C)	Groundwater	-	-	A	-	-	A	-	A	-	A	-	-	-	-	-
Pronto	PR-02[d]	Basin performance (primary), ETP operations	W	D	Q	Q	Q	Q	Q	M	M	Q	Q	-	-	M	M
	PR-03[d]	ETP operations	-	-	-	-	-	-	-	D	-	-	-	-	-	-	-
	PR-04[d]	Effluent	-	W	-	M	M	M	M	W	W	M	M	-	W	-	-

Note: "-" = not required.
[a] D = work days, W = weekly, M = monthly, S = semi-annually, A = annually, Q = quarterly.
[b] Monitoring requirement of SAMP.
[c] During the snow-free period (April - November).
[d] Sampled when treatment plant is operating.
[e] P-14 will revert to P-36 upon ETP shut down.

Table 2.2: Cycle 5 SAMP Stations, Parameters, and Monitoring Frequencies

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

Note: "-" = not required.

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

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

[c] This station is also TOMP effluent station and requirements have been harmonized to serve both programs.

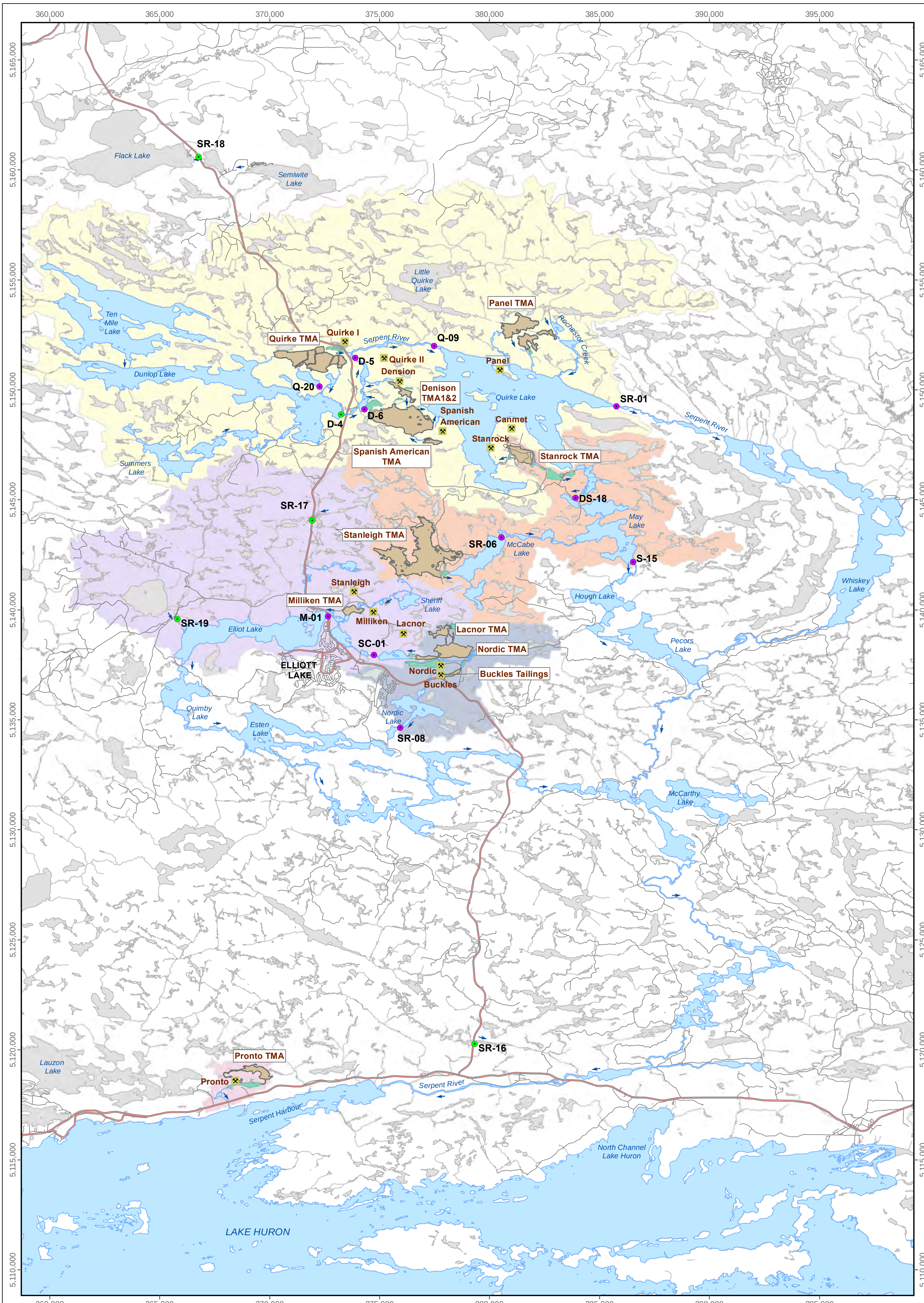
[d] Sampled when effluent treatment plant is operating.

[e] Flow is based on influent flow to the ETP at TOMP station P-13. P-14 will revert to P-36 if effluent treatment plant is shut down permanently or bypassing.

Table 2.3: Cycle 5 SRWMP Water Quality Stations, Parameters, and Monitoring Frequencies

Station Type	Station ID	Location / Description	Type	Parameters and Monitoring Frequencies							
				Barium	pH	Hardness[a]	Iron	Manganese	Radium-226	Sulphate	Uranium
Reference	D-4	Dunlop Lake Outlet (Q-14)	lake	S	S	S	S	S	S	S	S
	SR-19	Inlet to Elliot Lake		Q	Q	Q	Q	Q	Q	Q	Q
	SR-18	Outlet of Jim Christ Lake		S	S	S	S	S	S	S	S
	SR-16	Fox Creek at Highway 108	wetland/ stream	Q	Q	Q	Q	Q	Q	Q	Q
	SR-17	Unnamed Creek Drain Lake 3 at Hwy 108		Q	Q	Q	Q	Q	Q	Q	Q
Mine-exposed	DS-18	Halfmoon Lake Outlet	stream	Q	Q	Q	Q	-	Q	Q	Q
	SR-06	McCabe Lake Outlet	lake	S	S	S	-	-	S	S	S
	SR-15	May Lake Outlet	lake	S	S	S	-	-	S	S	S
	D-6	Cinder Lake Outlet	lake	Q	Q	Q	Q	Q	Q	Q	Q
	D-5	Serpent R between Denison & Quirke TMAs	lake	Q	Q	Q	-	-	Q	Q	Q
	Q-09	Serpent R Below Quirke TMA Effluent	lake	Q	Q	Q	-	-	Q	Q	Q
	Q-20	Evans Lake Outlet to Dunlop Lake	lake	A	A	A	-	-	A	A	A
	SR-01	Quirke Lake Outlet	lake	A	A	A	-	-	A	A	A
	M-01	Sherriff Creek at Highway 108	stream	Q	Q	Q	Q	-	Q	Q	Q
	SC-01	Westner Lake Outlet	stream	A	A	A	A	-	A	A	A
	SR-08	Nordic Lake Outlet	lake	Q	Q	Q	-	-	Q	Q	Q

Notes: "-" = not required. Q = quarterly, S = semi-annually, A = annually.
[a] Hardness is monitored as it is used to determine SRW benchmark for sulphate and manganese.



LEGEND

- Mine Site

Water Quality Monitoring Location

- Mine-exposed
- Reference
- Dam
- Tailings Management Area (TMA)
- Collection Pond / Settling Pond / Holding Pond
- May Lake Watershed
- Quirke Lake Watershed
- Elliot Lake Watershed
- Nordic Lake Watershed
- Pronto TMA Watershed (discharging to nearshore Lake Huron)

SRWMP Water Quality Monitoring Locations

0 2.5 5 10
Kilometers

N E S W

Map Projection: UTM Zone 17 NAD 1983
Data Source: Reproduced under licence from Her Majesty the Queen in Right of Canada, Department of Natural Resources Canada. All rights

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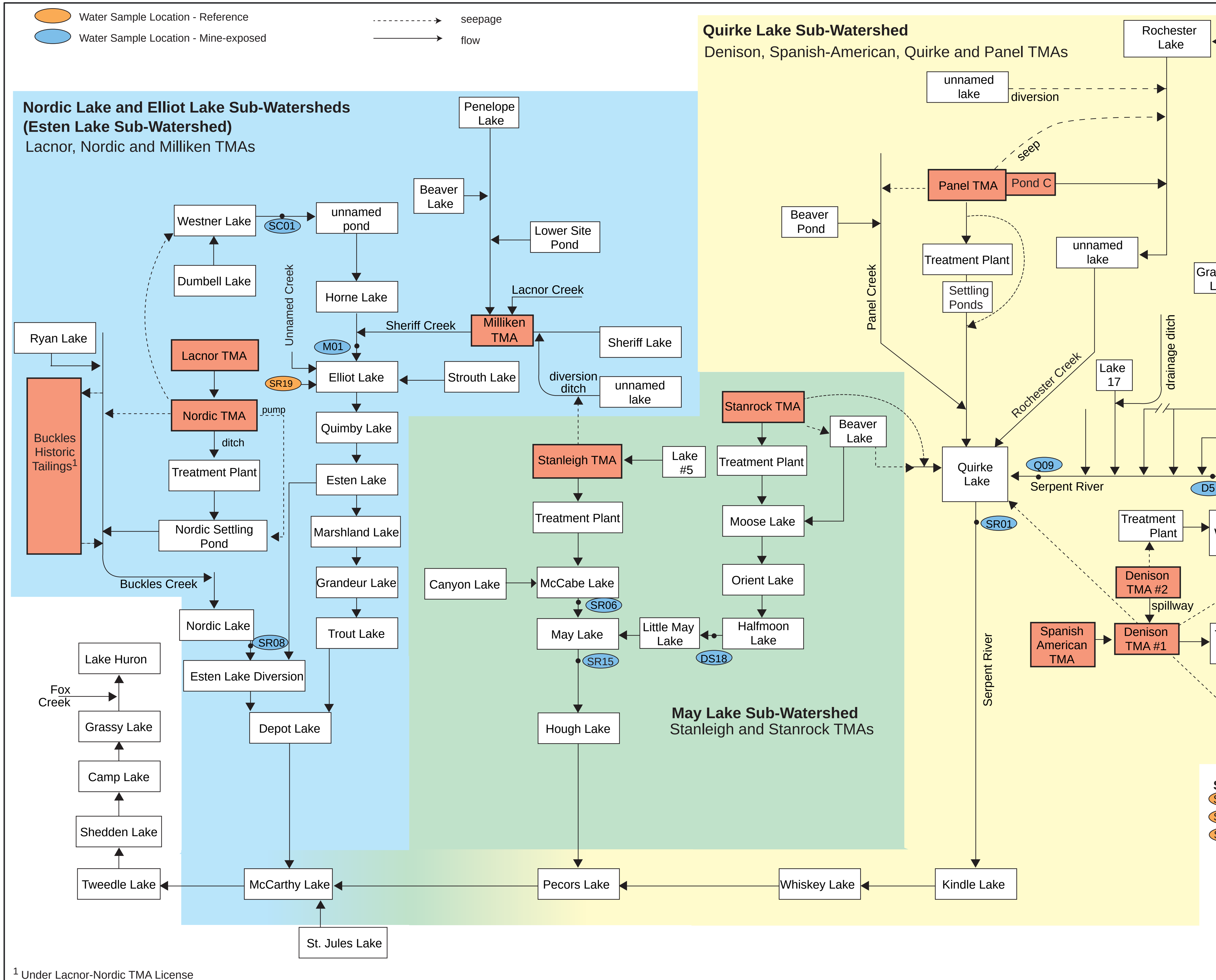
Figure 2.1

Document Path: C:\Users\MLaPalme\Trinity Consultants, Inc\BHP - 197202.0041 - Cycle 5 SOE\4 - GIS\Cycle 5 Report\19-41 Figure 2.1 SRWMP Water Quality Monitoring Locations.mxd



Cycle 5 Water Sample Collection Locations, SRWMP 2015 - 2019

Date: March 2021
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Figure 2.2

Document Path:Trinity Consultants, Inc\BHP - 197202.0041 - Cycle 5 SOE\4 - GIS\Cycle 5 Report\Graphics\19-41 Figure 2.2 Watershed Schematic Version A

Table 2.4: List of Standard Operating Procedures (SOPs) Associated with the Implementation of the TOMP and the SAMP, and Water Quality Component of the SRWMP

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.

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 to 2019 radium-226 was analyzed by the Elliot Lake Research Field Station (ELRFS), currently known as the Perdue Central Analytical Facility (PCAF; Laurentian University, Sudbury, Ontario). All three laboratories are accredited by the Canadian Association for Laboratory Accreditation (CALA)[7]. Water samples for toxicity testing were submitted to AquaTox (Puslinch, ON), for acute (*Daphnia magna* and rainbow trout) and sub-lethal (*Ceriodaphnia dubia*) testing following Environment Canada (2000 and 2007a,b) methods. AquaTox is recognized for Organisation for Economic Co-operation and Development (OECD) Good Laboratory Practice (GLP) compliance by the Standards Council of Canada (SCC).

2.1.2.2 Data Entry and Extraction

Water chemistry data generated as part of the TOMP, SAMP, and SRWMP were entered into an electronic database (emLine) according to specific SOPs designed to minimize data entry errors (Table 2.4; Appendix A). After a sample event was completed, an import file specific to the sample and the parameters required was generated within the emLine database and emailed to the laboratory that would be receiving the sample. The laboratory then populated the import file with the results for that specific sample and emailed it back in an Excel format for upload into the database by DMI. Prior to being accepted in the emLine database, laboratory data were screened against established Data Quality Objectives (DQO). Values exceeding DQA limits were flagged, reviewed, and validated through a quality assurance (QA) process (Table 2.4; Appendix A).

Data retrieval was managed by DMI. From 2015 to 2019, data were retrieved from emLine as needed to meet monthly and annual data regulatory reporting requirements and to satisfy data requests. Since the nature of a data retrieval request can affect the type and configuration of the data reported from emLine, the 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 (RAL 2020). For example, reported annual OCM averages are based on data collected solely for "regulated" monitoring and reporting;

[7] In June 2019, the laboratory accreditation from PCAF (formerly called the ELRFS) was withdrawn by CALA due to previous management not filing the "Management Review" document. However, PCAF continued to maintain and pass regular proficiency testing (PT) for radium analysis, to conduct analysis following the same radium-226 alpha spectrometer SOP method, and to assess all of the same quality control (QC) samples. Since ongoing procedures were identical to those conducted under the accreditation, PCAF continued to meet the requirements for regulatory reporting. Accreditation was formally restored on March 19, 2020 under ISO/IEC:17025-2017 for radium-226 in water and wastewater.

whereas the data extracted for this SOE report included all available data (e.g., also "Internal" and "Special Project" data).

2.1.2.3 Data Quality Control and Assessment

Data quality can be influenced by a variety of factors present in both field and laboratory settings that could lead to reporting data that do not accurately reflect actual environmental conditions. Potential factors influencing data quality can include inconsistencies in sampling or laboratory methods, use of instruments that are inadequately calibrated, use of instruments that cannot measure to the desired level of accuracy, and contamination of samples in the field or laboratory. Depending on the magnitude of a source of error or variability, the reliability of any conclusions made from the data may be affected. Therefore, it is important to ensure that monitoring programs incorporate appropriate steps to control the procedural 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.

The DQOs and procedures (e.g., Operating Procedure PR8.5.4.01 in Appendix A) are used to ensure data generated from these programs are representative of conditions at specific monitoring locations and times. In other words, DQOs determine the level of confidence with which the data can be used to derive conclusions. The DQOs established for the TOMP, SAMP, and SRWMP consider the intended use of the data and the technical feasibility of collecting data of such quality.

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 review was undertaken for the SRWMP, SAMP and TOMP data (Appendix B). Overall, the results of the DQA indicated the quality of the data was sufficient to serve the project objectives.

2.1.3 Data Evaluation

2.1.3.1 TOMP Data Analysis

Tailings Management Area elevations were assessed relative to operating levels specified in site-specific Operating Care and Maintenance Plans (RAL sites) and TMA Operating Manuals (DMI sites). Influent water quality data were compared to the 50-year post-decommissioning EIS predictions (i.e., predictions for the year 2040; RAL 1995, DMI 1995). Effluent water quality data were screened against effluent grab criteria and monthly average discharge criteria.

The TMA effluent treatment facilities in Elliot Lake treat with lime and/or barium chloride, or *ex situ* barite (XSB) in the case of Stanleigh. Lime is added to neutralize acidity and remove metals at most treatment plants, except for Denison TMA 1 and TMA 2. At Denison TMA 1, caustic soda was used briefly during spring freshet in 2017 and 2018 to neutralize acidity; however, currently the treatment plant no longer treats for acidity and caustic soda use has been discontinued. Barium chloride is also added at most treatment plants for removal of radium-226, except for Nordic TMA and Pronto TMA. Reagent use was evaluated relative to treated effluent volume to assess changes in reagent consumption over time. Effluent treatment performance was assessed based on reagent use relative to treated effluent volume as well as changes in reagent consumption over time.

Trends in pore water and groundwater quality data were assessed for the 1990 to 2019 period by testing for a correlation with year using a Kendall correlation test for monotonic trends (see Section 2.1.3.4), as data are collected annually. Trends in TOMP surface water quality data were assessed for the 2003 to 2019 period using the non-parametric seasonal Kendall test (see Section 2.1.3.5), which accounts for seasonal variability. A summary of tables and figures displaying TOMP data is provided in Table 2.5.

2.1.3.2 SAMP Data Analysis

Under the SAMP, discharge surface water quality was assessed based on acute (*Daphnia magna* and rainbow trout) and sub-lethal (*Ceriodaphnia dubia*) toxicity testing, according to Environment Canada (2000 and 2007a,b) methods. Water quality data were also compared to SRWMP benchmarks (Section 2.1.3.3) to identify potential variables or sources of concern relative to the downstream receiving environment; however, it is recognized that mine sources (effluent and seepage) are not expected to achieve benchmarks for receiving environment quality and these benchmarks are not required to be met for discharge to occur. Trends in SAMP water quality data were assessed for 2003 to 2019 using the non-parametric seasonal Kendall test (see Section 2.1.3.5). Annual loadings (from 2015 to 2019) of monitored substances were calculated for direct (controlled) discharge stations and seepage stations and compared to loadings in the receiving environment (see Section 2.1.3.6). A summary of tables and figures displaying SAMP data is provided in Table 2.6.

2.1.3.3 SRWMP Data Analysis

Water quality data from SRWMP stations DS-18 and SR-01 were compared to 1999 and 2099 predicted values (CNSC 2002), whereas data from station SR-06 were compared to 2012 predicted values (SENES 1997) and 2099 predicted values (CNSC 2002). Temporal trends in water quality were assessed for data from 2003 to 2019 using the non-parametric seasonal Kendall test (see Section 2.1.3.5). Although surface water data is available since 2000, trend analysis was only conducted on data collected between 2003 and 2019 to make the assessment

Table 2.5: Location of TOMP Data Tables and Figures Within this Cycle 5 SOE Report

TMA	TOMP Station	Station Type/Purpose	Also a SAMP Station? [a]	Map Figures	Elevation Tables	Elevation Figures	Water Quality Data Tables (flow, acidity, barium, cobalt, iron, manganese, pH, radium-226, sulphate, uranium, conductivity, TSS, and/or treatment chemical consumption)	Comparison to EIS Predictions Figures	Lime or NaOH Consumption Figures	Barium Chloride Consumption Figures	Comparison to Discharge Criteria Figures	Trend Tables	Water Quality Data Figures										
													Acidity	Barium	Cobalt	Iron	Manganese	pH	Radium-226	Sulphate	Uranium	Conductivity	TSS
Stanrock	DS-2	Basin performance (1°), ETP operations	no	3.2	na	na	C.3	na-p	3.5	3.5	na-c	3.4	C.1	C.2	C.3	C.4	C.5	C.6	C.7	C.8	C.9	na	na
	DS-3	ETP operations	no	3.2	na	na	C.4	na-p	na	na	na-c	na-t	na	na	na	na	na	C.18	na	na	na	na	na
	DS-4	Effluent	YES	3.1, 3.2	na	na	C.5	na-p	na	na	3.6, 3.7	3.11	na	M.1	M.2	M.3	M.4	M.5	M.6	M.7	M.8	na	C.20
	DS-1	Additional pH control, radium monitoring	no	3.2	na	na	C.6	na-p	na	na	na-c	na-t	na	na	na	na	na	C.18	C.19	na	na	na	na
	DS-6	Additional pH control	no	3.2	na	na	C.7	na-p	na	na	na-c	na-t	na	na	na	na	na	C.18	na	na	na	na	na
	DS-5	Seepages and surface water internal to TMA	no	3.2	na	na	C.8	na-p	na	na	na-c	na-t	na	na	na	na	na	C.18	na	na	na	C.16	na
	PN-ST3-P(3,5,6,8); BH91-SG2(A,D)	Pore water	no	3.2	na	na	C.9	na-p	na	na	na-c	3.5	C.12	na	na	C.13	na	C.10	na	C.11	na	na	na
	BH91-SG1A, BH98-16A, BH98-15A, BH91-SG3(A,B)	Groundwater	no	3.2	na	na	C.10	na-p	na	na	na-c	3.6	C.16	na	na	C.17	na	C.14	na	C.15	na	na	na
Stanleigh	CL-04	Basin performance (1°), ETP operations	no	3.3	D.7	3.8	D.3	3.9	3.1	3.1	na-c	3.7	D.1	D.2	D.3	D.4	D.5	D.6	D.7	D.8	D.9	na	na
	CL-05	ETP operations	no	3.3	na	na	D.4	na-p	na	na	na-c	na-t	na	na	na	na	na	D.14	na	na	na	na	na
	CL-06	Effluent	YES	3.1, 3.3	na	na	D.5	na-p	na	na	3.11, 3.12	3.11	na	M.1	M.2	M.3	M.4	M.5	M.6	M.7	M.8	na	D.15
	SGW-3, SGW-5	Groundwater	no	3.3	na	na	D.6	na-p	na	na	na-c	3.8	D.10	na	na	D.11	na	D.12	na	D.13	na	na	na
Denison	D-1	Basin performance (1°), ETP operations	no	4.2	E.13	4.6	E.3	4.7	4.8	4.8	na-c	4.6	E.1	E.2	E.3	E.4	E.5	E.6	E.7	E.8	E.9	na	na
	D-25	Basin performance (2°)	no	4.2	na	na	E.4	na-p	na	na	na-c	4.6	E.1	na	na	E.4	na	E.6	E.7	E.8	na	na	na
	D-22	ETP operations	no	4.2	na	na	E.5	na-p	na	4.9	na-c	4.6	E.1	E.2	E.3	E.4	E.5	E.6	E.7	E.8	E.9	na	na
	D-3	Effluent	YES	4.1, 4.2	na	na	E.6	na-p	na	na	4.10, 4.11	4.17	na	N.1	N.2	N.3	N.4	N.5	N.6	N.7	N.8	na	E.14
	D-2	Effluent	YES	4.1, 4.2	na	na	E.7	na-p	na	na	4.12, 4.13	4.17	na	N.1	N.2	N.3	N.4	N.5	N.6	N.7	N.8	na	E.14
	BH91-D1(A,B), BH91-D3(A,B), BH91-DG4B, BH91-D9A	Groundwater	no	4.2	na	na	E.8 to E.12	na-p	na	na	na-c	4.7	E.10	na	na	E.11	na	E.12	na	E.13	na	na	na
Spanish-American	ECA-128	Basin performance (1°)	no	4.1, 4.3	F.3	4.14	F.2	na-p	na	na	na-c	4.8	F.1	F.2	F.3	F.4	F.5	F.6	F.7	F.8	F.9	na	na
Quirke	Cell 14, Cell 15, Cell 16S, Cell 17	Basin performance (2°)	no	4.4	G.21 to G.24	4.15	G.3 to G.6	na-p	na	na	na-c	4.9	G.1	na	na	G.4	na	G.6	G.7	G.8	na	na	na
	Q-05	Basin performance (1°), ETP Influent	no	4.4	G.25	4.15	G.7	4.16	4.18	4.18	na-c	4.9	G.1	G.2	G.3	G.4	G.5	G.6	G.7	G.8	G.9	na	na
	Q-03	ETP operations	no	4.4	na	na	G.8	na-p	na	na	na-c	na-t	na	na	na	na	na	G.18	na	na	na	na	na
	Q-04P	ETP operations	no	4.4	na	na	G.9	na-p	na	na	na-c	na-t	na	na	na	na	na	G.18	na	na	na	na	na
	Q-28	Effluent	YES	4.1, 4.4	na	na	G.10	na-p	na	na	4.19, 4.20	4.17	na	N.1	N.2	N.3	N.4	N.5	N.6	N.7	N.8	na	G.19
	Q-29	Perimeter monitoring	no	4.4	G.26	4.15	G.11	na-p	na	na	na-c	na-t	S	na	na	S	na	S	S	S	na	na	na
	90DK-14-5C; DK15-2(A-D); DK15-4(A-D); DK16-2(A-D); DK17-2(A-D)	Pore water	no	4.4	na	na	G.12 to G.16	4.17	na	na	na-c	4.1	G.10	na	na	G.11	na	G.12	na	G.13	na	na	na
	QPW1-(1,4,8); 95QW-3(A,C,D); 95QW-4; 95QW-5(A,D)	Groundwater	no	4.4	na	na	G.17 to G.20	na-p	na	na	na-c	4.11	G.14	na	na	G.15	na	G.16	na	G.17	na	na	na
Panel	P-21	Basin performance (2°)	no	4.5	H.11	4.21	H.3	na-p	na	na	na-c	4.12	H.1	na	na	H.4	na	H.6	H.7	H.8	na	na	na
	P-13	Basin performance (1°), ETP operations	no	4.5	H.12	4.21	H.4	4.22	4.23	4.23	na-c	4.12	H.1	H.2	H.3	H.4	H.5	H.6	H.7	H.8	H.9	na	na
	ECA-349	ETP operations	no	4.5	na	na	H.5	na-p	na	na	na-c	na-t	na	na	na	na	na	H.15	na	na	na	na	na
	P-14	Effluent	YES	4.1, 4.5	na	na	H.6	na-p	na	na	4.24, 4.25	4.17	na	N.1	N.2	N.3	N.4	N.5	N.6	N.7	N.8	na	H.16
	P-15	Perimeter	no	4.5	na	na	H.7	na-p	na	na	na-c	na-t	na	na	na	na	na	na	na	na	na	H.14	na
	P-16A, P-20, P-31	Groundwater	no	4.5	na	na	H.8 to H.10	na-p	na	na	na-c	4.13	H.10	na	na	H.11	na	H.12	na	H.13	na	na	na
Lacnor/Nordic	L-03	Basin performance (1°)	no	6.2	I.30	6.3	I.3	na-p	na	na	na-c	6.4	I.1	I.2	I.3	I.4	I.5	I.6	I.7	I.8	I.9	na	na
	ECA-132	Basin performance (2°)	no	6.2	I.31	6.3	I.4 to I.5	na-p	na	na	na-c	6.4	I.1	I.2	I.3	I.4	I.5	I.6	I.7	I.8	I.9	na	na
	NWPH	Basin performance (2°)	no	6.2	na	na	I.6 to I.7	na-p	na	na	na-c	6.4	I.1	I.2	I.3	I.4	I.5	I.6	I.7	I.8	I.9	na	na
	N-22	Basin performance (2°)	no	6.2	na	na	I.8 to I.9	na-p	na	na	na-c	6.4	I.1	I.2	I.3	I.4	I.5	I.6	I.7	I.8	I.9	na	na
	CPW	Basin performance (2°)	no	6.2	I.32	6.3	I.10 to I.11	na-p	na	na	na-c	6.4	I.1	I.2	I.3	I.4	I.5	I.6	I.7	I.8	I.9	na	na
	N-20	Basin performance (2°)	no	6.2	na	na	I.12	na-p	na	na	na-c	6.4	I.1	I.2	I.3	I.4	I.5	I.6	I.7	I.8	I.9	na	na
	ECA-131	Basin performance (2°)	no	6.2	na	na	I.13	na-p	na	na	na-c	6.4	I.1	I.2	I.3	I.4	I.5	I.6	I.7	I.8	I.9	na	na
	N-17	Basin performance (1°), ETP operations	no	6.2	na	na	I.14	na-p	6.4	na	na-c	6.4	I.1	I.2	I.3	I.4	I.5	I.6	I.7	I.8	I.9	na	na
	N-19	Effluent	no	6.2	na	na	I.15	na-p	na	na	6.5, 6.6	6.4	na	I.2	I.3	I.4	I.5	I.6	I.7	I.8	I.9	na	I.19
	N-18	ETP operations	no	6.2	na	na	I.16	na-p	na	na	na-c	na-t	na	na	na	na	na	I.18	na	na	na	na	na
	UW7-(2,4,6); UW9-(1,2,3)	Pore water	no	6.2	na	na	I.17 to I.18	na-p	na	na	na-c	6.5	I.10	na	na	I.11	na	I.12	na	I.13	na	na	na
	M-12-(1,3,6,9); M-13-(1,3,6,9); M-14-(1,3,6,9); 95N-4(A,B); 95N-7(A,B); 95N-11; 95N-12(A,B); 95N-13(A,C,E); 95N-14(A,B,C); 95N-16(A,C,E); 95N-17(A,B,C)	Groundwater	no	6.2	na	na	I.19 to I.29	na-p	na	na	na-c	6.6	I.14	na	na	I.15	na	I.16	na	I.17	na	na	na
Pronto	PR-02	Basin performance (1°), ETP operations	no	7.1	J.6	7.2	J.3	na-p	7.4	7.4	na-c	7.3	J.1	J.2	J.3	J.4	J.5	J.6	J.7	J.8	J.9	na	na
	PR-03	ETP operations	no	7.1	na	na	J.4	na-p	na	na	na-c	na-t	na	na	na	na	na	J.10	na	na	na	na	na
	PR-04	Effluent	no	7.1	na	na	J.5	na-p	na	na	7.4, 7.5	7.3	J.1	J.2	J.3	J.4	J.5	J.6	J.7	J.8	J.9	na	J.11

Notes: 1° = primary. 2° = secondary. na = parameter not measured at this station (as per study design); therefore, data presentation is not applicable. na-p = EIS Predictions do not apply to this station (as per study design); therefore, data presentation is not applicable. na-c = discharge criteria do not apply to this station (as per study design); therefore, data presentation is not applicable. na-t = at this station, only one to three parameters (elevation, pH, flow, conductivity, and/or radium-226) are monitored to support ETP operations. Other stations provide more meaningful information regarding trends for these parameters; therefore, data presentation is not applicable.

[a] Data for this TOMP station also pertain to the SAMP. Trends are assessed in the SAMP section and water quality figures are provided in the SAMP section (Table 2.6).

Table 2.6: Location of SAMP Data Tables and Figures Within this Cycle 5 SOE Report

TMA	Location	Type	Description	Also a TOMP or SRWMP Station?	Map Figures	Water Quality Data Tables (barium, cobalt, hardness, iron, manganese, pH, radium-226, sulphate, and/or uranium)	Flow Data Tables	Flow Data Figures	Toxicity Data Tables	Trend Tables	Water Quality / Trend Figures	Loadings Tables	Loadings Figures	Percent Contribution to Loadings Figures	TMA Plant Operations Tables
Stanrock	DS-4	Principal	Orient Lake Outlet (Final Discharge Point)	TOMP	3.1, 3.2	M.2	M.2	M.9	3.9	3.11	M.1 to M.8	M.7	M.10, M.11	M.10	M.5
	DS-16	Drainage	Quirke Lake Delta	no	3.1, 3.2	M.3	M.3	N.8	na	4.17	N.1 to N.8	N.20	M.10, N.13		M.5
Stanleigh	CL-06	Principal	Final Treated Effluent	TOMP	3.1, 3.3	M.4	M.4	M.9	3.1	3.11	M.1 to M.8	M.7	M.11	na-l	M.6
Denison	D-2	Principal	Stollery Lake Outlet (Final Discharge Point)	TOMP	4.1, 4.2	N.2	N.2	N.8	4.14	4.17	N.1 to N.8	N.21	N.10, N.13	N.10	N.16, N.17
	D-3	Principal	TMA-2 Effluent (Final Discharge Point) at Denison Mine access road	TOMP	4.1, 4.2	N.3	N.3	N.8	na	4.17	N.1 to N.8	N.21	N.10, N.13		N.16, N.17
	D-9	Seepage	Seepage at Dam 17	no	4.1, 4.2	N.4	N.4	N.8	na	4.17	N.1 to N.8	N.21	N.10, N.13		N.16, N.17
	D-16	Seepage	Seepage at Dam 9	no	4.1, 4.2	N.5	N.5	N.8	na	4.17	N.1 to N.8	N.21	N.10, N.13		N.16, N.17
Quirke	ECA-398	Seepage	Quirke II north of access road	no	4.1, 4.3	N.6	N.6	N.8	na	4.17	N.1 to N.8	N.22	N.11, N.13	N.11	N.18
	Q-22	Drainage	Quirke II Drainage south of access road	no	4.1, 4.3	N.7	N.7	N.8	na	4.17	N.1 to N.8	N.22	N.11, N.13		N.18
	Q-23	Drainage	Swamp Outlet west of Dam K1	no	4.1, 4.3	N.8	N.8	N.8	na	4.17	N.1 to N.8	N.22	N.11, N.13		N.18
	Q-27	Seepage	Dam J Toe Seepage	no	4.1, 4.3	N.9	N.9	N.8	na	4.17	N.1 to N.8	N.22	N.11, N.13		N.18
	Q-28	Principal	Final Treated Effluent	TOMP	4.1, 4.3	N.10	N.10	N.8	4.15	4.17	N.1 to N.8	N.22	N.11, N.13		N.18
Panel	P-02	Seepage	Downstream of Dam B	no	4.1, 4.4	N.11	N.11	N.8	na	4.17	N.1 to N.8	N.23	N.12, N.13	N.12	N.19
	P-03	Drainage	Beaver Pond C Outlet	no	4.1, 4.4	N.12	N.12	N.8	na	4.17	N.1 to N.8	N.23	N.12, N.13		N.19
	P-05	Drainage	Swamp Outlet north of Dam E	no	4.1, 4.4	N.13	N.13	N.8	na	4.17	N.1 to N.8	N.23	N.12, N.13		N.19
	P-11	Drainage	Panel Creek Outlet at Quirke Lake	no	4.1, 4.4	N.14	N.14	N.8	na	4.17	N.1 to N.8	N.23	N.12, N.13		N.19
	P-14	Principal	Final Treated Effluent	TOMP	4.1, 4.4	N.15	N.15	N.8	4.16	4.17	N.1 to N.8	N.23	N.12, N.13		N.19
Milliken	MPE	Principal	Milliken Park Effluent	no	5.1, M.12	O.2	na	na	5.3	5.4	O.1 to O.8	O.3	O.9	na-l	na-m
Nordic	WL-4	Seepage	Seepage to Westner Lake from Coffer Pond	no	6.2, 5.1	P.2	na	na	na	5.4	O.1 to O.8	na	P.10	na-l	P.4
	N-12	Principal	Buckles Creek at Highway 108	no	6.1, 7.2	P.3	P.3	P.9	6.7	6.8	P.1 to P.8	P.5	P.10		P.4
Pronto	LL-01	Drainage	Pronto Creek at Inlet to Lake Lauzon	no	7.1	Q.2	Q.2	Q.9	na	7.5	Q.1 to Q.8	Q.5	7.7, Q.10, Q.11	Q.10	Q.4
	PR-01	Principal	Pronto Discharge Channel at Highway 17	no	7.1	Q.3	Q.3	Q.9	7.4	7.5	Q.1 to Q.8	Q.5	7.7, Q.10, Q.11		Q.4
Reference	SR-16	Reference	Fox Creek at Highway 108	SRWMP	2.2	S.4	na	na	na	na-r	S.1 to S.6	na-r	na-r	na-r	na-r
	SR-17	Reference	Unnamed Creek from Lake Three at Highway 108	SRWMP	2.2	S.4	na	na	na	na-r	S.1 to S.6	na-r	na-r	na-r	na-r

Notes: na = parameter not measured at this station (as per study design); therefore, data presentation is not applicable. na-r = data presentation not provided for reference SAMP station. na-l = percent contribution to loadings is not assessed for this TMA, as either there is only one station, or loadings are only measured at one station. na-m = not applicable, as Milliken TMA does not have an Effluent Treatment Plant (ETP).

period consistent with the TOMP and SAMP surface water data analyses. Annual loadings (from 2015 to 2019) of monitored substances were calculated at SRWMP stations downstream of mine discharge in the SRW (see Section 2.1.3.6). A summary of the tables and figures displaying SRWMP water quality data is provided in Table 2.7.

Water quality data were also compared to benchmarks established for the SRWMP[8] (Table 2.8, Appendix Tables S.1 and S.2). The radium-226 SRWMP benchmark is a site-specific dose-based water quality objective which was derived for the protection of aquatic life[9] (EcoMetrix 2019; Table 2.8), and is a lower concentration (i.e., more conservative) than the Provincial Water Quality Objective (PWQO). For other parameters, the benchmarks used for comparison were either water quality guidelines (WQGs) or the upper limit of background (i.e., reference concentrations), whichever was higher; see Appendix Table S.1 for details.

To calculate the upper limit of background, reference stations were pooled into two groups, based on the two main habitat categories present, as these habitats typically have differing water quality, particularly for parameters (e.g., iron) that can be influenced by the dissolved oxygen and the organic content of surface waters. The reference stations were grouped into: (1) stations located at lake outlets ("lake stations", stations SR-16 and SR-17) and (2) stations located downstream of shallow basins with wetland habitats ("wetland stations", D-4, SR-18, and SR-19). Upper limit of background concentrations for lake stations were used for screening mine-exposed stations D-5, D-6, Q-09, Q-20, SR-01, SR-06 and SR-08, where background concentration was higher than a parameter's WQG. Upper limit of background concentrations for wetland stations were used for screening mine-exposed stations M-01, DS-18, and SC-01, where background was higher than a parameter's WQG. Benchmark background water quality values were estimated as the upper 95th percentile of values collect from 2015 to 2019. If data were censored at the laboratory reporting limit (LRL), percentiles were calculated using the Kaplan-Meier (K-M) method using the survfit() function in the survival package (Therneau 2017) in R (R Core Team 2019) and following the methods described in (Helsel 2012). The method involved

[8] Within the Cycle 5 SOE report (herein), the 2015 to 2019 SRWMP water quality data were compared to the new Cycle 5 SRWMP benchmarks, as per the newest study design (Minnow 2019), which was approved in March 2020. These data have also been reported quarterly and annually, with data compared to SRWMP benchmarks from the Cycle 4 SOE report (Minnow 2017). Therefore, the Cycle 5 SOE may show a different number of values that exceed the benchmark, as compared to quarterly and annual reporting.

[9] The radium-226 SRWMP site-specific benchmark was the lowest (i.e., most conservative) concentration of radium-226 in water that would correspond to a calculated dose equal to aquatic biota, riparian wildlife, or generic human receptor dose benchmarks (UNSCEAR 2008 and ICRP 2007). Doses were calculated using radionuclide concentrations measured in samples of water, sediment, aquatic plants, benthic invertebrates, and fish collected from each of the lakes (McCabe, May, Elliot, Nordic, and Quirke),

Table 2.7: Location of SRWMP Water Quality Data Tables and Figures Within this Cycle 5 SOE Report

Station Type	Station	Location / Description	Habitat Type	Water Quality Data Tables (barium, pH, iron, manganese, radium-226, sulphate and/or uranium)	Water Quality / Trend Figures							Trend Tables	Loadings Tables	Loadings Figures	Comparison to EIS Predictions Figures
					Barium	pH	Iron	Manganese	Radium-226	Sulphate	Uranium				
Reference	D-4	Dunlop Lake Outlet (Q-14)	lake	S.3	S.1	S.3	S.2	S.10	S.4	S.5	S.6	3.12	N.21	4.12	na-p
	SR-19	Inlet to Elliot Lake	lake	S.3	S.1	S.3	S.2	S.10	S.4	S.5	S.6	3.12	na-l	na-l	na-p
	SR-18	Outlet of Jim Christ Lake	lake	S.3	S.1	S.3	S.2	S.10	S.4	S.5	S.6	3.12	na-l	na-l	na-p
	SR-16	Fox Creek at Highway 108	wetland/stream	S.4	S.1	S.3	S.2	S.10	S.4	S.5	S.6	3.12	na-l	na-l	na-p
	SR-17	Unnamed Creek Drain Lake 3 at Hwy 108	wetland/stream	S.4	S.1	S.3	S.2	S.10	S.4	S.5	S.6	3.12	na-l	na-l	na-p
Mine-exposed	DS-18	Halfmoon Lake Outlet	wetland/stream	S.5	S.1	S.3	S.2	na	S.4	S.5	S.6	3.12	M.7	3.14	3.15
	SR-06	McCabe Lake Outlet	lake	S.6	S.1	S.3	na	na	S.4	S.5	S.6	3.12	M.7	3.14	3.16
	SR-15	May Lake Outlet	lake	S.7	S.1	S.3	S.2	na	S.4	S.5	S.6	3.12	M.7	3.14	na-p
	D-6	Cinder Lake Outlet	lake	S.8	S.8	S.11	S.9	S.10	S.12	S.13	S.14	4.18	N.21	4.12	na-p
	D-5	Serpent R between Denison & Quirke TMAs	lake	S.9	S.8	S.11	na	na	S.12	S.13	S.14	4.18	N.21, N.22	4.12	na-p
	Q-09	Serpent R Below Quirke TMA Effluent	lake	S.10	S.8	S.11	na	na	S.12	S.13	S.14	4.18	N.21, N.22, N.23	4.12	na-p
	Q-20	Evans Lake Outlet to Dunlop Lake	lake	S.11	S.8	S.11	na	na	S.12	S.13	S.14	4.18	N.22	4.12	na-p
	SC-01	Westner Lake Outlet	wetland/stream	S.14	S.16	S.18	S.17	na	S.19	S.20	S.21	5.5	O.3	5.3	na-p
	M-01	Sherriff Creek at Highway 108	wetland/stream	S.13	S.16	S.18	S.17	na	S.19	S.20	S.21	5.5	O.3	5.3	na-p
	SR-01	Quirke Lake Outlet	lake	S.12	S.8	S.11	na	na	S.12	S.13	S.14	4.18	N.23	4.12	4.28
	SR-08	Nordic Lake Outlet	lake	S.15	S.23	S.24	na	na	S.25	S.26	F.27	6.9	P.5	6.8	na-p

Notes: na = parameter not measured at this station (as per study design); therefore, data presentation is not applicable. na-p = EIS Predictions do not apply to this station (as per study design); therefore, data presentation is not applicable. na-l = loadings not presented for reference stations.

Table 2.8: SRW Water Quality Benchmarks, SRWMP, Cycle 5

Parameter	Units	SRW Benchmark[a]	
		Lakes[b]	Stream / Wetlands[c]
Barium	mg/L	1	
Iron	mg/L	0.755	2.49
Manganese	mg/L	0.841	
pH	pH units	6.5	5.30
Radium-226	Bq/L	0.469	
Sulphate	mg/L	128 to 429	
Uranium	mg/L	0.015	

Benchmark applied to the lake stations (D-5, D-6, Q-09, Q-20, SR-01, SR-06, SR-08, SR-15).

Benchmark applied to the stream/wetland stations (i.e., stations located downstream of shallow basins with wetland habitats; M-01, DS-18, SC-01).

[a] See report Section 2.1.3.3 and Appendix Tables S.1 and S.2 for details regarding benchmark selection. The barium benchmark is the BC working WQG (BC EVN 2020). Iron and pH benchmarks are calculated based on reference concentrations, see footnotes b and c. The radium-226 benchmark is a site-specific dose-based water quality objective which was derived for the protection of aquatic life (EcoMetrix 2019). The manganese benchmark is the BCWQG (BC ENC 2019), which is hardness-dependent and calculated based on the average hardness at station D-6 (the only mine-exposed station where manganese is monitored). The sulphate benchmarks is the BCWQG (BC ENC 2019), which is hardness-dependent and is calculated for each station based on the average hardness at that station (see Appendix Table S.2).

[b] The upper limit of background concentration (95th percentile) was calculated using data collected from lake reference stations (D-4, SR-18, and SR-19) from 2015 to 2019 (Appendix Table S.3).

[c] The upper limit of background concentration (95th percentile) was calculated using data collected from reference stations located downstream of shallow basins that have wetland habitats (SR-16 and SR-17) from 2015 to 2019 (Appendix Table S.4).

transforming the left censored (i.e., < value) dataset to a right censored (i.e., > value) dataset, and then using the K-M estimator. The method used the distribution of values below a detection limit to represent a non-detected value. For example, the maximum value in a data set with values <2, 3, 4, <5, 6, 7, and <10, would be 7 (instead of <10) and the median would be 4 (instead of <5). When a greater proportion of the data was below the LRL than the percentile being estimated, the K-M method in R does not provide an estimate for that percentile. Instead, a ‘maximum’ percentile was calculated by replacing values with their detection limit and calculating the percentiles using the quantile function in R (type 7). If the estimated quantile was between values in the dataset, the higher value was reported as the percentile as ‘<’ the value.

2.1.3.4 Pore Water and Groundwater Trends

Trends in pore water and groundwater quality data were assessed by testing for a correlation between water quality and year for each station. Because some parameters contained values below the LRL, the correlations were tested using a Kendall’s Tau correlation test. The Kendall’s correlation coefficient is a measure of the strength and direction of the association between two variables and can be used to test for monotonic trends. The coefficient utilizes pairwise ranks among years thereby allowing for LRLs to be incorporated by using tied ranks in the significance test for unknown comparisons (i.e., <0.5 may or may not be lower than <1 and thus would be included as a tie in the test). The trend analysis was only conducted where a minimum number of four years of data were present, and correlations were considered significant at α = 0.05. Any stations with > 50% of data having values below the LRL were not tested for trends. The slope was reported as a percentage change of the median value per year.

2.1.3.5 Surface Water Trends

Trends in surface water quality data were assessed using the non-parametric seasonal Kendall test described by Hirsch et al. (1982). This approach accommodates values below the LRL. The tests were conducted using R software (R Core Team 2019). The seasonal Kendall test assessed temporal trends separately for each season (or month in this case) and combined the results for each season into an overall test for trend. The test is non-parametric and assessed whether there is a monotonic increasing or decreasing trend over time. The test was conducted by calculating the test statistic i, which is equal to the sum of the number of increases and decreases from a time period t to all time periods after t for each observation in season i. The overall test statistic S was computed as the sum of i for all seasons. If the number of pairwise comparisons was less than 45, the significance of the observed S was determined by comparing it to a critical value of S (at the significance level α = 0.05) determined from the exact sampling distribution of S (calculated by determining all possible permutations and combinations of S based on the increases and decreases from the number of pairwise comparisons made;

Hirsch et al. 1982). If more than 45 pairwise comparisons were made (equivalent to the number of pairwise comparisons for n = 10 in a single season), then the normal approximation was used to calculate a p-value and to assess significance (Hirsch et al. 1982). The standard normal deviate Z was calculated as:

$$Z = \begin{cases} \frac{S-1}{\sqrt{\sigma_S}} if\ S > 0 \\ 0 \quad if\ S = 0 \\ \frac{S+1}{\sqrt{\sigma_S}} if\ S < 0 \end{cases}$$

where:

- $\sigma_S = \sum_{i=1}^{k} \frac{n_i(n_i-1)(2n_i+5) - \sum_{T_i} t_i(t_i-1)(2t_i+5)}{18}$,
- n_i was the number of samples in month i,
- t_i was the number of tied values for each tied value T_i, and
- k was the number of seasons (Hirsch et al. 1982).

An estimate of the trend slope over time was determined by computing the median of all slopes between data pairs within the same month (Helsel and Hirsch 2002). The slope was reported as a percentage change of the median value per year. The intercept of a line through the time series was estimated as the median intercept of all lines through each point with the estimated slope (Pohlert 2016). The trend analysis was conducted with a minimum number of five pairwise comparisons, which is the minimum number required for all consecutive increases or decreases to be significant at α = 0.05.

2.1.3.6 Loadings Estimates

Annual loadings (from 2015 to 2019) of monitored substances were calculated for:

- TMA direct (controlled) discharge SAMP stations (Section 2.1.3.2);
- TMA seepage SAMP stations (Section 2.1.3.2); and
- Downstream locations within the Serpent River Watershed (Section 2.1.3.3).

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 below the LRL 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 (2015 to 2019). Spot flow and concentration data measured during discharge periods at the main TMA discharge locations (2015 to 2019) were used to calculate daily loads (kilograms per day [kg/day] or Becquerels per day [Bq/day]). Daily loads were summed to estimate annual loads for each variable. In some instances, flows were measured more frequently than concentrations, in which case concentrations from the most recent preceding measurement were applied to subsequent flows. The daily loadings were summed and weighted appropriately to approximate annual discharge loads (i.e., if weekly flows and concentrations were measured, the resulting daily loads were first multiplied by seven to approximate weekly discharge then summed to approximate annual discharge).

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 (2015 to 2019) for the same station to roughly estimate annual loads for each variable.

Loadings were also estimated for 12 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 of the locations (Table 2.10). Mean annual flow was determined for each year (2015 to 2019) at each location and pro-rated flow estimates were multiplied by mean annual concentrations to roughly estimate annual loads at SRW monitoring stations.

2.2 Sediment Quality

2.2.1 Overview

Sediment samples were collected between September 17 and September 25, 2019 as part of the Cycle 5 SRWMP, consistent with the timing of previous field programs. The samples were collected from eight lakes, four of which were reference lakes (Figure 2.3). Five stations were sampled in each lake (Appendix Table T.1; Appendix Figures T.1 to T.8).

2.2.2 Sample/Data Collection

Where possible, samples were collected from the same locations sampled in previous cycles. An average depth of 15 m was targeted for sample collection, although some stations were positioned at depths slightly shallower or deeper to ensure that comparable substrates were sampled across lakes.

Table 2.9: Non-point Source Discharge Design and Measured Flow Values

TMA	SAMP Station	Description	Receiver	Design Flow (L/sec)	Measured Flow Data							Design Flow Reference
					Mean (L/sec)	Minimum (L/sec)	Maximum (L/sec)	SD	Count	Length of Record		
										Starting Date	Final Date	
Panel	P-02	Seepage from Dam B	Rochester Creek	2	1.00	<1.00	1.00	-	20	26-Jan-15	07-Oct-19	Table 6.2.4 of Quirke & Panel EIS[b]
	P-03	Pond C discharge	Rochester Creek	10.7	9.55	1.30	40.5	11.3	19	26-Jan-15	07-Oct-19	
	P-11	Site drainage	Panel Creek P-26	NA	36.6	<1.00	125	39.3	13	26-Jan-15	07-Oct-19	
Quirke	ECA-398	Site drainage	Serpent River Upstream of Q-09	[d]	1.12	0.100	3.60	1.17	17	09-Feb-15	07-Oct-19	Table 6.2.2 of Quirke & Panel EIS[b]
	Q-22	Site drainage	Serpent River Upstream of Q-09	[d]	12.3	0.600	62.3	14.3	20	09-Feb-15	07-Oct-19	
	Q-23	Swamp Downstream of Dam K	Dunlop Lake	[d]	80.3	1.10	507	119	17	09-Feb-15	07-Oct-19	
	Q-27	Seepage from Dam J	Evans Lake	0.1	no flow data							
Milliken	All sources captured through monitoring at MPE thus no non-point source discharge											
Stanleigh[a]	All sources captured through monitoring at CL-06 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	6.55	0.770	23.0	6.54	20	11-Feb-15	13-Nov-19	Table 6.2.2 of Denison & Stanrock EIS[c]
Denison	D-3	Lower Williams Lake Discharge	Serpent River Upstream of D-5	0.3	12.1	<1.00	149	21.5	222	06-Jan-15	30-Dec-19	
	D-9	Seepage at Dam 17	Quirke Lake	3.4	2.19	0.173	5.70	1.38	20	13-Jan-15	08-Oct-19	
	D-16	Seepage at Dam 9	Quirke Lake	0.3	1.40	0.230	5.00	1.28	20	13-Jan-15	08-Oct-19	
Stanrock	DS-16	Drainage from Dam G and J	Quirke Lake	0.7	2.82	0.200	19.4	4.30	54	14-Apr-15	03-Dec-19	Table 6.2.2 (Dams B, C, D) of Denison & Stanrock EIS[c]

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

Notes: NA - not available. "-" - not applicable.

[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 (RAL 1995).

[c] Table 6.2.2 - Estimated Long Term Values (DMI 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.

Table 2.10: Watershed Areas and Prorated Flow Estimates[a] for Stations within the Serpent River Watershed, 2015 to 2019

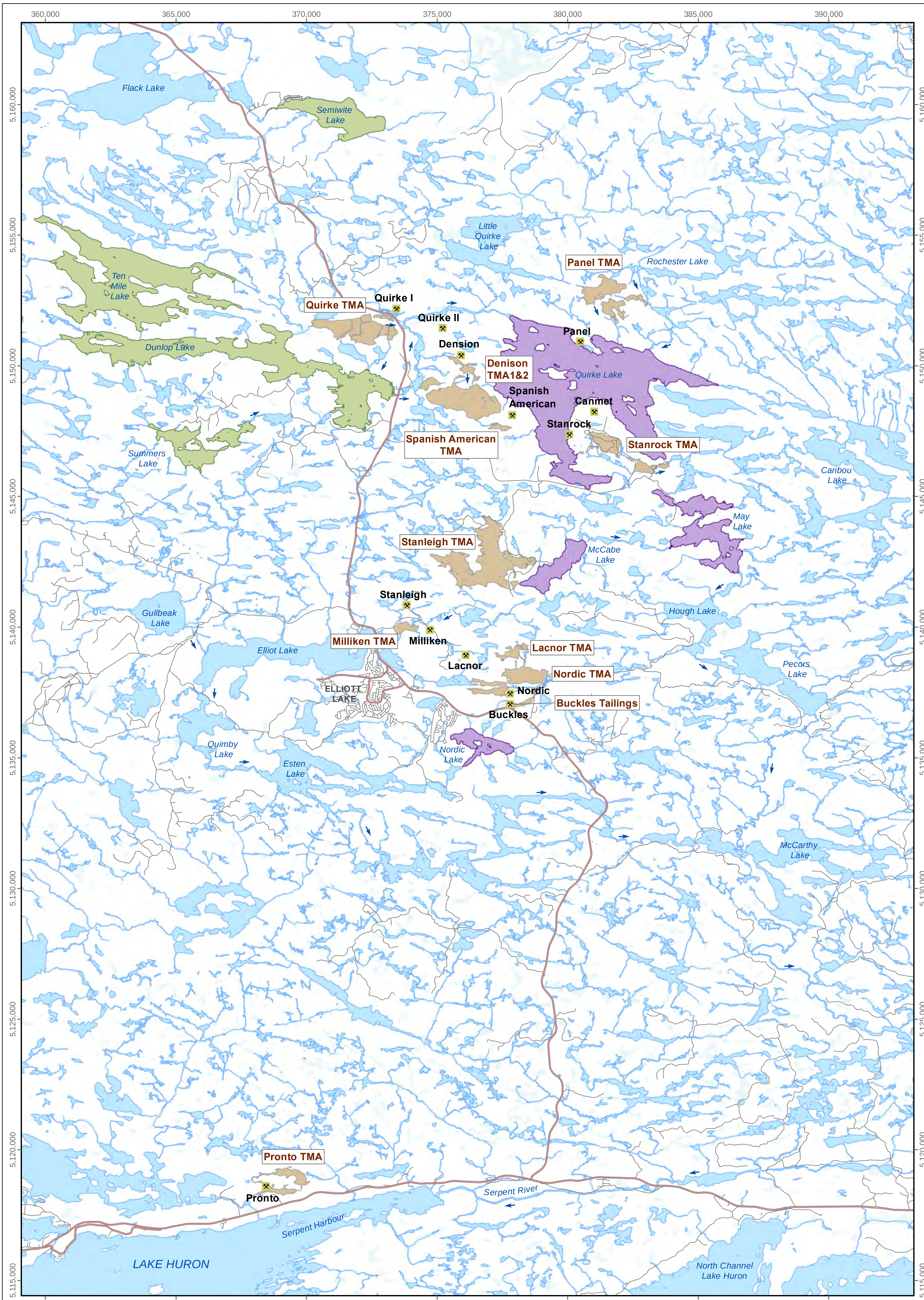
Station ID	Station Type[a]	Description	Watershed Area (km^2)	Mean Flow (L/s)[b]						Drainage Area Source
				2015	2016	2017	2018	2019	Mean Annual Flow	
SR-16	Ref	Fox Creek at Hwy 108	5.6	74	65	109	77	121	89	OMNRF LIO 2015
SR-17	Ref	Unnamed Creek d/s of Lake 3 at Hwy 108	14.5	191	168	282	199	312	230	OMNRF LIO 2015
SR-18	Ref	Outlet of Jim Christ Lake	28.8	380	334	559	394	621	458	OMNRF LIO 2015
SR-19	Ref	Inlet of Elliot Lake	38.4	507	445	746	526	828	610	OMNRF LIO 2015
SR-01	Exp	Quirke Lake Outlet	319	4,209	3,701	6,197	4,367	6,875	5,070	WSC (02CD003)
M-01	Exp	Elliot Lake Inlet	18.56	245	215	361	254	400	295	Senes 2007[c]
P-05	SAMP	Swamp Outlet north of Dam E	2.0	26	23	39	27	43	32	OMNRF LIO 2015
Q-20	Exp	Evans Lake Outlet	1.08	14	13	21	15	23	17	S. Kam e-mail June 14th 2007
DS-18	Exp	Halfmoon Lake Outlet	11.6	153	135	225	159	250	184	Table 6.3.3 Denison & Stanrock EIS
SR-06	Exp	McCabe Lake Outlet	32.8	433	381	637	449	707	521	Senes 2007[c]
SR-15	Exp	May Lake Outlet	72.2	953	839	1,402	988	1,556	1,148	OMNRF LIO 2020
SR-08	Exp	Nordic Lake Outlet	32.3	426	375	627	442	696	513	Senes 2007[c]
D-6	Exp	Outlet of Cinder Lake	4.13	54	48	80	57	89	66	Topo map 41 J10
D-4	Ref	Outlet of Dunlop Lake	109	1,438	1,265	2,117	1,492	2,349	1,732	WSC (02CD002)
MPE	SAMP	Outlet of Sherriff Creek Park	13.5	178	157	262	185	291	215	Golder 2004
Q-09	Exp	Quirke Lake Inlet	157	2,072	1,821	3,050	2,149	3,384	2,495	WSC (02CD006)
-	Exp	Serpent River @ Hwy 17	1,350	19,465	16,765	27,395	17,363	29,003	21,998	WSC (02CD001)
D-5	Exp	Serpent River downstream of Denison	118	1,557	1,369	2,292	1,615	2,543	1,875	Table 6.3.3 Denison & Stanrock EIS
SC-01	Exp	Westner Lake Outlet	2.37	31	27	46	32	51	37	Golder 2004

Notes: 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] Ref = reference station. Exp = mine-exposed station. SAMP = SAMP station.

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



LEGEND

- Mine Site
- Reference Sediment Quality and Benthic Invertebrate Community Monitoring Area
- Mine-exposed Sediment Quality and Benthic Invertebrate Community Monitoring Area
- Tailings Management Area (TMA)

Sediment Quality and Benthic Invertebrate Community Monitoring Areas, SRWMP

0 2.5 5 10
km

N E S W

Map Projection: UTM Zone 17 NAD 1983
Data Source: Reproduced under licence from Her Majesty the Queen in Right of Canada, Department of Natural Resources Canada. All rights

Date: March 2021
Project 197202.0041

minnow environmental inc.

Figure 2.3

Document Path: C:\Users\MLaPalme\Trinity Consultants, Inc\BHP - 197202.0041 - Cycle 5 SOE\4 - GIS\Cycle 5 Report\19-41 Figure 2.3 Sediment Quality and Benthic Invertebrate Community Monitoring Areas, SRWMP.mxd

Two types of sediment samples were collected at each station: one sample for metal concentrations and radium-226 analysis, and a second sample for total organic carbon (TOC) and particle size distribution analysis. Sediment samples for analysis of metal and radium-226 concentrations were collected using a Tech-Ops corer equipped with a 4-inch diameter cellulose acetate butyrate (CAB) core tube, to allow for precision sampling of the top 1-cm of sediment. The use of the 4-inch corer necessitated taking a minimum of three cores to meet minimum sample volume requirements for chemical analyses. The corer was deployed from a boat with care taken to control the rate of descent and to maintain the corer in a vertical position during ascent. After the corer penetrated the sediment, it was carefully pulled to the water surface where an extruder was inserted into the bottom of the core tube. Core samples were rejected if there was evidence that the core did not adequately penetrate the substrate or if there was evidence of disturbance of the sediment-water interface.

Water in the core tube was decanted with a siphon hose prior to extruding sediments. Siphoning was stopped when there was approximately 2 to 3 cm of water remaining above the sediment surface. The core extruder was used to push sediments upwards towards the top of the core tube in a controlled fashion with care taken to minimize suspension of fines. If sediment resuspension started to occur, extruding was stopped to allow solids to re-settle. Once the sediment was near the top of the tube, an extrusion collar marked in 1 cm intervals was carefully aligned on the top of the tube and the sediment was extruded upwards to a depth of 1 cm. A core slicer was then carefully inserted between the tube and the collar, and the sample was transferred from the slicer to labelled Ziploc bags. Duplicate side-by-side sediment subsamples were collected for 10% of all sediment samples as a quality control measure.

After sampling for metal and radium-226 concentrations was complete, additional sediment samples were collected for analysis of TOC and particle size using a petite Ponar grab sampler. A petite Ponar was used rather than a corer, as much larger sample volumes were needed. Surficial sediment (i.e., top 3 cm) was carefully removed from each of two intact grabs using a stainless-steel spoon and composited into a Ziploc bag. Supporting data were collected (see Section 2.4).

Sediment samples collected for metals, radium-226, TOC, and particle size analyses were submitted to Bureau Veritas Laboratories in Mississauga, ON. Sediments collected for metal content were digested in a mixture of hydrochloric acid, nitric acid, and reverse osmosis de-ionized water then analyzed by inductively coupled plasma mass spectrometry (ICP-MS). Sediment samples for radium-226 analysis were digested using nitric, hydrochloric, and hydrofluoric acids then analyzed for radium-226 activity using alpha spectroscopy. Particle size was analyzed using sieve and hydrometer methods while TOC was analyzed using a LECO Carbon Analyzer.

2.2.3 Data Evaluation

Sediment quality data were plotted over time and compared to SRWMP benchmarks. Benchmarks were selected as the higher of: (1) the lower and severe effect levels of Provincial Sediment Quality Guidelines (PSQG) for iron and manganese (OMOE 1993) and guidelines proposed by Thompson et al. (2005) for nickel, uranium, and radium-226, or (2) the upper limit of background (reference areas; Table 2.11; Appendix Table T.2). The upper limit of background was calculated each cycle following the collection of reference sediment samples within the SRWMP. The upper limit of background was estimated as the upper 95th percentile of values collected across all reference area replicates. If data were censored at the LRL, percentiles were calculated using the K-M method as described in Section 2.1.3.3. For the Cycle 5 SOE interpretive report, the upper limit of background was calculated using data collected in September 2019.

In addition to these benchmarks, lake-specific dose-based radium-226 benchmarks were also used for evaluation of sediment quality from a dose-based perspective (Table 2.11; EcoMetrix 2019). Dose-based sediment benchmarks were applied on a lake-by-lake basis, as sediment chemistry (Minnow 2011) and sediment deposition rates (Minnow 2013) vary from lake to lake.

Within each lake, a one-way analysis of variance (ANOVA) with a Year term was conducted on metal concentrations in sediment to investigate temporal differences among years. Where appropriate, concentrations were $\log_{10}$ transformed to better meet model assumptions of normality and equal variances. When these assumptions could not be met or concentrations included values below the LRL, the analysis was conducted on ranks. When the Year term was significant (P-value <0.05), post-hoc contrasts were performed as all pairwise comparisons between years within each lake and adjusted using Tukey's Honestly Significant Differences. Magnitudes of Difference (MOD) where determined using the back-transformed measures of central tendency (MCT) and calculated as: $(MCT_{2019}-MCT_{earlier\ year})/MCT_{2019} \times 100\%$. Measures of central tendency were calculated as means, geometric means, and medians for ANOVAs conducted with untransformed, $\log_{10}$ transformed, and rank transformed data.

2.3 Benthic Invertebrate Community

2.3.1 Overview

Benthic invertebrate samples were collected between September 17 and September 25, 2019 as part of the Cycle 5 SRWMP, consistent with the timing of previous field programs. The samples

Table 2.11: Sediment Benchmarks, SRWMP Cycle 5

Parameter	Units	Upper Limit of Background[a] (2015 to 2019)	Thompson et al. (2005)		Lake-specific Dose-based Radium-226 Benchmark (EcoMetrix 2019)			
			LEL	SEL	McCabe Lake	May Lake	Quirke Lake	Nordic Lake
Barium	mg/kg	795	-	-	-	-	-	-
Cobalt	mg/kg	29.0	-	-	-	-	-	-
Iron	mg/kg	108,000	-	-	-	-	-	-
Manganese	mg/kg	15,200	-	-	-	-	-	-
Nickel	mg/kg	29.5	na-t	484.0	-	-	-	-
Uranium	mg/kg	na-b	104.4	5,874.1	-	-	-	-
Radium-226	Bq/g	na-b	0.60	14.40	46.4	9.56	20.6	39.8

Note: For additional information regarding the upper limit of background values and applicable environmental criteria, see Appendix Table T.2. "-" = not available / not applicable. na-t = Thompson et al. (2005) LEL is less than the upper limit of background, therefore not used for assessment. na-b = upper limit of background is less than Thompson et al. (2005) LEL, therefore not used for assessment.

[a] The upper limit of background is estimated as upper 95th percentile of values collected across all reference area replicates (see Section 2.2.3).

were collected from eight lakes, four of which were reference (Figure 2.3). Five stations were sampled in each lake (Appendix Table T.1). The samples were collected from the same locations as sediment samples (Section 2.2.2) so that the BIC could be considered relative to sediment quality.

2.3.2 Sample/Data Collection

Benthic invertebrate samples were collected using a petite Ponar (0.023 m^2). Collected sediments were transferred to a 250 µm sieve bag and rinsed with site water to remove sediment particles. Reduced samples were then transferred to 1-L wide-mouth plastic jars and were preserved to a level of 10% buffered formalin in ambient water within approximately eight hours of collection to ensure that organisms were not lost through predation or decomposition. An internal label was placed into each sample bottle to ensure correct sample identification. Supporting data were collected (see Section 2.4).

Benthic invertebrate samples were submitted to ZEAS in Nobleton, Ontario. Upon arrival at the ZEAS laboratory, samples were checked to ensure that they were adequately preserved in the field and clearly and correctly labelled. Prior to detailed sorting, the samples were washed free of formalin and stained to aid in sorting recovery. The sample material retained was sorted with the aid of a stereomicroscope at a magnification of ten times. Benthic invertebrates were sorted from the debris into major taxonomic groups (i.e., order or family levels) and placed in vials containing 70% ethanol. The benthic invertebrates were then identified to the lowest practical level, which in most cases was genus or species, and enumerated by a senior taxonomist.

The laboratory quality assurance / quality control (QA/QC) indicated that the contents of two of the Nordic Lake samples (stations NL-1 and NL-3) indicated an issue with the preservative[10], based on the odour and on the stringy characteristic of the worms in the sample, which suggested degradation of benthic invertebrate tissues. Consequently, these samples were not included in the benthic invertebrate community analysis, as data were considered unreliable.

2.3.3 Data Evaluation

Benthic invertebrate community data evaluation included:

- Statistical comparisons of communities downstream of mine discharges relative to reference communities based on key benthic community metrics (i.e., density, number of taxa, percent composition of major taxonomic groups, and first three Correspondence Analysis [CA] axes);

[10] Due to Covid-19 related delays, the sample assessment by the laboratory occurred later than typical. Sitting for this extra duration may have contributed to the preservative issue.

- Correlation analysis of benthic invertebrate metrics and physical-chemical variables to identify potential relationships that might explain differences in the benthic invertebrate communities, and
- Statistical comparisons of Cycle 5 data to results from Cycles 3 (2009), 2 (2004), and 1 (1999).

Benthic invertebrate community data were assessed as part of a comprehensive data quality review to verify overall data quality prior to their use in data analysis (Appendix B).

Benthic invertebrate communities were evaluated using summary metrics including invertebrate density (number of organisms per m^2) and taxon richness based on Lowest Practical Level (LPL) taxonomy. Benthic invertebrate community data at LPL can contain a mixture of taxonomic levels (e.g., species, family, order, and class), which can affect the calculation of metrics such as taxon richness. To address this issue, a decision key was applied to the benthic invertebrate data to reassign taxon abundance across levels of taxa, while conserving the proportional abundances within the higher taxon levels (see Appendix R text and Appendix Figure R.1 for details). For each benthic sample, total organism density (individuals/m^2) was calculated based on the known area sampled (i.e., 0.232 m^2). Following application of the decision key, the benthic invertebrate metrics were calculated for each area and year, and the following summary statistics were reported for each metric by area and year: sample size, mean, median, minimum, maximum, and standard deviation. Percent composition was calculated for major taxonomic groups.

Analyses were conducted on BIC to investigate spatial and temporal trends. Endpoints were transformed to better meet model assumptions; density and richness were $\log_{10}$-transformed, and percent composition endpoints were $\log_{it}$-transformed. Transformed endpoints were analyzed using a two-way ANOVA with Lake and Year terms. This model was used to calculate planned contrasts of each exposed lake against the pooled reference lakes in each year and thus, these contrasts were not adjusted for multiple comparisons (i.e., Pagano 2013, Tucker 1991, Wang 1993). The MCTs were calculated as back-transformed estimated marginal means from the full ANOVA model. Magnitudes of difference were calculated based on differences in MCTs of each mine-exposed lake to the pooled reference mean in each year, divided by the standard deviation of the residuals of the full ANOVA model. Additional post-hoc contrasts were performed as all pairwise comparisons between years within mine-exposed lakes. Each MOD was calculated as the difference in MCTs between each year, and the earliest year of data for each mine-exposed lake. P-values were adjusted using Tukey's Honestly Significant Differences. These analyses were done on two datasets, one including Rochester Lake, and one excluding it.

Correspondence analysis was used to further examine benthic invertebrate community structure. Correspondence analysis is a multivariate ordination method that is used to reduce complex multivariate data into a smaller number of independent variables (Gauch 1982; Pielou 1984). The analysis extracts theoretical values (CA axis scores) that capture the variation in the abundance of benthic taxa. The CA ordination produces axis scores for each station as the sum of a weighted average of species proportions. Taxa scores were also produced as the sum of weighted averages of their abundances across stations. The structure of the data was then depicted in scatterplots of one CA axis against another, showing both taxa and station scores. Taxa that tended to co-occur plot together and those that rarely co-occurred plotted farther apart. Similarly, stations sharing many taxa plotted closer to one another, while those with few in common plotted farther apart. Thus, CA was used to describe which benthic invertebrate taxa best accounted for observed differences in the overall benthic invertebrate community between stations and/or areas.

Several CAs were conducted to identify patterns across stations within the 2019 sampling period, and to identify patterns within lakes over time (1999 to 2019, where available). The CA analysis was conducted at the LPL of taxonomic organization using $\log_{10}(x+1)$ transformed density data. Correspondence analysis is sensitive to the presence of rare taxa (Legendre and Legendre 1983; Poos and Jackson 2012). Taxa occurring in fewer than five samples, or those that made up less than 1% of the total density of the dataset were excluded from the analysis (Dolédec and Chessel 1991). The ordination was conducted using the cca() function in the vegan package (Oksanen et al. 2017) of R statistical software (R Core Team 2019). Results of the CA were summarized by area and year, including sample size, mean, median, minimum, maximum, and standard deviation. Taxa with the highest magnitude weights on the CA axes were identified and used in interpretation of the separation of stations on the CA axes. Statistical analyses of CA axis scores were conducted separately for the 2019 sampling period, and the individual exposed lakes over time. Analysis of the 2019 CA was conducted as a one-way ANOVA, with post-hoc comparisons between each exposed lake mean, and the pooled reference lake mean similar to the between lake contrasts of the other endpoint comparisons above. Analysis of temporal CAs was conducted as one-way ANOVAs similar to the temporal contrasts of the other endpoint comparisons above with pairwise comparisons between years conducted as all pairwise contrasts using Tukey's Honestly Significant Differences.

2.4 Sediment and BIC Supporting Data

At each station, Global Positioning System (GPS) coordinates, weather, and habitat descriptions were recorded. *In situ* measurements of water temperature, dissolved oxygen, pH, and specific conductance were taken at the top and bottom of the water column at all sediment sampling stations, and as a vertical profile of one metre intervals at three of every five sediment sampling stations. *In situ* measurements were collected using a handheld YSI 556 MPS Multiprobe unit. Meter readings of pH and specific conductance were checked against standard solutions daily and were calibrated as necessary. Dissolved oxygen concentration readings were checked and calibrated daily against atmospheric readings.

2.5 Public Dose

2.5.1 Overview

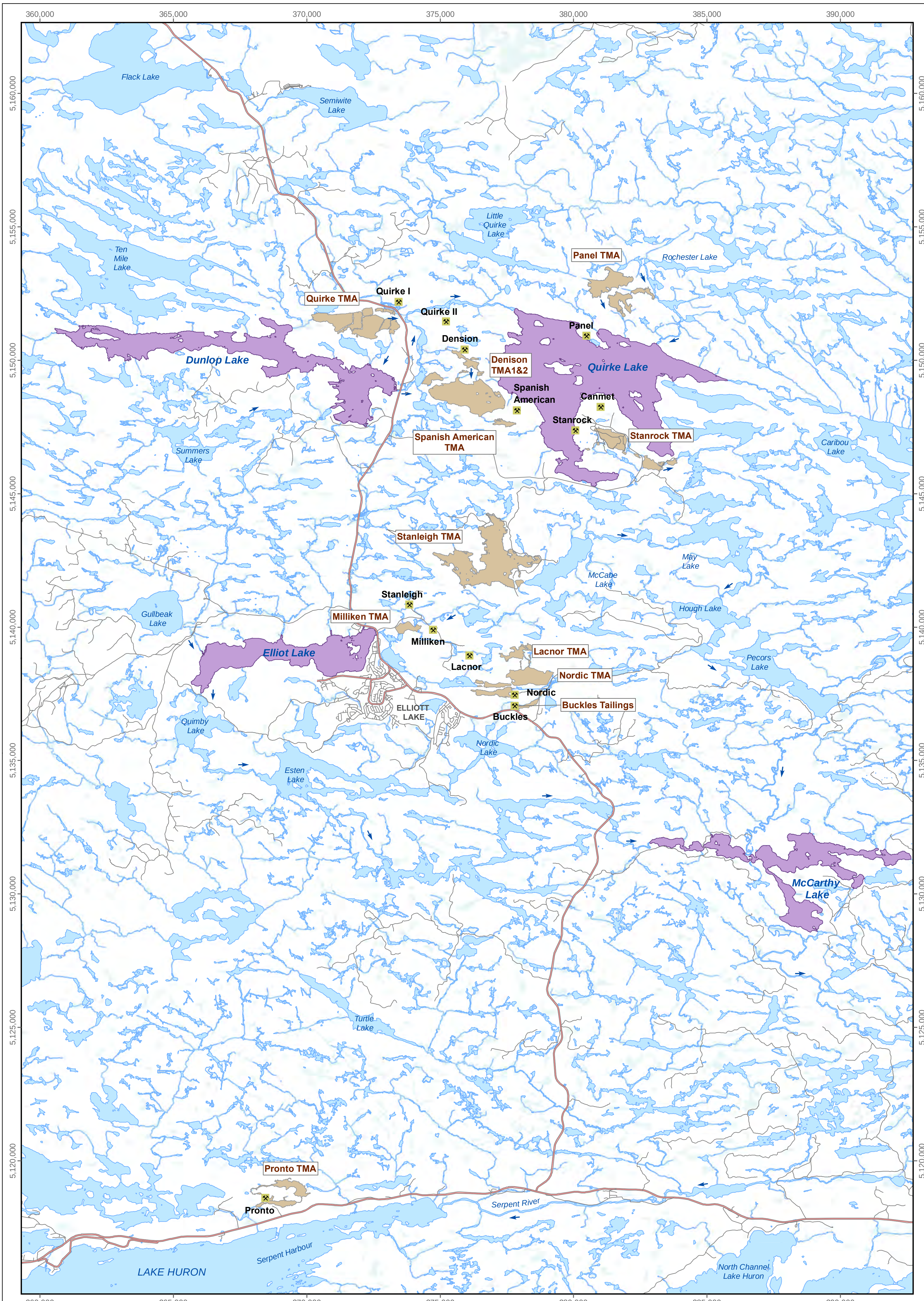
Sportfish tissue samples were collected between September 17 and September 21, 2019 as part of the Cycle 5 special investigation to update the estimated radiation dose to the public associated with the closed Elliot Lake mine sites in the SRW. The dose estimate was updated based on concentrations of radionuclides in sportfish collected in 2019.

2.5.2 Sample/Data Collection

The special investigation targeted commonly consumed species: primarily lake trout and walleye, or, where unavailable, smallmouth bass and northern pike in mine-exposed Elliot, McCarthy, and Quirke lakes, with Dunlop Lake serving as reference (Figure 2.4). A total of five individual fish were collected per lake to provide muscle tissue volume for analysis. A second piece of tissue (split sample) was collected for 10% of samples collected (i.e., two sets) as quality control duplicates.

Lakes were sampled using experimental gill nets and hoop nets. Gill nets were 1.8 m tall (6’), 30.48 m (100’) long, and had mesh sizes ranging from 7.6 cm to 10.1 cm (3” to 4”). Hoop nets had 15 m (50’) leads and 5.1 cm (2”) mesh sizes. Nets were set overnight (up to an approximate maximum duration of 24 hours). For each net set, information including duration of sampling, sampling depth range, GPS coordinates, and habitat descriptions were recorded.

Upon retrieval of each net, captured fish were identified to species and enumerated. Bycatch were released, and fish retained for sampling were euthanized and processed. Fish retained for sampling were subject to measurement of fork and total length to the nearest millimetre using a standard measuring board. Following length measurements, target fish were weighed using Pesola™ spring scales (Pesola AG, Baar Switzerland) demarcated at intervals of 1 to 2% of the total scale range and providing accuracy of ± 0.3% of the fish mass. The Pesola™ spring scale was selected so that the fish weight was near the top of the scale’s range to ensure that measurements achieved a resolution near 1%. All non-target fish were released near the location of capture.



LEGEND

- Mine Site
- Fish Sampling Lake
- Tailings Management Area (TMA)

Lakes Where Fish Tissue was Collected for the Public Dose Estimation Update

0 2.25 4.5 9
km

N W E S

Map Projection: UTM Zone 17 NAD 1983
Data Source: Reproduced under licence from Her Majesty the Queen in Right of Canada, Department of Natural Resources Canada. All rights

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Figure 2.4

Document Path: C:\Users\MLaPalme\Trinity Consultants, Inc\BHP - 197202.0041 - Cycle 5 SOE\4 - GIS\Cycle 5 Report\19-41 Figure 2.4 Lakes Where Fish Tissue was Collected for the Public Dose Estimation Update.mxd

Tissue samples were placed in labelled Whirl-Pak™ bags and frozen for shipment to the Saskatchewan Research Council (SRC) laboratory in Saskatoon, SK for analysis of radionuclides (i.e., uranium-nat, thorium-230, radium-226, lead-210, and polonium-210) and moisture content.

2.5.3 Data Evaluation

A detailed description of the method used to estimate dose and risk to human receptors is provided in Appendix U (EcoMetrix 2020).

3 MAY LAKE SUB-WATERSHED

3.1 Background

3.1.1 May Lake Sub-Watershed

The May Lake sub-watershed is within the SRW and has an approximate area of 72 km^2 (Figure 2.1). May Lake is a large (318 ha) deep lake (maximum depth of 47 m) that consists of three distinct basins. The lake receives discharges from two TMA facilities: Stanrock and Stanleigh (Figure 3.1). Stanrock TMA final effluent discharges to Halfmoon Lake and then flows into the north basin of May Lake via Little May Lake (Figures 3.1 and 3.2). Both Halfmoon and Little May Lake are small, shallow lakes compared to May Lake. Stanleigh TMA final effluent discharges into McCabe Lake and then flows into the middle basin of May Lake via McCabe Creek (Figures 3.1 and 3.3).

3.1.2 Stanrock TMA

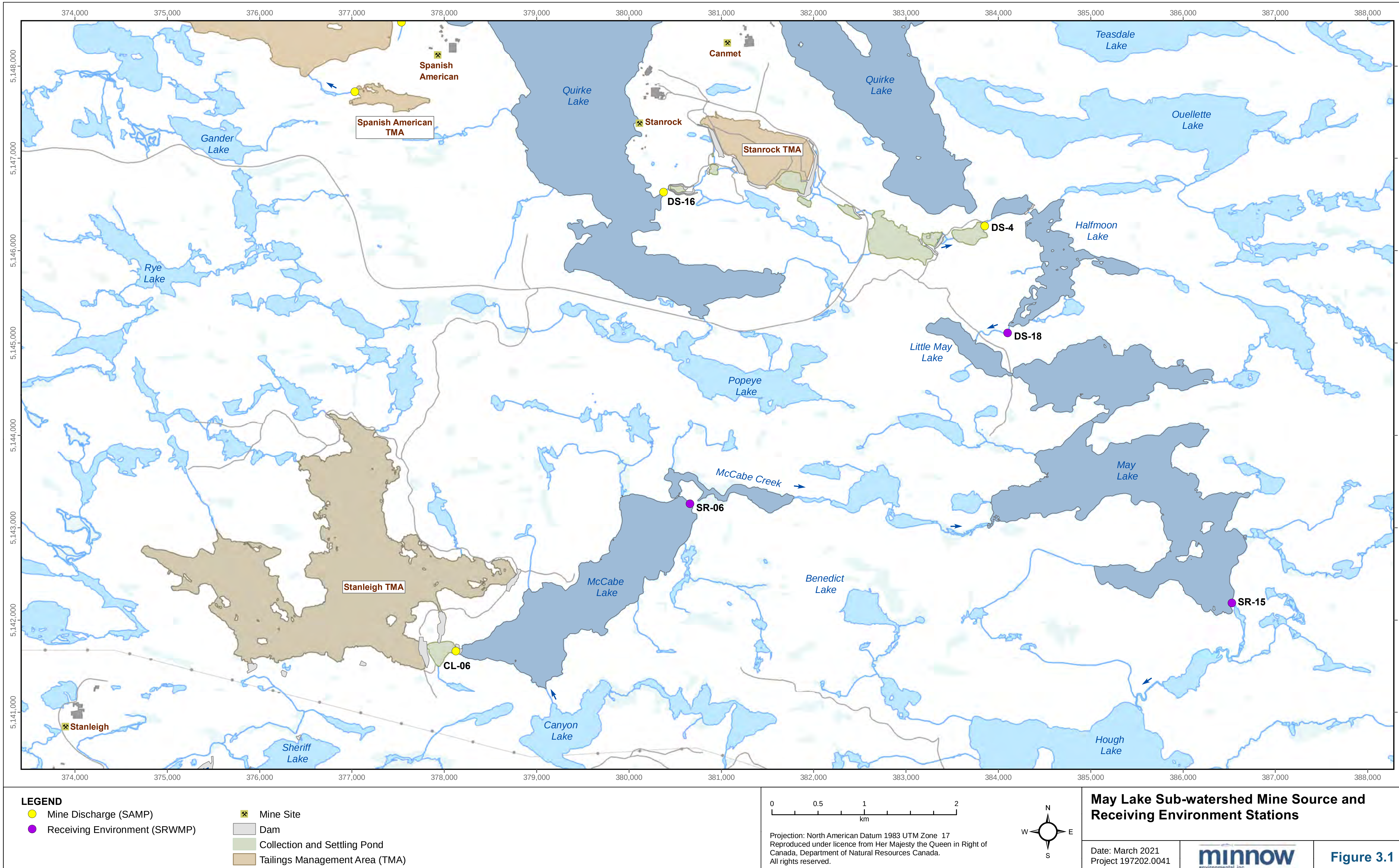
3.1.2.1 Site History

The Stanrock Mine, located 11.5 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 3.2). Approximately 5.7 million tonnes of tailings were produced and stored within the 52 ha 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. Numerous site improvements have been made since the tailings were vegetated in 1999 to control flows and water levels, contain historical tailings spills and to treat seepage and site water (Table 3.1).

3.1.2.2 Conceptual Hydrogeologic Model

Water is generally not impounded in the Stanrock TMA, but instead drains from the surface and is managed and collected through on-site ditching and collection ponds (Figure 3.2). Overburden in the vicinity of the Stanrock TMA is limited and generally restricted to topographic lows. As such, any overburden under the TMA is expected to be discontinuous, with most of the groundwater flowing through preferential pathways in the shallow and more permeable bedrock (Golder 2020; Appendix L). Groundwater flow directions are controlled by bedrock ridges, which direct flow through troughs and valleys that surround the TMA. Groundwater flow is mostly inward toward the TMA along the north perimeter, and outward



May Lake Sub-watershed Mine Source and Receiving Environment Stations

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Figure 3.1

Document Path: C:\Users\MLaPalme\Trinity Consultants, Inc\BHP - 197202.0041 - Cycle 5 SOE\4 - GIS\Cycle 5 Report\19-41 Figure 3.1 May Lake Sub-Watershed Mine Source and Receiving Environment Stations.mxd

LEGEND

Monitoring Station

- SAMP Surface Water
- TOMP Surface Water
- TOMP Groundwater
- TOMP Pore Water
- SAMP and TOMP Surface Water
- Gate
- Flow Station or Weir
- Pipeline
- Siphon Line
- Collection and Settling Pond
- Vegetated Tailings
- Contour (10 m)

0 200 400 800
Meters

N E S W

Projection: North American Datum 1983 UTM Zone 17
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Stanrock Site SAMP and TOMP Monitoring Stations

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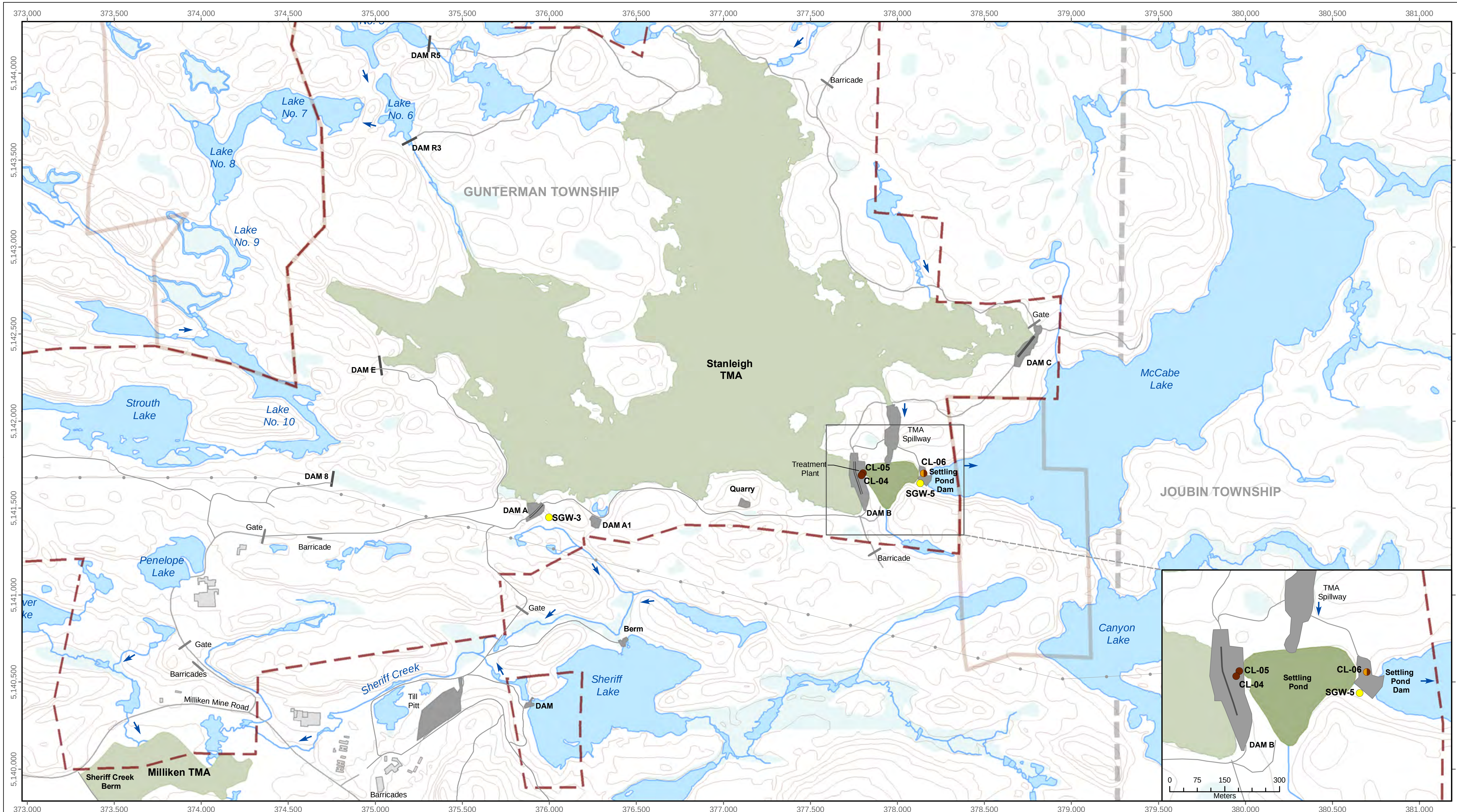
Figure 3.2

Document Path: C:\Users\MLaPalme\Trinity Consultants, Inc\BHP - 197202.0041 - Cycle 5 SOE\4 - GIS\Cycle 5 Report\19-41 Figure 3.2 Stanrock Site SAMP and TOMP Monitoring Stations.mxd



LEGEND

Monitoring Station

- SAMP Surface Water
- TOMP Surface Water
- TOMP Groundwater
- SAMP and TOMP Surface Water

- Water Covered Tailings
- Treatment Solids

- Limits of CNSC Licence
- Limits of Unlicenced Property
- Dam
- Contour (10 m)

0 350 700 1,400
Meters

N E S W

Projection: North American Datum 1983 UTM Zone 17
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Stanleigh Site SAMP and TOMP Monitoring Stations

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Figure 3.3

Document Path: C:\Users\MLaPalme\Trinity Consultants, Inc\BHP - 197202.0041 - Cycle 5 SOE\4 - GIS\Cycle 5 Report\19-41 Figure 3.3 Stanleigh SAMP and TOMP Monitoring Stations.mxd

Table 3.1: 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 3.1: 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.
2016	Protective canopies over the main and side doors at ETP.	Protect against falling ice.
	Cell booster installed at ETP.	Better cell service for communications.
2017	Staff gauge installed at the influent to the Halfmoon Wetland.	Monitor the Halfmoon dam water levels based on downstream beaver activity.
	Reagent tanks rotated.	Allow easier and safer access to valves.
2019	Clearing of debris accumulated throughout the ditch drainage systems on the TMA.	Ditch clearing was completed to improve drainage from the TMA and better convey water to the head pond and treatment plant.

Notes: TMA = tailings management area. ETP = effluent treatment plant. SCADA = supervisory control and data acquisition.

through topographic lows located along the southeast, south, and west perimeters. Seepage from Dam A flows to the southeast, where it reports to surface and subsequently flows through a spillway toward the effluent treatment plant (ETP) Holding Pond for treatment at the ETP, located to the southeast of the TMA (Figure 3.2). Along the western side of the Stanrock TMA, groundwater flow from Dam B and Dam C reports to the seepage collection pond that is upstream of Dam G (Dam G Collection Pond). Seepage from Dam G reports to surface to the southwest, where it is collected in the Runoff Collection Pond upstream of Dam M and pumped back to the Dam G Collection Pond. Water from the Dam G Collection Pond is pumped to the Dam A spillway where it flows downstream to the ETP Holding Pond. Treatment at the ETP includes both lime and barium chloride additions to decrease acidity and radium-226, respectively. Treated effluent is discharged from the ETP into the Moose Lake Settling Pond (Figure 3.2).

Measured groundwater elevations and inferred hydraulic gradients surrounding Dam D suggest that groundwater seepage beneath the dam reports to the south to Beaver Lake where it ultimately reports to the Moose Lake Settling Pond (Figure 3.2; Golder 2020; Appendix L). The Moose Lake Settling Pond flows into the Orient Lake Polishing Pond for further polishing and eventually flows into Halfmoon Lake, which is the first downstream receiver after the final point of control (DS-4, Orient Lake Outlet).

3.1.3 Stanleigh TMA

3.1.3.1 Site History

The Stanleigh Facility operated from 1954 to 1960 and from 1983 to 1996, at which time mining operations ceased after uranium deliveries under contract to Ontario Hydro were completed. The mine complex included an underground mine, a mill, and a TMA. The TMA was constructed in the basin formerly known as Crotch Lake, and received mill process tailings from ore originating at both the Stanleigh Facility and the nearby Milliken Mine. In total, approximately 20 million tonnes of tailings and waste rock were deposited to the Stanleigh TMA.

In the mid-1960's, a lime and barium chloride addition treatment plant was constructed at the outlet of the TMA West Arm from which treatment solids were directed to what is now the South Arm for settling prior to effluent discharge to McCabe Lake through a concrete structure upstream of the current Dam B (Figure 3.3). As part of the Stanleigh Facility mill reactivation in the early 1980's, Dams 9, 10, R3, and R5 were constructed north and west of the basin to divert non-contact surface water from the TMA and reduce the TMA watershed size from 22 km^2 to 13.3 km^2. 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 (Figure 3.3).

In 1981, the original treatment plant was replaced with a reagent addition building and complex sand filtration ETP built at the TMA outlet (i.e., Dam B; Figure 3.3) that operated until 1999 when, as part of the facility decommissioning following mine closure in 1996, the perimeter dams were raised to allow basin flooding between 1998 and 2002. During this time, treatment of TMA supernatant included neutralization by lime slurry addition to reduce acidity and metal concentrations, but no effluent was released to McCabe Lake from the basin. Numerous site improvements have been made since 1988 (when the TMA perimeter dams were raised to allow basin flooding) to control flows and to treat site water (Table 3.2). Beginning in 2003, water from the flooded TMA was siphoned over Dam B and treated in the sand filtration ETP prior to being released to McCabe Lake. During the operation of the sand filtration ETP, the system was back washed into the TMA (from 1981 to 1999 and then again from 2002 to 2007), resulting in the South Arm of the TMA also containing treatment solids.

In 2007, the sand filtration ETP was replaced with a conventional lime slurry/barium chloride treatment system. The barium chloride was added in the presence of relatively high sulphate concentrations in the TMA water (influent to the treatment plant), allowing the precipitation of barium sulphate (barite) in the Settling Pond, which was added to remove radium-226. The Settling Pond is located downstream of the treatment plant for removal of solids, and there is a Decant Channel for effluent discharge to McCabe Lake. Since the transition to the conventional radium-226 treatment system, seasonal spikes in radium were observed in the treated effluent (monitoring at station CL-06; see also Section 3.3.2.4 and Appendix K). Therefore in 2018, the treatment reagents were adjusted so that preformed barite was added to the influent water (as opposed to allowing barite to form in the Settling Pond). This adjustment has allowed larger barite particles to form and resulted in a decrease in effluent radium-226 concentrations.

3.1.3.2 Conceptual Hydrogeologic Model

The Stanleigh TMA is situated in a valley that is surrounded by bedrock ridges that ultimately control the prevailing groundwater flow and seepage pathways (Golder 2020; Appendix L). Groundwater recharge occurs at these bedrock ridges, with groundwater flow mostly occurring as inward pathways reporting to the TMA through shallow and fractured bedrock. Seepage through and beneath Dams A, A1, B, and C are the primary pathways where groundwater flow exits the TMA (Figure 3.3). Effluent seepage from Dams A and A1 reports to the south to Sheriff Creek, which flows into the Milliken TMA, located within the Elliot Lake sub-watershed (Section 5). Seepage from Dams B and C flows to the east and reports to

Table 3.2: 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 to 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.
2017	Addition of a zero permeability baffle curtain downstream of the ETP discharge to the Settling Pond.	To force water to flow under the curtain, thus increasing flow dispersion throughout the water column, increasing hydraulic retention time, improving radium removal.
2018	Stanleigh effluent treatment plant retrofit for use of preformed barite.	To allow for the use of preformed barite to treat for radium and maintain effluent discharge quality within compliance limits.
2019	Removed the temporary flocculation system and replaced it with a lime tank should lime addition be required.	The flocculation system was previously used as a part of a series of pilot tests used to improve radium treatment performance. The flocculation system is no longer required.
	ETP back-up generator was taken out of service.	Mitigate environmental risk of diesel to treated water in the ETP.

Notes: TMA = tailings management area. ETP = effluent treatment plant.

McCabe Lake, which flows into May Lake. The ETP is located at Dam B, and effluent from the Stanleigh ETP flows to the Settling Pond (to facilitate/promote particle settling) and then into the associated Decant Channel prior to discharge to McCabe Lake (Figure 3.3). The Settling Pond is contained by two dams. The Settling Pond water level can be controlled by means of a stoplog structure incorporated at the head of the Decant Channel, which also provides an additional 50,000 L of storage capacity in the Settling Pond (if needed). A stilling basin is located at the outlet of the Decant Channel to minimize turbulence and the potential for erosion of the bottom substrate in McCabe Lake (the effluent receiver).

3.2 Applicable Monitoring Programs

The existing monitoring programs applicable to the May Lake sub-watershed include:

- The TOMP (Minnow 2019), which includes effluent compliance monitoring requirements, designed to track TMA performance and support decisions regarding the management of the TMAs (Stanleigh Facility surface water stations CL-04, CL-05, and CL-06, and groundwater stations SGW-3 and SGW-5; Stanrock Facility surface water stations DS-1 through DS-6, pore water monitoring stations PN-ST3-P3,5,6,8; BH91-SG2A,D, and groundwater monitoring stations BH91-SG1A, BH98-16A, BH98-15A, BH91-SG3A,B; Figures 3.2 and 3.3; Table 3.3; Appendix Table C.1);

- The SAMP (Minnow 2019), which focuses on monitoring stations that represent the final points of release from each closed mine facility to the watershed, developed to monitor the nature and quantity of constituents being discharged (Stanleigh Facility station CL-06 and Stanrock Facility station DS-4[11]; Figures 3.2 and 3.3; Table 3.3; Appendix Table M.1); and,

- The SRWMP (Minnow 2019), an integrated monitoring program designed to assess the cumulative effects of the facility discharges on chemical and biological conditions in the watershed and to track changes over time. The SRWMP was designed to complement the SAMP, and also included mechanisms to allow the evolution of the sampling approach over time in response to monitoring findings for the watershed (Stations SR-06, DS-18, and SR-15; Figures 2.1 and 2.2; Table 3.3; Appendix Table S.1).

[11] The Stanrock facility has two stations under the SAMP, stations DS-4 and DS-16. Station DS-4 is the final point of control, and discharges to the May Lake sub-watershed. Station DS-16 is a drainage station that discharges to the Quirke Lake sub-watershed, and therefore data from station DS-16 are discussed in Section 4.3.

Table 3.3: Monitoring Programs and Stations Within or Downstream of the Stanrock TMA and Stanleigh TMA, and Within the May Lake Sub-Watershed

TMA	Station ID	Monitoring Program	Type	Description	Parameters and Frequencies [a]														
					Elevation	Flow	Hardness	pH	Conductivity	Sulphate	Radium-226	TSS	Acidity	Barium	Cobalt	Iron	Manganese	Uranium	Toxicity[b]
Stanrock	DS-2[c]	TOMP	Basin performance (primary), ETP operations	Treatment Plant Influent	-	D	-	M	-	Q	M	-	Q	Q	Q	Q	Q	Q	-
Stanrock	DS-3[c]	TOMP	ETP operations	Treatment Plant operations monitoring at Dam L	-	-	-	D	-	-	-	-	-	-	-	-	-	-	-
Stanrock	DS-1[c]	TOMP	Additional pH control, radium monitoring	Monitoring at Dam F, upstream from Orient Lake Polishing Pond	-	W	-	W	-	-	Q	-	-	-	-	-	-	-	-
Stanrock	DS-6[c]	TOMP	Additional pH control	Monitoring at Dam K, upstream from station DS-1	-	W	-	W	-	-	-	-	-	-	-	-	-	-	-
Stanrock	DS-5	TOMP	Seepages and surface water internal to TMA	Monitoring of seepages and surface water, downstream of Beaver Lake, and flowing into Moose Lake Settling Pond	-	Q	-	Q	Q	-	-	-	-	-	-	-	-	-	-
Stanrock	PN-ST3-P(3,5,6,8)	TOMP	Pore water	Upgradient of Dam A (5,3,6,8 have depths of 2.64 m, 5.94 m, 11.58 m, 20.91 m, respectively)	-	-	-	A	-	A	-	-	A	-	-	A	-	-	-
Stanrock	BH91-SG2(A,D)	TOMP	Pore water	Upgradient of Dam D (depth 33.31 m)	-	-	-	A	-	A	-	-	A	-	-	A	-	-	-
Stanrock	BH91-SG1A	TOMP	Groundwater	Downgradient of Dam A (depth 5.49 m)	-	-	-	A	-	A	-	-	A	-	-	A	-	-	-
Stanrock	BH98-16A	TOMP	Groundwater	Downgradient of Dam B (depth 5.49 m)	-	-	-	A	-	A	-	-	A	-	-	A	-	-	-
Stanrock	BH98-15A	TOMP	Groundwater	Downgradient of Dam C (depth 7.86 m)	-	-	-	A	-	A	-	-	A	-	-	A	-	-	-
Stanrock	BH91-SG3(A,B)	TOMP	Groundwater	Downgradient of Dam D (depths B = 5.85 m and A = 8.78 m)	-	-	-	A	-	A	-	-	A	-	-	A	-	-	-
Stanleigh	CL-04[c]	TOMP	Basin performance (primary), ETP operations	Treatment Plant influent	W	D	-	M	-	Q	M	-	Q	Q	Q	Q	Q	Q	-
Stanleigh	CL-05[c]	TOMP	ETP operations	ETP influent monitoring to adjust lime addition based on pH	-	-	-	D	-	-	-	-	-	-	-	-	-	-	-
Stanleigh	SGW-3	TOMP	Groundwater	Groundwater monitoring (6 m depth) downgradient from Dam A and upgradient of Sheriff Creek (which flows into Milliken TMA)	-	-	-	A	-	A	-	-	A	-	-	A	-	-	-
Stanleigh	SGW-5	TOMP	Groundwater	Groundwater monitoring (12.1 m depth) downgradient of Dam B	-	-	-	A	-	A	-	-	A	-	-	A	-	-	-
Stanrock	DS-4	TOMP, SAMP	Principal / effluent	Orient Lake Outlet (Final Point of Control), discharging into Halfmoon Lake, within the May Lake sub-watershed	-	W	M	W	-	M	W/M	W	-	M	M	M	M	M	S
Stanrock	DS-16	SAMP	Drainage	Discharges to the Quirke Lake Delta (see Section 4)	-	Q	Q	Q	-	Q	Q	-	-	Q	Q	Q	Q	Q	-
Stanleigh	CL-06[c]	TOMP, SAMP	Principal / effluent	Final treated effluent, discharged from Settling Pond into McCabe Lake, within the May Lake sub-watershed	-	W	M	W	-	M	W/M	W	-	M	M	M	M	M	S
Not Applicable	DS-18	SRWMP	Surface water	Halfmoon Lake outlet, downstream of Stanrock TMA discharge station DS-4	-	-	-	Q	-	Q	Q	-	-	Q	-	Q	-	Q	-
Not Applicable	SR-06	SRWMP	Surface water	McCabe Lake outlet, downstream of Stanleigh TMA station CL-06	-	-	-	S	-	S	S	-	-	S	-	-	-	S	-
Not Applicable	SR-15	SRWMP	Surface water	May Lake outlet, downstream of SRWMP stations DS-18 and SR-06	-	-	-	S	-	S	S	-	-	S	-	S	-	S	-

Notes: TMA = Tailings Management Area. ETP = Effluent Treatment Plant; "-" = not required.

[a] D=daily, W=weekly, M=monthly, Q=quarterly, S = semi-annually, A = annually. For stations that are monitored under both the TOMP and SAMP, monitoring frequencies under these programs may differ for a given parameter.

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

[c] Sampled when effluent treatment plant is operating.

3.3 TOMP: Basin Performance

3.3.1 Stanrock TMA

3.3.1.1 Basin Surface Water Quality

Stanrock is a vegetative covered TMA and as such there is no surface water contained within the TMA. Surface water runoff and seepage are collected in a holding pond and represent the influent to the Stanrock ETP (DS-2). In addition, water quality is monitored at the outlet of downstream settling ponds (DS-6), polishing ponds (DS-1), and final effluent (DS-4; Figure 3.2).

Since 2003, TMA water quality at the ETP influent (DS-2) has generally improved, with significant decreasing trends observed for cobalt, sulphate, and uranium, and some evidence of decreasing acidity, iron, and manganese concentrations (Table 3.4; Appendix Figures C.1 to C.9; Appendix Table C.3). Barium and radium-226 however, have increased slightly, and pH has remained acidic (Table 3.4; Appendix Figures C.1 to C.9).

3.3.1.2 Pore Water

Pore water is monitored annually for acidity, pH, iron, and sulphate at two locations in the Stanrock TMA: upgradient of Dam A (PN-STP3-P) and upgradient of Dam D (BH91-SG2; Figure 3.2). Upgradient of Dam A (PN-STP3-P), pore water chemistry has generally been degrading over time, with increasing concentrations of acidity, iron, and sulphate noted in all sampling depths except the 5.94 m depth (i.e., station PN-ST3-P3; Table 3.5; Appendix Figures C.10 to C.13; Appendix Table C.9). In contrast, pore water upgradient of Dam D (BH91-SG2), showed a slight increase in pH, and no trends in acidity, iron, or sulphate (Table 3.5; Appendix Figures C.11 to C.13; Appendix Table C.9).

Pore water pH at all depths except the shallowest (<3 m) achieved the EIS predicted level in 2019, indicating that the TMA is performing as expected (Figure 3.4). There were some instances where pH dropped slightly below the EIS prediction of 5.4 in the 16-20 m horizon over the 2015 to 2019 period (specifically in 2015, 2017, and 2018). Examination of the longer-term pattern for pH in this horizon suggests that there may be a notable decreasing trend (Figure 3.4).

3.3.1.3 Groundwater Quality

Groundwater is sampled annually for acidity, pH, iron, and sulphate at four locations; one downgradient of each of the TMA Dams; A (BH91-SG1), B (BH98-16), C (BH98-15) and D (BH98-SG3; see Section 3.1.2.2; Figure 3.2). Downgradient of Dam A, groundwater quality has improved over time, based on decreasing acidity and sulphate, and increasing pH (Table 3.6; Appendix Figures C.14 to C.17; Appendix Table C.10). Improved groundwater quality was also noted downgradient of Dams B and C, with decreasing concentrations of iron and sulphate noted

Table 3.4: Seasonal Kendall Trend Analysis for Water Quality Parameters, TOMP Water Quality Stations, Stanrock TMA, 2003 to 2019

Station	**DS-2**
Station Type/Location	Treatment Plant Influent
Acidity (mg/L)	NS
Barium (mg/L)	4.2
Cobalt (mg/L)	-5.6
Iron (mg/L)	NS
Manganese (mg/L)	NS
pH	-0.2
Radium (Bq/L)	1.70
Sulphate (mg/L)	-5.1
Uranium (mg/L)	-6.9

(Green) Significant decreasing temporal trend (Seasonal Kendall test for monotonic trend at α = 0.05). Value reported is the Sen's slope reported as a percentage of the median concentration or value.

(Blue) Significant increasing temporal trend (Seasonal Kendall test for monotonic trend at α = 0.05). Value reported is the Sen's slope reported as a percentage of the median concentration or value.

Note: See Appendix Table C.3 for raw data. '"NS" = no significant temporal trend (Seasonal Kendall test for monotonic trend at α = 0.05).

Table 3.5: Results of Temporal Trend Analyses for Pore Water Quality Parameters, TOMP Pore Water Stations, Stanrock TMA, 1990 to 2019

Station	PN-ST3-P5	PN-ST3-P3	PN-ST3-P6	PN-ST3-P8	BH91-SG2A
Station Type/Location	Upgradient of Dam A				Upgradient of Dam D
Depth (m)	2.64	5.94	11.58	20.91	33.31
Acidity (mg/L)	4.3	NS	5.5	5.3	NS
Field pH	1.2	1.3	NS	-0.91	0.33
Iron (mg/L)	7.2	-1.6	3.4	10	NS
Sulphate (mg/L)	2.4	NS	2.6	6.1	NS

(Green) Significant decreasing temporal trend (Kendall test for monotonic trend at α = 0.05). Value reported is the slope reported as a percentage of the median concentration or value.

(Blue) Significant increasing temporal trend (Kendall test for monotonic trend at α = 0.05). Value reported is the slope reported as a percentage of the median concentration or value.

Notes: Due to a change in analytical technique for acidity in 2006, acidity trends were assessed from 2007 to 2019. See Appendix Table C.9 for raw data. NS = no significant temporal trend (Kendall test for monotonic trend at α = 0.05).

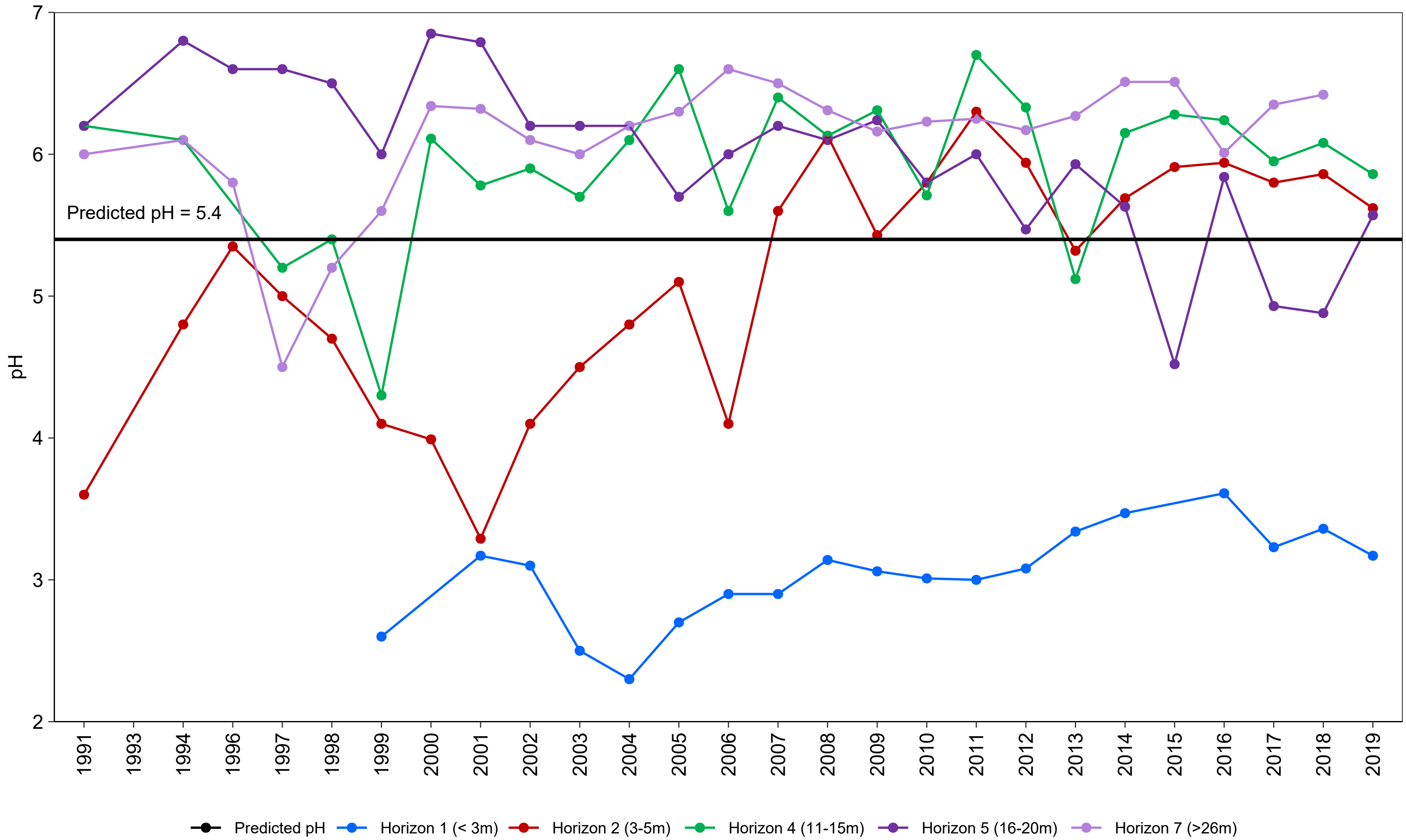


Figure 3.4: Comparison of Mean Pore Water pH at Various Depths to EIS (2010) Prediction, Stanrock TMA, 1991 to 2020

Notes: Black line delineates predicted pH. Horizon 1 - TOMP Station PN-STP3-P5. Horizon 2 - TOMP Station PN-STP3-P3 (1991-2019) and TOMP Station BH91-SG2D (1991-1999, as there has been no well recharge at BH91-SG2D since 2001). Horizon 4 - TOMP Station PN-STP3-P6.
Horizon 5 - TOMP Station PN-ST3-P8. Horizon 7 - TOMP Station BH91-SG2A (no recharge in 2019). See Appendix Table C.9 for raw data.

Table 3.6: Results of Temporal Trend Analyses for Groundwater Quality Parameters, TOMP Groundwater Stations, Stanrock TMA, 1990 to 2019

Station	BH91-SG1A	BH98-16A	BH98-15A	BH91-SG3B	BH91-SG3A
Station Type/Location	Downgradient of Dam A	Downgradient of Dam B	Downgradient of Dam C	Downgradient of Dam D	
Depth (m)	5.49	5.49	7.86	5.85	8.78
Acidity (mg/L)	-4.9	NS	-9.2	NS	NS
Field pH	1.2	NS	0.39	NS	NS
Iron (mg/L)	NS	-3.7	-6.0	NS	-10
Sulphate (mg/L)	-1.4	-2.6	-3.9	NS	NS

[green] Significant decreasing temporal trend (Kendall test for monotonic trend at α = 0.05). Value reported is the slope reported as a percentage of the median concentration or value.

[blue] Significant increasing temporal trend (Kendall test for monotonic trend at α = 0.05). Value reported is the slope reported as a percentage of the median concentration or value.

Notes: Due to a change in analytical technique for acidity in 2006, acidity trends were assessed from 2007 to 2019. See Appendix Table C.10 for raw data. NS = no significant temporal trend (Kendall test for monotonic trend at α = 0.05).

in both locations, and decreasing acidity and increasing pH also observed below Dam C (Table 3.6; Appendix Figures C.14 to C.17; Appendix Table C.10). Downgradient of Dam D, groundwater is sampled at two depths (5.85 m and 8.78 m), however samples have not been collected from the deeper depth since 2011, and only a single sample was collected from the shallower depth over the 2015 to 2019 period (i.e., in 2017), due to lack of well recharge. As such, the results of trend analyses (Table 3.6) are generally not reflective of the 2015 to 2019 period. The only significant trend was a decrease in iron concentration at the 8.78 m depth, which occurred over the 1999 to 2011 period (Appendix Figure C.15).

3.3.1.4 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 3.2). Treatment includes both lime and barium chloride additions to decrease acidity and radium-226, respectively. Barium chloride and lime consumption rates generally decreased over the 2015 through 2019 period, despite the volume of water requiring treatment being highest in 2017 and 2019 (Figure 3.5; Appendix Table C.3). Conversely, total consumption of barium chloride and lime tended to more closely mirror the volume of water being treated (Figure 3.5).

Following treatment, effluent quality is monitored at the outlet of the Orient Lake polishing pond (DS-4). Over the 2015 to 2019 period, effluent quality at DS-4 consistently met discharge criteria for pH, radium-226, and TSS (Figures 3.6 and 3.7; Appendix Table C.5).

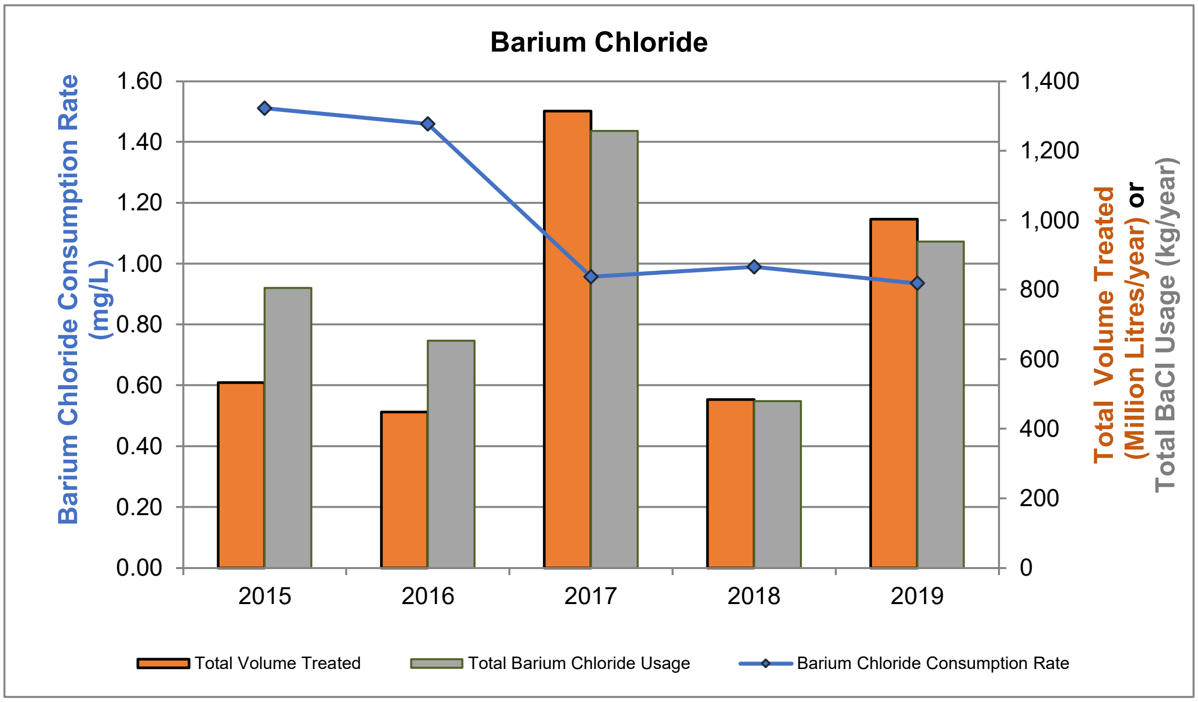
3.3.2 Stanleigh TMA

3.3.2.1 Water Management

Except for the period extending from late December 2015 through early May 2016, when water levels within the Stanleigh TMA were slightly greater than the maximum operating elevation, water levels were otherwise maintained between the minimum and maximum operating elevations from 2015 to 2019 (Figure 3.8; Appendix Table D.7).

3.3.2.2 Basin Surface Water Quality

Surface water quality is monitored at three stations associated with the Stanleigh TMA: the ETP influent (CL-04), a pH probe in the ETP (CL-05), and the final effluent (CL-06; Figure 3.3). Concentrations of radium-226, sulphate, and uranium decreased, and pH increased to near neutral since basin flooding at ETP influent station CL-04 (Figure 3.9). Concentrations of sulphate and uranium were below the 50-year (i.e., 2040) predictions over the 2015 to 2019 period, whereas radium-226 concentrations were near the predicted value of <0.5 Bq/L from 2015 to 2018, and mostly below the prediction in 2019 (Figure 3.9; Appendix Table D.3).



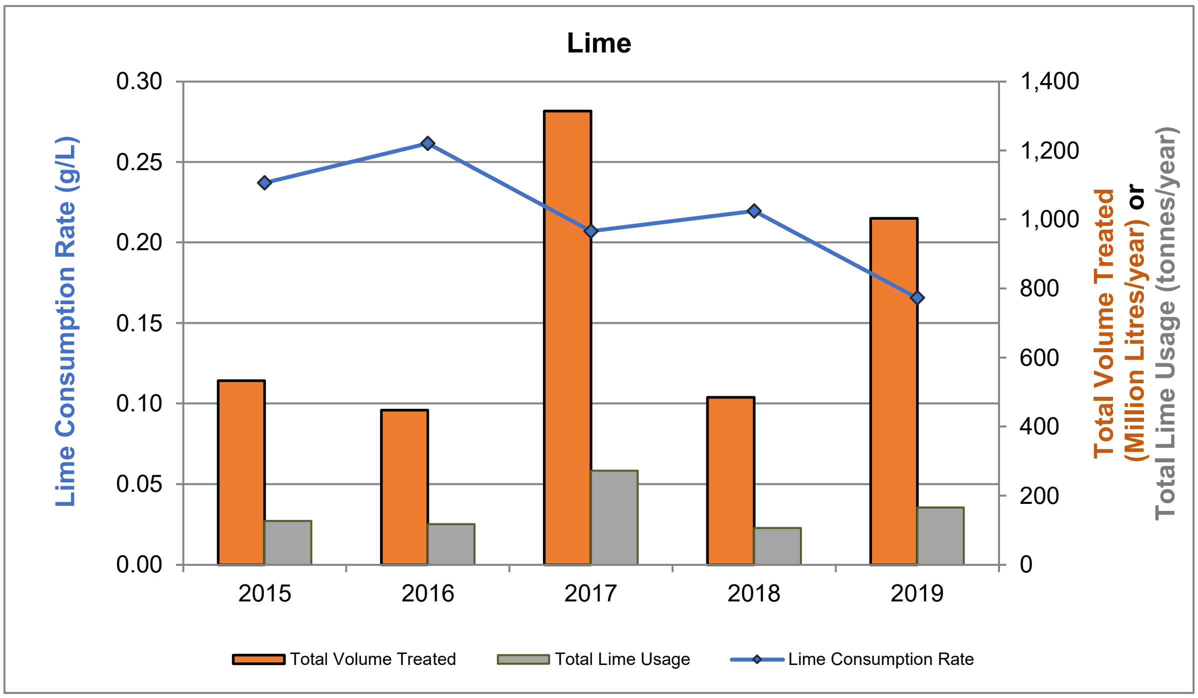


Figure 3.5: Comparison of Total Reagent Consumed Versus Total Volume Treated at Stanrock TMA from 2015 to 2019

Note: See Appendix Table C.3 for raw data (TOMP Station DS-2).

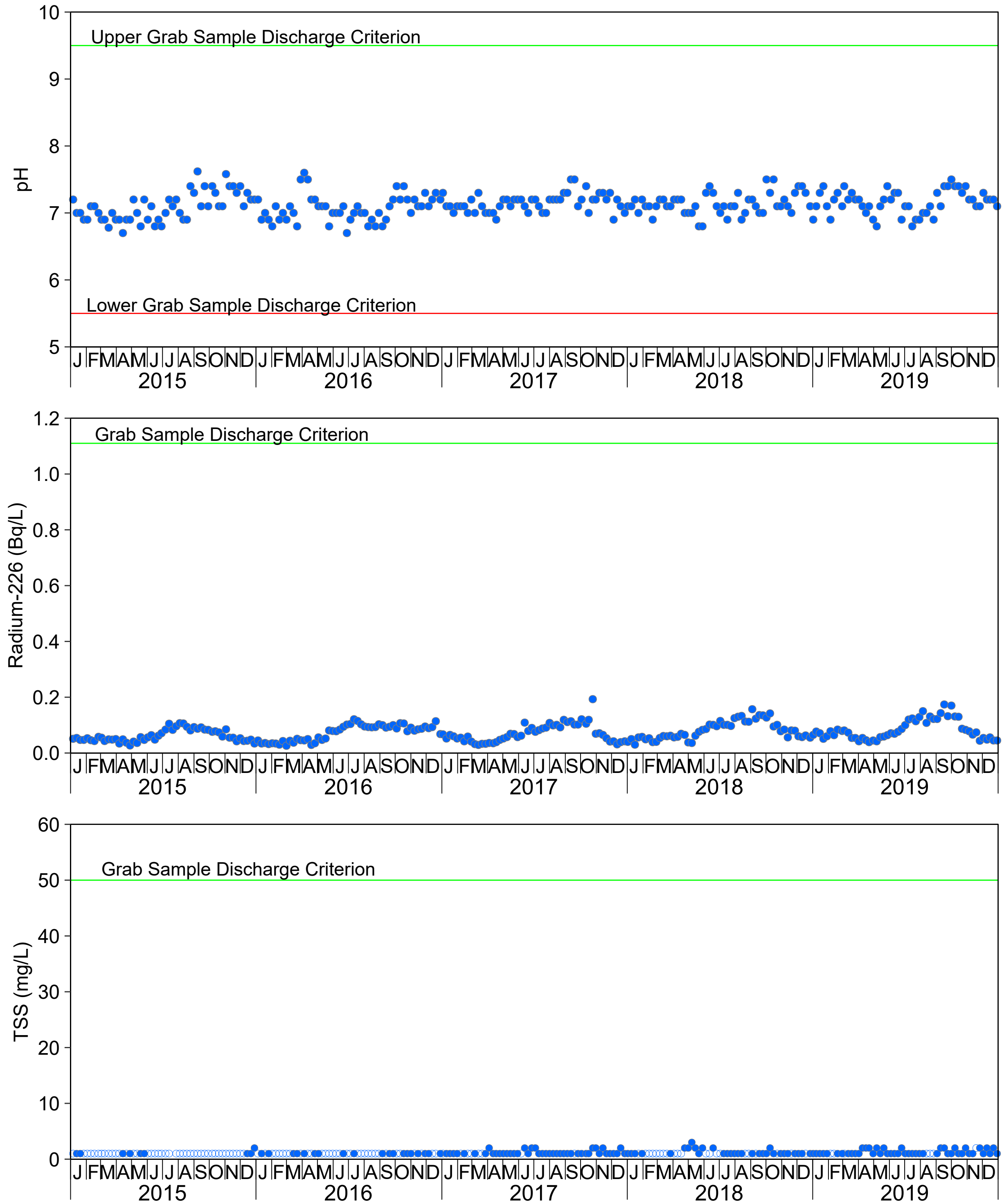


Figure 3.6: Effluent Concentrations Compared to Grab Sample Discharge Criteria at TOMP Station DS-4, Stanrock TMA, 2015 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Table C.5 for raw data.

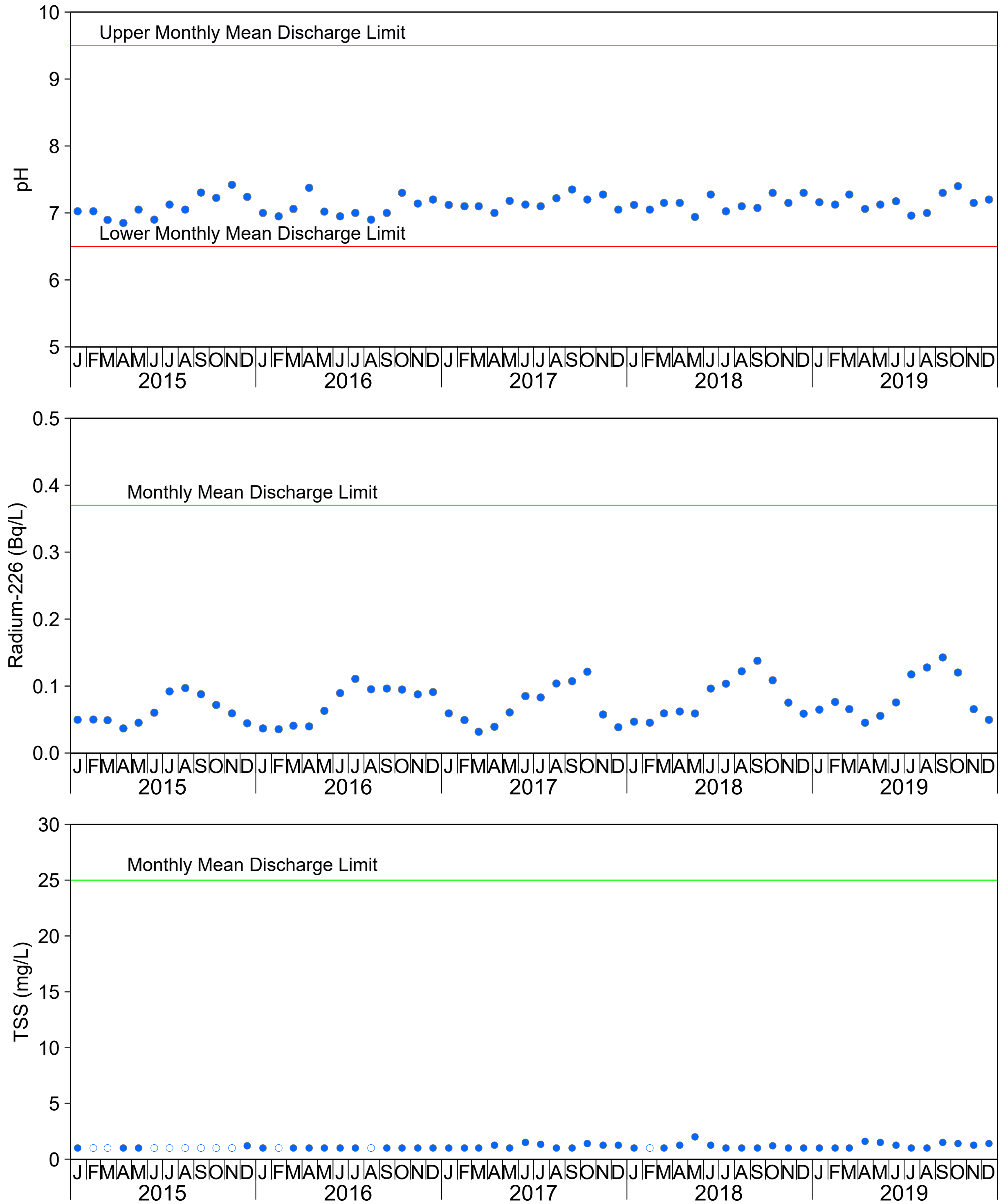


Figure 3.7: Monthly Mean Effluent Concentrations Compared to Monthly Mean Discharge Limits at TOMP Station DS-4, Stanrock TMA, 2015 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Table C.5 for raw data.

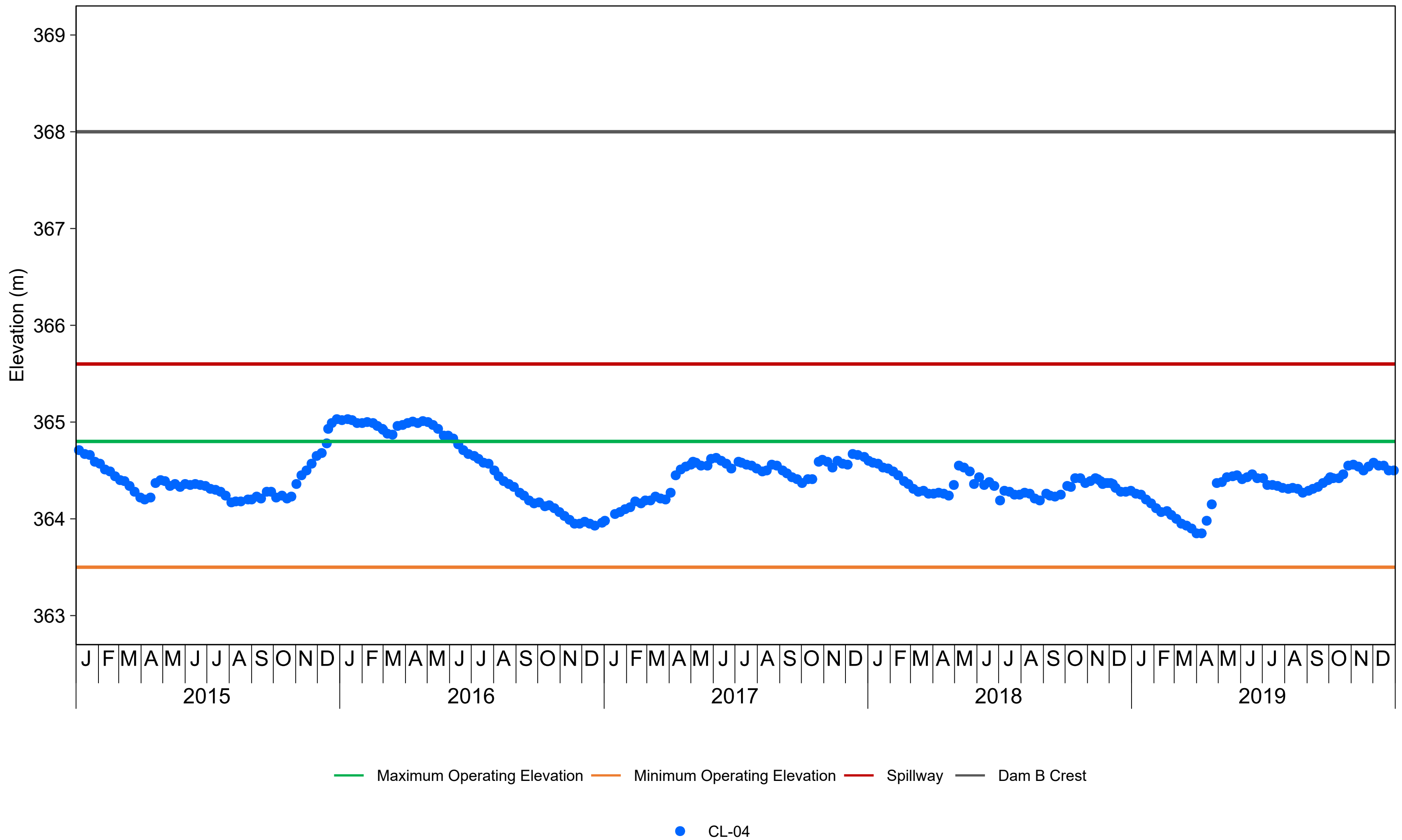


Figure 3.8: Water Level at TOMP Station CL-04 Relative to Minimum and Maximum Operating Elevations, Stanleigh TMA, 2015 to 2019

Notes: See Appendix Table D.7 for raw data.

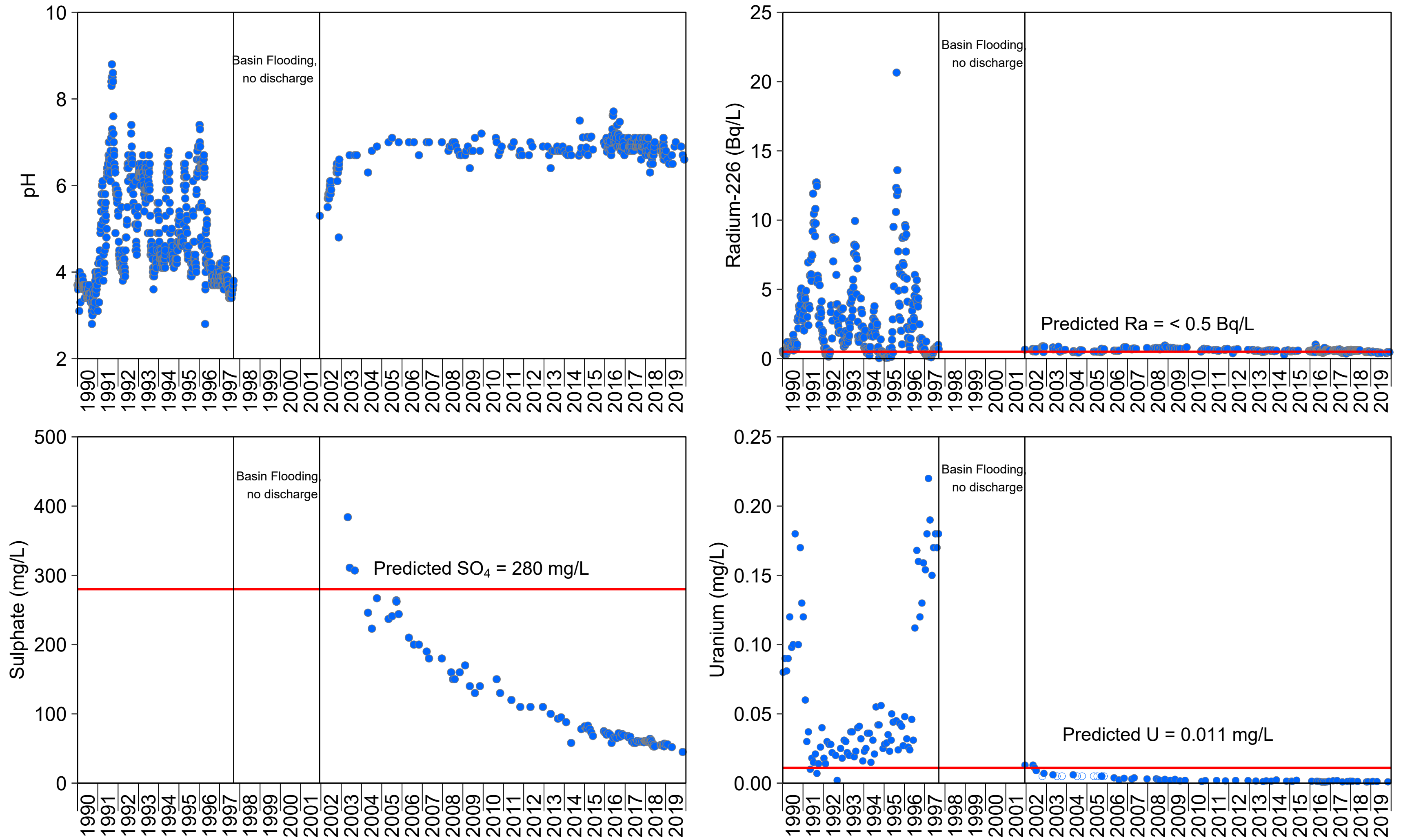


Figure 3.9: Water Quality at the Stanleigh TMA ETP Influent (TOMP Station CL-04) Relative to Predictions for 50 years (2040) Post-decommissioning

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Red line delineates predicted concentration. See Appendix Table D.3 for raw data.

Surface water quality in the Stanleigh TMA (as measured at the ETP influent at CL-04) has improved significantly over time, based on decreasing concentrations of cobalt, iron, manganese, radium-226, sulphate, and uranium (Table 3.7; Appendix Figures D.1 to D.9). Acidity concentrations have been below the laboratory reporting limit since monitoring for acidity commenced in 2007, and pH has been circumneutral since 2003 (Appendix Figures D.1 and D.6). As some areas of the Stanleigh TMA basin contain radium-226 that is hosted by barite (Minnow 2020b), the decreasing sulphate concentrations may have the effect of increasing in-basin radium-226 and barium concentrations in the future. However, this process will be slow, as anhydrite (present in the Stanleigh TMA) will dissolve before barite and produce sulphate, thereby stabilizing barite solids (Minnow 2020b). If surface water radium-226 concentrations were observed to increase, monitoring of summer anoxia and of possible changes in redox condition due to increased or decreased TOC accumulation may be helpful tools. Continued monitoring at station CL-04 of barium and sulphate would help predict when barite and anhydrite become undersaturated. The oxidation of pyrite appears to be stable suggesting that increased acidity is not expected (Minnow 2020b). The Stanleigh treatment plant has been susceptible to refractory radium (see Section 3.3.2.4 and Appendix K), however a modified treatment method (*ex situ* barite; XSB) has been in place since April 2018 as an effective treatment for refractory radium. Investigations are currently underway to assess the causes of refractory radium and the role and implications of lower sulphate concentrations on in-basin radium-226 concentrations.

3.3.2.3 Groundwater Quality

Two groundwater wells are sampled annually for acidity, pH, iron, and sulphate: downgradient of Dam A (SGW-3) and downgradient of Dam B (SGW-5; Figure 3.3). Groundwater quality down gradient of Dam A (towards Sheriff Creek) has continued to improve since monitoring commenced in 1999 (or 2007 for acidity), based on significantly decreasing concentrations of acidity, iron, and sulphate, and increasing pH (Table 3.8; Appendix Figures D.10 to D.13). Groundwater monitoring downgradient of Dam B commenced in 2010, and since then, the only significant change has been a decrease in sulphate concentrations (Table 3.8; Appendix Figures D.10 to D.13). Overall, groundwater quality at SGW-5 is considered good, with pH being circumneutral, iron concentrations generally achieving surface water criteria, and acidity concentrations below the laboratory reporting limit (Appendix Figures D.10 to D.13; Appendix Table D.6).

Table 3.7: Seasonal Kendall Trend Analysis for Water Quality Parameters, TOMP Water Quality Stations, Stanleigh TMA, 2003 to 2019

Station	CL-04
Station Type/Location	Treatment Plant Influent
Acidity (mg/L)	nt
Barium (mg/L)	NS
Cobalt (mg/L)	-15
Iron (mg/L)	-5.6
Manganese (mg/L)	-18
pH	NS
Radium-226 (Bq/L)	-2.4
Sulphate (mg/L)	-16
Uranium (mg/L)	-8.8

[green] Significant decreasing temporal trend (Seasonal Kendall test for monotonic trend at α = 0.05). Value reported is the Sen's slope reported as a percentage of the median concentration or value.
[blue] Significant increasing temporal trend (Seasonal Kendall test for monotonic trend at α = 0.05). Value reported is the Sen's slope reported as a percentage of the median concentration or value.
Note: See Appendix Table D.3 for raw data. '"NS" = no significant temporal trend (Seasonal Kendall test for monotonic trend at α = 0.05). '"nt" = parameter not included in the trend analysis for that particular station due to >50% non-detectable concentrations in the samples available for the analysis.

Table 3.8: Results of Temporal Trend Analyses for Groundwater Quality Parameters, TOMP Groundwater Stations, Stanleigh TMA, 1990 to 2019

Station	SGW-3	SGW-5
Station Type/Location	Downgradient Dam A	Downgradient Dam B
Depth (m)	6.0	12.1
Acidity (mg/L)	-9.5	nt
Field pH	1.7	NS
Iron (mg/L)	-17	NS
Sulphate (mg/L)	-9.1	-12

(green) Significant decreasing temporal trend (Kendall test for monotonic trend at α = 0.05). Value reported is the slope reported as a percentage of the median concentration or value.

(blue) Significant increasing temporal trend (Kendall test for monotonic trend at α = 0.05). Value reported is the slope reported as a percentage of the median concentration or value.

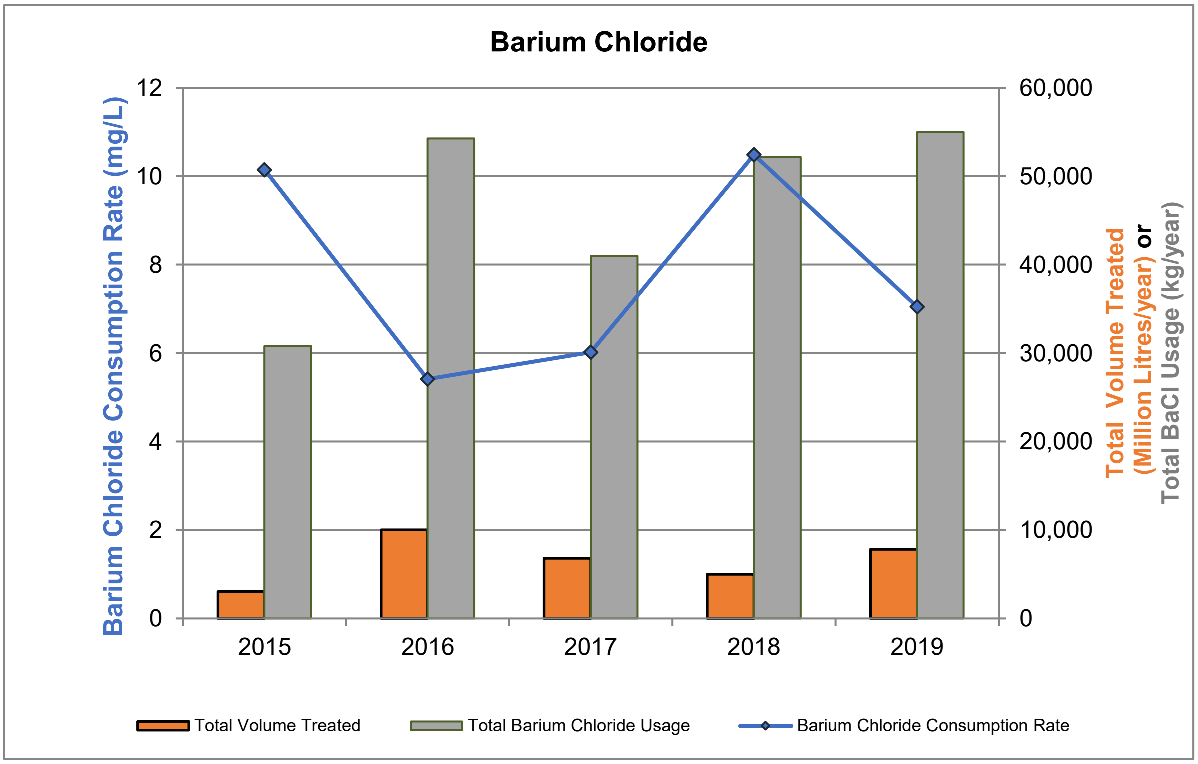
Notes: Due to a change in analytical technique for acidity in 2006, acidity trends were assessed from 2007 to 2019. See Appendix Table D.6 for raw data. NS = no significant temporal trend (Kendall test for monotonic trend at α = 0.05). "nt" = parameter not included in the trend analysis for that particular station due to >50% non-detectable concentrations in the samples available for the analysis.

3.3.2.4 Treatment Performance

Treatment of basin surface water at the ETP includes addition of lime to reduce acidity as well as either barium chloride (until 2018) or *ex situ* barite (XSB[12], after 2018) to reduce radium-226. In early 2015, RAL identified a seasonal phenomenon whereby the efficiency of treatment for radium-226 with barium chloride was reduced causing final effluent concentrations of radium-226 to increase. The increase was not due to a change or increase in radium concentrations within the basin but rather due to a factor effecting treatment performance and was termed "refractory radium". With concern over periodic increases in radium-226 and the risk of non-compliance in the future, RAL began exploring modification to the treatment process and trialling different treatment reagents. In 2016, as part of these efforts, a 100 m long impermeable silt curtain (baffle) was installed in a north-south orientation originating from the north shoreline approximately 60 m from the ETP discharge in the Settling Pond to increase the effluent retention time. A second low-permeable baffle was later installed a short distance away from the ETP outflow in the Settling Pond to improve initial dispersal of effluent within the water column. While these measures did increase the effluent residence time, they did not effectively improve the treatment efficiency for radium-226 (which relies on the settling of barite particles). RAL also trialed the use of ferric sulphate as a reagent addition to promote particulate settling within the Settling Pond and thereby reduce radium-226 during periods of refractory radium. This method also proved ineffective and was discontinued, as it resulted in increasing iron in the discharge and downstream in McCabe Lake and so was discontinued. At the same time, research on the nature of refractory radium identified that during refractory periods, the particle size of the barite crystal which adsorbs radium-226 was substantially smaller than during no-refractory radium periods, reducing the ability of particles to settle within the Settling Pond. Ultimately, preformed barite (barium chloride with sodium sulphate) was found to produce favourable results as it provided a larger crystal to settle out within the Settling Pond, removing radium-226 and yielding lower concentrations in effluent. Therefore, as of April 2018, RAL has employed preformed barite (known as XSB) in the Stanleigh Treatment Plant and the effluent radium-226 concentrations have been reduced to well below compliance levels (see Appendix K for additional detail).

Prior to the introduction of XSB (April 2018), barium chloride consumption fluctuated in response to the occurrence of refractory radium (seasonal phenomena), with consumption ranging from 5.4 and 10.5 mg/L on an annual basis from 2015 to 2017 (Figure 3.10). This variability reflected RAL's increased use of barium chloride in an attempt to reduce effluent radium concentrations

[12] XSB is made on site using barium chloride and sodium sulphate mixed in a slurry with TMA influent water.



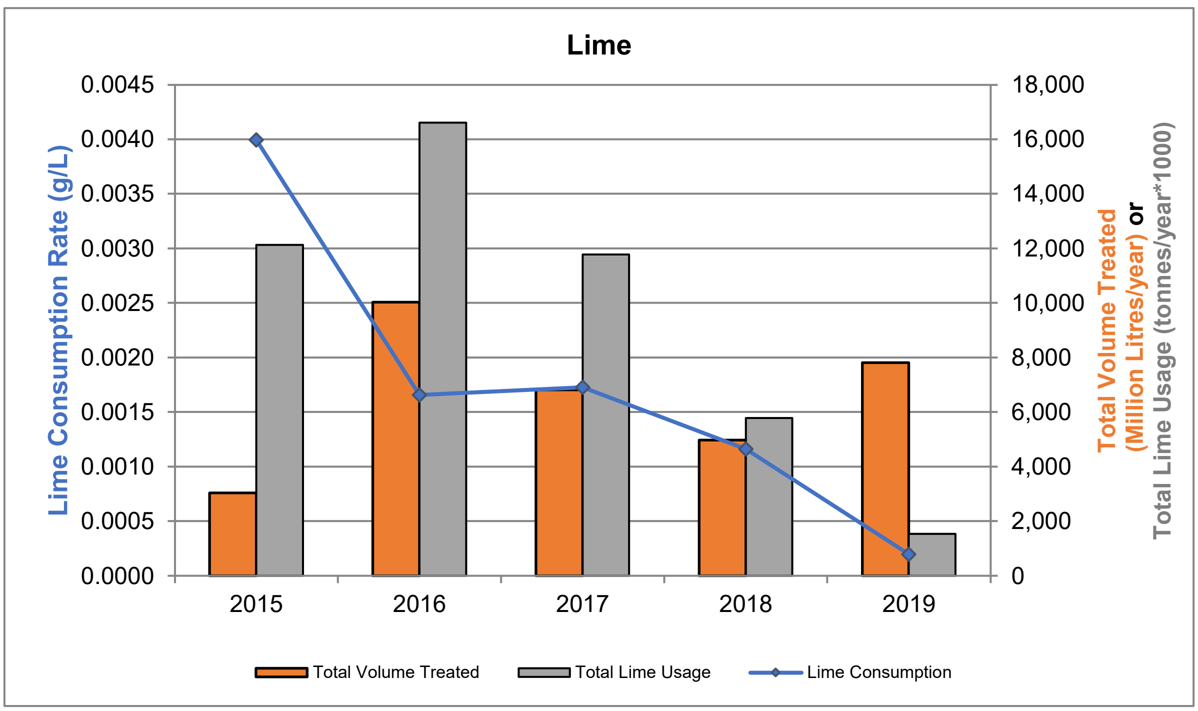


Figure 3.10: Comparison of Total Reagent Consumed Versus Total Volume Treated at Stanleigh TMA from 2015 to 2019 (lime usage multiplied by 1,000)

Note: See Appendix Tables D.3 for raw data (TOMP Station CL-04).

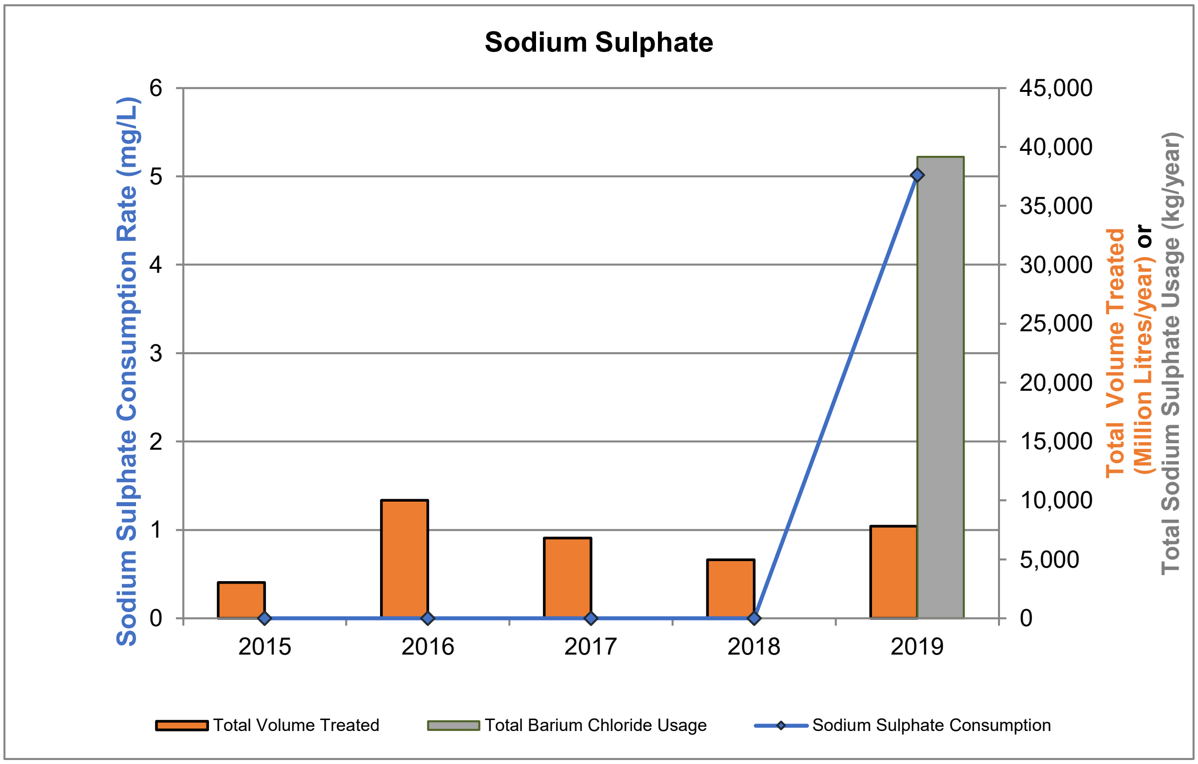


Figure 3.10: Comparison of Total Reagent Consumed Versus Total Volume Treated at Stanleigh TMA from 2015 to 2019 (lime usage multiplied by 1,000)

Note: See Appendix Tables D.3 for raw data (TOMP Station CL-04).

during periods of refractory radium. During the period between 2015 to April 2018, BHP was trialing several treatment options but continued to use barium chloride to ensure effluent compliance. In addition, discharge rates were varied within the operating range to see if change in throughput rate and residence time could improve treatment effectiveness during periods of refractory radium. Since the switch to XSB, the consumption of barium chloride and sodium sulphate (combined to form XSB) have largely fluctuated with the volume of water requiring treatment (Figure 3.10). In contrast, the annual lime consumption rate decreased substantially over the 2015 to 2019 period, from a high of 3.4 mg/L (i.e., per volume of water treated) in 2015 to a low of 0.2 mg/L in 2019 (Figure 3.10), reflecting the circumneutral pH within the TMA basin (i.e., pH in treatment plant influent [CL-04] generally achieves discharge criteria without treatment).

Following treatment, effluent quality is monitored at the settling pond outlet (CL-06), and over the past five years effluent quality has generally achieved discharge criteria (Figures 3.11 and 3.12; Appendix Table D.5). Two monthly mean radium-226 concentrations (December 2017 and January 2018) exceeded the monthly average discharge criterion, however, individual grab samples associated with each monthly mean were well below the grab sample criterion of 1.11 Bq/L (Figures 3.11 and 3.12; Appendix Table D.5). These exceedances were associated with refractory radium, and since the introduction of XSB in April 2018, effluent discharge has consistently achieved the discharge criteria.

3.4 SAMP: May Lake Sub-Watershed Sources

3.4.1 Discharge Quality and Loads

Effluent from the Stanrock Facility (at station DS-4) was non-lethal to *Daphnia magna* and rainbow trout over the 2015 to 2019 period, with no mortality reported in semi-annual acute toxicity tests (Table 3.9). Similarly, reproduction of *Ceriodaphnia dubia* was not affected by exposure to 100% effluent in all but one test conducted in October 2017, when reproduction was affected at an effluent concentration 55% (Table 3.9).

Effluent from the Stanleigh Facility (at station CL-06) was also consistently non-lethal to rainbow trout, and no effects on reproduction of *C. dubia* were observed in 100% effluent over the past five years (Table 3.10). Two of 24 toxicity tests on *D. magna* exhibited minimal mortality (i.e., 20% in one test from May 2017 and 3.3% in one test from May 2018), whereas no mortality was reported in all other tests (Table 3.10). It is possible that the limited toxicity response was associated with ongoing treatment trials and changes in reagents (Section 3.3.2.4); since the introduction of XSB there have been no additional toxicity responses. It is unlikely associated with changes in basin chemistry as concentrations of mine related substances have been stable

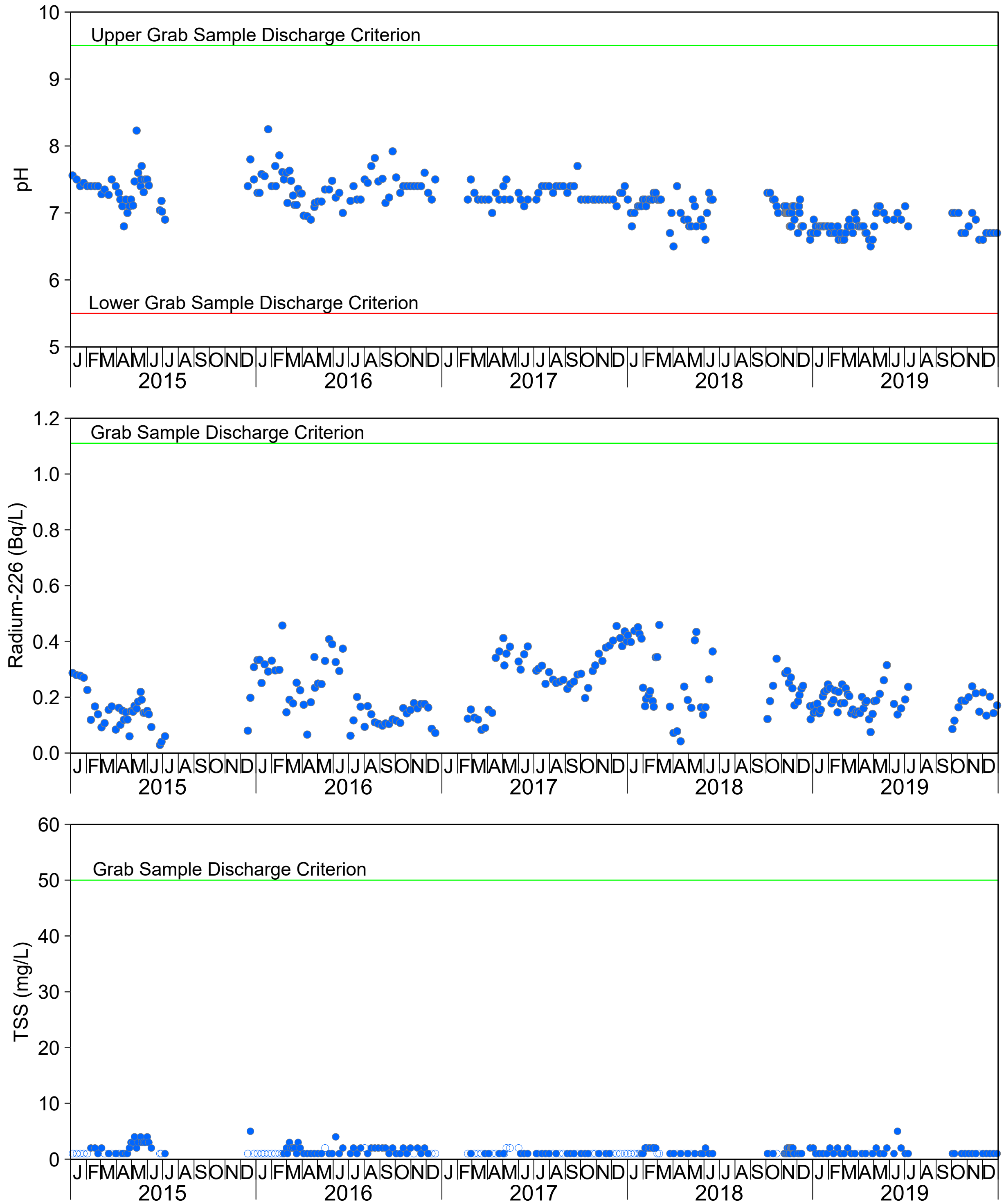


Figure 3.11: Effluent Concentrations Compared to Grab Sample Discharge Criteria at TOMP Station CL-06, Stanleigh TMA, 2015 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Table D.5 for raw data.

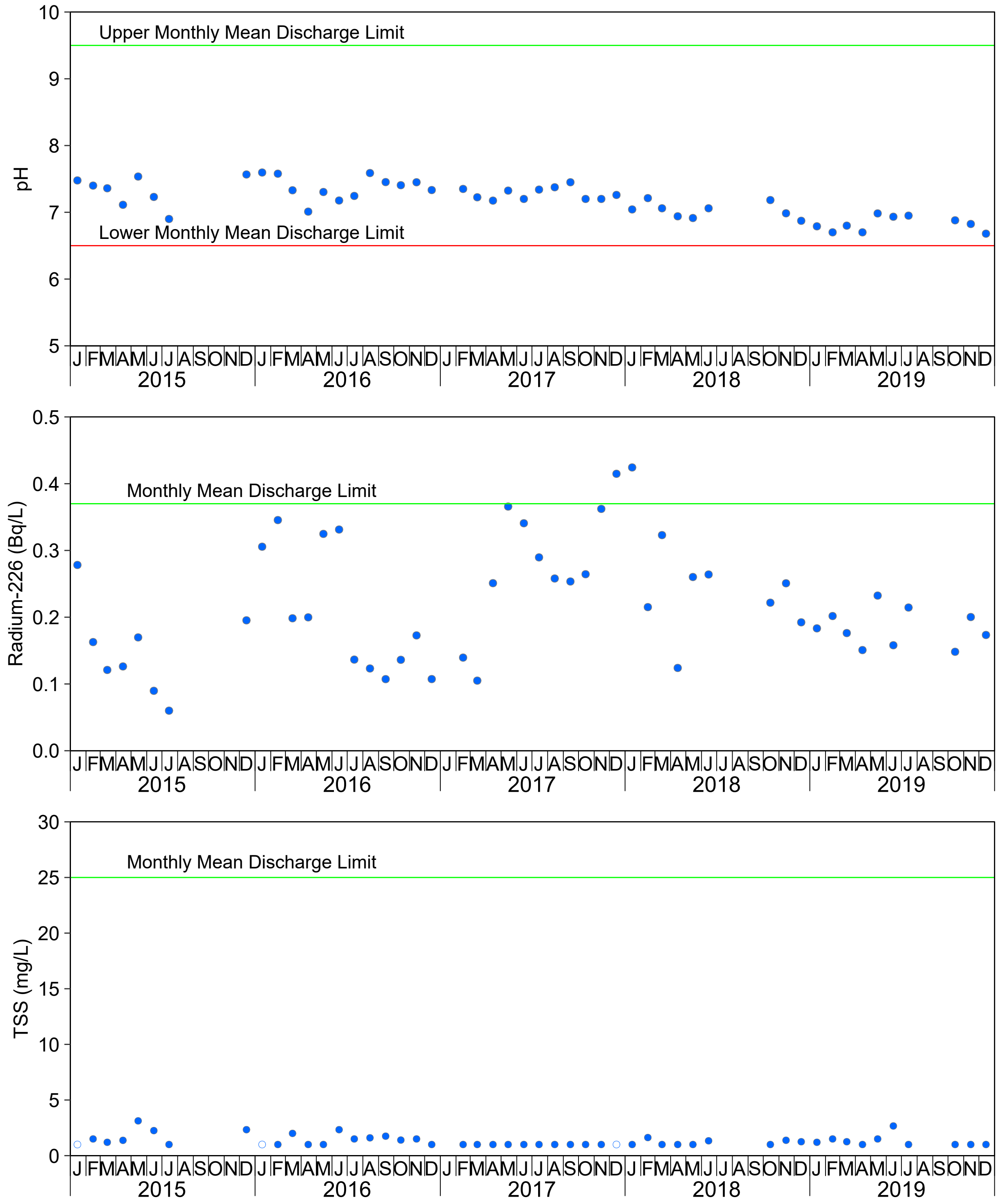


Figure 3.12: Monthly Mean Effluent Concentrations Compared to Monthly Mean Discharge Limits at TOMP Station CL-06, Stanleigh TMA, 2015 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Table D.5 for raw data.

Table 3.9: Toxicity Test Results for Samples Collected at Stanrock TMA SAMP and TOMP Station DS-4, 2015 to 2019

Date	Sublethal Toxicity (*Ceriodaphnia dubia*) IC25	Acute Toxicity (*Daphnia magna*) % Mortality	Acute Toxicity (Rainbow Trout) % Mortality
12-May-15	100	0	0
17-Nov-15	100	0	0
10-May-16	100	0	0
11-Oct-16	100	0	0
23-May-17	100	0	0
12-Oct-17	54.7	0	0
19-Jun-18	100	0	0
04-Dec-18	100	0	0
14-May-19	100	0	0
12-Nov-19	100	0	0
n	10	10	10
Minimum	54.7	0	0
Maximum	100	0	0
Mean	95.5	0	0
SD	14.3	-	-
Median	100	0	0
10th Percentile	77.4	0	0
95th Percentile	100	0	0

Note: n = number of samples. SD = standard deviation. "-" = SD not applicable.

Table 3.10: Toxicity Test Results for Samples Collected at Stanleigh TMA SAMP and TOMP Station CL-06, 2015 to 2019

Date	Sublethal Toxicity (*Ceriodaphnia dubia*) IC25	Acute Toxicity (*Daphnia magna*) % Mortality	Acute Toxicity (Rainbow Trout) % Mortality
06-Apr-15	100	0	0
20-May-15	100	0	0
16-Dec-15	100	0	0
09-Feb-16	100	0	0
01-Mar-16	100	0	0
02-May-16	100	0	0
07-Nov-16	100	0	0
04-May-17	100	20.0	0
26-Oct-17	100	0	0
27-Dec-17	100	0	0
10-Jan-18	100	0	0
22-Jan-18	100	0	0
07-Feb-18	100	0	0
20-Feb-18	100	0	0
26-Mar-18	100	0	0
09-Apr-18	100	0	0
23-Apr-18	100	0	0
07-May-18	100	0	0
28-May-18	100	3.30	0
12-Jun-18	100	0	0
15-Oct-18	100	0	0
12-Nov-18	100	0	0
22-Apr-19	100	0	0
04-Nov-19	100	0	0
n	24	24	24
Minimum	100	0	0
Maximum	100	20.0	0
Mean	100	0.971	0
SD	-	4.11	-
Median	100	0	0
10th Percentile	100	0	0
95th Percentile	100	3.30	0

Note: n = number of samples. SD = standard deviation. "-" = SD not applicable.

or decreasing over this period (Table 3.7). Toxicity effects are not expected in the receiving environment, as these toxicity responses occurred in 100% effluent, whereas Stanleigh effluent would be substantially diluted in the McCabe Lake receiving environment (i.e., less than 5% effluent; Minnow 2018).

Except for sulphate, annual mean concentrations of all substances in the Stanrock final discharge (DS-4) met the SRWMP benchmarks[13] over the 2015 to 2019 period, whereas all parameters except barium (in four out of the five years) met SRWMP benchmarks in the Stanleigh final effluent (CL-06; Figure 3.13). Although effluent discharge is not subject to receiving environment water quality criteria, achieving these benchmarks in effluent indicates that effluent is of good quality.

Loadings to the May Lake sub-watershed associated with the Stanrock TMA (based on data from station DS-4) showed little inter-annual variability over the 2015 to 2019 period. Loadings from the Stanrock TMA were consistently lower than loadings associated with the Stanleigh TMA, except for sulphate in 2017 (due to total discharge for DS-4 being highest in 2017 compared to other years; Figure 3.13; Appendix Table M.7). The highest loads of radium-226 and uranium from the Stanrock TMA (over the 2005 to 2019 period) were recorded in 2017 (Appendix Figure M.11). Barium loadings from the Stanleigh TMA were on an increasing trajectory until they reached their highest in 2017. The increase in barium loading was associated with the use of additional barium chloride to treat periods of refractory radium until the introduction of XSB in 2018. Since that time, barium loadings have reduced in response to the change in treatment method (Figure 3.13; Appendix Figure M.11). Reflective of improved TMA water quality at Stanleigh, manganese, sulphate, and uranium loadings have generally been decreasing over time (see Section 3.3.2.2). All other parameters generally exhibited variability within the range observed in the past, except iron, for which the highest loadings observed since 2005 from the Stanleigh TMA were measured in 2015 and 2016 (Appendix Figure M.11). These higher iron loadings were associated with treatment trials using ferric sulphate to treat refractory radium. The trials were found to result in increasing iron concentrations and were not able to address refractory radium concentrations.

3.4.2 Trends

Final treated effluent from the Stanrock Facility (DS-4) has generally been improving over time, based on decreasing concentrations of cobalt, manganese, and sulphate (Table 3.11; Appendix Figures M.1 to M.8). No temporal trends were noted for iron, radium-226, and uranium, whereas a slight increase in barium and decrease in pH were observed (Table 3.11 Appendix Figures M.3,

[13] These are receiving environment criteria, which are provided here for context, but are not required to be met for discharge to occur.

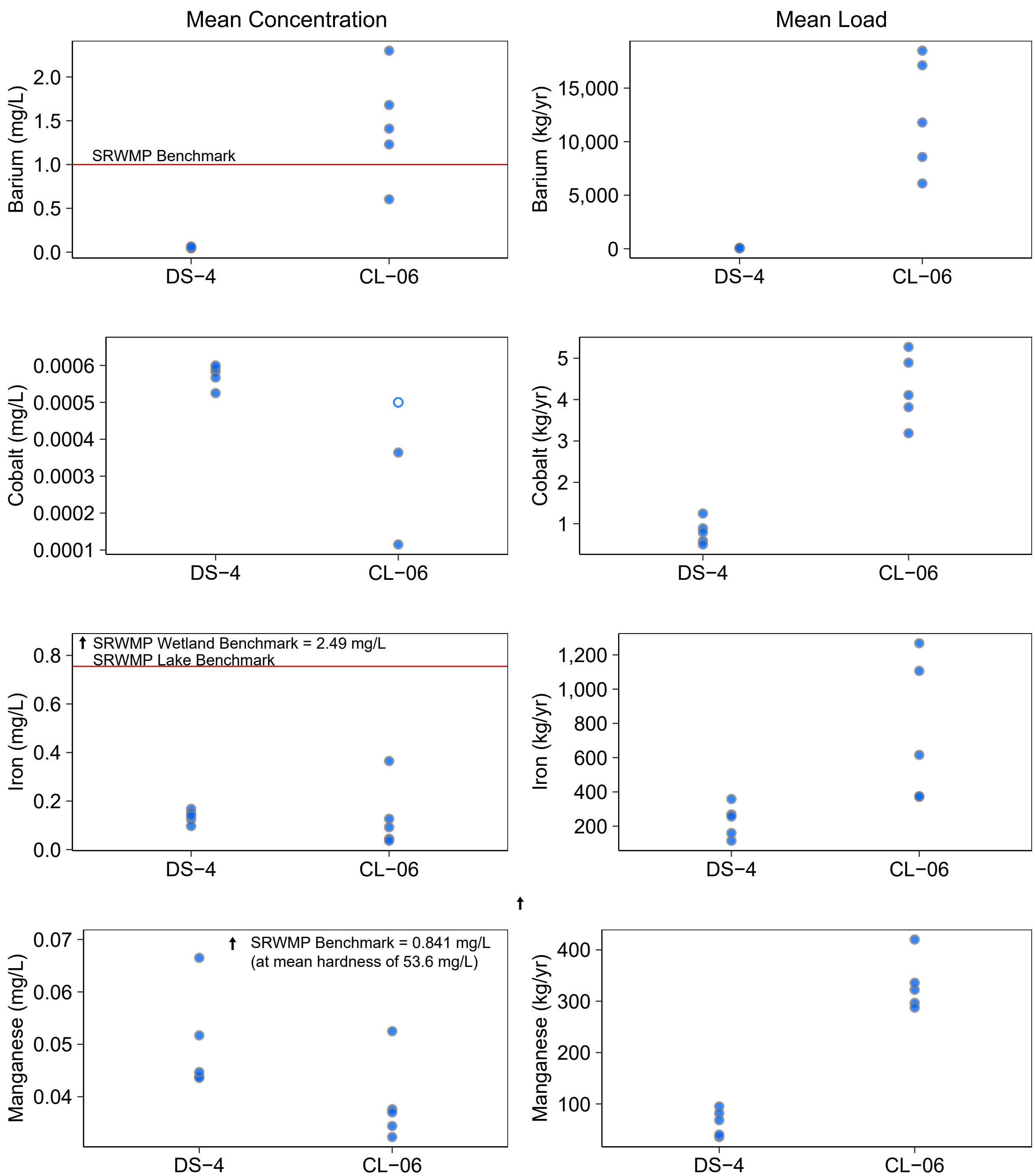


Figure 3.13: Annual Mean Concentrations and Annual Loads at SAMP Monitoring Stations Discharging from Stanrock and Stanleigh TMAs into the May Lake Sub-watershed, 2015 to 2019

Notes: SRWMP benchmarks (Table 2.8) apply to the receiving environment and are based on background (reference) concentrations or approved guidelines, provided here for context, but they are not criteria that need to be met for discharge to occur. Values at the LRL (open circles) were replaced with the LRL for calculations. See Appendix Tables M.2 and M.4 for raw data.

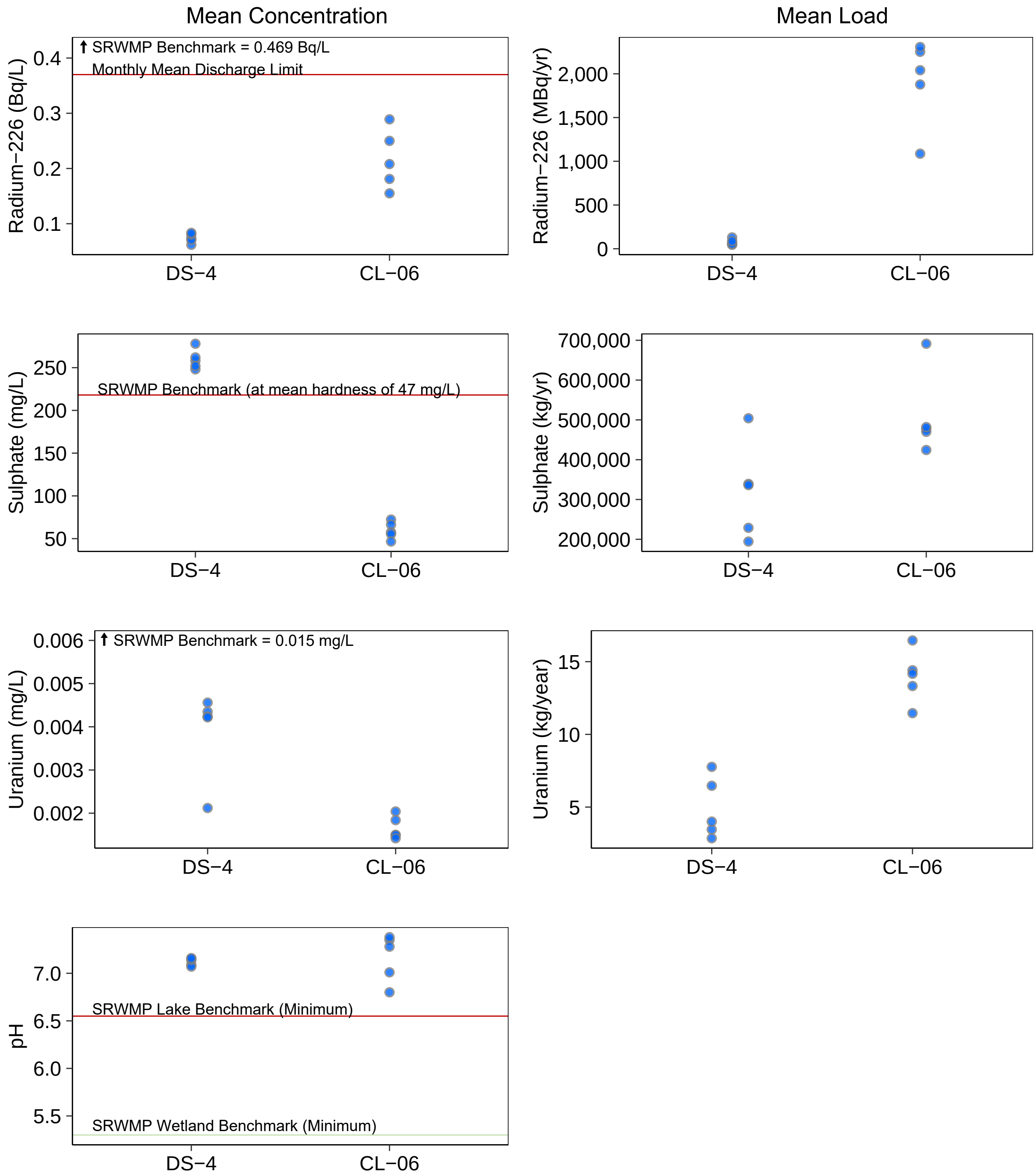


Figure 3.13: Annual Mean Concentrations and Annual Loads at SAMP Monitoring Stations Discharging from Stanrock and Stanleigh TMAs into the May Lake Sub-watershed, 2015 to 2019

Notes: SRWMP benchmarks (Table 2.8) apply to the receiving environment and are based on background (reference) concentrations or approved guidelines, provided here for context, but they are not criteria that need to be met for discharge to occur. Values at the LRL (open circles) were replaced with the LRL for calculations. See Appendix Tables M.2 and M.4 for raw data.

Table 3.11: Seasonal Kendall Trend Analysis for Water Quality Parameters, SAMP Water Quality Monitoring Stations in Stanleigh TMA and Stanrock TMA, Discharging to the May Lake Sub-watershed, 2003 to 2019

Station	Stanleigh TMA	Stanrock TMA
	CL-06	DS-4
	Principal	Principal
Barium (mg/L)	12.0	4.00
Cobalt (mg/L)	nt	-7.50
Iron (mg/L)	-3.10	NS
Manganese (mg/L)	-14.0	-1.70
pH	-0.300	-0.100
Radium (Bq/L)	4.30	NS
Sulphate (mg/L)	-12.0	-3.30
Uranium (mg/L)	-7.10	NS

[green] Significant decreasing temporal trend (Seasonal Kendall test for monotonic trend at α = 0.05). Value reported is the Sen's slope reported as a percentage of the median concentration or

[blue] Significant increasing temporal trend (Seasonal Kendall test for monotonic trend at α = 0.05). Value reported is the Sen's slope reported as a percentage of the median concentration or

Note: "NS" = no significant temporal trend (Seasonal Kendall test for monotonic trend at α = 0.05). "nt" = Parameter not tested for this station because >50% of values <LRL . See Appendix Tables M.2 and M.4 for raw data and Appendix Figures M.1 to M.9 for time series plots of the trends.

and M.5 to M.8). Both barium and pH are directly influenced by effluent treatment (and pH has remained near neutral despite the decrease observed), thus trends are more reflective of treatment efficiency.

Treated effluent from the Stanleigh Facility (CL-06) has also shown improvement over time, based on decreasing concentrations of cobalt, iron, manganese, sulphate, and uranium (Table 3.11; Appendix Figures M.1 to M.8). These changes were consistent with improvements in TMA water quality (see Section 3.3.2.2). However, both barium and radium-226 have increased over time, in response to refractory radium and initial treatment through increasing barium chloride. Since the introduction of XSB in 2018, both radium-226 and barium concentrations have decreased (i.e., peak in 2017; Appendix Figures M.1 and M.6). Similar to Stanrock, pH in effluent is managed by lime addition, and the slight temporal decrease observed (with pH continuing to be near-neutral) likely reflects treatment efficacy.

3.5 SRWMP Water Quality

In the May Lake sub-watershed, receiving water quality is assessed semi-annually at the outlets of McCabe Lake (SR-06) and May Lake (SR-15), and quarterly at the outlet of Halfmoon Lake (DS-18; Figures 2.1 and 2.2). Over the 2015 to 2019 period, annual mean concentrations of water quality analytes at SR-06, DS-18, and SR-15 were consistently lower than (or greater than for pH) SRWMP benchmarks (Figure 3.14; Appendix Tables S.9 to S.11). Sulphate and uranium concentrations decreased significantly at all three receiving water quality monitoring stations since 2003, indicating continued improvements in water quality (Table 3.12; Appendix Figures S.5 and S.6). In contrast, barium concentrations were observed to increase significantly over time at all stations (Table 3.12; Appendix Figure S.1), while iron at station DS-18 and radium-226 at station SR-06 were also found to increase (although from 2018 to 2019 there was a drop in radium-226 concentrations at DS-18, as well as both barium and radium-226 concentrations at stations SR-06 and SR-15; Table 3.12; Appendix Figures S.1, S.2, and S.4). The increase in radium-226 at SR-06 was associated with refractory radium and treatment trials in 2015 and 2016 (as described above in Section 3.3.2.4 and Appendix K). The lower concentrations of radium-226 and barium observed in 2018 and 2019 reflect the effectiveness of the XSB treatment. A slight but significant decrease in pH was further noted at DS-18, but pH values have continued to be circumneutral since 2003 (Table 3.12; Appendix Figure S.11).

Loadings are measured at the outlets of Halfmoon Lake (DS-18) and McCabe Lake (SR-06), and compared to upstream source area stations (i.e., DS-4 and CL-06, respectively). At the outlet of Halfmoon Lake (DS-18), loadings of barium, sulphate, and uranium were similar to those measured upstream at DS-4, whereas loadings of iron and radium-226 were higher (Figure 3.14). The higher loadings at DS-18 relative to DS-4 for iron and radium-226 may be indicative of

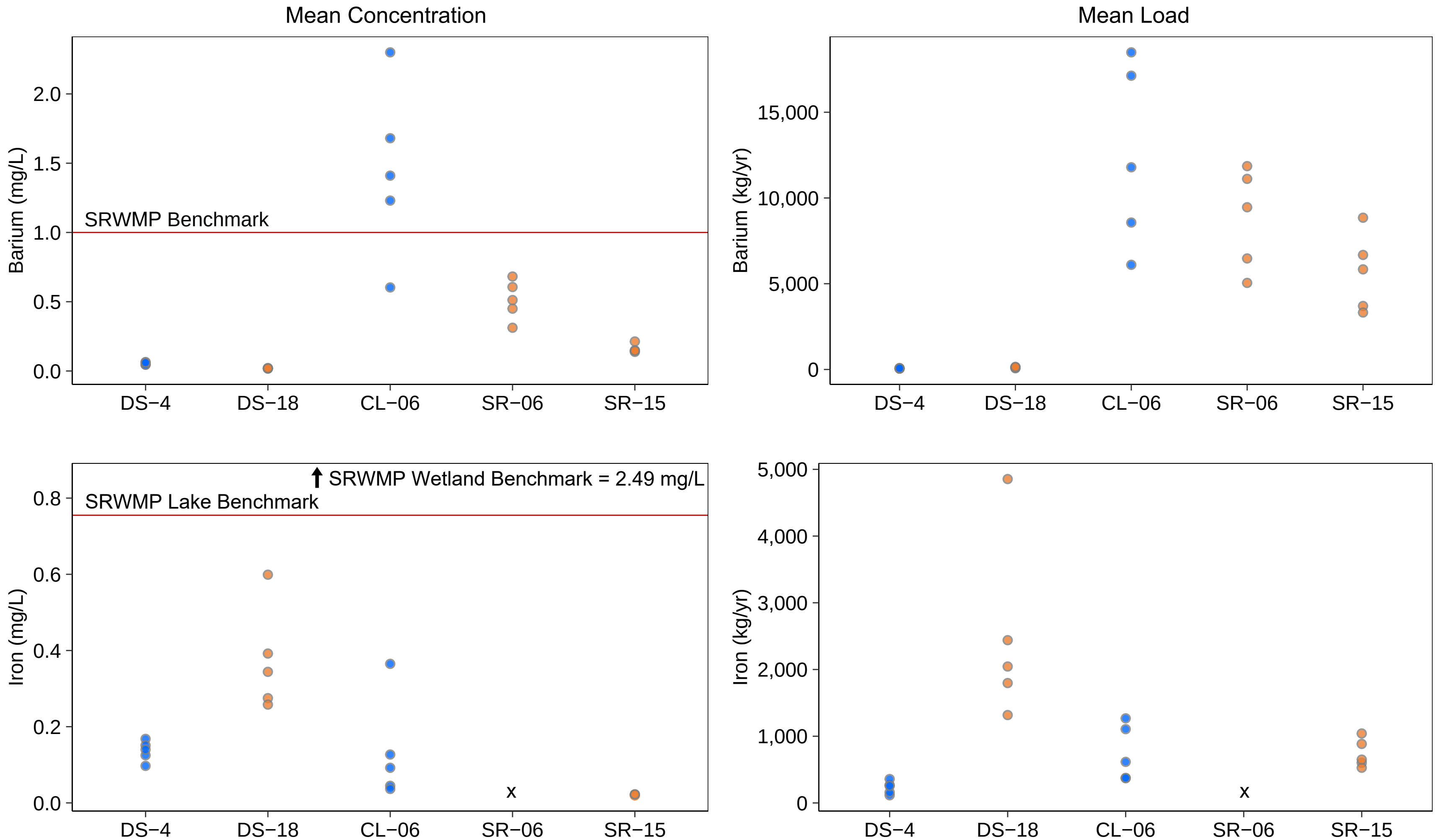


Figure 3.14: Annual Mean Concentrations and Annual Loads at SAMP and SRWMP Monitoring Stations Downstream of Stanrock and Stanleigh TMAs, 2015 to 2019

Notes: Blue circles represent SAMP stations, orange circles represent SRWMP stations. SRWMP benchmarks (Table 2.8) apply to the receiving environment and are based on background (reference) concentrations or approved guidelines, and is not applicable to SAMP stations. Values at the LRL (open circles) were replaced with the LRL for calculations. X indicates that parameter is not monitored for a given station. See Appendix Tables M.2,M.4, and S.9 to S.11 for raw data and Table M.7 for annual discharge and seepage loadings.

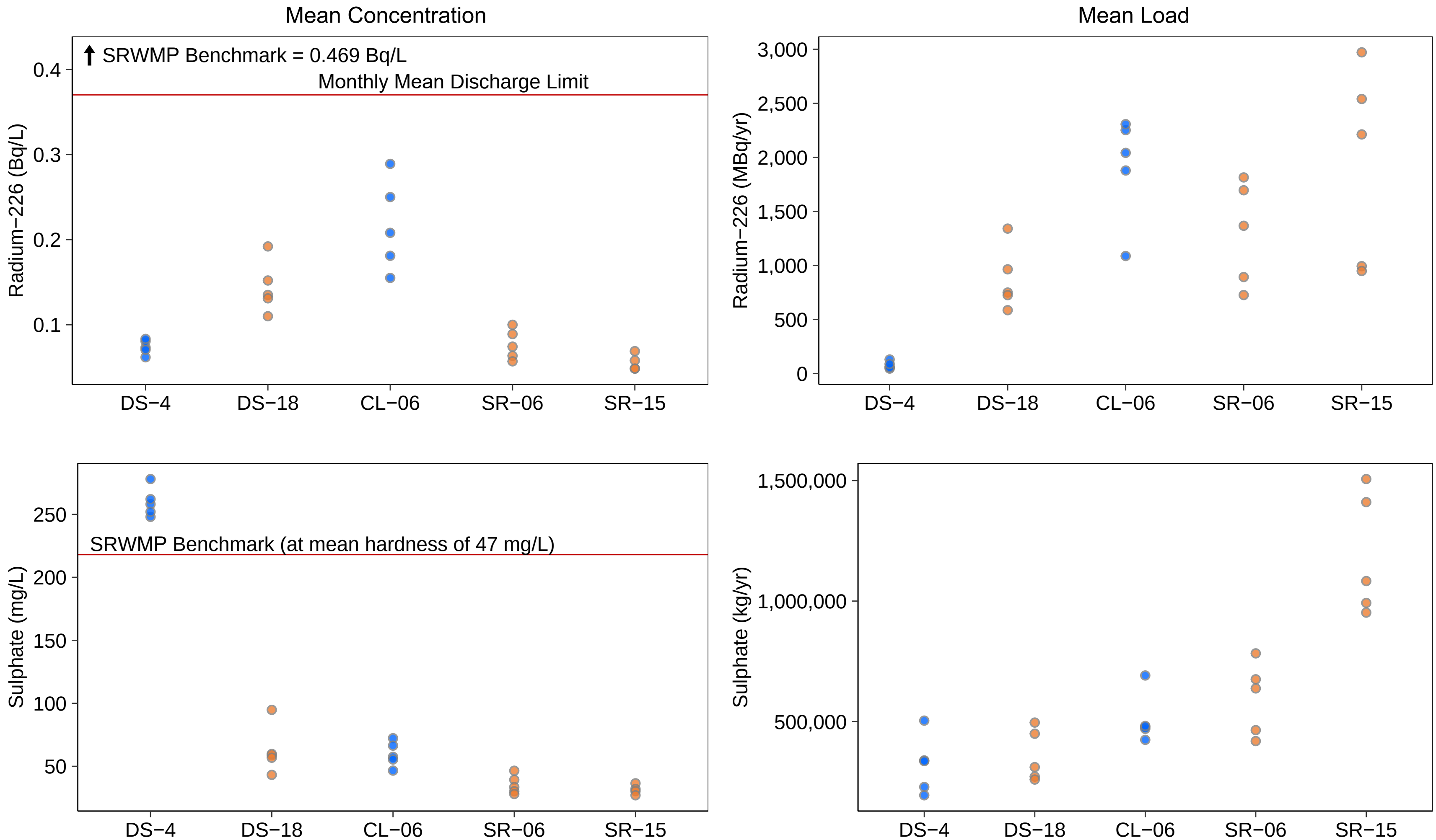


Figure 3.14: Annual Mean Concentrations and Annual Loads at SAMP and SRWMP Monitoring Stations Downstream of Stanrock and Stanleigh TMAs, 2015 to 2019

Notes: Blue circles represent SAMP stations, orange circles represent SRWMP stations. SRWMP benchmarks (Table 2.8) apply to the receiving environment and are based on background (reference) concentrations or approved guidelines, and is not applicable to SAMP stations. Values at the LRL (open circles) were replaced with the LRL for calculations. X indicates that parameter is not monitored for a given station. See Appendix Tables M.2,M.4, and S.9 to S.11 for raw data and Table M.7 for annual discharge and seepage loadings.

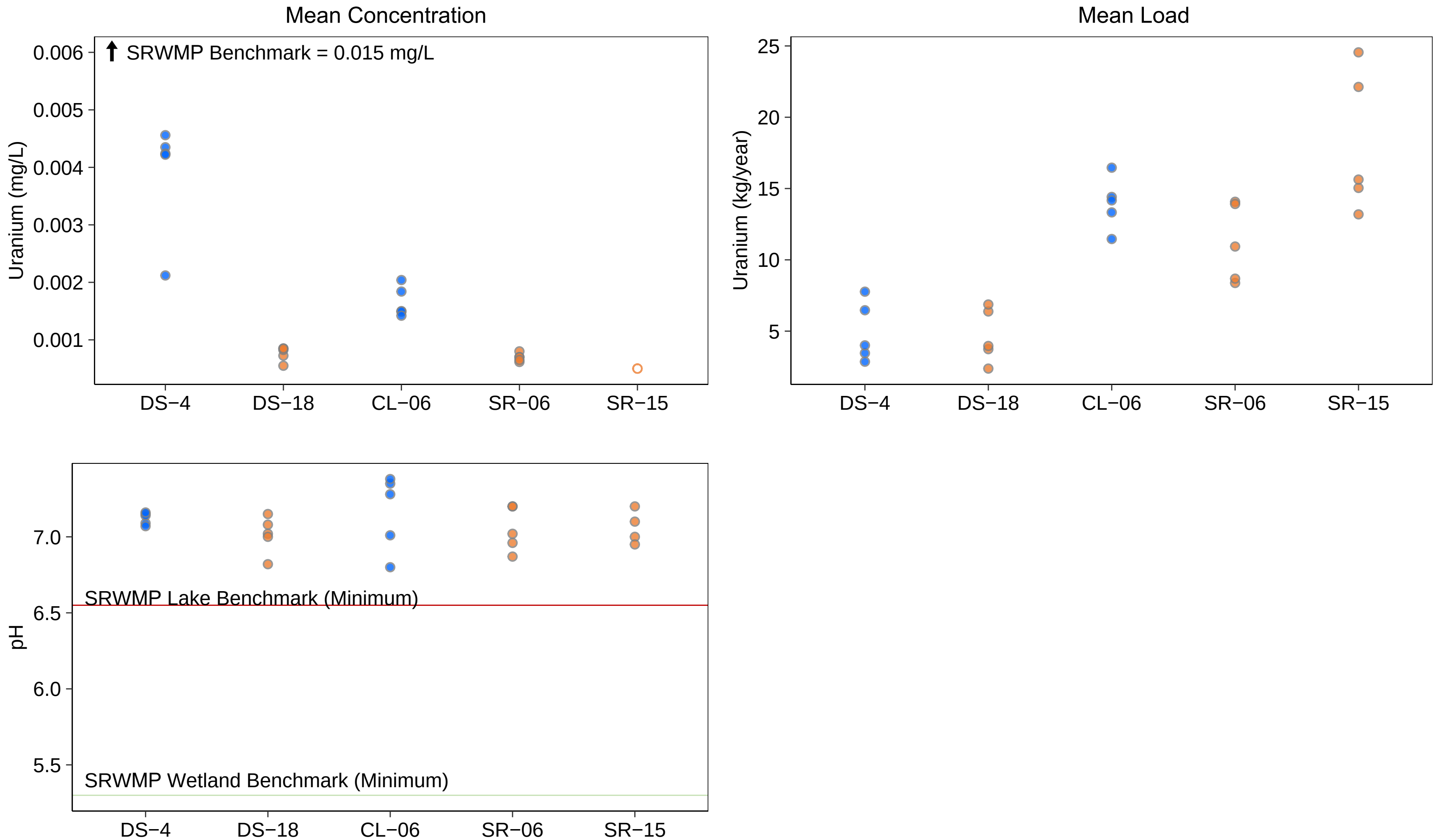


Figure 3.14: Annual Mean Concentrations and Annual Loads at SAMP and SRWMP Monitoring Stations Downstream of Stanrock and Stanleigh TMAs, 2015 to 2010

Notes: Blue circles represent SAMP stations, orange circles represent SRWMP stations. SRWMP benchmarks (Table 2.8) apply to the receiving environment and are based on background (reference) concentrations or approved guidelines, and is not applicable to SAMP stations. Values at the LRL (open circles) were replaced with the LRL for calculations. X indicates that parameter is not monitored for a given station. See Appendix Tables M.2,M.4, and S.9 to S.11 for raw data and Table M.7 for annual discharge and seepage loadings.

Table 3.12: Seasonal Kendall Trend Analysis for Water Quality Parameters, SRWMP Water Quality Monitoring Stations in the May Lake Sub-Watershed, 2003 to 2019

Station	Reference					Mine-Exposed		
	D-4	SR-19	SR-18	SR-16	SR-17	SR-06	DS-18	SR-15[a]
Barium (mg/L)	NS	NS	NS	NS	NS	15.0	3.30	27.0
Iron (mg/L)	NS	NS	NS	NS	NS	na	6.00	NS
Manganese (mg/L)	NS	NS	NS	NS	NS	na	NS	na
pH	NS	NS	NS	NS	1.10	NS	-0.300	NS
Radium (mg/L)	nt	nt	nt	nt	nt	6.00	NS	NS
Sulphate (mg/L)	-3.30	-3.10	-4.50	-6.40	-5.50	-13.00	-1.90	-7.00
Uranium (mg/L)	nt	nt	nt	nt	nt	-6.70	-3.60	-3.90

(Green) Significant decreasing temporal trend (Seasonal Kendall test for monotonic trend at α = 0.05). Value reported is the Sen's slope reported as a percentage of the median

(Blue) Significant increasing temporal trend (Seasonal Kendall test for monotonic trend at α = 0.05). Value reported is the Sen's slope reported as a percentage of the median concentration or value.

Notes: See Appendix Tables S.4 to S.11 for raw data. See Appendix Figures S.1 to S.6 for time series plots of the trends. NS = No significant temporal trend (Seasonal Kendall test for monotonic trend at α = 0.05). nt = Parameter not tested for this station because >50% of values <LRL. na = Parameter not assessed for this station, as per study design.

[a] May Lake outlet station SR-15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium-226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014.

contaminant release from sediments in Halfmoon Lake, possibly associated with flushing of historical deposits as overlying water quality improves. At the outlet of McCabe Lake, loadings were either similar to, or lower than, loadings at CL-06 (Figure 3.14).

Water quality at DS-18 is meeting EIS predictions for sulphate, with concentrations close to or better than the 2099 cumulative prediction (Figure 3.15). In contrast, radium-226 concentrations appear to have increased over the 2015 to 2018 period, and are ranging closer to, or above the 1999 cumulative prediction (Figure 3.15). A similar pattern was observed at SR-06, where sulphate concentrations have been decreasing steadily and appear on target to achieve predicted values for 2099, but radium-226 concentrations increased until 2018 in response to refractory radium (Figure 3.16). It is expected that the use of XSB in treatment will produce lower radium concentrations in effluent which in turn will continue to be reflected downstream. Uranium concentrations have been steadily decreasing at SR-06, and since 2003 have consistently been below the 2012 prediction.

3.6 Summary

Water quality within the May Lake sub-watershed is monitored under three separate programs, the TOMP, SAMP, and SRWMP. Mine-related sources to the sub-watershed include the Stanrock and Stanleigh TMAs, both of which discharge treated effluent to different locations within the sub-watershed.

Stanrock is a vegetative covered TMA, and as such, there is no surface water within the TMA. Instead, surface water runoff and seepage are collected in a holding pond prior to treatment. Since 2003, ETP influent quality has generally improved, although concentrations of barium and radium-226 have increased slightly, and pH has remained acidic. Pore water quality within the TMA has remained similar or deteriorated over time, whereas groundwater quality has generally improved, based on decreasing concentrations of acidity, iron, and/or sulphate, and increasing pH.

Water treatment at the Stanrock ETP includes both lime and barium chloride additions to decrease acidity and radium-226, respectively. Over the 2015 to 2019 period, treated effluent was non-lethal to *D. magna* and rainbow trout, and reproduction of *C. dubia* was not affected by exposure to 100% effluent in all but one test (effluent concentration = 55%). Final treated effluent has generally been improving over time, based on decreasing concentrations of cobalt, manganese, and sulphate.

Stanleigh is a flooded TMA, with water levels maintained within minimum and maximum operating elevations. Surface water quality in the Stanleigh TMA has improved significantly over time, based on decreasing concentrations of cobalt, iron, manganese, radium-226, sulphate,

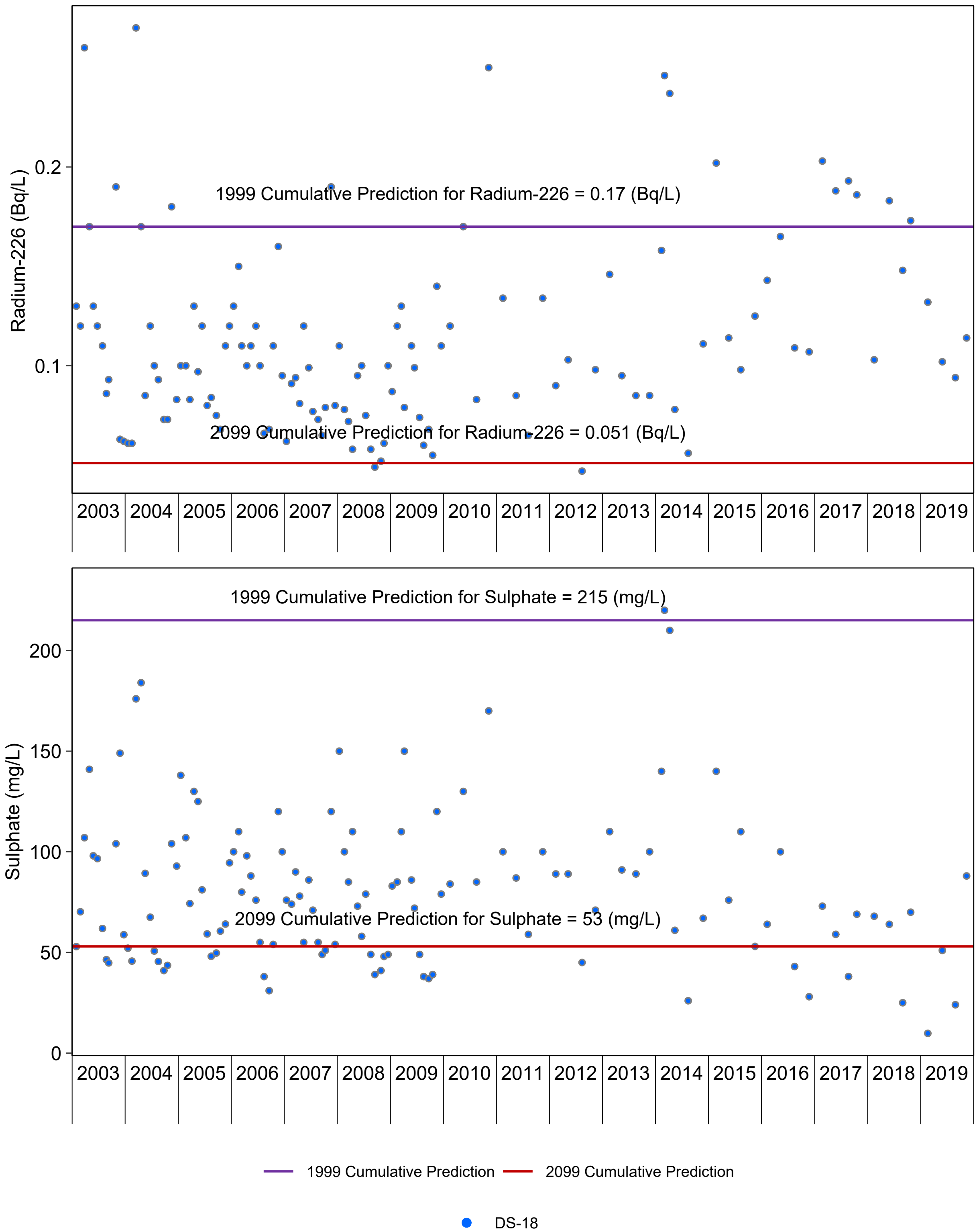


Figure 3.15: Concentrations of Radium-226 and Sulphate at SRWMP Station DS-18 (Halfmoon Lake Outlet) Compared to Cumulative Predictions (1999 and 2099)

Notes: Prediction values for 1999 and 2099 based on cumulative effects assessment (CNSC 2002). Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Table S.9 for raw data.

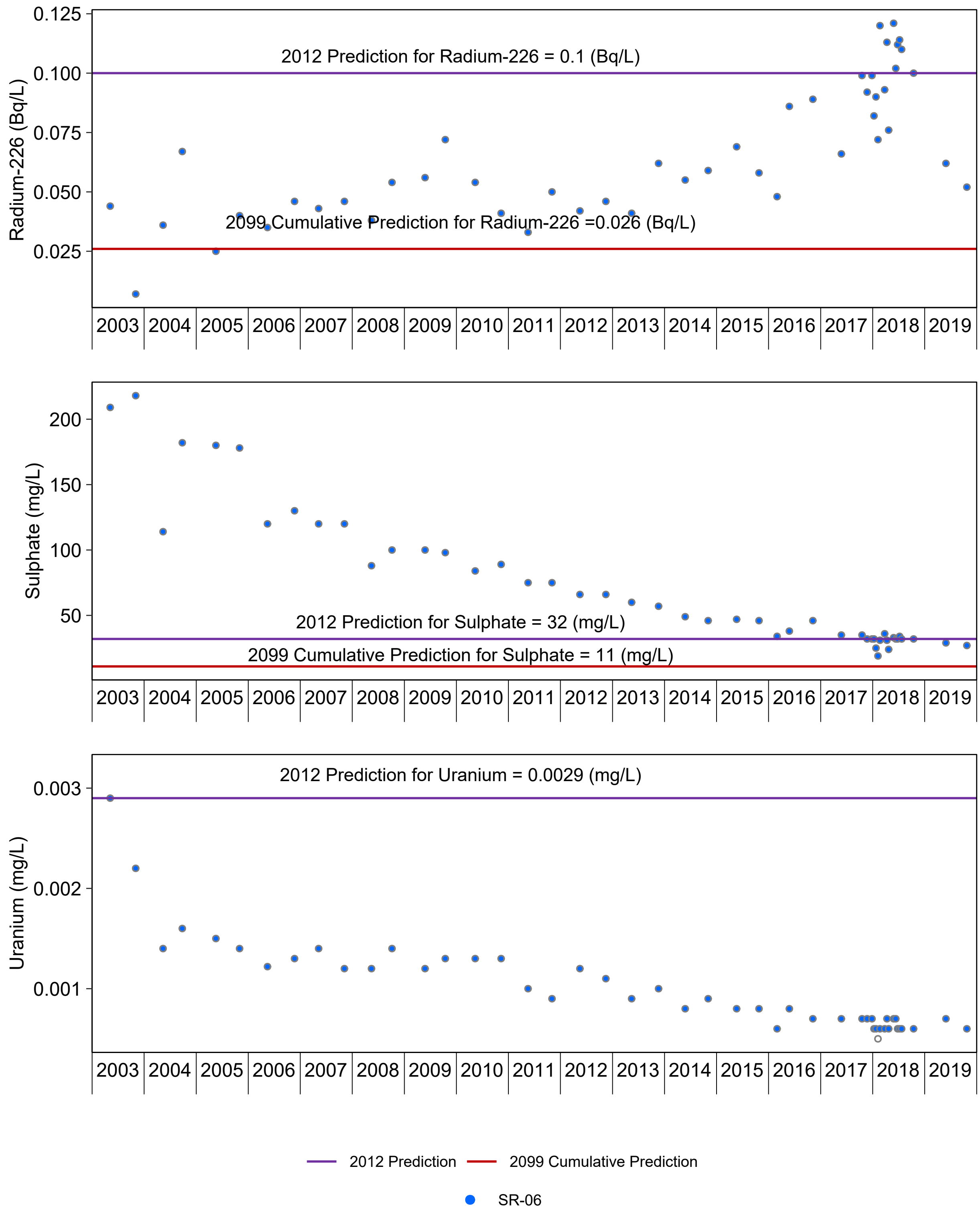


Figure 3.16: Concentrations of Radium-226, Sulphate, and Uranium at SRWMP Station SR-06 (McCabe Lake Outlet) Compared to Cumulative Predictions (2012 and 2099)

Notes: Predicted Uranium values converted from Bq/L to mg/L. 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 timeline for the graphs of predicted concentrations. Prediction values for 2099 are based on cumulative effects assessment (CNSC 2002). Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Table S.10 for raw data.

and uranium. Groundwater quality downgradient of the TMA dams has also shown improvements over time. However, there is some concern that decreasing sulphate concentrations within the TMA may have the effect of increasing in-basin radium-226 concentrations in the future.

Water treatment at the Stanleigh ETP includes addition of lime to reduce acidity as well as barium chloride (until April 2018) or XSB (after April 2018; for treatment of refractory radium) to reduce radium-226. Prior to the introduction of XSB, barium chloride consumption fluctuated in response to the occurrence of refractory radium. In addition, discharge rates were varied to see if a change in throughput and residence time could improve treatment efficacy. Since the switch to XSB, the consumption of barium has largely fluctuated with the volume of water requiring treatment, whereas lime consumption decreased substantially over the 2015 to 2019 period, reflecting the circumneutral pH within the TMA basin. Overall, effluent quality improved over time consistent with improvements in TMA water quality, achieved discharge criteria (particularly after the switch to XSB), and was consistently non-lethal to rainbow trout, and had no effects on reproduction of *C. dubia*. Two of 24 toxicity tests on *D. magna* exhibited minimal mortality in 100% effluent, whereas no mortality was reported in all other tests, and no toxicity would be expected in the receiving environment due to effluent dilution.

In the receiving environment downstream of the Stanrock and Stanleigh treated discharges, water quality consistently met SRWMP benchmarks over the 2015 to 2019 period, concentrations of sulphate and uranium have decreased over time, pH was circumneutral, and concentrations of barium have increased. Loadings to the receiving environment from the Stanrock TMA were consistently lower than loadings associated with the Stanleigh TMA. While loadings of barium, sulphate, and uranium at the outlet of Halfmoon Lake were similar to those measured upstream, loadings of iron and radium-226 were higher, potentially indicative of flushing of historical deposits as overlying water quality improves. At the outlet of McCabe Lake, loadings were either similar to, or lower than loadings from the Stanleigh TMA.

4 QUIRKE LAKE SUB-WATERSHED

4.1 Background

4.1.1 Quirke Lake Sub-Watershed

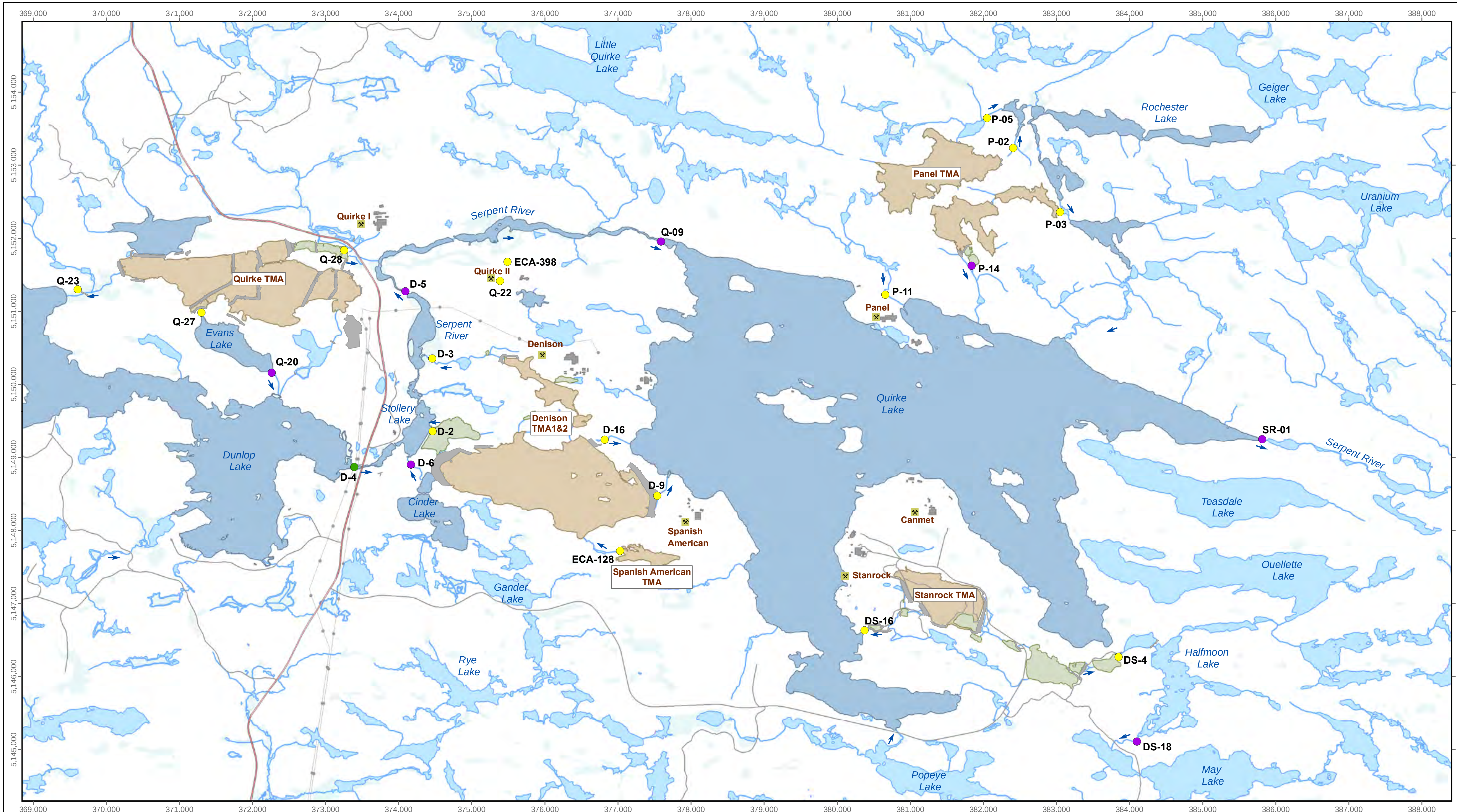
The Quirke Lake sub-watershed is within the SRW and has an area of approximately 313 km^2 (Figure 2.1). Quirke Lake is one of the largest lakes in the Serpent River watershed (maximum depth of 104 m and a surface area of 2,100 ha). The Serpent River flows through Quirke Lake, entering on the north west shore and exiting about five kilometres downstream at the northeast end of the lake (Figure 4.1). This sub-watershed receives discharges from the following TMA facilities:

- Denison TMA (Figures 4.1 and 4.2) which incorporates drainage from the Spanish American TMA, discharges to the Serpent River upstream of Quirke Lake and downstream of Dunlop Lake with seepage from Dam 9 and 17 reporting directly to Quirke Lake;
- Spanish-American TMA (Figure 4.3), which discharges to Denison TMA 1;
- Quirke TMA (Figures 4.1 and 4.4) which discharges into the Serpent River upstream of Quirke Lake but downstream of the Denison TMA and seepage from the former Quirke II mine draining to the Serpent River downstream of the effluent discharge;
- Stanrock TMA (see Section 3.1.2; Figure 3.2) which discharges seepage from Dam M to the south east shore of Quirke Lake; and
- Panel TMA (Figures 4.1 and 4.5) which discharges seepage and final effluent to Quirke Lake via small tributaries and Rochester Creek.

4.1.2 Denison TMA

4.1.2.1 Site History and Existing Operations

The Denison Facility is located 16 km north of the City of Elliot Lake. The facility consists of a decommissioned mine and mill, two TMAs; TMA 1 (formerly Bear Cub and Long Lake) and TMA 2 (formerly Upper Williams Lake). TMA 1 is the larger of the two basins and receives drainage from the Spanish American TMA, which is located immediately south east of TMA 1 (Figure 4.2). Flow from TMA 2 decants into TMA 1 prior to effluent treatment. The facility includes an ETP located at the northwest corner of TMA 1, an effluent spillway; and a settling pond.



LEGEND

- Mine Discharge (SAMP)
- Mine-exposed (SRWMP)
- Reference (SRWMP)
- Mine Site
- Dam
- Collection and Settling Pond
- Tailings Management Area (TMA)

0 0.75 1.5 3 km

Projection: North American Datum 1983 UTM Zone 17
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N E S W

Quirke Lake Sub-watershed Mine Source and Receiving Environment Stations

Date: March 2021
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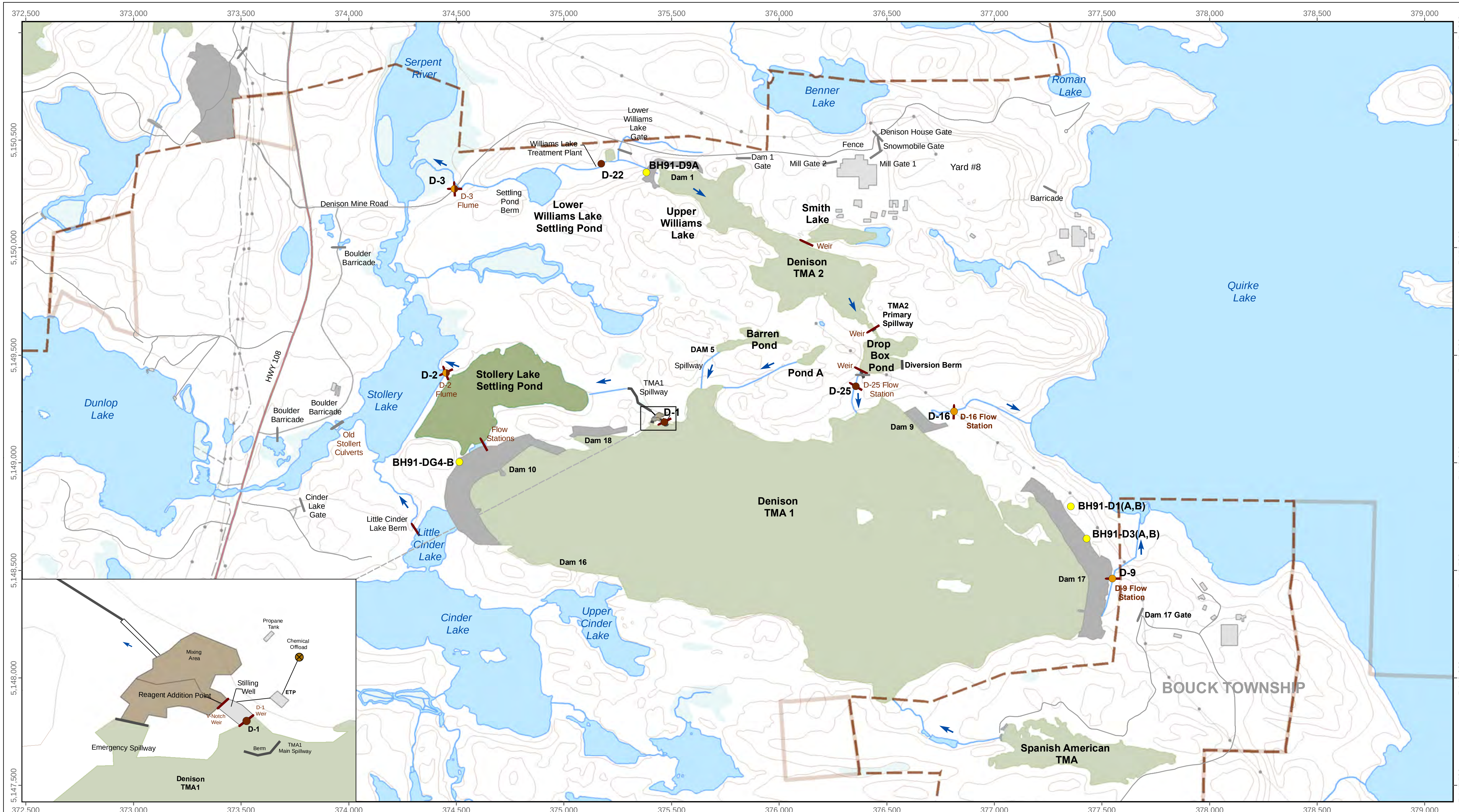
Figure 4.1



LEGEND

Monitoring Station
- SAMP Surface Water
- TOMP Surface Water
- TOMP Groundwater
- SAMP and TOMP Surface Water

- Water Covered Tailings
- Settling Pond
- MixingArea
- Dam
- Dam

- Contour (10 m)

0 280 560 1,120
Meters

Projection: North American Datum 1983 UTM Zone 17
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N
W E
S

Denison Site SAMP and TOMP Monitoring Stations

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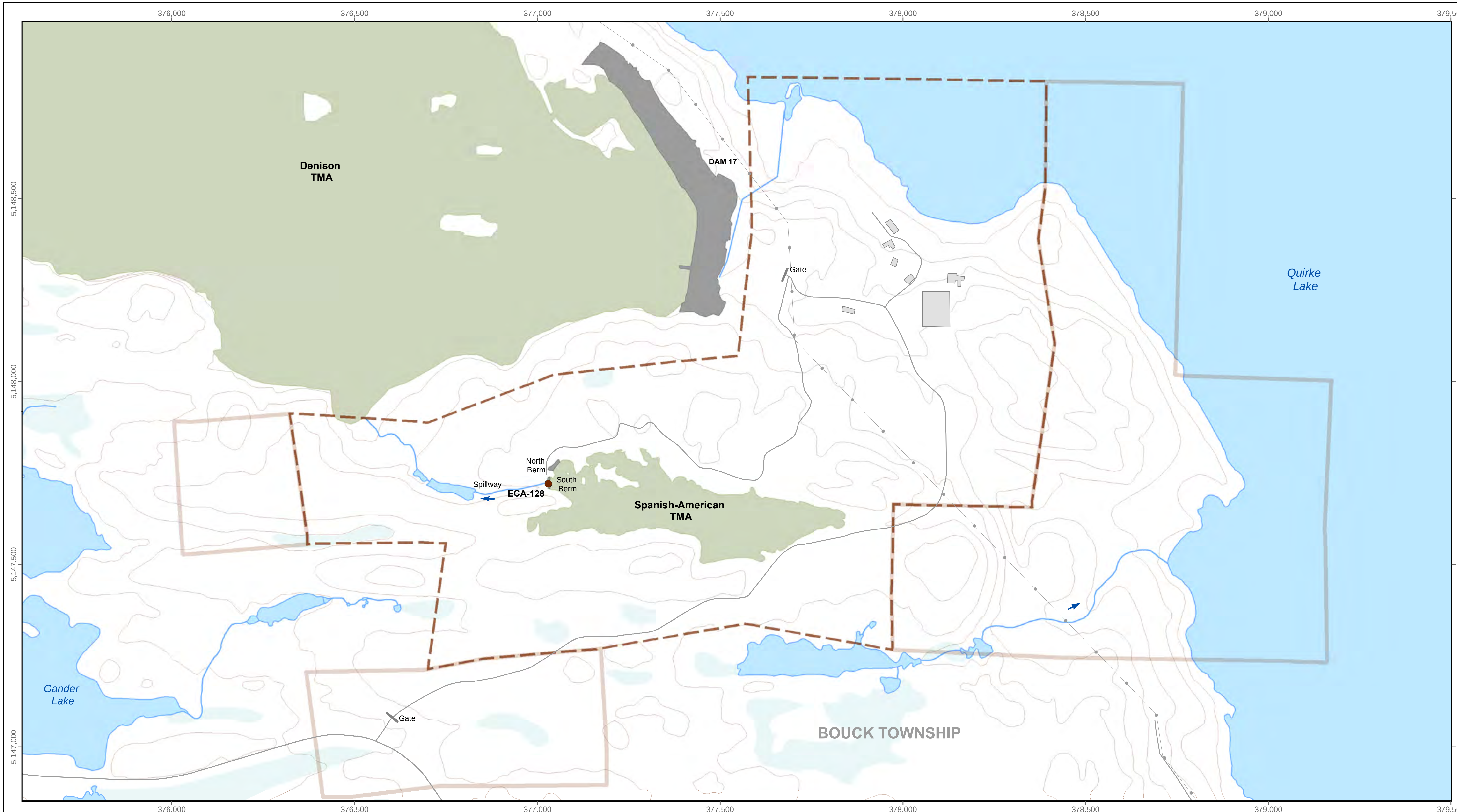
Figure 4.2

Document Path: C:\Users\MLaPalme\Trinity Consultants, Inc\BHP - 197202.0041 - Cycle 5 SOE\4 - GIS\Cycle 5 Report\19-41 Figure 4.2 Denison Site SAMP and TOMP Monitoring Stations.mxd



LEGEND
Sampling Station
● TOMP Surface Water

Water Covered Tailings

Limits of CNSC Licence
Limits of Unlicenced Property
Dam
Contour (10 m)

0 165 330 660
Meters

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N S W E

Spanish American TMA TOMP Monitoring Station

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Figure 4.3

Document Path: C:\Users\MLaPalme\Trinity Consultants, Inc\BHP - 197202.0041 - Cycle 5 SOE\4 - GIS\Cycle 5 Report\19-41 Figure 4.3 Spanish American TMA TOMP Monitoring Stations.mxd

LEGEND

Monitoring Station

- SAMP Surface Water
- TOMP Surface Water
- TOMP Groundwater
- TOMP Pore Water
- SAMP and TOMP Surface Water

Water Covered Tailings

Settling Pond

Limits of CNSC Licence

Limits of Unlicenced Property

Contour (10 m)

0 285 570 1,140

Meters

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N S E W

Quirke Site SAMP and TOMP Monitoring Stations

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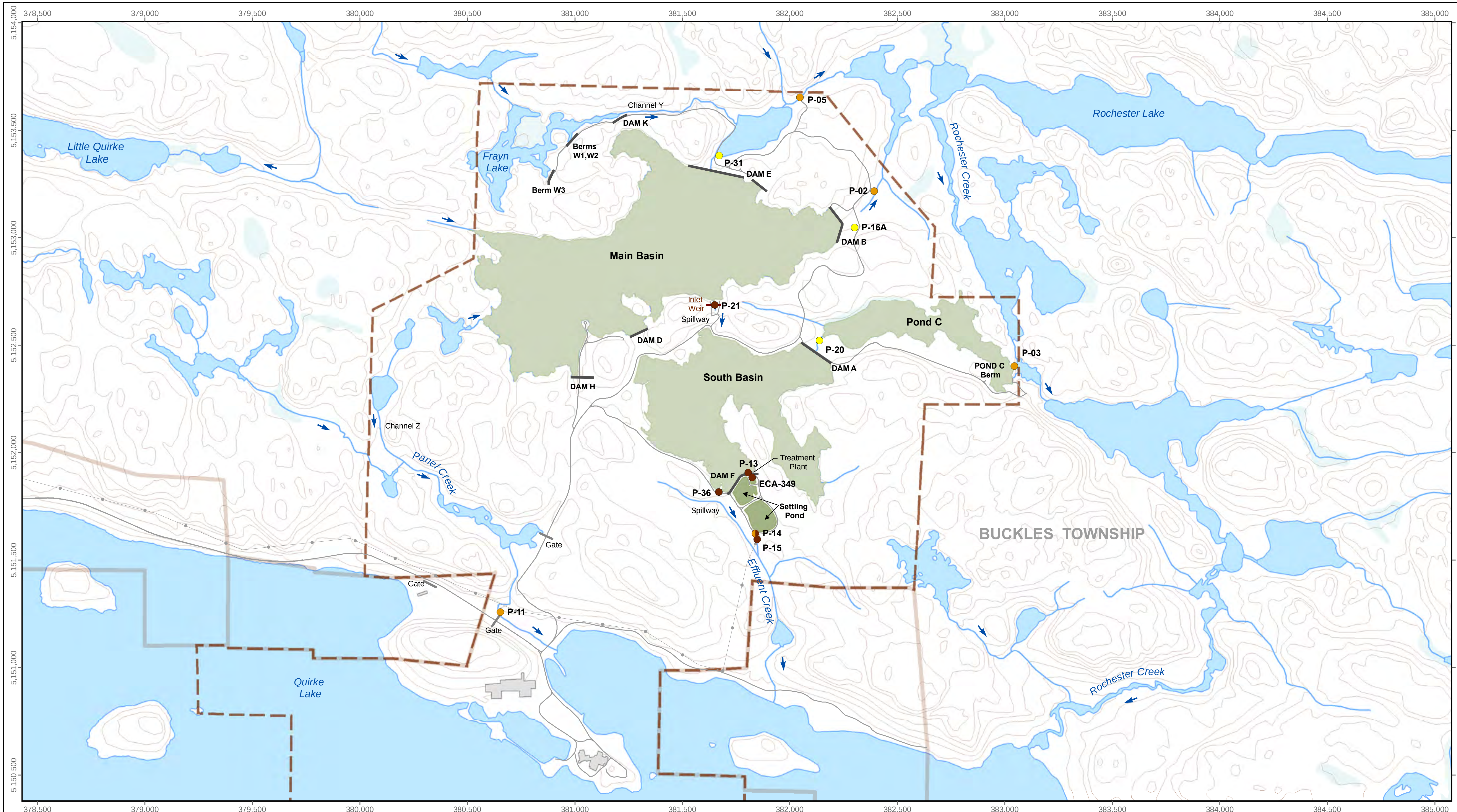
Figure 4.4

Document Path: C:\Users\MLaPalme\Trinity Consultants, Inc\BHP - 197202.0041 - Cycle 5 SOE\4 - GIS\Cycle 5 Report\19-41 Figure 4.4 Quirke Site SAMP and TOMP Monitoring Stations.mxd



LEGEND

Monitoring Station

- SAMP Surface Water
- TOMP Surface Water
- TOMP Groundwater
- SAMP and TOMP Surface Water

Water Covered Tailings

Settling Pond

Limits of Unlicenced Property

Limits of CNSC Licence

Contour (10 m)

0 0.25 0.5 1 Kilometers

Projection: North American Datum 1983 UTM Zone 17
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N E S W

Panel Site SAMP and TOMP Monitoring Stations

Date March 2021
Project 197202.0041

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Figure 4.5

Document Path: C:\Users\MLaPalme\Trinity Consultants, Inc\BHP - 197202.0041 - Cycle 5 SOE\4 - GIS\Cycle 5 Report\19-41 Figure 4.5 Panel Site SAMP and TOMP Monitoring Stations.mxd

The Denison mine and mill operated from 1957 to 1992, during which, 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 TMA1 (Figure 4.2). TMA 2 was used from start-up until it was filled in the early 1960s. After TMA 2 was filled, tailings were discharged into the Bear Cub Lake basin, which eventually merged with the Long Lake basin to form TMA 1. 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 (Table 4.1).

At the Denison Facility, 60 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 4.2). Effluent/decant from TMA 2 flows into TMA 1 via the TMA 2 spillway. The Denison 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 4.2). Seepage from TMA 2 is treated at the Williams Lake Treatment Plant which drains to the Lower Williams Lake Settling Pond prior to discharge to the Serpent River (Figure 4.2). Seepage at the east end of TMA 1 from Dams 9 and 17 drains to the west shore of Quirke Lake.

4.1.2.2 Conceptual Hydrogeologic Model

Overburden in the vicinity of the Denison TMA 1 and TMA 2 is limited and is disconnected from the TMAs (Golder 2020; Appendix L). Therefore, groundwater flow pathways are governed by the prevalence of bedrock outcrops that form ridges containing the TMAs, with groundwater flow from the TMAs occurring primarily through shallow fracture systems along areas with topographic lows. Seepage that exits Denison TMA 2 is expected to report toward the south to TMA 1 as well as toward the northwest, daylighting at the toe of Dam 1. Seepage pathways associated with deeper groundwater flow systems underlying Dam 1 are directed toward the William Lake ETP, prior to discharge into the Serpent River, upstream of Quirke Lake. Groundwater flow pathways from Denison TMA 1 exit mainly through/under Dam structures at both the east and west ends (Golder 2020; Appendix L). At the east end, groundwater flows toward the east through Dam 9 and Dam 17, and in fractured bedrock between and underlying the Dams, ultimately reporting to Quirke Lake (monitored at D-16 and D-9). At the western end of TMA 1, preferential groundwater seepage pathways have been identified in shallow bedrock underlying Dam 10, with horizontal hydraulic gradients that direct groundwater flow toward the

Table 4.1: Denison TMA Site Improvement Undertakings Since Closure

Year	Action	Rationale for Action
1992 to 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 to 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 4.1: Denison TMA Site Improvement Undertakings Since Closure

Year	Action	Rationale for Action
2015	Lowered the spillway of the filter berm, which lowered the level of Stollery Lake.	Allows for better monitoring of the seepage rates below Dam 10 which were partially submerged when the berm was constructed.
	TMA-2 outlet stop log structure was replaced with a more secure concrete structure as older stop logs showed sign of deterioration.	To secure containment and management of basin elevation.
	Drop Box Pond diversion berm was raised by one foot and a rock fill cover was applied.	Improve erosion protection.
	Upgrades to Williams Lake Effluent Treatment Plant at TMA-2. Included raised height of existing building, new tanks for chemical storage, new shingles and a new garage door was installed.	The raised height of the existing building allows for reagent spill containment. Old steel reagent tanks were replaced with plastic tanks.
2016	Placing additional boulders in areas of ATV access in Cinder Lake area.	Discourage public access.
	Boulders placed at end of Dyke 8.	Safety precaution for vehicles turning around.
2017	Chemical loading pad at TMA-1 was leveled with additional layer of sand and rock.	Safety precaution for vehicles off loading chemicals.
	Radon Fan Installed at TMA-1.	Ensure levels remain low for worker safety.
2018	Rain gauge installed at TMA-1 ETP .	To better monitor precipitation received in the area throughout the summer months.
	A secondary spill containment pad was installed at the chemical off loading area at the TMA-1 ETP.	Spill containment for off loading chemicals.
2019	The NaOH tank was drained and cleaned and barium chloride was then added to this secondary tank.	After barium chloride consumption increased at TMA-1 ETP, the creation of a secondary barium chloride tank reduced the need for continual transport of barium chloride to the site.
	Platform was fabricated and installed at TMA-1 ETP chemical offloading area.	Allow safer unloading of reagents.
	Heating lamp installed in the storage building wet well at TMA-1. This is where the pond elevation is monitored through the SCADA.	To prevent freezing and to ensure accurate elevation readings during the winter months. Also eliminates the need to heat the building and reduces costs.
	A chemical offloading spill containment unit was constructed and installed.	Spill containment for off loading chemicals.

Notes: TMA = tailings management area. ETP = effluent treatment plant. ATV = all-terrain vehicle. SCADA = supervisory control and data acquisition.

Stollery Lake Settling Pond and, potentially, Little Cinder Lake. Stollery Lake Settling Pond and Little Cinder Lake flow into the Serpent River, and then ultimately into Quirke Lake.

4.1.3 Spanish-American TMA

4.1.3.1 Site History and Existing Operations

The Spanish-American mine and mill operated from 1958 to 1959. During that time, the mine deposited approximately 0.45 million tonnes of tailings into the Spanish-American TMA. Since 1994, continual improvements have been made to the site to improve water quality and to manage tailings (Table 4.2). Notable events include moving approximately 90,000 m^3 of exposed tailings beaches at the eastern end of the 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 TMA (Table 4.2).

There is no ETP at the Spanish-American TMA. Drainage from the 37 ha Spanish-American TMA watershed is monitored at station ECA-128 as it passes through the South Berm spillway to Denison TMA 1 (Figure 4.3).

4.1.3.2 Conceptual Hydrogeologic Model

The Spanish-American TMA consists of flooded tailings that are contained within a basin characterized by surficial bedrock and surrounded by bedrock ridges/knobs (Golder 2020; Appendix L). The North and South berms on the western portion of the Spanish-American TMA control overflow of tailings effluent from the TMA (Figure 4.3). The majority of groundwater seepage and flow from the Spanish-American TMA is anticipated to pass through the berm structures or along fractured, shallow bedrock underlying the berms, ultimately connecting with the spillway. The spillway directs surface water flows and groundwater seeps northwest toward the Denison TMA (Golder 2020; Appendix L).

4.1.4 Quirke TMA

4.1.4.1 Site History and Existing Operations

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 (referred to as Quirke I), and again from 1968 to closure in 1990 (Quirke II). 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 4.4).

Table 4.2: 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 0.9 m and a maximum depth of 1.5 m.
1994 to 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.
2017	Lowering and resurfacing of emergency spillways.	To restore spillways to design elevations.

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 4.3).

4.1.4.2 Conceptual Hydrogeologic Model

Within the perimeter of the Quirke TMA, more permeable overburden deposits are limited and discontinuous (Golder 2020; Appendix L). Therefore, groundwater flow and seepage pathways under the TMA are anticipated to be predominately through the uppermost fractured zones in shallow bedrock. In areas downgradient of the TMA, groundwater flow is predominately through overburden deposits present in valleys located along the northeast, east, and south perimeters of the Quirke TMA. Seepage in the Quirke TMA is controlled by the variable elevation of the five terraced cells that were constructed to direct water eastward toward the treatment plant, prior to discharge into the Serpent River (Figure 4.4). Groundwater flow from Cell 18 reports to the northeast and ultimately reports to the Serpent River upstream of Quirke Lake (Figure 4.4). In addition to seepage between the terraced cells, groundwater flow from Cell 14 (in part) reports to the west via Dam K1 into the northeastern end of Dunlop Lake (upstream of the Serpent River and Quirke Lake), and groundwater flow from Cell 16 (in part) reports to the southwest via Dam I into Evans Lake (Figure 4.4; Golder 2020; Appendix L).

4.1.5 Panel TMA

4.1.5.1 Site History and Existing Operations

The Panel TMA is located 19 km northeast of the City of Elliot Lake, and is immediately north of Quirke Lake. The TMA is composed 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 (RAL 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 ha (Figure 4.5). 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 (RAL 2000; Figure 4.5). Pond C contains a small volume of fine tailings and treatment solids and receives seepage from Dam A and runoff from its 65 ha drainage area. Dam K and

Table 4.3: Quirke TMA Site Improvement Undertakings Since Closure

Year	Action	Rationale for Action
1989 to 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 to 1992	Dyke 14 raised to form Cell 14.	Submerge tailings with minimum 0.6 m water cover.
1994 to 1996	Dykes 15, 16, 17 constructed.	Submerge tailings with minimum 0.6 m water cover.
1995 to 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.
2016	ETP upgrades including but not limited to replacement of cladding and insulation, upgrade to the electrical system, addition of concrete secondary containment walls around reagent tanks, installation of a new PLC system.	The ETP was constructed in the early 1980's and required maintenance and upgrading to maintain reliable operability.

Table 4.3: Quirke TMA Site Improvement Undertakings Since Closure

Year	Action	Rationale for Action
2017	Installation of lightning and surge protection systems at the ETPs.	Resolve operational issues caused by lightning strikes on incoming power lines and communication towers.
	Raising the elevation of Dam L West	As recommended by the Engineer of Record during the Dam Crest Survey Review.
	Additional piezometers installed on dykes 14 and 15.	Additional instrumentation to inform dam performance.
2018	Manufactured and installed a platform at Q-28 discharge.	To allow for safe access to the sampling location.
2019	Decommissioning and where required reinstalling damaged piezometers as identified by the Engineer of Record.	To maintain valid monitoring instrumentation.
	Lowered Q46 spillway	To restore spillway to design elevations.
	Raise road surface on Dam L	To restore the dam crest to design.
	Piezometer installed on Main Dam	Additional instrumentation to inform dam performance.
	Place additional riprap to repair erosion on south inlet side slope of Dam D.	As recommended by the Engineer of Record during the Dam Safety Inspection.

Notes: TMA = tailings management area. ETP = effluent treatment plant. PLC = programmable logic controller.

Berms W1, W2, and W3 were constructed in 1978 to divert runoff from the sub-watershed north of the Main Basin, east to Rochester Creek through Channel Y (Figure 4.5). Additional surface runoff is diverted away from the west side of the Main Basin to Panel Creek and Quirke Lake via Channel Z, which was also constructed in 1978 (Figure 4.5).

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

After the mine was permanently closed in 1991, the Panel TMA was decommissioned through flooding, with the Main Basin draining into the South Basin via a spillway. The overflow from the South Basin enters the ETP where it is treated with a mixture of lime slurry and barium chloride to neutralize acidity (which controls dissolved metal concentrations) and to precipitate radium-226, respectively. Water levels in the TMA are actively maintained. Improvements have been made since decommissioning (Table 4.4) and have included work to maintain water levels and flow through dam and treatment plant upgrades.

4.1.5.2 Conceptual Hydrogeologic Model

The presence of thin, discontinuous overburden deposits suggests that most, if not all, of the groundwater flow and seepage at the Panel TMA occurs through fracture networks in shallow bedrock (Golder 2020; Appendix L). Within the Main Basin, groundwater seepage is expected to flow through shallow bedrock underlying Dam D toward the South Basin, and through shallow bedrock underlying Dams B and E toward the northeast and into the Rochester Lake flow system which flows in Quirke Lake (Figure 4.5). At the eastern end of the South Basin, tailings seepage is expected to migrate through fractured bedrock underlying Dam A, ultimately discharging into Pond C (Figure 4.5). Any groundwater daylighting to surface within the South Basin is directed via surface flows toward the treatment plant, after which it is discharged into the settling pond at Dam F and ultimately Quirke Lake.

Table 4.4: 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 to 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 to 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.
2017	Relocating the Panel electrical service underground.	Insulation on the aging electrical infrastructure was failing, due to their condition the electrical service was upgraded.
	Spillway from Main basin to South basin lowered	The rock spillway was lowered by excavator with hammer to remove rocks that trapped water in the spillway and restore the spillway to design elevation.
	Installation of lightning and surge protection systems at the ETPs.	Resolve operational issues caused by lightning strikes on incoming power lines and communication towers.
2019	Repairing of the Hypalon liner in and around the settling ponds.	To maintain the integrity of the settling pond liners.
	Inspection of the Panel power line identified deficiencies and the Panel power line was de-energized and locked out of service.	Due to the aged and deficient condition of the power line, the power line was de-energized and placed out of service. During this time a temporary mobile generator is used to power the Panel ETP until a permanent power solution is designed and installed.

Note: ETP = effluent treatment plant.

4.2 Applicable Monitoring Programs

The existing monitoring programs applicable to the Quirke Lake sub-watershed include (Table 4.5):

- The TOMP (Minnow 2019), which includes effluent compliance monitoring requirements, designed to track TMA performance and support decisions regarding the management of the TMAs:
    - Denison Facility surface water stations D-1, D-2, D-3, D-22, and D-25, and groundwater stations BH91-D1A,B, BH91-D3A,B, BH91-DG4B, and BH91-D9A;
    - Spanish-American Facility station ECA-128;
    - Quirke Facility surface water stations Q-03, Q-04P, Q-05, Q-28, Q-29, and Cell 14, 15, 16s, and 17, pore water stations 90DK-14-5C, DK15-2, DK15-4, DK16-2, DK17-2, and groundwater stations QPW1, 95QW-3, 95QW-4, 95QW-5; and
    - Panel Facility surface water stations ECA-349, P-13, P-14, P-15, P-21, and P-36, and groundwater stations P-16A, P-20, and P-31.
- The SAMP (Minnow 2019), which focuses on monitoring stations that represent the final points of release from each closed mine facility to the watershed, developed to monitor the nature and quantity of constituents being discharged (Denison Facility stations D-2, D-3, D-9, and D-16; Quirke Facility stations ECA-398, Q-22, Q-23, Q-27, and Q-28; Panel Facility stations P-02, P-03, P-05, P-11, and P-14; and Stanrock Facility station DS-16); and,
- The SRWMP (Minnow 2019), an integrated monitoring program designed to assess the cumulative effects of the facility discharges on chemical and biological conditions in the watershed and to track changes over time. The SRWMP was designed to complement the SAMP, and also included mechanisms to allow the evolution of the sampling approach over time in response to monitoring findings for the watershed. SRWMP stations associated with these TMAs and the Quirke Lake sub-watershed include:
    - station D-4, Serpent River at the outlet of Dunlop lake (reference);
    - station D-6, Cinder Lake Outlet;
    - station D-5, Serpent River downstream of Denison TMA discharges;
    - station Q-09, Serpent River downstream of Quirke TMA discharges;
    - station Q-20, unnamed tributary to Dunlop Lake; and

Table 4.5: Monitoring Programs and Stations Within or Downstream of Denison, Spanish American, Quirke, Stanrock, and Panel TMAs, and Within the Quirke Lake Sub-Watershed

TMA	Station ID	Monitoring Program	Type	Description	Parameters and Frequencies [a]														
					Elevation	Flow	Hardness	pH	Conductivity	Sulphate	Radium-226	TSS	Acidity	Iron	Barium	Cobalt	Manganese	Uranium	Toxicity[b]
Denison	D-1[c]	TOMP	Basin performance (primary), ETP operations	ETP Influent from Denison TMA 1 represents TMA1 water quality.	W	D	-	M	-	Q	M	-	Q	Q	Q	Q	Q	Q	-
Denison	D-22[c]	TOMP	ETP operations	ETP influent from Denison TMA 2 represents TMA2 water quality	-	-	-	W	-	Q	M	-	Q	Q	Q	Q	Q	Q	-
Denison	D-25	TOMP	Basin performance (secondary)	Drainage from TMA 2 to TMA 1 at the outlet of Drop Box Pond, represents water flow and quality released to TMA 1	-	-	-	S	-	S	S	-	S	S	-	-	-	-	-
Denison	BH91-D1A,B, BH91-D3A,B	TOMP	Groundwater	Situated at Dam 17 to monitor groundwater flow towards Quirke Lake	-	-	-	A	-	A	-	-	A	A	-	-	-	-	-
Denison	BH91-DG4B	TOMP	Groundwater	Down gradient of Dam 10 to assess groundwater pathway to Serpent River	-	-	-	A	-	A	-	-	A	A	-	-	-	-	-
Denison	BH91-D9A	TOMP	Groundwater	Down gradient of Dam 1 to asses groundwater seepage from TMA 1 toward Serpent River	-	-	-	A	-	A	-	-	A	A	-	-	-	-	-
Spanish American	ECA-128	TOMP	Basin performance (primary)	Discharge from Spanish American TMA to Denison TMA, represents TMA water quality and performance.	M[e]	Q	-	Q	-	Q	Q	-	Q	Q	Q	Q	Q	Q	-
Quirke	Q-05[c]	TOMP	Basin performance (primary), ETP operations	Influent from Cell 18 to ETP represents water quality prior to treatment	W	D	-	M	-	Q	M	-	Q	Q	Q	Q	Q	Q	-
Quirke	Q-03[c]	TOMP	ETP operations	pH monitoring location to assess reagent addition requirements at Pond 2 after initial treatment	-	-	-	W	-	-	-	-	-	-	-	-	-	-	-
Quirke	Q-04P[c]	TOMP	ETP operations	pH monitoring location at influent to ETP to assess reagent requirements	-	-	-	D	-	-	-	-	-	-	-	-	-	-	-
Quirke	Q-29	TOMP	Perimeter monitoring	Inflow from Gravel Pit Lake to monitor flow rate and water elevation	W	W[e]	-	-	-	-	-	-	-	-	-	-	-	-	-
Quirke	Cell 14, Cell 15, Cell 16S, Cell 17	TOMP	Basin performance (secondary)	Located at the spillway of each cell of the TMA to assess surface water quality across the TMA	M	-	-	S	-	S	S	-	S	S	-	-	-	-	-
Quirke	90DK-14-5C; DK15-2(A-D); DK15-4(A-D); DK16-2(A-D); DK17-2(A-D)	TOMP	Pore water	Wells within the dykes between the TMA cells to assess subsurface water quality in each cell	-	-	-	A	-	A	-	-	A	A	-	-	-	-	-
Quirke	QPW1-1,4,8; 95QW-5A,D	TOMP	Groundwater	Down gradient of Dams K1 and K2 to assess seepage to Dunlop Lake	-	-	-	A	-	A	-	-	A	A	-	-	-	-	-
Quirke	95QW-4	TOMP	Groundwater	Located at Dam G2 to assess seepage offsite towards the Serpent River from Cell 18	-	-	-	A	-	A	-	-	A	A	-	-	-	-	-
Quirke	95QW-3A,C,D	TOMP	Groundwater	Located at the Main Dam to assess seepage from Cell 16 N to the settling ponds and towards Serpent River	-	-	-	A	-	A	-	-	A	A	-	-	-	-	-
Panel	P-13[c]	TOMP	Basin performance (primary), ETP operations	Influent to the ETP from the South Basin, reflects surface water quality prior to treatment.	W	D	-	M	-	Q	M	-	Q	Q	Q	Q	Q	Q	-
Panel	ECA-349[c]	TOMP	ETP operations	pH monitoring location at influent to ETP to assess reagent requirements	-	-	-	D	-	-	-	-	-	-	-	-	-	-	-
Panel	P-15	TOMP	Perimeter	Conductivity measurement to assess for seepage from settling pond.	-	-	-	-	M	-	-	-	-	-	-	-	-	-	-
Panel	P-21	TOMP	Basin performance (secondary)	Discharge from Main Basin to South Basin represents surface water in Main Basin	M	-	-	S	-	S	S	-	S	S	-	-	-	-	-
Panel	P-16A	TOMP	Groundwater	Down gradient of Dam B to assess seepage and groundwater to Rochester Creek.	-	-	-	A	-	A	-	-	A	A	-	-	-	-	-
Panel	P-20	TOMP	Groundwater	Down gradient of Dam A to assess seepage and groundwater to Pond C and Rochester Creek.	-	-	-	A	-	A	-	-	A	A	-	-	-	-	-
Panel	P-31	TOMP	Groundwater	Down gradient of Dam E to assess seepage and groundwater to Rochester Creek.	-	-	-	A	-	A	-	-	A	A	-	-	-	-	-
Denison	D-3[c]	TOMP, SAMP	Effluent	Final discharge from Denison TMA 2 to Serpent River after treatment and settling in Lower Williams Lake Settling Pond	-	W	-	W	-	M	W	W	-	M	M	M	M	M	S
Denison	D-2[c]	TOMP, SAMP	Effluent	Final discharge from Denison TMA 2 to Serpent River after treatment and settling on Stollery Lake Settling Pond	-	W	-	W	-	M	W	W	-	M	M	M	M	M	S
Denison	D-9	SAMP	Seepage	Seepage at Dam 17 to Quirke Lake	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Denison	D-16	SAMP	Seepage	Seepage at Dam 9 to Quirke Lake	-	-	M	M	-	M	M	-	-	M	M/S	M	M	M/S	-
Quirke	Q-28[c]	TOMP, SAMP	Effluent	Final effluent from Quirke TMA flows via drainage ditch to Serpent River	-	W	-	W	-	M	W	W	-	M	M	M	M	M	S
Quirke	ECA-398	SAMP	Seepage	Seepage from the former Quirke II mine north of access road drains via wetland/intermittent flow to Serpent River	-	Q	Q	Q	-	Q	Q	-	-	Q	Q	Q	Q	Q	-
Quirke	Q-22	SAMP	Drainage	Seepage from the former Quirke II mine south of access road drains via wetland/intermittent flow to Serpent River	-	Q	Q	Q	-	Q	Q	-	-	Q	Q	Q	Q	Q	-
Quirke	Q-23	SAMP	Drainage	Swamp Outlet west of Dam K1 that drains to Dunlop Lake	-	Q	Q	Q	-	Q	Q	-	-	Q	Q	Q	Q	Q	-
Quirke	Q-27	SAMP	Seepage	Dam J Toe Seepage to Evans Lake	-	-	Q	Q	-	Q	Q	-	-	Q	Q	Q	Q	Q	-

Table 4.5: Monitoring Programs and Stations Within or Downstream of Denison, Spanish American, Quirke, Stanrock, and Panel TMAs, and Within the Quirke Lake Sub-Watershed

TMA	Station ID	Monitoring Program	Type	Description	Parameters and Frequencies [a]														
					Elevation	Flow	Hardness	pH	Conductivity	Sulphate	Radium-226	TSS	Acidity	Iron	Barium	Cobalt	Manganese	Uranium	Toxicity[b]
Stanrock	DS-16	SAMP	Drainage	Seepage downstream of Dam M drains for Quirke Lake	-	Q	Q	Q	-	Q	Q	-	-	Q	Q	Q	Q	Q	-
Panel	P-14	TOMP, SAMP	Effluent	Final Effluent from Panel TMA to Effluent Creek which discharges to the north shore of Quirke Lake	-	W	-	W	-	M	W	W	-	M	M	M	M	M	S
	P-02	SAMP	Seepage	Downstream of Dam B to Rochester Creek	-	Q	Q	Q	-	Q	Q	-	-	Q	Q	Q	Q	Q	-
	P-03	SAMP	Drainage	Beaver Pond C Outlet to Rochester Creek	-	Q	Q	Q	-	Q	Q	-	-	Q	Q	Q	Q	Q	-
	P-05	SAMP	Drainage	Swamp Outlet north of Dam E with drainage towards Rochester Creek via unnamed pond and tributary	-	-	Q	Q	-	Q	Q	-	-	Q	Q	Q	Q	Q	-
	P-11	SAMP	Drainage	Panel Creek Outlet at Quirke Lake	-	Q	Q	Q	-	Q	Q	-	-	Q	Q	Q	Q	Q	-
not applicable	D-4	SRWMP	Surface water	Outlet of Dunlop Lake (reference)	-	-	-	S	-	S	S	-	-	S	S	-	S	S	-
	D-6	SRWMP	Surface water	Cinder Lake Outlet to Serpent River receives seepage from Denison TMA 1	-	-	-	Q	-	Q	Q	-	-	Q	Q	-	Q	Q	-
	D-5	SRWMP	Surface water	Serpent River downstream of Denison TMA discharges	-	-	-	Q	-	Q	Q	-	-	-	Q	-	-	Q	-
	Q-20	SRWMP	Surface water	Evans Lake Outlet downstream of Quirke TMA seepage	-	-	-	A	-	A	A	-	-	-	A	-	-	A	-
	Q-09	SRWMP	Surface water	Serpent River downstream of Denison and Quirke TMA discharges	-	-	-	Q	-	Q	Q	-	-	-	Q	-	-	Q	-
	SR-01	SRWMP	Surface water	Outlet of Quirke Lake downstream of Denison, Quirke, Stanrock and Panel TMAs	-	-	-	A	-	A	A	-	-	-	A	-	-	A	-

Notes: TMA = Tailings Management Area. ETP = Effluent Treatment Plant; "-" = not required.

[a] D=daily, W=weekly, M=monthly, Q=quarterly, S = semi-annually, A = annually. For stations that are monitored under both the TOMP and SAMP, monitoring frequencies under these programs may differ for a given parameter.

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

[c] Sampled when effluent treatment plant is operating.

- station SR-01, outlet of Quirke Lake.

4.3 TOMP: Basin Performance

4.3.1 Denison TMA

4.3.1.1 Water Management

Water cover at the Denison TMA is used to inhibit oxidation and acidification of tailings and reduce gamma and radon exposure. Water levels within the Denison TMA were maintained with a 1-m cover during summer, from 2015 through 2019 (Figure 4.6).

4.3.1.2 Basin Surface Water Quality

Surface water quality is monitored at three stations: the ETP influents at D-1 and D-22, and the overflow between TMA 2 and TMA 1 (D-25; Figure 4.2).

Since decommissioning, concentrations of radium-226, sulphate, and uranium at station D-1 have decreased and pH has been near neutral with levels becoming more stable over time (Figure 4.7). Sulphate and pH are also near the 50-year (i.e., 2040) post-decommissioning predictions, whereas radium-226 and uranium continue to be above predictions (Figure 4.7).

Since 2003, concentrations of barium and radium-226 have increased, and pH and uranium have decreased at D-1 (although pH continued to be near neutral; Table 4.6; Appendix Figures E.2, E.6, E.7, and E.9). The barium and radium-226 trends are thought to be caused by decreasing sulphate concentrations in the TMA, resulting in the dissolution of sulphate mineral compounds with which radium-226 is associated, whereby radium-226 and barium (from barite dissolution) are released from the tailings. Acidity and cobalt were below the LRL at D-1, and no temporal trends were noted for iron and manganese (Table 4.6; Appendix Figures E.1 and E.3 to E.5).

Water quality from TMA 2 (as measured at the spillway between TMA 2 and TMA 1; station D-25), has shown improvements based on a slight increase in pH and a decrease in sulphate concentrations (Table 4.6; Appendix Figures E.6 and E.8). Acidity continues to be below laboratory reporting limits, and no temporal trends were noted for iron and radium-226 (Table 4.6; Appendix Figures E.1, E.4, and E.7).

Decreasing concentrations of radium-226 and sulphate were observed in seepage from TMA 2 (measured as ETP influent at D-22), along with a slight decrease in pH (although concentrations remained circumneutral; Table 4.6; Appendix Figures E.6, E.8, and E.9). All other parameters showed no significant changes over time, and acidity was below the laboratory reporting limit in all but one sample from 2018 (when the concentration was equal to the laboratory reporting limit; Table 4.6; Appendix Figures E.1 to E.5, and E.7).

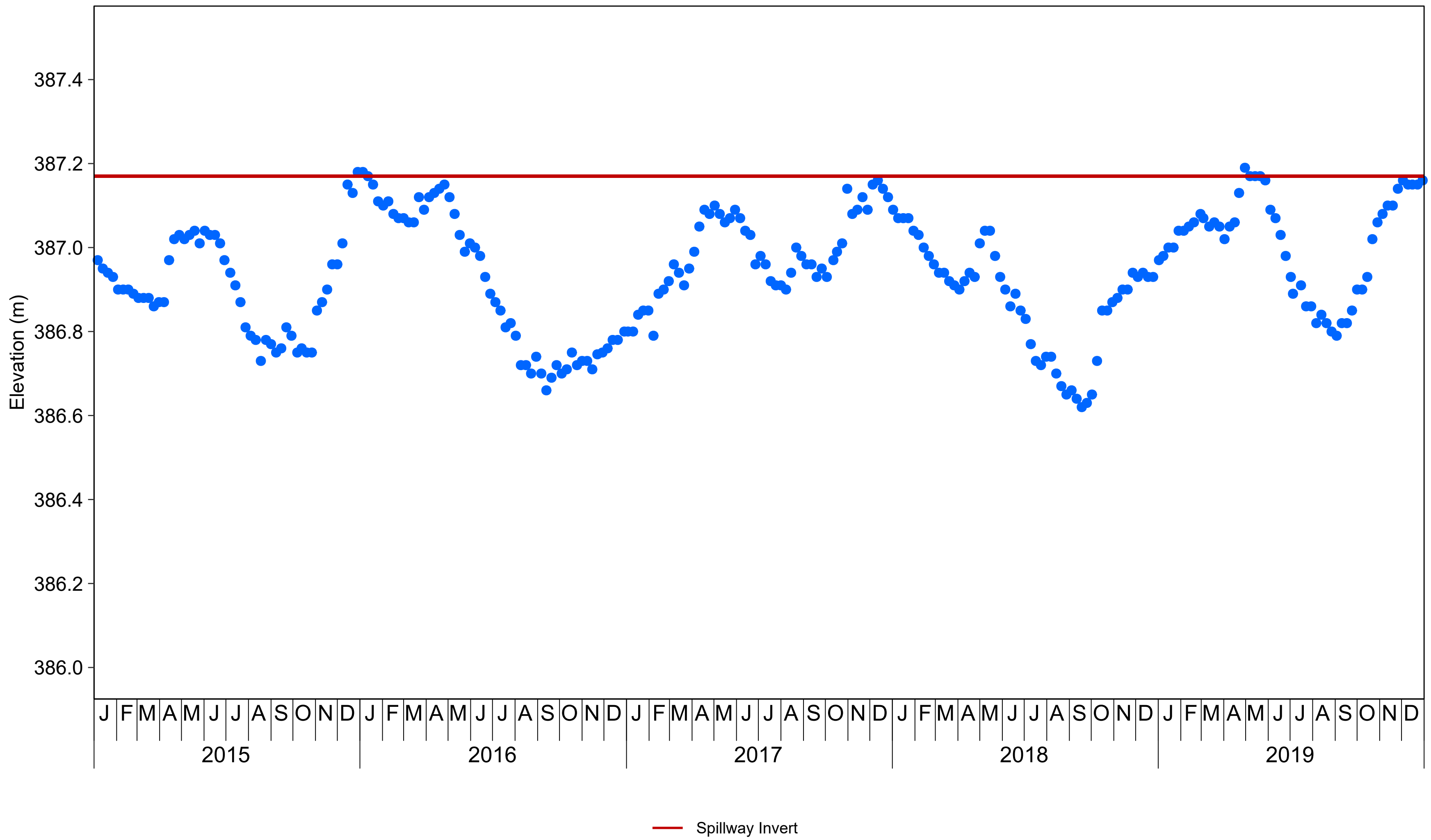


Figure 4.6: Water Level at TOMP Station D-1 Relative to the Spillway Invert, Denison TMA, 2015 to 2019

Notes: See Appendix Table E.13 for raw data.

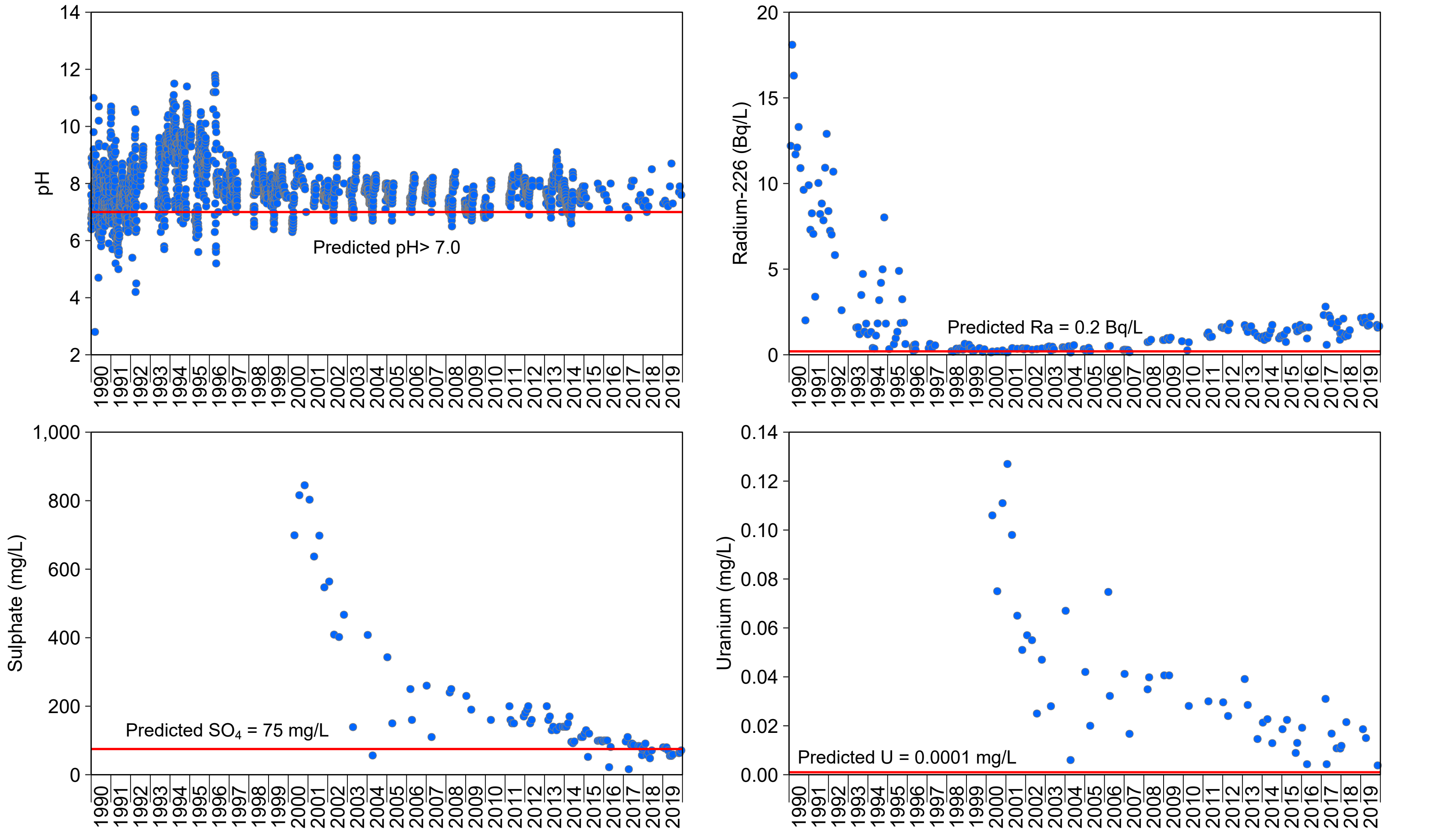


Figure 4.7: Water Quality at the Denison TMA-1 ETP Influent (TOMP Station D-1) Relative to Predictions for 50 years (2040) Post-decommissioning

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Red line delineates predicted concentration. See Appendix Table E.3 for raw data..

Table 4.6: Seasonal Kendall Trend Analysis For Water Quality Parameters, TOMP Water Quality Monitoring Stations, Denison TMA, 2003 to 2019

Station	D-1	D-25	D-22
Station Type/Location	TMA-1 Influent	Spillway between TMA-1 and TMA-2	Influent to ETP at TMA-2
Acidity (mg/L)	nt	nt	nt
Barium (mg/L)	11	na	NS
Cobalt (mg/L)	nt	na	NS
Iron (mg/L)	NS	NS	NS
Manganese (mg/L)	NS	na	NS
pH	-0.20	0.30	-0.10
Radium-226 (Bq/L)	8.3	NS	-4.70
Sulphate (mg/L)	-12	-8.70	-4.50
Uranium (mg/L)	-5.1	na	NS

(Green) Significant decreasing temporal trend (Seasonal Kendall test for monotonic trend at α = 0.05). Value reported is the Sen's slope reported as a percentage of the median concentration or value.

(Blue) Significant increasing temporal trend (Seasonal Kendall test for monotonic trend at α = 0.05). Value reported is the Sen's slope reported as a percentage of the median concentration or value.

Notes: '"NS" = no significant temporal trend (Seasonal Kendall test for monotonic trend at α = 0.05). '"na" = parameter not monitored for this station, as per study design. "nt" = parameter not included in the trend analysis for that particular station due to >50% non-detectable concentrations in the samples available for the analysis. See Appendix Tables E.3 to E.5 for raw data.

4.3.1.3 Groundwater Quality

Four locations (wells) are sampled annually for iron, pH, sulphate, and acidity; two are located downgradient of Dam 17 (BH91-D1 and BH91-D3), one is downgradient of Dam 1 (BH91- D9A), and one is downgradient of Dam 10 (BH91-DG4B; Figure 4.2).

Downgradient of Dam 17 at the east end of TMA 1, groundwater quality has significantly improved over time, with iron and sulphate concentrations decreasing and pH levels increasing to neutral levels at the 66 m depth in well BH91-D1 and both depths (21 m and 48 m) in well BH91-D3 (Table 4.7; Appendix Figures E.10 to E.13). Although sulphate concentrations have increased at the 45 m depth in well BH91-D1, concentrations were lower than all other groundwater monitoring stations (Table 4.7; Appendix Figure E.13). In addition, pH has been consistently near neutral since monitoring began and acidity has been below the laboratory reporting limit (in all but one sample from 2015; Table 4.7; Appendix Figures E.12).

Downgradient of Dam 10 (BH91-DG4B) at the west end of TMA 1, pH in groundwater has been decreasing, with pH measurements ranging from 6.58 to 6.20 over the 2015 to 2019 period (Table 4.7; Appendix Table E.11; Appendix Figure E.12). Sulphate has also been decreasing since 1990, although concentrations measured over the 2012 to 2019 period have been relatively stable (Table 4.7; Appendix Figure E.13). Concentrations of acidity were consistently lower than the laboratory reporting limit, and iron concentrations were variable, showing no consistent temporal changes (Table 4.7; Appendix Figures E.10 and E.11).

Downgradient of Dam 1 in TMA 2 (BH91-D9A), sulphate concentrations have been decreasing, whereas no significant temporal changes in acidity, iron, or pH were noted, with pH generally being near neutral (Table 4.7; Appendix Figures E.10 to E.13).

4.3.1.4 Treatment Performance

The primary ETP for the Denison TMA is located at the outlet of TMA 1 with a second ETP at TMA2 to treat seepage from TMA2 and a historical tailings spill (Figure 4.2). The ETP at the outlet of TMA 1 uses barium chloride for treatment of radium-226. Barium chloride consumption (kg/yr) and usage generally increased over the 2015 to 2019 period, with the highest consumption rate and usage occurring during the year requiring the greatest volume of water to be treated (i.e., 2019; Figure 4.8). In 2017 and 2018, caustic soda was used to in addition to barium chloride to treat radium-226 spikes (Figure 4.8); however, caustic soda did not improve treatment efficacy, and therefore was not used in 2019.

The historical spill and seepage from TMA 2 are treated with barium chloride to lower radium-226 concentrations (currently no treatment for pH). Barium chloride consumption (kg/yr) varied over the 2015 to 2019 period, with the highest consumption rates generally occurring

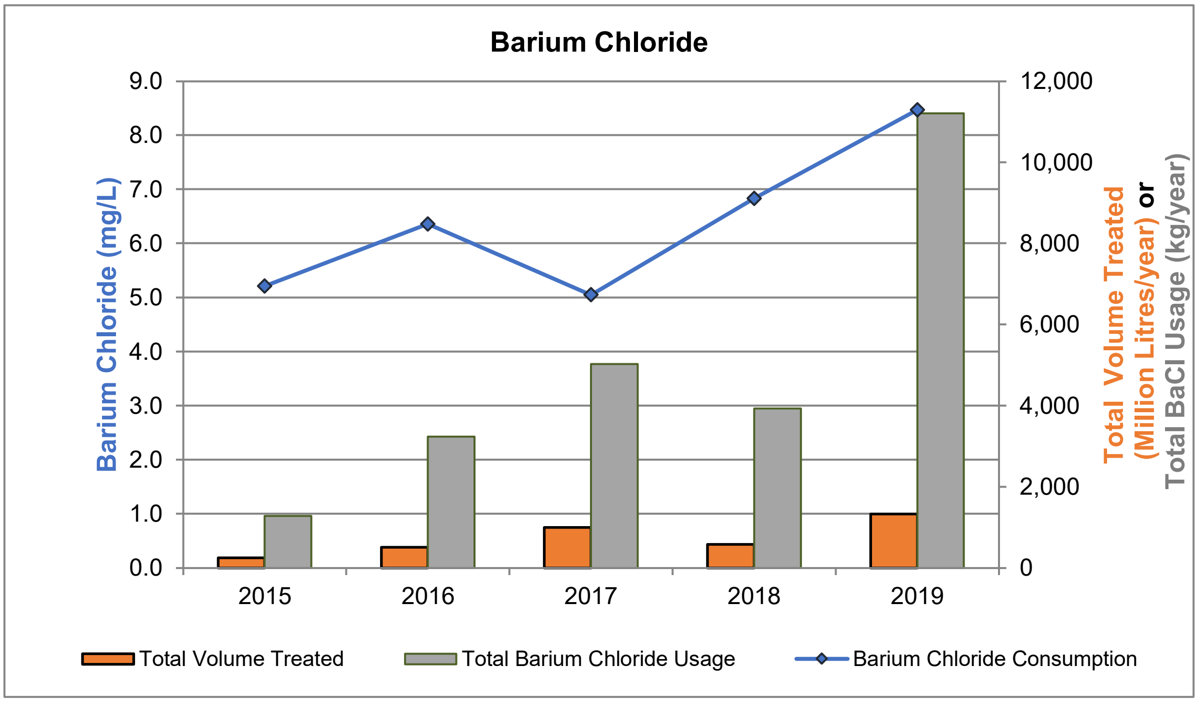
Table 4.7: Results of Temporal Trend Analyses for Groundwater Quality Parameters, TOMP Groundwater Stations, Denison TMA, 1990 to 2019

Station	BH91-D9A	BH91-DG4B	BH91-D1B	BH91-D1A	BH91-D3B	BH91-D3A
Station Type/Location	Downgradient of Dam 1 (TMA-2)	Downgradient of Dam 10 (TMA-1)	Downgradient of Dam 17 (TMA-1)		Downgradient of Dam 17 (TMA-1)	
Depth (m)	22	10.9	45	66	21	48
Acidity (mg/L)	NS	nt	nt	nt	-13	-19
Field pH	NS	-0.71	NS	1.1	1.8	0.96
Iron (mg/L)	NS	NS	NS	-12	-14	-7.4
Sulphate (mg/L)	-0.79	-5.6	4.0	-3.6	-5.9	-3.6

[Green] Significant decreasing temporal trend (Kendall test for monotonic trend at α = 0.05). Value reported as the slope reported as a percentage of the median concentration or value.

[Blue] Significant increasing temporal trend (Kendall test for monotonic trend at α = 0.05). Value reported as the slope reported as a percentage of the median concentration or value.

Notes: Due to a change in analytical technique for acidity in 2006, acidity trends were assessed from 2007 to 2019. See Appendix Tables E.8 to E.12 for raw data. NS = no significant temporal trend (Seasonal Kendall test for monotonic trend at α = 0.05). '"nt" = parameter not included in the trend analysis for that particular station due to >50% non-detectable concentrations in the samples available for the analysis.



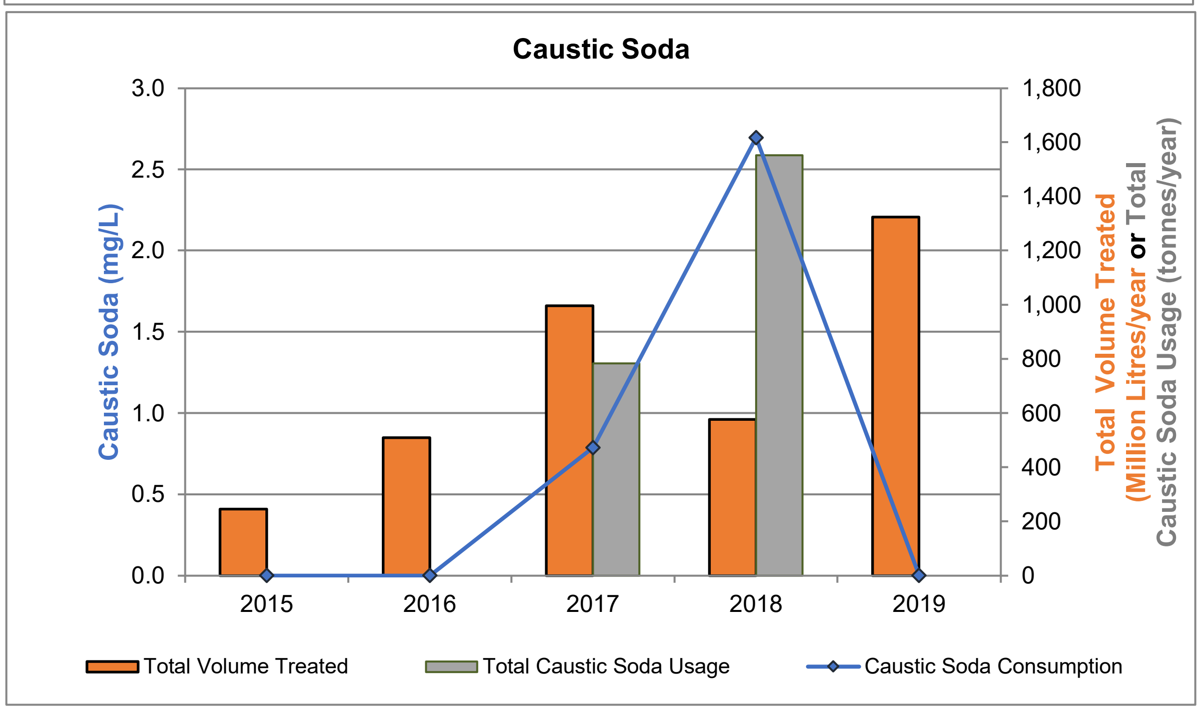


Figure 4.8: Comparison of Total Reagent Consumed Versus Total Volume Treated at Denison TMA-1 from 2015 to 2019

Note: See Appendix Table E.3 for raw data (TOMP Station D-1).

during years where the lowest volumes of water were treated (i.e., 2016 and 2018; Figure 4.9). That said, total barium chloride usage was highest in 2017, when the greatest volume of water was treated, despite the consumption rate being lowest (Figure 4.9). Overall, barium chloride usage at the TMA 2 ETP was lower than at the TMA1 ETP.

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 2015 to 2019 period, effluent pH, radium-226, and TSS concentrations consistently achieved discharge criteria at both locations (Figures 4.10 to 4.13).

4.3.2 Spanish-American TMA

Surface water quality is monitored at the outlet of the Spanish-American TMA prior to its discharge to Denison TMA1 (ECA-128; Appendix Table F.2). 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 indicated 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 4.14; Appendix Table F.3).

Since 2003, surface water quality within the Spanish-American TMA has improved, based on decreasing concentrations of sulphate and uranium (Table 4.8; Appendix Figures F.8 and F.9). Concentrations of radium-226 have also been decreasing since reaching a peak in 2008 (Appendix Figure F.7), whereas barium concentrations have been decreasing since 2010 (Appendix Figure F.2). Concentrations of both acidity and cobalt were below the laboratory reporting limit, pH was consistently near neutral, and no significant temporal trends were noted for iron and manganese (although peak concentrations of both parameters were lower over the 2015 to 2019 monitoring period compared to earlier years; Table 4.8; Appendix Figures F.1, F.3 to F.5).

4.3.3 Quirke TMA

4.3.3.1 Water Management

The five cells of the Quirke TMA are terraced, resulting in lower water elevations in each cell with progression from upstream (Cell 14) to furthest downstream (Cell 18; Figure 4.15). Water is taken seasonally from Gravel Pit Lake (via station Q-29) to maintain average water elevations within Cell 14 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 typically below the spillway invert in Cell 15 (Figure 4.15). Cells 16 and 17 were at or above spillway invert elevation over the 2015 to 2019 monitoring period (Figure 4.15). Water elevations in Cell 18 were generally

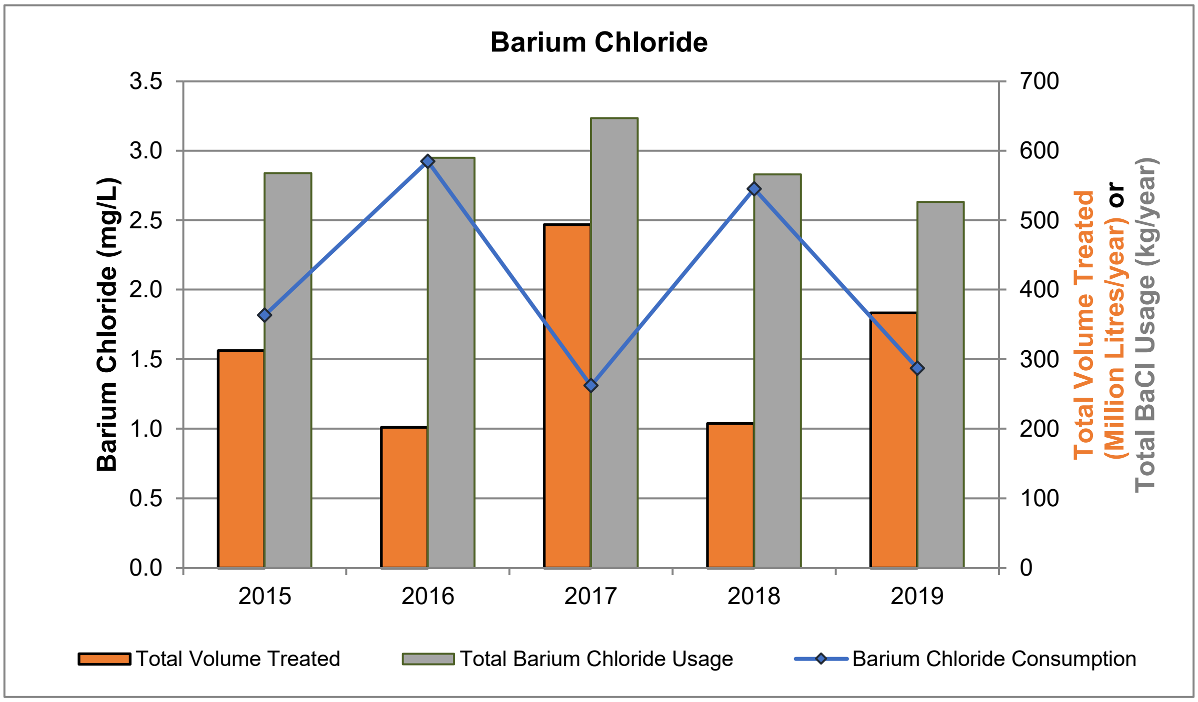


Figure 4.9: Comparison of Total Reagent Consumed Versus Total Volume Treated at Denison TMA-2 from 2015 to 2019

Note: See Appendix Table E.5 for raw data (TOMP Station D-22).

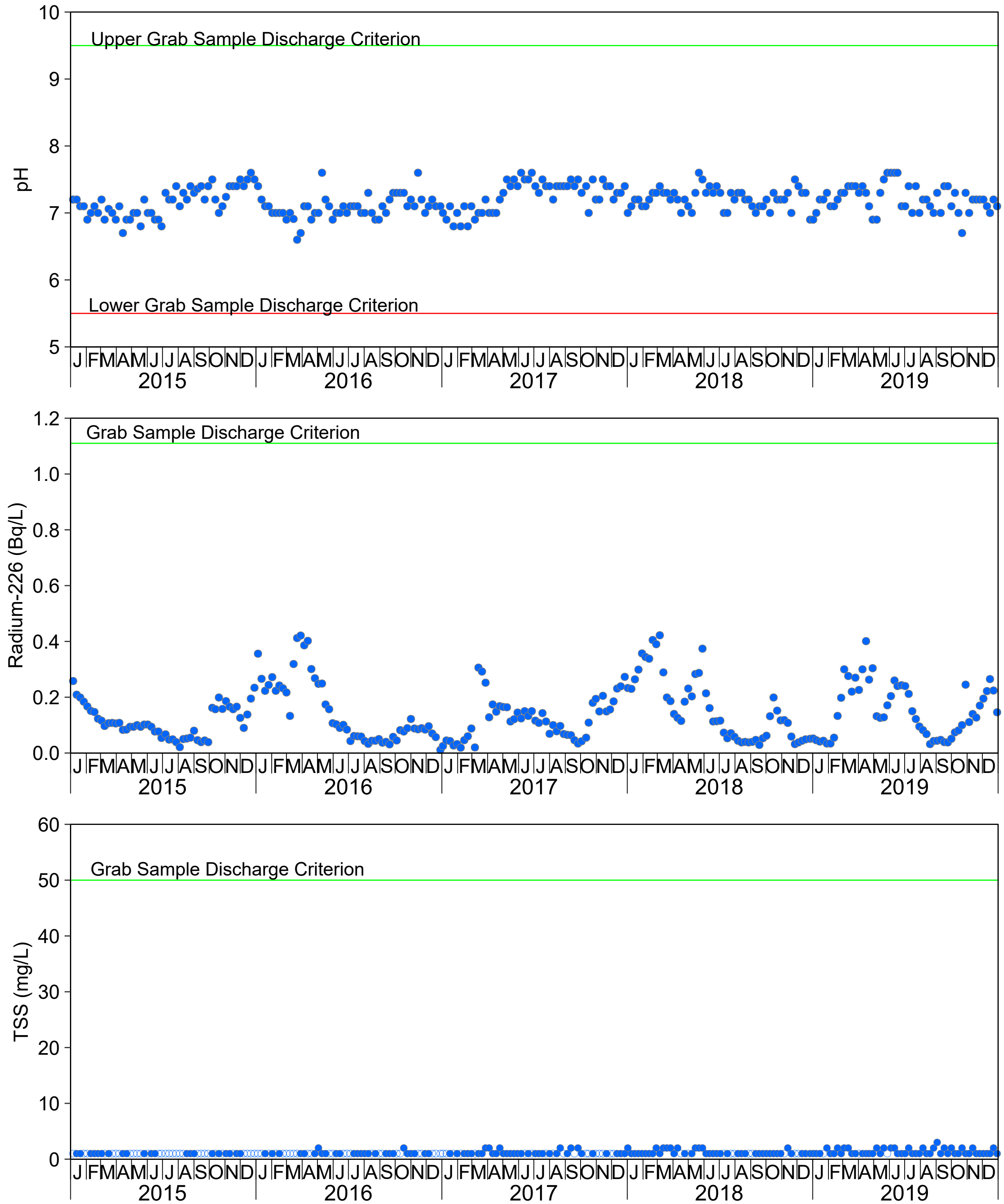


Figure 4.10: Effluent Concentrations Compared to Grab Sample Discharge Criteria at TOMP Station D-2, Denison TMA, 2015 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Table E.7 for raw data.

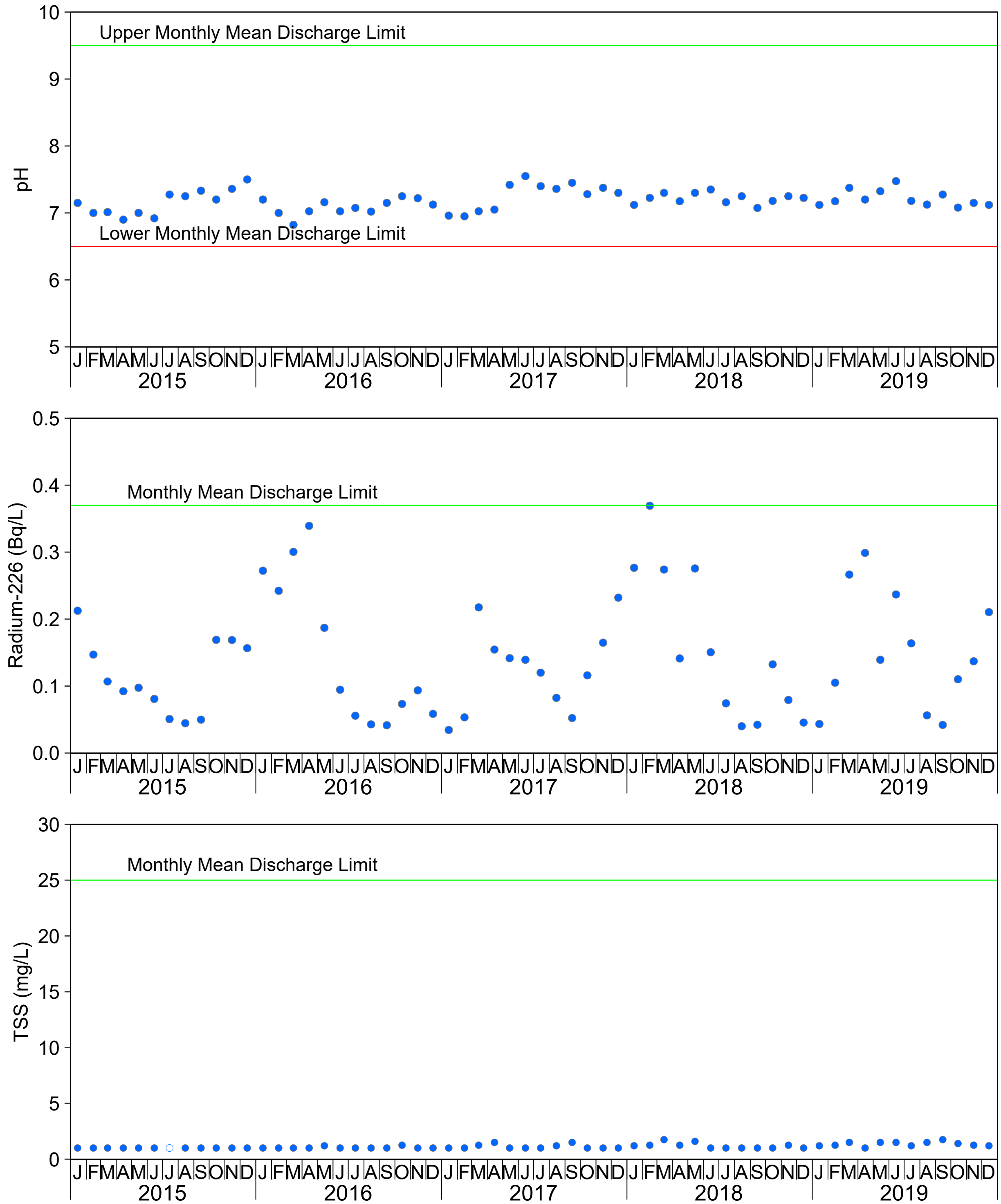


Figure 4.11: Monthly Mean Effluent Concentrations Compared to Monthly Mean Discharge Limits at TOMP Station D-2, Denison TMA, 2015 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Table E.7 for raw data.

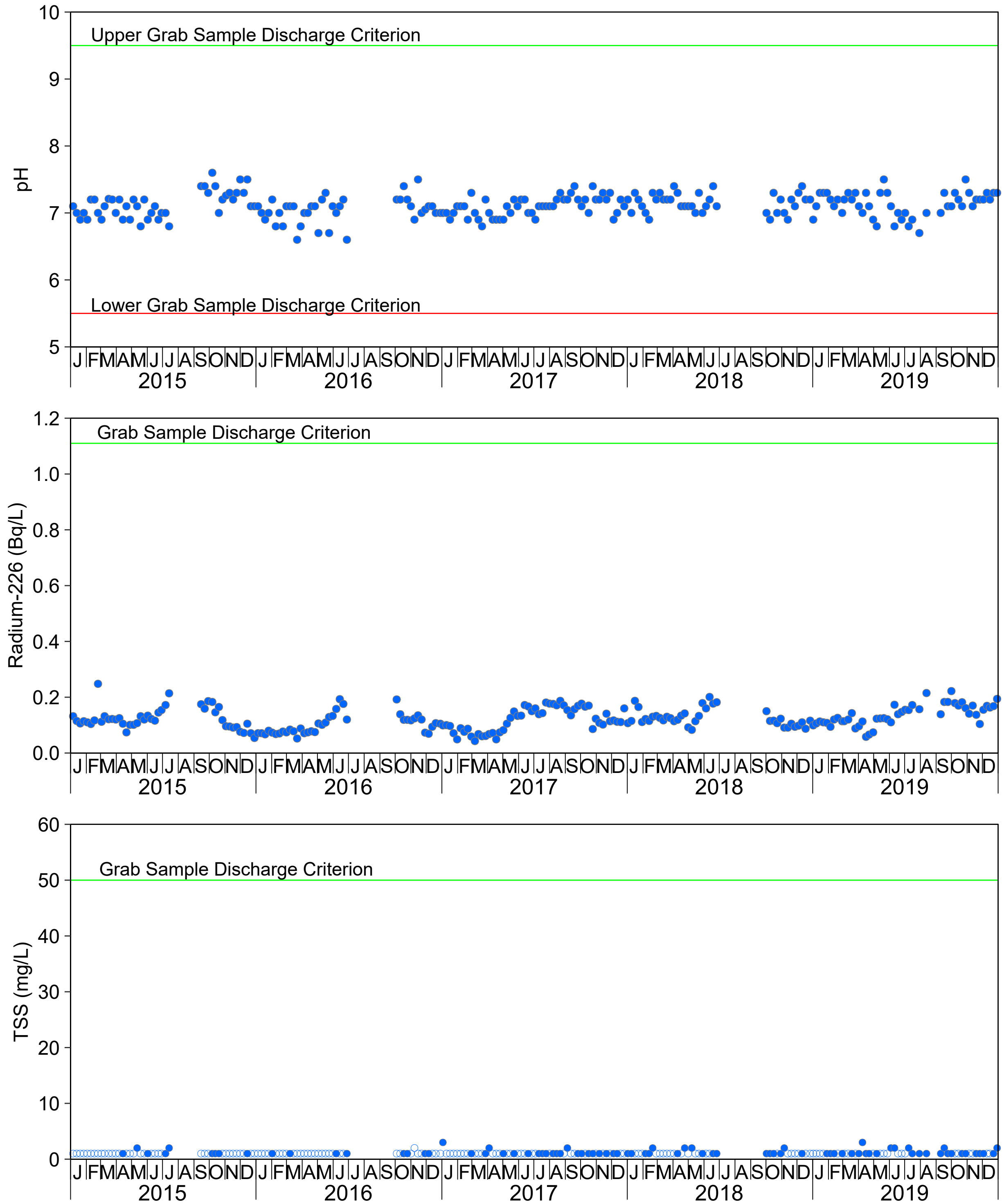


Figure 4.12: Effluent Concentrations Compared to Grab Sample Discharge Criteria at TOMP Station D-3, Denison TMA, 2015 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Table E.6 for raw data.

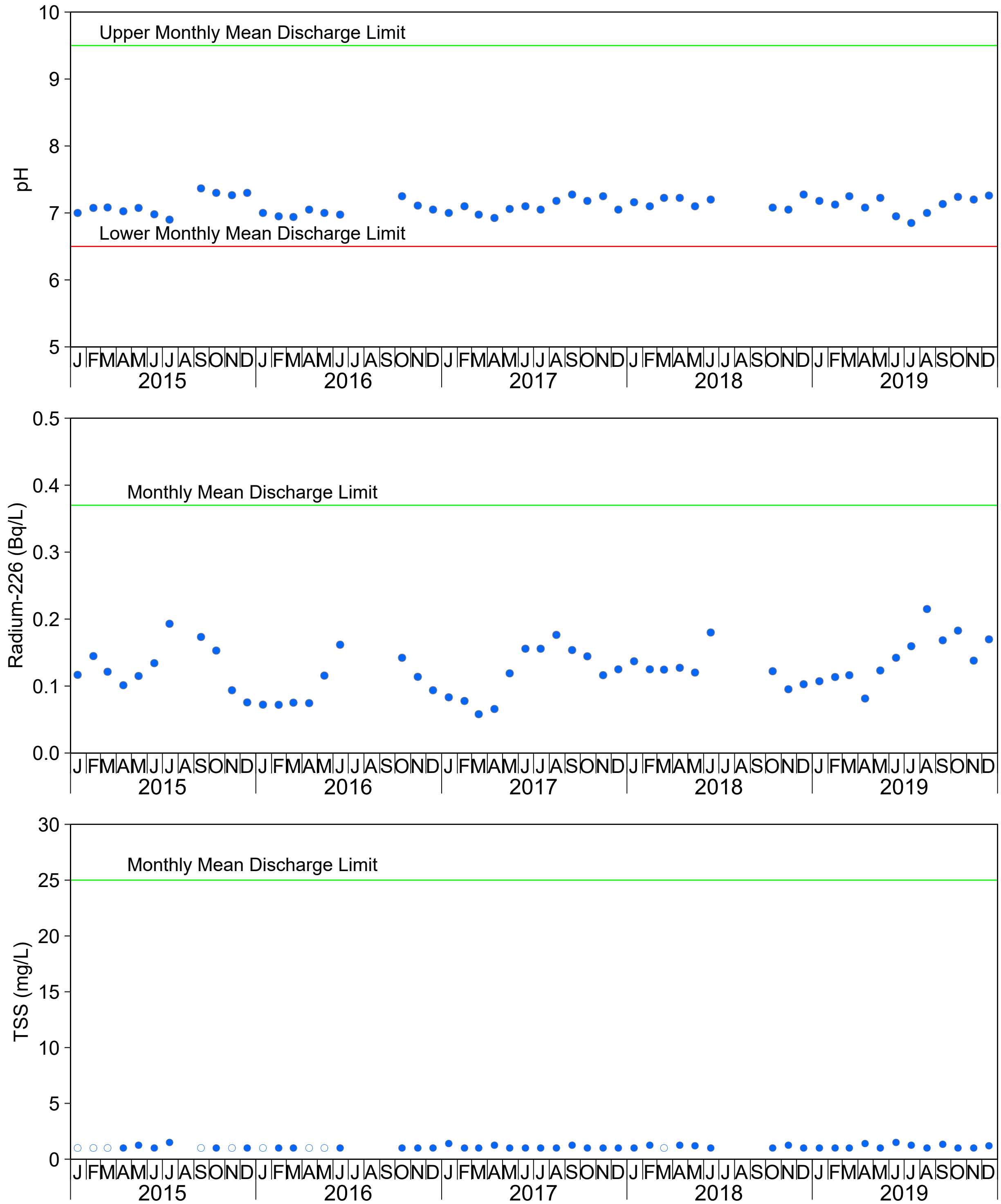


Figure 4.13: Monthly Mean Effluent Concentrations Compared to Monthly Mean Discharge Limits at TOMP Station D-3, Denison TMA, 2015 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Table E.6 for raw data.

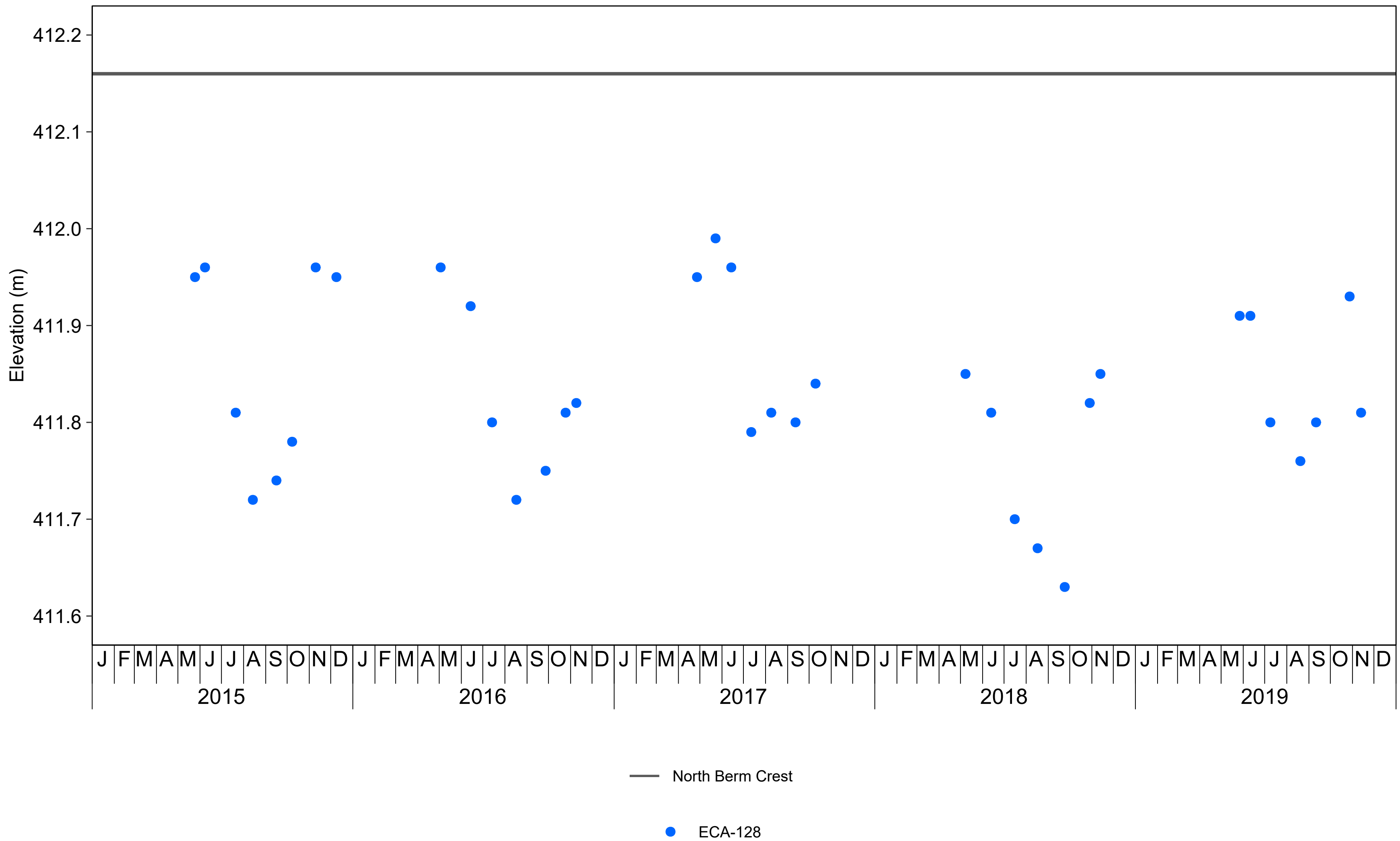


Figure 4.14: Water Level at TOMP Station ECA-128 Relative to North Berm Crest Elevation, Spanish-American TMA, 2015 to 2019

Notes: See Appendix Table F.3 for raw data.

Table 4.8: Seasonal Kendall Trend Analysis for Water Quality Parameters, TOMP Water Quality Monitoring Stations, Spanish-American TMA, 2003 to 2019

Station	ECA-128
Station Type/Location	TMA Effluent
Acidity (mg/L)	nt
Barium (mg/L)	NS
Cobalt (mg/L)	nt
Iron (mg/L)	NS
Manganese (mg/L)	NS
pH	NS
Radium-226 (Bq/L)	NS
Sulphate (mg/L)	-10
Uranium (mg/L)	-6.5

[green] Significant decreasing temporal trend (Seasonal Kendall test for monotonic trend at α = 0.05). Value reported is the Sen's slope reported as a percentage of the median concentration or value.

[blue] Significant increasing temporal trend (Seasonal Kendall test for monotonic trend at α = 0.05). Value reported is the Sen's slope reported as a percentage of the median concentration or value.

Note: See Appendix Table F.2 for raw data. '"NS" = no significant temporal trend (Seasonal Kendall test for monotonic trend at α = 0.05). '"nt" = parameter not included in the trend analysis for that particular station due to >50% non-detectable concentrations in the samples available for the analysis.

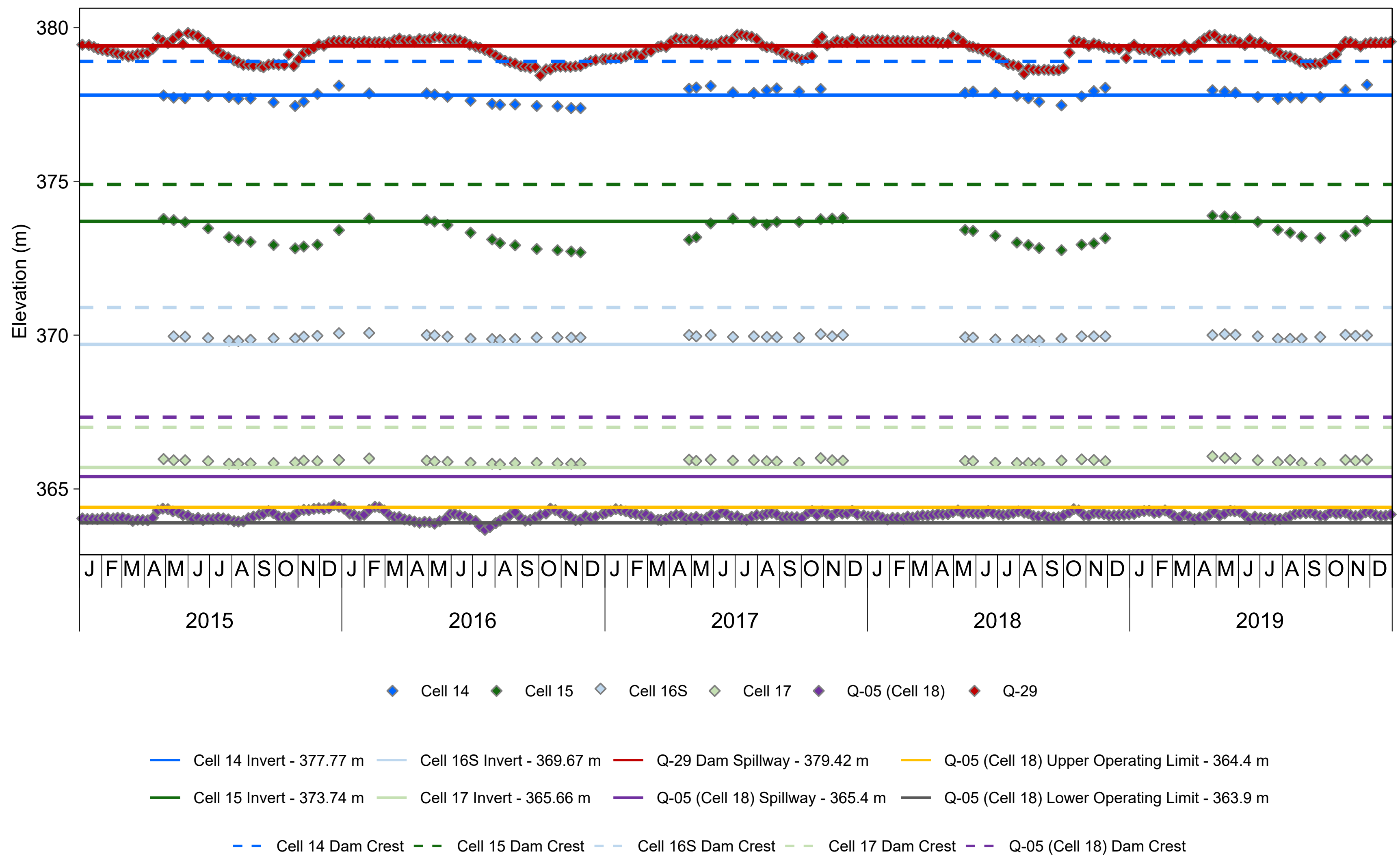


Figure 4.15: Water Level at TOMP Stations Cell 14, Cell 15, Cell 16S, Cell 17, Q-05, and Q-29 Relative to Inverts, Dam Spillways, and Dam Crests, Quirke TMA, 2015 to 2019

Notes: See Appendix Tables G.21 to G.26 for raw data.

within operating limits for the TMA, except in July 2016, when the water level dropped slightly below the lower operating limit (Figure 4.15).

4.3.3.2 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 4.9; Figure 4.4). Within each of the Cells, water quality is monitored for acidity, iron, pH, radium-226, and sulphate, whereas barium, cobalt, manganese, and uranium are also monitored in the ETP influent (Q-05).

Since 2003, the quality of influent water entering the ETP at Q-05 has improved considerably, based on decreasing concentrations of acidity, barium, cobalt, manganese, radium-226, sulphate, and uranium, and increasing pH (Table 4.9; Appendix Figures G.1 to G.9). Several of the improvements noted at Q-05, were also observed upstream, including decreasing concentrations of radium-226, sulphate, and acidity in each of the Cells (although trends for acidity were only tested for Cell 17 due to greater than 50% of concentrations being below laboratory reporting limits in all other Cells; Table 4.9; Appendix Figures G.1 to G.9). Although iron concentrations did not exhibit a decreasing trend at Q-05, concentrations were observed to decrease in Cells 15 and 16S (Table 4.9; Appendix Figure G.4). Concentrations of radium-226, sulphate, and uranium are approaching the 50 year (i.e., 2040) post-decommissioning predictions (Figure 4.16). These improvements are attributed to on-going lime additions within Cells 16 and 17 (Appendix Table N.18).

In general, maintenance of water levels in the Quirke TMA Cells (specifically Cells 14 and 16) has been shown to be the most important factor influencing water quality, and while water levels are continually maintained, water quality is not expected to change in terms of pH and radium-226 concentrations (Minnow 2020b). The flux of radium-226 from Cell 14 sediments was estimated twice in 2009 and 2017 and both results agreed well, indicating little change in flux over this time period and suggesting that the tailings were stable under the current environmental conditions (Minnow 2020b). Radium-226 flux from Cell 16 was low compared to Cell 14 and was controlled by the association of radium-226 with treatment solids and iron oxides from iron rich seepage through Dyke 15 (Figure 4.4).

Radium-226 and barium concentrations have been decreasing at the ETP influent station Q-05 (Figure 4.16), and it is expected that as sulphate also continues to decrease it may result in the dissolution of barium sulphate and the release of associated radium-226 (and a corresponding increase in radium-226 and barium concentrations), where radium-226 is hosted by barite in treatment solids in the Quirke TMA (e.g., Cell 16; EcoMetrix 2011b; Minnow 2020b). However, high iron concentrations in Cell 16 sediments (from iron seepage through Dyke 15) may attenuate radium-226 released from dissolving sulphate hosts (Minnow 2020b).

Table 4.9: Seasonal Kendall Trend Analysis for Water Quality Parameters, TOMP Water Quality Monitoring Stations, Quirke TMA, 2003 to 2019

Station	Cell 14	Cell 15	Cell 16S	Cell 17	Q-05
Station Type/Location	Cell 14 at Spillway	Cell 15 at Spillway	Cell 16S at Spillway	Cell 17 at Spillway	Treatment Plant Influent
Acidity (mg/L)	nt	nt	nt	-79	-22
Barium (mg/L)	na	na	na	na	-3.1
Cobalt (mg/L)	na	na	na	na	-13
Iron (mg/L)	NS	-4.5	-3.90	NS	NS
Manganese (mg/L)	na	na	na	na	-7.20
pH	NS	NS	NS	NS	1.80
Radium-226 (Bq/L)	-3.50	NS	-10.00	-4.90	-4.10
Sulphate (mg/L)	-3.7	-1.5	-2	-2.5	-2.6
Uranium (mg/L)	na	na	na	na	-11

(green) Significant decreasing temporal trend (Seasonal Kendall test for monotonic trend at α = 0.05). Value reported is the Sen's slope reported as a percentage of the median concentration or value.

(blue) Significant increasing temporal trend (Seasonal Kendall test for monotonic trend at α = 0.05). Value reported is the Sen's slope reported as a percentage of the median concentration or value.

Note: See Appendix Table G.3 to G.7 for raw data. '"NS" = no significant temporal trend (Seasonal Kendall test for monotonic trend at α = 0.05). "na" = parameter not monitored for this station. '"nt" = parameter not included in the trend analysis for that particular station due to >50% non-detectable concentrations in the samples available for the analysis.

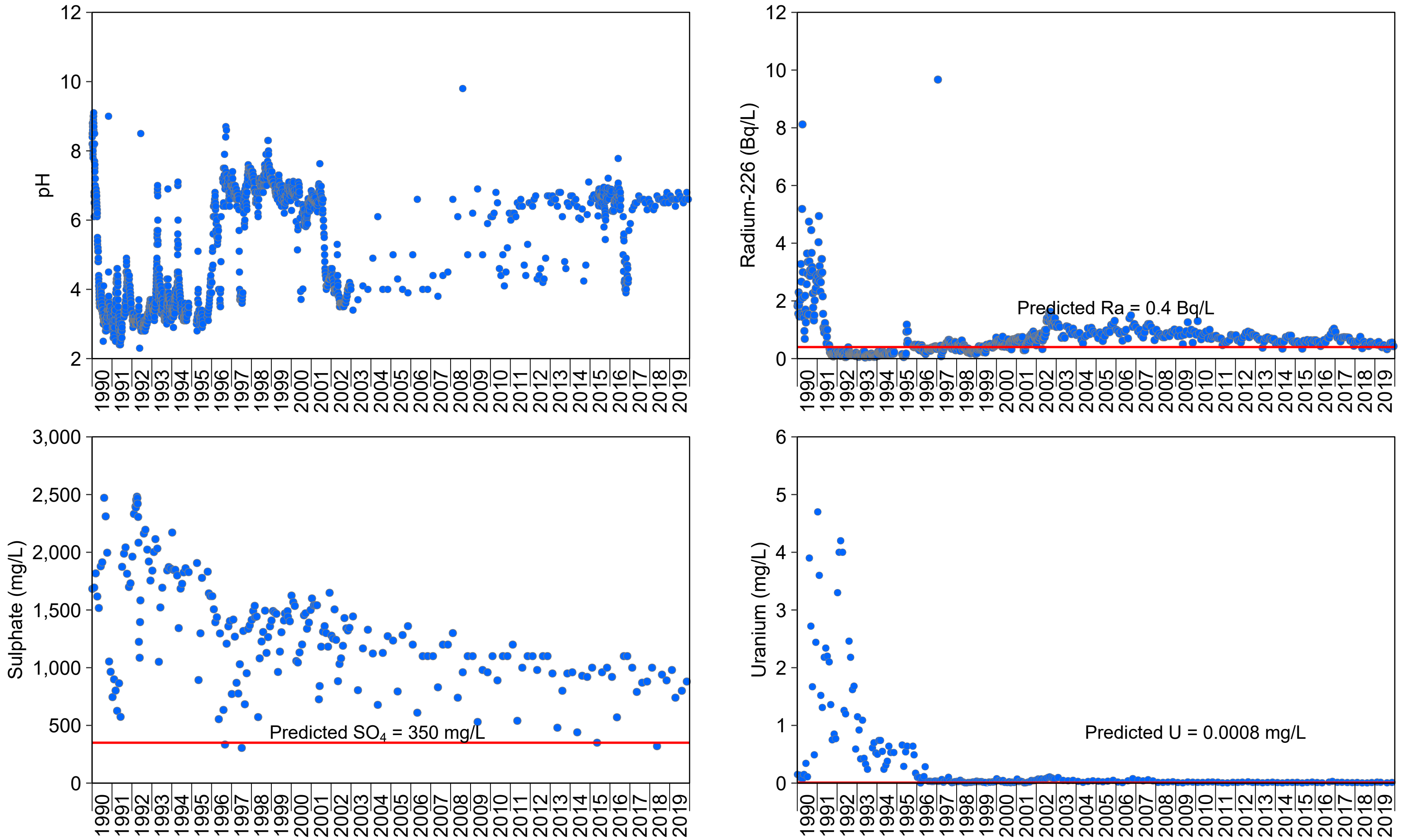


Figure 4.16: Water Quality at the Quirke TMA ETP Influent (TOMP Station Q-05) Relative to Predictions for 50 years (2040) Post-decommissioning

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Red line delineates predicted concentration. See Appendix Table G.7 for raw data.

4.3.3.3 Pore Water

Pore water is monitored annually for acidity, pH, iron, and sulphate in each of the five dykes within the Quirke TMA (Table 4.10; Figure 4.4; Appendix Figure G.10 to G.13). Pore water at the Quirke TMA represents surface water infiltration to the tailings, and flushing of historical pore water, and so it is not surprising that improvements in pore water quality have been noted over time, similar to basin surface water. In general, acidity, iron, and sulphate concentrations have been decreasing over time, while pH increased or remained similar at almost all locations and depths (Table 4.10). In shallow (3-5 m) and mid depth (6-10 m) pore water samples, pH has achieved the level predicted in the EIS for 2040 (i.e., 6.74) since the early 2000's (Figure 4.17). In contrast, pH in deeper (11-15 m) pore water samples has continued to improve over time, but remains about 0.5 units below the predicted level (Figure 4.17).

4.3.3.4 Groundwater Quality

Four locations (wells) are sampled annually at the Quirke Facility for acidity, pH, iron, and sulphate. One well is located at the east end of the TMA (95QW-4), one is downgradient of the Main Dam (95QW-3) at the north end of the TMA, and the other two are located downgradient of Dam K1 at the west end of the TMA (95QW-5 and QPW1; Figure 4.4).

At the north end of the TMA, downgradient of the Main Dam (95QW-3), groundwater quality has improved significantly over time, based on increasing pH (in the shallow and moderate monitoring depths) and decreases in acidity, iron, and sulphate (Table 4.11; Appendix Figures G.14 to G.17). Downgradient of Dam G-2 at the east end of the TMA (95QW-4), pH has decreased slightly over time, although remains near neutral (Table 4.11). Sulphate concentrations also decreased significantly at 95QW-4, after reaching a maximum in 2002 (Table 4.11). Downgradient of Dam K1 at 95QW-5 (closer in proximity to Dam K1 than QPW1), groundwater quality has improved based on decreasing iron, sulphate, and acidity concentrations (acidity has been below the laboratory reporting limit in all samples from this well since 2015; Table 4.11). Further downgradient of Dam K1, groundwater quality has generally shown the opposite, with increasing concentrations of iron and sulphate (acidity has been at or below the laboratory reporting limit in all samples from this well; Table 4.11). While pH has demonstrated a temporal decrease in all sampling depths at QPW1, it has remained near neutral, or just below (Table 4.11). The difference in trends observed at 95QW-5 relative to QPW1 may reflect the slower flushing of contaminants further downgradient of Cell 14, particularly in deeper sampling depths.

Table 4.10: Results of Temporal Trend Analyses for Pore Water Quality Parameters, TOMP Pore Water Stations, Quirke TMA, 1990 to 2019

Station	DK14-5C	DK15-2D	DK15-2C	DK15-2B	DK15-2A	DK15-4D	DK15-4C	DK15-4B	DK15-4A	DK16-2D	DK16-2C	DK16-2B	DK16-2A	DK17-2D	DK17-2C	DK17-2B	DK17-2A
Station Type/Location	Cell 15 below Dyke 14	Cell 16N below Dyke 15				Cell 16S below Dyke 15				Cell 17 below Dyke 16				Cell 18 below Dyke 17			
Depth (m)	5.91	4.13	5.5	7.25	10.24	4.01	5.61	7.08	10.3	4.01	5.6	7.1	10.21	3.91	5.57	7	12.17
Acidity (mg/L)	nt	-7.5	-11	-11	-13	-1.7	NS	NS	-7.0	-4.8	nt	nt	-55	nt	nt	-90	-16
Field pH	0.14	NS	NS	NS	NS	1.0	0.42	NS	0.27	1.7	1.1	0.69	NS	NS	NS	NS	1.8
Iron (mg/L)	-110	-8.5	-8.9	-8.4	-8.1	-9.7	-7.8	-8.0	-11	-8.3	-10	-160	-6.4	-120	NS	-5.8	NS
Sulphate (mg/L)	-0.75	-4.4	-4.4	-4.1	-4.8	-4.0	-2.7	-5.1	-4.0	-1.0	-1.2	-0.72	-0.91	-0.44	-0.98	-2.7	-1.7

(Green) Significant decreasing temporal trend (Kendall test for monotonic trend at α = 0.05). Value reported is the slope reported as a percentage of the median concentration or value.

(Blue) Significant increasing temporal trend (Kendall test for monotonic trend at α = 0.05). Value reported is the slope reported as a percentage of the median concentration or value.

Notes: Due to a change in analytical technique for acidity in 2006, acidity trends were assessed from 2007 to 2019. See Appendix Tables G.12 to G.16 for raw data. "NS" = no significant temporal trend (Kendall test for monotonic trend at α = 0.05). '"nt" = parameter not included in the trend analysis for that particular station due to >50% non-detectable concentrations in the samples available for the analysis.

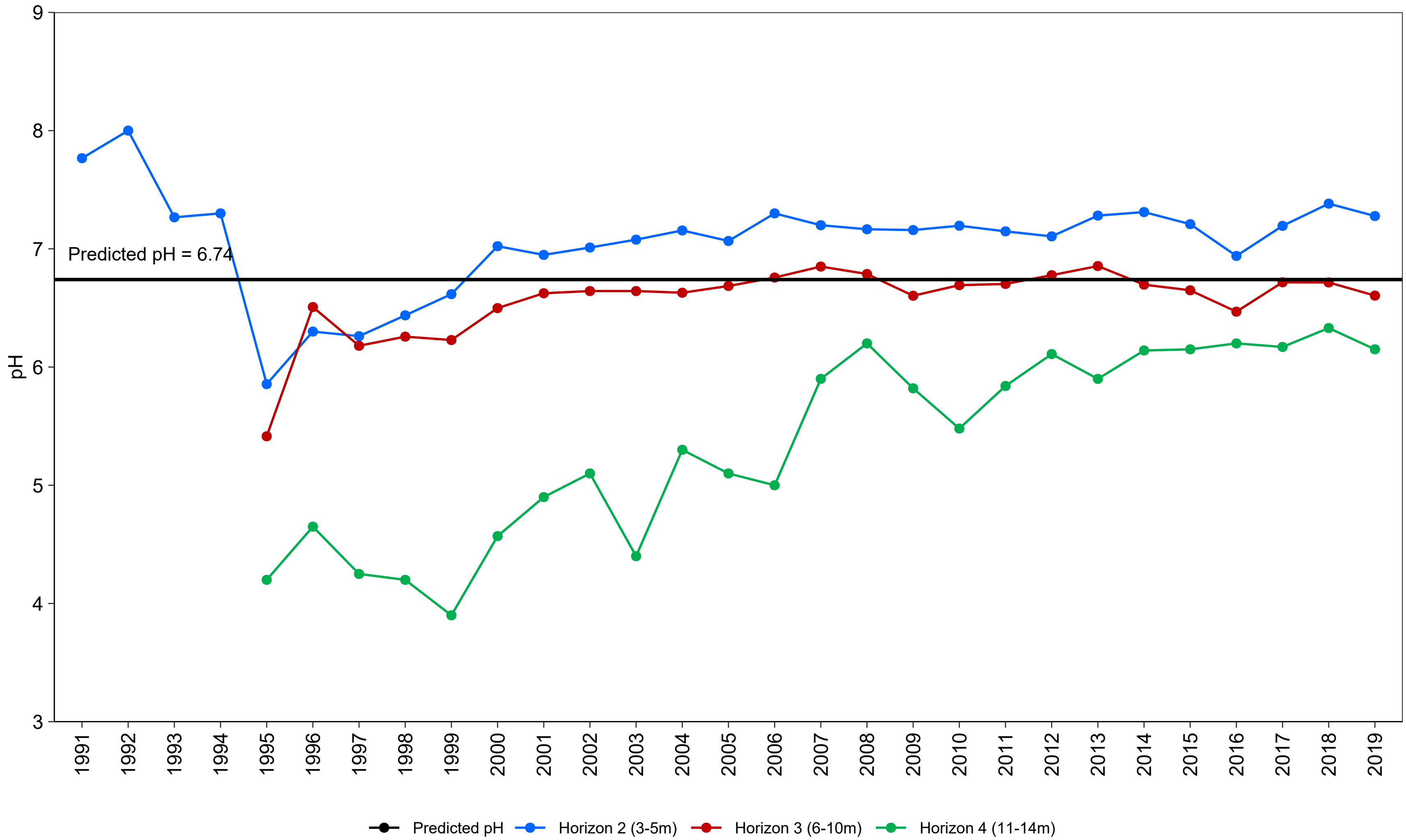


Figure 4.17: Comparison of Mean Pore Water pH at Various Depths to EIS (2040) Predictions, Quirke TMA, 1993 to 2020

Notes: Black line delineates predicted pH.
Horizon 2 - TOMP Stations DK14-5C, DK15-2C, DK15-2D, DK15-4C, DK15-4D, DK16-2C, DK16-2D, DK17-2C, DK17-2D.
Horizon 3 - TOMP Stations DK15-2A, DK15-2B, DK15-4A, DK15-4B, DK16-2A, DK16-2B, DK17-2B.
Horizon 4 - TOMP Station DK17-2A.
See Appendix Tables G.12 to G.16 for raw data.

Table 4.11: Results of Temporal Trend Analyses for Groundwater Quality Parameters, TOMP Groundwater Stations, Quirke TMA, 1990 to 2019

Station	95QW-3D	95QW-3C	95QW-3A	95QW-4	95QW-5D	95QW-5A	QPW1-1	QPW1-4	QPW1-8
Station Type/Location	Downgradient of Main Dam			Downgradient of Dam G2 at east end of TMA	Downgradient of Dam K1		Downgradient of Dam K1, upgradient of Dyke 23		
Depth (m)	4.6	9	20.7	10	4.3	9.75	2.1	11.4	23.9
Acidity (mg/L)	-5.9	-8.2	-8.2	nt	nt	-640	nt	nt	nt
Field pH	1.9	0.41	NS	-0.28	NS	NS	-0.43	-0.30	-0.26
Iron (mg/L)	NS	-4.2	-4.8	NS	-26	-2.9	2.8	4.4	2.6
Sulphate (mg/L)	-2.1	-3.1	-2.9	-1.2	-2.1	NS	NS	0.71	3.4

[Green] Significant decreasing temporal trend (Kendall test for monotonic trend at α = 0.05). Value reported is the slope reported as a percentage of the median concentration or value.

[Blue] Significant increasing temporal trend (Kendall test for monotonic trend at α = 0.05). Value reported is the slope reported as a percentage of the median concentration or value.

Notes: Due to a change in analytical technique for acidity in 2006, acidity trends were assessed from 2007 to 2019. See Appendix Tables G.17 to G.20 for raw data. "NS" = no significant temporal trend (Kendall test for monotonic trend at α = 0.05). '"nt" = parameter not included in the trend analysis for that particular station due to >50% non-detectable concentrations in the samples available for the analysis.

4.3.3.5 Treatment Performance

The Quirke TMA ETP is located at the spillway from Cell 18 (Figure 4.4). Treatment includes addition of both lime and barium chloride to lower acidity and radium-226, respectively. Annual barium chloride and lime consumption rates and total usage were relatively consistent during the 2015 to 2019 period, although consumption rates tended to be highest in 2016 when the lowest volume of water required treatment and concentrations of radium-226 in influent were highest (Figure 4.18; Appendix Figure G.7). Review of water elevations indicated lower water levels in 2016 in Cells 14 and 15 and less inflow from Gravel Pit Lake (Figure 4.15) which may have reduced freshwater dilution within the TMA and increased radium-226 concentrations, increasing treatment reagent demand. Treated effluent quality is monitored at the outlet of the ETP settling pond (station Q-28), and over the 2015 to 2019 period, has consistently achieved discharge criteria (Figures 4.19 and 4.20).

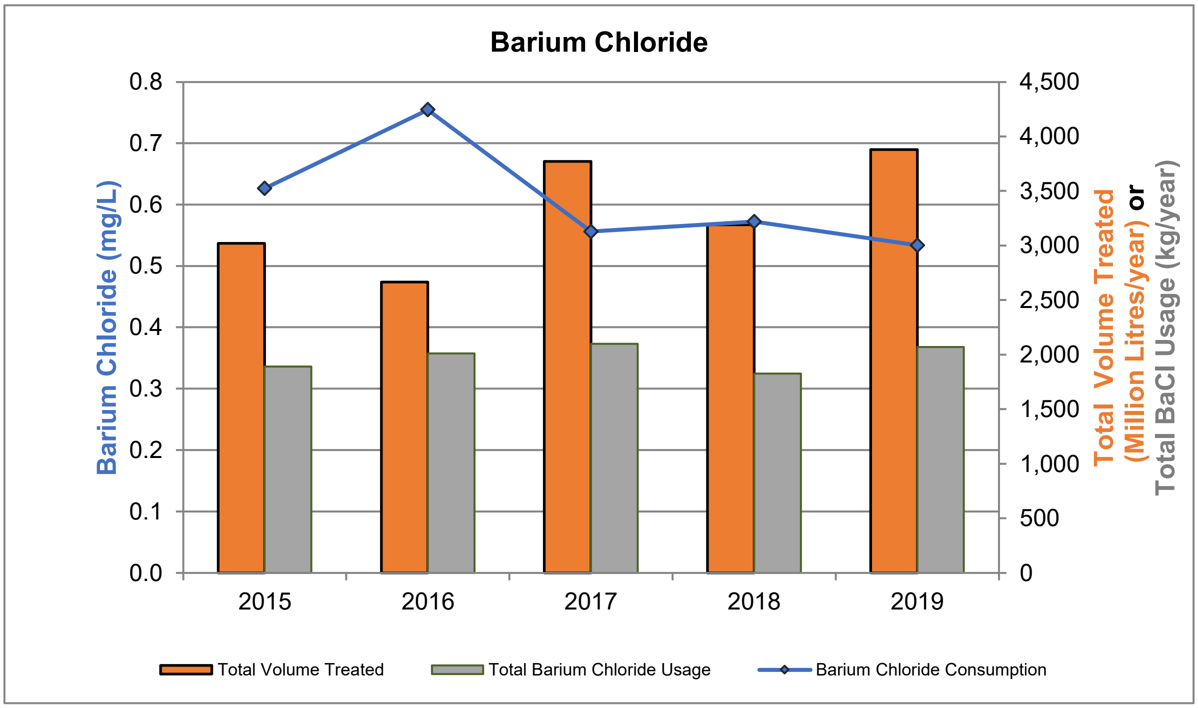
4.3.4 Panel TMA

4.3.4.1 Water Management

Water levels are monitored in both the Main and South Basins of the Panel TMA, at stations P-21 and P-13, respectively (Figure 4.5). The Main Basin water elevation generally remained above the spillway invert (393.2 m; although a bedrock outcrop downgradient of the spillway tends to retain water in the spillway to an elevation above 393.4 m) from 2015 through 2017, but then dropped below the invert level during several months in 2018 and 2019 (Figure 4.21; Appendix Table H.11). In the South Basin, water levels are managed to maintain a relatively consistent elevation while minimizing ETP start and stop cycles. 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 m (0.34 m fluctuation). Water levels in the South Basin were typically within the established operating elevations, although there was a brief period in December 2016 when water levels were below the minimum winter operating elevation (Figure 4.21; Appendix Table H.12).

4.3.4.2 Basin Surface Water Quality

Surface water quality is monitored at three stations at the Panel Facility: 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 4.12; Figure 4.5). Since decommissioning, radium-226, sulphate, and uranium concentrations have decreased, and pH has increased to near neutral in the ETP influent (Figure 4.22). Concentrations of radium-226, sulphate, and uranium are also at or approaching the 50-year (i.e., 2040) post decommissioning predictions (Figure 4.22).



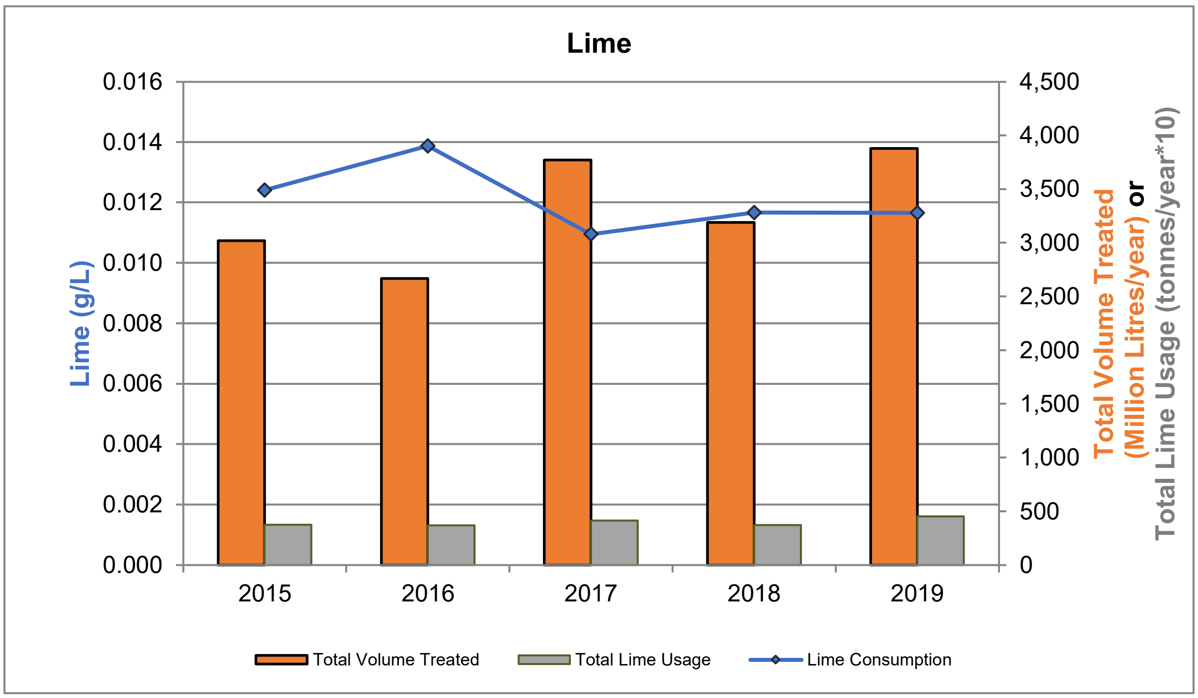


Figure 4.18: Comparison of Total Reagent Consumed Versus Total Volume Treated at Quirke TMA from 2015 to 2019 (lime usage multiplied by 10)

Note: See Appendix Table G.7 for raw data (TOMP Station Q-05).

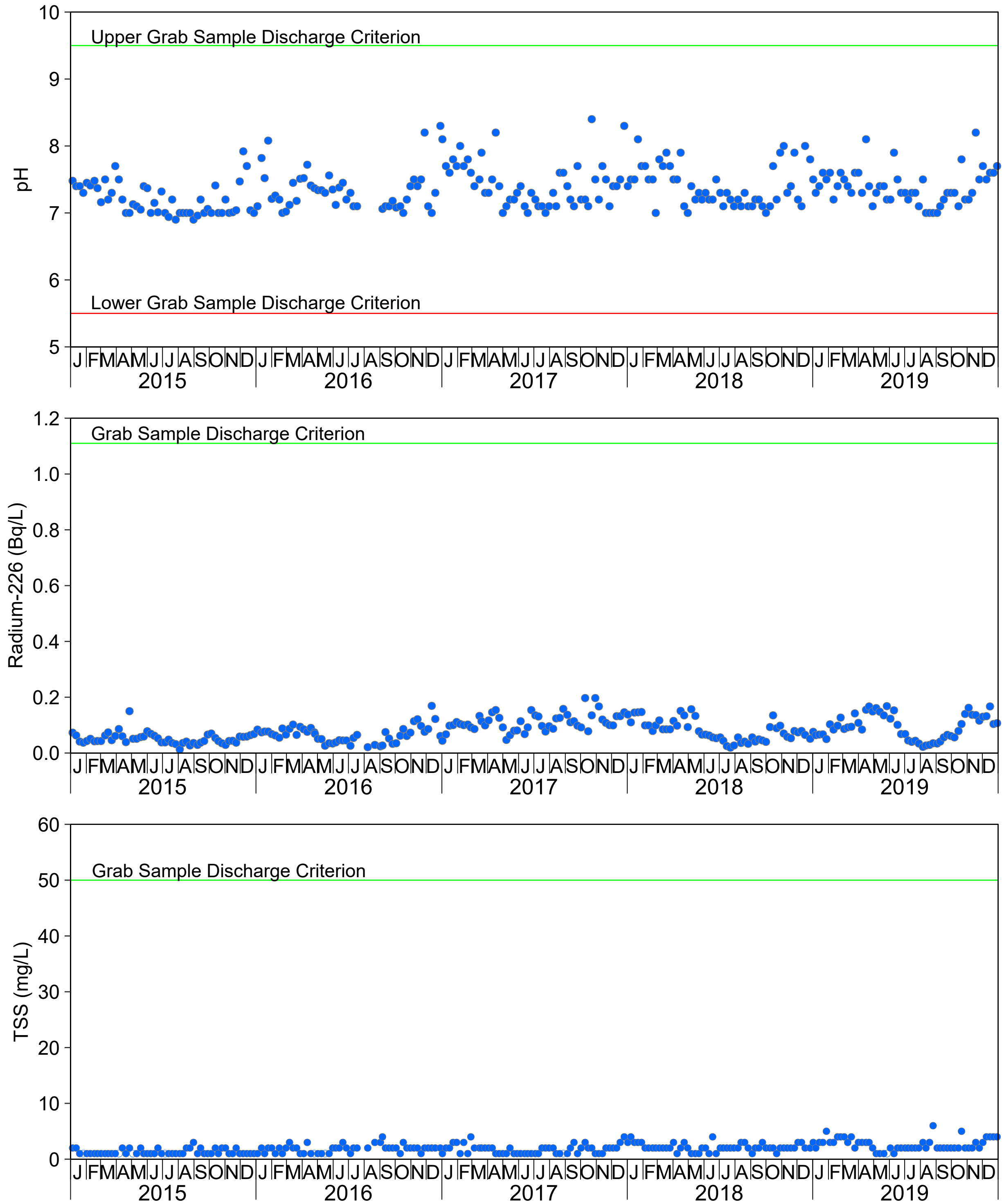


Figure 4.19: Effluent Concentrations Compared to Grab Sample Discharge Criteria at TOMP Station Q-28, Quirke TMA, 2015 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Table G.10 for raw data.

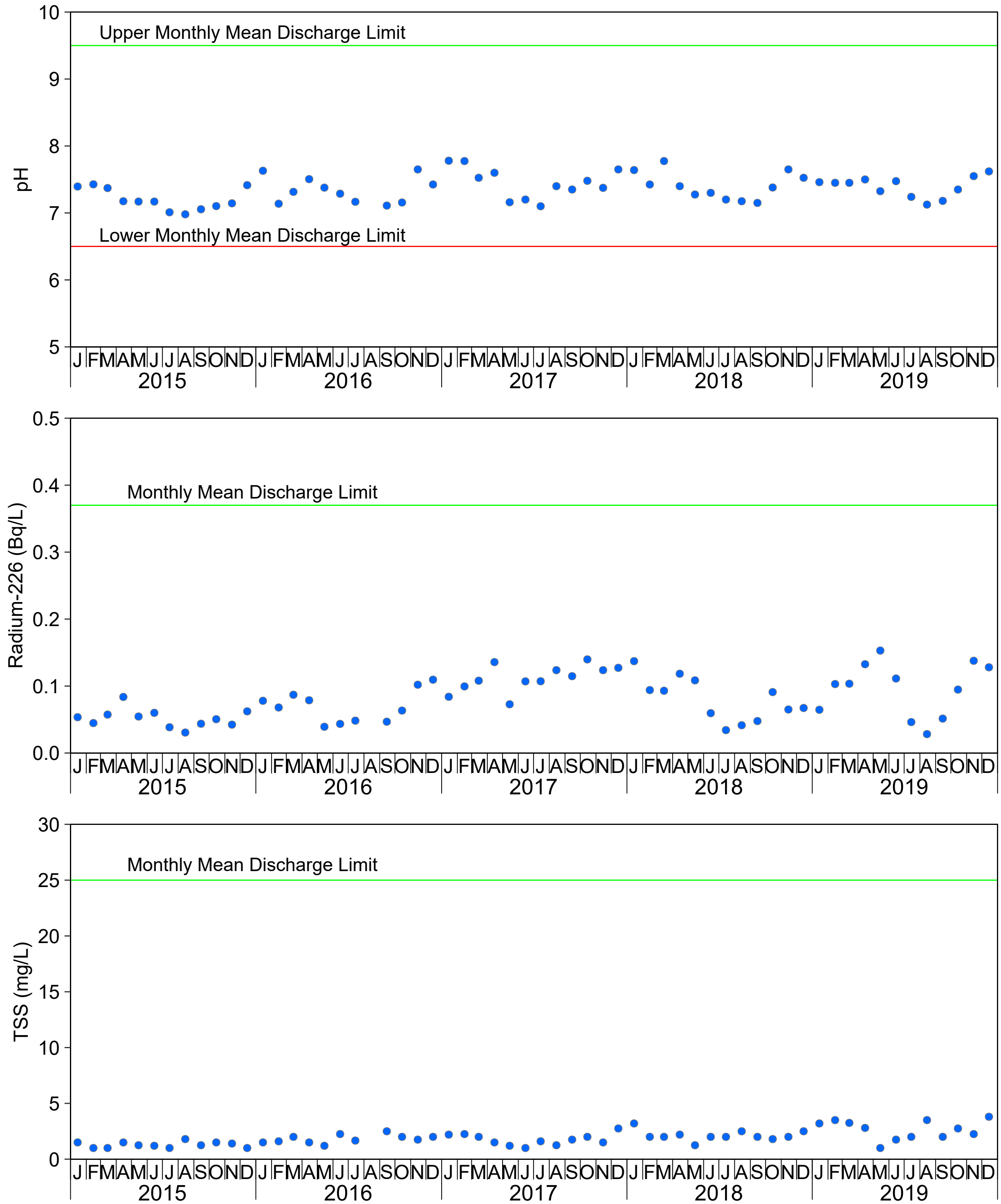


Figure 4.20: Monthly Mean Effluent Concentrations Compared to Monthly Mean Discharge Limits at TOMP Station Q-28, Quirke TMA, 2015 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Table G.10 for raw data.

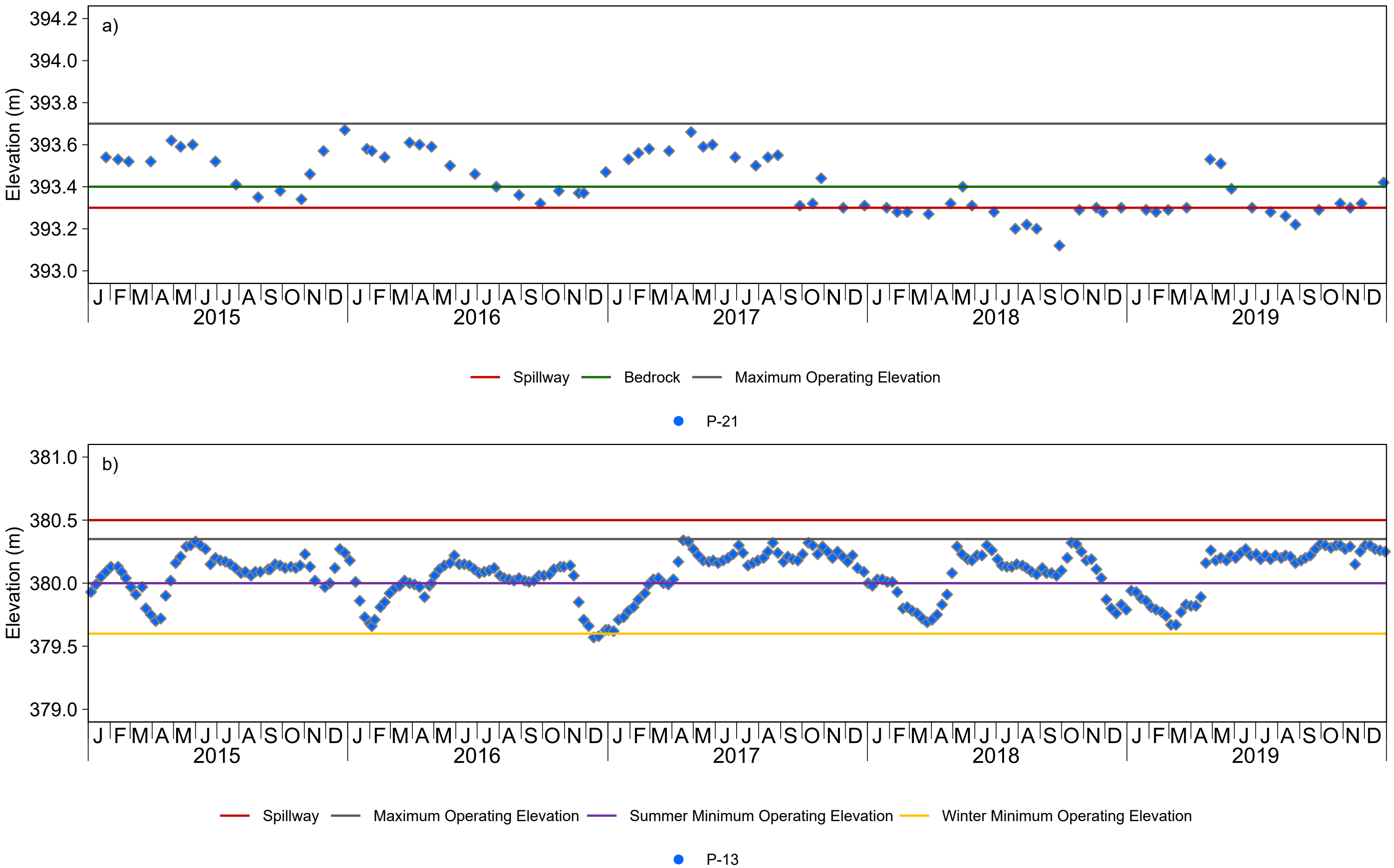


Figure 4.21: Water Level at TOMP Station P-21 (a - Main Basin) and Station P-13 (b - South Basin) Relative to Minimum Operating Elevations, Panel TMA, 2015 to 2019

Notes: See Appendix Table H.11 and H.12 for raw data.

Table 4.12: Seasonal Kendall Trend Analysis for Water Quality Parameters, TOMP Water Quality Monitoring Stations, Panel TMA, 2003 to 2019

Station	P-21	P-13
Station Type/Location	Main Basin Outflow	ETP Influent
Acidity (mg/L)	nt	nt
Barium (mg/L)	na	2.1
Cobalt (mg/L)	na	nt
Iron (mg/L)	NS	NS
Manganese (mg/L)	na	NS
pH	NS	0.4
Radium-226 (Bq/L)	NS	-1.8
Sulphate (mg/L)	-8.3	-7.2
Uranium (mg/L)	na	2.8

[green] Significant decreasing temporal trend (Seasonal Kendall test for monotonic trend at α = 0.05). Value reported is the Sen's slope reported as a percentage of the median concentration or value.
[blue] Significant increasing temporal trend (Seasonal Kendall test for monotonic trend at α = 0.05). Value reported is the Sen's slope reported as a percentage of the median concentration or value.
Note: See Appendix Table H.3 to H.4 for raw data. '"NS" = no significant temporal trend (Seasonal Kendall test for monotonic trend at α = 0.05). '"na" = parameter not monitored for this station. '"nt" = parameter not included in the trend analysis for that particular station due to >50% non-detectable concentrations in the samples available for the analysis.

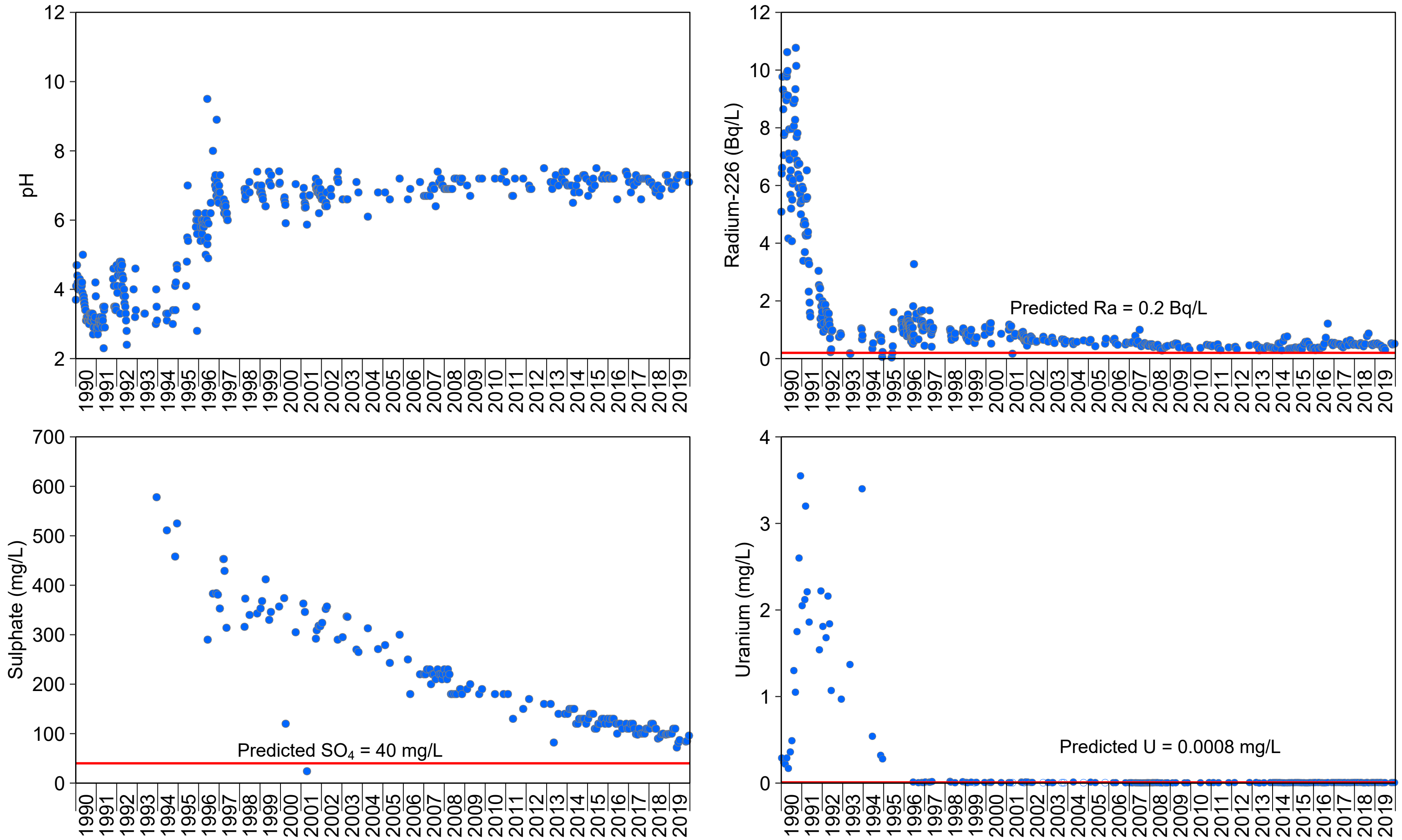


Figure 4.22: Water Quality at the Panel TMA ETP Influent (TOMP Station P-13) Relative to Predictions for 50 years (2040) Post-decommissioning

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Red line delineates predicted concentration. See Appendix Table H.4 for raw data.

More recently (2003 to 2019), ETP influent has continued to improve, based on significant reductions in the concentrations of cobalt (which have been below the laboratory reporting limit since 2014), radium-226, and sulphate, and a slight increase in pH (Table 4.12; Appendix Figures H.3, H.6 to H.8). Slight increases in barium and uranium were noted at station P-13, although concentrations for most samples collected over the 2015 to 2019 period were within the range observed in the past (i.e., Table 4.12; Appendix Figures H.2 and H.9). At the Main Basin overflow (station P-21), sulphate concentrations have decreased significantly, acidity has been below the laboratory reporting limit, and no significant changes were noted in iron, pH, and radium-226 (Table 4.12; Appendix Figures H.1, H.4, H.6, H.7).

At the ETP influent (P-13), pH meets the discharge criterion (6.5 to 9.5) and radium-226 concentrations are approaching the criterion (median of 0.464 Bq/L versus the criterion of 0.37 Bq/L; Appendix Table H.4). At the outlet of the Main Basin (station P-21), both pH and radium-226 achieve discharge criteria prior to treatment (Appendix Table H.3).

The Panel Main Basin tailings have been shown to be stable and radium-226 fluxes from tailings are not expected to increase, thus water quality is not expected to worsen (Minnow 2020b). In general, the maintenance of water level in both the Main Basin and the South Basin has been shown to be the most important factor influencing water quality, and while water levels are continually maintained, water quality is not expected to change in terms of pH and radium-226 concentrations (Minnow 2020b).

The Panel effluent treatment process has been shown to be susceptible to refractory radium (where settling of treatment solids loses efficacy seasonally; see Appendix K). The phenomenon of refractory radium is currently under investigation, however radium-226 concentrations in effluent are sufficiently low that barium chloride is maintained as the treatment reagent for radium-226.

Groundwater Quality

Three locations (wells) are sampled annually for acidity, pH, iron, and sulphate at the Panel Facility. Two wells are located downgradient of the Main Basin at Dam E (P-31) and Dam B (P-16A) and one is located downgradient of the South Basin at Dam A (P-20; Figure 4.5). Acidity in all groundwater monitoring wells has been below the laboratory reporting limit since 2009 (Appendix Figure H.10). While a significant decrease in pH was noted in the wells downgradient of Dams A and B, concentrations have remained near neutral in both wells (Table 4.13; Appendix Figure H.12). Downgradient of Dam B (P-16A), iron concentrations have decreased since the 1996 to 2002 period when they were at their highest, but have been relatively stable since 2003 (Table 4.13; Appendix Figure H.11). In contrast, iron concentrations downgradient of Dam E (P-31) have increased over time, but are still relatively low compared to

Table 4.13: Results of Temporal Trend Analyses for Groundwater Quality Parameters, TOMP Groundwater Stations, Panel TMA, 1990 to 2019

Station	P-20	P-16A	P-31
Station Type/Location	Downgradient of Dam A (South Basin)	Downgradient of Dam B (Main Basin)	Below Dam E (Main Basin)
Depth	13.9	24.8	9.97
Acidity (mg/L)	nt	nt	nt
Field pH	-0.31	-0.48	NS
Iron (mg/L)	NS	-5.6	8.3
Sulphate (mg/L)	-3.5	3.8	NS

[Green] Significant decreasing temporal trend (Kendall test for monotonic trend at α = 0.05). Value reported is the slope reported as a percentage of the median concentration or value.

[Blue] Significant increasing temporal trend (Kendall test for monotonic trend at α = 0.05). Value reported is the slope reported as a percentage of the median concentration or value.

Notes: Due to a change in analytical technique for acidity in 2006, acidity trends were assessed from 2007 to 2019. See Appendix Table H.8 to H.10 for raw data. "NS" = no significant temporal trend (Kendall test for monotonic trend at α = 0.05). '"nt" = parameter not included in the trend analysis for that particular station due to >50% non-detectable concentrations in the samples available for the analysis.

those in measured at P-20 (Table 4.13; Appendix Figure H.11). Downgradient of Dam A (P-20), sulphate concentrations in groundwater have decreased over time consistent with the improvements observed in South Basin surface water quality (Table 4.13; Appendix Figure H.13). While an increasing trend was noted for sulphate at P16-A (Table 4.13), this was primarily due to inclusion of data from the 1990s in the trend analysis. Since reaching a maximum in 2001, sulphate concentrations at P16-A have been decreasing over time (Appendix Figure H.13).

4.3.4.3 Treatment Performance

Influent from the Panel Facility South Basin is treated at the ETP and associated settling ponds prior to discharge to the receiving environment at station P-14 (Figure 4.5). The ETP uses both lime and barium chloride to reduce acidity and radium-226 levels, respectively. From 2015 to 2019, both barium chloride and lime consumption rates were lowest (and total usage was highest) in the years where the highest volume of water required treatment (2017 and 2019), whereas the opposite was true for the years with the lowest volumes of water treated (2015 and 2016; Figure 4.23).

Treated effluent is monitored at the outlet of the ETP settling pond (P-14) and, over the 2015 to 2019 period, effluent quality has consistently achieved discharge criteria for pH, radium-226, and TSS (Figures 4.24 and 4.25; Appendix Table H.6).

4.4 SAMP: Quirke Lake Sub-Watershed Sources

4.4.1 Discharge Quality and Loads

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 (through the runoff collection pond to the east; Figure 4.1), resulting in four TMA sources to the Quirke Lake sub-watershed.

Effluent from the Denison TMA has been consistently non-lethal to *Daphnia magna* and rainbow trout, with no mortality reported in semi-annual acute toxicity tests (Table 4.14). Similarly, reproduction of *Ceriodaphnia dubia* was not affected by exposure to 100% effluent over the 2015 to 2019 period (Table 4.14).

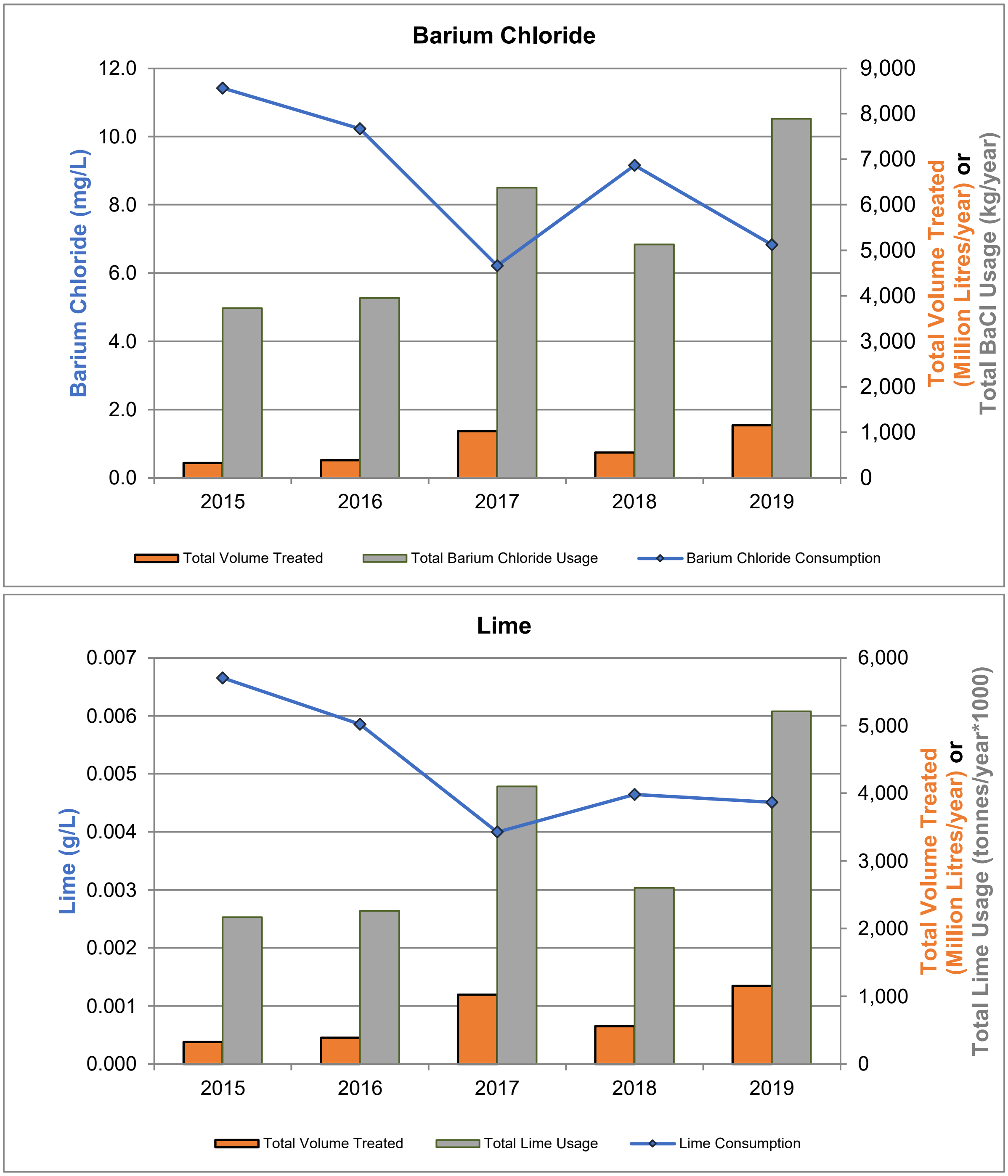


Figure 4.23: Comparison of Total Reagent Consumed Versus Total Volume Treated at Panel TMA from 2015 to 2019 (lime usage multiplied by 1,000)

Note: See Appendix Table H.4 for raw data (TOMP Station P-13).

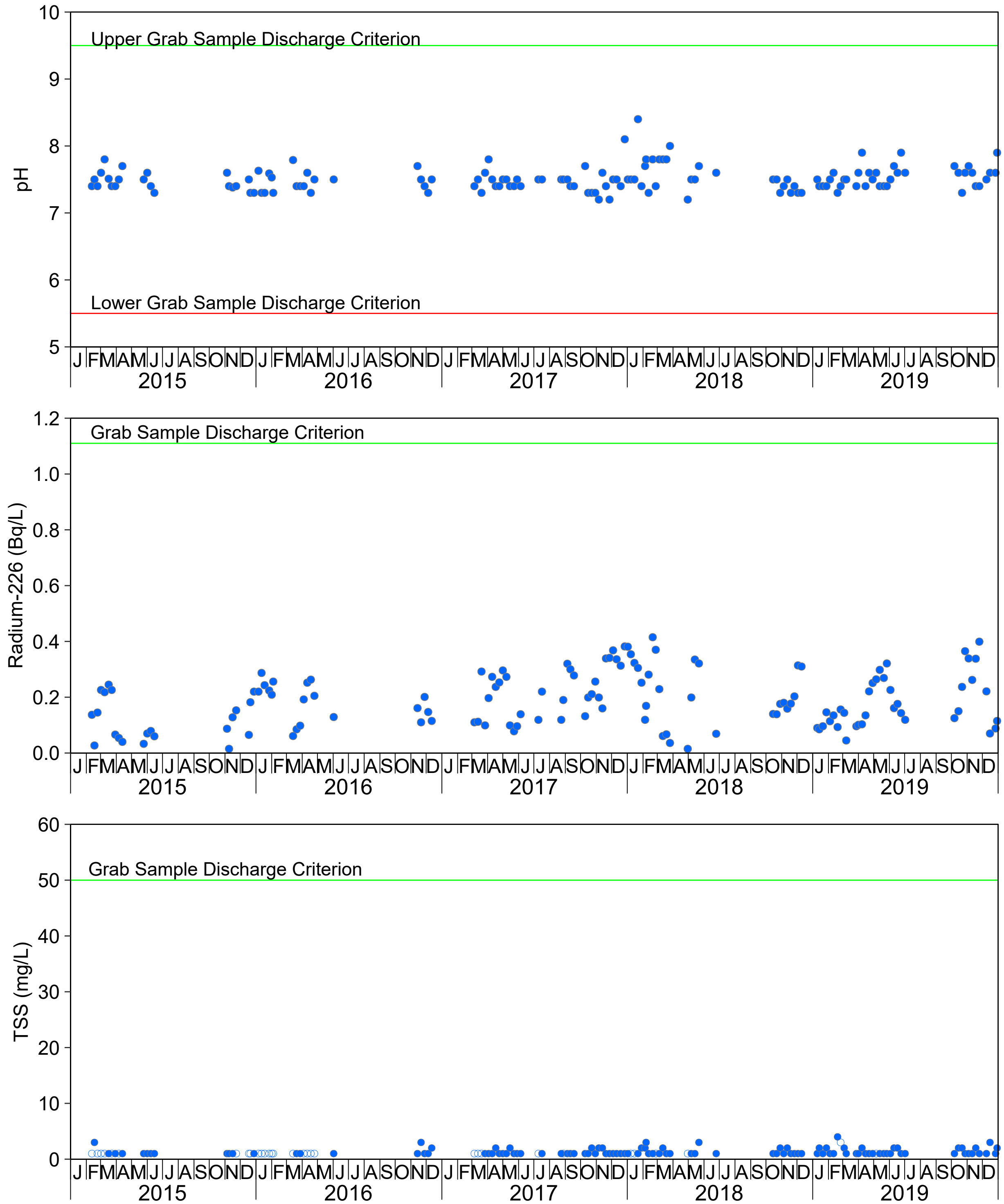


Figure 4.24: Effluent Concentrations Compared to Grab Sample Discharge Criteria at TOMP Station P-14, Panel TMA, 2015 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Table H.6 for raw data.

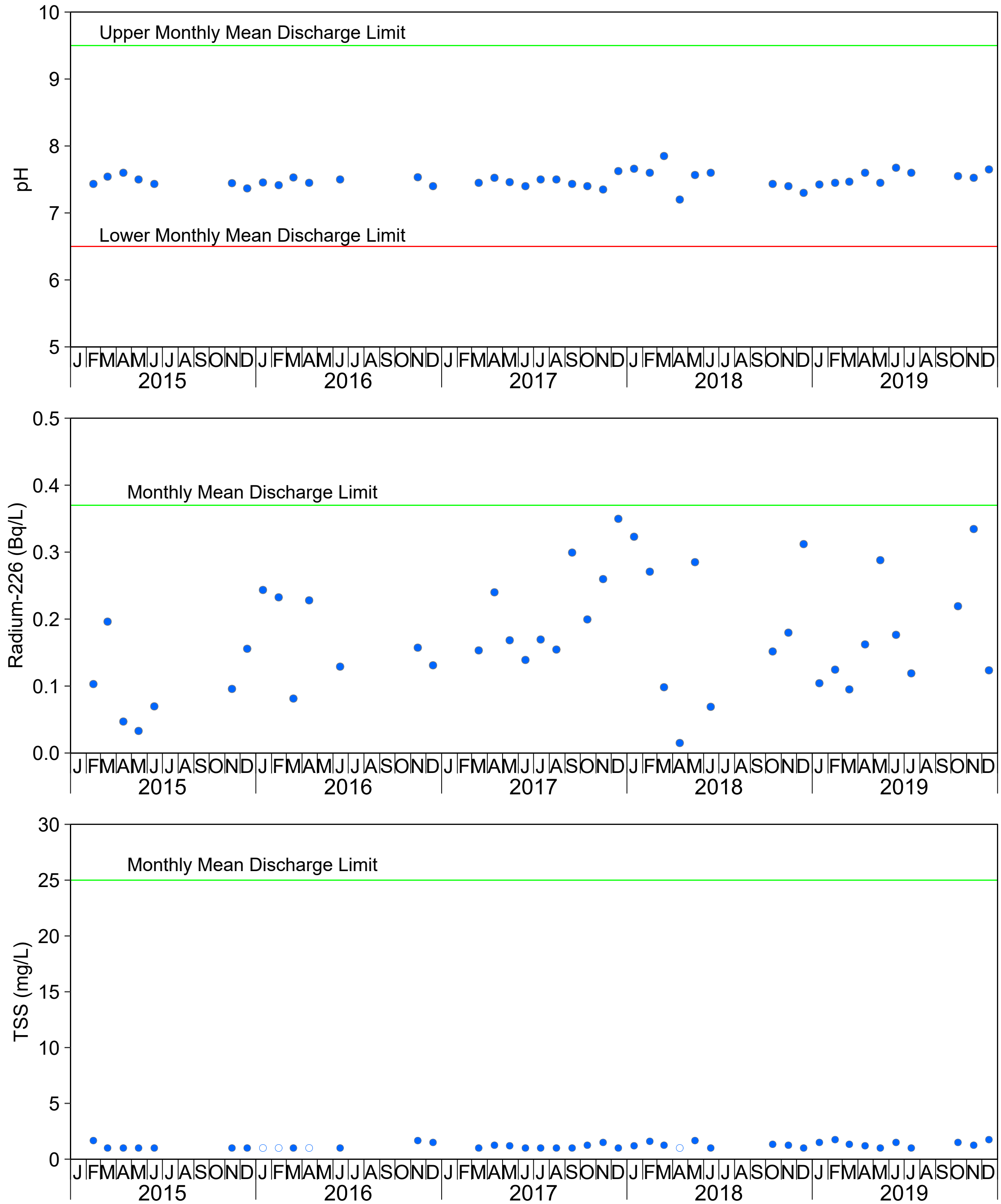


Figure 4.25: Monthly Mean Effluent Concentrations Compared to Monthly Mean Discharge Limits at TOMP Station P-14, Panel TMA, 2015 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Table H.6 for raw data.

Table 4.14: Toxicity Test Results for Samples Collected at Denison TMA SAMP and TOMP Station D-2, 2015 to 2019

Date	Sublethal Toxicity (*Ceriodaphnia dubia*) IC25	Acute Toxicity (*Daphnia magna*) % Mortality	Acute Toxicity (Rainbow Trout) % Mortality
12-May-15	100	0	0
17-Nov-15	100	0	0
10-May-16	100	0	0
11-Oct-16	100	0	0
23-May-17	100	0	0
12-Oct-17	100	0	0
19-Jun-18	100	0	0
04-Dec-18	100	0	0
14-May-19	100	0	0
12-Nov-19	100	0	0
n	10	10	10
Minimum	100	0	0
Maximum	100	0	0
Mean	100	0	0
SD	-	-	-
Median	100	0	0
10th Percentile	100	0	0
95th Percentile	100	0	0

Note: n = number of samples. SD = standard deviation. "-" = SD not applicable.

Annual mean concentrations for all parameters measured in the Denison TMA 2 effluent (D-3) met SRWMP benchmarks, whereas discharge from TMA 1 (D-2) met SRWMP benchmarks[14] for all parameters except sulphate (2015 to 2017 only) and uranium (all years; Figure 4.26).

The station D-9 seepage associated with the Denison TMA was above benchmarks for iron, manganese, and sulphate (Figure 4.26). At D-16, annual mean pH was slightly below the SRW minimum benchmark for lakes (in 4 of 5 years), but well above the minimum benchmark for wetlands (Figure 4.26).

Loadings associated with the Denison Facility have varied over time, with little change observed over the 2015 to 2019 period relative to the longer-term (i.e., 2005 to 2014) period for most parameters (Appendix Figure N.13). Barium and radium-226 were the main exceptions, where the highest loadings were measured in 2019, and appeared to be increasing over time (from 2005 to 2019; Appendix Figure N.13). Of all Denison TMA discharge and seepage locations, the Denison TMA 1 discharge (D-2) contributed the highest proportion of loadings to the receiving environment, although seepage from station D-9 contributed relatively large proportions (e.g., 10% to 30%) of cobalt, manganese, and iron loads (Appendix Figure N.10). However, over the past five years, the proportion of cobalt, iron, and manganese loads associated with seepages has decreased (Appendix Figure N.10).

Effluent from the Quirke TMA was non-lethal to *D. magna* in semi-annual acute toxicity tests, and except for one test in June 2018, where 10% mortality was observed, effluent was also non-lethal to rainbow trout (Table 4.15). Reproduction of *C. dubia* was not affected by exposure to 100% effluent in all but one of the tests conducted over the 2015 to 2019 period (i.e., May 2017; Table 4.15). However, the IC25 (effluent concentration causing 25% inhibition relative to control organisms) for this sample was 85.7%, whereas the concentration of effluent from the Quirke TMA in the Serpent River is much lower (i.e., <5%, Calder 2015). As such, effects to these invertebrates would not be expected in the receiving environment.

Annual mean concentrations of all substances in discharges associated with the Quirke TMA met the SRWMP benchmark[15] except for manganese, pH, and uranium in seepage at ECA-398; manganese and sulphate in final effluent (at Q-28); and uranium in drainage at Q-22, (Figure 4.26). While pH was below the SRW lake minimum benchmark at Q-23, it was above the

[14] These are receiving environment criteria, which are provided here for context but are not required to be met for discharge to occur.

[15] These are receiving environment criteria, which are provided here for context but are not required to be met for discharge to occur.

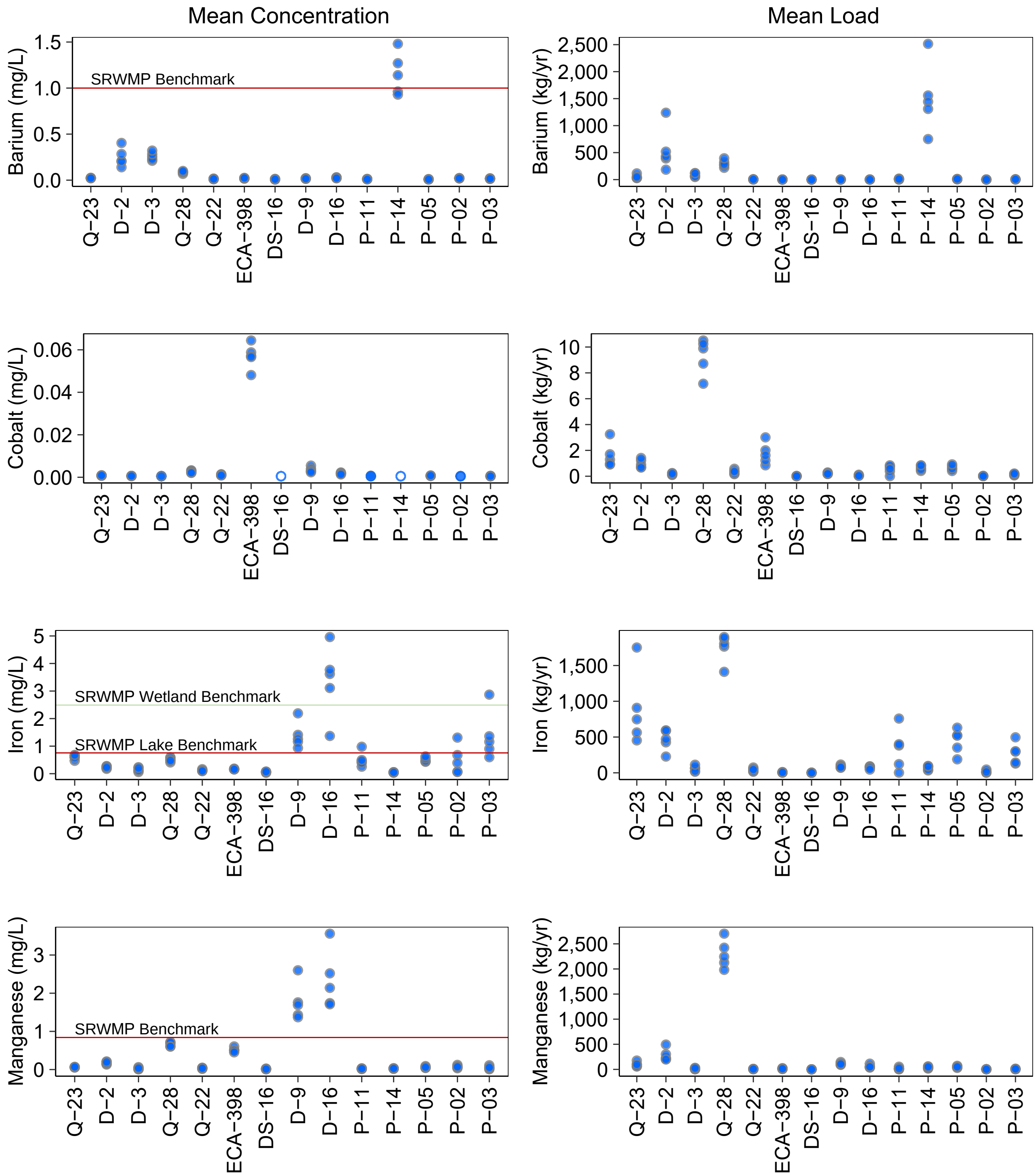


Figure 4.26: Annual Mean Concentrations and Loads at SAMP Monitoring Stations that Discharge to Quirke Lake Sub−Watershed, 2015 to 2019

Notes: SRWMP benchmarks (Table 2.8) apply to the receiving environment and are based on background (reference) concentrations or approved guidelines, provided here for context, but they are not criteria that need to be met for discharge to occur. Values at the LRL (open circles) were replaced with the LRL for calculations. See Appendix Tables M.3, N.2 to N.8, and N.10 to N.15 for raw data and Tables N.20 to N.23 for annual discharge and seepage loadings.

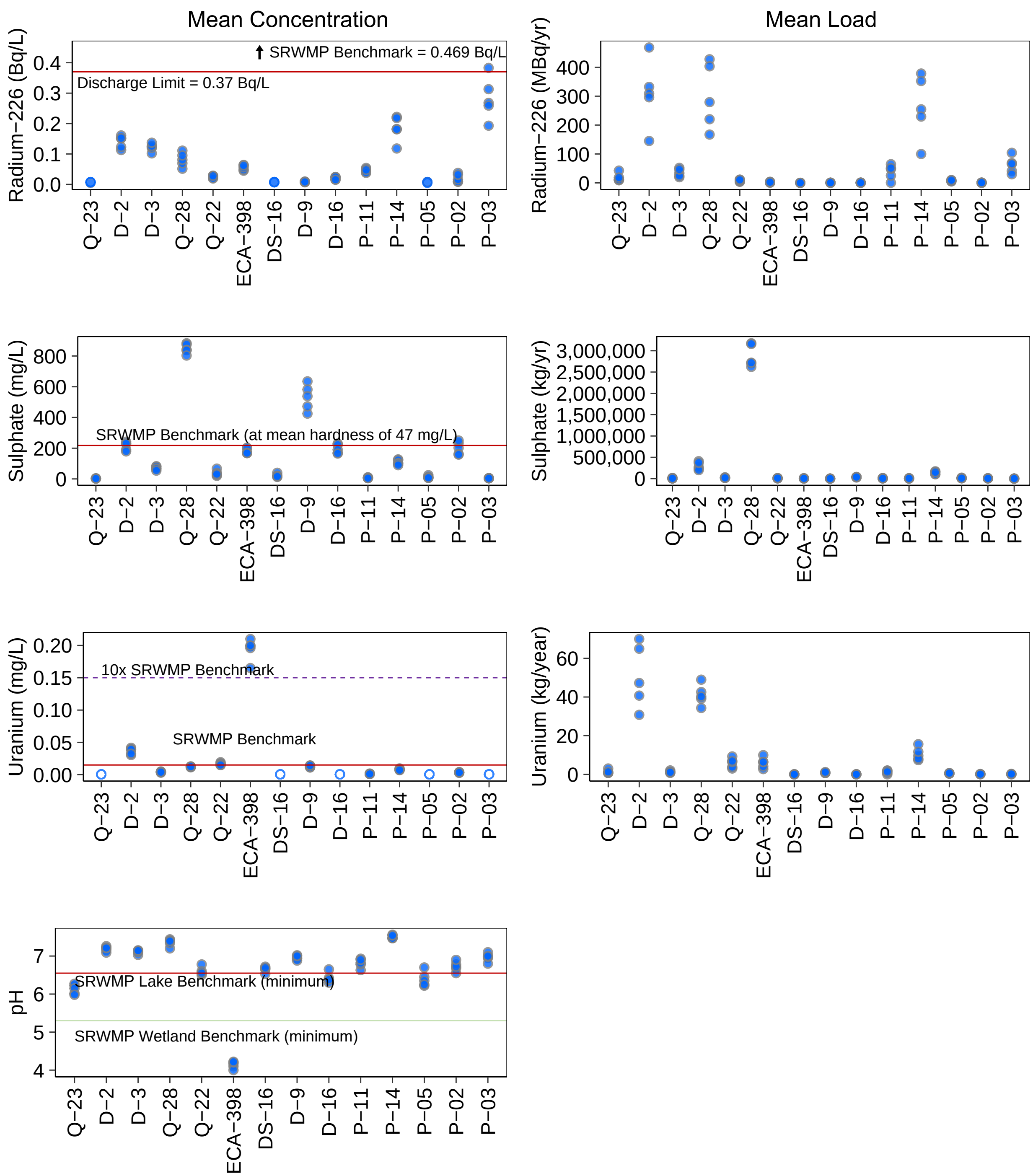


Figure 4.26: Annual Mean Concentrations and Loads at SAMP Monitoring Stations that Discharge to Quirke Lake Sub−Watershed, 2015 to 2019

Notes: SRWMP benchmarks (Table 2.8) apply to the receiving environment and are based on background (reference) concentrations or approved guidelines, provided here for context, but they are not criteria that need to be met for discharge to occur. Values at the LRL (open circles) were replaced with the LRL for calculations. See Appendix Tables M.3, N.2 to N.8, and N.10 to N.15 for raw data and Tables N.20 to N.23 for annual discharge and seepage loadings.

Table 4.15: Toxicity Test Results for Samples Collected at Quirke TMA SAMP and TOMP Station Q-28, 2015 to 2019

Date	Sublethal Toxicity (*Ceriodaphnia dubia*) IC25	Acute Toxicity (*Daphnia magna*) % Mortality	Acute Toxicity (Rainbow Trout) % Mortality
11-May-15	100	0	0
09-Nov-15	100	0	0
09-May-16	100	0	0
14-Nov-16	100	0	0
08-May-17	85.7	0	0
13-Nov-17	100	0	0
04-Jun-18	100	0	10.0
05-Nov-18	100	0	0
16-Apr-19	100	0	0
11-Nov-19	100	0	0
n	10	10	10
Minimum	85.7	0	0
Maximum	100	0	10.0
Mean	98.6	0	1.00
SD	4.52	-	3.16
Median	100	0	0
5th Percentile	92.8	0	0
95th Percentile	100	0	10.0

Note: n = number of samples. SD = standard deviation. "-" = SD not applicable.

wetland minimum benchmark, which is likely more applicable given Q-23 represents water quality at the outlet of a swamp west of Dam K1 (Figure 4.4).

Loadings associated with the Quirke TMA were variable over the 2015 to 2019 period, but generally within the range observed in previous years for most parameters (i.e., 2005 to 2014). Two main exceptions were cobalt and manganese, for which loadings have decreased steadily over the 2005 to 2019 period (Appendix Figure N.13). Most of the loads from the Quirke Facility are associated with the primary discharge (Q-28; Appendix Figure N.11).

At the Panel Facility (station P-14), effluent was non-lethal to rainbow trout in all semi-annual acute toxicity tests conducted over the 2015 to 2019 period, whereas one test (October 2019) resulted in minimal mortality (3.3%) to *D. magna* (Table 4.16). Similarly, reproduction of *C. dubia* was not affected by exposure to 100% effluent in all but one test (October 2019), when the IC25 equalled 68.9% (Table 4.16).

Few analytes exceeded SRWMP benchmarks[16] in discharges/seepages from the Panel TMA, and of those that did (i.e., barium at P-14 and sulphate at P-02), none were consistently greater than benchmarks over the 5-year (i.e., 2015 to 2019) monitoring period (Figure 4.26). Annual mean pH was below the SRW lake benchmark at P-05 from 2016 to 2019, but above the wetland benchmark, while mean iron concentrations in some Panel discharges/seepages were also occasionally greater than the SRW lake minimum benchmark, but not the SRW minimum wetland benchmark (Figure 4.26).

Since 2005, sulphate loadings associated with the Panel TMA have generally been decreasing, whereas barium and radium-226 have been increasing (with their highest loadings over the 2005 to 2019 period being measured in 2019; Appendix Figure N.13). Higher iron (2018) and uranium (2017) loadings were also noted over the 2015 to 2019 period relative to the longer-term period (i.e., 2005 to 2019; Appendix Figure N.13). Over 80% of the barium and uranium loads from the Panel TMA were associated with the primary discharge (P-14), whereas other discharges/seepages contributed more substantially to the loads for other analytes, including P-05 (cobalt, iron, and manganese), P-11 (cobalt, iron, manganese, and radium-226) and P-03 (iron and radium-226; Appendix Figure N.12).

Drainage from the Stanrock Facility to Quirke Lake (DS-16) met SRWMP benchmarks[11] for all parameters (based on annual means; Figure 4.26).

[16] These are receiving environment criteria, which are provided here for context but are not required to be met for discharge to occur.

Table 4.16: Toxicity Test Results for Samples Collected at Panel TMA SAMP and TOMP Station P-14, 2015 to 2019

Date	Sublethal Toxicity (*Ceriodaphnia dubia*) IC25	Acute Toxicity (*Daphnia magna*) % Mortality	Acute Toxicity (Rainbow Trout) % Mortality
13-Apr-15	100	0	0
09-Nov-15	100	0	0
11-Apr-16	100	0	0
21-Nov-16	100	0	0
15-May-17	100	0	0
16-Oct-17	100	0	0
07-May-18	100	0	0
29-Oct-18	100	0	0
15-Apr-19	100	0	0
22-Oct-19	68.9	3.30	0
n	10	10	10
Minimum	68.9	0	0
Maximum	100	3.30	0
Mean	96.9	0.330	0
SD	9.83	1.04	-
Median	100	0	0
10th Percentile	84.4	0	0
95th Percentile	100	3.30	0

Note: n = number of samples. SD = standard deviation. "-" = SD not applicable.

In terms of the relative loadings associated with the TMAs within the Quirke Lake sub-watershed, the Quirke TMA tended to produce the highest loadings of most metals (cobalt, iron, and manganese) and sulphate (Figure 4.26). Barium loads were slightly higher from the Panel TMA than the others, while radium-226 loads were similar among the Quirke, Denison, and Panel TMAs (Figure 4.26). The decrease in uranium loads from the Quirke TMA has resulted in nearly equal loadings relative to the Denison TMA as of 2019 (Figure 4.26). Loadings to the Quirke sub-watershed from the Stanrock Facility (DS-16) were substantially lower than all other facilities (Figure 4.26).

4.4.2 Trends

Cobalt, manganese, sulphate, and radium-226 concentrations have decreased or remained similar over time in all discharges to Quirke Lake, except for a small but significant increase in manganese at D-3 (Table 4.17; Appendix Figures N.2, N.4, N.6, and N.7). Uranium concentrations also decreased or remained stable at most stations, but increasing trends were noted in seepages from the Denison Facility (at station D-9) and Panel (at station P-02; Table 4.17; Appendix Figure N.8).

Increasing trends for barium were noted at each of the primary discharge locations (D2, D-3, Q-28, and P-14; Table 4.17; Appendix Figure N.8), largely due to greater barium chloride use to maintain treatment effectiveness at lower influent sulphate concentrations. An increasing trend for barium was also found in seepage from the Quirke TMA (at station ECA-398; Table 4.17; Appendix Figure N.8). Barium was decreasing or showed no significant change over time at all other source areas (Table 4.17; Appendix Figure N.8). Despite iron concentrations either decreasing or showing no trend within the main basin of either Denison or Quirke TMA (D-1 and Q-05; Sections 4.2.3.2 and 4.2.4.2), iron concentrations increased in the primary discharges at both the Denison (D-2 and D-3) and Quirke (Q-28) TMAs from 2003 to 2019 (Table 4.17), although iron in the Quirke discharge (Q-28) appears to have declined more recently (i.e., 2013 to 2019; Appendix Figure N.3). Although iron concentrations have increased at these discharge stations, mean iron concentrations in effluent have remained low (i.e., ≤ SRWMP benchmark; Figure 4.26).

Similar to iron, pH improved (increased) or remained stable at all discharge locations except for the primary discharges from Quirke and Denison (i.e., stations Q-28, D-2, and D-3; Table 4.17; Appendix Figure N.5). Drainage from the Stanrock TMA (station DS-16) also showed an overall increase in pH from 2003 to 2019, though decreased slightly from 2006 to 2013 (Table 4.17; Appendix Figure N.5). From 2003 to 2005, Dam G seepage caused pH to be low at station DS-16 (Appendix Figure N.5), so caustic soda was used to increase the pH before seepage discharged into Quirke Lake. In 2010, Dam M was built to collect Dam G seepage and pump seepage to the

Table 4.17: Seasonal Kendall Trend Analysis for Water Quality Parameters, SAMP Water Quality Monitoring Stations in Denison, Quirke, Panel, and Stanrock TMAs, Discharging to the Quirke Lake Sub-watershed, 2003 to 2019

Station	Denison				Quirke					Panel					Stanrock
	D-2	D-3	D-9	D-16	ECA398	Q-22	Q-23	Q-27	Q-28	P-02	P-03	P-05	P-11	P-14	DS-16
	Principal	Principal	Seepage	Seepage	Seepage	Drainage	Drainage	Seepage	Principal	Seepage	Drainage	Drainage	Drainage	Principal	Drainage
Barium (mg/L)	9.00	2.80	NS	-1.60	2.50	-3.30	-1.80	NS	1.70	-1.20	-4.90	-4.50	NS	10.0	NS
Cobalt (mg/L)	-11.0	nt	-18.0	-10.0	-5.90	-13.0	NS	-3.60	-14.0	-10.0	nt	NS	nt	nt	-14.0
Iron (mg/L)	2.50	6.70	-18.0	NS	-2.20	NS	NS	-3.00	1.4	NS	NS	NS	NS	-13.0	-10.0
Manganese (mg/L)	-7.40	4.10	-6.60	NS	-5.50	-10.0	-2.50	NS	-8.20	NS	NS	NS	NS	-2.60	-8.40
pH	-0.100	-0.200	0.600	0.600	0.600	0.800	NS	NS	-0.300	0.600	NS	NS	NS	NS	-0.800
Radium (Bq/L)	NS	NS	-5.10	-6.50	NS	-6.10	nt	NS	-1.90	-5.20	-4.50	-2.90	NS	NS	-19.0
Sulphate (mg/L)	-8.20	-2.30	-2.20	-2.90	-6.20	-8.20	-5.50	NS	-2.80	-11.0	-4.90	-7.80	-4.90	-7.10	-12.0
Uranium (mg/L)	-6.40	-7.70	4.20	nt	-8.00	-10.0	nt	-8.30	-5.80	4.30	nt	nt	NS	NS	nt

[green] Significant decreasing temporal trend (Seasonal Kendall test for monotonic trend at α = 0.05). Value reported is the Sen's slope reported as a percentage of the median concentration or value.

[blue] Significant increasing temporal trend (Seasonal Kendall test for monotonic trend at α = 0.05). Value reported is the Sen's slope reported as a percentage of the median concentration or value.

Note: "NS" = no significant temporal trend (Seasonal Kendall test for monotonic trend at α = 0.05). "nt" = Parameter not tested for this station because >50% of values <LRL . See Appendix Tables N.2 to N.15 and M.3 for raw data and Appendix Figures N.1 to N.9 for time series plots of the trends.

treatment plant. This resulted in substantially less discharge from DS-16 (Appendix Figure N.13), and therefore caustic soda treatment at this location was discontinued. Following the construction of Dam M in 2010, pH has remained at of near neutral (Appendix Figure N.5). The only discharge location where pH has remained low (i.e., below 5) is the seepage from the historical Quirke II mine (station ECA-398; Appendix Figure N.5).

4.5 SRWMP Water Quality

Receiving water quality in the Quirke Lake sub-watershed is monitored quarterly at the outlet of Cinder Lake (D-6) and in the Serpent River between the Denison and Quirke TMAs (D-5) and downstream of the Quirke TMA effluent (Q-09; Figure 4.1). Samples are also collected annually at the outlet of Evans Lake (Q-20) and Quirke Lake (SR-01; Figure 4.1). The upstream reference station at the outlet of Dunlop Lake (D-4) is monitored semi-annually (Figure 4.1).

Over the 2015 to 2019 period, annual mean concentrations of water quality analytes at all receiving water stations within the Quirke Lake sub-watershed met SRWMP benchmarks, although individual samples, mostly from the outlet of Cinder Lake (D-6), occasionally exceeded benchmarks (Figure 4.27; Appendix Tables S.12 to S.16 and S.20). Less that 20 % of the iron, manganese, and sulphate samples at station D-6 exceeded the SRW benchmarks (Appendix Table S.16). The SRWMP iron benchmark for this station is calculated from the upper limit of background concentrations for 'lake' stations based on the study design (Appendix Table S.1); however, the habitat at station D-6 is notably wetland in characteristic, and it may be more appropriate to compare to the wetland upper limit of background (see Photos Set S.1). If compared to the wetland benchmark, iron concentrations from two out of 20 samples collected from station D-6 would be slightly above the benchmark. The exceedances of manganese and sulphate were partially a function of using an average hardness values in the data screening. Had the specific hardness of each sample been used instead, two manganese and one sulphate samples would have exceeded the benchmark. Water quality within the sub-watershed has generally improved since 2003 based on decreasing concentrations of sulphate at all locations, and decreasing radium-226 and uranium at stations within the Serpent River (i.e., D-5 and Q-09; Table 4.18; Appendix Figures S.8 to S.14).

Loadings measured at receiving environment stations in the Quirke Lake sub-watershed were typically highest in the Serpent River at stations D-5 and Q-09 (Figure 4.27). Station D-5 is located downstream of the Denison TMA discharges and upstream of Quirke TMA discharges, whereas Q-09 represents combined loads from D-5 and the Quirke Facility primary discharge (Figures 4.1 and 4.27). Loads for iron were highest at the upstream reference station D-4 (Dunlop Lake outlet upstream of the Serpent River; Figures 4.1 and 4.27). As noted in the previous SOE report (Minnow 2017), the barium and radium-226 load within the Serpent River downstream of the

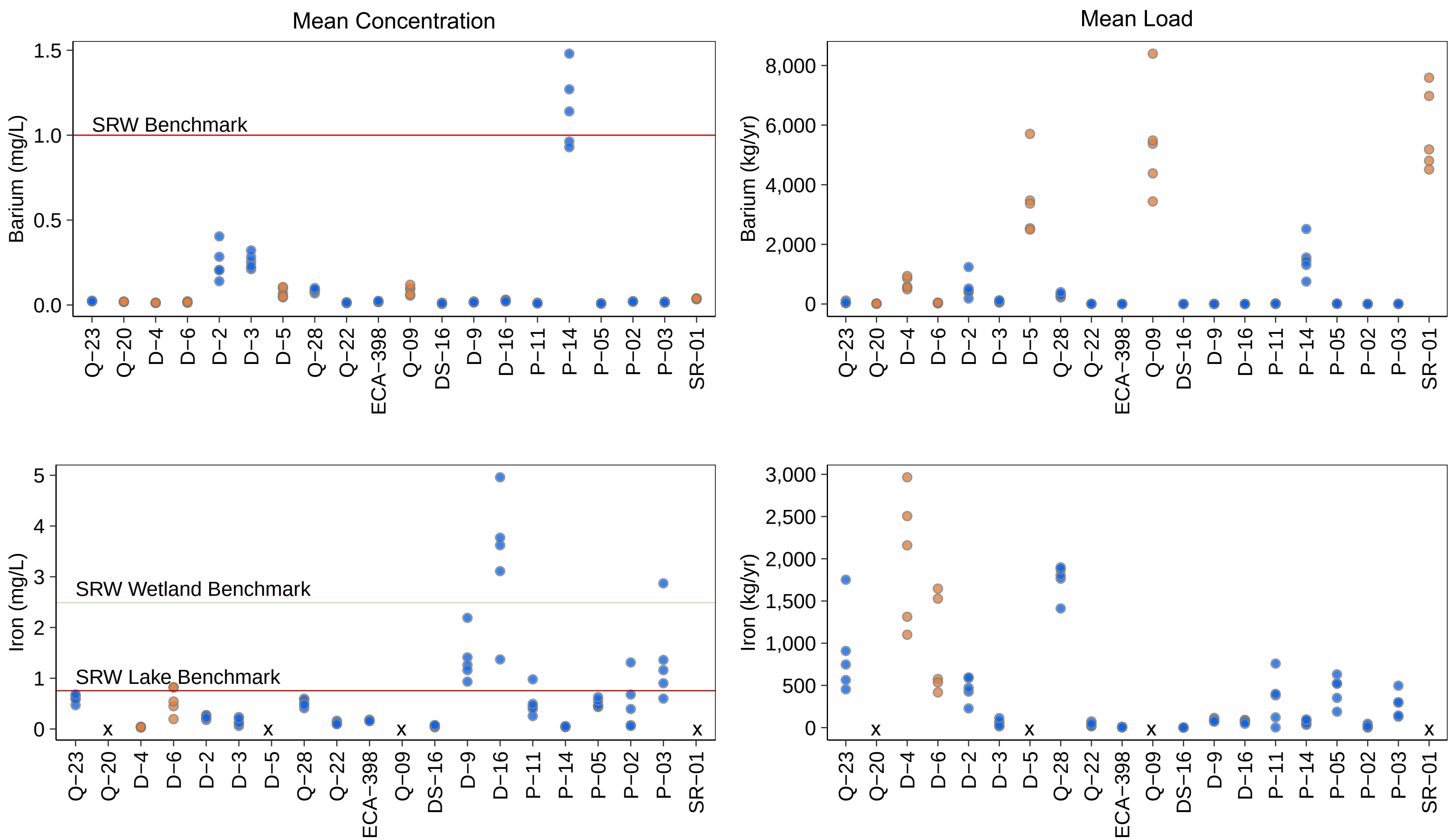


Figure 4.27: Annual Mean Concentrations and Loads at SAMP and SRWMP Monitoring Stations Upstream of Quirke Lake Outlet, 2015 to 2019

Notes: Blue circles represent SAMP stations, orange circles represent SRWMP stations. SRWMP benchmarks (Table 2.8) apply to the receiving environment and are based on background (reference) concentrations or approved guidelines, and is not applicable to SAMP stations. Values at the LRL (open circles) were replaced with the LRL for calculations. X indicates that parameter is not monitored for a given station. See Appendix Tables M.3, N.2 to N.8, N.10 to N.15, S.4, and S.12 to S.16 for raw data and Tables N.20 to N.23 for annual discharge and seepage loadings.

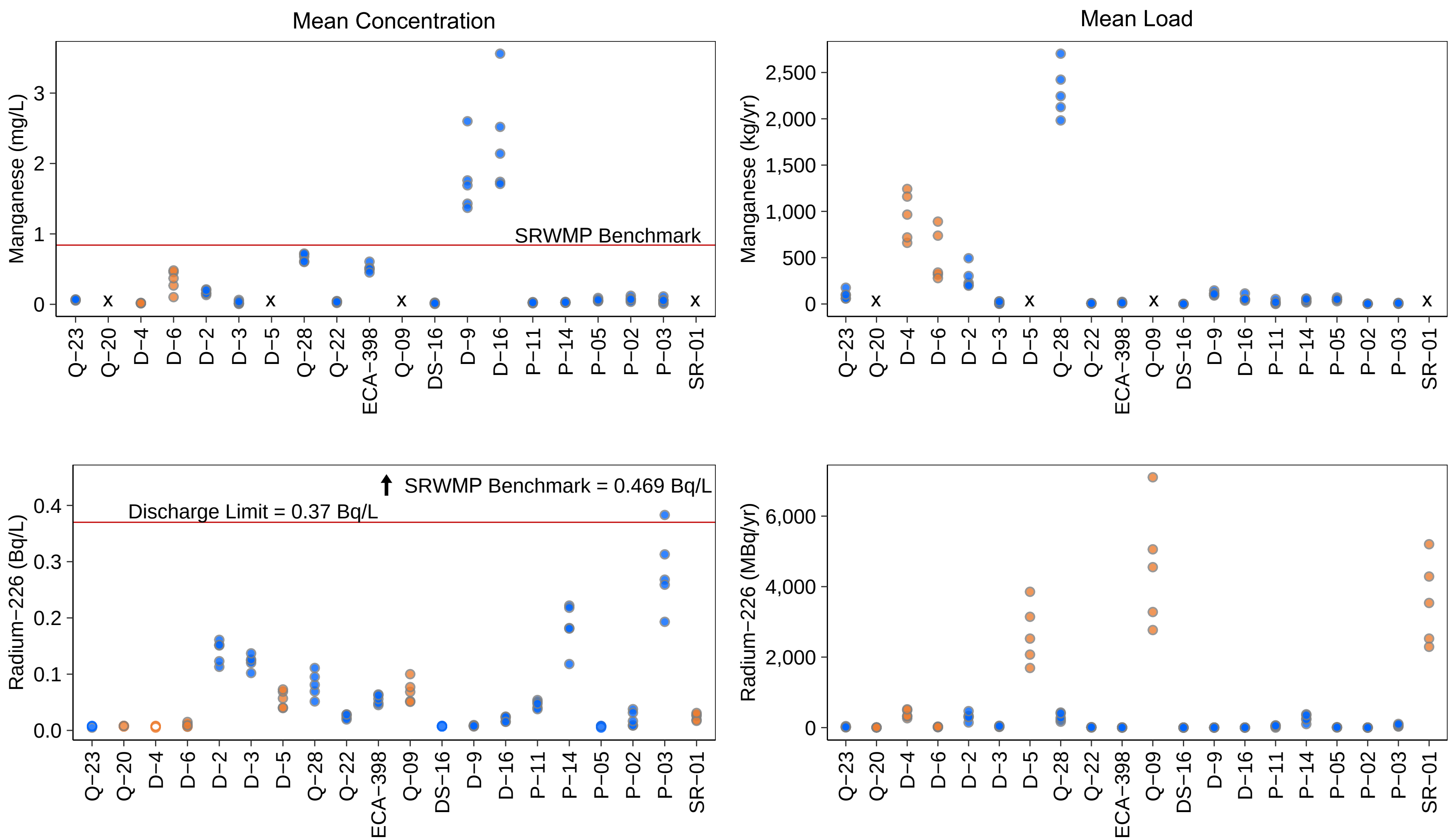


Figure 4.27: Annual Mean Concentrations and Loads at SAMP and SRWMP Monitoring Stations Upstream of Quirke Lake Outlet, 2015 to 2019

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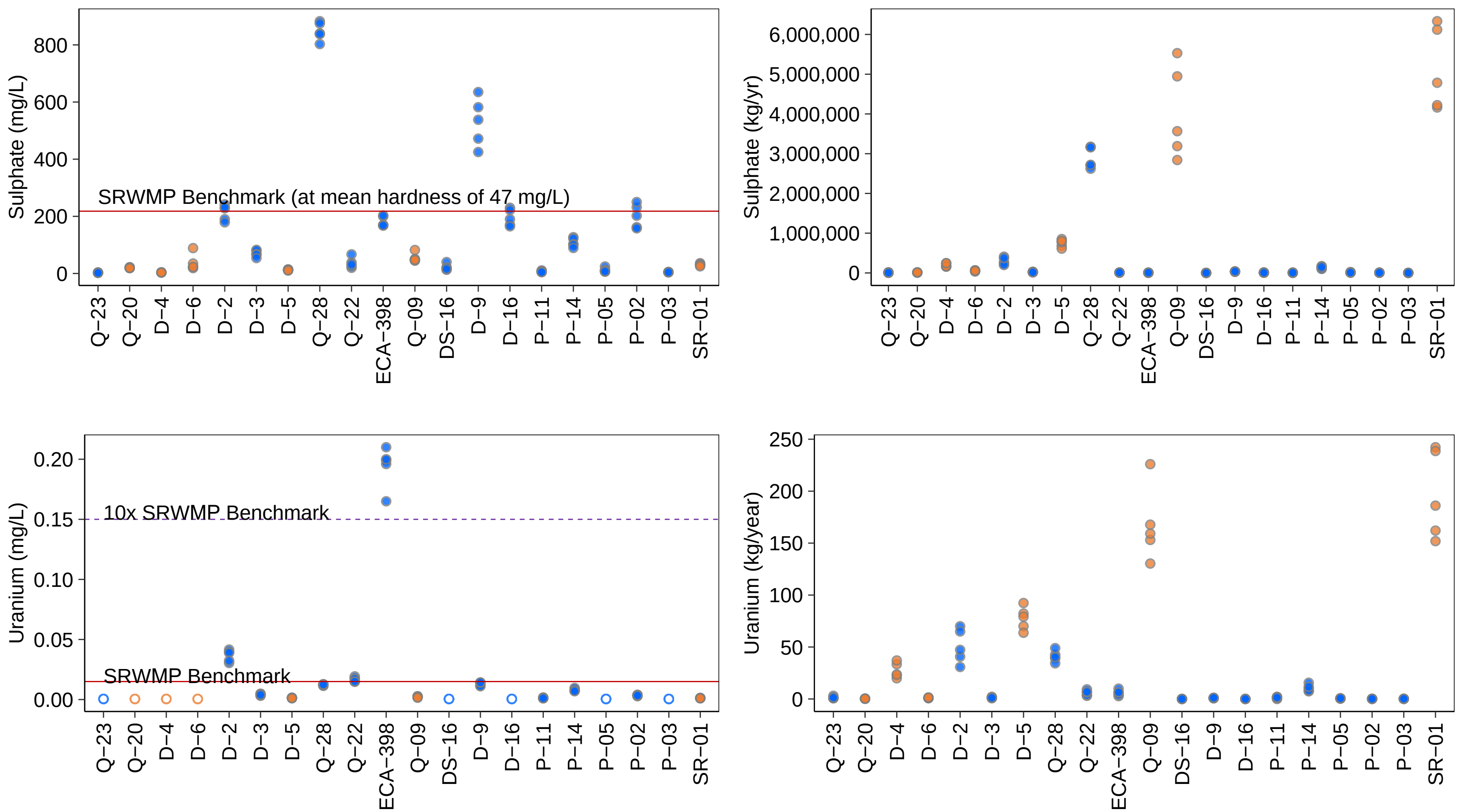


Figure 4.27: Annual Mean Concentrations and Loads at SAMP and SRWMP Monitoring Stations Upstream of Quirke Lake Outlet, 2015 to 2019

Notes: Blue circles represent SAMP stations, orange circles represent SRWMP stations. SRWMP benchmarks (Table 2.8) apply to the receiving environment and are based on background (reference) concentrations or approved guidelines, and is not applicable to SAMP stations. Values at the LRL (open circles) were replaced with the LRL for calculations. X indicates that parameter is not monitored for a given station. See Appendix Tables M.3, N.2 to N.8, N.10 to N.15, S.4, and S.12 to S.16 for raw data and Tables N.20 to N.23 for annual discharge and seepage loadings.

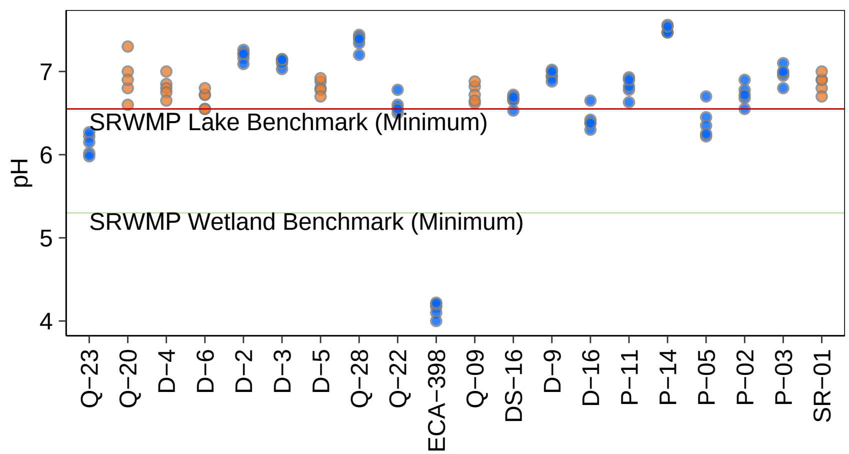


Figure 4.27: Annual Mean Concentrations and Loads at SAMP and SRWMP Monitoring Stations Upstream of Quirke Lake Outlet, 2015 to 2019

Notes: Blue circles represent SAMP stations, orange circles represent SRWMP stations. SRWMP benchmarks (Table 2.8) apply to the receiving environment and are based on background (reference) concentrations or approved guidelines, and is not applicable to SAMP stations. Values at the LRL (open circles) were replaced with the LRL for calculations. X indicates that parameter is not monitored for a given station. See Appendix Tables M.3, N.2 to N.8, N.10 to N.15, S.4, and S.12 to S.16 for raw data and Tables N.20 to N.23 for annual discharge and seepage loadings.

Table 4.18: Seasonal Kendall Trend Analysis for Water Quality Parameters, SRWMP Water Quality Monitoring Stations in the Quirke Sub-Watershed, 2003 to 2019

Station	Reference					Mine-Exposed				
	D-4	SR-19	SR-18	SR-16	SR-17	D-6	D-5	Q-09	Q-20	SR-01
Barium (mg/L)	NS	NS	NS	NS	NS	-1.30	NS	NS	NS	NS
Iron (mg/L)	NS	NS	NS	NS	NS	NS	na	na	NS	na
Manganese (mg/L)	NS	NS	NS	NS	NS	NS	na	na	na	na
pH	NS	NS	NS	NS	1.10	NS	-0.300	NS	NS	NS
Radium (mg/L)	nt	nt	nt	nt	nt	nt	-3.90	-2.40	nt	NS
Sulphate (mg/L)	-3.30	-3.10	-4.50	-6.40	-5.50	-3.00	-4.70	-3.20	-2.00	-5.60
Uranium (mg/L)	nt	nt	nt	nt	nt	nt	-2.90	-5.00	nt	NS

[Green] Significant decreasing temporal trend (Seasonal Kendall test for monotonic trend at α = 0.05). Value reported is the Sen's slope reported as a percentage of the median

[Blue] Significant increasing temporal trend (Seasonal Kendall test for monotonic trend at α = 0.05). Value reported is the Sen's slope reported as a percentage of the median

Note: See Appendix Tables S.4 to S.8 and S.12 to S.16 for raw data. See Appendix Figures S.8 to S.14 for time series plots of the trend. NS = No significant temporal trend (Seasonal Kendall test for monotonic trend at α = 0.05). nt = Parameter not tested for this station because >50% of values <LRL na = Parameter not assessed for this station, as per study design.

Denison TMA discharge (SRWMP station D-5) continues to be higher than the loading from the Denison TMA (SAMP stations D-2 and D-3) or the upstream watershed (SRWMP reference station D-4), and is likely associated with the historical deposits of treatment solids downstream of the Denison TMA (EcoMetrix 2011a). Loads for some parameters (e.g., barium, sulphate, and uranium) were slightly higher the outlet of Quirke Lake (SR-01) compared to Q-09, reflecting the limited additional inputs to Quirke Lake from sources associated with the Panel and Denison TMAs (i.e., loads from SAMP stations DS-16, D-9, D-16, P-11, P-14, P-05, P-02, and P-03; Figures 4.1 and 4.27). Loading of iron and manganese were lower at the outlet of Quirke Lake, reflecting losses to the sediments for these substances.

Water quality at SR-01 is meeting EIS predictions for sulphate and radium-226, with concentrations nearing or better than the 2099 cumulative predictions in recent years (Figure 4.28).

4.6 Summary

Water quality within the Quirke Lake sub-watershed is monitored under three separate programs, the TOMP, SAMP, and SRWMP. Mine-related sources to the sub-watershed include the Denison, Spanish-American, Quirke, Stanrock, and Panel TMAs, all of which are flooded TMAs. The Spanish-American TMA discharges to the Denison TMA. Denison, Quirke, and Panel TMAs treat influent at their respective ETPs prior to discharge either to the Serpent River or to Quirke Lake. Stanrock and Panel TMAs discharge seepage (both TMAs) and final treated effluent (Panel TMA) to Quirke Lake. Treatment at ETPs includes addition of both lime and barium chloride to lower acidity and radium-226, respectively.

Water levels at the Denison TMA were maintained with a 1-m cover during summer, from 2015 to 2019. Since decommissioning, concentrations of radium-226, sulphate, and uranium in ETP influent have decreased and pH has been near neutral with levels becoming more stable over time. However, since 2003, concentrations of barium and radium-226 in ETP influent have increased. Groundwater quality has shown improvements over time, with sulphate concentrations decreasing at most stations and pH levels increasing to near neutral. Over the 2015 to 2019 period, treated effluent was non-lethal to *D. magna* and rainbow trout, and reproduction of *C. dubia* was not affected by exposure to 100% effluent. Effluent also consistently achieved discharge criteria.

Water levels at the Spanish-American Facility were maintained between the minimum operating elevation and the crest elevation of constructed berms. Overall, surface water quality within the Spanish-American TMA has improved, based on decreasing concentrations of barium, radium-226, sulphate, and uranium, near neutral pH.

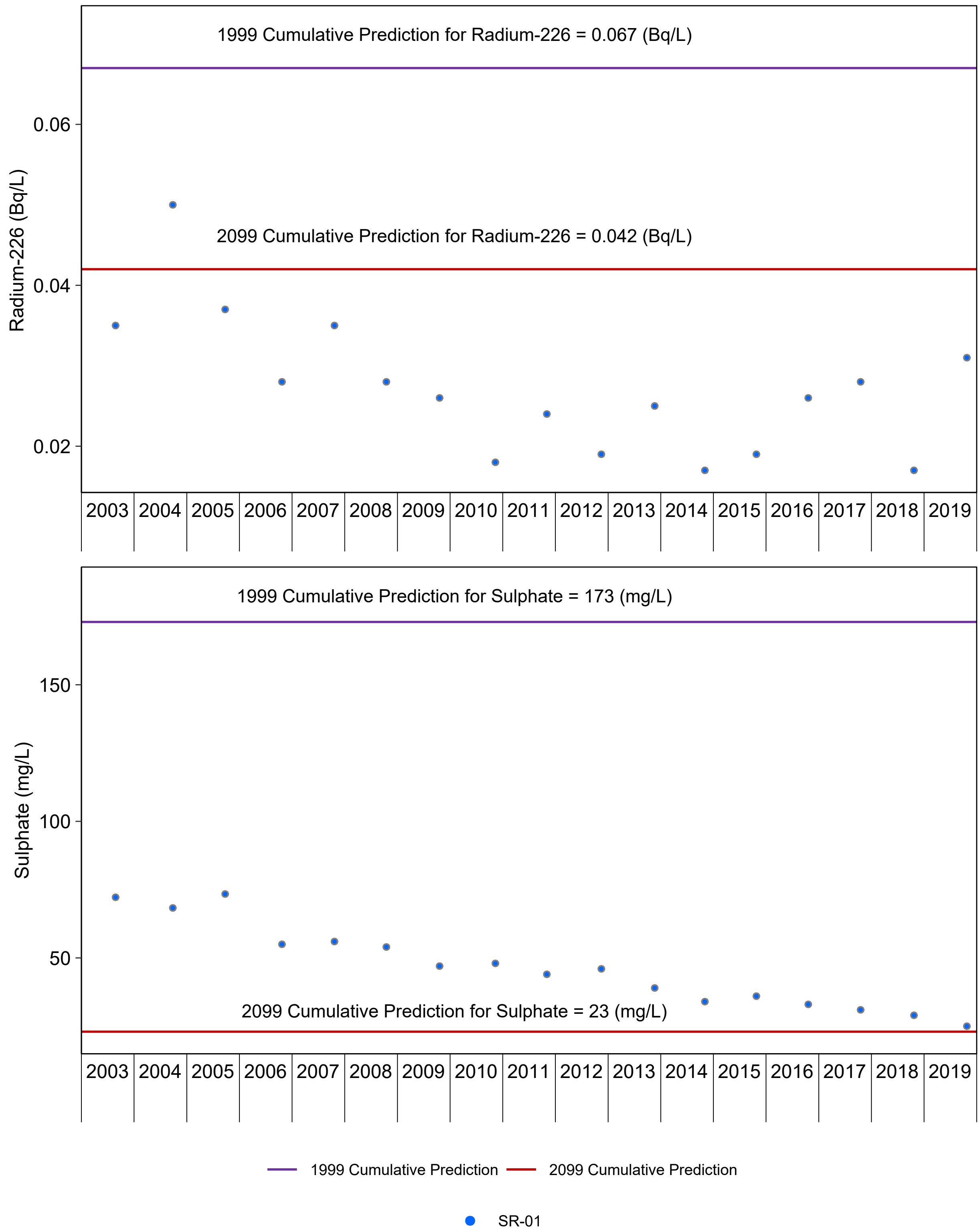


Figure 4.28: Concentrations of Radium-226 and Sulphate at SRWMP Station SR-01 (Quirke Lake Outlet) Compared to Cumulative Predictions (1999 and 2099)

Notes: Prediction values for 1999 and 2099 based on cumulative effects assessment (CNSC 2002). Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Table S.16 for raw data.

The Quirke TMA has five terraced cells. Water elevations in the most downstream cell (Cell 18) were generally within operating limits for the TMA, except in July 2016, when the water level dropped slightly below the lower operating limit. Since 2003, the quality of ETP influent has improved considerably, based on decreasing concentrations of acidity, barium, cobalt, manganese, radium-226, sulphate, and uranium, and increasing pH. Some of these improvements were also observed in surface water upstream from Cell 18 in the TMA. Pore water quality generally reflected surface water quality, exhibiting decreasing acidity, iron, and sulphate concentrations, while pH increased or remained similar at most locations and depths. There is some concern that decreasing sulphate concentrations within the TMA may have the effect of increasing radium-226 concentrations in the future. Like surface water and pore water, groundwater has generally improved downgradient of the Main Dam, downgradient of Dam G-2, and downgradient and close to Dam K1. Further downgradient of Dam K1, groundwater quality showed increasing concentrations of iron and sulphate, possibly due to slower flushing of contaminants further downgradient of Cell 14, particularly in deeper sampling depths.

Over the 2015 to 2019 period, Quirke TMA effluent consistently achieved discharge criteria, was non-lethal to *D. magna*, and except for one test in June 2018, where 10% mortality was observed, effluent was also non-lethal to rainbow trout. Reproduction of *C. dubia* was not affected by exposure to effluent, except in one test; however, the effluent concentration (85.7%) that caused effects was much higher than would be expected in the receiving environment (<5%).

The Panel TMA consists of a Main Basin and a South Basin. The Main Basin water elevation generally remained above the spillway invert from 2015 through 2017, but dropped below the invert level during several months in 2018 and 2019. In the South Basin, water levels are managed to maintain a relatively consistent elevation while minimizing ETP start and stop cycles. Water levels in the South Basin were typically within the established operating elevations, although there was a brief period in December 2016 when water levels were below the minimum winter operating elevation.

Surface water quality of Panel TMA ETP influent has improved over time, based on significant reductions in the concentrations of cobalt, radium-226, and sulphate, and a slight increase in pH. Groundwater quality downgradient of the Main Basin at Dam E and Dam B indicated acidity below the laboratory reporting limit since 2009 and near neutral pH. In the well downgradient of Dam E, iron concentrations have increased, whereas downgradient of Dam B, iron concentrations have decreased, but sulphate increased. Sulphate decreased in groundwater downgradient of the South Basin at Dam A, and pH decreased but remained near neutral.

The Panel treatment plant has been shown to be susceptible to refractory radium; however, barium chloride treatment for radium-226 has remained effective and effluent concentrations of radium-226 are still sufficiently low. In general, the maintenance of water level in both the Main Basin and the South Basin has been shown to be the most important factor influencing water quality, and while water levels are continually maintained, water quality is not expected to change in terms of pH and radium-226 concentrations. Over the 2015 to 2019 period, effluent quality consistently achieved discharge criteria, and was non-lethal to rainbow trout. One toxicity test (October 2019) resulted in minimal mortality (3.3%) to *D. magna*. Similarly, reproduction of *C. dubia* was not affected by exposure to 100% effluent in all but one test (October 2019), when the IC25 equalled 68.9%.

Within the Quirke Lake sub-watershed, the Quirke TMA tended to produce the highest loadings of most metals (cobalt, iron, and manganese) and sulphate. Barium loads were slightly higher from the Panel TMA than the others, while radium-226 loads were similar among the Quirke, Denison, and Panel TMAs. The decrease in uranium loads from the Quirke TMA has resulted in nearly equal loadings relative to the Denison TMA as of 2019. Loadings to the Quirke sub watershed from the Stanrock Facility (DS-16) were substantially lower than all other facilities.

In the Quirke Lake sub-watershed receiving environment, water quality typically met SRWMP benchmarks over the 2015 to 2019 period, although individual samples, mostly from the outlet of Cinder Lake (D-6), occasionally exceeded criteria. Water quality within the Quirke Lake sub-watershed has generally improved since 2003, based on decreasing concentrations of sulphate at all locations, and decreasing radium-226 and uranium at stations within the Serpent River.

5 ELLIOT LAKE SUB-WATERSHED

5.1 Background

5.1.1 Elliot Lake Sub-Watershed

The Elliot Lake sub-watershed is within the SRW and has an area of approximately 112 km^2 (Figure 2.1). Elliot Lake is a large lake (surface area of 615 ha, with an approximate volume of 96 million m^3) with a moderate depth (mean depth of 17 m) located next to the City of Elliot Lake (Figure 5.1). It is significant in the watershed as it is the drinking supply to the City of Elliot Lake. Mine drainage to the lake comes from:

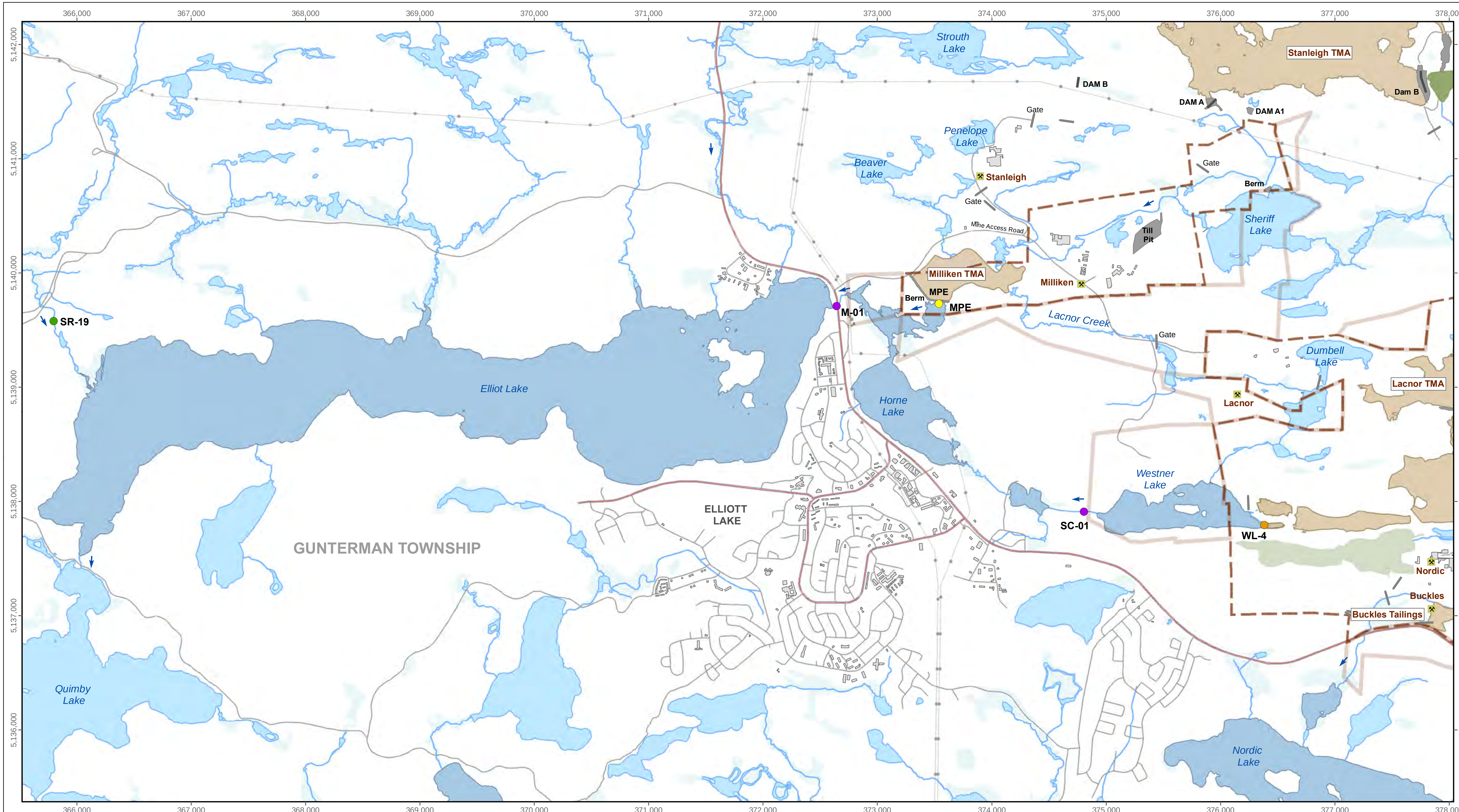
- the Milliken TMA (a historical remediated tailing spill upstream of Elliot Lake);
- seepage from the Stanleigh TMA (via Sheriff Creek),
- the Lacnor TMA; and
- the Nordic TMA that potentially reports to Westner Lake which flows to Horne Lake prior to discharging to Elliot Lake.

Water from all of these sites combines at the lake inflow at the eastern end of Elliot Lake (Figure 5.1). Milliken TMA drainage reports to the Elliot Lake sub-watershed and is therefore discussed below. The Stanleigh TMA primarily discharges to the May Lake sub-watershed, while the Lacnor and Nordic TMAs primarily discharge to the Nordic Lake sub-watershed; therefore, the TMA site histories and conceptual hydrogeologic models for these TMAs are discussed in Sections 3.3.2 and 6.1.1, respectively.

5.1.2 Milliken TMA

5.1.2.1 Site History

The Milliken mine and mill operated from 1958 to 1964, during which time it produced approximately 6.3 million tonnes of ore, 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 ha 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 of the tailings to form playing fields and flooding the remaining tailings to form a wetland. The resulting Sheriff Creek Sanctuary is now an important wildlife habitat area enjoyed by local naturalist groups. Improvements to the Sheriff Creek Berm have been made several times during the past twenty years (Table 5.1). Except for the Sheriff Creek Berm, no site infrastructure remains at the Milliken site.



LEGEND

- Reference (SRWMP)
- SAMP Surface Water
- Mine Discharge (SAMP)
- Receiving Environment (SRWMP)
- Mine Site
- Dam
- Gate
- Dam
- Limits of CNSC Licence
- Limits of Unlicenced Property
- Treatment Solids
- Vegetated Tailings
- Collection and Settling Pond

0 0.5 1 2 km

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N E S W

Elliot Lake Sub-watershed Mine Source and Receiving Environment Stations

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Figure 5.1

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Table 5.1: 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.
2016	Excavation, cleaning and re-installation of the beaver deceiver pipes.	To allow for continued water level control during periods of beaver activity.
2017	Repairs to areas near shaft cap.	The repairs were to an old foundation near the shaft cap to stop downcast airflow.

5.1.2.2 Conceptual Hydrogeologic Model

Milliken TMA is located downstream and southwest of the Stanleigh TMA Dams A and A1 (Figure 5.1; Section 3.1.3.2). A remediated tailings spill area is located downgradient of Stanleigh TMA Dam A. Drainage from this area is received by Sheriff Creek, upstream of Sheriff Lake (Figure 5.1). Until its closure in 1996, the Stanleigh mine influenced the quality of water discharging from Penelope Lake, which drains into the north perimeter of the Milliken TMA (Figure 5.1). Similarly, the re-habilitated Lacnor Mine site (closed in 1960 and rehabilitated in 1999), influences the water quality in Lacnor Creek, which flows into the southeast corner of the Milliken TMA (Figure 5.1). Tailings in the Milliken TMA are kept under saturated conditions, with tailings seepage reporting to the southwest into a wetland area at the upstream end of Horne Lake (Golder 2020; Appendix L).

5.2 Applicable Monitoring Programs

The existing monitoring programs applicable to the Elliot Lake sub-watershed include:

- The SAMP (Minnow 2019), which focuses on monitoring stations that represent the final points of release from each closed mine facility to the watershed, developed to monitor the nature and quantity of constituents being discharged. One monitoring station (Milliken facility station MPE) was retained at the Milliken TMA outlet to track the combined inputs from all upstream sources and releases to the SRW, and one monitoring station is located in Westner Lake (WL-4) to track seepage from the Coffer Pond (part of the Nordic Facility; see Section 6.1; Figure 5.1; Table 5.2; Appendix Table O.1); and,
- The SRWMP (Minnow 2019), is an integrated monitoring program designed to assess the cumulative effects of the facility discharges on chemical and biological conditions in the watershed and to track changes over time. The SRWMP was designed to complement the SAMP, and also included mechanisms to allow the evolution of the sampling approach over time in response to monitoring findings for the watershed. To meet this objective surface water is monitored downstream of all sources but upstream of the discharge to Elliot Lake (station M-01; Figures 2.2 and 5.1). Surface water is also monitored downstream of potential seepage from the Nordic TMA Coffer Pond at the outlet of Westner Lake (station SC-01) which is also upstream of M-01 (Figures 2.2 and 5.1).

5.3 SAMP: Elliot Lake Sources

5.3.1 Discharge Quality and Loads

Surface water quality is monitored at the outlet of the Milliken TMA (MPE) and reflects conditions within the TMA. Since 2015, water samples collected at MPE have been non-toxic to both

Table 5.2: Monitoring Programs and Stations Downstream of Milliken TMA and Nordic TMA, Within the Elliot Lake Sub-Watershed

Monitoring Program	TMA	Station ID	Type	Description	Parameters and Frequencies [a]														
					Elevation	Flow	Hardness	pH	Conductivity	Sulphate	Radium-226	TSS	Acidity	Iron	Barium	Cobalt	Manganese	Uranium	Toxicity[b]
SAMP	Milliken	MPE	Basin performance (primary), ETP operations	Final Discharge from Milliken Wetland (TMA)			M	M		M	M			M/S	M/S	M	M	M/S	
SAMP	Nordic	WL-4	Seepage	Westner Lake at the Coffer Pond to assess for influence of seepage			Q	M		Q	Q			Q	Q	Q	Q	Q	
SRWMP	not applicable	SC-01	Westner Lake Outlet	Downstream of seepage from West Arm of Nordic TMA. Flows to Horne Lake which discharges to Elliot Lake via M-01				A		A	A			A	A			A	
SRWMP	not applicable	M-01	Inlet to Elliot Lake	Downstream of Sheriff Creek (Milliken and Stanleigh TMAs) and discharge from Horne Lake (downstream of Westner Lake and Nordic TMA seepage)				Q		Q	Q			Q	Q			Q	

Notes: ETP = Effluent Treatment Plant. TMA = Tailings Management Area.
[a] M=monthly, Q=quarterly, S = semi-annually, A = annually.
[b] Toxicity includes: acute (*Daphnia magna* and rainbow trout) and sublethal (*Ceriodaphnia dubia*) testing following Environment Canada (2000a,b and 2007) methods.

Daphnia magna and rainbow trout, with no mortality reported in semi-annual acute toxicity tests (Table 5.3). Similarly, reproduction of *Ceriodaphnia dubia* was not affected by exposure to 100% effluent, except in one sample from October 2019 (Table 5.3).

With the exception of iron, for which annual mean concentrations from MPE were higher than the SRWMP lake benchmark[17] but not the wetland benchmark, annual mean concentrations for all substances met receiving environment benchmarks (Figure 5.2). However, since effluent from the Milliken TMA discharges to a downstream wetland prior to joining the outflow from Horne Lake, the SRWMP wetland benchmark is likely more appropriate for iron. Water quality at WL-4 was also well below (or above, in the case of pH) SRWMP benchmarks (Figure 5.2).

Annual loadings associated with the Milliken TMA have generally remained within the range observed since 2005, except for sulphate, which has been decreasing over time (Appendix Figure O.9).

In some cases, loadings from the Milliken TMA may be over-estimated because flow at station MPE is prorated based on drainage area (i.e., measured concentrations are not synoptic with actual flows; see Section 2.1.3.6), 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.

5.3.2 Trends

Concentrations of most parameters measured in effluent at MPE have been decreasing over time, indicating improved water quality (Table 5.4; Appendix Figures O.1 to O.8). Iron, pH, and uranium are the only parameters that have remained relatively unchanged over time, and in the case of pH, measurements have consistently been circumneutral (Appendix Figure O.5).

Water quality at WL-4 has improved over time, based on decreasing concentrations of barium, cobalt, and sulphate, and increasing pH (although pH has been near neutral; Table 5.4; Appendix Figures O.1, O.2, O.5 and O.7). There is some evidence of slightly higher radium-226 concentrations at WL-4 in 2018 and 2019 (Appendix Figure O.6), but additional data will be required to verify a potentially increasing trend.

5.4 SRWMP Water Quality

Receiving water quality in the Elliot Lake sub-watershed is monitored quarterly in Sheriff Creek at the Highway 108 bridge (M-01) and annually at the outlet of Westner Lake (SC-01; Figure 5.1).

[17] These are receiving environment criteria, which are provided here for context, but are not required to be met for discharge to occur.

Table 5.3: Toxicity Test Results for Samples Collected at Milliken TMA SAMP Station MPE, 2015 to 2019

Date	Sublethal Toxicity (*Ceriodaphnia dubia*) IC25	Acute Toxicity (*Daphnia magna*) % Mortality	Acute Toxicity (Rainbow Trout) % Mortality
19-May-15	100	0	0
16-Nov-15	100	0	0
16-May-16	100	0	0
19-Oct-16	100	0	0
08-May-17	100	0	0
20-Nov-17	100	0	0
22-May-18	100	0	0
22-Oct-18	100	0	0
21-May-19	100	0	0
21-Oct-19	71.4	0	0
n	10	10	10
Minimum	71.4	0	0
Maximum	100	0	0
Mean	97.1	0	0
SD	9.04	-	-
Median	100	0	0
10th Percentile	85.7	0	0
95th Percentile	100	0	0

Note: n = number of samples. SD = standard deviation. "-" = SD not applicable.

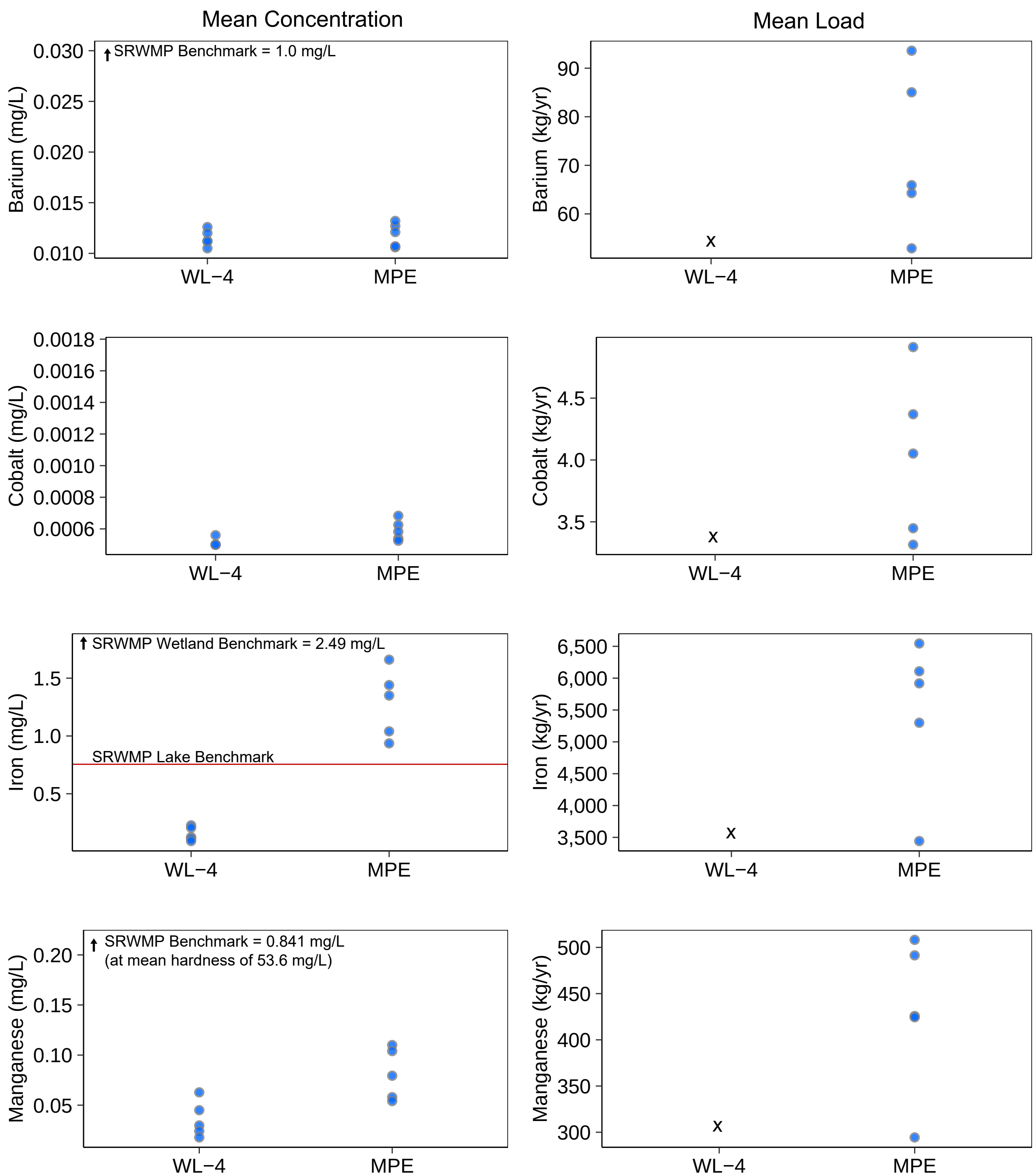


Figure 5.2: Annual Mean Concentrations and Annual Loads at SAMP Monitoring Stations Downstream of Milliken and Nordic TMAs, Within the Elliot Lake Sub−Watershed, 2015 to 2019

Notes: SRWMP benchmarks (Table 2.8) apply to the receiving environment and are based on background (reference) concentrations or approved guidelines, provided here for context, but they are not criteria that need to be met for discharge to occur. Values at the LRL (open circles) were replaced with the LRL for calculations. See Appendix Tables O.2 and P.2 for raw data. Flow is not measured at WL−4, as per the study design; therefore, loadings were not calculated.

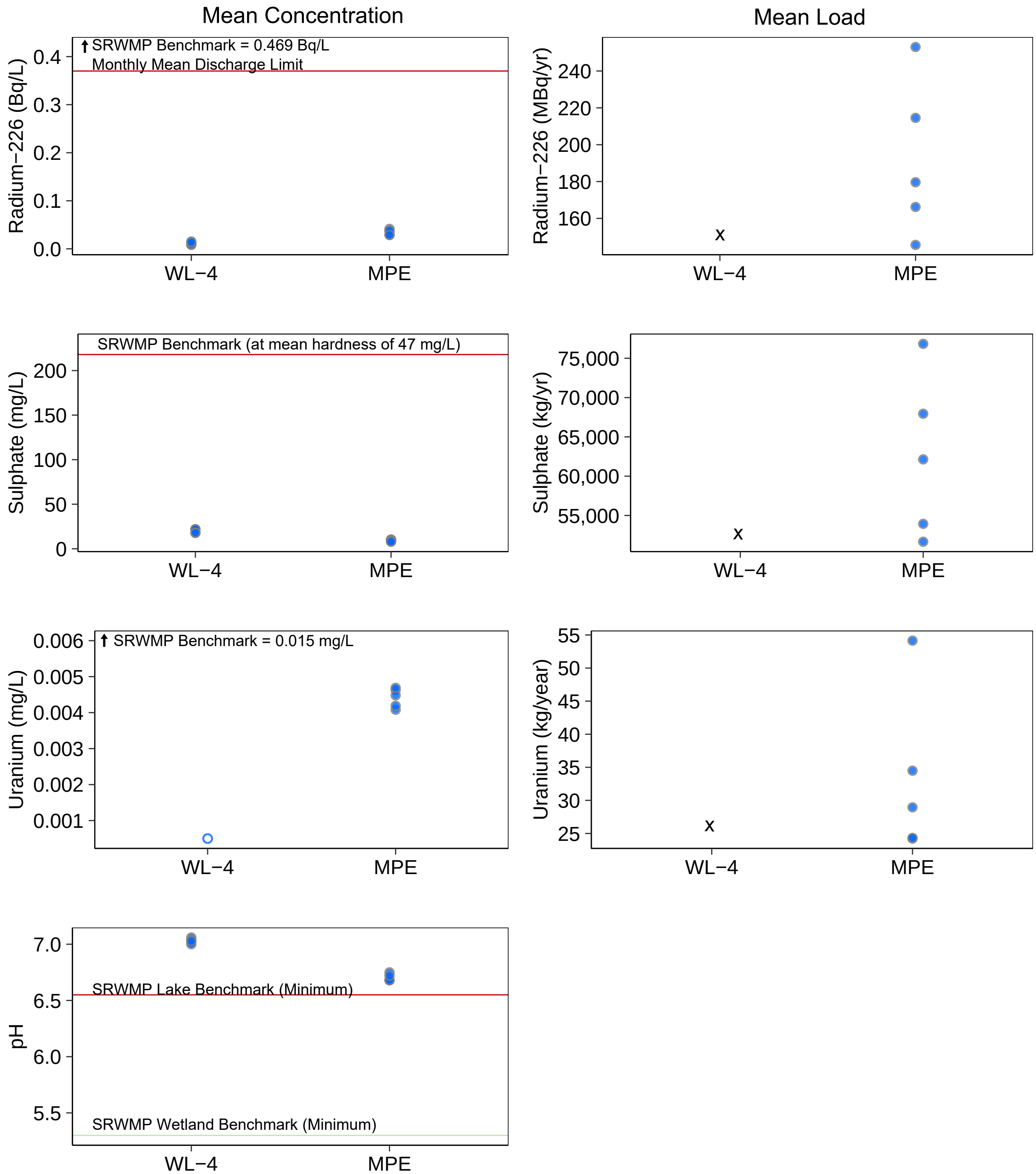


Figure 5.2: Annual Mean Concentrations and Annual Loads at SAMP Monitoring Stations Downstream of Milliken and Nordic TMAs, Within the Elliot Lake Sub−Watershed, 2015 to 2019

Notes: SRWMP benchmarks (Table 2.8) apply to the receiving environment and are based on background (reference) concentrations or approved guidelines, provided here for context, but they are not criteria that need to be met for discharge to occur. Values at the LRL (open circles) were replaced with the LRL for calculations. See Appendix Tables O.2 and P.2 for raw data. Flow is not measured at WL−4, as per the study design; therefore, loadings were not calculated.

Table 5.4: Seasonal Kendall Trend Analysis for Water Quality Parameters, SAMP Water Quality Monitoring Stations in Milliken TMA and Nordic TMA, Discharging to the Elliot Lake Sub-watershed, 2003 to 2019

	Nordic TMA	Milliken TMA
Station	WL-4	MPE
	Seepage	Principal
Barium (mg/L)	-3.50	-1.10
Cobalt (mg/L)	nt	-5.60
Iron (mg/L)	NS	NS
Manganese (mg/L)	NS	-2.10
pH	0.4	NS
Radium (Bq/L)	NS	-3.20
Sulphate (mg/L)	-5.80	-5.70
Uranium (mg/L)	nt	NS

[green] Significant decreasing temporal trend (Seasonal Kendall test for monotonic trend at α = 0.05). Value reported is the Sen's slope reported as a percentage of the median concentration or value.

[blue] Significant increasing temporal trend (Seasonal Kendall test for monotonic trend at α = 0.05). Value reported is the Sen's slope reported as a percentage of the median concentration or value.

Note: "NS" = no significant temporal trend (Seasonal Kendall test for monotonic trend at α = 0.05). "nt" = Parameter not tested for this station because >50% of values <LRL . See Appendix Tables P.2 and O.2 for raw data and Appendix Figures O.1 to O.8 for time series plots of the trends.

Over the 2015 to 2019 period, concentrations of water quality analytes at M-01 and SC-01 were consistently lower than (or greater than for pH) SRWMP benchmarks (Figure 5.3; Appendix Tables S.17 and S.18). Water quality at both stations was also shown to improve significantly over time, based on decreasing concentrations of radium-226 and sulphate (both stations), iron (SC-01 only; iron is not measured at M-01), and barium and uranium (M-01 only; uranium has been below the LRL at SC-01 since 2005; Table 5.5; Appendix Figures S.16 to S.21). Higher concentrations of barium at M-01 compared to MPE suggest that there is more barium coming from Horne Lake than the Milliken TMA (Figure 5.1).

Loadings measured at station M-01 represent inputs from the Milliken TMA, and water quality within Horne and Westner lakes, including any inputs associated with seepage from the Coffer Pond at west end of the Nordic TMA (as measured at the outlet of Westner Lake at station SC-01). In general, loadings at station SC-01 were very low, and thus would have very limited influence on loadings measured at station M-01 (Appendix Figure O.9). In contrast, loadings at station M-01 for barium were often higher than those associated with the discharge from the Milliken TMA (at MPE; Appendix Figure O.9). Higher loadings for some parameters (i.e., barium, manganese, and sulphate) observed at M-01 versus MPE despite similar concentrations suggest that differences in loadings are flow-related.

5.5 Summary

The primary mine-related source to the Elliot Lake sub-watershed is the Milliken TMA, although the Stanleigh TMA (via seepage to Sheriff Creek), Lacnor TMA (via drainage to Lacnor Creek into the Milliken TMA), and potential seepage from the Nordic TMA to Westner Lake are also considered sources. Water quality within the Elliot Lake sub-watershed is monitored under the SAMP and SRWMP.

Since 2015, water samples collected at outlet of the Milliken TMA have been non-toxic, water quality has met receiving environment benchmarks, and loadings have generally remained within the range observed since 2005, except for sulphate, which has decreased over time. Water quality in Westner Lake and at the outlet was also well below (or above, in the case of pH) SRWMP benchmarks. Concentrations of most parameters measured in effluent from the Milliken TMA and water from Westner Lake have decreased over time, indicating improvements in water quality. Further downstream (i.e., in Sheriff Creek just upstream of Elliot Lake), water quality was also consistently lower than (or greater than for pH) SRWMP benchmarks, and has improved significantly over time, based on decreasing concentrations of barium, radium-226, sulphate, and uranium.

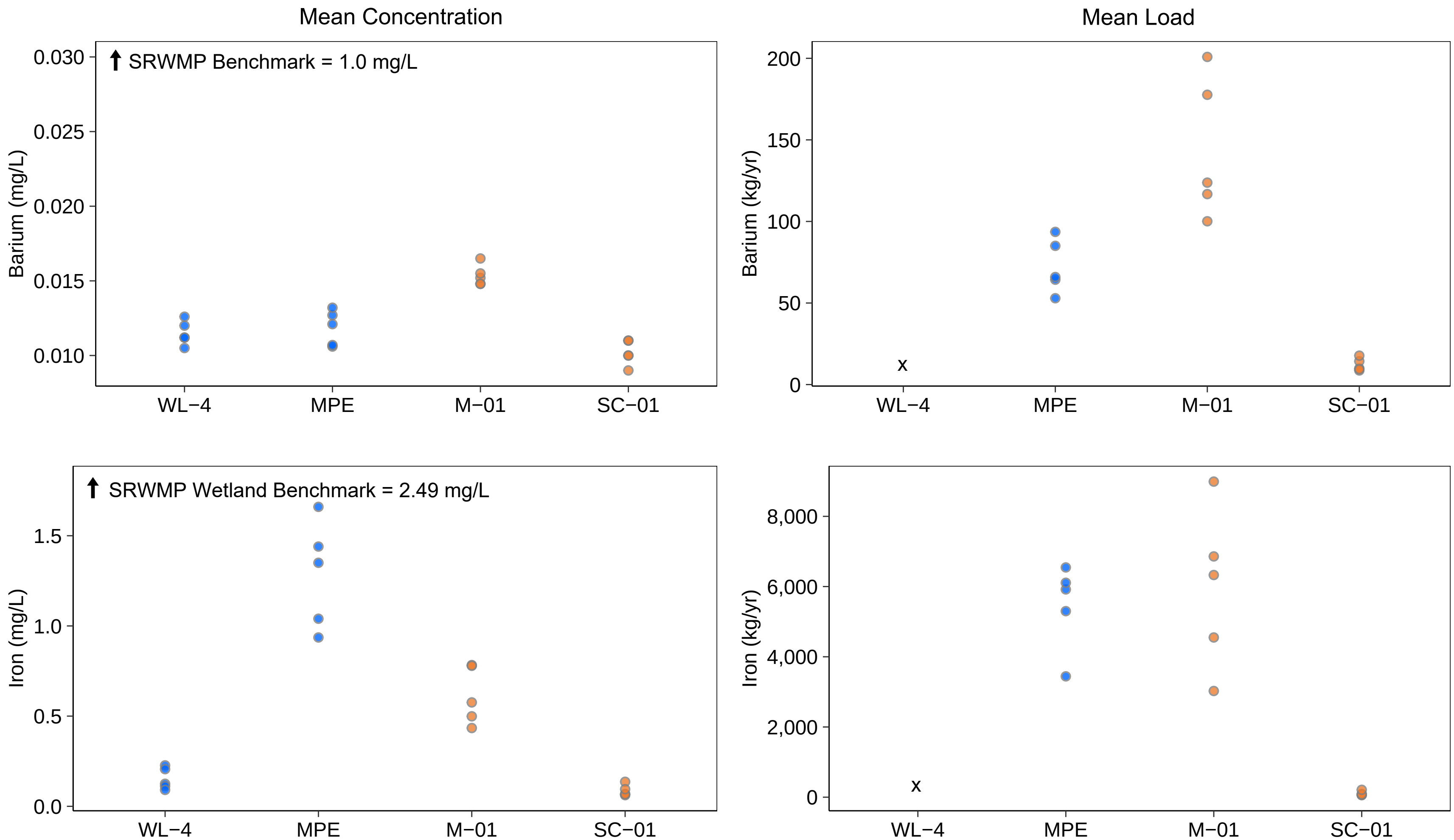


Figure 5.3: Annual Mean Concentrations and Annual Loads at SAMP and SRWMP Monitoring Stations Downstream of Milliken and Nordic TMAs, Within the Elliot Lake Sub−Watershed, 2015 to 2019

Notes: Blue circles represent SAMP stations, orange circles represent SRWMP stations. SRWMP benchmarks (Table 2.8) apply to the receiving environment and are based on background (reference) concentrations or approved guidelines, and is not applicable to SAMP stations. Values at the LRL (open circles) were replaced with the LRL for calculations. Flow is not measured at WL−4, as per the study design; therefore, loadings were not calculated (indicated by X). See Appendix Tables O.2, P.2, S.17 and S.18 for raw data and Tables O.3 for annual discharge and seepage loadings.

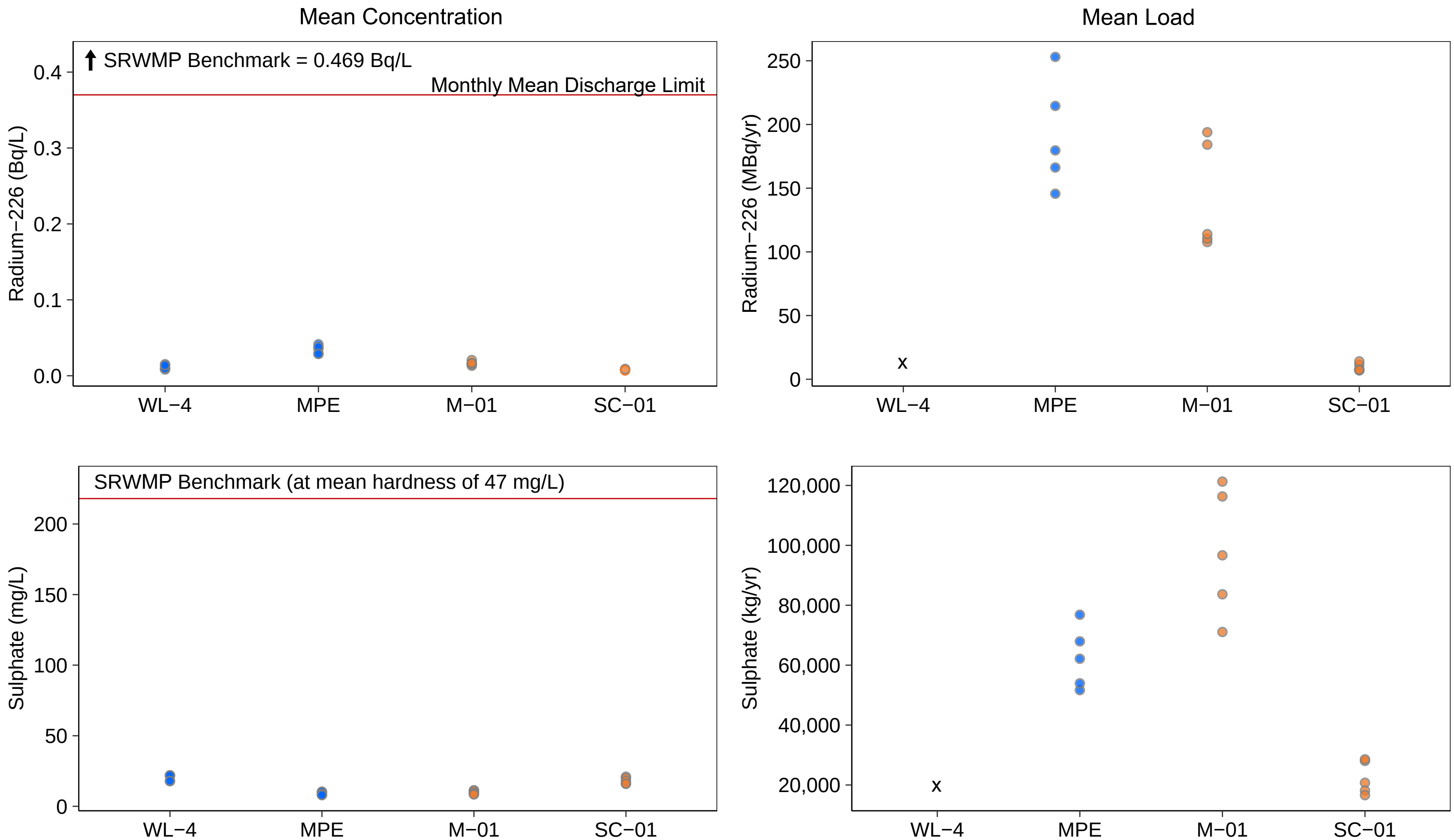


Figure 5.3: Annual Mean Concentrations and Annual Loads at SAMP and SRWMP Monitoring Stations Downstream of Milliken and Nordic TMAs, Within the Elliot Lake Sub−Watershed, 2015 to 2019

Notes: Blue circles represent SAMP stations, orange circles represent SRWMP stations. SRWMP benchmarks (Table 2.8) apply to the receiving environment and are based on background (reference) concentrations or approved guidelines, and is not applicable to SAMP stations. Values at the LRL (open circles) were replaced with the LRL for calculations. Flow is not measured at WL−4, as per the study design; therefore, loadings were not calculated (indicated by X). See Appendix Tables O.2, P.2, S.17 and S.18 for raw data and Tables O.3 for annual discharge and seepage loadings.

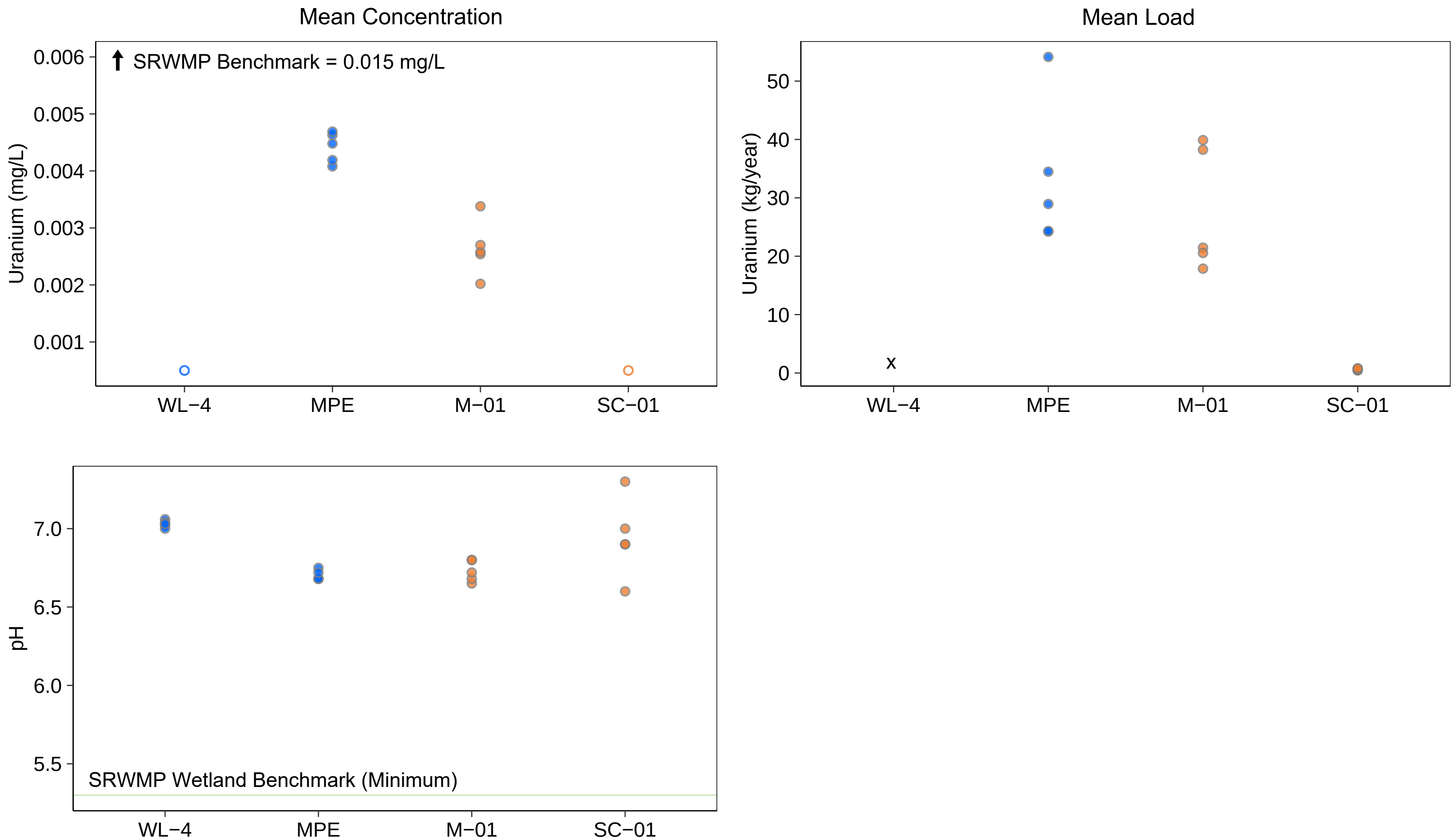


Figure 5.3: Annual Mean Concentrations and Annual Loads at SAMP and SRWMP Monitoring Stations Downstream of Milliken and Nordic TMAs, Within the Elliot Lake Sub−Watershed, 2015 to 2019

Notes: Blue circles represent SAMP stations, orange circles represent SRWMP stations. SRWMP benchmarks (Table 2.8) apply to the receiving environment and are based on background (reference) concentrations or approved guidelines, and is not applicable to SAMP stations. Values at the LRL (open circles) were replaced with the LRL for calculations. Flow is not measured at WL−4, as per the study design; therefore, loadings were not calculated (indicated by X). See Appendix Tables O.2, P.2, S.17 and S.18 for raw data and Tables O.3 for annual discharge and seepage loadings.

Table 5.5: Seasonal Kendall Trend Analysis for Water Quality Parameters, SRWMP Stations in the Elliot Lake Sub-watershed, 2003 to 2019

Station	Reference					Mine-Exposed	
	D-4	SR-19	SR-18	SR-16	SR-17	M-01	SC-01
Barium (mg/L)	NS	NS	NS	NS	NS	-1.50	NS
Iron (mg/L)	NS	NS	NS	NS	NS	na	-8.20
Manganese (mg/L)	NS	NS	NS	NS	NS	na	NS
pH	NS	NS	NS	NS	1.1	NS	NS
Radium (mg/L)	nt	nt	nt	nt	nt	-4.90	-5.80
Sulphate (mg/L)	-3.30	-3.10	-4.50	-6.40	-5.50	-4.70	-5.10
Uranium (mg/L)	nt	nt	nt	nt	nt	-3.10	nt

[Green] Significant decreasing temporal trend (Seasonal Kendall test for monotonic trend at α = 0.05). Value reported is the Sen's slope reported as a percentage of the median concentration or value.

[Blue] Significant increasing temporal trend (Seasonal Kendall test for monotonic trend at α = 0.05). Value reported is the Sen's slope reported as a percentage of the median concentration or value.

Note: See Appendix Tables S.4 to S.8, S.17, and S.18 for raw data. See Appendix Figures S.16 to S.21 for time series plots of the trends. NS = No significant temporal trend (Seasonal Kendall test for monotonic trend at α = 0.05). nt = Parameter not tested for this station because >50% of values <LRL. na = Parameter not assessed for this station, as per study design.

6 NORDIC LAKE SUB-WATERSHED

6.1 Background

6.1.1 Nordic Lake Sub-Watershed

The Nordic Lake sub-watershed is within the SRW and has an approximate area of 26 km^2 (Figure 2.1). Nordic Lake is a moderately-sized lake (surface area of 122 ha and mean depth of 9 m) which receives drainage from the Nordic TMA complex via Buckles Creek which discharges into the lake on the north east shore (Figure 6.1).

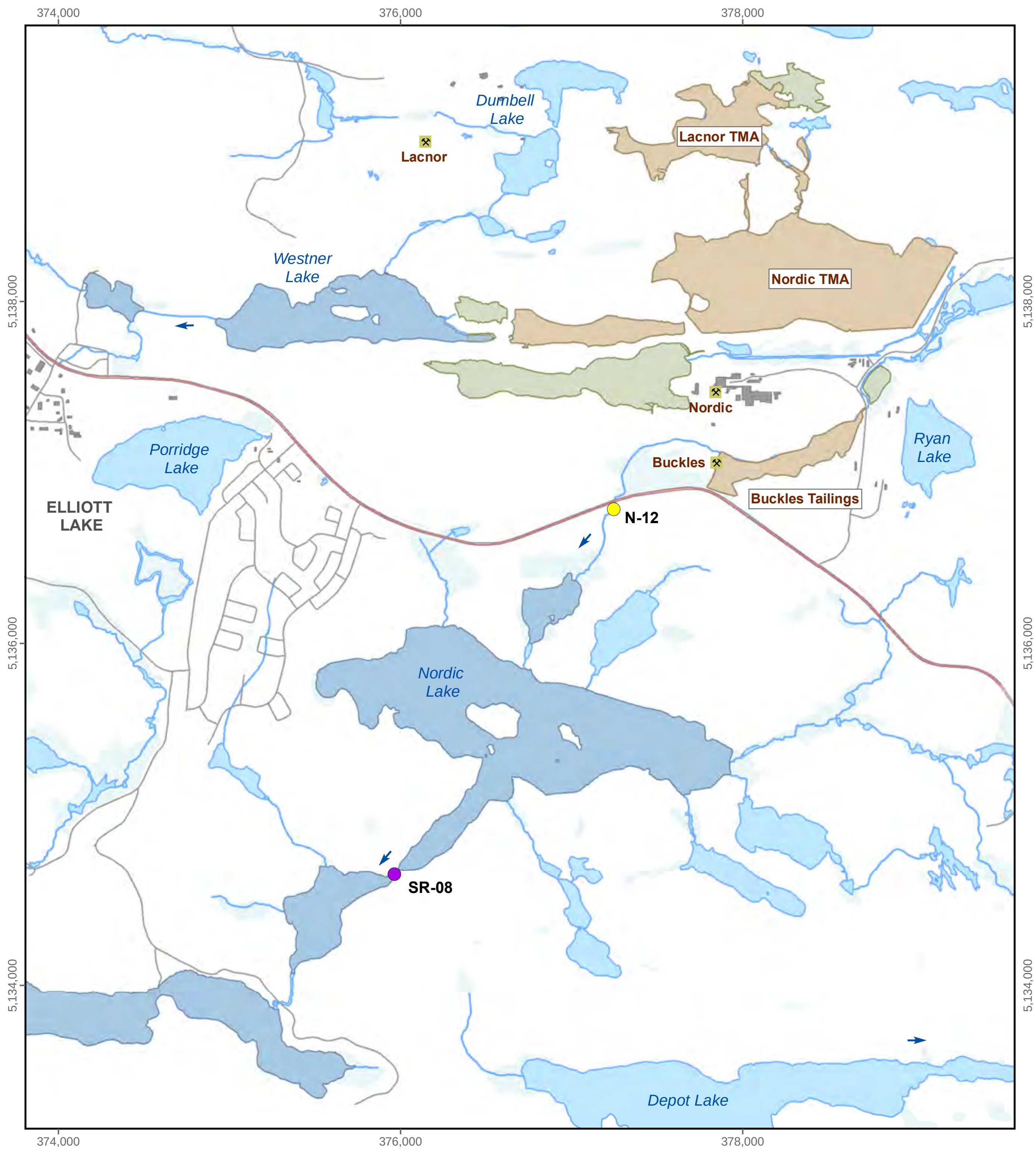
6.1.2 Nordic and Lacnor TMAs

6.1.2.1 Site History and Existing Operations

The Lacnor, Nordic, and Buckles mines produced uranium ore from underground operations over the period from 1957 to 1960, 1957 to 1968, and 1957 to 1958, respectively. At the Lacnor site, ore was milled at an on-site facility from which a total of approximately 2.7 million tonnes of tailings were deposited to the Lacnor Basin over the life of the mine. The Lacnor mill tailings are contained by two dams within an irregular shaped, rock-rimmed basin approximately 1,220 m long (along its major west-east axis) and 520 m wide. The demolition of the Lacnor mine, mill, and ancillary structures was mostly completed in the 1960s. Decommissioning of the remaining facilities, including demolition, re-capping and/or backfilling of mine openings[18], and further site rehabilitation was conducted at the Lacnor site in 1994 and 1995. 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 6.1). However, much of the seeding and planting on bare tailings failed over time due to acidic conditions (RAL 2000). In 1998 and 1999, an engineered cover was placed over the tailings, which consisted of a layer of blast rock to form a capillary break and a layer of till at surface to serve as a growth medium. Limestone (200 kg/ha) was applied below the capillary break and fertilizer (500 kg/ha of 15-15-15) was applied prior to seeding. The cover areas were re-vegetated in 1999 through seeding of grasses and legumes and isolated tree plantings (Table 6.1). Permanent rock channels were also installed to prevent erosion.

During mine operation, ore from the Nordic operation was processed at an on-site mill which, by the end of mine life, had produced approximately 12 million tonnes of tailings. These tailings were deposited to the Nordic Main and West Arm basins, which collectively cover about 107 ha. The Main Basin, located just north of the former Nordic mill site, measures approximately 1,500 m

[18] Mine shafts that were formerly capped were re-capped to meet Ontario MNDM guidelines.



LEGEND

- Mine Discharge (SAMP)
- Receiving Environment (SRWMP)
- Mine Site
- Collection and Settling Pond
- Tailings Management Area (TMA)

Nordic Lake Sub-watershed Mine Source and Receiving Environment Stations

0 0.5 1 2 km

N E S W

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Figure 6.1

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Table 6.1: Lacnor TMA Site Improvement Undertakings Since Closure

Year	Action	Rationale for Action
1970s	Original revegetation of tailings.	Establish vegetation.
1998 to 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 to 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.

Note: TMA = tailings management area.

long and 600 m wide, and was constructed using mine waste embankments set largely around an extensive alluvial sand deposit. The smaller West Arm Basin, located north of the Nordic Settling Pond, measures approximately 1,000 m long by 100 m wide, and is confined between east-west trending bedrock features. The Nordic mill continued to process mine water from mid-1968 to September 1970. In addition, a drying and packing plant at the Nordic site continued processing yellowcake (uranium oxide) until 1990 in support of other RAL mills in the Elliot Lake area. Demolition of the surface facilities at the Nordic site was initiated in 1986; however, most of the plant site was left intact at that time to allow for the processing and packing of yellowcake. The demolition of the remaining mine infrastructure and the yellowcake processing plant was carried out in 1994 and 1995. These activities included the capping of two mine openings and the backfilling to surface of four others, subsequently allowing the mine workings to flood. The Nordic Main and West Arm basins were successfully revegetated in the late 1970s (RAL 2000). In 1998 and 1999, areas of Nordic West Arm that exhibited poor drainage, were prone to erosion, and showed poor vegetative cover, were rehabilitated through the addition of layers of rock (serving as a capillary break) and till and subsequent reseeding (Table 6.2). In 2004, a coffer berm was constructed downstream of the East Collection Pond to facilitate removal of a small tailings spill discovered following the natural breaching of a beaver dam located at the outlet of Westner Lake in the previous year.[19]

At the Buckles site, ore taken from underground operations was transported to the Lacnor mill or off-site to the Spanish-American Mine/Mill for processing. However, an estimated 42,000 tonnes of tailings fines and barium-radium sulphate co-precipitate were deposited in the old Buckles Creek bed during historical operations. The Buckles Creek Diversion Channel was constructed to route the flow of Buckles Creek north of these historical deposits. The residual 10.3 ha area located just south of the Nordic Main Basin that was created (referred to as Buckles Wetland), includes an area of historical tailings slimes deposition and a barium-radium sulphate co-precipitation pond situated within the licensed property. After shutdown in 1958, the surface openings were sealed, most of the surface structures were demolished, and the mine was allowed to flood. From 1994 to 1995, both mine openings were resealed using reinforced concrete caps with stainless steel ventilation pipe caps and the remaining building foundations were demolished or covered as part of the final site grading and reclamation. Since closure, numerous projects have been undertaken to improve conditions and performance of the Nordic TMA (Table 6.2).

[19] This berm prevents free movement of water and sediments between the Coffer Pond and the main body of Westner Lake, thereby isolating the historical tailings spill area. The tailings were removed from the Coffer Pond during the winter of 2005.

Table 6.2: 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 to 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.

Table 6.2: Nordic-Buckles TMA Site Improvement Undertakings Since Closure

Year	Action	Rationale for Action
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.
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.
2015	Fibre optic lines installed at East and West pump houses.	More reliable communication and tie-in to upgraded PLC.
2016	Designed, engineered and installed a steel platform to access the ETP lime tank.	Eliminate the working at heights hazards and provide workers with a safe work platform.
2017	Piezometers installed in Dams D, E, F	Additional instrumentation to inform dam performance.
	Lowering and resurfacing of emergency spillways.	To restore spillways to design elevations.
	Installation of lightning and surge protection systems at the ETPs.	Resolve operational issues caused by lightning strikes on incoming power lines and communication towers.
2018	Installation of a sample platform outside treatment plant downstream of mixing channel.	To address safety concerns when sampling.
	Flow meter replacement	Replaced aged equipment.

Notes: ETP = effluent treatment plant. PLC = programmable logic controller.

The buildings remaining at the Nordic Facility include an ETP, lime slaker, storage facilities, Westner Service Water Pump House, and East and West Pump Houses.

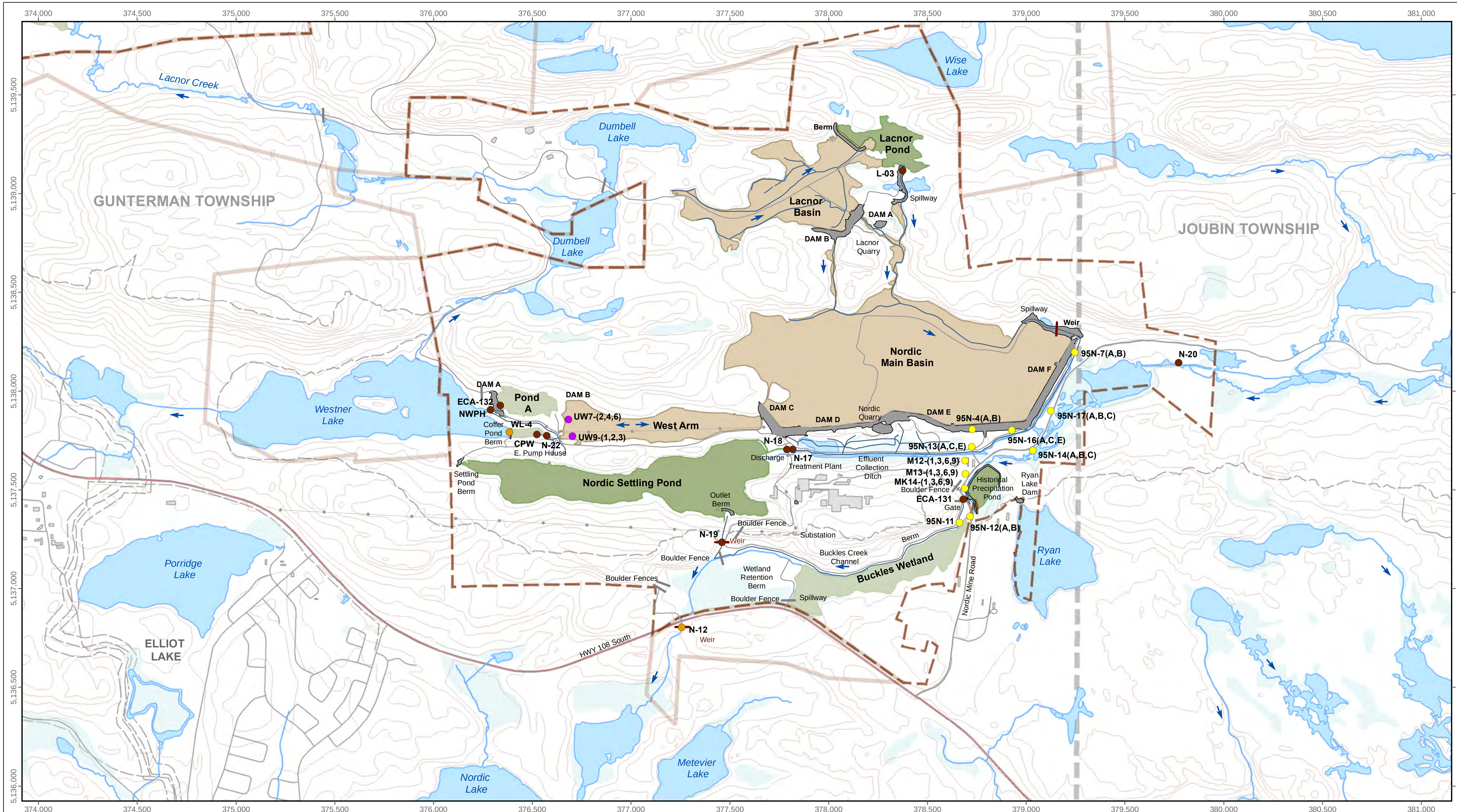
Infrastructure for the collection of surface runoff and seepage at the site include:

- the West Seepage Collection Dam, which intercepts seepage from existing Pond A, located in the West Valley downstream of existing Nordic Dam A;
- the West Seepage Collection Pond, located in the West Valley, which has a maximum capacity of 1,470 cubic metres;
- the East Seepage Collection Dam, which intercepts seepage from existing Nordic Dam B, located in the East Valley downstream of existing Dam B;
- the East Seepage Collection Pond located in the East Valley, which has a maximum capacity of 350 cubic metres; and,
- a Coffer Pond, located at the east end of Westner Lake, which discharges to the East Seepage Collection Pond.

The majority of surface runoff and seepage from the Nordic West Arm Basin drains in an easterly direction and is intercepted and directed by a series of ditches to the Nordic ETP for treatment. However, surface runoff and seepage from the western portion of the Nordic West Arm Basin is collected in Pond A, the West Seepage Collection Pond, and the East Seepage Collection Pond. The West and East Seepage Collection Dams (and associated ponds) were constructed in 1989 to intercept seepage from Pond A and the West Arm Basin, respectively, from entering Westner Lake. The West Seepage Collection Dam is located between Nordic Dam A and Westner Lake and, the East Seepage Collection Dam is located between Nordic Dam B and Westner Lake (Figure 6.2). The crest elevations and spillways of these containment structures were designed to safely convey the flows resulting from precipitation events up to and including the Probable Maximum Precipitation (PMP) design storm event.

The Coffer Pond was created at the east end of Westner Lake in 2004. The coffer berm currently prevents free movement of water and sediments between the Coffer Pond and the main body of Westner Lake, thereby isolating the area of the historical tailings deposit. Lime slurry is added to the Coffer Pond as required (currently twice per year) to maintain a neutral pH and a pump well installed in the Coffer Pond is used to pump surplus surface water/runoff to the East Seepage Collection Pond.

The majority of surface runoff and seepage from the Nordic facility is directed to the Nordic ETP through a series of collection ditches that extend from the Lacnor Basin/Pond through and around the north, east, and south of the Nordic Main Basin, as well as along the south border of the



LEGEND

Monitoring Station

- SAMP Surface Water
- TOMP Surface Water
- TOMP Groundwater
- TOMP Pore Water

- Vegetated Tailings
- Water Covered Tailings
- Settling Pond
- Drainage Channel

- Limits of CNSC Licence
- Limits of Unlicenced Property
- Contour (10 m)

0 305 610 1,220
Meters

N W E S

Projection: North American Datum 1983 UTM Zone 17
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Lacnor, Nordic and Buckles Sites SAMP and TOMP Monitoring Stations

Date: March 2021
Project 197202.0041

minnow environmental inc.

Figure 6.2

Document Path: C:\Users\MLaPalme\Trinity Consultants, Inc\BHP - 197202.0041 - Cycle 5 SOE\4 - GIS\Cycle 5 Report\19-41 Figure 6.2 Lacnor, Nordic, Buckles Site SAMP and TOMP Monitoring Stations.mxd

Nordic West Arm Basin, to the effluent treatment works (Figure 6.2). The Lacnor Basin has been designed with vegetated soil covers and a series of ditches graded to collect and transmit surface runoff drainage east towards Lacnor Pond. This pond discharges at a spillway which drains south, combining with the seepage from Lacnor Dams A and B to form the North Collection Ditch along the northern periphery of the Nordic Main Basin, approximately 610 m south of Lacnor Basin. The combined drainage in the North Collection Ditch travels east to a spillway located at the north abutment of Nordic Dam F. The spillway was constructed to route the flow from the Nordic Main Basin surface through Dam F to the Effluent Collection Ditch (ECD). The ECD directs flow along the toes of Dams F, E, and D to the Nordic ETP, located at the southwest corner of Nordic Main Basin. Originally constructed in 1971, the ECD was deepened in 1994 as part of initiatives implemented to improve interception of tailings porewater and reduce groundwater contamination of Buckles Creek located south of the Nordic Main Basin. Runoff and seepage from the eastern portion of the Nordic West Arm Basin is collected by a series of ditches (referred to as the West Arm Discharge Channel system) that extend from the toe of Nordic Dam C, along the base of Nordic Dam D, to a juncture with the main ECD upstream of the Nordic ETP, where the effluent is directed for treatment. Retention of flow to the ETP within the ECD is limited to the moderating effects of the Lacnor Pond spillway and Nordic Dam F weirs, and as a result, flow to the ETP is continuous, highly variable, and strongly influenced by snowmelt and precipitation events.

Following treatment at the ETP, effluent is directed by gravity flow to the Nordic Settling Pond for solids removal by settling. The 20 ha settling pond has a nominal retention volume of over 2 million cubic metres, yielding retention times of 2 to 46 days depending upon flow rates, ice cover, and wind conditions. The settling pond was lowered by 0.6 m in 1997 as part of initiatives to improve interception of tailings porewater from the Nordic basins to Buckles Creek. The Nordic Settling Pond has been outfitted with berm structures at the discharge inlet and discharge outlet to prevent short-circuiting of flow to the outlet during periods of ice cover. The outlet discharge channel, which is a bedrock-based conduit that connects the settling pond to the Discharge Weir (station N-19), is located at the southeast shore of the Nordic Settling Pond. Water levels in the Nordic Settling Pond are controlled by a stop log structure located at the Discharge Weir. From this weir, the effluent flows approximately 150 m downstream to Buckles Creek.

Drainage from the Buckles Wetland follows the former Buckles Creek channel (i.e., prior to construction of the Buckle Creek Diversion), which joins with Buckles Creek downstream of the confluence with the Nordic ETP final discharge via the N-19 Discharge Weir. The combined flow passes through a culvert under Highway 108 where it is monitored at the Buckles Creek Weir (N-12) prior to continuing along the natural flow path to Nordic Lake approximately 1,200 m downstream.

6.1.2.2 Conceptual Hydrogeological Model

Surface water at the Lacnor-Nordic site is managed through a series of ditches and collection ponds (Figure 6.2). The Lacnor Basin is bounded and rimmed by bedrock ridges and therefore groundwater flow is predominately inward. Seepage that exits the Lacnor Basin is through/under Dam A, which reports to the south and into the Nordic Main Basin (the north collection ditch; Golder 2020; Appendix L; Figure 6.2). Groundwater flow from the Nordic Main Basin occurs primarily within shallow overburden under the tailings and through the relatively permeable overburden deposits of variable thickness surrounding the east and southern perimeters of the TMA (Golder 2020; Appendix L). Downgradient of the Nordic Main Basin, the majority of groundwater seepage is captured by the ECD, which is designed to intercept seepage and direct it toward the ETP. Similarly, the ECD collects surface runoff from the Nordic Main TMA.

At the western end of the Nordic TMA, surrounding the Nordic West Arm, overburden is thin and limited to narrow valleys, and groundwater seepage occurs primarily through shallow, fractured bedrock (Golder 2020, Appendix L).

6.2 Applicable Monitoring Programs

The existing monitoring programs applicable to the Nordic Lake sub-watershed include:

- The TOMP (Minnow 2019), which includes effluent compliance monitoring requirements, designed to track TMA performance and support decisions regarding the management of the TMAs (Nordic facility surface water stations CPW, L-03, ECA-131, ECA-132, N-17, N-18, N-19, N-20, N-22, and NWPH; pore water monitoring locations at UW7 and UW9 (3 depths per location); and groundwater monitoring stations 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; Table 6.3 and Figure 6.2);
- The SAMP (Minnow 2019), which focuses on monitoring stations that represent the final points of release from each closed mine facility to the watershed, developed to monitor the nature and quantity of constituents being discharged (Nordic facility station N-12[20]; Table 6.3 and Figure 6.2); and,
- The SRWMP (Minnow 2019), an integrated monitoring program designed to assess the cumulative effects of the facility discharges on chemical and biological conditions in the watershed and to track changes over time. The SRWMP was designed to complement the SAMP, and included mechanisms to allow the evolution of the sampling approach over

[20] Nordic SAMP station WL-4 (Westner Lake) trends are discussed in the Elliot Lake sub-watershed, as Westner Lake is within the Elliot Lake catchment.

Table 6.3: Monitoring Stations Within or Downstream of Lacnor and Nordic TMAs, Within the Nordic Lake Sub-Watershed

Monitoring Program	Location	Type	Description	Parameters and Frequencies[a]														
				Elevation	Flow	Hardness	pH	Conductivity	Sulphate	Radium-226	TSS	Acidity	Iron	Barium	Cobalt	Manganese	Uranium	Toxicity[b]
TOMP	L-03	Basin performance (primary)	Discharge from Lacnor Pond (groundwater, seepage and surface water runoff)	M	Q		Q		Q	Q		Q	Q	Q	Q	Q	Q	
	N-17	Basin performance (primary), ETP operations	ETP influent quality		D		M		Q	M		Q	Q	Q	Q	Q	Q	
	N-18	ETP operations	ETP for lime addition				D											
	N-19	Effluent	Nordic Settling Pond discharge		W		W		M	W	W		M	M	M	M	M	
	N-22	Basin performance (secondary)	East Pumphouse - seepage		M		S		S	S		S	S	S	S	S	S	
	ECA-132	Basin performance (secondary)	Pond A seepage	M	M		M		S	S		S	S	S	S	S	S	
	NWPH	Basin performance (secondary)	West Pumphouse - seepage		M		S		S	S		S	S	S	S	S	S	
	ECA-131, N-20	Basin performance (secondary)	Buckles Creek upstream of Buckles Wetland				Q		Q	Q		Q	Q	Q	Q	Q	Q	
	CPW	Basin performance (secondary)	Coffer Pond	M	M		M		S	S		S	S	S	S	S	S	
	UW7-2,4,6; UW9-1,2,3	Pore water	Nordic West Arm seepage to collection ponds				A		A			A	A					
	M-12-1,3,6,9; M-13-1,3,6,9; M-14-1,3,6,9	Groundwater	Wells downgradient of ECD to test for migration south of ECD				A		A			A	A					
	95N-4A,B	Groundwater	Along Dam E to assess seepage quality to ECD				A		A			A	A					
	95N-7A,B	Groundwater	Along Dam F to assess seepage quality to ECD				A		A			A	A					
	95N-11; 95N-12A,B	Groundwater	Downgradient of Historical Precipitation Pond to assess groundwater to Buckles Wetland and Buckles Creek				A		A			A	A					
	95N-13A,C,E; 95N-16A,C,E	Groundwater	Downgradient of Dam E to assess groundwater reporting to ECD				A		A			A	A					
	95N-14A,B,C	Groundwater	Downgradient of ECD and Dam F but upgradient of Buckles Creek to assess groundwater to Buckles Creek and effectiveness of ECD				A		A			A	A					
	95N-17A,B,C	Groundwater	Along Dam F to assess seepage quality to ECD				A		A			A	A					
SAMP	N-12	Principal	Buckles Creek at Hwy. 108		M	M	M		M	M			M	M/S	M	M	M/S	S
SRWMP	SR-08	Surface Water	Outlet of Nordic Lake				Q		Q	Q				Q			Q	

Notes: TMA = Tailings Management Area. ETP = Effluent Treatment Plant. ECD = Effluent Collection Ditch.
[a] D=daily, W=weekly, M=monthly, Q=quarterly, S= Semi-annual.
[b] Toxicity includes: acute (*Daphnia magna* and rainbow trout) and sublethal (*Ceriodaphnia dubia*) testing following Environment Canada (2000a,b and 2007) methods.

- time in response to monitoring findings for the watershed. To meet this objective, surface water is monitored at the outlet of Nordic Lake (station SR-08; Table 6.3 and Figure 6.1).

6.3 TOMP: Lacnor and Nordic TMA Basin Performance

6.3.1 Water Management

Water levels at the Lacnor pond (station L-03) were above the spillway invert over most of the 2015 to 2019 period, with only one measurement below the invert level (Figure 6.3; Appendix Table I.3). Water levels in the Coffer Pond (station CPW) were consistently below the maximum operating level, and except for the summer months in most years, water levels were also above the normal operating level (Figure 6.3; Appendix Table I.10). Pumping from the Coffer Pond occurs when water levels are above the normal operating level (334.5 masl). Water levels in Pond A are monitored at station ECA-132 and fluctuate seasonally (Figure 6.3; Appendix Table I.4). Water in Pond A is pumped back to the ECD seasonally to provide storage capacity for winter and spring accumulation of runoff and seepage from the Nordic West Arm.

6.3.2 Basin Surface Water Quality

Surface water quality associated with the Lacnor TMA is monitored at station L-03 (Figure 6.2). Water quality associated with the Lacnor TMA has improved significantly over time, with decreasing trends observed for acidity, cobalt, iron, manganese, sulphate, and uranium since 2003 (Table 6.4; Appendix Figures I.1, I.3 to I.5 and I.8 to I.9). The pH of the surface water in Lacnor Pond currently remains acidic (i.e., between 3 and 4) and has not changed significantly over time (Appendix Table I.6).

Water quality within Pond A (station ECA-132) and at the North West Pump House (station NWPH; on the downstream side of Dam A from Pond A) has shown little change over time, with the exception of decreases in barium and uranium at station ECA-132, and sulphate at NWPH (Table 6.4; Appendix Figures I.2, I.8, and I.9). The pH in water from both stations is circumneutral (Appendix Figure I.6). Immediately south of Pond A, water quality within the Coffer Pond (station CPW) has remained relatively unchanged over time, except for a slight increase in manganese (Table 6.4; Appendix Figure I.5). Water in the East Seepage Collection Pond (immediately east of CPW; station N-22) has shown significant improvement over time, with decreasing trends in most routine water quality parameters, and an increase in pH (Table 6.4; Appendix Figures I.1 to I.9). Despite the increase in pH, surface water associated with the East Seepage Collection Pond remains acidic (i.e., pH generally between 3 and 4; Appendix Figure I.6).

In Buckles Creek upstream of the Nordic Plume (i.e., station N-20), decreasing concentrations of both barium and sulphate were noted, while all other parameters remained unchanged (Table 6.4;

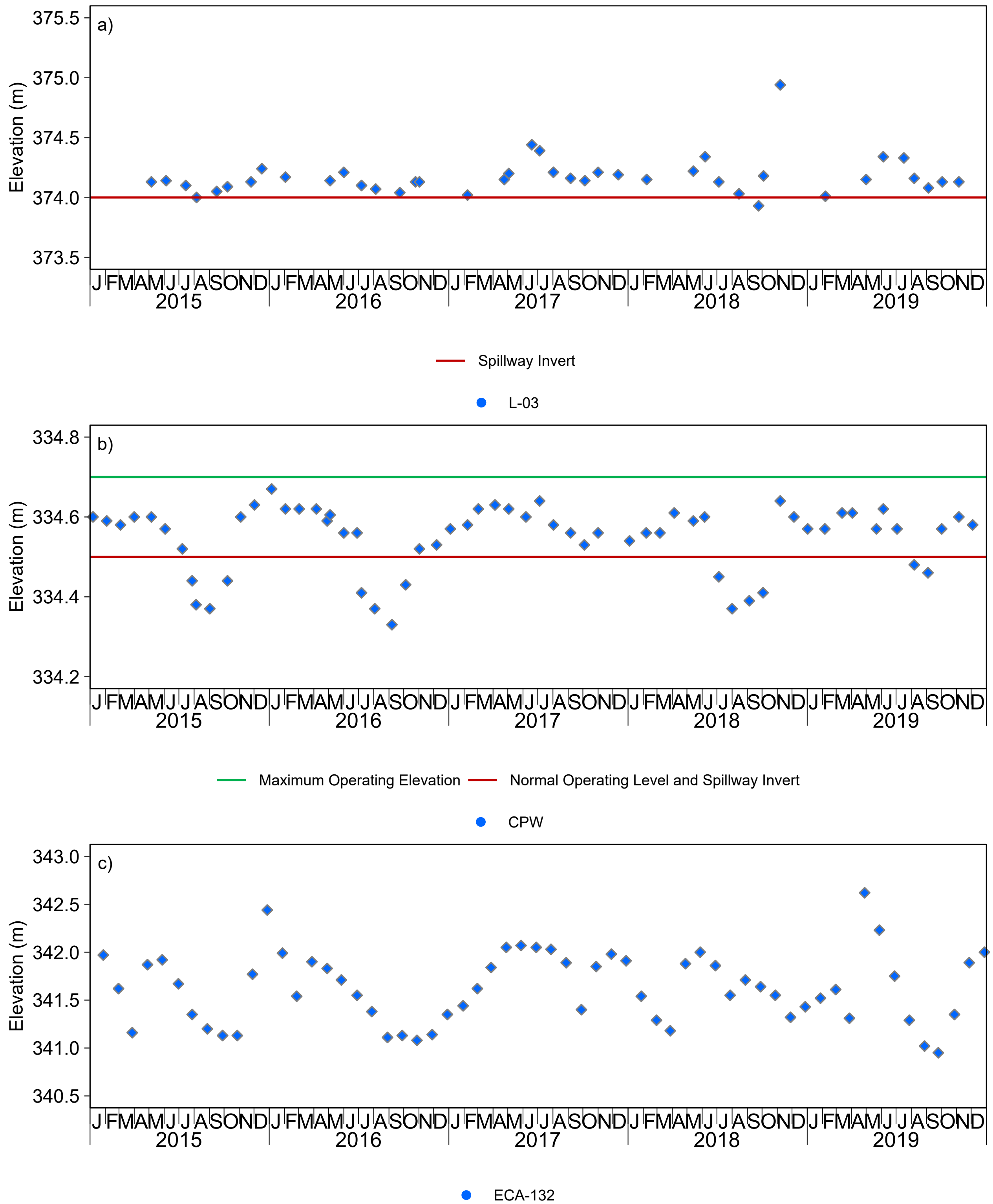


Figure 6.3: Water Level at TOMP Station L-03 (a), Station CPW (b) and Station ECA-132 (c) Relative to Maximum Operating Elevations and Spillway Inverts, Lacnor- Nordic TMA, 2015 to 2019

Notes: See Appendix Tables I.30 to I.32 for raw data.

Table 6.4: Seasonal Kendall Trend Analysis for Water Quality Parameters, TOMP Water Quality Monitoring Stations, Lacnor and Nordic TMAs, 2003 to 2019

Station	L-03	ECA-132	NWPH	N-22	CPW	N-20	ECA-131	N-17	N-19
Station Type/ Location	Coffer Pond West	Buckles Creek at Mine Road	Final Treated Effluent	Nordic Pond A upstream of Westner seepage	Buckles Creek Upstream of Nordic Plume	Lacnor Tailings Discharge	Treatment Plant Influent	West Arm Pump Discharge (East Seepage Collection Pond)	North West Pump House
Acidity (mg/L)	-7.10	nt	nt	-8.10	nt	nt	nt	NS	nt
Barium (mg/L)	NS	-2.70	NS	NS	NS	-2.30	-4.60	NS	NS
Cobalt (mg/L)	-3.80	NS	NS	-11.00	NS	NS	nt	-2.60	-4.50
Iron (mg/L)	-6.70	NS	NS	-11.00	NS	NS	-11.00	NS	NS
Manganese (mg/L)	-4.50	NS	NS	-7.40	16.00	NS	NS	-3.70	-2.80
pH	NS	NS	NS	1.70	NS	NS	0.50	0.70	-0.20
Radium-226 (Bq/L)	NS	NS	NS	NS	NS	nt	-13.00	NS	NS
Sulphate (mg/L)	-10.00	NS	-3.50	-6.30	NS	-3.90	-8.00	NS	-2.10
Uranium (mg/L)	-6.80	-13.00	NS	-12.00	nt	nt	nt	-2.00	NS

[Green] Significant decreasing temporal trend (Seasonal Kendall test for monotonic trend at α = 0.05). Value reported is the Sen's slope reported as a percentage of the median concentration or value.

[Blue] Significant increasing temporal trend (Seasonal Kendall test for monotonic trend at α = 0.05). Value reported is the Sen's slope reported as a percentage of the median concentration or value.

Note: See Appendix Table I.3 to I.15 for raw data. '"NS" = no significant temporal trend (Seasonal Kendall test for monotonic trend at α = 0.05). '"nt" = parameter not included in the trend analysis for that particular station due to >50% non-detectable concentrations in the samples available for the analysis.

Appendix Figures I.1 to I.9). Decreasing concentrations of barium and sulphate were also noted further downstream in Buckles Creek (near the Mine Road/upstream of Buckles Creek wetland; station ECA-131), in addition to decreasing concentrations of iron, radium-226, and sulphate, and a slight increase in pH (Table 6.4; Appendix Figures I.1 to I.9). Remediation work conducted in 2005 to isolate the Wetland and Historical Precipitate Pond from the Diversion Channel, and streambed modifications completed in 2006 which restored groundwater gradients towards the Effluent Collection Ditch (i.e., away from Buckles Creek) are partly responsible for the improvements in water quality over time.

Water quality associated with the Treatment Plant influent (N-17) has significantly improved over time, with decreasing concentrations of cobalt, manganese, and uranium, and an increase in pH (Table 6.4; Appendix Figures I.1 to I.9). These changes in influent water chemistry were reflected in effluent chemistry (station N-19), which also demonstrated significant decreases in cobalt and manganese (Table 6.4; Appendix Figures I.3 and I.5). Sulphate and pH have also decreased significantly in effluent; however, pH is managed as part of effluent treatment (i.e., pH of influent is typically between 3.5 and 5.5), and the minimal change observed simply reflects better management practices to keep pH closer to neutral (Table 6.4; Appendix Figures I.6 and I.8).

6.3.3 Pore Water

Pore water 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 6.2). Pore water at station UW7-6 (the deepest monitoring station at UW7) has not been sampled since 2015 as the well has been dry or had no recharge during sampling events, therefore trend analyses only reflect findings up to that year.

Since 2007, acidity has decreased significantly in the shallow pore water at UW7 (and has remained below the laboratory reporting limit at deeper depths), whereas no significant changes were noted at UW9 (Table 6.5; Appendix Figure I.10). Field pH remained relatively unchanged and circumneutral since 1993 in the moderate depth at UW7, whereas slight increasing trends were noted in the shallower and deeper depths (Table 6.5; Appendix Figure I.12). At the deepest monitoring station (UW7-6), pore water pH has also been near neutral since 2001, following a step change improvement associated with the upgrading of Dam A in 2000 (Table 6.5; Appendix Figure I.12). At UW9, a decrease in pH was noted in the shallowest monitoring station, whereas no changes were observed at the moderate and deep stations (Table 6.5; Appendix Figure I.12). Pore water pH has continued to be acidic at all monitoring depths at UW9 (Appendix Figure I.12). Iron concentrations have decreased significantly in the shallowest monitoring depth at UW7, where a nearly 25-fold decrease has occurred since monitoring began in 1993 (Appendix Figure I.11). Iron also decreased significantly in the moderate and deep

Table 6.5: Results of Temporal Trend Analyses for Pore Water Quality Parameters, TOMP Pore Water Stations, Lacnor/Nordic TMA, 1990 to 2019

Station	UW7-4	UW7-2	UW7-6	UW9-3	UW9-2	UW9-1
Station Type/Location	Nordic west arm, pore water north			Nordic west arm, pore water south		
Depth (m)	5.14	8.23	16	4.27	6.4	8.53
Acidity (mg/L)	-30	nt	nt	NS	NS	NS
Field pH	0.69	NS	0.49	-1.5	NS	NS
Iron (mg/L)	-13	NS	NS	NS	-3.4	-4.8
Sulphate (mg/L)	-6.9	NS	NS	NS	NS	-2.7

[Green] Significant decreasing temporal trend (Kendall test for monotonic trend at α = 0.05). Value reported is the slope reported as a percentage of the median concentration or value.

[Blue] Significant increasing temporal trend (Kendall test for monotonic trend at α = 0.05). Value reported is the slope reported as a percentage of the median concentration or value.

Notes: Due to a change in analytical technique for acidity in 2006, acidity trends were assessed from 2007 to 2019. See Appendix Tables I.17 to I.18 for raw data. 'NS = no significant temporal trend (Kendall test for monotonic trend at α = 0.05). '"nt" = parameter not included in the trend analysis for that particular station due to >50% non-detectable concentrations in the samples available for the analysis.

stations at UW9 (i.e., UW9-1 and UW9-2), but this was primarily attributable to changes observed from 1993 through 2011; iron concentrations have remained relatively stable over the 2011 to 2019 period (Appendix Figure I.11). Sulphate concentrations decreased in the shallow monitoring depth at UW7 and the deep monitoring station at UW9, but no temporal changes were observed at the other monitoring depths at both locations (Table 6.5; Appendix Figure I.13).

6.3.4 Groundwater Quality

Groundwater quality is monitored annually at several locations downgradient of the Nordic TMA (Figure 6.2) to assess the effectiveness of measures to remediate the plume migrating south from the Main Tailings Basin. Generally, groundwater quality has continued to improve over time, with decreasing concentrations of acidity, iron, and sulphate, and increasing pH at most locations where trends were observed (Table 6.6; Appendix Figures I.14 to I.17). Acidity has decreased or remained similar over time in all well clusters where sufficient data were available to test for trends (Table 6.6; Appendix Figure I.14). Measurements of pH showed little change over time in most monitoring locations, except for notable increases at M-12 and M-13 (downgradient of ECD south), where pH has improved significantly (e.g., from approximately 4.5 to over 6 in some depths; Table 6.6; Appendix Figure I.16). Slight decreasing trends in pH were noted in the shallow monitoring depths at 95N-4 and 95N-12, and the shallow and moderate depths at 95N-17, but in most cases, pH remained near neutral (Table 6.6; Appendix Figure I.16). Groundwater iron concentrations decreased significantly at nearly all stations in the vicinity of the Nordic TMA, except for the deep station at 95N-17 (Table 6.6, Appendix Figure I.15). Despite the noted increase, concentrations of iron at 95N-17A continue to be low (i.e., generally below 4 mg/L). Sulphate concentrations have also been improving over time, likely in association with lower tailings oxidation (Table 6.5; Appendix Figure I.17). Only one station was flagged as having increasing sulphate concentrations (95N-11; Table 6.5; Appendix Figure I.17).

Remedial measures were undertaken downgradient of the Nordic TMA and ECD to reduce 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 pore water from the tailings and reduce seepage to Buckles Creek located immediately east and south of the Nordic TMA. These measures were effective in improving groundwater quality downgradient of the ECD, with significant reductions in iron and increases in pH at most locations (Table 6.6; Appendix Figures I.15 and I.16). Previous review of routine monitoring data including groundwater elevations/chemistry data, and water chemistry in Buckles Creek indicated that the ECD has been effective at capturing seepage from the TMA and shallow groundwater (EcoMetrix 2011a).

Table 6.6: Results of Temporal Trend Analyses for Groundwater Quality Parameters, TOMP Groundwater Stations, Lacnor/Nordic TMAs, 1990 to 2019

Station	95N-7B	95N-7A	95N-17C	95N-17B	95N-17A	95N-14C	95N-14B	95N-14A	95N-16E	95N-16C	95N-16A
Station Type/Location	Downgradient of ECD at northeast corner Nordic main		Downgradient of ECD at east perimeter Nordic main			Downgradient of ECD at southeast corner Nordic main			Upgradient of ECD at southeast corner Nordic main		
Depth (m)	3.69	7.72	3.49	8.09	12.68	3.49	7.6	11.39	3.86	11.03	18.21
Acidity (mg/L)	NS	-8.4	nt	nt	nt	nt	nt	nt	-2.2	NS	-11
Field pH	NS	NS	-0.25	-0.20	NS	NS	NS	NS	NS	NS	0.28
Iron (mg/L)	-4.5	-11	NS	NS	3.1	NS	NS	-2.8	-6.2	-6.5	-5.8
Sulphate (mg/L)	NS	-3.0	NS	NS	-1.5	NS	NS	NS	-4.0	-2.2	-1.9

(Green) Significant decreasing temporal trend (Kendall test for monotonic trend at α = 0.05). Value reported is the slope reported as a percentage of the median concentration or value.

(Blue) Significant increasing temporal trend (Kendall test for monotonic trend at α = 0.05). Value reported is the slope reported as a percentage of the median concentration or value.

Notes: Due to a change in analytical technique for acidity in 2006, acidity trends were assessed from 2007 to 2019. See Appendix Tables I.19 to I.29 for raw data. NS = no significant temporal trend (Kendall test for monotonic trend at α = 0.05). "nt" = parameter not included in the trend analysis for that particular station due to >50% non-detectable concentrations in the samples available for the analysis.

Table 6.6: Results of Temporal Trend Analyses for Groundwater Quality Parameters, TOMP Groundwater Stations, Lacnor/Nordic TMAs, 1990 to 2019

Station	95N-4B	95N-4A	95N-13E	95N-13C	95N-13A	M-12-9	M-12-6	M-12-3	M-12-1	M-13-9	M-13-6	M-13-3	M-13-1
Station Type/Location	Upgradient of ECD at south perimeter Nordic main		Upgradient of ECD at head Nordic plume			Downgradient of ECD south of 95N-13				Downgradient of ECD south of M-12			
Depth (m)	5.31	9.91	2.82	9.61	15.36	2.5	5.49	6.54	13.41	2.04	5.46	6.43	11.46
Acidity (mg/L)	NS	-1.7	NS	NS	-2.8	nt	-117	-150	NS	nt	NS	-2,300	-100
Field pH	-0.89	NS	0.67	NS	NS	1.7	0.57	0.51	0.33	0.91	1.1	0.59	0.66
Iron (mg/L)	-3.2	-2.8	-3.5	-4.0	-3.7	NS	-34	-11	NS	NS	-82	-21	-5.3
Sulphate (mg/L)	-1.5	-1.9	-1.8	-2.6	-1.9	-15	-28	-5.5	NS	-12	-300	-120	-8.1

(Green) Significant decreasing temporal trend (Kendall test for monotonic trend at α = 0.05). Value reported is the slope reported as a percentage of the median concentration or value.

(Blue) Significant increasing temporal trend (Kendall test for monotonic trend at α = 0.05). Value reported is the slope reported as a percentage of the median concentration or value.

Notes: Due to a change in analytical technique for acidity in 2006, acidity trends were assessed from 2007 to 2019. See Appendix Tables I.19 to I.29 for raw data. NS = no significant temporal trenc (Kendall test for monotonic trend at α = 0.05). "nt" = parameter not included in the trend analysis for that particular station due to >50% non-detectable concentrations in the samples available for the analysis.

Table 6.6: Results of Temporal Trend Analyses for Groundwater Quality Parameters, TOMP Groundwater Stations, Lacnor/Nordic TMAs, 1990 to 2019

Station	M-14-9	M-14-6	M-14-3	M-14-1	95N-12B	95N-12A	95N-11
Station Type/Location	Downgradient of ECD south of M-13; west of historic precipitate pond				Downgradient of ECD, south of M-14; adjacent to ECA-131		Downgradient of ECD, south of 95N-12
Depth (m)	1.8	3.84	12.83	8.75	3.67	6.87	4.34
Acidity (mg/L)	nt	nt	-26	-8.5	nt	nt	-23
Field pH	0.33	NS	NS	NS	-0.14	NS	NS
Iron (mg/L)	NS	-110	-10	NS	-4.0	NS	-24
Sulphate (mg/L)	-13	-120	-13	-5.6	-3.9	-2.4	4.6

[Green] Significant decreasing temporal trend (Kendall test for monotonic trend at α = 0.05). Value reported is the slope reported as a percentage of the median concentration or value.

[Blue] Significant increasing temporal trend (Kendall test for monotonic trend at α = 0.05). Value reported is the slope reported as a percentage of the median concentration or value.

Notes: Due to a change in analytical technique for acidity in 2006, acidity trends were assessed from 2007 to 2019. See Appendix Tables I.19 to I.29 for raw data. NS = no significant temporal trend (Kendall test for monotonic trend at α = 0.05). "nt" = parameter not included in the trend analysis for that particular station due to >50% non-detectable concentrations in the samples available for the analysis.

6.3.5 Treatment Performance

The ETP at Nordic uses lime to neutralize acidity, promote settling of particulates, and lower the concentrations of metals (predominantly iron). Barium chloride has not been required at the Nordic ETP because radium-226 is co-precipitated with the iron hydroxides formed by lime addition, and treatment plant influent (N-17) has met radium-226 discharge criteria. While the total amount of lime used per year has remained relatively stable from 2015 through 2019, the annual rate of lime consumption (i.e., per volume of water treated) has fluctuated between a minimum of 0.27 g/L in 2019 and a maximum of 0.41 g/L in 2018 (Figure 6.4).

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 (Figures 6.5 and 6.6, Appendix Table I.15).

6.4 SAMP: Nordic Lake Sources

6.4.1 Discharge Quality and Loads

Water quality in the Nordic final discharge (N-12) has been consistently non-lethal to *Daphnia magna* and rainbow trout over the 2015 to 2019 period (Table 6.7). Similarly, reproduction of *Ceriodaphnia dubia* was not affected by exposure to 100% effluent in all tests conducted over the past five years (Table 6.7).

Except for iron (2017 and 2018 only) and sulphate (all five years), annual mean concentrations of all substances in the Nordic final discharge (N-12) met the SRWMP benchmarks[21] (Figure 6.7).

Loadings associated with the Nordic TMA were highly variable over the 2015 to 2019 period, with the highest loads ever recorded for almost all substances (over the 2005 to 2019 period) being documented in 2017 (a high flow year), and some of the lowest loads occurring in 2019 (Appendix Figure P.10).

6.4.2 Trends

Water quality in the Nordic final discharge (N-12) has improved over time, based on decreasing concentrations of barium, cobalt, radium-226, sulphate, and uranium, and increasing pH (although pH has been near neutral; Table 6.8; Appendix Figures P.1 to P.8) .

[21] These are receiving environment criteria, which are provided here for context, but are not required to be met for discharge to occur.

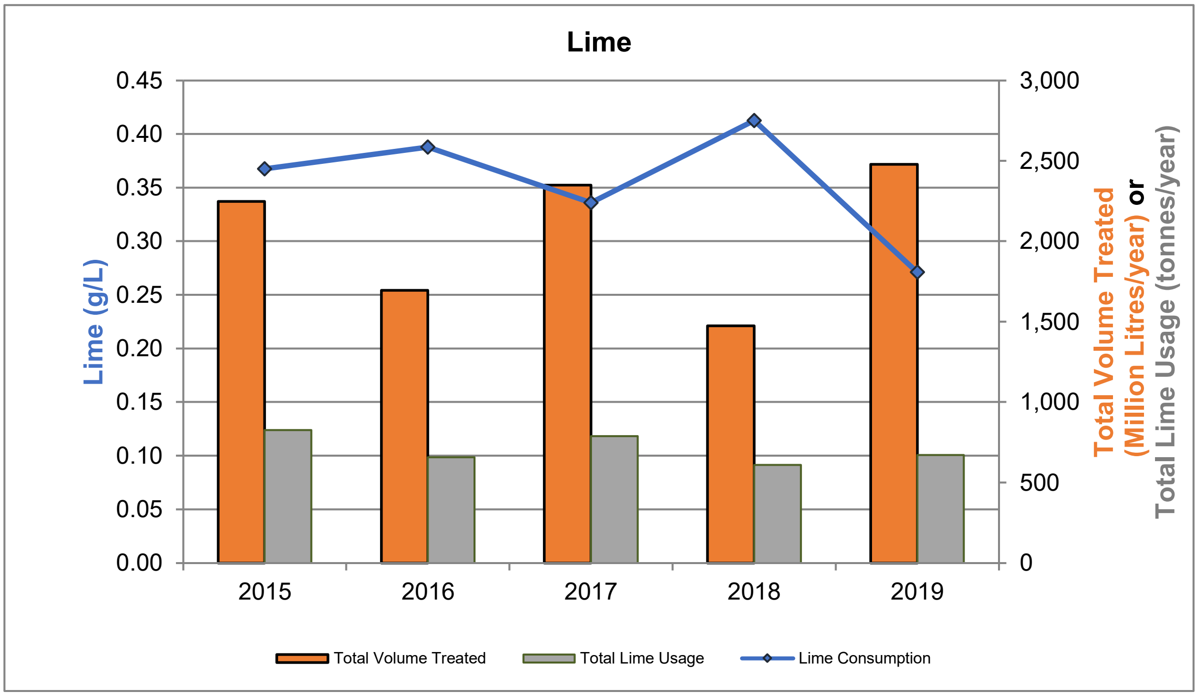


Figure 6.4: Comparison of Total Reagent Consumed Versus Total Volume Treated at Nordic TMA from 2015 to 2019

Note: See Appendix Table J.14 for raw data (TOMP Station N-17).

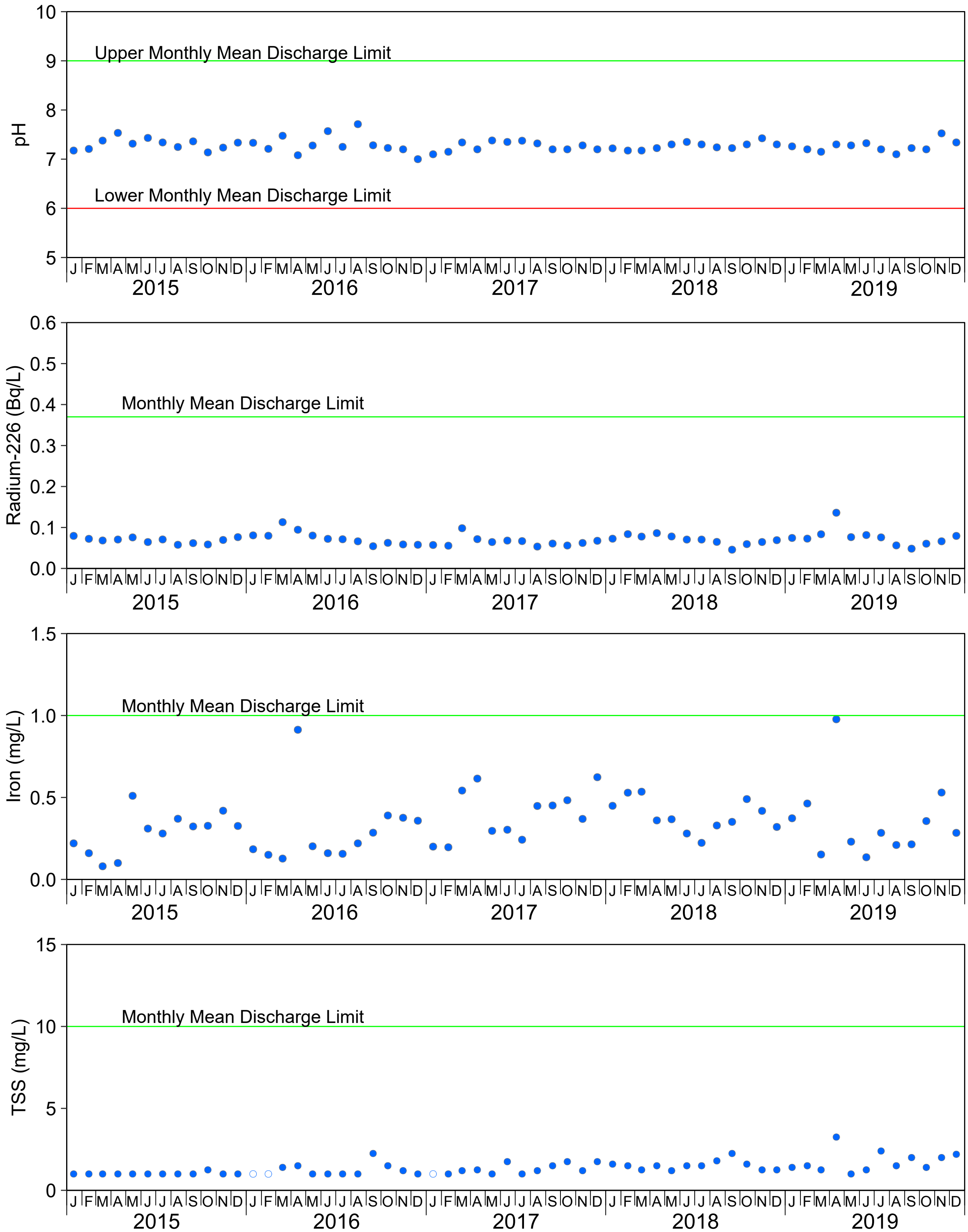


Figure 6.5: Monthly Mean Effluent Concentrations Compared to Monthly Mean Discharge Limits at TOMP Station N-19, Lacnor/Nordic TMA, 2015 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Table I.15 for raw data. The discharge criteria for iron were updated by the Environmental Compliance Approval (ECA) amendment for the Nordic Facility, September 2020 (MECP 2020). Since this update was approved after the study period, the updated criteria will be used in the Cycle 6 report.

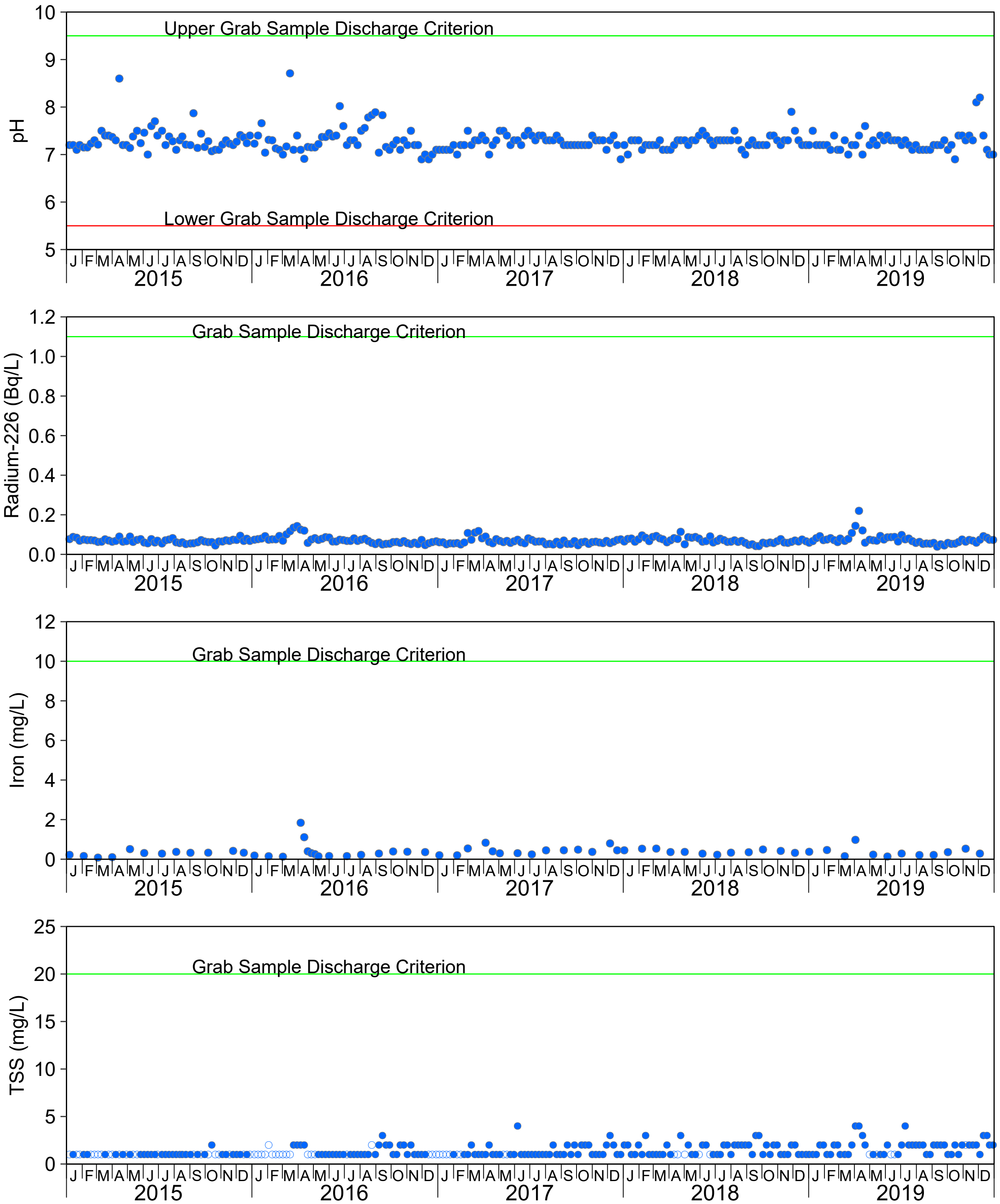


Figure 6.6: Effluent Concentrations Compared to Grab Sample Discharge Criteria at TOMP Station N-19, Lacnor/Nordic TMA, 2015 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Table I.15 for raw data. The discharge criteria for iron were updated by the Environmental Compliance Approval (ECA) amendment for the Nordic Facility, September 2020 (MECP 2020). Since this update was approved after the study period, the updated criteria will be used in the Cycle 6 report.

Table 6.7: Toxicity Test Results for Samples Collected at Nordic TMA SAMP Station N-12, 2015 to 2019

Date	Sublethal Toxicity (*Ceriodaphnia dubia*) IC25	Acute Toxicity (*Daphnia magna*) % Mortality	Acute Toxicity (Rainbow Trout) % Mortality
06-May-15	100	0	0
25-Nov-15	100	0	0
04-May-16	100	0	0
04-Oct-16	100	0	0
03-May-17	100	0	0
01-Nov-17	100	0	0
02-May-18	100	0	0
07-Nov-18	100	0	0
08-May-19	100	0	0
06-Nov-19	100	0	0
n	10	10	10
Minimum	100	0	0
Maximum	100	0	0
Mean	100	0	0
SD	-	-	-
Median	100	0	0
10th Percentile	100	0	0
95th Percentile	100	0	0

Note: n = number of samples. SD = standard deviation. "-" = SD not applicable.

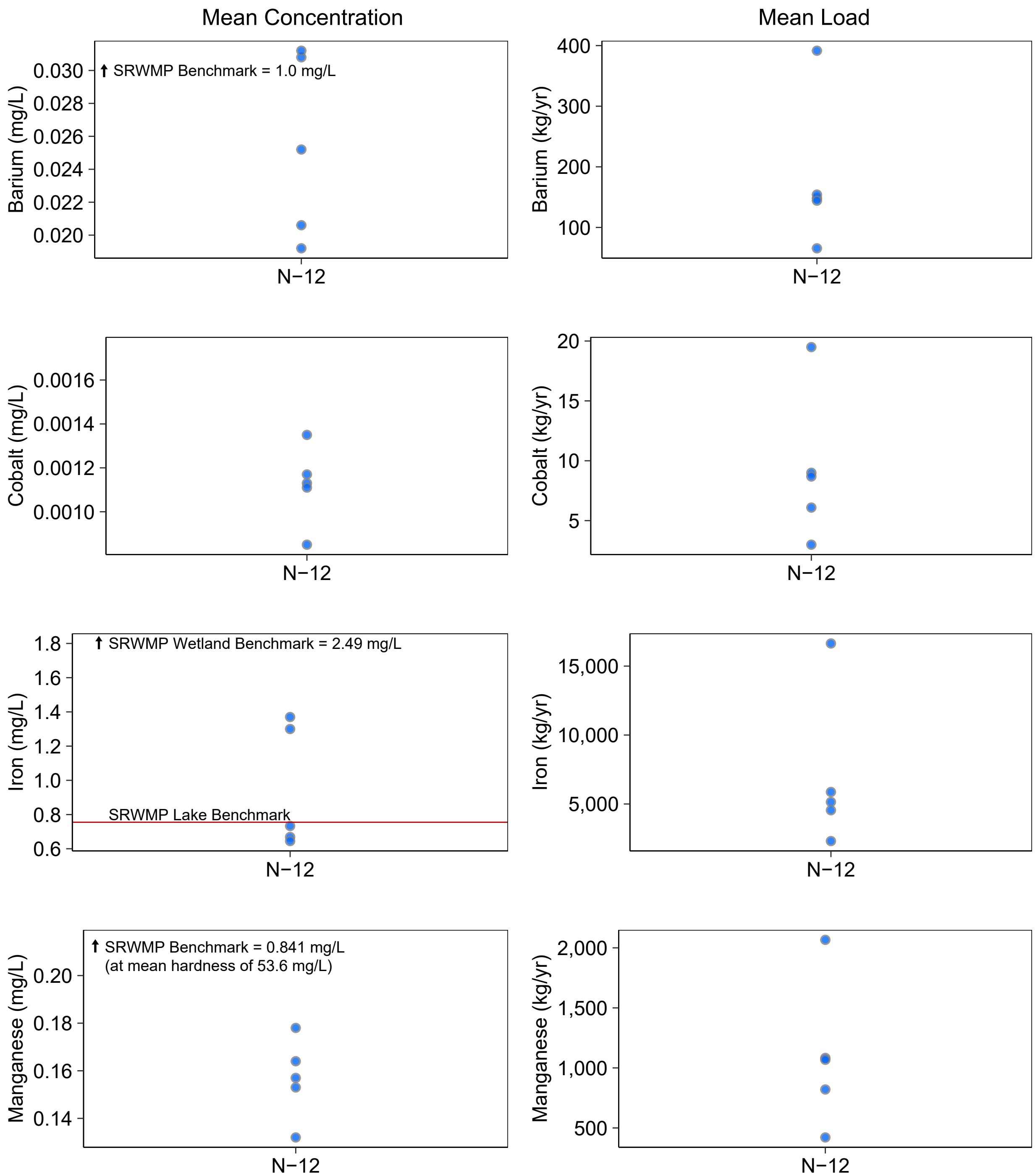


Figure 6.7: Annual Mean Concentrations and Annual Loads at SAMP Monitoring Stations Downstream of Lacnor and Nordic TMAs, Within the Nordic Lake Sub−Watershed, 2015 to 2019

Notes: SRWMP benchmarks (Table 2.8) apply to the receiving environment and are based on background (reference) concentrations or approved guidelines, provided here for context, but they are not criteria that need to be met for discharge to occur. Values at the LRL (open circles) were replaced with the LRL for calculations. See Appendix Table P.5 for raw data.

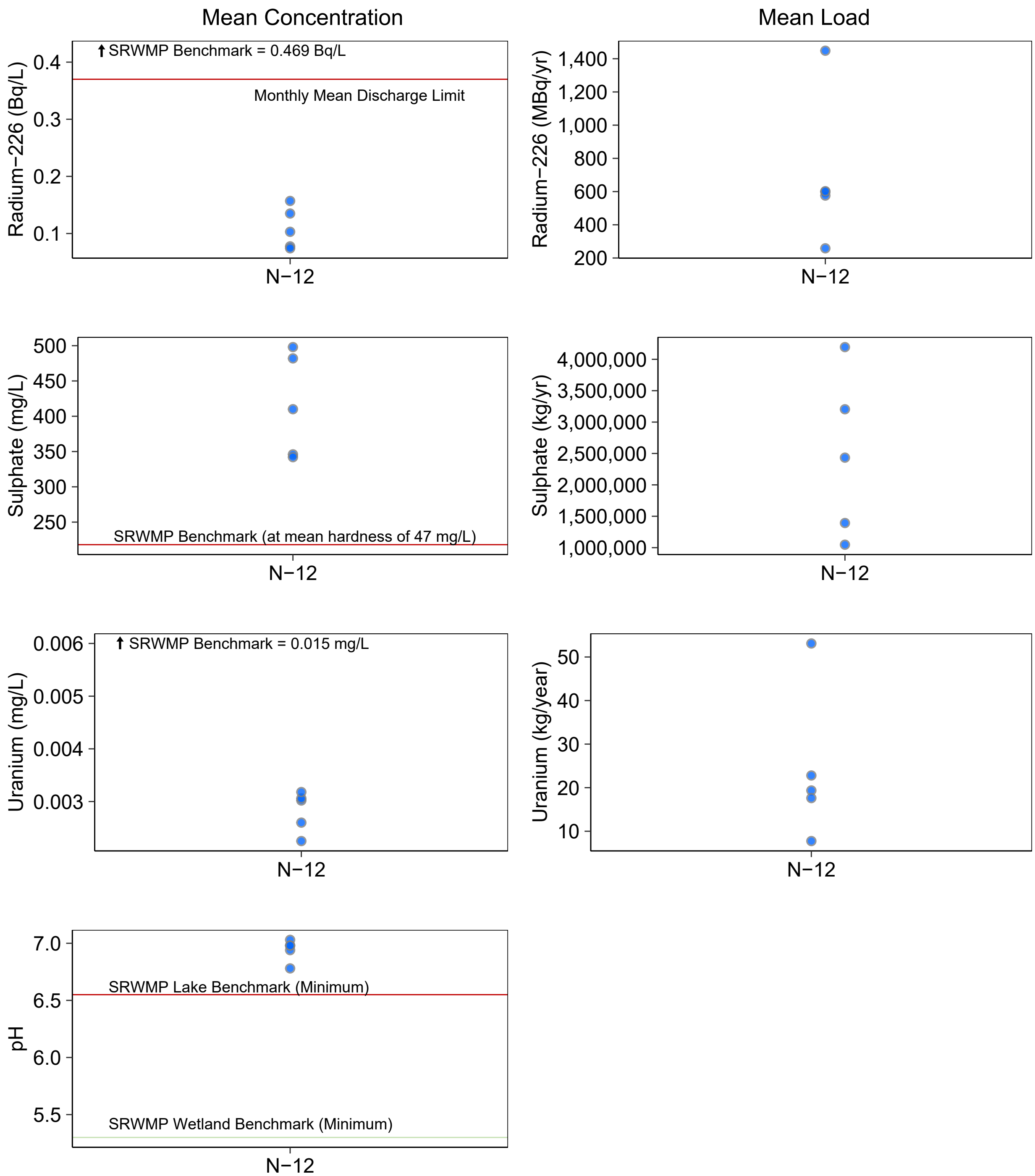


Figure 6.7: Annual Mean Concentrations and Annual Loads at SAMP Monitoring Stations Downstream of Lacnor and Nordic TMAs, Within the Nordic Lake Sub−Watershed, 2015 to 2019

Notes: SRWMP benchmarks (Table 2.8) apply to the receiving environment and are based on background (reference) concentrations or approved guidelines, provided here for context, but they are not criteria that need to be met for discharge to occur. Values at the LRL (open circles) were replaced with the LRL for calculations. See Appendix Table P.5 for raw data.

Table 6.8: Seasonal Kendall Trend Analysis for Water Quality Parameters, SAMP Water Quality Monitoring Stations in Nordic TMA, Discharging to the Nordic Lake Sub-watershed, 2003 to 2019

Station	Nordic TMA
	N-12
	Principal
Barium (mg/L)	-2.30
Cobalt (mg/L)	-6.00
Iron (mg/L)	NS
Manganese (mg/L)	NS
pH	0.400
Radium (Bq/L)	-2.80
Sulphate (mg/L)	-3.10
Uranium (mg/L)	-2.90

[Green] Significant decreasing temporal trend (Seasonal Kendall test for monotonic trend at $\alpha = 0.05$). Value reported is the Sen's slope reported as a percentage of the median concentration or value.

[Blue] Significant increasing temporal trend (Seasonal Kendall test for monotonic trend at $\alpha = 0.05$). Value reported is the Sen's slope reported as a percentage of the median concentration or value.

Note: "NS" = no significant temporal trend (Seasonal Kendall test for monotonic trend at $\alpha = 0.05$). See Appendix Table P.3 for raw data and Appendix Figures P.1 to P.8 for time series plots of the trends.

6.5 SRWMP Water Quality

Receiving water quality associated with the Nordic Facility is monitored quarterly at the outlet of Nordic Lake (station SR-08; Figure 6.1). Over the 2015 to 2019 period, concentrations of water quality analytes at station SR-08 consistently met SRWMP benchmarks (Figure 6.8; Appendix Table S.19). Improvements in water quality have also been realized since 2003, based on decreasing concentrations of barium, radium-226, sulphate, and uranium (Table 6.9; Appendix Figures S.23 to S.27).

Loadings measured at outlet of Nordic Lake (SR-08) were typically lower than, or similar to, those measured at the Nordic Facility final discharge (N-12; Figure 6.8). Loadings were notably lower at the outlet of Nordic Lake for cobalt, iron, and manganese as these substances tend to associate with particulate matter and are lost to sedimentation.

6.6 Summary

Surface and groundwater at the Lacnor/Nordic TMA are managed through ditching and holding ponds that are directed or pumped to an ETP where effluent is treated with lime to neutralize pH and precipitate metals. Following treatment, effluent is discharged to the Nordic Settling Pond to allow for solids to settle before discharging to Buckles Creek, which also received flow from the Buckles Wetland prior to flowing southwest to Nordic Lake. Water quality in the Nordic Lake sub-watershed is monitored through the TOMP, SAMP, and SRWMP. Improvements in surface water, pore water, and groundwater quality have been observed over time. Effluent treatment has performed well, with discharge achieving effluent limits and water at N-12 (final release from site) being non-toxic over the past five years. Improvements in water quality were also observed at the Nordic Lake outlet, with concentrations of barium, radium-226, sulphate, and uranium decreasing over time. Overall, the Lacnor/Nordic TMA continues to perform well and meet compliance criteria, with water quality trends indicating improving or stable conditions.

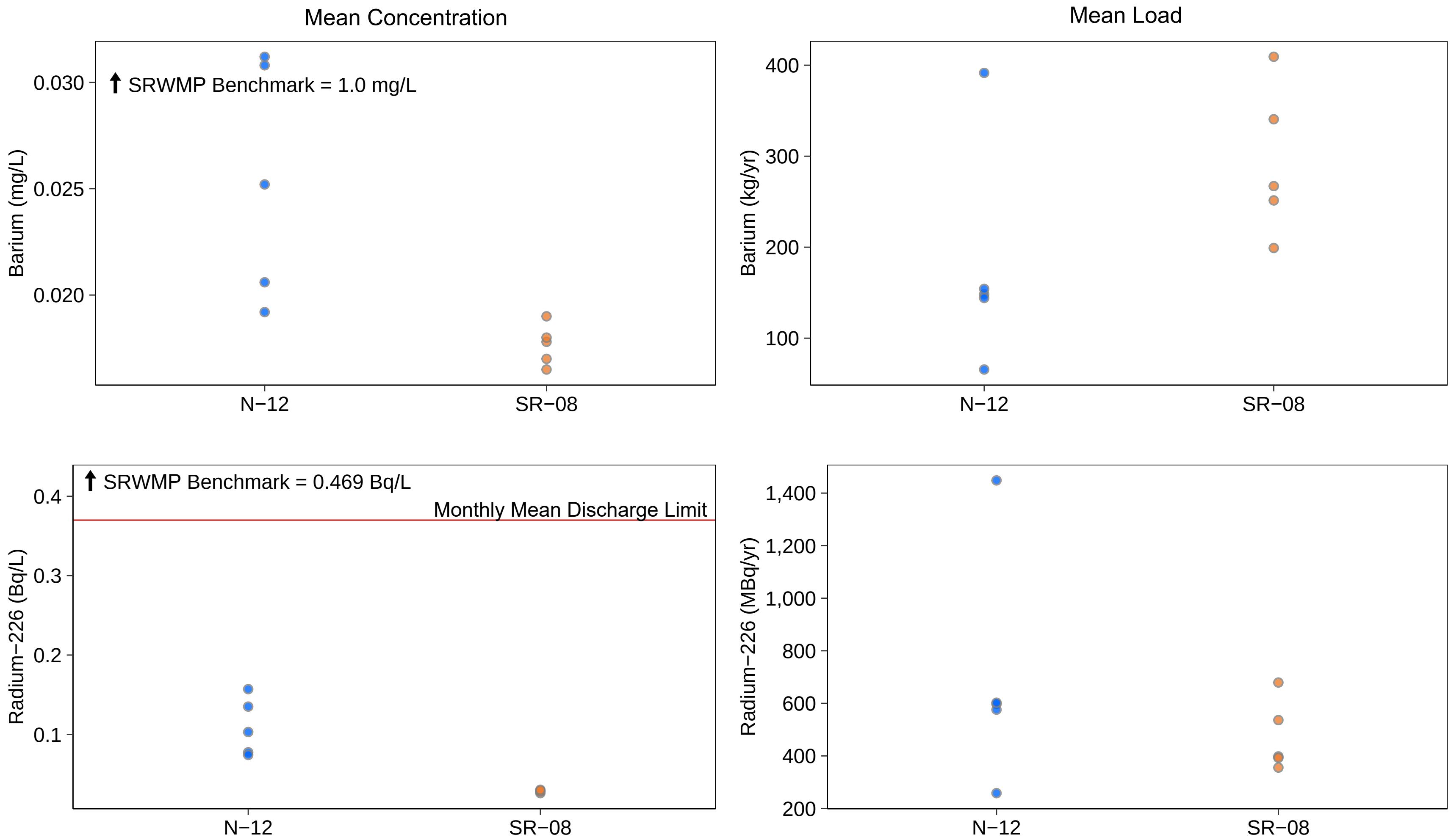


Figure 6.8: Annual Mean Concentrations and Annual Loads at SAMP and SRWMP Monitoring Stations Downstream of Lacnor and Nordic TMAs, Within the Nordic Lake Sub−Watershed, 2015 to 2019

Notes: Blue circles represent SAMP stations, orange circles represent SRWMP stations. SRWMP benchmarks (Table 2.8) apply to the receiving environment and are based on background (reference) concentrations or approved guidelines, and is not applicable to SAMP stations. Values at the LRL (open circles) were replaced with the LRL for calculations. See Appendix Tables P.3 and S.19 for raw data and Tables P.5 and O.3 for annual discharge and seepage loadings.

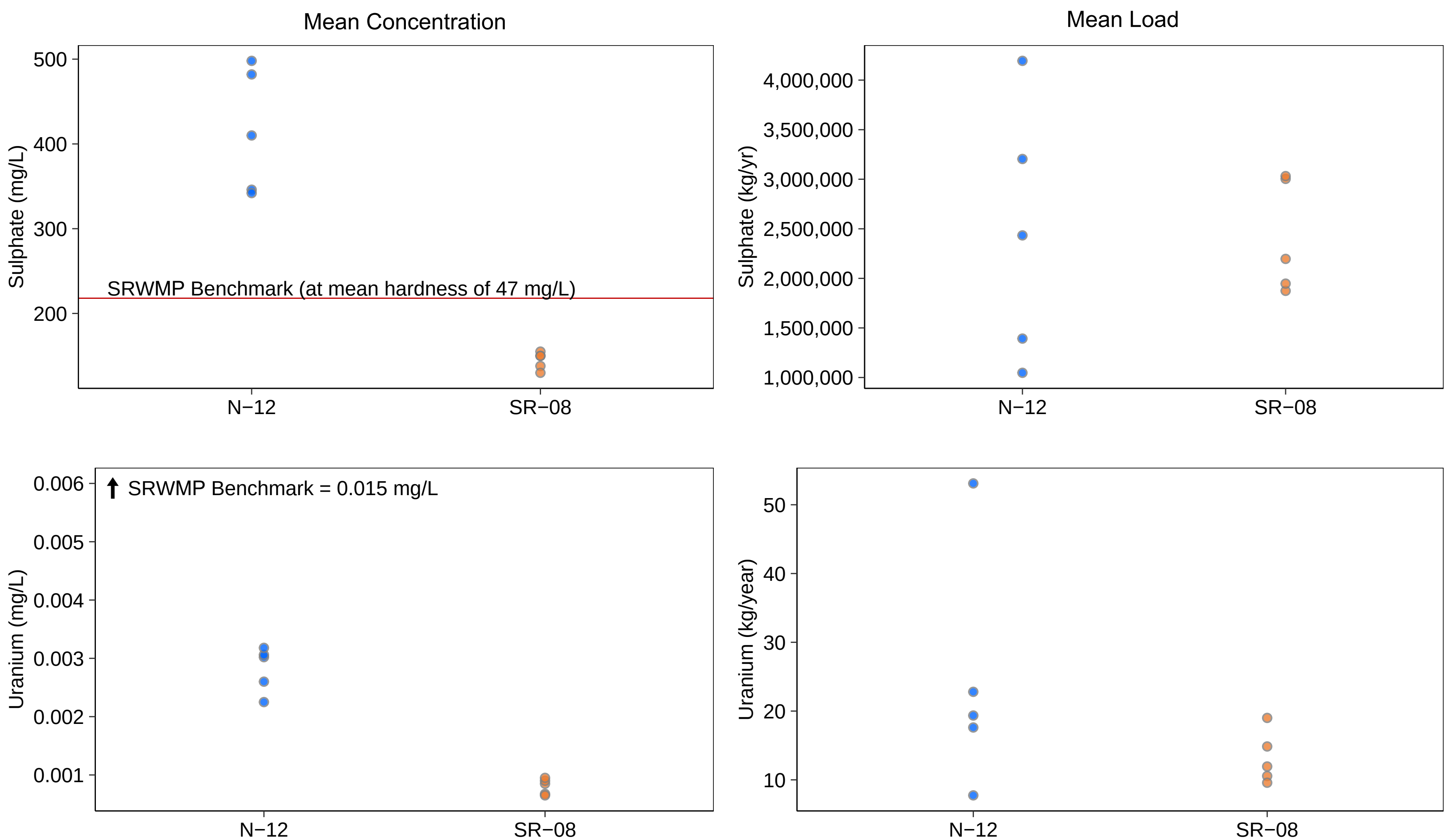


Figure 6.8: Annual Mean Concentrations and Annual Loads at SAMP and SRWMP Monitoring Stations Downstream of Lacnor and Nordic TMAs, Within the Nordic Lake Sub−Watershed, 2015 to 2019

Notes: Blue circles represent SAMP stations, orange circles represent SRWMP stations. SRWMP benchmarks (Table 2.8) apply to the receiving environment and are based on background (reference) concentrations or approved guidelines, and is not applicable to SAMP stations. Values at the LRL (open circles) were replaced with the LRL for calculations. See Appendix Tables P.3 and S.19 for raw data and Tables P.5 and O.3 for annual discharge and seepage loadings.

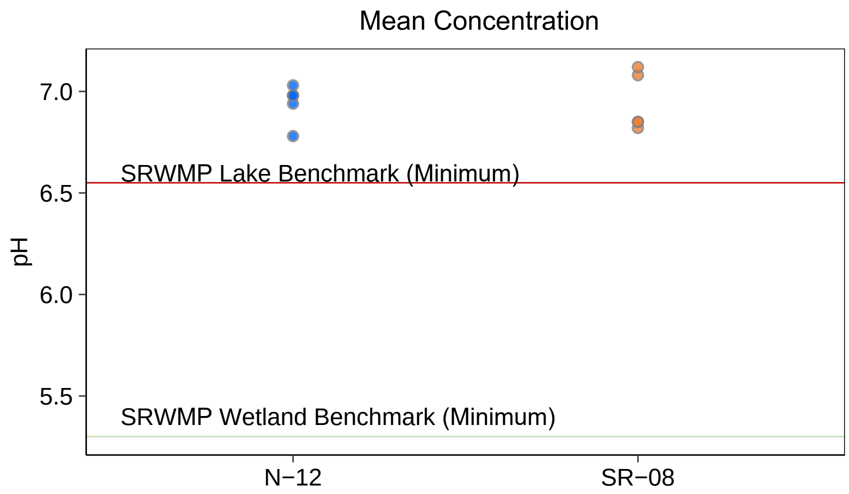


Figure 6.8: Annual Mean Concentrations and Annual Loads at SAMP and SRWMP Monitoring Stations Downstream of Lacnor and Nordic TMAs, Within the Nordic Lake Sub−Watershed, 2015 to 2019

Notes: Blue circles represent SAMP stations, orange circles represent SRWMP stations. SRWMP benchmarks (Table 2.8) apply to the receiving environment and are based on background (reference) concentrations or approved guidelines, and is not applicable to SAMP stations. Values at the LRL (open circles) were replaced with the LRL for calculations. See Appendix Tables P.3 and S.19 for raw data and Tables P.5 and O.3 for annual discharge and seepage loadings.

Table 6.9: Seasonal Kendall Trend Analysis for Water Quality Parameters, SRWMP Stations in the Nordic Lake Sub-Watershed, 2003 to 2019

Station	Reference					Mine-Exposed
	D-4	SR-19	SR-18	SR-16	SR-17	SR-08
Barium (mg/L)	NS	NS	NS	NS	NS	-2.00
Iron (mg/L)	NS	NS	NS	NS	NS	na
Manganese (mg/L)	NS	NS	NS	NS	NS	na
pH	NS	NS	NS	NS	1.1	NS
Radium (mg/L)	nt	nt	nt	nt	nt	-5.40
Sulphate (mg/L)	-3.30	-3.10	-4.50	-6.40	-5.50	-2.80
Uranium (mg/L)	nt	nt	nt	nt	nt	-5.30

(green) Significant decreasing temporal trend (Seasonal Kendall test for monotonic trend at α = 0.05). Value reported is the Sen's slope reported as a percentage of the median concentration or value.

(blue) Significant increasing temporal trend (Seasonal Kendall test for monotonic trend at α = 0.05). Value reported is the Sen's slope reported as a percentage of the median concentration or value.

Note: See Appendix Tables S.4 to S.8 and S.19 for raw data. See Appendix Figures S.23 to S.27 for time series plots of the trends. NS = No significant temporal trend (Seasonal Kendall test for monotonic trend at α = 0.05). nt = Parameter not tested for this station because >50% of values <LRL. na = Parameter not assessed for this station, as per study design.

7 NEAR-SHORE LAKE HURON

7.1 Background

7.1.1 Near-Shore Lake Huron

The near shore of Lake Huron represents the terminus of the Serpent River watershed which discharges its 1,376 km^2 drainage area into Serpent Harbour and then west into the north channel of Lake Huron. Further west of the Serpent River discharge point, the Pronto TMA also drains to Serpent Harbour via an unnamed drainage ditch (Figures 2.1, 7.1). The Pronto TMA final discharge point has a watershed area of 5.1 km^2 (Figure 2.1).

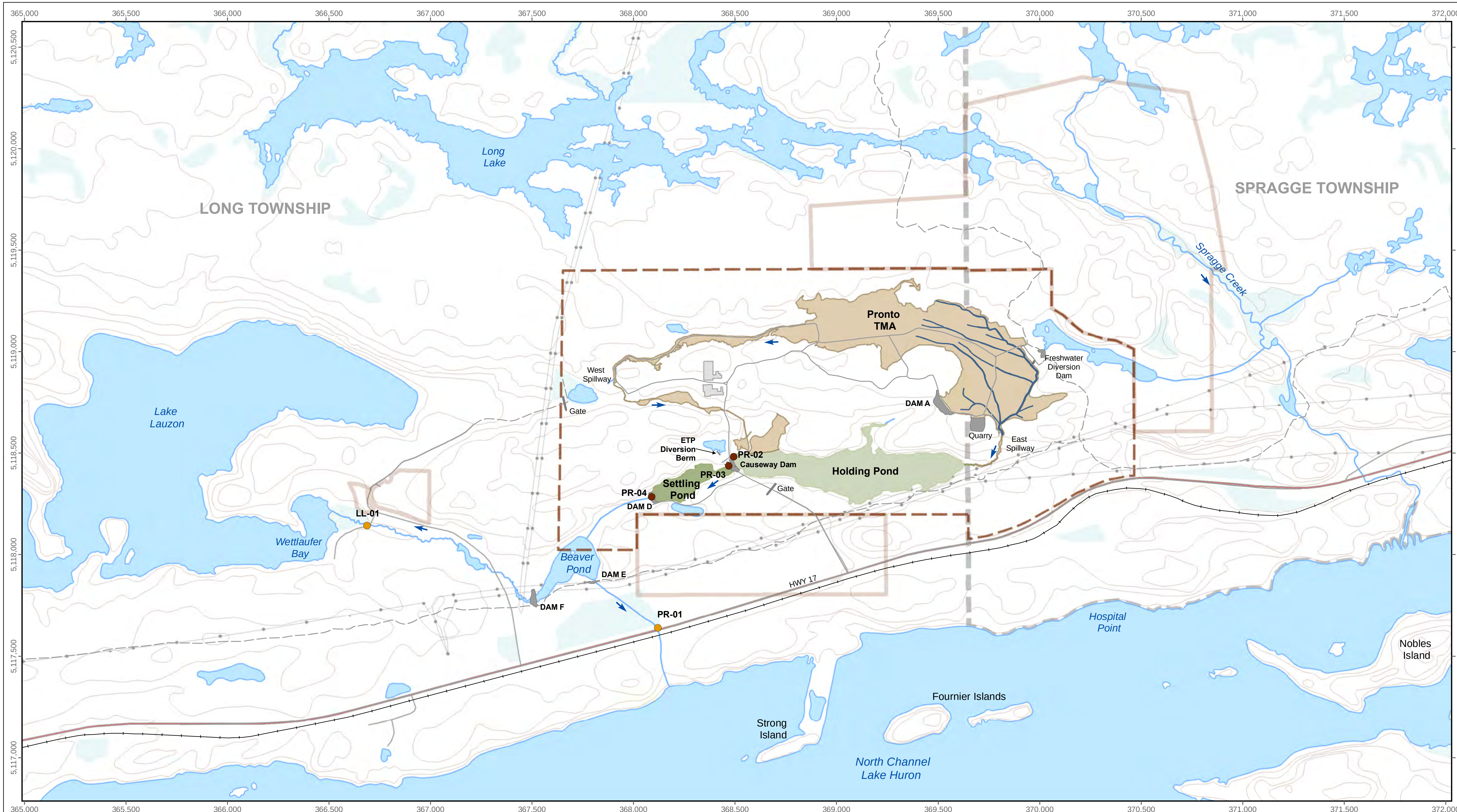
7.1.2 Pronto TMA

7.1.2.1 Site History and Existing Operations

The only TMA facility located in the near-shore Lake Huron sub-watershed is the closed Pronto mine and associated infrastructure (Figure 7.1). The Pronto Facility is a former uranium mine located immediately north of Highway 17, approximately 22 km east of Blind River along Highway 17 and 34 km south of Elliot Lake city center (Figure 1.1).

The Pronto Mine was developed for uranium extraction and began operating in 1955. Tailings from the uranium milling process were discharged to the TMA, northeast of the mill. While operating, ore was processed at a rate of 1,360 tonnes per day using an acid-leach ion-exchange precipitation process. Approximately 2.1 million tonnes of ore were processed from 1955 to 1960. In 1960, after uranium mining ceased, the mill process was modified for the processing of copper ores originating from the nearby Pater Mine located south of Highway 17. Copper tailings were discharged to the northeast of the mill, covering most of the uranium operation tailings. While operating as a copper concentrator, a total of 2 million tonnes of ore were processed to produce 36 million kg of copper. The copper operation was discontinued in 1970.

The Pronto Mine workings were shallow with mine stopes on the first level often occurring within 6 m of the surface. A total of 16 stope raises that were originally open to the surface were backfilled with waste rock as part of a 1994 site remediation program. Three openings to the underground mine, including the main shaft and two ventilation raises, were re-capped with concrete in 1994 in accordance with Ontario Ministry of Energy, Northern Development and Mines guidelines. The crown pillar was located along the north end of the mine workings in a relatively inaccessible area characterized by swamp lands and bedrock outcrops (Hedley 1994).



LEGEND

Monitoring Station
- SAMP Surface Water
- TOMP Surface Water

- Vegetated Tailings
- Water Covered Tailings
- Treatment Solids
- Ditch

- Limits of CNSC Licence
- Limits of Unlicenced Property
- Dam
- Contour (10 m)

0 0.25 0.5 1 Kilometers

Projection: North American Datum 1983 UTM Zone 17
Reproduced under licence from Her Majesty the Queen in Right of Canada, Department of Natural Resources Canada.

N W E S

Pronto Site SAMP and TOMP Monitoring Stations

Date: March 2021
Project 197202.0041

minnow environmental inc.

Figure 7.1

The former Pronto mill, mine, and ancillary structures were demolished over a five-year period ending in 1994. The Pronto Facility was cleaned up by collecting and disposing of demolition materials in the Pronto TMA. All hazardous materials were removed from facility buildings and disposed of in accordance with provincial legislation prior to demolition. Detailed surveys of the mine site were completed in 1976, 1994, and 1996 after reclamation to identify any remaining areas of contamination and confirm compliance with gamma radiation remediation criteria.

Vegetated tailings are located in a 47 ha natural rock basin contained by a till core dam. A high water table (close to the surface) at the Pronto TMA serves to reduce acid generation (RAL 2000). In the eastern portion of the TMA, the saturation extended to surface which originally precluded the traditional use of direct liming and seeding to successfully maintain an established vegetative cover. However, modifications were made to the TMA from 1999 to 2001 which were effective in maintaining a 100% vegetative cover (Minnow 2017). Other site improvements have been implemented since 2001 to manage on-site flow, stability, vegetative cover, and effluent treatment. In addition, in 2009, approximately 33,000 tonnes of rock fill from adjacent residential properties was relocated to the Pronto TMA (Table 7.1)

The only remaining operational structure at the Pronto Facility is the ETP. The ETP is a remotely operated facility and includes lime and barium chloride[22] storage tanks, reaction tanks, and feed facilities.

Dam A is the primary containment structure for the Pronto TMA and is located on the southern limit of the East Tailings Area (Figure 7.1). A Fresh Water Diversion Berm was constructed at the north-eastern limit of the East Area in 1998. This berm was intended to divert non-contact water from a pond system located adjacent to the east border of the TMA in the opposite direction, thereby reducing the volume of water requiring treatment at the ETP. The diversion berm effectively reduced the area of the watershed by approximately 19.4 ha.

Drainage from the West and East Areas is transported via the West Spillway and East Spillway, respectively, to a 24 ha Holding Pond. The Holding Pond has a retention volume of 726,000 m^3 and collects all runoff and effluent from the 326 ha site, including the 47 ha TMA. Operating elevations in the Holding Pond ensure adequate storage capacity to contain and treat the “Timmins Storm” event (193 mm in 12 hrs), and also provide adequate water cover to prevent freeze-up of the ETP influent pipe. Water is retained in the Holding Pond by the Causeway Dam and is seasonally pumped to the ETP at a maximum rate of 200 L/s where effluent is treated with lime slurry to neutralize pH and precipitate metals. Effluent from the ETP is discharged to the

[22] Barium chloride treatment has not been required to maintain discharge water quality since 2009, however the system is maintained should it be required for future operations.

Table 7.1: 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 to 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 to 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.
2017	Installation of lightning and surge protection systems at the ETPs.	Resolve operational issues caused by lightning strikes on incoming power lines and communication towers.
	Lowering of the road along the Causeway Dam.	Restore proper elevation below the spillway.
	Lowering and resurfacing of emergency spillways.	To restore spillways to design elevations.
2019	Dredging of settling pond.	Treatment solids moved to the holding pond to maintain settling capacity in the settling pond.

Note: ETP = effluent treatment plant.

Settling Pond where the precipitates settle out of the water column. The Settling Pond is retained by Dam D (Figure 7.1) which provides for a nominal retention volume of 55,000 m^3 yielding retention times of 3 to 4 days. Periodic dredging of the Settling Pond to relocate the treatment sludge to the Holding Pond is required to maintain treatment effectiveness. It was most recently dredged in 2019 (Table 7.1). Dam D incorporates a decant structure on the north side of the dam with stop logs that are used to adjust flow through the final point of control to a small pond, referred to as the Beaver Pond. Dam F was constructed along the southwest corner of the Beaver Pond to divert flow away from Lake Lauzon. Some seepage from Dam F reports via an unnamed tributary to Wettlaufer Bay of Lake Lauzon. Beaver Pond is also contained by Dam E, a 2 m maximum height overflow structure located on the southern shore. A 20 m wide spillway channel on Dam E conveys flow to the North Channel of Lake Huron via a Diversion Channel. In October 2006, the Dam E spillway was lowered to minimize seepage through Dam F and to reduce the potential for erosion of Dam F during high water periods.

7.1.2.2 Conceptual Hydrogeologic Model

Groundwater flow is limited to shallow, fractured bedrock within natural valleys and bedrock depressions. The Pronto TMA and associated infrastructure is well-contained by bedrock ridges with low permeability. Site seepage and preferential flow pathways are directed toward the Holding Pond and Settling Pond (Golder 2020; Appendix L). Tailings-derived groundwater from the TMA Basin migrates through shallow bedrock underlying Dam A, with seepage reporting west and south toward the Holding Pond through a narrow valley (Golder 2020; Appendix L). Within the Holding Pond, groundwater seeps may daylight and discharge with effluent to the west toward the Settling Pond. Thus, surface and groundwater from the TMA are expected to be captured and managed within the treatment system, except for seepage to Lake Lauzon, which is monitored at surface water station LL-01.

7.2 Applicable Monitoring Programs

The existing monitoring programs applicable to the Pronto TMA include:

- The TOMP (Minnow 2019), which includes effluent compliance monitoring requirements, designed to track TMA performance and support decisions regarding the management of the TMAs (Pronto facility stations PR-02, PR-03, and PR-04; Table 7.2) and
- The SAMP (Minnow 2019), which focuses on monitoring stations that represent the final points of release to the watershed, developed to monitor the nature and quantity of constituents being discharged These stations are located on an unnamed drainage ditch to Lake Huron downstream of the effluent discharge (station PR-01) and the outlet of an

Table 7.2: Monitoring Programs and Stations for the Pronto TMA, Lake Huron Watershed

Monitoring Program	Station ID	Type	Description	Parameters and Frequencies [a]														
				Elevation	Flow	Hardness	pH	Conductivity	Sulphate	Radium-226	TSS	Acidity	Iron	Barium	Cobalt	Manganese	Uranium	Toxicity[b]
TOMP	PR-02	Basin performance (primary), ETP operations	Holding Pond and ETP influent water quality	W	D	-	M	-	Q	M	-	Q	Q	Q	Q	Q	Q	-
TOMP	PR-03	ETP operations	ETP influent to adjust lime addition based on pH	-	-	-	D	-	-	-	-	-	-	-	-	-	-	-
TOMP	PR-04	Effluent	Final effluent discharge from Settling Pond	-	W	-	W	-	M	W	W	-	M	M	M	M	M	-
SAMP	LL-01	Drainage	Pronto Creek at Inlet to Lake Lauzon	-	Q	Q	Q	-	Q	Q	-	-	Q	Q	Q	Q	Q	-
SAMP	PR-01	Principal	Pronto final discharge to unnamed channel at Highway 17, which flows into Lake Huron	-	M	M	M	-	M	M	-	-	M	M	M	M	M	S

Note: ETP = Effluent Treatment Plant; "-" = not required.

[a] D=daily, W=weekly, M=monthly, Q=quarterly, S=semi-annually.

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

- unnamed tributary to Lake Lauzon which historically received seepage from Dam F (station LL-01; Table 7.2).

7.3 TOMP: Pronto TMA Basin Performance

7.3.1 Water Elevations

Operating elevations in the Holding Pond were established to ensure adequate storage capacity to contain and treat the “Timmins Storm” and prevent freeze-up of the influent pipe. In November 2019, the maximum operating level in the Pronto Holding Pond was lowered from 197.75 m (Canadian Geodetic Vertical Datum of 1928; CGVD28) to 196.50 m (CGVD28) following a review of operating water levels and hydrotechnical assessments with the Geotechnical Engineer of Record and Responsible Dam Engineer. An elevation of 196.50 m (CGVD28) provides sufficient storage below the spillway in the Holding Pond for the environmental design flood (EDF) during a regional storm event (Timmins Storm).

The water levels within the Holding Pond at the Pronto TMA are monitored regularly at PR-02 and have generally been maintained within the operating limits over the 2015 to 2019 period, except for a short period in November and December 2019, when water levels were lowered to slightly below the minimum operating elevation (Figure 7.2).

7.3.2 Basin Surface Water Quality

Surface water quality at the Pronto TMA is monitored at three stations to assess conditions downstream of the TMA (stations PR-02, PR03, and PR-04; Figure 7.1). Station PR-02 represents water quality in the Holding Pond (i.e., influent to the ETP), and PR-04 represents final treated effluent. Station PR-03 is considered part of ETP operations and is only monitored for pH to assess lime addition requirements. As such, PR-03 is not included in the assessment of basin surface water quality; however, pH data for PR-03 are provided in Appendix Table J.4.

Since 2003, a number of improvements in ETP influent quality (station PR-02) have been realized, including reductions in concentrations of acidity, cobalt, sulphate, and uranium, and an increase in pH (Table 7.3; Appendix Figures J.1 to J.9). The improvements in ETP influent quality were also reflected in improved effluent quality, particularly decreasing concentrations of sulphate and uranium (Table 7.3; Appendix Figures J.8 and J.9). The reduction in barium in treated effluent (station PR-04) was a result of cessation of effluent treatment with barium chloride in 2009, and as such, there has been no temporal change in barium concentrations in effluent since that time. The decrease in effluent pH is also likely due to better management of effluent treatment to maintain a pH closer to neutral (7). In the past, effluent pH was maintained closer to or above 8, whereas over the 2015 to 2019 period, mean effluent pH was 7.35 (Appendix Table J.5). Concentrations of iron and radium-226 have remained relatively stable in both ETP influent and

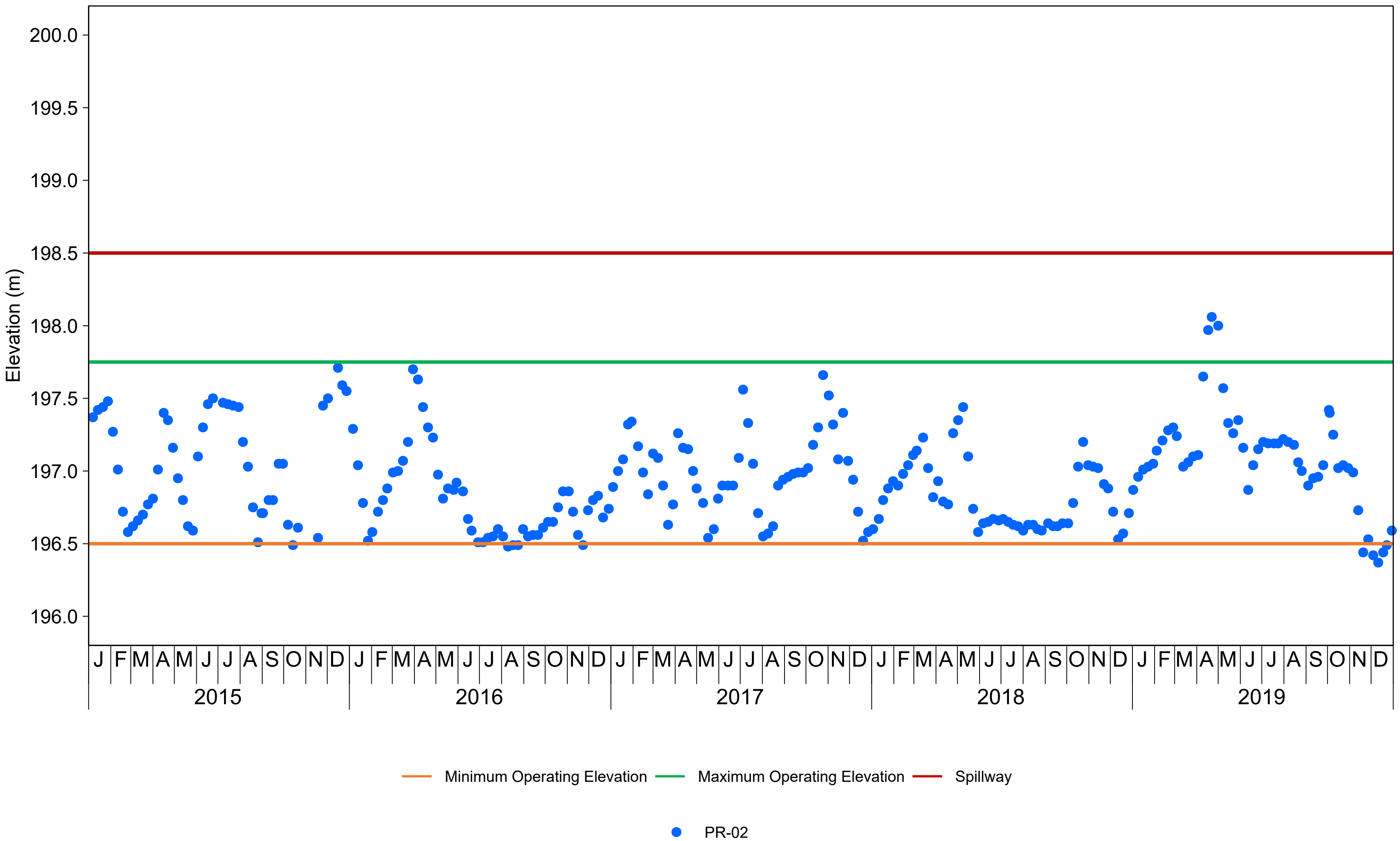


Figure 7.2: Water Level at TOMP Station PR-02 Relative to Minimum Operating Elevations, Pronto TMA, 2015 to 2019

Notes: See Appendix Table J.6 for raw data.

Table 7.3: Seasonal Kendall Trend Analysis for Water Quality Parameters, TOMP Water Quality Monitoring Stations, Pronto TMA, 2003 to 2019

Station	PR-02	PR-04
Station Type/Location	Treatment Plant Influent	Final Treated Effluent
Acidity (mg/L)	-7.9	na
Barium (mg/L)	NS	-5.4
Cobalt (mg/L)	-3.5	NS
Iron (mg/L)	NS	NS
Manganese (mg/L)	NS	-3.1
pH	0.80	-0.70
Radium-266 (Bq/L)	NS	NS
Sulphate (mg/L)	-3.3	-5.2
Uranium (mg/L)	-7.3	-6.2

[green] Significant decreasing temporal trend (Seasonal Kendall test for monotonic trend at α = 0.05). Value reported is the Sen's slope reported as a percentage of the median concentration or value.

[blue] Significant increasing temporal trend (Seasonal Kendall test for monotonic trend at α = 0.05). Value reported is the Sen's slope reported as a percentage of the median concentration or value.

Note: See Appendix Tables J.3 and J.5 for raw data. "NS" = no significant temporal trend (Seasonal Kendall test for monotonic trend at α = 0.05). "na" = parameter not monitored for this station, as per study design.

effluent, although there may be some evidence of a decrease in iron at PR-02 in 2019 (Appendix Figure J.4). There is also evidence of increased pH at PR-02 in 2019 (Appendix Figure J.4). The decrease in iron and increase in pH at PR-02 was likely due to the relocation of treatment solids from the Pronto Settling Pond to the Pronto Holding Pond (upstream of station PR-02) in September 2019, as part of a long-term management plan. A total of 1,077 metric tonnes of solids (an estimated 25% of the total treatment solids; Minnow 2020b) were relocated. As treatment solids contained unreacted lime, a localized effect of increased pH would likely have resulted in a decrease in dissolved iron at PR-02.

7.3.3 Treatment Performance

Water treatment at the Pronto Facility consists of lime addition to neutralize acidity, remove dissolved metals and hydroxides, and promote settling of particulates. Barium chloride addition may also be used to remove radium-226; 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 fluctuated from 2015 to 2019 (i.e., between 0.0032 and 0.0048 g/L), with the total usage generally increasing with the total volume of water treated (Figure 7.3).

Following treatment, effluent quality is monitored at the outlet of the Settling Pond (PR-04) and over the past five years effluent quality has consistently achieved discharge criteria (Figures 7.4 and 7.5; Appendix Table J.5).

7.4 SAMP: Lake Huron Sources

7.4.1 Discharge Quality and Loads

Final discharge from the Pronto facility (at PR-01) was consistently non-lethal to *Daphnia magna* and rainbow trout, with no mortality reported in semi-annual acute toxicity tests (Table 7.4). Similarly, reproduction of *Ceriodaphnia dubia* was not affected by exposure to 100% effluent in any tests conducted over the 2015 to 2019 period (Table 7.4).

Annual mean concentration of uranium was higher than SRWMP benchmarks at PR-01 during 2016 only, whereas all other substances were below (or above, in the case of pH; Figure 7.6). However, effluent quality is not expected to achieve receiving environment standards and effluent would be expected to be sufficiently diluted upon discharge to Lake Huron to concentrations less than the SRWMP benchmarks. In contrast, drainage to Lake Lauzon (at LL-01) met receiving environment criteria for all substances, except iron (Figure 7.6).

Loads from PR-01, the primary discharge location, were substantially greater for all substances except iron, compared to those from LL-01 (Figure 7.6; Appendix Table Q.5). The drainage to

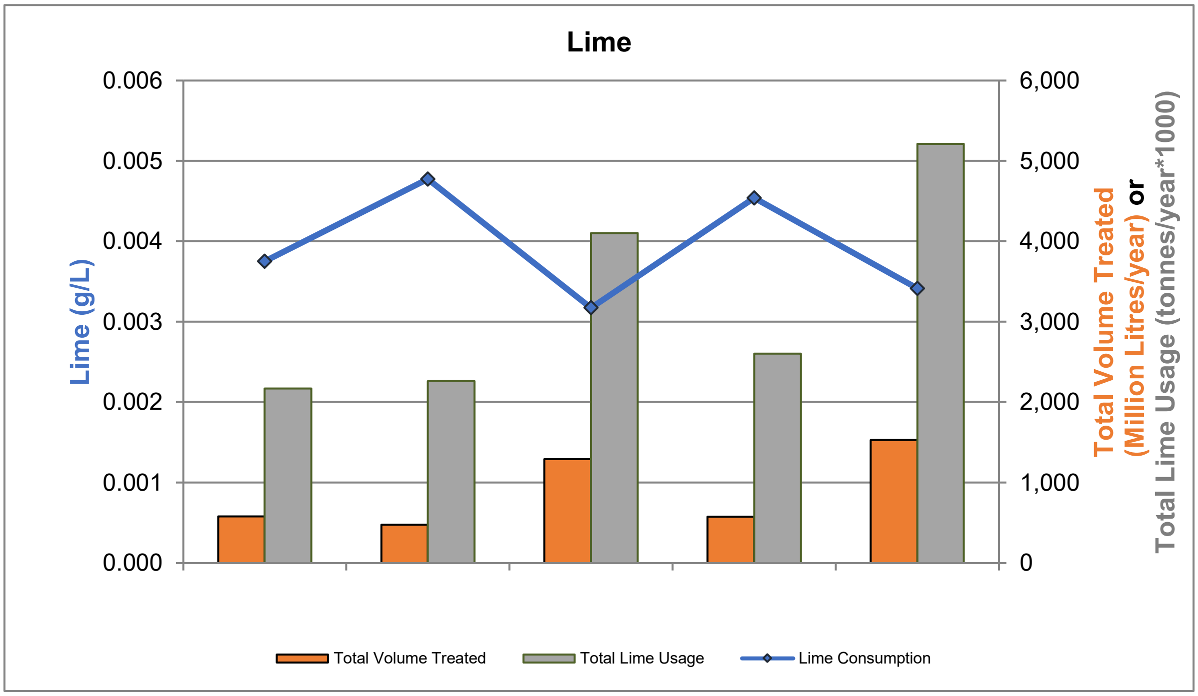
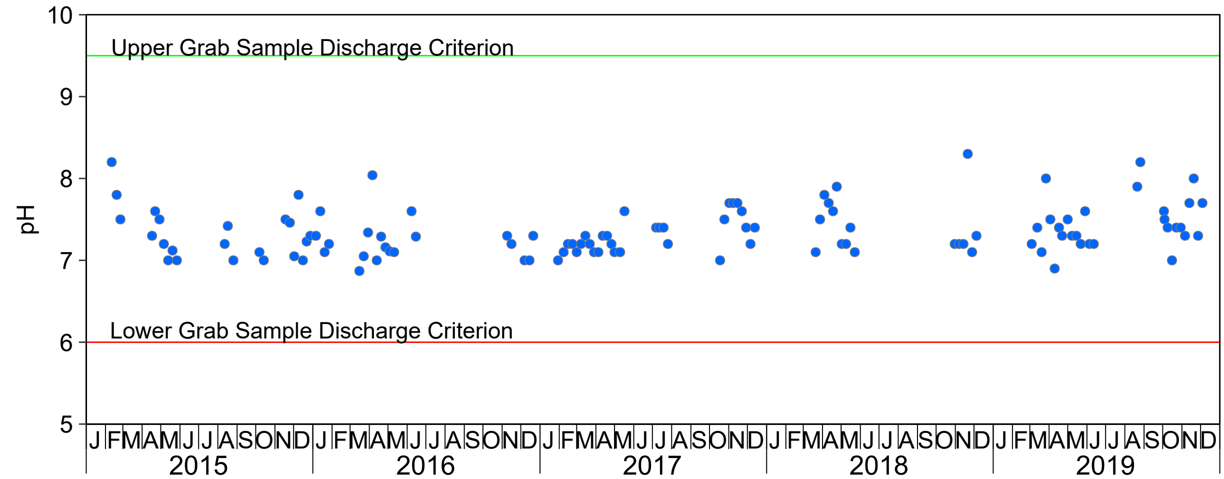


Figure 7.3: Comparison of Total Reagent Consumed Versus Total Volume Treated at Pronto TMA from 2015 to 2019 (lime usage multiplied by 1,000)

Note: See Appendix Table J.3 for raw data (TOMP Station PR-02).



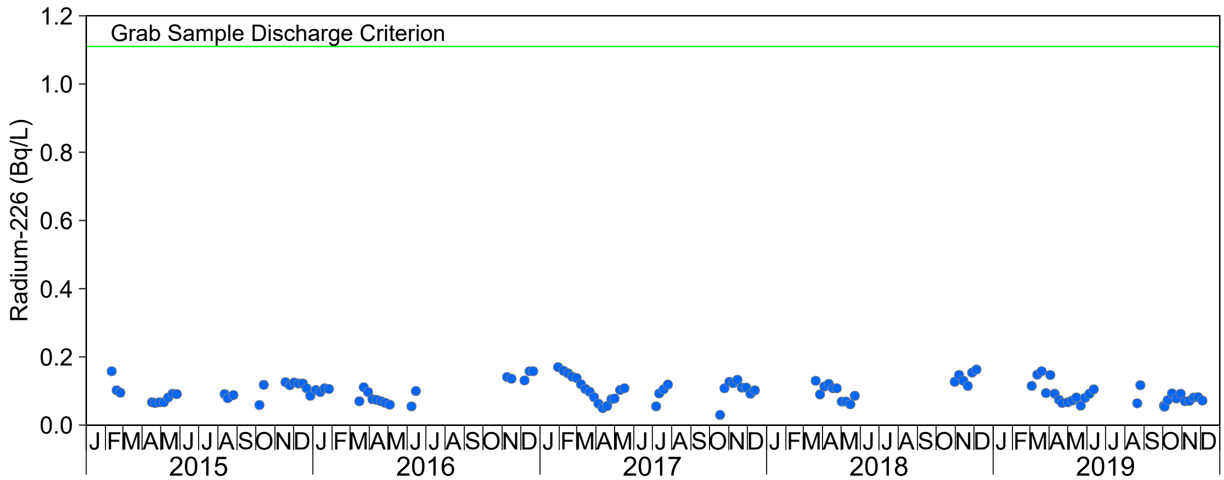


Figure 7.4: Effluent Concentrations Compared to Grab Sample Discharge Criteria at TOMP Station PR-04, Pronto TMA, 2015 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Table J.5 for raw data.

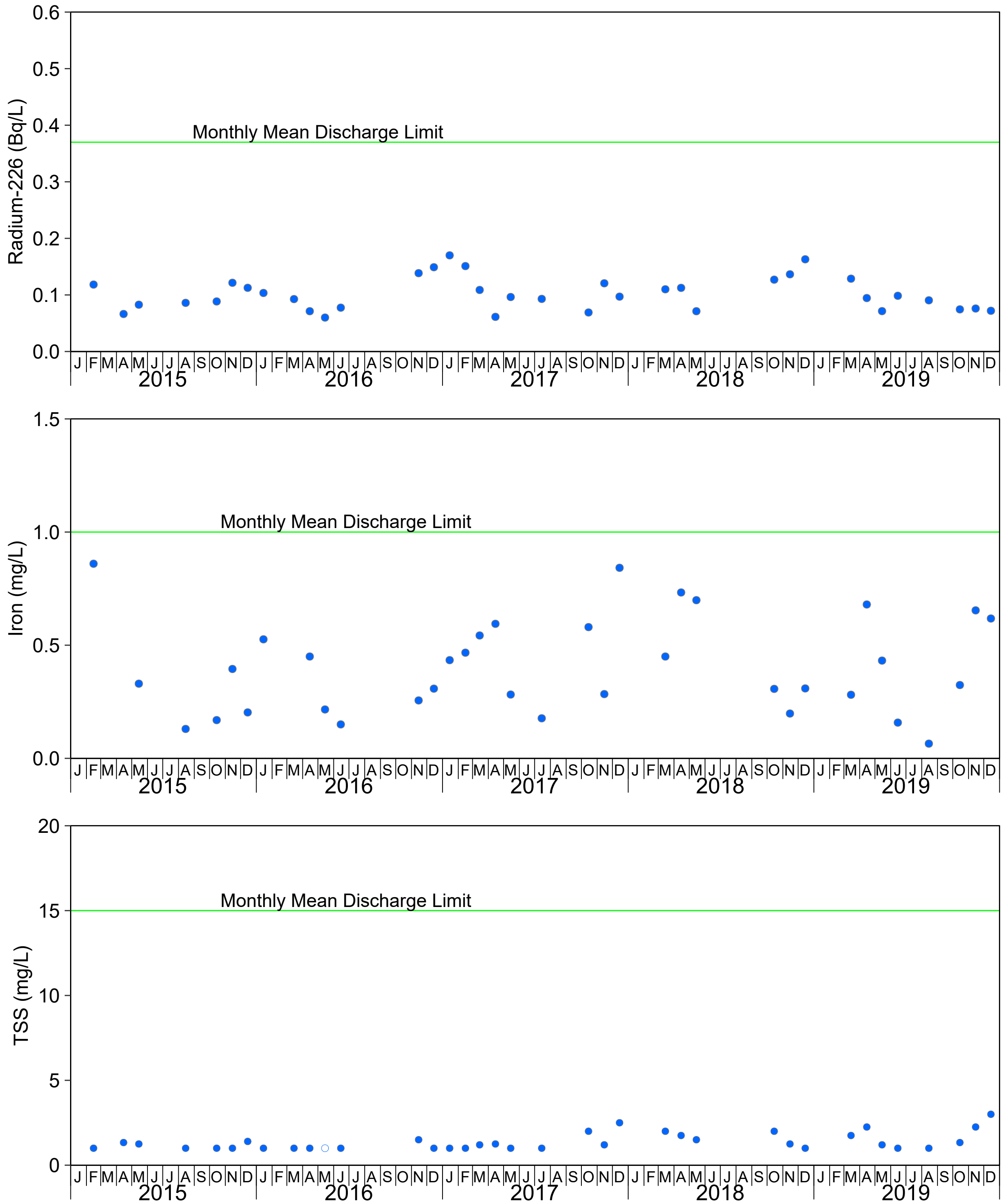


Figure 7.5: Monthly Mean Effluent Concentrations Compared to Monthly Mean Discharge Limits at TOMP Station PR-04, Pronto TMA, 2015 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Table J.5 for raw data.

Table 7.4 Toxicity Test Results for Samples Collected at Pronto TMA SAMP Station PR-01, 2015 to 2019

Date	Sublethal Toxicity (*Ceriodaphnia dubia*) IC25	Acute Toxicity (*Daphnia magna*) % Mortality	Acute Toxicity (Rainbow Trout) % Mortality
13-May-15	100	0	0
14-Oct-15	100	0	0
13-Apr-16	100	0	0
09-Nov-16	100	0	0
01-May-17	100	0	0
25-Oct-17	100	0	0
09-May-18	100	0	0
21-Nov-18	100	0	0
22-Apr-19	100	0	0
16-Oct-19	100	0	0
n	10	10	10
Minimum	100	0	0
Maximum	100	0	0
Mean	100	0	0
SD	-	-	-
Median	100	0	0
10th Percentile	100	0	0
95th Percentile	100	0	0

Note: n = number of samples. SD = standard deviation. "-" = SD not applicable.

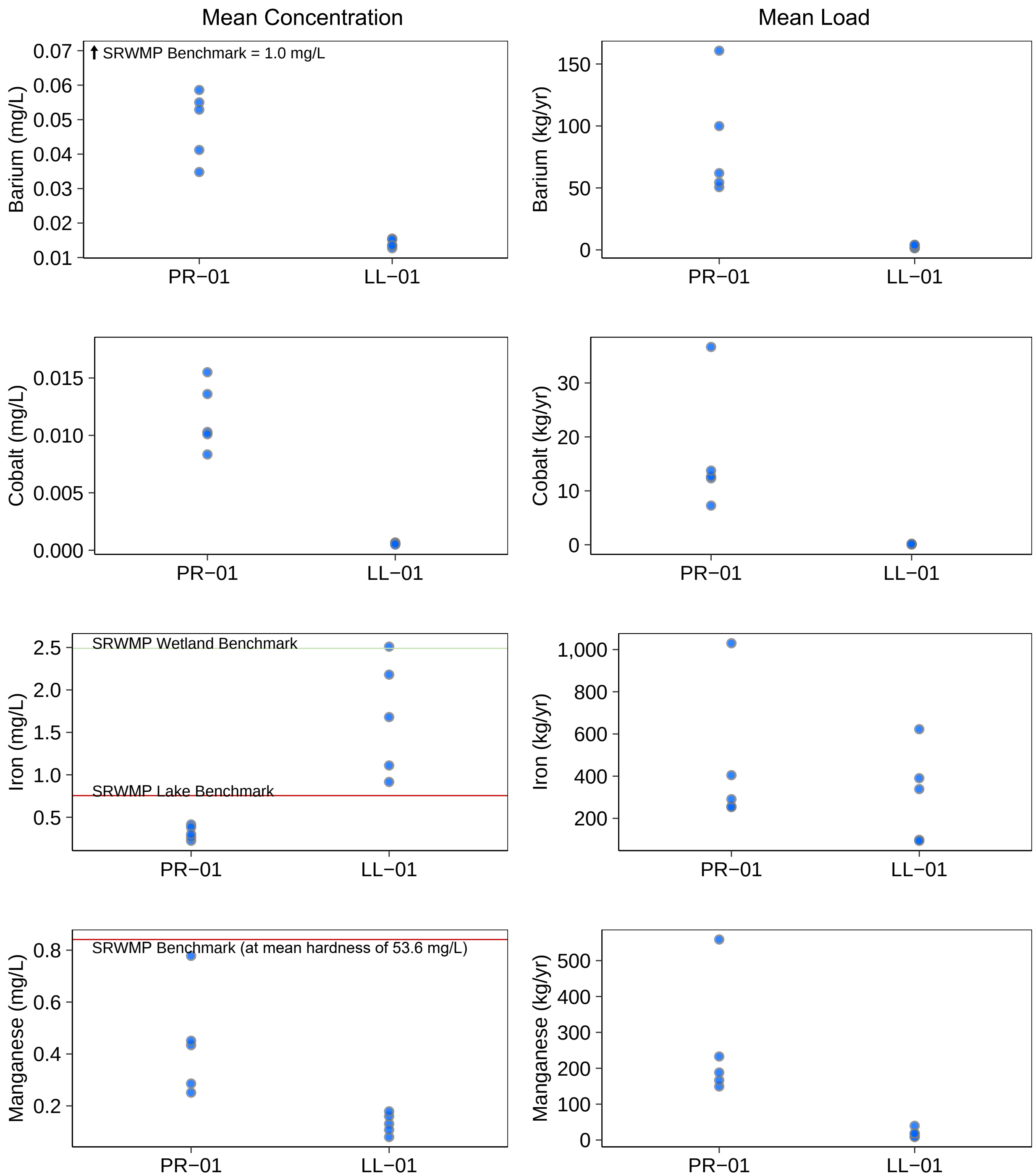


Figure 7.6: Annual Mean Concentrations and Annual Loads at SAMP Monitoring Stations Downstream of Pronto TMA, 2015 to 2019

Notes: SRWMP benchmarks (Table 2.8) apply to the receiving environment and are based on background (reference) concentrations or approved guidelines, provided here for context, but they are not criteria that need to be met for discharge to occur. Values at the LRL (open circles) were replaced with the LRL for calculations. See Appendix Table Q.5 for raw data.

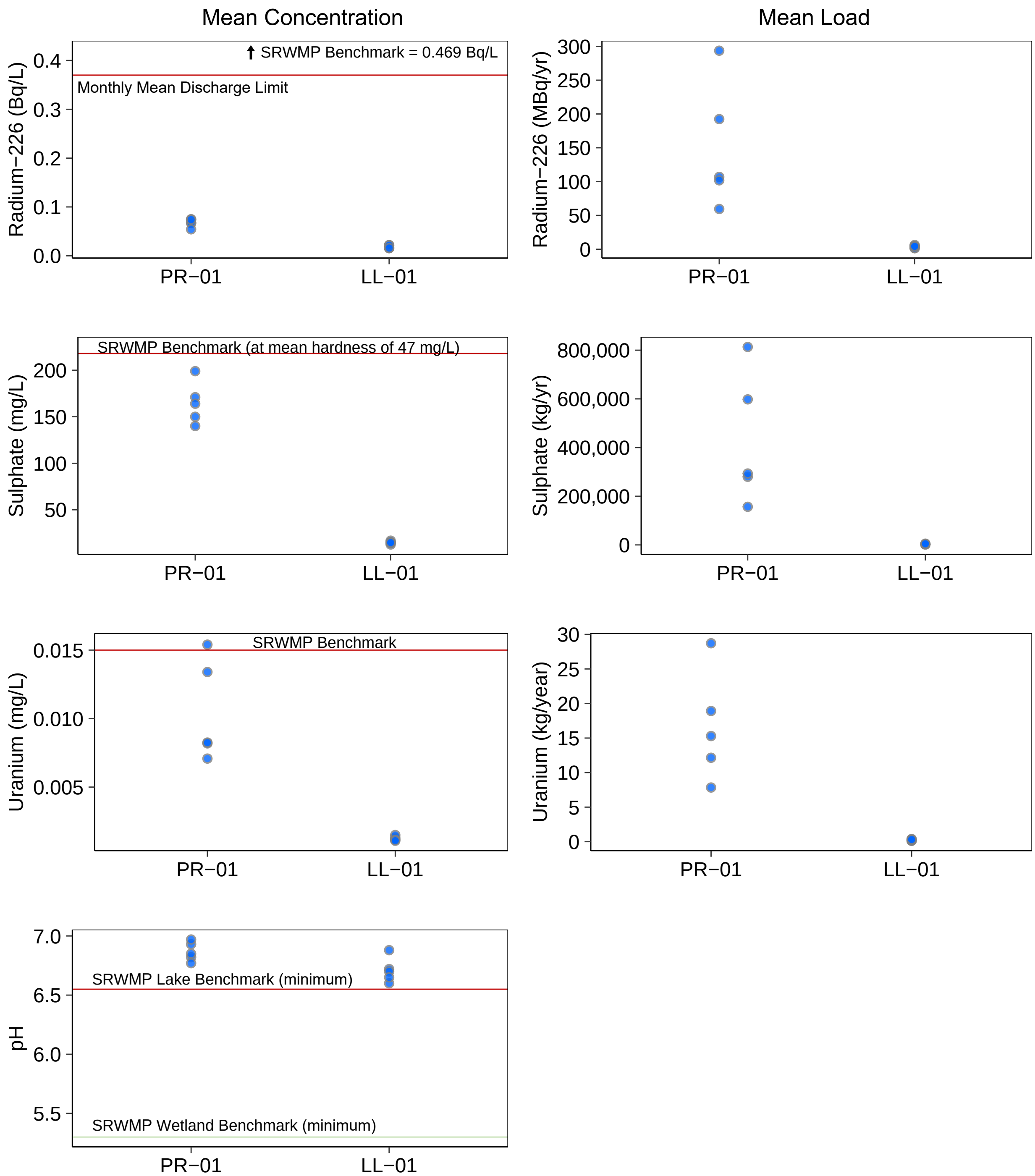


Figure 7.6: Annual Mean Concentrations and Annual Loads at SAMP Monitoring Stations Downstream of Pronto TMA, 2015 to 2019

Notes: SRWMP benchmarks (Table 2.8) apply to the receiving environment and are based on background (reference) concentrations or approved guidelines, provided here for context, but they are not criteria that need to be met for discharge to occur. Values at the LRL (open circles) were replaced with the LRL for calculations. See Appendix Table Q.5 for raw data.

Lake Lauzon was generally responsible for <5% of the loads to the receiving environment, except for iron, where percent contributions were substantially greater (Appendix Figure Q.10). Over the 2015 to 2019 period, loadings associated with all measured parameters have generally been within the range observed in earlier years, except for slightly higher loadings for radium-226 and sulphate in 2017 (Appendix Figure Q.11).

7.4.2 Trends

Concentrations of barium, cobalt, and uranium have been decreasing at station PR-01 since 2003 (Table 7.5). 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 (i.e., below discharge criteria) such that both pH and radium-226 could be treated with lime. Since 2003, there has been a slight increase in the concentration of radium-226 (Table 7.5; Appendix Figure Q.6), although levels remain well below the discharge criterion (0.37 Bq/L) and below the SRWMP benchmark of 0.469 Bq/L. Concentrations of barium, radium-226, sulphate, and uranium decreased at station LL-01, primarily due to a step change that occurred after 2007 associated with the lowering of the Dam E spillway in 2006 (Table 7.5; Appendix Figures Q.1 and Q.6 to Q.8). Unlike other substances, iron concentrations have been increasing at station LL-01, particularly over more recent years (i.e., the highest concentrations observed since 2003 were measured in 2017 and 2018; Table 7.5; Appendix Figure Q.3). A slight decreasing trend in pH was also observed at LL-01, but measurements have remained near neutral (Table 7.5; Appendix Figure Q.3).

7.5 Summary

Surface water and groundwater drainage from the Pronto TMA is captured and managed on-site and monitored through the SAMP and TOMP. Changes at site continue to focus on improvements to water management. Water quality in the Holding Pond, which captures most of the surface and groundwater discharges, has improved over time with significant decreasing trends in acidity, cobalt, sulphate, and uranium, and increasing pH. Effluent quality consistently achieved discharge criteria and was not toxic. Overall, water quality associated with the Pronto Facility has been improving over time, with many of the positive changes associated with management actions that occurred prior to the 2015 to 2019 period.

Table 7.5: Seasonal Kendall Trend Analysis for Pronto TMA SAMP Water Quality Monitoring Stations , Discharging to the Near-shore Lake Huron, 2003 to 2019

Station	Pronto TMA	
	LL-01	PR-01
	Drainage	Primary
Barium (mg/L)	-4.20	-2.10
Cobalt (mg/L)	nt	-2.50
Iron (mg/L)	8.80	NS
Manganese (mg/L)	NS	NS
pH	-0.700	NS
Radium (Bq/L)	-9.20	2.50
Sulphate (mg/L)	-11.0	NS
Uranium (mg/L)	-8.30	-2.90

[Green] Significant decreasing temporal trend (Seasonal Kendall test for monotonic trend at α = 0.05). Value reported is the Sen's slope reported as a percentage of the median concentration or value.

[Blue] Significant increasing temporal trend (Seasonal Kendall test for monotonic trend at α = 0.05). Value reported is the Sen's slope reported as a percentage of the median concentration or value.

Note: "NS" = no significant temporal trend (Seasonal Kendall test for monotonic trend at α = 0.05). "nt" = Parameter not tested for this station because >50% of values <LRL . See Appendix Tables Q.2 and Q.3 for raw data and Appendix Figures Q.1 to Q.8 for time series plots of the trends.

8 SRWMP

8.1 Sediment Quality

Physical characteristics of sediment samples collected from mine-exposed and reference lakes in September 2019 were generally very similar, with silt being the dominant size class (i.e., mean silt content in mine-exposed lakes ranged from 51 to 60%, compared to 50 to 72% in reference lakes; Figure 8.1; Appendix Tables T.3 and T.4). Clay was the next most dominant size class, followed by sand (Figure 8.1). Except for two of five sediment samples from Ten Mile Lake, where a very small proportion of gravel was noted (i.e., <1%), gravel was not found in any other samples (Appendix Tables T.3 and T.4). The TOC from a mean of 7.6 to 9.1% in mine-exposed lakes compared to 8.2 to 11% in reference lakes, and tended to be lower in samples containing higher proportions of sand (Figure 8.1; Appendix Tables T.3 and T.4).

Mean concentrations of metals and radium-226 in most mine-exposed lakes exceeded the upper limit of background or LEL benchmarks in 2019 (i.e., barium in McCabe and Quirke lakes, cobalt, nickel, radium-226 in all lakes, manganese in McCabe and Nordic lakes, and uranium in all lakes except May Lake; Figure 8.2; Appendix Table T.4). In no instance did sediment concentrations of nickel, radium-226, or uranium exceed the SEL[23] (Figure 8.2; Appendix Table T.4). Iron was the only metal for which mean concentrations in sediments in 2019 were below the SRWMP benchmark in all mine-exposed lakes (Figure 8.2; Appendix Table T.4). In addition to the Thompson et al (2005) benchmarks, lake-specific dose-based radium-226 benchmarks were used for data screening. The dose-based benchmarks were calculated for each mine-exposed lake as the concentration of radium-226 in sediment that would correspond to a calculated dose equal to the applicable dose benchmark. Dose benchmarks used in the derivation of lake-specific benchmarks were 10 mGy/d for aquatic biota and 2.4 mGy/d for riparian wildlife (UNSCEAR 2008), and 1 mSv/y for the generic human (ICRP 2007). All radium-226 concentrations in sediment from mine-exposed lakes (historically, and in 2019) were lower than dose-based benchmarks (Figure 8.2; Appendix Table T.4).

Temporally, there have been few significant changes in sediment chemistry over the past 20 years (i.e., 1999 to 2019; Figure 8.2; Tables 8.1 and 8.2), based on sediment quality measured from the top 1-cm. This lack of change in sediment chemistry is consistent with slow deposition rate for these receiving lakes (Minnow 2013). Deposition rate in McCabe lake has been estimated as 22 years to accumulate 1 cm of sediment at the SRWMP benthic stations (Minnow 2013).

[23] Barium and cobalt do not have applicable PSQG or Thompson et al. (2005) LEL or SEL values. The upper limit of background concentrations for iron and manganese were higher than the PSQG LEL and SEL. See Appendix Table T.2 for details.

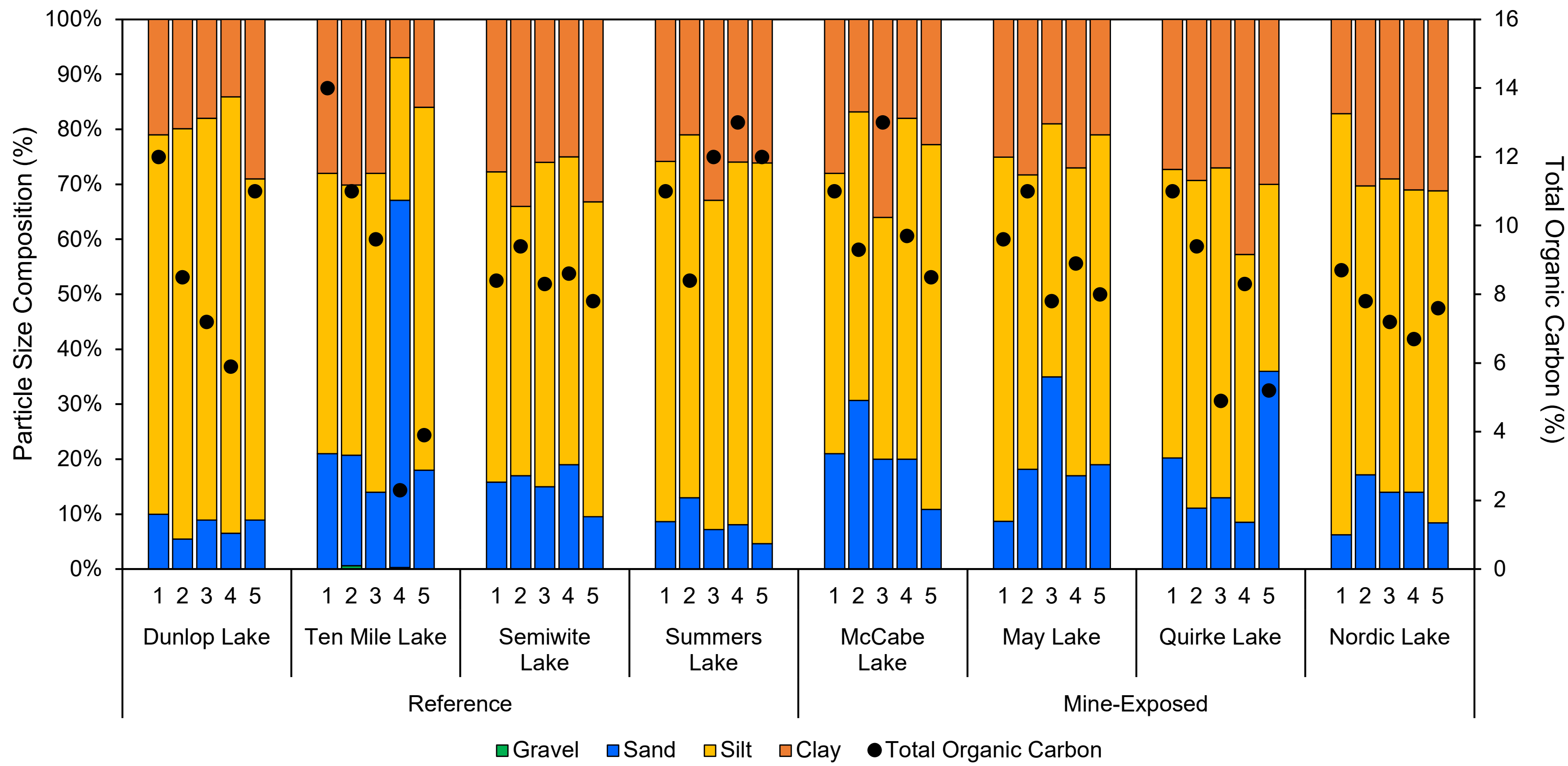


Figure 8.1: Sediment Particle Size Distribution and Total Organic Carbon Content, SRWMP, September 2019

Notes: Values below the laboratory detection limit were considered as zero.

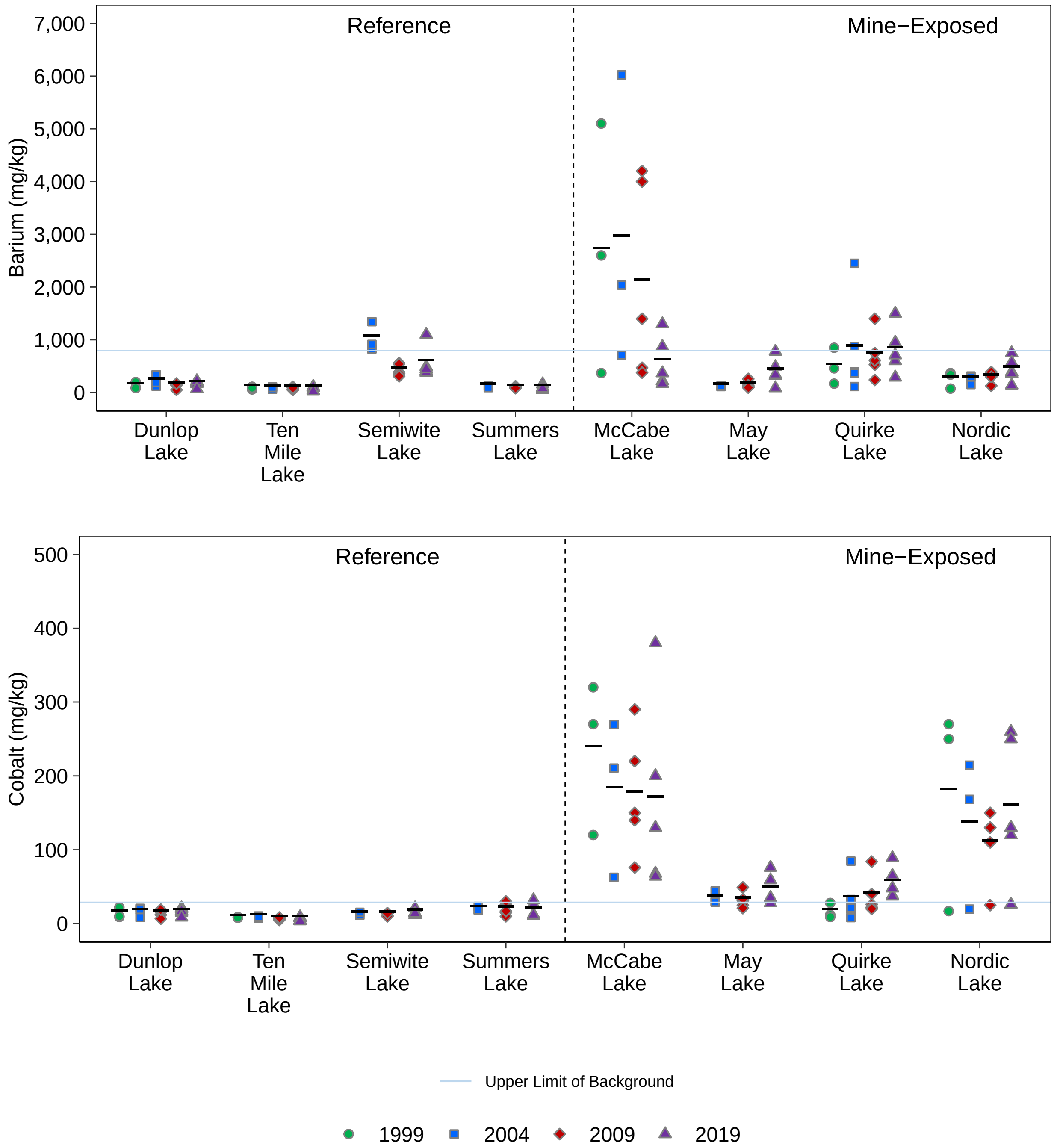
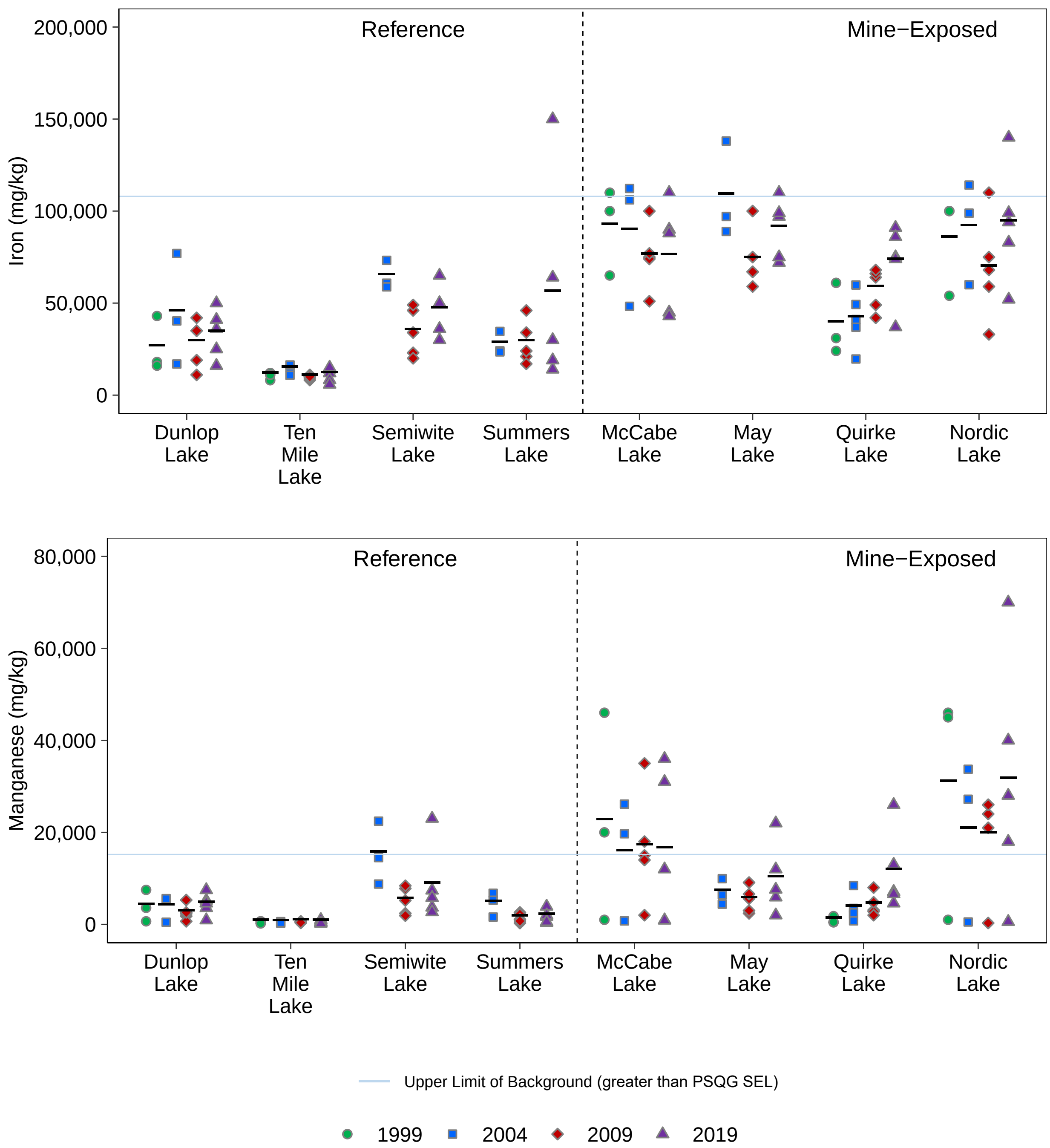


Figure 8.2: Mean Concentrations of Metals in Lake Sediment for 1999 (Cycle 1, n = 3), 2004 (Cycle 2, n = 3 or 5), 2009 (Cycle 3, n = 5), and 2019 (Cycle 5, n = 5), SRWMP

Notes: See Table 2.11 for benchmarks details. See Appendix Tables T.3 and T.4 for raw data. Black horizontal bars indicate mean values. All samples were collected in September or October.



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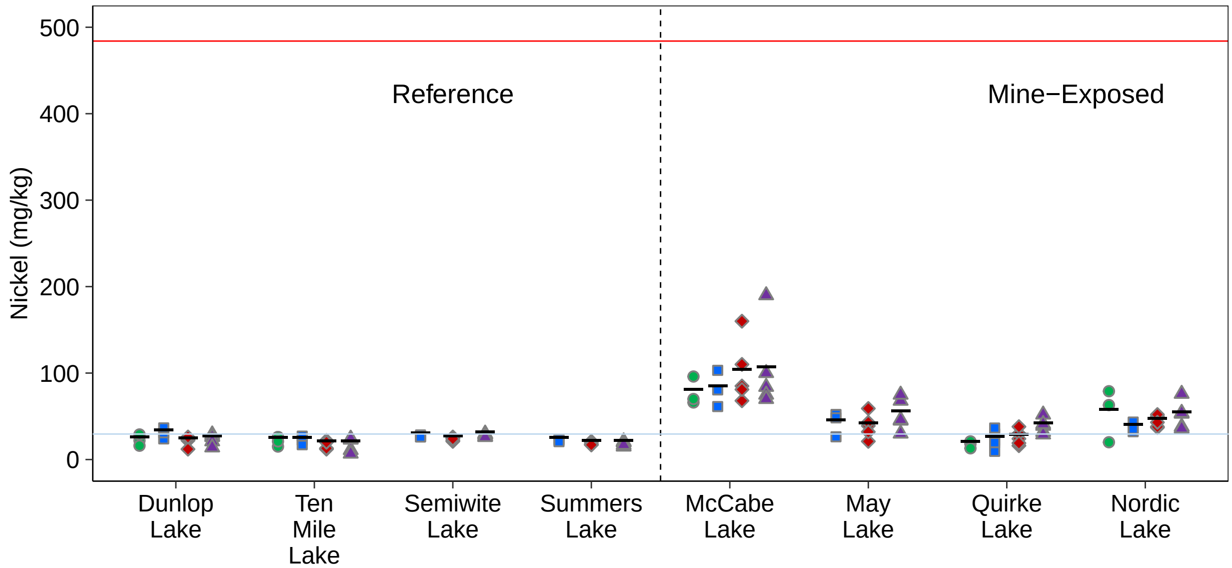

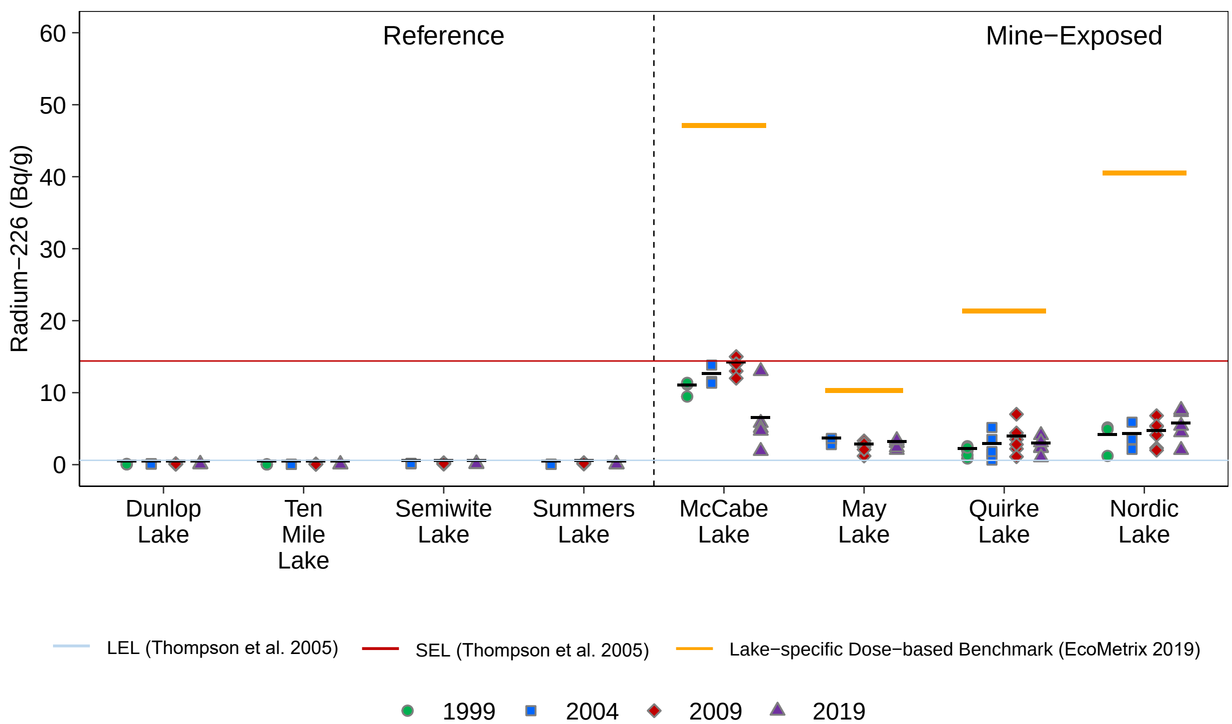

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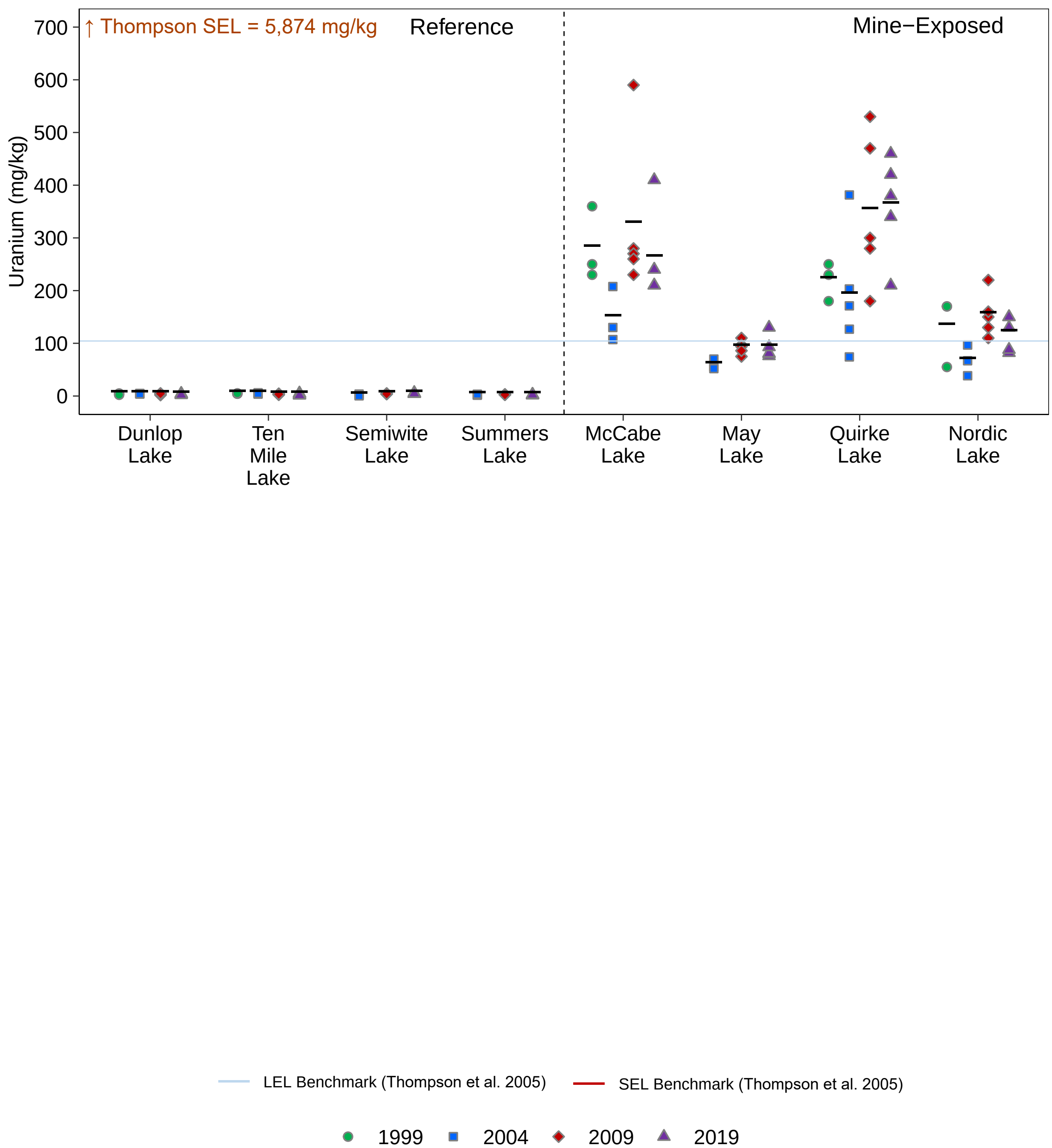

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Notes: See Table 2.11 for benchmarks details. See Appendix Tables T.3 and T.4 for raw data. Black horizontal bars indicate mean values. All samples were collected in September or October.

Table 8.1: Temporal Sediment Chemistry Comparisons at Mine-Exposed Lakes, SRWMP, 1999 to 2019

Lake	Analyte	Units	Sample Size				Measure of Central Tendency				Test	Summary Statistic	Area	Pairwise Comparisons Between Years				MOD Temporal Comparisons to 2019		
			1999	2004	2009	2019	1999	2004	2009	2019			P-value	1999	2004	2009	2019	1999	2004	2009
May Lake	Barium	mg/kg dw	-	3	5	5	-	122	133	325	ANOVA	Geometric Mean	0.054	-	A	A	A	-	NS	NS
	Cobalt	mg/kg dw	-	3	5	5	-	34.6	31.8	46.4	ANOVA	Mean	0.320	-	A	A	A	-	NS	NS
	Iron	mg/kg dw	-	3	5	5	-	108,000	73,600	90,600	ANOVA	Mean	0.080	-	A	A	A	-	NS	NS
	Manganese	mg/kg dw	-	3	5	5	-	6,930	5,340	9,900	ANOVA	Mean	0.420	-	A	A	A	-	NS	NS
	Nickel	mg/kg dw	-	3	5	5	-	42.2	38.8	52.8	ANOVA	Mean	0.393	-	A	A	A	-	NS	NS
	Radium-226	Bq/g dw	-	3	5	5	-	3.28	2.40	2.79	ANOVA	Mean	0.227	-	A	A	A	-	NS	NS
	Uranium	mg/kg dw	-	3	5	5	-	59.1	92.4	92.0	ANOVA	Mean	0.041	-	A	A	A	-	NS	NS
McCabe Lake	Barium	mg/kg dw	3	3	5	5	2,690	2,920	2,090	586	ANOVA	Mean	0.310	A	A	A	A	NS	NS	NS
	Cobalt	mg/kg dw	3	3	5	5	237	181	175	168	ANOVA	Mean	0.836	A	A	A	A	NS	NS	NS
	Iron	mg/kg dw	3	3	5	5	91,667	88,900	75,400	75,200	ANOVA	Mean	0.750	A	A	A	A	NS	NS	NS
	Manganese	mg/kg dw	3	3	5	5	22,300	15,500	16,800	16,200	ANOVA	Mean	0.945	A	A	A	A	NS	NS	NS
	Nickel	mg/kg dw	3	3	5	5	76.3	79.8	96.2	96.5	ANOVA	Geometric Mean	0.676	A	A	A	A	NS	NS	NS
	Radium-226	Bq/g dw	3	3	5	5	11.1	11.5	14.0	5.10	K-W	Median	0.020	B	AB	A	B	NS	NS	-63.6
	Uranium	mg/kg dw	3	3	5	5	250	130	270	240	K-W	Median	0.041	A	B	A	AB	NS	NS	NS
Nordic Lake	Barium	mg/kg dw	3	3	5	5	262	255	294	442	ANOVA	Mean	0.333	A	A	A	A	NS	NS	NS
	Cobalt	mg/kg dw	3	3	5	5	179	134	109	157	ANOVA	Mean	0.754	A	A	A	A	NS	NS	NS
	Iron	mg/kg dw	3	3	5	5	84,700	91,000	69,000	93,600	ANOVA	Mean	0.578	A	A	A	A	NS	NS	NS
	Manganese	mg/kg dw	3	3	5	5	30,700	20,500	19,500	31,300	ANOVA	Mean	0.758	A	A	A	A	NS	NS	NS
	Nickel	mg/kg dw	3	3	5	5	54.0	37.0	44.0	51.4	ANOVA	Mean	0.542	A	A	A	A	NS	NS	NS
	Radium-226	Bq/g dw	3	3	5	5	3.76	3.84	4.78	5.37	ANOVA	Mean	0.649	A	A	A	A	NS	NS	NS
	Uranium	mg/kg dw	3	3	5	5	132	67.4	154	120	ANOVA	Mean	0.098	A	A	A	A	NS	NS	NS
Quirke Lake	Barium	mg/kg dw	3	5	5	5	405	515	606	707	ANOVA	Geometric Mean	0.812	A	A	A	A	NS	NS	NS
	Cobalt	mg/kg dw	3	5	5	5	14.5	24.8	32.9	52.3	ANOVA	Geometric Mean	0.076	A	A	A	A	NS	NS	NS
	Iron	mg/kg dw	3	5	5	5	38,700	41,300	57,800	72,600	ANOVA	Mean	0.033	AB	B	AB	A	NS	75.6	NS
	Manganese	mg/kg dw	3	5	5	5	739	2,630	3,670	9,390	ANOVA	Geometric Mean	0.002	B	AB	A	A	1,170	NS	NS
	Nickel	mg/kg dw	3	5	5	5	17.3	23.3	25.4	38.6	ANOVA	Mean	0.022	B	AB	AB	A	123	NS	NS
	Radium-226	Bq/g dw	3	5	5	5	1.78	2.52	3.64	2.58	ANOVA	Mean	0.497	A	A	A	A	NS	NS	NS
	Uranium	mg/kg dw	3	5	5	5	220	191	352	362	ANOVA	Mean	0.075	A	A	A	A	NS	NS	NS

P-value < 0.05.

Analyte concentration in 2019 was significantly greater than comparison year.

Analyte concentration in 2019 was significantly less than comparison year.

Notes: "-" indicates no data available, as lake was not sampled that year. NS = no significant temporal trend. Comparisons were made using a T-Test unless assumption of normality was violated or there were values at the laboratory reporting limit (LRL) forcing the use of a Mann-Whitney U test (M-W). Magnitude of Difference (MOD) was calculated as $(MCT_{2019} - MCT_{yeari})/MCT_{yeari} *100$.

Table 8.2: Temporal Sediment Chemistry Comparisons at Reference Lakes, SRWMP, 1999 to 2019

Lake	Analyte	Units	Sample Size				Measure of Central Tendency				Test	Summary Statistic	Area	Pairwise Comparisons Between Years				MOD Temporal Comparisons to 2019		
			1999	2004	2009	2019	1999	2004	2009	2019			P-value	1999	2004	2009	2019	1999	2004	2009
Dunlop Lake	Barium	mg/kg dw	3	3	5	5	128	218	136	172	ANOVA	Mean	0.359	A	A	A	A	NS	NS	NS
	Cobalt	mg/kg dw	3	3	5	5	13.7	16.2	14.4	16.3	ANOVA	Mean	0.894	A	A	A	A	NS	NS	NS
	Iron	mg/kg dw	3	3	5	5	25,700	44,700	28,400	33,600	ANOVA	Mean	0.547	A	A	A	A	NS	NS	NS
	Manganese	mg/kg dw	3	3	5	5	3,920	3,750	2,530	4,370	ANOVA	Mean	0.700	A	A	A	A	NS	NS	NS
	Nickel	mg/kg dw	3	3	5	5	22.3	30.5	21.4	23.4	ANOVA	Mean	0.247	A	A	A	A	NS	NS	NS
	Radium-226	Bq/g dw	3	3	5	5	0.0642	0.0964	0.0880	0.0778	ANOVA	Mean	0.649	A	A	A	A	NS	NS	NS
	Uranium	mg/kg dw	3	3	5	5	3.60	4.20	3.82	3.46	ANOVA	Mean	0.808	A	A	A	A	NS	NS	NS
Ten Mile Lake	Barium	mg/kg dw	4	3	5	5	92.5	90.3	81.6	76.2	ANOVA	Mean	0.846	A	A	A	A	NS	NS	NS
	Cobalt	mg/kg dw	4	3	5	5	8.25	9.16	6.86	6.70	ANOVA	Mean	0.177	A	A	A	A	NS	NS	NS
	Iron	mg/kg dw	4	3	5	5	10,800	14,000	9,700	11,000	ANOVA	Mean	0.220	A	A	A	A	NS	NS	NS
	Manganese	mg/kg dw	4	3	5	5	435	410	518	492	ANOVA	Mean	0.909	A	A	A	A	NS	NS	NS
	Nickel	mg/kg dw	4	3	5	5	21.5	21.8	17.1	15.8	ANOVA	Geometric Mean	0.560	A	A	A	A	NS	NS	NS
	Radium-226	Bq/g dw	3	3	5	5	0.0376	0.0446	0.0640	0.0460	ANOVA	Mean	0.225	A	A	A	A	NS	NS	NS
	Uranium	mg/kg dw	3	3	5	5	4.67	4.83	3.32	3.22	ANOVA	Mean	0.198	A	A	A	A	NS	NS	NS
Semiwite Lake	Barium	mg/kg dw	-	3	5	5	-	914	390	450	K-W	Median	0.068	-	A	A	A	-	NS	NS
	Cobalt	mg/kg dw	-	3	5	5	-	12.9	12.6	15.4	ANOVA	Mean	0.245	-	A	A	A	-	NS	NS
	Iron	mg/kg dw	-	3	5	5	-	64,300	34,400	46,200	ANOVA	Mean	0.026	-	A	B	AB	-	NS	NS
	Manganese	mg/kg dw	-	3	5	5	-	15,200	5,140	8,520	ANOVA	Mean	0.144	-	A	A	A	-	NS	NS
	Nickel	mg/kg dw	-	3	5	5	-	26.9	23.6	28.2	ANOVA	Mean	0.006	-	AB	B	A	-	NS	19.5
	Radium-226	Bq/g dw	-	3	5	5	-	0.146	0.154	0.119	ANOVA	Mean	0.630	-	A	A	A	-	NS	NS
	Uranium	mg/kg dw	-	3	5	5	-	1.87	4.16	4.76	ANOVA	Mean	0.004	-	B	A	A	-	155	NS
Summers Lake	Barium	mg/kg dw	-	3	5	5	-	120	98.6	96.8	ANOVA	Mean	0.516	-	A	A	A	-	NS	NS
	Cobalt	mg/kg dw	-	3	5	5	-	20.1	19.6	18.6	ANOVA	Mean	0.963	-	A	A	A	-	NS	NS
	Iron	mg/kg dw	-	3	5	5	-	27,000	26,600	37,700	ANOVA	Geometric Mean	0.672	-	A	A	A	-	NS	NS
	Manganese	mg/kg dw	-	3	5	5	-	4,540	1,380	1,710	ANOVA	Mean	0.052	-	A	A	A	-	NS	NS
	Nickel	mg/kg dw	-	3	5	5	-	22.2	18.6	18.6	ANOVA	Mean	0.071	-	A	A	A	-	NS	NS
	Radium-226	Bq/g dw	-	3	5	5	-	0.0534	0.146	0.0570	ANOVA	Geometric Mean	0.005	-	B	A	B	-	NS	-60.9
	Uranium	mg/kg dw	-	3	5	5	-	2.33	2.70	2.30	ANOVA	Mean	0.509	-	A	A	A	-	NS	NS

(grey) P-value < 0.05.
(blue) Analyte concentration in 2019 was significantly greater than comparison year.
(green) Analyte concentration in 2019 was significantly less than comparison year.

Notes: "-" indicates no data available, as lake was not sampled that year. NS = no significant temporal trend. Comparisons were made using a T-Test unless assumption of normality was violated or there were values at the laboratory reporting limit (LRL) forcing the use of a Mann-Whitney U test (M-W). Magnitude of Difference (MOD) was calculated as $(MCT_{2019} - MCT_{yeari})/MCT_{yeari}$ *100.

In Quirke Lake, the deep-basin deposition rate was estimated at 33 years to accumulate 1 cm of sediment (considered conservative relative to SRWMP benthic stations; Minnow 2013). The Nordic lake deposition rate at the benthic stations indicated that it would take between 10 and 18 years to accumulate 1 cm of sediment (Minnow 2013). Since it has been 20 years since sediment quality was first measured in these three lakes, it is unsurprising that few changes in sediment chemistry have been observed. Sediment deposition rates have not been estimated for May Lake; however, this lake receives water from upstream McCabe Lake and, although May Lake is larger than McCabe Lake (Table 1.3) it has a similar retention time, therefore May Lake deposition rates are likely a similar magnitude as McCabe Lake. In McCabe Lake, the only notable change was a significant decrease in radium-226 concentrations in 2019 relative to 2009 (Table 8.1). No significant changes in sediment chemistry were observed for Nordic Lake or May Lake (Table 8.1). In Quirke Lake, concentrations of iron, manganese, and nickel were significantly higher in 2019 than in 1999 (manganese, nickel) and 2004 (iron), with mean iron and nickel concentrations in 2019 being nearly double those observed in 1999, and mean manganese concentrations being more than ten times greater (Table 8.1). The increasing trends in sediment metal concentrations (iron, cobalt, and nickel) were likely due to the increased concentrations of TOC in sediment over the same time period (Appendix Figure T.10), this was particularly the case for iron. Manganese, nickel, and to a lesser extent iron, appeared to also be influenced by the proportion of fine (clay size; <4um) particles. The proportion of clay particles did not increase from 2004 to 2009 but did increase in 2019 (Appendix Figure T.10); this temporal pattern was reflected in the temporal changes in concentrations of manganese, nickel, and cobalt in sediment (Figure 8.2). Both organic matter and fine particulate have been shown to accumulate metals in sediment, including iron, manganese, nickel, and cobalt (Horowitz 1985). Nonetheless, mean iron and manganese concentrations remain less than the upper limit of background concentrations, and nickel concentrations are slightly above the upper limit of background concentrations, but well below the SEL (Figure 8.1). Although a few significant changes in sediment chemistry were noted in two of the four reference lakes (i.e., Semiwite and Summers lakes; both of which were not sampled in 1999), none of the observed differences were indicative of a general increasing or decreasing trend over time (Table 8.2).

8.2 Benthic Invertebrates

8.2.1 Overall Community Structure

Both mine-exposed and reference BIC in the SRW were predominantly composed of organisms belonging to the Family Chironomidae (Appendix Table T.5). Other organisms that contributed significantly to overall densities among the study lakes included Nematoda, Ostracoda, Harpacticoida (particularly in Dunlop and Ten Mile lakes), and *Pisidium* clams (Appendix Table T.5).

In 2019, mean benthic organism density was highest in McCabe Lake and lowest in Quirke Lake, bracketing the mean densities observed in the reference lakes (Figure 8.3; Appendix Tables T.6 and T.7). Mean taxa richness (LPL) was highest in Ten Mile and Dunlop lakes and lowest in Quirke Lake (Figure 8.3; Appendix Tables T.6 and T.7), though richness in Quirke lake was in the range of previous years (Figure 8.4). Among the three main sub-families of Chironomidae (i.e., Chironominae, Orthocladiinae, and Tanypodinae; sub-family Diamesinae was excluded from further analyses due to limited presence among all BIC samples; Appendix Table T.5), Chironominae were generally most prevalent, followed by Orthocladiinae and Tanypodinae (Figure 8.3). The main exception was Quirke Lake, which had a higher proportion of Orthocladiinae than Chironominae (Figure 8.3).

Variability in community structure among study lakes was further assessed using CA. The first three axes of the CA explained 62% of the variability in benthic community structure in 2019, with the first axis (CA1) showing some separation between mine-exposed and reference communities (Figure 8.5; Appendix Tables T.8 and T.9). The separation along CA1 was primarily due to the prevalence of more Harpacticoida and *Sergentia* sp., and fewer (if any) *Tanytarsus* sp., *Heterotrissocladius* sp., and *Micropsectra* sp. in reference lakes (especially Summers Lake) compared to mine-exposed lakes (Figure 8.5; Appendix Table T.8). Separation along CA2 was primarily based on presence/absence of *Stictochironomus* sp. and *Chironomus* sp., with the greatest difference occurring between the communities in May Lake (*Stictochironomus* sp. present and *Chironomus* sp. absent) and Quirke Lake (*Stictochironomus* sp. absent and *Chironomus* sp. present) (Figure 8.5; Appendix Tables T.8 and T.9). Similar to CA2, separation along CA3 was primarily due to differences among mine-exposed lakes, with BIC samples from McCabe Lake having substantially greater numbers of Nematoda (in particular) and fewer *Sergentia* sp. compared to samples from Nordic and May lakes (Figure 8.6; Appendix Tables T.8 and T.9).

8.2.2 Statistical Comparisons

The BIC from each of the mine-exposed lakes were compared to those of the reference lakes for each of the endpoints discussed above (i.e., density, LPL richness, % Chironominae, % Orthocladiinae, % Tanypodinae, CA1, CA2, and CA3). Except for CA, each BIC endpoint was simultaneously compared to reference over time, both including and excluding Rochester Lake. Rochester Lake was removed from the study design for Cycle 5 (2019) because it was not considered a suitable habitat match for the mine-exposed lakes. Statistical comparisons of CA results for mine-exposed lakes relative to reference focused on 2019 only, whereas temporal CA

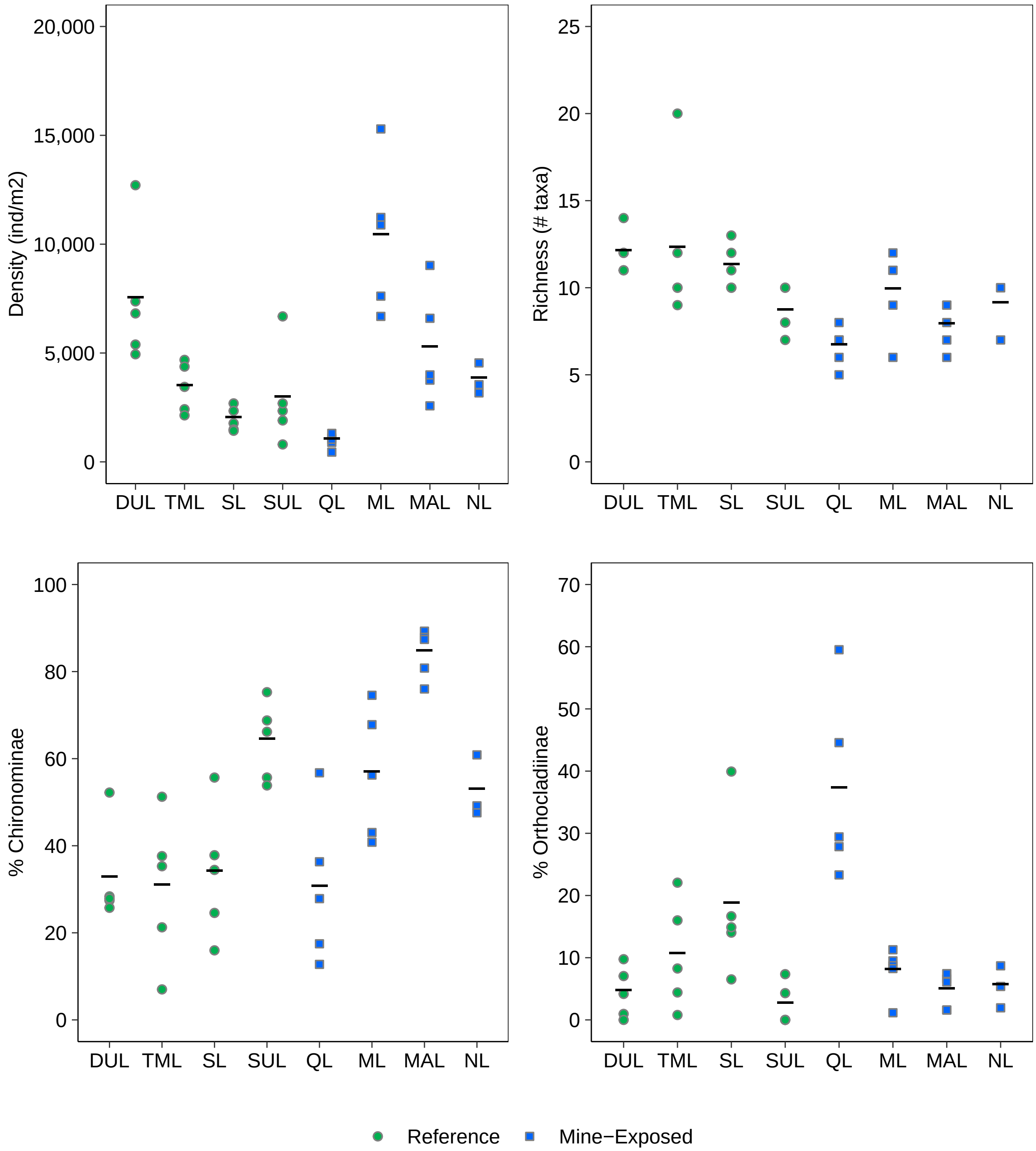

Figure 8.3: Benthic Invertebrate Community Endpoints, SRWMP, September 2019

Notes: Black horizontal bars indicate mean values.
Mine−exposed areas: Quirke Lake (QL), McCabe Lake (ML), May Lake (MAL), Nordic Lake (NL).
Reference areas: Dunlop Lake (DUL), Ten Mile Lake (TML), Semiwite Lake (SL), Summers Lake (SUL).

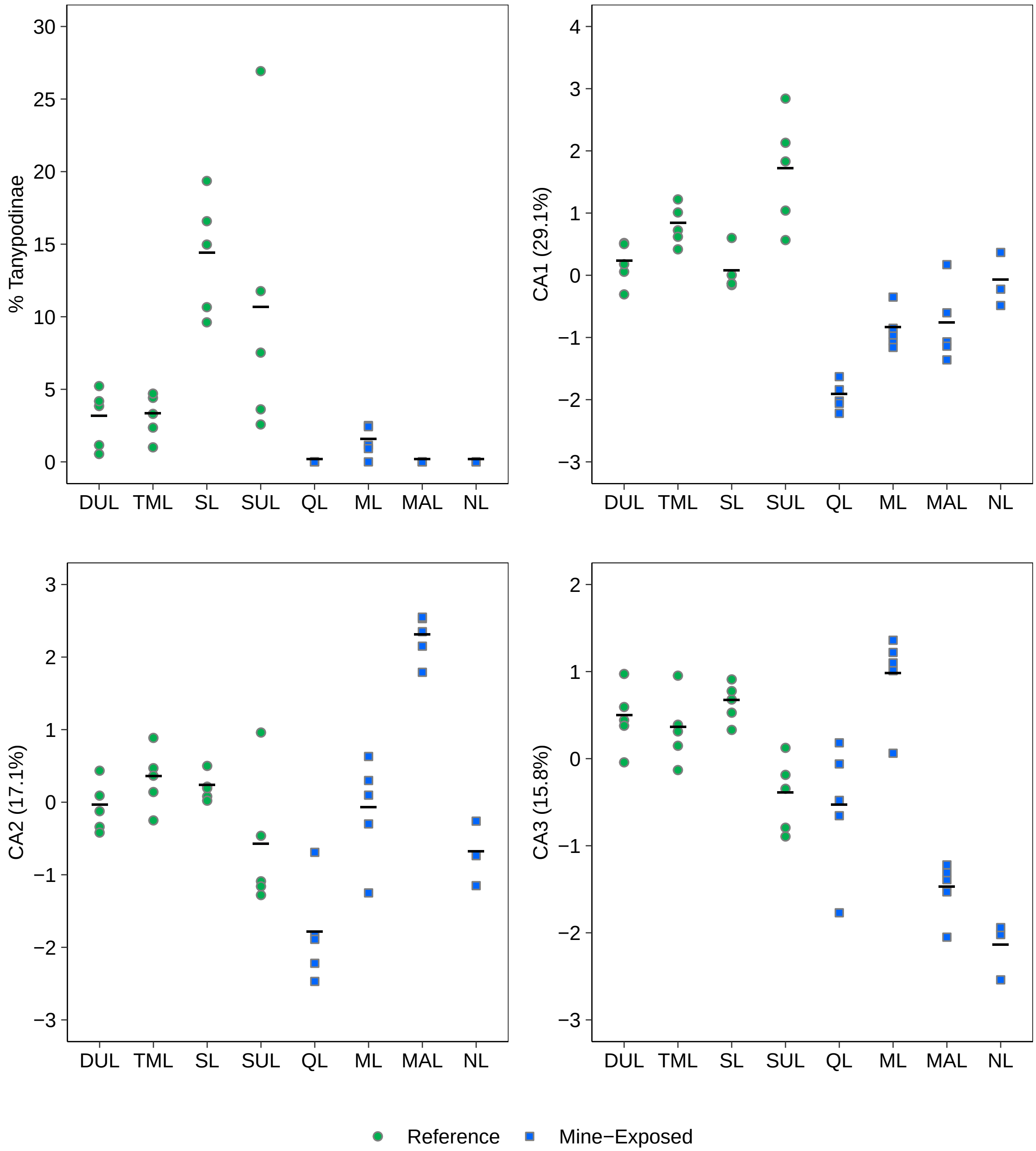

Figure 8.3: Benthic Invertebrate Community Endpoints, SRWMP, September 2019

Notes: Black horizontal bars indicate mean values.
Mine−exposed areas: Quirke Lake (QL), McCabe Lake (ML), May Lake (MAL), Nordic Lake (NL).
Reference areas: Dunlop Lake (DUL), Ten Mile Lake (TML), Semiwite Lake (SL), Summers Lake (SUL).

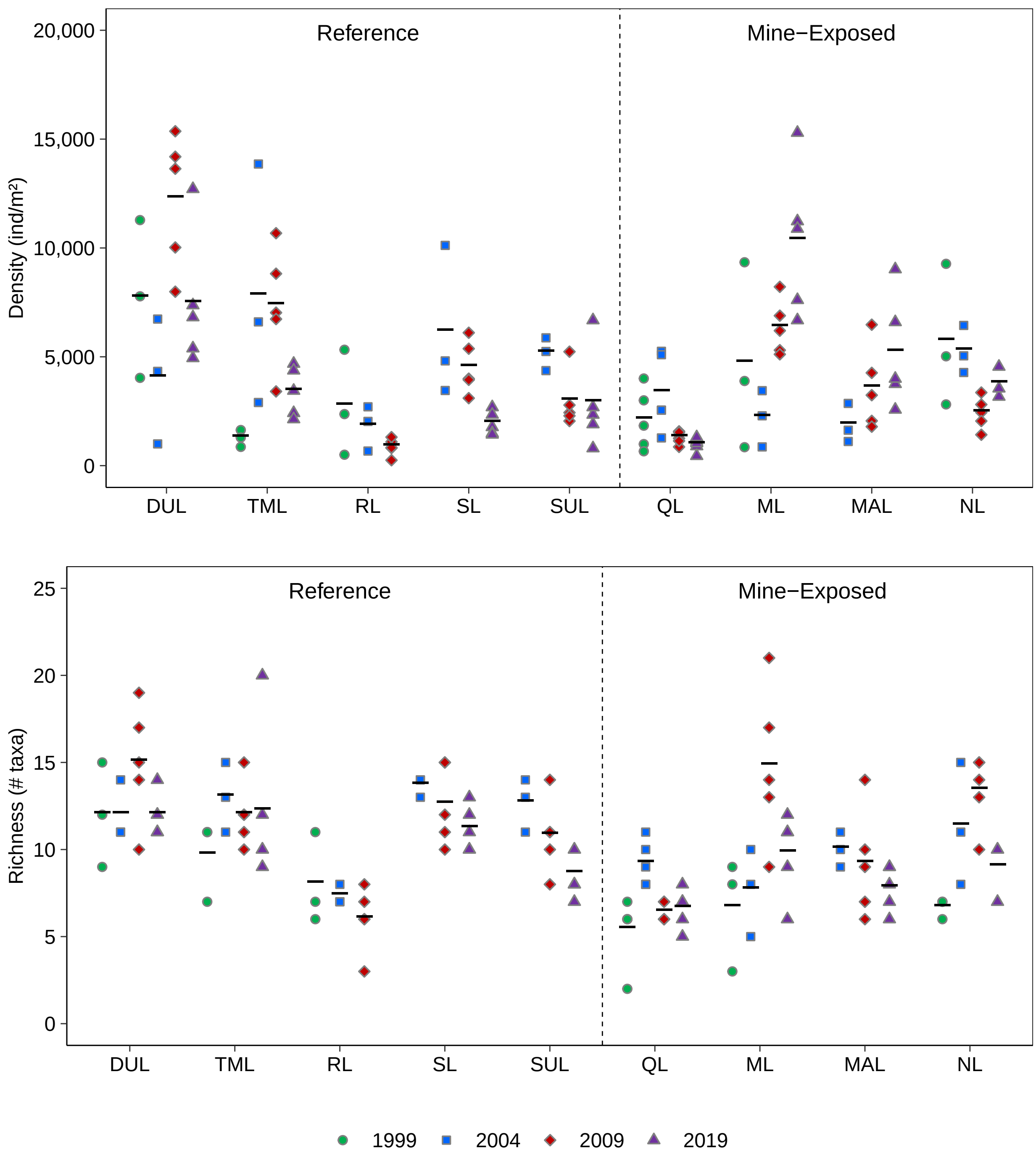

Figure 8.4: Benthic Invertebrate Community Endpoints, SRWMP, September 1999, 2004, 2009, and 2019

Notes: Black horizontal bars indicate mean values.
Mine−exposed areas: Quirke Lake (QL), McCabe Lake (ML), May Lake (MAL), Nordic Lake (NL).
Reference areas: Dunlop Lake (DUL), Ten Mile Lake (TML), Semiwite Lake (SL), Summers Lake (SUL), Rochester Lake (RL).

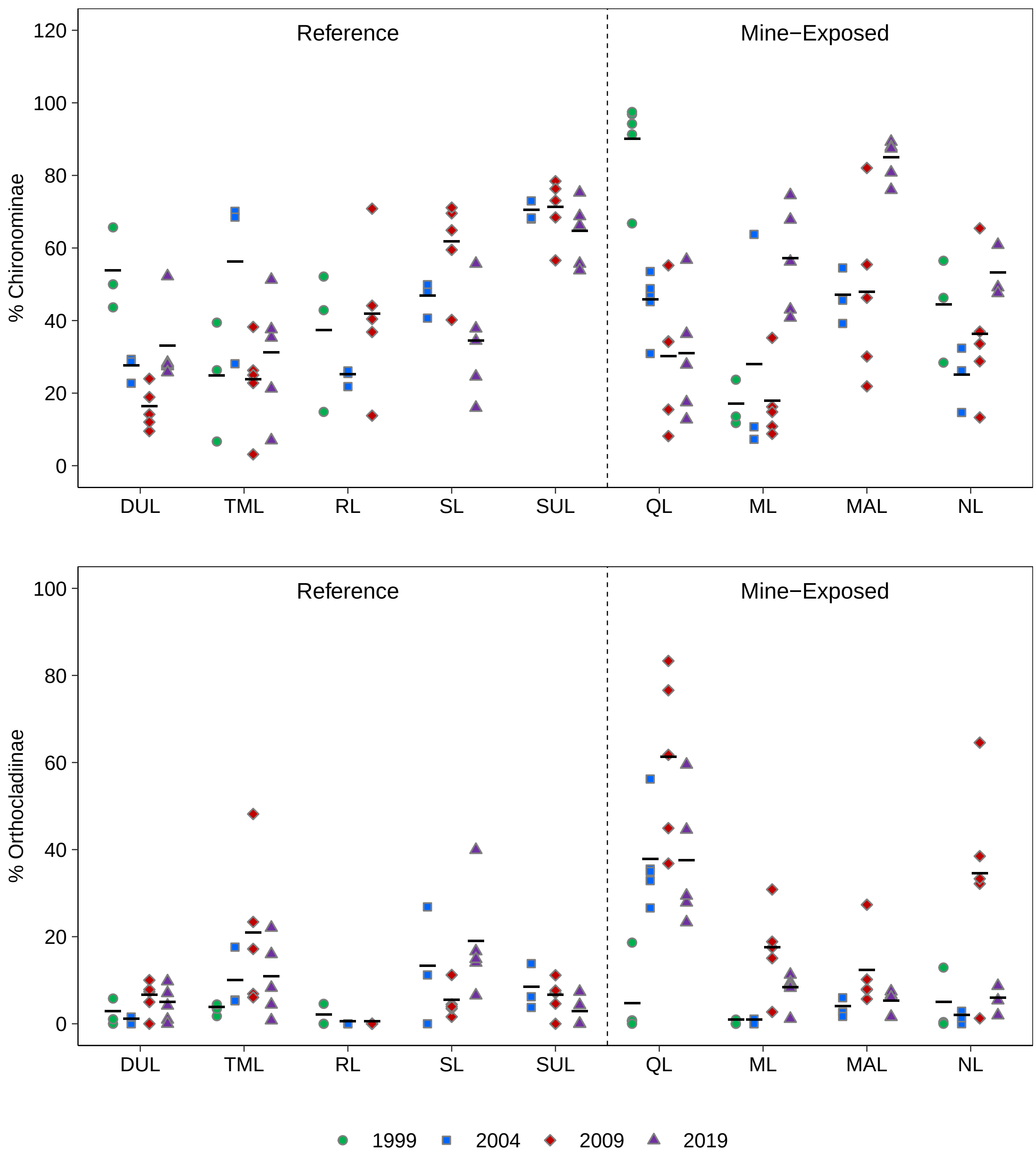

Figure 8.4: Benthic Invertebrate Community Endpoints, SRWMP, September 1999, 2004, 2009, and 2019

Notes: Black horizontal bars indicate mean values.
Mine−exposed areas: Quirke Lake (QL), McCabe Lake (ML), May Lake (MAL), Nordic Lake (NL).
Reference areas: Dunlop Lake (DUL), Ten Mile Lake (TML), Semiwite Lake (SL), Summers Lake (SUL), Rochester Lake (RL).

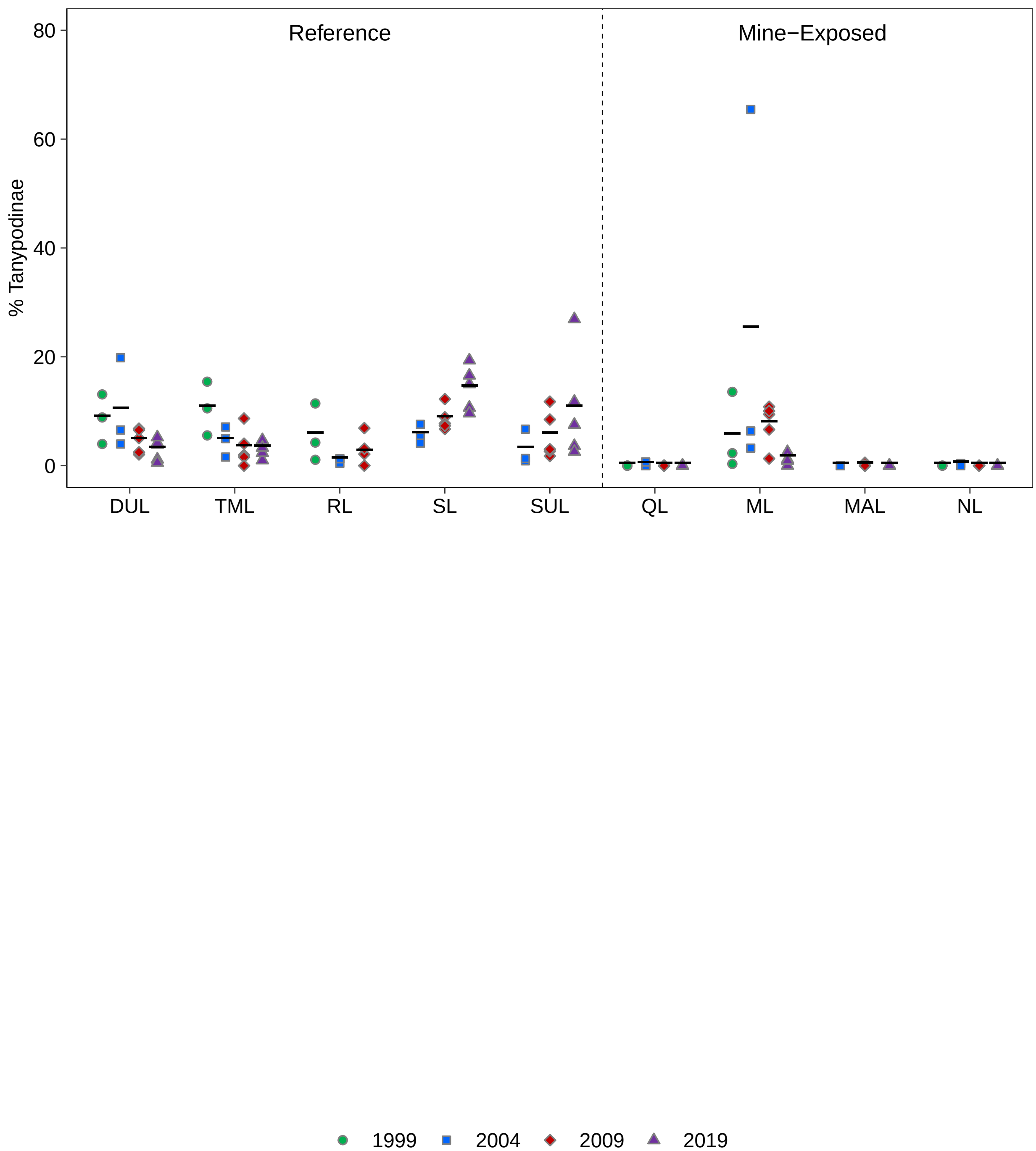

Figure 8.4: Benthic Invertebrate Community Endpoints, SRWMP, September 1999, 2004, 2009, and 2019

Notes: Black horizontal bars indicate mean values.
Mine−exposed areas: Quirke Lake (QL), McCabe Lake (ML), May Lake (MAL), Nordic Lake (NL).
Reference areas: Dunlop Lake (DUL), Ten Mile Lake (TML), Semiwite Lake (SL), Summers Lake (SUL), Rochester Lake (RL).

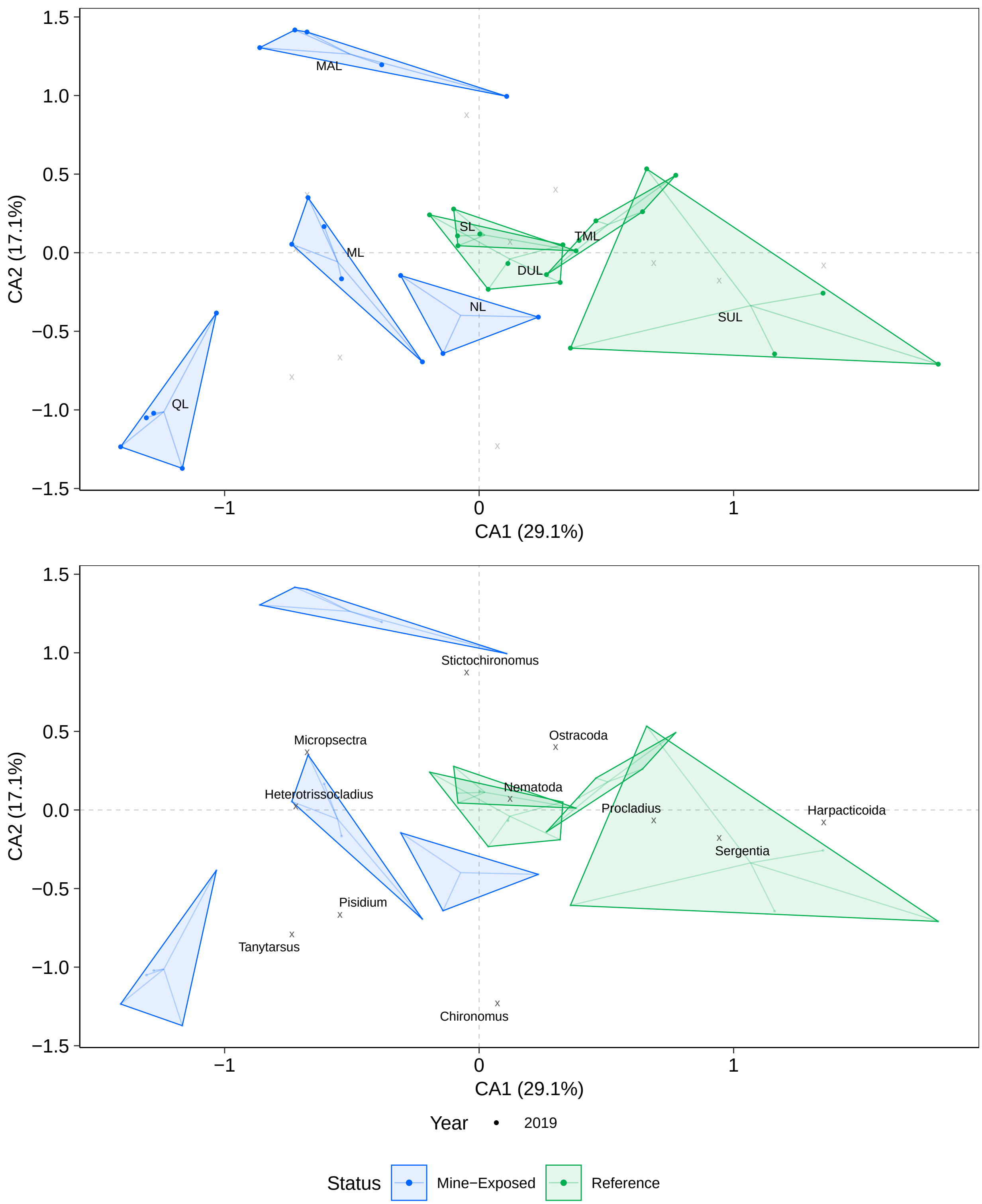

Figure 8.5: Scatterplots of Correspondence Analysis Axis (CA1 and CA2) Taxa and Station Scores, SRWMP, September 2019

Notes: Correspondence Analysis performed at the LPL level of ln(x+1) transformed densities. Taxa present at fewer than 3% of samples or that made up less than 3% of the total density in the dataset were excluded from analysis. Mine−exposed areas: Quirke Lake (QL), McCabe Lake (ML), May Lake (MAL), Nordic Lake (NL). Reference areas: Dunlop Lake (DUL), Ten Mile Lake (TML), Semiwite Lake (SL), Summers Lake (SUL).

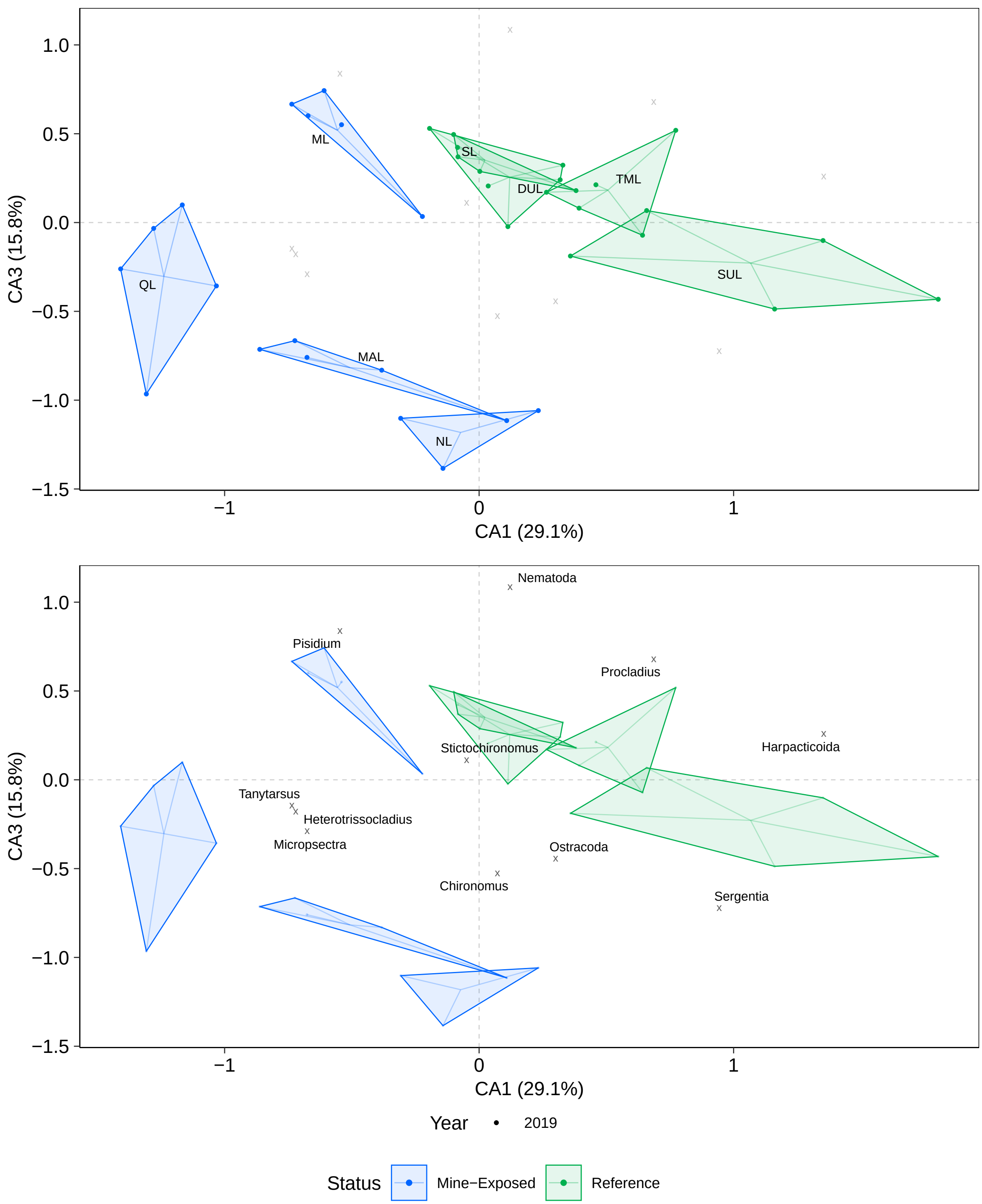

Figure 8.6: Scatterplots of Correspondence Analysis Axis (CA1 and CA3) Taxa and Station Scores, SRWMP, September 2019

Notes: Correspondence Analysis performed at the LPL level of ln(x+1) transformed densities. Taxa present at fewer than 3% of samples or that made up less than 3% of the total density in the dataset were excluded from analysis. Mine−exposed areas: Quirke Lake (QL), McCabe Lake (ML), May Lake (MAL), Nordic Lake (NL). Reference areas: Dunlop Lake (DUL), Ten Mile Lake (TML), Semiwite Lake (SL), Summers Lake (SUL).

comparisons focused strictly on individual lakes (to understand changes in the BIC from each of the mine-exposed lakes over time).

In 2019, the BIC in May Lake had fewer taxa, lower % Tanypodinae, and higher % Chironominae than reference, and differed significantly from the reference lakes on CA1 and CA3 (Appendix Tables T.10 and T.11). Density, however, has been increasing over time to the point where it was no longer different from reference in 2019, indicating significant improvement (Figure 8.4; Appendix Table T.10). Temporal changes in BIC from May Lake were primarily evident on CA1, where the community in May Lake in 2019 separated from 2004 and 2009 based on greater prevalence of *Stictochironomus* sp., *Parakiefferiella* sp., and *Micropsectra* sp. and reduced prevalence of *Chironomus* sp., Arachnida, and *Sergentia* sp. (Figures 8.7 and 8.8; Table 8.3; Appendix Tables T.11 to T.13). The changes observed among years in the temporal CA for May Lake were not observed in the reference lakes, indicating that it was not a regional occurrence (Figures 8.9 and 8.10).

The BIC from McCabe Lake had greater density, higher % Chironominae, and lower % Tanypodinae than reference, and differed significantly from the reference lakes on CA1, CA2, and CA3 (Figure 8.3; Table 8.4; Appendix Table T.10). The temporal increase in density suggests improvements over time, as does the lack of difference in LPL richness relative to reference, which was first noted in 2009 (excluding Rochester Lake; Table 8.4). Temporally, changes in BIC were evident on CA1 and CA2, with CA1 explaining 35.7% of the variability, and following a general increasing trend from more negative scores in 1999 to more positive scores in 2019 (Figures 8.7 and 8.8; Appendix Tables T.11, T.14, and T.15). The temporal changes in community structure on CA1 were primarily linked to greater prevalence of *Stictochironomus* sp. and Nematoda, and reduced prevalence of *Chironomus* sp., Ostracoda, and *Sergentia* sp. in more recent years compared to earlier years (Figure 8.7; Appendix Table T.15).

With the exception of lower % Tanypodinae, and significant differences in CA2 and CA3, the BIC from Nordic Lake did not differ from reference in 2019 (Table 8.5; Appendix Table T.10). This is generally consistent with earlier years, where few differences were noted relative to reference (Table 8.5). No distinct increasing or decreasing trends in density or LPL richness have been noted over time, but there was some evidence of shifts in overall community structure, based on significant differences among years on CA1 (Figures 8.4 and 8.7; Appendix Tables T.11, T.16, and T.17). From 1999 through 2009, the BIC shifted significantly from negative to positive scores on CA1, associated with greater prevalence of *Stictochironomus* sp. and Arachnida, and reduced prevalence of Nematoda and *Sergentia* sp. (Figure 8.7; Appendix Table T.17). In 2019, the community shifted back slightly, and as a result, did not differ significantly from 2004 or 2009 on CA1 (Figure 8.7; Appendix Table T.11).

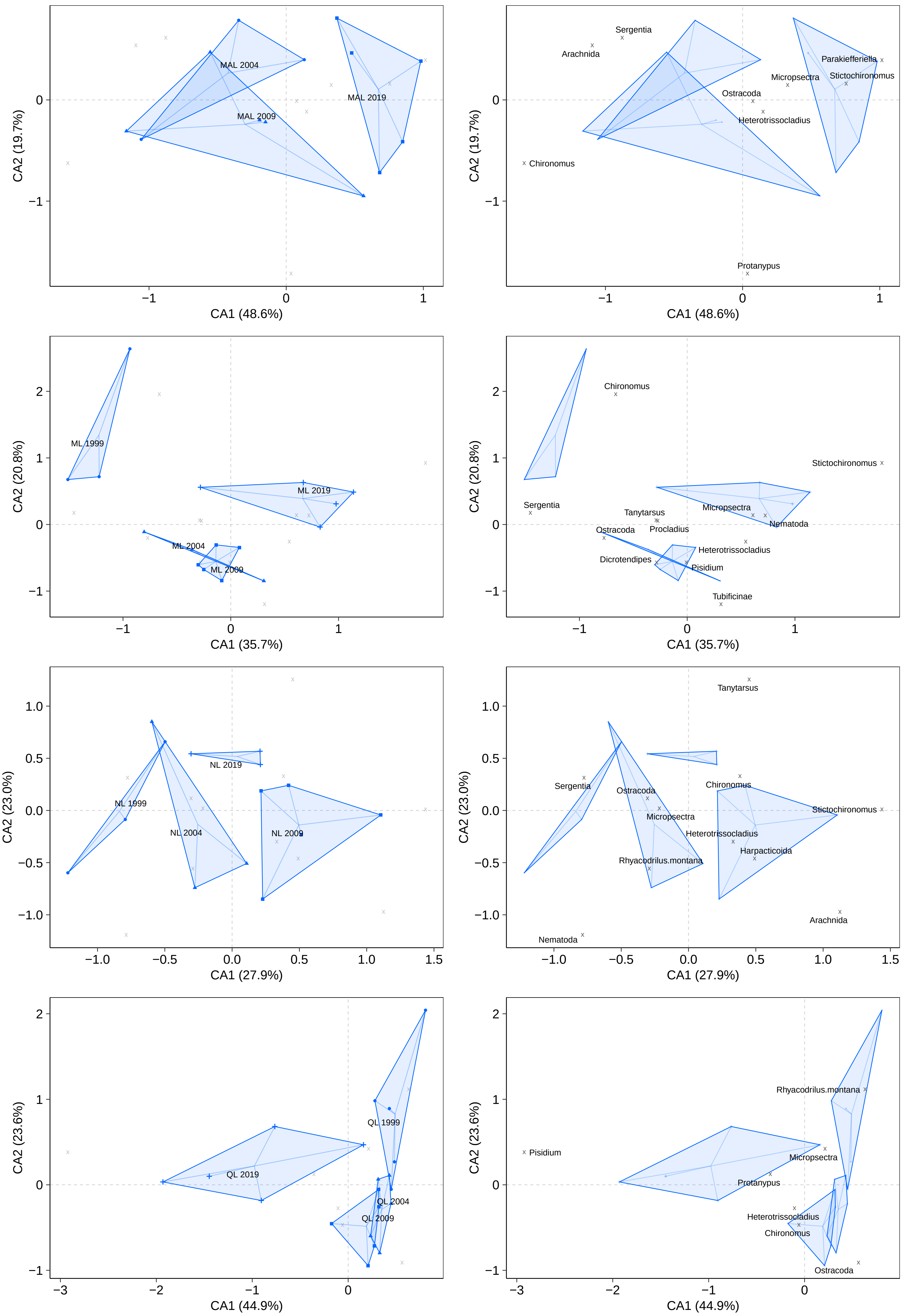

Figure 8.7: Scatterplots of Correspondence Analysis Axis (CA1 and CA2) Taxa and Station Scores from Mine−Exposed Lakes, SRWMP, September 1999, 2004, 2009, and 2019

Notes: Correspondence Analysis performed at the LPL level of ln(x+1) transformed densities. Taxa present at fewer than 3% of samples or that made up less than 3% of the total density in the dataset were excluded from analysis. Mine−exposed areas: Quirke Lake (QL), McCabe Lake (ML), May Lake (MAL), Nordic Lake (NL).

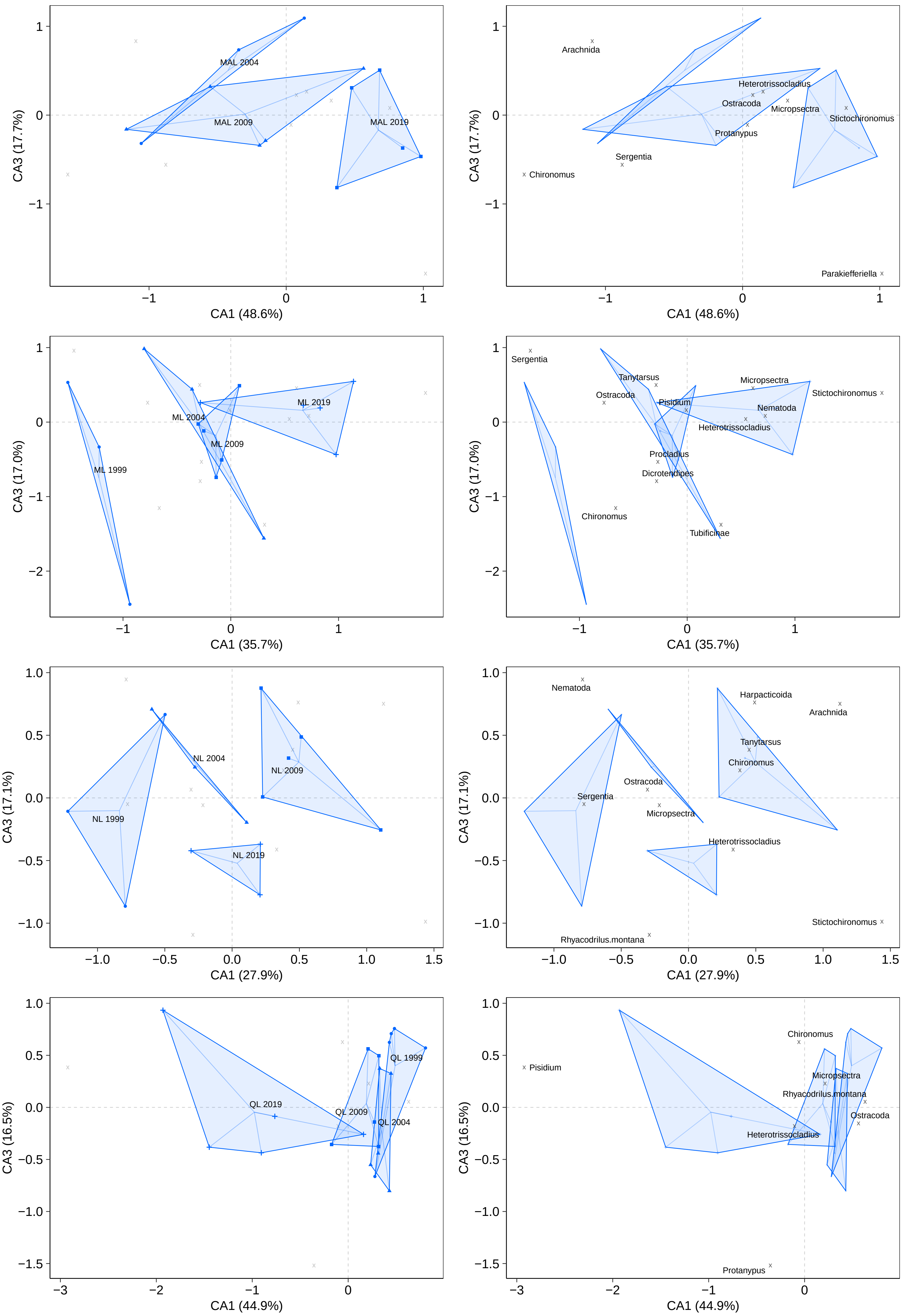

Figure 8.8: Scatterplots of Correspondence Analysis Axis (CA1 and CA3) Taxa and Station Scores from Mine−Exposed Lakes, SRWMP, September 1999, 2004, 2009, and 2019

Notes: Correspondence Analysis performed at the LPL level of ln(x+1) transformed densities. Taxa present at fewer than 3% of samples or that made up less than 3% of the total density in the dataset were excluded from analysis. Mine−exposed areas: Quirke Lake (QL), McCabe Lake (ML), May Lake (MAL), Nordic Lake (NL).

Table 8.3: Benthic Invertebrate Community ANOVA Results for May Lake, 2004 to 2019

Endpoint	Transformation	Year	MCT[a]	Temporal Differences		Reference Comparison with RL			Reference Comparison without RL		
				Pairwise Contrasts[b]	MOD[d] vs 2004	Reference MCT[c]	P-Value	MOD[e]	Reference MCT[c]	P-Value	MOD[e]
Density (ind./m²)	log10	2004	1,729	B	b	3,867	0.020	-1.5	4,863	0.002	-2.1
		2009	3,188	AB	1.2	3,754	0.535	-0.30	5,614	0.026	-1.1
		2019	4,702	A	2.2	3,154	0.139	0.75	3,154	0.114	0.80
Richness (# Taxa)	log10	2004	9.97	A	b	11.4	0.397	-0.54	12.8	0.124	-1.0
		2009	8.80	A	-0.18	10.6	0.144	-0.72	12.3	0.008	-1.4
		2019	7.71	A	-0.77	10.7	0.010	-1.3	10.7	0.009	-1.3
Chironominae (%)	logit	2004	46.4	B	b	44.0	0.833	0.13	49.4	0.792	-0.17
		2009	47.3	B	0.30	39.7	0.382	0.43	39.6	0.383	0.44
		2019	84.8	A	2.8	38.6	<0.001	2.9	38.6	<0.001	3.0
Orthocladiinae (%)	logit	2004	3.20	A	b	3.69	0.847	-0.12	5.20	0.508	-0.43
		2009	10.5	A	0.99	4.87	0.079	0.87	7.01	0.352	0.47
		2019	4.20	A	-0.23	6.00	0.478	-0.36	6.00	0.493	-0.34
Tanypodinae (%)	logit	2004	0	A	b	3.89	0.002	-2.0	4.91	<0.001	-2.3
		2009	0.101	A	0.016	4.08	<0.001	-2.0	4.77	<0.001	-2.2
		2019	0	A	-0.64	6.05	<0.001	-2.6	6.05	<0.001	-2.6

[grey shading] P-value < 0.1.

[blue shading] 2 < MOD < -2.

Notes: ANOVA = analysis of variance. RL = Rochester Lake.

[a] Measures of Central Tendency (MCT) calculated as back-transformed estimated marginal means from a two-way ANOVA with reference lakes nested within a pooled reference status, and individual mine-exposed lakes over time.

[b] Years that share a letter are not significantly different based on Tukey's Honestly Significant Difference (α=0.1).

[c] Calculated as the back-transformed estimated marginal mean of the pooled reference areas from two-way ANOVA.

[d] Magnitude of Difference (MOD) calculated as $(MCT_{year}-MCT_{baseline})/SD_{model}$, where SDmodel is the standard deviation of the two-way ANOVA model residuals.

[e] Magnitude of Difference (MOD) calculated as $(MCT_{exposed}-MCT_{ReferencePool})/SD_{model}$, where SDmodel is the standard deviation of the two-way ANOVA model residuals.

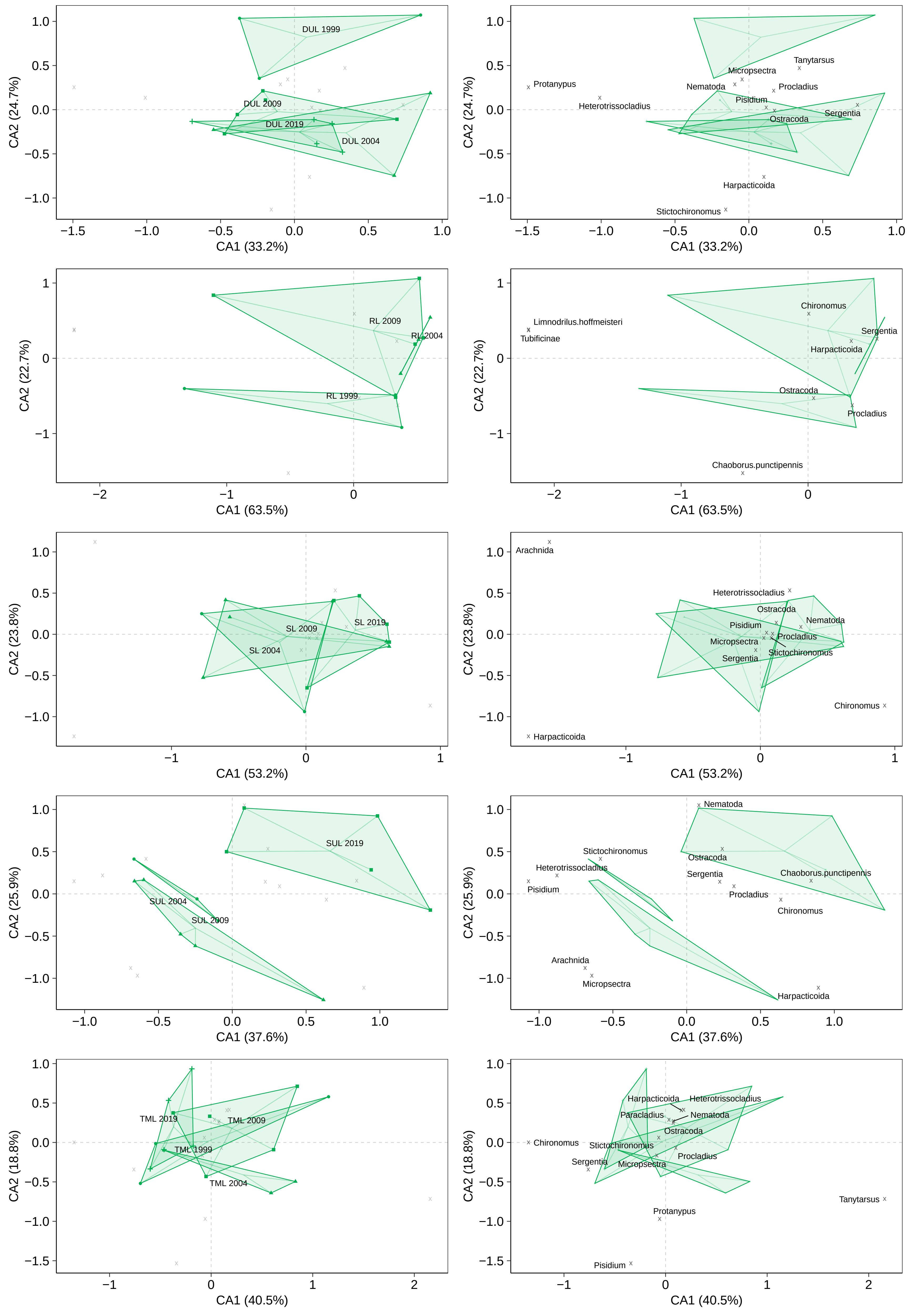

Figure 8.9: Scatterplots of Correspondence Analysis Axis (CA1 and CA2) Taxa and Station Scores from Reference Lakes, SRWMP, September 1999, 2004, 2009, and 2019

Notes: Correspondence Analysis performed at the LPL level of ln(x+1) transformed densities. Taxa present at fewer than 3% of samples or that made up less than 3% of the total density in the dataset were excluded from analysis. Reference areas: Dunlop Lake (DUL), Ten Mile Lake (TML), Semiwite Lake (SL), Summers Lake (SUL), Rochester Lake (RL).

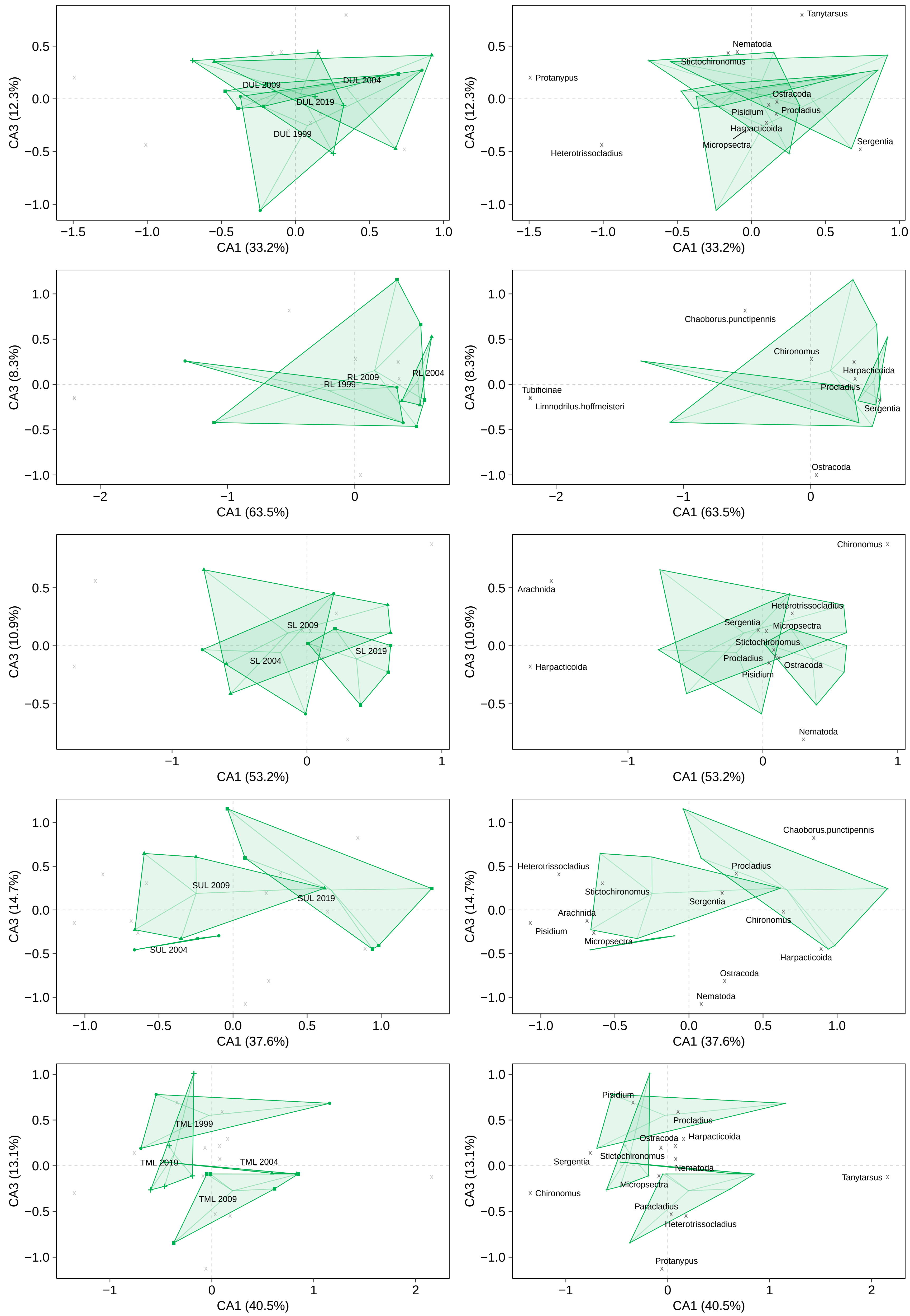

Figure 8.10: Scatterplots of Correspondence Analysis Axis (CA1 and CA3) Taxa and Station Scores from Reference Lakes, SRWMP, September 1999, 2004, 2009, and 2019

Notes: Correspondence Analysis performed at the LPL level of ln(x+1) transformed densities. Taxa present at fewer than 3% of samples or that made up less than 3% of the total density in the dataset were excluded from analysis. Reference areas: Dunlop Lake (DUL), Ten Mile Lake (TML), Semiwite Lake (SL), Summers Lake (SUL), Rochester Lake (RL).

Table 8.4: Benthic Invertebrate Community ANOVA Results for McCabe Lake, 1999 to 2019

Endpoint	Transformation	Year	MCT[a]	Temporal Differences		Reference Comparison with RL			Reference Comparison without RL		
				Pairwise Contrasts[b]	MOD[d] vs 1999	eference MCT	P-Value	MOD[e]	Reference MCT[c]	P-Value	MOD[e]
Density (ind./m²)	log10	1999	3,134	BC	b	2,519	0.543	0.41	2,939	0.857	0.13
		2004	1,894	C	-1.7	3,867	0.038	-1.3	4,863	0.004	-1.9
		2009	6,248	AB	0.54	3,754	0.055	0.95	5,614	0.670	0.21
		2019	9,900	A	1.7	3,154	<0.001	2.1	3,154	<0.001	2.3
Richness (# Taxa)	log10	1999	6.00	C	b	9.51	0.007	-1.8	10.5	0.002	-2.3
		2004	7.37	BC	0.089	11.4	0.007	-1.7	12.8	<0.001	-2.2
		2009	14.2	A	3.0	10.6	0.017	1.2	12.3	0.243	0.59
		2019	9.53	B	1.4	10.7	0.349	-0.47	10.7	0.338	-0.48
Chironominae (%)	logit	1999	15.8	B	b	35.4	0.036	-1.4	35.7	0.042	-1.5
		2004	21.4	B	-0.019	44.0	0.025	-1.4	49.4	0.008	-1.8
		2009	15.8	B	-0.25	39.7	<0.001	-1.7	39.6	0.001	-1.7
		2019	57.0	A	2.4	38.6	0.043	1.0	38.6	0.041	1.0
Orthocladiinae (%)	logit	1999	0.290	B	b	1.89	0.341	-0.64	2.37	0.286	-0.76
		2004	0.318	B	-0.48	3.69	0.079	-1.1	5.20	0.033	-1.4
		2009	14.8	A	2.0	4.87	0.007	1.3	7.01	0.069	0.92
		2019	6.99	A	0.81	6.00	0.739	0.17	6.00	0.748	0.16
Tanypodinae (%)	logit	1999	3.67	BC	b	7.28	0.129	-1.0	8.96	0.050	-1.4
		2004	16.1	A	3.5	3.89	<0.001	2.5	4.91	0.001	2.2
		2009	6.89	AB	1.8	4.08	0.112	0.79	4.77	0.253	0.58
		2019	1.29	C	-0.73	6.05	<0.001	-1.8	6.05	<0.001	-1.8

[grey shading] P-value < 0.1.

[blue shading] 2 < MOD < -2.

Notes: ANOVA = analysis of variance. RL = Rochester Lake.

[a] Measures of Central Tendency (MCT) calculated as back-transformed estimated marginal means from a two-way ANOVA with reference lakes nested within a pooled reference status, and individual mine-exposed lakes over time.

[b] Years that share a letter are not significantly different based on Tukey's Honestly Significant Difference (α=0.1).

[c] Calculated as the back-transformed estimated marginal mean of the pooled reference areas from two-way ANOVA.

[d] Magnitude of Difference (MOD) calculated as $(MCT_{year}-MCT_{baseline})/SD_{model}$, where SDmodel is the standard deviation of the two-way ANOVA model residuals.

[e] Magnitude of Difference (MOD) calculated as $(MCT_{exposed}-MCT_{ReferencePool})/SD_{model}$, where SDmodel is the standard deviation of the two-way ANOVA model residuals.

Table 8.5: Benthic Invertebrate Community ANOVA Results for Nordic Lake, 1999 to 2019

Endpoint	Transformation	Year	MCT[a]	Temporal Differences		Reference Comparison with RL			Reference Comparison without RL		
				Pairwise Contrasts[b]	MOD[d] vs 1999	Reference MCT[c]	P-Value	MOD[e]	Reference MCT[c]	P-Value	MOD[e]
Density (ind./m²)	log10	1999	5,079	A	b	2,519	0.053	1.3	2,939	0.126	1.1
		2004	5,181	A	-0.76	3,867	0.390	0.55	4,863	0.845	0.13
		2009	2,319	A	-2.2	3,754	0.070	-0.90	5,614	<0.001	-1.8
		2019	3,711	A	-1.0	3,154	0.625	0.30	3,154	0.601	0.32
Richness (# Taxa)	log10	1999	6.65	B	b	9.51	0.036	-1.4	10.5	0.010	-1.9
		2004	11.0	A	1.3	11.4	0.804	-0.16	12.8	0.345	-0.61
		2009	13.3	A	2.3	10.6	0.069	0.90	12.3	0.553	0.30
		2019	8.88	AB	0.67	10.7	0.229	-0.75	10.7	0.218	-0.77
Chironominae (%)	logit	1999	43.3	A	b	35.4	0.492	0.46	35.7	0.533	0.44
		2004	23.7	A	-1.7	44.0	0.048	-1.3	49.4	0.016	-1.6
		2009	34.0	A	-0.79	39.7	0.501	-0.33	39.6	0.508	-0.33
		2019	52.6	A	0.32	38.6	0.210	0.78	38.6	0.205	0.79
Orthocladiinae (%)	logit	1999	2.46	B	b	1.89	0.795	0.17	2.37	0.971	0.026
		2004	1.25	B	-0.90	3.69	0.256	-0.72	5.20	0.121	-1.0
		2009	27.8	A	2.2	4.87	<0.001	2.3	7.01	<0.001	1.9
		2019	4.87	B	-0.39	6.00	0.729	-0.22	6.00	0.738	-0.21
Tanypodinae (%)	logit	1999	0	A	b	7.28	<0.001	-2.9	8.96	<0.001	-3.3
		2004	0.221	A	1.1	3.89	0.006	-1.8	4.91	0.001	-2.1
		2009	0	A	0.88	4.08	<0.001	-2.0	4.77	<0.001	-2.3
		2019	0	A	0.30	6.05	<0.001	-2.6	6.05	<0.001	-2.6

(grey shading) P-value < 0.1.
(blue shading) 2 < MOD < -2.

Notes: ANOVA = analysis of variance. RL = Rochester Lake.

[a] Measures of Central Tendency (MCT) calculated as back-transformed estimated marginal means from a two-way ANOVA with reference lakes nested within a pooled reference status, and individual mine-exposed lakes over time.

[b] Years that share a letter are not significantly different based on Tukey's Honestly Significant Difference (α=0.1).

[c] Calculated as the back-transformed estimated marginal mean of the pooled reference areas from two-way ANOVA.

[d] Magnitude of Difference (MOD) calculated as $(MCT_{year}-MCT_{baseline})/SD_{model}$, where SDmodel is the standard deviation of the two-way ANOVA model residuals.

[e] Magnitude of Difference (MOD) calculated as $(MCT_{exposed}-MCT_{ReferencePool})/SD_{model}$, where SDmodel is the standard deviation of the two-way ANOVA model residuals.

The BIC in Quirke Lake differed from reference for all endpoints except % Chironominae (Table 8.6; Appendix Table T.10). Density and LPL richness were low in Quirke Lake (relative to reference and the other mine-exposed lakes) and have not shown improvement over time (Figure 8.4). This is perhaps not surprising, considering sediment quality has not improved, and in some cases (i.e., increasing concentrations of iron, manganese, and nickel) has deteriorated (see Section 8.2). Despite the lack of change in density and richness, there was some evidence of an overall change in community structure based on significant differences among years along CA1 (Figure 8.6; Appendix Tables T.11, T.18, and T.19). The primary change in the community appeared to be driven by presence of *Pisidium* sp. in 2019, which were not found in earlier years. Relative abundance and/or presence/absence of Ostracoda, *Rhyacodrilus montana*, and various chironomid genera also contributed to the separation of sampling years along CA1 (Figure 8.6; Appendix Table T.19).

8.2.3 Correlations between Benthic Endpoints and Supporting Measures

A total of 44 correlations between habitat variables and BIC endpoints were significant at $p<0.05$, but only 24 were significant at a more stringent level of $p=0.0033$ (Appendix Table T.20). Correlations with metal concentrations in sediment and specific conductance in water generally separated the reference areas from the mine-exposed areas. In most cases, much greater variability in BIC endpoint values was observed in the reference areas over a comparatively low range of metal concentrations or specific conductance, resulting in a negative and often L-shaped curve (Appendix Figure T.9). Of the correlations significant at $p<0.0033$, the only ones that showed sufficient variability among data from both mine-exposed and reference areas (and thus may be suggestive of a causal relationship) were the correlations with water temperature (i.e., density, LPL richness, and CA3; Appendix Table T.20; Appendix Figure T.9). All other correlations should be interpreted with caution.

8.2.4 Summary

Overall, the BIC from both the mine-exposed and reference lakes in the SRW continue to be dominated by chironomids. Some improvements in mine-exposed communities were noted over time (i.e., increased organism densities in May Lake and McCabe Lake), whereas others were already similar to reference (Nordic Lake) or unchanged from previous study years (Quirke Lake). Temporal CAs indicated that community structure has been changing over time in the mine-exposed lakes.

Table 8.6: Benthic Invertebrate Community ANOVA Results for Quirke Lake, 1999 to 2019

Endpoint	Transformation	Year	MCT[a]	Temporal Differences		Reference Comparison with RL			Reference Comparison without RL		
				Pairwise Contrasts[b]	MOD[d] vs 1999	Reference MCT[c]	P-Value	MOD[e]	Reference MCT[c]	P-Value	MOD[e]
Density (ind./m²)	log10	1999	1,705	AB	b	2,519	0.195	-0.73	2,939	0.076	-1.1
		2004	2,946	A	0.22	3,867	0.328	-0.51	4,863	0.063	-1.0
		2009	1,243	B	-1.3	3,754	<0.001	-2.1	5,614	<0.001	-3.0
		2019	902	B	-1.6	3,154	<0.001	-2.3	3,154	<0.001	-2.5
Richness (# Taxa)	log10	1999	4.97	B	b	9.51	<0.001	-2.6	10.5	<0.001	-3.1
		2004	9.13	A	1.7	11.4	0.089	-0.89	12.8	0.012	-1.4
		2009	6.38	AB	0.58	10.6	<0.001	-2.0	12.3	<0.001	-2.7
		2019	6.52	AB	0.60	10.7	<0.001	-2.0	10.7	<0.001	-2.0
Chironominae (%)	logit	1999	92.2	A	b	35.4	<0.001	4.0	35.7	<0.001	4.1
		2004	44.9	B	-4.0	44.0	0.921	0.051	49.4	0.634	-0.25
		2009	26.6	B	-4.8	39.7	0.101	-0.81	39.6	0.105	-0.82
		2019	28.3	B	-4.7	38.6	0.208	-0.63	38.6	0.203	-0.64
Orthocladiinae (%)	logit	1999	2.06	B	b	1.89	0.924	0.054	2.37	0.881	-0.091
		2004	36.9	A	3.1	3.69	<0.001	3.2	5.20	<0.001	2.7
		2009	62.2	A	4.2	4.87	<0.001	4.3	7.01	<0.001	3.8
		2019	36.2	A	2.6	6.00	<0.001	2.6	6.00	<0.001	2.6
Tanypodinae (%)	logit	1999	0	A	b	7.28	<0.001	-2.9	8.96	<0.001	-3.3
		2004	0.125	A	1.0	3.89	<0.001	-1.9	4.91	<0.001	-2.2
		2009	0	A	0.88	4.08	<0.001	-2.0	4.77	<0.001	-2.3
		2019	0	A	0.30	6.05	<0.001	-2.6	6.05	<0.001	-2.6

[grey] P-value < 0.1.
[blue] 2 < MOD < -2.

Notes: ANOVA = analysis of variance. RL = Rochester Lake.

[a] Measures of Central Tendency (MCT) calculated as back-transformed estimated marginal means from a two-way ANOVA with reference lakes nested within a pooled reference status, and individual mine-exposed lakes over time.

[b] Years that share a letter are not significantly different based on Tukey's Honestly Significant Difference (α=0.1).

[c] Calculated as the back-transformed estimated marginal mean of the pooled reference areas from two-way ANOVA.

[d] Magnitude of Difference (MOD) calculated as $(MCT_{year}\text{-}MCT_{baseline})/SD_{model}$, where SDmodel is the standard deviation of the two-way ANOVA model residuals.

[e] Magnitude of Difference (MOD) calculated as $(MCT_{exposed}\text{-}MCT_{ReferencePool})/SD_{model}$, where SDmodel is the standard deviation of the two-way ANOVA model residuals.

9 PUBLIC DOSE

9.1 Historical Dose Estimates and Risk Assessments

Risk assessments were previously conducted in the SRW as part of the Environmental Assessments completed in support of mine decommissioning (RAL 1995, DMI 1995, AECB 1997, CNSC 2002) and the 1999 SRWMP (Minnow and Beak 2001). A comprehensive study of dose and risk was completed in 2009 as part of the Cycle 3 SOE interpretive report and was updated in 2011 (EcoMetrix 2011c, Minnow 2012). The 2009 Dose and Risk Assessment was used to confirm or adjust assumptions made in previous assessments, to generate comprehensive dose estimates (to aquatic biota and riparian wildlife) based on measured data, and to update the human health risk assessment (EcoMetrix 2011c). As part of the 2009 Dose and Risk Assessment, doses were calculated for aquatic biota (aquatic plants, benthic invertebrates, and fish), riparian wildlife (muskrat, mink, mallard, scaup, merganser), and a generic human receptor in five mine-exposed SRW lakes (McCabe, May, Elliot, Nordic, and Quirke lakes). Doses were calculated using measured radionuclide values from water, sediment, macrophytes, and small-bodied forage fish that were sampled in each lake and analyzed for uranium-nat, thorium-230, radium-226, polonium-210, and lead-210 (i.e., the uranium-238 decay chain), as well as thorium-232, radium-228 and thorium-228 (i.e., the thorium-232 decay chain). Exposure pathways were identified as: sediment occupancy, water intake rate, food intake, and incidental ingestion of sediment. Calculated doses to aquatic biota ranged from 0.0627 to 0.664 mGy/d, all well below the UNSCEAR (2008) benchmark dose of 10 mGy/d. Calculated doses to riparian wildlife ranged from 0.00687 to 0.381 mGy/d, all well below the UNSCEAR (2008) benchmark dose of 2.4 mGy/d. These dose rates are considered to be protective of natural populations, as they are based on consideration of radiation effects on population relevant endpoints. The calculated doses to a generic human ranged from 0.022 mSv/y to 0.103 mSv/y (background corrected), all less than the public dose limit of 1 mSv/y as well as Health Canada’s (2014) dose constraint value of 0.3 mSv/y. Health Canada’s (2014) dose constraint value is an incremental value above which dose management may be needed for naturally occurring radioactive materials. It is a conservative value which allows for exposure from other sources while still ensuring that incremental dose to a member of the public does not exceed the public dose limit. The calculated dose to a Serpent River First Nation member based on realistic use of the six SRW lakes and Lake Huron, was 0.062 mSv/y (total, including background dose), less than the public dose limit and the dose constraint value.

Since 2009, when the Dose and Risk Assessment was conducted, there have been no significant changes in the operation of the Elliot Lake site facilities. A review of the 2009 to 2018 SRWMP water quality data from the receiving water of key near-field lakes (Quirke, McCabe, Nordic, and

May lakes) was conducted to assess the need to update the 2009 Dose and Risk Assessment (Minnow 2019). Radium-226 concentrations were screened against the proposed site-specific water quality objective of 0.469 Bq/L (EcoMetrix 2019), as this is the lowest concentration of radium-226 in water that would equal a dose benchmark. Concentrations above the benchmark would be considered indicators of potential human or ecological concern that would trigger further investigative action. All water quality data were well below this benchmark (Minnow 2019). Therefore, no risk was anticipated and updating the 2009 Dose and Risk Assessment was not warranted. To meet the general intent of Canadian Standards Association (CSA) Standard N288.6-12[24], the data will be screened and reviewed again in five years with the review of the TOMP, SAMP, and SRWMP study designs, or more frequently if major facility changes are proposed that would represent a potential increase in risk.

9.2 Current Public Dose Estimate

The current public dose estimation is based on realistic doses for a representative person residing in the town of Elliot Lake. 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. The public dose estimation was based on ingestion of drinking water from Elliot Lake (U-238 series radionuclide data from 2014 through 2016), ingestion of fish caught from Elliot Lake and other lakes downstream of the TMAs (most recently sampled in September 2019 for U-238 series radionuclides), and radon and gamma exposure from use of roads and trails near TMAs (estimated based on data collected in April, July, October, and December 2016). Since adults are the dominant age class in Elliot Lake, dose results were calculated specifically for this group.

The representative dose was calculated using the following assumptions:

- 110.76 hours per year spent walking near the TMAs;
- Consumption of 1.5 L of treated Elliot Lake drinking water per day, 365 days per year; and
- Consumption of 1.59 kg/year of sport fish (on a fresh weight basis).

The doses calculated from measured radon, gamma, and radionuclide concentrations also include a natural background component, which was removed prior to comparing to the public dose limit.

[24] The CSA standard is for operating sites, whereas the Elliot Lake sites are closed/decommissioning sites in the process of demonstrating recovery. Nevertheless, the CSA standard was used as a general guideline for dose and risk assessment as part of this Cycle 5 SOE study design.

The incremental dose limit for members of the general public is 1 mSv/a (ICRP 1991), with background radiation exposure usually being about 2 mSv/a (Health Canada 2014). Health Canada (2014) has also defined a more conservative incremental dose constraint of 0.3 mSv/a for naturally occurring radiation, which may result in dose management if exceeded.

Based on detailed calculations completed using the most up-to-date radiochemistry data and surveys of residents to define assumptions used in calculations (e.g., the amount of fish consumed annually per resident), the total dose for an adult from Elliot Lake (including background), was estimated to be 0.035 mSv/a (Appendix U). Of this, 0.026 mSv/a was attributable to background, while the incremental dose was 0.01 mSv/a (Appendix U). Overall, the public dose of approximately 0.01 mSv/a after removal of background is well below the incremental public limit of 1 mSv/a and the dose constraint of 0.3 mSv/a (Appendix U).

10 SUMMARY

10.1 In-Basin Performance (TOMP)

The TOMP includes: surface water monitoring for the Stanrock, Stanleigh, Denison, Spanish-American, Quirke, Panel, Lacnor/Nordic, and Pronto TMAs; pore water monitoring for Stanrock, Quirke, and Lacnor/Nordic TMAs; and groundwater monitoring for Stanrock, Stanleigh, Denison, Quirke, and Lacnor/Nordic TMAs. Since decommissioning, conditions in the TMA basins have generally improved.

Surface water quality was generally at or near EIS-predicted levels for Cycle 5 data (2015 to 2019). At most TMAs, surface water quality has continued to improve in recent years (2003 to 2019) based on decreasing concentrations of radium-226, sulphate, and uranium, as well as increasing pH levels. However, at Stanrock TMA and Denison TMA, concentrations of barium and radium-226 in surface water have increased slightly since 2003. At Denison TMA pH has slightly decreased. Decreasing pH in the Denison TMA 1 basin was likely 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 relatively small and pH within the TMA remains neutral, achieving the PWQO prior to treatment at station D-1.

Over the past five years, effluent quality has consistently achieved discharge criteria at all TMAs, except for two monthly mean radium-226 concentrations at Stanleigh TMA (December 2017 and January 2018). Although these two monthly means exceeded the monthly average discharge criterion, individual grab samples associated with each monthly mean were well below the grab sample criterion. These exceedances were associated with the refractory radium treatment issue. Since the introduction of XSB treatment in April 2018, effluent discharge has consistently achieved the discharge criteria.

Pore water and groundwater quality have also generally improved over time for most TMAs, except for pore water at Stanrock TMA and groundwater at one of the Quirke TMA stations. Stanrock TMA pore water quality has remained similar or deteriorated over time, whereas groundwater quality has generally improved. Concentrations of acidity, iron, and sulphate were increasing in the TMA upgradient of Dam A (pore water station PN-STP3-P); however, acidity and sulphate were decreasing, and iron did not show a trend in groundwater downgradient of Dam A (station BH91-SG1A). For Quirke TMA, improving trends were noted for pore water quality at all stations and groundwater quality stations downgradient of the Main Dam and Dam G-2, and down gradient of and closest to Dam K1 (station 95QW-5). Further downgradient of Dam K1, groundwater concentrations of iron and sulphate were increasing. The difference in trends observed at station 95QW-5 relative to the upgradient station may reflect the slower flushing of contaminants further downgradient of Cell 14, particularly in deeper sampling depths. In 2019, pore water pH at all depths achieved the EIS predicted level (only applicable to Stanrock and Quirke TMAs), except for the shallowest horizon (<3 m) at Stanrock TMA.

Overall, the TOMP surface water, pore water, and groundwater data indicated that the TMAs were performing as expected.

10.2 TMA Discharges and Seepages (SAMP)

Primary mine discharges contribute the majority of chemical loadings to the receiving environment. Although trends of increasing concentrations or decreasing pH were observed at many of the mines, concentrations typically either improved or remained relatively unchanged over time, effluent continued to achieve discharge criteria, and concentrations were frequently below (or above for pH) receiving environment SRWMP benchmarks. At Stanrock (DS-4), Stanleigh (CL-06), Denison (D-2, D-3), and Quirke (Q-28) TMA principal discharge locations, effluent pH showed slight decreasing trends. Also at these stations and at Panel TMA (P-14), barium concentrations increased from 2003 to 2019. Changes in pH and barium concentrations likely reflected treatment efficacy. In all cases, effluent barium concentrations were below toxicity thresholds, and pH remained circumneutral. Within the May Lake sub-watershed, barium and radium-226 concentrations increased at the Stanleigh TMA (CL-06) in response to refractory radium and initial treatment of increased barium chloride additions. Since the introduction of XSB treatment in 2018, both radium-226 and barium concentrations have decreased. Within the Quirke Lake sub-watershed, iron concentrations increased in the primary discharges at both the Denison (D-2 and D-3) and Quirke (Q-28) TMAs from 2003 to 2019, though iron concentrations in the Quirke discharge (Q-28) appear to have declined since 2013. In addition to increased iron concentrations, there was a small but significant increase in manganese concentrations at SAMP station D-3. Although concentrations of manganese and iron increased, concentrations remained below the SRWMP benchmarks. At Pronto TMA, since 2003 there has been a slight increase in the concentration of radium-226 at SAMP station PR-01, although concentrations remain well below the discharge criterion (0.37 Bq/L) and below the SRWMP benchmark of 0.469 Bq/L.

Effluents from the TMAs have been consistently non-lethal to *Daphnia magna* and rainbow trout, with no mortality reported in semi-annual acute toxicity tests, except for effluent from Stanleigh, Quirke, and Panel TMAs, which each had one or two *D. magna* toxicity tests toxicity tests that exhibited minimal mortality. Reproduction of *Ceriodaphnia dubia* was not affected by exposure to 100% effluent from any of the TMAs over the 2015 to 2019 period, except for one sample each from Stanrock, Quirke, Panel, and Milliken, with the IC25 (effluent concentration causing 25% inhibition relative to control organisms) for each of these samples being 55%, 85.7%, 68.9%, and 71.4% respectively. Effluent from these TMAs would be substantially diluted in the Halfmoon Lake, McCabe Lake, Serpent River, and Quirke Lake receiving environments. As such, effects to these invertebrates would not be expected in the receiving environment.

Direct seepage releases from the TMAs to the receiving environment occur in the Quirke Lake sub-watershed and Elliot Lake sub-watershed. Generally, seepage concentrations have been improving since 2003 at all seepage monitoring locations, except for increasing uranium concentrations at station D-9 (Denison TMA) and station P-02 (Panel TMA), increasing barium concentrations at ECA-398 (Quirke TMA), and some evidence of slightly higher radium-226 concentrations at station WL-4 (Nordic TMA) in 2018 and 2019. Despite increasing trends at these seepage locations, barium and radium-226 concentrations remained below SRWMP benchmarks. The only discharge location where pH has remained low (i.e., below 5) is the seepage from the historical Quirke II mine (station ECA-398). While metal concentrations tend to be highest and pH lowest in these seepage sources compared to the primary mine discharges, their loads to the receiving environment are low compared to primary discharges and background (upstream) loads.

10.3 Watershed Conditions (SRWMP)

The improvements within the TMAs and at the TMA discharges were reflected in the downstream receiving environment. Annual mean water concentrations (2015 to 2019) were less than SRWMP benchmarks for all substances, except for mean iron concentrations at station D-6 in 2018 and 2019. For individual samples, all concentrations of barium, pH, radium-226, and uranium in water were less than (or greater than for pH) the SRWMP benchmarks. Water metal concentrations at station D-6 (Cinder Lake outlet, downstream of Denison TMA 1) exceeded benchmark for iron, manganese and sulphate in four, three and one sample(s) out of 20 samples, respectively. At station Q-09 (Serpent River, downstream of Quirke TMA and Denison TMA 1), sulphate concentrations marginally exceeded the SRWMP in one out of 20 samples.

Water quality trends indicated that SRW water quality has generally improved or remained stable since 2003, with some exceptions in the May Lake sub-watershed. Within the May lake sub-watershed, sulphate and uranium concentrations decreased significantly, indicating continued improvements in water quality. However, barium concentrations were observed to increase significantly over time at the three SRWMP stations (SR-06, DS-18, and SR-15). Increasing trends were also shown for iron at station DS-18 (Halfmoon Lake outlet, downstream of Stanrock TMA) and radium-226 at station SR-06 (McCabe Lake outlet, downstream of Stanleigh TMA). Contrary to these increasing trends, from 2018 to 2019 there was a drop in radium-226 concentrations at station DS-18, as well as in both barium and radium-226 concentrations at stations SR-06 and SR-15. Notably, barium, iron, and radium-226 concentrations remained well below the SRWMP benchmarks at these locations. The increases in barium and radium-226 at station SR-06 were associated with refractory radium-226 and treatment trials at the Stanleigh TMA ETP in 2015 and 2016. The lower concentrations of barium and radium-226 observed in 2018 and 2019 reflect the effectiveness of the XSB treatment. Loadings of barium, sulphate, and uranium at the outlet of Halfmoon Lake (SRWMP station DS-18) were similar to those measured upstream (SAMP station DS-4), whereas loadings of iron and radium-226 were higher. This was potentially indicative of flushing of historical deposits as overlying water quality improves.

In 2019, mean sediment concentrations of metals and radium-226 in most mine-exposed lakes exceeded the upper limit of background or LEL benchmarks (i.e., barium in McCabe and Quirke lakes, cobalt, nickel, radium 226 in all lakes, manganese in McCabe and Nordic lakes, and uranium in all lakes except May Lake). However, in no instance did sediment concentrations exceed the SEL for nickel, radium-226, or uranium[25], or the lake-specific dose-based benchmarks for radium-226. Temporally, there have been few significant changes in sediment chemistry over the past 20 years, consistent with slow deposition rates. In McCabe Lake, radium-226 concentrations in sediment decreased in 2019 relative to 2009. In Quirke Lake, sediment concentrations of iron, manganese, and nickel were significantly higher in 2019 compared to 1999 (manganese, nickel) and 2004 (iron). These higher concentrations were likely due to increased TOC concentrations and proportion of clay particles, which have been shown to accumulate metals in sediment. Nonetheless, mean iron and manganese concentrations remain less than the upper limit of background concentrations, and nickel concentrations were slightly above the upper limit of background concentrations but well below the SEL.

The BIC from both the mine-exposed and reference lakes in the SRW continued to be dominated by chironomids as is typically the case for deep lake sediments. Some improvements in mine-exposed communities were noted over time (i.e., increased organism densities in May Lake and McCabe Lake), whereas others were already similar to reference (Nordic Lake) or unchanged from previous study years (Quirke Lake). Temporal CAs indicated that community structure has been changing over time in the mine-exposed lakes as conditions improve. The next sediment and benthic invertebrate community monitoring will be conducted in 2029, and the findings of the assessment will be included in the Cycle 7 (2025 to 2029) SOE report.

[25] Barium and cobalt do not have applicable provincial sediment quality guideline (PSQG) or Thompson et al. (2005) LEL or SEL values. The upper limit of background concentrations for iron and manganese were higher than the PSQG LEL and SEL. See Appendix Table T.2 for details.

10.4 Public Dose

The estimated radiation dose to the public associated with the closed Elliot Lake mine sites in the SRW was updated. Based on detailed calculations completed using the most up-to-date radiochemistry data (for fish tissue) and updated surveys of residents to define assumptions used in calculations, the total dose for an adult from Elliot Lake (including background dose), was estimated to be 0.035 mSv/a. Of this, 0.026 mSv/a was attributable to background, while the incremental dose was 0.01 mSv/a. Overall, the public dose of approximately 0.01 mSv/a (after removal of background) is well below the incremental public limit of 1 mSv/a and the dose constraint of 0.3 mSv/a.

10.5 Conclusions

The TMAs are performing well and reflecting improving conditions, with parameters meeting EIS predictions, effluents achieving discharge criteria, and low to no effects in acute and sublethal toxicity testing of effluents. The SRW is responding to these improvements as demonstrated by surface water quality consistently achieving the SRWMP benchmarks, with few exceptions. SRW water quality has improved more rapidly than sediment and benthic invertebrates. The estimated radiation dose to the public associated with the closed Elliot Lake mine sites in the SRW was well below the public dose limits.

11 RECOMMENDATIONS

The TOMP, SAMP, and SRWMP are effectively designed to meet their respective objectives to capture changes in TMA performance, mine release, and the receiving environment conditions. However, a few changes are recommended:

- At the Pronto TMA primary discharge SAMP station PR-01, there has been a slight increase in the concentration of radium-226 since 2003, however concentrations remain well below the discharge criterion (0.37 Bq/L) and below the SRWMP benchmark of 0.469 Bq/L. If concentrations continue to rise, an investigation into the cause should be conducted.
- Based on habitat characterization, SRWMP station D-6, located the outlet of Cinder Lake, should be considered a "wetland" type station, rather than “lake” with respect to SRWMP benchmarks (see Section 2.1.3.3). Compared to most other lake outlets monitored for water quality in the SRWMP, Cinder Lake is relatively small surface area (36.6 Ha) and is relatively shallow (10 m average depth). This is similar in size to Westner Lake; the Westner Lake outlet station SC-01 is compared to the “wetland” SRWMP benchmark. The Cinder stream channel is narrow and shallow, with abundant emergent vegetation (see Appendix Photo Set S.1).
- For SRWMP water quality benchmarks, it is proposed that hardness-based benchmarks be calculated for each individual sample using the hardness of that sample, rather than using the average hardness for that station over the study period.
- The public dose estimation will next be reviewed, and if required, updated as part of the Cycle 6 (2020 to 2025) SOE report.
- In 2020, a formal gap analysis was conducted between the existing monitoring network (TOMP, SAMP, and SRWMP) and its evolution and the CSA Standards N288.5-11 and N288.4-10 (Minnow 2020a). From this, the recommendation was made that to meet the requirement of the N288.5-11 (Clause 11.2.2), reporting needs to include a statement of uncertainties inherent in the monitoring results and any dose estimates derived from them. Currently, annual reporting includes a statement on whether data quality objectives are met; however, uncertainties can arise from other sources. In the future, a statement of uncertainties shall be included as part of SOE reporting, beginning with Cycle 6.

Data collected prior to the next study design will be considered and presented to support any further program changes proposed in the study design.

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APPENDIX A
STANDARD OPERATING PROCEDURES
(SOPS)

Table A.1: List of Standard Operating Procedures (SOPs) Associated with the Implementation of the TOMP and the SAMP, and Water Quality Component of the SRWMP

Procedure Name	Operating Procedure Number
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

Control Limit Maintenance

Revision: 2016.01	Replaces: 2011.01
Approved: April 28, 2016	Valid until: April 28, 2021
Document Maintainer	Compliance Coordinator/Environmental Coordinator
Document Approver	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 Elliot Lake performance monitoring data generated from any of the following programs:

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

Field parameters, samples and analytes subject to control limits are scheduled in the environmental database in accordance with RG8.7.2.01 Performance Monitoring Registry.

Table 2.1 provides a summary of control limit designations, source documents, objective and data sets to which the control limits apply.

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

Water quality assessment and response protocols are documented in PR8.0.0.01 Water Quality Assessment and Response Plans.

Table 2.1. Control Limit Designations

Control Limit Type	Source Documents	Objective	Applies to
Compliance Limits	Site-specficic OCM Plans, Certificate of Approvals Sewage	to provide immediate notification of compliance issue	Final point of control (CL-06, N-19, P14, PR-04, Q-28)
Action Levels	Site-specficic OCM Plans	to provide early warning of potential compliance issue	
Internal Investigation		to provide identification of upset or unusual operating conditions	
Data Validation	Performance monitoring current design documents	to provide automated approach to identification of outliers and potential data quality issues	All data entered into database
Evaluation Criteria	Performance monitoring current State of Environment Report		SRWMP water quality data; SAMP and TOMP surface water quality data at 10x criteria

3 Roles and Responsibilities

3.1 The Rio Algom Site Superintendent

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

- Periodic auditing of implementation 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:

- Final authorization of review and revisions of this procedure;
- 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; and
- 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; and
- 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: and
- Developing and initiating responses to control limits working with Environmental Coordinator as identified in RG8.7.2.01 Control Limit Registry and communicating progress to Environmental Manager and Reclamation Manager.

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 exceedances 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; and
- Informing the Environmental Coordinator/Compliance 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; and
- Evaluation Criteria: documents the parameter-specific water quality environmental assessment criteria and associated references.

4.1.1 The Rio Algom Reclamation Manager as appropriate is 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 and Compliance Coordinators are responsible for reviewing performance monitoring design documents and periodic State of the Environment Reports to identify changes in evaluation criteria.

4.1.3 The Compliance Coordinator is responsible for making 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 (i.e. Rio Algom Limited 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 high/low limits which are configured under Station Limits. These limits are automatically calculated based on the statistical trends of historical data (using the last 12 values), 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 (i.e. daily, weekly monthly etc.) followed by the period to 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, 2016	The Cycle 4 Study Design for the SRWMP, SAMP and TOMP
Minnow, 2016	The 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
2016-01	April 28, 2016	Update formatting, remove Denison, Requirements to reflect standardized data quality assessment programs; update associated report forms and data quality objectives based on Cycle 4 Design Study for the SRWMP, SAMP and TOMP; Feb, 2016

Data Entry

Procedure: PR8.7.3.01	Page 1 of 9
Revision: 2019.01	Replaces: 2014.01
Created: June 30, 2019	Valid until: June 30, 2024
Document Approver	Environmental Manager
Document Maintainer	Environmental Technician
Document Endorser	Environmental 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 BHP Site Superintendent and Denison Environmental Manager

The Site Superintendent and Environmental 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/Compliance 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;
- Conducting scheduled and unscheduled spot checks to verify care and maintenance contractor and consultant conformance with this procedure
- 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.

3.4 Field Technicians

Field Technicians 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 Coordinator of flagged data during the data entry/importing phase in accordance with RG8.7.2.02 Control Limit Registry
- Informing the 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 4 Design documents and Canadian Nuclear Safety Commission program approval. Additional performance monitoring requirements may arise from response monitoring programs and internal monitoring initiatives as identified by the Site Superintendent and/or Environmental Manager.

4.1.2 The 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 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 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 (i.e. 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 Coordinator of flagged data as detailed in accordance with RG8.7.2.02 Control Limit Registry
- Inform the 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 Coordinator of flagged data as detailed in accordance with RG8.7.2.02 Control Limit Registry
- Inform the 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 (EMLINE 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 Coordinator of flagged data as detailed in accordance with RG8.7.2.02 Control Limit Registry

  - Inform the 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 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 BHP SS 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
2019.01	June 30, 2019	All	All	Revised wording, headers and footers

Data Validation Procedure

PR8.7.3.02	Page 1 of 8
Revision: 2016.01	Replaces: 2011.01
Approved: April 28, 2016	Valid until: April 28, 2021
Document Maintainer	Environmental/Compliance Coordinator
Document Approver	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 with program requirements and procedures and optimal environmental database functionality.

2 APPLICATION

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

- SRWMP: Serpent River Watershed Monitoring Program;
- SAMP: Source Area Monitoring Program; and
- 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 Site Superintendent

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

- Audit of implementation 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:

- Final authorization of review and revisions of this procedure;
- 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/Compliance Coordinator

The 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;
- Reviewing responses to data that does not conform to the data validation criteria and communicating progress to Environmental Manager and Reclamation Manager;
- Reviewing data validation reports and programs and initiating and supervising modifications as required; and
- Conducting scheduled and unscheduled spot checks to verify care and maintenance contractor and consultant conformance with this procedure.

3.4 Environmental/Compliance Coordinator

The 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;
- Investigating and responding to any issues that may be causing the outliers and evaluating possible trends developing based on outliers;
- 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; and
- 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 Environmental/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 Environmental/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. Assessment 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 Environmental/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 (i.e. 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/Compliance 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 Environmental/Compliance Coordinator (or designate):

- Log into em-Line and select the appropriate application in which the data will be validated (i.e. Rio Algom Limited 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 exceedances; save after each one;
- Report any Action, Compliance, High/Low Flags or Internal limit exceedances to Environmental Coordinator (or designate) first before posting;
- As a check refresh by selecting the Status.

4.2.4 The Environmental/Compliance Coordinator is responsible for ensuring 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 Environmental/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 Environmental/Compliance Coordinator is responsible for running RF8.7.3.02 Flagged Data Report on a monthly basis.

- 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 (i.e.: 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/Compliance 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

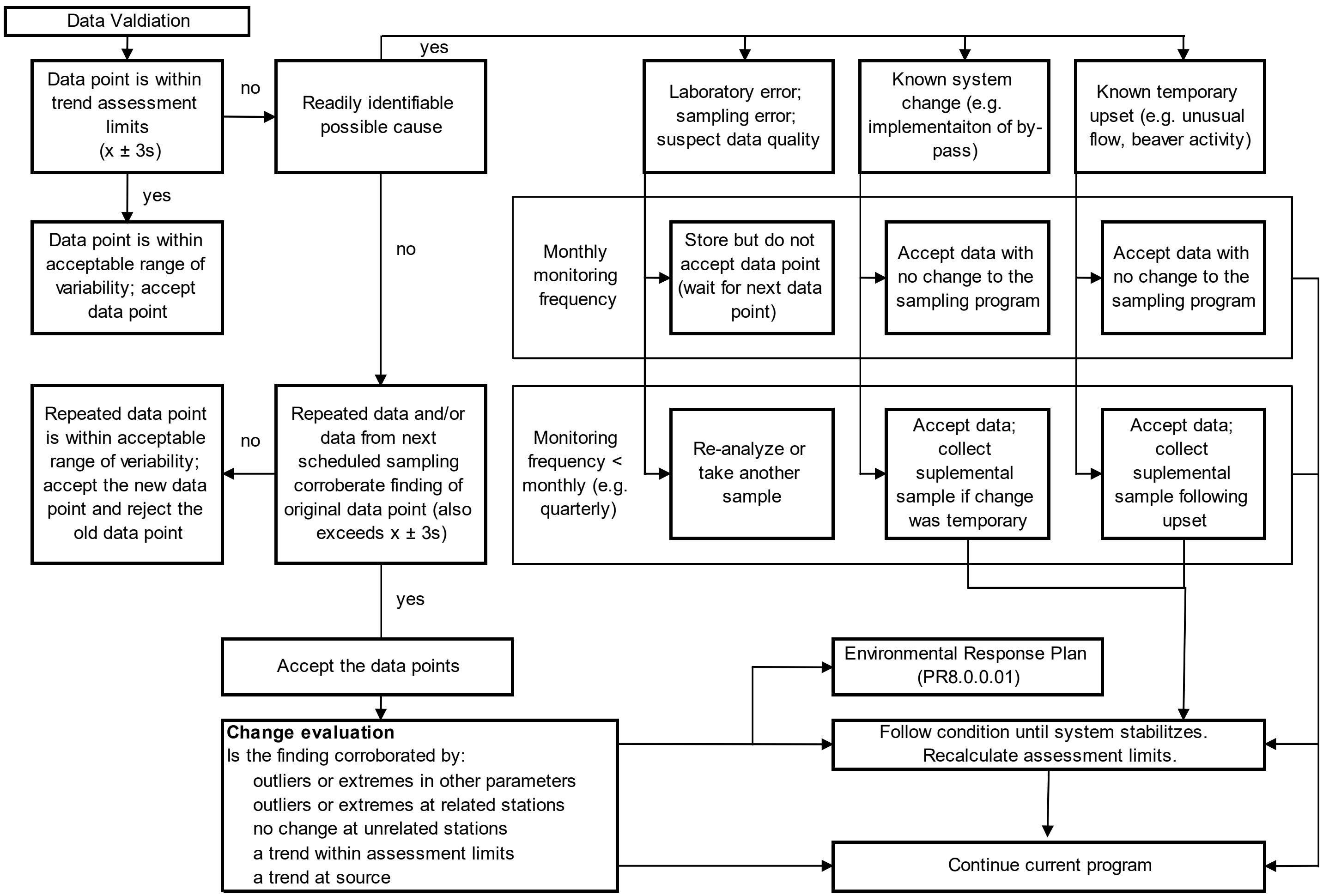
6.1 Procedure Review

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, 2016	The Cycle 4 Study Design for the SRWMP, SAMP and TOMP
Minnow, 2016	The 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
2016-01	April 28, 2016	Update formatting, remove Denison, Requirements to reflect standardized data quality assessment programs; update associated report forms and data quality objectives based on Cycle 4 Design Study for the SRWMP, SAMP and TOMP; Feb, 2016. Update role of Environmental/Compliance Coordinator.

Water Elevation Determination Procedure

PR8.6.4.03	Page 1 of 11
Revision: 2018.01	Replaces: 2015.01
Approved: February 26, 2018	Valid Until: February 26, 2021
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.

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.:

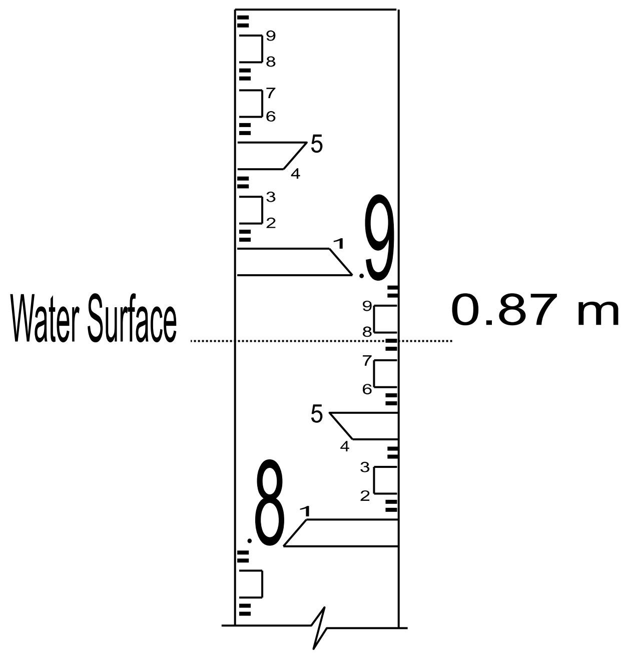
1. Remove any channel obstructions that may have artificially raised water elevations and allow sufficient time for elevation to reach equilibrium (dependent on size of pondage immediately upstream) before taking measurements.

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.
2018.01	Feb 26, 2018	Remove reference to Document Clerk

Field Conductivity Determination

Revision: 2017.01 | Replaces: 2011.01

Approved: Jan 3, 2017 | Valid Until: Jan 3, 2022

Document Maintainer: Environmental Technician

Document Endorser: Environmental Coordinator

Document Approver: Environmental Manager

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 (monthly)
- DS-5: Seepages and Surface water internal to TMA (weekly)
- DS-16: Orient Creek (quarterly)

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:

- 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
- Final authorization of review and revisions of 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 determination modifications required in response to changes to this procedure;
- Initiating and reviewing modifications to this procedure; and
- Conducting scheduled and unscheduled spot checks to verify care and maintenance contractor and consultant conformance with this procedure.

Compliance Coordinator

The Compliance Coordinator is responsible for supporting implementation of the Field 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.
- Review and assessment of data collected and then entered in to the data management software.

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 MOE, TOMP, as per the Cycle 4 Design documents and Canadian Nuclear Safety Commission program approval dated June 2016.

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 environmental 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
2017.01	Jan. 3, 2017	Update Denison logo, remove individual names in the header, change document control responsibility to environmental manager, add sample locations with frequency, change reference of cycle 3 to cycle 4 and the approval date, remove reference to emline, update to EC responsibilities.

PH Determination

PR8.6.3.01	
Revision: 2019.01	Replaces: 2014.01
Approved: December 6, 2019	Valid until: December 6, 2024
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 Site Superintendent

The Rio Algom Site Superintendent 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 Sampling Quality Control

PR8.5.3.01	Page 1 of 6
Revision: 2016.01	Replaces: 2013.01
Approved: April 21, 2016	Valid until: April 21, 2021
Document Maintainer	Compliance Coordinator
Document Approver	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 in Elliot Lake monitoring locations included in each of the following programs:

- SRWMP: Serpent River Watershed Monitoring Program;
- SAMP: Source Area Monitoring Program; and
- 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 Site Superintendent

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

- 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:

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

3.3 Environmental Coordinator

The Environmental Coordinator is responsible for overseeing implementation of the 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; and
- Data validation, review and reporting in accordance to Data Validation Procedure PR8.7.3.02.

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; and
- 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 (e.g. 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 (i.e.; 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 Location Requirements Registry. Criteria is as follows:

- 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;
- Representative of field conditions and sampling protocols (e.g. use of sample collection devices); and
- 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; and
- 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, 2016	The Cycle 4 Study Design for the SRWMP, SAMP and TOMP
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
2016-01	April 21, 2016	Update formatting, remove Denison, Requirements to reflect standardized data quality assessment programs; update associated report forms and data quality objectives based on Cycle 4 Design Study for the SRWMP, SAMP and TOMP; Feb, 2016

Revision 2016.01 | Replaces: 2011.01

Approved: April 28, 2016 | Valid Until: April 28, 2021

Document Owner | Environmental Technician

Document Approver | Environmental Manager

Key Contacts

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;
- Streams;
- Environment Canada flow station;
- MAG-X;
- Multi-ranger Plus (sonic level element).

3 ROLES AND RESPONSIBILITIES

The Rio Algom Reclamation Manager and Denison Environmental 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:

- Periodic Auditing of the implementation 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:

- Final authorization of review and revisions of this procedure;
- 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;
- In-stream measuring device (ex: Flow Probe)
- 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 4 Design documents and Canadian Nuclear Safety Commission program approval dated February 2016.

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
2016.01	April 28, 2016	Section 2: Added “Streams” to areas requiring flow determination Section 3: Changed wording to read “Environmental Manager” – removed the word “Services” Section 4, Equip. Preparation: Added the in-stream measuring device Section 4: Updated program to Cycle 4 with approval dated updated to February 2016.

Groundwater Sampling

PR8.6.2.01	
Revision: 2019.01	Replaces: 2018.01
Approved : 2019/06/20	Valid until: 2022/06/20
Document Maintainer	Environmental Technician
Document Approver	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 Responsibilities

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:

- Final authorization of review and revisions of this procedure;
- 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 REQUIREMENTS

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.

5 PROCEDURE

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. 500ml squirt bottle w/ distilled water;
10. Graduated purge containers (various volumes: 2L, 4L, 10L, 20L)
11. Cooler and ice packs;
12. Pre-labeled volumetric sample bottles;
13. Paper towels/disposable wipes;
14. Groundwater field sheets and groundwater sampling field forms (calculation sheets);
15. Groundwater tool box w/ appropriate spare assorted connectors, Waterra foot valves and electrical tape (4 rolls minimum);
16. White paint marker, extra locks and oil for maintaining Piezometer I.D., proper security and lid function.

Scheduling

The Compliance Coordinator will, prior to each sampling season, ensure 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;
- Ensuring any changes to sampling programs are incorporated into the schedule as per PR8.7.2.01: Scheduling.

Sampling

The field personnel who will be performing any groundwater monitoring shall collect groundwater grab samples and prepare samples for shipping in accordance with the following protocols:

Protocol: Office Preparation Before Sampling

Prior to preparing field equipment and beginning sampling, use the environmental database (emLine) to pull the field forms for the stations scheduled to be monitored. These forms are used because they allow review of the groundwater well conditions during previous sample events to ensure that erroneous measurements are identified in the field. In order to pull these field reports, the following procedure is followed:

- Login to emLine;
- Go to Reports, Report Manager, User Defined Report
- Choose Groundwater Field Sheet Multi and define the group of stations as “Groundwater all” (or you can select stations that will be monitored individually). DO NOT select the start and end date.
- The user should get a collection of field sheets for all of the stations to be monitored. An example of what this sheet looks like is shown below.

Denison Environmental Services

Groundwater Sampling Field Form

RF8.6.2.01
2013.01
Page 1 of 1

Site: ____________________ Date: __________ (Purged) | __________ (Sampled)

Location: ____________________ Sampler: ____________________

FIELD MEASUREMENTS	Water Level (WL)	**WL =**	**m**
	End of Hole (EOH)	**EOH =**	**m**
	Pipe Diameter (PD)	**PD =**	**m**
	Field pH:	**pH(f) =**	**m**
CALCULATIONS	Pipe radius	**R =**	**m**
	Height of water	**H =** [EOH-WL]	**m**
	Volume of water	**V =** [3.14 * R * R * H * 1000]	**L**
	Volume to purge, 3x	**V =** [3 * volume (L)]	**L**
	Volume purged, actual	**V =**	**L**
SAMPLE COLLECTION	Purge Duration		
	Well Recharge Duration		

Comments:

Issued by:

DES Environmental Manager

Issued on: March 15, 2013
Printed on: 30/08/2018

Denison Environmental Services

M12-1
2016 GW Field Sheet

Northing	Easting	Top of Pipe Elev (m)	Inclination (˚)	Correction Factor	Pipe Diameter (m)	As-Built DTB (m)	Sampler's Initials	Sample Date / Time
5137648.3	378690.6	339.36	90	1	0.009	0		

Date	Measured DTB (m)	Measured Depth (m)	Purge Volume (L)	Purge Method	Recharge Rate	pH	Maintenance / Comments
2011-08-19	13.6	2.1336	2.25	Peristaltic pump	Instant	6.1	Original purpose(s): TOMP;This is the original result which was confirmed by the repeated result of 2380 mg/L.;This is the original result which was confirmed by the repeated result of 3790 mg/L.
2012-08-13	13.47	2.19456	2.25	Peristaltic pump	Instant	6.3	Original purpose(s): TOMP
2013-07-15	13.47	1.6764	2.25	Peristaltic pump	Instant	6.2	Original purpose(s): TOMP;This is the repeat result which marginally confirmed the original of 5400 mg. The repeat falls within the typical range of values and in agreement with BSR-GW8.
2014-07-31	13.47	1.78	2.25	Peristaltic pump	Instant	6.26	water yellow color out of filter
2014-08-19	13.47	1.87	2.5	Peristaltic pump	Instant	6.2	more air than water, also BSR-GW8
2015-09-08	13.49	1.98	2.73	NA	Instant	6.1	Clear water. Sampling done in heavy rain.

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 Sampling Field Forms .
- Calculate the purge volume on the field sheet and then review measured values with historic values to ensure that there are no significant deviations caused by measurement or transcription error

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

All wells must be purged or emptied a minimum of three times before any sample is collected. If a well does not recharge within one day after purging, the well should not be sampled. The sample collection process is describe below:

- The 1½ and 2¼ inch monitoring wells are **purged** using a Waterra Inertia pumping system (foot valve) and **sampled** either with filter directly attached to Waterra tubing or using the peristaltic pumping system with an in-line filter where needed.
- In the cases where the head differential is >8 metres after purging, the Waterra (provided 3 times the volume has been removed from the well through it) can be used to fill a clean 2L container and the Peristaltic system with clean tubing may be used for filtering the sample from that container into the appropriate volumetric bottles for analysis at the lab;
- The ¾ and ½ inch diameter are flushed and sampled using a peristaltic pump;
- The ⅜ inch monitoring wells are purged and sampled by connecting the peristaltic pump directly to the ⅜ inch well casing with the appropriate connector from the GW tool box;
- Monitoring wells greater than 100 feet will be purged and sampled using the Nitrogen gas method. Samples are recovered by placing a small diameter polyethylene hose into the piezometer lead pipe down to the bottom of the water zone. As gas is released from the supply bottle, pressure in the piezometer builds and displaces water through the well cap adapter that the gas line is passed through. The sample water is collected in a clean 2L bottle and filtered from that bottle with the peristaltic pump and in-line filter into the appropriate volumetric bottles for analysis at the lab. This is done in the same way as bullet point 1 of this sub-section;
- <u>ALL</u> samples will be filtered through an in-line, 0.45μ pore size, high flow GW filter (at least 700cm^2 filter area) directly to the pre-labelled, precharged, volumetric sample bottles in the field if needed using the peristaltic pumping system;
- As per the electronic schedule, pH will be measured in the field using calibrated meters and recorded on the Groundwater Sampling Field Forms under the appropriate heading;

- Field parameters will be measured directly after sample collection by filling one of the plastic attachments for the pH field meter, and record measurement once the pH has stabilized, if needed, perform multiple times to ensure accuracy;
- Field parameters may be measured in a clean 500mL bottle if there is damage to plastic attachment or as needed.

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;
- A new section of rubber hose is to be use for each well to avoid any contamination that may occur from cleaning with Nitric acid solution. It is acceptable to keep the used sections of hose, clean them at a later time and store them for reuse.
- 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 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.
- 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;
- 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.

5.1.1.1 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. One C of C is to be included in the sample cooler for shipment. Electronic text files and pdf files of the C of Cs are saved on the Denison Sharepoint.

- 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 Sheet 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

6 RELEVANT REFERENCES

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
	Groundwater Field Sheet
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

REVISION HISTORY

Table 8.1. Revision History

Rev #	**Date**	**Revision Rationale and Highlights**
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
2016.01	Apr 15, 2016	Update procedure with new forms from emLine. Update roles and responsibilities.
2019.01	June 20, 2019	Updated procedure, changes to the use of ground water tubing (new tubing for each sample). Update to section on saving C of Cs.

Surface Water Grab Sampling

Operating Procedure: PR8.6.1.01	Page 1 of 6
Revision: 2016.01	Replaces: 2011.01
Approved: April 28, 2016	Valid Until: April 28, 2021
Document Maintainer	Environmental Technician
Document Approver	Environmental Manager
Key Contacts	Operations Superintendent

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.

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.

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:

- 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:

- Final authorization of review and revisions of this procedure

- 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

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 4 Design documents and Canadian Nuclear Safety Commission program approval dated February, 2016.

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.

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 environmental 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.

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.

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

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
2016-01	April 28 2016	Update Denison logo, remove individual names in the header, change document control responsibility to environmental manager, change reference of cycle 3 to cycle 4 and the approval date, remove reference to emline.

Toxicity Sampling

Operating Procedure: PR8.6.1.03	Page 1 of 7
Revision: 2016.01	Replaces: 2011.01
Approved: April 28, 2016	Valid Until: April 28, 2021
Document Owner	Environmental Technician
Document Approver	Environmental Manager
Key Contacts	

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:

- 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:

- Final authorization of review and revisions of this procedure;
- 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 4 Design documents and Canadian Nuclear Safety Commission program approval dated February, 2016.

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 environmental 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
2016.01	April ?, 2016	Update Denison logo, remove assigned individual names in the header, change document control responsibility to environmental manager, change reference of cycle 3 to cycle 4 and the approval

		date, remove reference to emline.

Rio Algom

Water Quality Data Quality Assessment

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 *Rio Algom Site Superintendent*

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

- Auditing implementation 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:

- Final authorization of review and revisions of this procedure;
- 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:

- 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;
- Reviewing modifications to this procedure and associated registries and report forms;
- 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:

- Initiating and directing data management and analytical services modifications required in response to changes to this procedure;
- 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 identified 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;
- 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, determining any sample mix-up issues and requesting repeat analysis and run follow-ups 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 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 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.

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 COMPANION DOCUMENTS

Document Number	Document Name
Minnow, 2016	The Cycle 4 Study Design for the SRWMP, SAMP and TOMP
Minnow, 2016	The Serpent River Watershed State of the Environment Report
RG8.5.2-01	Data Quality Objectives (DQO)
RG8.5.3-01	Quality Control and Quality Assurance (QAQC) Location 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
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
2016-01	April 21, 2016	Update formatting, remove Denison, Requirements to reflect standardized data quality assessment programs; update associated report forms and data quality objectives based on Cycle 4 Design Study for the SRWMP, SAMP and TOMP; Feb, 2016

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 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 Site Superintendent

The Rio Algom Site Superintendent has responsibility for the on-going operating, care and maintenance of the Rio Algom Limited (RAL) 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/Compliance Specialist

The Environmental Coordinator/Compliance Specialist 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 Site Superintendent and Environmental Manager;
- Reviewing monthly water quality reports and initiating response as required to emerging trends in consultation with Site Superintendent 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 Site Superintendent 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.
- 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.

3.4 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 Environmental Coordinator/Compliance Specialist of flagged data during the data entry/importing phase in accordance with RG8.7.2.02 Control Limit Registry
- Informing the Environmental Coordinator/Compliance Specialist 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 Environmental Coordinator/Compliance Specialist who is responsible for initiating response as required to emerging trends in consultation with Site Superintendent 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 Environmental Coordinator/Compliance Specialist who is responsible for initiating response as required to emerging trends in consultation with Site Superintendent 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 and reviewed by the Environmental Coordinator/Compliance Specialist who is responsible for initiating response as required to emerging trends in consultation with RAL Site Superintendent 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 are to be identified and reviewed by the Environmental Coordinator/Compliance Specialist. The Environmental Coordinator/Compliance Specialist is responsible for evaluating trends and initiating response as required to emerging trends in consultation with Site Superintendent and Environmental Manager

4.3 Trend Confirmation

4.3.1 The Environmental Coordinator/Compliance Specialist in consultation with the Rio Site Superintendent and Environmental Manager 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/Compliance Specialist is responsible for ensuring that confirmed trends are reported in the Monthly Water Quality Report.

4.4 Trend Evaluation

4.4.1 The Environmental Manager or designate 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 Site Superintendent or Environmental 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/Compliance Specialist is responsible for incorporating the findings in the monthly and annual water quality reports.

Figure 4.1. Trend Evaluation

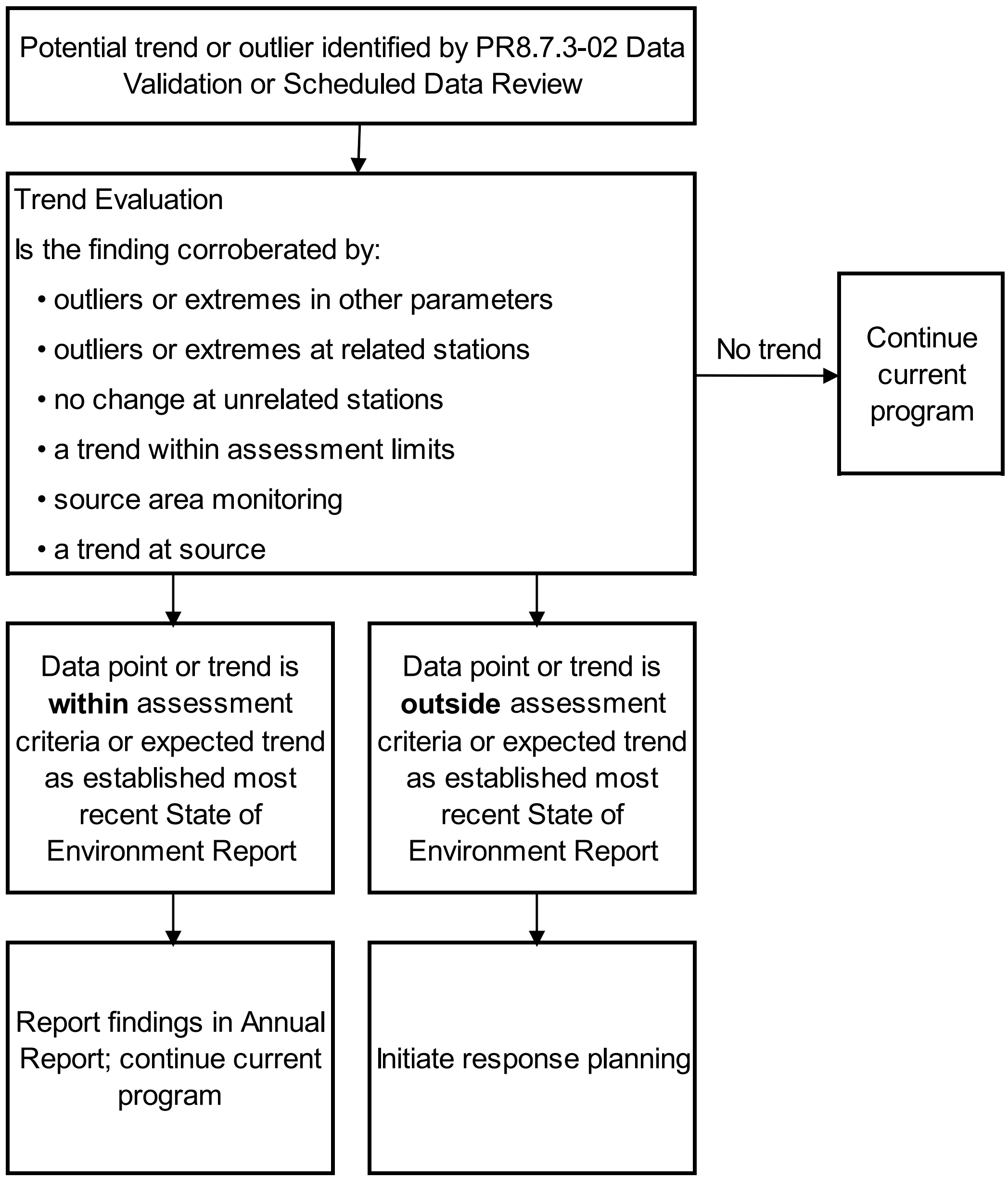
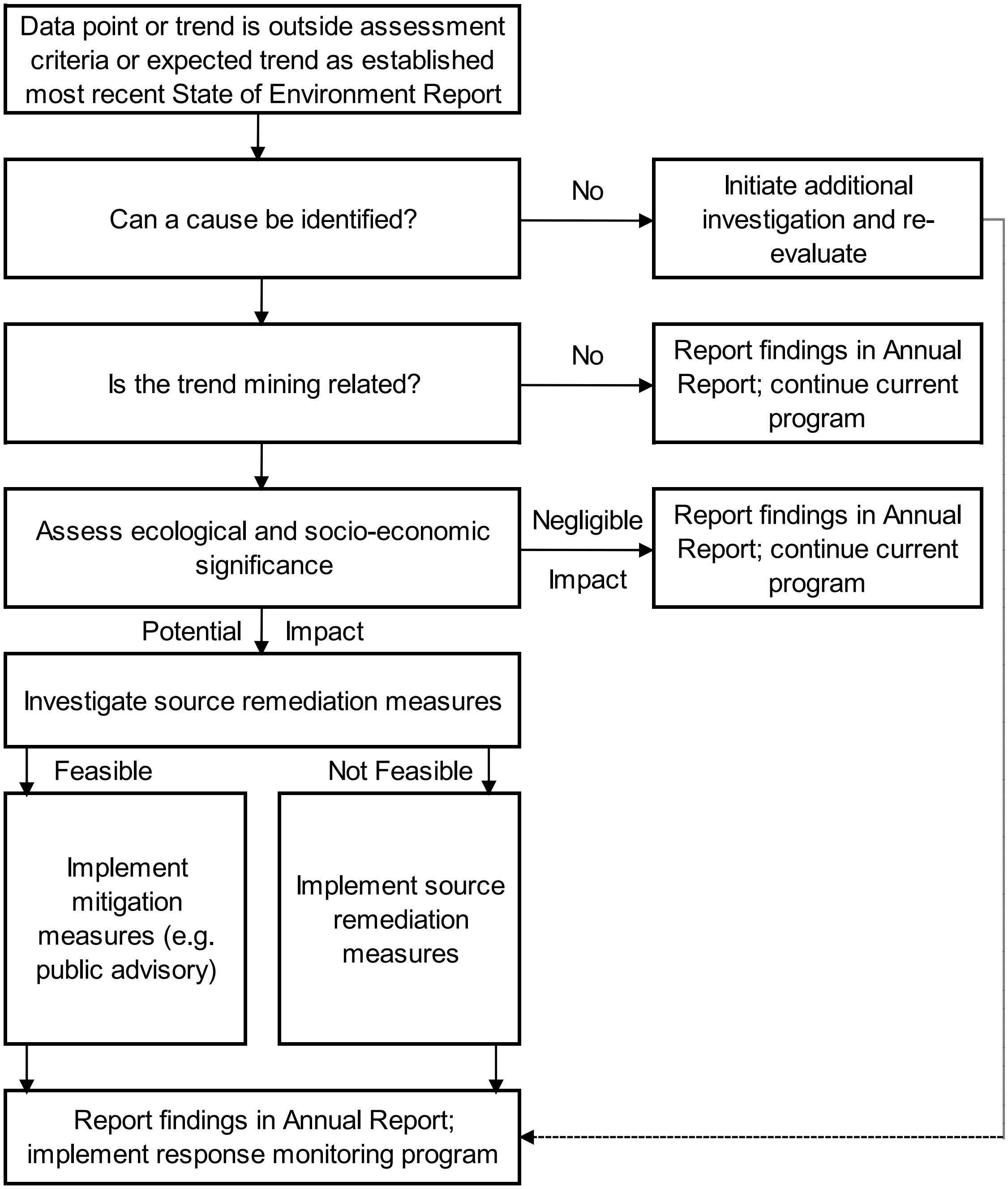


Figure 4.2. Environmental Response Plan Process



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 Rio Algom Site Superintendent and Environmental Manager or designate 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 Site Superintendent and/or Environmental Manager are 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/Compliance Specialist is responsible for ensuring that updates on Response Plan implementation are included in monthly and annual water quality reports.

5 TRAINING

The Environmental Coordinator/Compliance Specialist 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
2017.01	June 20, 2019	Review, update headers/footers, and update responsibilities.
2019.01	June 21, 2019	Review, update roles and responsibilities

APPENDIX B

DATA QUALITY AND ASSESSMENT

APPENDIX B DATA QUALITY ASSESSMENT

B1 INTRODUCTION

Data Quality Assessment (DQA) was conducted on water quality data collected under the TOMP, SAMP, and SRWMP between January 2015 and December 2019, as well as sediment quality, benthic invertebrate community, and fish tissue samples collected in September 2019 for the SRWMP (Tables B.1 to B.3). 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 to establish a relevant basis for judging whether 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 (see Appendix A). 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 2009a,b; Minnow 2014). Data quality for data collected during Cycle 5 (2015 to 2019) of the TOMP, SAMP, and

SRWMP 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 TOMP, SAMP, and SRWMP (Appendix Tables B.1 to B.3). 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 Mines Inc. (DMI) under contract to Rio Algom Limited (RAL) and DMI. DMI 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).

DMI is also responsible for ensuring that all staff participating in the collection and handling of samples and data management for the TOMP, SAMP, and SRWMP are adequately trained. In addition to the provision of standard operating procedures (SOPs) for each aspect of the program, DMI maintains a training module on their database which tracks the completion of training for each employee by equipment or task.

RAL and DMI have an Operating Document Registry which provides procedures and protocols to address all aspects of decommissioning operations and monitoring. DMI 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 2015 to 2019 for all parameters except radium-226. Radium-226 was analyzed by the Elliot Lake Research Field Station (ELRFS), currently known as the Perdue Central Analytical Facility (PCAF; Laurentian University, Sudbury, Ontario). All three laboratories are accredited by the Canadian Association for Laboratory Accreditation (CALA)[1]. Water samples for toxicity testing were submitted to AquaTox (Puslinch, ON), for acute (*Daphnia magna* and rainbow trout) and sub-lethal (*Ceriodaphnia dubia*) testing following Environment Canada (2000 and 2007a,b) methods. AquaTox is recognized for Organisation for Economic Co-operation and Development (OECD) Good Laboratory Practice (GLP) compliance by the Standards Council of Canada (SCC).

Water chemistry data generated as part of the TOMP, SAMP, and SRWMP were entered into an electronic database (emLine) according to specific SOPs designed to minimize data entry errors (Table 2.4; Appendix A). After a sample event was completed, an import file specific to the sample and the parameters required was generated within the emLine database and emailed to the laboratory that would be receiving the sample. The laboratory then populated the import file with the results for that specific sample and emailed it back in an Excel format for upload into the database by DMI. Prior to being accepted in the emLine database, laboratory data were screened against established DQOs. Values exceeding DQA limits were flagged, reviewed, and validated through a quality assurance (QA) process. This minimizes data entry errors.

As per the TOMP, SAMP, and SRWMP study designs, 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

[1] In June 2019, the laboratory accreditation from PCAF (formerly called the ELRFS) was withdrawn by CALA due to previous management not filing the "Management Review" document. However, PCAF continued to maintain and pass regular proficiency testing (PT) for radium analysis, to conduct analysis following the same radium-226 alpha spectrometer SOP method, and to assess all of the same quality control (QC) samples. Since ongoing procedures were identical to those conducted under the accreditation, PCAF continued to meet the requirements for regulatory reporting. Accreditation was formally restored on March 19, 2020 under ISO/IEC:17025-2017 for radium-226 in water and wastewater.

data quality objectives (2015 to 2019 annual reports can be found at the end of this appendix). Detailed QA reports are kept on file as part of the monitoring archives with RAL and DMI.

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.

- **Sub-Sampling Checks** are typically performed on benthic invertebrate community samples when excessive sample volume and/or organism density results in only a small amount of the original sample being analyzed. By comparing the numbers of benthic invertebrates recovered between at least two sub-samples, this measure provides an evaluation of how effective the sub-sampling method was in evenly dividing the original sample. Therefore, sub-sampling error provides a measure of analytical accuracy and precision. The processing of entire samples in representative sample fractions also allows an evaluation of sub-sampling accuracy.
- **Organism Recovery Checks** for benthic invertebrate community samples involve the re-processing of previously sorted material from a randomly selected sample to determine the number of invertebrates that were not recovered during the original sample processing. The reprocessing is conducted by an analyst not involved during the original processing to reduce any bias. This check allows the determination of accuracy through assessment of recovery efficiency.

B2 WATER SAMPLES

B2.1 Method Detection Limits

The requested method detection limits (MDLs), outlined in the DQOs, were achieved for SRWMP, SAMP, and TOMP for all parameters assessed during the 2015 to 2019 period with no exceptions (Tables B.2 to B.5). 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

B2.2.1 Field Blanks

Analytical results for blank samples are considered acceptable when concentrations are below the DQO of two-times the requested MDL. Detected concentrations were <two-times the MDL for SRWMP and SAMP samples, except for suphate in the October 2017 sample from SAMP station D-2 (Appendix Tables B.6 to B.8). All TOMP surface water samples met the DQO (Appendix Table B.9 to B.11). A number of samples from TOMP porewater and groundwater stations exceeded the field blank criteria (Appendix Table B.12 and B.13); 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.

B2.2.2 Laboratory Blanks

Laboratory blank data were summarized as part of the annual quality control reports for 2015 to 2019; however, data were not provided for individual laboratory blank samples (Appendix Table B.14). 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

B2.3.1 Overview

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 as 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.

B2.3.2 Field Precision

More than 200 duplicate water samples were collected in the field from 2015 to 2019 from the SRWMP, SAMP, and TOMP, and they generally showed good agreement in analyte concentrations (Appendix Tables B.15 to B.21). These RPDs are calculated using Minnow's approach (absolute difference between samples divided by the average of the samples, multiplied by 100). Most parameters RPDs that exceeded the DQO could be considered isolated cases due to the low number of exceedances over the five-year sampling period: acidity (2), iron (6), barium (4), cobalt (1), and manganese (4). Radium-226 and TSS exceeded the DQO in 14 and 23 sets, respectively. For TSS, in all cases the high RPD was a result of concentrations being close to the detection limit and therefore were considered acceptable. For radium-226, the majority of RPD values mainly occurred in SAMP and TOMP stations at concentrations orders of magnitude higher than the MDL. Despite this, most RPD values that exceed the DQO were between 20% and 30% for radium-226, with only five RPDs >30%, and results had improved compared to the results from 2010 to 2014 (i.e., data within the Cycle 4 SOE; Minnow 2017). This may reflect environmental variability, as the replicates as side-by-side samples. Although possible that some of the "field variability" for radium-226 may be caused by analytical difficulties, this is unlikely, as radium-226 met all criteria in laboratory duplicates and CRM samples (Section B.2.3.3). In the SRWMP data set, only one for radium-226 set exceeded the DQO (RPD = 37%; Table B.15). Radium-226 concentrations were typically well below discharge criteria, and were consistently well below the SRWMP benchmark, so this field variability does not impact the assessment of rick to biota. 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.

B2.3.3 Laboratory Duplicate Samples

Overall, there is close agreement between original and duplicate water analysis in the laboratory for all parameters (Table B.23). Out of 8,858 laboratory duplicate analyses, no samples exceeded the program DQO of 10%.

B2.4 Laboratory Data Accuracy

Recovery of certified reference material (CRM) met the DQO of 80 to 120% for all parameters (6,940 analyses: Table B.24). For the most part, analyte recoveries for spiked blank samples met the laboratory DQO of 80 to 120%; 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 to 120% (Table B.25). As with the lab duplicates, all the exceedances occurred in 2016, 2017 and 2018, and can be explained by concentrations approaching the method detection limit.

B3 SEDIMENT QUALITY

B3.1 Laboratory Reporting Limits

Target LRLs for sediment sample analyses were established at levels below applicable sediment quality guidelines (Appendix Table B.26). Reported LRLs were below the applicable sediment quality guidelines, meaning that sample data for this project could be reliably interpreted relative to the guidelines.

B3.2 Holding Time and General Laboratory Flags

There were no data quality issues reported by the laboratory for the sediment samples submitted under BV Labs Job Number B9R1693 (Appendix T).

B3.3 Field Duplicate Samples

Five duplicate sediment samples were collected (split) in the field from Dunlop Lake, Semiwite Lake, Nordic Lake, McCabe Lake, and Quirke Lake (Appendix Table B.27).

There were 13 comparisons (out of 65) that had RPD that exceeded the DQO of 40% (20.0% of all pairs; Appendix Table B.3). The majority of the DQO exceedances occurred within two duplicate pairs, ML-2019-3 and QL-2019-2 (Appendix Table B.27). Variability in sediment replicates is typically high (as demonstrated by laboratory duplicate RPD% DQO of 30%) due to particle size differences. Overall, precision associated with sediment physical and chemical characteristics was acceptable.

B3.4 Laboratory Blank Sample Analysis

Analyte concentrations within laboratory blank samples should be non-detectable, although a data quality objective of twice the method detection limit allows for variability at this low concentration level, around the detection limit. The DQOs of the laboratory blank quality control samples were established and screened by Bureau Veritas Laboratories. All of the 95 measured laboratory method blank results associated with the analyses of metals in sediment were non-detectable (BV Labs Job Number B9R1693; Appendix T). Thus, the method blank results for this study indicated no inadvertent contamination of samples within the laboratory during analysis.

B3.5 Laboratory Duplicate Samples

The DQOs for the laboratory duplicate samples were established and screened by Bureau Veritas Laboratories. Overall, there were 101 duplicate measurements made on sediment samples (BV Labs Job Number B9R1693; Appendix T) . None of the duplicate measurements exceeded the laboratory-established DQOs. Thus, laboratory reproducibility achieved in this study were considered excellent.

B3.6 Data Accuracy

The DQOs for reference materials (matrix spikes, QC standards, and spiked blanks) were established and screened by Bureau Veritas Laboratories. Data accuracy within the laboratory reports was evaluated based on results of reference materials. Overall, 294 measurements were made on 15 sediment chemistry standards (BV Labs Job Number B9R1693; Appendix T), with all 294 measurements meeting the laboratory DQO. Thus, the reference material results for this study demonstrated the acceptable accuracy of the laboratory methods used for this study.

B4 BENTHIC INVERTEBRATE COMMUNITY

Three of the four subsampled benthic invertebrate community samples did not meet the DQO of 20%, having a precision ranges with high ends of 32.1%, 21.8%, and 29.6% (Table B.28). However, the low end of the sampling precision range was 5.1 to 15.4%, so average precision was acceptable. Sub-sampled fractions ranged from 1/4 to whole sample sorted (Table B.29).

Sorting efficiency (i.e., percent recovery) of benthic invertebrate samples was high; achieving an average of 96.9% for the four samples evaluated (Table B.30). Sorting efficiency for each sample achieved the DQO of ≥ 90% recovery, and therefore the benthic invertebrate community sample recovery was acceptable.

The laboratory QA/QC indicated that the contents of samples NL-1 and NL-3 indicated a preservative[2], issue, based on the odour and on the stringy characteristic of the worms in the sample, which suggested degradation of benthic invertebrate tissues. Therefore, these samples were not included in the benthic invertebrate community analysis, as reported results were considered unreliable.

[2] Due to Covid-19 related delays, the sample assessment by the laboratory occurred later than typical. Sitting for this extra duration may have contributed to the preservative issue.

B5 FISH TISSUE

B5.1 Laboratory Reporting Limits

Achieved LRLs from fish tissue samples were all below established target concentrations, except for thorium-230 (2019-14432; Appendix Table B.31). Overall, the achieved LRLs were adequate for interpretation of results.

B5.2 Field Splits

Two field duplicate samples were collected from smallmouth bass muscle tissues from Quirke Lake and McCabe Lake (Appendix B Table B.8). The RPD values for analytes were below the DQO of 30% with the exception of radium-226 for sample QL-SMB-01 (Table B.32). Overall, field precision of muscle tissue samples were acceptable.

B5.3 Laboratory Duplicates

Laboratory precision for fish muscle was good, and met the laboratory requirements (see Quality Control Report for SRC Group # 2019-14432).

B5.4 Laboratory Reference Materials and Standards

Accuracy of certified reference material analyses were good, and met the laboratory requirements (see Quality Control Report for SRC Group # 2019-14432).

B6 DATA QUALITY STATEMENT

Benthic invertebrate taxonomy laboratory QA/QC indicated that the contents of samples NL-1 and NL-3 showed a preservative issue, based on the odour and on the stringy characteristic of the worms in the sample, which suggested degradation of benthic invertebrate tissues. The reported results were considered unreliable; therefore, these samples were not included in the benthic invertebrate community analysis. Aside from this, overall, the results of the DQA indicate the quality of the data was considered sufficient to serve the project objectives.

Table B.1: Field and Laboratory Data Quality Objectives for SAMP and TOMP Stations, 2015 to 2019

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	varies w/ method	0.1	-	-	-	-	-	-
pH	pH units	0.1	0.01	-	-	20%	-	-	-
Laboratory Parameters									
Acidity	mg/L	2.0	-	2	2	20%	10%	-	80 - 120%
Barium	mg/L	0.005	-	0.01	0.01	20%	10%	80 - 120%	80 - 120%
Cobalt	mg/L	0.0005	-	0.001	0.001	20%	10%	80 - 120%	80 - 120%
Iron	mg/L	0.02	-	0.04	0.04	20%	10%	80 - 120%	80 - 120%
Manganese	mg/L	0.002	-	0.004	0.004	20%	10%	80 - 120%	80 - 120%
Radium-226	Bq/L	0.005	-	0.01	0.01	20%	10%	80 - 120%	80 - 120%
Sulphate	mg/L	0.1	-	0.2	0.2	20%	10%	80 - 120%	80 - 120%
TSS	mg/L	1	-	2	2	20%	-	-	-
Uranium	mg/L	0.0005	-	0.001	0.001	20%	10%	80 - 120%	80 - 120%

Notes: TSS = Total Suspended Solids.

Table B.2: Data Quality Objectives for Water Quality Samples, SRWMP, 2015 to 2019

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%

Note: CRM = Certified Reference Material.

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

Table B.3: Data Quality Objectives for Sediment Quality, Fish Tissue, and Benthic Invertebrate Community Samples, SRWMP, September 2019

Quality Control Measure	Quality Control Sample Type	Study Component		
		Sediment Quality	Fish Tissue	Benthic Invertebrate Community
Field Precision	Field Duplicates	≤40% RPD	≤30% RPD	-
Laboratory Reporting Limits (LRL)	Comparison actual LRL versus target LRL	LRL for each parameter should be at least as low as applicable guidelines, ideally ≤1/10th guideline value	< Radionuclide-specific targets	-
Laboratory Quality Control (QC)	Blanks, laboratory duplicates, spike recovery, certified reference material	Laboratory standards are established for each control type, with QC results presented in the analytical reports.	Within the laboratory target limits. QC results presented in the analytical report.	Sub-Sampling Error: 20% difference between samples. Organism Recovery: ≥90%

Notes: RPD - Relative Percent Difference. QC - Quality Control.

Table B.4: Field and Laboratory Method Detection Limits (MDLs) for SRWMP Water Quality Analysis, 2015 to 2019

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

(grey box) MDL does not meet DQO.

Table B.5: Field and Laboratory Method Detection Limits (MDLs) for TOMP and SAMP Water Quality Analysis, 2015 to 2019

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
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

(grey box) MDL does not meet DQO.

Note: TSS - Total Dissolved Solids.

Table B.6: Field blanks for the SRWMP, 2015 to 2019

Parameter	Units	Field Blank Criterion	Field Blank Denison (FBD2)									
			20-May-15	17-Nov-15	3-May-16	29-Nov-16	16-May-17	21-Nov-17	24-May-18	26-Nov-18	23-May-19	12-Nov-19
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	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
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	-	5.30	5.40	5.50	5.80	5.20	5.20	5.20	5.90	5.80	5.80
Radium-226	Bq/L	0.01	< 0.005	< 0.008	< 0.008	< 0.008	< 0.008	< 0.007	< 0.007	< 0.007	< 0.007	< 0.007
Sulphate	mg/L	0.2	< 0.1	0.40	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Uranium	mg/L	0.001	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005

Parameter	Units	Field Blank Criterion	Field Blank Rio (FBR2)									
			19-May-15	16-Nov-15	16-May-16	23-Nov-16	24-May-17	21-Nov-17	22-May-18	26-Nov-18	22-May-19	19-Nov-19
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	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
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	-	5.60	5.50	5.30	5.20	5.50	5.20	5.60	5.90	5.90	6.00
Radium-226	Bq/L	0.01	< 0.005	< 0.008	< 0.008	< 0.008	< 0.008	< 0.007	< 0.007	< 0.007	< 0.007	< 0.007
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
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

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

Table B.7: Field Blanks for SAMP (Station Q-28) Water Samples, 2015 to 2019

Parameter	Units	Field Blank Criterion	Q-28															
			9-Feb-15	11-May-15	8-Jun-15	10-Aug-15	14-Sep-15	9-Nov-15	8-Feb-16	9-May-16	13-Jun-16	12-Sep-16	14-Nov-16	12-Dec-16	13-Feb-17	16-Mar-17	8-May-17	13-Jun-17
Barium	mg/L	0.01	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Cobalt	mg/L	0.001	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
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	< 0.5	0.09	< 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	< 0.02	< 0.02	< 0.02
Manganese	mg/L	0.004	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
pH	-	-	5.9	7.1	5.89	5.2	5.7	5.89	5.51	4.52	4.66	5.9	6.5	5.6	5.7	4.8	5.8	5.8
Radium-226	Bq/L	0.01	<0.005	<0.005	<0.005	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.007	<0.007	<0.007	<0.007
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	< 0.1	< 0.1	< 0.1
TSS	mg/L	2	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	<1	1
Uranium	mg/L	0.001	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005

Parameter	Units	Field Blank Criterion	Q-28														
			14-Aug-17	11-Sep-17	13-Nov-17	12-Feb-18	15-May-18	4-Jun-18	13-Aug-18	10-Sep-18	12-Nov-18	11-Feb-19	16-Apr-19	10-Jun-19	12-Aug-19	9-Sep-19	11-Nov-19
Barium	mg/L	0.01	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Cobalt	mg/L	0.001	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
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	0.6	< 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	< 0.02	< 0.02
Manganese	mg/L	0.004	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
pH	-	-	5.9	5.8	5.9	5.8	5.7	5.9	5.1	5.9	5.8	5.9	5.9	6.9	5.9	5.9	5.9
Radium-226	Bq/L	0.01	< 0.007	< 0.007	< 0.007	< 0.007	< 0.007	< 0.007	< 0.007	< 0.007	< 0.007	0.009	< 0.007	< 0.007	< 0.007	< 0.007	< 0.007
Sulphate	mg/L	0.2	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.9	< 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	< 1	< 1
Uranium	mg/L	0.001	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005

Field blank criterion not met.
Actual MDL does not meet target MDL.
Note: TSS = Total Suspended Solids.

Table B.8: Field Blanks for SAMP (Station D-2) Water Samples, 2015 to 2019

Parameter	Units	Field Blank Criterion	D-2											
			Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-15	Jul-15	Aug-15	Sep-15	Oct-15	Nov-15	Dec-15
Barium	mg/L	0.01	< 0.005	< 0.005	< 0.005	< 0.005	0.006	< 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
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	< 0.02	< 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	-	-	5.1	5.8	5.51	5.9	5.8	5.8	5.8	5.4	5.4	5.2	5.4	5.7
Radium-226	Bq/L	0.01	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.008	< 0.008	< 0.008	< 0.008	< 0.008	< 0.008
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

Parameter	Units	Field Blank Criterion	D-2											
			Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Aug-16	Sep-16	Oct-16	Nov-16	Dec-16
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
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	< 0.02	< 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	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
pH	-	-	5.3	5.3	5.8	5.3	5.3	5.9	5.2	5.7	5.6	5.8	5.8	6.6
Radium-226	Bq/L	0.01	< 0.008	< 0.008	< 0.008	< 0.008	< 0.008	< 0.008	< 0.008	< 0.008	< 0.008	< 0.008	< 0.008	< 0.008
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

Parameter	Units	Field Blank Criterion	D-2											
			Jan-17	Feb-17	Mar-17	Apr-17	May-17	Jun-17	Jul-17	Aug-17	Sep-17	Oct-17	Nov-17	Dec-17
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
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	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	0.04	< 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	-	-	6.9	6.2	7	6.3	6.4	6.1	6.3	6.5	6.5	6	6.5	6.5
Radium-226	Bq/L	0.01	< 0.007	< 0.007	< 0.007	< 0.007	< 0.007	< 0.007	0.009	< 0.007	< 0.007	< 0.007	< 0.007	< 0.007
Sulphate	mg/L	0.2	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.2	< 0.1	< 0.1	< 0.1	0.7	< 0.1	< 0.1
TSS	mg/L	2	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
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

Field blank criterion not met.
Actual MDL does not meet target MDL.
Note: TSS = Total Suspended Solids.

Table B.8: Field Blanks for SAMP (Station D-2) Water Samples, 2015 to 2019

Parameter	Units	Field Blank Criterion	D-2											
			Jan-18	Feb-18	Mar-18	Apr-18	May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18
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
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	< 0.02	< 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	-	-	7	6.5	5.2	6.5	5.6	5.9	5.9	5.2	6	5.9	6.3	5.8
Radium-226	Bq/L	0.01	< 0.007	< 0.007	< 0.007	< 0.007	< 0.007	< 0.007	< 0.007	< 0.007	< 0.007	< 0.007	< 0.007	< 0.007
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

Parameter	Units	Field Blank Criterion	D-2											
			Jan-19	Feb-19	Mar-19	Apr-19	May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19
Barium	mg/L	0.01	t	< 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
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	< 0.02	< 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	-	-	5.9	6.5	6.5	6.5	7	6.6	6.3	6.3	6.3	6.5	7	5.7
Radium-226	Bq/L	0.01	< 0.007	< 0.007	< 0.007	< 0.007	< 0.007	< 0.007	< 0.007	< 0.007	< 0.007	< 0.007	< 0.007	< 0.007
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

Field blank criterion not met.
Actual MDL does not meet target MDL.
Note: TSS = Total Suspended Solids.

Table B.9: **Field blanks for TOMP (Station N-19) Water Samples, 2015 to 2019**

Parameter	Units	Field Blank Criterion	N-19																			
			07-Jan-15	04-Feb-15	04-Mar-15	01-Apr-15	06-May-15	03-Jun-15	08-Jul-15	########	02-Sep-15	07-Oct-15	25-Nov-15	16-Dec-15	06-Jan-16	03-Feb-16	02-Mar-16	06-Apr-16	04-May-16	01-Jun-16	06-Jul-16	########
Barium	mg/L	0.01	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Cobalt	mg/L	0.001	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Iron	mg/L	0.04	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Manganese	mg/L	0.004	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
pH	-	-	5.4	5.60	5.6	6.10	5.95	5.49	5.8	5.8	5.6	5.9	5.5	5.4	5.74	5.41	5.97	5.7	5.76	6.81	5.9	8.17
Radium-226	Bq/L	0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
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	<0.1	<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	<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	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005

Parameter	Units	Field Blank Criterion	N-19																			
			07-Sep-16	05-Oct-16	02-Nov-16	07-Dec-16	04-Jan-17	08-Feb-17	01-Mar-17	05-Apr-17	03-May-17	07-Jun-17	05-Jul-17	########	06-Sep-17	04-Oct-17	01-Nov-17	06-Dec-17	03-Jan-18	07-Feb-18	07-Mar-18	04-Apr-18
Barium	mg/L	0.01	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Cobalt	mg/L	0.001	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Iron	mg/L	0.04	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	0.03	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Manganese	mg/L	0.004	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
pH	-	-	7.04	5.05	8.2	6.0	5.7	5.5	5.7	5.6	5.8	6.7	5.7	5.8	5.9	5.8	5.9	6.2	5.8	5.3	6.2	5.6
Radium-226	Bq/L	0.01	<0.008	<0.008	<0.008	<0.008	<0.007	<0.007	<0.007	<0.007	0.009	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007
Sulphate	mg/L	0.2	<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	<0.1	<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	<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	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005

Parameter	Units	Field Blank Criterion	N-19																			
			02-May-18	06-Jun-18	05-Jul-18	########	05-Sep-18	03-Oct-18	07-Nov-18	05-Dec-18	02-Jan-19	06-Feb-19	13-Mar-19	03-Apr-19	08-May-19	05-Jun-19	03-Jul-19	########	04-Sep-19	02-Oct-19	06-Nov-19	04-Dec-19
Barium	mg/L	0.01	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Cobalt	mg/L	0.001	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Iron	mg/L	0.04	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	0.033	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Manganese	mg/L	0.004	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
pH	-	-	5.4	5.9	5.7	6.1	5.7	5.7	6.3	5.3	5.4	6.5	6.5	6.5	6.6	6.7	5.9	5.9	5.9	7.0	6.6	7.1
Radium-226	Bq/L	0.01	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007
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	<0.1	<0.1	<0.1	<0.2	<0.1	<0.1	<0.1
TSS	mg/L	2	<1	<1	1	<1	<2	<1	<1	<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	<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.
Note: TSS = Total Suspended Solids.

Table B.10: Field Blanks for TOMP (Station Q-05) Water Samples, 2015 to 2019

Parameter	Units	Field Blank Criterion	Q-05											
			9-Feb-15	11-May-15	10-Aug-15	9-Nov-15	8-Feb-16	9-May-16	12-Sep-16	14-Nov-16	13-Feb-17	8-May-17	14-Aug-17	13-Nov-17
Acidity	mg/L	2	1	2	<1	1	<1	1	2	2	<1	2	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	-	-	5.91	5.91	5.2	5.85	5.49	4.52	5.9	6.5	5.7	5.8	5.9	5.9
Radium-226	Bq/L	0.01	-	-	-	-	-	-	-	-	-	-	-	-
Sulphate	mg/L	0.2	-	-	-	-	-	-	-	-	-	-	-	-
TSS	mg/L	2	-	-	-	-	-	-	-	-	-	-	-	-
Uranium	mg/L	0.001	-	-	-	-	-	-	-	-	-	-	-	-

Parameter	Units	Field Blank Criterion	Q-05							
			12-Feb-18	14-May-18	13-Aug-18	12-Nov-18	11-Feb-19	16-Apr-19	12-Aug-19	11-Nov-19
Acidity	mg/L	2	1	<1	<1	2	2	<1	<1	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	-	-	5.8	5.7	5.1	5.8	5.9	5.9	5.9	5.9
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.

Note: TSS = Total Suspended Solids.

Table B.11: Field Blanks for TOMP (Station DS-2) Water Samples, 2015 to 2019

Parameter	Units	Field Blank Criterion	DS-2						
			Jan-15	Apr-15	Sep-15	Oct-15	Jan-16	Apr-16	Oct-16
Acidity	mg/L	2	1	2	1	2	1	1	11
Barium	mg/L	0.01	-	-	-	-	-	-	-
Cobalt	mg/L	0.001	-	-	-	-	-	-	-
Hardness	mg/L	1.0	-	-	-	-	-	-	-
Iron	mg/L	0.04	-	-	-	-	-	-	-
Manganese	mg/L	0.004	-	-	-	-	-	-	-
pH	-	-	5.1	5.9	5.8	5.2	5.3	5.3	5.9
Radium-226	Bq/L	0.01	-	-	-	-	-	-	-
Sulphate	mg/L	0.2	-	-	-	-	-	-	-
TSS	mg/L	2	-	-	-	-	-	-	-
Uranium	mg/L	0.001	-	-	-	-	-	-	-

Parameter	Units	Field Blank Criterion	DS-2						
			Jan-17	Apr-17	Jul-17	Oct-17	Jan-18	Apr-18	Jul-18
Acidity	mg/L	2	<1	1	1	3	<1	1	2
Barium	mg/L	0.01	-	-	-	-	-	-	-
Cobalt	mg/L	0.001	-	-	-	-	-	-	-
Hardness	mg/L	1.0	-	-	-	-	-	-	-
Iron	mg/L	0.04	-	-	-	-	-	-	-
Manganese	mg/L	0.004	-	-	-	-	-	-	-
pH	-	-	6.8	5.8	6.8	6.4	7	5.5	5.9
Radium-226	Bq/L	0.01	-	-	-	-	-	-	-
Sulphate	mg/L	0.2	-	-	-	-	-	-	-
TSS	mg/L	2	-	-	-	-	-	-	-
Uranium	mg/L	0.001	-	-	-	-	-	-	-

Parameter	Units	Field Blank Criterion	DS-2				
			Oct-18	Jan-19	Apr-19	Jul-19	Oct-19
Acidity	mg/L	2	<1	2	2	2	<1
Barium	mg/L	0.01	-	-	-	-	-
Cobalt	mg/L	0.001	-	-	-	-	-
Hardness	mg/L	1.0	-	-	-	-	-
Iron	mg/L	0.04	-	-	-	-	-
Manganese	mg/L	0.004	-	-	-	-	-
pH	-	-	6.2	5.9	6.6	6.6	6.5
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.
Notes: TSS = Total Suspended Solids.

Table B.12: Field Blanks in RAL TOMP Groundwater, 2015 to 2019

Parameter	Units	Field Blank Criterion	UW9-1					95N4A					95QW5A					P-31				
			Aug-15	Jul-16	Aug-17	Aug-18	Jul-19	Aug-15	Jul-16	Jul-17	Aug-18	Jul-19	Jul-15	Jun-16	Jul-17	Jul-18	Jul-19	Jul-15	Jun-16	Jul-17	Jul-18	Aug-19
Acidity	mg/L as $CaCO_3$	4	3	1	7	2	2	3	2	3	<1	2	< 1	3	< 1	< 1	< 1	<1	2	5	1	2
Iron	mg/L	0.04	0.36	0.28	0.15	<0.02	<0.02	1.1	0.07	0.213	<0.02	<0.02	0.02	< 0.02	0.024	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
pH	pH units	-	6.9	7.7	5.8	5.6	6.4	5.54	6.35	5.5	6.26	6.29	5.95	5.73	5.70	6.36	6.54	5.63	5.76	5.77	6.54	6.48
Sulphate	mg/L	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	< 0.1	< 0.1	0.2	< 0.1	< 0.1	0.1	< 0.1	0.5	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.1

Parameter	Units	Field Blank Criterion	DK16-2B					SGW-3					M12-1				95QW-4				
			Jul-15	Jun-16	Jul-17	Jul-18	Jul-19	Jul-15	Jun-16	Jul-17	Aug-18	Aug-19	Jul-16	Aug-17	Aug-18	Jul-19	Jul-15	Jun-16	Jul-17	Jul-18	Jul-19
Acidity	mg/L as $CaCO_3$	4	<1	1	5	2	2	<1	<1	8	<1	2	1	4	1	6	<1	<1	26	<1	2
Iron	mg/L	0.04	<0.02	<0.02	0.05	<0.02	<0.02	< 0.02	0.18	< 0.02	0.023	0.064	0.02	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
pH	pH units	-	5.2	6.2	5.5	6.3	6.3	5.94	6.80	6.41	6.46	6.36	6.7	6.5	6.3	6.4	6.2	5.7	5.5	6.5	6.4
Sulphate	mg/L	0.2	<0.1	<0.1	0.2	<0.1	0.1	<0.1	<0.1	<0.1	0.3	<0.1	<0.1	<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.

Table B.13: Field Blanks in Denison TOMP Groundwater, 2015 to 2019

Parameter	Units	Field Blank Criterion	98-15A					BH91-DG4B					BH91-SG2A			
			Jul-15	Jul-16	Aug-17	Aug-18	Aug-19	Aug-15	Jul-16	Aug-17	Sep-18	Aug-19	Jul-18	Jul-16	Aug-17	Sep-18
Acidity	mg/L as $CaCO_3$	4	< 1.0	1	< 1.0	4	2	1	< 1.0	4	2	2	< 1.0	2	3	< 1.0
Iron	mg/L	0.04	< 0.02	0.37	0.08	< 0.02	0.03	0.03	< 0.02	0.07	< 0.02	0.01	< 0.02	5.99	< 0.02	< 0.02
pH	pH units	-	5.4	6.7	5.6	6.5	6.5	6.2	5.8	5.7	6.2	6.3	5.5	6.4	5.5	6.5
Sulphate	mg/L	0.2	< 1.0	0.1	0.2	0.1	0.1	0.2	< 0.1	0.2	< 0.1	< 0.1	< 0.02	< 0.1	< 0.1	< 0.1

Field blank criterion not met.

Actual MDL does not meet target MDL.

Note: BH91-SG2A was not sampled in 2019 as the well was dry/had no recharge.

Table B.14: Summary of Laboratory Blank Results, 2015 to 2019

Year	Description	Acidity	Barium	Cobalt	Iron	Hardness	Manganese	Radium-226	Sulphate	TSS	Uranium	Total
		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	0.04	-	0.004	0.01	0.2	2	0.001	
	Lab Criteria	1	0.005	0.0005	0.020	0.50	0.0020	0.010	0.10	1	0.001	
2015	Mean	1.60	0.0025	0.00020	0.0096	0.22	0.0010	0.00060	0.052	0.46	0.00030	**-**
	# 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	95	179	184	78	160	174	8	201	336	173	**1,666**
2016	Mean	1.60	0.0023	0.00024	0.008	0.11	0.00090	0.00060	0.051	0.45	0.00020	**-**
	# above criteria	7	0	1	0	0	0	0	0	0	0	**8**
	% above criteria	5.9	0	0.6	0	0	0	0	0	0	0	**0.4**
	# samples	119	219	170	240	64	172	96	198	354	167	**1,800**
2017	Mean	1.50	0.023	0.00020	0.009	0.22	0.00090	0.00062	0.053	0.48	0.00020	**-**
	# above criteria	13	0	0	0	0	0	0	0	0	0	**13**
	% above criteria	12.5	0	0	0	0	0	0	0	0	0	**0.8**
	# samples	104	192	156	223	62	166	101	187	364	153	**1,710**
2018	Mean	1.58	0.0021	0.00022	0.0081	0.16	0.00081	0.00063	0.054	0.44	0.00020	**-**
	# above criteria	11	0	0	0	0	0	0	0	0	0	**11**
	% above criteria	11.0	0	0	0	0	0	0	0	0	0	**0.6**
	# samples	100	193	152	223	96	167	122	245	385	154	**1,879**
2019	Mean	2.00	<0.005	<0.0005	<0.02	<0.5	<0.002	0.00063	<0.2	<1	<0.0005	**-**
	# above criteria	-	-	-	-	-	-	0	-	-	-	**-**
	% above criteria	-	-	-	-	-	-	0	-	-	-	**-**
	# samples	143	264	188	228	157	192	104	282	400	185	**2039**
Total	**# above criteria**	**31**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**32**
	% above criteria	**5.5**	**0.0**	**0.1**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.4**
	# samples	**561**	**1,047**	**850**	**992**	**539**	**871**	**431**	**1,113**	**1,839**	**832**	**9,094**

Samples above lab and program criteria.

Notes: "-" = Data not available. TSS =Total Suspended Solids.

Table B.15: **Field Duplicates for SRWMP, 2015 to 2019**

Date	Units	Field Precision Criteria (%)	Blind Sample Denison (BSD2)																	
			May-15			Nov-15			May-16			Nov-16			May-17			Nov-17		
			Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)
Barium	mg/L	20	0.014	0.014	0	0.014	0.013	7	0.015	0.016	6	0.019	0.02	5	0.016	0.016	0	0.012	0.013	8
Cobalt	mg/L	20	-	<0.0005	-	-	<0.0005	-	-	0.0006	-	-	<0.0005	-	-	<0.0005	-	-	<0.0005	-
Iron	mg/L	20	0.45	0.48	6	0.206	0.179	14	0.41	0.48	15	0.35	0.34	2	0.40	0.39	1	0.23	0.25	6
Manganese	mg/L	20	-	-	-	-	-	-	-	0.159	-	-	0.136	-	-	0.095	-	-	0.033	-
pH	-	20	6.8	6.8	0	6.9	6.9	0	6.6	6.6	0	6.7	6.7	0	6.9	6.9	0	6.8	6.8	0
Radium-226	Bq/L	20	0.017	0.016	6	0.013	0.011	17	0.033	0.031	6	0.019	0.021	10	0.016	0.018	12	0.010	0.010	0
Sulphate	mg/L	20	10	10	0	12	12	0	11	11	0	15	15	0	9.8	9.1	7	9.3	9.2	1
Uranium	mg/L	20	0.0023	0.0025	6	0.0029	0.0028	4	0.0022	0.0023	4	0.0018	0.0019	5	0.0020	0.0019	5	0.0041	0.0043	5

Date	Units	Field Precision Criteria (%)	Blind Sample Denison (BSD2)											
			May-18			Nov-18			May-19			Nov-19		
			Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)
Barium	mg/L	20	0.016	0.015	6	0.015	0.015	0	0.012	0.013	8	0.014	0.014	0
Cobalt	mg/L	20	-	<0.0005	-	-	<0.0005	-	-	<0.0005	-	-	<0.0005	-
Iron	mg/L	20	0.41	0.41	0	0.48	0.46	4	0.22	0.22	3	0.42	0.43	1
Manganese	mg/L	20	-	0.13	-	-	0.040	-	-	0.031	-	-	0.034	-
pH	-	20	6.7	6.7	0	6.8	6.8	0	6.9	6.9	0	7	7	0
Radium-226	Bq/L	20	0.017	0.020	16	0.018	0.015	18	0.017	0.017	0	0.016	0.014	13
Sulphate	mg/L	20	8.9	9.1	2	11	11	0	8.8	8.8	0	8.9	9.0000	1
Uranium	mg/L	20	0.0018	0.0018	0	0.0029	0.0030	3	0.0019	0.0021	10	0.0025	0.0025	0

Date	Units	Field Precision Criteria (%)	Blind Sample Rio (BSR5)																	
			May-15			Nov-15			May-16			Nov-16			May-17			Nov-17		
			Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)
Barium	mg/L	20	0.013	0.012	8	0.012	0.012	0	0.012	0.012	0	0.022	0.022	0	0.013	0.013	0	0.012	0.012	0
Cobalt	mg/L	20	-	<0.0005	-	-	<0.0005	-	-	<0.0005	-	-	0.00070	-	-	<0.0005	-	-	<0.0005	-
Iron	mg/L	20	0.15	0.15	0	0.107	0.1	7	0.12	0.12	2	0.46	0.44	6	0.17	0.18	6	0.15	0.16	1
Manganese	mg/L	20	0.074	0.075	1	0.056	0.057	2	0.078	0.075	4	0.25	0.24	2	0.11	0.12	5	0.079	0.08	1
pH	-	20	6.9	6.9	0	6.7	6.7	0	6.5	6.5	0	6.6	6.6	0	6.6	6.6	0	6.7	6.7	0
Radium-226	Bq/L	20	<0.007	<0.005	33	<0.008	0.008	0	<0.008	<0.008	0	0.013	0.012	8	<0.007	<0.007	-	0.007	<0.007	0
Sulphate	mg/L	20	16	16	0	26	26	0	14	13	7	95	95	0	21	22	5	14	14	0
Uranium	mg/L	20	<0.0005	<0.0005	0	<0.0005	<0.0005	0	<0.0005	<0.0005	0	<0.0005	<0.0005	0	<0.0005	<0.0005	0	<0.0005	<0.0005	0

Date	Units	Field Precision Criteria (%)	Blind Sample Rio (BSR5)											
			May-18			Nov-18			May-19			Nov-19		
			Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)
Barium	mg/L	20	0.013	0.012	8	0.012	0.012	0	0.012	0.012	0	0.013	0.013	0
Cobalt	mg/L	20	-	<0.0005	-	-	<0.0005	-	-	<0.0005	-	-	<0.0005	-
Iron	mg/L	20	0.18	0.18	1	0.17	0.16	5	0.15	0.14	5	0.19	0.20	6
Manganese	mg/L	20	0.10	0.10	0	0.08	0.08	4	0.07	0.07	3	0.08	0.08	-
pH	-	20	6.5	6.5	0	6.6	6.6	0	7.0	7.0	0	6.8	6.8	0
Radium-226	Bq/L	20	<0.007	0.007	-	<0.00700	<0.007	-	<0.00700	<0.007	-	<0.00700	<0.007	-
Sulphate	mg/L	20	16	16	0	13	14	7	9.4	8.7	8	16	16	0
Uranium	mg/L	20	<0.0005	<0.0005	0	<0.000500	<0.0005	0	<0.000500	<0.0005	0	<0.000500	<0.0005	0

Field blank criterion not met.
Actual MDL does not meet target MDL.
Note: Values less than MDL will be treated at MDL for RPD calculations.

Table B.16: Field Duplicates for RAL SAMP station Q-28, 2015 to 2019

Date	Units	Field Precision Criteria (%)	Q-28																	
			Feb-15			May-15			Jun-15			Aug-15			Sep-15			Nov-15		
			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	0.063	0.065	3	0.095	0.093	2	0.104	0.104	0	0.024	0.023	4	0.031	0.028	10	0.074	0.074	0
Cobalt	mg/L	20	0.0049	0.0046	6	0.0028	0.0028	0	0.0027	0.0026	4	0.0014	0.0014	0	0.0014	0.0015	7	0.0024	0.0025	4
DOC	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iron	mg/L	20	0.56	0.58	4	0.36	0.38	5	0.7	0.73	4	0.6	0.58	3	0.68	0.724	6	0.496	0.5	1
Hardness	mg/L	-	983	1030	5	636	664	4	657	648	1	915	894	2	880	877	0	957	955	0
Manganese	mg/L	20	1.01	1.03	2	0.602	0.612	2	0.581	0.562	3	0.38	0.377	1	0.357	0.395	10	0.491	0.504	3
pH	-	20	7.41	7.41	0	7.1	7.1	0	7	7	0	7	7	0	7.2	7.2	0	7	7	0
Radium-266	Bq/L	20	0.051	0.058	13	0.051	0.051	0	0.069	0.082	17	0.036	0.032	12	0.037	0.039	5	0.043	0.044	2
Sulphate	mg/L	20	1,000	990	1	650	620	5	640	640	0	890	900	1	930	970	4	1,000	1000	0
TSS	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Uranium	mg/L	20	0.0155	0.0162	4	0.0122	0.0122	0	0.0108	0.0107	1	0.01	0.0095	5	0.0127	0.012	6	0.011	0.0113	3

Date	Units	Field Precision Criteria (%)	Q-28																	
			Feb-16			May-16			Jun-16			Sep-16			Nov-16			Dec-16		
			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	0.075	0.075	0	0.12	0.115	4	0.068	0.067	1	0.059	0.058	2	0.069	0.067	3	0.084	0.085	1
Cobalt	mg/L	20	0.0044	0.0044	0	0.0032	0.0032	0	0.0021	0.0021	0	0.0014	0.0014	0	0.0019	0.0019	0	0.0039	0.004	3
Iron	mg/L	20	0.8	0.795	1	0.332	0.33	1	0.484	0.467	4	0.558	0.565	1	0.345	0.338	2	0.623	0.665	7
Hardness	mg/L	-	865	866	0	718	711	1	812	841	4	1,060	1030	3	1,050	1050	0	1,120	1140	2
Manganese	mg/L	20	0.951	0.952	0	0.727	0.715	2	0.504	0.52	3	0.369	0.375	2	0.411	0.407	1	1.01	1.03	2
pH	-	20	7.26	7.27	0	7.34	7.3	1	7.38	7.36	0	7.1	7.1	0	7.4	7.4	0	7	7	0
Radium-266	Bq/L	20	0.063	0.07	11	0.05	0.041	20	0.046	0.047	2	0.075	0.068	10	0.121	0.113	7	0.169	0.15	12
Sulphate	mg/L	20	910	910	0	570	570	0	730	720	1	1,000	980	2	1,000	1000	0	1,100	1100	0
TSS	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Uranium	mg/L	20	0.0107	0.0108	1	0.0097	0.0096	1	0.0112	0.0112	0	0.0189	0.0186	2	0.0143	0.0143	0	0.0117	0.012	3

Field blank criterion not met.
Actual MDL does not meet target MDL.
Notes: Values less than MDL will be treated at MDL for RPD calculations. TSS = Total Suspended Solids.

Table B.16: Field Duplicates for RAL SAMP station Q-28, 2015 to 2019

Date	Units	Field Precision Criteria (%)	Q-28																				
			Feb-17			Mar-17			May-17			Jun-17			Aug-17			Sep-17			Nov-17		
			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	0.074	0.051	37	0.08	0.08	0	0.088	0.085	3	0.082	0.084	2	0.078	0.078	0	0.083	0.085	2	0.112	0.115	3
Cobalt	mg/L	20	0.0045	0.0043	5	0.0063	0.0063	0	0.002	0.002	0	0.0016	0.0016	0	0.0014	0.0014	0	0.0014	0.0014	0	0.0026	0.0027	4
Iron	mg/L	20	0.77	0.797	3	1.01	1.02	1	0.331	0.332	0	0.382	0.376	2	0.444	0.437	2	0.351	0.359	2	0.276	0.285	3
Hardness	mg/L	-	1,120	1060	6	1,000	1000	0	727	738	2	837	849	1	900	858	5	916	930	2	769	796	3
Manganese	mg/L	20	1.21	1.2	1	1.42	1.41	1	0.615	0.633	3	0.388	0.378	3	0.418	0.411	2	0.353	0.357	1	0.793	0.82	3
pH	-	20	7.7	7.7	0	7.5	7.5	0	7.1	7.1	0	7.1	7.1	0	7.1	7.2	1	7.2	7.2	0	7.7	7.7	0
Radium-266	Bq/L	20	0.1	0.081	21	0.133	0.144	8	0.047	0.052	10	0.068	0.074	8	0.124	0.123	1	0.11	0.137	22	0.12	0.119	1
Sulphate	mg/L	20	1,000	990	1	940	950	1	620	570	8	740	740	0	830	830	0	850	850	0	880	950	8
TSS	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Uranium	mg/L	20	0.0139	0.0131	6	0.013	0.0128	2	0.0111	0.0105	6	0.0111	0.0114	3	0.0128	0.0131	2	0.013	0.0139	7	0.0072	0.0071	1

Date	Units	Field Precision Criteria (%)	Q-28																	
			Feb-18			May-18			Jun-18			Aug-18			Sep-18			Nov-18		
			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	0.088	0.092	4	0.105	0.106	1	0.093	0.088	6	0.049	0.052	6	0.071	0.073	3	0.104	0.105	1
Cobalt	mg/L	20	0.0033	0.0033	0	0.0018	0.0017	6	0.0009	0.0009	0	0.0008	0.0007	13	0.0007	0.0008	13	0.0019	0.002	5
Iron	mg/L	20	0.458	0.474	3	0.194	0.182	6	0.229	0.24	5	0.33	0.35	6	0.32	0.328	2	0.37	0.37	1
Hardness	mg/L	-	1,290	1070	19	666	663	0	640	667	4	831	884	6	891	915	3	994	990	0
Manganese	mg/L	20	0.96	0.966	1	0.523	0.526	1	0.317	0.321	1	0.252	0.264	5	0.215	0.222	3	0.703	0.706	0
pH	-	20	7.5	7.5	0	7.2	7.2	0	7.3	7.3	0	7.1	7.1	0	7.2	7.2	0	7.3	7.3	0
Radium-266	Bq/L	20	0.099	0.094	5	0.133	0.134	1	0.066	0.087	27	0.036	0.047	27	0.041	0.043	5	0.058	0.049	17
Sulphate	mg/L	20	960	960	0	550	560	2	560	530	6	880	890	1	860	900	5	880	810	8
TSS	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Uranium	mg/L	20	0.013	0.013	2	0.013	0.013	0	0.014	0.013	4	0.015	0.016	6	0.012	0.013	4	0.0082	0.0082	0

Date	Units	Field Precision Criteria (%)	Q-28																	
			Feb-19			Apr-19			Jun-19			Aug-19			Sep-19			Nov-19		
			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	0.098	0.107	9	0.108	0.106	2	0.143	0.148	3	0.038	0.04	5	0.057	0.059	3	0.121	0.118	3
Cobalt	mg/L	20	0.0035	0.0034	3	0.0035	0.0036	3	0.0009	0.001	11	0.0013	0.0014	7	0.0013	0.001308	1	0.0019	0.0019	0
Iron	mg/L	20	0.553	0.548	1	0.576	0.603	5	0.167	0.173	4	0.42	0.44	5	0.52	0.54	4	0.406	0.414	2
Hardness	mg/L	-	976	959	2	897	902	1	689	692	0	856	884	3	874	892	2	942	946	0
Manganese	mg/L	20	0.87	0.862	1	0.881	0.899	2	0.31	0.313	1	0.492	0.514	4	0.323	0.33	2	0.726	0.729	0
pH	-	20	7.2	7.2	0	8.1	8.1	0	7.9	7.9	0	7	7	0	7.1	7.1	0	7.3	7.3	0
Radium-266	Bq/L	20	0.084	0.098	15	0.155	0.177	13	0.153	0.146	5	0.027	0.027	0	0.041	0.037	10	0.137	0.127	8
Sulphate	mg/L	20	960	900	6	760	810	6	630	620	2	740	750	1	860	860	0	900	890	1
TSS	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Uranium	mg/L	20	0.0201	0.0209	4	0.0166	0.0167	1	0.0071	0.0074	4	0.0144	0.0156	8	0.0133	0.0138	4	0.008	0.0078	3

Field blank criterion not met.
Actual MDL does not meet target MDL.
Notes: Values less than MDL will be treated at MDL for RPD calculations. TSS = Total Suspended Solids.

Table B.17: Field Duplicates for Denison SAMP/TOMP Station D-2, 2015 to 2019

Date	Units	Field Precision Criteria (%)	D-2																	
			Jan-15			May-15			Mar-15			Apr-15			May-15			Jun-15		
			Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)
Barium	mg/L	20	0.318	0.319	0	0.238	0.247	4	0.166	0.161	3	0.134	0.134	0	0.16	0.167	4	0.12	0.119	1
Cobalt	mg/L	20	0.0006	0.0005	18	0.0006	0.0006	0	0.0006	0.0006	0	0.0005	0.0005	0	0.0005	0.0005	0	0.0006	0.0006	0
Hardness	mg/L	20	235	230	2	252	247	2	237	236	0	202	201	0	224	233	4	269	270	0
Iron	mg/L	20	0.27	0.27	0	0.25	0.26	4	0.31	0.32	3	0.25	0.25	0	0.28	0.29	4	0.14	0.14	0
Manganese	mg/L	20	0.204	0.219	7	0.178	0.179	1	0.208	0.201	3	0.18	0.184	2	0.217	0.207	5	0.285	0.29	2
pH	-	20	7.2	7.2	0	7	7	0	7.06	7.06	0	6.7	6.7	0	7	7	0	7	7	0
Radium-226	Bq/L	20	0.209	0.22	5	0.151	0.162	7	0.107	0.104	3	0.083	0.083	0	0.1	0.087	14	0.094	0.086	9
Sulphate	mg/L	20	190	190	0	180	180	0	180	190	5	140	140	0	200	200	0	220	220	0
TSS	mg/L	20	1	1	0	1	< 1	0	1	1	0	1	< 1	0	< 1	< 1	0	1	< 1	0
Uranium	mg/L	20	0.0301	0.0289	4	0.0305	0.0313	3	0.0304	0.0305	0	0.0236	0.0242	3	0.0283	0.0287	1	0.0326	0.0337	3

Date	Units	Field Precision Criteria (%)	D-2																	
			Jul-15			Aug-15			Sep-15			Oct-15			Nov-15			Dec-15		
			Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)
Barium	mg/L	20	0.077	0.081	5	0.064	0.062	3	0.051	0.052	2	0.139	0.146	5	0.12	0.115	4	0.094	0.088	7
Cobalt	mg/L	20	< 0.0005	< 0.0005	0	< 0.0005	< 0.0005	0	0.0005	0.0005	0	0.0006	0.0006	0	0.001	0.0009	11	0.0011	0.001	10
Hardness	mg/L	20	316	303	4	329	339	3	352	342	3	402	402	0	366	358	2	377	372	1
Iron	mg/L	20	0.07	0.06	15	0.07	0.07	0	0.074	0.072	3	0.108	0.108	0	0.152	0.146	4	0.155	0.148	5
Manganese	mg/L	20	0.188	0.178	5	0.159	0.156	2	0.116	0.129	11	0.244	0.267	9	0.273	0.268	2	0.29	0.276	5
pH	-	20	7.2	7.2	0	7.3	7.3	0	7.4	7.3	1	7.2	7.2	0	7.4	7.4	0	7.4	7.4	0
Radium-226	Bq/L	20	0.048	0.044	9	0.05	0.053	6	0.039	0.033	17	0.157	0.143	9	0.157	0.194	21	0.09	0.094	4
Sulphate	mg/L	20	260	260	0	290	280	4	300	300	0	310	320	3	320	320	0	310	320	3
TSS	mg/L	20	< 1	< 1	0	< 1	1	0	< 1	< 1	0	< 1	1	0	< 1	1	0	< 1	< 1	0
Uranium	mg/L	20	0.0399	0.0441	10	0.0507	0.0508	0	0.0465	0.0474	2	0.0619	0.0642	4	0.0629	0.0623	1	0.0622	0.0628	1

Field blank criterion not met.

Actual MDL does not meet target MDL.

Notes: Values less than MDL will be treated at MDL for RPD calculations. TSS = Total Suspended Solids.

Table B.17: Field Duplicates for Denison SAMP/TOMP Station D-2, 2015 to 2019

Date	Units	Field Precision Criteria (%)	D-2																	
			Jan-16			Feb-16			Mar-16			Apr-16			May-16			Jun-16		
			Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)
Barium	mg/L	20	0.319	0.308	4	0.272	0.273	0	0.289	0.282	2	0.565	0.589	4	0.376	0.393	4	0.161	0.157	3
Cobalt	mg/L	20	0.0008	0.0008	0	0.0006	0.0007	15	0.0006	0.0007	15	< 0.0005	< 0.0005	#VALUE!	0.0007	0.0007	0	< 0.0005	< 0.0005	0
Hardness	mg/L	-	223	220	1	212	215	1	247	258	4	180	180	0	237	238	0	263	261	1
Iron	mg/L	20	0.289	0.279	4	0.373	0.371	1	0.447	0.379	16	0.339	0.343	1	0.36	0.363	1	0.151	0.149	1
Manganese	mg/L	20	0.164	0.166	1	0.141	0.141	0	0.127	0.132	4	0.111	0.112	1	0.198	0.2	1	0.103	0.1	3
pH	-	20	7.2	7.2	0	7	7	0	7	7	0	7.1	7.1	0	7.6	7.6	0	7	7	0
Radium-226	Bq/L	20	0.266	0.255	4	0.223	0.238	7	0.133	0.148	11	0.402	0.396	2	0.249	0.215	15	0.09	0.093	3
Sulphate	mg/L	20	190	200	5	180	180	0	180	180	0	130	130	0	150	150	0	200	200	0
TSS	mg/L	20	< 1	< 1	0	< 1	< 1	0	< 1	< 1	0	< 1	< 1	0	1	1	0	1	1	0
Uranium	mg/L	20	0.0354	0.0345	3	0.0313	0.0315	1	0.031	0.0311	0	0.0223	0.0225	1	0.0251	0.0248	1	0.0294	0.0286	3

Date	Units	Field Precision Criteria (%)	D-2																	
			Jul-16			Aug-16			Sep-16			Oct-16			Nov-16			Dec-16		
			Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)
Barium	mg/L	20	0.103	0.106	3	0.085	0.087	2	0.075	0.065	14	0.07	0.076	8	0.08	0.092	14	0.079	0.098	21
Cobalt	mg/L	20	< 0.0005	< 0.0005	0	< 0.0005	< 0.0005	0	< 0.0005	< 0.0005	0	< 0.0005	< .0005	0	0.0006	0.0006	0	0.0009	0.001	11
Hardness	mg/L	-	289	287	1	319	319	0	350	367	5	379	396	4	378	391	3	377	383	2
Iron	mg/L	20	0.07	0.06	15	0.063	0.059	7	0.084	0.071	17	0.086	0.088	2	0.116	0.115	1	0.214	0.223	4
Manganese	mg/L	20	0.083	0.08	4	0.076	0.072	5	0.072	0.065	10	0.146	0.15	3	0.152	0.149	2	0.212	0.21	1
pH	-	20	7.1	7.1	0	7.3	7.3	0	7	7	0	7.3	7.3	0	7.1	7.1	0	7.2	7.2	0
Radium-226	Bq/L	20	0.061	0.07	14	0.033	0.043	26	0.04	0.032	22	0.082	0.07	16	0.088	0.072	20	0.07	0.081	15
Sulphate	mg/L	20	220	230	4	260	260	0	280	280	0	300	300	0	310	330	6	330	330	0
TSS	mg/L	-	1	1	0	1	1	0	1	1	0	< 1	< 1	0	1	1	0	< 1	1	0
Uranium	mg/L	20	0.037	0.0364	2	0.045	0.0458	2	0.0504	0.0524	4	0.0518	0.0574	10	0.0586	0.0573	2	0.0579	0.0569	2

Field blank criterion not met.

Actual MDL does not meet target MDL.

Notes: Values less than MDL will be treated at MDL for RPD calculations. TSS = Total Suspended Solids.

Table B.17: Field Duplicates for Denison SAMP/TOMP Station D-2, 2015 to 2019

Date	Units	Field Precision Criteria (%)	D-2																	
			Jan-17			Feb-17			Mar-17			Apr-17			May-17			Jun-17		
			Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)
Barium	mg/L	20	0.057	0.042	30	0.067	0.141	71	0.409	0.406	1	0.261	0.198	27	0.161	0.161	0	0.217	0.226	4
Cobalt	mg/L	20	0.0009	0.0008	12	0.0011	0.0019	53	0.0007	0.0007	0	0.0007	0.0006	15	0.0006	0.0006	0	< 0.0005	< 0.0005	0
Hardness	mg/L	-	376	377	0	421	419	0	298	301	1	209	177	17	356	354	1	297	292	2
Iron	mg/L	20	0.313	0.307	2	0.437	0.615	34	0.54	0.558	3	0.609	0.486	22	0.315	0.304	4	0.151	0.141	7
Manganese	mg/L	20	0.214	0.193	10	0.251	0.406	47	0.168	0.162	4	0.172	0.138	22	0.182	0.183	1	0.129	0.119	8
pH	-	20	6.9	6.9	0	7.1	7	1	7	7	0	7	6.9	1	7.5	7.5	0	7.5	7.5	0
Radium-226	Bq/L	20	0.045	0.032	34	0.046	0.092	67	0.292	0.302	3	0.174	0.125	33	0.121	0.115	5	0.15	0.122	21
Sulphate	mg/L	20	320	320	0	320	320	0	200	200	0	140	120	15	240	230	4	220	220	0
TSS	mg/L	-	< 1	1	0	1	1	0	1	2	67	1	1	0	1	2	67	< 1	1	0
Uranium	mg/L	20	0.055	0.0576	5	0.0615	0.062	1	0.0414	0.0433	4	0.0239	0.0193	21	0.0393	0.0408	4	0.0375	0.0387	3

Date	Units	Field Precision Criteria (%)	D-2																	
			Jul-17			Aug-17			Sep-17			Oct-17			Nov-17			Dec-17		
			Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)
Barium	mg/L	20	0.235	0.245	4	0.147	0.148	1	0.105	0.094	11	0.097	0.087	11	0.333	0.329	1	0.37	0.379	2
Cobalt	mg/L	20	< 0.0005	< 0.0005	0	< 0.0005	< 0.0005	0	< 0.0005	< 0.0005	0	< 0.0005	< 0.0005	0	0.0006	0.0007	15	0.0006	0.0006	0
Hardness	mg/L	-	290	295	2	281	267	5	294	300	2	349	357	2	278	282	1	221	224	1
Iron	mg/L	20	0.126	0.128	2	0.139	0.118	16	0.2	0.126	45	0.12	0.11	9	0.134	0.14	4	0.204	0.205	0
Manganese	mg/L	20	0.117	0.117	0	0.089	0.097	9	0.125	0.05	86	0.109	0.092	17	0.178	0.186	4	0.15	0.151	1
pH	-	20	7.3	7.4	1	7.2	7.3	1	7.5	7.5	0	7.4	7.4	0	7.5	7.4	1	7.3	7.2	1
Radium-226	Bq/L	20	0.108	0.13	18	0.1	0.089	12	0.064	0.059	8	0.055	0.043	24	0.205	0.212	3	0.231	0.192	18
Sulphate	mg/L	20	200	210	5	220	220	0	240	240	0	270	260	4	210	210	0	190	190	0
TSS	mg/L	-	1	1	0	< 1	1	0	2	1	67	< 1	< 1	0	< 1	< 1	0	1	1	0
Uranium	mg/L	20	0.0335	0.0335	0	0.0326	0.0317	3	0.0388	0.0367	6	0.0399	0.0386	3	0.0328	0.0313	5	0.0318	0.0324	2

Field blank criterion not met.

Actual MDL does not meet target MDL.

Notes: Values less than MDL will be treated at MDL for RPD calculations. TSS = Total Suspended Solids.

Table B.17: Field Duplicates for Denison SAMP/TOMP Station D-2, 2015 to 2019

Date	Units	Field Precision Criteria (%)	D-2																	
			Jan-18			Feb-18			Mar-18			Apr-18			May-18			Jun-18		
			Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)
Barium	mg/L	20	0.451	0.452	0	0.533	0.535	0	0.454	0.45	1	0.343	0.348	1	0.45	0.493	9	0.293	0.286	2
Cobalt	mg/L	20	0.0005	0.0006	18	0.0005	0.0005	0	0.0005	0.0005	0	0.0005	0.0005	0	< 0.0005	0.0005	0	< 0.0005	< 0.0005	0
Hardness	mg/L	-	213	223	5	272	266	2	223	227	2	249	245	2	123	149	19	203	198	2
Iron	mg/L	20	0.449	0.465	4	0.569	0.559	2	0.593	0.631	6	0.455	0.443	3	0.334	0.357	7	0.142	0.132	7
Manganese	mg/L	20	0.123	0.126	2	0.144	0.15	4	0.125	0.128	2	0.186	0.183	2	0.161	0.183	13	0.153	0.151	1
pH	-	20	7.1	7.1	0	7.2	7.2	0	7.3	7.3	0	7.2	7.2	0	7	7	0	7.3	7.3	0
Radium-226	Bq/L	20	0.23	0.216	6	0.338	0.313	8	0.289	0.288	0	0.126	0.135	7	0.203	0.204	0	0.113	0.119	5
Sulphate	mg/L	20	160	150	6	140	150	7	140	150	7	150	160	6	98	99	1	170	160	6
TSS	mg/L	-	1	1	0	1	2	67	2	1	67	2	1	67	1	1	0	1	< 1	0
Uranium	mg/L	20	0.0241	0.0236	2	0.0195	0.0184	6	0.0196	0.0196	0	0.0234	0.0235	0	0.0134	0.015	11	0.0198	0.0206	4

Date	Units	Field Precision Criteria (%)	D-2																	
			Jul-18			Aug-18			Sep-18			Oct-18			Nov-18			Dec-18		
			Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)
Barium	mg/L	20	0.228	0.211	8	0.107	0.1	7	0.079	0.076	4	0.107	0.11	3	0.1	0.089	12	0.046	0.047	2
Cobalt	mg/L	20	< 0.0005	< 0.0005	0	< 0.0005	< 0.0005	0	< 0.0005	< 0.0005	0	0.0007	0.0006	15	0.0008	0.0008	0	0.0007	0.0007	0
Hardness	mg/L	20	237	241	2	270	256	5	280	288	3	266	284	7	303	304	0	319	340	6
Iron	mg/L	20	0.13	0.12	8	0.08	0.061	27	0.083	0.077	8	0.123	0.113	8	0.168	0.162	4	0.107	0.11	3
Manganese	mg/L	20	0.097	0.147	41	0.116	0.064	58	0.073	0.066	10	0.234	0.232	1	0.238	0.234	2	0.228	0.238	4
pH	-	20	7	7	0	7.3	7.3	0	7	7	0	7	7	0	7.3	7.3	0	7.4	7.4	0
Radium-226	Bq/L	20	0.073	0.1	31	0.038	0.046	19	0.047	0.037	24	0.132	0.133	1	0.108	0.108	0	0.038	0.049	25
Sulphate	mg/L	20	190	190	0	240	230	4	230	230	0	240	250	4	250	270	8	270	250	8
TSS	mg/L	20	< 1	1	0	1	1	0	1	1	0	1	1	0	2	1	67	< 1	< 1	0
Uranium	mg/L	20	0.0283	0.0299	5	0.036	0.0347	4	0.0357	0.035	2	0.0467	0.0456	2	0.0475	0.0489	3	0.0507	0.0507	0

Field blank criterion not met.
Actual MDL does not meet target MDL.
Notes: Values less than MDL will be treated at MDL for RPD calculations. TSS = Total Suspended Solids.

Table B.17: Field Duplicates for Denison SAMP/TOMP Station D-2, 2015 to 2019

Date	Units	Field Precision Criteria (%)	D-2																	
			Jan-19			Feb-19			Mar-19			Apr-19			May-19			Jun-19		
			Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)
Barium	mg/L	20	0.056	0.055	2	0.081	0.084	4	0.474	0.468	1	0.616	0.626	2	0.368	0.373	1	0.696	0.688	1
Cobalt	mg/L	20	0.0008	0.0008	0	0.0009	0.0008	12	0.0007	0.0007	0	0.0007	0.0006	15	0.0005	0.0006	18	0.0005	0.0005	0
Hardness	mg/L	20	310	313	1	290	281	3	227	223	2	205	209	2	154	165	7	185	183	1
Iron	mg/L	20	0.206	0.209	1	0.176	0.15	16	0.544	0.528	3	0.341	0.343	1	0.216	0.226	5	0.213	0.197	8
Manganese	mg/L	20	0.26	0.262	1	0.429	0.423	1	0.198	0.193	3	0.223	0.223	0	0.226	0.237	5	0.201	0.187	7
pH	-	20	7	7	0	7.1	7.1	0	7.4	7.4	0	7.4	7.4	0	7.3	7.3	0	7.6	7.6	0
Radium-226	Bq/L	20	0.046	0.056	20	0.055	0.059	7	0.276	0.25	10	0.3	0.279	7	0.126	0.159	23	0.26	0.231	12
Sulphate	mg/L	20	260	270	4	240	230	4	150	150	0	150	150	0	120	120	0	130	130	0
TSS	mg/L	20	1	1	0	1	1	0	2	1	67	1	1	0	1	1	0	2	2	0
Uranium	mg/L	20	0.0472	0.048	2	0.0555	0.0565	2	0.0299	0.0295	1	0.0225	0.0234	4	0.0176	0.0188	7	0.0197	0.0192	3

Date	Units	Field Precision Criteria (%)	D-2																	
			Jul-19			Aug-19			Sep-19			Oct-19			Nov-19			Dec-19		
			Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)
Barium	mg/L	20	0.667	0.647	3	0.221	0.224	1	0.118	0.12	2	0.102	0.101	1	0.2	0.182	9	0.46	0.463	1
Cobalt	mg/L	20	< 0.0005	< 0.0005	0	< 0.0005	< 0.0005	0	< 0.0005	< 0.0005	0	< 0.0005	< 0.0005	0	0.0008	0.0007	13	0.0006	0.0006	0
Hardness	mg/L	20	180	179	1	204	205	0	264	264	0	286	284	1	279	258	8	249	250	0
Iron	mg/L	20	0.122	0.11	10	0.089	0.078	13	0.078	0.082	5	0.105	0.098	7	0.206	0.167	21	0.362	0.365	1
Manganese	mg/L	20	0.129	0.107	19	0.084	0.073	14	0.045	0.05	11	0.191	0.181	5	0.241	0.21	14	0.182	0.186	2
pH	-	20	7.4	7.4	0	7.2	7.2	0	7	7.5	7	7.3	7.2	1	7.2	7.2	0	7.1	7.1	0
Radium-226	Bq/L	20	0.212	0.191	10	0.068	0.063	8	0.047	0.042	11	0.074	0.069	7	0.14	0.151	8	0.222	0.235	6
Sulphate	mg/L	20	120	120	0	160	160	0	190	190	0	230	220	4	220	220	0	180	170	6
TSS	mg/L	20	2	1	67	1	1	0	1	< 1	0	1	1	0	2	1	67	1	1	0
Uranium	mg/L	20	0.0176	0.0185	5	0.023	0.0241	5	0.0334	0.0322	4	0.0447	0.0437	2	0.0458	0.0467	2	0.0325	0.034	5

Field blank criterion not met.
Actual MDL does not meet target MDL.
Notes: Values less than MDL will be treated at MDL for RPD calculations. TSS = Total Suspended Solids.

Table B.18: Field Duplicates for RAL TOMP station N-19, 2015 to 2019

Date	Units	Field Precision Criteria (%)	N-19																	
			Jan-15			Feb-15			Mar-15			Apr-15			May-15			Jun-15		
			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	0.013	0.012	8	0.012	0.013	8	0.012	0.012	0	0.012	0.011	9	0.011	0.012	9
Cobalt	mg/L	20	0.0022	0.0023	4	0.0022	0.0022	0	0.0021	0.0021	0	0.0023	0.0023	0	0.0023	0.0023	0	0.0012	0.0012	0
Hardness	mg/L	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iron	mg/L	20	0.22	0.22	0	0.16	0.19	17	0.08	0.08	0	0.1	0.11	10	0.51	0.43	17	0.31	0.32	3
Manganese	mg/L	20	0.171	0.183	7	0.179	0.175	2	0.169	0.167	1	0.177	0.17	4	0.157	0.148	6	0.122	0.125	2
pH	-	20	7.2	7.2	0	7.15	7.15	0	7.21	7.21	0	7.37	7.37	0	7.14	7.14	0	7.46	7.46	0
Radium-226	Bq/L	20	0.077	0.063	20	0.075	0.08	6	0.063	0.063	0	0.064	0.071	10	0.09	0.077	16	0.06	0.07	15
Sulphate	mg/L	20	730	700	4	720	720	0	770	750	3	840	830	1	690	680	1	730	720	1
TSS	mg/L	20	<1.00	<1	0	1	1	0	<1.00	<1	0	<1.00	<1	0	1	1	0	1	1	0
Uranium	mg/L	20	0.0056	0.0058	4	0.0051	0.0052	2	0.0054	0.0055	2	0.0051	0.005	2	0.0044	0.0041	7	0.0039	0.0041	5

Date	Units	Field Precision Criteria (%)	N-19																	
			Jul-15			Aug-15			Sep-15			Oct-15			Nov-15			Dec-15		
			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	0.011	9	0.012	0.012	0	0.011	0.011	0	0.011	0.011	0	0.011	0.011	0	0.011	0.012	9
Cobalt	mg/L	20	0.001	0.0009	11	0.0008	0.0008	0	0.0008	0.0008	0	0.0007	0.0007	0	0.0014	0.0015	7	0.0017	0.0019	11
Hardness	mg/L	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iron	mg/L	20	0.28	0.28	0	0.37	0.31	18	0.323	0.336	4	0.327	0.318	3	0.419	0.398	5	0.326	0.318	2
Manganese	mg/L	20	0.108	0.103	5	0.114	0.106	7	0.102	0.109	7	0.094	0.1	6	0.152	0.156	3	0.142	0.153	7
pH	-	20	7.5	7.5	0	7.1	7.1	0	7.2	7.2	0	7.28	7.1	3	7.2	7.2	0	7.36	7.3	1
Radium-226	Bq/L	20	0.055	0.065	17	0.061	0.074	19	0.055	0.051	8	0.062	0.058	7	0.074	0.067	10	0.068	0.079	15
Sulphate	mg/L	20	800	800	0	840	820	2	930	940	1	910	900	1	820	830	1	740	720	3
TSS	mg/L	20	1	1	0	1	1	0	1	1	0	<1.00	1	0	1	<1	0	<1.00	<1	0
Uranium	mg/L	20	0.0032	0.0031	3	0.0036	0.0035	3	0.0032	0.0031	3	0.0032	0.0034	6	0.0042	0.0043	2	0.0056	0.0065	15

Field blank criterion not met.

Actual MDL does not meet target MDL.

Notes: Values less than MDL will be treated at MDL for RPD calculations. TSS = Total Suspended Solids.

Table B.18: Field Duplicates for RAL TOMP station N-19, 2015 to 2019

Date	Units	Field Precision Criteria (%)	N-19																	
			Jan-16			Feb-16			Mar-16			Apr-16			May-16			Jun-16		
			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	0.012	8	0.011	0.011	0	0.012	0.012	0	0.012	0.01	18	0.013	0.013	0	0.013	0.012	8
Cobalt	mg/L	20	0.0015	0.0017	13	0.0017	0.0017	0	0.0021	0.0021	0	0.0056	0.0054	4	0.0027	0.0027	0	0.0016	0.0015	6
Hardness	mg/L	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iron	mg/L	20	0.184	0.181	2	0.15	0.14	7	0.127	0.124	2	1.84	1.76	4	0.256	0.228	12	0.16	0.158	1
Manganese	mg/L	20	0.146	0.152	4	0.151	0.148	2	0.171	0.172	1	0.184	0.177	4	0.19	0.185	3	0.17	0.16	6
pH	-	20	7.23	7.23	0	7.31	7.33	0	7	7	0	7.1	7.1	0	7.15	7.13	0	7.45	7.54	1
Radium-226	Bq/L	20	0.074	0.07	6	0.074	0.071	4	0.069	0.066	4	0.125	0.109	14	0.082	0.08	2	0.085	0.07	19
Sulphate	mg/L	20	680	680	0	680	670	1	720	710	1	450	390	14	650	660	2	730	730	0
TSS	mg/L	20	<1.00	<1	0	<2.00	<1	67	<1.00	<1	0	2	2	0	<1.00	<1	0	1	<1	0
Uranium	mg/L	20	0.0065	0.006	8	0.0055	0.0055	0	0.0061	0.006	2	0.004	0.0039	3	0.0045	0.0044	2	0.0038	0.0038	0

Date	Units	Field Precision Criteria (%)	N-19																	
			Jul-16			Aug-16			Sep-16			Oct-16			Nov-16			Dec-16		
			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	0.014	0.014	0	0.012	0.013	8	0.013	0.013	0	0.012	0.012	0	0.013	0.012	8
Cobalt	mg/L	20	0.0012	0.0011	9	0.001	0.001	0	0.0009	0.0008	12	0.0011	0.0011	0	0.0017	0.0017	0	0.0022	0.0021	5
Hardness	mg/L	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iron	mg/L	20	0.156	0.159	2	0.22	0.24	9	0.285	0.258	10	0.39	0.403	3	0.376	0.381	1	0.358	0.342	5
Manganese	mg/L	20	0.18	0.172	5	0.149	0.146	2	0.128	0.133	4	0.128	0.129	1	0.158	0.159	1	0.202	0.193	5
pH	-	20	7.2	7.2	0	7.5	7.5	0	7.04	6.8	3	7.21	7.21	0	7.2	7.1	1	7	6.9	1
Radium-226	Bq/L	20	0.068	0.063	8	0.074	0.072	3	0.06	0.048	22	0.062	0.052	18	0.057	0.07	20	0.047	0.069	38
Sulphate	mg/L	20	840	730	14	870	840	4	950	910	4	920	910	1	930	920	1	900	900	0
TSS	mg/L	20	<1.00	1	0	1	1	0	2	1	67	1	1	0	1	1	0	1	<1	0
Uranium	mg/L	20	0.004	0.0041	2	0.0037	0.0035	6	0.0034	0.0032	6	0.0035	0.0035	0	0.0036	0.0036	0	0.004	0.0036	11

Field blank criterion not met.

Actual MDL does not meet target MDL.

Notes: Values less than MDL will be treated at MDL for RPD calculations. TSS = Total Suspended Solids.

Table B.18: Field Duplicates for RAL TOMP station N-19, 2015 to 2019

Date	Units	Field Precision Criteria (%)	N-19																	
			Jan-17			Feb-17			Mar-17			Apr-17			May-17			Jun-17		
			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	0.014	0.014	0	0.013	0.014	7	0.009	0.008	12	0.011	0.011	0	0.012	0.013	8
Cobalt	mg/L	20	0.0021	0.0022	5	0.0023	0.0023	0	0.0026	0.0027	4	0.0025	0.0025	0	0.0017	0.0016	6	0.0012	0.0013	8
Hardness	mg/L	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iron	mg/L	20	0.2	0.203	1	0.196	0.206	5	0.542	0.561	3	0.832	0.791	5	0.296	0.285	4	0.303	0.38	23
Manganese	mg/L	20	0.195	0.201	3	0.218	0.213	2	0.179	0.181	1	0.081	0.077	5	0.156	0.155	1	0.14	0.142	1
pH	-	20	7.1	7.1	0	7	7	0	7.5	7.5	0	7.3	7.3	0	7.5	7.5	0	7.3	7.3	0
Radium-226	Bq/L	20	0.061	0.048	24	0.057	0.053	7	0.108	0.099	9	0.09	0.077	16	0.068	0.072	6	0.074	0.067	10
Sulphate	mg/L	20	880	890	1	990	970	2	770	780	1	190	190	0	690	700	1	770	730	5
TSS	mg/L	20	<1.00	<1	0	<1.00	<1	0	1	1	0	1	1	0	1	1	0	4	5	22
Uranium	mg/L	20	0.0035	0.0035	0	0.0043	0.0043	0	0.0067	0.0065	3	0.0072	0.0072	0	0.0048	0.0048	0	0.0043	0.0047	9

Date	Units	Field Precision Criteria (%)	N-19																	
			Jul-17			Aug-17			Sep-17			Oct-17			Nov-17			Dec-17		
			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	0.011	0.012	9	0.011	0.01	10	0.011	0.011	0	0.012	0.012	0	0.01	0.011	10	0.01	0.011	10
Cobalt	mg/L	20	0.0008	0.0008	0	0.0008	0.0008	0	0.0009	0.0009	0	0.001	0.001	0	0.0009	0.001	11	0.0013	0.0015	14
Hardness	mg/L	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iron	mg/L	20	0.242	0.247	2	0.448	0.36	22	0.451	0.452	0	0.483	0.517	7	0.369	0.378	2	0.798	0.794	1
Manganese	mg/L	20	0.106	0.108	2	0.123	0.117	5	0.123	0.118	4	0.123	0.134	9	0.086	0.092	7	0.105	0.106	1
pH	-	20	7.4	7.4	0	7.3	7.3	0	7.2	7.2	0	7.2	7.2	0	7.4	7.4	0	7.3	7.3	0
Radium-226	Bq/L	20	0.073	0.062	16	0.051	0.059	15	0.07	0.059	17	0.046	0.049	6	0.062	0.065	5	0.057	0.063	10
Sulphate	mg/L	20	760	750	1	820	770	6	870	810	7	800	800	0	720	740	3	680	620	9
TSS	mg/L	20	1	1	0	1	2	67	1	2	67	1	2	67	1	2	67	3	2	40
Uranium	mg/L	20	0.0034	0.0036	6	0.0032	0.0031	3	0.0031	0.0031	0	0.0033	0.0032	3	0.0054	0.0054	0	0.0054	0.0054	0

Field blank criterion not met.

Actual MDL does not meet target MDL.

Notes: Values less than MDL will be treated at MDL for RPD calculations. TSS = Total Suspended Solids.

Table B.18: Field Duplicates for RAL TOMP station N-19, 2015 to 2019

Date	Units	Field Precision Criteria (%)	N-19																	
			Jan-18			Feb-18			Mar-18			Apr-18			May-18			Jun-18		
			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	0.011	9	0.012	0.012	0	0.014	0.013	7	0.013	0.013	0	0.006	0.006	0	0.012	0.012	0
Cobalt	mg/L	20	0.0012	0.0013	8	0.0017	0.0016	6	0.0017	0.0017	0	0.0014	0.0014	0	0.0007	0.0008	13	0.0013	0.0013	0
Hardness	mg/L	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iron	mg/L	20	0.449	0.468	4	0.529	0.506	4	0.535	0.524	2	0.36	0.31	15	0.367	0.379	3	0.28	0.302	8
Manganese	mg/L	20	0.101	0.106	5	0.117	0.113	3	0.13	0.126	3	0.136	0.134	1	0.038	0.039	3	0.132	0.131	1
pH	-	20	7.2	7.2	0	7.1	7.1	0	7.2	7.2	0	7.1	7.2	1	7.3	7.3	0	7.5	7.5	0
Radium-226	Bq/L	20	0.065	0.066	2	0.096	0.085	12	0.093	0.088	6	0.071	0.067	6	0.051	0.051	0	0.064	0.074	14
Sulphate	mg/L	20	710	730	3	710	740	4	680	680	0	800	760	5	160	160	0	710	750	5
TSS	mg/L	20	2	1	67	1	1	0	1	1	0	1	1	0	<1.00	1	0	2	2	0
Uranium	mg/L	20	0.0054	0.0055	2	0.0052	0.0053	2	0.0049	0.0047	4	0.0044	0.0044	0	0.0051	0.0051	0	0.0031	0.003	3

Date	Units	Field Precision Criteria (%)	N-19																	
			Jul-18			Aug-18			Sep-18			Oct-18			Nov-18			Dec-18		
			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	0.012	0.013	8	0.011	0.01	10	0.01	0.01	0	0.011	0.011	0	0.012	0.012	0
Cobalt	mg/L	20	0.0011	0.0011	0	0.0012	0.0012	0	0.001	0.0011	10	0.0015	0.0015	0	0.0014	0.0015	7	0.0014	0.0014	0
Hardness	mg/L	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iron	mg/L	20	0.223	0.22	1	0.329	0.316	4	0.351	0.339	3	0.49	0.494	1	0.418	0.421	1	0.32	0.318	1
Manganese	mg/L	20	0.158	0.16	1	0.163	0.166	2	0.129	0.133	3	0.155	0.157	1	0.139	0.143	3	0.134	0.135	1
pH	-	20	7.3	7.3	0	7.3	7.3	0	7.2	7.3	1	7.2	7.2	0	7.2	7.2	0	7.5	7.5	0
Radium-226	Bq/L	20	0.068	0.076	11	0.064	0.059	8	0.048	0.054	12	0.059	0.048	21	0.077	0.067	14	0.07	0.07	0
Sulphate	mg/L	20	800	770	4	960	930	3	890	940	5	1,000	1000	0	870	870	0	910	910	0
TSS	mg/L	20	1	1	0	1	1	0	2	2	0	1	1	0	1	1	0	2	1	67
Uranium	mg/L	20	0.0032	0.0032	0	0.0032	0.0032	0	0.003	0.0032	6	0.0034	0.0034	0	0.0034	0.0034	0	0.0044	0.0043	2

Field blank criterion not met.

Actual MDL does not meet target MDL.

Notes: Values less than MDL will be treated at MDL for RPD calculations. TSS = Total Suspended Solids.

Table B.18: Field Duplicates for RAL TOMP station N-19, 2015 to 2019

Date	Units	Field Precision Criteria (%)	N-19																	
			Jan-19			Feb-19			Mar-19			Apr-19			May-19			Jun-19		
			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	0.013	0.013	0	0.012	0.012	0	0.015	0.015	0	0.01	0.011	10	0.012	0.012	0
Cobalt	mg/L	20	0.0016	0.0016	0	0.0018	0.0018	0	0.0021	0.0021	0	0.0027	0.0027	0	0.0015	0.0016	6	0.0012	0.0012	0
Hardness	mg/L	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iron	mg/L	20	0.373	0.366	2	0.463	0.386	18	0.152	0.152	0	0.977	0.98	0	0.23	0.24	4	0.135	0.133	1
Manganese	mg/L	20	0.145	0.14	4	0.157	0.157	0	0.178	0.173	3	0.155	0.157	1	0.079	0.089	12	0.106	0.106	0
pH	-	20	7.2	7.2	0	7.2	7.2	0	7.3	7.2	1	7.2	7.2	0	7.3	7.3	0	7.4	7.4	0
Radium-226	Bq/L	20	0.059	0.062	5	0.075	0.064	16	0.068	0.077	12	0.144	0.127	13	0.071	0.079	11	0.086	0.064	29
Sulphate	mg/L	20	930	930	0	920	930	1	840	850	1	830	830	0	480	460	4	700	700	0
TSS	mg/L	20	1	1	0	1	1	0	1	1	0	4	4	0	1	1	0	2	1	67
Uranium	mg/L	20	0.0038	0.0037	3	0.0043	0.004	7	0.0037	0.0039	5	0.0062	0.0062	0	0.0038	0.0039	3	0.0034	0.0033	3

Date	Units	Field Precision Criteria (%)	N-19																	
			Jul-19			Aug-19			Sep-19			Oct-19			Nov-19			Dec-19		
			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	0.011	0.011	0	0.01	0.01	0	0.01	0.01	0	0.011	0.01	10	0.011	0.011	0
Cobalt	mg/L	20	0.001	0.0009	11	0.0008	0.0007	13	0.0006	0.0006	0	0.0007	0.0007	0	0.0011	0.0011	0	0.0008	0.0009	12
Hardness	mg/L	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iron	mg/L	20	0.284	0.267	6	0.21	0.22	5	0.214	0.21	2	0.356	0.33	8	0.53	0.52	2	0.284	0.289	2
Manganese	mg/L	20	0.103	0.1	3	0.118	0.116	2	0.093	0.094	1	0.088	0.085	3	0.097	0.099	2	0.071	0.071	0
pH	-	20	7.2	7.2	0	7.1	7.1	0	7.2	7.2	0	7.1	7.1	0	7.3	7.3	0	8.2	8.2	0
Radium-226	Bq/L	20	0.098	0.083	17	0.063	0.056	12	0.058	0.062	7	0.058	0.058	0	0.064	0.058	10	0.074	0.085	14
Sulphate	mg/L	20	730	730	0	760	750	1	870	860	1	810	790	3	770	820	6	690	700	1
TSS	mg/L	20	2	2	0	2	1	67	2	2	0	1	2	67	<2.00	2	0	1	2	67
Uranium	mg/L	20	0.0035	0.0034	3	0.0028	0.0029	4	0.003	0.0029	3	0.0034	0.0038	11	0.0045	0.0044	2	0.0074	0.0069	7

Field blank criterion not met.
Actual MDL does not meet target MDL.
Notes: Values less than MDL will be treated at MDL for RPD calculations. TSS = Total Suspended Solids.

Table B.19: Field Duplicates for TOMP (Station Q-05), 2015 to 2019

Date	Units	Field Precision Criteria (%)	Q-05																	
			Feb-15			May-15			Aug-15			Nov-15			Feb-16			May-16		
			Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)
Acidity	mg/L	20	<1	<1	0	<1	<1	0	4	6	40	16	15	6	4	4	0	<1	<1	0
Barium	mg/L	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cobalt	mg/L	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hardness	mg/L	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iron	mg/L	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Manganese	mg/L	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pH	-	20	6.65	6.65	0	6.68	6.68	0	6.50	6.50	0	6.65	6.65	0	6.26	6.26	0	6.54	6.76	3
Radium-226	Bq/L	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sulphate	mg/L	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TSS	mg/L	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Uranium	mg/L	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Date	Units	Field Precision Criteria (%)	Q-05																	
			Sep-16			Nov-16			Feb-17			May-17			Aug-17			Nov-17		
			Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)
Acidity	mg/L	20	9	8	12	21	20	5	4	4	0	8	8	0	7	6	15	3	2	40
Barium	mg/L	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cobalt	mg/L	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hardness	mg/L	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iron	mg/L	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Manganese	mg/L	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pH	-	20	5.60	5.60	0	4.40	4.50	2	6.30	6.30	0	6.50	6.50	0	6.60	6.60	0	6.30	6.30	0
Radium-226	Bq/L	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sulphate	mg/L	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TSS	mg/L	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Uranium	mg/L	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Date	Units	Field Precision Criteria (%)	Q-05																	
			Feb-18			May-18			Aug-18			Nov-18			Feb-19			Apr-19		
			Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)
Acidity	mg/L	20	<1	<1	0	<1	<1	0	<1	<1	0	<1	<1	0	<1	<1	0	<1	<1	0
Barium	mg/L	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cobalt	mg/L	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hardness	mg/L	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iron	mg/L	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Manganese	mg/L	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pH	-	20	6.40	6.40	0	6.70	6.70	0	6.60	6.60	0	6.70	6.80	1	6.60	6.60	0	6.40	6.40	0
Radium-226	Bq/L	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sulphate	mg/L	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TSS	mg/L	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Uranium	mg/L	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Field blank criterion not met.
Actual MDL does not meet target MDL.
Notes: Values less than MDL will be treated at MDL for RPD calculations. TSS = Total Suspended Solids.

Table B.19: Field Duplicates for TOMP (Station Q-05), 2015 to 2019

Date	Units	Field Precision Criteria (%)	Q-05					
			Aug-19			Nov-19		
			Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)
Acidity	mg/L	20	<1	<1	0	2	2	0
Barium	mg/L	20	-	-	-	-	-	-
Cobalt	mg/L	20	-	-	-	-	-	-
Hardness	mg/L	20	-	-	-	-	-	-
Iron	mg/L	20	-	-	-	-	-	-
Manganese	mg/L	20	-	-	-	-	-	-
pH	-	20	6.60	6.60	0	6.80	6.80	0
Radium-226	Bq/L	20	-	-	-	-	-	-
Sulphate	mg/L	20	-	-	-	-	-	-
TSS	mg/L	20	-	-	-	-	-	-
Uranium	mg/L	20	-	-	-	-	-	-

Field blank criterion not met.

Actual MDL does not meet target MDL.

Notes: Values less than MDL will be treated at MDL for RPD calculations. TSS = Total Suspended Solids.

Table B.20: Field Duplicates for RAL TOMP Groundwater Samples, 2015 to 2019

Date	Units	Field Precision Criteria (%)	95N-4A														
			Aug-15			Jul-16			Aug-17			Aug-18			Jul-19		
			Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)
Acidity	mg/L	20	2,310	2070	11	2,130	2340	9	2,180	2120	3	2,140	2140	0	2,110	2110	0
Iron	mg/L	20	1,260	1280	2	1,060	1090	3	1,130	1220	8	1,100	1110	1	1,130	1090	4
pHf	-	20	6.07	6.07	0	5.88	5.88	0	5.82	5.8	0	5.73	5.86	2	5.87	5.81	1
Sulphate	mg/L	20	3,700	3700	0	3,440	3813	10	3,200	3400	6	3,600	3600	0	3,500	3700	6

Date	Units	Field Precision Criteria (%)	P-31														
			Jul-15			Jun-16			Jul-17			Jul-18			Aug-19		
			Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)
Acidity	mg/L	20	<1.00	<1	0	<1.00	<1	0	<1.00	<1	0	<1.00	<1	0	<1.00	<1	0
Iron	mg/L	20	0.160	0.14	13	0.221	0.218	1	0.730	0.76	4	0.320	0.111	97	0.266	0.229	15
pHf	-	20	6.57	6.57	0	6.06	6.06	0	6.48	6.48	0	6.53	6.53	0	6.65	6.64	0
Sulphate	mg/L	20	1,000	1000	0	1,000	1000	0	1,100	960	14	960	990	3	940	960	2

Date	Units	Field Precision Criteria (%)	95QW-5A														
			Jul-15			Jun-16			Jul-17			Jul-18			Aug-19		
			Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)
Acidity	mg/L	20	<1.00	<1	0	<1.00	<1	0	<1.00	<1	0	<1.00	<1	0	<1.00	<1	0
Iron	mg/L	20	7.71	7.74	0	6.09	6.21	2	6.09	5.14	17	5.79	6.21	7	3.96	4.08	3
pHf	-	20	5.77	5.77	0	4.99	4.99	0	4.99	5.76	14	5.74	5.74	0	5.9	5.93	1
Sulphate	mg/L	20	420	420	0	390	360	8	390	310	23	440	430	2	300	310	3

Date	Units	Field Precision Criteria (%)	SGW-3														
			Jul-15			Jun-16			Jul-17			Aug-18			Aug-19		
			Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)
Acidity	mg/L	20	738	763	3	687	679	1	605	594	2	586	590	1	556	596	7
Iron	mg/L	20	451	455	1	424	421	1	439	459	4	394	390	1	375	163	79
pHf	-	20	5.91	5.91	0	5.31	5.31	0	5.44	5.44	0	5.58	5.58	0	5.53	5.51	0
Sulphate	mg/L	20	1,700	1700	0	1,800	1700	6	1,600	1600	0	1,500	1500	0	1,400	1400	0

Field blank criterion not met.
Actual MDL does not meet target MDL.

Table B.21: Field Duplicates for DEN TOMP Groundwater Samples, 2015 to 2019

Date	Units	Field Precision Criteria (%)	98-15A														
			Jul-15			Jul-16			Aug-17			Aug-18			Aug-19		
			Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)
Acidity	mg/L	20	1,200	1,220	2	1,130	1,060	6	1,040	1,090	5	1,080	1,190	10	1130	1080	5
Iron	mg/L	20	838	768	9	626	623	0	651	700	7	601	576	4	504	503	0
pHf	-	20	6.4	6.4	0	6	6	0	5.4	6.45	18	6.18	6.15	0	6	5.9	2
Sulphate	mg/L	20	2,700	2,700	0	2,600	2,900	11	2,400	2,500	4	2,400	2,400	0	2400	2400	0

Date	Units	Field Precision Criteria (%)	BH91 DG4B														
			Aug-15			Jul-16			Aug-17			Sep-18			Aug-19		
			Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	original	duplicate	RPD (%)	Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)
Acidity	mg/L	20	< 1	< 1	0	< 1	< 1	0	< 1	< 1	0	< 1	< 1	0	<1.0	<1.0	0
Iron	mg/L	20	10.5	11.78	11	10.4	8.67	18	21.9	21.7	1	13.9	12.5	11	13.8	13.8	0
pHf	-	20	6.3	6.3	0	6.6	6.7	2	6.2	6.2	0	6.58	6.58	0	6.22	6.4	3
Sulphate	mg/L	20	710	815	14	700	650	7	730	820	12	560	560	0	670	670	0

Date	Units	Field Precision Criteria (%)	BH91 SG2A											
			Jul-15			Jul-16			Aug-17			Sep-18		
			Original	Duplicate	RPD (%)	Original	Duplicate	RPD (%)	original	duplicate	RPD (%)	Original	Duplicate	RPD (%)
Acidity	mg/L	20	4,500	4,500	0	2,260	2,290	1	2,450	2,370	3	3,140	2,910	8
Iron	mg/L	20	1,330	1,270	5	1,160	1,230	6	1,450	1,430	1	1,280	1,320	3
pHf	-	20	6.5	6.5	0	6	6	0	6.3	6.4	2	6.4	6.4	0
Sulphate	mg/L	20	2,200	2,160	2	4,000	4,000	0	4,400	4,400	0	4,500	4,400	2

Field blank criterion not met.
Actual MDL does not meet target MDL.
Note: BH91-SG2A was not sampled in 2019 as the well was dry/had no recharge. pHf = field pH.

Table B.22: Summary of Field Duplicate Results Greater Than DQO, 2015 to 2019

Program	Station	Date	Parameter	Units	MDL	RPD (%)	Original Conc.	Duplicate Conc.
SRWMP	BSR5	May-15	Radium-226	Bq/L	0.005	33	<0.007	<0.005
SAMP	Q-28	Feb-17	Barium	mg/L	0.005	37	0.074	0.051
SAMP / TOMP	D-2	Aug-16	Radium-226	Bq/L	0.005	26	0.033	0.043
		Jan-17	Barium	mg/L	0.005	30	0.057	0.042
			Radium-226	mg/L	0.005	34	0.045	0.032
		Feb-17	Barium	mg/L	0.005	71	0.067	0.14
			Cobalt	mg/L	0.0005	53	0.0011	0.0019
			Iron	mg/L	0.02	34	0.44	0.62
			Manganese	mg/L	0.002	47	0.25	0.41
			Radium-226	Bq/L	0.005	67	0.046	0.092
		Mar-17	TSS	mg/L	1	67	1	2
		Apr-17	Barium	mg/L	0.005	27	0.26	0.20
			Radium-226	Bq/L	0.005	33	0.17	0.13
		May-17	TSS	mg/L	1	67	1	2
		Sep-17	Iron	mg/L	0.02	45	0.2	0.13
			Manganese	mg/L	0.002	86	0.13	0.05
			TSS	mg/L	1	67	2	1
		Feb-18	TSS	mg/L	1	67	1	2
		Mar-18	TSS	mg/L	1	67	2	1
		Apr-18	TSS	mg/L	1	67	2	1
		Jul-18	Manganese	mg/L	0.002	41	0.097	0.15
			Radium-226	Bq/L	0.005	31	0.073	0.1
		Aug-18	Iron	mg/L	0.02	27	0.08	0.061
			Manganese	mg/L	0.002	58	0.12	0.064
		Sep-18	Radium-226	Bq/L	0.005	24	0.047	0.037
		Nov-18	TSS	mg/L	1	67	2	1
		Dec-18	Radium-226	Bq/L	0.005	25	0.038	0.049
		Mar-19	TSS	Bq/L	1	67	2	1
		May-19	Radium-226	Bq/L	0.005	23	0.13	0.2
		Jul-19	TSS	mg/l	1	67	2	1
		Nov-19	Iron	mg/L	0.02	21	0.21	0.17
			TSS	mg/L	1	67	2	1
TOMP	N-19	Feb-16	TSS	mg/L	1	67	<2	<1
		Sep-16	Radium-226	Bq/L	0.005	22	0.060	0.048
			TSS	mg/L	1	67	2	1
		Dec-16	Radium-226	Bq/L	0.005	38	0.047	0.069
		Jan-17	Radium-226	Bq/L	0.005	24	0.061	0.048
		Jun-17	Iron	mg/L	0.02	23	0.30	0.38
			TSS	mg/L	1	22	4	5
		Aug-17	Iron	mg/L	0.02	22	0.45	0.36
		Sep-17	TSS	mg/L	1	67	1	2
		Oct-17	TSS	mg/L	1	67	1	2
		Nov-17	TSS	mg/L	1	67	1	2
		Dec-17	TSS	mg/L	1	40	3	2
		Jan-18	TSS	mg/L	1	67	2	1
		Oct-18	Radium-226	Bq/L	0.005	21	0.059	0.048
		Dec-18	TSS	mg/L	1	67	2	1
		Jun-19	Radium-226	Bq/L	0.005	29	0.086	0.064
			TSS	mg/L	1	67	2	1
		Aug-19	TSS	mg/L	1	67	2	1
		Oct-19	TSS	mg/L	1	67	1	2
		Dec-19	TSS	mg/L	1	67	1	2
	Q-05	Aug-15	Acidity	mg/L	1	40	4	6
		Nov-17	Acidity	mg/L	1	40	3	2

Exceedance of DQO (20%) not explained by concentrations near MDL.

Note: TSS = Total Suspended Solids.

Table B.23: Summary of Laboratory Duplicate Results, 2015 to 2019

Year	Description	Acidity	Barium	Cobalt	Iron	Hardness	Manganese	Radium-226	Sulphate	TSS	Uranium	Total
		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%	
	Lab Criteria	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	
2015	Mean	0.10	0.70	1.60	1.80	0.40	2.00	5.20	0.70	0.50	2.10	**-**
	# 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	76	164	165	187	138	156	88	94	302	151	**1,579**
2016	Mean	0.00	0.00	1.20	1.80	2.50	1.40	6.30	2.00	3.00	1.70	**-**
	# 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	118	4	216	230	54	165	96	130	356	165	**1,699**
2017	Mean	1.10	3.00	4.00	2.80	11.60	2.90	6.31	2.80	2.60	4.90	**-**
	# above criteria	-	-	-	-	-	-	0	-	-	-	**0**
	% above criteria	-	-	-	-	-	-	0	-	-	-	**0**
	# samples	95	189	152	201	18	161	101	138	352	154	**1,671**
2018	Mean	0.90	3.60	5.00	2.80	0.90	2.50	6.41	2.30	1.60	3.80	**-**
	# above criteria	-	-	-	-	-	-	0	-	-	-	**0**
	% above criteria	-	-	-	-	-	-	0	-	-	-	**0.0**
	# samples	92	199	154	219	80	166	122	171	380	153	**1,777**
2019	Mean	2.60	3.70	5.60	4.50	2.30	3.10	6.48	1.70	1.40	3.30	**-**
	# 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	142	264	188	228	158	181	104	282	400	185	**2,132**
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**	**0.0**	**0.0**	**0.0**	**0.0**	**0**
	# samples	**523**	**820**	**875**	**1065**	**448**	**829**	**511**	**815**	**1790**	**808**	**8,858**

Samples above lab and program criteria. (shaded)

Notes: TSS = Total Suspended Solids.

Table B.24: **Summary of Laboratory Certified Reference Material (CRM) Quality Control Results, 2015 to 2019**

Year	Description	Acidity	Barium	Cobalt	Iron	Hardness	Manganese	Radium-226	Sulphate	Uranium	Total
		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%	
	Lab Criteria	80 - 120%	80 - 120%	80 - 120%	80 - 120%	80 - 120%	80 - 120%	80 - 120%	80 - 120%	80 - 120%	
2015	Mean	3.09	1.2	2.9	0.08	1.54	1.6	0.044	0.8	1.1	**-**
	# above criteria	0	0	0	0	0	0	0	0	0	**0**
	% above criteria	0	0	0	0	0	0	0	0	0	**0**
	# samples	82	170	175	193	147	158	88	114	310	**1,493**
2016	Mean	3.0	3.1	3.0	3.4	-	2.9	0.045	1.2	3.6	**-**
	# above criteria	3	0	0	2	-	0	0	0	0	**5**
	% above criteria	2.5	0	0	1	-	0	0	0	0	**0.4**
	# samples	118	4	169	321	0	165	96	129	165	**1,167**
2017	Mean	2.9	3.1	2.5	7.4	-	2.5	0.044	2.0	3.4	**-**
	# above criteria	0	0	0	14	-	0	0	0	0	**14**
	% above criteria	0	0	0	7	-	0	0	0	0	**1.1**
	# samples	97	185	153	210	0	164	101	179	156	**1,245**
2018	Mean	3.7	2.8	2.2	6.3	12.4	2.3	0.047	2.2	4.2	**-**
	# above criteria	3	0	0	14	7	0	0	0	0	**25**
	% above criteria	3.2	0.0	0.0	6.4	10.0	0.0	0	0.0	0.0	**1.7**
	# samples	93	200	154	218	70	165	122	247	153	**1,460**
2019	Mean	0.0	0.0	1.0	0.0	0.0	1.0	0.045	4.0	2.0	**-**
	# above criteria	-	-	-	-	-	-	0	-	-	**0**
	% above criteria	-	-	-	-	-	-	0	-	-	**0**
	# samples	143	262	44	228	135	192	104	282	185	**1,575**
Total	**# above criteria**	**6**	**0**	**0**	**30**	**7**	**0**	**0.047**	**0**	**0**	**44**
	% above criteria	**1**	**0**	**0**	**3**	**2**	**0**	**0**	**0**	**0**	**0.6**
	# samples	**533**	**821**	**695**	**1170**	**352**	**844**	**511**	**951**	**969**	**6,940**

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

Notes: TSS = Total Suspended Solids.

Table B.25: Summary of Laboratory Matrix Spike Blank Quality Control Results, 2015 to 2019

Year	Description	Acidity	Barium	Cobalt	Iron	Hardness	Manganese	Radium-226	Sulphate	Uranium	Total
		mg/L	mg/L	mg/L	mg/L	mg/L as $CaCO_3$	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	70 - 130%	70 - 130%	70 - 130%	70 - 130%	70 - 130%	70 - 130%	80 - 120%	70 - 130%	70 - 130%	
2015	Mean	100.5	53.7	94.7	98.2	103.1	103.0	96.0	99.9	95.8	**-**
	# above criteria	14	153	2	3	1	22	4	0	0	**199**
	% above criteria	14	93	1.1	2.0	0.9	15	4.5	0	0	**15.0**
	# samples	99	165	178	148	108	145	88	150	122	**1,323**
2016	Mean	107.6	53.6	95.2	98.0	-	103.8	98.0	100.1	96.2	**-**
	# above criteria	0	186	3	5	-	5	0	0	1	**200**
	% above criteria	0	90	1.8	2.2	-	3.4	0	0	0.63	**15.3**
	# samples	114	207	164	225	-	148	96	197	159	**1,310**
2017	Mean	112.6	53.7	99.0	117.8	107.0	111.5	101	121.9	99.2	**-**
	# above criteria	0	173	0	25	1	13	0	0	2	**214**
	% above criteria	0	90	0	14	2.9	8.5	0	0	1.8	**17.5**
	# samples	100	193	158	179	34	153	101	187	114	**1,221**
2018	Mean	111.4	54.5	98.1	121.2	101.2	111.8	96	97.6	92.8	**-**
	# above criteria	0	68	1	31	0	11	0	0	0	**111**
	% above criteria	0	38	0.72	22	0	8.0	0	0	0	**8.8**
	# samples	80	180	139	143	56	138	122	235	133	**1,260**
2019	Mean	-	-	-	-	-	-	94	-	-	**-**
	# above criteria	-	-	-	-	-	-	0	-	-	**0**
	% above criteria	-	-	-	-	-	-	0	-	-	**0**
	# samples	-	-	-	-	-	-	104	-	-	**104**
Total	**# above criteria**	**14**	**580**	**6**	**64**	**2**	**51**	**4**	**0**	**3**	**724**
	% above criteria	**4**	**77.9**	**1**	**9.2**	**1.0**	**9**	**1**	**0**	**1**	**13.9**
	# samples	**393**	**745**	**639**	**695**	**198**	**584**	**511**	**769**	**528**	**5,218**

Mean spike recovery does not meet program DQO.

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

Notes: TSS = Total Suspended Solids.

Table B.26: Laboratory Reporting Limits (LRL) for Sediment Samples Relative to Targets and to Guidelines, SRWMP, September 2019

	Analytes	Units	Achieved LRL	Sediment Quality Guidelines								
				PSQG[a] (1993)		Thompson et al. (2005)		EcoMetrix (2019)[d]				
				LEL[b]	SEL[c]	LEL	SEL	McCabe	May	Quirke	Nordic	Elliot
Physical Attributes	Moisture	%	1.0	-	-	-	-	-	-	-	-	-
	Total Organic Carbon	mg/kg	500	10,000	100,000	-	-	-	-	-	-	-
	Radium-226	Bq/g	0.010	-	-	0.60	14.4	46.4	9.56	20.6	39.8	63.9
	% Gravel (>2mm)	%	0.10	-	-	-	-	-	-	-	-	-
	% Sand (2.0mm - 0.063mm)	%	0.10	-	-	-	-	-	-	-	-	-
	% Silt (0.063mm - 4µm)	%	0.10	-	-	-	-	-	-	-	-	-
	% Clay (<4µm)	%	0.10	-	-	-	-	-	-	-	-	-
Total Metals	Total Barium (Ba)	µg/g	5.0	-	-	-	-	-	-	-	-	-
	Total Cobalt (Co)	µg/g	0.10	-	-	-	-	-	-	-	-	-
	Total Iron (Fe)	µg/g	2,500	20,000	40,000	-	-	-	-	-	-	-
	Total Manganese (Mn)	µg/g	50	460	1,100	-	-	-	-	-	-	-
	Total Nickel (Ni)	µg/g	0.50	16	75	23.4	484	-	-	-	-	-
	Total Uranium (U)	µg/g	0.25	-	-	104.4	5,874.1	-	-	-	-	-

Highlighted cells indicate achieved LRL values that exceed target LRL.

[a] Ontario Provincial Sediment Quality Guidelines (OMOE 1993).

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

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

[d] Proposed dose-based radium-226 benchmark is provided on a lake by lake basis.

Table B.27: Sediment Sample Field Split Results and Relative Percent Difference (RPD), SRWMP, September 2019

	Parameters	Units	DUL-2019-1	DUL-2019-1X	RPD	NL-2019-1	NL-2019-1X	RPD	ML-2019-3	ML-2019-3X	RPD
			24-Sep-19	24-Sep-19		23-Sep-19	23-Sep-19		18-Sep-19	18-Sep-19	
Physical Attributes	Moisture	%	90	90	0	85	84	1.2	90	90	0
	Total Organic Carbon	mg/kg	120,000	120,000	0	87,000	87,000	0	130,000	130,000	0
	Radium-226	Bq/g	0.081	0.066	20	2.04	-	-	1.90	4.90	88
	Gravel	%	0	0	0	0	0	0	0	0	0
	Sand	%	10	5.8	53	6.2	5.5	12	20	25	22
	Silt	%	69	67	2.9	76	78	2.6	44	43	2.3
	Clay	%	21	27	25	17	17	0	36	31	15
Total Metals	Barium (Ba)	µg/g	190	200	5.1	140	-	-	220	560	87
	Cobalt (Co)	µg/g	20	21	4.9	26	-	-	68	35	64
	Iron (Fe)	µg/g	36,000	38,000	5.4	52,000	-	-	45,000	71,000	45
	Manganese (Mn)	µg/g	3,600	3,800	5.4	580	-	-	910	4,300	130
	Nickel (Ni)	µg/g	29	30	3.4	38.0	-	-	75	30	86
	Uranium (U)	µg/g	4.4	4.6	4.4	82	-	-	210	320	42

Highlighted values did not meet the data quality objective of ≤40% Relative Percent Difference (RPD).

Note: "-" indicates data not available

Table B.27: Sediment Sample Field Split Results and Relative Percent Difference (RPD), SRWMP, September 2019

Parameters		Units	QL-2019-2	QL-2019-2X	RPD	SL-2019-4	SL-2019-4X	RPD
			23-Sep-19	23-Sep-19		25-Sep-19	25-Sep-19	
Physical Attributes	Moisture	%	84	83	1.2	88	88	0
	Total Organic Carbon	mg/kg	94,000	96,000	2.1	86,000	86,000	0
	Radium-226	Bq/g	2.30	1.41	48	0.072	0.079	9.3
	Gravel	%	0	0	0	0	0	0
	Sand	%	11	9	20	19	18	5.4
	Silt	%	59	62	5.0	56	49	13
	Clay	%	29	29	0	25	33	28
Total Metals	Barium (Ba)	µg/g	600	1200	67	380	390	2.6
	Cobalt (Co)	µg/g	38	180	130	12	11	8.7
	Iron (Fe)	µg/g	75,000	87,000	15	30,000	29,000	3.4
	Manganese (Mn)	µg/g	4,600	23,000	133	2,700	2,700	0
	Nickel (Ni)	µg/g	32	110	110	27.0	26	3.8
	Uranium (U)	µg/g	340	240	34	4.3	4.60	6.7

Highlighted values did not meet the data quality objective of ≤40% Relative Percent Difference (RPD).

Note: "-" indicates data not available

Table B.28: Calculation of Benthic Invertebrate Community Subsampling Error, SRWMP, September 2019

Station	Whole Organisms	Number of Organisms in Fraction 1	Number of Organisms in Fraction 2	Number of Organisms in Fraction 3	Number of Organisms in Fraction 4	Actual Density*	Precision (% range)		Accuracy	
									min	max
MAL-2019-5	0	137	162	-	-	299	15.4	-	8.4	-
DUL-2019-2	0	131	147	155	193	626	5.2	32.1	1.0	23.3
TML-2019-4	0	61	68	74	78	281	5.1	21.8	3.2	13.2
MAL-2019-1	0	81	90	97	115	-	7.2	29.6	-	-

Highlighted values did not meet the DQO of <20%.

Notes: * whole large organisms excluded in calculations. "-" = not applicable. min = minimum absolute % error. max = maximum absolute % error.

Table B.29: Benthic Invertebrate Community Sample Fractions Sorted, SRWMP, September 2019

Station	Fraction Sorted (500 um)	Station	Fraction Sorted (500 um)	Station	Fraction Sorted (500 um)
DUL-2019-1	1/4	ML-2019-5	1/8	SL-2019-4	1/2
DUL-2019-2	Whole[b]	NL-2019-1	1/4	SL-2019-5	1/2
DUL-2019-3	1/4	NL-2019-2	1/8	SUL-09-1	Whole
DUL-2019-4	1/4	NL-2019-3	1/4	SUL-09-2	1/4
DUL-2019-5	1/8	NL-2019-4	1/4	SUL-09-3	1/4
MAL-2019-1	1/2[c]	NL-2019-5	1/2	SUL-09-4	1/4
MAL-2019-2	1/8	QL-2019-1	1/4	SUL-09-5	1/4
MAL-2019-3	1/4	QL-2019-2	1/2	TML-09-1	1/8
MAL-2019-4	1/8	QL-2019-3	Whole	TML-09-2	1/4
MAL-2019-5	Whole[a]	QL-2019-4	Whole	TML-09-3	1/4
ML-2019-1	1/8	QL-2019-5	1/2	TML-09-4	Whole[b]
ML-2019-2	1/8	SL-2019-1	1/2	TML-09-5	1/4
ML-2019-3	1/8	SL-2019-2	Whole	-	-
ML-2019-4	1/4	SL-2019-3	1/2	-	-

Note: -" = not applicable.

[a] two halves sorted for subsampling error calculations.

[b] four quarters sorted for subsampling error calculations.

[c] four eighths sorted for subsampling error calculations.

Table B.30: Percent Recovery of Benthic Macroinvertebrates, SRWMP, September 2019

Station	Number of Organisms Recovered (initial sort)	Number of Organisms in Re-sort	Percent Recovery
DUL-2019-3	142	145	97.9%
MAL-2019-4	56	58	96.6%
SL-2019-4	81	83	97.6%
SUL-2019-2	65	68	95.6%
		Average % Recovery	**96.9%**

Highlighted values did not meet the DQO of >90%.

QA/QC Notes

Pupae were not counted toward total number of taxa unless they were the sole representative of their taxa group.

Immatures were not counted toward total number of taxa unless they were the sole representative of their taxa group.

The contents of samples NL-1 and NL-3 indicated a preservative issue, based on the odour and on the stringy characteristic of the worms in the sample (suggesting degradation). NL-1 more so than NL-3.

Table B.31: Achieved Laboratory Reporting Limits (LRLs) for Fish Tissue Compared to Target LRLs, SRWMP, September 2019

Parameter	Units	Target LRL	Achieved LRL
Uranium-nat	µg/g	0.001	0.001
Thorium-230	Bq/g	0.0001	0.0001 / 0.0002 / 0.0005
Radium-226	Bq/g	0.0006	0.0002
Lead-210	Bq/g	0.001	0.001
Polonium-210	Bq/g	0.0002	0.0002

Highlighted values indicate LRLs that did not meet the target LRL.

Table B.32: Fish Tissue Sample Field Split Results and Relative Percent Difference (RPD), SRWMP, September 2019

Parameters	Units	QL-SMB-01	QL-SMB-01X	RPD	MCL-SMB-05	MCL-SMB-05X	RPD
		20-Sep-19	20-Sep-19		18-Sep-19	18-Sep-19	
Lead-210	Bq/g	<0.001	<0.001	-	<0.001	<0.001	-
Polonium-210	Bq/g	0.0029	0.0032	10	0.0036	0.0042	15
Radium-226	Bq/g	0.0003	<0.0002	40	<0.0002	<0.0002	-
Thorium-230	Bq/g	<0.0002	<0.0001	-	<0.0002	<0.0002	-
Uranium	µg/g	<0.001	<0.001	-	<0.001	<0.001	-

[grey box] Highlighted values did not meet the data quality objective of ≤30% Relative Percent Difference (RPD).

[blue box] Indicates only one of the sample values was <LRL and the RPD was calculated using the LRL value; the RPD did not meet the data quality objective of ≤30%.

Note: "-" indicates data not available

LABORATORY QUALITY ASSESSMENT REPORTS

SGS

Environment, Health & Safety

REPORT CODE: *DEN-ANN17*

REPORT TITLE: *Annual Quality Assessment Report*

REVISION: *1.0*

ISSUED BY:

Quality Coordinator

AUTHORIZED BY:

Technical Manager

DATE: *20 Feb. 2018*

Table of Contents

1. BACKGROUND

SGS Environmental Services entered into an agreement with Denison Environmental Services for the analytical lab to provide analysis according to RFT #05-016. Below is a summary of the laboratory quality management system, key actions taken by the laboratory for samples analyzed during 2017, as well as a summary of the significant findings and the corrective actions implemented.

2. QUALITY MANAGEMENT SYSTEM

SGS Environmental Services is accredited to ISO/IEC 17025 by the Canadian Association for Laboratory Accreditation (CALA), for specific tests listed in the scope of accreditation. ISO/IEC 17025 addresses both quality management and the technical aspects of operating a testing laboratory.

The quality management system at SGS Environmental Services consists of a documented quality system, which is directed by the Quality Coordinator who is independent of the production area. All appropriate documentation (quality manual, methods, written instructions, standard operating procedures, and data approval criteria) is in place and includes both general and method specific quality control requirements.

The quality control procedures include duplicate samples, spiked blanks, spiked replicates, reagent/instrument blanks, preparation control samples, certified reference material analysis, and instrument control samples, as appropriate for the individual methods. Matrix matching of reference materials to samples is always attempted. Frequency of insertion of control samples is method specific and follows legislated guidelines. A summary of the quality control recoveries is presented in the tables following.

3. QUALITY CONTROL PARAMETERS

The analysis of quality control samples is method specific and includes duplicate samples, spiked blanks, spiked replicates, reagent/instrument blanks, preparation control samples, certified reference material analysis, and instrument control samples, as appropriate for the individual methods. Matrix matching of reference materials to samples is always attempted. Frequency of insertion of control samples is method specific and follows legislated guidelines and/or customer requirements. All QC analyses for Denison Environmental Services are tracked in unique files, specific to Denison Environmental Services. The samples are processed as part of our "worksheet" batch system and a compilation of all Denison Environmental Services QC data for the parameters tested during 2017 has been compiled below.

4. MAJOR ACHIEVEMENTS IN QUALITY CONTROL

- SGS Environmental Services performed 7769 analyses with 6685 QC checks, which represents 86% QC for sample analysis. This level of QC is significantly higher than the lab standard, which is generally 20%.
- All blank data results were within the data quality objectives. **Corrective Action**: N/A
- All CRM data results were within the data quality objectives. **Corrective Action**: N/A
- No duplicate value exceeded the data quality objectives. **Corrective Action:** N/A
- No spike blanks exceeded the data quality objectives. **Corrective Action**: N/A
- Barium (Ba) reporting limit as per the Denison reports is set at 0.005 mg/L. The detection limit normally reported for Ba by SGS Environmental Services – Lakefield is 0.0001 mg/L. The concentration of the Ba spike is 0.005 mg/L. The Ba spikes all passed under lab limits; however, with the detection limit set at 0.005 mg/L for the Denison reports a number of the spikes appear to fail when taking into account the detection level. **Corrective Action**: N/A
- Iron (Fe) reporting limit as per Denison reports is set at 0.02 mg/L. The detection limit normally reported for Fe by SGS Environmental Services – Lakefield is 0.007 mg/L. The concentration of the Fe spike is 0.01 mg/L. The Fe spikes all passed under lab limits; however, with the detection limit set at 0.02 mg/L for the Denison reports a number of the spikes appear to fail when taking into account the detection level. **Corrective Action:** N/A
- No spike duplicates fell outside of the data quality objectives. **Corrective Action**: N/A

5. QC DATA SUMMARY

5.1. Blank Data

Parameter	Unit	Required Limit	Mean Blank Result	Number of Blanks	Number Greater than Limit	Number Outside +/- Limit
Acidity	mg/L as CaCO3	1	1.5	104	49	13
Alkalinity	mg/L as CaCO3	2	0.88	9		
Barium	mg/L	0.005	0.023	192		

Cobalt	mg/L	0.0005	0.0002	156		
Dissolved Organic Carbon	mg/L	0.5	0.25	2		
Iron	mg/L	0.02	0.009	223	7	
Hardness	mg/L as CaCO3	0.5	0.22	62		
Manganese	mg/L	0.002	0.0009	166		
Sulphate	mg/L	0.1	0.053	187		
Total Dissolved Solids	mg/L	10	15	11	11	
Total Suspended Solids	mg/L	1	0.48	364		
Uranium	mg/L	0.0005	0.0002	153	0	0
Zinc	mg/L	0.001	0.001	1		

5.2. CRM Data

Parameter	Unit	Certified Value	Lower Limit (at 10% Rel. Error)	Upper Limit (at 10% Rel. Error	Number of CRM's	Mean Value	% RSD (Precision)	Number QC CRM outside of DQO
Acidity	mg/L as CaCO3	50	45	55	97	49.9	2.85	
Alkalinity	mg/L as CaCO3	47.2	42.5	51.9	9	48.0	2.09	
Barium	mg/L	0.1	0.09	0.11	185	0.10	3.05	
Cobalt	mg/L	0.1	0.09	0.11	153	0.10	2.49	
Iron	mg/L	500	450	550	210	0.102	7.41	14
Hardness	mg/L as CaCO3	0.1	0	0	47	0.87	10.64	
Manganese	mg/L	0.1	0.09	0.11	164	0.102	2.53	
Sulphate	mg/L	5	4.5	5.5	179	4.82	1.96	
Total Suspended Solids	mg/L	100	90	110	348	97.8	2.17	
Uranium	mg/L	0.1	0.09	0.11	156	0.100	3.44	

5.3. *Duplicate Data*

Parameter	Unit	Expected Recovery (Rel. %)	Lower Limit (Rel. %)	Upper Limit (Rel. %)	Number of Duplicates	Mean Recovery (%)
Acidity	mg/L as CaCO3	100	90	110	95	98.9
Silver	mg/L	100	90	110	1	100.0
Alkalinity	mg/L as CaCO3	100	90	110	8	99.1
Arsenic	mg/L	100	90	110	1	99.0
Barium	mg/L	100	90	110	189	97.0
Cobalt	mg/L	100	90	110	152	96.0
Copper	mg/L	100	90	110	1	97.0
DOC	mg/L	100	90	110	1	98.9
Iron	mg/L	100	90	110	201	97.2
Hardness	mg/L as CaCO3	100	90	110	18	88.4
Manganese	mg/L	100	90	110	161	97.1
Nickel	mg/L	100	90	110	1	95.0
Lead	mg/L	100	90	110	1	94.0
Selenium	mg/L	100	90	110	1	97.0
Sulphate	mg/L	100	90	110	138	97.2
Total Dissolved Solids	mg/L	100	90	110	11	97.8
Total Suspended Solids	mg/L	100	90	110	352	97.4
Uranium	mg/L	100	90	110	154	95.1

5.4. Spike Blank Data

Parameter	Unit	Certified Value	Lower Limit (at 30% Rel. Error)	Upper limit (at 30% Rel. Error)	Number of Spike Blank's	Mean % Recovery	Precision (%RSD)	Number Spike Blank outside of DQO	Number Spike Blank within SGS QC protocols and below Denison MDL
Acidity	mg/L as CaCO3	10	7	13	100	112.6	7.2	0	0
Silver	mg/L	0.0002	0.00014	0.00026	1	75.0		0	0
Alkalinity	mg/L as CaCO3	9.4	6.58	12.22	9	92.6	5.4	0	0
Arsenic	mg/L	0.0064	0.00448	0.00832	1	103.1		0	0
Barium	mg/L	0.005	0.0035	0.00832	193	53.7	18.0	173	0
Cobalt	mg/L	0.002	0.0014	0.0026	158	99.0	4.1	0	0
DOC	mg/L	10	7	13	2	99.0		0	0
Iron ICP-MS	mg/L	0.01	0.007	0.013	179	117.8	39.9	25	0
Iron ICP-OES	mg/L	0.05	0.035	0.065	7	78.2	2.2	0	0
Hardness	mg/L as CaCO3	0	0	0	34	107.0	23.3	1	0
Manganese	mg/L	0.003	0.0021	0.004	153	111.5	14.1	13	0
Nickel	mg/L	0.005	0.0035	0.0065	1	104.0		0	0
Selenium	mg/L	0.0008	0.00056	0.00104	1	106.3		0	0
Sulphate	mg/L	4	2.8	5.2	187	121.9	1.6	0	0
Uranium	mg/L	0.0008	0.00056	0.00104	114	99.2	7.8	2	0
Zinc	mg/L	0.006	0.0042	0.0078	47	39.0	5.7	0	0

5.5. Spike Duplicate Data

Parameter	Unit	Certified Value	Lower Limit (at 30% Rel. Error)	Upper limit (at 30% Rel. Error)	Number of Spike Rep's	Mean % Recovery	Precision (%RSD)	Number Spike Rep outside of DQO	Number Spike Dup. outside of SGS QC protocols and below Denison MDL
Arsenic	mg/L	0.64	0.448	0.832	20	110.7	9.20	0	0
Barium	mg/L	4	2.8	5.2	153	99.2	0.58	8	0
Cobalt	mg/L	2	1.4	2.6	125	93.5	0.31	6	0
DOC-Low	mg/L	100	70	130	30	73.7	17.6	0	0
DOC-SK	mg/L	100	70	130	24	99.0	3.93	0	0
Iron ICP-MS	mg/L	0.05	0.035	0.065	6	93.0	0.01	2	0
Iron ICP-OES	mg/L	0.05	0.035	0.065	1	104.0		0	0
Hardness	mg/L as $CaCO_3$	4.55	3.18	5.92	51	48.4	9.41	0	0
Manganese	mg/L	3.2	2.24	4.16	122	102.6	0.52	3	0
Lead	mg/L	3.2	2.24	4.16	1	106.5		0	0
Selenium	mg/L	0.8	0.56	1.04	20	106.7	8.29	0	0
Sulphate	mg/L	100	70	130	153	97.3	5.73	0	0
Uranium	mg/L	0.8	0.56	1.04	128	97.5	0.09	0	0

5.6. QC Frequency

Total Number of Blanks:	1630
Total Number of CRM:	1548
Total Number of Duplicates:	1486
Total Number of Spike Blanks:	1187
Total Number of Spike Duplicates:	834
Sum of QC Insertion:	**6685**
Total Analysis:	**7769**

6. CONCLUSION & SIGNIFICANT FINDINGS

SGS Environmental Services analyzed QC samples for this project beyond the lab standard of 20% QC insertion. Where the data quality objectives for the lab were exceeded, the additional QC samples analyzed within the run supported the data values and data was released on this basis.

SGS Environmental Services remains committed to delivering data that meets and/or exceeds the data quality objectives for Denison Environmental Services and staff will continue to work closely with Denison Environmental Services staff to ensure all objectives are achieved in 2018.

SGS

Environment, Health & Safety

REPORT CODE: *DEN-ANN18*

REPORT TITLE: *Annual 2018 Data Quality Report*

REVISION: *1.0*

ISSUED BY:

Quality Coordinator,
SGS Environment, Health & Safety

AUTHORIZED BY:

Technical Manager,
SGS Environment, Health & Safety

DATE: *01 Mar. 2019*

Table of Contents

1. BACKGROUND

SGS Laboratory entered into an agreement with Denison Environmental Services for the analytical lab to provide analysis according to RFT #05-016. Please find below a summary of the laboratory quality management system, key actions taken by the laboratory, as well as a summary of numbers of samples analyzed.

2. QUALITY MANAGEMENT SYSTEM

SGS Environment, Health & Safety is accredited to ISO/IEC 17025 by the Canadian Association for Laboratory Accreditation (CALA), for specific tests listed in the scope of accreditation. ISO/IEC 17025 addresses both quality management and the technical aspects of operating a testing laboratory.

The quality management system at SGS Environment, Health & Safety consists of a documented quality system, which is directed by the Quality Coordinator who is independent of the production area. All appropriate documentation (quality manual, methods, written instructions, standard operating procedures, and data approval criteria) is in place and includes both general and method specific quality control requirements.

The quality control procedures include duplicate samples, spiked blanks, spiked replicates, reagent/instrument blanks, preparation control samples, certified reference material analysis, and instrument control samples, as appropriate for the individual methods. Matrix matching of reference materials to samples is always attempted. Frequency of insertion of control samples is method specific and follows legislated guidelines. A summary of the quality control recoveries is presented in the tables following.

3. QUALITY CONTROL PARAMETERS

All QC parameters are taken directly from SGS LIMS. Denison Environmental Services samples are processed as part of our "worksheet" batch system. A compilation of all QC data appropriate to the parameters tested has been compiled below.

4. NOTABLE OCCURANCES/ACTIONS

- SGS Environment, Health & Safety Lakefield laboratory performed 8703 analyses with 7109 QC checks, which represents 82% QC for sample analysis. **Corrective Action**: N/A
- All blank data results were within the data quality objectives. *Note: Laboratory deionized water is used for the acidity blank. Deionized water is slightly acidic at approximately pH 5.5 to 5.8.* **Corrective Action**: N/A
- All CRM data results were within the data quality objectives. **Corrective Action**: N/A
- No duplicate value exceeded the data quality objectives. **Corrective Action:** N/A

- No spike blanks exceeded the data quality objectives. *Note: Barium (Ba) reporting limit as per the Denison reports is set at 0.005 mg/L, the detection limit normally reported for Ba by SGS is 0.0001 mg/L. The concentration of the Ba spike is 0.005 mg/L. The Ba spikes all passed under lab limits; however, with the detection limit set at 0.005 mg/L for the Denison reports and number of the spikes appear to fail when taking into account the detection level.* **Corrective Action**: N/A
- No spike duplicates fell outside of the data quality objectives. **Corrective Action**: N/A

5. QC DATA SUMMARY

5.1. Blank Data

Parameter	Unit	Required Limit	Mean Blank Result	Number of Blanks	Number greater than Limit	Number Outside +/- Limit
Acidity	mg/L as CaCO3	1	1.58	100	47	11
Silver	mg/L	0.0001	0.0000015	10	0	0
Alkalinity	mg/L as CaCO3	2	0.319	6	0	0
Arsenic	mg/L	0.0005	0.00008	1	0	0
Barium	mg/L	0.005	0.00212	193	0	0
Cobalt	mg/L	0.0005	0.000217	152	0	0
Copper	mg/L	0.0005	0.000011	11	0	0
DOC low	mg/L	0.5	0.178	42	0	0
Iron ICP-MS	mg/L	0.007	0.00814	223	0	0
Hardness ICP-MS	mg/L as CaCO3	0.5	0.164	96	1	0
Manganese	mg/L	0.002	0.000806	167	0	0
Nickel	mg/L	0.002	0.000025	8	0	0
Lead	mg/L	0.00002	0.000015	7	0	0
Selenium	mg/L	0.0005	0.000010	8	0	0
Sulphate	mg/L	0.1	0.054	245	0	0
Total Dissolved Solids	mg/L	10	12.5	11	11	0
Total Suspended Solids	mg/L	1	0.439	385	0	0
Uranium	mg/L	0.0005	0.000204	154	0	0
Zinc	mg/L	0.001	0.000500	8	0	0

5.2. CRM Data

Parameter	Unit	Certified Value	Lower Limit (at 20% Rel. Error)	Upper Limit (at 20% Rel. Error)	Number of CRM's	Mean Value	% RSD (Precision)	Number QC CRM outside of DQO
Acidity	mg/L as CaCO3	50	45	55	93	50.1	3.69	3
Silver	mg/L	0.1	0.09	0.11	10	0.101	0.28	0
Alkalinity	mg/L as CaCO3	47.2	42.5	51.9	6	49.6	0.79	1
Arsenic	mg/L	0.1	0.09	0.11	1	0.106	0.00	0
Barium	mg/L	0.1	0.09	0.11	200	0.101	2.82	0
Cobalt	mg/L	0.1	0.09	0.11	154	0.101	2.22	0
Copper	mg/L	0.1	0.09	0.11	11	0.100	0.34	0
DOC low	mg/L	5	4.5	5.5	38	5.068	3.18	1
Iron ICP-MS	mg/L	0.1	0.09	0.11	218	0.101	6.33	14
Hardness ICP-MS	mg/L as CaCO3	1.5	1.8	2.2	70	1.466	12.38	7
Manganese	mg/L	0.1	0.09	0.11	165	0.103	2.26	0
Nickel	mg/L	0.1	0.09	.011	7	0.102	0.37	0
Lead	mg/L	0.1	0.09	0.11	7	0.100	0.60	0
Selenium	mg/L	0.1	0.09	0.11	7	0.101	0.37	0
Sulphate	mg/L	5	4.5	5.5	247	4.826	2.23	0
Total Suspended Solids	mg/L	100	90	110	166	97.73	3.26	0
Uranium	mg/L	0.1	0.09	0.11	153	0.099	4.16	0
Zinc	mg/L	0.1	0.09	0.11	8	0.101	0.17	0

5.3. Duplicate Data

Parameter	Unit	Expected Recovery (Rel. %)	Lower Limit (Rel. %)	Upper Limit (Rel. %)	Number of Duplicates	Mean Recovery (%)
Acidity	mg/L as CaCO3	100	90	110	92	99.1
Silver	mg/L	100	90	110	8	98.8
Alkalinity	mg/L as CaCO3	100	90	110	6	100.9
Arsenic	mg/L	100	90	110	1	99.0
Barium	mg/L	100	90	110	199	96.4
Cobalt	mg/L	100	90	110	154	95.0
Copper	mg/L	100	90	110	7	98.4
DOC low	mg/L	100	90	110	41	101.1
Iron ICP-MS	mg/L	100	90	110	219	97.2
Hardness ICP-MS	mg/L as CaCO3	100	90	110	80	99.1

Manganese	mg/L	100	90	110	166	97.5
Nickel	mg/L	100	90	110	6	98.1
Lead	mg/L	100	90	110	6	95.7
Selenium	mg/L	100	90	110	6	97.8
Sulphate	mg/L	100	90	110	171	97.7
Total Dissolved Solids	mg/L	100	90	110	10	98.0
Total Suspended Solids	mg/L	100	90	110	380	98.4
Uranium	mg/L	100	90	110	153	96.2
Zinc	mg/L	100	90	110	6	98.7

5.4. Spike Blank Data

Parameter	Unit	Certified Value	Lower Limit (at 30% Rel. Error)	Upper limit (at 30 % Rel. Error)	Number of Spike Blank's	Mean % Recovery	Precision (%RSD)	Number Spike Blank outside of DQO
Acidity	mg/L as CaCO3	10	7	13	80	111.4	7.15	0
Silver	mg/L	0.0002	0.00014	0.00026	9	79.0	1.46	0
Alkalinity	mg/L as CaCO3	9.4	6.58	12.22	5	96.6	1.55	0
Arsenic	mg/L	0.0064	0.00448	0.00832	1	98.4	0.00	0
Barium	mg/L	0.005	0.0035	0.0065	180	54.5	20.63	68*
Cobalt	mg/L	0.002	0.0014	0.0026	139	98.1	6.75	1
Copper	mg/L	0.016	0.00112	0.00208	10	109.6	8.79	2
DOC low	mg/L	10	7	13	34	100.1	1.60	0
Iron ICP-MS	mg/L	0	0	0	143	121.2	30.17	31
Hardness ICP-MS	mg/L as CaCO3	0	0	0	56	101.2	4.33	0
Manganese	mg/L	0.003	0.0021	0.0039	138	111.8	16.27	11
Nickel	mg/L	0.005	0.0035	0.0065	7	95.3	0.94	0
Lead	mg/L	0.0032	0.00224	0.00416	7	99.2	0.19	0
Selenium	mg/L	0.0008	0.00056	0.00104	7	94.0	1.75	0
Sulphate	mg/L	5	4.5	5.5	235	97.6	2.07	0
Uranium	mg/L	0.0008	0.00056	0.00104	133	92.8	7.76	1
Zinc	mg/L	0.006	0.0042	0.0078	6	113.3	4.04	1

*Barium spike concentration is below the required detection limit.

5.5. Spike Duplicate Data

Parameter	Unit	Certified Value	Lower Limit (at 30% Rel. Error)	Upper limit (at 30% Rel. Error)	Number of Spike Rep's	Mean % Recovery	Precision (%RSD)	Number Spike Rep outside of DQO
Silver	mg/L	0.16	0.112	0.208	6	100.2	0.93	0
Arsenic	mg/L	0.64	0.448	0.832	1	98.3	0.00	0
Barium	mg/L	4	2.8	5.5	151	104.6	11.79	12
Cobalt	mg/L	2	1.4	2.6	120	99.5	7.55	2
Copper	mg/L	1.6	1.12	2.08	7	110.3	9.03	2
DOC low	mg/L	100	70	130	36	102.1	5.39	0
Iron ICP-MS	mg/L	0	0	0	15	89.4	18.42	0
Hardness ICP-MS	mg/L as CaCO3	4.55	3.185	5.915	0			
Manganese	mg/L	3.2	2.24	4.16	118	106.9	8.73	0
Nickel	mg/L	4.8	3.36	6.24	6	99.6	1.05	0
Lead	mg/L	3.2	2.24	4.16	6	101.1	0.23	0
Selenium	mg/L	0.8	0.56	1.04	6	94.4	2.11	0
Sulphate	mg/L	100	70	130	227	98.1	5.50	0
Uranium	mg/L	0.8	0.56	1.04	116	93.2	6.23	2
Zinc	mg/L	5.6	3.92	7.28	5	121.2	3.94	2

5.6. QC Frequency

Total Number of Blanks:	1827
Total Number of Reference Materials:	1561
Total Number of Duplicate Samples:	1711
Total Number of Spiked Blanks:	1190
Total Number of Spiked Duplicate Samples:	820
Sum of QC Insertion:	**7109**
Total Analysis:	**8703**

6. CONCLUSION AND SIGNIFICANT FINDINGS

SGS Environment, Health and Safety - Lakefield analyzed quality control samples for this project beyond the laboratory standard of 20% QC insertion. Where the data quality objectives for the laboratory were exceeded, the additional quality control samples analyzed within the run supported the data values and data was released on this basis.

SGS Environment, Health and Safety remains committed to delivering data that meets and/or exceeds the data quality objectives for Denison Environmental Services and staff will continue to work closely with Denison Environmental Services staff to ensure all objectives are achieved in 2019.

SGS

Environment, Health & Safety

REPORT CODE: *DEN-ANN19*

REPORT TITLE: *Annual 2019 Denison Data Quality Report*

REVISION: *1.0*

ISSUED BY:

Quality Coordinator,
SGS Environment, Health & Safety

AUTHORIZED BY:

Technical Manager,
SGS Environment, Health & Safety

DATE: *26 Feb. 2020*

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1. BACKGROUND

SGS Laboratory entered into an agreement with Denison Environmental Services for the analytical lab to provide analysis according to RFT #05-016. Please find below a summary of the laboratory quality management system, key actions taken by the laboratory, as well as a summary of numbers of samples analyzed.

2. QUALITY MANAGEMENT SYSTEM

SGS Environment, Health & Safety is accredited to ISO/IEC 17025 by the Canadian Association for Laboratory Accreditation (CALA), for specific tests listed in the scope of accreditation. ISO/IEC 17025 addresses both quality management and the technical aspects of operating a testing laboratory.

The quality management system at SGS Environment, Health & Safety consists of a documented quality system, which is directed by the Quality Coordinator who is independent of the production area. All appropriate documentation (quality manual, methods, written instructions, standard operating procedures, and data approval criteria) is in place and includes both general and method specific quality control requirements.

The quality control procedures include duplicate samples, spiked blanks, spiked replicates, reagent/instrument blanks, preparation control samples, certified reference material analysis, and instrument control samples, as appropriate for the individual methods. Matrix matching of reference materials to samples is always attempted. Frequency of insertion of control samples is method specific and follows legislated guidelines. A summary of the quality control recoveries is presented in the tables following.

3. QUALITY CONTROL PARAMETERS

All QC parameters are taken directly from SGS LIMS. Denison Environmental Services samples are processed as part of our "worksheet" batch system. A compilation of all QC data appropriate to the parameters tested has been compiled below.

4. NOTABLE OCCURANCES/ACTIONS

- SGS Environment, Health & Safety Lakefield laboratory performed 11183 analyses with 7973 QC checks, which represents 71% QC for sample analysis. **Corrective Action**: N/A
- All blank data results were within the data quality objectives. **Corrective Action**: N/A
- All CRM data results were within the data quality objectives. **Corrective Action**: N/A
- No duplicate value exceeded the data quality objectives. **Corrective Action:** N/A
- No spike blanks exceeded the data quality objectives. **Corrective Action**: N/A
- No spike duplicates fell outside of the data quality objectives. **Corrective Action**: N/A

- During the second half of 2019 Denison requested TSS reanalysis on some of their samples. The repeated TSS results differed from the original TSS results reported in varying degrees. A quality investigation was initiated and documented in SGS NCR 51839.

  Original and repeated low level TSS sample results (<10mg/L) varied within the range from 1 to 10mg/L. It is difficult to determine exactly why there are variations at this level. Some contributing factors for variations at this low level include using less sample volume to perform the reanalysis and sub-sampling from a different sample container for the reanalysis. Another factor to consider is the reanalysis was performed on sample portions that were past the holding time.

  For samples with TSS concentrations reported above 10mg/L, the investigation found analytical carryover was a contributing factor in the discrepancy of the results. The technicians involved have been provided additional training to eliminate carryover issues during TSS analysis where required.

5. QC DATA SUMMARY

5.1. Blank Data

Parameter	Unit	Required Limit	Number of Blanks	Mean Blank Result
Acidity	mg/L as CaCO3	1	143	2
Silver	mg/L	0.0001	44	<0.0001
Alkalinity	mg/L as CaCO3	1	24	<1
Arsenic	mg/L	0.0005	4	<0.0005
Barium	mg/L	0.005	264	<0.005
Cobalt	mg/L	0.0005	188	<0.0005
Copper	mg/L	0.0005	44	<0.0005
DOC	mg/L	0.5	0	
Iron	mg/L	0.02	228	<0.02
Hardness	mg/L as CaCO3	0.5	157	<0.5
Manganese	mg/L	0.002	192	<0.002
Nickel	mg/L	0.002	40	<0.002
Lead	mg/L	0.00002	44	<0.00002
Selenium	mg/L	0.0005	38	<0.0005
Sulphate	mg/L	0.2	282	<0.2
Total Dissolved Solids	mg/L	10	3	<30
Total Suspended Solids	mg/L	1	400	<1
Uranium	mg/L	0.0005	185	<0.0005

Zinc	mg/L	0.001	44	<0.002

5.2. *Reference Material/Spiked Blank Data*

Parameter	Unit	Number of RM or SB	% Recovery
Acidity	mg/L as CaCO3	143	100
Silver	mg/L	44	99
Alkalinity	mg/L as CaCO3	18	102
Arsenic	mg/L	4	101
Barium	mg/L	262	100
Cobalt	mg/L	188	99
Copper	mg/L	44	99
DOC	mg/L	0	
Iron	mg/L	228	100
Hardness	mg/L as CaCO3	135	100
Manganese	mg/L	192	101
Nickel	mg/L	44	100
Lead	mg/L	45	98
Selenium	mg/L	45	101
Sulphate	mg/L	282	96
Total Suspended Solids	mg/L	NV*	
Uranium	mg/L	185	98
Zinc	mg/L	44	100

*NV – No value, certified reference materials unavailable for this test

5.3. *Duplicate Data*

Parameter	Unit	RPD* Limit	Number of Duplicates	RPD*
Acidity	mg/L as CaCO3	20	142	2.6
Silver	mg/L	20	40	4.8
Alkalinity	mg/L as CaCO3	20	19	3.3
Arsenic	mg/L	20	4	4.2
Barium	mg/L	20	264	3.7
Cobalt	mg/L	20	188	5.6
Copper	mg/L	20	40	4.3
DOC	mg/L	20	0	

Iron	mg/L	20	228	4.5
Hardness	mg/L as CaCO3	20	158	2.3
Manganese	mg/L	20	181	3.1
Nickel	mg/L	20	43	5.0
Lead	mg/L	20	45	4.6
pH	units	20	3	1.0
Selenium	mg/L	20	45	6.5
Sulphate	mg/L	20	282	1.7
Total Dissolved Solids	mg/L	20	3	ND
Total Suspended Solids	mg/L	20	400	1.4
Uranium	mg/L	20	185	3.3
Zinc	mg/L	20	44	6.6

*RPD – Relative Percent Difference

5.4. *Spike Duplicate Data*

Parameter	Unit	Number of Spike Dups	Mean % Recovery
Silver	mg/L	40	92
Arsenic	mg/L	4	111
Barium	mg/L	256	103
Cobalt	mg/L	188	99
Copper	mg/L	37	100
DOC	mg/L	0	
Iron	mg/L	0	
Hardness	mg/L as CaCO3	142	99
Manganese	mg/L	167	103
Nickel	mg/L	24	98
Lead	mg/L	45	98
Selenium	mg/L	45	103
Sulphate	mg/L	262	97
Uranium	mg/L	185	95
Zinc	mg/L	37	107

5.5. *QC Frequency*

Total Number of Blanks:	2324
Total Number of Reference Materials/Spiked Blanks:	1903
Total Number of Duplicate Samples:	2314
Total Number of Spiked Duplicate Samples:	1432
Sum of QC Insertion:	**7973**
Total Analysis:	**11183**

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^{226}Ra DATA QUALITY REPORT

2015 Annual

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Elliot Lake Research Field Station of Laurentian University
Date: February 8, 2016

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1 Background

Elliot Lake Research Field Station (ELRFS) entered into an agreement with Denison Environmental Services (DES) for the analytical laboratory to provide ^{226}Ra analysis according to the ELFRS Offer of Services document submitted to DES on December 3, 2010. Please find below the summaries of the 2015 annual Quality Control (QC) results for blanks, duplicates, certified reference material (CRM), and spiked sample analysis.

The Analytical Services Laboratory of the Elliot Lake Research Field Station (ELRFS) was established in 1992. The initial work of the laboratory was to support research into the effects of low-level radioactivity on the environment resulting from regional uranium mining activities.

From this base, the laboratory has provided analytical services in support of local decommissioning and environmental monitoring programs, and in support of academic research. While the laboratory specializes in **radionuclide** analysis, it also provides a wide range of **inorganic** services for environmental samples, including solid wastes, effluents, receiving waters, ground waters, soils, sediments, geological materials, plant tissues and animal and fish tissues. The ELRFS analytical team will also complete specialty analyses outside of the scope of accreditation, following good laboratory practice procedures, using similar QA/QC protocols.

2 Quality Management System

ELRFS is ISO/IEC 17025:2005 accredited by the Canadian Association of Laboratory Accreditation (CALA) for specific environmental tests listed in the Scope of Accreditation. Accreditation is the formal recognition of the competence of a laboratory to achieve and demonstrate the highest levels of scientific and management excellence through the combined principles of Competence, Consistency, Credibility and Communication.

The quality management system at ELRFS consists of a documented quality system stating the quality policy, quality system and quality practices designed to demonstrate quality control operations are being carried out, to ensure accountability of data, to assure traceability of reported data, and to show that reasonable precautions are being taken against the possibility of falsification of data. Within this manual, Quality Assurance Procedures and Standard Operation Procedures define the laboratory operational duties that guide the analytical QC data. This includes a minimum target of 20% of the samples analysed being distributed as blanks, duplicate analysis, CRMs, and spiked samples. The sample and QC results are logged into excel spread sheets and Envista data management systems with monthly and annual QC reports generated.

3 Quality Control Parameters

All QC parameters are taken directly from the Excel spread sheets and Envista. DES samples are processed as part of the worksheet batch system. A compilation of all QC data appropriate to the parameters tested has been compiled below.

The QC summary reports are presented as control charts with the mean +/- 1 standard deviation illustrated as the SD Level, the mean +/- 2 standard deviations illustrated as the Warning Level and the mean +/- 3 standard deviations illustrated as the Control Level.

Control Level - If the Control Level is exceeded, the analysis of standards and samples must be repeated and if the repeat analysis exceeds the Control Level again, corrective action is required.
Warning Level – If 2 or more consecutive points exceed the Warning Level, another standard must be analyzed and if this analysis exceeds the Warning Level again, corrective action is required.
SD Level – If 4 consecutive results exceed the SD Level, analyse the next sample and if the SD Level is exceeded again, corrective action is required.

4 Notable Occurrences /Actions

Through the year of 2015, ELRFS analysed 88 batches totaling 954 samples for ^{226}Ra. Each batch incorporated blank, CRM, duplicate, and spiked samples providing greater than 25% quality control samples. All quality control samples are within control limits (mean +/- 3SD).

Twenty-two quality control samples exceeded the warning (mean +/- 2SD) levels. This included one QC Blank (Figure 1a) sample, three QC Duplicate (Figure 2) samples, three QC CRM (Figure 3a) samples and fifteen QC Spike (Figure 4a) samples. With the exception of 3 QC Spike samples in the month of July (please refer to section 4.2), all samples exceeding the warning level were not consecutive, with the next consecutive sample falling within the warning level (mean +/- 2SD) limit, thus no corrective actions were required.

Six quality control samples exceeded objectives. Four QC CRM samples (January 7th, 9th, 16th and February 6th) and two QC Spike samples (January 9th & 28th) had recoveries of less than 80%. All of these low Ra-226 recoveries occurred with a new Ra-226 standard solution used from January 1st through February 10th which was discontinued on February 11th. ELRFS returned back to using the old Ra-226 solution from February 11th onward. All QC samples measured after the switch back to the old standards (February 11th through December 31st) meet objectives.

4.1: Investigation into New Ra-226 Standard Solution from Eckert & Ziegler

The reason for the abrupt change in QC data quality stems from the purchase of a new certified stock solution from Eckert & Ziegler in the spring of 2014. The stock solution, certified at 514.3 Bq/L (+/- 3.1%) which is equivalent to 0.5143 Bq/mL, was diluted by a factor of two to yield a new QC-SPIKE working solution of 0.257 Bq/mL and was diluted by a factor of ten to yield a new QC-CRM working solution of

0.051 Bq/mL (Units of Bq/mL are correct for the QC-Solutions, however since we take 1mL and add it to a beaker of ultrapure water we report as Bq/L).

Testing of the new solutions was conducted between July 23, 2014 and September 5, 2014. Each solution was run 40 times as a normal sample to generate statistically acceptable control charts. The results show a mean value of 0.045 Bq/mL for the QC-CRM solution (88.39% recovery with a standard deviation of 0.004 Bq/mL) and a mean value of 0.228 Bq/mL for the QC-SPIKE solution (88.64% recovery with a standard deviation of 0.011 Bq/mL). These results were low compared to the certified values, but consistent and within control limits of new control charts.

The decision was made to switch from the old QC solutions to the new solutions starting in January 2015, this way control charts would not have to be changed in mid-year. However, the results for January 2015 show consistently lower results than in the summer of 2014 with an average QC-CRM result of 0.042 Bq/mL (81.66% recovery on 6 results) and an average QC-SPIKE result of 0.210 Bq/mL (81.71% recovery on 6 results). The consistent drop in recovery is now no longer acceptable, falls outside of control limits and indicates that the new QC Spike and QC CRM solutions are not stable.

After reviewing the January 2015 data, ELRFS determined as of February 11, 2015 that all further Ra-226 analysis would immediately switch back to the old QC-CRM and QC-SPIKE solutions and that an investigation would begin.

The investigation began by determining if the newly purchased heavy duty 1L polypropylene storage bottles may be to blame for the drop in readings, possibly due to adsorption on the plastic. However, a test involving the re-dilution of the original stock solution purchased (and shipped in a different brand of bottle) revealed triplicate results of 0.207, 0.212 & 0.220 Bq/L respectively (82.62% average recovery), indicating that the original standard solution shipped from the manufacturer may also be dropping in value.

The investigation then resulted in a call to the manufacturer for clarification on certain terminology in the certificate of analysis. Specifically, the statement on page 4 that states "*Calibrated solutions may vary within the total uncertainty stated on the Certificate of Calibration. Nominal and calibrated solutions are prepared to within a tolerance of +/-15% unless otherwise agreed to by Eckert & Ziegler Isotope Products in writing at the time or order quotation."* We were assured that the +/- 15% value refers to achieving the amount of activity requested, not the actual uncertainty in the 1L custom solution produced for ELRFS which was measured to be 514.3Bq with a total uncertainty of 3.1% at the 99% confidence level.

Furthermore, during the same conversation with the manufacturer, it was recommended that upon any dilutions of the stock solution, that both acid matrix and carrier concentration not be diluted. Therefore, any diluted solution should maintain a 1M HNO3 matrix and a 10ug/mL concentration of Barium (in $Ba(NO_3)_2$ form) so as to match the original stock solution as provided. This was not done to the prepared solutions upon dilution at ELRFS and may explain the low concentrations obtained in recovery and the inconsistent and low recovery obtained over time.

It is unknown if the diluted working solutions have Ra-226 that has either precipitated from solution or absorbed to the container side walls. It is also unknown if adding additional Barium carrier or concentrated nitric acid can reverse the possible side effects which would lead to increased recoveries. If successful, this may salvage the diluted solutions. There is also enough original stock solution left to attempt a proper dilution with added Barium carrier and nitric acid, but only in limited quantities, enough for testing but not enough for long term production.

Another option is to purchase a more concentrated standard from NIST, which would allow for independent verification of the procedure and provide a new set of QC standards for long term use. In the meantime the old standards will be used for production.

4.2: Investigation into three consecutive QC Spike results exceeding the warning limits.

The three samples in question (July 10th, 15th & 17th) represent values of 0.234Bq/L, 0.230Bq/L & 0.234Bq/L respectively which technically meet the objectives of being within 20% error. However, the violation of the warning limit (0.237Bq/L) is based on the statistical data generated from the previous year (2014) where n=99.

At the time the second violation of the warning limit was found on July 17th, the batch of samples containing the third violation had already begun, including the spike sample. Thus, investigating the cause of all three violations began only after it was too late to reverse the third violation.

The designated Ra-226 micro-pipette (Serial #A84013201) was re-tested to ensure it was delivering an accurate aliquot of 1mL to the 600mL beakers employed for analysis. This was operating within 1% error when tested and the daily logbook confirmed the same error tolerance on July 10th and 15th.

The alpha detector's "region of interest" files were checked to ensure if any peak positions had shifted. This is done by running a high level Ra-226 standard disc on the detector to determine if any peaks are falling outside of the counting area, resulting in low counts. This test is routinely conducted every six months. The results of the peak position check were normal and no drifting had occurred.

It was then noted that in the three samples that violated the warning level, the gamma measurement of the Ba-133 internal standard was above 100% recovery by a slight margin. The internal standard is used to correct for any loss in recovery. With internal standard results over 100% recovery, the resulting mathematical correction would be to reduce the Ra-226 results by a few percent. Table 1 illustrates these results. Prior to internal standard correction, based solely on alpha emissions from Ra-226, all samples are within the warning limit of 0.237Bq/L. Only after internal standard corrections of 3% do the values fall below the warning limit. These corrections are applied equally to QC samples as to client samples.

Error does exist during pipeting of the internal standard and the QC Spike sample, however the same micro pipette is used to do both (different tips are used). Therefore, if there was bias in the pipet, it should have been constant for both the QC Spike and the addition of internal standard. Despite the fact that recoveries over 100% do occur, they are much less frequent than recoveries below 100% due to the fact that material can be lost at any of the steps in the analysis. While statistically improbable that three consecutive QC Spike samples had lower than average alpha counts for Ra-226 and simultaneously higher than normal gamma counts for Ba-133, it appears to have happened.

There is no currently no additional information or explanation for this occurrence.

Table 1. Summary of Ba-133 Internal Standard Corrections

Batch Date	Ba-133 Recovery %	Uncorrected Ra-226 Result (Bq/L)	Int. Std. Corrected Ra-226 Result (Bq/L)
July 8/15	97.93	0.2536	0.259
July 10/15	102.90	0.2407	0.234
July 15/15	103.36	0.2377	0.230
July 17/15	103.29	0.2417	0.234
July 22/15	97.39	0.2386	0.245

5 QC Data Summary

Table 2. Summary of QC results for new standard from Eckert & Ziegler for January-February, 2015.

Quality Element	Unit	Objective	Total Number of Samples QC Samples	Expected Value	Mean	Number Outside Warning Limit	Number Outside Control Limit	Number Exceeding Objective
Blank	**Bq/L**	**0.01**	**8**	**0**	**0.00060**	**0**	**0**	**0**
Duplicate % error	**%**	**20**	**8**	**0**	**4.66**	**0**	**0**	**0**
CRM	**Bq/L**	**20**	**8**	**0.051**	**0.042**	**1**	**0**	**4**
Spike	**Bq/L**	**20**	**8**	**0.257**	**0.212**	**2**	**0**	**2**

Table 3. Summary of QC results for old standards from ERA # RAD-A for February-December, 2015.

Quality Element	Unit	Objective	Total Number of Samples QC Samples	Expected Value	Mean	Number Outside Warning Limit	Number Outside Control Limit	Number Exceeding Objective
Blank	**Bq/L**	**0.01**	**80**	**0**	**0.00061**	**1**	**0**	**0**
Duplicate % error	**%**	**20**	**80**	**0**	**5.25**	**3**	**0**	**0**
CRM	**Bq/L**	**20**	**80**	**0.044**	**0.044**	**2**	**0**	**0**
Spike	**Bq/L**	**20**	**80**	**0.249**	**0.247**	**13**	**0**	**0**

1 Blanks

The blank sample is composed of ultra pure water and is treated in an identical manner, including all of the added reagents, as normal samples. The criterion of the blank sample is 0.01 Bq/L which is equal to 6 counts per 100 min (0.06 cpm). The 2015 mean blank value is 1.02 counts per 100min. ELRFS uses counts to monitor the blank quality control data.

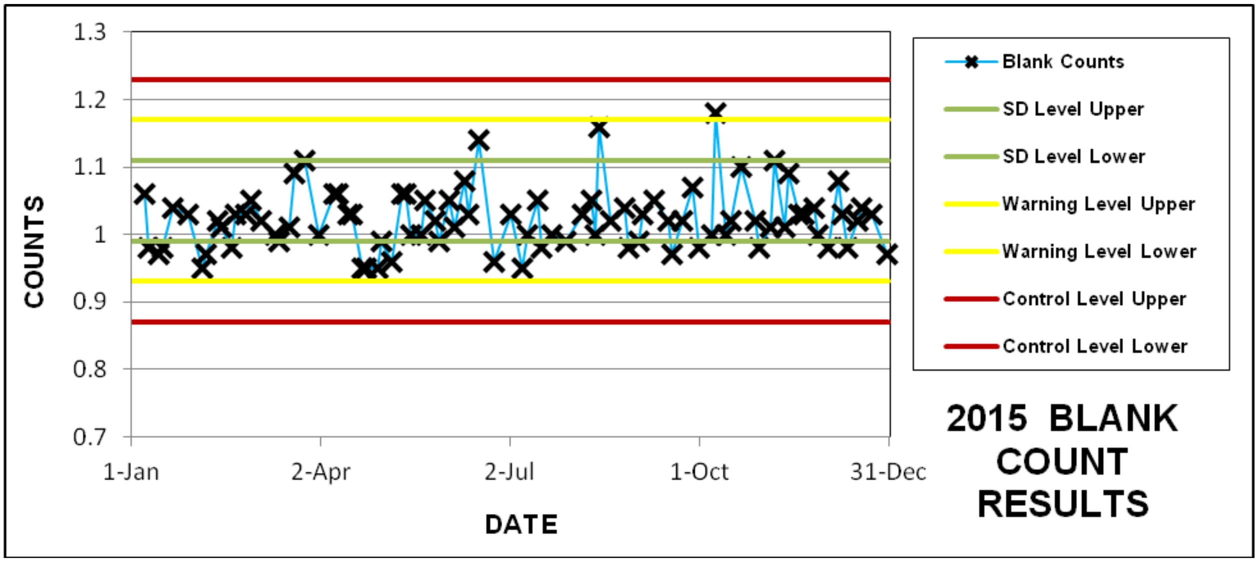

Figure 1a: Blank quality control results for the 2015 year.

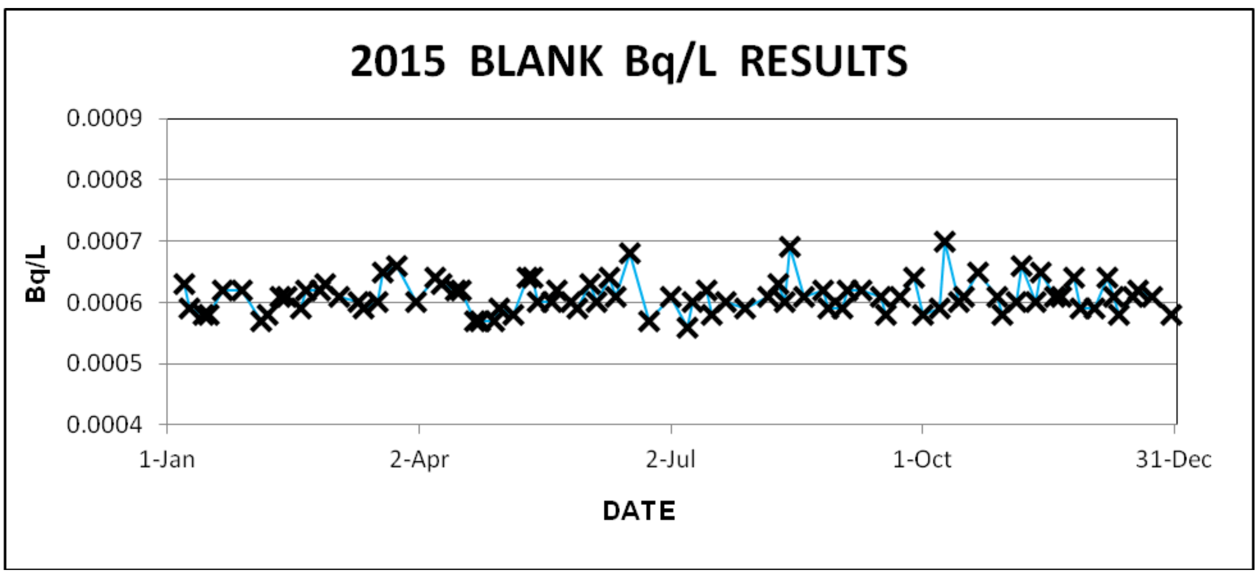

Figure 1b: Blank quality control concentrations for the 2015 year. Note maximum concentrations are 10 times lower than the 0.01 Bq/L criteria.

2 Duplicates

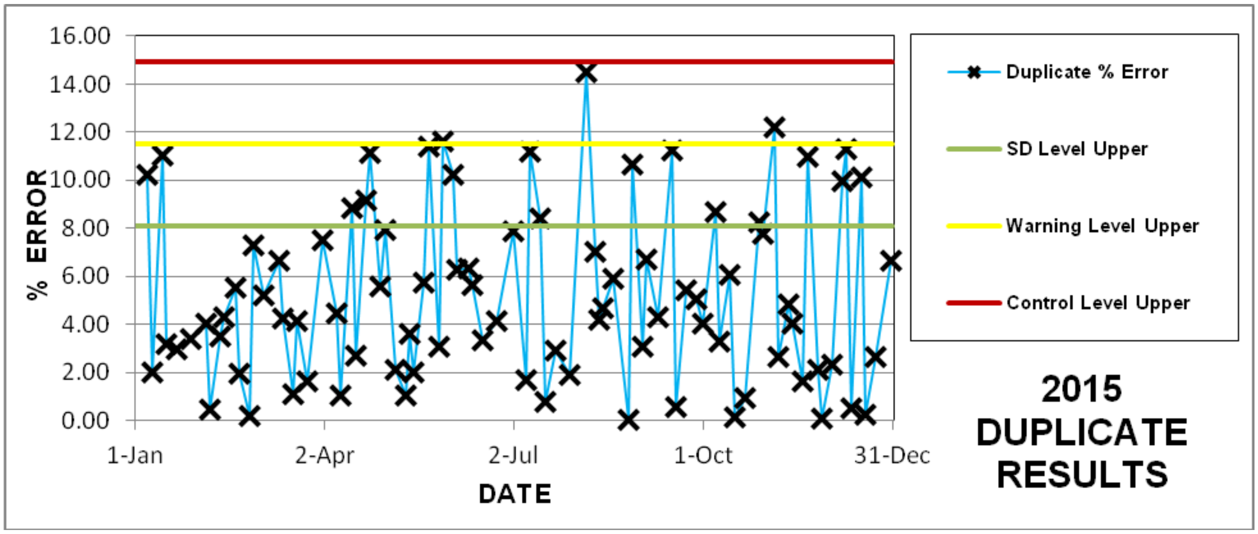

Figure 2: Duplicate quality control results for the 2015 year.

3 CRM

The CRM material used from January 1st until February 10th 2015 is from Eckert & Ziegler (0.051Bq/L) and from February 11th until December 31st from ERA # RAD-A (0.044 Bq/L).

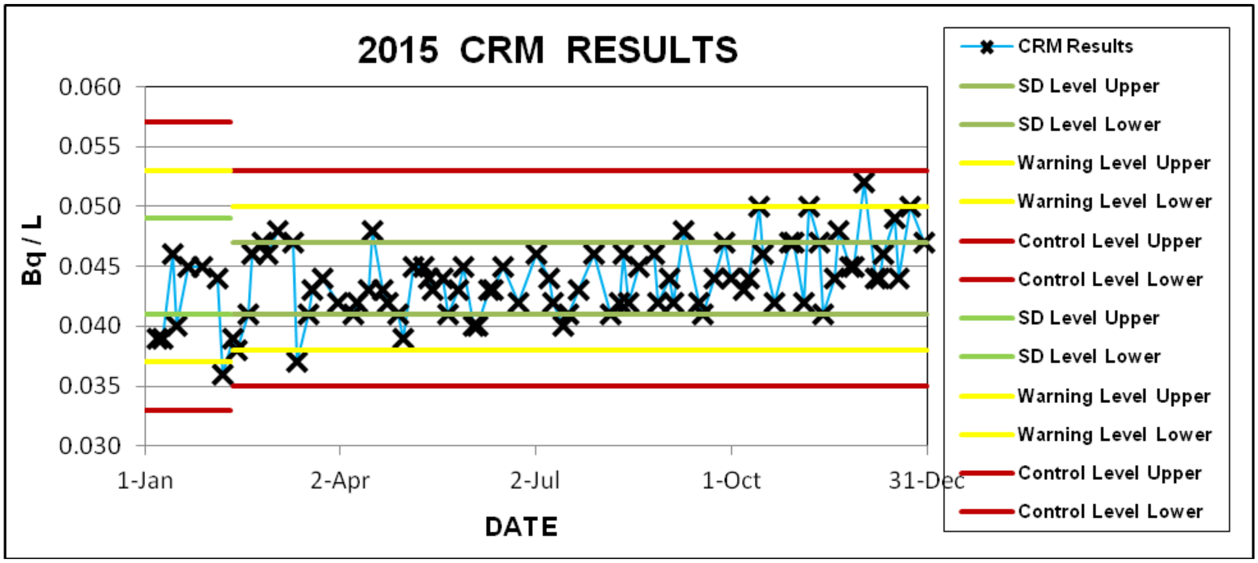

Figure 3a: CRM quality control results for the 2015 year

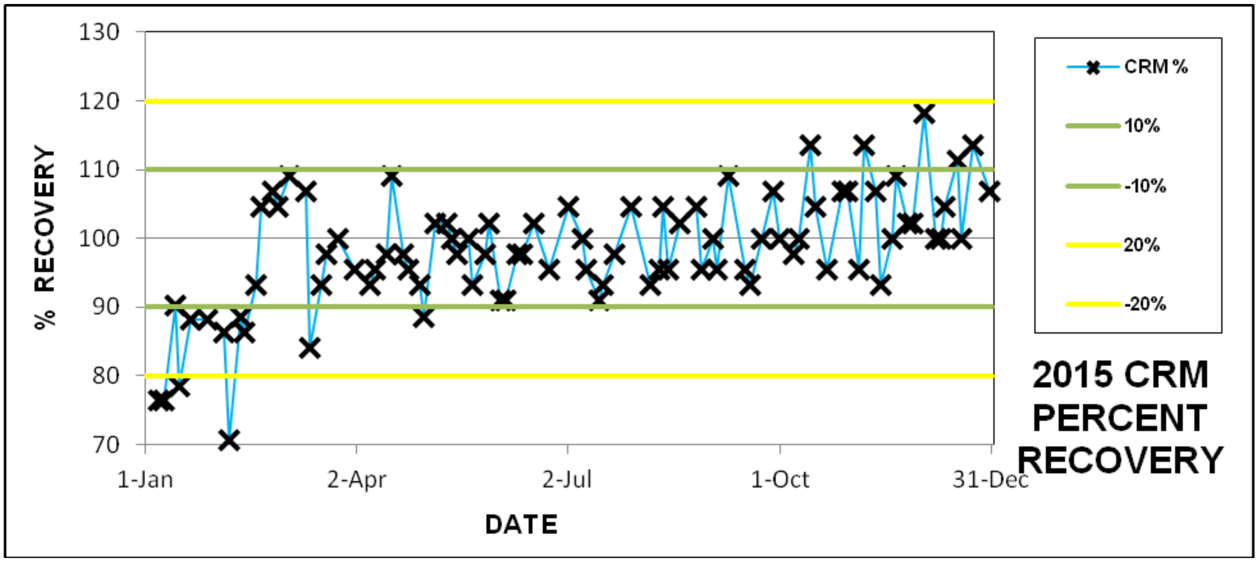

Figure 3b: CRM percent recovery quality control results for the 2015 year.

4 Spikes

The spike recovery concentration is 0.257 Bq/L for the Eckert & Ziegler solution used from January 1st through February 10th, 2015 and 0.249Bq/L for the old solution used from February 11th through December 31st, 2015.

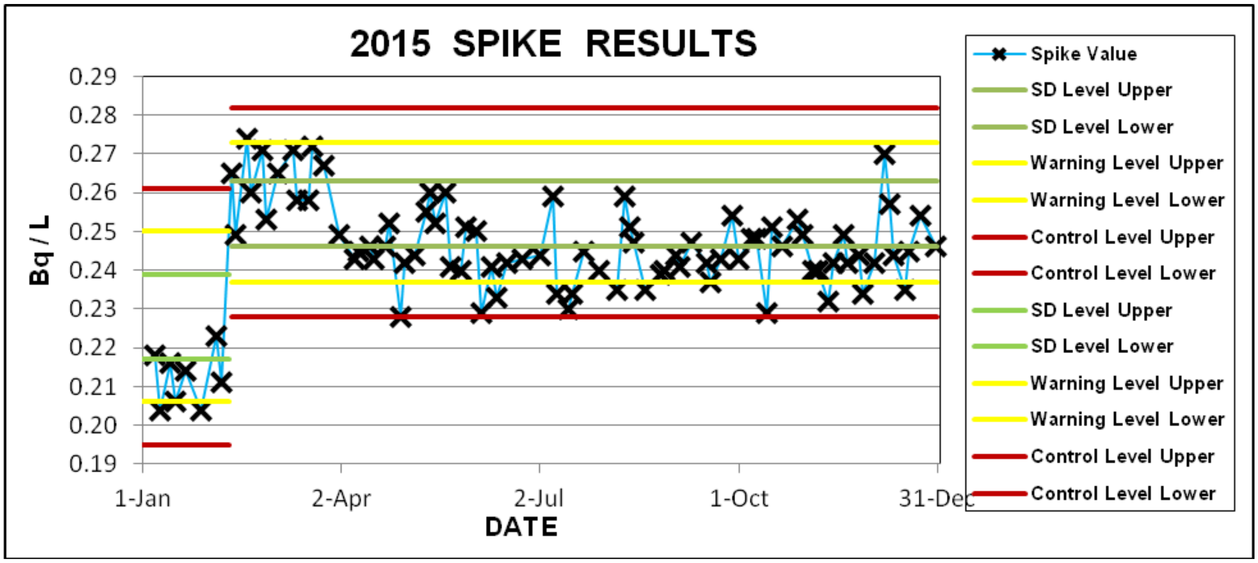

Figure 4a: Spike recovery quality control results for the 2015 year

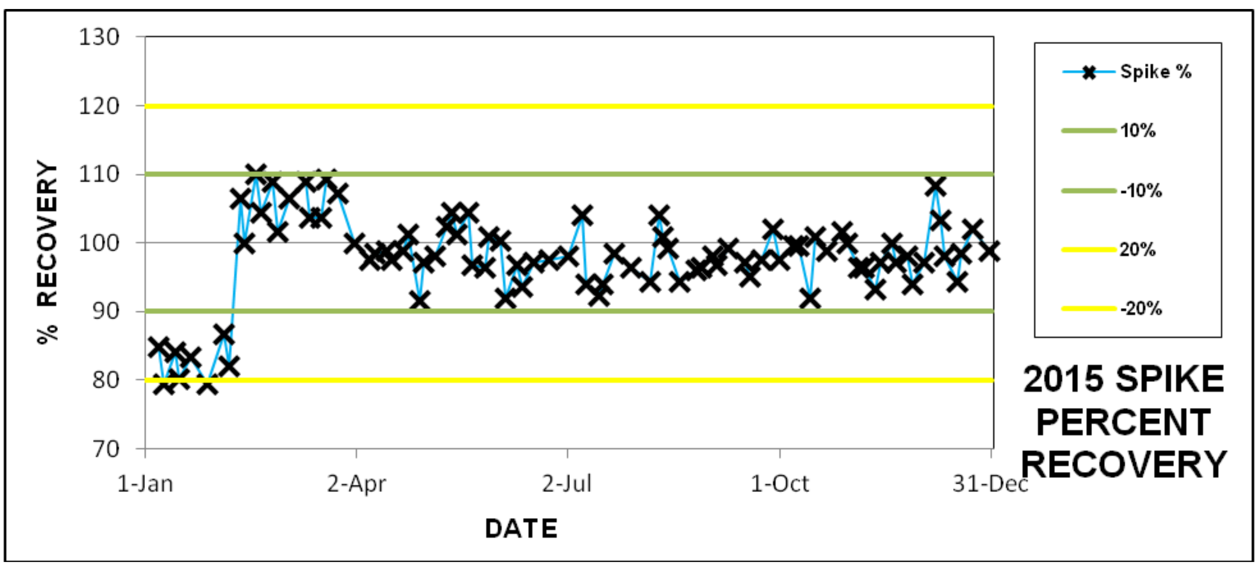

Figure 4b: Percent spike recovery quality control results for the 2015 year.

QC Frequency

Through the 2015 year, ELRFS analysed 88 batches totaling 954 samples for ^{226}Ra. Each batch incorporated blank, CRM, duplicate, and spiked samples providing greater than 25% quality control samples.

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Environmental Monitoring and Reclamation Research An ISO:17025 Accredited Laboratory

^{226}Ra DATA QUALITY REPORT

2016 Annual

Prepared by:

Troy Maki

Troy Maki - Analytical Chemist

Reviewed by:

Dr. Graeme Spiers - Director

Elliot Lake Research Field Station of Laurentian University
Date: February 17, 2017

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2 Quality Management System

ELRFS is ISO/IEC 17025:2005 accredited by the Canadian Association of Laboratory Accreditation (CALA) for specific environmental tests listed in the Scope of Accreditation. Accreditation is the formal recognition of the competence of a laboratory to achieve and demonstrate the highest levels of scientific and management excellence through the combined principles of Competence, Consistency, Credibility and Communication.

The quality management system at ELRFS consists of a documented quality system stating the quality policy, quality system and quality practices designed to demonstrate quality control operations are being carried out, to ensure accountability of data, to assure traceability of reported data, and to show that reasonable precautions are being taken against the possibility of falsification of data. Within this manual, Quality Assurance Procedures and Standard Operation Procedures define the laboratory operational duties that guide the analytical QC data. This includes a minimum target of 20% of the samples analysed being distributed as blanks, duplicate analysis, CRMs, and spiked samples. The sample and QC results are logged into excel spread sheets and Envista data management systems with monthly and annual QC reports generated.

3 Quality Control Parameters

All QC parameters are taken directly from the Excel spread sheets and Envista. DES samples are processed as part of the worksheet batch system. A compilation of all QC data appropriate to the parameters tested has been compiled below.

The QC summary reports are presented as control charts with the mean +/- 1 standard deviation illustrated as the SD Level, the mean +/- 2 standard deviations illustrated as the Warning Level and the mean +/- 3 standard deviations illustrated as the Control Level.

Control Level - If the Control Level is exceeded, the analysis of standards and samples must be repeated and if the repeat analysis exceeds the Control Level again, corrective action is required.
Warning Level – If 2 or more consecutive points exceed the Warning Level, another standard must be analyzed and if this analysis exceeds the Warning Level again, corrective action is required.
SD Level – If 4 consecutive results exceed the SD Level, analyse the next sample and if the SD Level is exceeded again, corrective action is required.

4 Notable Occurrences /Actions

Through the year of 2016, ELRFS analyzed 96 batches totaling 1048 samples for ^{226}Ra. Each batch incorporated blank, CRM, duplicate, and spiked samples providing greater than 25% quality control samples. All quality control samples are within control limits (mean +/- 3SD).

Eighteen quality control samples exceeded the warning (mean +/- 2SD) levels. This included one QC Blank (Figure 1a) sample, nine QC Duplicate (Figure 2) samples, three QC CRM (Figure 3a) samples and five QC Spike (Figure 4a) samples. All samples exceeding the warning level were not consecutive, with the next consecutive QC sample falling within the warning level (mean +/- 2SD) limit, thus no corrective actions were required. No QC samples exceeded objectives.

5 QC Data Summary

Table 1. Summary of QC results for 2016.

Quality Element	Unit	Objective	Total Number of Samples QC Samples	Expected Value	Mean	Number Outside Warning Limit	Number Outside Control Limit	Number Exceeding Objective
Blank	Bq/L	0.01	96	0	0.00060	1	0	0
Duplicate % error	%	20	96	0	6.30	9	0	0
CRM	Bq/L	20	96	0.049	0.045	3	0	0
Spike	Bq/L	20	96	0.249	0.244	5	0	0

1 Blanks

The blank sample is composed of ultra pure water and is treated in an identical manner, including all of the added reagents, as normal samples. The criterion of the blank sample is 0.01 Bq/L which is equal to 6 counts per 100 min (0.06 cpm). The 2016 mean blank value is 1.01 counts per 100min (0.00060 Bq/L). ELRFS uses counts to monitor the blank quality control data.

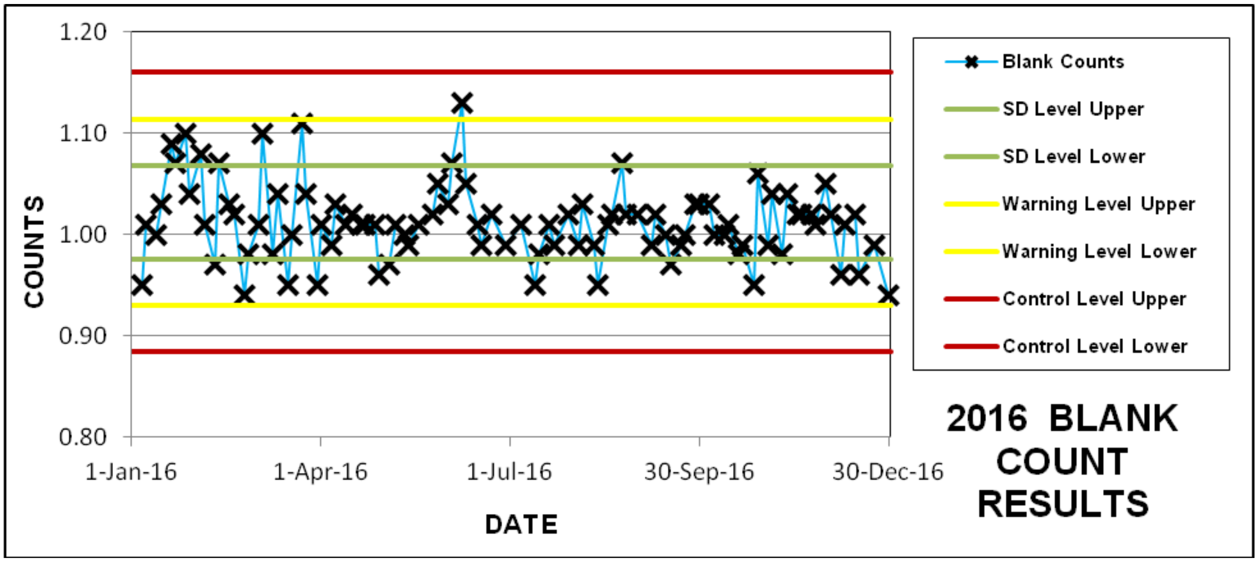

Figure 1a: Blank quality control results for the 2016 year.

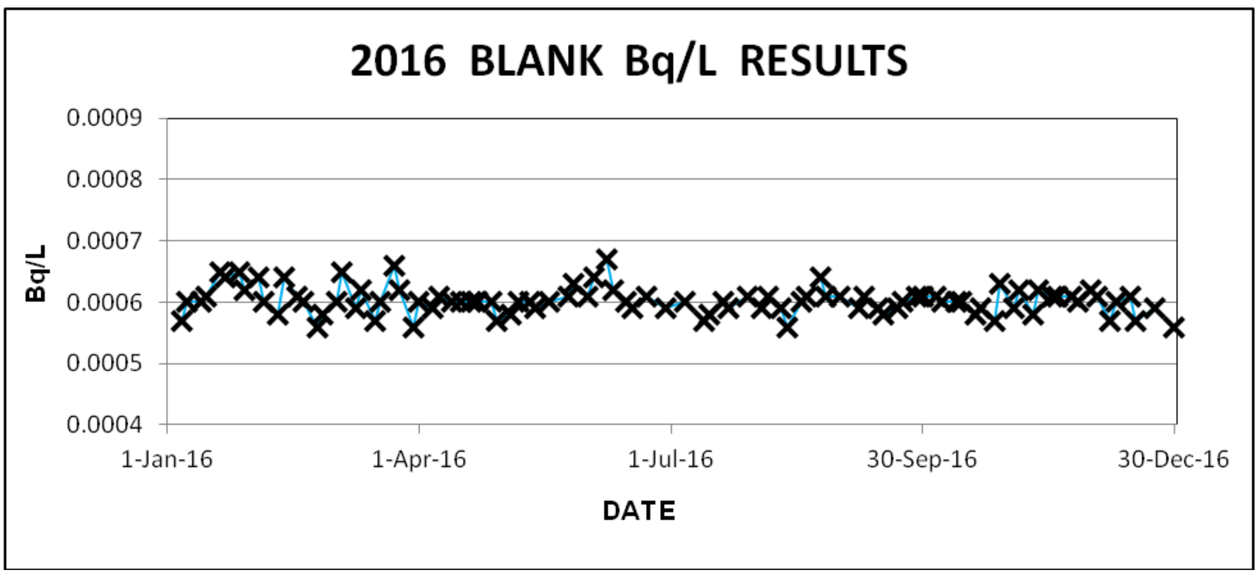

Figure 1b: Blank quality control concentrations for the 2016 year. Note maximum concentrations are 10 times lower than the 0.01 Bq/L criteria.

2 Duplicates

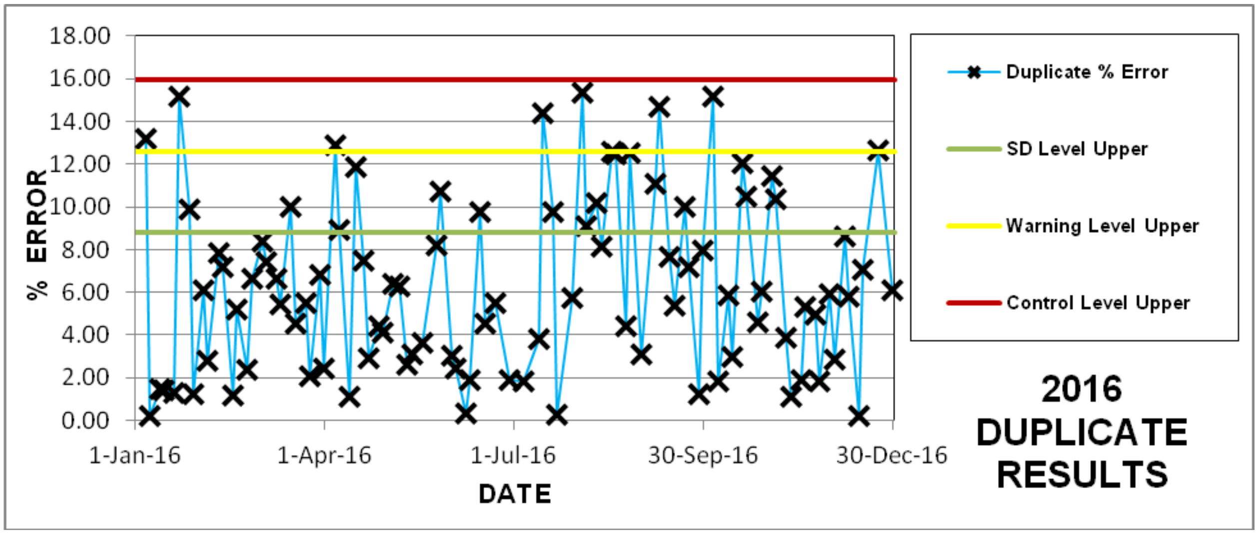

Figure 2: Duplicate quality control results for the 2016 year.

3 CRM

The CRM material used is ERA # RAD-A and contains 0.044 Bq/L.

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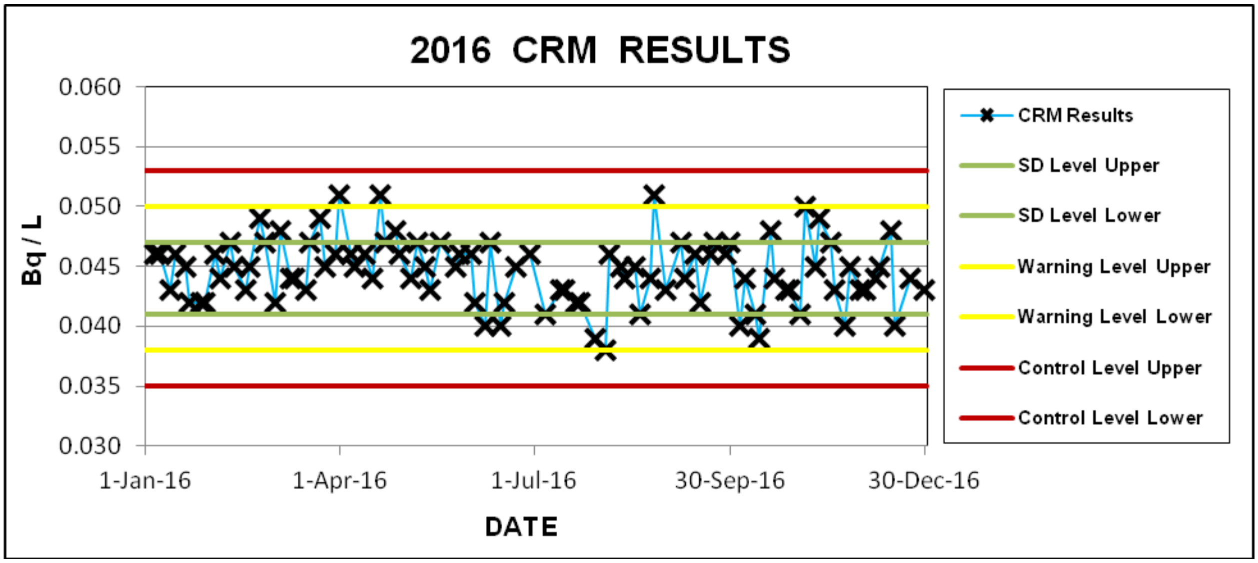

Figure 3a: CRM quality control results for the 2016 year.

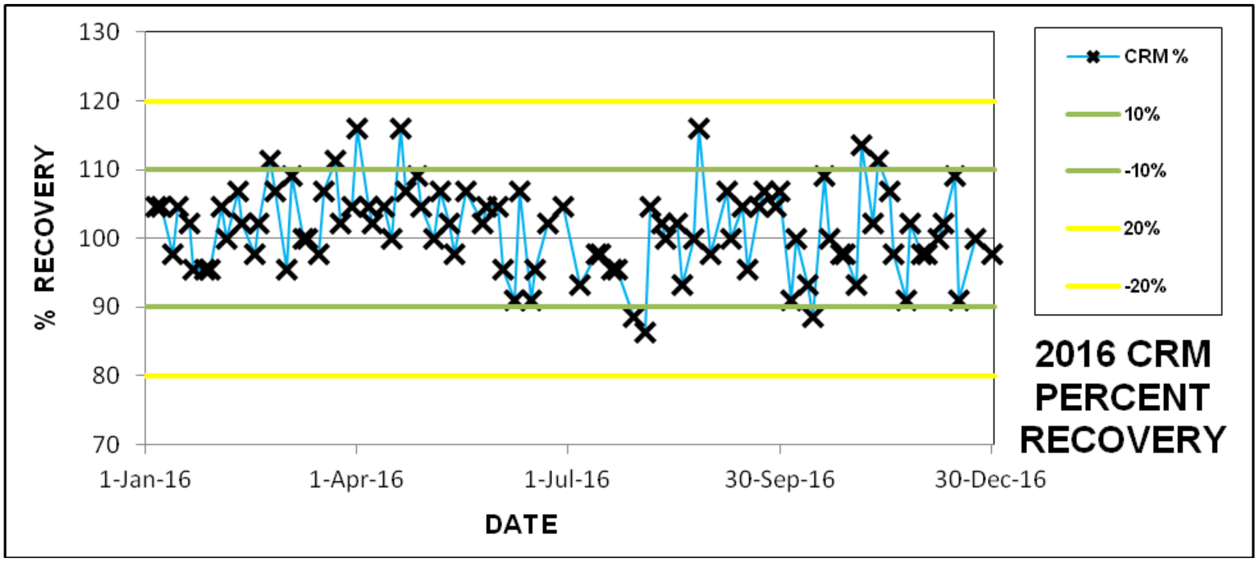

Figure 3b: CRM percent recovery quality control results for the 2016 year.

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4 Spikes

The spike recovery concentration is 0.249 Bq/L.

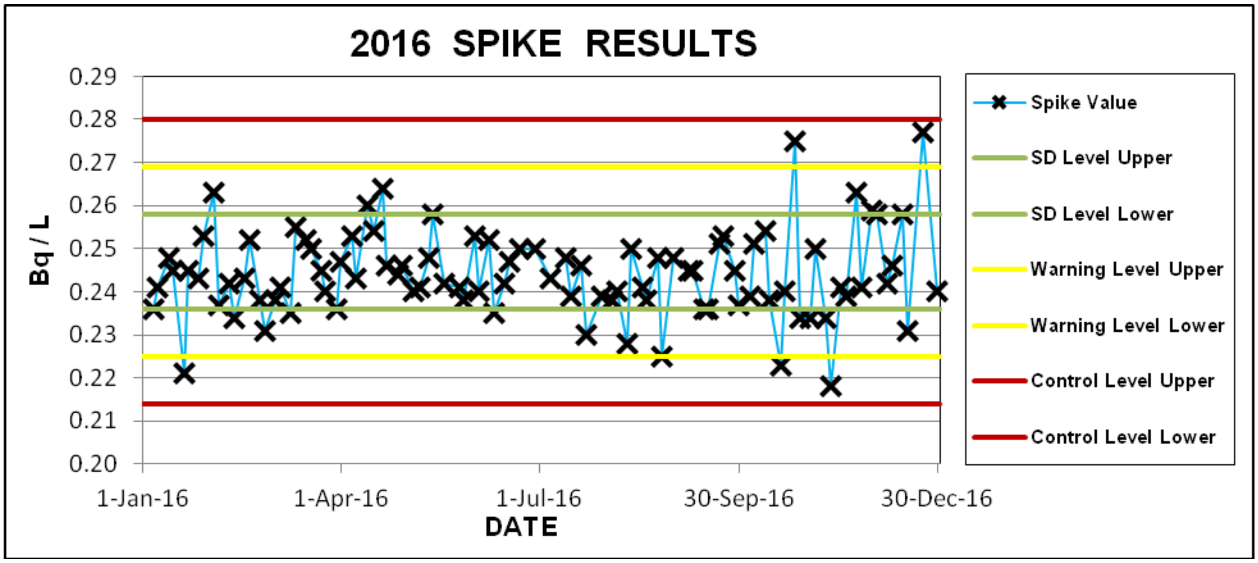

Figure 4a: Spike recovery quality control results for the 2016 year

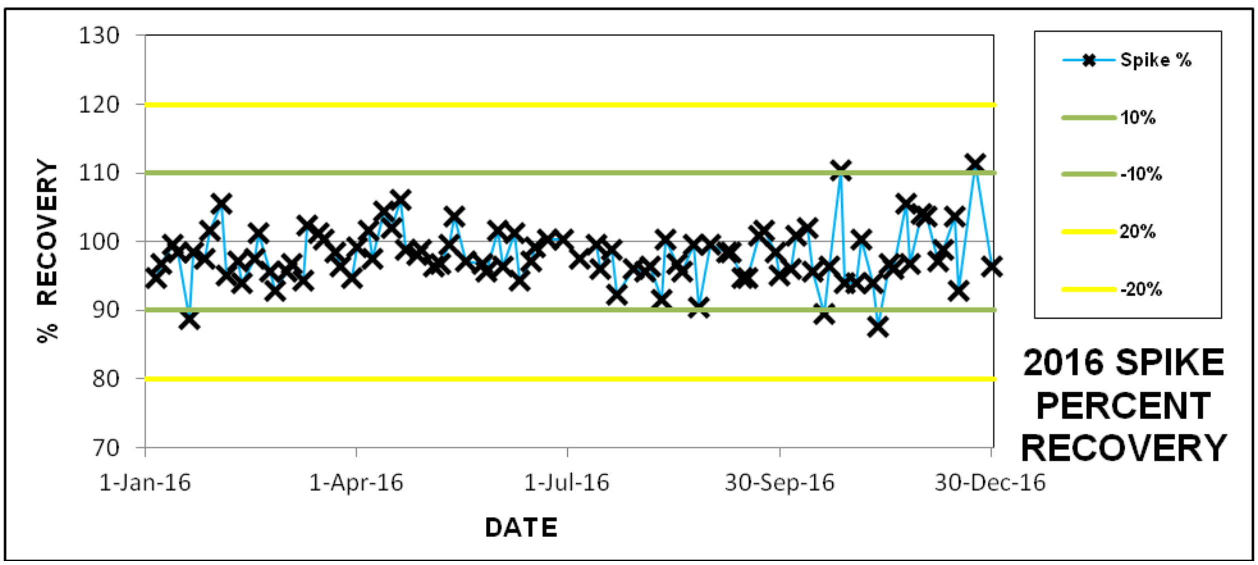

Figure 4b: Percent spike recovery quality control results for the 2016 year.

QC Frequency

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Environmental Monitoring and Reclamation Research An ISO:17025 Accredited Laboratory

^{226}Ra DATA QUALITY REPORT

2017 Annual

Prepared by:

Troy Maki

Troy Maki - Analytical Chemist

Reviewed by:

Dr. Graeme Spiers - Director

Elliot Lake Research Field Station of Laurentian University
Date: January 19, 2018

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Warning Level – If 2 or more consecutive points exceed the Warning Level, another standard must be analyzed and if this analysis exceeds the Warning Level again, corrective action is required.
SD Level – If 4 consecutive results exceed the SD Level, analyse the next sample and if the SD Level is exceeded again, corrective action is required.

4 Notable Occurrences /Actions

Through the year of 2017, ELRFS analyzed 101 batches totaling 1197 samples for ^{226}Ra. Each batch incorporated blank, CRM, duplicate, and spiked samples providing greater than 25% quality control samples. All quality control samples are within control limits (mean +/- 3SD).

Twenty-four quality control samples exceeded the warning (mean +/- 2SD) levels. This included five QC Blank (Figure 1a) samples, 4 QC Duplicate (Figure 2) samples, four QC CRM (Figure 3a) samples and 11 QC Spike (Figure 4a) samples. All samples exceeding the warning level were not consecutive, with the next consecutive QC sample falling within the warning level (mean +/- 2SD) limit, thus no corrective actions were required. No QC samples exceeded objectives.

5 QC Data Summary

Table 1. Summary of QC results for 2017.

Quality Element	Unit	Objective	Total Number of Samples QC Samples	Expected Value	Mean	Number Outside Warning Limit	Number Outside Control Limit	Number Exceeding Objective
Blank	Bq/L	0.01	101	0	0.00062	5	0	0
Duplicate % error	%	20	101	0	6.31	4	0	0
CRM	Bq/L	20	101	0.044	0.044	4	0	0
Spike	Bq/L	20	101	0.249	0.251	11	0	0

1 Blanks

The blank sample is composed of ultra pure water and is treated in an identical manner, including all of the added reagents, as normal samples. The criterion of the blank sample is 0.01 Bq/L which is equal to 6 counts per 100 min (0.06 cpm). The 2017 mean blank value is 1.01 counts per 100min (0.00062 Bq/L). ELRFS uses counts to monitor the blank quality control data.

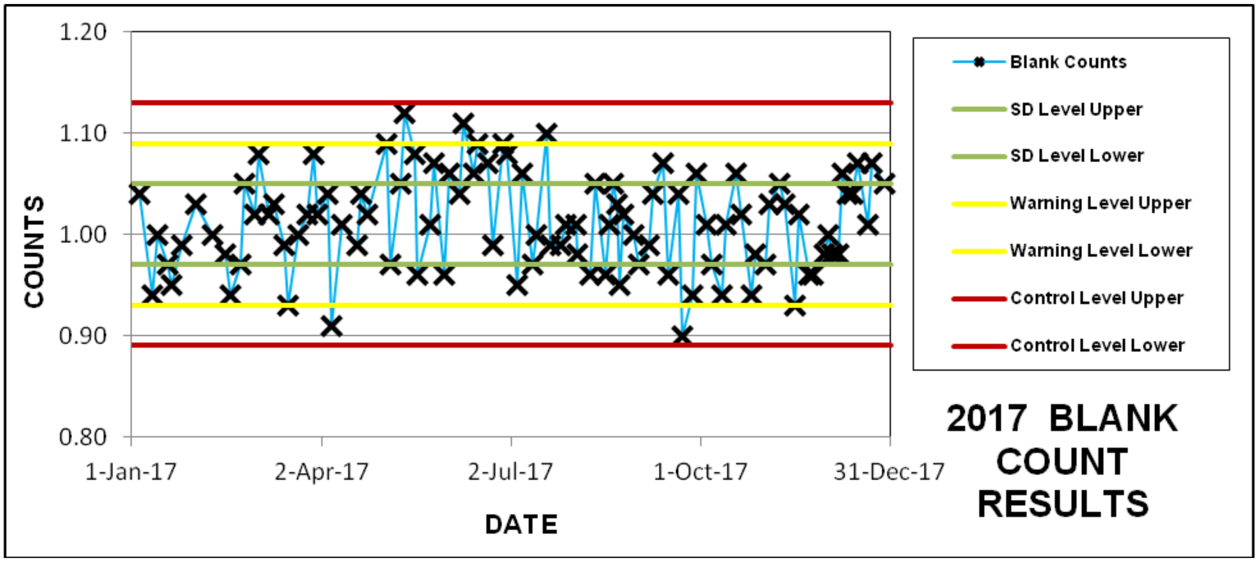


Figure 1a: Blank quality control results for the 2017 year.

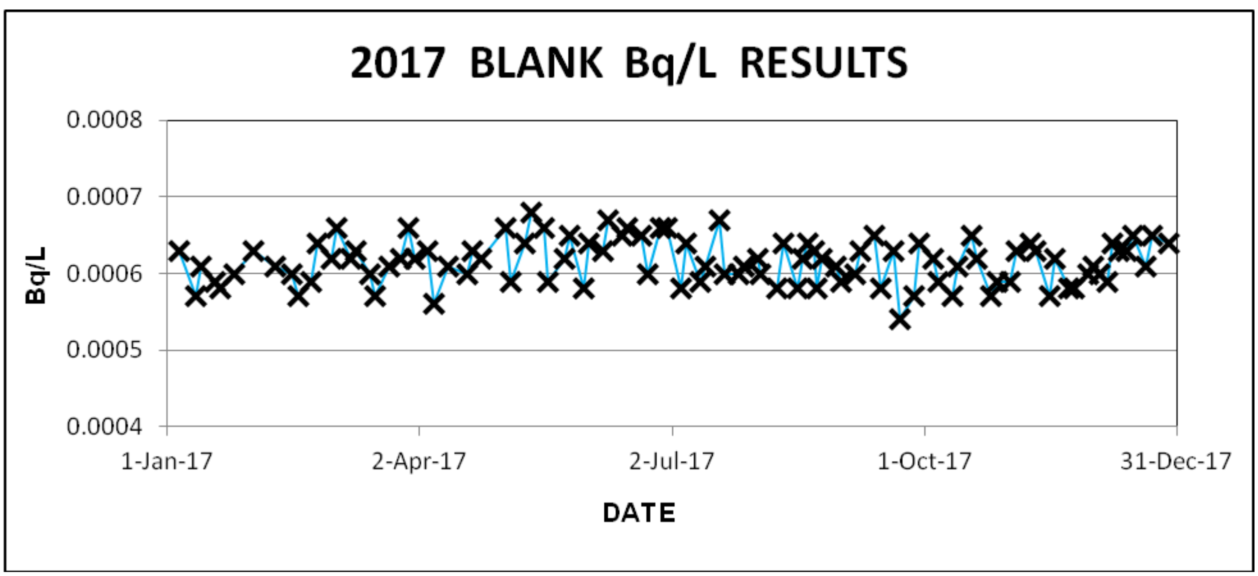


Figure 1b: Blank quality control concentrations for the 2017 year. Note maximum concentrations are 10 times lower than the 0.01 Bq/L criteria.

2 Duplicates

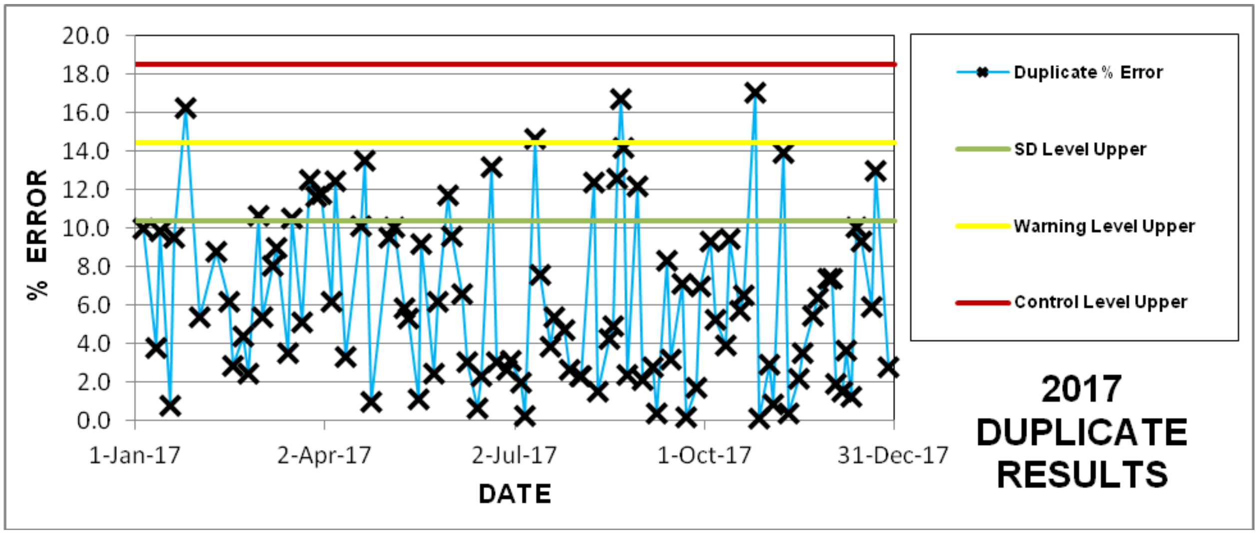
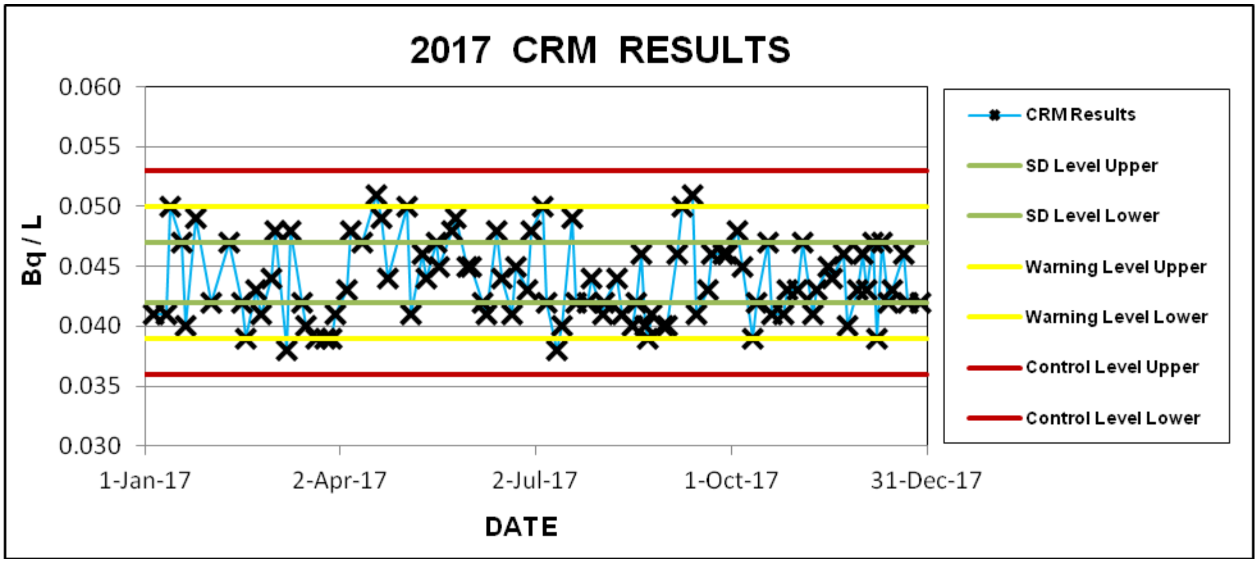


Figure 2: Duplicate quality control results for the 2017 year.

3 CRM

The CRM material used is ERA # RAD-A and contains 0.044 Bq/L.

.



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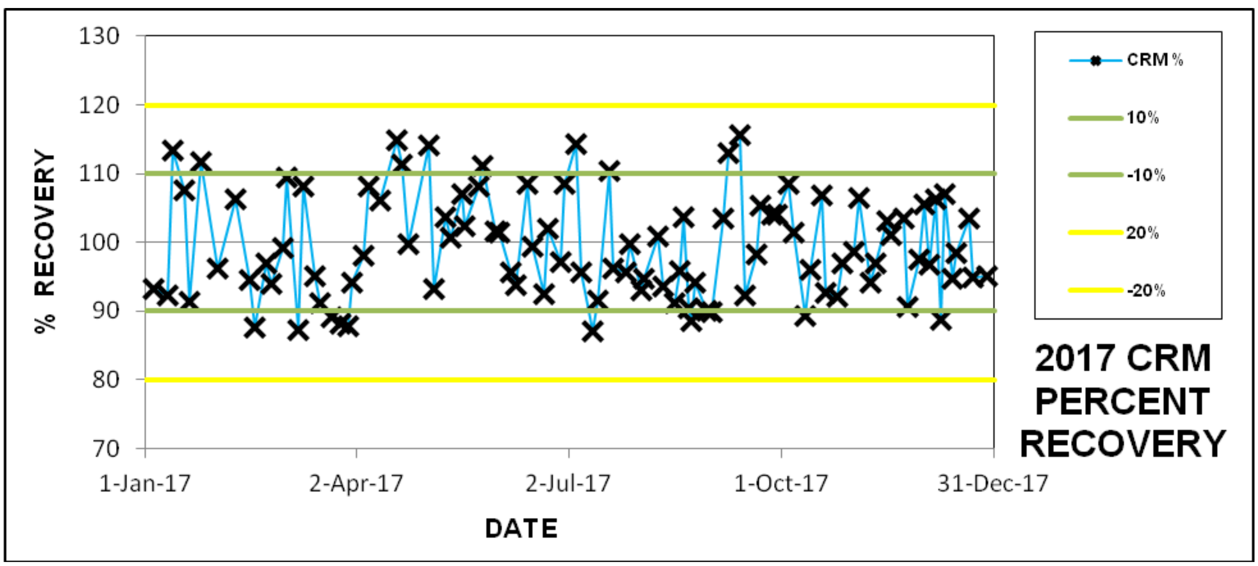
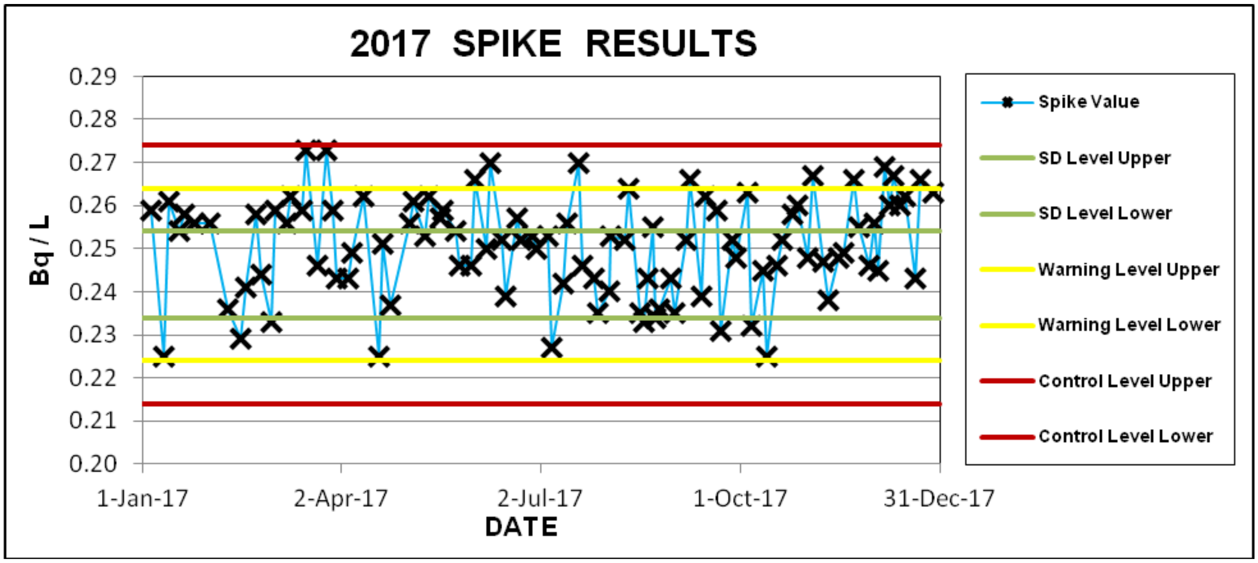


Figure 3b: CRM percent recovery quality control results for the 2017 year.

4 Spikes

The spike recovery concentration is 0.249 Bq/L.



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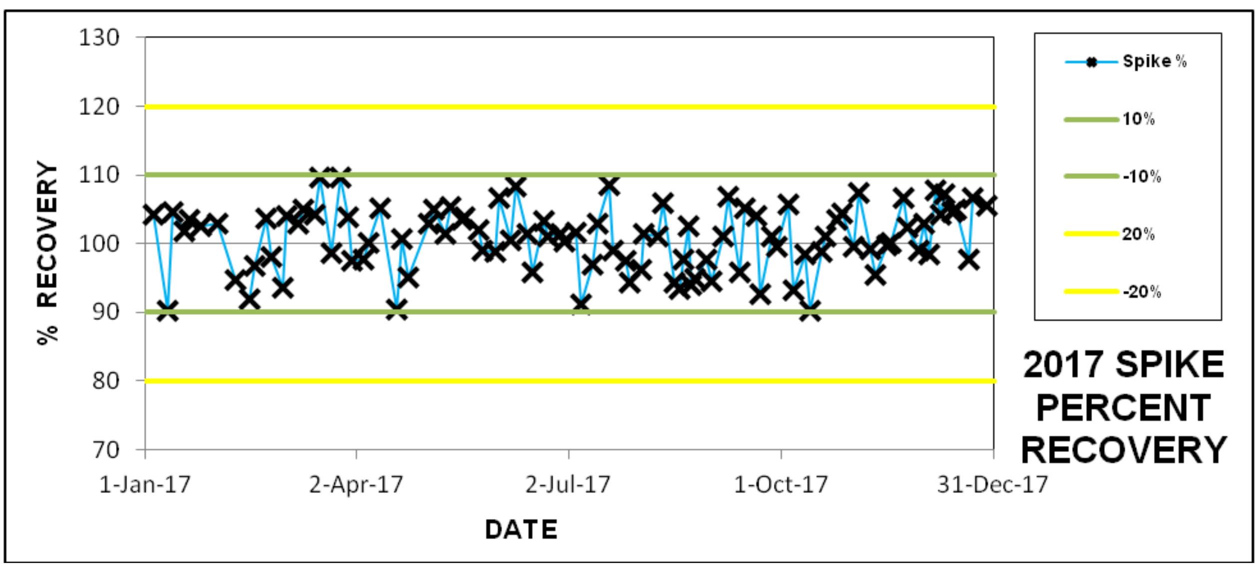

Figure 4b: Percent spike recovery quality control results for the 2017 year.

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^{226}Ra DATA QUALITY REPORT

2018 Annual

Prepared by:

Troy Maki - Analytical Chemist

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Dr. Graeme Spiers - Director

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Date: March 12, 2019

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SD Level – If 4 consecutive results exceed the SD Level, analyse the next sample and if the SD Level is exceeded again, corrective action is required.

4 Notable Occurrences /Actions

In late 2017, ELRFS purchased a new NIST traceable Ra-226 standard from Eckert & Ziegler to replace the existing ERA #RAD-A. The intent was to implement the new standard for the start of the 2018 calendar year but due to larger than anticipated sample volume there was insufficient time to process the necessary test samples to generate adequate statistics for control chart generation. The testing process involved 32 independently processed CRM samples (0.050Bq/L) which yielded an average recovery of 0.048Bq/L (96.38%, St-dev. = 0.0035Bq/L) and 33 independently processed Spike samples (0.250Bq/L) which yielded an average recovery of 0.237Bq/L (94.67%, St-dev. = 0.0113Bq/L). Implementation of the new QC CRM and QC Spike standards occurred on March 1st, 2018.

Through the year of 2018, ELRFS analyzed 122 batches totaling 1426 samples for ^{226}Ra. The first 24 batches (320 samples) occurred using the old ERA CRM & Spike standards and the following 98 batches (1106 samples) utilized the new Eckert & Ziegler CRM and Spike standards. Each batch incorporated blank, CRM, duplicate, and spiked samples providing greater than 20% quality control samples. All quality control samples are within control limits (mean +/- 3SD).

Twelve quality control samples exceeded the warning (mean +/- 2SD) levels. This included seven QC Blank (Figure 1a) samples, two QC Duplicate (Figure 2) samples, two QC CRM (Figure 3a) samples and one QC Spike (Figure 4a) samples. All samples exceeding the warning level were not consecutive, with the next consecutive QC sample falling within the warning level (mean +/- 2SD) limit, thus no corrective actions were required. No QC samples exceeded objectives.

5 QC Data Summary

Table 1. Summary of QC results for old standard from ERA #RAD-A for January – February 2018.

Quality Element	Unit	Objective	Total Number of QC Samples	Expected Value	Mean	Number Outside Warning Limit	Number Outside Control Limit	Number Exceeding Objective
Blank	**Bq/L**	**0.01**	**24**	**0**	**0.00063**	**1**	**0**	**0**
Duplicate % error	**%**	**20**	**24**	**0**	**5.67**	**0**	**0**	**0**
CRM	**Bq/L**	**20**	**24**	**0.044**	**0.046**	**2**	**0**	**0**
Spike	**Bq/L**	**20**	**24**	**0.249**	**0.258**	**1**	**0**	**0**

Table 2. Summary of QC results for new standard from Eckert & Ziegler for March – December 2018.

Quality Element	Unit	Objective	Total Number of Samples QC Samples	Expected Value	Mean	Number Outside Warning Limit	Number Outside Control Limit	Number Exceeding Objective
Blank	**Bq/L**	**0.01**	**98**	**0**	**0.00063**	**6**	**0**	**0**
Duplicate % error	**%**	**20**	**98**	**0**	**6.59**	**2**	**0**	**0**
CRM	**Bq/L**	**20**	**98**	**0.050**	**0.047**	**0**	**0**	**0**
Spike	**Bq/L**	**20**	**98**	**0.250**	**0.239**	**0**	**0**	**0**

1 Blanks

The blank sample is composed of ultra pure water and is treated in an identical manner, including all of the added reagents, as normal samples. The criterion of the blank sample is 0.01 Bq/L which is equal to 6 counts per 100 min (0.06 cpm). The 2018 mean blank value is 1.02 counts per 100min (0.00063 Bq/L). ELRFS uses counts to monitor the blank quality control data.

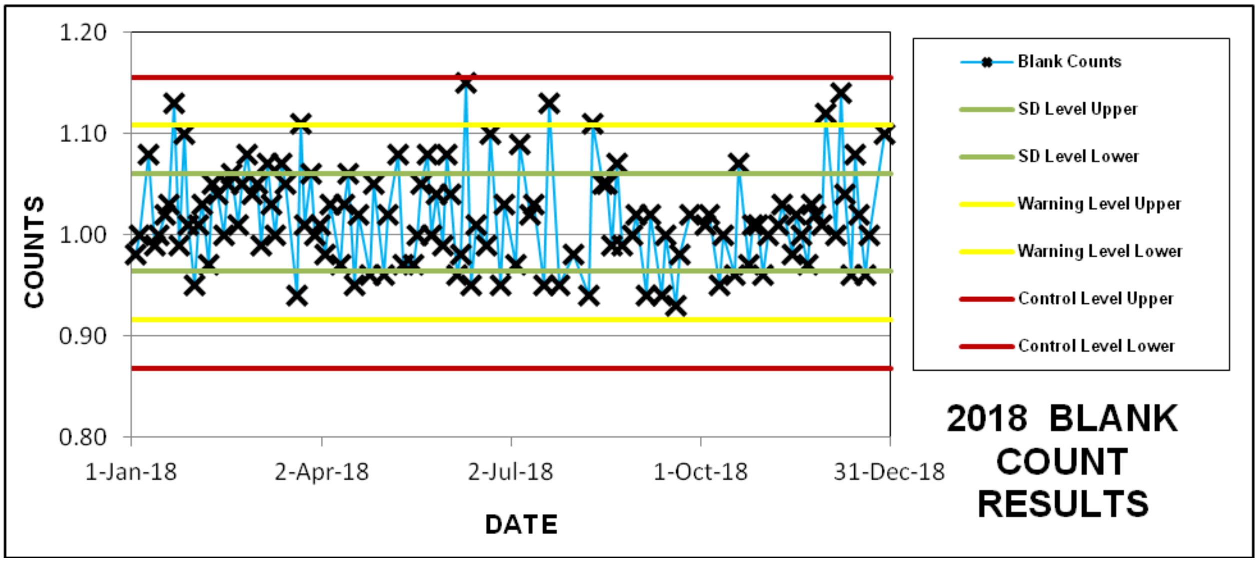

Figure 1a: Blank quality control results for the 2018 year.

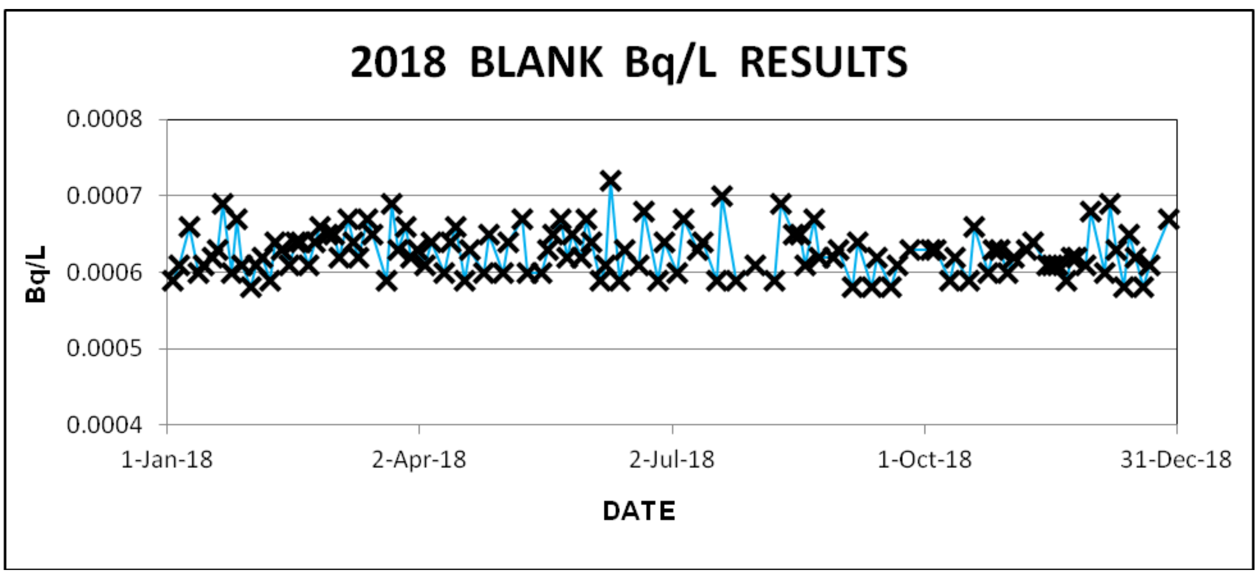

Figure 1b: Blank quality control concentrations for the 2018 year. Note maximum concentrations are 10 times lower than the 0.01 Bq/L criteria.

2 Duplicates

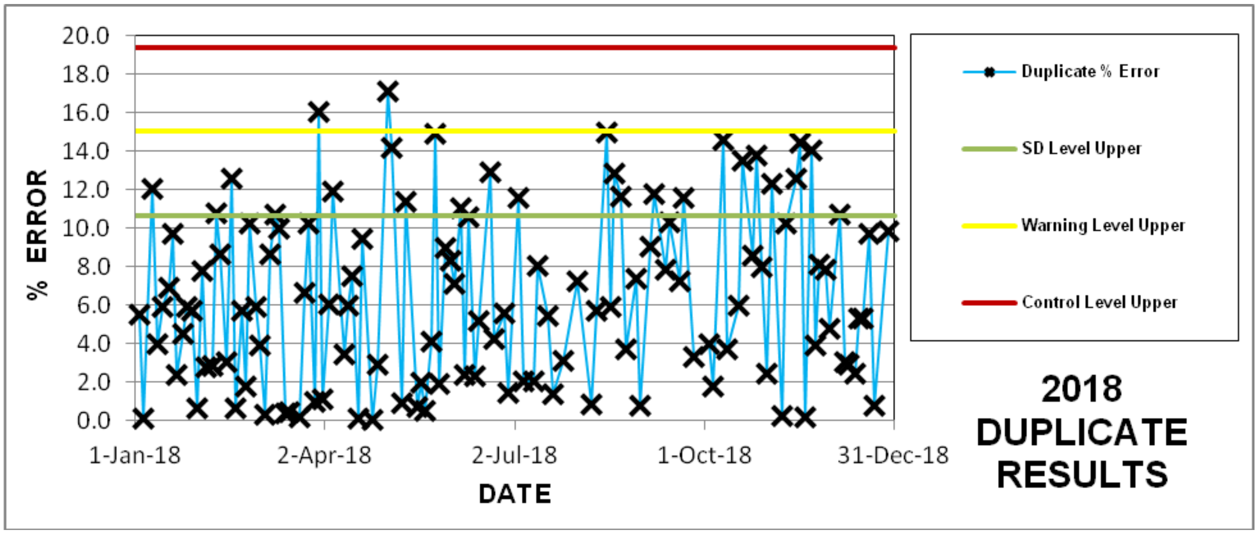

Figure 2: Duplicate quality control results for the 2018 year.

3 CRM

The CRM material used from January 1st through February 28th 2018 is from ERA # RAD-A (0.044 Bq/L) and from March 1st through December 31st 2018 from Eckert & Ziegler (0.050Bq/L).

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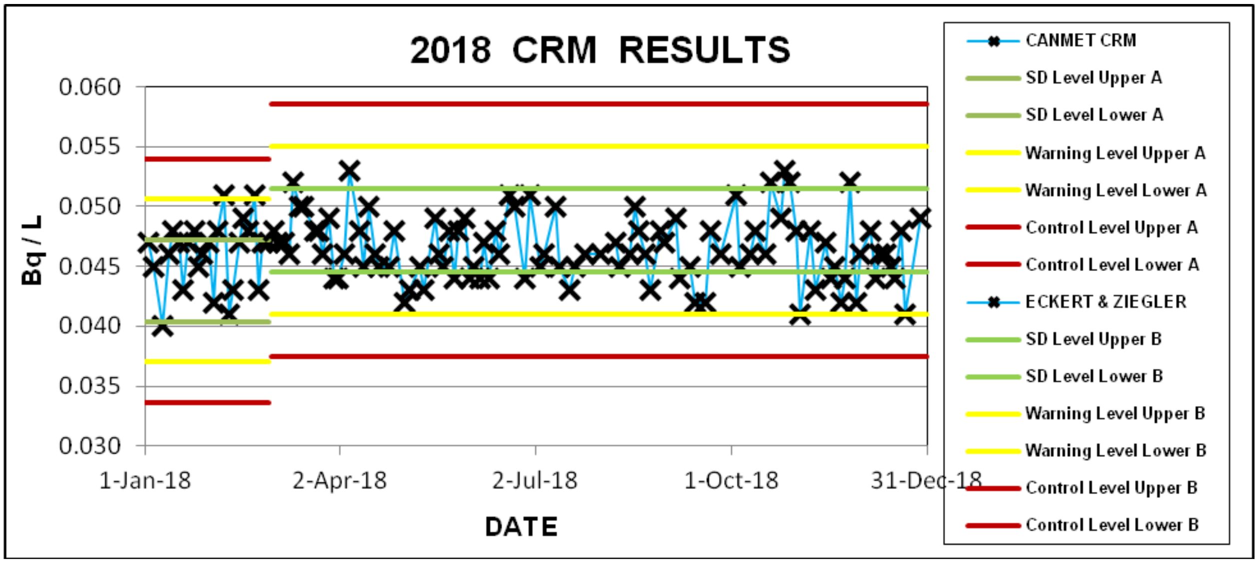

Figure 3a: CRM quality control results for the 2018 year.

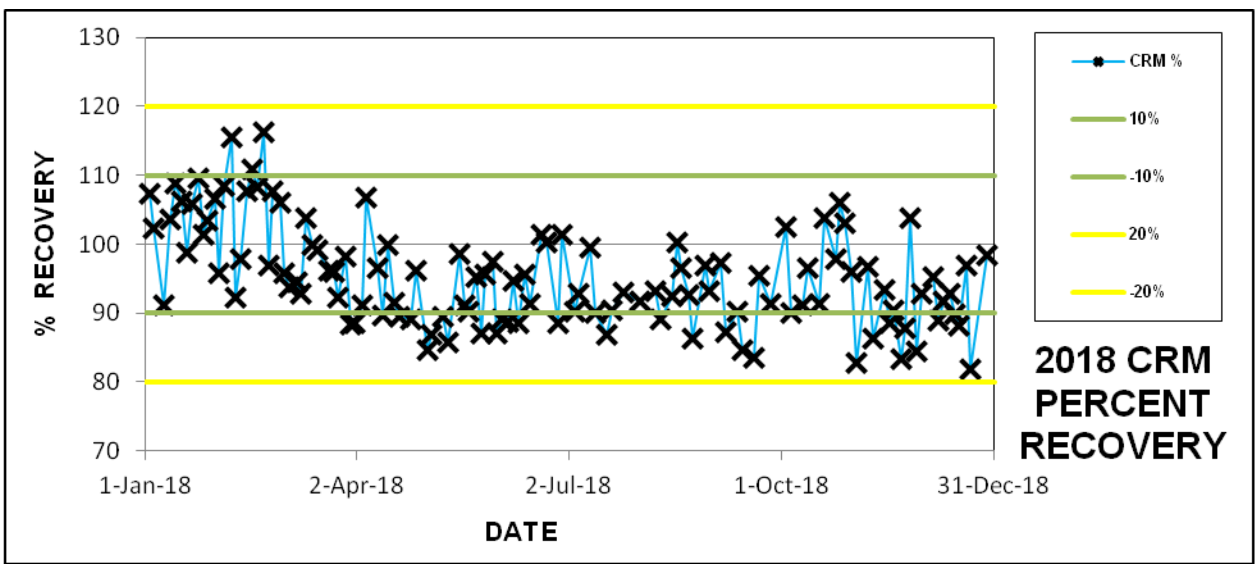

Figure 3b: CRM percent recovery quality control results for the 2018 year.

4 Spikes

The spike standard used from January 1st through February 28th 2018 is from ERA #RAD-A (0.249Bq/L) and from March 1st through December 31st is from Eckert & Ziegler (0.250Bq/L) .

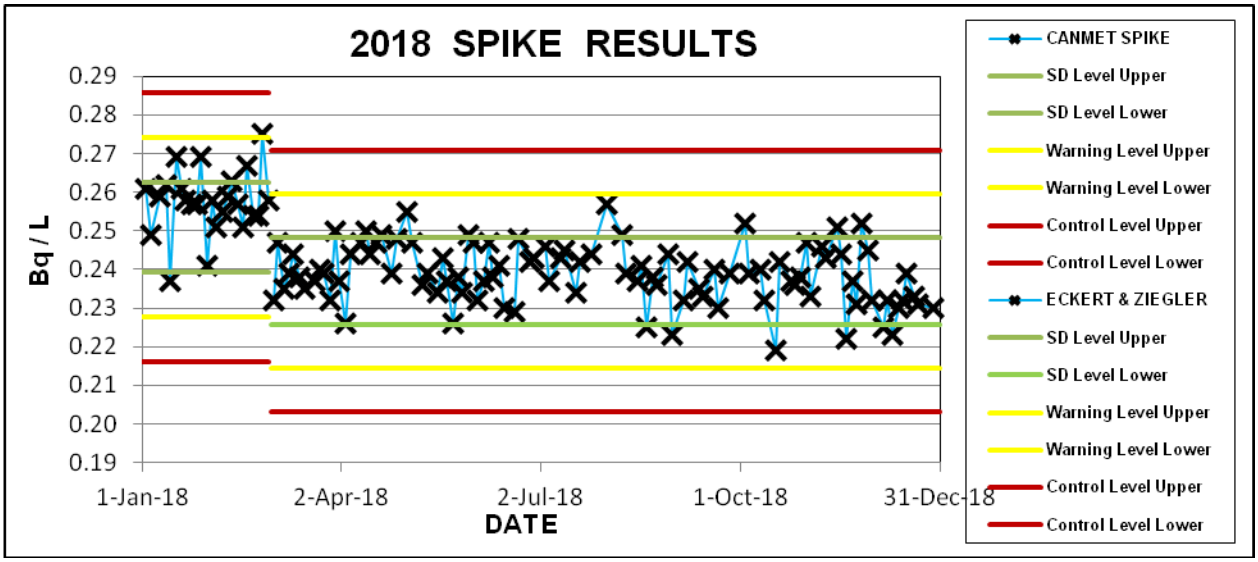

Figure 4a: Spike recovery quality control results for the 2018 year

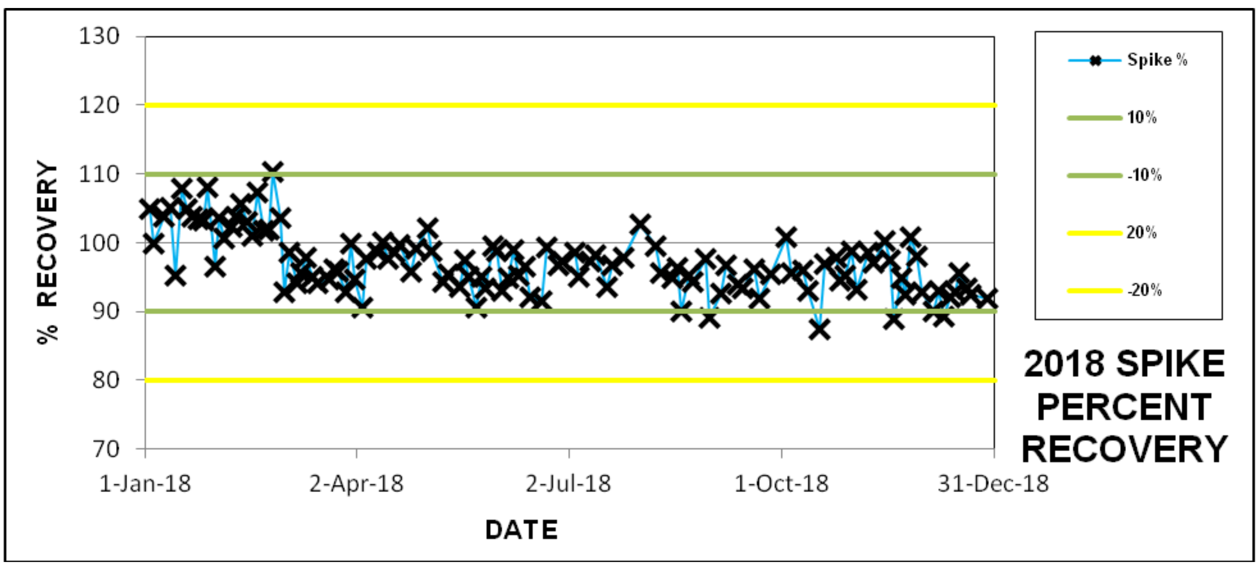

Figure 4b: Percent spike recovery quality control results for the 2018 year.

Dr. Graeme Spiers Willet Green Miller Centre
Phone: 1-705-675-1151 x5087 Laurentian University
E-mail: gspiers@laurentian.ca 935 Ramsey Lake Rd.
Web: www.elrfs.org Sudbury, Ontario P3E 2C6

QC Frequency

Through the 2018 year, ELRFS analyzed 122 batches totaling 1426 samples for ^{226}Ra. Each batch incorporated blank, CRM, duplicate, and spiked samples providing greater than 20% quality control samples.

^{226}Ra DATA QUALITY REPORT

2019 Annual

Prepared by:

Troy Maki

Troy Maki - Chemical Technologist

Reviewed by:

Alan Lock

Dr. Alan Lock – PCAF Laboratory Manager

Elliot Lake Research Field Station of Laurentian University
Date: January 7, 2020

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1 Background

The Perdue Central Analytical Facility (PCAF), previously Elliot Lake Research Field Station (ELRFS), entered into an agreement with Denison Environmental Services (DES) for the analytical laboratory to provide ^{226}Ra analysis according to the ELFRS Offer of Services document submitted to DES on December 3, 2010. Please find below the summaries of the monthly Quality Control (QC) results for blanks, duplicates, certified reference material (CRM), and spiked sample analysis.

The Analytical Services Laboratory of the Elliot Lake Research Field Station (ELRFS) was established in 1992. In July 2019, ELRFS analytical services was incorporated as part of the new Perdue Central Analytical Facility (PCAF) at Laurentian University to support improved operations through new purposed space and additional, dedicated technical and management staff. The initial (1992) work of the laboratory was to support research into the effects of low-level radioactivity on the environment resulting from regional uranium mining activities.

From this base, the laboratory has provided analytical services in support of local decommissioning and environmental monitoring programs, and in support of academic research. While the laboratory specializes in **radionuclide** analysis, it also provides a wide range of inorganic and organic services for environmental samples, including solid wastes, effluents, receiving waters, ground waters, soils, sediments, geological materials, plant tissues and animal and fish tissues. The PCAF analytical team will also complete specialty analyses outside of the scope of accreditation, following good laboratory practice procedures, using similar QA/QC protocols.

2 Quality Management System

ELRFS maintained ISO/IEC 17025 accreditation by the Canadian Association of Laboratory Accreditation (CALA) for specific environmental tests listed in the Scope of Accreditation since 2001. Shortly before the transition of ELRFS to PCAF, the laboratory accreditation was withdrawn by CALA due to previous management not submitting the Management Review document as required under the standard. Accreditation is the formal recognition of the competence of a laboratory to achieve and demonstrate the highest levels of scientific and management excellence through the combined principles of Competence, Consistency, Credibility and Communication. PCAF takes this very seriously and is currently completing the application process with CALA to obtain laboratory accreditation again. Until formally accredited again, PCAF is committed to operate using Good Laboratory Practice (GLP) and incorporate the same quality control data, impartiality, document control, and client confidentiality that has been used under the ISO: 17025 standard.

The quality management system at PCAF consists of a documented quality system stating the quality policy, quality system and quality practices designed to demonstrate quality control operations are being carried out, to ensure accountability of data, to assure traceability of reported data, and to show that reasonable precautions are being taken against the possibility of falsification of data. Within this manual, Quality Assurance Procedures and Standard Operation Procedures define the laboratory operational duties that guide the analytical QC data. This includes a minimum target of 20% of the samples analysed being distributed as blanks, duplicate analysis, CRMs, and spiked samples. The sample and QC results are logged into excel spread sheets with monthly and annual QC reports generated from the data sets.

3 Quality Control Parameters

All QC parameters are taken directly from the Excel spread sheets and Envista. DES samples are processed as part of the worksheet batch system. A compilation of all QC data appropriate to the parameters tested has been compiled below.

The QC summary reports are presented as control charts with the mean +/- 1 standard deviation illustrated as the SD Level, the mean +/- 2 standard deviations illustrated as the Warning Level and the mean +/- 3 standard deviations illustrated as the Control Level.

Control Level - If the Control Level is exceeded, the analysis of standards and samples must be repeated and if the repeat analysis exceeds the Control Level again, corrective action is required.
Warning Level – If 2 or more consecutive points exceed the Warning Level, another standard must be analyzed and if this analysis exceeds the Warning Level again, corrective action is required.
SD Level – If 4 consecutive results exceed the SD Level, analyse the next sample and if the SD Level is exceeded again, corrective action is required.

4 Notable Occurrences /Actions

Through the year of 2019, ELRFS analyzed 104 batches totaling 1206 samples for ^{226}Ra. Each batch incorporated blank, CRM, duplicate, and spiked samples providing greater than 20% quality control samples. All quality control samples are within control limits (mean +/- 3SD).

Sixteen quality control samples exceeded the warning (mean +/- 2SD) levels. This included five QC Duplicate (Figure 2) samples and eleven QC Spike (Figure 4a) samples. All samples exceeding the warning level were not consecutive, with the next consecutive QC sample falling within the warning level (mean +/- 2SD) limit, thus no corrective actions were required. No QC samples exceeded objectives.

5 QC Data Summary

Table 1. Summary of QC results for January - December 2019.

Quality Element	Unit	Objective	Total Number of QC Samples	Expected Value	Mean	Number Outside Warning Limit	Number Outside Control Limit	Number Exceeding Objective
Blank	Bq/L	0.01	104	0	0.00063	0	0	0
Duplicate % error	%	20	104	0	6.48	5	0	0
CRM	Bq/L	20	104	0.050	0.045	0	0	0
Spike	Bq/L	20	104	0.250	0.234	11	0	0

Central Analytical Facility
PCAF AT LAURENTIAN UNIVERSITY
PERDUE
Centre d'analyse
CAP À L'UNIVERSITÉ LAURENTIENNE

LaurentianUniversity
UniversitéLaurentienne

1 Blanks

The blank sample is composed of ultra pure water and is treated in an identical manner, including all of the added reagents, as normal samples. The criterion of the blank sample is 0.01 Bq/L which is equal to 6 counts per 100 min (0.06 cpm). The 2019 mean blank value is 1.02 counts per 100min (0.00063 Bq/L). PCAF uses counts to monitor the blank quality control data.

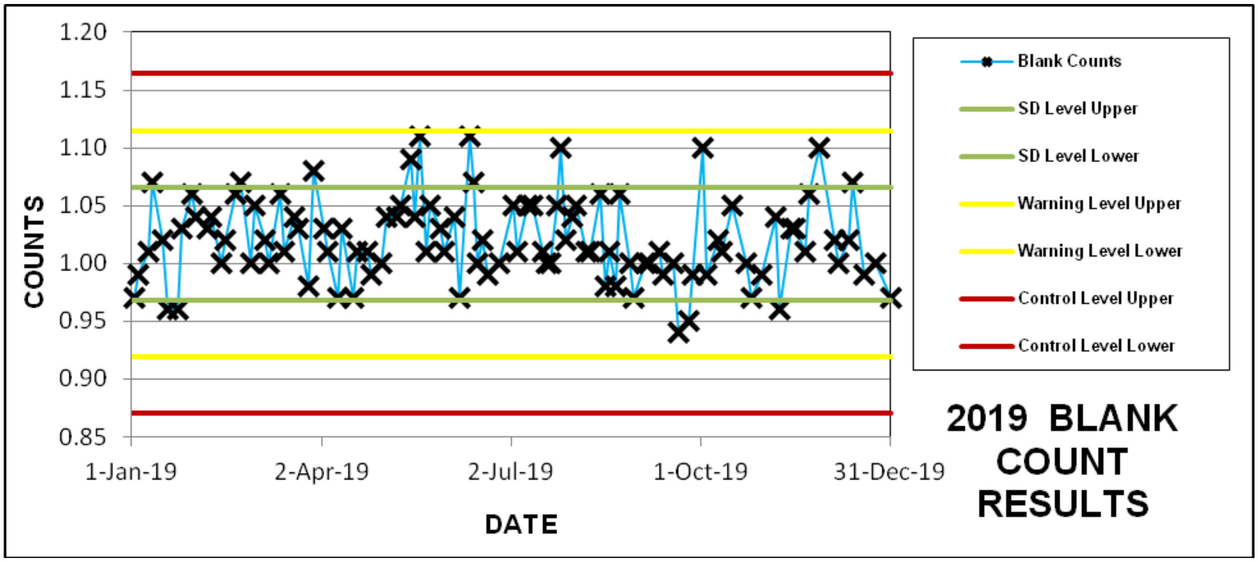

Figure 1a: Blank quality control results for the 2019 year.

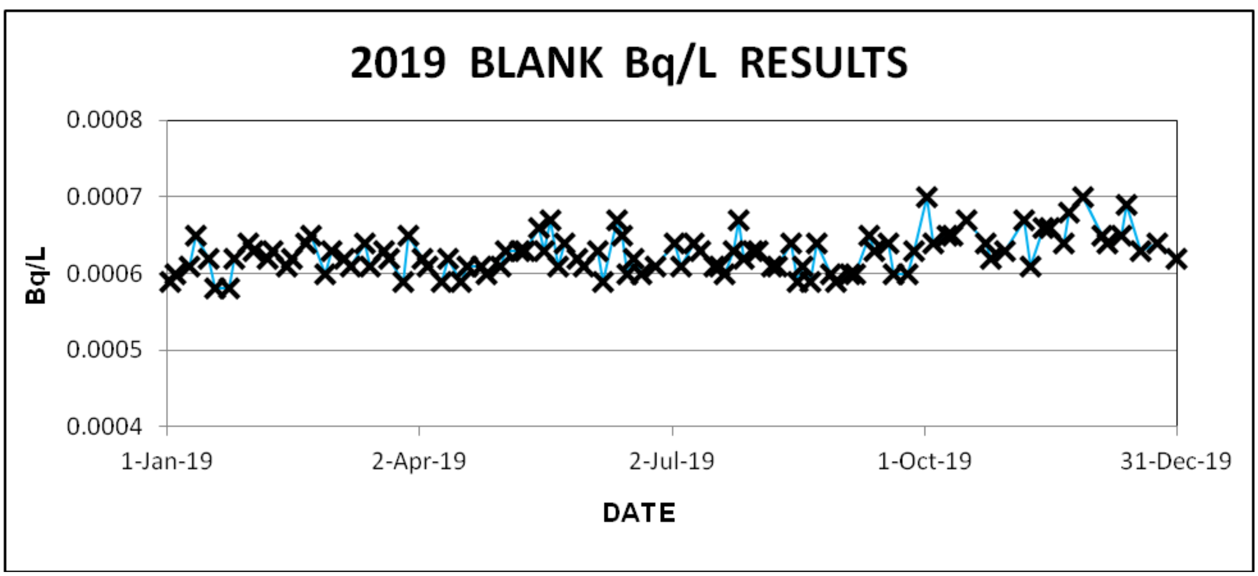

Figure 1b: Blank quality control concentrations for the 2019 year. Note maximum concentrations are 10 times lower than the 0.01 Bq/L criteria.

2 Duplicates

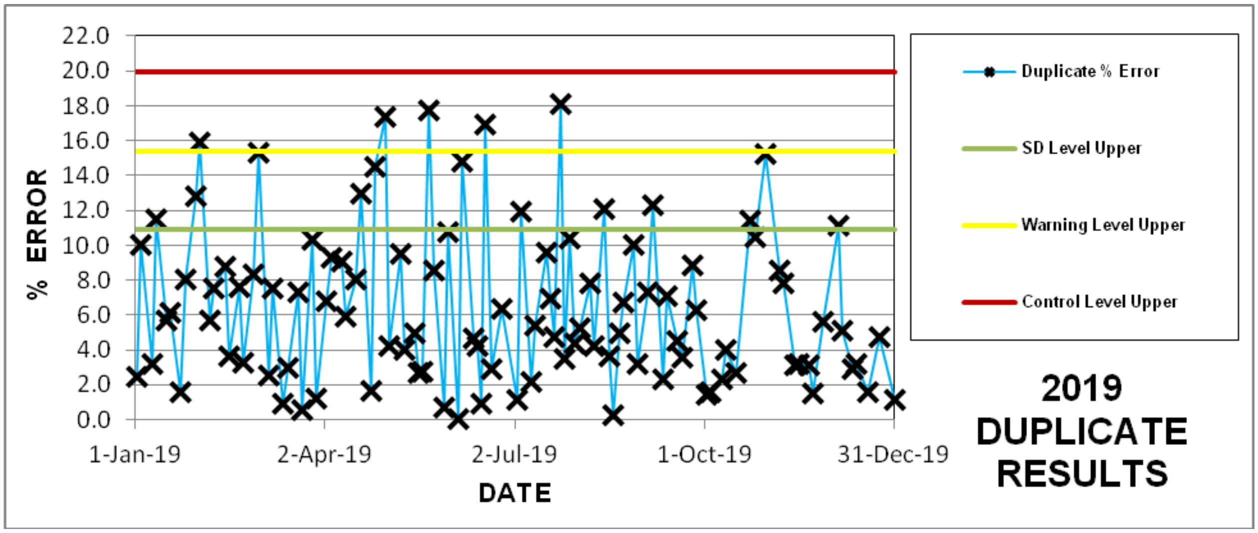

Figure 2: Duplicate quality control results for the 2019 year.

3 CRM

The CRM material used is from Eckert & Ziegler (0.050Bq/L).

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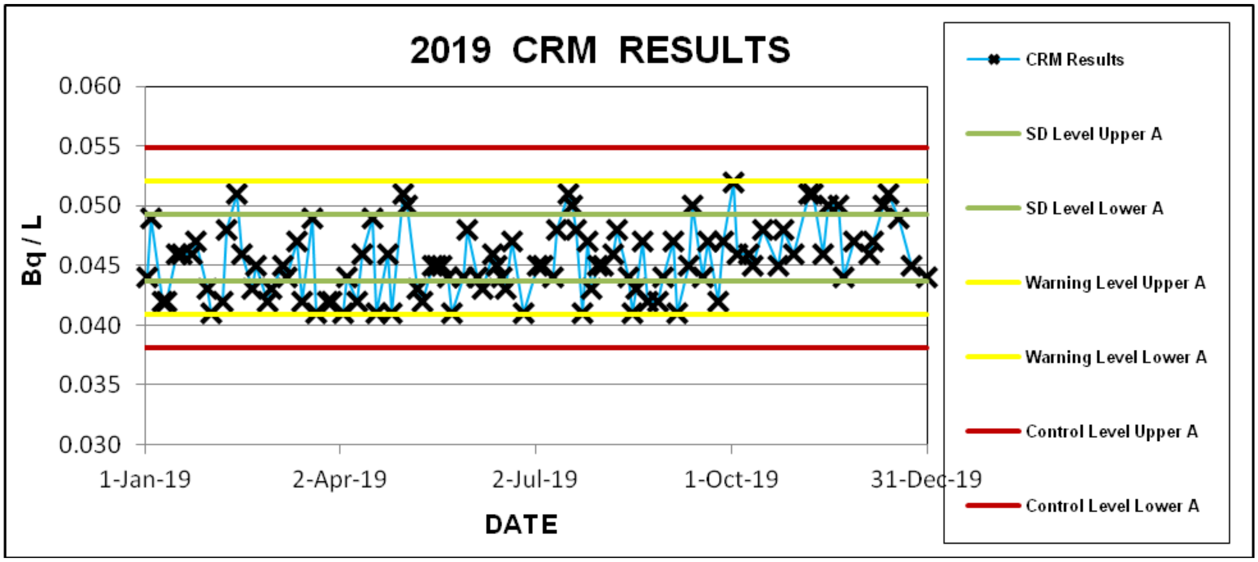

Figure 3a: CRM quality control results for the 2019 year.

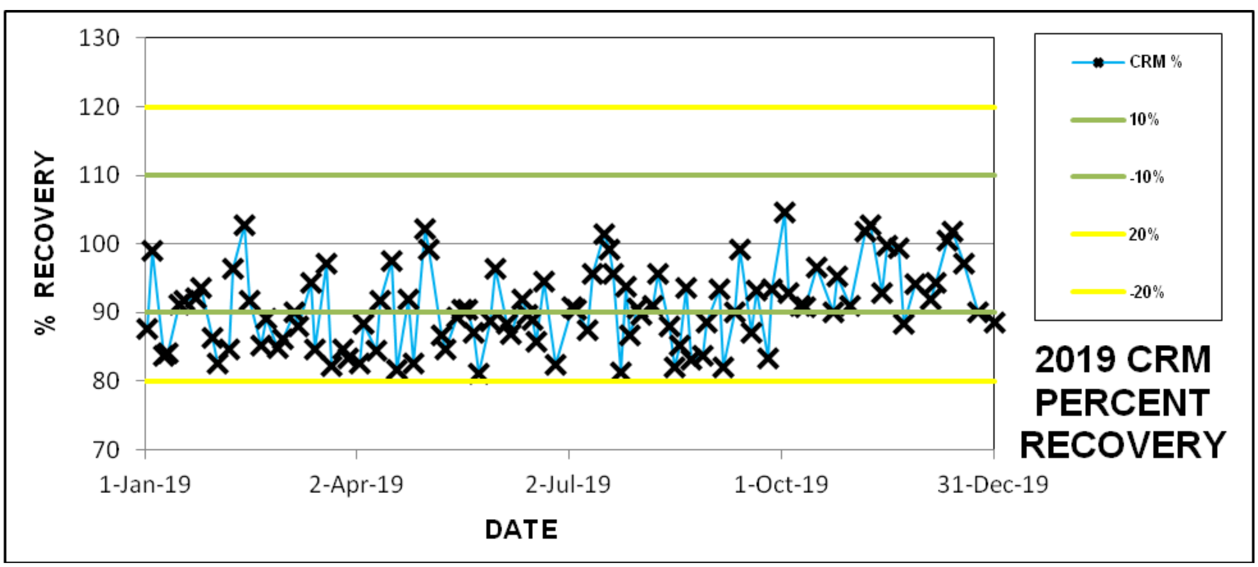

Figure 3b: CRM percent recovery quality control results for the 2019 year.

4 Spikes

The spike standard used is from Eckert & Ziegler (0.250Bq/L) .

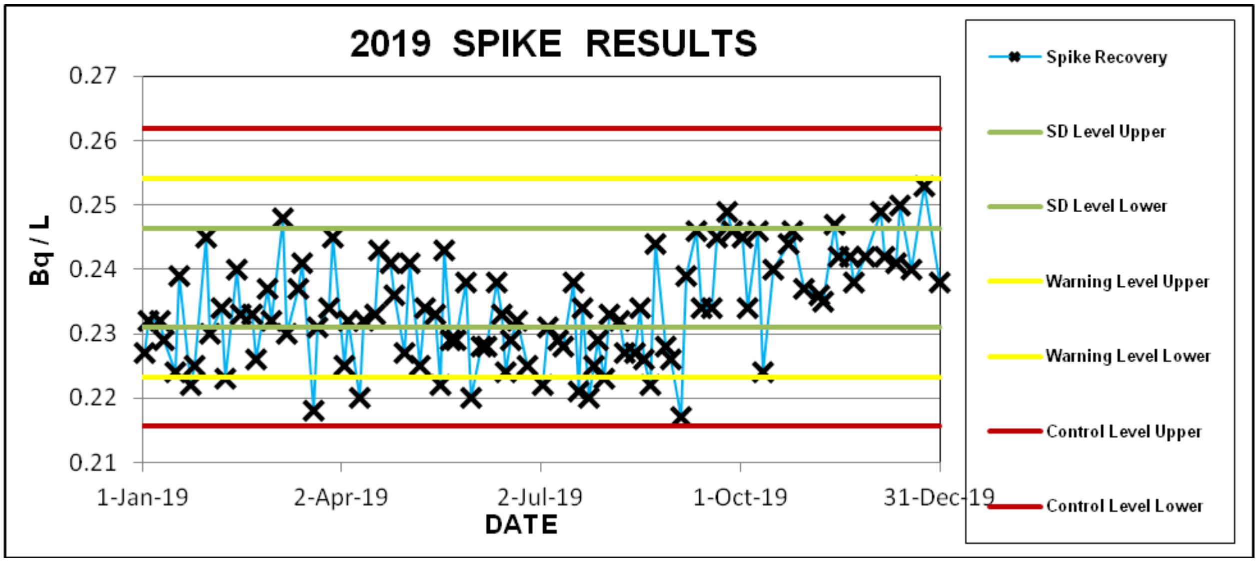

Figure 4a: Spike recovery quality control results for the 2019 year

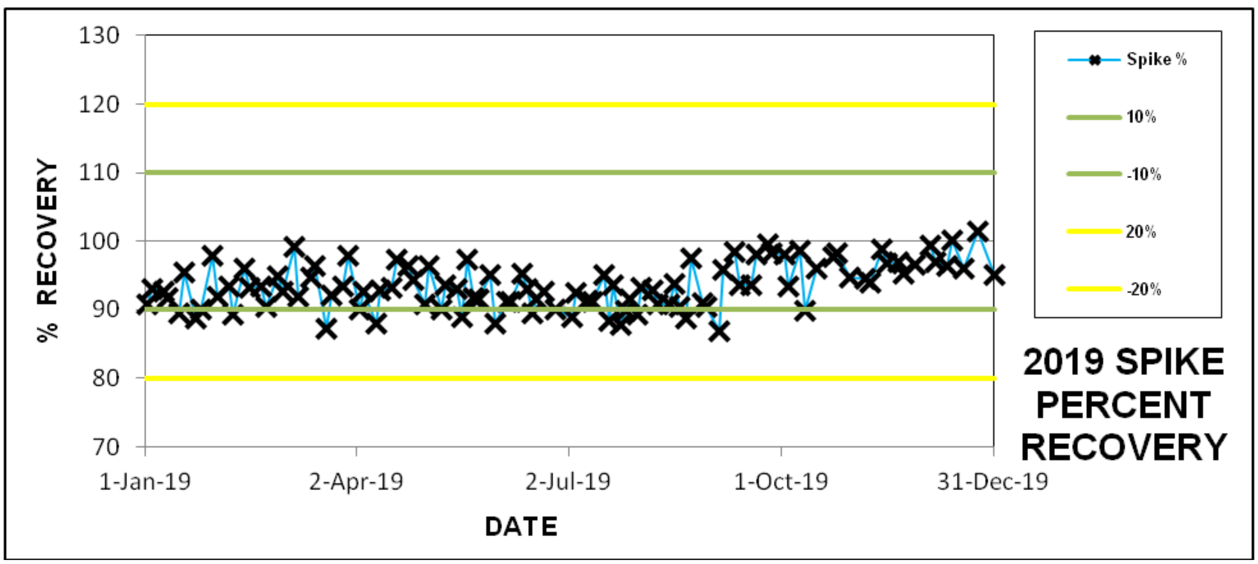

Figure 4b: Percent spike recovery quality control results for the 2019 year.

QC Frequency

Through the 2019 year, ELRFS analyzed 104 batches totaling 1206 samples for ^{226}Ra. Each batch incorporated blank, CRM, duplicate, and spiked samples providing greater than 20% quality control samples.

Your Project #: 19-41
Site Location: CYCLE 5 SRWMP

Attention: Jess Tester

Minnow Environmental Inc
2 Lamb St
Georgetown, ON
CANADA L7G 3M9

Your C.O.C. #: 738008-01-01, 738008-03-01, 738008-04-01, 738008-02-01, 737959-01-01

Report Date: 2019/12/11
Report #: R6000276
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BV LABS JOB #: B9R1693
Received: 2019/09/27, 14:20

Sample Matrix: Soil
Samples Received: 89

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Strong Acid Leachable Metals by ICPMS	31	2019/10/02	2019/10/02	CAM SOP-00447	EPA 6020B m
Strong Acid Leachable Metals by ICPMS	13	2019/10/02	2019/10/03	CAM SOP-00447	EPA 6020B m
Moisture	45	N/A	2019/09/30	CAM SOP-00445	Carter 2nd ed 51.2 m
Particle size in solids (pipette&sieve) (1, 3)	19	N/A	2019/11/12	ATL SOP 00012	MSAMS'78/WREP-125R3m
Particle size in solids (pipette&sieve) (1, 3)	19	N/A	2019/11/13	ATL SOP 00012	MSAMS'78/WREP-125R3m
Particle size in solids (pipette&sieve) (1, 3)	7	N/A	2019/11/14	ATL SOP 00012	MSAMS'78/WREP-125R3m
Radium by Alpha Spectrometry (2)	17	N/A	2019/12/04	BQL SOP-00006	Alpha Spectrometry
Radium by Alpha Spectrometry (2)	5	N/A	2019/12/05	BQL SOP-00006	Alpha Spectrometry
Radium by Alpha Spectrometry (2)	11	N/A	2019/12/06	BQL SOP-00006	Alpha Spectrometry
Radium by Alpha Spectrometry (2)	10	N/A	2019/12/08	BQL SOP-00006	Alpha Spectrometry
Radium by Alpha Spectrometry (2)	1	N/A	2019/12/09	BQL SOP-00006	Alpha Spectrometry
Total Organic Carbon in Soil	45	N/A	2019/10/02	CAM SOP-00468	BCMOE TOC Aug 2014

Remarks:

Bureau Veritas Laboratories are accredited to ISO/IEC 17025 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by BV Labs are based upon recognized Provincial, Federal or US method compendia such as CCME, MELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in BV Labs profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and BV Labs in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported; unless indicated otherwise, associated sample data are not blank corrected. Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

BV Labs liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. BV Labs has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by BV Labs, unless otherwise agreed in writing.

Your Project #: 19-41
Site Location: CYCLE 5 SRWMP

Attention: Jess Tester

Minnow Environmental Inc
2 Lamb St
Georgetown, ON
CANADA L7G 3M9

Your C.O.C. #: 738008-01-01, 738008-03-01, 738008-04-01, 738008-02-01, 737959-01-01

Report Date: 2019/12/11
Report #: R6000276
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BV LABS JOB #: B9R1693
Received: 2019/09/27, 14:20

BV Labs is not responsible for the accuracy or any data impacts, that result from the information provided by the customer or their agent.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.
Results relate to samples tested. When sampling is not conducted by BV Labs, results relate to the supplied samples tested.
This Certificate shall not be reproduced except in full, without the written approval of the laboratory.
Reference Method suffix “m” indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.
(1) This test was performed by BV Labs Bedford
(2) This test was performed by Bureau Veritas Laboratories Kitimat
(3) Note: Graphical representation of larger fractions (PHI-4, PHI -3 and PHI -2) not applicable unless these optional parameters are specifically requested.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Sara Singh, B.Sc, Senior Project Manager
Email: Sara.Singh@bvlabs.com
Phone# (905)817-5827
==
This report has been generated and distributed using a secure automated process.
BV Labs has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per ISO/IEC 17025, signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

RESULTS OF ANALYSES OF SOIL

BV Labs ID		KWZ018	KWZ019	KWZ020	KWZ021	KWZ022		
Sampling Date		2019/09/24	2019/09/24	2019/09/24	2019/09/24	2019/09/19		
COC Number		738008-01-01	738008-01-01	738008-01-01	738008-01-01	738008-01-01		
	UNITS	**DUL-2019-1-P**	**DUL-2019-2-P**	**DUL-2019-3-P**	**DUL-2019-4-P**	**DUL-2019-5-P**	**RDL**	**QC Batch**
Inorganics								
Moisture	%	90	85	84	81	89	1.0	6360261
Total Organic Carbon	mg/kg	120000	85000	72000	59000	110000	500	6364450
< -1 Phi (2 mm)	%	100	100	100	100	100	0.10	6401290
< 0 Phi (1 mm)	%	100	100	100	100	100	0.10	6401290
< +1 Phi (0.5 mm)	%	99	99	100	100	99	0.10	6401290
< +2 Phi (0.25 mm)	%	96	99	100	100	97	0.10	6401290
< +3 Phi (0.12 mm)	%	95	98	99	99	95	0.10	6401290
< +4 Phi (0.062 mm)	%	90	94	91	93	91	0.10	6401290
< +5 Phi (0.031 mm)	%	87	76	58	73	83	0.10	6401290
< +6 Phi (0.016 mm)	%	56	45	38	38	58	0.10	6401290
< +7 Phi (0.0078 mm)	%	27	24	22	18	34	0.10	6401290
< +8 Phi (0.0039 mm)	%	21	20	18	14	29	0.10	6401290
< +9 Phi (0.0020 mm)	%	16	14	12	10	21	0.10	6401290
Gravel	%	ND	ND	ND	ND	ND	0.10	6401290
Sand	%	10	5.5	8.9	6.5	8.9	0.10	6401290
Silt	%	69	75	73	79	62	0.10	6401290
Clay	%	21	20	18	14	29	0.10	6401290

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
ND = Not detected

RESULTS OF ANALYSES OF SOIL

BV Labs ID		KWZ022			KWZ023	KWZ024	KWZ025		
Sampling Date		2019/09/19			2019/09/24	2019/09/23	2019/09/23		
COC Number		738008-01-01			738008-01-01	738008-01-01	738008-01-01		
	UNITS	**DUL-2019-5-P Lab-Dup**	**RDL**	**QC Batch**	**DUL-2019-1-PX**	**NL-2019-1-XP**	**NL-2019-1-P**	**RDL**	**QC Batch**
Inorganics									
Moisture	%				90	84	85	1.0	6360261
Total Organic Carbon	mg/kg	110000	500	6364450	120000	87000	87000	500	6364450
< -1 Phi (2 mm)	%				100	100	100	0.10	6401290
< 0 Phi (1 mm)	%				100	100	100	0.10	6401290
< +1 Phi (0.5 mm)	%				100	99	100	0.10	6401290
< +2 Phi (0.25 mm)	%				99	97	99	0.10	6401290
< +3 Phi (0.12 mm)	%				97	96	97	0.10	6401290
< +4 Phi (0.062 mm)	%				94	94	94	0.10	6401290
< +5 Phi (0.031 mm)	%				90	92	92	0.10	6401290
< +6 Phi (0.016 mm)	%				60	76	75	0.10	6401290
< +7 Phi (0.0078 mm)	%				34	22	21	0.10	6401290
< +8 Phi (0.0039 mm)	%				27	17	17	0.10	6401290
< +9 Phi (0.0020 mm)	%				16	14	14	0.10	6401290
Gravel	%				ND	ND	ND	0.10	6401290
Sand	%				5.8	5.5	6.2	0.10	6401290
Silt	%				67	78	76	0.10	6401290
Clay	%				27	17	17	0.10	6401290

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate
ND = Not detected

BV Labs Job #: B9R1693
Report Date: 2019/12/11

Minnow Environmental Inc
Client Project #: 19-41
Site Location: CYCLE 5 SRWMP
Sampler Initials: JT

RESULTS OF ANALYSES OF SOIL

BV Labs ID		KWZ025			KWZ026	KWZ027	KWZ041	KWZ042		
Sampling Date		2019/09/23			2019/09/23	2019/09/23	2019/09/23	2019/09/23		
COC Number		738008-01-01			738008-01-01	738008-01-01	738008-03-01	738008-03-01		
	UNITS	NL-2019-1-P Lab-Dup	RDL	QC Batch	NL-2019-2-P	NL-2019-3-P	NL-2019-4-P	NL-2019-5-P	RDL	QC Batch
Inorganics										
Moisture	%				84	80	83	83	1.0	6360261
Total Organic Carbon	mg/kg				78000	72000	67000	76000	500	6364450
< -1 Phi (2 mm)	%	100	0.10	6401290	100	100	100	100	0.10	6401290
< 0 Phi (1 mm)	%	100	0.10	6401290	100	100	100	100	0.10	6401290
< +1 Phi (0.5 mm)	%	100	0.10	6401290	99	100	99	99	0.10	6401290
< +2 Phi (0.25 mm)	%	98	0.10	6401290	97	97	95	97	0.10	6401290
< +3 Phi (0.12 mm)	%	97	0.10	6401290	93	93	90	95	0.10	6401290
< +4 Phi (0.062 mm)	%	95	0.10	6401290	83	86	86	92	0.10	6401290
< +5 Phi (0.031 mm)	%	92	0.10	6401290	70	76	80	86	0.10	6401290
< +6 Phi (0.016 mm)	%	75	0.10	6401290	54	58	59	61	0.10	6401290
< +7 Phi (0.0078 mm)	%	30	0.10	6401290	36	36	38	39	0.10	6401290
< +8 Phi (0.0039 mm)	%	23	0.10	6401290	30	29	31	31	0.10	6401290
< +9 Phi (0.0020 mm)	%	16	0.10	6401290	21	19	20	20	0.10	6401290
Gravel	%	ND	0.10	6401290	ND	ND	ND	ND	0.10	6401290
Sand	%	4.8	0.10	6401290	17	14	14	8.4	0.10	6401290
Silt	%	72	0.10	6401290	52	57	55	60	0.10	6401290
Clay	%	23	0.10	6401290	30	29	31	31	0.10	6401290

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate
ND = Not detected

BUREAU VERITAS

BV Labs Job #: B9R1693
Report Date: 2019/12/11

Minnow Environmental Inc
Client Project #: 19-41
Site Location: CYCLE 5 SRWMP
Sampler Initials: JT

RESULTS OF ANALYSES OF SOIL

BV Labs ID		KWZ043	KWZ044	KWZ045		KWZ046		KWZ047		
Sampling Date		2019/09/22	2019/09/24	2019/09/24		2019/09/24		2019/09/24		
COC Number		738008-03-01	738008-03-01	738008-03-01		738008-03-01		738008-03-01		
	UNITS	**SUL-2019-1-P**	**SUL-2019-2-P**	**SUL-2019-3-P**	**QC Batch**	**SUL-2019-4-P**	**QC Batch**	**SUL-2019-5-P**	**RDL**	**QC Batch**
Inorganics										
Moisture	%	87	82	86	6360261	88	6360148	88	1.0	6360148
Total Organic Carbon	mg/kg	110000	84000	120000	6364450	130000	6364450	120000	500	6364418
< -1 Phi (2 mm)	%	100	100	100	6401290	100	6401290	100	0.10	6401290
< 0 Phi (1 mm)	%	100	100	100	6401290	100	6401290	100	0.10	6401290
< +1 Phi (0.5 mm)	%	99	100	100	6401290	99	6401290	99	0.10	6401290
< +2 Phi (0.25 mm)	%	97	99	98	6401290	98	6401290	99	0.10	6401290
< +3 Phi (0.12 mm)	%	94	96	97	6401290	96	6401290	98	0.10	6401290
< +4 Phi (0.062 mm)	%	91	87	93	6401290	92	6401290	95	0.10	6401290
< +5 Phi (0.031 mm)	%	86	65	87	6401290	88	6401290	77	0.10	6401290
< +6 Phi (0.016 mm)	%	59	44	61	6401290	54	6401290	50	0.10	6401290
< +7 Phi (0.0078 mm)	%	32	26	38	6401290	32	6401290	31	0.10	6401290
< +8 Phi (0.0039 mm)	%	26	21	33	6401290	26	6401290	26	0.10	6401290
< +9 Phi (0.0020 mm)	%	20	14	26	6401290	21	6401290	21	0.10	6401290
Gravel	%	ND	ND	ND	6401290	ND	6401290	ND	0.10	6401290
Sand	%	8.7	13	7.2	6401290	8.1	6401290	4.6	0.10	6401290
Silt	%	66	66	60	6401290	66	6401290	69	0.10	6401290
Clay	%	26	21	33	6401290	26	6401290	26	0.10	6401290

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
ND = Not detected

Bureau Veritas Laboratories 6740 Campobello Road, Mississauga, Ontario, L5N 2L8 Tel: (905) 817-5700 Toll-Free: 800-563-6266 Fax: (905) 817-5777 www.bvlabs.com

Microbiology testing is conducted at 6660 Campobello Rd. Chemistry testing is conducted at 6740 Campobello Rd.

BV Labs Job #: B9R1693
Report Date: 2019/12/11

Minnow Environmental Inc
Client Project #: 19-41
Site Location: CYCLE 5 SRWMP
Sampler Initials: JT

RESULTS OF ANALYSES OF SOIL

BV Labs ID		KWZ048			KWZ048			KWZ049		
Sampling Date		2019/09/22			2019/09/22			2019/09/22		
COC Number		738008-03-01			738008-03-01			738008-03-01		
	UNITS	**MAL-2019-1-P**	**RDL**	**QC Batch**	**MAL-2019-1-P Lab-Dup**	**RDL**	**QC Batch**	**MAL-2019-2-P**	**RDL**	**QC Batch**
Inorganics										
Moisture	%	85	1.0	6360148				87	1.0	6360148
Total Organic Carbon	mg/kg	96000	500	6364418	95000	500	6364418	110000	500	6364418
< -1 Phi (2 mm)	%	100	0.10	6401290				100	0.10	6401290
< 0 Phi (1 mm)	%	98	0.10	6401290				98	0.10	6401290
< +1 Phi (0.5 mm)	%	96	0.10	6401290				94	0.10	6401290
< +2 Phi (0.25 mm)	%	94	0.10	6401290				90	0.10	6401290
< +3 Phi (0.12 mm)	%	93	0.10	6401290				86	0.10	6401290
< +4 Phi (0.062 mm)	%	91	0.10	6401290				82	0.10	6401290
< +5 Phi (0.031 mm)	%	86	0.10	6401290				74	0.10	6401290
< +6 Phi (0.016 mm)	%	49	0.10	6401290				51	0.10	6401290
< +7 Phi (0.0078 mm)	%	31	0.10	6401290				33	0.10	6401290
< +8 Phi (0.0039 mm)	%	25	0.10	6401290				28	0.10	6401290
< +9 Phi (0.0020 mm)	%	18	0.10	6401290				20	0.10	6401290
Gravel	%	ND	0.10	6401290				ND	0.10	6401290
Sand	%	8.7	0.10	6401290				18	0.10	6401290
Silt	%	66	0.10	6401290				53	0.10	6401290
Clay	%	25	0.10	6401290				28	0.10	6401290

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate
ND = Not detected

BV Labs Job #: B9R1693
Report Date: 2019/12/11

Minnow Environmental Inc
Client Project #: 19-41
Site Location: CYCLE 5 SRWMP
Sampler Initials: JT

RESULTS OF ANALYSES OF SOIL

BV Labs ID		KWZ050	KWZ055	KWZ056	KWZ057			KWZ057		
Sampling Date		2019/09/22	2019/09/22	2019/09/22	2019/09/18			2019/09/18		
COC Number		738008-03-01	738008-04-01	738008-04-01	738008-04-01			738008-04-01		
	UNITS	**MAL-2019-3-P**	**MAL-2019-4-P**	**MAL-2019-5-P**	**ML-2019-3X-P**	**RDL**	**QC Batch**	**ML-2019-3X-P Lab-Dup**	**RDL**	**QC Batch**
Inorganics										
Moisture	%	80	85	83	90	1.0	6360148			
Total Organic Carbon	mg/kg	78000	89000	80000	130000	500	6364418			
< -1 Phi (2 mm)	%	100	100	100	100	0.10	6401294	100	0.10	6401294
< 0 Phi (1 mm)	%	100	97	99	100	0.10	6401294	99	0.10	6401294
< +1 Phi (0.5 mm)	%	95	93	97	91	0.10	6401294	89	0.10	6401294
< +2 Phi (0.25 mm)	%	92	90	93	84	0.10	6401294	84	0.10	6401294
< +3 Phi (0.12 mm)	%	79	86	87	80	0.10	6401294	81	0.10	6401294
< +4 Phi (0.062 mm)	%	65	83	81	75	0.10	6401294	77	0.10	6401294
< +5 Phi (0.031 mm)	%	55	72	70	69	0.10	6401294	72	0.10	6401294
< +6 Phi (0.016 mm)	%	38	51	45	58	0.10	6401294	59	0.10	6401294
< +7 Phi (0.0078 mm)	%	23	33	25	36	0.10	6401294	39	0.10	6401294
< +8 Phi (0.0039 mm)	%	19	27	21	31	0.10	6401294	33	0.10	6401294
< +9 Phi (0.0020 mm)	%	13	19	14	23	0.10	6401294	23	0.10	6401294
Gravel	%	ND	ND	ND	ND	0.10	6401294	ND	0.10	6401294
Sand	%	35	17	19	25	0.10	6401294	23	0.10	6401294
Silt	%	46	56	60	43	0.10	6401294	43	0.10	6401294
Clay	%	19	27	21	31	0.10	6401294	33	0.10	6401294

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate
ND = Not detected

BV Labs Job #: B9R1693
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Minnow Environmental Inc
Client Project #: 19-41
Site Location: CYCLE 5 SRWMP
Sampler Initials: JT

RESULTS OF ANALYSES OF SOIL

BV Labs ID		KWZ058	KWZ059	KWZ060	KWZ061	KWZ062	KWZ063		
Sampling Date		2019/09/25	2019/09/18	2019/09/18	2019/09/25	2019/09/25	2019/09/23		
COC Number		738008-04-01	738008-04-01	738008-04-01	738008-04-01	738008-04-01	738008-04-01		
	UNITS	**ML-2019-1-P**	**ML-2019-2-P**	**ML-2019-3-P**	**ML-2019-4-P**	**ML-2019-5-P**	**QL-2019-2-PX**	**RDL**	**QC Batch**
Inorganics									
Moisture	%	90	87	90	87	85	83	1.0	6360148
Total Organic Carbon	mg/kg	110000	93000	130000	97000	85000	96000	500	6364418
< -1 Phi (2 mm)	%	100	100	100	100	100	100	0.10	6401294
< 0 Phi (1 mm)	%	100	100	100	100	100	100	0.10	6401294
< +1 Phi (0.5 mm)	%	97	97	97	99	98	98	0.10	6401294
< +2 Phi (0.25 mm)	%	89	89	89	93	97	97	0.10	6401294
< +3 Phi (0.12 mm)	%	84	81	85	87	94	95	0.10	6401294
< +4 Phi (0.062 mm)	%	79	69	80	80	89	91	0.10	6401294
< +5 Phi (0.031 mm)	%	76	59	75	72	72	79	0.10	6401294
< +6 Phi (0.016 mm)	%	56	37	60	43	47	56	0.10	6401294
< +7 Phi (0.0078 mm)	%	35	21	42	22	29	34	0.10	6401294
< +8 Phi (0.0039 mm)	%	28	17	36	18	23	29	0.10	6401294
< +9 Phi (0.0020 mm)	%	16	11	28	11	15	21	0.10	6401294
Gravel	%	ND	ND	ND	ND	ND	ND	0.10	6401294
Sand	%	21	31	20	20	11	9.0	0.10	6401294
Silt	%	51	53	44	62	67	62	0.10	6401294
Clay	%	28	17	36	18	23	29	0.10	6401294

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
ND = Not detected

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BV Labs Job #: B9R1693
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Minnow Environmental Inc
Client Project #: 19-41
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Sampler Initials: JT

RESULTS OF ANALYSES OF SOIL

BV Labs ID		KWZ064	KWZ160	KWZ161		KWZ162		KWZ163		
Sampling Date		2019/09/19	2019/09/23	2019/09/23		2019/09/19		2019/09/23		
COC Number		738008-04-01	738008-02-01	738008-02-01		738008-02-01		738008-02-01		
	UNITS	**QL-2019-1-P**	**QL-2019-2-P**	**QL-2019-3-P**	**QC Batch**	**QL-2019-4-P**	**QC Batch**	**QL-2019-5-P**	**RDL**	**QC Batch**
Inorganics										
Moisture	%	87	84	81	6360148	85	6360261	82	1.0	6360148
Total Organic Carbon	mg/kg	110000	94000	49000	6364418	83000	6364450	52000	500	6364418
< -1 Phi (2 mm)	%	100	100	100	6401294	100	6401294	100	0.10	6401294
< 0 Phi (1 mm)	%	93	99	99	6401294	100	6401294	99	0.10	6401294
< +1 Phi (0.5 mm)	%	90	97	98	6401294	99	6401294	97	0.10	6401294
< +2 Phi (0.25 mm)	%	88	96	95	6401294	98	6401294	91	0.10	6401294
< +3 Phi (0.12 mm)	%	84	93	92	6401294	95	6401294	78	0.10	6401294
< +4 Phi (0.062 mm)	%	80	89	87	6401294	91	6401294	64	0.10	6401294
< +5 Phi (0.031 mm)	%	72	81	73	6401294	87	6401294	58	0.10	6401294
< +6 Phi (0.016 mm)	%	49	59	55	6401294	76	6401294	49	0.10	6401294
< +7 Phi (0.0078 mm)	%	33	35	33	6401294	51	6401294	34	0.10	6401294
< +8 Phi (0.0039 mm)	%	27	29	27	6401294	43	6401294	30	0.10	6401294
< +9 Phi (0.0020 mm)	%	20	21	17	6401294	28	6401294	21	0.10	6401294
Gravel	%	ND	ND	ND	6401294	ND	6401294	ND	0.10	6401294
Sand	%	20	11	13	6401294	8.6	6401294	36	0.10	6401294
Silt	%	52	59	60	6401294	49	6401294	34	0.10	6401294
Clay	%	27	29	27	6401294	43	6401294	30	0.10	6401294

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
ND = Not detected

BV Labs Job #: B9R1693
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Minnow Environmental Inc
Client Project #: 19-41
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Sampler Initials: JT

RESULTS OF ANALYSES OF SOIL

BV Labs ID		KWZ164		KWZ165	KWZ166	KWZ167		KWZ168		
Sampling Date		2019/09/25		2019/09/25	2019/09/25	2019/09/25		2019/09/25		
COC Number		738008-02-01		738008-02-01	738008-02-01	738008-02-01		738008-02-01		
	UNITS	**SL-2019-1-P**	**QC Batch**	**SL-2019-2-P**	**SL-2019-3-P**	**SL-2019-4-P**	**QC Batch**	**SL-2019-5-P**	**RDL**	**QC Batch**
Inorganics										
Moisture	%	87	6360148	88	88	88	6360284	85	1.0	6360069
Total Organic Carbon	mg/kg	84000	6364418	94000	83000	86000	6364450	78000	500	6364418
< -1 Phi (2 mm)	%	100	6401294	100	100	100	6401294	100	0.10	6401297
< 0 Phi (1 mm)	%	99	6401294	92	97	94	6401294	98	0.10	6401297
< +1 Phi (0.5 mm)	%	94	6401294	89	95	92	6401294	96	0.10	6401297
< +2 Phi (0.25 mm)	%	92	6401294	87	93	91	6401294	95	0.10	6401297
< +3 Phi (0.12 mm)	%	88	6401294	85	88	88	6401294	93	0.10	6401297
< +4 Phi (0.062 mm)	%	84	6401294	83	85	81	6401294	90	0.10	6401297
< +5 Phi (0.031 mm)	%	80	6401294	79	80	75	6401294	83	0.10	6401297
< +6 Phi (0.016 mm)	%	61	6401294	63	56	60	6401294	64	0.10	6401297
< +7 Phi (0.0078 mm)	%	34	6401294	40	32	31	6401294	41	0.10	6401297
< +8 Phi (0.0039 mm)	%	28	6401294	34	26	25	6401294	33	0.10	6401297
< +9 Phi (0.0020 mm)	%	19	6401294	25	19	18	6401294	24	0.10	6401297
Gravel	%	ND	6401294	ND	ND	ND	6401294	ND	0.10	6401297
Sand	%	16	6401294	17	15	19	6401294	9.5	0.10	6401297
Silt	%	57	6401294	49	59	56	6401294	57	0.10	6401297
Clay	%	28	6401294	34	26	25	6401294	33	0.10	6401297

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
ND = Not detected

BV Labs Job #: B9R1693
Report Date: 2019/12/11

Minnow Environmental Inc
Client Project #: 19-41
Site Location: CYCLE 5 SRWMP
Sampler Initials: JT

RESULTS OF ANALYSES OF SOIL

BV Labs ID		KWZ169		KWZ176		KWZ177		KWZ178		
Sampling Date		2019/09/25		2019/09/20		2019/09/21		2019/09/20		
COC Number		738008-02-01		737959-01-01		737959-01-01		737959-01-01		
	UNITS	**SL-2019-4-PX**	**QC Batch**	**TML-2019-1-P**	**QC Batch**	**TML-2019-2-P**	**QC Batch**	**TML-2019-3-P**	**RDL**	**QC Batch**
Inorganics										
Moisture	%	88	6360284	88	6360261	89	6360345	86	1.0	6360261
Total Organic Carbon	mg/kg	86000	6364474	140000	6364474	110000	6364418	96000	500	6364474
< -1 Phi (2 mm)	%	100	6401297	100	6401297	99	6401297	100	0.10	6401297
< 0 Phi (1 mm)	%	94	6401297	96	6401297	95	6401297	100	0.10	6401297
< +1 Phi (0.5 mm)	%	92	6401297	93	6401297	92	6401297	99	0.10	6401297
< +2 Phi (0.25 mm)	%	91	6401297	91	6401297	89	6401297	97	0.10	6401297
< +3 Phi (0.12 mm)	%	90	6401297	86	6401297	85	6401297	94	0.10	6401297
< +4 Phi (0.062 mm)	%	82	6401297	79	6401297	80	6401297	86	0.10	6401297
< +5 Phi (0.031 mm)	%	77	6401297	71	6401297	72	6401297	67	0.10	6401297
< +6 Phi (0.016 mm)	%	61	6401297	46	6401297	52	6401297	50	0.10	6401297
< +7 Phi (0.0078 mm)	%	39	6401297	31	6401297	34	6401297	33	0.10	6401297
< +8 Phi (0.0039 mm)	%	33	6401297	28	6401297	30	6401297	28	0.10	6401297
< +9 Phi (0.0020 mm)	%	26	6401297	24	6401297	23	6401297	19	0.10	6401297
Gravel	%	ND	6401297	ND	6401297	0.64	6401297	ND	0.10	6401297
Sand	%	18	6401297	21	6401297	20	6401297	14	0.10	6401297
Silt	%	49	6401297	51	6401297	49	6401297	58	0.10	6401297
Clay	%	33	6401297	28	6401297	30	6401297	28	0.10	6401297

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
ND = Not detected

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BV Labs Job #: B9R1693
Report Date: 2019/12/11

Minnow Environmental Inc
Client Project #: 19-41
Site Location: CYCLE 5 SRWMP
Sampler Initials: JT

RESULTS OF ANALYSES OF SOIL

BV Labs ID		KWZ179			KWZ179			KWZ180		
Sampling Date		2019/09/21			2019/09/21			2019/09/20		
COC Number		737959-01-01			737959-01-01			737959-01-01		
	UNITS	TML-2019-4-P	RDL	QC Batch	TML-2019-4-P Lab-Dup	RDL	QC Batch	TML-2019-5-P	RDL	QC Batch
Inorganics										
Moisture	%	64	1.0	6360261				74	1.0	6360284
Total Organic Carbon	mg/kg	23000	500	6364474	20000	500	6364474	39000	500	6364474
< -1 Phi (2 mm)	%	100	0.10	6401297				100	0.10	6401297
< 0 Phi (1 mm)	%	98	0.10	6401297				100	0.10	6401297
< +1 Phi (0.5 mm)	%	96	0.10	6401297				100	0.10	6401297
< +2 Phi (0.25 mm)	%	84	0.10	6401297				99	0.10	6401297
< +3 Phi (0.12 mm)	%	54	0.10	6401297				97	0.10	6401297
< +4 Phi (0.062 mm)	%	33	0.10	6401297				82	0.10	6401297
< +5 Phi (0.031 mm)	%	18	0.10	6401297				50	0.10	6401297
< +6 Phi (0.016 mm)	%	12	0.10	6401297				33	0.10	6401297
< +7 Phi (0.0078 mm)	%	8.1	0.10	6401297				19	0.10	6401297
< +8 Phi (0.0039 mm)	%	7.0	0.10	6401297				16	0.10	6401297
< +9 Phi (0.0020 mm)	%	5.2	0.10	6401297				11	0.10	6401297
Gravel	%	0.31	0.10	6401297				ND	0.10	6401297
Sand	%	67	0.10	6401297				18	0.10	6401297
Silt	%	26	0.10	6401297				66	0.10	6401297
Clay	%	7.0	0.10	6401297				16	0.10	6401297

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate
ND = Not detected

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Microbiology testing is conducted at 6660 Campobello Rd. Chemistry testing is conducted at 6740 Campobello Rd.

BV Labs Job #: B9R1693
Report Date: 2019/12/11

Minnow Environmental Inc
Client Project #: 19-41
Site Location: CYCLE 5 SRWMP
Sampler Initials: JT

ISOTOPES BY ALPHA SPECTROMETRY (SOIL)

BV Labs ID		KWZ181	KWZ181	KWZ182	KWZ183	KWZ184	KWZ185		
Sampling Date		2019/09/20	2019/09/20	2019/09/21	2019/09/20	2019/09/21	2019/09/20		
COC Number		737959-01-01	737959-01-01	737959-01-01	737959-01-01	737959-01-01	737959-01-01		
	UNITS	**TML-2019-1-C**	**TML-2019-1-C Lab-Dup**	**TML-2019-2-C**	**TML-2019-3-C**	**TML-2019-4-C**	**TML-2019-5-C**	**RDL**	**QC Batch**
RADIONUCLIDE									
Radium-226	Bq/g	0.048	0.049	0.074	0.052	0.021	0.035	0.010	6463090

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate

BV Labs ID		KWZ208	KWZ209	KWZ210	KWZ211	KWZ212	KWZ213		
Sampling Date		2019/09/24	2019/09/24	2019/09/24	2019/09/24	2019/09/24	2019/09/19		
COC Number		737959-01-01	737959-01-01	737959-01-01	737959-01-01	737959-01-01	737959-01-01		
	UNITS	**DUL-2019-1X-C**	**DUL-2019-1-C**	**DUL-2019-2-C**	**DUL-2019-3-C**	**DUL-2019-4-C**	**DUL-2019-5-C**	**RDL**	**QC Batch**
RADIONUCLIDE									
Radium-226	Bq/g	0.066	0.081	0.073	0.083	0.042	0.110	0.010	6463090

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

BV Labs ID		KWZ214	KWZ215	KWZ216	KWZ217	KWZ237	KWZ238		
Sampling Date		2019/09/23	2019/09/23	2019/09/23	2019/09/23	2019/09/23	2019/09/22		
COC Number		737959-01-01	737959-01-01	737959-01-01	737959-01-01	737959-01-01	737959-01-01		
	UNITS	**NL-2019-1-C**	**NL-2019-2-C**	**NL-2019-3-C**	**NL-2019-4-C**	**NL-2019-5-C**	**SUL-2019-1-C**	**RDL**	**QC Batch**
RADIONUCLIDE									
Radium-226	Bq/g	2.04	7.30	4.50	5.40	7.60	0.115	0.010	6463090

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

BV Labs ID		KWZ239	KWZ240	KWZ241	KWZ242	KWZ243		
Sampling Date		2019/09/22	2019/09/22	2019/09/22	2019/09/22	2019/09/19		
COC Number		737959-01-01	737959-01-01	737959-01-01	737959-01-01	737959-01-01		
	UNITS	**SUL-2019-2-C**	**SUL-2019-3-C**	**SUL-2019-4-C**	**SUL-2019-5-C**	**MAL-2019-1-C**	**RDL**	**QC Batch**
RADIONUCLIDE								
Radium-226	Bq/g	0.039	0.061	0.046	0.048	3.10	0.010	6463090

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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BV Labs Job #: B9R1693
Report Date: 2019/12/11

Minnow Environmental Inc
Client Project #: 19-41
Site Location: CYCLE 5 SRWMP
Sampler Initials: JT

ISOTOPES BY ALPHA SPECTROMETRY (SOIL)

BV Labs ID		KWZ244	KWZ245	KWZ246	KWZ251	KWZ252	KWZ253		
Sampling Date		2019/09/19	2019/09/19	2019/09/22	2019/09/19	2019/09/17	2019/09/17		
COC Number		737959-01-01	737959-01-01	737959-01-01	737959-01-01	737959-01-01	737959-01-01		
	UNITS	**MAL-2019-2-C**	**MAL-2019-3-C**	**MAL-2019-4-C**	**MAL-2019-5-C**	**ML-2019-1-C**	**ML-2019-2-C**	**RDL**	**QC Batch**
RADIONUCLIDE									
Radium-226	Bq/g	3.00	2.05	2.40	3.40	13.0	5.80	0.010	6463354

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

BV Labs ID		KWZ254	KWZ255	KWZ256	KWZ257	KWZ258	KWZ259		
Sampling Date		2019/09/18	2019/09/18	2019/09/18	2019/09/18	2019/09/23	2019/09/19		
COC Number		737959-01-01	737959-01-01	737959-01-01	737959-01-01	737959-01-01	737959-01-01		
	UNITS	**ML-2019-3-C**	**ML-2019-4-C**	**ML-2019-5-C**	**ML-2019-3X-C**	**QL-2019-2-CX**	**QL-2019-1-C**	**RDL**	**QC Batch**
RADIONUCLIDE									
Radium-226	Bq/g	1.90	5.10	4.70	4.90	1.41	2.40	0.010	6463354

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

BV Labs ID		KWZ260	KWZ268	KWZ269	KWZ270	KWZ271	KWZ272		
Sampling Date		2019/09/23	2019/09/23	2019/09/19	2019/09/19	2019/09/25	2019/09/25		
COC Number		737959-01-01	737959-01-01	737959-01-01	737959-01-01	737959-01-01	737959-01-01		
	UNITS	**QL-2019-2-C**	**QL-2019-3-C**	**QL-2019-4-C**	**QL-2019-5-C**	**SL-2019-4-CX**	**SL-2019-1-C**	**RDL**	**QC Batch**
RADIONUCLIDE									
Radium-226	Bq/g	2.30	1.02	4.10	3.10	0.079	0.122	0.010	6463354

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

BV Labs ID		KWZ273	KWZ274	KWZ275	KWZ276	KWZ276		
Sampling Date		2019/09/25	2019/09/25	2019/09/25	2019/09/25	2019/09/25		
COC Number		737959-01-01	737959-01-01	737959-01-01	737959-01-01	737959-01-01		
	UNITS	**SL-2019-2-C**	**SL-2019-3-C**	**SL-2019-4-C**	**SL-2019-5-C**	**SL-2019-5-C Lab-Dup**	**RDL**	**QC Batch**
RADIONUCLIDE								
Radium-226	Bq/g	0.163	0.146	0.072	0.093	0.088	0.010	6463354

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate

BUREAU VERITAS

BV Labs Job #: B9R1693
Report Date: 2019/12/11

Minnow Environmental Inc
Client Project #: 19-41
Site Location: CYCLE 5 SRWMP
Sampler Initials: JT

ELEMENTS BY ATOMIC SPECTROSCOPY (SOIL)

BV Labs ID		KWZ181	KWZ182	KWZ183	KWZ184	KWZ185		
Sampling Date		2019/09/20	2019/09/21	2019/09/20	2019/09/21	2019/09/20		
COC Number		737959-01-01	737959-01-01	737959-01-01	737959-01-01	737959-01-01		
	UNITS	TML-2019-1-C	TML-2019-2-C	TML-2019-3-C	TML-2019-4-C	TML-2019-5-C	RDL	QC Batch
Metals								
Acid Extractable Aluminum (Al)	ug/g	9100	10000	9600	3500	5100	50	6364557
Acid Extractable Antimony (Sb)	ug/g	0.57	0.57	0.40	ND	ND	0.20	6364557
Acid Extractable Arsenic (As)	ug/g	8.7	7.4	5.2	2.1	2.3	1.0	6364557
Acid Extractable Barium (Ba)	ug/g	110	110	95	23	43	0.50	6364557
Acid Extractable Beryllium (Be)	ug/g	0.67	0.67	0.52	ND	0.30	0.20	6364557
Acid Extractable Bismuth (Bi)	ug/g	ND	ND	ND	ND	ND	1.0	6364557
Acid Extractable Boron (B)	ug/g	ND	ND	ND	ND	ND	5.0	6364557
Acid Extractable Cadmium (Cd)	ug/g	2.3	2.0	1.8	0.30	0.53	0.10	6364557
Acid Extractable Calcium (Ca)	ug/g	6400	4500	4900	1800	2400	50	6364557
Acid Extractable Chromium (Cr)	ug/g	19	23	22	8.0	13	1.0	6364557
Acid Extractable Cobalt (Co)	ug/g	7.8	8.7	8.8	3.5	4.7	0.10	6364557
Acid Extractable Copper (Cu)	ug/g	42	41	36	8.0	14	0.50	6364557
Acid Extractable Iron (Fe)	ug/g	14000	15000	12000	5800	8300	50	6364557
Acid Extractable Lead (Pb)	ug/g	94	92	62	15	25	1.0	6364557
Acid Extractable Magnesium (Mg)	ug/g	2200	2300	3200	1400	1900	50	6364557
Acid Extractable Manganese (Mn)	ug/g	580	1000	430	210	240	1.0	6364557
Acid Extractable Molybdenum (Mo)	ug/g	0.95	1.1	0.76	ND	ND	0.50	6364557
Acid Extractable Nickel (Ni)	ug/g	24	24	23	6.8	11	0.50	6364557
Acid Extractable Phosphorus (P)	ug/g	690	890	670	360	480	50	6364557
Acid Extractable Potassium (K)	ug/g	670	830	830	240	440	200	6364557
Acid Extractable Selenium (Se)	ug/g	2.9	2.5	1.9	ND	0.67	0.50	6364557
Acid Extractable Silver (Ag)	ug/g	ND	ND	ND	ND	ND	0.20	6364557
Acid Extractable Sodium (Na)	ug/g	81	100	100	57	91	50	6364557
Acid Extractable Strontium (Sr)	ug/g	19	18	16	6.9	10	1.0	6364557
Acid Extractable Thallium (Tl)	ug/g	0.19	0.18	0.15	ND	0.057	0.050	6364557
Acid Extractable Tin (Sn)	ug/g	3.0	3.4	2.1	ND	ND	1.0	6364557
Acid Extractable Uranium (U)	ug/g	5.1	4.8	3.3	1.2	1.7	0.050	6364557
Acid Extractable Vanadium (V)	ug/g	19	22	20	12	17	5.0	6364557
Acid Extractable Zinc (Zn)	ug/g	180	150	140	49	60	5.0	6364557
Acid Extractable Mercury (Hg)	ug/g	0.10	0.10	0.078	ND	ND	0.050	6364557

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
ND = Not detected

Bureau Veritas Laboratories 6740 Campobello Road, Mississauga, Ontario, L5N 2L8 Tel: (905) 817-5700 Toll-Free: 800-563-6266 Fax: (905) 817-5777 www.bvlabs.com

Microbiology testing is conducted at 6660 Campobello Rd. Chemistry testing is conducted at 6740 Campobello Rd.

ELEMENTS BY ATOMIC SPECTROSCOPY (SOIL)

BV Labs ID		KWZ208	KWZ209	KWZ210		KWZ211		
Sampling Date		2019/09/24	2019/09/24	2019/09/24		2019/09/24		
COC Number		737959-01-01	737959-01-01	737959-01-01		737959-01-01		
	UNITS	**DUL-2019-1X-C**	**DUL-2019-1-C**	**DUL-2019-2-C**	**RDL**	**DUL-2019-3-C**	**RDL**	**QC Batch**
Metals								
Acid Extractable Aluminum (Al)	ug/g	17000	17000	15000	50	9900	50	6364557
Acid Extractable Antimony (Sb)	ug/g	1.0	0.92	0.53	0.20	0.70	0.20	6364557
Acid Extractable Arsenic (As)	ug/g	15	14	8.5	1.0	12	1.0	6364557
Acid Extractable Barium (Ba)	ug/g	200	190	170	0.50	220	0.50	6364557
Acid Extractable Beryllium (Be)	ug/g	1.3	1.3	0.98	0.20	0.78	0.20	6364557
Acid Extractable Bismuth (Bi)	ug/g	ND	ND	ND	1.0	ND	1.0	6364557
Acid Extractable Boron (B)	ug/g	ND	ND	ND	5.0	ND	5.0	6364557
Acid Extractable Cadmium (Cd)	ug/g	3.2	3.1	2.3	0.10	2.1	0.10	6364557
Acid Extractable Calcium (Ca)	ug/g	3600	3400	3600	50	2700	50	6364557
Acid Extractable Chromium (Cr)	ug/g	26	25	24	1.0	18	1.0	6364557
Acid Extractable Cobalt (Co)	ug/g	21	20	15	0.10	17	0.10	6364557
Acid Extractable Copper (Cu)	ug/g	48	46	35	0.50	26	0.50	6364557
Acid Extractable Iron (Fe)	ug/g	38000	36000	25000	50	41000	50	6364557
Acid Extractable Lead (Pb)	ug/g	120	120	81	1.0	69	1.0	6364557
Acid Extractable Magnesium (Mg)	ug/g	1800	1700	2400	50	1700	50	6364557
Acid Extractable Manganese (Mn)	ug/g	3800	3600	4600	1.0	7500	5.0	6364557
Acid Extractable Molybdenum (Mo)	ug/g	2.5	2.3	1.6	0.50	1.7	0.50	6364557
Acid Extractable Nickel (Ni)	ug/g	30	29	26	0.50	21	0.50	6364557
Acid Extractable Phosphorus (P)	ug/g	1100	1100	970	50	800	50	6364557
Acid Extractable Potassium (K)	ug/g	720	680	720	200	500	200	6364557
Acid Extractable Selenium (Se)	ug/g	3.3	3.2	2.2	0.50	2.1	0.50	6364557
Acid Extractable Silver (Ag)	ug/g	0.22	0.24	ND	0.20	ND	0.20	6364557
Acid Extractable Sodium (Na)	ug/g	100	100	110	50	97	50	6364557
Acid Extractable Strontium (Sr)	ug/g	17	15	16	1.0	13	1.0	6364557
Acid Extractable Thallium (Tl)	ug/g	0.42	0.43	0.30	0.050	0.29	0.050	6364557
Acid Extractable Tin (Sn)	ug/g	3.8	3.7	2.5	1.0	2.0	1.0	6364557
Acid Extractable Uranium (U)	ug/g	4.6	4.4	3.6	0.050	2.9	0.050	6364557
Acid Extractable Vanadium (V)	ug/g	35	32	28	5.0	26	5.0	6364557
Acid Extractable Zinc (Zn)	ug/g	310	300	240	5.0	220	5.0	6364557
Acid Extractable Mercury (Hg)	ug/g	0.15	0.16	0.090	0.050	0.094	0.050	6364557

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
ND = Not detected

BV Labs Job #: B9R1693
Report Date: 2019/12/11

Minnow Environmental Inc
Client Project #: 19-41
Site Location: CYCLE 5 SRWMP
Sampler Initials: JT

ELEMENTS BY ATOMIC SPECTROSCOPY (SOIL)

BV Labs ID		KWZ212		KWZ213	KWZ214		KWZ215		
Sampling Date		2019/09/24		2019/09/19	2019/09/23		2019/09/23		
COC Number		737959-01-01		737959-01-01	737959-01-01		737959-01-01		
	UNITS	DUL-2019-4-C	QC Batch	DUL-2019-5-C	NL-2019-1-C	RDL	NL-2019-2-C	RDL	QC Batch
Metals									
Acid Extractable Aluminum (Al)	ug/g	9200	6364557	17000	16000	50	11000	50	6364529
Acid Extractable Antimony (Sb)	ug/g	0.34	6364557	1.1	0.65	0.20	0.65	0.20	6364529
Acid Extractable Arsenic (As)	ug/g	4.2	6364557	15	12	1.0	17	1.0	6364529
Acid Extractable Barium (Ba)	ug/g	70	6364557	210	140	0.50	750	0.50	6364529
Acid Extractable Beryllium (Be)	ug/g	0.57	6364557	1.3	0.74	0.20	0.57	0.20	6364529
Acid Extractable Bismuth (Bi)	ug/g	ND	6364557	ND	ND	1.0	ND	1.0	6364529
Acid Extractable Boron (B)	ug/g	ND	6364557	ND	7.4	5.0	6.7	5.0	6364529
Acid Extractable Cadmium (Cd)	ug/g	1.1	6364557	2.7	0.77	0.10	1.1	0.10	6364529
Acid Extractable Calcium (Ca)	ug/g	2800	6364557	3600	9300	50	9300	50	6364529
Acid Extractable Chromium (Cr)	ug/g	17	6364557	27	35	1.0	22	1.0	6364529
Acid Extractable Cobalt (Co)	ug/g	8.6	6364557	21	26	0.10	260	0.10	6364529
Acid Extractable Copper (Cu)	ug/g	20	6364557	41	53	0.50	36	0.50	6364529
Acid Extractable Iron (Fe)	ug/g	16000	6364557	50000	52000	50	94000	2500	6364529
Acid Extractable Lead (Pb)	ug/g	44	6364557	110	79	1.0	55	1.0	6364529
Acid Extractable Magnesium (Mg)	ug/g	2000	6364557	1900	4100	50	2700	50	6364529
Acid Extractable Manganese (Mn)	ug/g	930	6364557	5200	580	1.0	70000	50	6364529
Acid Extractable Molybdenum (Mo)	ug/g	0.69	6364557	2.6	1.8	0.50	13	0.50	6364529
Acid Extractable Nickel (Ni)	ug/g	14	6364557	27	38	0.50	76	0.50	6364529
Acid Extractable Phosphorus (P)	ug/g	700	6364557	1000	1000	50	1000	50	6364529
Acid Extractable Potassium (K)	ug/g	490	6364557	680	1100	200	1100	200	6364529
Acid Extractable Selenium (Se)	ug/g	1.2	6364557	2.9	2.1	0.50	1.6	0.50	6364529
Acid Extractable Silver (Ag)	ug/g	ND	6364557	ND	0.22	0.20	ND	0.20	6364529
Acid Extractable Sodium (Na)	ug/g	110	6364557	110	650	50	300	50	6364529
Acid Extractable Strontium (Sr)	ug/g	12	6364557	17	26	1.0	31	1.0	6364529
Acid Extractable Thallium (Tl)	ug/g	0.14	6364557	0.37	0.18	0.050	0.60	0.050	6364529
Acid Extractable Tin (Sn)	ug/g	1.6	6364557	3.7	2.5	1.0	1.7	1.0	6364529
Acid Extractable Uranium (U)	ug/g	2.1	6364557	4.3	82	0.050	150	0.050	6364529
Acid Extractable Vanadium (V)	ug/g	22	6364557	38	36	5.0	32	5.0	6364529
Acid Extractable Zinc (Zn)	ug/g	120	6364557	290	150	5.0	200	5.0	6364529
Acid Extractable Mercury (Hg)	ug/g	ND	6364557	0.15	0.17	0.050	0.12	0.050	6364529

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
ND = Not detected

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BUREAU VERITAS

BV Labs Job #: B9R1693
Report Date: 2019/12/11

Minnow Environmental Inc
Client Project #: 19-41
Site Location: CYCLE 5 SRWMP
Sampler Initials: JT

ELEMENTS BY ATOMIC SPECTROSCOPY (SOIL)

BV Labs ID		KWZ216		KWZ217		KWZ237		KWZ238		
Sampling Date		2019/09/23		2019/09/23		2019/09/23		2019/09/22		
COC Number		737959-01-01		737959-01-01		737959-01-01		737959-01-01		
	UNITS	**NL-2019-3-C**	**RDL**	**NL-2019-4-C**	**RDL**	**NL-2019-5-C**	**RDL**	**SUL-2019-1-C**	**RDL**	**QC Batch**
Metals										
Acid Extractable Aluminum (Al)	ug/g	10000	50	12000	50	10000	50	17000	50	6364581
Acid Extractable Antimony (Sb)	ug/g	0.41	0.20	0.61	0.20	0.64	0.20	1.3	0.20	6364581
Acid Extractable Arsenic (As)	ug/g	14	1.0	26	1.0	24	1.0	35	1.0	6364581
Acid Extractable Barium (Ba)	ug/g	390	0.50	360	0.50	570	0.50	160	0.50	6364581
Acid Extractable Beryllium (Be)	ug/g	0.43	0.20	0.59	0.20	0.52	0.20	1.3	0.20	6364581
Acid Extractable Bismuth (Bi)	ug/g	ND	1.0	ND	1.0	ND	1.0	ND	1.0	6364581
Acid Extractable Boron (B)	ug/g	ND	5.0	5.8	5.0	7.1	5.0	ND	5.0	6364581
Acid Extractable Cadmium (Cd)	ug/g	0.47	0.10	0.70	0.10	0.65	0.10	1.8	0.10	6364581
Acid Extractable Calcium (Ca)	ug/g	7600	50	8700	50	10000	50	2000	50	6364581
Acid Extractable Chromium (Cr)	ug/g	24	1.0	26	1.0	21	1.0	26	1.0	6364581
Acid Extractable Cobalt (Co)	ug/g	120	0.10	130	0.10	250	0.10	26	0.10	6364581
Acid Extractable Copper (Cu)	ug/g	26	0.50	42	0.50	32	0.50	30	0.50	6364581
Acid Extractable Iron (Fe)	ug/g	83000	50	99000	50	140000	500	150000	250	6364581
Acid Extractable Lead (Pb)	ug/g	47	1.0	86	1.0	50	1.0	110	1.0	6364581
Acid Extractable Magnesium (Mg)	ug/g	2600	50	3200	50	2400	50	1400	50	6364581
Acid Extractable Manganese (Mn)	ug/g	18000	5.0	28000	10	40000	10	3900	1.0	6364581
Acid Extractable Molybdenum (Mo)	ug/g	7.4	0.50	10	0.50	10	0.50	3.2	0.50	6364581
Acid Extractable Nickel (Ni)	ug/g	36	0.50	53	0.50	54	0.50	21	0.50	6364581
Acid Extractable Phosphorus (P)	ug/g	800	50	1100	50	1200	50	1300	50	6364581
Acid Extractable Potassium (K)	ug/g	640	200	930	200	850	200	580	200	6364581
Acid Extractable Selenium (Se)	ug/g	1.2	0.50	2.0	0.50	2.0	0.50	3.8	0.50	6364581
Acid Extractable Silver (Ag)	ug/g	ND	0.20	ND	0.20	ND	0.20	0.22	0.20	6364581
Acid Extractable Sodium (Na)	ug/g	260	50	370	50	320	50	73	50	6364581
Acid Extractable Strontium (Sr)	ug/g	24	1.0	27	1.0	29	1.0	14	1.0	6364581
Acid Extractable Thallium (Tl)	ug/g	0.18	0.050	0.26	0.050	0.30	0.050	0.19	0.050	6364581
Acid Extractable Tin (Sn)	ug/g	1.4	1.0	2.3	1.0	1.7	1.0	3.7	1.0	6364581
Acid Extractable Uranium (U)	ug/g	88	0.050	150	0.050	130	0.050	2.5	0.050	6364581
Acid Extractable Vanadium (V)	ug/g	26	5.0	33	5.0	29	5.0	30	5.0	6364581
Acid Extractable Zinc (Zn)	ug/g	110	5.0	170	5.0	180	5.0	210	5.0	6364581
Acid Extractable Mercury (Hg)	ug/g	0.082	0.050	0.15	0.050	0.10	0.050	0.16	0.050	6364581

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
ND = Not detected

BV Labs Job #: B9R1693
Report Date: 2019/12/11

Minnow Environmental Inc
Client Project #: 19-41
Site Location: CYCLE 5 SRWMP
Sampler Initials: JT

ELEMENTS BY ATOMIC SPECTROSCOPY (SOIL)

BV Labs ID		KWZ239	KWZ239	KWZ240	KWZ241	KWZ242		
Sampling Date		2019/09/22	2019/09/22	2019/09/22	2019/09/22	2019/09/22		
COC Number		737959-01-01	737959-01-01	737959-01-01	737959-01-01	737959-01-01		
	UNITS	**SUL-2019-2-C**	**SUL-2019-2-C Lab-Dup**	**SUL-2019-3-C**	**SUL-2019-4-C**	**SUL-2019-5-C**	**RDL**	**QC Batch**
Metals								
Acid Extractable Aluminum (Al)	ug/g	8300	8700	20000	21000	18000	50	6364581
Acid Extractable Antimony (Sb)	ug/g	0.28	0.26	0.91	0.72	0.49	0.20	6364581
Acid Extractable Arsenic (As)	ug/g	4.3	4.6	15	3.6	4.9	1.0	6364581
Acid Extractable Barium (Ba)	ug/g	53	57	100	91	80	0.50	6364581
Acid Extractable Beryllium (Be)	ug/g	0.53	0.55	1.4	1.2	1.1	0.20	6364581
Acid Extractable Bismuth (Bi)	ug/g	ND	ND	ND	ND	ND	1.0	6364581
Acid Extractable Boron (B)	ug/g	ND	ND	ND	ND	ND	5.0	6364581
Acid Extractable Cadmium (Cd)	ug/g	1.0	1.1	1.4	1.4	0.94	0.10	6364581
Acid Extractable Calcium (Ca)	ug/g	1700	1800	2500	2400	2300	50	6364581
Acid Extractable Chromium (Cr)	ug/g	14	15	27	29	25	1.0	6364581
Acid Extractable Cobalt (Co)	ug/g	11	11	32	12	12	0.10	6364581
Acid Extractable Copper (Cu)	ug/g	12	14	31	35	26	0.50	6364581
Acid Extractable Iron (Fe)	ug/g	14000	15000	64000	19000	30000	50	6364581
Acid Extractable Lead (Pb)	ug/g	39	41	89	84	53	1.0	6364581
Acid Extractable Magnesium (Mg)	ug/g	1500	1700	1600	1700	1600	50	6364581
Acid Extractable Manganese (Mn)	ug/g	1700	1800	2000	380	560	1.0	6364581
Acid Extractable Molybdenum (Mo)	ug/g	0.81	0.76	2.1	1.4	1.0	0.50	6364581
Acid Extractable Nickel (Ni)	ug/g	15	15	20	20	17	0.50	6364581
Acid Extractable Phosphorus (P)	ug/g	580	600	1300	1400	1100	50	6364581
Acid Extractable Potassium (K)	ug/g	400	420	610	690	520	200	6364581
Acid Extractable Selenium (Se)	ug/g	1.1	1.2	3.2	3.1	2.3	0.50	6364581
Acid Extractable Silver (Ag)	ug/g	ND	ND	ND	ND	ND	0.20	6364581
Acid Extractable Sodium (Na)	ug/g	70	76	78	82	87	50	6364581
Acid Extractable Strontium (Sr)	ug/g	11	11	17	16	14	1.0	6364581
Acid Extractable Thallium (Tl)	ug/g	0.11	0.10	0.15	0.12	0.10	0.050	6364581
Acid Extractable Tin (Sn)	ug/g	1.4	1.4	3.3	3.3	2.2	1.0	6364581
Acid Extractable Uranium (U)	ug/g	1.4	1.5	2.7	2.6	2.3	0.050	6364581
Acid Extractable Vanadium (V)	ug/g	17	17	38	33	27	5.0	6364581
Acid Extractable Zinc (Zn)	ug/g	94	100	140	120	97	5.0	6364581
Acid Extractable Mercury (Hg)	ug/g	0.060	0.072	0.17	0.19	0.098	0.050	6364581

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate
ND = Not detected

BV Labs Job #: B9R1693
Report Date: 2019/12/11

Minnow Environmental Inc
Client Project #: 19-41
Site Location: CYCLE 5 SRWMP
Sampler Initials: JT

ELEMENTS BY ATOMIC SPECTROSCOPY (SOIL)

BV Labs ID		KWZ243		KWZ244		KWZ245	KWZ246		
Sampling Date		2019/09/19		2019/09/19		2019/09/19	2019/09/22		
COC Number		737959-01-01		737959-01-01		737959-01-01	737959-01-01		
	UNITS	**MAL-2019-1-C**	**RDL**	**MAL-2019-2-C**	**RDL**	**MAL-2019-3-C**	**MAL-2019-4-C**	**RDL**	**QC Batch**
Metals									
Acid Extractable Aluminum (Al)	ug/g	17000	50	15000	50	16000	19000	50	6364581
Acid Extractable Antimony (Sb)	ug/g	1.0	0.20	1.0	0.20	0.97	1.2	0.20	6364581
Acid Extractable Arsenic (As)	ug/g	19	1.0	33	1.0	23	28	1.0	6364581
Acid Extractable Barium (Ba)	ug/g	87	0.50	490	0.50	320	340	0.50	6364581
Acid Extractable Beryllium (Be)	ug/g	0.79	0.20	0.67	0.20	0.78	0.76	0.20	6364581
Acid Extractable Bismuth (Bi)	ug/g	ND	1.0	ND	1.0	ND	ND	1.0	6364581
Acid Extractable Boron (B)	ug/g	5.0	5.0	ND	5.0	ND	ND	5.0	6364581
Acid Extractable Cadmium (Cd)	ug/g	0.87	0.10	1.2	0.10	1.1	0.61	0.10	6364581
Acid Extractable Calcium (Ca)	ug/g	6200	50	6400	50	5400	5800	50	6364581
Acid Extractable Chromium (Cr)	ug/g	38	1.0	32	1.0	31	36	1.0	6364581
Acid Extractable Cobalt (Co)	ug/g	28	0.10	59	0.10	34	35	0.10	6364581
Acid Extractable Copper (Cu)	ug/g	85	0.50	67	0.50	55	65	0.50	6364581
Acid Extractable Iron (Fe)	ug/g	110000	250	97000	250	72000	75000	50	6364581
Acid Extractable Lead (Pb)	ug/g	110	1.0	160	1.0	150	180	1.0	6364581
Acid Extractable Magnesium (Mg)	ug/g	2800	50	2100	50	2600	3100	50	6364581
Acid Extractable Manganese (Mn)	ug/g	2000	1.0	12000	5.0	5900	7600	5.0	6364581
Acid Extractable Molybdenum (Mo)	ug/g	3.4	0.50	10	0.50	6.4	7.7	0.50	6364581
Acid Extractable Nickel (Ni)	ug/g	30	0.50	68	0.50	45	46	0.50	6364581
Acid Extractable Phosphorus (P)	ug/g	1200	50	1100	50	980	1300	50	6364581
Acid Extractable Potassium (K)	ug/g	770	200	670	200	670	820	200	6364581
Acid Extractable Selenium (Se)	ug/g	3.2	0.50	4.4	0.50	3.1	3.4	0.50	6364581
Acid Extractable Silver (Ag)	ug/g	0.22	0.20	ND	0.20	ND	0.23	0.20	6364581
Acid Extractable Sodium (Na)	ug/g	110	50	87	50	100	120	50	6364581
Acid Extractable Strontium (Sr)	ug/g	16	1.0	17	1.0	16	19	1.0	6364581
Acid Extractable Thallium (Tl)	ug/g	0.37	0.050	0.66	0.050	0.44	0.34	0.050	6364581
Acid Extractable Tin (Sn)	ug/g	4.0	1.0	3.4	1.0	2.9	3.7	1.0	6364581
Acid Extractable Uranium (U)	ug/g	76	0.050	130	0.050	80	81	0.050	6364581
Acid Extractable Vanadium (V)	ug/g	31	5.0	27	5.0	33	36	5.0	6364581
Acid Extractable Zinc (Zn)	ug/g	180	5.0	170	5.0	170	170	5.0	6364581
Acid Extractable Mercury (Hg)	ug/g	0.14	0.050	0.14	0.050	0.13	0.17	0.050	6364581

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
ND = Not detected

BUREAU VERITAS

BV Labs Job #: B9R1693
Report Date: 2019/12/11

Minnow Environmental Inc
Client Project #: 19-41
Site Location: CYCLE 5 SRWMP
Sampler Initials: JT

ELEMENTS BY ATOMIC SPECTROSCOPY (SOIL)

BV Labs ID		KWZ251		KWZ252		KWZ253		KWZ254		
Sampling Date		2019/09/19		2019/09/17		2019/09/17		2019/09/18		
COC Number		737959-01-01		737959-01-01		737959-01-01		737959-01-01		
	UNITS	**MAL-2019-5-C**	**RDL**	**ML-2019-1-C**	**RDL**	**ML-2019-2-C**	**RDL**	**ML-2019-3-C**	**RDL**	**QC Batch**
Metals										
Acid Extractable Aluminum (Al)	ug/g	13000	50	28000	50	21000	50	20000	50	6364581
Acid Extractable Antimony (Sb)	ug/g	0.91	0.20	1.1	0.20	0.99	0.20	0.94	0.20	6364581
Acid Extractable Arsenic (As)	ug/g	34	1.0	26	1.0	33	1.0	20	1.0	6364581
Acid Extractable Barium (Ba)	ug/g	780	0.50	370	5.0	870	0.50	220	0.50	6364581
Acid Extractable Beryllium (Be)	ug/g	0.62	0.20	2.0	0.20	1.0	0.20	0.91	0.20	6364581
Acid Extractable Bismuth (Bi)	ug/g	ND	1.0	ND	1.0	1.4	1.0	1.8	1.0	6364581
Acid Extractable Boron (B)	ug/g	ND	5.0	5.8	5.0	ND	5.0	5.5	5.0	6364581
Acid Extractable Cadmium (Cd)	ug/g	1.1	0.10	1.3	0.10	0.87	0.10	0.99	0.10	6364581
Acid Extractable Calcium (Ca)	ug/g	5800	50	5100	50	5500	50	6200	50	6364581
Acid Extractable Chromium (Cr)	ug/g	28	1.0	25	1.0	30	1.0	30	1.0	6364581
Acid Extractable Cobalt (Co)	ug/g	76	0.10	380	0.10	130	0.10	68	0.10	6364581
Acid Extractable Copper (Cu)	ug/g	54	0.50	150	0.50	55	0.50	64	0.50	6364581
Acid Extractable Iron (Fe)	ug/g	99000	50	110000	500	90000	250	45000	50	6364581
Acid Extractable Lead (Pb)	ug/g	130	1.0	580	1.0	200	1.0	230	1.0	6364581
Acid Extractable Magnesium (Mg)	ug/g	2500	50	1300	50	2100	50	2200	50	6364581
Acid Extractable Manganese (Mn)	ug/g	22000	5.0	31000	10	12000	5.0	910	1.0	6364581
Acid Extractable Molybdenum (Mo)	ug/g	11	0.50	29	0.50	25	0.50	12	0.50	6364581
Acid Extractable Nickel (Ni)	ug/g	75	0.50	190	0.50	84	0.50	75	0.50	6364581
Acid Extractable Phosphorus (P)	ug/g	960	50	1100	50	1300	50	1200	50	6364581
Acid Extractable Potassium (K)	ug/g	750	200	590	200	700	200	870	200	6364581
Acid Extractable Selenium (Se)	ug/g	3.2	0.50	4.2	0.50	3.7	0.50	4.1	0.50	6364581
Acid Extractable Silver (Ag)	ug/g	ND	0.20	0.22	0.20	0.22	0.20	0.29	0.20	6364581
Acid Extractable Sodium (Na)	ug/g	110	50	100	50	96	50	110	50	6364581
Acid Extractable Strontium (Sr)	ug/g	17	1.0	36	1.0	27	1.0	35	1.0	6364581
Acid Extractable Thallium (Tl)	ug/g	0.72	0.050	0.64	0.050	0.67	0.050	0.67	0.050	6364581
Acid Extractable Tin (Sn)	ug/g	3.4	1.0	3.2	1.0	3.7	1.0	4.8	1.0	6364581
Acid Extractable Uranium (U)	ug/g	93	0.050	410	0.050	240	0.050	210	0.050	6364581
Acid Extractable Vanadium (V)	ug/g	28	5.0	24	5.0	34	5.0	34	5.0	6364581
Acid Extractable Zinc (Zn)	ug/g	200	5.0	320	5.0	210	5.0	180	5.0	6364581
Acid Extractable Mercury (Hg)	ug/g	0.14	0.050	0.12	0.050	0.16	0.050	0.19	0.050	6364581

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
ND = Not detected

BV Labs Job #: B9R1693
Report Date: 2019/12/11

Minnow Environmental Inc
Client Project #: 19-41
Site Location: CYCLE 5 SRWMP
Sampler Initials: JT

ELEMENTS BY ATOMIC SPECTROSCOPY (SOIL)

BV Labs ID		KWZ255		KWZ256	KWZ257		KWZ258		
Sampling Date		2019/09/18		2019/09/18	2019/09/18		2019/09/23		
COC Number		737959-01-01		737959-01-01	737959-01-01		737959-01-01		
	UNITS	**ML-2019-4-C**	**RDL**	**ML-2019-5-C**	**ML-2019-3X-C**	**RDL**	**QL-2019-2-CX**	**RDL**	**QC Batch**
Metals									
Acid Extractable Aluminum (Al)	ug/g	19000	50	19000	13000	50	19000	50	6364581
Acid Extractable Antimony (Sb)	ug/g	1.0	0.20	0.94	0.98	0.20	1.0	0.20	6364581
Acid Extractable Arsenic (As)	ug/g	34	1.0	20	25	1.0	32	1.0	6364581
Acid Extractable Barium (Ba)	ug/g	1300	0.50	170	560	0.50	1200	0.50	6364581
Acid Extractable Beryllium (Be)	ug/g	0.99	0.20	0.84	0.74	0.20	0.93	0.20	6364581
Acid Extractable Bismuth (Bi)	ug/g	1.2	1.0	1.7	4.6	1.0	1.3	1.0	6364581
Acid Extractable Boron (B)	ug/g	ND	5.0	5.3	ND	5.0	ND	5.0	6364581
Acid Extractable Cadmium (Cd)	ug/g	1.1	0.10	0.89	0.54	0.10	0.92	0.10	6364581
Acid Extractable Calcium (Ca)	ug/g	5500	50	5700	4100	50	5600	50	6364581
Acid Extractable Chromium (Cr)	ug/g	27	1.0	29	27	1.0	27	1.0	6364581
Acid Extractable Cobalt (Co)	ug/g	200	0.10	64	35	0.10	180	0.10	6364581
Acid Extractable Copper (Cu)	ug/g	48	0.50	59	61	0.50	51	0.50	6364581
Acid Extractable Iron (Fe)	ug/g	88000	50	43000	71000	50	87000	50	6364581
Acid Extractable Lead (Pb)	ug/g	170	1.0	220	180	1.0	170	1.0	6364581
Acid Extractable Magnesium (Mg)	ug/g	1900	50	2100	2300	50	1900	50	6364581
Acid Extractable Manganese (Mn)	ug/g	36000	10	890	4300	1.0	23000	5.0	6364581
Acid Extractable Molybdenum (Mo)	ug/g	32	0.50	12	31	0.50	28	0.50	6364581
Acid Extractable Nickel (Ni)	ug/g	100	0.50	70	30	0.50	110	0.50	6364581
Acid Extractable Phosphorus (P)	ug/g	1300	50	1100	950	50	1200	50	6364581
Acid Extractable Potassium (K)	ug/g	720	200	820	730	200	680	200	6364581
Acid Extractable Selenium (Se)	ug/g	3.4	0.50	4.0	3.3	0.50	3.6	0.50	6364581
Acid Extractable Silver (Ag)	ug/g	0.20	0.20	0.34	0.33	0.20	ND	0.20	6364581
Acid Extractable Sodium (Na)	ug/g	100	50	110	100	50	95	50	6364581
Acid Extractable Strontium (Sr)	ug/g	19	1.0	33	18	1.0	22	1.0	6364581
Acid Extractable Thallium (Tl)	ug/g	0.89	0.050	0.63	0.20	0.050	0.91	0.050	6364581
Acid Extractable Tin (Sn)	ug/g	3.5	1.0	4.6	3.2	1.0	3.4	1.0	6364581
Acid Extractable Uranium (U)	ug/g	240	0.050	210	320	0.050	240	0.050	6364581
Acid Extractable Vanadium (V)	ug/g	32	5.0	32	34	5.0	32	5.0	6364581
Acid Extractable Zinc (Zn)	ug/g	220	5.0	170	110	5.0	210	5.0	6364581
Acid Extractable Mercury (Hg)	ug/g	0.16	0.050	0.21	0.13	0.050	0.14	0.050	6364581

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
ND = Not detected

ELEMENTS BY ATOMIC SPECTROSCOPY (SOIL)

BV Labs ID		KWZ259			KWZ260		KWZ268		
Sampling Date		2019/09/19			2019/09/23		2019/09/23		
COC Number		737959-01-01			737959-01-01		737959-01-01		
	UNITS	QL-2019-1-C	RDL	QC Batch	QL-2019-2-C	RDL	QL-2019-3-C	RDL	QC Batch
Metals									
Acid Extractable Aluminum (Al)	ug/g	16000	50	6364560	14000	50	12000	50	6364557
Acid Extractable Antimony (Sb)	ug/g	1.0	0.20	6364560	1.0	0.20	0.71	0.20	6364557
Acid Extractable Arsenic (As)	ug/g	41	1.0	6364560	28	1.0	14	1.0	6364557
Acid Extractable Barium (Ba)	ug/g	1500	0.50	6364560	600	0.50	290	0.50	6364557
Acid Extractable Beryllium (Be)	ug/g	0.92	0.20	6364560	0.81	0.20	0.54	0.20	6364557
Acid Extractable Bismuth (Bi)	ug/g	1.3	1.0	6364560	4.7	1.0	ND	1.0	6364557
Acid Extractable Boron (B)	ug/g	ND	5.0	6364560	ND	5.0	ND	5.0	6364557
Acid Extractable Cadmium (Cd)	ug/g	0.80	0.10	6364560	0.56	0.10	0.56	0.10	6364557
Acid Extractable Calcium (Ca)	ug/g	5100	50	6364560	4300	50	4100	50	6364557
Acid Extractable Chromium (Cr)	ug/g	27	1.0	6364560	29	1.0	29	1.0	6364557
Acid Extractable Cobalt (Co)	ug/g	65	0.10	6364560	38	0.10	37	0.10	6364557
Acid Extractable Copper (Cu)	ug/g	74	0.50	6364560	64	0.50	53	0.50	6364557
Acid Extractable Iron (Fe)	ug/g	91000	50	6364560	75000	50	37000	50	6364557
Acid Extractable Lead (Pb)	ug/g	250	1.0	6364560	190	1.0	120	1.0	6364557
Acid Extractable Magnesium (Mg)	ug/g	1900	50	6364560	2300	50	2800	50	6364557
Acid Extractable Manganese (Mn)	ug/g	7100	5.0	6364560	4600	1.0	6600	5.0	6364557
Acid Extractable Molybdenum (Mo)	ug/g	76	0.50	6364560	33	0.50	19	0.50	6364557
Acid Extractable Nickel (Ni)	ug/g	39	0.50	6364560	32	0.50	29	0.50	6364557
Acid Extractable Phosphorus (P)	ug/g	940	50	6364560	1000	50	920	50	6364557
Acid Extractable Potassium (K)	ug/g	640	200	6364560	790	200	720	200	6364557
Acid Extractable Selenium (Se)	ug/g	4.1	0.50	6364560	3.7	0.50	2.5	0.50	6364557
Acid Extractable Silver (Ag)	ug/g	0.22	0.20	6364560	0.32	0.20	ND	0.20	6364557
Acid Extractable Sodium (Na)	ug/g	80	50	6364560	110	50	120	50	6364557
Acid Extractable Strontium (Sr)	ug/g	30	1.0	6364560	20	1.0	16	1.0	6364557
Acid Extractable Thallium (Tl)	ug/g	0.25	0.050	6364560	0.22	0.050	0.30	0.050	6364557
Acid Extractable Tin (Sn)	ug/g	3.7	1.0	6364560	3.2	1.0	2.5	1.0	6364557
Acid Extractable Uranium (U)	ug/g	460	0.25	6364560	340	0.050	210	0.050	6364557
Acid Extractable Vanadium (V)	ug/g	33	5.0	6364560	36	5.0	35	5.0	6364557
Acid Extractable Zinc (Zn)	ug/g	150	5.0	6364560	110	5.0	91	5.0	6364557
Acid Extractable Mercury (Hg)	ug/g	0.12	0.050	6364560	0.12	0.050	0.080	0.050	6364557

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
ND = Not detected

ELEMENTS BY ATOMIC SPECTROSCOPY (SOIL)

BV Labs ID		KWZ269		KWZ270		KWZ271		KWZ272		
Sampling Date		2019/09/19		2019/09/19		2019/09/25		2019/09/25		
COC Number		737959-01-01		737959-01-01		737959-01-01		737959-01-01		
	UNITS	**QL-2019-4-C**	**RDL**	**QL-2019-5-C**	**RDL**	**SL-2019-4-CX**	**RDL**	**SL-2019-1-C**	**RDL**	**QC Batch**
Metals										
Acid Extractable Aluminum (Al)	ug/g	16000	50	15000	50	13000	50	15000	50	6364557
Acid Extractable Antimony (Sb)	ug/g	1.5	0.20	1.3	0.20	0.99	0.20	0.94	0.20	6364557
Acid Extractable Arsenic (As)	ug/g	36	1.0	34	1.0	13	1.0	21	1.0	6364557
Acid Extractable Barium (Ba)	ug/g	950	0.50	710	0.50	390	0.50	490	0.50	6364557
Acid Extractable Beryllium (Be)	ug/g	0.87	0.20	0.75	0.20	1.1	0.20	1.3	0.20	6364557
Acid Extractable Bismuth (Bi)	ug/g	2.9	1.0	3.8	1.0	ND	1.0	ND	1.0	6364557
Acid Extractable Boron (B)	ug/g	ND	5.0	ND	5.0	ND	5.0	ND	5.0	6364557
Acid Extractable Cadmium (Cd)	ug/g	1.1	0.10	0.75	0.10	2.7	0.10	2.8	0.10	6364557
Acid Extractable Calcium (Ca)	ug/g	5400	50	4700	50	3400	50	3500	50	6364557
Acid Extractable Chromium (Cr)	ug/g	34	1.0	36	1.0	23	1.0	25	1.0	6364557
Acid Extractable Cobalt (Co)	ug/g	89	0.10	48	0.10	11	0.10	15	0.10	6364557
Acid Extractable Copper (Cu)	ug/g	90	0.50	81	0.50	48	0.50	60	0.50	6364557
Acid Extractable Iron (Fe)	ug/g	86000	50	74000	50	29000	50	50000	50	6364557
Acid Extractable Lead (Pb)	ug/g	300	1.0	270	1.0	110	1.0	120	1.0	6364557
Acid Extractable Magnesium (Mg)	ug/g	2400	50	2700	50	2000	50	2000	50	6364557
Acid Extractable Manganese (Mn)	ug/g	26000	10	13000	5.0	2700	1.0	7400	5.0	6364557
Acid Extractable Molybdenum (Mo)	ug/g	47	0.50	40	0.50	2.6	0.50	8.5	0.50	6364557
Acid Extractable Nickel (Ni)	ug/g	52	0.50	41	0.50	26	0.50	29	0.50	6364557
Acid Extractable Phosphorus (P)	ug/g	1300	50	1200	50	920	50	1200	50	6364557
Acid Extractable Potassium (K)	ug/g	1000	200	1000	200	650	200	710	200	6364557
Acid Extractable Selenium (Se)	ug/g	5.5	0.50	5.2	0.50	2.9	0.50	3.2	0.50	6364557
Acid Extractable Silver (Ag)	ug/g	0.41	0.20	0.36	0.20	ND	0.20	ND	0.20	6364557
Acid Extractable Sodium (Na)	ug/g	120	50	120	50	120	50	130	50	6364557
Acid Extractable Strontium (Sr)	ug/g	26	1.0	21	1.0	19	1.0	23	1.0	6364557
Acid Extractable Thallium (Tl)	ug/g	0.64	0.050	0.36	0.050	0.33	0.050	0.37	0.050	6364557
Acid Extractable Tin (Sn)	ug/g	5.2	1.0	5.5	1.0	3.3	1.0	3.3	1.0	6364557
Acid Extractable Uranium (U)	ug/g	420	0.050	380	0.050	4.6	0.050	6.1	0.050	6364557
Acid Extractable Vanadium (V)	ug/g	40	5.0	40	5.0	30	5.0	35	5.0	6364557
Acid Extractable Zinc (Zn)	ug/g	160	5.0	120	5.0	240	5.0	290	5.0	6364557
Acid Extractable Mercury (Hg)	ug/g	0.22	0.050	0.19	0.050	0.15	0.050	0.16	0.050	6364557

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
ND = Not detected

BUREAU VERITAS

BV Labs Job #: B9R1693
Report Date: 2019/12/11

Minnow Environmental Inc
Client Project #: 19-41
Site Location: CYCLE 5 SRWMP
Sampler Initials: JT

ELEMENTS BY ATOMIC SPECTROSCOPY (SOIL)

BV Labs ID		KWZ273		KWZ274	KWZ274		KWZ275		
Sampling Date		2019/09/25		2019/09/25	2019/09/25		2019/09/25		
COC Number		737959-01-01		737959-01-01	737959-01-01		737959-01-01		
	UNITS	SL-2019-2-C	RDL	SL-2019-3-C	SL-2019-3-C Lab-Dup	RDL	SL-2019-4-C	RDL	QC Batch
Metals									
Acid Extractable Aluminum (Al)	ug/g	15000	50	15000	15000	50	13000	50	6364557
Acid Extractable Antimony (Sb)	ug/g	1.1	0.20	1.1	1.2	0.20	0.88	0.20	6364557
Acid Extractable Arsenic (As)	ug/g	17	1.0	25	24	1.0	13	1.0	6364557
Acid Extractable Barium (Ba)	ug/g	410	0.50	1100	1100	0.50	380	0.50	6364557
Acid Extractable Beryllium (Be)	ug/g	1.2	0.20	1.3	1.3	0.20	1.1	0.20	6364557
Acid Extractable Bismuth (Bi)	ug/g	ND	1.0	ND	ND	1.0	ND	1.0	6364557
Acid Extractable Boron (B)	ug/g	ND	5.0	ND	ND	5.0	ND	5.0	6364557
Acid Extractable Cadmium (Cd)	ug/g	3.2	0.10	2.6	2.6	0.10	2.9	0.10	6364557
Acid Extractable Calcium (Ca)	ug/g	3200	50	3400	3400	50	3400	50	6364557
Acid Extractable Chromium (Cr)	ug/g	24	1.0	25	24	1.0	24	1.0	6364557
Acid Extractable Cobalt (Co)	ug/g	15	0.10	21	20	0.10	12	0.10	6364557
Acid Extractable Copper (Cu)	ug/g	55	0.50	52	50	0.50	49	0.50	6364557
Acid Extractable Iron (Fe)	ug/g	36000	50	65000	63000	50	30000	50	6364557
Acid Extractable Lead (Pb)	ug/g	130	1.0	130	120	1.0	110	1.0	6364557
Acid Extractable Magnesium (Mg)	ug/g	2000	50	2100	2100	50	2000	50	6364557
Acid Extractable Manganese (Mn)	ug/g	3700	1.0	23000	22000	5.0	2700	1.0	6364557
Acid Extractable Molybdenum (Mo)	ug/g	2.5	0.50	7.3	7.1	0.50	2.6	0.50	6364557
Acid Extractable Nickel (Ni)	ug/g	29	0.50	30	29	0.50	27	0.50	6364557
Acid Extractable Phosphorus (P)	ug/g	1100	50	1200	1200	50	940	50	6364557
Acid Extractable Potassium (K)	ug/g	690	200	760	730	200	680	200	6364557
Acid Extractable Selenium (Se)	ug/g	3.0	0.50	2.9	2.9	0.50	3.0	0.50	6364557
Acid Extractable Silver (Ag)	ug/g	0.23	0.20	0.22	0.20	0.20	0.20	0.20	6364557
Acid Extractable Sodium (Na)	ug/g	170	50	130	140	50	140	50	6364557
Acid Extractable Strontium (Sr)	ug/g	18	1.0	22	22	1.0	19	1.0	6364557
Acid Extractable Thallium (Tl)	ug/g	0.43	0.050	0.41	0.43	0.050	0.37	0.050	6364557
Acid Extractable Tin (Sn)	ug/g	3.5	1.0	3.2	3.5	1.0	3.5	1.0	6364557
Acid Extractable Uranium (U)	ug/g	4.5	0.050	4.3	4.2	0.050	4.3	0.050	6364557
Acid Extractable Vanadium (V)	ug/g	32	5.0	38	37	5.0	32	5.0	6364557
Acid Extractable Zinc (Zn)	ug/g	290	5.0	310	300	5.0	250	5.0	6364557
Acid Extractable Mercury (Hg)	ug/g	0.21	0.050	0.21	0.20	0.050	0.19	0.050	6364557

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate
ND = Not detected

BUREAU VERITAS

BV Labs Job #: B9R1693
Report Date: 2019/12/11

Minnow Environmental Inc
Client Project #: 19-41
Site Location: CYCLE 5 SRWMP
Sampler Initials: JT

ELEMENTS BY ATOMIC SPECTROSCOPY (SOIL)

BV Labs ID		KWZ276		
Sampling Date		2019/09/25		
COC Number		737959-01-01		
	UNITS	**SL-2019-5-C**	**RDL**	**QC Batch**
Metals				
Acid Extractable Aluminum (Al)	ug/g	15000	50	6364557
Acid Extractable Antimony (Sb)	ug/g	0.88	0.20	6364557
Acid Extractable Arsenic (As)	ug/g	18	1.0	6364557
Acid Extractable Barium (Ba)	ug/g	450	0.50	6364557
Acid Extractable Beryllium (Be)	ug/g	1.4	0.20	6364557
Acid Extractable Bismuth (Bi)	ug/g	ND	1.0	6364557
Acid Extractable Boron (B)	ug/g	ND	5.0	6364557
Acid Extractable Cadmium (Cd)	ug/g	2.5	0.10	6364557
Acid Extractable Calcium (Ca)	ug/g	3300	50	6364557
Acid Extractable Chromium (Cr)	ug/g	25	1.0	6364557
Acid Extractable Cobalt (Co)	ug/g	14	0.10	6364557
Acid Extractable Copper (Cu)	ug/g	53	0.50	6364557
Acid Extractable Iron (Fe)	ug/g	50000	50	6364557
Acid Extractable Lead (Pb)	ug/g	96	1.0	6364557
Acid Extractable Magnesium (Mg)	ug/g	2100	50	6364557
Acid Extractable Manganese (Mn)	ug/g	5800	5.0	6364557
Acid Extractable Molybdenum (Mo)	ug/g	4.1	0.50	6364557
Acid Extractable Nickel (Ni)	ug/g	26	0.50	6364557
Acid Extractable Phosphorus (P)	ug/g	1400	50	6364557
Acid Extractable Potassium (K)	ug/g	650	200	6364557
Acid Extractable Selenium (Se)	ug/g	3.0	0.50	6364557
Acid Extractable Silver (Ag)	ug/g	ND	0.20	6364557
Acid Extractable Sodium (Na)	ug/g	120	50	6364557
Acid Extractable Strontium (Sr)	ug/g	19	1.0	6364557
Acid Extractable Thallium (Tl)	ug/g	0.34	0.050	6364557
Acid Extractable Tin (Sn)	ug/g	2.7	1.0	6364557
Acid Extractable Uranium (U)	ug/g	4.6	0.050	6364557
Acid Extractable Vanadium (V)	ug/g	38	5.0	6364557
Acid Extractable Zinc (Zn)	ug/g	260	5.0	6364557
Acid Extractable Mercury (Hg)	ug/g	0.18	0.050	6364557

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
ND = Not detected

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	9.3°C
Package 2	9.7°C
Package 3	8.7°C
Package 4	9.7°C

Results relate only to the items tested.

Bureau Veritas Laboratories 6740 Campobello Road, Mississauga, Ontario, L5N 2L8 Tel: (905) 817-5700 Toll-Free: 800-563-6266 Fax: (905) 817-5777 www.bvlabs.com

BUREAU VERITAS

BV Labs Job #: B9R1693
Report Date: 2019/12/11

Minnow Environmental Inc
Client Project #: 19-41
Site Location: CYCLE 5 SRWMP
Sampler Initials: JT

QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
6360069	KJP	RPD	Moisture	2019/09/30	0		%	20
6360148	KJP	RPD	Moisture	2019/09/30	0.63		%	20
6360261	KJP	RPD	Moisture	2019/09/30	2.0		%	20
6360284	JMP	RPD	Moisture	2019/09/30	7.8		%	20
6360345	KJP	RPD	Moisture	2019/09/30	1.8		%	20
6364418	DM1	QC Standard	Total Organic Carbon	2019/10/02		108	%	75 - 125
6364418	DM1	Method Blank	Total Organic Carbon	2019/10/02	ND, RDL=500		mg/kg	
6364418	DM1	RPD [KWZ048-01]	Total Organic Carbon	2019/10/02	0.52		%	35
6364450	DM1	QC Standard	Total Organic Carbon	2019/10/02		105	%	75 - 125
6364450	DM1	Method Blank	Total Organic Carbon	2019/10/02	ND, RDL=500		mg/kg	
6364450	DM1	RPD [KWZ022-01]	Total Organic Carbon	2019/10/02	0.12		%	35
6364474	DM1	QC Standard	Total Organic Carbon	2019/10/02		108	%	75 - 125
6364474	DM1	Method Blank	Total Organic Carbon	2019/10/02	ND, RDL=500		mg/kg	
6364474	DM1	RPD [KWZ179-01]	Total Organic Carbon	2019/10/02	12		%	35
6364529	DT1	Matrix Spike	Acid Extractable Aluminum (Al)	2019/10/02		NC	%	75 - 125
			Acid Extractable Antimony (Sb)	2019/10/02		99	%	75 - 125
			Acid Extractable Arsenic (As)	2019/10/02		103	%	75 - 125
			Acid Extractable Barium (Ba)	2019/10/02		101	%	75 - 125
			Acid Extractable Beryllium (Be)	2019/10/02		100	%	75 - 125
			Acid Extractable Bismuth (Bi)	2019/10/02		96	%	75 - 125
			Acid Extractable Boron (B)	2019/10/02		95	%	75 - 125
			Acid Extractable Cadmium (Cd)	2019/10/02		98	%	75 - 125
			Acid Extractable Calcium (Ca)	2019/10/02		NC	%	75 - 125
			Acid Extractable Chromium (Cr)	2019/10/02		103	%	75 - 125
			Acid Extractable Cobalt (Co)	2019/10/02		96	%	75 - 125
			Acid Extractable Copper (Cu)	2019/10/02		101	%	75 - 125
			Acid Extractable Iron (Fe)	2019/10/02		NC	%	75 - 125
			Acid Extractable Lead (Pb)	2019/10/02		99	%	75 - 125
			Acid Extractable Magnesium (Mg)	2019/10/02		NC	%	75 - 125
			Acid Extractable Manganese (Mn)	2019/10/02		NC	%	75 - 125
			Acid Extractable Molybdenum (Mo)	2019/10/02		102	%	75 - 125
			Acid Extractable Nickel (Ni)	2019/10/02		101	%	75 - 125
			Acid Extractable Phosphorus (P)	2019/10/02		NC	%	75 - 125
			Acid Extractable Potassium (K)	2019/10/02		NC	%	75 - 125
			Acid Extractable Selenium (Se)	2019/10/02		101	%	75 - 125
			Acid Extractable Silver (Ag)	2019/10/02		91	%	75 - 125
			Acid Extractable Sodium (Na)	2019/10/02		101	%	75 - 125
			Acid Extractable Strontium (Sr)	2019/10/02		NC	%	75 - 125
			Acid Extractable Thallium (Tl)	2019/10/02		98	%	75 - 125
			Acid Extractable Tin (Sn)	2019/10/02		100	%	75 - 125
			Acid Extractable Uranium (U)	2019/10/02		99	%	75 - 125
			Acid Extractable Vanadium (V)	2019/10/02		102	%	75 - 125
			Acid Extractable Zinc (Zn)	2019/10/02		93	%	75 - 125
			Acid Extractable Mercury (Hg)	2019/10/02		89	%	75 - 125
6364529	DT1	Spiked Blank	Acid Extractable Aluminum (Al)	2019/10/02		97	%	80 - 120
			Acid Extractable Antimony (Sb)	2019/10/02		103	%	80 - 120
			Acid Extractable Arsenic (As)	2019/10/02		102	%	80 - 120
			Acid Extractable Barium (Ba)	2019/10/02		101	%	80 - 120

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Acid Extractable Beryllium (Be)	2019/10/02		99	%	80 - 120
			Acid Extractable Bismuth (Bi)	2019/10/02		97	%	80 - 120
			Acid Extractable Boron (B)	2019/10/02		99	%	80 - 120
			Acid Extractable Cadmium (Cd)	2019/10/02		101	%	80 - 120
			Acid Extractable Calcium (Ca)	2019/10/02		104	%	80 - 120
			Acid Extractable Chromium (Cr)	2019/10/02		95	%	80 - 120
			Acid Extractable Cobalt (Co)	2019/10/02		100	%	80 - 120
			Acid Extractable Copper (Cu)	2019/10/02		98	%	80 - 120
			Acid Extractable Iron (Fe)	2019/10/02		101	%	80 - 120
			Acid Extractable Lead (Pb)	2019/10/02		98	%	80 - 120
			Acid Extractable Magnesium (Mg)	2019/10/02		96	%	80 - 120
			Acid Extractable Manganese (Mn)	2019/10/02		100	%	80 - 120
			Acid Extractable Molybdenum (Mo)	2019/10/02		100	%	80 - 120
			Acid Extractable Nickel (Ni)	2019/10/02		98	%	80 - 120
			Acid Extractable Phosphorus (P)	2019/10/02		98	%	80 - 120
			Acid Extractable Potassium (K)	2019/10/02		92	%	80 - 120
			Acid Extractable Selenium (Se)	2019/10/02		98	%	80 - 120
			Acid Extractable Silver (Ag)	2019/10/02		100	%	80 - 120
			Acid Extractable Sodium (Na)	2019/10/02		93	%	80 - 120
			Acid Extractable Strontium (Sr)	2019/10/02		105	%	80 - 120
			Acid Extractable Thallium (Tl)	2019/10/02		95	%	80 - 120
			Acid Extractable Tin (Sn)	2019/10/02		103	%	80 - 120
			Acid Extractable Uranium (U)	2019/10/02		96	%	80 - 120
			Acid Extractable Vanadium (V)	2019/10/02		97	%	80 - 120
			Acid Extractable Zinc (Zn)	2019/10/02		100	%	80 - 120
			Acid Extractable Mercury (Hg)	2019/10/02		85	%	80 - 120
6364529	DT1	Method Blank	Acid Extractable Aluminum (Al)	2019/10/02	ND, RDL=50		ug/g	
			Acid Extractable Antimony (Sb)	2019/10/02	ND, RDL=0.20		ug/g	
			Acid Extractable Arsenic (As)	2019/10/02	ND, RDL=1.0		ug/g	
			Acid Extractable Barium (Ba)	2019/10/02	ND, RDL=0.50		ug/g	
			Acid Extractable Beryllium (Be)	2019/10/02	ND, RDL=0.20		ug/g	
			Acid Extractable Bismuth (Bi)	2019/10/02	ND, RDL=1.0		ug/g	
			Acid Extractable Boron (B)	2019/10/02	ND, RDL=5.0		ug/g	
			Acid Extractable Cadmium (Cd)	2019/10/02	ND, RDL=0.10		ug/g	
			Acid Extractable Calcium (Ca)	2019/10/02	ND, RDL=50		ug/g	
			Acid Extractable Chromium (Cr)	2019/10/02	ND, RDL=1.0		ug/g	
			Acid Extractable Cobalt (Co)	2019/10/02	ND, RDL=0.10		ug/g	
			Acid Extractable Copper (Cu)	2019/10/02	ND, RDL=0.50		ug/g	
			Acid Extractable Iron (Fe)	2019/10/02	ND, RDL=50		ug/g	

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Acid Extractable Lead (Pb)	2019/10/02	ND, RDL=1.0		ug/g	
			Acid Extractable Magnesium (Mg)	2019/10/02	ND, RDL=50		ug/g	
			Acid Extractable Manganese (Mn)	2019/10/02	ND, RDL=1.0		ug/g	
			Acid Extractable Molybdenum (Mo)	2019/10/02	ND, RDL=0.50		ug/g	
			Acid Extractable Nickel (Ni)	2019/10/02	ND, RDL=0.50		ug/g	
			Acid Extractable Phosphorus (P)	2019/10/02	ND, RDL=50		ug/g	
			Acid Extractable Potassium (K)	2019/10/02	ND, RDL=200		ug/g	
			Acid Extractable Selenium (Se)	2019/10/02	ND, RDL=0.50		ug/g	
			Acid Extractable Silver (Ag)	2019/10/02	ND, RDL=0.20		ug/g	
			Acid Extractable Sodium (Na)	2019/10/02	ND, RDL=50		ug/g	
			Acid Extractable Strontium (Sr)	2019/10/02	ND, RDL=1.0		ug/g	
			Acid Extractable Thallium (Tl)	2019/10/02	ND, RDL=0.050		ug/g	
			Acid Extractable Tin (Sn)	2019/10/02	ND, RDL=1.0		ug/g	
			Acid Extractable Uranium (U)	2019/10/02	ND, RDL=0.050		ug/g	
			Acid Extractable Vanadium (V)	2019/10/02	ND, RDL=5.0		ug/g	
			Acid Extractable Zinc (Zn)	2019/10/02	ND, RDL=5.0		ug/g	
			Acid Extractable Mercury (Hg)	2019/10/02	ND, RDL=0.050		ug/g	
6364529	DT1	RPD	Acid Extractable Antimony (Sb)	2019/10/02	NC		%	30
			Acid Extractable Arsenic (As)	2019/10/02	0.60		%	30
			Acid Extractable Barium (Ba)	2019/10/02	2.5		%	30
			Acid Extractable Beryllium (Be)	2019/10/02	NC		%	30
			Acid Extractable Boron (B)	2019/10/02	NC		%	30
			Acid Extractable Cadmium (Cd)	2019/10/02	113 (1)		%	30
			Acid Extractable Chromium (Cr)	2019/10/02	14		%	30
			Acid Extractable Cobalt (Co)	2019/10/02	29		%	30
			Acid Extractable Copper (Cu)	2019/10/02	25		%	30
			Acid Extractable Lead (Pb)	2019/10/02	5.3		%	30
			Acid Extractable Molybdenum (Mo)	2019/10/02	NC		%	30
			Acid Extractable Nickel (Ni)	2019/10/02	11		%	30
			Acid Extractable Selenium (Se)	2019/10/02	NC		%	30
			Acid Extractable Silver (Ag)	2019/10/02	91 (1)		%	30
			Acid Extractable Thallium (Tl)	2019/10/02	NC		%	30
			Acid Extractable Uranium (U)	2019/10/02	9.1		%	30
			Acid Extractable Vanadium (V)	2019/10/02	8.5		%	30
			Acid Extractable Zinc (Zn)	2019/10/02	17		%	30

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Acid Extractable Mercury (Hg)	2019/10/02	NC		%	30
6364557	DT1	Matrix Spike [KWZ274-01]	Acid Extractable Aluminum (Al)	2019/10/02		NC	%	75 - 125
			Acid Extractable Antimony (Sb)	2019/10/02		90	%	75 - 125
			Acid Extractable Arsenic (As)	2019/10/02		NC	%	75 - 125
			Acid Extractable Barium (Ba)	2019/10/02		NC	%	75 - 125
			Acid Extractable Beryllium (Be)	2019/10/02		106	%	75 - 125
			Acid Extractable Bismuth (Bi)	2019/10/02		103	%	75 - 125
			Acid Extractable Boron (B)	2019/10/02		102	%	75 - 125
			Acid Extractable Cadmium (Cd)	2019/10/02		105	%	75 - 125
			Acid Extractable Calcium (Ca)	2019/10/02		NC	%	75 - 125
			Acid Extractable Chromium (Cr)	2019/10/02		110	%	75 - 125
			Acid Extractable Cobalt (Co)	2019/10/02		106	%	75 - 125
			Acid Extractable Copper (Cu)	2019/10/02		NC	%	75 - 125
			Acid Extractable Iron (Fe)	2019/10/02		NC	%	75 - 125
			Acid Extractable Lead (Pb)	2019/10/02		NC	%	75 - 125
			Acid Extractable Magnesium (Mg)	2019/10/02		NC	%	75 - 125
			Acid Extractable Manganese (Mn)	2019/10/02		NC	%	75 - 125
			Acid Extractable Molybdenum (Mo)	2019/10/02		105	%	75 - 125
			Acid Extractable Nickel (Ni)	2019/10/02		NC	%	75 - 125
			Acid Extractable Phosphorus (P)	2019/10/02		NC	%	75 - 125
			Acid Extractable Potassium (K)	2019/10/02		NC	%	75 - 125
			Acid Extractable Selenium (Se)	2019/10/02		109	%	75 - 125
			Acid Extractable Silver (Ag)	2019/10/02		107	%	75 - 125
			Acid Extractable Sodium (Na)	2019/10/02		111	%	75 - 125
			Acid Extractable Strontium (Sr)	2019/10/02		111	%	75 - 125
			Acid Extractable Thallium (Tl)	2019/10/02		106	%	75 - 125
			Acid Extractable Tin (Sn)	2019/10/02		101	%	75 - 125
			Acid Extractable Uranium (U)	2019/10/02		108	%	75 - 125
			Acid Extractable Vanadium (V)	2019/10/02		NC	%	75 - 125
			Acid Extractable Zinc (Zn)	2019/10/02		NC	%	75 - 125
			Acid Extractable Mercury (Hg)	2019/10/02		100	%	75 - 125
6364557	DT1	Spiked Blank	Acid Extractable Aluminum (Al)	2019/10/02		102	%	80 - 120
			Acid Extractable Antimony (Sb)	2019/10/02		97	%	80 - 120
			Acid Extractable Arsenic (As)	2019/10/02		100	%	80 - 120
			Acid Extractable Barium (Ba)	2019/10/02		99	%	80 - 120
			Acid Extractable Beryllium (Be)	2019/10/02		100	%	80 - 120
			Acid Extractable Bismuth (Bi)	2019/10/02		100	%	80 - 120
			Acid Extractable Boron (B)	2019/10/02		101	%	80 - 120
			Acid Extractable Cadmium (Cd)	2019/10/02		99	%	80 - 120
			Acid Extractable Calcium (Ca)	2019/10/02		106	%	80 - 120
			Acid Extractable Chromium (Cr)	2019/10/02		101	%	80 - 120
			Acid Extractable Cobalt (Co)	2019/10/02		101	%	80 - 120
			Acid Extractable Copper (Cu)	2019/10/02		102	%	80 - 120
			Acid Extractable Iron (Fe)	2019/10/02		103	%	80 - 120
			Acid Extractable Lead (Pb)	2019/10/02		103	%	80 - 120
			Acid Extractable Magnesium (Mg)	2019/10/02		108	%	80 - 120
			Acid Extractable Manganese (Mn)	2019/10/02		100	%	80 - 120
			Acid Extractable Molybdenum (Mo)	2019/10/02		99	%	80 - 120
			Acid Extractable Nickel (Ni)	2019/10/02		101	%	80 - 120
			Acid Extractable Phosphorus (P)	2019/10/02		106	%	80 - 120

BUREAU VERITAS

BV Labs Job #: B9R1693
Report Date: 2019/12/11

Minnow Environmental Inc
Client Project #: 19-41
Site Location: CYCLE 5 SRWMP
Sampler Initials: JT

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Acid Extractable Potassium (K)	2019/10/02		98	%	80 - 120
			Acid Extractable Selenium (Se)	2019/10/02		103	%	80 - 120
			Acid Extractable Silver (Ag)	2019/10/02		101	%	80 - 120
			Acid Extractable Sodium (Na)	2019/10/02		103	%	80 - 120
			Acid Extractable Strontium (Sr)	2019/10/02		102	%	80 - 120
			Acid Extractable Thallium (Tl)	2019/10/02		102	%	80 - 120
			Acid Extractable Tin (Sn)	2019/10/02		96	%	80 - 120
			Acid Extractable Uranium (U)	2019/10/02		101	%	80 - 120
			Acid Extractable Vanadium (V)	2019/10/02		101	%	80 - 120
			Acid Extractable Zinc (Zn)	2019/10/02		112	%	80 - 120
			Acid Extractable Mercury (Hg)	2019/10/02		91	%	80 - 120
6364557	DT1	Method Blank	Acid Extractable Aluminum (Al)	2019/10/02	ND, RDL=50		ug/g	
			Acid Extractable Antimony (Sb)	2019/10/02	ND, RDL=0.20		ug/g	
			Acid Extractable Arsenic (As)	2019/10/02	ND, RDL=1.0		ug/g	
			Acid Extractable Barium (Ba)	2019/10/02	ND, RDL=0.50		ug/g	
			Acid Extractable Beryllium (Be)	2019/10/02	ND, RDL=0.20		ug/g	
			Acid Extractable Bismuth (Bi)	2019/10/02	ND, RDL=1.0		ug/g	
			Acid Extractable Boron (B)	2019/10/02	ND, RDL=5.0		ug/g	
			Acid Extractable Cadmium (Cd)	2019/10/02	ND, RDL=0.10		ug/g	
			Acid Extractable Calcium (Ca)	2019/10/02	ND, RDL=50		ug/g	
			Acid Extractable Chromium (Cr)	2019/10/02	ND, RDL=1.0		ug/g	
			Acid Extractable Cobalt (Co)	2019/10/02	ND, RDL=0.10		ug/g	
			Acid Extractable Copper (Cu)	2019/10/02	ND, RDL=0.50		ug/g	
			Acid Extractable Iron (Fe)	2019/10/02	ND, RDL=50		ug/g	
			Acid Extractable Lead (Pb)	2019/10/02	ND, RDL=1.0		ug/g	
			Acid Extractable Magnesium (Mg)	2019/10/02	ND, RDL=50		ug/g	
			Acid Extractable Manganese (Mn)	2019/10/02	ND, RDL=1.0		ug/g	
			Acid Extractable Molybdenum (Mo)	2019/10/02	ND, RDL=0.50		ug/g	
			Acid Extractable Nickel (Ni)	2019/10/02	ND, RDL=0.50		ug/g	
			Acid Extractable Phosphorus (P)	2019/10/02	ND, RDL=50		ug/g	
			Acid Extractable Potassium (K)	2019/10/02	ND, RDL=200		ug/g	

Bureau Veritas Laboratories 6740 Campobello Road, Mississauga, Ontario, L5N 2L8 Tel: (905) 817-5700 Toll-Free: 800-563-6266 Fax: (905) 817-5777 www.bvlabs.com

Microbiology testing is conducted at 6660 Campobello Rd. Chemistry testing is conducted at 6740 Campobello Rd.

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QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Acid Extractable Selenium (Se)	2019/10/02	ND, RDL=0.50		ug/g	
			Acid Extractable Silver (Ag)	2019/10/02	ND, RDL=0.20		ug/g	
			Acid Extractable Sodium (Na)	2019/10/02	ND, RDL=50		ug/g	
			Acid Extractable Strontium (Sr)	2019/10/02	ND, RDL=1.0		ug/g	
			Acid Extractable Thallium (Tl)	2019/10/02	ND, RDL=0.050		ug/g	
			Acid Extractable Tin (Sn)	2019/10/02	ND, RDL=1.0		ug/g	
			Acid Extractable Uranium (U)	2019/10/02	ND, RDL=0.050		ug/g	
			Acid Extractable Vanadium (V)	2019/10/02	ND, RDL=5.0		ug/g	
			Acid Extractable Zinc (Zn)	2019/10/02	ND, RDL=5.0		ug/g	
			Acid Extractable Mercury (Hg)	2019/10/02	ND, RDL=0.050		ug/g	
6364557	DT1	RPD [KWZ274-01]	Acid Extractable Aluminum (Al)	2019/10/02	0.029		%	30
			Acid Extractable Antimony (Sb)	2019/10/02	7.9		%	30
			Acid Extractable Arsenic (As)	2019/10/02	4.3		%	30
			Acid Extractable Barium (Ba)	2019/10/02	4.4		%	30
			Acid Extractable Beryllium (Be)	2019/10/02	2.3		%	30
			Acid Extractable Bismuth (Bi)	2019/10/02	NC		%	30
			Acid Extractable Boron (B)	2019/10/02	NC		%	30
			Acid Extractable Cadmium (Cd)	2019/10/02	1.8		%	30
			Acid Extractable Calcium (Ca)	2019/10/02	1.7		%	30
			Acid Extractable Chromium (Cr)	2019/10/02	3.6		%	30
			Acid Extractable Cobalt (Co)	2019/10/02	4.1		%	30
			Acid Extractable Copper (Cu)	2019/10/02	3.5		%	30
			Acid Extractable Iron (Fe)	2019/10/02	2.8		%	30
			Acid Extractable Lead (Pb)	2019/10/02	3.2		%	30
			Acid Extractable Magnesium (Mg)	2019/10/02	0.55		%	30
			Acid Extractable Manganese (Mn)	2019/10/02	5.4		%	30
			Acid Extractable Molybdenum (Mo)	2019/10/02	2.0		%	30
			Acid Extractable Nickel (Ni)	2019/10/02	3.4		%	30
			Acid Extractable Phosphorus (P)	2019/10/02	1.6		%	30
			Acid Extractable Potassium (K)	2019/10/02	4.3		%	30
			Acid Extractable Selenium (Se)	2019/10/02	1.1		%	30
			Acid Extractable Silver (Ag)	2019/10/02	6.5		%	30
			Acid Extractable Sodium (Na)	2019/10/02	1.3		%	30
			Acid Extractable Strontium (Sr)	2019/10/02	0.57		%	30
			Acid Extractable Thallium (Tl)	2019/10/02	4.7		%	30
			Acid Extractable Tin (Sn)	2019/10/02	10		%	30
			Acid Extractable Uranium (U)	2019/10/02	2.8		%	30
			Acid Extractable Vanadium (V)	2019/10/02	3.3		%	30
			Acid Extractable Zinc (Zn)	2019/10/02	1.9		%	30
			Acid Extractable Mercury (Hg)	2019/10/02	1.6		%	30
6364560	DT1	Matrix Spike	Acid Extractable Aluminum (Al)	2019/10/02		NC	%	75 - 125
			Acid Extractable Antimony (Sb)	2019/10/02		100	%	75 - 125

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QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Acid Extractable Arsenic (As)	2019/10/02		111	%	75 - 125
			Acid Extractable Barium (Ba)	2019/10/02		NC	%	75 - 125
			Acid Extractable Beryllium (Be)	2019/10/02		110	%	75 - 125
			Acid Extractable Bismuth (Bi)	2019/10/02		107	%	75 - 125
			Acid Extractable Boron (B)	2019/10/02		101	%	75 - 125
			Acid Extractable Cadmium (Cd)	2019/10/02		110	%	75 - 125
			Acid Extractable Calcium (Ca)	2019/10/02		NC	%	75 - 125
			Acid Extractable Chromium (Cr)	2019/10/02		114	%	75 - 125
			Acid Extractable Cobalt (Co)	2019/10/02		109	%	75 - 125
			Acid Extractable Copper (Cu)	2019/10/02		109	%	75 - 125
			Acid Extractable Iron (Fe)	2019/10/02		NC	%	75 - 125
			Acid Extractable Lead (Pb)	2019/10/02		112	%	75 - 125
			Acid Extractable Magnesium (Mg)	2019/10/02		NC	%	75 - 125
			Acid Extractable Manganese (Mn)	2019/10/02		NC	%	75 - 125
			Acid Extractable Molybdenum (Mo)	2019/10/02		111	%	75 - 125
			Acid Extractable Nickel (Ni)	2019/10/02		103	%	75 - 125
			Acid Extractable Phosphorus (P)	2019/10/02		NC	%	75 - 125
			Acid Extractable Potassium (K)	2019/10/02		NC	%	75 - 125
			Acid Extractable Selenium (Se)	2019/10/02		107	%	75 - 125
			Acid Extractable Silver (Ag)	2019/10/02		113	%	75 - 125
			Acid Extractable Sodium (Na)	2019/10/02		108	%	75 - 125
			Acid Extractable Strontium (Sr)	2019/10/02		118	%	75 - 125
			Acid Extractable Thallium (Tl)	2019/10/02		108	%	75 - 125
			Acid Extractable Tin (Sn)	2019/10/02		117	%	75 - 125
			Acid Extractable Uranium (U)	2019/10/02		110	%	75 - 125
			Acid Extractable Vanadium (V)	2019/10/02		NC	%	75 - 125
			Acid Extractable Zinc (Zn)	2019/10/02		NC	%	75 - 125
			Acid Extractable Mercury (Hg)	2019/10/02		93	%	75 - 125
6364560	DT1	Spiked Blank	Acid Extractable Aluminum (Al)	2019/10/02		99	%	80 - 120
			Acid Extractable Antimony (Sb)	2019/10/02		99	%	80 - 120
			Acid Extractable Arsenic (As)	2019/10/02		99	%	80 - 120
			Acid Extractable Barium (Ba)	2019/10/02		98	%	80 - 120
			Acid Extractable Beryllium (Be)	2019/10/02		97	%	80 - 120
			Acid Extractable Bismuth (Bi)	2019/10/02		98	%	80 - 120
			Acid Extractable Boron (B)	2019/10/02		100	%	80 - 120
			Acid Extractable Cadmium (Cd)	2019/10/02		96	%	80 - 120
			Acid Extractable Calcium (Ca)	2019/10/02		104	%	80 - 120
			Acid Extractable Chromium (Cr)	2019/10/02		95	%	80 - 120
			Acid Extractable Cobalt (Co)	2019/10/02		97	%	80 - 120
			Acid Extractable Copper (Cu)	2019/10/02		97	%	80 - 120
			Acid Extractable Iron (Fe)	2019/10/02		99	%	80 - 120
			Acid Extractable Lead (Pb)	2019/10/02		99	%	80 - 120
			Acid Extractable Magnesium (Mg)	2019/10/02		87	%	80 - 120
			Acid Extractable Manganese (Mn)	2019/10/02		97	%	80 - 120
			Acid Extractable Molybdenum (Mo)	2019/10/02		98	%	80 - 120
			Acid Extractable Nickel (Ni)	2019/10/02		96	%	80 - 120
			Acid Extractable Phosphorus (P)	2019/10/02		98	%	80 - 120
			Acid Extractable Potassium (K)	2019/10/02		92	%	80 - 120
			Acid Extractable Selenium (Se)	2019/10/02		98	%	80 - 120
			Acid Extractable Silver (Ag)	2019/10/02		99	%	80 - 120
			Acid Extractable Sodium (Na)	2019/10/02		94	%	80 - 120

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QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Acid Extractable Strontium (Sr)	2019/10/02		96	%	80 - 120
			Acid Extractable Thallium (Tl)	2019/10/02		98	%	80 - 120
			Acid Extractable Tin (Sn)	2019/10/02		101	%	80 - 120
			Acid Extractable Uranium (U)	2019/10/02		99	%	80 - 120
			Acid Extractable Vanadium (V)	2019/10/02		97	%	80 - 120
			Acid Extractable Zinc (Zn)	2019/10/02		88	%	80 - 120
			Acid Extractable Mercury (Hg)	2019/10/02		85	%	80 - 120
6364560	DT1	Method Blank	Acid Extractable Aluminum (Al)	2019/10/02	ND, RDL=50		ug/g	
			Acid Extractable Antimony (Sb)	2019/10/02	ND, RDL=0.20		ug/g	
			Acid Extractable Arsenic (As)	2019/10/02	ND, RDL=1.0		ug/g	
			Acid Extractable Barium (Ba)	2019/10/02	ND, RDL=0.50		ug/g	
			Acid Extractable Beryllium (Be)	2019/10/02	ND, RDL=0.20		ug/g	
			Acid Extractable Bismuth (Bi)	2019/10/02	ND, RDL=1.0		ug/g	
			Acid Extractable Boron (B)	2019/10/02	ND, RDL=5.0		ug/g	
			Acid Extractable Cadmium (Cd)	2019/10/02	ND, RDL=0.10		ug/g	
			Acid Extractable Calcium (Ca)	2019/10/02	ND, RDL=50		ug/g	
			Acid Extractable Chromium (Cr)	2019/10/02	ND, RDL=1.0		ug/g	
			Acid Extractable Cobalt (Co)	2019/10/02	ND, RDL=0.10		ug/g	
			Acid Extractable Copper (Cu)	2019/10/02	ND, RDL=0.50		ug/g	
			Acid Extractable Iron (Fe)	2019/10/02	ND, RDL=50		ug/g	
			Acid Extractable Lead (Pb)	2019/10/02	ND, RDL=1.0		ug/g	
			Acid Extractable Magnesium (Mg)	2019/10/02	ND, RDL=50		ug/g	
			Acid Extractable Manganese (Mn)	2019/10/02	ND, RDL=1.0		ug/g	
			Acid Extractable Molybdenum (Mo)	2019/10/02	ND, RDL=0.50		ug/g	
			Acid Extractable Nickel (Ni)	2019/10/02	ND, RDL=0.50		ug/g	
			Acid Extractable Phosphorus (P)	2019/10/02	ND, RDL=50		ug/g	
			Acid Extractable Potassium (K)	2019/10/02	ND, RDL=200		ug/g	
			Acid Extractable Selenium (Se)	2019/10/02	ND, RDL=0.50		ug/g	
			Acid Extractable Silver (Ag)	2019/10/02	ND, RDL=0.20		ug/g	

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Acid Extractable Sodium (Na)	2019/10/02	ND, RDL=50		ug/g	
			Acid Extractable Strontium (Sr)	2019/10/02	ND, RDL=1.0		ug/g	
			Acid Extractable Thallium (Tl)	2019/10/02	ND, RDL=0.050		ug/g	
			Acid Extractable Tin (Sn)	2019/10/02	ND, RDL=1.0		ug/g	
			Acid Extractable Uranium (U)	2019/10/02	ND, RDL=0.050		ug/g	
			Acid Extractable Vanadium (V)	2019/10/02	ND, RDL=5.0		ug/g	
			Acid Extractable Zinc (Zn)	2019/10/02	ND, RDL=5.0		ug/g	
			Acid Extractable Mercury (Hg)	2019/10/02	ND, RDL=0.050		ug/g	
6364560	DT1	RPD	Acid Extractable Antimony (Sb)	2019/10/02	NC		%	30
			Acid Extractable Arsenic (As)	2019/10/02	5.4		%	30
			Acid Extractable Barium (Ba)	2019/10/02	2.8		%	30
			Acid Extractable Beryllium (Be)	2019/10/02	1.8		%	30
			Acid Extractable Boron (B)	2019/10/02	4.5		%	30
			Acid Extractable Cadmium (Cd)	2019/10/02	6.0		%	30
			Acid Extractable Chromium (Cr)	2019/10/02	2.2		%	30
			Acid Extractable Cobalt (Co)	2019/10/02	3.1		%	30
			Acid Extractable Copper (Cu)	2019/10/02	1.9		%	30
			Acid Extractable Lead (Pb)	2019/10/02	2.6		%	30
			Acid Extractable Molybdenum (Mo)	2019/10/02	NC		%	30
			Acid Extractable Nickel (Ni)	2019/10/02	5.2		%	30
			Acid Extractable Selenium (Se)	2019/10/02	NC		%	30
			Acid Extractable Silver (Ag)	2019/10/02	NC		%	30
			Acid Extractable Thallium (Tl)	2019/10/02	0.92		%	30
			Acid Extractable Uranium (U)	2019/10/02	5.9		%	30
			Acid Extractable Vanadium (V)	2019/10/02	2.9		%	30
			Acid Extractable Zinc (Zn)	2019/10/02	4.1		%	30
			Acid Extractable Mercury (Hg)	2019/10/02	NC		%	30
6364581	DT1	Matrix Spike [KWZ239-01]	Acid Extractable Aluminum (Al)	2019/10/02		NC	%	75 - 125
			Acid Extractable Antimony (Sb)	2019/10/02		92	%	75 - 125
			Acid Extractable Arsenic (As)	2019/10/02		100	%	75 - 125
			Acid Extractable Barium (Ba)	2019/10/02		NC	%	75 - 125
			Acid Extractable Beryllium (Be)	2019/10/02		97	%	75 - 125
			Acid Extractable Bismuth (Bi)	2019/10/02		99	%	75 - 125
			Acid Extractable Boron (B)	2019/10/02		93	%	75 - 125
			Acid Extractable Cadmium (Cd)	2019/10/02		100	%	75 - 125
			Acid Extractable Calcium (Ca)	2019/10/02		NC	%	75 - 125
			Acid Extractable Chromium (Cr)	2019/10/02		101	%	75 - 125
			Acid Extractable Cobalt (Co)	2019/10/02		102	%	75 - 125
			Acid Extractable Copper (Cu)	2019/10/02		102	%	75 - 125
			Acid Extractable Iron (Fe)	2019/10/02		NC	%	75 - 125
			Acid Extractable Lead (Pb)	2019/10/02		NC	%	75 - 125
			Acid Extractable Magnesium (Mg)	2019/10/02		NC	%	75 - 125
			Acid Extractable Manganese (Mn)	2019/10/02		NC	%	75 - 125

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Acid Extractable Molybdenum (Mo)	2019/10/02		98	%	75 - 125
			Acid Extractable Nickel (Ni)	2019/10/02		101	%	75 - 125
			Acid Extractable Phosphorus (P)	2019/10/02		NC	%	75 - 125
			Acid Extractable Potassium (K)	2019/10/02		NC	%	75 - 125
			Acid Extractable Selenium (Se)	2019/10/02		100	%	75 - 125
			Acid Extractable Silver (Ag)	2019/10/02		99	%	75 - 125
			Acid Extractable Sodium (Na)	2019/10/02		103	%	75 - 125
			Acid Extractable Strontium (Sr)	2019/10/02		103	%	75 - 125
			Acid Extractable Thallium (Tl)	2019/10/02		101	%	75 - 125
			Acid Extractable Tin (Sn)	2019/10/02		97	%	75 - 125
			Acid Extractable Uranium (U)	2019/10/02		102	%	75 - 125
			Acid Extractable Vanadium (V)	2019/10/02		99	%	75 - 125
			Acid Extractable Zinc (Zn)	2019/10/02		NC	%	75 - 125
			Acid Extractable Mercury (Hg)	2019/10/02		96	%	75 - 125
6364581	DT1	Spiked Blank	Acid Extractable Aluminum (Al)	2019/10/02		97	%	80 - 120
			Acid Extractable Antimony (Sb)	2019/10/02		96	%	80 - 120
			Acid Extractable Arsenic (As)	2019/10/02		102	%	80 - 120
			Acid Extractable Barium (Ba)	2019/10/02		98	%	80 - 120
			Acid Extractable Beryllium (Be)	2019/10/02		98	%	80 - 120
			Acid Extractable Bismuth (Bi)	2019/10/02		99	%	80 - 120
			Acid Extractable Boron (B)	2019/10/02		96	%	80 - 120
			Acid Extractable Cadmium (Cd)	2019/10/02		95	%	80 - 120
			Acid Extractable Calcium (Ca)	2019/10/02		101	%	80 - 120
			Acid Extractable Chromium (Cr)	2019/10/02		98	%	80 - 120
			Acid Extractable Cobalt (Co)	2019/10/02		100	%	80 - 120
			Acid Extractable Copper (Cu)	2019/10/02		97	%	80 - 120
			Acid Extractable Iron (Fe)	2019/10/02		101	%	80 - 120
			Acid Extractable Lead (Pb)	2019/10/02		100	%	80 - 120
			Acid Extractable Magnesium (Mg)	2019/10/02		97	%	80 - 120
			Acid Extractable Manganese (Mn)	2019/10/02		100	%	80 - 120
			Acid Extractable Molybdenum (Mo)	2019/10/02		97	%	80 - 120
			Acid Extractable Nickel (Ni)	2019/10/02		102	%	80 - 120
			Acid Extractable Phosphorus (P)	2019/10/02		102	%	80 - 120
			Acid Extractable Potassium (K)	2019/10/02		99	%	80 - 120
			Acid Extractable Selenium (Se)	2019/10/02		100	%	80 - 120
			Acid Extractable Silver (Ag)	2019/10/02		101	%	80 - 120
			Acid Extractable Sodium (Na)	2019/10/02		100	%	80 - 120
			Acid Extractable Strontium (Sr)	2019/10/02		100	%	80 - 120
			Acid Extractable Thallium (Tl)	2019/10/02		100	%	80 - 120
			Acid Extractable Tin (Sn)	2019/10/02		94	%	80 - 120
			Acid Extractable Uranium (U)	2019/10/02		99	%	80 - 120
			Acid Extractable Vanadium (V)	2019/10/02		100	%	80 - 120
			Acid Extractable Zinc (Zn)	2019/10/02		100	%	80 - 120
			Acid Extractable Mercury (Hg)	2019/10/02		91	%	80 - 120
6364581	DT1	Method Blank	Acid Extractable Aluminum (Al)	2019/10/02	ND, RDL=50		ug/g	
			Acid Extractable Antimony (Sb)	2019/10/02	ND, RDL=0.20		ug/g	
			Acid Extractable Arsenic (As)	2019/10/02	ND, RDL=1.0		ug/g	

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Acid Extractable Barium (Ba)	2019/10/02	ND, RDL=0.50		ug/g	
			Acid Extractable Beryllium (Be)	2019/10/02	ND, RDL=0.20		ug/g	
			Acid Extractable Bismuth (Bi)	2019/10/02	ND, RDL=1.0		ug/g	
			Acid Extractable Boron (B)	2019/10/02	ND, RDL=5.0		ug/g	
			Acid Extractable Cadmium (Cd)	2019/10/02	ND, RDL=0.10		ug/g	
			Acid Extractable Calcium (Ca)	2019/10/02	ND, RDL=50		ug/g	
			Acid Extractable Chromium (Cr)	2019/10/02	ND, RDL=1.0		ug/g	
			Acid Extractable Cobalt (Co)	2019/10/02	ND, RDL=0.10		ug/g	
			Acid Extractable Copper (Cu)	2019/10/02	ND, RDL=0.50		ug/g	
			Acid Extractable Iron (Fe)	2019/10/02	ND, RDL=50		ug/g	
			Acid Extractable Lead (Pb)	2019/10/02	ND, RDL=1.0		ug/g	
			Acid Extractable Magnesium (Mg)	2019/10/02	ND, RDL=50		ug/g	
			Acid Extractable Manganese (Mn)	2019/10/02	ND, RDL=1.0		ug/g	
			Acid Extractable Molybdenum (Mo)	2019/10/02	ND, RDL=0.50		ug/g	
			Acid Extractable Nickel (Ni)	2019/10/02	ND, RDL=0.50		ug/g	
			Acid Extractable Phosphorus (P)	2019/10/02	ND, RDL=50		ug/g	
			Acid Extractable Potassium (K)	2019/10/02	ND, RDL=200		ug/g	
			Acid Extractable Selenium (Se)	2019/10/02	ND, RDL=0.50		ug/g	
			Acid Extractable Silver (Ag)	2019/10/02	ND, RDL=0.20		ug/g	
			Acid Extractable Sodium (Na)	2019/10/02	ND, RDL=50		ug/g	
			Acid Extractable Strontium (Sr)	2019/10/02	ND, RDL=1.0		ug/g	
			Acid Extractable Thallium (Tl)	2019/10/02	ND, RDL=0.050		ug/g	
			Acid Extractable Tin (Sn)	2019/10/02	ND, RDL=1.0		ug/g	
			Acid Extractable Uranium (U)	2019/10/02	ND, RDL=0.050		ug/g	
			Acid Extractable Vanadium (V)	2019/10/02	ND, RDL=5.0		ug/g	
			Acid Extractable Zinc (Zn)	2019/10/02	ND, RDL=5.0		ug/g	

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Acid Extractable Mercury (Hg)	2019/10/02	ND, RDL=0.050		ug/g	
6364581	DT1	RPD [KWZ239-01]	Acid Extractable Aluminum (Al)	2019/10/02	4.7		%	30
			Acid Extractable Antimony (Sb)	2019/10/02	9.5		%	30
			Acid Extractable Arsenic (As)	2019/10/02	7.1		%	30
			Acid Extractable Barium (Ba)	2019/10/02	8.6		%	30
			Acid Extractable Beryllium (Be)	2019/10/02	3.9		%	30
			Acid Extractable Bismuth (Bi)	2019/10/02	NC		%	30
			Acid Extractable Boron (B)	2019/10/02	NC		%	30
			Acid Extractable Cadmium (Cd)	2019/10/02	7.4		%	30
			Acid Extractable Calcium (Ca)	2019/10/02	4.8		%	30
			Acid Extractable Chromium (Cr)	2019/10/02	3.9		%	30
			Acid Extractable Cobalt (Co)	2019/10/02	3.4		%	30
			Acid Extractable Copper (Cu)	2019/10/02	9.0		%	30
			Acid Extractable Iron (Fe)	2019/10/02	6.6		%	30
			Acid Extractable Lead (Pb)	2019/10/02	6.0		%	30
			Acid Extractable Magnesium (Mg)	2019/10/02	7.3		%	30
			Acid Extractable Manganese (Mn)	2019/10/02	6.4		%	30
			Acid Extractable Molybdenum (Mo)	2019/10/02	5.8		%	30
			Acid Extractable Nickel (Ni)	2019/10/02	3.0		%	30
			Acid Extractable Phosphorus (P)	2019/10/02	3.5		%	30
			Acid Extractable Potassium (K)	2019/10/02	5.4		%	30
			Acid Extractable Selenium (Se)	2019/10/02	0.97		%	30
			Acid Extractable Silver (Ag)	2019/10/02	NC		%	30
			Acid Extractable Sodium (Na)	2019/10/02	8.1		%	30
			Acid Extractable Strontium (Sr)	2019/10/02	3.9		%	30
			Acid Extractable Thallium (Tl)	2019/10/02	7.5		%	30
			Acid Extractable Tin (Sn)	2019/10/02	3.4		%	30
			Acid Extractable Uranium (U)	2019/10/02	7.5		%	30
			Acid Extractable Vanadium (V)	2019/10/02	2.3		%	30
			Acid Extractable Zinc (Zn)	2019/10/02	7.2		%	30
			Acid Extractable Mercury (Hg)	2019/10/02	18		%	30
6401290	MLW	RPD [KWZ025-02]	Gravel	2019/11/12	NC		%	35
			Sand	2019/11/12	25		%	35
			Silt	2019/11/12	6.1		%	35
			Clay	2019/11/12	29		%	35
6401294	MLW	RPD [KWZ057-02]	Gravel	2019/11/13	NC		%	35
			Sand	2019/11/13	9.4		%	35
			Silt	2019/11/13	0.55		%	35
			Clay	2019/11/13	6.3		%	35
6401297	MLW	RPD	Gravel	2019/11/12	55 (2)		%	35
			Sand	2019/11/12	5.2		%	35
			Silt	2019/11/12	2.3		%	35
			Clay	2019/11/12	2.7		%	35
6463090	JK2	QC Standard	Radium-226	2019/12/06		103	%	79 - 121
6463090	JK2	Method Blank	Radium-226	2019/12/06	ND, RDL=0.010		Bq/g	
6463090	JK2	RPD [KWZ181-01]	Radium-226	2019/12/06	NC		%	N/A
6463354	FK1	QC Standard	Radium-226	2019/12/04		95	%	79 - 121
6463354	FK1	Method Blank	Radium-226	2019/12/04	ND, RDL=0.010		Bq/g	

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
6463354	FK1	RPD [KWZ276-01]	Radium-226	2019/12/04	NC		%	N/A

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

QC Standard: A sample of known concentration prepared by an external agency under stringent conditions. Used as an independent check of method accuracy.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spike amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than the native sample concentration)

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).

(1) Recovery or RPD for this parameter is outside control limits. The overall quality control for this analysis meets acceptability criteria.

(2) Duplicate %RPD violation not applicable. Absolute % Difference within 10%.

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Colleen Acker, Scientific Service Specialist

CHARTERED Eva Pranjic CHEMIST

Ewa Pranjic, M.Sc., C.Chem, Scientific Specialist

CHARTERED STEVEN SIMPSON CHEMIST

Steven Simpson, Lab Director

BV Labs has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per ISO/IEC 17025, signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Bureau Veritas Laboratories
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CHAIN OF CUSTODY RECORD

Page 1 of 1

INVOICE TO:		REPORT TO:		PROJECT INFORMATION:	
Company Name	#767 Minnow Environmental Inc	Company Name	MINNOW	Quotation #	B93464
Attention	Jess Tester jtester@minnow.ca	Attention	Jess Tester	P.O. #	
Address	2 Lamb St	Address	Jtester@minnow.ca	Project	19-41
	Georgetown ON L7G 3M9			Project Name	Cycle 5 SRWMP
Tel	(905) 873-3371 Ext: 2727 Fax (905) 873-6370	Tel	(905) 873-3371 Ext: 2727 Fax	Site #	
Email	jtester@minnow-environmental.com	Email	jtester@minnow-environmental.com	Sampled By	

Laboratory Use Only:

BV Labs Job #:	Bottle Order #:
	736008
COC #: C#736008-01-01	Project Manager: Sara Singh

MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE BV LABS DRINKING WATER CHAIN OF CUSTODY

Regulation 153 (2011): ☐ Table 1 ☐ Res/Park ☐ Medium/Fine ☐ Table 2 ☐ Ind/Comm ☐ Coarse ☐ Table 3 ☐ Agri/Other ☐ For RSC ☐ Table ___

Other Regulations: ☐ CCME ☐ Sanitary Sewer Bylaw ☐ Reg 558 ☐ Storm Sewer Bylaw ☐ MISA Municipality ___ ☐ PWQO ☐ Other ___

Special Instructions

Include Criteria on Certificate of Analysis (Y/N)? ___

Turnaround Time (TAT) Required:
Please provide advance notice for rush projects

Regular (Standard) TAT: ☑
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Please note: Standard TAT for certain tests such as BOD and Dioxins/Furans are > 5 days - contact your Project Manager for details.

Job Specific Rush TAT (if applies to entire submission)
Date Required: ___ Time Required: ___ ☐
Rush Confirmation Number: ___ (call lab for #)

ANALYSIS REQUESTED (PLEASE BE SPECIFIC)

#	Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Field Filtered (please circle): Metals / Hg / Cr VI	Particle size in solids (pipette&sieve)	Radium by Alpha Spectrometry	Strong Acid Leachable Metals by ICPMS	Total Organic Carbon in Soil	Moisture	# of Bottles	Comments
1		DUL-2019-1-P	24-Sep		Sed		✓			✓	✓	2	
2		DUL-2019-2-P	24-Sep		↓		✓			✓	✓	2	
3		DUL-2019-3-P	24-Sep		↓		✓			✓	✓	2	
4		DUL-2019-4-P	24-Sep		↓		✓			✓	✓	2	
5		DUL-2019-5-P	24-Sep		↓		✓			✓	✓	2	
6		DUL-2019-1-PX	24-Sep		↓		✓			✓	✓	2	
7		NL-2019-1X-P	23-Sep		↓		✓			✓	✓	2	
8		NL-2019-1-P	23-Sep	16:00	↓		✓			✓	✓	2	
9		NL-2019-2-P	23 Sep	12:00	↓		✓			✓	✓	2	
10		NL-2019-3-P	23-Sep	17:06	↓		✓			✓	✓	2	

* RELINQUISHED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	RECEIVED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	# jars used and not submitted	Laboratory Use Only
[signature]	27/09/19	12:30	TRUSHNA PATEL	2019/09/27	14:20		Time Sensitive; Temperature (°C) on Recei: REFER ACTR; Custody Seal Present / Intact: Yes / No

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SAMPLES MUST BE KEPT COOL (< 10° C) FROM TIME OF SAMPLING UNTIL DELIVERY TO BV LABS

White: BV Labs Yellow: Client

COURIER

27-Sep-19 14:20
Sara Singh
B9R1693
URE ENV-946

Bureau Veritas Laboratories
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CHAIN OF CUSTODY RECORD

Page 2 of 2

INVOICE TO:		REPORT TO:	
Company Name	#767 Minnow Environmental Inc	Company Name	Minnow Environmental
Attention	Jess Tester jtester@minnow.ca	Attention	Jess Tester
Address	2 Lamb St Georgetown ON L7G 3M9	Address	jtester@minnow.ca
Tel	(905) 873-3371 Ext ~~21~~ 227 Fax (905) 873-6370	Tel	(905) 873-3371 Ext ~~27~~ 227 Fax
Email	~~jtester@minnow-environmental.com~~	Email	~~jtester@minnow-environmental.com~~

PROJECT INFORMATION:	
Quotation #	B93464
P.O. #	
Project	19-41
Project Name	Cycle 5 SPWMP
Site #	
Sampled By	

Laboratory Use Only:	
BV Labs Job #	Bottle Order #: 738008
COC #: C#738008-03-01	Project Manager: Sara Singh

MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE BV LABS DRINKING WATER CHAIN OF CUSTODY

Regulation 153 (2011): ☐ Table 1 ☐ Res/Park ☐ Medium/Fine ☐ Table 2 ☐ Ind/Comm ☐ Coarse ☐ Table 3 ☐ Agr/Other ☐ For RSC ☐ Table ___

Other Regulations: ☐ CCME ☐ Sanitary Sewer Bylaw ☐ Reg 558 ☐ Storm Sewer Bylaw ☐ MISA Municipality ________ ☐ PWQO ☐ Other ________

Special Instructions:

Include Criteria on Certificate of Analysis (Y/N)? ______

Turnaround Time (TAT) Required: Please provide advance notice for rush projects

Regular (Standard) TAT: ☑
(will be applied if Rush TAT is not specified)
Standard TAT = 5-7 Working days for most tests
Please note: Standard TAT for certain tests such as BOD and Dioxins/Furans are > 5 days - contact your Project Manager for details

Job Specific Rush TAT (if applies to entire submission)
Date Required ________ Time Required ________ ☐
Rush Confirmation Number: ________ (call lab for #)

ANALYSIS REQUESTED (PLEASE BE SPECIFIC)

#	Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Field Filtered (please circle): Metals / Hg / Cr VI	Particle size in soils (pipette&sieve)	Radium by Alpha Spectrometry	Strong Acid Leachable Metals by ICPMS	Total Organic Carbon in Soil	Moisture	# of Bottles	Comments
1		NL-2019-4-P	23-Sep	~~12:44~~	Soil		✓			✓	✓	2	
2		NL-2019-5-P	23-Sep	~~14:00~~	↓		✓			✓	✓	2	
3		SUL-2019-1-P	22-Sep	~~10:36~~	↓		✓			✓	✓	2	
4		SUL-2019-2-P	24-Sep	~~15:30~~	↓		✓			✓	✓	2	
5		SUL-2019-3-P	24-Sep	~~11:21~~	↓		✓			✓	✓	2	
6		SUL-2019-4-P	24-Sep	~~12:15~~	↓		✓			✓	✓	2	
7		SUL-2019-5-P	24-Sep	~~13:00~~	↓		✓			✓	✓	2	
8		MAL-2019-1-P	22-Sep		↓		✓			✓	✓	2	
9		MAL-2019-2-P	22-Sep		↓		✓			✓	✓	2	
10		MAL-2019-3-P	22-Sep		↓		✓			✓	✓	2	

* RELINQUISHED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	RECEIVED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	# jars used and not submitted
[signature]	19/09/27	13:00	SEE PAGE 1			

Laboratory Use Only				
Time Sensitive	Temperature (°C) on Recei	Custody Seal	Yes	No
		Present		
		Intact		

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White: BV Labs Yellow: Client

Bureau Veritas Laboratories
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CHAIN OF CUSTODY RECORD

Page 3 of 4

INVOICE TO:		REPORT TO:		PROJECT INFORMATION:	
Company Name	#767 Minnow Environmental Inc	Company Name	Minnow Environmental	Quotation #	B93464
Attention	Jess Tester jtester@minnow.ca	Attention	Jess Tester	P.O. #	
Address	2 Lamb St	Address	jtester@minnow.ca	Project	
	Georgetown ON L7G 3M9			Project Name	
Tel	(905) 873-3371 Ext: 2227 Fax (905) 873-6370	Tel	(905) 873-3371 Ext: 2227 Fax	Site #	
Email	jtester@minnow-environmental.com	Email	jtester@minnow-environmental.com	Sampled By	

Laboratory Use Only:

BV Labs Job #:	Bottle Order #:
	738008
COC #:	Project Manager:
C#738008-04-01	Sara Singh

MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE BV LABS DRINKING WATER CHAIN OF CUSTODY

Regulation 153 (2011): ☐ Table 1 ☐ Res/Park ☐ Medium/Fine ☐ Table 2 ☐ Ind/Comm ☐ Coarse ☐ Table 3 ☐ Agri/Other ☐ For RSC ☐ Table ___

Other Regulations: ☐ CCME ☐ Sanitary Sewer Bylaw ☐ Reg 558 ☐ Storm Sewer Bylaw ☐ MISA Municipality ______ ☐ PWQO ☐ Other ______

Special Instructions

Include Criteria on Certificate of Analysis (Y/N)? ______

Turnaround Time (TAT) Required:
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Job Specific Rush TAT (if applies to entire submission)
Date Required ______ Time Required ______ ☐
Rush Confirmation Number ______ (call lab for #)

ANALYSIS REQUESTED (PLEASE BE SPECIFIC)

#	Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Field Filtered (please circle): Metals / Hg / Cr VI	Particle size in soils (pipette&sieve)	Retain by Alpha Spectrometry	Strong Acid Leachable Metals by ICPMS	Total Organic Carbon in Soil	Moisture	# of Bottles	Comments
1		MHL-2019-4-P	22-Sep		Sed		✓			✓	✓	2	
2		MAL-2019-5-P	22-Sep				✓			✓	✓	2	
3		ML-2019-3X-P	18-Sep				✓			✓	✓	2	
4		ML-2019-1-P	25-Sep				✓			✓	✓	2	
5		ML-2019-2P	18-Sep				✓			✓	✓	2	
6		ML-2019-3-P	18-Sep				✓			✓	✓	2	
7		ML-2019-4-P	25-Sep				✓			✓	✓	2	
8		ML-2019-5-P	25-Sep				✓			✓	✓	2	
9		QL-2019-2-Px	23-Sep				✓			✓	✓	2	
10		QL-2019-1-P	19-Sep				✓			✓	✓	2	

RELINQUISHED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	RECEIVED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	# jars used and not submitted
[signature]	19/09/27	15:00	SEE PAGE 1			

Laboratory Use Only: Time Sensitive | Temperature (°C) on Receipt | Custody Seal Present / Intact | Yes | No

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Bureau Veritas Laboratories
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CHAIN OF CUSTODY RECORD

Page 4 of 7

INVOICE TO:		REPORT TO:		PROJECT INFORMATION:	
Company Name	#767 Minnow Environmental Inc	Company Name		Quotation #	B93464
Attention	Jess Tester jtester@minnow.ca	Attention	Jess Tester jtester@minnow.ca	P.O. #	
Address	2 Lamb St	Address		Project	19-41
	Georgetown ON L7G 3M9			Project Name	Cycle 5 SRWMP
Tel	(905) 873-3371 Ext: 27 Fax (905) 873-6370	Tel	(905) 873-3371 Ext: 27 Fax	Site #	
Email	jtester@minnow-environmental.com	Email	jtester@minnow-environmental.com	Sampled By	

Laboratory Use Only:

BV Labs Job #:	Bottle Order #:
	730008
COC #:	Project Manager:
C#730008-02-01	Sara Singh

MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE BV LABS DRINKING WATER CHAIN OF CUSTODY

Regulation 153 (2011): ☐ Table 1 ☐ Res/Park ☐ Medium/Fine ☐ Table 2 ☐ Ind/Comm ☐ Coarse ☐ Table 3 ☐ Agri/Other ☐ For RSC ☐ Table ___

Other Regulations: ☐ CCME ☐ Sanitary Sewer Bylaw ☐ Reg 558 ☐ Storm Sewer Bylaw ☐ MISA Municipality ______ ☐ PWQO ☐ Other ______

Special Instructions:

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Job Specific Rush TAT (if applies to entire submission)
Date Required: ______ Time Required: ______ ☐
Rush Confirmation Number: ______ (call lab for #)

ANALYSIS REQUESTED (PLEASE BE SPECIFIC)

#	Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Field Filtered (please circle) Metals / Hg / Cr VI	Particle size in soils (pipette&sieve)	Redox by Alpha Spectrometry	Strong Acid Leachable Metals by ICPMS	Total Organic Carbon in Soil	Moisture	# of Bottles	Comments
1		QL-2019-2-P	23-Sep		Sed		✓			✓	✓	2	
2		QL-2019-3-P	23-Sep		↓		✓			✓	✓	2	
3		QL-2019-4-P	19-Sep				✓			✓	✓	2	
4		QL-2019-5-P	23-Sep				✓			✓	✓	2	
5		SL-2019-1-P	25-Sep				✓			✓	✓	2	
6		SL-2019-2-P	25-Sep				✓			✓	✓	2	
7		SL-2019-3-P	25-Sep				✓			✓	✓	2	
8		SL-2019-4-P	25-Sep				✓			✓	✓	2	
9		SL-2019-5-P	25-Sep				✓			✓	✓	2	
10		SL-2019-4-Px	25-Sep		↓		✓			✓	✓	2	

* RELINQUISHED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	RECEIVED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	# jars used and not submitted
[signature]	19/09/27	13:00	SEE PAGE 1			

Laboratory Use Only: Time Sensitive | Temperature (°C) on Recei | Custody Seal Present / Intact | Yes | No

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SAMPLES MUST BE KEPT COOL (< 10° C) FROM TIME OF SAMPLING UNTIL DELIVERY TO BV LABS

White: BV Labs Yellow: Client

Bureau Veritas Laboratories
6740 Campobello Road, Mississauga, Ontario Canada L5N 2L8 Tel (905) 817-5700 Toll-free 800-563-6266 Fax (905) 817-5777 www.bvlabs.com

CHAIN OF CUSTODY RECORD

Page 5 of 7

INVOICE TO:	REPORT TO:	PROJECT INFORMATION:	Laboratory Use Only:
Company Name: #767 Minnow Environmental Inc	Company Name: Minnow Environmental Inc.	Quotation #: B93464	BV Labs Job #:
Attention: Jess Tester	Attention: Jess Tester	P.O. #:	Bottle Order #: 737959
Address: 2 Lamb St, Georgetown ON L7G 3M9	Address:	Project: 19-41	COC #: C#737959-01-01
Tel: (905) 873-3371 Ext: 227	Tel: (905) 873-3371 Ext: 227 Fax:	Project Name: BHP DMI Cycle 5 SRWMP and SOE	Project Manager: Sara Singh
Email: jtester@minnow.ca	Email: jtester@minnow.ca	Site #:	
		Sampled By:	

MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE BV LABS DRINKING WATER CHAIN OF CUSTODY

Regulation 153 (2011): ☐ Table 1 ☐ Res/Park ☐ Medium/Fine ☐ Table 2 ☐ Ind/Comm ☐ Coarse ☐ Table 3 ☐ Agri/Other ☐ For RSC ☐ Table ___

Other Regulations: ☐ CCME ☐ Sanitary Sewer Bylaw ☐ Reg 558 ☐ Storm Sewer Bylaw ☐ MISA Municipality ___ ☐ PWQO ☐ Other ___

Special Instructions

Include Criteria on Certificate of Analysis (Y/N)? ___

ANALYSIS REQUESTED (PLEASE BE SPECIFIC)

Turnaround Time (TAT) Required: Please provide advance notice for rush projects

Regular (Standard) TAT: ☑
(will be applied if Rush TAT is not specified)
Standard TAT = 5-7 Working days for most tests.
Please note: Standard TAT for certain tests such as BOD and Dioxins/Furans are > 5 days - contact your Project Manager for details.

Job Specific Rush TAT (if applies to entire submission)
Date Required: ___ Time Required: ___ ☐
Rush Confirmation Number: ___ (call lab for #)

#	Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Field Filtered (please circle): Metals / Hg / Cr VI	Strong Acid Leachable Metals by ICPMS	Total Organic Carbon in Soil	Particle size in solids (pipette&sieve)	Radium by Alpha Spectrometry	Moisture	# of Bottles	Comments
1		TML-2019-1-P	20-Sep		Sediment			✓	✓		✓	2	
2		TML-2019-2-P	21-Sep		Sediment			✓	✓		✓	2	
3		TML-2019-3-P	20-Sep		Sediment			✓	✓		✓	2	
4		TML-2019-4-P	21-Sep		Sediment			✓	✓		✓	2	
5		TML-2019-5-P	20-Sep		Sediment			✓	✓		✓	2	
6		TML-2019-1-C	20-Sep		Sediment		✓			✓		1	
7		TML-2019-2-C	21-Sep		Sediment		✓			✓		1	
8		TML-2019-3-C	20-Sep		Sediment		✓			✓		1	
9		TML-2019-4-C	21-Sep		Sediment		✓			✓		1	
10		TML-2019-5-C	20-Sep		Sediment		✓			✓		1	

* RELINQUISHED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	RECEIVED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	# jars used and not submitted	Time Sensitive	Laboratory Use Only
[signature]	19/09/27	13:00	SEE PAGE 1					Temperature (°C) on Recei

Custody Seal: Present / Intact — Yes / No

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CHAIN OF CUSTODY RECORD

Page 2 of 4

INVOICE TO:		REPORT TO:		PROJECT INFORMATION:		Laboratory Use Only:	
Company Name:	#767 Minnow Environmental Inc	Company Name:	Minnow Environmental Inc.	Quotation #:	B93464	BV Labs Job #:	Bottle Order #: 737959
Attention:	Jess Tester	Attention:	Jess Tester	P.O. #:			
Address:	2 Lamb St	Address:		Project:	19-41	COC #: C#737959-01-01	Project Manager: Sara Singh
	Georgetown ON L7G 3M9			Project Name:	BHP DMI Cycle 5 SRWMP and SOE		
Tel:	(905) 873-3371 Ext: 227	Tel:	(905) 873-3371 Ext: 227 Fax:	Site #:			
Email:	jtester@minnow.ca	Email:	jtester@minnow.ca	Sampled By:			

MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE BV LABS DRINKING WATER CHAIN OF CUSTODY

Regulation 153 (2011)	Other Regulations	Special Instructions
☐ Table 1 ☐ Res/Park ☐ Medium/Fine	☐ CCME ☐ Sanitary Sewer Bylaw	
☐ Table 2 ☐ Ind/Comm ☐ Coarse	☐ Reg 558 ☐ Storm Sewer Bylaw	
☐ Table 3 ☐ Agri/Other ☐ For RSC	☐ MISA Municipality ____	
☐ Table ___	☐ PWQO	
	☐ Other ____	

Include Criteria on Certificate of Analysis (Y/N)? ______

ANALYSIS REQUESTED (PLEASE BE SPECIFIC)

Turnaround Time (TAT) Required:
Please provide advance notice for rush projects

Regular (Standard) TAT: ☑
(will be applied if Rush TAT is not specified)
Standard TAT = 5-7 Working days for most tests.
Please note: Standard TAT for certain tests such as BOD and Dioxins/Furans are > 5 days - contact your Project Manager for details.

Job Specific Rush TAT (if applies to entire submission)
Date Required ______ Time Required ______ ☐
Rush Confirmation Number ______ *(call lab for #)*

	Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Field Filtered (please circle): Metals / Hg / Cr VI	Strong Acid Leachable Metals by ICPMS	Total Organic Carbon in Soil	Particle size in solids (pipette&sieve)	Radium by Alpha Spectrometry	Moisture						# of Bottles	Comments
1		DUL-2019-1X-C	24-Sep		Sediment		✓			✓							1	
2		DUL-2019-1-C	24-Sep		Sediment		✓			✓							1	
3		DUL-2019-2-C	24-Sep		Sediment		✓			✓							1	
4		DUL-2019-3-C	24-Sep		Sediment		✓			✓							1	
5		DUL-2019-4-C	24-Sep		Sediment		✓			✓							1	
6		DUL-2019-5-C	19-Sep		Sediment		✓			✓							1	
7		NL-2019-1-C	23-Sep		Sediment		✓			✓							1	
8		NL-2019-2-C	23-Sep		Sediment		✓			✓							1	
9		NL-2019-3-C	23-Sep		Sediment		✓			✓							1	
10		NL-2019-4-C	23-Sep		Sediment		✓			✓							1	

* RELINQUISHED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	RECEIVED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	# jars used and not submitted
[signature]	19/09/27	15:00	SEE PAGE 1			

Laboratory Use Only				
Time Sensitive	Temperature (°C) on Recei	Custody Seal	Yes	No
		Present		
		Intact		

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CHAIN OF CUSTODY RECORD

INVOICE TO:		REPORT TO:	
Company Name:	#767 Minnow Environmental Inc	Company Name:	Minnow Environmental Inc.
Attention:	Jess Tester	Attention:	Jess Tester
Address:	2 Lamb St Georgetown ON L7G 3M9	Address:	
Tel:	(905) 873-3371 Ext: 227	Tel:	(905) 873-3371 Ext: 227 Fax:
Email:	jtester@minnow.ca	Email:	jtester@minnow.ca

PROJECT INFORMATION:	
Quotation #:	B93464
P.O. #:	
Project:	19-41
Project Name:	BHP DMI Cycle 5 SRWMP and SOE
Site #:	
Sampled By:	

Laboratory Use Only:	
BV Labs Job #:	Bottle Order #: 737959
COC #: C#737959-01-01	Project Manager: Sara Singh

MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE BV LABS DRINKING WATER CHAIN OF CUSTODY

Regulation 153 (2011)	Other Regulations	Special Instructions
☐ Table 1 ☐ Res/Park ☐ Medium/Fine	☐ CCME ☐ Sanitary Sewer Bylaw	
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☐ Table 3 ☐ Agri/Other ☐ For RSC	☐ MISA Municipality ____	
☐ Table ___	☐ PWQO	
	☐ Other ____	

Include Criteria on Certificate of Analysis (Y/N)? ____

ANALYSIS REQUESTED (PLEASE BE SPECIFIC)

	Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Field Filtered (please circle) Metals / Hg / Cr VI	Strong Acid Leachable Metals by ICPMS	Total Organic Carbon in Soil	Particle size in solids (pipette&sieve)	Radium by Alpha Spectrometry	Moisture						# of Bottles	Comments
1		[illegible] ML-2019-5-C	23-Sep		Sediment		✓			✓							1	
2		SUL-2019-1-C	22-Sep		Sediment		✓			✓							1	
3		SUL-2019-2-C	22-Sep		Sediment		✓			✓							1	
4		SUL-2019-3-C	22-Sep		Sediment		✓			✓							1	
5		SUL-2019-4-C	22-Sep		Sediment		✓			✓							1	
6		SUL-2019-5-C	22-Sep		Sediment		✓			✓							1	
7		MAL-2019-1-C	19-Sep		Sediment		✓			✓							1	
8		MAL-2019-2-C	19-Sep		Sediment		✓			✓							1	
9		MAL-2019-3-C	19-Sep		Sediment		✓			✓							1	
10		MAL-2019-4-C	22-Sep		Sediment		✓			✓							1	

Turnaround Time (TAT) Required:
Please provide advance notice for rush projects
Regular (Standard) TAT: ☑
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Job Specific Rush TAT (if applies to entire submission)
Date Required: ____ Time Required: ____ ☐
Rush Confirmation Number: ____ (call lab for #)

* RELINQUISHED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	RECEIVED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	# jars used and not submitted
[signature]	19/09/27	13:00	SEE PAGE 1			

Laboratory Use Only				
Time Sensitive	Temperature (°C) on Recei	Custody Seal	Yes	No
		Present		
		Intact		

SAMPLES MUST BE KEPT COOL (< 10° C) FROM TIME OF SAMPLING UNTIL DELIVERY TO BV LABS

White: BV Labs Yellow: Client

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Page 8 of 8

CHAIN OF CUSTODY RECORD

INVOICE TO:		REPORT TO:		PROJECT INFORMATION:	
Company Name:	#767 Minnow Environmental Inc	Company Name:	Minnow Environmental Inc.	Quotation #:	B93464
Attention:	Jess Tester	Attention:	Jess Tester	P.O. #:	
Address:	2 Lamb St	Address:		Project:	19-41
	Georgetown ON L7G 3M9			Project Name:	BHP DMI Cycle 5 SRWMP and SOE
Tel:	(905) 873-3371 Ext: 227	Tel:	(905) 873-3371 Ext: 227 Fax:	Site #:	
Email:	jtester@minnow.ca	Email:	jtester@minnow.ca	Sampled By:	

Laboratory Use Only:

BV Labs Job #:	Bottle Order #:
	737959
COC #:	Project Manager:
C#737959-01-01	Sara Singh

MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE BV LABS DRINKING WATER CHAIN OF CUSTODY

Regulation 153 (2011): ☐ Table 1 ☐ Res/Park ☐ Medium/Fine ☐ Table 2 ☐ Ind/Comm ☐ Coarse ☐ Table 3 ☐ Agri/Other ☐ For RSC ☐ Table ___

Other Regulations: ☐ CCME ☐ Sanitary Sewer Bylaw ☐ Reg 558 ☐ Storm Sewer Bylaw ☐ MISA Municipality ______ ☐ PWQO ☐ Other ______

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Date Required: ______ Time Required: ______ ☐
Rush Confirmation Number ______ *(call lab for #)*

	Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Field Filtered (please circle): Metals / Hg / Cr VI	Strong Acid Leachable Metals by ICPMS	Total Organic Carbon in Soil	Particle size in solids (pipette&sieve)	Radium by Alpha Spectrometry	Moisture						# of Bottles	Comments
1		MAL-2019-5-C	19-Sep		Sediment		✓			✓							1	
2		ML-2019-1-C	17-Sep		Sediment		✓			✓							1	
3		ML-2019-2-C	17-Sep		Sediment		✓			✓							1	
4		ML-2019-3-C	18-Sep		Sediment		✓			✓							1	
5		ML-2019-4-C	18-Sep		Sediment		✓			✓							1	
6		ML-2019-5-C	18-Sep		Sediment		✓			✓							1	
7		ML-2019-3X-C	18-Sep		Sediment		✓			✓							1	
8		QL-2019-2-CX	23-Sep		Sediment		✓			✓							1	
9		QL-2019-1-C	19-Sep		Sediment		✓			✓							1	
10		QL-2019-2-C	23-Sep		Sediment		✓			✓							1	

* RELINQUISHED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	RECEIVED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	# jars used and not submitted
[signature]	19/09/27	13:00	SEE PAGE 1			

Laboratory Use Only				
Time Sensitive	Temperature (°C) on Recei	Custody Seal	Yes	No
		Present		
		Intact		

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CHAIN OF CUSTODY RECORD

Page 9 of 10

INVOICE TO:		REPORT TO:		PROJECT INFORMATION:		Laboratory Use Only:	
Company Name	#767 Minnow Environmental Inc	Company Name	Minnow Environmental Inc.	Quotation #	B93464	BV Labs Job #:	Bottle Order #: 737959
Attention	Jess Tester	Attention	Jess Tester	P.O. #			
Address	2 Lamb St, Georgetown ON L7G 3M9	Address		Project	19-41	COC #: C#737959-01-01	Project Manager: Sara Singh
Tel	(905) 873-3371 Ext: 227	Tel	(905) 873-3371 Ext: 227 Fax	Project Name	BHP DMI Cycle 5 SRWMP and SOE		
Email	jtester@minnow.ca	Email	jtester@minnow.ca	Site # / Sampled By			

MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE BV LABS DRINKING WATER CHAIN OF CUSTODY

Regulation 153 (2011): Table 1, Table 2, Table 3, Table ___; Res/Park, Ind/Comm, Agri/Other, Medium/Fine, Coarse, For RSC

Other Regulations: CCME, Reg 558, MISA, PWQO, Other; Sanitary Sewer Bylaw, Storm Sewer Bylaw, Municipality

Special Instructions

Include Criteria on Certificate of Analysis (Y/N)? ______

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Job Specific Rush TAT (if applies to entire submission): Date Required ___ Time Required ___
Rush Confirmation Number ___ (call lab for #)

ANALYSIS REQUESTED (PLEASE BE SPECIFIC)

#	Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Field Filtered (please circle): Metals / Hg / Cr VI	Strong Acid Leachable Metals by ICPMS	Total Organic Carbon in Soil	Particle size in solids (pipette&sieve)	Radium by Alpha Spectrometry	Moisture	# of Bottles	Comments
1		QI-2019-3-C	23-Sep		Sediment		✓			✓		1	
2		QI-2019-4-C	19-Sep		Sediment		✓			✓		1	
3		QI-2019-5-C	19-Sep		Sediment		✓			✓		1	
4		SL-2019-4-CX	25-Sep		Sediment		✓			✓		1	
5		SL-2019-1-C	25-Sep		Sediment		✓			✓		1	
6		SL-2019-2-C	25-Sep		Sediment		✓			✓		1	
7		SL-2019-3-C	25-Sep		Sediment		✓			✓		1	
8		SL-2019-4-C	25-Sep		Sediment		✓			✓		1	
9		SL-2019-5-C	25-Sep		Sediment		✓			✓		1	
10					Sediment								

* RELINQUISHED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	RECEIVED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	# jars used and not submitted	Time Sensitive	Laboratory Use Only
[signature]	19/09/27	13:00	SEE PAGE 1					Temperature (°C) on Recei; Custody Seal Present / Intact: Yes / No

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White: BV Labs Yellow: Client

SRC SASKATCHEWAN RESEARCH COUNCIL

Environmental Analytical Laboratories
143-111 Research Drive, Saskatoon, SK Canada S7N 3R2

T: 306-933-6932 F: 306-933-7922
Toll-free: 1-800-240-8808
E: analytical@src.sk.ca

www.src.sk.ca/analytical

Dec 06, 2019

This report was generated for samples included in SRC Group # 2019-14432

Quality Control Report

Jess Tester
Minnow Environmental Inc.
2 Lamb Street
Georgetown, ON L7G 3M9

Reference Materials and Standards:

A reference material of known concentration is used whenever possible as either a control sample or control standard and analyzed with each batch of samples. These "QC" results are used to assess the performance of the method and must be within clearly defined limits; otherwise corrective action is required.

QC Analysis	Units	Target Value	Obtained Value
Lead-210	Bq/L	19.7	21.0
Lead-210	Bq	7.47	7.72
Lead-210	Bq/L	19.7	20.3
Lead-210	Bq	0.370	0.398
Polonium-210	Bq/L	18.8	19.0
Polonium-210	Bq	0.370	0.353
Polonium-210	Bq/L	18.8	20.3
Polonium-210	Bq	0.075	0.082
Polonium-210	Bq/L	18.8	18.4
Polonium-210	Bq	0.370	0.334
Radium-226	Bq/L	16.8	15.4
Radium-226	Bq	0.043	0.040
Thorium-230	Bq/L	19.9	23.6
Thorium-232	Bq	0.195	0.218

Duplicates:

Duplicates are used to assess problems with precision and help ensure that samples within a given batch were processed appropriately. The difference between duplicates must be within strict limits, otherwise corrective action is required. Please note, the duplicate(s) in this report are duplicates analyzed within a given batch of test samples and may not be from this specific group of samples.

Duplicate Analysis	Units	Sample ID	First Result	Second Result
Lead-210	Bq/g	66730	<0.001	<0.001
Lead-210	Bq/g	66734	<0.001	<0.001
Lead-210	Bq/g	68033	<0.08	<0.08
Lead-210	Bq/g	68078	0.22	0.26
Polonium-210	Bq/g	66730	0.0046	0.0052
Polonium-210	Bq/g	66734	0.0004	0.0007
Polonium-210	Bq/g	67926	<0.005	<0.005
Radium-226	Bq/g	66744	0.0007	<0.0002
Radium-226	Bq/g	66749	0.0003	<0.0002
Radium-226	Bq/g	67603	0.01	<0.005

SASKATCHEWAN RESEARCH COUNCIL
Environmental Analytical Laboratories
143-111 Research Drive, Saskatoon, SK Canada S7N 3R2
T: 306-933-6932 F: 306-933-7922
Toll-free: 1-800-240-8808
E: analytical@src.sk.ca
www.src.sk.ca/analytical

Dec 06, 2019

This report was generated for samples included in SRC Group # 2019-14432

Duplicate Analysis	Units	Sample ID	First Result	Second Result
Thorium-230	Bq/g	66738	<0.0005	<0.0005
Thorium-230	Bq/g	66743	<0.0005	<0.0005
Uranium	ug/g	66733	<0.001	<0.001
Uranium	ug/g	66751	<0.001	<0.001

All quality control results were within the specified limits and considered acceptable.

Roxane Ortmann - Quality Assurance Supervisor

APPENDIX C
STANROCK TMA, TOMP DATA

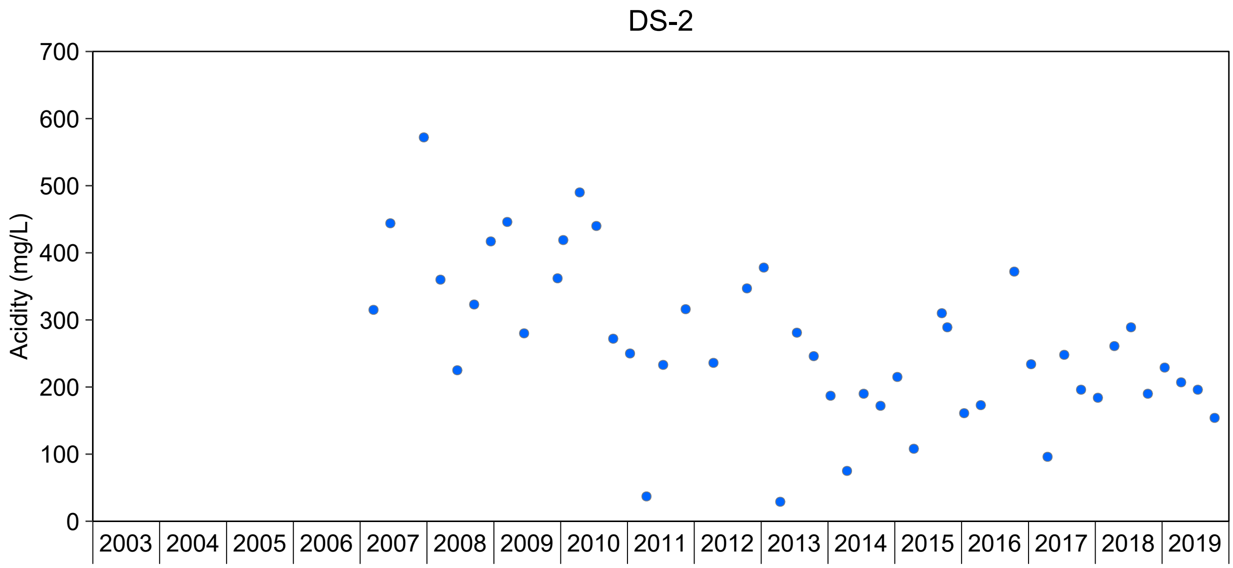


Figure C.1: Concentrations of Acidity for TOMP Water Monitoring Stations, Stanrock TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 3.4 for Seasonal Kendall trend analysis results and Appendix Table C.3 for raw data.

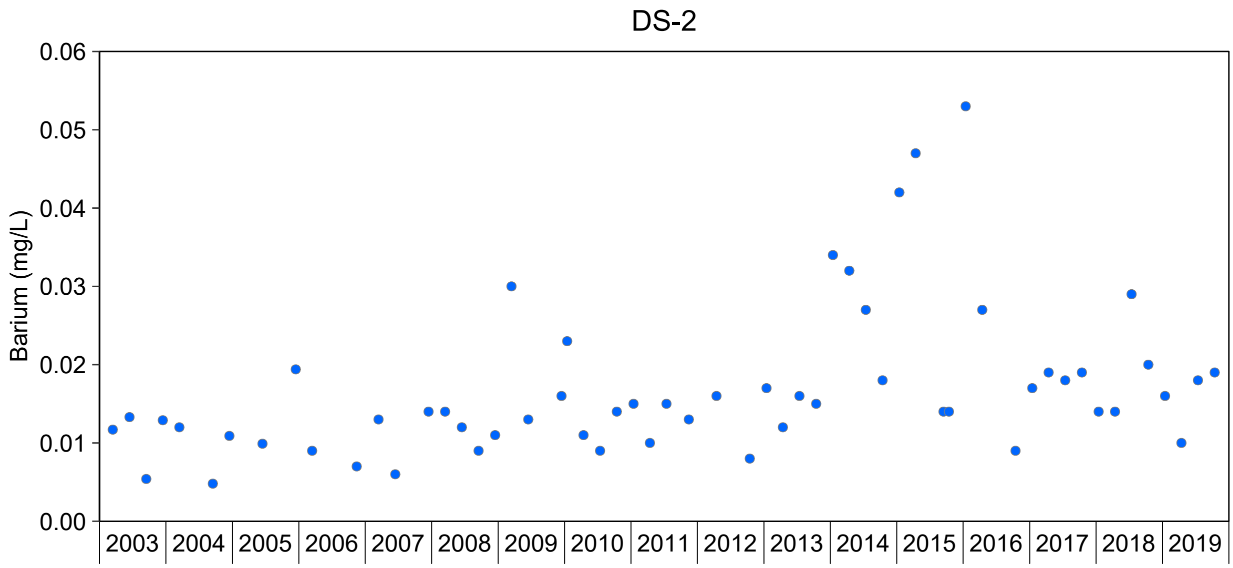


Figure C.2: Concentrations of Barium for TOMP Water Monitoring Stations, Stanrock TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 3.4 for Seasonal Kendall trend analysis results and Appendix Table C.3 for raw data.

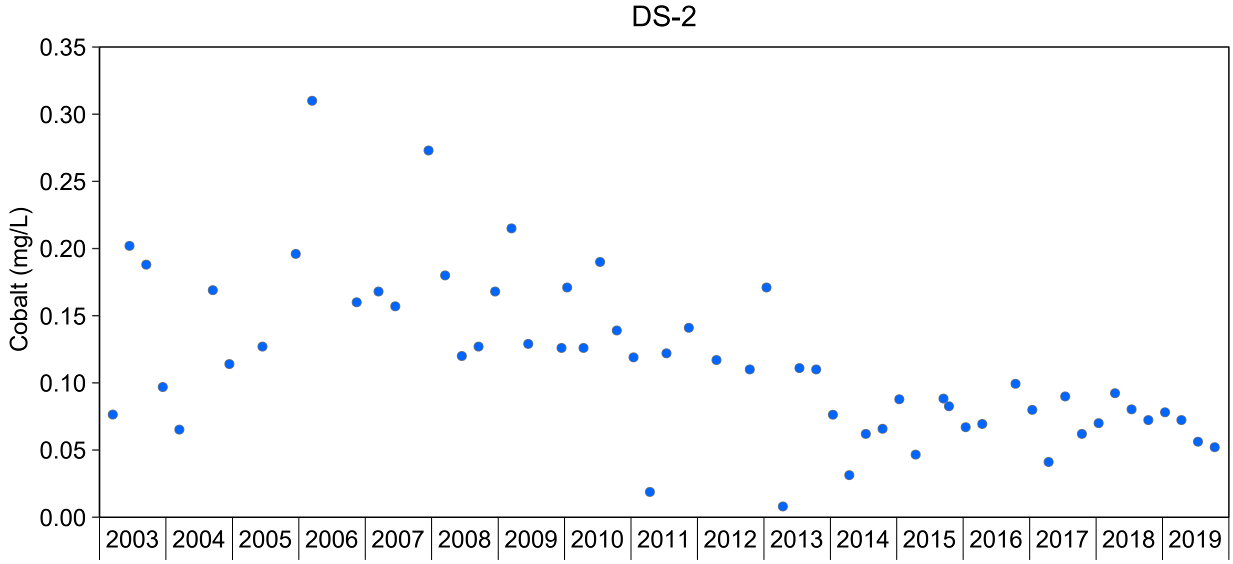


Figure C.3: Concentrations of Cobalt for TOMP Water Monitoring Stations, Stanrock TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 3.4 for Seasonal Kendall trend analysis results and Appendix Table C.3 for raw data.

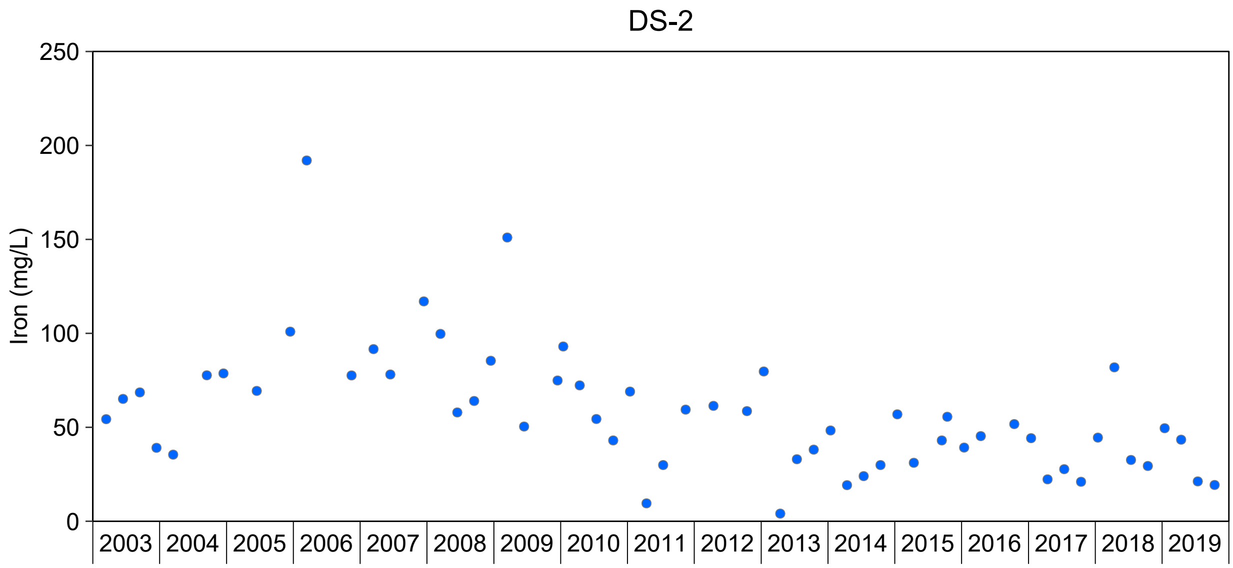


Figure C.4: Concentrations of Iron for TOMP Water Monitoring Stations, Stanrock TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 3.4 for Seasonal Kendall trend analysis results and Appendix Table C.3 for raw data.

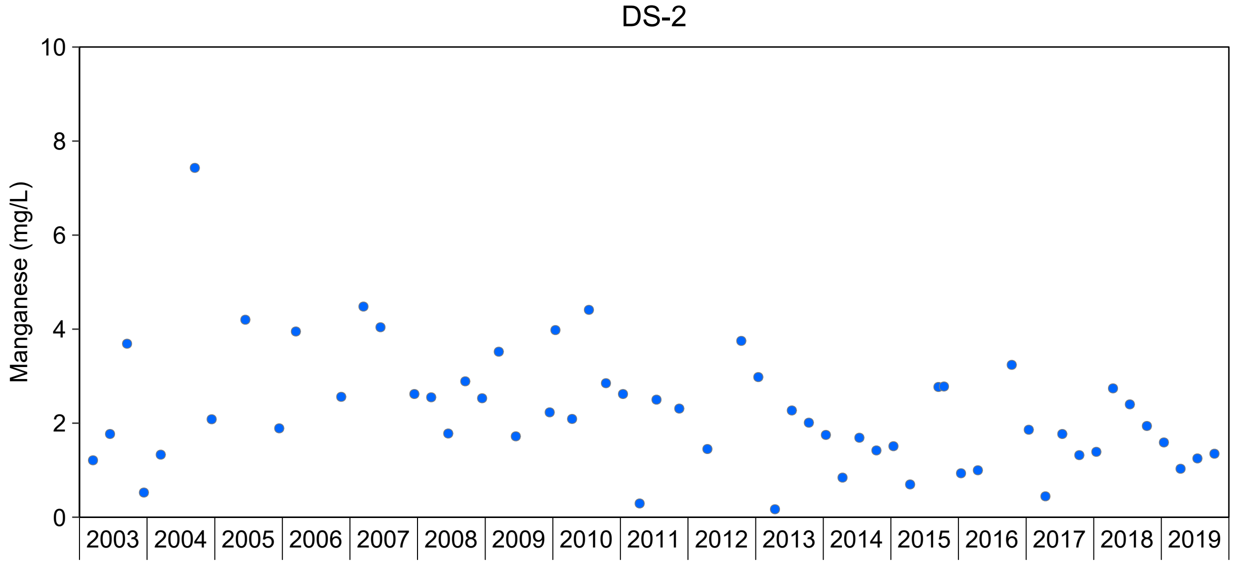


Figure C.5: Concentrations of Manganese for TOMP Water Monitoring Stations, Stanrock TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 3.4 for Seasonal Kendall trend analysis results and Appendix Table C.3 for raw data.

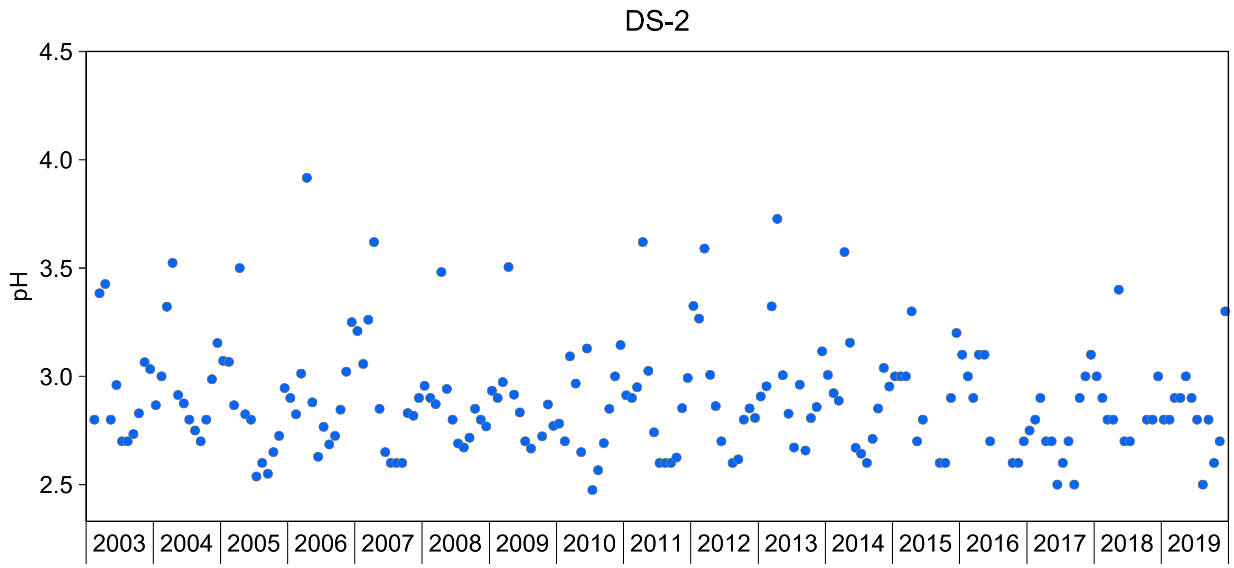


Figure C.6: Field Measurements of pH for TOMP Water Monitoring Stations, Stanrock TMA, 2003 to 2019

Notes: See Table 3.4 for Seasonal Kendall trend analysis results and Appendix Table C.3 for raw data.

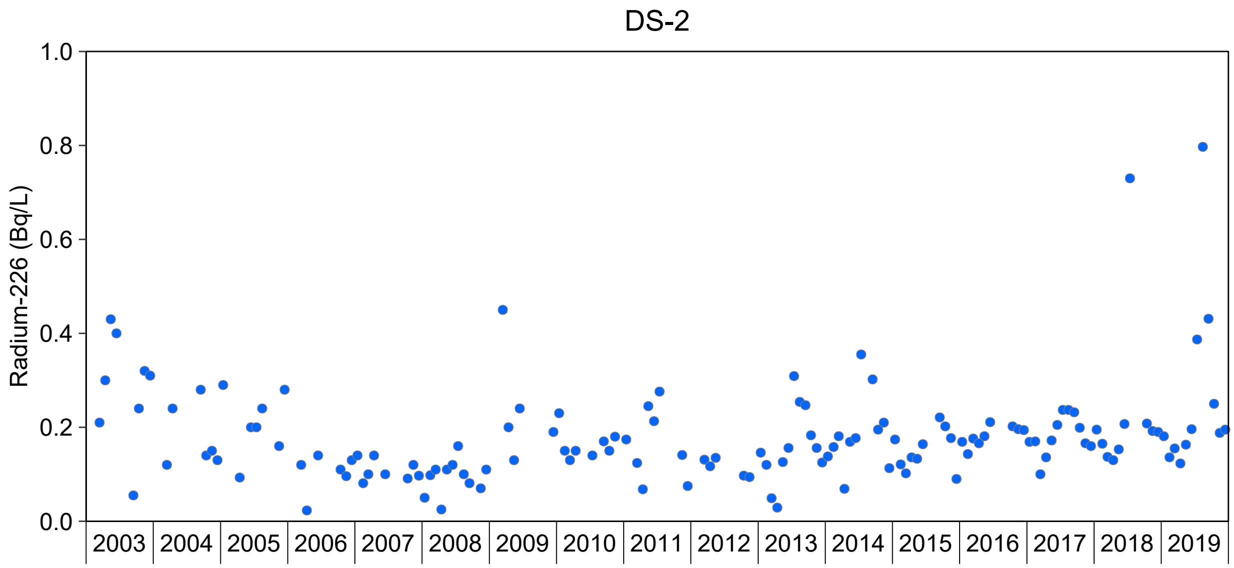


Figure C.7: Concentrations of Radium-226 for TOMP Water Monitoring Stations, Stanrock TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 3.4 for Seasonal Kendall trend analysis results and Appendix Table C.3 for raw data.

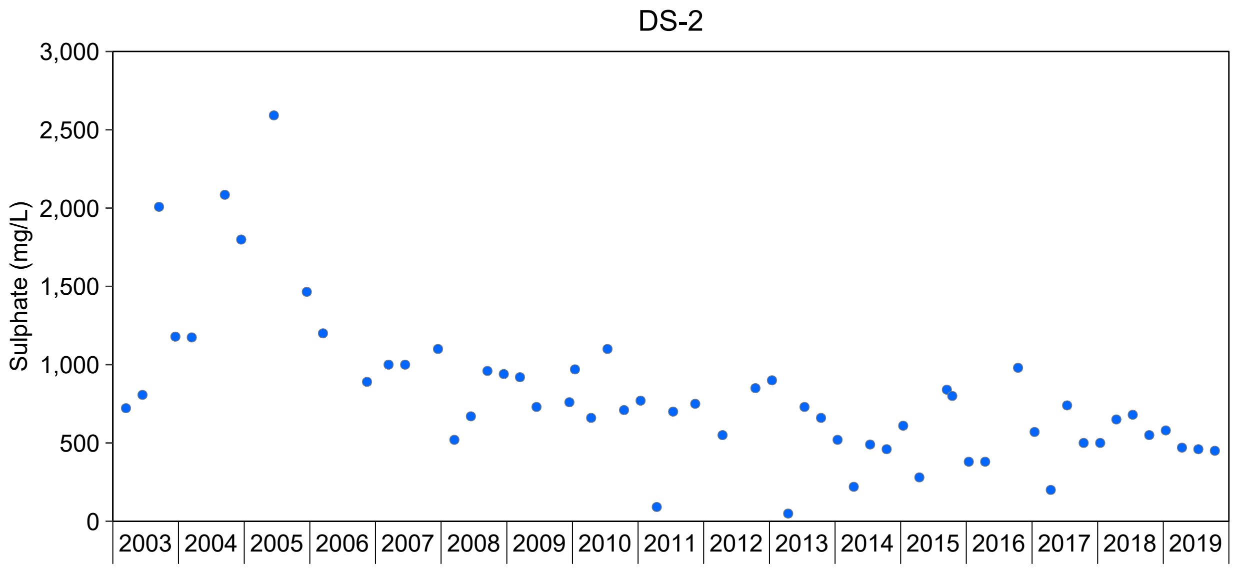


Figure C.8: Concentrations of Sulphate for TOMP Water Monitoring Stations, Stanrock TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 3.4 for Seasonal Kendall trend analysis results and Appendix Table C.3 for raw data.

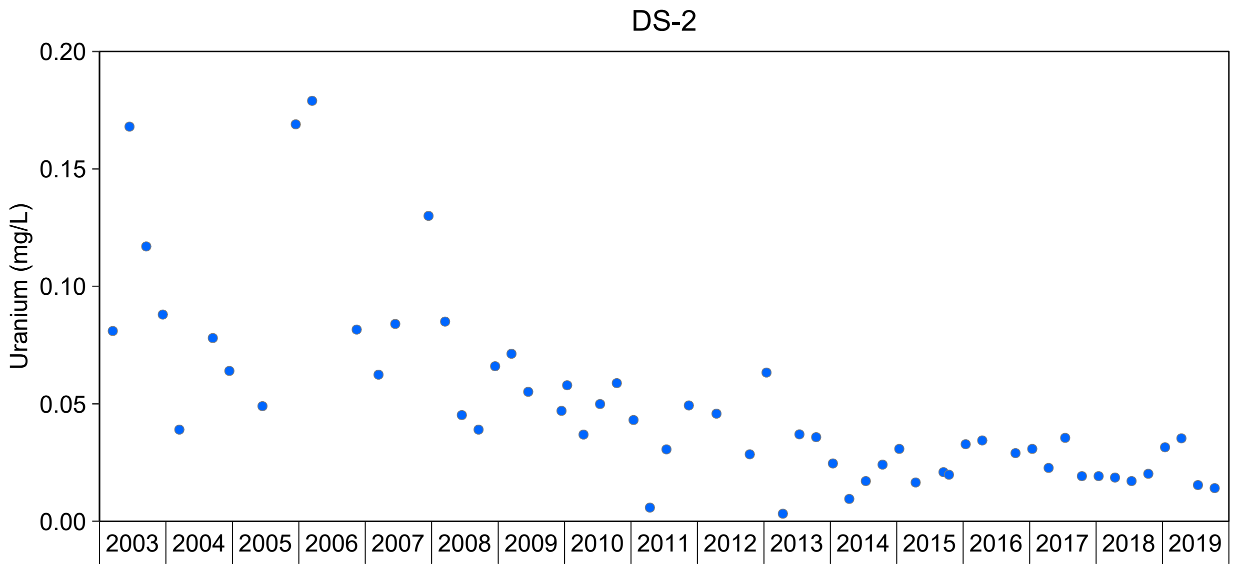


Figure C.9: Concentrations of Uranium for TOMP Water Monitoring Stations, Stanrock TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 3.4 for Seasonal Kendall trend analysis results and Appendix Table C.3 for raw data.

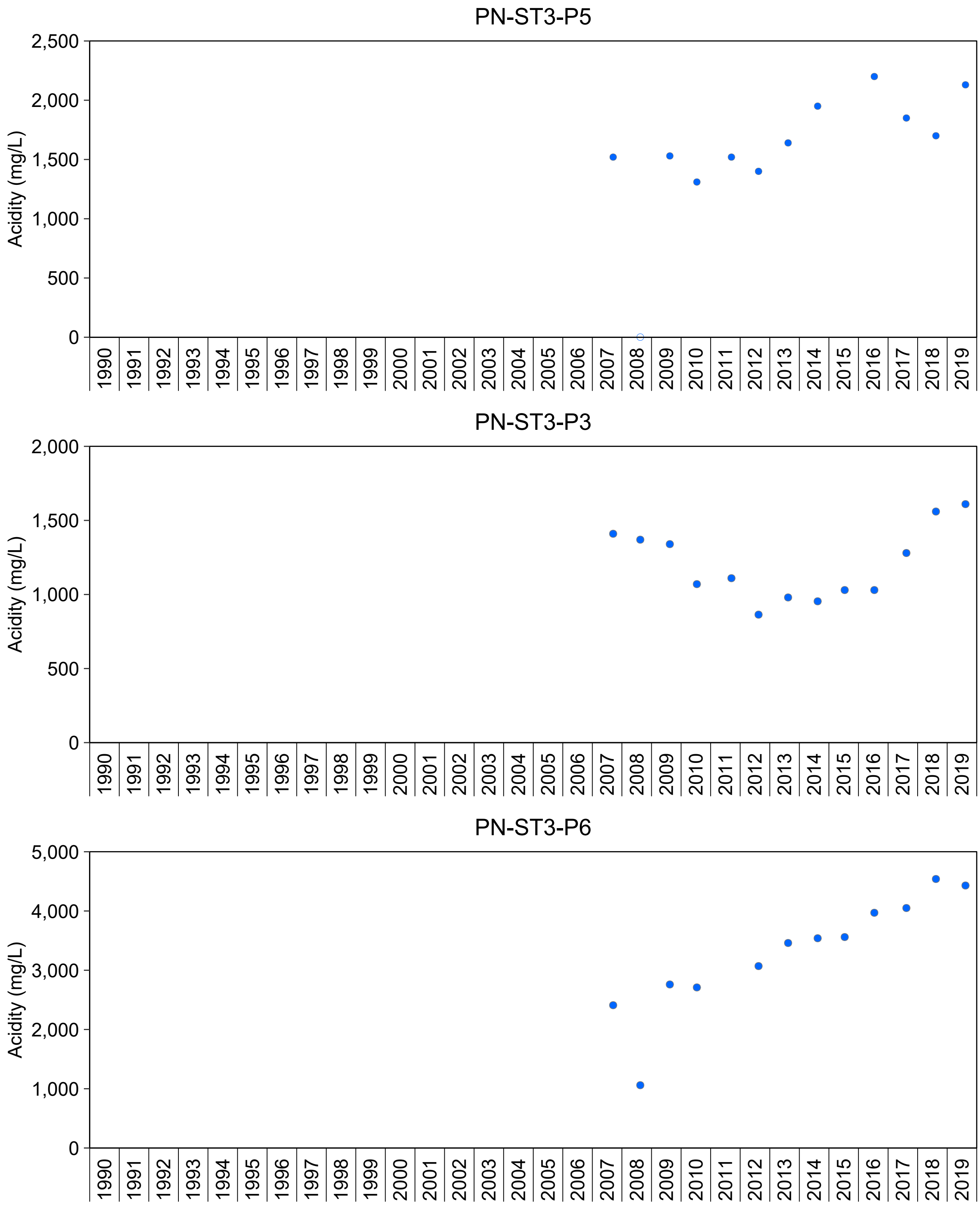
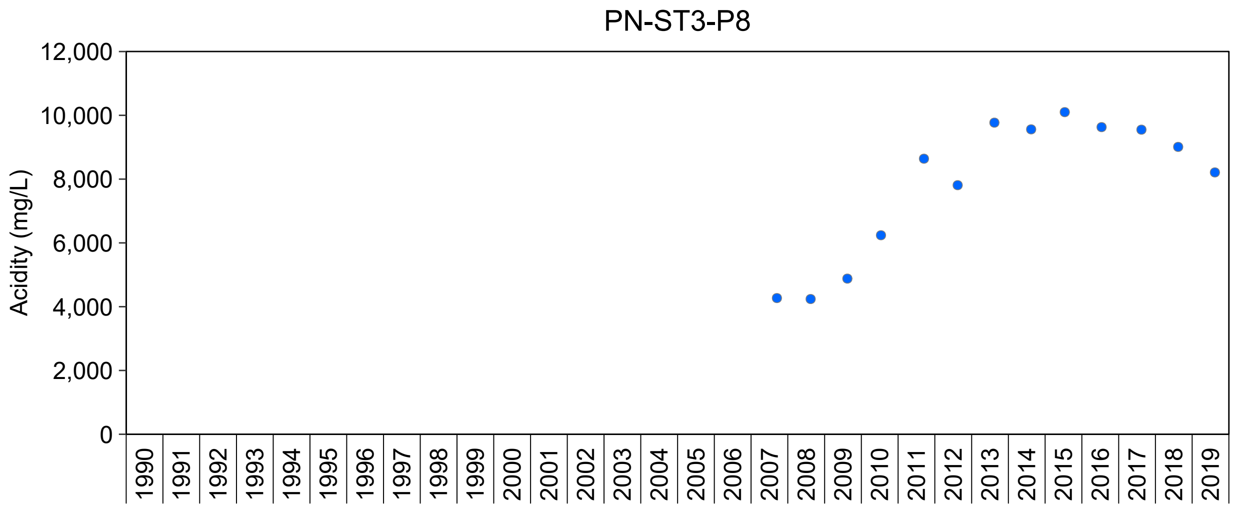


Figure C.10: Concentrations of Acidity for TOMP Pore Water Stations, Stanrock TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Due to a change in analytical technique for acidity in 2006, acidity trends were assessed from 2007 to 2019. See Table 3.5 for Kendall trend analysis results and Appendix Table C.9 for raw data.



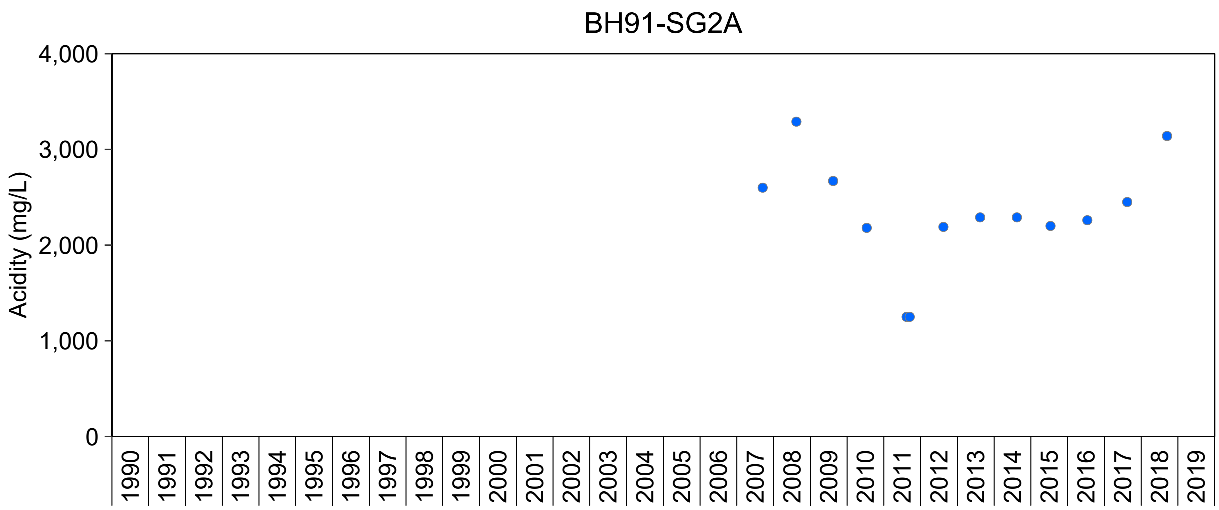


Figure C.10: Concentrations of Acidity for TOMP Pore Water Stations, Stanrock TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Due to a change in analytical technique for acidity in 2006, acidity trends were assessed from 2007 to 2019. See Table 3.5 for Kendall trend analysis results and Appendix Table C.9 for raw data.

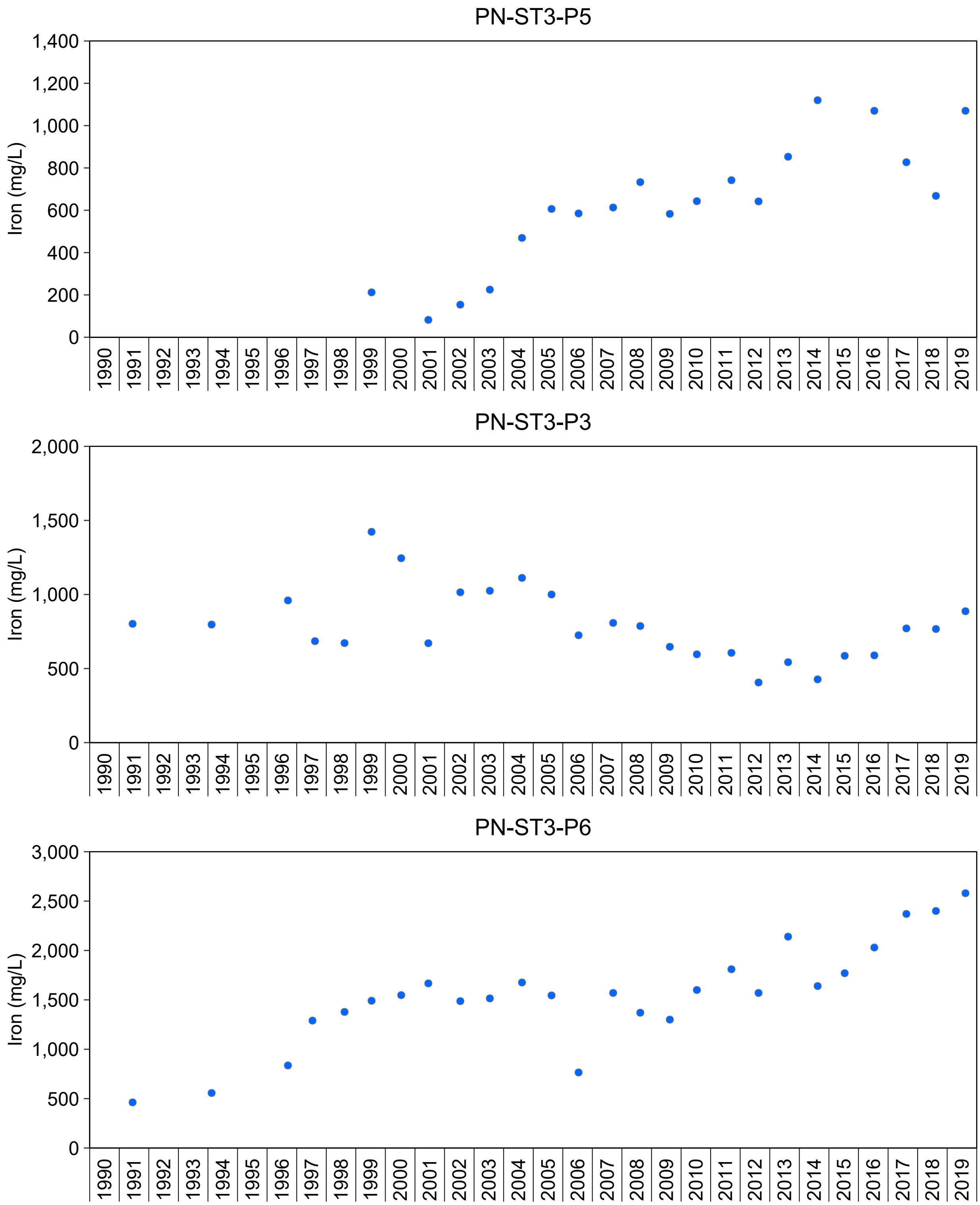


Figure C.11: Concentrations of Iron for TOMP Pore Water Stations, Stanrock TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 3.5 for Kendall trend analysis results and Appendix Table C.9 for raw data.

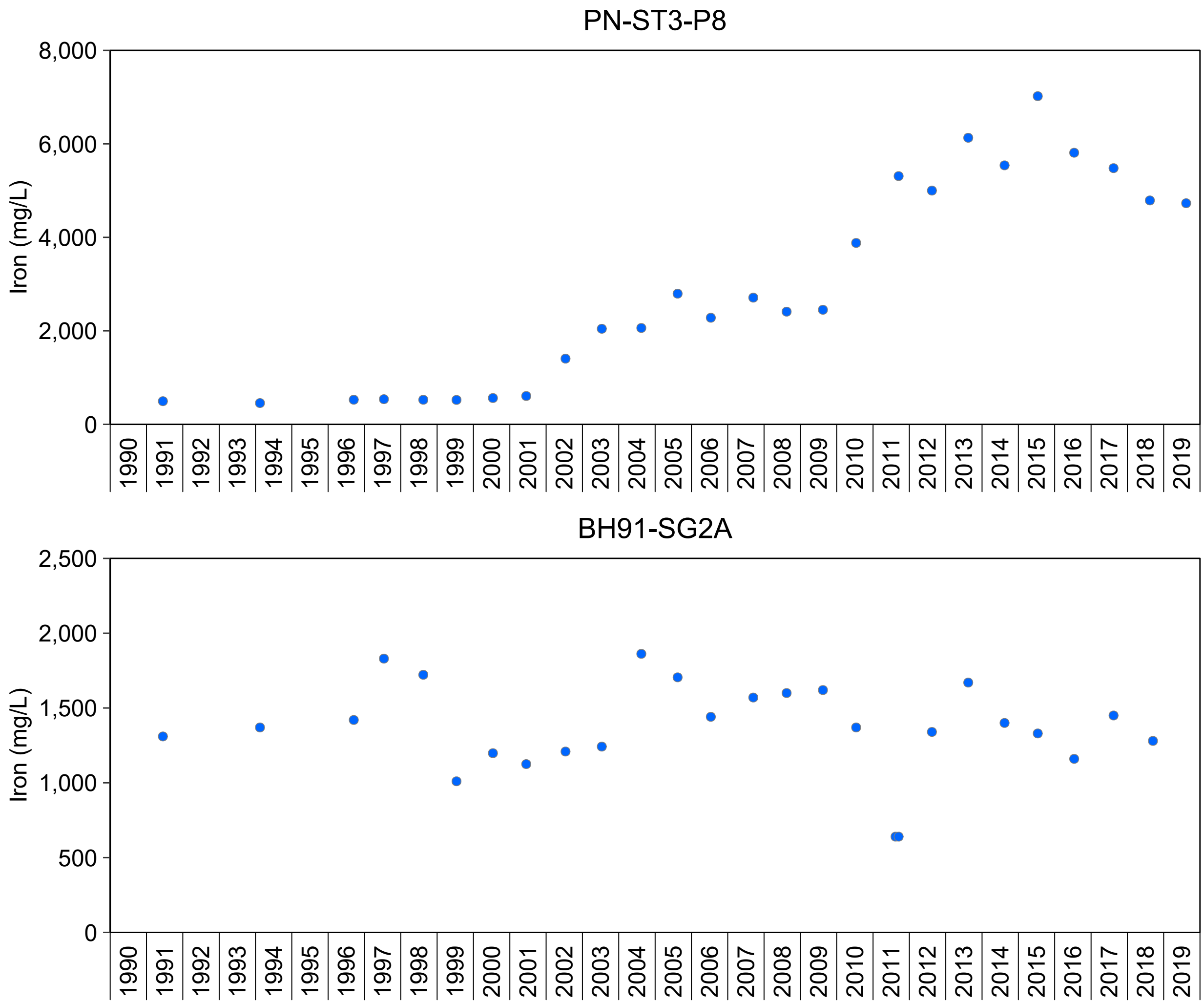


Figure C.11: Concentrations of Iron for TOMP Pore Water Stations, Stanrock TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 3.5 for Kendall trend analysis results and Appendix Table C.9 for raw data.

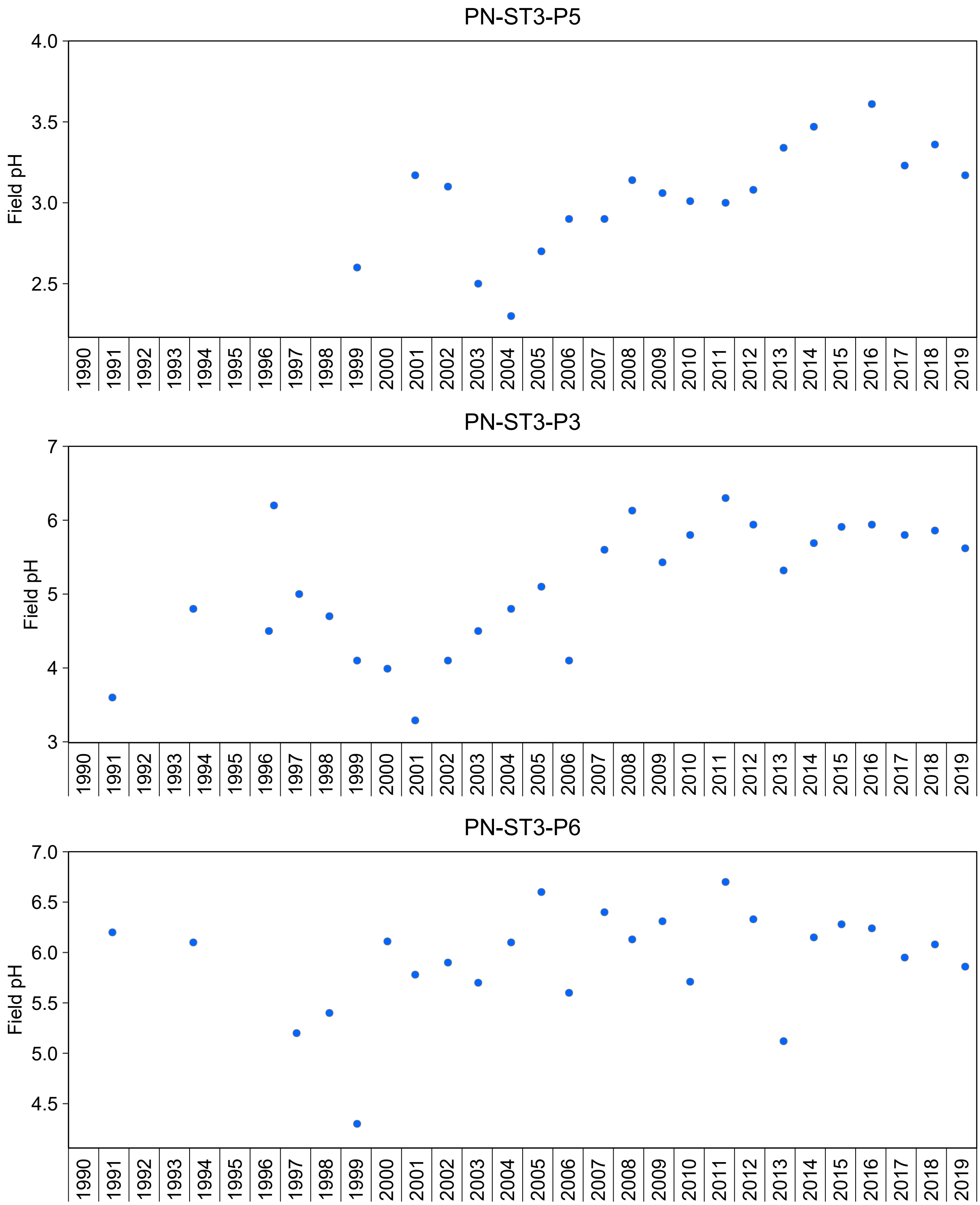


Figure C.12: Field Measurements of pH for TOMP Pore Water Stations, Stanrock TMA, 1990 to 2019

Notes: See Table 3.5 for Kendall trend analysis results and Appendix Table C.9 for raw data.

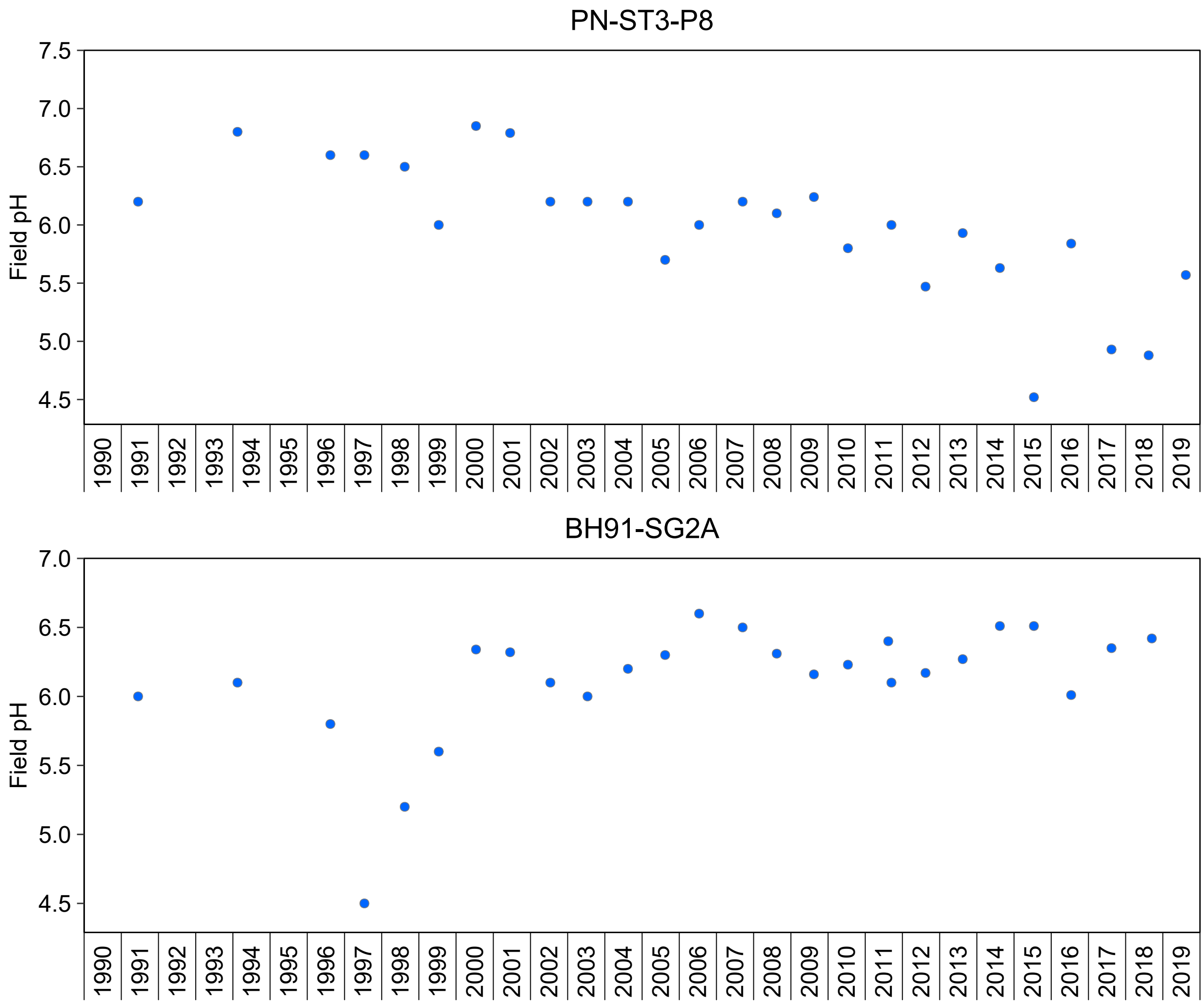


Figure C.12: Field Measurements of pH for TOMP Pore Water Stations, Stanrock TMA, 1990 to 2019

Notes: See Table 3.5 for Kendall trend analysis results and Appendix Table C.9 for raw data.

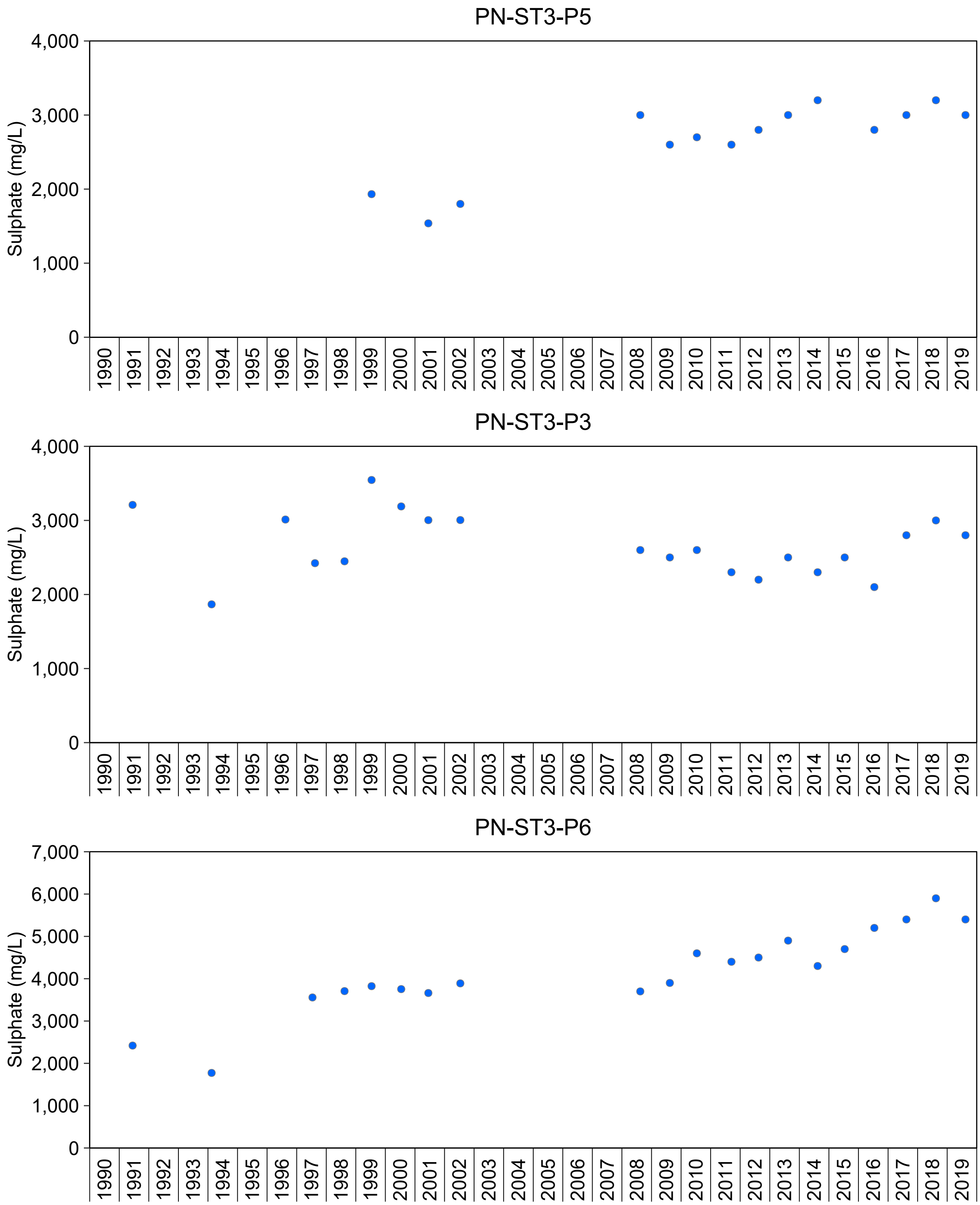


Figure C.13: Concentrations of Sulphate for TOMP Pore Water Stations, Stanrock TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL.
See Table 3.5 for Kendall trend analysis results and Appendix Table C.9 for raw data.

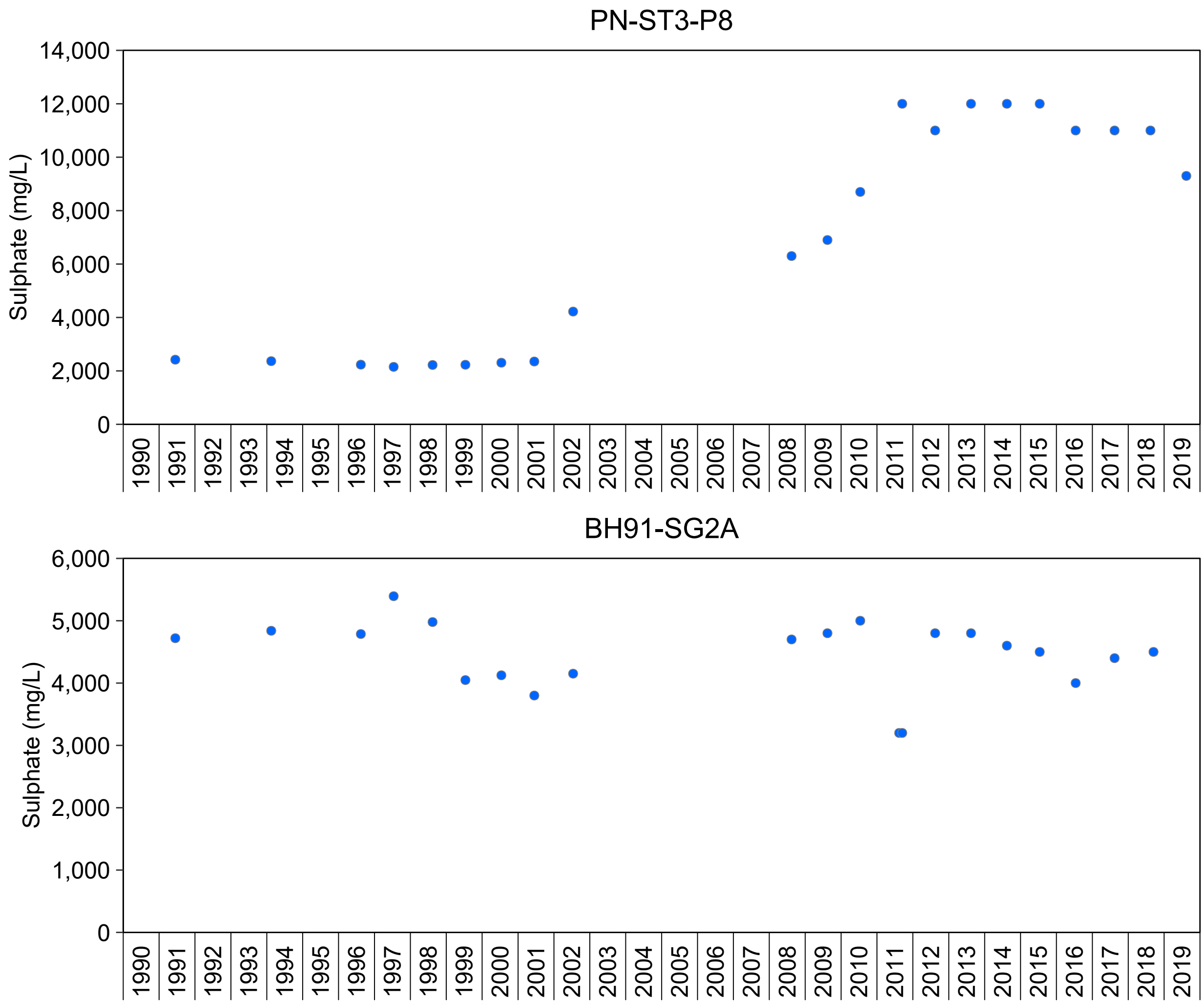


Figure C.13: Concentrations of Sulphate for TOMP Pore Water Stations, Stanrock TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 3.5 for Kendall trend analysis results and Appendix Table C.9 for raw data.

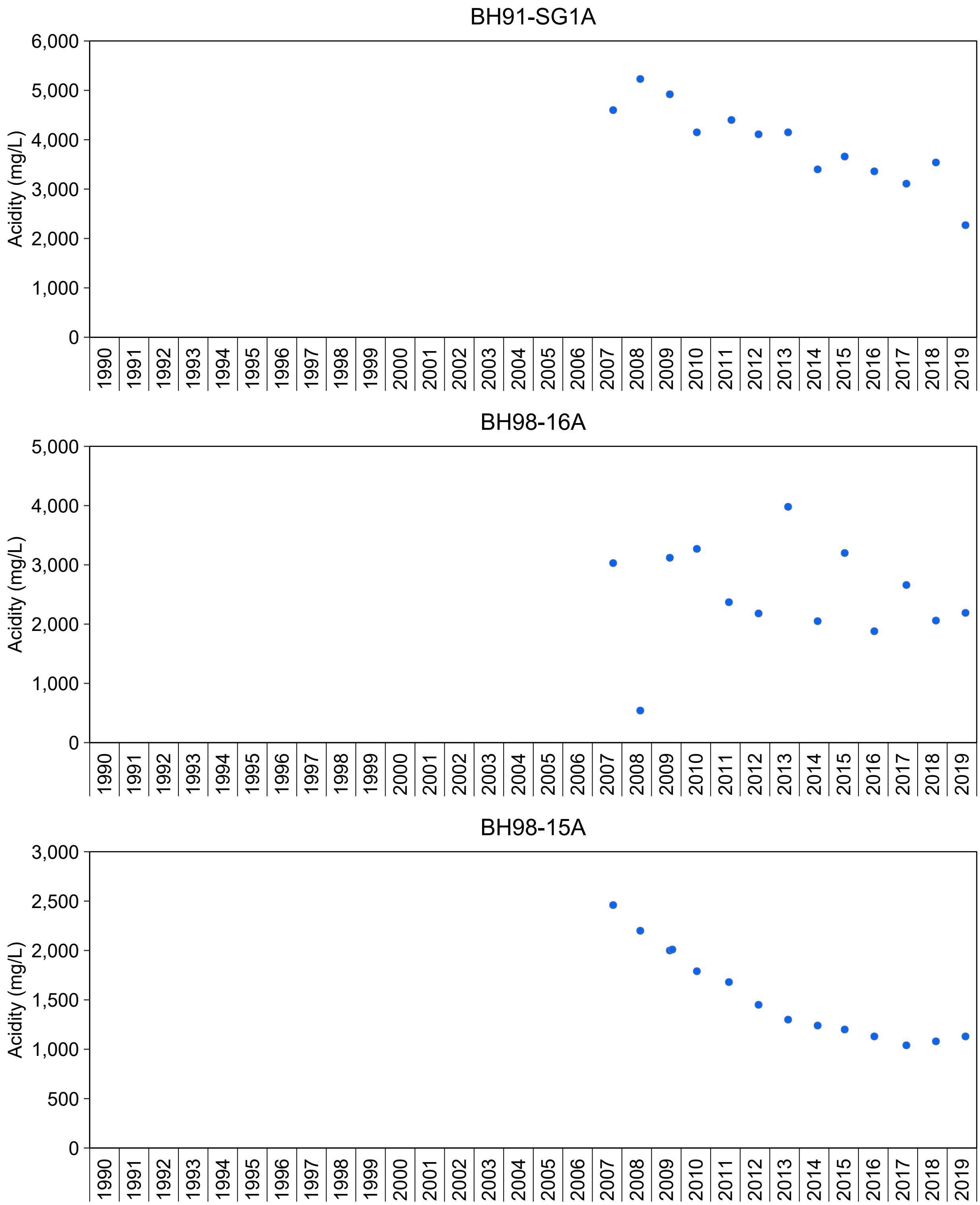


Figure C.14: Concentrations of Acidity for TOMP Groundwater Stations, Stanrock TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Due to a change in analytical technique for acidity in 2006, acidity trends were assessed from 2007 to 2019. See Table 3.6 for Kendall trend analysis results and Appendix Table C.10 for raw data.

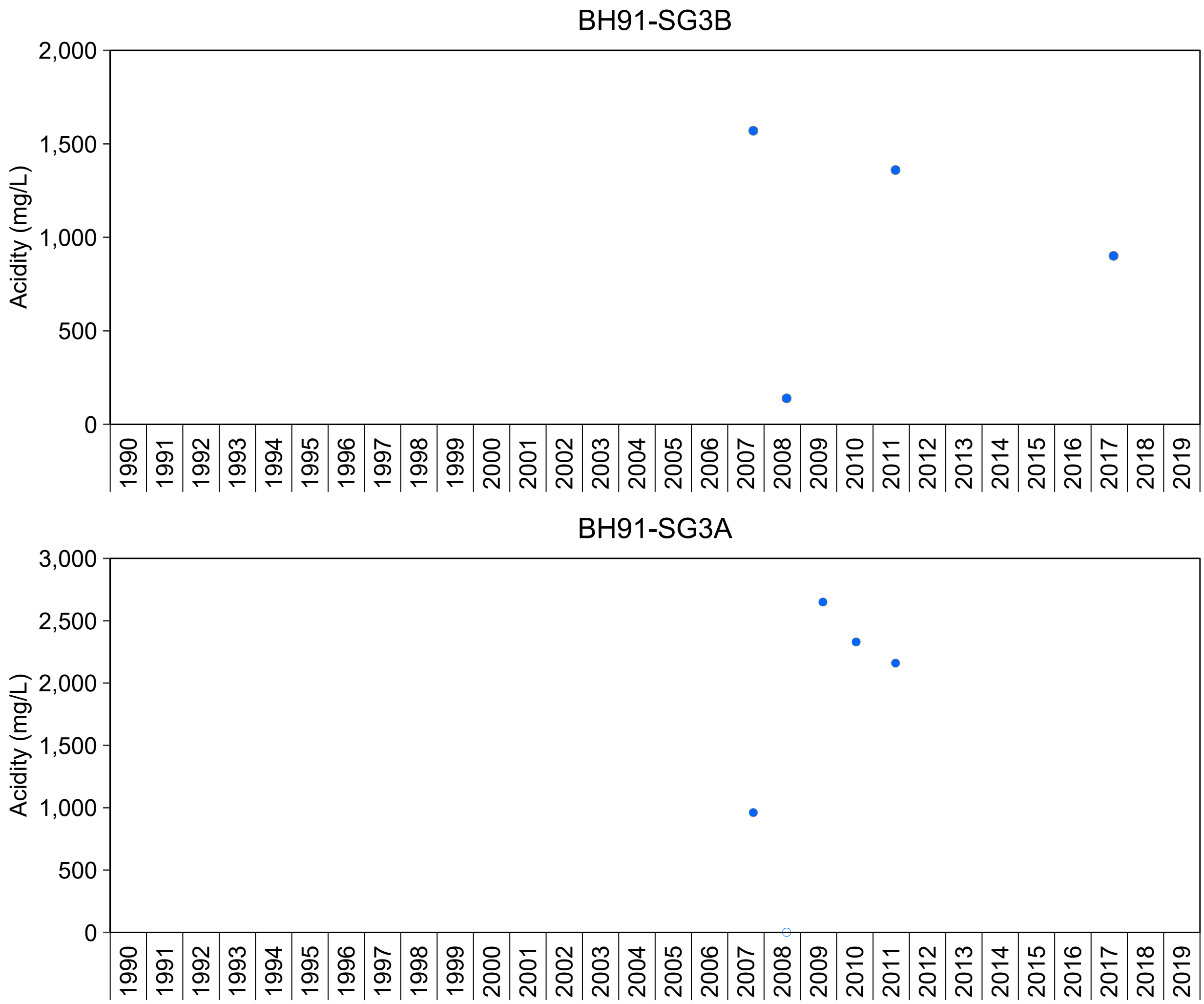


Figure C.14: Concentrations of Acidity for TOMP Groundwater Stations, Stanrock TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Due to a change in analytical technique for acidity in 2006, acidity trends were assessed from 2007 to 2019. See Table 3.6 for Kendall trend analysis results and Appendix Table C.10 for raw data.

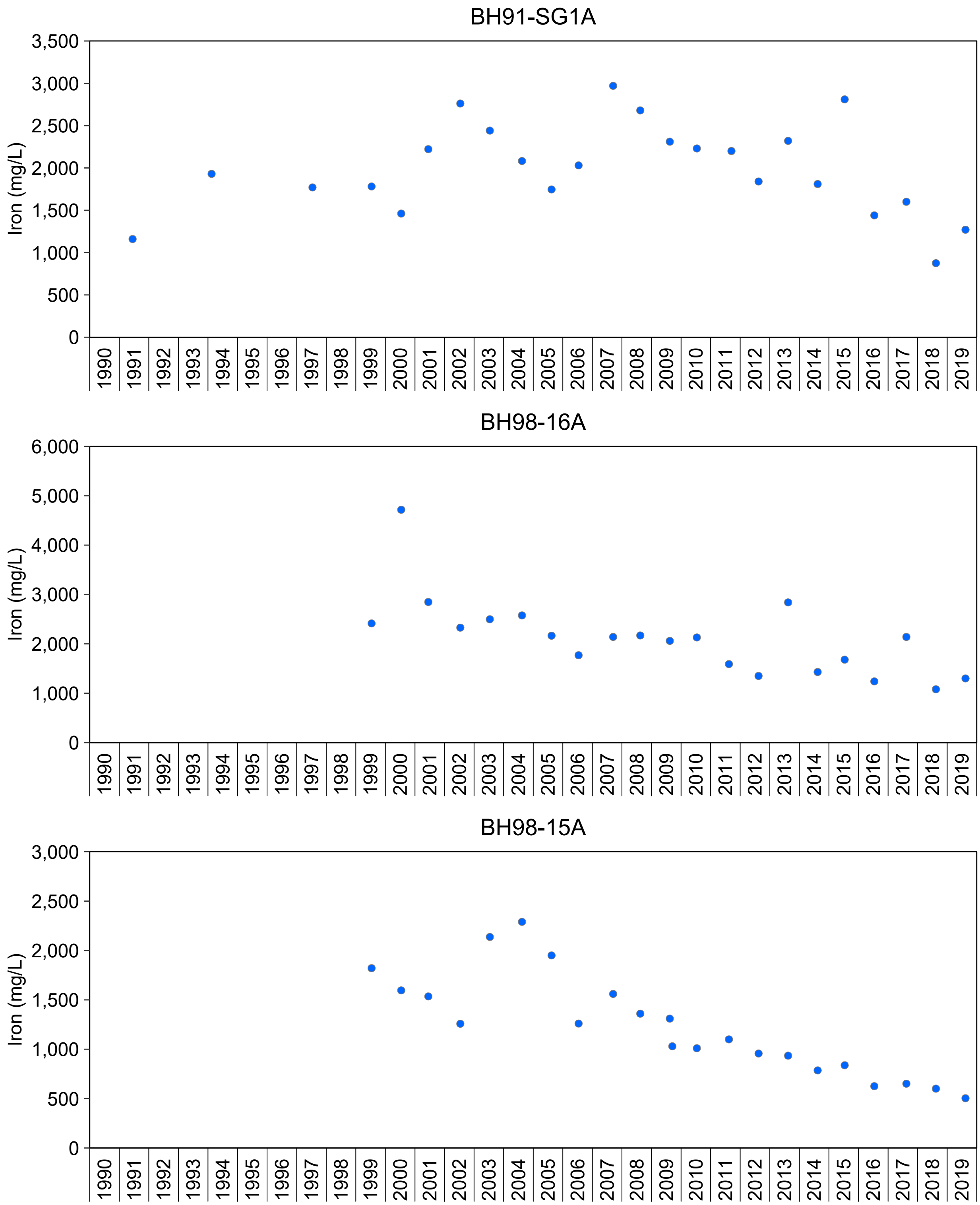


Figure C.15: Concentrations of Iron for TOMP Groundwater Stations, Stanrock TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 3.6 for Kendall trend analysis results and Appendix Table C.10 for raw data.

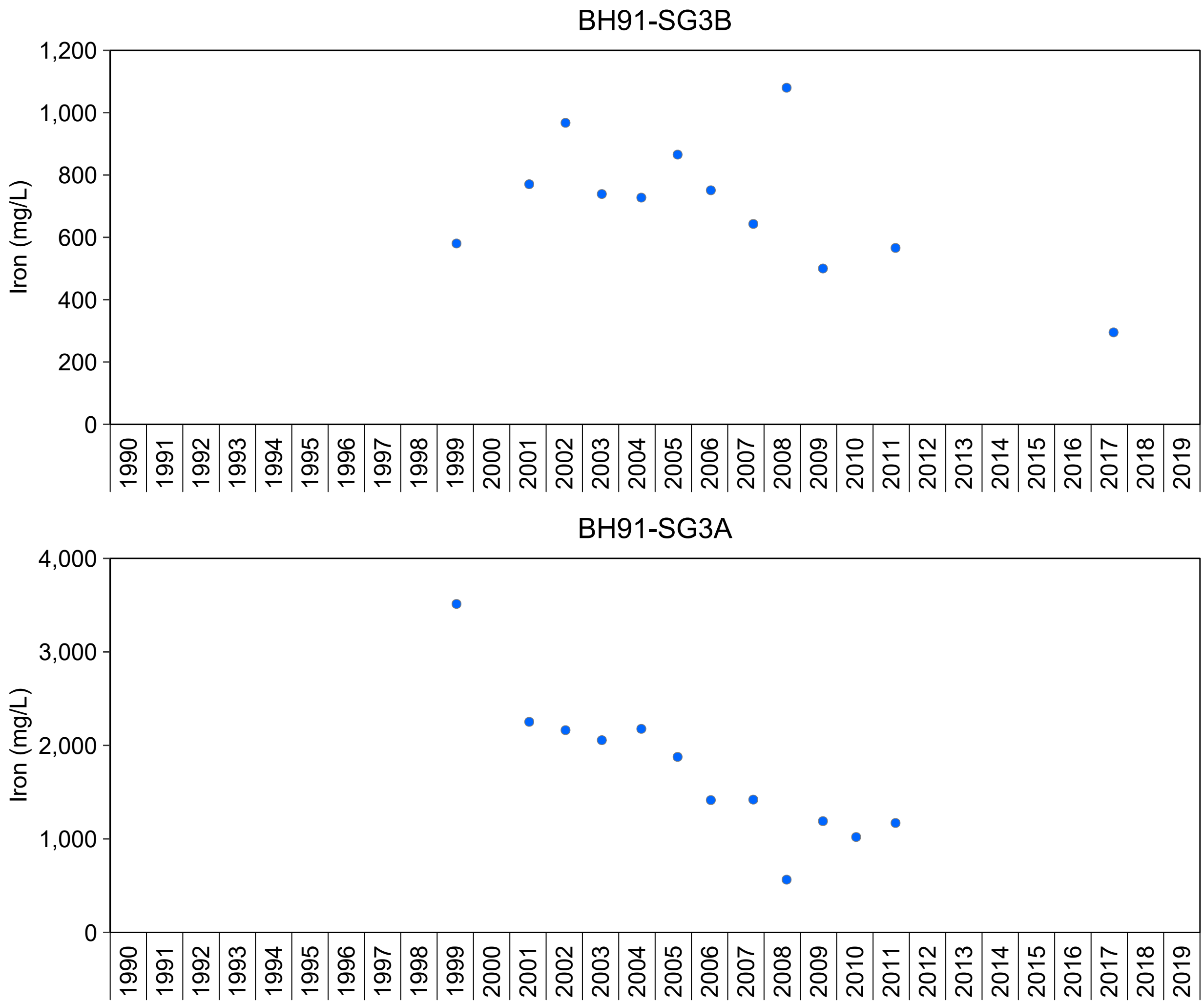


Figure C.15: Concentrations of Iron for TOMP Groundwater Stations, Stanrock TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 3.6 for Kendall trend analysis results and Appendix Table C.10 for raw data.

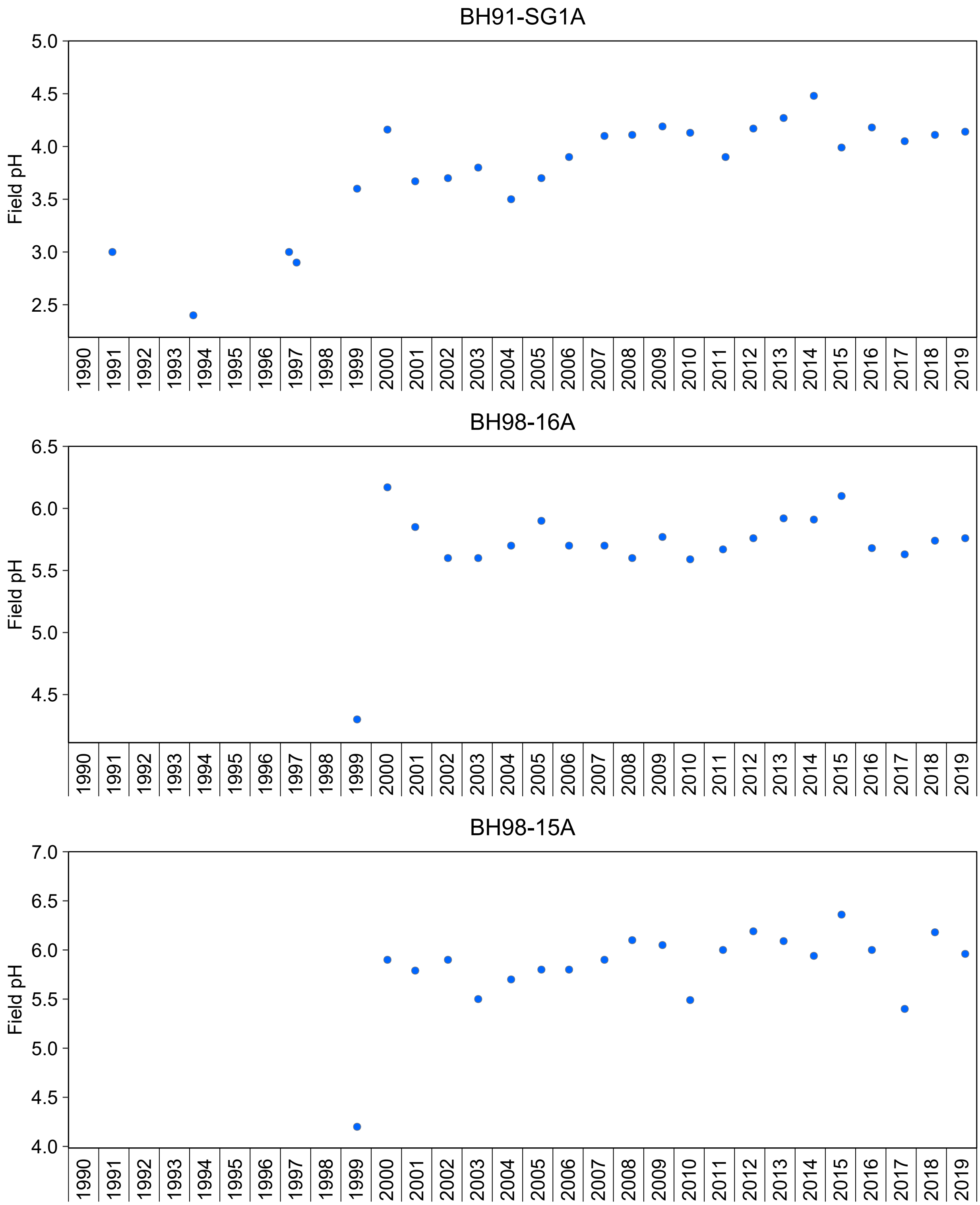


Figure C.16: Field Measurements of pH for TOMP Groundwater Stations, Stanrock TMA, 1990 to 2019

Notes: See Table 3.6 for Kendall trend analysis results and Appendix Table C.10 for raw data.

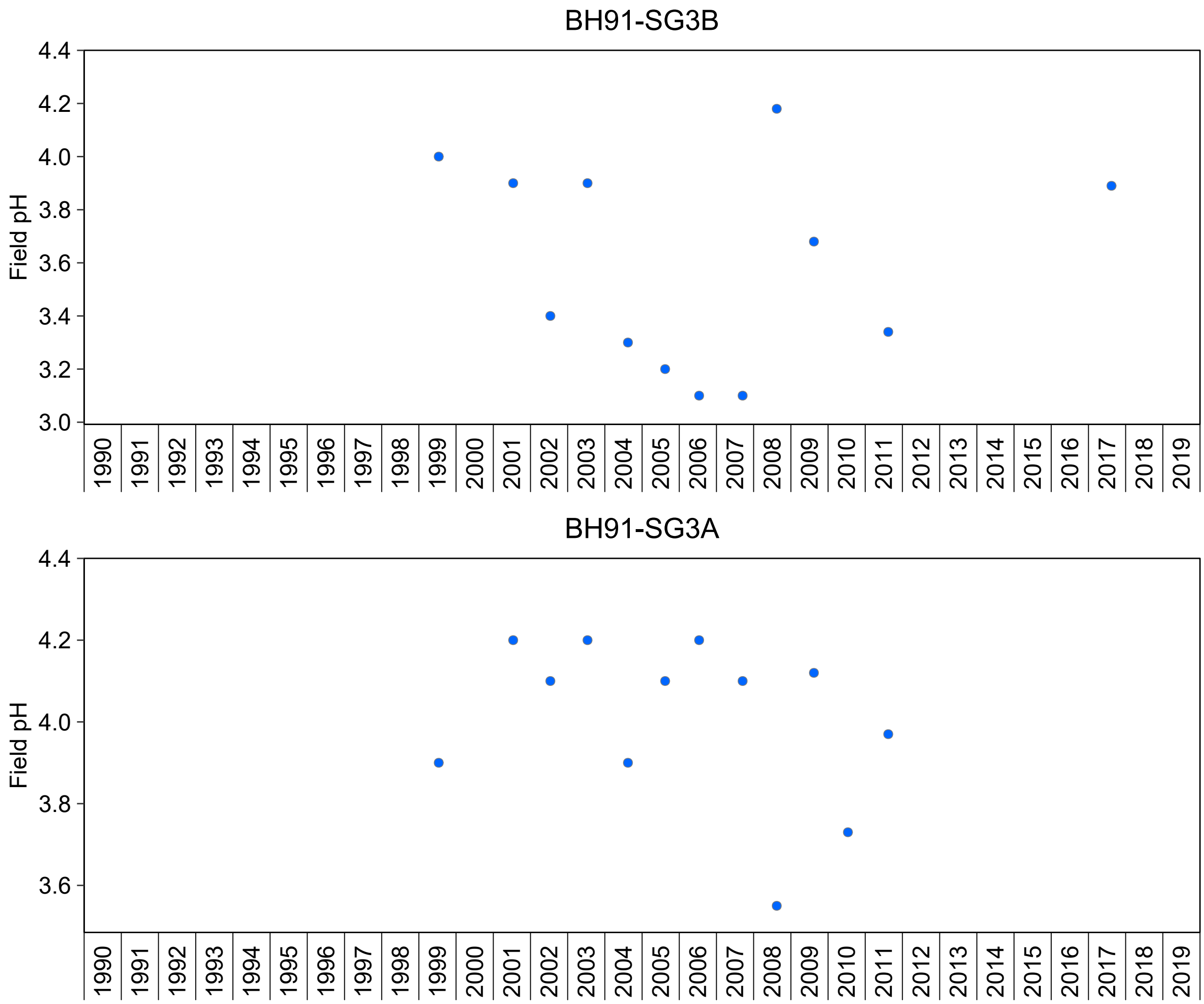


Figure C.16: Field Measurements of pH for TOMP Groundwater Stations, Stanrock TMA, 1990 to 2019

Notes: See Table 3.6 for Kendall trend analysis results and Appendix Table C.10 for raw data.

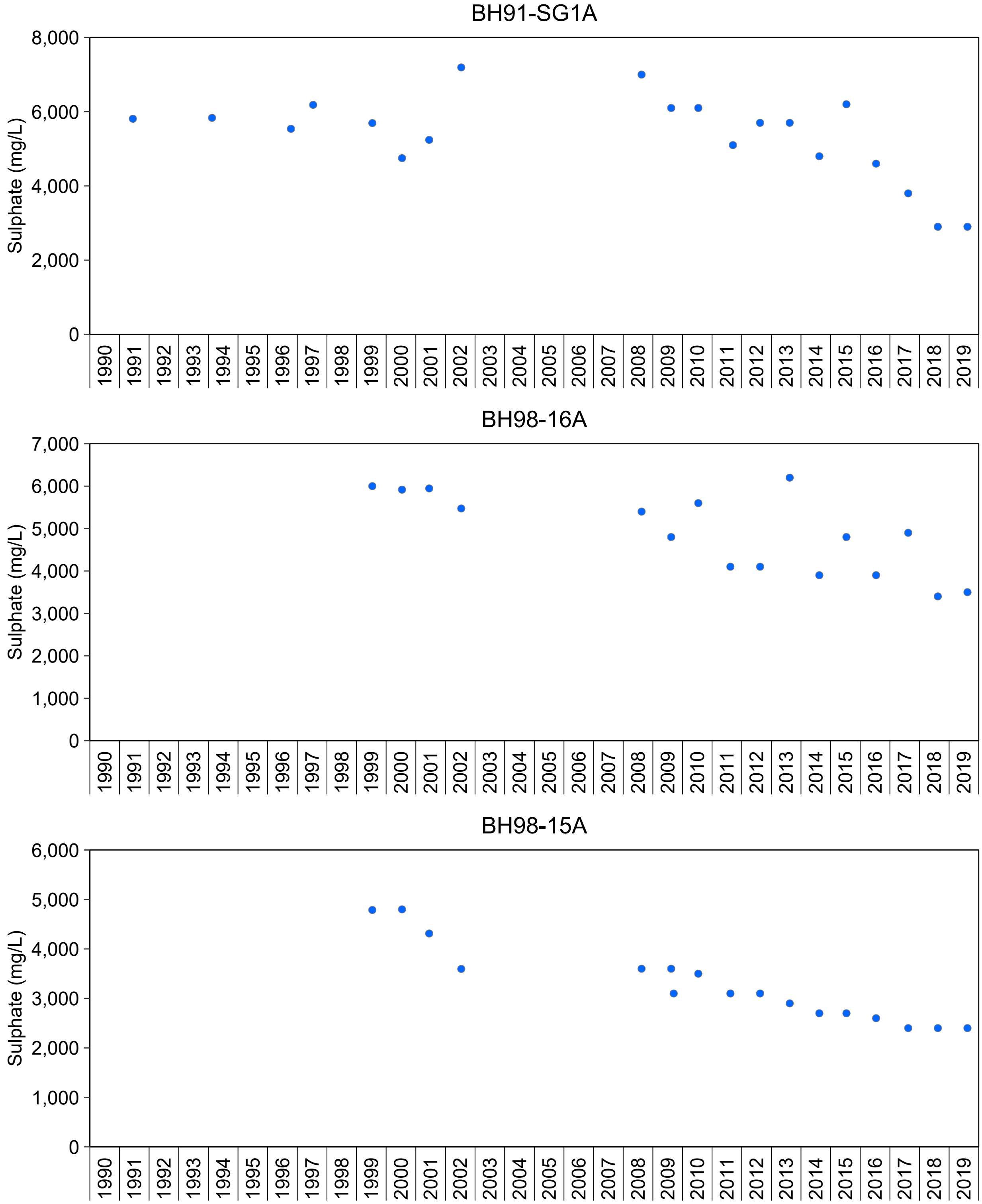
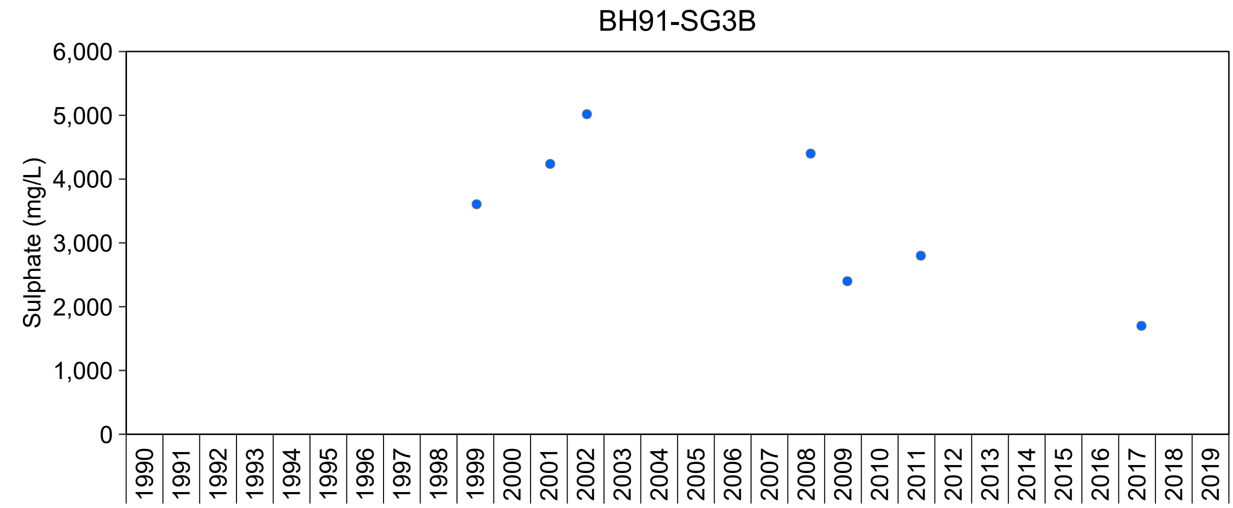


Figure C.17: Concentrations of Sulphate for TOMP Groundwater Stations, Stanrock TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL.
See Table 3.6 for Kendall trend analysis results and Appendix Table C.10 for raw data.



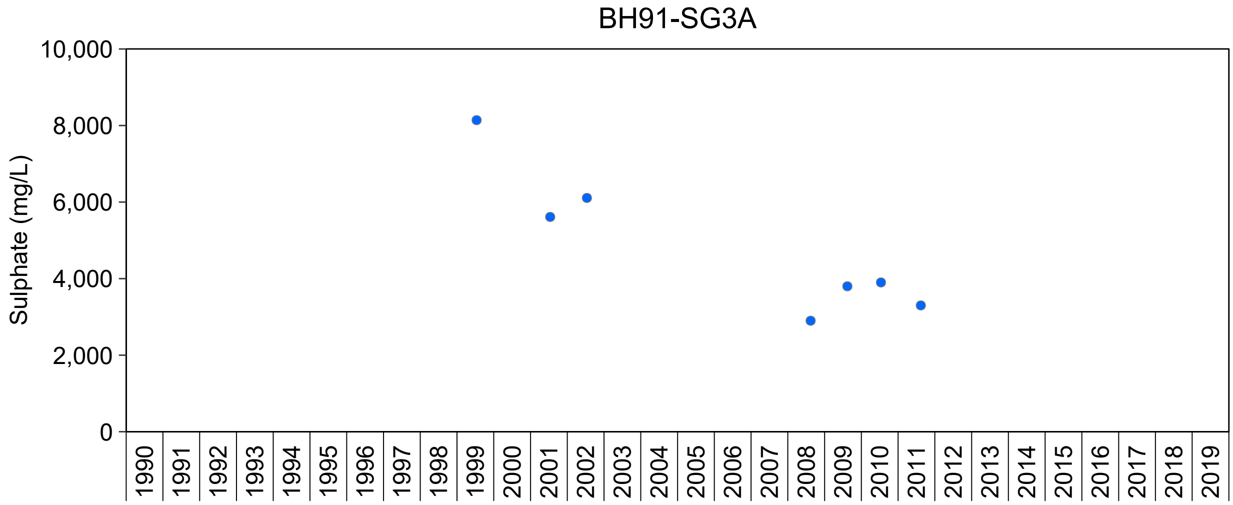


Figure C.17: Concentrations of Sulphate for TOMP Groundwater Stations, Stanrock TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL.
See Table 3.6 for Kendall trend analysis results and Appendix Table C.10 for raw data.

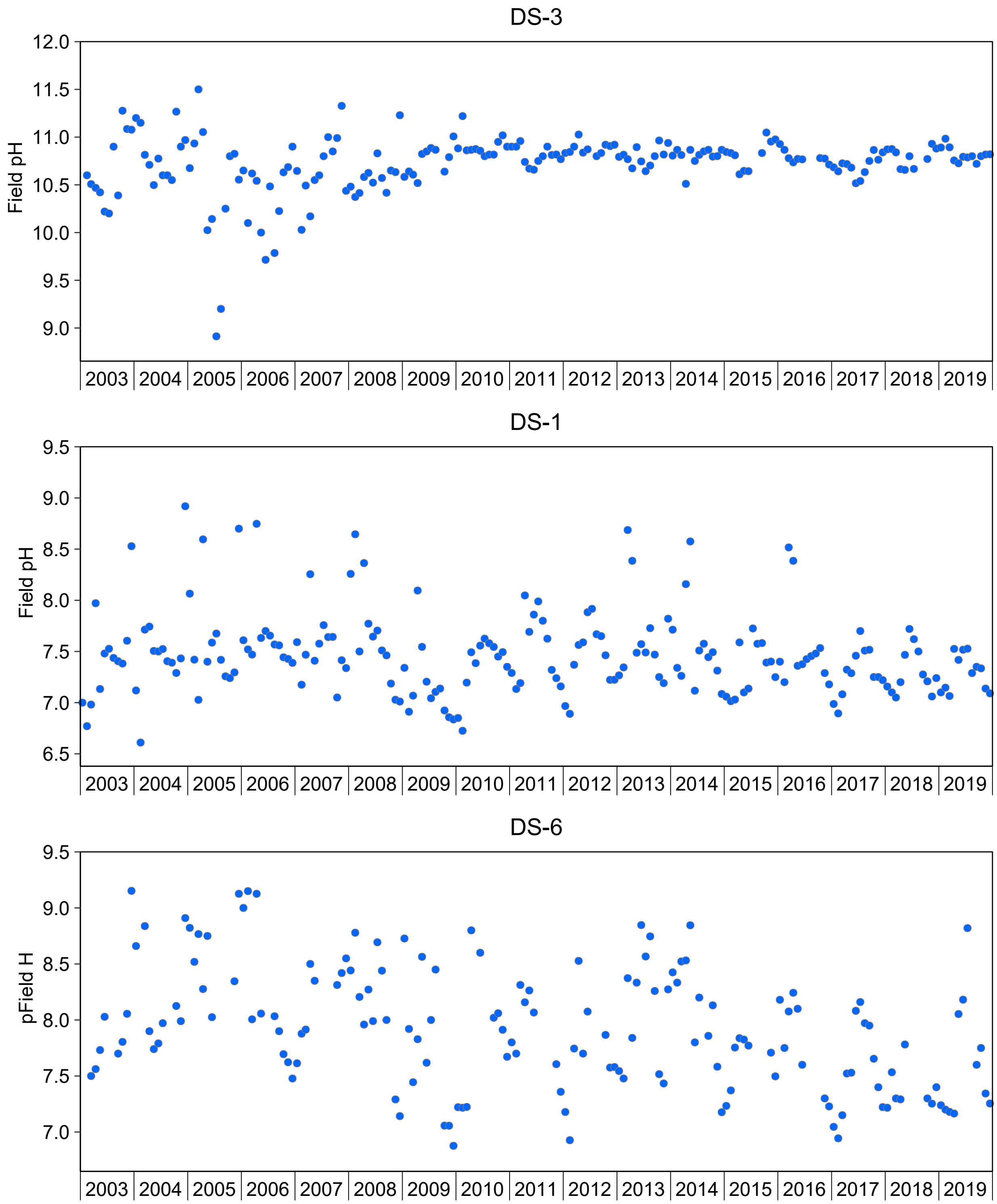


Figure C.18: Field Measurements of pH for TOMP Water Monitoring Stations, Stanrock TMA, 2003 to 2019

Notes: pH is not included in the trend analysis for TOMP stations DS-3, DS-1, DS-6, and DS-5 because the monitoring is in support of ETP operations. Other stations at this TMA provide more meaningful information regarding trends for this parameter. Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Tables C.4, C.6, and C.7 for raw data.

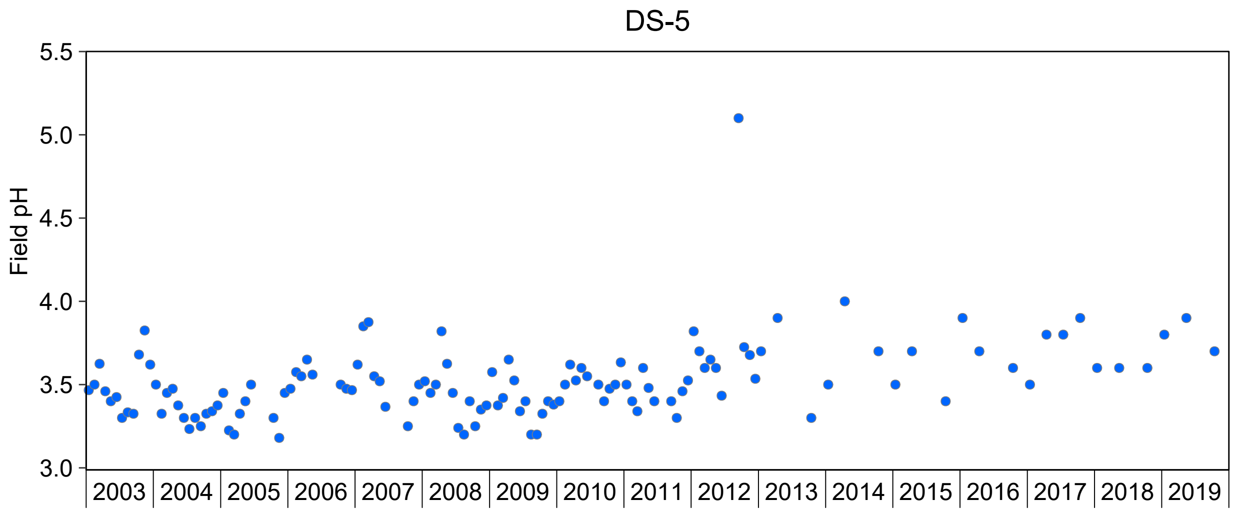


Figure C.18: Field Measurements of pH for TOMP Water Monitoring Stations, Stanrock TMA, 2003 to 2019

Notes: pH is not included in the trend analysis for TOMP stations DS-3, DS-1, DS-6, and DS-5 because the monitoring is in support of ETP operations. Other stations at this TMA provide more meaningful information regarding trends for this parameter. Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Table C.8 for raw data.

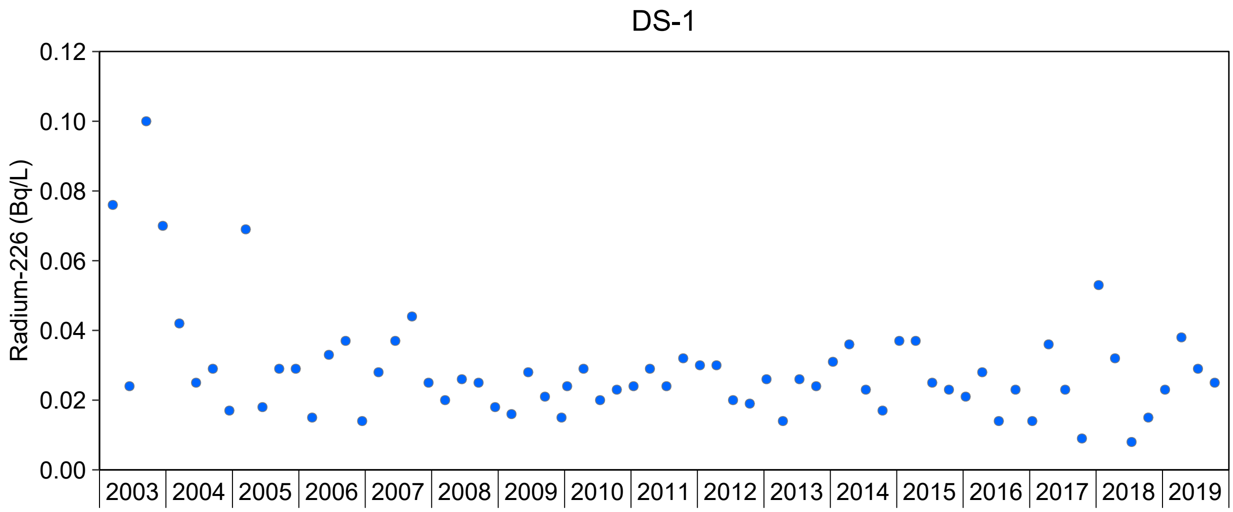


Figure C.19: Concentrations of Radium-226 for TOMP Water Monitoring Stations, Stanrock TMA, 2003 to 2019

Notes: Radium-226 is not included in the trend analysis for TOMP station DS-1 because the monitoring is in support of ETP operations. Other stations at this TMA provide more meaningful information regarding trends for this parameter. Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Table C.6 for raw data.

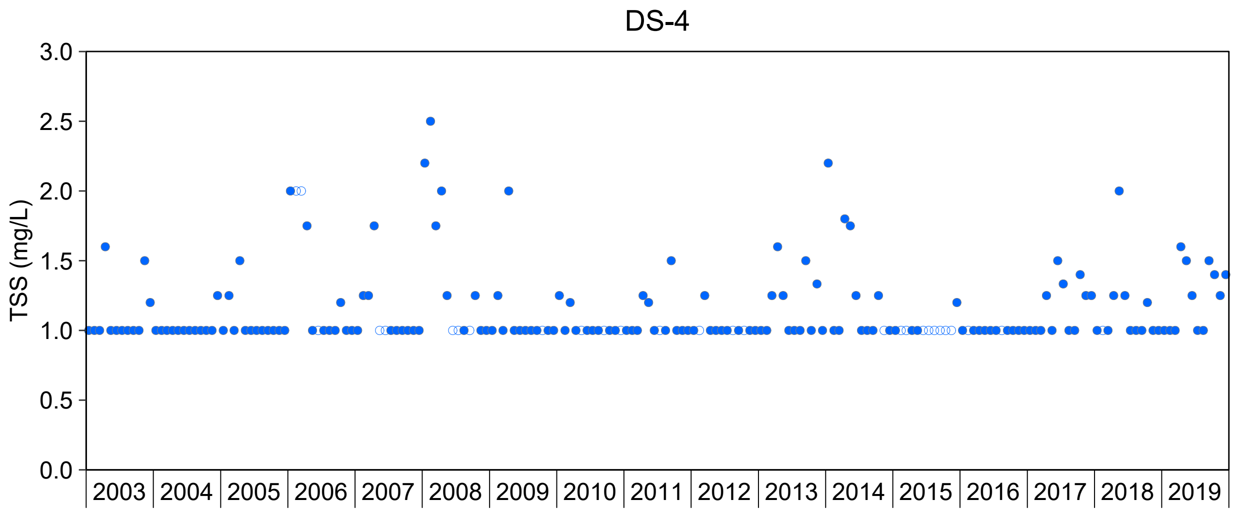


Figure C.20: Concentrations of Total Suspended Solids for TOMP Water Monitoring Stations, Stanrock TMA, 2003 to 2019

Notes: TSS is not included in the trend analysis for TOMP station DS-4 because the monitoring is in support of ETP operations. Other stations at this TMA provide more meaningful information regarding trends for this parameter. Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Table C.5 for raw data.

Table C.1: Location of TOMP Data Tables and Figures Within this Cycle 5 SOE Report, Stanrock TMA

TMA	TOMP Station	Station Type/Purpose	Also a SAMP Station? [a]	Map Figures	Elevation Tables	Elevation Figures	Water Quality Data Tables (flow, acidity, barium, cobalt, iron, manganese, pH, radium-226, sulphate, uranium, conductivity, TSS, and/or treatment chemical consumption)	Comparison to EIS Predictions Figures	Lime or NaOH Consumption Figures	Barium Chloride Consumption Figures	Comparison to Discharge Criteria Figures	Trend Tables	Water Quality Data Figures										
													Acidity	Barium	Cobalt	Iron	Manganese	pH	Radium-226	Sulphate	Uranium	Conductivity	TSS
Stanrock	DS-2	Basin performance (primary), ETP operations	no	3.2	na	na	C.3	na-p	3.5	3.5	na-c	3.4	C.1	C.2	C.3	C.4	C.5	C.6	C.7	C.8	C.9	na	na
	DS-3	ETP operations	no	3.2	na	na	C.4	na-p	na	na	na-c	na-t	na	na	na	na	na	C.18	na	na	na	na	na
	DS-4	Effluent	YES	3.1, 3.2	na	na	C.5	na-p	na	na	3.6, 3.7	3.11	na	M.1	M.2	M.3	M.4	M.5	M.6	M.7	M.8	na	C.20
	DS-1	Additional pH control, radium monitoring	no	3.2	na	na	C.6	na-p	na	na	na-c	na-t	na	na	na	na	na	C.18	C.19	na	na	na	na
	DS-6	Additional pH control	no	3.2	na	na	C.7	na-p	na	na	na-c	na-t	na	na	na	na	na	C.18	na	na	na	na	na
	DS-5	Seepages and surface water internal to TMA	no	3.2	na	na	C.8	na-p	na	na	na-c	na-t	na	na	na	na	na	C.18	na	na	na	C.16	na
	PN-ST3-P(3,5,6,8); BH91-SG2(A,D)	Pore water	no	3.2	na	na	C.9	na-p	na	na	na-c	3.5	C.12	na	na	C.13	na	C.10	na	C.11	na	na	na
	BH91-SG1A, BH98-16A, BH98-15A, BH91-SG3(A,B)	Groundwater	no	3.2	na	na	C.10	na-p	na	na	na-c	3.6	C.16	na	na	C.17	na	C.14	na	C.15	na	na	na

Notes: na = parameter not measured at this station (as per study design); therefore, data presentation is not applicable. na-p = EIS Predictions do not apply to this station (as per study design); therefore, data presentation is not applicable. na-c = discharge criteria do not apply to this station (as per study design); therefore, data presentation is not applicable. na-t = at this station, only one to three parameters (elevation, pH, flow, conductivity, and/or radium-226) are monitored to support ETP operations. Other stations provide more meaningful information regarding trends for these parameters; therefore, data presentation is not applicable.

[a] Data for this TOMP station also pertain to the SAMP. Trends are assessed in the SAMP section and water quality figures are provided in the SAMP section (Table 2.6).

Table C.2: 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 / Total Radium-226[c]	Bq/L	1.11	0.37
Total Suspended Solids	mg/L	50	25

[a] Samples to be collected during periods of discharge.

[b] Arithmetic mean of twelve consecutive samples.

[c] Discharge criteria are for dissolved radium-226, but the amended Stanrock C of A from MECP (Oct, 2009) limit has been updated to total radium. Measured and reported values are for total radium- 226.

Table C.3: Water Quality at TOMP Station DS-2 (Basin Performance - Primary, ETP Operations), Stanrock TMA, 2015 to 2019

Date	Flow (L/s)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Lime Consumption (kg per month)	Barium Chloride Consumption (kg per month)	Acidity (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
13-Jan-15	128	3.00	610	0.174	7.4	50.6	215	0.0420	0.0878	56.9	1.51	0.0308
12-Feb-15	131	3.00	-	0.121	4.1	29.2	-	-	-	-	-	-
17-Mar-15	0	-	-	0.127	6.9	52.7	-	-	-	-	-	-
24-Mar-15	126	3.00	-	0.102	6.9	52.7	-	-	-	-	-	-
14-Apr-15	190	3.30	280	0.136	23.6	209.4	108	0.0470	0.0466	31.1	0.697	0.0165
12-May-15	137	2.70	-	0.133	9.8	77.1	-	-	-	-	-	-
12-Jun-15	69.0	2.80	-	0.164	5.8	42.1	-	-	-	-	-	-
29-Sep-15	95.0	2.60	840	0.221	2.6	9.9	310	0.0140	0.0883	43.0	2.77	0.0209
13-Oct-15	100	2.60	800	0.202	5.4	26.9	289	0.0140	0.0826	55.6	2.78	0.0198
10-Nov-15	78.8	2.90	-	0.177	28.7	139.9	-	-	-	-	-	-
8-Dec-15	124	3.20	-	0.0900	32	167.5	-	-	-	-	-	-
12-Jan-16	112	3.10	380	0.169	10.7	75.3	161	0.0530	0.0670	39.2	0.934	0.0328
9-Feb-16	145	3.00	-	0.143	10.1	66.7	-	-	-	-	-	-
8-Mar-16	139	2.90	-	0.176	28.3	224.2	-	-	-	-	-	-
12-Apr-16	100	3.10	380	0.166	24.2	134.7	173	0.0270	0.0694	45.3	0.998	0.0344
10-May-16	139	3.10	-	0.181	6.1	29.7	-	-	-	-	-	-
7-Jun-16	122	2.70	-	0.211	3.6	11.9	-	-	-	-	-	-
6-Oct-16	121	2.60	980	0.202	5.5	19.3	372	0.00900	0.0993	51.7	3.24	0.0290
8-Nov-16	139	2.60	-	0.196	12.3	37.5	-	-	-	-	-	-
21-Dec-16	151	2.70	-	0.194	16.3	54.1	-	-	-	-	-	-
10-Jan-17	154	2.70	-	-	14.06	59.3	-	-	-	-	-	-
18-Jan-17	151	2.80	570	0.169	14.06	59.3	234	0.0170	0.0799	44.2	1.86	0.0308
15-Feb-17	155	2.80	-	0.170	15.1	55.4	-	-	-	-	-	-
21-Mar-17	114	2.90	-	0.100	23.77	103.6	-	-	-	-	-	-
11-Apr-17	136	2.70	200	0.136	22.36	177.06	96.0	0.0190	0.0411	22.3	0.444	0.0227
23-May-17	154	2.70	-	0.172	20	97.82	-	-	-	-	-	-
19-Jun-17	160	2.50	-	0.205	14.6	57.4	-	-	-	-	-	-
27-Jul-17	142	2.60	740	0.237	78.96	53.5	248	0.0180	0.0899	27.7	1.77	0.0355
15-Aug-17	143	2.70	-	0.237	11.9	71.7	-	-	-	-	-	-
13-Sep-17	115	2.50	-	0.232	6.05	41.08	-	-	-	-	-	-
10-Oct-17	130	2.90	-	-	30.5	249.8	-	-	-	-	-	-
12-Oct-17	94.0	2.90	500	0.199	30.5	249.8	196	0.0190	0.0620	21.0	1.32	0.0192
14-Nov-17	132	3.00	-	0.166	18.35	168	-	-	-	-	-	-
14-Dec-17	148	3.10	-	0.160	16.3	122.1	-	-	-	-	-	-
9-Jan-18	148	3.00	500	0.195	9.9	42.2	184	0.0140	0.0700	44.5	1.39	0.0192
14-Feb-18	138	2.90	-	0.165	4.6	19	-	-	-	-	-	-
15-Mar-18	133	2.80	-	0.137	3.1	9.7	-	-	-	-	-	-
12-Apr-18	136	2.80	650	0.130	11.6	36	261	0.0140	0.0923	81.9	2.74	0.0186
8-May-18	158	3.40	-	0.153	15.1	109.8	-	-	-	-	-	-
20-Jun-18	124	2.70	-	0.207	6.48	23.68	-	-	-	-	-	-
10-Jul-18	90.0	2.70	680	0.730	1.8	6	289	0.0290	0.0803	32.6	2.40	0.0171
9-Oct-18	86.0	2.80	550	0.208	26.1	151.3	190	0.0200	0.0723	29.4	1.94	0.0202
13-Nov-18	126	2.80	-	0.192	15.9	73.9	-	-	-	-	-	-
11-Dec-18	134	3.00	-	0.190	11.8	7.9	-	-	-	-	-	-
8-Jan-19	134	2.80	580	0.181	9.1	33.6	229	0.0160	0.0781	49.5	1.59	0.0315
12-Feb-19	117	2.80	-	0.136	4.77	9.71	-	-	-	-	-	-
12-Mar-19	95.0	2.90	-	0.155	15.3	36.2	-	-	-	-	-	-
9-Apr-19	163	2.90	470	0.123	29	179.2	207	0.0100	0.0723	43.4	1.03	0.0353
14-May-19	126	3.00	-	0.163	23.31	248.51	-	-	-	-	-	-
11-Jun-19	118	2.90	-	0.196	17.4	87.3	-	-	-	-	-	-
11-Jul-19	125	2.80	460	0.387	8.5	28.8	196	0.0180	0.0562	21.2	1.25	0.0154
27-Aug-19	95.0	2.50	-	0.797	2.5	4	-	-	-	-	-	-
24-Sep-19	131	2.80	-	0.431	3.6	17.5	-	-	-	-	-	-
8-Oct-19	126	2.60	450	0.250	26.4	150.4	154	0.0190	0.0521	19.3	1.35	0.0141
14-Nov-19	141	2.70	-	0.188	16.9	92.6	-	-	-	-	-	-
10-Dec-19	118	3.30	-	0.195	9.3	50.3	-	-	-	-	-	-
n	683	55	19	53	60	60	19	19	19	19	19	19
Minimum	47.0	2.50	200	0.0900	0	0	96.0	0.00900	0.0411	19.3	0.444	0.0141
Maximum	230	3.40	980	0.797	79.0	250	372	0.0530	0.0993	81.9	3.24	0.0355
Mean	130	2.85	559	0.205	13.1	68.9	216	0.0221	0.0730	40.0	1.68	0.0244
SD	28.8	0.205	194	0.126	12.5	67.1	68.6	0.0124	0.0160	15.7	0.784	0.00749
Median	130	2.80	550	0.177	10.4	50.4	207	0.0180	0.0723	43.0	1.51	0.0209
10th Percentile	95.0	2.60	280	0.130	0	0	108	0.0100	0.0466	21.0	0.697	0.0154
95th Percentile	185	3.30	980	0.431	29.8	217	372	0.0530	0.0993	81.9	3.24	0.0355

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table C.4: Water Quality at TOMP Station DS-3 (ETP Operations), Stanrock TMA, 2015 to 2019

Date	pH
6-Jan-15	10.9
7-Jan-15	10.8
9-Jan-15	10.8
13-Jan-15	10.8
14-Jan-15	10.8
20-Jan-15	10.9
21-Jan-15	10.8
28-Jan-15	10.8
29-Jan-15	11.0
4-Feb-15	10.8
5-Feb-15	10.8
12-Feb-15	10.9
13-Feb-15	10.9
24-Feb-15	10.8
25-Feb-15	10.8
5-Mar-15	11.0
6-Mar-15	10.8
12-Mar-15	11.0
13-Mar-15	10.8
19-Mar-15	10.8
20-Mar-15	10.8
24-Mar-15	10.9
25-Mar-15	10.6
27-Mar-15	10.7
31-Mar-15	10.7
1-Apr-15	10.8
2-Apr-15	10.8
6-Apr-15	10.7
7-Apr-15	10.6
8-Apr-15	10.7
9-Apr-15	10.6
10-Apr-15	10.7
13-Apr-15	10.6
14-Apr-15	10.6
15-Apr-15	10.0
16-Apr-15	9.90
17-Apr-15	10.6
20-Apr-15	10.6
21-Apr-15	10.8
22-Apr-15	10.8
23-Apr-15	10.8
24-Apr-15	10.8
27-Apr-15	10.6
30-Apr-15	10.6
1-May-15	10.6
4-May-15	10.6
7-May-15	10.7
8-May-15	10.7
12-May-15	10.6
13-May-15	10.6
14-May-15	10.6
15-May-15	10.6
25-May-15	10.7
26-May-15	10.7
27-May-15	10.7
28-May-15	10.6
29-May-15	10.7
2-Jun-15	10.7
3-Jun-15	10.5
4-Jun-15	10.6
11-Jun-15	10.7
12-Jun-15	10.7
18-Jun-15	10.6
19-Jun-15	10.7
18-Sep-15	10.9
28-Sep-15	10.7
29-Sep-15	10.9
13-Oct-15	10.9
14-Oct-15	11.0
28-Oct-15	11.0
29-Oct-15	11.2
30-Oct-15	11.1
2-Nov-15	11.0
3-Nov-15	11.2
4-Nov-15	11.1
5-Nov-15	11.1
6-Nov-15	11.3
7-Nov-15	11.0
8-Nov-15	11.0
9-Nov-15	10.9
10-Nov-15	10.9
11-Nov-15	10.9
12-Nov-15	10.9
13-Nov-15	10.9
17-Nov-15	10.7
18-Nov-15	10.9
19-Nov-15	10.8
20-Nov-15	10.8
25-Nov-15	10.8
26-Nov-15	10.9
27-Nov-15	10.7
30-Nov-15	11.1
2-Dec-15	10.8
3-Dec-15	10.8
4-Dec-15	10.9
8-Dec-15	10.8
9-Dec-15	11.2
10-Dec-15	11.0
11-Dec-15	11.0
14-Dec-15	11.1

Date	pH
15-Dec-15	10.8
16-Dec-15	11.0
17-Dec-15	11.0
18-Dec-15	11.1
21-Dec-15	11.1
22-Dec-15	11.0
23-Dec-15	11.0
24-Dec-15	11.0
7-Jan-16	10.9
8-Jan-16	10.9
11-Jan-16	10.9
12-Jan-16	11.0
14-Jan-16	10.9
20-Jan-16	10.9
21-Jan-16	10.9
25-Jan-16	11.0
26-Jan-16	10.9
28-Jan-16	11.0
29-Jan-16	10.9
2-Feb-16	11.0
3-Feb-16	10.9
4-Feb-16	10.9
5-Feb-16	10.8
9-Feb-16	10.9
10-Feb-16	10.8
12-Feb-16	10.8
18-Feb-16	10.9
19-Feb-16	10.9
23-Feb-16	10.8
24-Feb-16	10.8
29-Feb-16	10.9
1-Mar-16	10.8
4-Mar-16	11.0
8-Mar-16	10.9
9-Mar-16	10.9
10-Mar-16	10.8
11-Mar-16	10.8
14-Mar-16	10.9
15-Mar-16	10.9
16-Mar-16	11.3
17-Mar-16	11.2
18-Mar-16	11.2
21-Mar-16	10.7
22-Mar-16	10.5
23-Mar-16	10.2
24-Mar-16	10.5
28-Mar-16	10.7
29-Mar-16	10.5
30-Mar-16	10.5
31-Mar-16	10.5
1-Apr-16	10.7
4-Apr-16	10.6
5-Apr-16	10.7
6-Apr-16	10.7
11-Apr-16	10.7
12-Apr-16	10.7
13-Apr-16	10.8
18-Apr-16	10.7
19-Apr-16	10.7
20-Apr-16	10.9
21-Apr-16	10.7
22-Apr-16	10.7
25-Apr-16	10.8
26-Apr-16	10.8
27-Apr-16	10.8
28-Apr-16	10.7
29-Apr-16	10.8
5-May-16	10.8
10-May-16	10.8
11-May-16	10.7
12-May-16	10.7
13-May-16	10.8
19-May-16	10.8
20-May-16	10.8
7-Jun-16	10.8
8-Jun-16	10.7
9-Jun-16	10.8
6-Oct-16	10.9
7-Oct-16	11.1
19-Oct-16	10.8
20-Oct-16	10.3
21-Oct-16	10.8
1-Nov-16	10.7
2-Nov-16	10.6
8-Nov-16	10.9
9-Nov-16	10.8
17-Nov-16	10.8
18-Nov-16	10.8
29-Nov-16	10.8
7-Oct-16	11.1
19-Oct-16	10.8
20-Oct-16	10.3
21-Oct-16	10.8
1-Nov-16	10.7
2-Nov-16	10.6
8-Nov-16	10.9
9-Nov-16	10.8
17-Nov-16	10.8
18-Nov-16	10.8
29-Nov-16	10.8

Date	pH
7-Oct-16	11.1
19-Oct-16	10.8
20-Oct-16	10.3
21-Oct-16	10.8
1-Nov-16	10.7
2-Nov-16	10.6
8-Nov-16	10.9
9-Nov-16	10.8
17-Nov-16	10.8
18-Nov-16	10.8
29-Nov-16	10.8
30-Nov-16	10.8
1-Dec-16	10.6
2-Dec-16	10.7
7-Dec-16	10.8
8-Dec-16	10.8
9-Dec-16	10.8
16-Dec-16	10.6
21-Dec-16	10.8
22-Dec-16	10.6
4-Jan-17	10.7
5-Jan-17	10.8
10-Jan-17	10.8
11-Jan-17	10.8
18-Jan-17	10.6
19-Jan-17	10.6
20-Jan-17	10.5
24-Jan-17	10.8
25-Jan-17	10.6
26-Jan-17	10.6
30-Jan-17	10.7
31-Jan-17	10.7
2-Feb-17	10.6
3-Feb-17	10.6
8-Feb-17	10.6
9-Feb-17	11.0
10-Feb-17	10.7
15-Feb-17	10.5
16-Feb-17	10.6
17-Feb-17	10.9
22-Feb-17	10.5
23-Feb-17	10.5
24-Feb-17	10.5
28-Feb-17	10.7
1-Mar-17	10.5
2-Mar-17	10.7
3-Mar-17	10.6
6-Mar-17	10.6
7-Mar-17	10.6
8-Mar-17	10.8
9-Mar-17	10.8
10-Mar-17	10.6
13-Mar-17	10.6
14-Mar-17	10.8
17-Mar-17	11.0
20-Mar-17	10.8
21-Mar-17	11.0
24-Mar-17	11.0
26-Mar-17	11.1
27-Mar-17	10.5
28-Mar-17	10.5
29-Mar-17	10.8
30-Mar-17	10.6
31-Mar-17	10.6
3-Apr-17	10.7
4-Apr-17	10.6
5-Apr-17	10.9
6-Apr-17	10.9
7-Apr-17	10.7
10-Apr-17	10.8
11-Apr-17	10.8
12-Apr-17	10.6
13-Apr-17	10.6
17-Apr-17	10.6
18-Apr-17	10.7
19-Apr-17	10.7
20-Apr-17	10.7
21-Apr-17	10.7
24-Apr-17	10.7
25-Apr-17	10.7
28-Apr-17	10.8
1-May-17	10.8
2-May-17	10.7
3-May-17	10.7
4-May-17	10.7
5-May-17	10.7
9-May-17	10.7
11-May-17	10.7
12-May-17	10.5
19-May-17	10.7
23-May-17	10.5
25-May-17	10.9
26-May-17	10.8
29-May-17	10.8
30-May-17	10.5
31-May-17	10.5
1-Jun-17	10.5
2-Jun-17	10.5
5-Jun-17	10.6
6-Jun-17	10.4

Table C.4: Water Quality at TOMP Station DS-3 (ETP Operations), Stanrock TMA, 2015 to 2019

Date	pH
8-Jun-17	10.7
9-Jun-17	10.6
19-Jun-17	10.5
20-Jun-17	10.5
26-Jun-17	10.3
27-Jun-17	10.5
29-Jun-17	10.3
30-Jun-17	10.8
4-Jul-17	10.6
5-Jul-17	10.4
26-Jul-17	10.6
27-Jul-17	10.5
28-Jul-17	10.6
2-Aug-17	10.6
3-Aug-17	10.5
4-Aug-17	10.6
15-Aug-17	10.6
16-Aug-17	10.6
18-Aug-17	10.7
19-Aug-17	10.6
22-Aug-17	10.6
23-Aug-17	10.7
24-Aug-17	10.7
30-Aug-17	10.7
31-Aug-17	10.7
6-Sep-17	10.7
7-Sep-17	10.8
8-Sep-17	10.7
13-Sep-17	10.8
14-Sep-17	10.8
27-Sep-17	10.6
28-Sep-17	10.8
29-Sep-17	10.8
2-Oct-17	10.8
3-Oct-17	10.9
5-Oct-17	10.9
6-Oct-17	10.9
8-Oct-17	10.9
9-Oct-17	10.9
10-Oct-17	10.9
11-Oct-17	11.0
12-Oct-17	10.7
13-Oct-17	10.7
16-Oct-17	10.8
17-Oct-17	10.8
18-Oct-17	10.8
19-Oct-17	10.8
20-Oct-17	10.8
22-Oct-17	10.8
23-Oct-17	10.9
24-Oct-17	11.2
25-Oct-17	11.2
26-Oct-17	10.9
27-Oct-17	10.8
30-Oct-17	10.8
31-Oct-17	10.7
1-Nov-17	10.9
2-Nov-17	11.0
3-Nov-17	10.9
6-Nov-17	10.8
7-Nov-17	10.8
9-Nov-17	10.8
10-Nov-17	10.6
13-Nov-17	10.6
14-Nov-17	10.6
15-Nov-17	10.7
16-Nov-17	10.7
17-Nov-17	10.8
21-Nov-17	10.4
22-Nov-17	10.6
23-Nov-17	10.7
24-Nov-17	11.0
27-Nov-17	10.8
28-Nov-17	11.0
30-Nov-17	10.8
1-Dec-17	11.0
4-Dec-17	10.6
5-Dec-17	10.8
6-Dec-17	10.8
7-Dec-17	11.0
8-Dec-17	11.0
11-Dec-17	11.0
14-Dec-17	10.6
15-Dec-17	11.0
19-Dec-17	10.5
20-Dec-17	11.0
22-Dec-17	10.9
25-Dec-17	10.8
26-Dec-17	10.8
29-Dec-17	10.8
3-Jan-18	10.9
4-Jan-18	11.0
5-Jan-18	11.0
9-Jan-18	10.8
11-Jan-18	10.9
12-Jan-18	10.9
13-Jan-18	10.8
14-Jan-18	10.8
15-Jan-18	10.8
18-Jan-18	11.0
19-Jan-18	10.7
24-Jan-18	10.8
25-Jan-18	10.8
30-Jan-18	11.0
1-Feb-18	10.9
2-Feb-18	10.9
7-Feb-18	10.7

Date	pH
8-Feb-18	11.0
14-Feb-18	11.1
15-Feb-18	10.8
23-Feb-18	10.8
28-Feb-18	10.8
1-Mar-18	10.8
9-Mar-18	10.9
15-Mar-18	11.0
28-Mar-18	10.8
29-Mar-18	10.7
5-Apr-18	10.7
6-Apr-18	10.7
12-Apr-18	10.9
13-Apr-18	10.9
18-Apr-18	10.9
19-Apr-18	10.8
20-Apr-18	10.7
23-Apr-18	10.9
24-Apr-18	10.9
25-Apr-18	10.7
26-Apr-18	10.3
27-Apr-18	9.60
28-Apr-18	10.6
30-Apr-18	10.7
1-May-18	10.6
2-May-18	10.4
3-May-18	10.6
4-May-18	10.6
5-May-18	10.7
6-May-18	10.2
7-May-18	10.6
8-May-18	10.7
9-May-18	10.7
10-May-18	10.8
11-May-18	10.8
17-May-18	10.8
18-May-18	10.7
22-May-18	10.7
23-May-18	10.8
24-May-18	10.8
5-Jun-18	11.1
6-Jun-18	10.9
14-Jun-18	10.8
15-Jun-18	10.7
16-Jun-18	10.8
20-Jun-18	10.6
21-Jun-18	10.7
10-Jul-18	10.8
12-Jul-18	10.8
13-Jul-18	10.6
20-Jul-18	10.6
26-Jul-18	10.6
27-Jul-18	10.6
2-Oct-18	10.9
3-Oct-18	10.9
4-Oct-18	10.7
5-Oct-18	11.0
9-Oct-18	10.9
10-Oct-18	10.5
11-Oct-18	10.7
12-Oct-18	10.7
15-Oct-18	10.5
16-Oct-18	10.7
17-Oct-18	10.6
18-Oct-18	10.8
19-Oct-18	10.7
24-Oct-18	10.9
25-Oct-18	10.9
26-Oct-18	10.7
31-Oct-18	11.0
1-Nov-18	11.0
2-Nov-18	10.9
6-Nov-18	10.9
7-Nov-18	11.0
8-Nov-18	10.9
9-Nov-18	10.8
10-Nov-18	10.8
13-Nov-18	10.8
14-Nov-18	11.0
20-Nov-18	11.0
21-Nov-18	10.9
25-Nov-18	10.8
26-Nov-18	10.7
27-Nov-18	11.3
28-Nov-18	11.0
29-Nov-18	11.0
30-Nov-18	11.0
5-Dec-18	10.8
6-Dec-18	10.8
11-Dec-18	10.9
12-Dec-18	10.7
13-Dec-18	11.0
14-Dec-18	11.0
20-Dec-18	11.0
21-Dec-18	10.7
26-Dec-18	11.0
27-Dec-18	10.9
1-Jan-19	10.9
2-Jan-19	10.9
3-Jan-19	10.8
4-Jan-19	10.8
8-Jan-19	10.9
9-Jan-19	10.9
11-Jan-19	10.9
16-Jan-19	10.9
17-Jan-19	11.0
24-Jan-19	10.9

Date	pH
25-Jan-19	10.9
1-Feb-19	11.0
7-Feb-19	11.0
12-Feb-19	11.0
14-Feb-19	10.9
21-Feb-19	11.0
28-Feb-19	11.0
1-Mar-19	10.9
11-Mar-19	10.9
12-Mar-19	11.0
15-Mar-19	11.0
17-Mar-19	10.8
18-Mar-19	11.2
19-Mar-19	11.0
20-Mar-19	11.0
22-Mar-19	11.0
23-Mar-19	10.6
24-Mar-19	10.6
26-Mar-19	10.7
27-Mar-19	10.9
29-Mar-19	11.0
30-Mar-19	10.8
2-Apr-19	10.8
3-Apr-19	10.5
5-Apr-19	10.9
6-Apr-19	10.8
8-Apr-19	10.7
9-Apr-19	10.7
10-Apr-19	10.6
11-Apr-19	10.7
12-Apr-19	10.6
13-Apr-19	10.7
14-Apr-19	10.7
15-Apr-19	10.7
16-Apr-19	10.6
17-Apr-19	10.7
18-Apr-19	10.7
19-Apr-19	11.0
20-Apr-19	11.0
21-Apr-19	11.0
22-Apr-19	11.1
23-Apr-19	12.3
24-Apr-19	9.60
25-Apr-19	10.6
26-Apr-19	10.5
27-Apr-19	10.8
28-Apr-19	10.8
29-Apr-19	10.7
30-Apr-19	10.6
1-May-19	10.9
2-May-19	10.5
3-May-19	10.6
4-May-19	10.8
5-May-19	10.8
6-May-19	10.7
7-May-19	10.6
8-May-19	10.6
9-May-19	10.8
10-May-19	10.7
11-May-19	10.8
12-May-19	10.8
13-May-19	10.7
14-May-19	10.6
15-May-19	10.7
16-May-19	10.7
17-May-19	10.6
18-May-19	10.8
19-May-19	10.8
20-May-19	10.8
21-May-19	10.7
22-May-19	10.6
23-May-19	10.6
24-May-19	11.0
25-May-19	10.6
26-May-19	10.6
27-May-19	10.6
28-May-19	10.9
29-May-19	10.8
30-May-19	10.9
31-May-19	10.9
4-Jun-19	10.7
5-Jun-19	10.7
6-Jun-19	10.7
7-Jun-19	10.7
10-Jun-19	10.8
11-Jun-19	10.8
12-Jun-19	10.8
13-Jun-19	10.9
14-Jun-19	10.7
18-Jun-19	10.8
19-Jun-19	11.0
20-Jun-19	10.8
21-Jun-19	10.7
26-Jun-19	10.8
27-Jun-19	11.0
28-Jun-19	10.8
4-Jul-19	10.5
5-Jul-19	10.8
11-Jul-19	10.9
12-Jul-19	10.5
17-Jul-19	11.0
18-Jul-19	10.9
25-Jul-19	10.9
26-Jul-19	10.8
26-Aug-19	10.5
27-Aug-19	11.1
5-Sep-19	10.6

Table C.4: Water Quality at TOMP Station DS-3 (ETP Operations), Stanrock TMA, 2015 to 2019

Date	pH
12-Sep-19	10.6
13-Sep-19	10.8
26-Sep-19	10.7
27-Sep-19	10.9
1-Oct-19	10.7
2-Oct-19	10.9
3-Oct-19	10.9
4-Oct-19	11.0
8-Oct-19	10.9
9-Oct-19	10.9
10-Oct-19	10.8
15-Oct-19	10.7
16-Oct-19	10.9
17-Oct-19	10.7
18-Oct-19	10.9
21-Oct-19	10.8
22-Oct-19	10.8
23-Oct-19	10.8
24-Oct-19	10.6
25-Oct-19	10.9
28-Oct-19	10.7
29-Oct-19	10.6
30-Oct-19	10.7
31-Oct-19	10.8
1-Nov-19	10.8
4-Nov-19	10.9
5-Nov-19	10.7
6-Nov-19	10.9
8-Nov-19	10.7
9-Nov-19	10.8
14-Nov-19	10.9
15-Nov-19	10.8
18-Nov-19	10.7
19-Nov-19	10.9
21-Nov-19	10.9
22-Nov-19	10.8
25-Nov-19	10.6
26-Nov-19	10.9
27-Nov-19	10.8
28-Nov-19	10.9
29-Nov-19	10.9
3-Dec-19	11.1
4-Dec-19	11.0
6-Dec-19	11.0
9-Dec-19	10.9
10-Dec-19	10.9
12-Dec-19	10.7
13-Dec-19	10.6
17-Dec-19	10.6
18-Dec-19	10.6
20-Dec-19	10.9
23-Dec-19	10.8
24-Dec-19	10.7
27-Dec-19	10.8
30-Dec-19	10.8
31-Dec-19	10.9
n	655
Minimum	9.60
Maximum	12.3
Mean	10.8
SD	0.193
Median	10.8
10th Percentile	10.6
95th Percentile	11.0

Note: "SD" = standard deviation. "n" = number of samples.

Table C.5: Water Quality at TOMP Station DS-4 (Effluent), Stanrock TMA, 2015 to 2019

Date	Flow (L/s)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	TSS (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
6-Jan-15	13.0	7.20	-	0.0510	<1.00	-	-	-	-	-
13-Jan-15	13.0	7.00	280	0.0540	1.00	0.0650	0.000700	0.250	0.0600	0.00180
20-Jan-15	9.00	7.00	-	0.0470	1.00	-	-	-	-	-
27-Jan-15	9.00	6.90	-	0.0470	<1.00	-	-	-	-	-
3-Feb-15	9.00	6.90	-	0.0530	<1.00	-	-	-	-	-
10-Feb-15	13.0	7.10	270	0.0460	<1.00	0.0560	0.000600	0.130	0.0560	0.00160
17-Feb-15	13.0	7.10	-	0.0430	<1.00	-	-	-	-	-
25-Feb-15	6.00	7.00	-	0.0580	<1.00	-	-	-	-	-
3-Mar-15	6.00	6.90	-	0.0550	<1.00	-	-	-	-	-
9-Mar-15	6.00	6.90	-	0.0430	<1.00	-	-	-	-	-
17-Mar-15	17.0	6.78	270	0.0490	<1.00	0.0540	0.000600	0.0800	0.0760	0.00190
24-Mar-15	9.00	7.00	-	0.0480	<1.00	-	-	-	-	-
31-Mar-15	13.0	6.90	-	0.0500	<1.00	-	-	-	-	-
7-Apr-15	35.0	6.90	-	0.0340	<1.00	-	-	-	-	-
14-Apr-15	254	6.70	270	0.0490	1.00	0.0560	0.00110	0.390	0.155	0.00180
21-Apr-15	254	6.90	-	0.0370	<1.00	-	-	-	-	-
28-Apr-15	47.0	6.90	-	0.0270	1.00	-	-	-	-	-
5-May-15	41.0	7.20	-	0.0410	<1.00	-	-	-	-	-
12-May-15	91.0	7.00	150	0.0360	<1.00	0.0750	<0.000500	0.160	0.0540	0.000700
19-May-15	9.00	6.80	-	0.0570	1.00	-	-	-	-	-
26-May-15	47.0	7.20	-	0.0470	1.00	-	-	-	-	-
2-Jun-15	35.0	6.90	-	0.0560	<1.00	-	-	-	-	-
9-Jun-15	6.00	7.10	220	0.0640	<1.00	0.0580	<0.000500	0.0500	0.0290	0.000900
16-Jun-15	25.0	6.80	-	0.0480	<1.00	-	-	-	-	-
23-Jun-15	9.00	6.90	-	0.0620	<1.00	-	-	-	-	-
29-Jun-15	3.00	6.80	-	0.0710	<1.00	-	-	-	-	-
7-Jul-15	3.00	7.00	-	0.0840	<1.00	-	-	-	-	-
14-Jul-15	3.00	7.20	250	0.105	<1.00	0.0510	<0.000500	0.0300	0.0650	0.00100
21-Jul-15	3.00	7.10	-	0.0830	-	-	-	-	-	-
28-Jul-15	1.00	7.20	-	0.0960	<1.00	-	-	-	-	-
4-Aug-15	1.00	7.00	-	0.107	<1.00	-	-	-	-	-
11-Aug-15	1.00	6.90	280	0.106	<1.00	0.0430	<0.000500	0.0300	0.115	0.00100
18-Aug-15	1.00	6.90	-	0.0940	<1.00	-	-	-	-	-
25-Aug-15	1.00	7.40	-	0.0810	<1.00	-	-	-	-	-
1-Sep-15	1.00	7.30	-	0.0930	<1.00	-	-	-	-	-
8-Sep-15	10.0	7.62	-	0.0870	<1.00	-	-	-	-	-
15-Sep-15	1.00	7.10	270	0.0920	<1.00	0.0390	<0.000500	0.0620	0.0780	0.00200
22-Sep-15	3.00	7.40	-	0.0840	<1.00	-	-	-	-	-
29-Sep-15	3.00	7.10	-	0.0830	<1.00	-	-	-	-	-
7-Oct-15	3.00	7.40	-	0.0760	<1.00	-	-	-	-	-
13-Oct-15	6.00	7.30	280	0.0780	<1.00	0.0400	<0.000500	0.0190	0.0480	0.00380
20-Oct-15	3.00	7.10	-	0.0740	<1.00	-	-	-	-	-
27-Oct-15	3.00	7.10	-	0.0590	<1.00	-	-	-	-	-
3-Nov-15	78.0	7.58	-	0.0850	<1.00	-	-	-	-	-
10-Nov-15	78.0	7.40	-	0.0550	<1.00	-	-	-	-	-
17-Nov-15	21.0	7.40	300	0.0550	<1.00	0.0290	<0.000500	0.150	0.0300	0.00560

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table C.5: Water Quality at TOMP Station DS-4 (Effluent), Stanrock TMA, 2015 to 2019

Date	Flow (L/s)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	TSS (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
24-Nov-15	35.0	7.30	-	0.0420	<1.00	-	-	-	-	-
1-Dec-15	58.0	7.40	-	0.0530	<1.00	-	-	-	-	-
8-Dec-15	21.0	7.10	260	0.0430	<1.00	0.0280	<0.000500	0.153	0.0320	0.00330
15-Dec-15	693	7.30	-	0.0440	1.00	-	-	-	-	-
22-Dec-15	105	7.20	-	0.0480	1.00	-	-	-	-	-
29-Dec-15	91.0	7.20	-	0.0340	2.00	-	-	-	-	-
5-Jan-16	30.0	7.20	-	0.0450	<1.00	-	-	-	-	-
12-Jan-16	47.0	6.90	280	0.0340	1.00	0.0400	0.00100	0.258	0.0360	0.00220
19-Jan-16	17.0	7.00	-	0.0360	<1.00	-	-	-	-	-
26-Jan-16	41.0	6.90	-	0.0320	1.00	-	-	-	-	-
2-Feb-16	17.0	6.80	-	0.0350	<1.00	-	-	-	-	-
9-Feb-16	21.0	7.10	290	0.0340	<1.00	0.0400	0.000800	0.123	0.0350	0.00210
16-Feb-16	13.0	6.90	-	0.0300	<1.00	-	-	-	-	-
23-Feb-16	13.0	7.00	-	0.0430	<1.00	-	-	-	-	-
1-Mar-16	47.0	6.90	-	0.0260	<1.00	-	-	-	-	-
8-Mar-16	13.0	7.10	290	0.0440	<1.00	0.0450	0.000800	0.114	0.0470	0.00220
15-Mar-16	136	7.00	-	0.0370	1.00	-	-	-	-	-
22-Mar-16	191	6.80	-	0.0510	1.00	-	-	-	-	-
29-Mar-16	71.0	7.50	-	0.0460	<1.00	-	-	-	-	-
5-Apr-16	91.0	7.60	-	0.0450	1.00	-	-	-	-	-
12-Apr-16	78.0	7.50	190	0.0500	<1.00	0.115	0.000500	0.157	0.0330	0.000900
19-Apr-16	172	7.20	-	0.0290	<1.00	-	-	-	-	-
26-Apr-16	78.0	7.20	-	0.0350	1.00	-	-	-	-	-
3-May-16	13.0	7.10	-	0.0560	1.00	-	-	-	-	-
10-May-16	6.00	7.10	180	0.0470	<1.00	0.0580	<0.000500	0.0600	0.0390	0.000800
17-May-16	9.00	7.10	-	0.0520	<1.00	-	-	-	-	-
24-May-16	3.00	6.80	-	0.0810	<1.00	-	-	-	-	-
31-May-16	3.00	7.00	-	0.0790	<1.00	-	-	-	-	-
7-Jun-16	6.00	7.00	-	0.0780	<1.00	-	-	-	-	-
14-Jun-16	13.0	7.00	230	0.0840	<1.00	0.0508	<0.000500	0.0710	0.0233	0.00316
21-Jun-16	3.00	7.10	-	0.0940	1.00	-	-	-	-	-
28-Jun-16	1.00	6.70	-	0.102	<1.00	-	-	-	-	-
5-Jul-16	3.00	6.90	-	0.104	<1.00	-	-	-	-	-
12-Jul-16	3.00	7.00	270	0.121	1.00	0.0480	<0.000500	0.0300	0.0460	0.00170
19-Jul-16	1.00	7.10	-	0.115	<1.00	-	-	-	-	-
26-Jul-16	3.00	7.00	-	0.103	<1.00	-	-	-	-	-
2-Aug-16	3.00	7.00	-	0.0950	<1.00	-	-	-	-	-
9-Aug-16	3.00	6.80	280	0.0930	<1.00	0.0410	<0.000500	0.0280	0.0880	0.00210
16-Aug-16	3.00	6.90	-	0.0920	<1.00	-	-	-	-	-
23-Aug-16	3.00	6.80	-	0.0930	<1.00	-	-	-	-	-
30-Aug-16	3.00	7.00	-	0.103	<1.00	-	-	-	-	-
6-Sep-16	3.00	6.80	-	0.100	1.00	-	-	-	-	-
13-Sep-16	3.00	6.90	290	0.0910	<1.00	0.0350	<0.000500	0.0500	0.0620	0.00430
20-Sep-16	6.00	7.10	-	0.0940	1.00	-	-	-	-	-
27-Sep-16	35.0	7.20	-	0.100	1.00	-	-	-	-	-
4-Oct-16	3.00	7.40	-	0.0880	<1.00	-	-	-	-	-

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table C.5: Water Quality at TOMP Station DS-4 (Effluent), Stanrock TMA, 2015 to 2019

Date	Flow (L/s)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	TSS (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
11-Oct-16	3.00	7.20	280	0.107	<1.00	0.0320	<0.000500	0.0640	0.0500	0.00910
18-Oct-16	25.0	7.40	-	0.106	1.00	-	-	-	-	-
25-Oct-16	3.00	7.20	-	0.0780	1.00	-	-	-	-	-
1-Nov-16	9.00	7.00	-	0.0910	1.00	-	-	-	-	-
8-Nov-16	3.00	7.20	280	0.0800	<1.00	0.0300	<0.000500	0.0680	0.0400	0.0121
15-Nov-16	2.00	7.10	-	0.0850	1.00	-	-	-	-	-
22-Nov-16	1.00	7.10	-	0.0870	<1.00	-	-	-	-	-
29-Nov-16	58.0	7.30	-	0.0950	1.00	-	-	-	-	-
6-Dec-16	35.0	7.10	-	0.0890	1.00	-	-	-	-	-
13-Dec-16	18.0	7.20	290	0.0930	<1.00	0.0280	<0.000500	0.143	0.0260	0.0115
20-Dec-16	21.0	7.30	-	0.114	<1.00	-	-	-	-	-
29-Dec-16	35.0	7.20	-	0.0680	1.00	-	-	-	-	-
3-Jan-17	9.00	7.30	-	0.0670	<1.00	-	-	-	-	-
10-Jan-17	32.0	7.10	280	0.0520	1.00	0.0260	<0.000500	0.141	0.0270	0.00970
17-Jan-17	15.0	7.10	-	0.0650	1.00	-	-	-	-	-
24-Jan-17	21.0	7.00	-	0.0600	1.00	-	-	-	-	-
31-Jan-17	47.0	7.10	-	0.0520	1.00	-	-	-	-	-
7-Feb-17	17.0	7.10	-	0.0550	<1.00	-	-	-	-	-
14-Feb-17	17.0	7.10	330	0.0420	1.00	0.0270	<0.000500	0.170	0.0410	0.00640
21-Feb-17	21.0	7.00	-	0.0590	<1.00	-	-	-	-	-
28-Feb-17	47.0	7.20	-	0.0410	<1.00	-	-	-	-	-
7-Mar-17	58.0	7.00	-	0.0320	1.00	-	-	-	-	-
14-Mar-17	67.0	7.30	-	0.0290	<1.00	-	-	-	-	-
21-Mar-17	47.0	7.10	310	0.0330	<1.00	0.0380	0.00100	0.247	0.0760	0.00300
28-Mar-17	105	7.00	-	0.0330	1.00	-	-	-	-	-
4-Apr-17	324	7.00	-	0.0360	2.00	-	-	-	-	-
12-Apr-17	255	7.00	160	0.0350	1.00	0.0570	0.000800	0.217	0.0400	0.00100
18-Apr-17	158	6.90	-	0.0390	1.00	-	-	-	-	-
25-Apr-17	83.0	7.10	-	0.0470	1.00	-	-	-	-	-
2-May-17	105	7.20	-	0.0520	1.00	-	-	-	-	-
9-May-17	25.0	7.20	-	0.0570	1.00	-	-	-	-	-
16-May-17	9.00	7.10	-	0.0690	1.00	-	-	-	-	-
23-May-17	35.0	7.20	250	0.0680	1.00	0.0570	<0.000500	0.139	0.0310	0.00330
30-May-17	58.0	7.20	-	0.0570	1.00	-	-	-	-	-
6-Jun-17	47.0	7.20	-	0.0620	<1.00	-	-	-	-	-
13-Jun-17	13.0	7.10	270	0.109	2.00	0.0510	<0.000500	0.0800	0.0400	0.00260
20-Jun-17	17.0	7.00	-	0.0790	1.00	-	-	-	-	-
27-Jun-17	35.0	7.20	-	0.0900	2.00	-	-	-	-	-
4-Jul-17	67.0	7.20	-	0.0760	2.00	-	-	-	-	-
11-Jul-17	1.00	7.10	290	0.0820	1.00	0.0470	<0.000500	0.0780	0.0670	0.00250
25-Jul-17	9.00	7.00	-	0.0910	1.00	-	-	-	-	-
1-Aug-17	9.00	7.20	-	0.108	1.00	-	-	-	-	-
8-Aug-17	9.00	7.20	300	0.0990	1.00	0.0350	<0.000500	0.0980	0.0520	0.00380
15-Aug-17	17.0	7.20	-	0.101	1.00	-	-	-	-	-
22-Aug-17	47.0	7.20	-	0.0920	1.00	-	-	-	-	-
29-Aug-17	9.00	7.30	-	0.119	1.00	-	-	-	-	-

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table C.5: Water Quality at TOMP Station DS-4 (Effluent), Stanrock TMA, 2015 to 2019

Date	Flow (L/s)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	TSS (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
5-Sep-17	9.00	7.30	-	0.111	1.00	-	-	-	-	-
12-Sep-17	9.00	7.50	300	0.114	1.00	0.0300	<0.000500	0.0740	0.0350	0.00630
19-Sep-17	6.00	7.50	-	0.102	<1.00	-	-	-	-	-
26-Sep-17	6.00	7.10	-	0.102	1.00	-	-	-	-	-
3-Oct-17	17.0	7.20	-	0.121	1.00	-	-	-	-	-
12-Oct-17	58.0	7.40	300	0.105	1.00	0.0230	<0.000500	0.172	0.0320	0.00710
17-Oct-17	105	7.00	-	0.119	1.00	-	-	-	-	-
25-Oct-17	400	7.20	-	0.193	2.00	-	-	-	-	-
31-Oct-17	105	7.20	-	0.0690	2.00	-	-	-	-	-
7-Nov-17	51.0	7.30	-	0.0710	1.00	-	-	-	-	-
14-Nov-17	35.0	7.30	290	0.0650	2.00	0.0550	0.000600	0.184	0.0390	0.00350
21-Nov-17	47.0	7.20	-	0.0530	1.00	-	-	-	-	-
28-Nov-17	51.0	7.30	-	0.0410	1.00	-	-	-	-	-
5-Dec-17	299	6.90	-	0.0420	1.00	-	-	-	-	-
12-Dec-17	51.0	7.20	250	0.0310	1.00	0.0900	0.000800	0.413	0.0430	0.00170
19-Dec-17	25.0	7.10	-	0.0390	2.00	-	-	-	-	-
27-Dec-17	25.0	7.00	-	0.0420	1.00	-	-	-	-	-
2-Jan-18	13.0	7.10	-	0.0400	1.00	-	-	-	-	-
9-Jan-18	9.00	7.10	250	0.0500	1.00	0.0970	0.000600	0.220	0.0470	0.00140
16-Jan-18	47.0	7.20	-	0.0300	1.00	-	-	-	-	-
23-Jan-18	25.0	7.00	-	0.0560	<1.00	-	-	-	-	-
30-Jan-18	9.00	7.20	-	0.0580	1.00	-	-	-	-	-
6-Feb-18	6.00	7.10	-	0.0490	<1.00	-	-	-	-	-
13-Feb-18	6.00	7.10	280	0.0530	<1.00	0.111	0.000500	0.135	0.0570	0.00210
20-Feb-18	9.00	6.90	-	0.0390	<1.00	-	-	-	-	-
27-Feb-18	17.0	7.10	-	0.0400	<1.00	-	-	-	-	-
6-Mar-18	6.00	7.20	-	0.0540	<1.00	-	-	-	-	-
13-Mar-18	6.00	7.20	290	0.0610	<1.00	0.0920	<0.000500	0.0860	0.0500	0.00280
20-Mar-18	3.00	7.10	-	0.0600	<1.00	-	-	-	-	-
27-Mar-18	3.00	7.10	-	0.0620	1.00	-	-	-	-	-
3-Apr-18	13.0	7.20	-	0.0560	<1.00	-	-	-	-	-
10-Apr-18	9.00	7.20	280	0.0580	<1.00	0.0740	<0.000500	0.0940	0.0650	0.00300
17-Apr-18	35.0	7.20	-	0.0690	<1.00	-	-	-	-	-
24-Apr-18	105	7.00	-	0.0650	2.00	-	-	-	-	-
1-May-18	211	7.00	-	0.0380	2.00	-	-	-	-	-
8-May-18	136	7.00	110	0.0360	3.00	0.0730	0.00120	0.592	0.0650	0.000600
15-May-18	30.0	7.10	-	0.0620	2.00	-	-	-	-	-
22-May-18	17.0	6.80	-	0.0760	1.00	-	-	-	-	-
29-May-18	9.00	6.80	-	0.0830	2.00	-	-	-	-	-
5-Jun-18	6.00	7.30	-	0.0860	<1.00	-	-	-	-	-
12-Jun-18	6.00	7.40	-	0.102	<1.00	-	-	-	-	-
19-Jun-18	21.0	7.30	220	0.101	2.00	0.0600	<0.000500	0.105	0.0350	0.00270
26-Jun-18	6.00	7.10	-	0.0960	<1.00	-	-	-	-	-
3-Jul-18	3.00	7.00	-	0.115	<1.00	-	-	-	-	-
10-Jul-18	3.00	7.10	230	0.101	1.00	0.0510	<0.000500	0.0360	0.0880	0.00190
17-Jul-18	3.00	6.90	-	0.101	1.00	-	-	-	-	-

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table C.5: Water Quality at TOMP Station DS-4 (Effluent), Stanrock TMA, 2015 to 2019

Date	Flow (L/s)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	TSS (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
24-Jul-18	6.00	7.10	-	0.0970	1.00	-	-	-	-	-
7-Aug-18	6.00	7.30	-	0.130	1.00	-	-	-	-	-
14-Aug-18	3.00	6.90	270	0.133	1.00	0.0490	<0.000500	0.0570	0.0650	0.00500
21-Aug-18	1.00	7.00	-	0.113	<1.00	-	-	-	-	-
28-Aug-18	3.00	7.20	-	0.112	<1.00	-	-	-	-	-
4-Sep-18	13.0	7.20	-	0.157	1.00	-	-	-	-	-
11-Sep-18	3.00	7.10	260	0.123	<1.00	0.0390	<0.000500	0.0700	0.0570	0.00730
18-Sep-18	3.00	7.00	-	0.136	1.00	-	-	-	-	-
25-Sep-18	9.00	7.00	-	0.135	1.00	-	-	-	-	-
2-Oct-18	6.00	7.50	-	0.127	1.00	-	-	-	-	-
9-Oct-18	78.0	7.30	250	0.142	2.00	0.0360	<0.000500	0.129	0.0370	0.0122
16-Oct-18	105	7.50	-	0.0950	1.00	-	-	-	-	-
23-Oct-18	47.0	7.10	-	0.101	<1.00	-	-	-	-	-
30-Oct-18	21.0	7.10	-	0.0780	1.00	-	-	-	-	-
6-Nov-18	25.0	7.20	-	0.0840	1.00	-	-	-	-	-
13-Nov-18	35.0	7.10	270	0.0560	1.00	0.0400	<0.000500	0.141	0.0240	0.00660
20-Nov-18	17.0	7.00	-	0.0810	<1.00	-	-	-	-	-
27-Nov-18	91.0	7.30	-	0.0800	1.00	-	-	-	-	-
4-Dec-18	35.0	7.40	270	0.0600	1.00	0.0530	<0.000500	0.147	0.0300	0.00500
11-Dec-18	13.0	7.40	-	0.0570	1.00	-	-	-	-	-
18-Dec-18	17.0	7.30	-	0.0630	<1.00	-	-	-	-	-
27-Dec-18	21.0	7.10	-	0.0550	1.00	-	-	-	-	-
2-Jan-19	35.0	6.90	-	0.0650	1.00	-	-	-	-	-
8-Jan-19	35.0	7.10	270	0.0770	1.00	0.0460	<0.000500	0.127	0.0300	0.00450
15-Jan-19	13.0	7.30	-	0.0710	1.00	-	-	-	-	-
22-Jan-19	13.0	7.40	-	0.0510	1.00	-	-	-	-	-
29-Jan-19	17.0	7.10	-	0.0600	1.00	-	-	-	-	-
5-Feb-19	17.0	6.90	-	0.0780	<1.00	-	-	-	-	-
12-Feb-19	9.00	7.20	280	0.0640	<1.00	0.0560	<0.000500	0.0970	0.0430	0.00560
19-Feb-19	21.0	7.30	-	0.0840	1.00	-	-	-	-	-
28-Feb-19	17.0	7.10	-	0.0790	1.00	-	-	-	-	-
4-Mar-19	17.0	7.40	-	0.0810	<1.00	-	-	-	-	-
12-Mar-19	13.0	7.20	280	0.0730	1.00	0.0560	<0.000500	0.158	0.0610	0.00520
19-Mar-19	47.0	7.30	-	0.0540	1.00	-	-	-	-	-
26-Mar-19	21.0	7.20	-	0.0540	1.00	-	-	-	-	-
2-Apr-19	35.0	7.20	-	0.0420	1.00	-	-	-	-	-
9-Apr-19	105	7.10	270	0.0540	2.00	0.0410	0.000800	0.314	0.0880	0.00280
16-Apr-19	105	7.00	-	0.0460	2.00	-	-	-	-	-
22-Apr-19	254	7.10	-	0.0390	2.00	-	-	-	-	-
30-Apr-19	136	6.90	-	0.0450	1.00	-	-	-	-	-
7-May-19	51.0	6.80	-	0.0420	2.00	-	-	-	-	-
14-May-19	78.0	7.10	160	0.0570	1.00	0.0790	<0.000500	0.138	0.0240	0.00130
21-May-19	105	7.20	-	0.0590	2.00	-	-	-	-	-
28-May-19	67.0	7.40	-	0.0640	1.00	-	-	-	-	-
4-Jun-19	9.00	7.20	-	0.0710	1.00	-	-	-	-	-
11-Jun-19	67.0	7.30	240	0.0690	1.00	0.0970	<0.000500	0.0970	0.0280	0.00280

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table C.5: Water Quality at TOMP Station DS-4 (Effluent), Stanrock TMA, 2015 to 2019

Date	Flow (L/s)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	TSS (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
18-Jun-19	17.0	7.30	-	0.0760	1.00	-	-	-	-	-
25-Jun-19	41.0	6.90	-	0.0860	2.00	-	-	-	-	-
2-Jul-19	11.0	7.10	-	0.100	1.00	-	-	-	-	-
9-Jul-19	1.00	7.10	250	0.120	1.00	0.0720	<0.000500	0.0420	0.0460	0.00170
16-Jul-19	6.00	6.80	-	0.124	1.00	-	-	-	-	-
23-Jul-19	3.00	6.90	-	0.114	1.00	-	-	-	-	-
30-Jul-19	6.00	6.90	-	0.129	1.00	-	-	-	-	-
6-Aug-19	1.00	7.00	-	0.150	1.00	-	-	-	-	-
13-Aug-19	2.00	7.00	260	0.108	<1.00	0.0560	<0.000500	0.0590	0.0620	0.00440
20-Aug-19	3.00	7.10	-	0.131	<1.00	-	-	-	-	-
27-Aug-19	6.00	6.90	-	0.122	<1.00	-	-	-	-	-
3-Sep-19	1.00	7.30	-	0.122	1.00	-	-	-	-	-
10-Sep-19	6.00	7.10	250	0.143	2.00	0.0490	<0.000500	0.111	0.0550	0.00810
17-Sep-19	9.00	7.40	-	0.174	2.00	-	-	-	-	-
24-Sep-19	9.00	7.40	-	0.132	1.00	-	-	-	-	-
1-Oct-19	47.0	7.50	-	0.170	1.00	-	-	-	-	-
8-Oct-19	17.0	7.40	260	0.131	2.00	0.0460	<0.000500	0.117	0.0360	0.0112
15-Oct-19	35.0	7.40	-	0.130	1.00	-	-	-	-	-
22-Oct-19	162	7.30	-	0.0870	1.00	-	-	-	-	-
29-Oct-19	120	7.40	-	0.0830	2.00	-	-	-	-	-
5-Nov-19	67.0	7.20	-	0.0780	1.00	-	-	-	-	-
12-Nov-19	35.0	7.20	260	0.0660	1.00	0.0520	<0.000500	0.171	0.0280	0.00500
19-Nov-19	52.0	7.10	-	0.0740	<2.00	-	-	-	-	-
26-Nov-19	120	7.10	-	0.0440	2.00	-	-	-	-	-
3-Dec-19	25.0	7.30	-	0.0540	1.00	-	-	-	-	-
10-Dec-19	67.0	7.20	240	0.0480	2.00	0.0690	<0.000500	0.244	0.0350	0.00210
16-Dec-19	21.0	7.20	-	0.0560	1.00	-	-	-	-	-
23-Dec-19	17.0	7.20	-	0.0450	2.00	-	-	-	-	-
30-Dec-19	35.0	7.10	-	0.0450	1.00	-	-	-	-	-
n	259	259	60	259	258	60	60	60	60	60
Minimum	1.00	6.70	110	0.0260	<1.00	0.0230	<0.000500	0.0190	0.0233	0.000600
Maximum	693	7.62	330	0.193	3.00	0.115	0.00120	0.592	0.155	0.0122
Mean	39.9	7.12	260	0.0740	1.12	0.0531	0.000573	0.136	0.0500	0.00390
SD	69.9	0.180	40.8	0.0312	0.334	0.0208	0.000166	0.102	0.0236	0.00301
Median	17.0	7.10	270	0.0680	1.00	0.0509	<0.000500	0.120	0.0445	0.00280
10th Percentile	3.00	6.90	205	0.0390	<1.00	0.0295	<0.000500	0.0390	0.0280	0.00100
95th Percentile	158	7.40	300	0.131	2.00	0.0970	0.00100	0.352	0.0880	0.0113

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table C.6: Water Quality at TOMP Station DS-1 (Additional pH Control, Radium Monitoring), Stanrock TMA, 2015 to 2019

Date	Flow (L/s)	pH	Radium (Bq/L)
6-Jan-15	16.0	7.10	-
8-Jan-15	44.0	7.40	-
13-Jan-15	11.0	7.10	0.0370
15-Jan-15	32.0	7.10	-
20-Jan-15	7.00	7.00	-
21-Jan-15	-	7.00	-
22-Jan-15	44.0	7.00	-
23-Jan-15	-	7.00	-
27-Jan-15	7.00	6.90	-
28-Jan-15	-	7.00	-
29-Jan-15	-	7.00	-
30-Jan-15	-	7.10	-
2-Feb-15	-	7.00	-
3-Feb-15	7.00	6.90	-
5-Feb-15	-	7.00	-
10-Feb-15	7.00	7.00	-
17-Feb-15	7.00	7.20	-
25-Feb-15	38.0	7.00	-
26-Feb-15	26.0	7.00	-
2-Mar-15	7.00	7.00	-
3-Mar-15	4.00	6.90	-
13-Mar-15	44.0	7.10	-
17-Mar-15	11.0	7.10	-
23-Mar-15	7.00	7.20	-
24-Mar-15	7.00	7.00	-
25-Mar-15	58.0	7.00	-
26-Mar-15	38.0	7.00	-
27-Mar-15	4.00	7.00	-
31-Mar-15	11.0	7.00	-
1-Apr-15	58.0	7.00	-
7-Apr-15	58.0	7.00	-
9-Apr-15	81.0	7.00	-
10-Apr-15	98.0	7.30	-
13-Apr-15	212	7.10	-
14-Apr-15	253	7.10	0.0370
15-Apr-15	253	7.30	-
16-Apr-15	253	8.10	-
17-Apr-15	231	8.80	-
20-Apr-15	212	7.40	-
21-Apr-15	253	7.50	-
22-Apr-15	231	7.40	-
23-Apr-15	212	7.90	-
24-Apr-15	169	8.00	-
27-Apr-15	107	8.30	-
28-Apr-15	26.0	8.20	-
30-Apr-15	-	7.60	-
5-May-15	38.0	7.20	-
12-May-15	81.0	7.00	-
19-May-15	7.00	7.00	-
26-May-15	73.0	7.20	-
2-Jun-15	26.0	7.00	-
4-Jun-15	-	7.60	-
8-Jun-15	-	7.00	-
9-Jun-15	4.00	6.90	-
16-Jun-15	21.0	7.00	-
18-Jun-15	-	7.50	-
23-Jun-15	4.00	7.00	-
29-Jun-15	1.00	7.10	-
7-Jul-15	11.0	7.60	-
14-Jul-15	4.00	7.80	0.0250
21-Jul-15	4.00	7.60	-
28-Jul-15	4.00	7.90	-
4-Aug-15	4.00	7.50	-
11-Aug-15	4.00	7.60	-
18-Aug-15	4.00	7.50	-
25-Aug-15	4.00	7.70	-
1-Sep-15	4.00	7.60	-
8-Sep-15	42.0	7.81	-
15-Sep-15	32.0	7.50	-
22-Sep-15	4.00	7.50	-
29-Sep-15	26.0	7.50	-
7-Oct-15	38.0	7.40	-
13-Oct-15	7.00	7.40	0.0230
16-Oct-15	0	7.70	-
20-Oct-15	7.00	7.30	-
27-Oct-15	7.00	7.20	-
29-Oct-15	21.0	7.50	-
30-Oct-15	-	7.55	-
2-Nov-15	44.0	7.55	-
3-Nov-15	90.0	7.64	-
4-Nov-15	90.0	7.52	-
5-Nov-15	90.0	7.43	-
9-Nov-15	107	7.61	-
10-Nov-15	73.0	7.40	-
11-Nov-15	58.0	7.63	-
12-Nov-15	58.0	7.57	-
13-Nov-15	116	7.10	-
17-Nov-15	21.0	7.50	-
18-Nov-15	73.0	7.40	-
19-Nov-15	163	7.00	-
20-Nov-15	163	7.30	-
23-Nov-15	21.0	7.53	-
24-Nov-15	38.0	7.40	-
25-Nov-15	21.0	7.10	-
26-Nov-15	47.0	7.54	-
30-Nov-15	116	7.00	-
1-Dec-15	73.0	7.50	-
2-Dec-15	44.0	7.00	-
4-Dec-15	107	7.00	-
7-Dec-15	26.0	7.30	-
8-Dec-15	21.0	7.30	-
9-Dec-15	73.0	7.00	-
10-Dec-15	81.0	7.04	-
11-Dec-15	163	7.00	-
14-Dec-15	212	7.20	-
15-Dec-15	416	7.40	-
16-Dec-15	253	7.00	-
17-Dec-15	231	7.10	-
18-Dec-15	212	7.20	-
21-Dec-15	181	7.10	-
22-Dec-15	163	7.60	-

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table C.6: Water Quality at TOMP Station DS-1 (Additional pH Control, Radium Monitoring), Stanrock TMA, 2015 to 2019

Date	Flow (L/s)	pH	Radium (Bq/L)
23-Dec-15	163	7.60	-
29-Dec-15	144	7.90	-
5-Jan-16	26.0	7.80	-
12-Jan-16	81.0	7.30	0.0210
19-Jan-16	7.00	7.50	-
20-Jan-16	7.00	7.10	-
26-Jan-16	73.0	7.30	-
27-Jan-16	51.0	7.40	-
2-Feb-16	16.0	7.20	-
9-Feb-16	21.0	7.30	-
16-Feb-16	7.00	7.10	-
23-Feb-16	11.0	7.20	-
1-Mar-16	81.0	7.00	-
8-Mar-16	11.0	7.10	-
10-Mar-16	125	7.50	-
15-Mar-16	163	7.10	-
21-Mar-16	195	8.90	-
22-Mar-16	195	9.10	-
23-Mar-16	195	9.20	-
24-Mar-16	163	9.20	-
28-Mar-16	73.0	9.30	-
29-Mar-16	116	9.20	-
30-Mar-16	163	9.30	-
31-Mar-16	195	9.30	-
1-Apr-16	195	9.20	-
5-Apr-16	144	8.80	-
12-Apr-16	116	9.10	0.0280
19-Apr-16	212	7.80	-
21-Apr-16	195	7.50	-
25-Apr-16	116	7.90	-
26-Apr-16	107	8.40	-
3-May-16	7.00	7.50	-
10-May-16	7.00	7.60	-
17-May-16	7.00	7.30	-
24-May-16	7.00	7.20	-
31-May-16	4.00	7.20	-
7-Jun-16	7.00	7.40	-
14-Jun-16	21.0	7.50	-
21-Jun-16	7.00	7.30	-
28-Jun-16	32.0	7.30	-
5-Jul-16	1.00	7.20	-
12-Jul-16	4.00	7.50	0.0140
19-Jul-16	0	7.50	-
26-Jul-16	7.00	7.40	-
29-Jul-16	4.00	7.60	-
2-Aug-16	4.00	7.30	-
4-Aug-16	4.00	7.30	-
5-Aug-16	4.00	7.30	-
9-Aug-16	4.00	7.70	-
16-Aug-16	4.00	7.40	-
19-Aug-16	4.00	7.40	-
23-Aug-16	4.00	7.30	-
24-Aug-16	4.00	7.50	-
25-Aug-16	4.00	7.50	-
30-Aug-16	4.00	7.80	-
31-Aug-16	4.00	7.50	-
6-Sep-16	4.00	7.60	-
8-Sep-16	4.00	7.40	-
13-Sep-16	4.00	7.40	-
20-Sep-16	7.00	7.50	-
27-Sep-16	58.0	7.50	-
4-Oct-16	4.00	7.60	-
11-Oct-16	4.00	7.50	0.0230
13-Oct-16	4.00	7.70	-
18-Oct-16	16.0	7.50	-
20-Oct-16	3.00	7.50	-
25-Oct-16	4.00	7.40	-
1-Nov-16	11.0	7.30	-
8-Nov-16	4.00	7.30	-
15-Nov-16	4.00	7.10	-
16-Nov-16	4.00	7.10	-
17-Nov-16	0	7.20	-
18-Nov-16	4.00	7.60	-
21-Nov-16	4.00	7.50	-
22-Nov-16	0	7.10	-
23-Nov-16	1.00	7.10	-
29-Nov-16	32.0	7.30	-
30-Nov-16	48.0	7.30	-
1-Dec-16	91.0	7.30	-
2-Dec-16	99.0	7.40	-
5-Dec-16	32.0	7.30	-
6-Dec-16	21.0	7.00	-
8-Dec-16	32.0	7.30	-
9-Dec-16	58.0	7.30	-
12-Dec-16	21.0	7.10	-
13-Dec-16	21.0	7.00	-
14-Dec-16	11.0	7.20	-
15-Dec-16	11.0	7.20	-
16-Dec-16	8.00	7.10	-
20-Dec-16	21.0	7.30	-
29-Dec-16	32.0	7.00	-
30-Dec-16	21.0	7.00	-
2-Jan-17	7.00	7.20	-
3-Jan-17	4.00	6.90	-
9-Jan-17	4.00	7.20	-
11-Jan-17	90.0	7.20	-
12-Jan-17	7.00	6.70	0.0140
16-Jan-17	17.0	7.00	-
17-Jan-17	11.0	6.70	-
18-Jan-17	7.00	7.00	-
19-Jan-17	11.0	6.90	-
20-Jan-17	32.0	6.90	-
23-Jan-17	16.0	7.00	-
24-Jan-17	16.0	6.90	-
26-Jan-17	90.0	7.10	-
30-Jan-17	11.0	6.90	-
31-Jan-17	51.0	7.20	-
1-Feb-17	32.0	6.80	-
2-Feb-17	26.0	6.80	-

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table C.6: Water Quality at TOMP Station DS-1 (Additional pH Control, Radium Monitoring), Stanrock TMA, 2015 to 2019

Date	Flow (L/s)	pH	Radium (Bq/L)
3-Feb-17	32.0	6.90	-
6-Feb-17	11.0	6.70	-
7-Feb-17	7.00	6.80	-
8-Feb-17	16.0	7.00	-
9-Feb-17	51.0	7.00	-
10-Feb-17	32.0	7.00	-
13-Feb-17	11.0	6.90	-
14-Feb-17	11.0	6.90	-
15-Feb-17	7.00	6.80	-
16-Feb-17	51.0	6.90	-
17-Feb-17	44.0	7.00	-
21-Feb-17	21.0	6.80	-
22-Feb-17	16.0	6.80	-
23-Feb-17	90.0	7.00	-
24-Feb-17	90.0	7.10	-
27-Feb-17	58.0	6.70	-
28-Feb-17	32.0	7.10	-
1-Mar-17	44.0	7.10	-
3-Mar-17	32.0	7.30	-
6-Mar-17	16.0	7.00	-
7-Mar-17	58.0	7.00	-
8-Mar-17	195	6.90	-
9-Mar-17	169	7.10	-
10-Mar-17	11.0	7.00	-
13-Mar-17	11.0	7.10	-
14-Mar-17	81.0	7.30	-
21-Mar-17	73.0	7.10	-
22-Mar-17	32.0	7.00	-
23-Mar-17	21.0	7.10	-
28-Mar-17	81.0	7.10	-
29-Mar-17	90.0	6.90	-
30-Mar-17	166	7.20	-
31-Mar-17	107	7.10	-
3-Apr-17	195	7.20	-
4-Apr-17	173	7.30	-
5-Apr-17	262	7.10	-
6-Apr-17	214	7.30	-
7-Apr-17	173	7.20	-
10-Apr-17	181	7.40	-
12-Apr-17	181	6.90	0.0360
13-Apr-17	98.0	7.70	-
17-Apr-17	181	7.50	-
18-Apr-17	81.0	7.40	-
19-Apr-17	66.0	7.80	-
20-Apr-17	26.0	7.30	-
21-Apr-17	73.0	7.40	-
24-Apr-17	51.0	7.30	-
25-Apr-17	44.0	7.20	-
26-Apr-17	26.0	7.30	-
27-Apr-17	21.0	7.30	-
28-Apr-17	16.0	7.20	-
1-May-17	32.0	7.30	-
2-May-17	73.0	7.20	-
3-May-17	90.0	7.30	-
4-May-17	90.0	7.30	-
5-May-17	90.0	7.40	-
9-May-17	21.0	7.40	-
10-May-17	11.0	7.30	-
11-May-17	7.00	7.00	-
12-May-17	38.0	7.30	-
16-May-17	4.00	7.20	-
18-May-17	1.00	7.20	-
19-May-17	4.00	7.20	-
23-May-17	32.0	7.30	-
25-May-17	16.0	7.30	-
30-May-17	58.0	7.40	-
31-May-17	81.0	7.50	-
5-Jun-17	21.0	7.40	-
6-Jun-17	26.0	7.50	-
7-Jun-17	26.0	7.40	-
8-Jun-17	11.0	7.40	-
13-Jun-17	7.00	7.40	-
15-Jun-17	0	7.60	-
19-Jun-17	11.0	7.30	-
20-Jun-17	21.0	7.40	-
21-Jun-17	11.0	7.50	-
26-Jun-17	11.0	7.50	-
27-Jun-17	38.0	7.70	-
28-Jun-17	21.0	7.60	-
29-Jun-17	26.0	7.40	-
4-Jul-17	90.0	8.00	-
6-Jul-17	26.0	7.30	-
7-Jul-17	16.0	7.70	-
10-Jul-17	4.00	8.40	-
11-Jul-17	1.00	7.70	0.0230
12-Jul-17	1.00	7.60	-
13-Jul-17	1.00	7.40	-
14-Jul-17	1.00	7.40	-
17-Jul-17	1.00	8.00	-
18-Jul-17	0	7.90	-
20-Jul-17	1.00	7.70	-
24-Jul-17	4.00	7.70	-
25-Jul-17	3.00	7.60	-
27-Jul-17	32.0	7.40	-
31-Jul-17	11.0	7.90	-
1-Aug-17	4.00	7.60	-
4-Aug-17	32.0	7.60	-
8-Aug-17	4.00	7.40	-
10-Aug-17	4.00	7.60	-
14-Aug-17	11.0	7.50	-
15-Aug-17	11.0	7.60	-
17-Aug-17	21.0	7.40	-
22-Aug-17	32.0	7.70	-
23-Aug-17	58.0	7.40	-
24-Aug-17	58.0	7.40	-
28-Aug-17	11.0	7.50	-
29-Aug-17	7.00	7.40	-
5-Sep-17	4.00	7.40	-
7-Sep-17	4.00	7.40	-

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table C.6: Water Quality at TOMP Station DS-1 (Additional pH Control, Radium Monitoring), Stanrock TMA, 2015 to 2019

Date	Flow (L/s)	pH	Radium (Bq/L)
12-Sep-17	4.00	7.60	-
19-Sep-17	7.00	7.80	-
26-Sep-17	4.00	7.40	-
28-Sep-17	11.0	7.50	-
3-Oct-17	32.0	7.40	-
6-Oct-17	32.0	7.20	-
12-Oct-17	44.0	7.40	0.00900
16-Oct-17	169	7.10	-
17-Oct-17	169	7.00	-
18-Oct-17	163	7.00	-
20-Oct-17	90.0	7.30	-
24-Oct-17	416	7.20	-
25-Oct-17	356	7.40	-
27-Oct-17	181	7.40	-
30-Oct-17	181	7.20	-
31-Oct-17	169	7.40	-
2-Nov-17	181	7.30	-
6-Nov-17	125	7.20	-
7-Nov-17	58.0	7.40	-
10-Nov-17	51.0	7.10	-
13-Nov-17	21.0	7.40	-
14-Nov-17	16.0	7.60	-
15-Nov-17	58.0	7.10	-
17-Nov-17	166	7.00	-
21-Nov-17	26.0	7.60	-
23-Nov-17	32.0	7.20	-
24-Nov-17	32.0	7.20	-
28-Nov-17	51.0	6.90	-
5-Dec-17	416	7.00	-
6-Dec-17	212	7.10	-
7-Dec-17	195	7.10	-
8-Dec-17	181	7.00	-
11-Dec-17	66.0	7.30	-
12-Dec-17	21.0	7.30	-
19-Dec-17	21.0	7.30	-
20-Dec-17	32.0	7.40	-
22-Dec-17	21.0	7.20	-
27-Dec-17	26.0	7.50	-
2-Jan-18	7.00	7.00	-
4-Jan-18	11.0	7.20	-
9-Jan-18	7.00	7.20	0.0530
16-Jan-18	32.0	7.30	-
17-Jan-18	21.0	7.30	-
23-Jan-18	11.0	7.00	-
30-Jan-18	1.00	7.10	-
6-Feb-18	4.00	7.10	-
13-Feb-18	4.00	7.10	-
20-Feb-18	2.00	7.00	-
27-Feb-18	11.0	7.20	-
6-Mar-18	4.00	7.40	-
13-Mar-18	4.00	7.10	-
20-Mar-18	1.00	7.10	-
27-Mar-18	1.00	6.90	-
28-Mar-18	7.00	6.90	-
29-Mar-18	51.0	6.90	-
3-Apr-18	11.0	7.30	-
5-Apr-18	11.0	7.20	-
6-Apr-18	73.0	7.20	-
10-Apr-18	4.00	7.40	0.0320
17-Apr-18	32.0	7.30	-
18-Apr-18	21.0	7.10	-
19-Apr-18	73.0	7.00	-
24-Apr-18	166	6.80	-
25-Apr-18	212	7.00	-
26-Apr-18	301	7.20	-
27-Apr-18	301	7.10	-
30-Apr-18	212	7.80	-
1-May-18	212	7.40	-
2-May-18	253	7.10	-
3-May-18	276	7.00	-
4-May-18	253	7.00	-
7-May-18	181	7.20	-
8-May-18	169	8.00	-
9-May-18	169	8.80	-
10-May-18	166	7.90	-
11-May-18	163	7.90	-
14-May-18	44.0	7.30	-
15-May-18	21.0	7.60	-
16-May-18	21.0	7.50	-
18-May-18	32.0	7.40	-
22-May-18	11.0	6.90	-
24-May-18	32.0	7.00	-
4-Jun-18	7.00	7.30	-
5-Jun-18	4.00	7.70	-
12-Jun-18	7.00	7.90	-
19-Jun-18	7.00	7.80	-
26-Jun-18	7.00	7.90	-
3-Jul-18	4.00	7.70	-
10-Jul-18	4.00	7.70	0.00800
17-Jul-18	7.00	7.60	-
24-Jul-18	7.00	7.40	-
31-Jul-18	6.00	7.70	-
7-Aug-18	1.00	7.50	-
14-Aug-18	7.00	7.30	-
21-Aug-18	7.00	7.60	-
28-Aug-18	11.0	7.60	-
4-Sep-18	16.0	7.60	-
11-Sep-18	7.00	7.20	-
18-Sep-18	7.00	7.30	-
25-Sep-18	4.00	7.00	-
2-Oct-18	4.00	7.50	-
9-Oct-18	73.0	7.30	0.0150
10-Oct-18	107	7.10	-
11-Oct-18	181	7.20	-
15-Oct-18	169	7.20	-
16-Oct-18	169	7.30	-
17-Oct-18	163	7.20	-
19-Oct-18	90.0	7.30	-
23-Oct-18	44.0	7.10	-
24-Oct-18	21.0	6.90	-
26-Oct-18	90.0	7.30	-

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table C.6: Water Quality at TOMP Station DS-1 (Additional pH Control, Radium Monitoring), Stanrock TMA, 2015 to 2019

Date	Flow (L/s)	pH	Radium (Bq/L)
30-Oct-18	16.0	7.10	-
1-Nov-18	32.0	6.80	-
2-Nov-18	32.0	6.90	-
6-Nov-18	11.0	7.30	-
8-Nov-18	90.0	7.20	-
9-Nov-18	163	7.10	-
13-Nov-18	11.0	7.10	-
15-Nov-18	44.0	7.00	-
16-Nov-18	38.0	7.00	-
20-Nov-18	16.0	6.90	-
21-Nov-18	66.0	7.00	-
22-Nov-18	44.0	7.00	-
26-Nov-18	73.0	7.10	-
27-Nov-18	125	7.40	-
28-Nov-18	58.0	7.00	-
30-Nov-18	44.0	7.10	-
3-Dec-18	73.0	7.00	-
4-Dec-18	32.0	7.50	-
7-Dec-18	44.0	7.20	-
11-Dec-18	16.0	7.40	-
12-Dec-18	21.0	7.30	-
18-Dec-18	11.0	7.20	-
21-Dec-18	26.0	7.20	-
27-Dec-18	44.0	7.10	-
28-Dec-18	66.0	7.10	-
31-Dec-18	21.0	7.40	-
2-Jan-19	58.0	7.00	-
3-Jan-19	44.0	6.90	-
4-Jan-19	44.0	7.40	-
7-Jan-19	4.00	7.00	-
8-Jan-19	51.0	7.10	0.0230
10-Jan-19	51.0	7.10	-
11-Jan-19	16.0	7.00	-
14-Jan-19	16.0	7.00	-
15-Jan-19	11.0	7.20	-
16-Jan-19	11.0	7.00	-
17-Jan-19	32.0	6.80	-
18-Jan-19	44.0	7.20	-
21-Jan-19	11.0	7.00	-
22-Jan-19	11.0	7.30	-
23-Jan-19	7.00	7.30	-
24-Jan-19	11.0	6.90	-
29-Jan-19	11.0	7.20	-
31-Jan-19	11.0	7.40	-
4-Feb-19	7.00	7.20	-
5-Feb-19	16.0	6.90	-
7-Feb-19	11.0	7.00	-
11-Feb-19	5.00	6.90	-
12-Feb-19	4.00	7.00	-
13-Feb-19	26.0	7.30	-
14-Feb-19	21.0	7.30	-
19-Feb-19	7.00	7.40	-
20-Feb-19	4.00	7.50	-
21-Feb-19	4.00	7.00	-
25-Feb-19	32.0	7.40	-
27-Feb-19	11.0	7.00	-
28-Feb-19	11.0	7.00	-
1-Mar-19	66.0	7.00	-
4-Mar-19	16.0	7.30	-
5-Mar-19	11.0	7.20	-
6-Mar-19	11.0	7.00	-
7-Mar-19	8.00	6.80	-
8-Mar-19	4.00	7.00	-
11-Mar-19	7.00	7.10	-
12-Mar-19	32.0	7.10	-
13-Mar-19	44.0	7.10	-
18-Mar-19	81.0	7.00	-
19-Mar-19	21.0	7.30	-
20-Mar-19	73.0	7.20	-
21-Mar-19	58.0	7.20	-
22-Mar-19	32.0	7.00	-
25-Mar-19	32.0	6.90	-
26-Mar-19	11.0	7.00	-
27-Mar-19	73.0	6.90	-
1-Apr-19	21.0	7.20	-
2-Apr-19	26.0	7.10	-
4-Apr-19	32.0	7.00	-
8-Apr-19	58.0	7.00	-
9-Apr-19	125	6.90	0.0380
10-Apr-19	212	7.00	-
11-Apr-19	212	7.00	-
12-Apr-19	212	7.00	-
15-Apr-19	212	7.10	-
16-Apr-19	212	7.20	-
17-Apr-19	212	7.20	-
18-Apr-19	301	7.00	-
19-Apr-19	301	8.30	-
22-Apr-19	253	7.90	-
23-Apr-19	301	8.90	-
24-Apr-19	356	8.70	-
25-Apr-19	253	8.00	-
26-Apr-19	253	8.10	-
29-Apr-19	181	7.90	-
30-Apr-19	181	8.00	-
1-May-19	166	7.60	-
2-May-19	166	8.10	-
3-May-19	163	8.10	-
6-May-19	125	7.60	-
8-May-19	107	7.50	-
9-May-19	90.0	7.50	-
7-May-19	163	7.10	-
10-May-19	212	7.20	-
13-May-19	169	7.10	-
14-May-19	90.0	7.20	-
15-May-19	90.0	7.30	-
16-May-19	58.0	7.20	-
21-May-19	107	7.20	-
22-May-19	90.0	7.20	-
27-May-19	58.0	7.30	-
28-May-19	58.0	7.50	-
29-May-19	58.0	7.40	-

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table C.6: Water Quality at TOMP Station DS-1 (Additional pH Control, Radium Monitoring), Stanrock TMA, 2015 to 2019

Date	Flow (L/s)	pH	Radium (Bq/L)
3-Jun-19	4.00	7.00	-
4-Jun-19	2.00	7.50	-
5-Jun-19	113	7.20	-
10-Jun-19	21.0	7.40	-
11-Jun-19	51.0	7.50	-
12-Jun-19	90.0	7.40	-
13-Jun-19	98.0	7.40	-
14-Jun-19	58.0	7.60	-
17-Jun-19	4.00	7.60	-
18-Jun-19	16.0	7.80	-
19-Jun-19	38.0	7.70	-
20-Jun-19	51.0	7.50	-
21-Jun-19	44.0	7.80	-
24-Jun-19	6.00	7.70	-
25-Jun-19	51.0	7.20	-
26-Jun-19	58.0	7.50	-
27-Jun-19	81.0	7.50	-
28-Jun-19	90.0	8.00	-
2-Jul-19	9.00	7.80	-
3-Jul-19	7.00	7.60	-
4-Jul-19	7.00	7.60	-
5-Jul-19	13.0	7.50	-
9-Jul-19	1.00	7.60	0.0290
12-Jul-19	21.0	7.50	-
15-Jul-19	1.00	7.70	-
16-Jul-19	7.00	7.60	-
18-Jul-19	1.00	7.60	-
23-Jul-19	4.00	7.20	-
30-Jul-19	7.00	7.10	-
6-Aug-19	3.00	7.50	-
12-Aug-19	1.00	7.40	-
13-Aug-19	1.00	7.30	-
15-Aug-19	1.00	7.20	-
19-Aug-19	4.00	7.30	-
20-Aug-19	1.00	7.30	-
23-Aug-19	7.00	7.10	-
27-Aug-19	16.0	7.10	-
28-Aug-19	4.00	7.40	-
3-Sep-19	1.00	7.10	-
10-Sep-19	3.00	7.40	-
13-Sep-19	4.00	7.40	-
17-Sep-19	1.00	7.60	-
20-Sep-19	7.00	7.20	-
23-Sep-19	9.00	7.30	-
24-Sep-19	4.00	7.50	-
25-Sep-19	9.00	7.30	-
26-Sep-19	9.00	7.30	-
27-Sep-19	32.0	7.40	-
1-Oct-19	32.0	7.50	-
2-Oct-19	98.0	7.40	-
3-Oct-19	73.0	7.40	-
8-Oct-19	11.0	7.30	0.0250
9-Oct-19	32.0	7.40	-
10-Oct-19	44.0	7.40	-
11-Oct-19	23.0	7.50	-
15-Oct-19	26.0	7.40	-
16-Oct-19	181	7.30	-
17-Oct-19	107	7.50	-
18-Oct-19	107	7.50	-
21-Oct-19	125	7.40	-
22-Oct-19	195	7.40	-
23-Oct-19	212	7.00	-
24-Oct-19	181	7.30	-
25-Oct-19	64.0	7.30	-
28-Oct-19	169	7.10	-
29-Oct-19	169	7.40	-
30-Oct-19	169	7.10	-
31-Oct-19	163	7.10	-
1-Nov-19	163	7.10	-
4-Nov-19	32.0	7.10	-
5-Nov-19	98.0	7.40	-
6-Nov-19	107	7.30	-
7-Nov-19	44.0	7.20	-
8-Nov-19	32.0	7.20	-
12-Nov-19	21.0	7.20	-
13-Nov-19	16.0	7.10	-
14-Nov-19	16.0	7.30	-
18-Nov-19	16.0	7.10	-
19-Nov-19	66.0	7.10	-
20-Nov-19	44.0	7.10	-
21-Nov-19	44.0	6.90	-
22-Nov-19	231	7.00	-
25-Nov-19	181	6.90	-
26-Nov-19	163	7.20	-
3-Dec-19	21.0	7.20	-
4-Dec-19	81.0	7.00	-
5-Dec-19	51.0	6.80	-
9-Dec-19	21.0	6.80	-
10-Dec-19	98.0	7.20	-
11-Dec-19	44.0	7.00	-
16-Dec-19	21.0	7.20	-
19-Dec-19	44.0	7.00	-
23-Dec-19	16.0	7.20	-
30-Dec-19	38.0	7.20	-
31-Dec-19	125	7.40	-
n	632	640	20
Minimum	1.00	6.70	0.00800
Maximum	416	9.30	0.0530
Mean	62.3	7.33	0.0256
SD	76.0	0.390	0.0111
Median	32.0	7.30	0.0240
10th Percentile	4.00	7.00	0.0115
95th Percentile	212	7.90	0.0455

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table C.7: Water Quality at TOMP Station DS-6 (Additional pH Control), Stanrock TMA, 2015 to 2019

Date	Flow (L/s)	pH
6-Jan-15	6.00	7.40
8-Jan-15	16.0	7.50
13-Jan-15	6.00	7.60
15-Jan-15	29.0	7.30
20-Jan-15	1.00	7.00
21-Jan-15	-	7.00
22-Jan-15	29.0	7.10
23-Jan-15	-	7.30
27-Jan-15	1.00	7.00
28-Jan-15	-	7.00
29-Jan-15	-	7.10
30-Jan-15	-	7.50
2-Feb-15	-	7.10
3-Feb-15	1.00	7.00
5-Feb-15	-	7.40
10-Feb-15	1.00	7.50
17-Feb-15	1.00	7.30
25-Feb-15	103	7.70
26-Feb-15	29.0	7.60
2-Mar-15	-	7.70
3-Mar-15	1.00	7.60
13-Mar-15	62.0	8.10
17-Mar-15	6.00	7.74
23-Mar-15	6.00	7.80
24-Mar-15	6.00	7.40
25-Mar-15	62.0	8.00
26-Mar-15	29.0	7.80
27-Mar-15	16.0	7.80
31-Mar-15	6.00	7.60
1-Apr-15	103	8.40
7-Apr-15	62.0	7.50
9-Apr-15	82.0	7.60
10-Apr-15	82.0	7.60
13-Apr-15	232	7.10
14-Apr-15	292	6.80
15-Apr-15	356	7.20
16-Apr-15	323	8.70
17-Apr-15	232	7.80
20-Apr-15	232	6.90
21-Apr-15	292	6.90
22-Apr-15	232	7.50
23-Apr-15	203	8.50
24-Apr-15	176	8.10
27-Apr-15	103	9.40
28-Apr-15	45.0	9.40
5-May-15	16.0	8.70
12-May-15	126	7.60
19-May-15	126	7.50
26-May-15	82.0	7.50
2-Jun-15	29.0	7.50
4-Jun-15	-	7.90
8-Jun-15	-	7.60
9-Jun-15	6.00	7.80
16-Jun-15	6.00	7.90
18-Jun-15	-	8.00
23-Jun-15	6.00	7.70
16-Oct-15	0	7.80
2-Nov-15	59.0	7.73
3-Nov-15	82.0	7.82
4-Nov-15	62.0	7.75
5-Nov-15	62.0	7.69
9-Nov-15	62.0	7.86
10-Nov-15	62.0	8.00
11-Nov-15	62.0	8.00
12-Nov-15	62.0	7.88
13-Nov-15	103	7.60
17-Nov-15	29.0	7.80
18-Nov-15	82.0	7.70
19-Nov-15	151	7.30
20-Nov-15	126	7.80
23-Nov-15	29.0	7.66
24-Nov-15	29.0	7.70
25-Nov-15	16.0	7.40
26-Nov-15	176	7.66
30-Nov-15	126	7.40
1-Dec-15	62.0	7.70
2-Dec-15	45.0	7.40
4-Dec-15	103	7.50
7-Dec-15	16.0	7.40
8-Dec-15	6.00	7.40
9-Dec-15	82.0	7.10
10-Dec-15	103	6.95
11-Dec-15	126	7.20
14-Dec-15	151	7.50
15-Dec-15	653	7.70
16-Dec-15	292	7.20
17-Dec-15	261	7.50
18-Dec-15	232	8.10
21-Dec-15	176	7.30
22-Dec-15	151	7.80
23-Dec-15	126	7.30
29-Dec-15	126	8.40
5-Jan-16	16.0	8.40
12-Jan-16	203	8.20
19-Jan-16	1.00	8.10
26-Jan-16	103	8.10
27-Jan-16	29.0	8.10
2-Feb-16	6.00	7.40
9-Feb-16	16.0	8.30
16-Feb-16	1.00	8.00
23-Feb-16	1.00	7.30
1-Mar-16	62.0	8.40
8-Mar-16	6.00	7.10
10-Mar-16	203	8.20
15-Mar-16	176	7.31
21-Mar-16	203	7.80
22-Mar-16	203	8.00
23-Mar-16	203	9.00
24-Mar-16	151	9.40

Date	Flow (L/s)	pH
28-Mar-16	82.0	8.50
29-Mar-16	126	7.40
30-Mar-16	126	7.80
31-Mar-16	176	8.00
1-Apr-16	203	7.50
5-Apr-16	126	7.80
12-Apr-16	103	8.70
19-Apr-16	232	7.50
21-Apr-16	203	7.50
25-Apr-16	126	9.30
26-Apr-16	103	9.40
3-May-16	45.0	8.90
10-May-16	6.00	8.30
17-May-16	6.00	7.70
24-May-16	1.00	7.50
14-Jun-16	<1.00	7.60
30-Nov-16	126	7.30
1-Dec-16	108	7.40
2-Dec-16	108	7.40
5-Dec-16	45.0	7.30
6-Dec-16	16.0	7.10
8-Dec-16	74.0	7.40
9-Dec-16	82.0	7.10
12-Dec-16	16.0	6.90
13-Dec-16	16.0	7.00
14-Dec-16	11.0	7.40
15-Dec-16	16.0	7.30
16-Dec-16	16.0	7.40
20-Dec-16	6.00	7.30
29-Dec-16	45.0	7.10
30-Dec-16	16.0	7.10
2-Jan-17	7.00	7.20
3-Jan-17	4.00	7.00
11-Jan-17	108	7.20
16-Jan-17	16.0	7.00
17-Jan-17	7.00	7.10
18-Jan-17	6.00	6.80
19-Jan-17	16.0	7.10
20-Jan-17	45.0	7.10
23-Jan-17	16.0	7.00
24-Jan-17	6.00	7.00
26-Jan-17	103	7.10
30-Jan-17	4.00	6.90
31-Jan-17	62.0	7.10
1-Feb-17	45.0	7.00
2-Feb-17	16.0	6.90
3-Feb-17	45.0	7.00
6-Feb-17	6.00	6.90
7-Feb-17	2.00	6.90
8-Feb-17	2.00	7.10
9-Feb-17	103	6.90
10-Feb-17	62.0	7.00
16-Feb-17	45.0	7.00
17-Feb-17	45.0	6.90
21-Feb-17	2.00	6.90
22-Feb-17	2.00	6.80
23-Feb-17	82.0	7.00
24-Feb-17	103	7.00
27-Feb-17	45.0	6.80
28-Feb-17	16.0	7.00
1-Mar-17	45.0	7.00
3-Mar-17	45.0	7.30
6-Mar-17	16.0	7.00
7-Mar-17	62.0	7.00
8-Mar-17	232	7.30
9-Mar-17	176	7.40
10-Mar-17	29.0	7.00
13-Mar-17	29.0	7.20
14-Mar-17	82.0	7.10
21-Mar-17	103	7.00
22-Mar-17	45.0	7.00
23-Mar-17	16.0	7.20
28-Mar-17	126	7.50
29-Mar-17	126	7.00
30-Mar-17	176	7.30
31-Mar-17	126	7.10
3-Apr-17	232	7.30
4-Apr-17	261	6.80
5-Apr-17	356	6.80
6-Apr-17	232	6.70
7-Apr-17	203	6.70
10-Apr-17	232	7.00
12-Apr-17	203	7.60
13-Apr-17	203	7.30
17-Apr-17	203	7.30
18-Apr-17	126	7.80
19-Apr-17	126	8.30
20-Apr-17	292	8.70
21-Apr-17	126	8.40
24-Apr-17	82.0	7.90
25-Apr-17	62.0	7.90
26-Apr-17	82.0	7.70
27-Apr-17	16.0	7.70
28-Apr-17	6.00	7.50
1-May-17	16.0	7.40
2-May-17	82.0	7.50
3-May-17	82.0	7.50
4-May-17	126	7.40
5-May-17	82.0	7.60
9-May-17	16.0	7.60
10-May-17	16.0	7.60
11-May-17	6.00	7.50
12-May-17	82.0	7.40
16-May-17	2.00	7.40
18-May-17	1.00	7.40
19-May-17	6.00	7.30
23-May-17	53.0	7.60
25-May-17	16.0	7.60
29-May-17	-	7.80

Date	Flow (L/s)	pH
30-May-17	82.0	7.60
31-May-17	82.0	7.80
5-Jun-17	2.00	7.90
6-Jun-17	29.0	7.90
7-Jun-17	29.0	7.90
8-Jun-17	16.0	7.80
13-Jun-17	2.00	7.90
20-Jun-17	29.0	8.00
21-Jun-17	16.0	8.10
26-Jun-17	6.00	8.30
27-Jun-17	29.0	8.40
28-Jun-17	16.0	8.40
29-Jun-17	45.0	8.30
4-Jul-17	62.0	8.40
6-Jul-17	45.0	8.00
7-Jul-17	6.00	8.60
10-Jul-17	2.00	7.70
27-Jul-17	45.0	8.10
4-Aug-17	82.0	8.10
14-Aug-17	16.0	8.00
15-Aug-17	16.0	8.00
17-Aug-17	6.00	8.00
22-Aug-17	45.0	7.40
23-Aug-17	126	8.10
24-Aug-17	151	8.20
7-Sep-17	82.0	8.00
28-Sep-17	16.0	7.90
3-Oct-17	45.0	7.90
6-Oct-17	16.0	7.90
10-Oct-17	-	7.70
12-Oct-17	45.0	8.00
16-Oct-17	45.0	7.20
17-Oct-17	82.0	7.60
18-Oct-17	45.0	7.50
20-Oct-17	29.0	7.80
24-Oct-17	356	7.40
25-Oct-17	356	7.40
27-Oct-17	82.0	7.40
30-Oct-17	126	7.60
31-Oct-17	126	8.10
2-Nov-17	126	7.70
6-Nov-17	82.0	7.50
7-Nov-17	45.0	8.20
10-Nov-17	82.0	7.50
13-Nov-17	16.0	7.70
14-Nov-17	6.00	7.40
15-Nov-17	82.0	7.30
17-Nov-17	82.0	7.10
21-Nov-17	45.0	7.00
23-Nov-17	29.0	7.00
24-Nov-17	45.0	7.40
28-Nov-17	82.0	7.00
5-Dec-17	232	6.90
6-Dec-17	232	6.90
7-Dec-17	232	7.10
8-Dec-17	203	7.00
11-Dec-17	126	7.40
12-Dec-17	16.0	7.30
20-Dec-17	62.0	8.00
22-Dec-17	6.00	7.20
27-Dec-17	6.00	7.20
2-Jan-18	6.00	7.00
4-Jan-18	6.00	7.00
9-Jan-18	6.00	7.60
16-Jan-18	16.0	7.30
17-Jan-18	16.0	7.20
23-Jan-18	16.0	7.20
6-Feb-18	6.00	7.60
13-Feb-18	6.00	7.50
27-Feb-18	6.00	7.50
6-Mar-18	6.00	7.40
13-Mar-18	6.00	7.40
28-Mar-18	-	6.90
29-Mar-18	62.0	7.50
3-Apr-18	6.00	7.80
5-Apr-18	6.00	7.70
6-Apr-18	82.0	7.70
10-Apr-18	6.00	7.20
17-Apr-18	16.0	7.00
18-Apr-18	6.00	7.40
19-Apr-18	82.0	7.70
24-Apr-18	176	6.90
25-Apr-18	292	7.10
26-Apr-18	261	6.80
27-Apr-18	292	7.30
30-Apr-18	232	6.90
1-May-18	126	6.70
2-May-18	232	7.00
3-May-18	261	7.00
4-May-18	292	6.90
7-May-18	151	8.10
8-May-18	151	8.00
9-May-18	126	9.00
10-May-18	126	8.90
11-May-18	126	8.40
14-May-18	45.0	8.00
15-May-18	29.0	8.90
16-May-18	16.0	7.70
18-May-18	126	7.80
22-May-18	45.0	7.20
23-May-18	16.0	7.50
24-May-18	82.0	7.40
9-Oct-18	82.0	7.40
10-Oct-18	126	7.30
11-Oct-18	203	7.40
15-Oct-18	176	7.30
16-Oct-18	103	7.60
17-Oct-18	62.0	7.30
19-Oct-18	82.0	7.20

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table C.7: Water Quality at TOMP Station DS-6 (Additional pH Control), Stanrock TMA, 2015 to 2019

Date	Flow (L/s)	pH
23-Oct-18	45.0	7.20
24-Oct-18	16.0	7.10
26-Oct-18	103	7.20
30-Oct-18	16.0	7.30
1-Nov-18	29.0	7.10
2-Nov-18	45.0	7.20
6-Nov-18	16.0	7.20
8-Nov-18	126	7.40
9-Nov-18	126	7.20
13-Nov-18	16.0	7.30
15-Nov-18	45.0	7.10
16-Nov-18	29.0	7.00
20-Nov-18	6.00	7.40
21-Nov-18	82.0	7.20
22-Nov-18	29.0	7.10
26-Nov-18	126	7.30
27-Nov-18	126	7.70
28-Nov-18	62.0	7.20
30-Nov-18	82.0	7.40
3-Dec-18	45.0	7.20
4-Dec-18	16.0	7.60
7-Dec-18	16.0	7.40
11-Dec-18	6.00	7.30
12-Dec-18	16.0	7.40
18-Dec-18	6.00	7.30
21-Dec-18	29.0	7.60
27-Dec-18	82.0	7.20
28-Dec-18	62.0	7.50
31-Dec-18	16.0	7.50
2-Jan-19	82.0	7.10
3-Jan-19	45.0	7.10
4-Jan-19	82.0	7.50
7-Jan-19	6.00	6.90
8-Jan-19	29.0	7.10
10-Jan-19	45.0	7.30
11-Jan-19	16.0	7.10
14-Jan-19	6.00	7.00
15-Jan-19	6.00	7.40
16-Jan-19	6.00	7.20
17-Jan-19	62.0	6.90
18-Jan-19	45.0	7.40
21-Jan-19	6.00	7.10
22-Jan-19	6.00	7.50
23-Jan-19	6.00	7.60
24-Jan-19	6.00	7.30
29-Jan-19	6.00	7.20
31-Jan-19	6.00	7.60
4-Feb-19	6.00	7.50
5-Feb-19	2.00	6.90
7-Feb-19	2.00	7.00
11-Feb-19	1.00	6.90
12-Feb-19	1.00	6.90
13-Feb-19	6.00	7.50
14-Feb-19	6.00	7.60
25-Feb-19	45.0	7.50
27-Feb-19	6.00	7.00
28-Feb-19	6.00	7.20
1-Mar-19	82.0	7.20
4-Mar-19	6.00	7.50
5-Mar-19	6.00	7.40
6-Mar-19	6.00	7.30
7-Mar-19	2.00	6.90
12-Mar-19	45.0	7.50
13-Mar-19	45.0	7.30
18-Mar-19	103	7.20
19-Mar-19	29.0	7.20
20-Mar-19	103	7.20
21-Mar-19	82.0	7.20
22-Mar-19	45.0	7.00
25-Mar-19	29.0	6.90
26-Mar-19	16.0	7.00
27-Mar-19	103	6.90
1-Apr-19	29.0	6.90
2-Apr-19	29.0	7.10
4-Apr-19	45.0	6.90
8-Apr-19	126	6.80
9-Apr-19	232	6.80
10-Apr-19	261	7.20
11-Apr-19	232	6.80
12-Apr-19	232	6.80
15-Apr-19	176	6.80
16-Apr-19	103	6.80
17-Apr-19	126	7.10
18-Apr-19	232	6.80
19-Apr-19	574	7.40
22-Apr-19	261	7.20
23-Apr-19	292	6.50
24-Apr-19	574	8.20
25-Apr-19	323	7.60
26-Apr-19	292	7.10
29-Apr-19	176	7.70
30-Apr-19	126	8.80
1-May-19	126	9.10
2-May-19	126	8.80
3-May-19	126	8.80
6-May-19	126	8.10
7-May-19	151	7.60
8-May-19	126	8.20
9-May-19	126	8.30
10-May-19	232	8.30
13-May-19	151	8.00
14-May-19	103	7.90
15-May-19	103	7.90
16-May-19	82.0	7.70
21-May-19	151	7.80
22-May-19	126	8.00
27-May-19	82.0	7.30
28-May-19	82.0	7.60
29-May-19	62.0	7.50
5-Jun-19	-	7.30

Date	Flow (L/s)	pH
10-Jun-19	232	7.70
11-Jun-19	176	7.90
12-Jun-19	-	7.90
13-Jun-19	-	7.90
14-Jun-19	176	8.20
17-Jun-19	82.0	8.10
18-Jun-19	16.0	8.40
19-Jun-19	62.0	8.60
20-Jun-19	82.0	8.50
21-Jun-19	62.0	8.60
24-Jun-19	10.0	8.40
25-Jun-19	45.0	7.90
26-Jun-19	62.0	8.40
27-Jun-19	126	8.50
28-Jun-19	82.0	8.60
2-Jul-19	1.00	8.90
3-Jul-19	1.00	8.70
5-Jul-19	16.0	9.10
12-Jul-19	126	8.60
18-Jul-19	16.0	8.80
13-Sep-19	0	7.70
23-Sep-19	0	7.60
25-Sep-19	0	7.60
26-Sep-19	1.00	7.60
27-Sep-19	72.0	7.60
1-Oct-19	82.0	7.50
2-Oct-19	232	7.60
3-Oct-19	176	7.80
8-Oct-19	1.00	8.20
9-Oct-19	92.0	8.00
10-Oct-19	53.0	8.20
11-Oct-19	16.0	7.90
15-Oct-19	22.0	7.70
16-Oct-19	232	7.70
17-Oct-19	176	7.60
18-Oct-19	176	7.70
21-Oct-19	151	8.00
22-Oct-19	232	7.90
23-Oct-19	261	7.20
24-Oct-19	176	7.50
25-Oct-19	176	7.40
28-Oct-19	176	7.20
29-Oct-19	151	8.10
30-Oct-19	126	7.90
31-Oct-19	126	7.90
1-Nov-19	126	7.80
4-Nov-19	62.0	7.40
5-Nov-19	151	7.60
6-Nov-19	176	7.50
7-Nov-19	62.0	7.40
8-Nov-19	29.0	7.40
12-Nov-19	2.00	7.40
13-Nov-19	6.00	7.30
14-Nov-19	6.00	7.30
18-Nov-19	6.00	7.50
19-Nov-19	82.0	7.30
20-Nov-19	45.0	7.40
21-Nov-19	16.0	7.20
22-Nov-19	232	7.00
25-Nov-19	203	7.00
26-Nov-19	176	7.00
3-Dec-19	16.0	7.20
4-Dec-19	126	6.90
5-Dec-19	45.0	7.10
9-Dec-19	16.0	6.80
10-Dec-19	103	7.50
11-Dec-19	45.0	7.10
16-Dec-19	16.0	7.70
19-Dec-19	45.0	7.10
23-Dec-19	6.00	7.40
30-Dec-19	45.0	7.40
31-Dec-19	126	7.60
n	489	505
Minimum	<1.00	6.50
Maximum	653	9.40
Mean	86.2	7.54
SD	90.4	0.522
Median	62.0	7.40
10th Percentile	6.00	7.00
95th Percentile	261	8.60

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table C.8: Water Quality at TOMP Station DS-5 (Seepages and Surface Water Internal to TMA), Stanrock TMA, 2015 to 2019

Date	Flow (L/s)	pH	Conductivity (µmho/cm)
15-Jan-15	1.00	3.50	157
27-Apr-15	4.77	3.70	127
13-Oct-15	0.890	3.40	218
12-Jan-16	-	3.90	103
12-Apr-16	5.00	3.70	108
6-Oct-16	0.890	3.60	195
12-Jan-17	1.00	3.50	134
18-Apr-17	10.4	3.80	92.0
11-Jul-17	0.220	3.80	245
11-Oct-17	0.890	3.90	175
16-Jan-18	2.00	3.60	191
9-May-18	10.4	3.60	129
9-Oct-18	10.4	3.60	188
4-Jan-19	1.00	3.80	124
15-May-19	2.57	3.90	129
8-Oct-19	2.57	3.70	186
n	15	16	16
Minimum	0.220	3.40	92.0
Maximum	10.4	3.90	245
Mean	3.60	3.69	156
SD	3.79	0.154	44.6
Median	2.00	3.70	146
10th Percentile	0.890	3.50	103
95th Percentile	10.4	3.90	245

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table C.9: Water Quality at TOMP Stations PN-ST3-P3,5,6,8; BH91-SG2A (Pore Water), Stanrock TMA, 2015 to 2019

Station	Date	pH	Sulphate (mg/L)	Acidity (mg/L)	Iron (mg/L)
PN-ST3-P3	8-Jul-15	5.91	2,500	1,030	586
	12-Jul-16	5.94	2,100	1,030	589
	17-Aug-17	5.80	2,800	1,280	771
	28-Aug-18	5.86	3,000	1,560	767
	20-Aug-19	5.62	2,800	1,610	887
	n	5	5	5	5
	Minimum	5.62	2,100	1,030	586
	Maximum	5.94	3,000	1,610	887
	Mean	5.83	2,640	1,300	720
	SD	0.127	351	278	130
	Median	5.86	2,800	1,280	767
	10th Percentile	5.62	2,100	1,030	586
	95th Percentile	5.94	3,000	1,610	887
PN-ST3-P5	12-Jul-16	3.61	2,800	2,200	1,070
	17-Aug-17	3.23	3,000	1,850	827
	29-Aug-18	3.36	3,200	1,700	668
	20-Aug-19	3.17	3,000	2,130	1,070
	n	4	4	4	4
	Minimum	3.17	2,800	1,700	668
	Maximum	3.61	3,200	2,200	1,070
	Mean	3.34	3,000	1,970	909
	SD	0.195	163	235	197
	Median	3.30	3,000	1,990	948
	10th Percentile	3.17	2,800	1,700	668
	95th Percentile	3.61	3,200	2,200	1,070
PN-ST3-P6	8-Jul-15	6.28	4,700	3,560	1,770
	12-Jul-16	6.24	5,200	3,970	2,030
	17-Aug-17	5.95	5,400	4,050	2,370
	28-Aug-18	6.08	5,900	4,540	2,400
	20-Aug-19	5.86	5,400	4,430	2,580
	n	5	5	5	5
	Minimum	5.86	4,700	3,560	1,770
	Maximum	6.28	5,900	4,540	2,580
	Mean	6.08	5,320	4,110	2,230
	SD	0.181	432	391	325
	Median	6.08	5,400	4,050	2,370
	10th Percentile	5.86	4,700	3,560	1,770
	95th Percentile	6.28	5,900	4,540	2,580
PN-STS-P8	8-Jul-15	4.52	12,000	10,100	7,020
	12-Jul-16	5.84	11,000	9,630	5,810
	17-Aug-17	4.93	11,000	9,550	5,480
	28-Aug-18	4.88	11,000	9,010	4,790
	20-Aug-19	5.57	9,300	8,210	4,730
	n	5	5	5	5
	Minimum	4.52	9,300	8,210	4,730
	Maximum	5.84	12,000	10,100	7,020
	Mean	5.15	10,900	9,300	5,570
	SD	0.541	974	722	933
	Median	4.93	11,000	9,550	5,480
	10th Percentile	4.52	9,300	8,210	4,730
	95th Percentile	5.84	12,000	10,100	7,020
BH91-SG2A[a]	8-Jul-15	6.51	4,500	2,200	1,330
	12-Jul-16	6.01	4,000	2,260	1,160
	30-Aug-17	6.35	4,400	2,450	1,450
	4-Sep-18	6.42	4,500	3,140	1,280
	n	4	4	4	4
	Minimum	6.01	4,000	2,200	1,160
	Maximum	6.51	4,500	3,140	1,450
	Mean	6.32	4,350	2,510	1,300
	SD	0.218	238	432	120
	Median	6.38	4,450	2,360	1,300
	10th Percentile	6.01	4,000	2,200	1,160
	95th Percentile	6.51	4,500	3,140	1,450
BH91-SG2D[b]	**n**	0	0	0	0
	Minimum	-	-	-	-
	Maximum	-	-	-	-
	Mean	-	-	-	-
	SD	-	-	-	-
	Median	-	-	-	-
	10th Percentile	-	-	-	-
	95th Percentile	-	-	-	-

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

[a] Pore water station was dry when sampling was attempted in 2019, therefore no samples were collected

[b] Pore water station was dry when sampling was attempted in 2015, 2016, 2017, 2018, and 2019, therefore no samples were collected

Table C.10: Water Quality at TOMP Stations BH91-SG1A, BH98-16A, BH98-15A (Groundwater), Stanrock TMA, 2015 to 2019

Station	Date	pH	Sulphate (mg/L)	Acidity (mg/L)	Iron (mg/L)
BH91-SG1A	8-Jul-15	3.99	6,200	3,660	2,810
	11-Jul-16	4.18	4,600	3,360	1,440
	16-Aug-17	4.05	3,800	3,110	1,600
	29-Aug-18	4.11	2,900	3,540	875
	19-Aug-19	4.14	2,900	2,270	1,270
	n	5	5	5	5
	Minimum	3.99	2,900	2,270	875
	Maximum	4.18	6,200	3,660	2,810
	Mean	4.09	4,080	3,190	1,600
	SD	0.0750	1,380	553	729
	Median	4.11	3,800	3,360	1,440
	10th Percentile	3.99	2,900	2,270	875
	95th Percentile	4.18	6,200	3,660	2,810
BH98-16A	8-Jul-15	6.10	4,800	3,200	1,680
	13-Jul-16	5.68	3,900	1,880	1,240
	17-Aug-17	5.63	4,900	2,660	2,140
	28-Aug-18	5.74	3,400	2,060	1,080
	20-Aug-19	5.76	3,500	2,190	1,300
	n	5	5	5	5
	Minimum	5.63	3,400	1,880	1,080
	Maximum	6.10	4,900	3,200	2,140
	Mean	5.78	4,100	2,400	1,490
	SD	0.185	711	533	426
	Median	5.74	3,900	2,190	1,300
	10th Percentile	5.63	3,400	1,880	1,080
	95th Percentile	6.10	4,900	3,200	2,140
BH98-15A	8-Jul-15	6.36	2,700	1,200	838
	13-Jul-16	6.00	2,600	1,130	626
	17-Aug-17	5.40	2,400	1,040	651
	28-Aug-18	6.18	2,400	1,080	601
	21-Aug-19	5.96	2,400	1,130	504
	n	5	5	5	5
	Minimum	5.40	2,400	1,040	504
	Maximum	6.36	2,700	1,200	838
	Mean	5.98	2,500	1,120	644
	SD	0.361	141	60.2	122
	Median	6.00	2,400	1,130	626
	10th Percentile	5.40	2,400	1,040	504
	95th Percentile	6.36	2,700	1,200	838
BH91-SG3A[a]	**n**	0	0	0	0
	Minimum	-	-	-	-
	Maximum	-	-	-	-
	Mean	-	-	-	-
	SD	-	-	-	-
	Median	-	-	-	-
	10th Percentile	-	-	-	-
	95th Percentile	-	-	-	-
BH91-SG3B[b]	16-Aug-17	3.89	1,700	901	295
	n	1	1	1	1
	Minimum	3.89	1,700	901	295
	Maximum	3.89	1,700	901	295
	Mean	3.89	1,700	901	295
	SD	-	-	-	-
	Median	3.89	1,700	901	295
	10th Percentile	3.89	1,700	901	295
	95th Percentile	3.89	1,700	901	295

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected, or SD was incalculable because there was no variability in the data.

[a] Groundwater well was dry when sampling was attempted in 2015, 2016, 2017, 2018, and 2019, therefore no samples were collected

[b] Groundwater well was dry when sampling was attempted in 2015, 2016, 2018, and 2019, therefore no samples were collected

APPENDIX D

STANLEIGH TMA, TOMP DATA

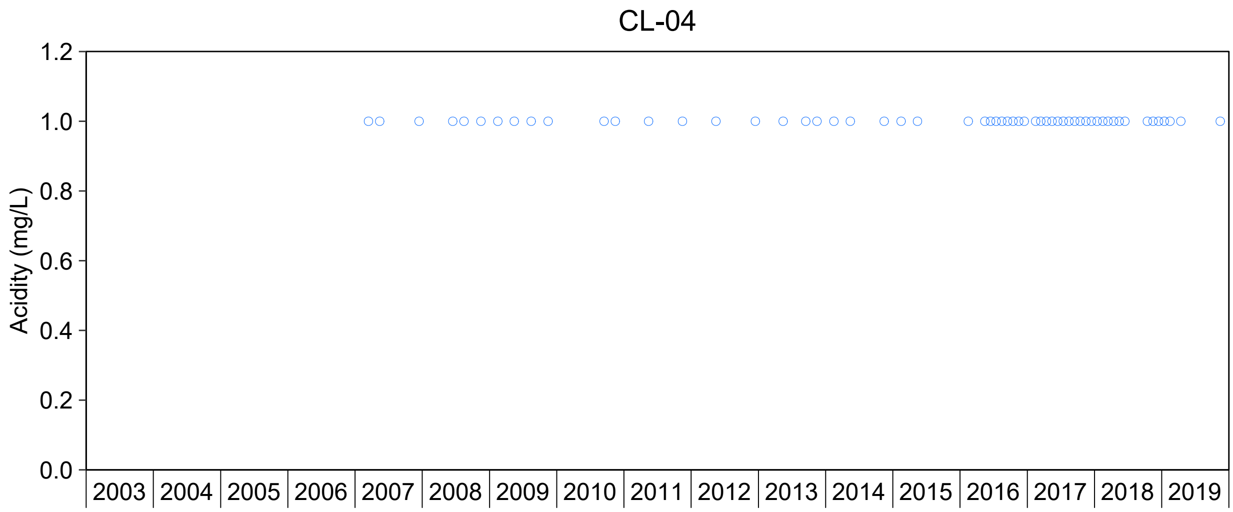


Figure D.1: Concentrations of Acidity for TOMP Water Monitoring Stations, Stanleigh TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 3.7 for Seasonal Kendall trend analysis results and Appendix Table D.3 for raw data. Acidity (mg/L) is not included in the trend analysis for TOMP station CL-04 due to >50% non-detectable concentrations in the dataset.

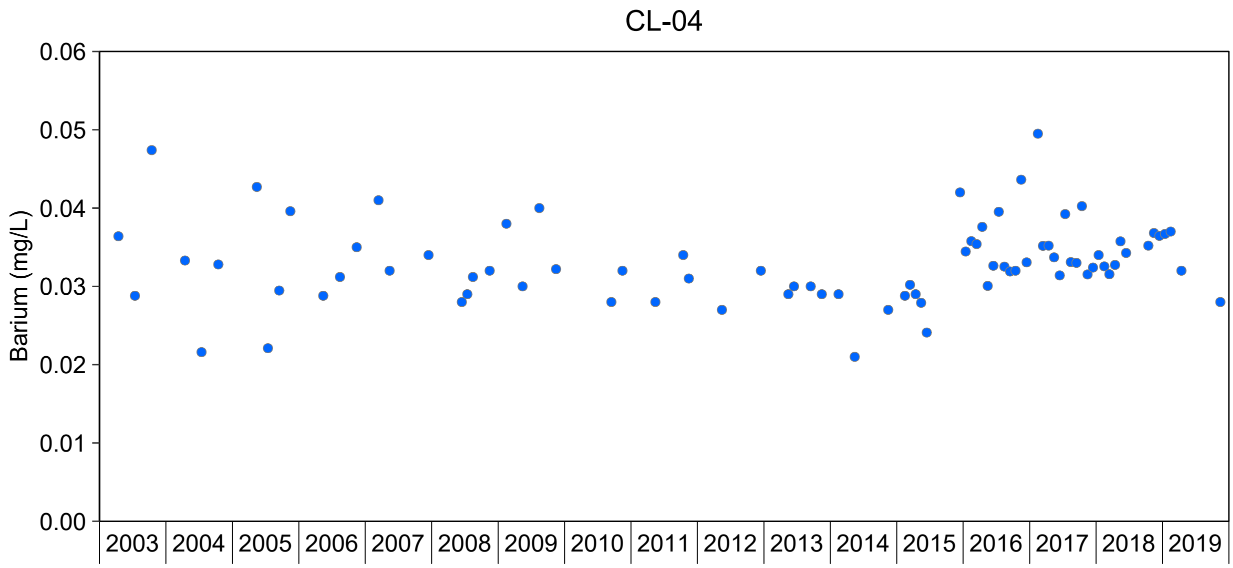


Figure D.2: Concentrations of Barium for TOMP Water Monitoring Stations, Stanleigh TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 3.7 for Seasonal Kendall trend analysis results and Appendix Table D.3 for raw data.

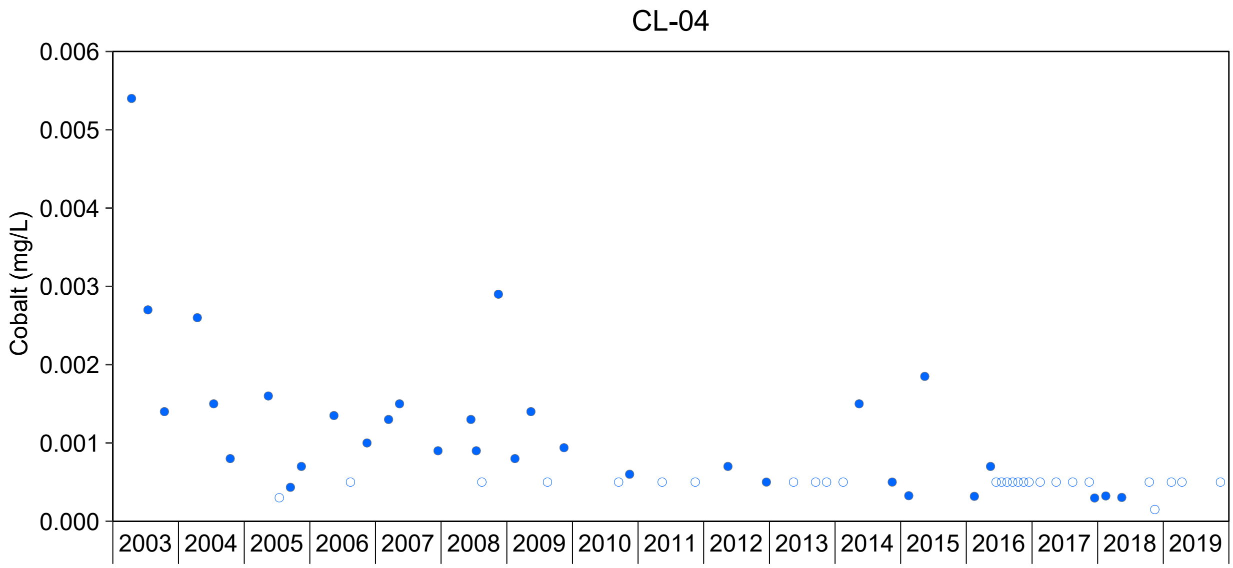


Figure D.3: Concentrations of Cobalt for TOMP Water Monitoring Stations, Stanleigh TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 3.7 for Seasonal Kendall trend analysis results and Appendix Table D.3 for raw data.

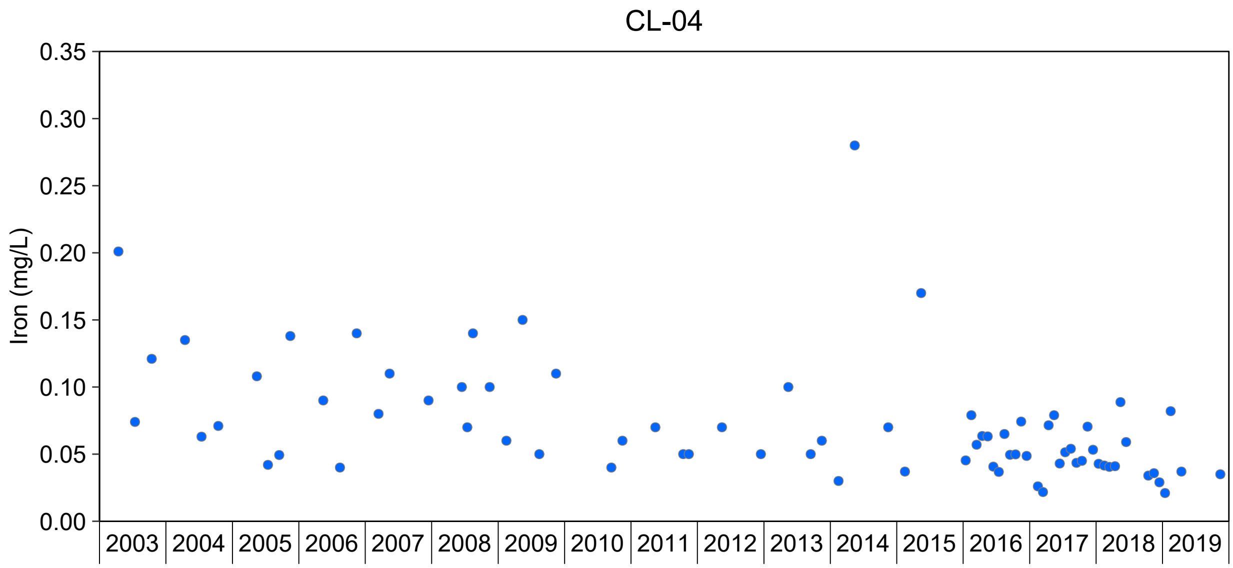


Figure D.4: Concentrations of Iron for TOMP Water Monitoring Stations, Stanleigh TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 3.7 for Seasonal Kendall trend analysis results and Appendix Table D.3 for raw data.

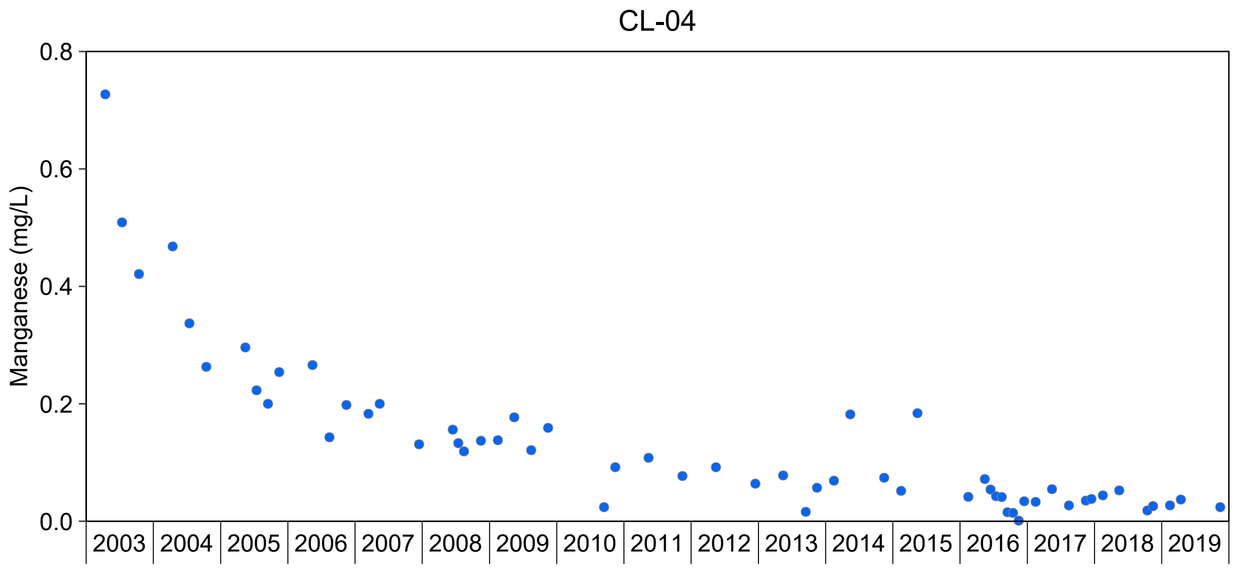


Figure D.5: Concentrations of Manganese for TOMP Water Monitoring Stations, Stanleigh TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 3.7 for Seasonal Kendall trend analysis results and Appendix Table D.3 for raw data.

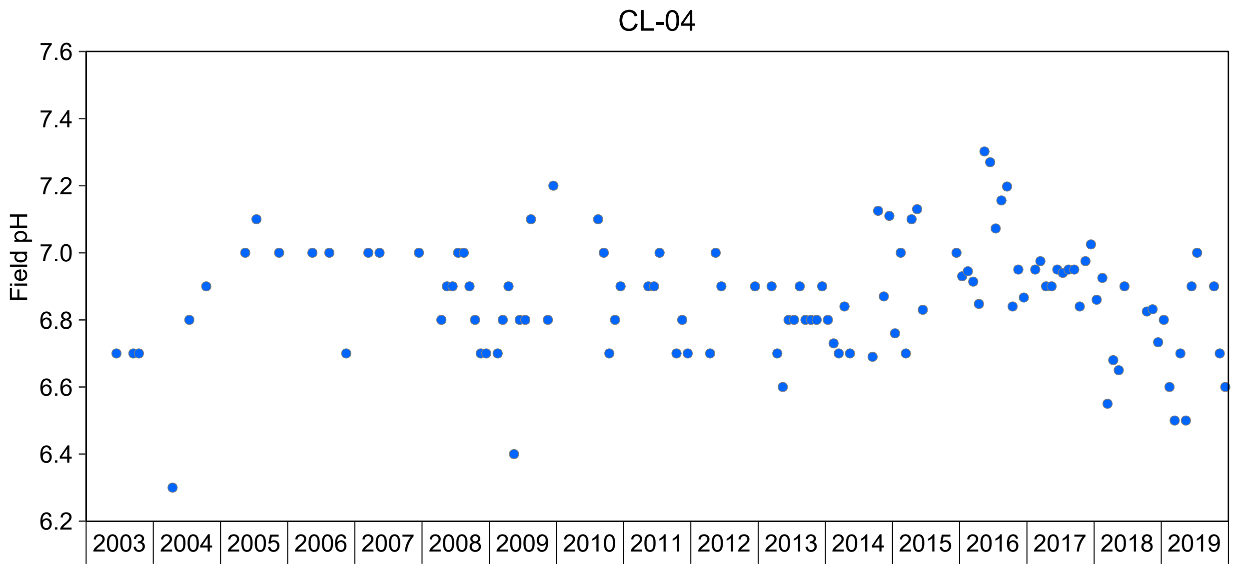


Figure D.6: Field Measurements of pH for TOMP Water Monitoring Stations, Stanleigh TMA, 2003 to 2019

Notes: See Table 3.7 for Seasonal Kendall trend analysis results and Appendix Table D.3 for raw data.

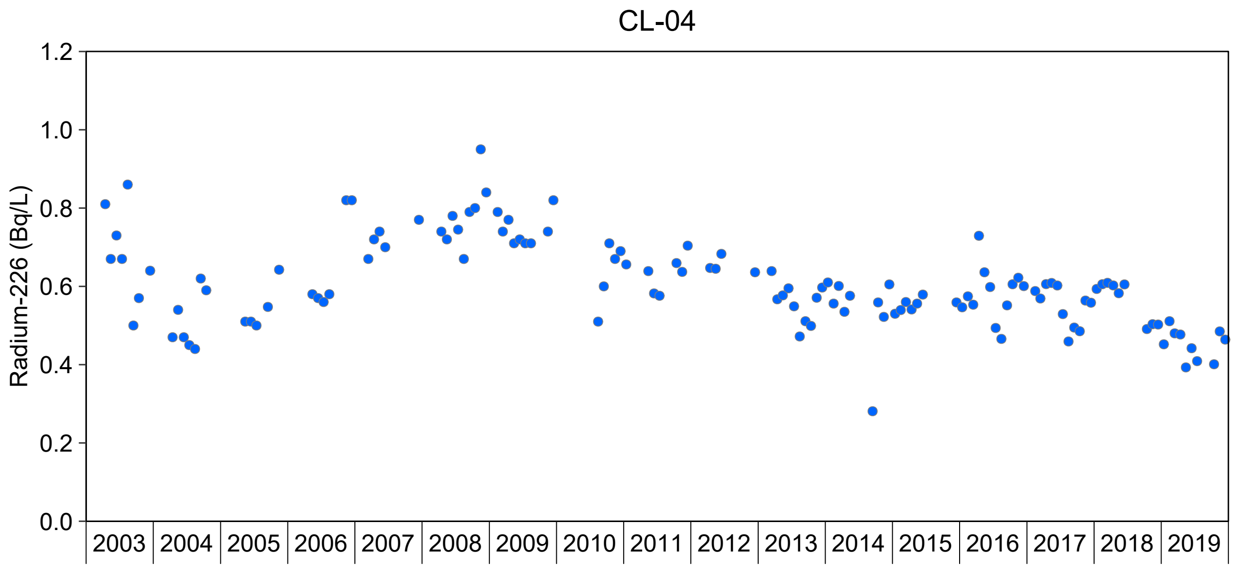


Figure D.7: Concentrations of Radium-226 for TOMP Water Monitoring Stations, Stanleigh TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 3.7 for Seasonal Kendall trend analysis results and Appendix Table D.3 for raw data.

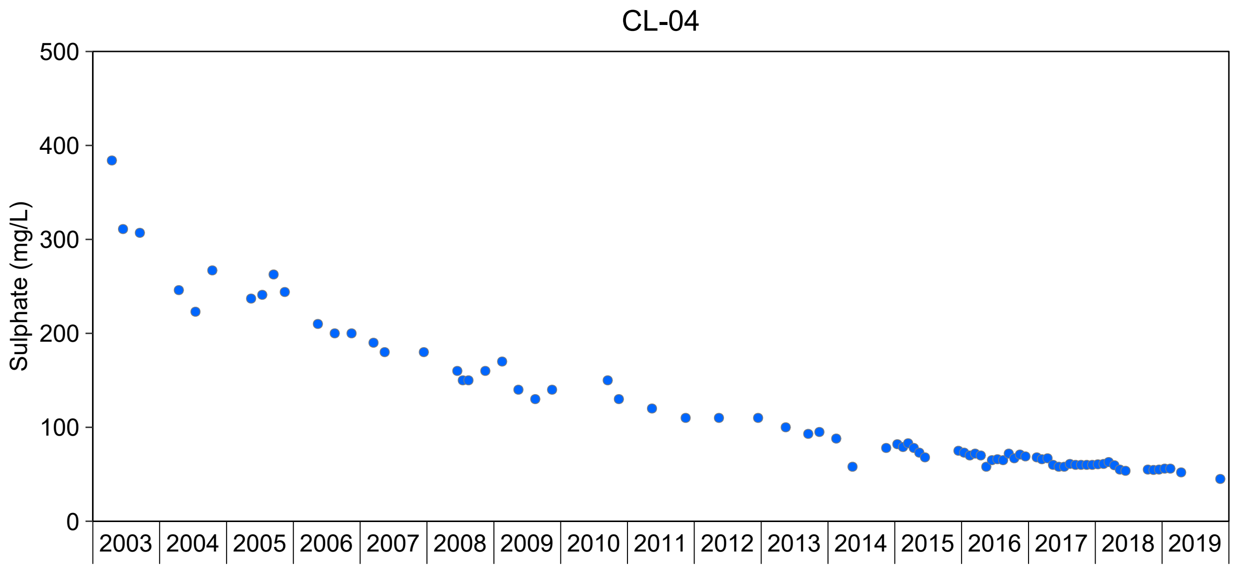


Figure D.8: Concentrations of Sulphate for TOMP Water Monitoring Stations, Stanleigh TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL.
See Table 3.7 for Seasonal Kendall trend analysis results and Appendix Table D.3 for raw data.

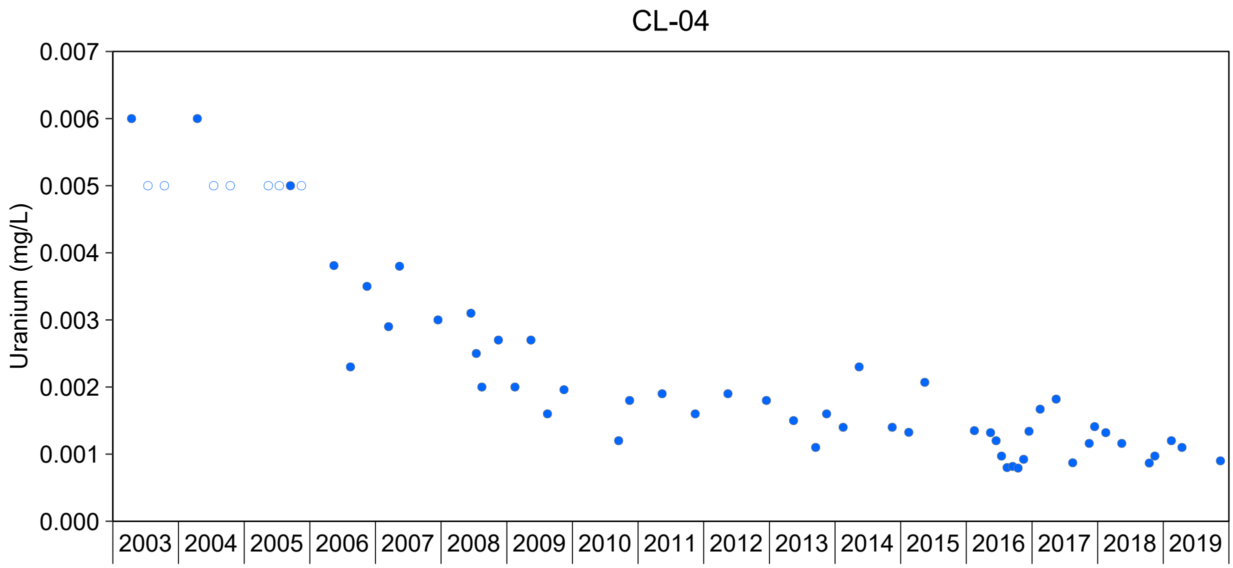


Figure D.9: Concentrations of Uranium for TOMP Water Monitoring Stations, Stanleigh TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 3.7 for Seasonal Kendall trend analysis results and Appendix Table D.3 for raw data.

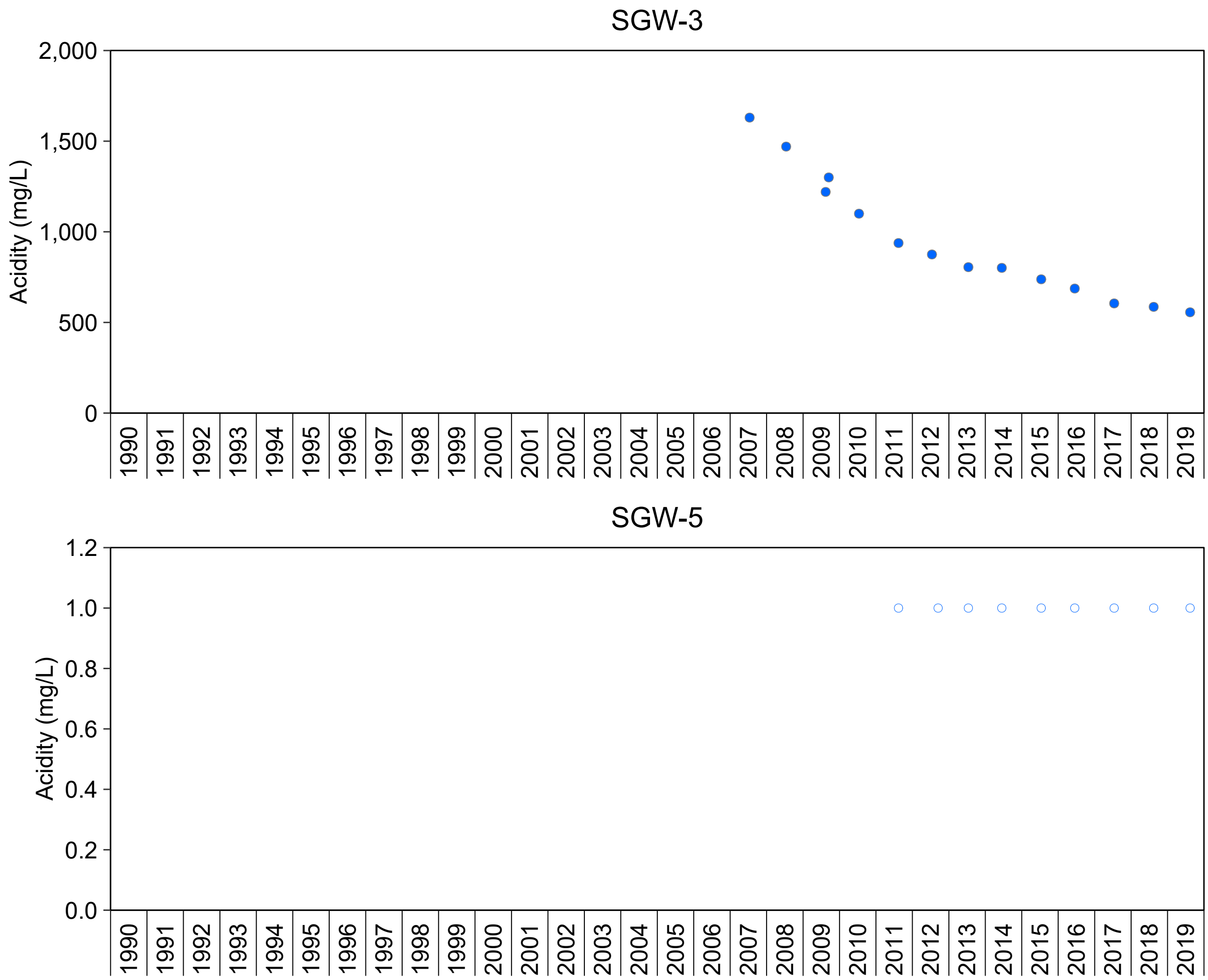


Figure D.10: Concentrations of Acidity for TOMP Groundwater Stations,Stanleigh TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Due to a change in analytical technique for acidity in 2006, acidity trends were assessed from 2007 to 2019. See Table 3.8 for Kendall trend analysis results and Appendix Tables D.6 for raw data. Acidity (mg/L) is not included in the trend analysis for TOMP station SGW-5 due to >50% non-detectable concentrations in the dataset.

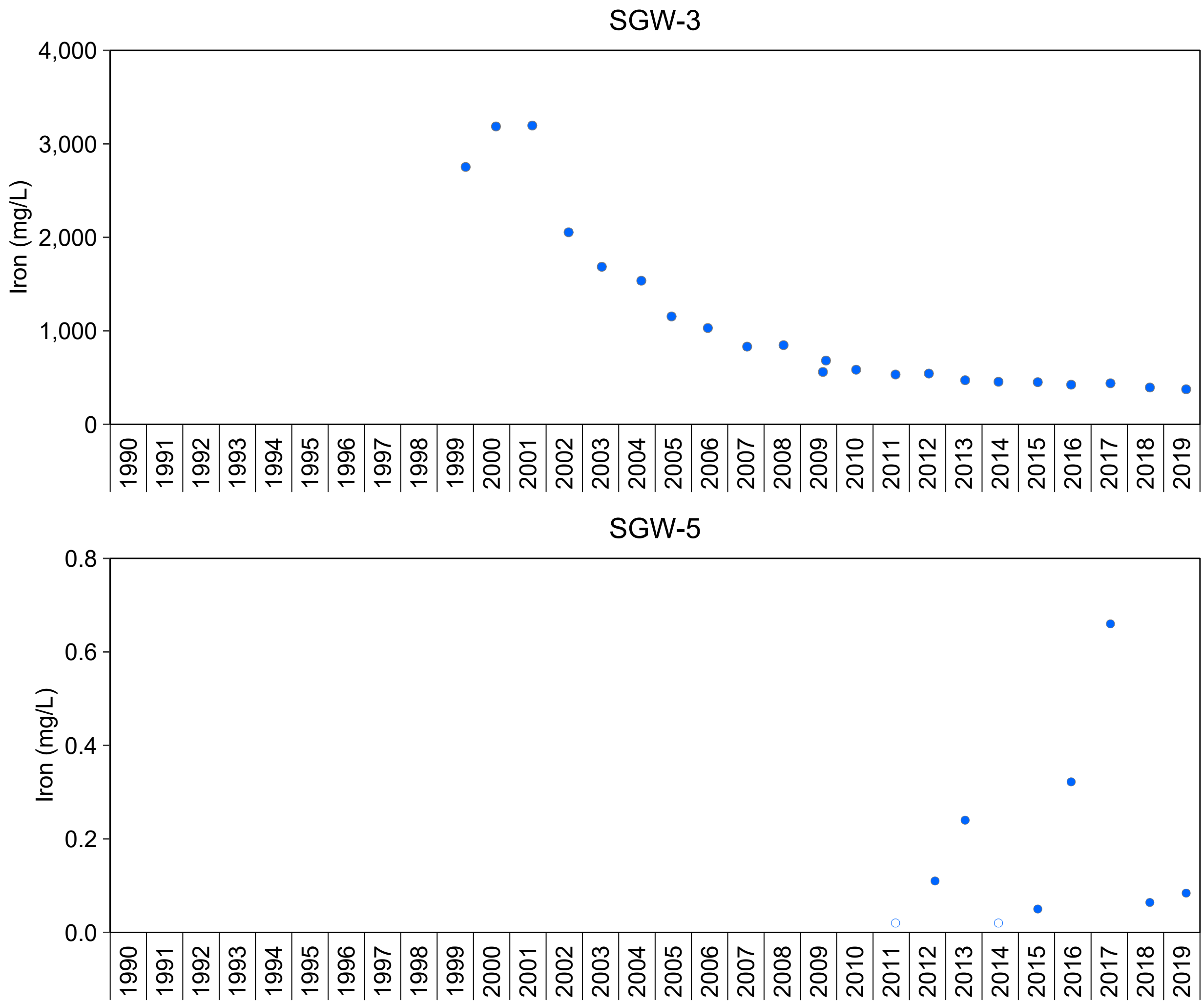


Figure D.11: Concentrations of Iron for TOMP Groundwater Stations, Stanleigh TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 3.8 for Kendall trend analysis results and Appendix Tables D.6 for raw data.

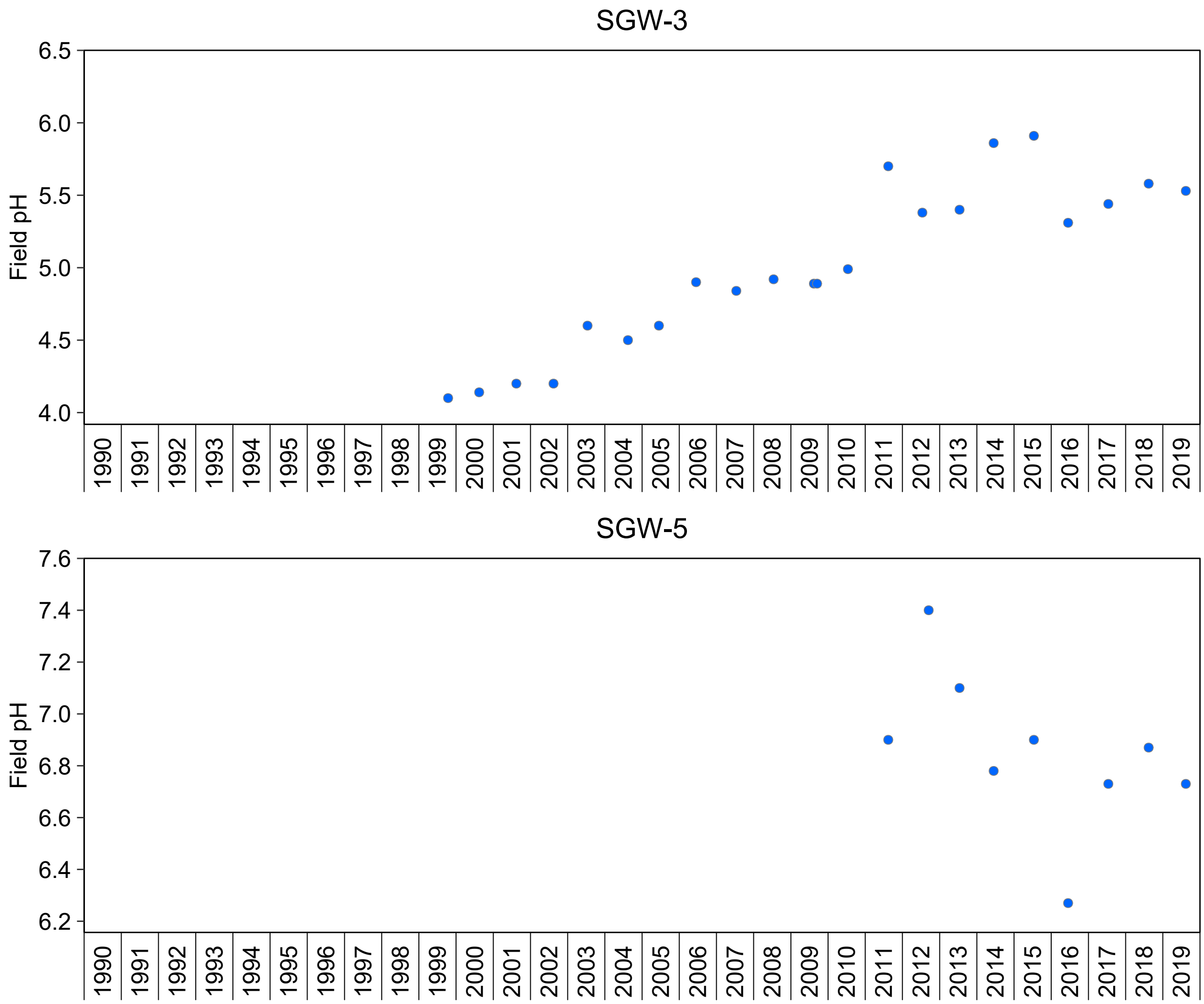


Figure D.12: Field Measurements of pH for TOMP Groundwater Stations, Stanleigh TMA, 1990 to 2019

Notes: See Table 3.8 for Kendall trend analysis results and Appendix Tables D.6 for raw data.

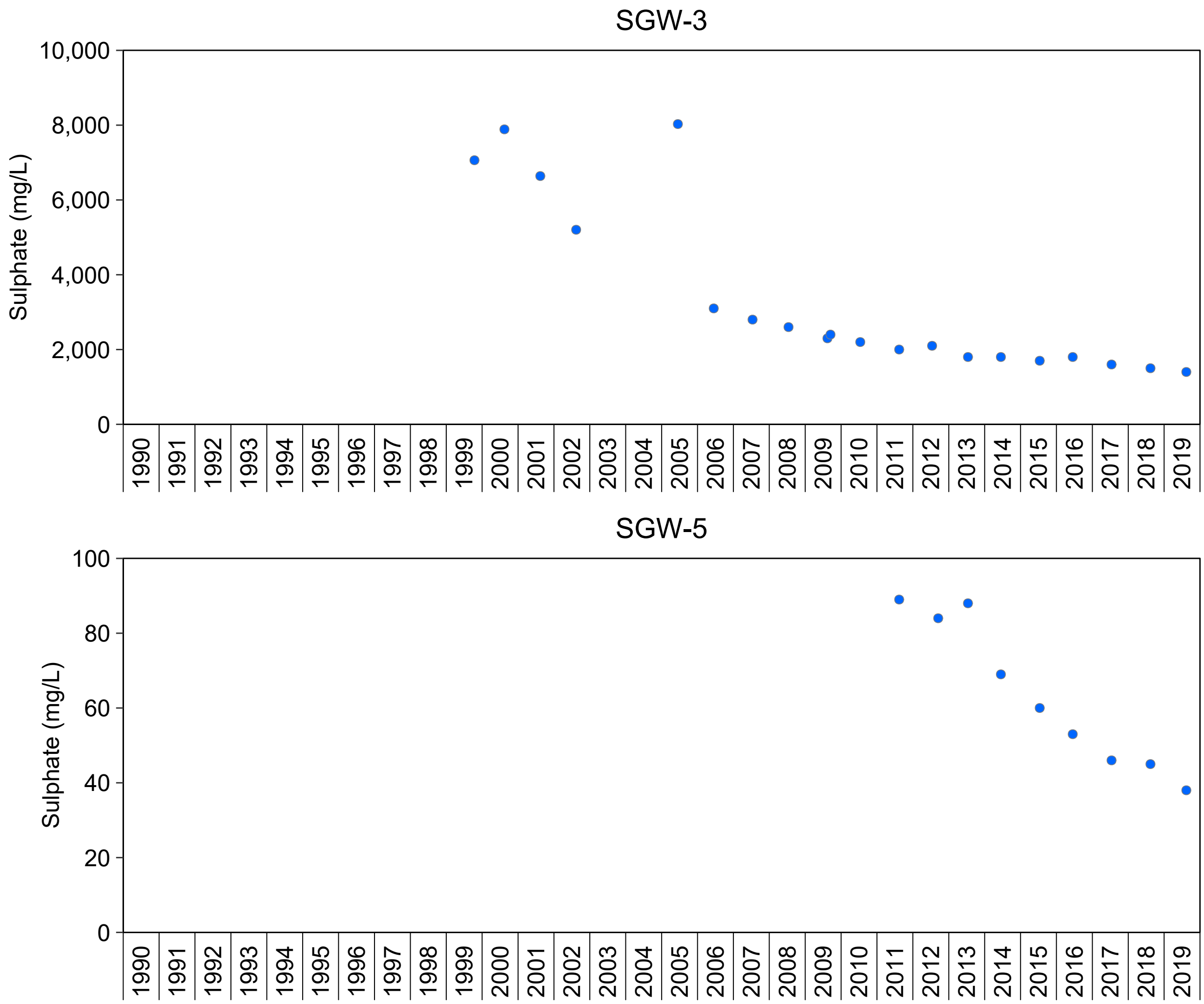


Figure D.13: Concentrations of Sulphate for TOMP Groundwater Stations, Stanleigh TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL.
See Table 3.8 for Kendall trend analysis results and Appendix Tables D.6 for raw data.

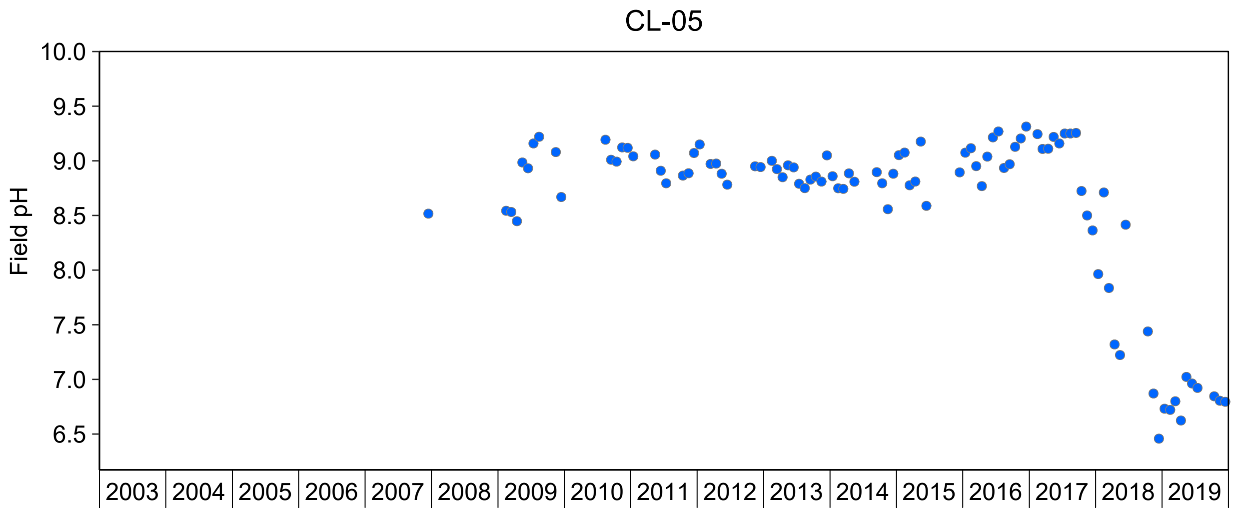


Figure D.14: Field Measurements of pH for TOMP Water Monitoring Stations, Stanleigh TMA, 2003 to 2019

Notes: pH is not included in the trend analysis for TOMP station CL-05 because the monitoring is in support of ETP operations. Other stations at this TMA provide more meaningful information regarding trends for this parameter.
Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL.
See Appendix Table D.4 for raw data.

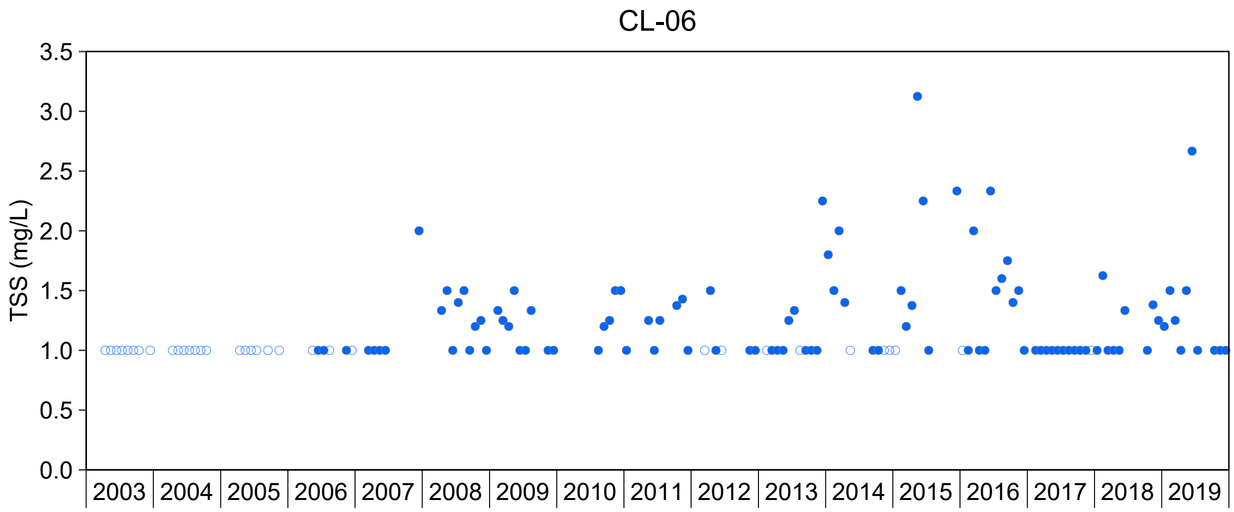


Figure D.15: Concentrations of Total Suspended Solids for TOMP Water Monitoring Stations, Stanleigh TMA, 2003 to 2019

Notes: TSS is not included in the trend analysis for TOMP station CL-06 because the monitoring is in support of ETP operations. Other stations at this TMA provide more meaningful information regarding trends for this parameter. Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Table D.5 for raw data.

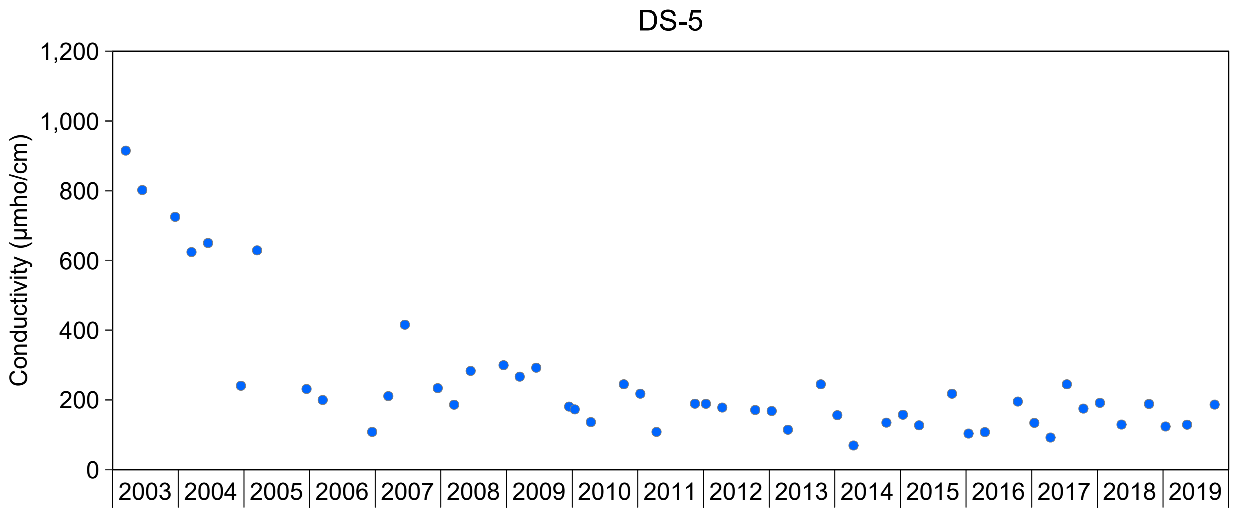


Figure D.16: Field Measurements of Conductivity for TOMP Water Monitoring Stations, Stanrock TMA, 2003 to 2019

Notes: Conductivity is not included in the trend analysis for TOMP station DS-5 because the monitoring is in support of ETP operations. Other stations at this TMA provide more meaningful information regarding trends for this parameter. Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Table C.8 for raw data.

Table D.1: Location of TOMP Data Tables and Figures Within this Cycle 5 SOE Report, Stanleigh TMA

TMA	TOMP Station	Station Type/Purpose	Also a SAMP Station? [a]	Map Figures	Elevation Tables	Elevation Figures	Water Quality Data Tables (flow, acidity, barium, cobalt, iron, manganese, pH, radium-226, sulphate, uranium, conductivity, TSS, and/or treatment chemical consumption)	Comparison to EIS Predictions Figures	Lime or NaOH Consumption Figures	Barium Chloride Consumption Figures	Comparison to Discharge Criteria Figures	Trend Tables	Water Quality Data Figures										
													Acidity	Barium	Cobalt	Iron	Manganese	pH	Radium-226	Sulphate	Uranium	Conductivity	TSS
Stanleigh	CL-04	Basin performance (primary), ETP operations	no	3.3	D.7	3.8	D.3	3.9	3.1	3.1	na-c	3.7	D.1	D.2	D.3	D.4	D.5	D.6	D.7	D.8	D.9	na	na
	CL-05	ETP operations	no	3.3	na	na	D.4	na-p	na	na	na-c	na-t	na	na	na	na	na	D.14	na	na	na	na	na
	CL-06	Effluent	YES	3.1, 3.3	na	na	D.5	na-p	na	na	3.11, 3.12	3.11	na	M.1	M.2	M.3	M.4	M.5	M.6	M.7	M.8	na	D.15
	SGW-3, SGW-5	Groundwater	no	3.3	na	na	D.6	na-p	na	na	na-c	3.8	D.10	na	na	D.11	na	D.12	na	D.13	na	na	na

Notes: na = parameter not measured at this station (as per study design); therefore, data presentation is not applicable. na-p = EIS Predictions do not apply to this station (as per study design); therefore, data presentation is not applicable. na-c = discharge criteria do not apply to this station (as per study design); therefore, data presentation is not applicable. na-t = at this station, only one to three parameters (elevation, pH, flow, conductivity, and/or radium-226) are monitored to support ETP operations. Other stations provide more meaningful information regarding trends for these parameters; therefore, data presentation is not applicable.

[a] Data for this TOMP station also pertain to the SAMP. Trends are assessed in the SAMP section and water quality figures are provided in the SAMP section (Table 2.6).

Table D.2: Stanleigh Final Point of Control (CL-06) Discharge Criteria

Parameter	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	0.2
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.

Table D.3: Water Quality at TOMP Station CL-04 (Basin Performance - Primary, ETP Operations), Stanleigh TMA, 2015 to 2019

Date	Elevation (m)	Flow (L/s)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Lime Consumption (kg per month)	Barium Chloride Consumption (kg per month)	Acidity (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)	TSS (mg/L)
5-Jan-15	365	414	6.76	82.0	0.530	1.6	5750	-	-	-	-	-	-	-
3-Feb-15	365	390	6.88	79.0	0.523	1.4	5225	<1.00	0.0290	<0.000500	0.0400	0.0520	0.00140	-
17-Feb-15	364	400	7.12	79.0	0.556	1.4	5225	<1.00	0.0286	0.000326	0.0340	0.0514	0.00125	-
3-Mar-15	364	400	6.70	83.0	0.560	1.16	5175	-	0.0302	-	-	-	-	-
6-Apr-15	364	500	7.10	78.0	0.541	2.08	5000	-	0.0290	-	-	-	-	-
4-May-15	364	320	7.13	73.0	0.556	3.71	5000	<1.00	0.0279	0.00185	0.170	0.184	0.00207	-
1-Jun-15	364	330	6.83	68.0	0.579	0	775	-	0.0241	-	-	-	-	-
16-Dec-15	365	510	7.00	75.0	0.559	0.87	2875	-	0.0420	-	-	-	-	-
4-Jan-16	365	492	6.93	73.0	0.554	1.08	4750	-	0.0358	-	-	-	-	-
12-Jan-16	365	312	-	-	0.504	1.08	4750	-	0.0310	-	0.0430	-	-	-
18-Jan-16	365	300	-	-	0.565	1.08	4750	-	0.0300	-	0.0340	-	-	-
25-Jan-16	365	297	-	-	0.563	1.08	4750	-	0.0410	-	0.0590	-	-	-
1-Feb-16	365	300	7.10	70.0	0.598	2	4000	<1.00	0.0401	0.000318	0.0960	0.0415	0.00135	-
8-Feb-16	365	300	6.78	-	0.570	2	4000	-	0.0300	-	0.0300	-	-	-
16-Feb-16	365	320	7.03	-	0.563	2	4000	-	0.0380	-	0.0800	-	-	-
22-Feb-16	365	540	6.87	-	0.567	2	4000	-	0.0350	-	0.110	-	-	-
1-Mar-16	365	410	7.00	-	0.469	1.84	5125	-	0.0390	-	0.0400	-	-	-
7-Mar-16	365	500	6.88	72.0	0.550	1.84	5125	-	0.0340	-	0.0400	-	-	-
14-Mar-16	365	540	6.93	-	0.545	1.84	5125	-	0.0360	-	0.133	-	-	-
28-Mar-16	365	528	6.95	-	0.601	1.84	5125	-	0.0340	-	0.0380	-	-	-
4-Apr-16	365	508	7.02	70.0	0.466	2.1	4125	-	0.0364	-	0.0960	-	-	-
11-Apr-16	365	285	6.83	-	1.02	2.1	4125	-	0.0380	-	0.0450	-	-	-
18-Apr-16	365	534	6.84	-	0.823	2.1	4125	-	0.0430	-	0.0660	-	-	-
25-Apr-16	365	526	6.70	-	0.612	2.1	4125	-	0.0330	-	0.0470	-	-	-
2-May-16	365	427	6.82	58.0	0.678	1.74	6100	<1.00	0.0303	0.000700	0.0680	0.0718	0.00132	-
9-May-16	365	456	7.16	-	0.623	1.74	6100	-	0.0290	-	0.0600	-	-	-
16-May-16	365	423	7.30	-	0.572	1.74	6100	-	0.0310	-	0.0640	-	-	-
24-May-16	365	452	7.62	-	0.630	1.74	6100	-	0.0300	-	0.0600	-	-	-
30-May-16	365	296	7.61	-	0.677	1.74	6100	-	0.0300	-	0.0640	-	-	-
6-Jun-16	365	236	7.71	65.0	0.650	0.33	3575	<1.00	0.0289	<0.000500	0.0500	0.0540	0.00120	-
13-Jun-16	365	250	7.10	-	0.554	0.33	3575	-	0.0340	-	0.0520	-	-	-
20-Jun-16	365	300	7.00	-	0.591	0.33	3575	-	0.0350	-	0.0200	-	-	-
5-Jul-16	365	235	7.19	-	0.471	0.82	4300	-	0.0470	-	0.0220	-	-	-
11-Jul-16	365	220	7.00	66.0	0.524	0.82	4300	<1.00	0.0371	<0.000500	0.0360	0.0426	0.000971	-
18-Jul-16	365	240	7.00	-	0.514	0.82	4300	-	0.0380	-	0.0540	-	-	-
25-Jul-16	365	240	7.10	-	0.466	0.82	4300	-	0.0360	-	0.0350	-	-	-
2-Aug-16	364	243	7.38	65.0	0.522	0.91	5350	<1.00	0.0316	<0.000500	0.0670	0.0412	0.000800	-
8-Aug-16	364	280	6.90	-	0.433	0.91	5350	-	0.0310	-	0.0360	-	-	-
15-Aug-16	364	280	7.40	-	0.485	0.91	5350	-	0.0340	-	0.0810	-	-	-
22-Aug-16	364	295	6.91	-	0.448	0.91	5350	-	0.0330	-	0.0610	-	-	-
29-Aug-16	364	291	7.19	-	0.441	0.91	5350	-	0.0330	-	0.0800	-	-	-
6-Sep-16	364	319	7.17	72.0	0.444	1.3	5775	<1.00	0.0321	<0.000500	0.0400	0.0153	0.000817	-
12-Sep-16	364	297	7.04	-	0.482	1.3	5775	-	0.0302	-	0.0480	-	-	-
19-Sep-16	364	306	7.11	-	0.782	1.3	5775	-	0.0333	-	0.0560	-	-	-
26-Sep-16	364	303	7.47	-	0.498	1.3	5775	-	0.0320	-	0.0540	-	-	-
3-Oct-16	364	300	6.90	67.0	0.574	2.8	3925	<1.00	0.0297	<0.000500	0.0410	0.0142	0.000792	-
11-Oct-16	364	304	6.90	-	0.582	2.8	3925	-	0.0333	-	0.0560	-	-	-
17-Oct-16	364	308	6.80	-	0.645	2.8	3925	-	0.0340	-	0.0520	-	-	-
18-Oct-16	-	297	-	-	-	2.8	3925	-	-	-	-	-	-	-
24-Oct-16	364	303	6.80	-	0.624	2.8	3925	-	0.0340	-	0.0520	-	-	-
31-Oct-16	364	301	6.80	-	0.602	2.8	3925	-	0.0290	-	0.0480	-	-	-
7-Nov-16	364	303	6.90	71.0	0.554	1.3	4375	<1.00	0.0680	<0.000500	0.0630	0.000970	0.000923	-
14-Nov-16	364	300	6.90	-	0.632	1.3	4375	-	0.0340	-	0.0650	-	-	-
21-Nov-16	364	309	6.90	-	0.653	1.3	4375	-	0.0375	-	0.105	-	-	-
28-Nov-16	364	297	7.10	-	0.649	1.3	4375	-	0.0350	-	0.0640	-	-	-
5-Dec-16	364	291	7.00	69.0	0.602	0.39	2875	<1.00	0.0342	<0.000500	0.0600	0.0340	0.00134	-
12-Dec-16	364	300	6.90	-	0.609	0.39	2875	-	0.0330	-	0.0480	-	-	-
19-Dec-16	364	303	6.70	-	0.591	0.39	2875	-	0.0320	-	0.0380	-	-	-
21-Feb-17	364	290	7.10	68.0	0.595	1	2125	<1.00	0.0610	<0.000500	0.0220	0.0329	0.00167	-
27-Feb-17	364	281	6.80	-	0.581	1	2125	-	0.0380	-	0.0300	-	-	-
6-Mar-17	364	290	7.10	66.0	0.551	1.6	4000	<1.00	0.0367	-	0.0190	-	-	-
13-Mar-17	364	320	6.90	-	0.540	1.6	4000	-	0.0340	-	<0.0200	-	-	-
20-Mar-17	364	340	6.90	-	0.590	1.6	4000	-	0.0340	-	0.0210	-	-	-
27-Mar-17	364	343	7.00	-	0.595	1.6	4000	-	0.0360	-	0.0280	-	-	-
3-Apr-17	364	332	6.90	67.0	0.635	1.75	3750	<1.00	0.0348	-	0.0210	-	-	-
10-Apr-17	364	362	6.80	-	0.571	1.75	3750	-	0.0320	-	0.0540	-	-	-
17-Apr-17	365	340	6.90	-	0.579	1.75	3750	-	0.0400	-	0.137	-	-	-
24-Apr-17	365	330	7.00	-	0.638	1.75	3750	-	0.0340	-	0.0740	-	-	-
4-May-17	365	235	7.00	60.0	0.650	0	3125	<1.00	0.0371	<0.000500	0.0800	0.0546	0.00182	-
8-May-17	365	230	6.80	-	0.616	0	3125	-	0.0310	-	0.0800	-	-	-
15-May-17	365	229	6.90	-	0.560	0	3125	-	0.0330	-	0.0770	-	-	-
1-Jun-17	-	300	6.80	-	0.535	0.7	3375	-	0.0310	-	0.0380	-	-	-
5-Jun-17	365	300	7.00	58.0	0.614	0.7	3375	<1.00	0.0296	-	0.0450	-	-	-
12-Jun-17	365	300	7.10	-	0.592	0.7	3375	-	0.0330	-	0.0460	-	-	-
19-Jun-17	365	300	6.90	-	0.668	0.7	3375	-	0.0320	-	0.0430	-	-	-
6-Jul-17	365	260	7.10	58.0	0.573	1.7	3250	<1.00	0.0427	-	0.0290	-	-	-
10-Jul-17	365	250	6.90	-	0.516	1.7	3250	-	-	-	0.0430	-	-	-
17-Jul-17	365	228	6.90	-	0.605	1.7	3250	-	0.0390	-	0.0580	-	-	-
24-Jul-17	365	251	6.90	-	0.431	1.7	3250	-	-	-	0.0570	-	-	-
31-Jul-17	365	260	6.90	-	0.521	1.7	3250	-	0.0360	-	0.0700	-	-	-
8-Aug-17	364	260	7.00	61.0	0.476	0.92	3625	<1.00	0.0314	<0.000500	0.0440	0.0269	0.000871	-
14-Aug-17	364	260	7.00	-	0.508	0.92	3625	-	0.0340	-	0.0600	-	-	-
21-Aug-17	365	262	6.90	-	0.413	0.92	3625	-	0.0340	-	0.0540	-	-	-
28-Aug-17	365	260	6.90	-	0.440	0.92	3625	-	0.0330	-	0.0580	-	-	-
5-Sep-17	364	300	7.00	60.0	0.469	1.7	4125	<1.00	0.0330	-	0.0460	-	-	-
11-Sep-17	364	302	6.90	-	0.462	1.7	4125	-	0.0330	-	0.0460	-	-	-
18-Sep-17	364	300	7.00	-	0.500	1.7	4125	-	0.0300	-	0.0350	-	-	-
25-Sep-17	364	350	6.90	-	0.548	1.7	4125	-	0.0360	-	0.0470	-	-	-
2-Oct-17	364	300	7.10	60.0	0.555	0.6	4000	<1.00	0.0290	-	0.0330	-	-	-
10-Oct-17	364	230	6.80	-	0.471	0.6	4000	-	0.0610	-	0.0530	-	-	-
16-Oct-17	364	350	6.60	-	0.367	0.6	4000	-	-	-	0.0210	-	-	-
25-Oct-17	365	450	6.80	-	0.531	0.6	4000	-	0.0400	-	0.0720	-	-	-
30-Oct-17	365	495	6.90	-	0.503	0.6	4000	-	0.0310	-	0.0460	-	-	-
6-Nov-17	365	500	6.90	60.0	0.576	1.1	4750	<1.00	0.0331	<0.000500	0.0820	0.0351	0.00116	-
13-Nov-17	365	500	7.00	-	0.615	1.1	4750	-	0.0340	-	0.0520	-	-	-
20-Nov-17	365	500	6.90	-	0.517	1.1	4750	-	0.0280	-	0.0670	-	-	-
27-Nov-17	365	300	7.10	-	0.547	1.1	4750	-	0.0310	-	0.0810	-	-	-
4-Dec-17	365	350	7.10	59.0	0.579	0.7	4875	<1.00	0.0316	-	0.0330	-	-	-
11-Dec-17	365	350	6.90	-	0.623	0.7	4875	-	0.0320	-	0.0620	-	-	-
18-Dec-17	365	230	7.00	-	0.557	0.7	4875	-	0.0320	-	0.0600	-	-	-
27-Dec-17	365	400	7.10	61.0	0.474	0.7	4875	<1.00	0.0340	0.000297	0.0580	0.0379	0.00141	<1.00
2-Jan-18	365	400	6.90	61.0	0.603	1.7	5125	<1.00	0.0370	-	0.0540	-	-	<1.00
8-Jan-18	365	400	6.70	61.0	0.644	1.7	5125	-	0.0430	-	0.0470	-	-	<1.00
15-Jan-18	365	400	6.80	61.0	0.618	1.7	5125	-	0.0310	-	0.0440	-	-	<1.00
22-Jan-18	365	400	7.00	60.0	0.573	1.7	5125	-	0.0280	-	0.0280	-	-	<1.00
29-Jan-18	365	400	6.90	60.0	0.529	1.7	5125	-	0.0310	-	0.0410	-	-	1.00
5-Feb-18	364	200	7.10	61.0	0.618	0.6	4250	<1.00	0.0372	0.000323	0.0470	0.0440	0.00132	1.00

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected, or SD was incalculable because there was no variability in the data.

Table D.3: Water Quality at TOMP Station CL-04 (Basin Performance - Primary, ETP Operations), Stanleigh TMA, 2015 to 2019

Date	Elevation (m)	Flow (L/s)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Lime Consumption (kg per month)	Barium Chloride Consumption (kg per month)	Acidity (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)	TSS (mg/L)
12-Feb-18	364	450	6.80	61.0	0.637	0.6	4250	-	0.0310	-	0.0400	-	-	<1.00
20-Feb-18	364	450	7.10	61.0	0.618	0.6	4250	-	0.0300	-	0.0410	-	-	<1.00
26-Feb-18	364	500	6.70	61.0	0.549	0.6	4250	-	0.0320	-	0.0380	-	-	3.00
5-Mar-18	364	500	6.80	62.0	0.609	0.98	5375	<1.00	0.0321	-	0.0430	-	-	<1.00
26-Mar-18	364	200	6.30	64.0	0.609	0.98	5375	-	0.0310	-	0.0380	-	-	<1.00
2-Apr-18	364	190	6.50	59.0	0.638	1.5	10025	<1.00	0.0327	-	0.0410	-	-	1.00
9-Apr-18	364	200	6.90	61.0	0.626	1.5	10025	-	0.0300	-	0.0400	-	-	<1.00
16-Apr-18	364	400	6.70	62.0	0.582	1.5	10025	-	0.0360	-	0.0510	-	-	<1.00
23-Apr-18	364	400	6.70	60.0	0.589	1.5	10025	-	0.0330	-	0.0360	-	-	<1.00
30-Apr-18	364	400	6.60	56.0	0.577	1.5	10025	-	0.0320	-	0.0370	-	-	<1.00
7-May-18	365	500	6.70	55.0	0.564	0	8750	<1.00	0.0320	0.000304	0.0550	0.0525	0.00116	<1.00
14-May-18	365	500	6.50	57.0	0.585	0	8750	-	0.0380	-	0.113	-	-	1.00
22-May-18	364	400	6.70	53.0	0.584	0	8750	-	0.0360	-	0.0870	-	-	1.00
28-May-18	364	380	6.70	55.0	0.597	0	8750	-	0.0370	-	0.100	-	-	2.00
4-Jun-18	364	355	6.80	53.0	0.623	1	5375	<1.00	0.0378	-	0.0700	-	-	1.00
11-Jun-18	364	355	6.90	55.0	0.590	1	5375	-	0.0330	-	0.0520	-	-	<1.00
18-Jun-18	364	355	7.00	53.0	0.602	1	5375	-	0.0320	-	0.0550	-	-	1.00
4-Oct-18	364	300	6.80	55.0	0.467	0	2950	-	0.0370	-	0.0340	-	-	1.00
9-Oct-18	364	300	6.90	55.0	0.497	0	2950	-	0.0330	-	0.0290	-	-	1.00
15-Oct-18	364	300	6.80	55.0	0.494	0	2950	<1.00	0.0358	<0.000500	0.0370	0.0183	0.000867	1.00
22-Oct-18	364	450	6.80	55.0	0.506	0	2950	-	0.0350	-	0.0360	-	-	1.00
8-Nov-18	-	400	6.70	54.0	0.492	0	5625	-	0.0382	<0.000150	0.0380	0.0258	0.000972	<1.00
10-Nov-18	-	400	6.90	-	-	0	5625	-	-	-	-	-	-	-
11-Nov-18	-	400	6.90	-	-	0	5625	-	-	-	-	-	-	-
12-Nov-18	364	400	6.80	54.0	0.498	0	5625	<1.00	0.0366	-	0.0280	-	-	<1.00
13-Nov-18	-	400	6.80	-	-	0	5625	-	-	-	-	-	-	-
14-Nov-18	-	400	6.80	-	-	0	5625	-	-	-	-	-	-	-
15-Nov-18	364	400	6.80	55.0	0.498	0	5625	-	0.0358	-	0.0440	-	-	<1.00
16-Nov-18	-	400	6.90	-	-	0	5625	-	-	-	-	-	-	-
17-Nov-18	-	400	6.70	-	-	0	5625	-	-	-	-	-	-	-
18-Nov-18	-	400	6.70	-	-	0	5625	-	-	-	-	-	-	-
19-Nov-18	364	400	6.70	56.0	0.531	0	5625	-	0.0390	-	0.0400	-	-	<1.00
20-Nov-18	-	400	6.80	-	-	0	5625	-	-	-	-	-	-	-
21-Nov-18	-	400	7.00	-	-	0	5625	-	-	-	-	-	-	-
22-Nov-18	364	400	7.00	-	-	0	5625	-	-	-	-	-	-	-
23-Nov-18	-	400	7.10	-	-	0	5625	-	-	-	-	-	-	-
24-Nov-18	-	400	6.90	-	-	0	5625	-	-	-	-	-	-	-
25-Nov-18	-	400	6.60	-	-	0	5625	-	-	-	-	-	-	-
26-Nov-18	364	400	6.80	54.0	0.498	0	5625	-	0.0345	-	0.0290	-	-	<1.00
30-Nov-18	-	400	6.90	-	-	0	5625	-	-	-	-	-	-	-
3-Dec-18	364	400	6.60	53.0	0.505	0	4700	<1.00	0.0356	-	0.0300	-	-	1.00
5-Dec-18	-	400	6.70	-	-	0	4700	-	-	-	-	-	-	-
10-Dec-18	364	400	6.80	57.0	0.500	0	4700	-	0.0373	-	0.0280	-	-	<1.00
11-Dec-18	-	400	6.80	-	-	0	4700	-	-	-	-	-	-	-
12-Dec-18	-	400	6.70	-	-	0	4700	-	-	-	-	-	-	-
13-Dec-18	-	400	6.80	-	-	0	4700	-	-	-	-	-	-	-
7-Jan-19	364	400	6.80	56.0	0.452	0	6875	<1.00	0.0367	-	0.0210	-	-	<1.00
4-Feb-19	364	475	6.60	56.0	0.511	0	6500	<1.00	0.0370	<0.000500	0.0820	0.0270	0.00120	-
4-Mar-19	364	475	6.50	-	0.480	0	7750	-	-	-	-	-	-	-
22-Apr-19	364	475	6.70	52.0	0.477	0.54	5375	<1.00	0.0320	<0.000500	0.0370	0.0370	0.00110	-
6-May-19	364	475	6.50	-	0.393	0.99	5500	-	-	-	-	-	-	-
10-Jun-19	364	200	6.90	-	0.442	0	4000	-	-	-	-	-	-	-
2-Jul-19	364	400	7.00	-	0.409	0	1000	-	-	-	-	-	-	-
7-Oct-19	364	380	6.90	-	0.401	0	7250	-	-	-	-	-	-	-
4-Nov-19	365	400	6.70	45.0	0.485	0	5625	<1.00	0.0280	<0.000500	0.0350	0.0240	0.000900	-
2-Dec-19	365	400	6.60	-	0.464	0	5125	-	-	-	-	-	-	-
n	196	1183	160	70	145	60	60	37	135	24	133	24	24	36
Minimum	364	190	6.30	45.0	0.367	0	0	<1.00	0.0241	<0.000150	0.0190	0.000970	0.000792	<1.00
Maximum	365	550	7.71	83.0	1.02	3.71	10,000	<1.00	0.0680	0.00185	0.170	0.184	0.00207	3.00
Mean	364	369	6.91	62.0	0.556	0.797	3,890	<1.00	0.0345	0.000369	0.0525	0.0425	0.00120	1.08
SD	0.274	89.8	0.203	7.91	0.0818	0.842	2,370	-	0.00570	0.000340	0.0244	0.0340	0.000329	0.377
Median	364	400	6.90	60.5	0.560	0.700	4,190	<1.00	0.0340	0.000318	0.0470	0.0375	0.00118	<1.00
10th Percentile	364	250	6.70	54.0	0.464	0	0	<1.00	0.0297	<0.000150	0.0290	0.0153	0.000817	<1.00
95th Percentile	365	500	7.19	79.0	0.650	2.09	7,500	<1.00	0.0427	0.000700	0.100	0.0718	0.00182	2.00

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected, or SD was incalculable because there was no variability in the data.

Table D.4: Water Quality at TOMP Station CL-05 (ETP Operations), Stanleigh TMA, 2015 to 2019

Date	pH
2-Jan-15	9.10
5-Jan-15	9.10
6-Jan-15	9.30
7-Jan-15	9.20
8-Jan-15	9.08
9-Jan-15	9.16
12-Jan-15	9.10
13-Jan-15	9.02
14-Jan-15	9.10
15-Jan-15	9.00
16-Jan-15	8.98
19-Jan-15	9.00
20-Jan-15	9.00
21-Jan-15	8.90
22-Jan-15	9.00
23-Jan-15	9.00
26-Jan-15	8.90
27-Jan-15	9.05
28-Jan-15	9.00
29-Jan-15	9.04
30-Jan-15	9.06
2-Feb-15	9.16
3-Feb-15	9.12
4-Feb-15	9.10
5-Feb-15	9.05
6-Feb-15	9.10
9-Feb-15	9.00
10-Feb-15	9.16
11-Feb-15	9.10
12-Feb-15	9.10
13-Feb-15	9.00
17-Feb-15	9.10
18-Feb-15	9.12
19-Feb-15	9.00
20-Feb-15	9.02
23-Feb-15	9.00
24-Feb-15	9.00
25-Feb-15	9.20
26-Feb-15	9.00
27-Feb-15	9.10
2-Mar-15	9.00
3-Mar-15	9.00
4-Mar-15	9.10
5-Mar-15	9.05
6-Mar-15	9.00
9-Mar-15	9.00
10-Mar-15	9.00
11-Mar-15	8.85
12-Mar-15	8.70
13-Mar-15	8.60
17-Mar-15	8.70
18-Mar-15	8.50
19-Mar-15	8.60
20-Mar-15	8.70
23-Mar-15	8.50
24-Mar-15	8.60
25-Mar-15	8.70
26-Mar-15	8.70
27-Mar-15	8.70
30-Mar-15	8.70
31-Mar-15	8.60
1-Apr-15	8.70
2-Apr-15	8.80
6-Apr-15	8.70
7-Apr-15	8.60
8-Apr-15	8.70
9-Apr-15	8.70
10-Apr-15	8.80
13-Apr-15	8.70
14-Apr-15	8.80
15-Apr-15	8.90
16-Apr-15	9.00
17-Apr-15	9.00
20-Apr-15	8.90
21-Apr-15	9.00
22-Apr-15	8.55
23-Apr-15	8.90
24-Apr-15	8.90
27-Apr-15	8.80
28-Apr-15	8.47
29-Apr-15	9.20
30-Apr-15	8.90
1-May-15	9.20
4-May-15	9.16
5-May-15	9.16
6-May-15	8.98
7-May-15	9.22
8-May-15	9.60
11-May-15	9.30
12-May-15	9.20
13-May-15	9.28
14-May-15	9.40
15-May-15	9.10
19-May-15	9.30
20-May-15	9.20
21-May-15	9.30
22-May-15	9.30
25-May-15	9.12
26-May-15	9.10
27-May-15	9.00
28-May-15	8.70
29-May-15	8.90
1-Jun-15	8.94
2-Jun-15	9.40
3-Jun-15	8.20
4-Jun-15	8.10
5-Jun-15	8.30
2-Dec-15	9.20
3-Dec-15	9.40
15-Dec-15	8.70
16-Dec-15	8.80
17-Dec-15	8.83
18-Dec-15	8.81
21-Dec-15	8.98
22-Dec-15	8.73
23-Dec-15	8.67
24-Dec-15	9.00
28-Dec-15	8.90
29-Dec-15	8.80
30-Dec-15	9.00
31-Dec-15	8.70
4-Jan-16	8.86
5-Jan-16	9.18
6-Jan-16	9.21
7-Jan-16	9.26
8-Jan-16	9.13
11-Jan-16	9.06
12-Jan-16	9.10
13-Jan-16	9.30
14-Jan-16	9.24
15-Jan-16	9.00
18-Jan-16	9.26
19-Jan-16	9.17
20-Jan-16	9.05
21-Jan-16	7.80
22-Jan-16	9.23
25-Jan-16	9.21
26-Jan-16	9.02
27-Jan-16	9.19
28-Jan-16	9.00
29-Jan-16	9.22
1-Feb-16	9.20
2-Feb-16	9.11
3-Feb-16	9.13
4-Feb-16	9.08
5-Feb-16	9.05
8-Feb-16	9.06
9-Feb-16	9.10
10-Feb-16	9.08
11-Feb-16	9.01
12-Feb-16	9.07
16-Feb-16	9.18
17-Feb-16	9.25
18-Feb-16	9.23
19-Feb-16	9.32
22-Feb-16	9.16
23-Feb-16	8.98
24-Feb-16	9.20
25-Feb-16	8.90
26-Feb-16	8.90
29-Feb-16	9.30
1-Mar-16	9.00
2-Mar-16	9.10
3-Mar-16	9.20
4-Mar-16	9.51
7-Mar-16	8.81
8-Mar-16	9.04
9-Mar-16	8.92
10-Mar-16	8.97
11-Mar-16	8.90
14-Mar-16	8.79
15-Mar-16	8.88
16-Mar-16	8.81
17-Mar-16	8.82
18-Mar-16	8.84
21-Mar-16	8.95
22-Mar-16	9.06
23-Mar-16	9.00
24-Mar-16	8.92
28-Mar-16	8.99
29-Mar-16	9.01
30-Mar-16	8.84
31-Mar-16	8.57
1-Apr-16	8.62
4-Apr-16	8.87
5-Apr-16	8.73
6-Apr-16	8.86
7-Apr-16	8.77
8-Apr-16	9.26
11-Apr-16	9.05
12-Apr-16	8.73
13-Apr-16	8.60
14-Apr-16	8.80
15-Apr-16	8.81
18-Apr-16	8.56
19-Apr-16	8.72
20-Apr-16	8.80
21-Apr-16	8.60
22-Apr-16	8.60
25-Apr-16	8.72
26-Apr-16	8.85
27-Apr-16	8.68
28-Apr-16	8.79
29-Apr-16	8.72
2-May-16	8.81
3-May-16	8.71
4-May-16	8.94
5-May-16	8.69
6-May-16	8.93
9-May-16	9.18
10-May-16	8.96
11-May-16	8.73
12-May-16	9.18
13-May-16	9.12
16-May-16	9.18
17-May-16	8.95
18-May-16	9.10
19-May-16	9.13
20-May-16	9.10
24-May-16	8.90
25-May-16	9.12
26-May-16	9.29
27-May-16	9.28
30-May-16	9.22
31-May-16	9.29
1-Jun-16	9.09
2-Jun-16	9.15
3-Jun-16	9.20
6-Jun-16	9.25
7-Jun-16	9.20
8-Jun-16	9.15
9-Jun-16	9.20
10-Jun-16	9.30
13-Jun-16	9.30
14-Jun-16	9.30
15-Jun-16	9.20
16-Jun-16	9.20
17-Jun-16	9.22
20-Jun-16	9.10
21-Jun-16	9.20
22-Jun-16	9.30
23-Jun-16	9.40
24-Jun-16	9.10
4-Jul-16	9.20
5-Jul-16	9.29
6-Jul-16	9.30
7-Jul-16	9.30
8-Jul-16	9.30
11-Jul-16	9.20
12-Jul-16	9.30
13-Jul-16	9.40
14-Jul-16	9.30

Note: "SD" = standard deviation. "n" = number of samples.

Table D.4: Water Quality at TOMP Station CL-05 (ETP Operations), Stanleigh TMA, 2015 to 2019

Date	pH
15-Jul-16	9.30
18-Jul-16	9.30
19-Jul-16	9.40
20-Jul-16	9.10
21-Jul-16	9.20
22-Jul-16	9.31
25-Jul-16	9.30
26-Jul-16	9.20
27-Jul-16	9.10
28-Jul-16	9.17
29-Jul-16	9.40
2-Aug-16	8.80
3-Aug-16	9.22
4-Aug-16	9.00
5-Aug-16	9.20
8-Aug-16	8.92
9-Aug-16	7.50
10-Aug-16	9.16
11-Aug-16	9.07
12-Aug-16	9.07
15-Aug-16	9.20
16-Aug-16	9.00
17-Aug-16	9.00
18-Aug-16	9.03
19-Aug-16	9.40
22-Aug-16	9.13
23-Aug-16	8.80
24-Aug-16	8.87
25-Aug-16	8.71
26-Aug-16	8.89
29-Aug-16	8.95
30-Aug-16	8.84
31-Aug-16	8.80
1-Sep-16	8.89
2-Sep-16	8.86
6-Sep-16	8.72
7-Sep-16	8.69
8-Sep-16	8.90
9-Sep-16	8.82
12-Sep-16	8.94
13-Sep-16	8.82
14-Sep-16	8.80
15-Sep-16	8.85
16-Sep-16	9.00
19-Sep-16	9.23
20-Sep-16	9.08
21-Sep-16	9.03
22-Sep-16	9.02
23-Sep-16	9.28
26-Sep-16	9.11
27-Sep-16	9.20
28-Sep-16	9.00
29-Sep-16	9.00
30-Sep-16	9.11
3-Oct-16	9.07
4-Oct-16	9.06
5-Oct-16	9.03
6-Oct-16	9.10
7-Oct-16	9.00
11-Oct-16	9.10
12-Oct-16	9.20
14-Oct-16	9.30
17-Oct-16	9.10
18-Oct-16	9.20
19-Oct-16	9.20
20-Oct-16	9.00
21-Oct-16	9.10
24-Oct-16	9.20
25-Oct-16	9.20
26-Oct-16	9.20
27-Oct-16	9.20
28-Oct-16	9.10
31-Oct-16	9.20
1-Nov-16	9.10
2-Nov-16	9.20
3-Nov-16	9.00
4-Nov-16	9.10
7-Nov-16	9.10
8-Nov-16	9.30
9-Nov-16	9.30
10-Nov-16	9.20
11-Nov-16	9.20
14-Nov-16	9.30
15-Nov-16	9.10
16-Nov-16	9.30
17-Nov-16	9.10
18-Nov-16	9.20
21-Nov-16	9.10
22-Nov-16	9.20
23-Nov-16	9.30
24-Nov-16	9.40
25-Nov-16	9.00
28-Nov-16	9.40
29-Nov-16	9.40
30-Nov-16	9.20
1-Dec-16	9.30
2-Dec-16	9.20
5-Dec-16	9.40
6-Dec-16	9.30
7-Dec-16	9.30
8-Dec-16	9.30
9-Dec-16	9.10
12-Dec-16	9.40
13-Dec-16	9.40
14-Dec-16	9.40
15-Dec-16	9.40
16-Dec-16	9.20
19-Dec-16	9.20
20-Dec-16	9.40
21-Dec-16	9.40
15-Feb-17	9.10
16-Feb-17	9.10
17-Feb-17	9.30
21-Feb-17	9.20
22-Feb-17	9.30
23-Feb-17	9.40
24-Feb-17	9.30
27-Feb-17	9.30
28-Feb-17	9.20
1-Mar-17	9.30
2-Mar-17	9.10
3-Mar-17	9.20
6-Mar-17	9.10
7-Mar-17	9.00
8-Mar-17	9.10
9-Mar-17	9.20
10-Mar-17	9.00
13-Mar-17	9.10
14-Mar-17	9.00
15-Mar-17	9.10
16-Mar-17	9.20
17-Mar-17	9.10
20-Mar-17	9.00
21-Mar-17	9.20
22-Mar-17	9.20
23-Mar-17	9.10
24-Mar-17	8.80
27-Mar-17	9.10
28-Mar-17	9.20
29-Mar-17	9.00
30-Mar-17	9.20
31-Mar-17	9.20
3-Apr-17	9.30
4-Apr-17	9.20
5-Apr-17	9.20
6-Apr-17	9.20
7-Apr-17	9.10
10-Apr-17	9.00
11-Apr-17	8.90
12-Apr-17	9.10
13-Apr-17	9.00
17-Apr-17	8.70
18-Apr-17	9.20
19-Apr-17	9.10
20-Apr-17	9.10
21-Apr-17	9.10
24-Apr-17	9.30
25-Apr-17	9.00
26-Apr-17	9.20
27-Apr-17	9.20
28-Apr-17	9.20
2-May-17	9.20
3-May-17	9.40
4-May-17	9.20
5-May-17	9.30
8-May-17	9.30
9-May-17	9.20
10-May-17	9.10
11-May-17	9.30
12-May-17	9.50
15-May-17	9.20
16-May-17	9.00
17-May-17	9.20
18-May-17	9.00
19-May-17	9.00
23-May-17	9.40
31-May-17	9.20
1-Jun-17	9.20
2-Jun-17	9.10
5-Jun-17	9.20
6-Jun-17	9.00
7-Jun-17	9.10
8-Jun-17	9.10
9-Jun-17	9.20
12-Jun-17	9.10
13-Jun-17	9.20
14-Jun-17	9.20
15-Jun-17	9.10
16-Jun-17	9.20
19-Jun-17	9.30
20-Jun-17	9.20
21-Jun-17	9.20
22-Jun-17	9.10
23-Jun-17	9.20
4-Jul-17	9.10
5-Jul-17	9.20
6-Jul-17	9.50
7-Jul-17	9.00
10-Jul-17	9.30
11-Jul-17	9.30
12-Jul-17	9.30
13-Jul-17	9.30
14-Jul-17	9.30
17-Jul-17	9.20
18-Jul-17	9.30
19-Jul-17	9.40
20-Jul-17	9.20
21-Jul-17	9.20
24-Jul-17	9.20
25-Jul-17	9.20
26-Jul-17	9.20
27-Jul-17	9.30
28-Jul-17	9.20
31-Jul-17	9.30
1-Aug-17	9.30
2-Aug-17	9.40
3-Aug-17	9.30
4-Aug-17	9.40
8-Aug-17	9.20
9-Aug-17	9.30
10-Aug-17	9.10
11-Aug-17	9.30
14-Aug-17	9.00
15-Aug-17	9.30
16-Aug-17	9.20
17-Aug-17	9.30
18-Aug-17	9.10
21-Aug-17	9.20
22-Aug-17	9.30
23-Aug-17	9.30
24-Aug-17	9.20
25-Aug-17	9.40
28-Aug-17	9.40
29-Aug-17	9.10
30-Aug-17	9.20
31-Aug-17	9.20
1-Sep-17	9.40
5-Sep-17	9.30
6-Sep-17	9.40
7-Sep-17	9.20
8-Sep-17	9.30
11-Sep-17	9.30
12-Sep-17	9.30
13-Sep-17	9.30

Note: "SD" = standard deviation. "n" = number of samples.

Table D.4: **Water Quality at TOMP Station CL-05 (ETP Operations), Stanleigh TMA, 2015 to 2019**

Date	pH	Date	pH	Date	pH	Date	pH
14-Sep-17	9.30	12-Dec-17	7.50	28-Mar-18	6.60	10-Oct-18	9.20
15-Sep-17	9.30	13-Dec-17	7.60	29-Mar-18	6.80	11-Oct-18	6.70
18-Sep-17	9.30	14-Dec-17	7.60	2-Apr-18	6.40	12-Oct-18	6.80
19-Sep-17	9.30	15-Dec-17	7.50	3-Apr-18	6.60	15-Oct-18	7.10
20-Sep-17	9.20	18-Dec-17	8.80	4-Apr-18	6.80	16-Oct-18	7.00
21-Sep-17	9.30	19-Dec-17	8.90	5-Apr-18	6.90	17-Oct-18	6.90
22-Sep-17	9.20	20-Dec-17	8.90	6-Apr-18	6.80	18-Oct-18	6.80
25-Sep-17	9.30	21-Dec-17	8.80	9-Apr-18	7.10	19-Oct-18	6.80
26-Sep-17	9.10	22-Dec-17	9.30	10-Apr-18	6.80	22-Oct-18	7.00
27-Sep-17	9.20	27-Dec-17	8.60	11-Apr-18	6.70	23-Oct-18	7.60
28-Sep-17	9.00	28-Dec-17	8.60	12-Apr-18	6.70	24-Oct-18	6.80
29-Sep-17	9.10	29-Dec-17	7.50	13-Apr-18	6.80	25-Oct-18	6.80
2-Oct-17	9.00	2-Jan-18	6.90	16-Apr-18	6.70	26-Oct-18	6.90
3-Oct-17	9.00	3-Jan-18	6.80	17-Apr-18	6.70	3-Nov-18	7.00
4-Oct-17	8.80	4-Jan-18	6.90	18-Apr-18	6.80	5-Nov-18	7.00
5-Oct-17	8.90	5-Jan-18	6.80	20-Apr-18	8.60	6-Nov-18	6.80
6-Oct-17	9.10	8-Jan-18	8.00	23-Apr-18	8.50	7-Nov-18	6.70
10-Oct-17	9.10	9-Jan-18	8.00	24-Apr-18	8.30	8-Nov-18	6.80
11-Oct-17	9.00	10-Jan-18	8.10	25-Apr-18	8.30	9-Nov-18	6.90
12-Oct-17	8.80	11-Jan-18	8.00	26-Apr-18	8.40	10-Nov-18	6.90
13-Oct-17	8.90	12-Jan-18	8.00	27-Apr-18	8.30	11-Nov-18	6.70
16-Oct-17	8.70	15-Jan-18	7.80	30-Apr-18	8.20	12-Nov-18	6.90
17-Oct-17	8.70	16-Jan-18	8.10	1-May-18	8.80	13-Nov-18	6.80
18-Oct-17	8.60	17-Jan-18	7.90	2-May-18	8.90	14-Nov-18	6.90
19-Oct-17	8.80	18-Jan-18	8.10	3-May-18	8.80	15-Nov-18	7.00
20-Oct-17	8.80	19-Jan-18	7.90	4-May-18	8.60	16-Nov-18	6.90
23-Oct-17	8.80	22-Jan-18	8.20	7-May-18	8.50	17-Nov-18	6.70
24-Oct-17	8.70	23-Jan-18	8.30	8-May-18	8.50	18-Nov-18	6.70
25-Oct-17	8.50	24-Jan-18	8.10	9-May-18	6.40	19-Nov-18	6.70
26-Oct-17	8.30	25-Jan-18	8.70	10-May-18	6.60	20-Nov-18	6.80
27-Oct-17	8.20	26-Jan-18	8.70	11-May-18	6.60	21-Nov-18	6.90
30-Oct-17	8.20	29-Jan-18	8.80	14-May-18	6.70	22-Nov-18	7.10
31-Oct-17	8.30	30-Jan-18	8.60	15-May-18	6.70	23-Nov-18	7.00
1-Nov-17	8.10	31-Jan-18	8.50	16-May-18	6.60	24-Nov-18	7.00
2-Nov-17	8.40	1-Feb-18	9.00	17-May-18	6.60	25-Nov-18	7.00
3-Nov-17	8.40	2-Feb-18	8.80	18-May-18	6.70	26-Nov-18	6.80
6-Nov-17	8.40	5-Feb-18	9.20	22-May-18	6.80	30-Nov-18	6.90
7-Nov-17	8.10	6-Feb-18	9.20	23-May-18	6.70	3-Dec-18	6.60
8-Nov-17	8.30	7-Feb-18	9.10	24-May-18	6.50	4-Dec-18	6.70
9-Nov-17	8.30	8-Feb-18	9.10	25-May-18	6.80	5-Dec-18	7.00
10-Nov-17	8.20	9-Feb-18	8.90	28-May-18	6.70	6-Dec-18	6.80
13-Nov-17	8.30	12-Feb-18	8.40	29-May-18	6.90	7-Dec-18	7.00
14-Nov-17	8.40	13-Feb-18	8.60	30-May-18	6.70	10-Dec-18	6.80
15-Nov-17	8.90	14-Feb-18	8.40	31-May-18	6.80	11-Dec-18	6.80
16-Nov-17	8.90	15-Feb-18	8.40	1-Jun-18	7.20	12-Dec-18	6.80
17-Nov-17	8.40	16-Feb-18	8.70	4-Jun-18	7.00	13-Dec-18	6.80
20-Nov-17	8.50	20-Feb-18	8.70	5-Jun-18	7.20	14-Dec-18	6.80
21-Nov-17	8.80	21-Feb-18	8.50	6-Jun-18	6.70	17-Dec-18	6.70
22-Nov-17	8.40	22-Feb-18	8.50	7-Jun-18	9.20	18-Dec-18	6.90
23-Nov-17	8.80	23-Feb-18	8.50	8-Jun-18	9.20	19-Dec-18	0
24-Nov-17	8.60	26-Feb-18	8.50	11-Jun-18	9.20	20-Dec-18	6.90
27-Nov-17	8.80	27-Feb-18	8.50	12-Jun-18	9.00	21-Dec-18	6.90
28-Nov-17	8.70	28-Feb-18	8.50	13-Jun-18	9.00	24-Dec-18	7.10
29-Nov-17	8.70	1-Mar-18	8.60	14-Jun-18	9.10	27-Dec-18	6.60
30-Nov-17	8.60	2-Mar-18	8.60	15-Jun-18	8.90	28-Dec-18	6.60
1-Dec-17	8.60	5-Mar-18	8.40	18-Jun-18	8.90	31-Dec-18	6.90
4-Dec-17	8.60	6-Mar-18	8.60	19-Jun-18	8.80	2-Jan-19	6.70
5-Dec-17	8.50	7-Mar-18	8.30	2-Oct-18	9.20	3-Jan-19	6.60
6-Dec-17	8.50	8-Mar-18	8.40	3-Oct-18	9.10	4-Jan-19	6.80
7-Dec-17	8.60	9-Mar-18	8.50	4-Oct-18	9.20	7-Jan-19	6.70
8-Dec-17	9.00	26-Mar-18	6.50	5-Oct-18	7.00	8-Jan-19	6.70
11-Dec-17	7.50	27-Mar-18	6.90	9-Oct-18	7.00	9-Jan-19	6.70

Note: "SD" = standard deviation. "n" = number of samples.

Table D.4: Water Quality at TOMP Station CL-05 (ETP Operations), Stanleigh TMA, 2015 to 2019

Date	pH
10-Jan-19	6.70
11-Jan-19	6.70
14-Jan-19	6.70
15-Jan-19	6.70
16-Jan-19	6.70
17-Jan-19	6.70
18-Jan-19	6.70
21-Jan-19	6.90
22-Jan-19	6.80
23-Jan-19	6.70
24-Jan-19	6.80
25-Jan-19	6.80
28-Jan-19	6.70
29-Jan-19	6.80
30-Jan-19	6.70
31-Jan-19	6.80
1-Feb-19	6.80
4-Feb-19	6.70
5-Feb-19	6.80
6-Feb-19	6.80
7-Feb-19	6.70
8-Feb-19	6.70
11-Feb-19	6.70
12-Feb-19	6.70
13-Feb-19	6.50
14-Feb-19	6.70
15-Feb-19	6.70
19-Feb-19	6.80
20-Feb-19	6.90
21-Feb-19	6.50
22-Feb-19	6.70
25-Feb-19	6.70
26-Feb-19	7.00
27-Feb-19	6.70
28-Feb-19	6.60
1-Mar-19	6.70
4-Mar-19	6.60
5-Mar-19	6.90
6-Mar-19	6.90
7-Mar-19	6.60
8-Mar-19	6.80
11-Mar-19	6.80
12-Mar-19	6.90
13-Mar-19	6.80
14-Mar-19	7.00
15-Mar-19	6.70
18-Mar-19	6.90
19-Mar-19	6.90
20-Mar-19	6.80
21-Mar-19	6.70
22-Mar-19	6.80
25-Mar-19	6.80
26-Mar-19	6.90
27-Mar-19	6.70
28-Mar-19	6.90
29-Mar-19	6.70
1-Apr-19	6.70
2-Apr-19	6.80
3-Apr-19	6.50
4-Apr-19	6.70
5-Apr-19	6.70
8-Apr-19	6.70
9-Apr-19	6.70
10-Apr-19	6.70
11-Apr-19	6.70
12-Apr-19	6.70
15-Apr-19	6.60

Date	pH
16-Apr-19	6.40
17-Apr-19	6.60
18-Apr-19	6.60
22-Apr-19	6.60
23-Apr-19	6.50
24-Apr-19	6.60
25-Apr-19	6.50
26-Apr-19	6.50
29-Apr-19	6.60
30-Apr-19	6.70
1-May-19	7.40
2-May-19	7.10
3-May-19	7.10
6-May-19	7.20
7-May-19	7.10
8-May-19	7.00
9-May-19	7.20
10-May-19	8.50
13-May-19	7.10
14-May-19	7.40
15-May-19	6.70
16-May-19	6.70
17-May-19	6.70
20-May-19	6.80
22-May-19	6.80
23-May-19	6.70
24-May-19	6.80
27-May-19	6.70
28-May-19	6.90
29-May-19	6.90
30-May-19	6.90
31-May-19	6.80
7-Jun-19	6.80
10-Jun-19	6.90
11-Jun-19	7.20
12-Jun-19	7.10
13-Jun-19	7.10
14-Jun-19	7.00
17-Jun-19	7.00
18-Jun-19	7.10
19-Jun-19	7.10
20-Jun-19	7.00
21-Jun-19	7.10
24-Jun-19	7.00
25-Jun-19	6.70
26-Jun-19	6.70
27-Jun-19	6.80
28-Jun-19	6.80
2-Jul-19	7.00
3-Jul-19	6.90
4-Jul-19	7.00
5-Jul-19	6.90
8-Jul-19	6.90
9-Jul-19	7.00
10-Jul-19	6.80
11-Jul-19	6.90
12-Jul-19	6.90
1-Oct-19	6.80
2-Oct-19	6.70
3-Oct-19	7.00
4-Oct-19	6.90
7-Oct-19	7.00
8-Oct-19	6.90
9-Oct-19	7.00
10-Oct-19	6.80
11-Oct-19	7.10
15-Oct-19	6.90

Date	pH
16-Oct-19	6.70
17-Oct-19	7.00
18-Oct-19	6.70
21-Oct-19	7.00
22-Oct-19	6.90
23-Oct-19	6.90
24-Oct-19	6.80
25-Oct-19	6.70
28-Oct-19	6.60
29-Oct-19	6.70
30-Oct-19	6.70
31-Oct-19	6.80
1-Nov-19	6.70
4-Nov-19	6.80
5-Nov-19	6.70
6-Nov-19	6.80
7-Nov-19	6.80
8-Nov-19	6.70
11-Nov-19	6.90
12-Nov-19	6.80
13-Nov-19	6.80
14-Nov-19	6.90
15-Nov-19	6.80
18-Nov-19	7.00
19-Nov-19	6.90
20-Nov-19	6.80
21-Nov-19	6.70
22-Nov-19	6.90
25-Nov-19	6.70
26-Nov-19	6.80
27-Nov-19	6.70
28-Nov-19	6.80
29-Nov-19	6.90
2-Dec-19	6.70
3-Dec-19	6.70
4-Dec-19	6.70
5-Dec-19	6.70
6-Dec-19	6.80
9-Dec-19	6.80
10-Dec-19	6.90
11-Dec-19	6.70
12-Dec-19	6.80
13-Dec-19	6.90
16-Dec-19	6.80
17-Dec-19	6.60
18-Dec-19	6.70
19-Dec-19	6.80
20-Dec-19	6.90
23-Dec-19	6.90
24-Dec-19	6.90
27-Dec-19	6.80
30-Dec-19	6.80
31-Dec-19	7.00
n	932
Minimum	0
Maximum	9.60
Mean	8.29
SD	1.08
Median	8.84
10th Percentile	6.70
95th Percentile	9.30
95th Percentile	9.30

Note: "SD" = standard deviation. "n" = number of samples.

Table D.5: Water Quality at TOMP Station CL-06 (Effluent), Stanleigh TMA, 2015 to 2019

Date	Flow (L/s)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	TSS (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
5-Jan-15	414	7.56	80.0	0.287	<1.00	2.89	<0.000500	0.0400	0.0430	0.00180
13-Jan-15	400	7.50	-	0.279	<1.00	3.04	-	-	-	-
20-Jan-15	400	7.40	-	0.277	<1.00	2.78	-	-	-	-
27-Jan-15	390	7.45	-	0.270	<1.00	2.67	-	-	-	-
3-Feb-15	390	7.40	80.0	0.226	<1.00	2.23	<0.000500	0.0300	0.0460	0.00150
10-Feb-15	400	7.40	-	0.119	2.00	1.10	-	-	-	-
18-Feb-15	400	7.40	76.0	0.167	2.00	0.905	<0.000500	0.0240	0.0451	0.00131
24-Feb-15	400	7.40	-	0.139	1.00	0.676	-	-	-	-
3-Mar-15	400	7.28	80.0	0.0920	2.00	0.824	<0.000500	0.0300	0.0473	0.00152
9-Mar-15	400	7.35	-	0.107	<1.00	0.787	-	-	-	-
17-Mar-15	510	7.27	-	0.155	1.00	0.764	-	-	-	-
23-Mar-15	500	7.50	-	0.167	<1.00	0.878	-	-	-	-
31-Mar-15	510	7.40	-	0.0840	1.00	0.943	-	-	-	-
6-Apr-15	500	7.30	75.0	0.162	<1.00	0.716	<0.000500	0.0230	0.0463	0.00158
9-Apr-15	510	7.20	80.0	0.101	<1.00	0.775	-	0.0700	-	-
13-Apr-15	510	7.10	79.0	0.152	1.00	0.685	-	0.110	-	-
16-Apr-15	440	6.80	72.0	0.119	<1.00	0.867	-	0.180	-	-
20-Apr-15	440	7.20	76.0	0.146	1.00	0.921	-	0.290	-	-
23-Apr-15	440	7.00	75.0	0.120	1.00	0.875	-	0.450	-	-
27-Apr-15	440	7.10	72.0	0.0600	2.00	1.09	-	0.540	-	-
30-Apr-15	440	7.20	73.0	0.150	3.00	0.800	-	0.580	-	-
4-May-15	320	7.11	68.0	0.148	3.00	0.927	<0.000500	0.600	0.0662	0.00185
7-May-15	330	7.47	63.0	0.169	4.00	1.11	-	0.760	-	-
11-May-15	330	8.23	71.0	0.159	2.00	1.44	-	0.510	-	-
14-May-15	320	7.60	67.0	0.184	3.00	1.60	-	0.770	-	-
19-May-15	330	7.40	-	0.219	4.00	1.78	-	0.490	-	-
20-May-15	330	7.50	-	-	-	-	-	-	-	-
21-May-15	330	7.70	69.0	0.191	3.00	1.07	-	0.520	-	-
25-May-15	330	7.31	71.0	0.144	3.00	0.903	-	0.620	-	-
28-May-15	330	7.50	70.0	0.144	3.00	1.07	-	0.680	-	-
1-Jun-15	330	7.50	69.0	0.151	4.00	1.17	<0.000500	0.803	0.0619	0.00150
4-Jun-15	330	7.41	69.0	0.139	3.00	0.897	-	0.520	-	-
26-Jun-15	132	7.04	68.0	0.0290	<1.00	0.363	<0.000500	0.0800	0.0560	0.00130
29-Jun-15	132	7.18	-	0.0400	<1.00	-	-	-	-	-
30-Jun-15	66.0	7.02	-	-	-	-	-	-	-	-
2-Jul-15	66.0	-	-	-	-	-	-	-	-	-
3-Jul-15	66.0	-	-	-	-	-	-	-	-	-
4-Jul-15	4.00	-	-	-	-	-	-	-	-	-
5-Jul-15	4.00	-	-	-	-	-	-	-	-	-
6-Jul-15	4.00	6.90	-	0.0600	1.00	-	-	-	-	-
16-Dec-15	510	7.40	61.0	0.0800	<1.00	0.489	<0.000500	0.0460	0.0610	0.00600
21-Dec-15	492	7.80	-	0.198	5.00	1.24	-	-	-	-
28-Dec-15	510	7.50	-	0.308	<1.00	1.86	-	-	-	-
4-Jan-16	492	7.30	70.0	0.333	<1.00	2.14	<0.000500	0.0400	0.0381	0.00226
8-Jan-16	300	7.30	-	0.334	-	-	-	-	-	-
12-Jan-16	312	7.58	-	0.251	<1.00	2.60	-	0.0370	-	-
18-Jan-16	300	7.55	-	0.318	<1.00	2.76	-	0.0360	-	-
25-Jan-16	297	8.25	-	0.292	<1.00	3.21	-	0.0340	-	-
1-Feb-16	300	7.40	70.0	0.331	<1.00	3.51	<0.000500	0.0330	0.0405	0.00177
8-Feb-16	300	7.70	-	0.296	<1.00	3.24	-	0.0310	-	-
9-Feb-16	-	7.40	-	-	-	-	-	-	-	-
16-Feb-16	320	7.86	-	0.298	<1.00	3.58	-	0.0340	-	-
22-Feb-16	540	7.61	-	0.457	<1.00	3.28	-	0.188	-	-
25-Feb-16	-	7.50	68.0	-	1.00	-	-	0.281	-	-
1-Mar-16	410	7.60	-	0.146	2.00	0.885	-	0.382	-	-
3-Mar-16	-	7.15	69.0	-	1.00	-	-	0.435	-	-
7-Mar-16	500	7.63	71.0	0.191	3.00	0.696	<0.000500	0.520	0.0444	0.00136
10-Mar-16	-	7.48	69.0	-	2.00	-	-	0.509	-	-
14-Mar-16	540	7.26	-	0.178	2.00	0.681	-	0.539	-	-
17-Mar-16	-	7.12	65.0	-	2.00	-	-	0.468	-	-
21-Mar-16	540	7.12	-	0.252	1.00	0.869	-	0.493	-	-
24-Mar-16	-	7.36	69.0	-	3.00	-	-	0.493	-	-
28-Mar-16	528	7.29	-	0.225	2.00	0.766	-	0.469	-	-
31-Mar-16	-	7.29	-	-	-	-	-	-	-	-
4-Apr-16	508	6.96	62.0	0.173	1.00	1.17	<0.000500	0.272	0.0445	0.00165
11-Apr-16	285	6.95	-	0.0660	1.00	0.699	-	0.142	-	-
18-Apr-16	534	6.90	-	0.182	1.00	0.972	-	0.0640	-	-
25-Apr-16	526	7.09	-	0.344	1.00	1.47	-	0.0490	-	-
26-Apr-16	529	7.15	-	0.234	-	-	-	-	-	-
2-May-16	427	7.17	64.0	0.249	1.00	1.27	<0.000500	0.0480	0.0478	0.00145
9-May-16	456	7.17	-	0.247	1.00	1.46	-	0.0460	-	-
16-May-16	423	7.35	-	0.330	<2.00	2.03	-	0.0490	-	-
24-May-16	452	7.35	-	0.408	1.00	2.58	-	0.0600	-	-
30-May-16	296	7.48	-	0.390	1.00	3.34	-	0.0500	-	-
6-Jun-16	236	7.23	62.0	0.326	4.00	3.72	<0.000500	0.0460	0.0553	0.00146
13-Jun-16	250	7.30	-	0.294	1.00	3.40	-	0.0390	-	-
20-Jun-16	300	7.00	-	0.374	2.00	3.57	-	0.0400	-	-
5-Jul-16	235	7.18	-	0.0620	1.00	0.782	-	0.0470	-	-
11-Jul-16	220	7.40	63.0	0.117	2.00	2.11	<0.000500	0.0440	0.0188	0.00111
18-Jul-16	240	7.20	-	0.201	1.00	2.38	-	0.0460	-	-
25-Jul-16	240	7.20	-	0.166	2.00	2.49	-	0.0400	-	-
2-Aug-16	243	7.50	63.0	0.0940	<2.00	1.61	<0.000500	0.0580	0.0125	0.00110
8-Aug-16	280	7.45	-	0.168	1.00	2.35	-	0.0420	-	-
15-Aug-16	280	7.70	-	0.139	2.00	2.13	-	0.0530	-	-
22-Aug-16	295	7.82	-	0.110	2.00	1.07	-	0.0370	-	-
29-Aug-16	291	7.47	-	0.105	2.00	0.920	-	0.0300	-	-
6-Sep-16	319	7.51	67.0	0.0980	2.00	0.870	<0.000500	0.0300	0.00782	0.00108
12-Sep-16	297	7.15	-	0.106	2.00	0.950	-	0.0280	-	-
19-Sep-16	306	7.23	-	0.104	1.00	0.762	-	0.0390	-	-
26-Sep-16	303	7.92	-	0.121	2.00	0.928	-	0.0220	-	-
3-Oct-16	300	7.53	64.0	0.116	1.00	0.833	<0.000500	0.0240	0.0726	0.00146
11-Oct-16	304	7.30	-	0.108	1.00	0.762	-	0.0390	-	-
17-Oct-16	308	7.40	-	0.161	2.00	1.02	-	0.0560	-	-
24-Oct-16	303	7.40	-	0.142	1.00	0.880	-	0.0570	-	-
31-Oct-16	301	7.40	-	0.154	2.00	0.841	-	0.0450	-	-
7-Nov-16	303	7.40	67.0	0.179	<1.00	0.891	<0.000500	0.0390	0.0346	0.00153
14-Nov-16	300	7.40	-	0.160	2.00	0.952	-	0.0420	-	-
21-Nov-16	309	7.40	-	0.176	1.00	0.907	-	0.0550	-	-
28-Nov-16	297	7.60	-	0.176	2.00	1.51	-	0.0530	-	-
5-Dec-16	291	7.30	66.0	0.163	1.00	0.828	<0.000500	0.0430	0.0348	0.00160
12-Dec-16	300	7.20	-	0.0870	<1.00	0.611	-	0.0360	-	-
19-Dec-16	303	7.50	-	0.0720	<1.00	0.614	-	0.0410	-	-

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table D.5: **Water Quality at TOMP Station CL-06 (Effluent), Stanleigh TMA, 2015 to 2019**

Date	Flow (L/s)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	TSS (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
17-Feb-17	290	-	-	-	-	-	-	-	-	-
18-Feb-17	290	-	-	-	-	-	-	-	-	-
19-Feb-17	290	-	-	-	-	-	-	-	-	-
20-Feb-17	290	-	-	-	-	-	-	-	-	-
21-Feb-17	290	7.20	63.0	0.123	<1.00	1.08	<0.000500	0.0290	0.0388	0.00241
22-Feb-17	290	-	-	-	-	-	-	-	-	-
23-Feb-17	288	-	-	-	-	-	-	-	-	-
24-Feb-17	284	-	-	-	-	-	-	-	-	-
25-Feb-17	290	-	-	-	-	-	-	-	-	-
26-Feb-17	290	-	-	-	-	-	-	-	-	-
27-Feb-17	281	7.50	-	0.156	1.00	0.791	-	0.0300	-	-
28-Feb-17	297	-	-	-	-	-	-	-	-	-
1-Mar-17	293	-	-	-	-	-	-	-	-	-
2-Mar-17	294	-	-	-	-	-	-	-	-	-
3-Mar-17	295	-	-	-	-	-	-	-	-	-
4-Mar-17	290	-	-	-	-	-	-	-	-	-
5-Mar-17	290	-	-	-	-	-	-	-	-	-
6-Mar-17	290	7.30	63.0	0.127	<1.00	0.799	<0.000500	0.0240	0.0392	0.00184
7-Mar-17	298	-	-	-	-	-	-	-	-	-
8-Mar-17	290	-	-	-	-	-	-	-	-	-
9-Mar-17	290	-	-	-	-	-	-	-	-	-
10-Mar-17	300	-	-	-	-	-	-	-	-	-
11-Mar-17	320	-	-	-	-	-	-	-	-	-
12-Mar-17	320	-	-	-	-	-	-	-	-	-
13-Mar-17	320	7.20	-	0.120	<1.00	0.843	-	0.0320	-	-
14-Mar-17	320	-	-	-	-	-	-	-	-	-
15-Mar-17	320	-	-	-	-	-	-	-	-	-
16-Mar-17	320	-	-	-	-	-	-	-	-	-
17-Mar-17	340	-	-	-	-	-	-	-	-	-
18-Mar-17	340	-	-	-	-	-	-	-	-	-
19-Mar-17	340	-	-	-	-	-	-	-	-	-
20-Mar-17	340	7.20	-	0.0830	<1.00	0.633	-	0.0270	-	-
21-Mar-17	340	-	-	-	-	-	-	-	-	-
22-Mar-17	340	-	-	-	-	-	-	-	-	-
23-Mar-17	340	-	-	-	-	-	-	-	-	-
24-Mar-17	340	-	-	-	-	-	-	-	-	-
25-Mar-17	340	-	-	-	-	-	-	-	-	-
26-Mar-17	340	-	-	-	-	-	-	-	-	-
27-Mar-17	343	7.20	-	0.0900	1.00	0.780	-	0.0250	-	-
28-Mar-17	339	-	-	-	-	-	-	-	-	-
29-Mar-17	341	-	-	-	-	-	-	-	-	-
30-Mar-17	336	-	-	-	-	-	-	-	-	-
31-Mar-17	340	-	-	-	-	-	-	-	-	-
1-Apr-17	336	-	-	-	-	-	-	-	-	-
2-Apr-17	336	-	-	-	-	-	-	-	-	-
3-Apr-17	332	7.20	47.0	0.155	1.00	0.819	<0.000500	0.0400	0.0371	0.00130
4-Apr-17	345	-	-	-	-	-	-	-	-	-
5-Apr-17	348	-	-	-	-	-	-	-	-	-
6-Apr-17	360	-	-	-	-	-	-	-	-	-
7-Apr-17	370	-	-	-	-	-	-	-	-	-
8-Apr-17	370	-	-	-	-	-	-	-	-	-
9-Apr-17	370	-	-	-	-	-	-	-	-	-
10-Apr-17	362	7.00	-	0.144	<1.00	0.880	-	0.0380	-	-
11-Apr-17	367	-	-	-	-	-	-	-	-	-
12-Apr-17	363	-	-	-	-	-	-	-	-	-
13-Apr-17	351	-	-	-	-	-	-	-	-	-
14-Apr-17	350	-	-	-	-	-	-	-	-	-
15-Apr-17	350	-	-	-	-	-	-	-	-	-
16-Apr-17	350	-	-	-	-	-	-	-	-	-
17-Apr-17	340	7.30	-	0.341	<1.00	2.15	-	0.0670	-	-
18-Apr-17	340	-	-	-	-	-	-	-	-	-
19-Apr-17	360	-	-	-	-	-	-	-	-	-
20-Apr-17	360	-	-	-	-	-	-	-	-	-
21-Apr-17	360	-	-	-	-	-	-	-	-	-
22-Apr-17	330	-	-	-	-	-	-	-	-	-
23-Apr-17	330	-	-	-	-	-	-	-	-	-
24-Apr-17	330	7.20	-	0.364	1.00	2.56	-	0.0830	-	-
25-Apr-17	330	-	-	-	-	-	-	-	-	-
26-Apr-17	340	-	-	-	-	-	-	-	-	-
27-Apr-17	330	-	-	-	-	-	-	-	-	-
28-Apr-17	330	-	-	-	-	-	-	-	-	-
29-Apr-17	200	-	-	-	-	-	-	-	-	-
30-Apr-17	100	-	-	-	-	-	-	-	-	-
2-May-17	50.0	7.40	-	0.412	1.00	-	-	-	-	-
3-May-17	234	-	-	-	-	-	-	-	-	-
4-May-17	235	7.20	56.0	0.314	<1.00	2.26	<0.000500	0.0930	0.0583	0.00217
5-May-17	235	-	-	-	-	-	-	-	-	-
6-May-17	235	-	-	-	-	-	-	-	-	-
7-May-17	235	-	-	-	-	-	-	-	-	-
8-May-17	230	7.50	-	0.356	<2.00	2.44	-	0.0840	-	-
9-May-17	230	-	-	-	-	-	-	-	-	-
10-May-17	235	-	-	-	-	-	-	-	-	-
11-May-17	235	-	-	-	-	-	-	-	-	-
12-May-17	235	-	-	-	-	-	-	-	-	-
13-May-17	235	-	-	-	-	-	-	-	-	-
14-May-17	235	-	-	-	-	-	-	-	-	-
15-May-17	229	7.20	-	0.381	<2.00	3.55	-	0.0710	-	-
16-May-17	235	-	-	-	-	-	-	-	-	-
17-May-17	235	-	-	-	-	-	-	-	-	-
18-May-17	235	-	-	-	-	-	-	-	-	-
19-May-17	235	-	-	-	-	-	-	-	-	-
20-May-17	235	-	-	-	-	-	-	-	-	-
21-May-17	235	-	-	-	-	-	-	-	-	-
22-May-17	235	-	-	-	-	-	-	-	-	-
23-May-17	235	-	-	-	-	-	-	-	-	-
24-May-17	150	-	-	-	-	-	-	-	-	-
25-May-17	50.0	-	-	-	-	-	-	-	-	-
31-May-17	10.0	-	-	-	-	-	-	-	-	-
1-Jun-17	300	7.30	-	0.328	<2.00	2.84	-	0.0350	-	-
2-Jun-17	300	-	-	-	-	-	-	-	-	-
3-Jun-17	300	-	-	-	-	-	-	-	-	-
4-Jun-17	300	-	-	-	-	-	-	-	-	-

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table D.5: Water Quality at TOMP Station CL-06 (Effluent), Stanleigh TMA, 2015 to 2019

Date	Flow (L/s)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	TSS (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
5-Jun-17	300	7.20	56.0	0.299	1.00	2.85	<0.000500	0.0320	0.0438	0.00258
6-Jun-17	300	-	-	-	-	-	-	-	-	-
7-Jun-17	300	-	-	-	-	-	-	-	-	-
8-Jun-17	300	-	-	-	-	-	-	-	-	-
9-Jun-17	300	-	-	-	-	-	-	-	-	-
10-Jun-17	300	-	-	-	-	-	-	-	-	-
11-Jun-17	300	-	-	-	-	-	-	-	-	-
12-Jun-17	300	7.10	-	0.354	1.00	2.88	-	0.0320	-	-
13-Jun-17	300	-	-	-	-	-	-	-	-	-
14-Jun-17	300	-	-	-	-	-	-	-	-	-
15-Jun-17	300	-	-	-	-	-	-	-	-	-
16-Jun-17	300	-	-	-	-	-	-	-	-	-
17-Jun-17	300	-	-	-	-	-	-	-	-	-
18-Jun-17	300	-	-	-	-	-	-	-	-	-
19-Jun-17	300	7.20	-	0.382	1.00	2.92	-	0.0420	-	-
20-Jun-17	300	-	-	-	-	-	-	-	-	-
21-Jun-17	300	-	-	-	-	-	-	-	-	-
22-Jun-17	300	-	-	-	-	-	-	-	-	-
23-Jun-17	300	-	-	-	-	-	-	-	-	-
24-Jun-17	300	-	-	-	-	-	-	-	-	-
25-Jun-17	300	-	-	-	-	-	-	-	-	-
26-Jun-17	260	-	-	-	-	-	-	-	-	-
27-Jun-17	150	-	-	-	-	-	-	-	-	-
28-Jun-17	75.0	-	-	-	-	-	-	-	-	-
5-Jul-17	250	-	-	-	-	-	-	-	-	-
6-Jul-17	260	7.20	60.0	0.295	1.00	2.84	<0.000500	0.0400	0.0482	0.00215
7-Jul-17	250	-	-	-	-	-	-	-	-	-
8-Jul-17	250	-	-	-	-	-	-	-	-	-
9-Jul-17	250	-	-	-	-	-	-	-	-	-
10-Jul-17	250	7.30	-	0.302	<1.00	2.95	-	0.0460	-	-
11-Jul-17	250	-	-	-	-	-	-	-	-	-
12-Jul-17	250	-	-	-	-	-	-	-	-	-
13-Jul-17	250	-	-	-	-	-	-	-	-	-
14-Jul-17	240	-	-	-	-	-	-	-	-	-
15-Jul-17	240	-	-	-	-	-	-	-	-	-
16-Jul-17	240	-	-	-	-	-	-	-	-	-
17-Jul-17	228	7.40	-	0.313	1.00	3.09	-	0.0490	-	-
18-Jul-17	235	-	-	-	-	-	-	-	-	-
19-Jul-17	229	-	-	-	-	-	-	-	-	-
20-Jul-17	236	-	-	-	-	-	-	-	-	-
21-Jul-17	242	-	-	-	-	-	-	-	-	-
22-Jul-17	242	-	-	-	-	-	-	-	-	-
23-Jul-17	242	-	-	-	-	-	-	-	-	-
24-Jul-17	251	7.40	-	0.248	1.00	2.92	-	0.0470	-	-
25-Jul-17	260	-	-	-	-	-	-	-	-	-
26-Jul-17	258	-	-	-	-	-	-	-	-	-
27-Jul-17	260	-	-	-	-	-	-	-	-	-
28-Jul-17	258	-	-	-	-	-	-	-	-	-
29-Jul-17	255	-	-	-	-	-	-	-	-	-
30-Jul-17	255	-	-	-	-	-	-	-	-	-
31-Jul-17	260	7.40	-	0.290	1.00	2.97	-	0.0500	-	-
1-Aug-17	257	-	-	-	-	-	-	-	-	-
2-Aug-17	258	-	-	-	-	-	-	-	-	-
3-Aug-17	255	-	-	-	-	-	-	-	-	-
4-Aug-17	260	-	-	-	-	-	-	-	-	-
5-Aug-17	260	-	-	-	-	-	-	-	-	-
6-Aug-17	260	-	-	-	-	-	-	-	-	-
7-Aug-17	260	-	-	-	-	-	-	-	-	-
8-Aug-17	260	7.30	57.0	0.263	<1.00	2.30	<0.000500	0.0340	0.0161	0.00161
9-Aug-17	260	-	-	-	-	-	-	-	-	-
10-Aug-17	257	-	-	-	-	-	-	-	-	-
11-Aug-17	260	-	-	-	-	-	-	-	-	-
12-Aug-17	260	-	-	-	-	-	-	-	-	-
13-Aug-17	260	-	-	-	-	-	-	-	-	-
14-Aug-17	260	7.40	-	0.251	1.00	3.10	-	0.0330	-	-
15-Aug-17	260	-	-	-	-	-	-	-	-	-
16-Aug-17	262	-	-	-	-	-	-	-	-	-
17-Aug-17	260	-	-	-	-	-	-	-	-	-
18-Aug-17	260	-	-	-	-	-	-	-	-	-
19-Aug-17	260	-	-	-	-	-	-	-	-	-
20-Aug-17	260	-	-	-	-	-	-	-	-	-
21-Aug-17	262	7.40	-	0.256	<1.00	2.98	-	0.0380	-	-
22-Aug-17	260	-	-	-	-	-	-	-	-	-
23-Aug-17	260	-	-	-	-	-	-	-	-	-
24-Aug-17	260	-	-	-	-	-	-	-	-	-
25-Aug-17	260	-	-	-	-	-	-	-	-	-
26-Aug-17	260	-	-	-	-	-	-	-	-	-
27-Aug-17	260	-	-	-	-	-	-	-	-	-
28-Aug-17	260	7.40	-	0.262	<1.00	2.83	-	0.0310	-	-
29-Aug-17	260	-	-	-	-	-	-	-	-	-
30-Aug-17	260	-	-	-	-	-	-	-	-	-
31-Aug-17	260	-	-	-	-	-	-	-	-	-
1-Sep-17	260	-	-	-	-	-	-	-	-	-
2-Sep-17	260	-	-	-	-	-	-	-	-	-
3-Sep-17	260	-	-	-	-	-	-	-	-	-
4-Sep-17	260	-	-	-	-	-	-	-	-	-
5-Sep-17	260	7.30	57.0	0.230	1.00	2.61	<0.000500	0.0290	0.0163	0.00192
6-Sep-17	303	-	-	-	-	-	-	-	-	-
7-Sep-17	300	-	-	-	-	-	-	-	-	-
8-Sep-17	305	-	-	-	-	-	-	-	-	-
9-Sep-17	300	-	-	-	-	-	-	-	-	-
10-Sep-17	300	-	-	-	-	-	-	-	-	-
11-Sep-17	302	7.40	-	0.247	1.00	2.61	-	0.0300	-	-
12-Sep-17	300	-	-	-	-	-	-	-	-	-
13-Sep-17	300	-	-	-	-	-	-	-	-	-
14-Sep-17	300	-	-	-	-	-	-	-	-	-
15-Sep-17	300	-	-	-	-	-	-	-	-	-
16-Sep-17	300	-	-	-	-	-	-	-	-	-
17-Sep-17	300	-	-	-	-	-	-	-	-	-
18-Sep-17	300	7.40	-	0.256	1.00	2.53	-	0.0300	-	-
19-Sep-17	300	-	-	-	-	-	-	-	-	-
20-Sep-17	300	-	-	-	-	-	-	-	-	-

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table D.5: Water Quality at TOMP Station CL-06 (Effluent), Stanleigh TMA, 2015 to 2019

Date	Flow (L/s)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	TSS (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
21-Sep-17	300	-	-	-	-	-	-	-	-	-
22-Sep-17	300	-	-	-	-	-	-	-	-	-
23-Sep-17	300	-	-	-	-	-	-	-	-	-
24-Sep-17	300	-	-	-	-	-	-	-	-	-
25-Sep-17	300	7.70	-	0.281	<1.00	3.07	-	0.0270	-	-
26-Sep-17	350	-	-	-	-	-	-	-	-	-
27-Sep-17	350	-	-	-	-	-	-	-	-	-
28-Sep-17	350	-	-	-	-	-	-	-	-	-
29-Sep-17	350	-	-	-	-	-	-	-	-	-
30-Sep-17	350	-	-	-	-	-	-	-	-	-
1-Oct-17	350	-	-	-	-	-	-	-	-	-
2-Oct-17	300	7.20	56.0	0.284	1.00	1.94	<0.000500	<0.0200	0.0330	0.00128
3-Oct-17	300	-	-	-	-	-	-	-	-	-
4-Oct-17	150	-	-	-	-	-	-	-	-	-
5-Oct-17	235	-	-	-	-	-	-	-	-	-
6-Oct-17	230	-	-	-	-	-	-	-	-	-
7-Oct-17	230	-	-	-	-	-	-	-	-	-
8-Oct-17	230	-	-	-	-	-	-	-	-	-
9-Oct-17	230	-	-	-	-	-	-	-	-	-
10-Oct-17	230	7.20	-	0.197	1.00	1.81	-	0.0310	-	-
11-Oct-17	300	-	-	-	-	-	-	-	-	-
12-Oct-17	300	-	-	-	-	-	-	-	-	-
13-Oct-17	300	-	-	-	-	-	-	-	-	-
14-Oct-17	300	-	-	-	-	-	-	-	-	-
15-Oct-17	350	-	-	-	-	-	-	-	-	-
16-Oct-17	350	7.20	-	0.233	1.00	1.90	-	0.0490	-	-
17-Oct-17	350	-	-	-	-	-	-	-	-	-
18-Oct-17	370	-	-	-	-	-	-	-	-	-
19-Oct-17	360	-	-	-	-	-	-	-	-	-
20-Oct-17	360	-	-	-	-	-	-	-	-	-
21-Oct-17	360	-	-	-	-	-	-	-	-	-
22-Oct-17	360	-	-	-	-	-	-	-	-	-
23-Oct-17	350	-	-	-	-	-	-	-	-	-
24-Oct-17	360	-	-	-	-	-	-	-	-	-
25-Oct-17	450	7.20	-	0.294	<1.00	1.39	-	0.0580	-	-
26-Oct-17	455	-	-	-	-	-	-	-	-	-
27-Oct-17	500	-	-	-	-	-	-	-	-	-
28-Oct-17	500	-	-	-	-	-	-	-	-	-
29-Oct-17	500	-	-	-	-	-	-	-	-	-
30-Oct-17	495	7.20	-	0.314	<1.00	2.01	-	0.0540	-	-
31-Oct-17	500	-	-	-	-	-	-	-	-	-
1-Nov-17	496	-	-	-	-	-	-	-	-	-
2-Nov-17	500	-	-	-	-	-	-	-	-	-
3-Nov-17	500	-	-	-	-	-	-	-	-	-
4-Nov-17	500	-	-	-	-	-	-	-	-	-
5-Nov-17	500	-	-	-	-	-	-	-	-	-
6-Nov-17	500	7.20	59.0	0.356	1.00	2.23	<0.000500	0.0590	0.0348	0.00172
7-Nov-17	510	-	-	-	-	-	-	-	-	-
8-Nov-17	500	-	-	-	-	-	-	-	-	-
9-Nov-17	500	-	-	-	-	-	-	-	-	-
10-Nov-17	500	-	-	-	-	-	-	-	-	-
11-Nov-17	500	-	-	-	-	-	-	-	-	-
12-Nov-17	501	-	-	-	-	-	-	-	-	-
13-Nov-17	500	7.20	-	0.330	<1.00	2.54	-	0.0460	-	-
14-Nov-17	500	-	-	-	-	-	-	-	-	-
15-Nov-17	500	-	-	-	-	-	-	-	-	-
16-Nov-17	500	-	-	-	-	-	-	-	-	-
17-Nov-17	500	-	-	-	-	-	-	-	-	-
18-Nov-17	500	-	-	-	-	-	-	-	-	-
19-Nov-17	500	-	-	-	-	-	-	-	-	-
20-Nov-17	500	7.20	-	0.378	1.00	2.43	-	0.0630	-	-
21-Nov-17	500	-	-	-	-	-	-	-	-	-
22-Nov-17	500	-	-	-	-	-	-	-	-	-
23-Nov-17	500	-	-	-	-	-	-	-	-	-
24-Nov-17	500	-	-	-	-	-	-	-	-	-
25-Nov-17	300	-	-	-	-	-	-	-	-	-
26-Nov-17	300	-	-	-	-	-	-	-	-	-
27-Nov-17	300	7.20	-	0.385	1.00	2.20	-	0.0640	-	-
28-Nov-17	350	-	-	-	-	-	-	-	-	-
29-Nov-17	350	-	-	-	-	-	-	-	-	-
30-Nov-17	350	-	-	-	-	-	-	-	-	-
1-Dec-17	350	-	-	-	-	-	-	-	-	-
2-Dec-17	260	-	-	-	-	-	-	-	-	-
3-Dec-17	260	-	-	-	-	-	-	-	-	-
4-Dec-17	260	7.20	57.0	0.403	<1.00	2.50	<0.000500	0.0360	0.0396	0.00112
5-Dec-17	350	-	-	-	-	-	-	-	-	-
6-Dec-17	350	-	-	-	-	-	-	-	-	-
7-Dec-17	350	-	-	-	-	-	-	-	-	-
8-Dec-17	350	-	-	-	-	-	-	-	-	-
9-Dec-17	350	-	-	-	-	-	-	-	-	-
10-Dec-17	350	-	-	-	-	-	-	-	-	-
11-Dec-17	350	7.10	-	0.455	<1.00	3.21	-	0.0580	-	-
12-Dec-17	350	-	-	-	-	-	-	-	-	-
13-Dec-17	350	-	-	-	-	-	-	-	-	-
14-Dec-17	350	-	-	-	-	-	-	-	-	-
15-Dec-17	260	-	-	-	-	-	-	-	-	-
16-Dec-17	250	-	-	-	-	-	-	-	-	-
17-Dec-17	250	-	-	-	-	-	-	-	-	-
18-Dec-17	230	7.30	-	0.412	<1.00	3.49	-	0.0580	-	-
19-Dec-17	230	-	-	-	-	-	-	-	-	-
20-Dec-17	210	-	-	-	-	-	-	-	-	-
21-Dec-17	210	-	-	-	-	-	-	-	-	-
22-Dec-17	200	7.30	-	0.383	-	-	-	-	-	-
23-Dec-17	400	-	-	-	-	-	-	-	-	-
24-Dec-17	400	-	-	-	-	-	-	-	-	-
25-Dec-17	400	-	-	-	-	-	-	-	-	-
26-Dec-17	400	-	-	-	-	-	-	-	-	-
27-Dec-17	400	7.40	59.0	0.436	<1.00	3.56	<0.000500	0.0660	0.0394	0.00194
28-Dec-17	400	-	-	-	-	-	-	-	-	-
29-Dec-17	400	-	-	-	-	-	-	-	-	-
30-Dec-17	400	-	-	-	-	-	-	-	-	-
31-Dec-17	400	-	-	0.400	-	-	-	-	-	-

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table D.5: Water Quality at TOMP Station CL-06 (Effluent), Stanleigh TMA, 2015 to 2019

Date	Flow (L/s)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	TSS (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
1-Jan-18	400	-	-	-	-	-	-	-	-	-
2-Jan-18	400	7.20	59.0	0.422	<1.00	2.81	<0.000500	0.0550	0.0399	0.00179
3-Jan-18	400	-	-	-	-	-	-	-	-	-
4-Jan-18	400	-	-	-	-	-	-	-	-	-
5-Jan-18	400	-	-	-	-	-	-	-	-	-
6-Jan-18	400	-	-	-	-	-	-	-	-	-
7-Jan-18	400	-	-	-	-	-	-	-	-	-
8-Jan-18	400	7.00	60.0	0.398	<1.00	2.91	-	0.0460	-	-
9-Jan-18	400	-	-	-	-	-	-	-	-	-
10-Jan-18	400	6.80	-	-	-	-	-	-	-	-
11-Jan-18	400	-	-	-	-	-	-	-	-	-
12-Jan-18	400	-	-	-	-	-	-	-	-	-
13-Jan-18	400	-	-	-	-	-	-	-	-	-
14-Jan-18	400	-	-	-	-	-	-	-	-	-
15-Jan-18	400	7.00	60.0	0.438	<1.00	2.90	-	0.0550	-	-
16-Jan-18	400	-	-	-	-	-	-	-	-	-
17-Jan-18	400	-	-	-	-	-	-	-	-	-
18-Jan-18	400	-	-	-	-	-	-	-	-	-
19-Jan-18	400	-	-	-	-	-	-	-	-	-
20-Jan-18	400	-	-	-	-	-	-	-	-	-
21-Jan-18	400	-	-	-	-	-	-	-	-	-
22-Jan-18	400	7.10	59.0	0.451	<1.00	2.68	-	0.0350	-	-
23-Jan-18	400	-	-	-	-	-	-	-	-	-
24-Jan-18	400	-	-	-	-	-	-	-	-	-
25-Jan-18	400	7.10	57.0	0.427	<1.00	2.71	-	0.0520	-	-
26-Jan-18	400	-	-	-	-	-	-	-	-	-
27-Jan-18	400	-	-	-	-	-	-	-	-	-
28-Jan-18	400	-	-	-	-	-	-	-	-	-
29-Jan-18	400	7.10	57.0	0.410	1.00	2.83	-	0.0530	-	-
30-Jan-18	400	-	-	-	-	-	-	-	-	-
31-Jan-18	400	-	-	-	-	-	-	-	-	-
1-Feb-18	400	7.20	60.0	0.234	1.00	1.11	-	0.0820	-	-
2-Feb-18	200	-	-	-	-	-	-	-	-	-
3-Feb-18	200	-	-	-	-	-	-	-	-	-
4-Feb-18	200	-	-	-	-	-	-	-	-	-
5-Feb-18	200	7.20	58.0	0.168	2.00	1.03	<0.000500	0.198	0.0391	0.00148
6-Feb-18	200	-	-	-	-	-	-	-	-	-
7-Feb-18	200	7.10	56.0	0.194	<2.00	1.22	-	0.209	-	-
8-Feb-18	200	-	-	-	-	-	-	-	-	-
9-Feb-18	200	-	-	-	-	-	-	-	-	-
10-Feb-18	450	-	-	-	-	-	-	-	-	-
11-Feb-18	450	-	-	-	-	-	-	-	-	-
12-Feb-18	450	7.20	59.0	0.208	2.00	1.08	-	0.241	-	-
13-Feb-18	450	-	-	-	-	-	-	-	-	-
14-Feb-18	450	-	-	-	-	-	-	-	-	-
15-Feb-18	450	7.20	58.0	0.222	2.00	1.03	-	0.236	-	-
16-Feb-18	450	-	-	-	-	-	-	-	-	-
17-Feb-18	450	-	-	-	-	-	-	-	-	-
18-Feb-18	450	-	-	-	-	-	-	-	-	-
19-Feb-18	450	-	-	-	-	-	-	-	-	-
20-Feb-18	450	7.20	58.0	0.186	2.00	0.787	-	0.394	-	-
21-Feb-18	500	-	-	-	-	-	-	-	-	-
22-Feb-18	500	7.30	61.0	0.166	<2.00	0.961	-	0.408	-	-
23-Feb-18	500	-	-	-	-	-	-	-	-	-
24-Feb-18	500	-	-	-	-	-	-	-	-	-
25-Feb-18	500	-	-	-	-	-	-	-	-	-
26-Feb-18	500	7.30	61.0	0.343	2.00	1.83	-	0.199	-	-
27-Feb-18	500	-	-	-	-	-	-	-	-	-
28-Feb-18	500	-	-	-	-	-	-	-	-	-
1-Mar-18	500	7.20	60.0	0.344	<1.00	1.81	-	0.258	-	-
2-Mar-18	500	-	-	-	-	-	-	-	-	-
3-Mar-18	500	-	-	-	-	-	-	-	-	-
4-Mar-18	500	-	-	-	-	-	-	-	-	-
5-Mar-18	500	7.20	61.0	0.459	<1.00	2.93	0.000500	0.0900	0.0409	0.00125
6-Mar-18	500	-	-	-	-	-	-	-	-	-
7-Mar-18	500	-	-	-	-	-	-	-	-	-
8-Mar-18	500	7.20	-	-	-	-	-	-	-	-
9-Mar-18	500	-	-	-	-	-	-	-	-	-
10-Mar-18	500	-	-	-	-	-	-	-	-	-
11-Mar-18	200	-	-	-	-	-	-	-	-	-
12-Mar-18	100	-	-	-	-	-	-	-	-	-
21-Mar-18	200	-	-	-	-	-	-	-	-	-
22-Mar-18	200	-	-	-	-	-	-	-	-	-
23-Mar-18	200	-	-	-	-	-	-	-	-	-
24-Mar-18	200	-	-	-	-	-	-	-	-	-
25-Mar-18	200	-	-	-	-	-	-	-	-	-
26-Mar-18	200	6.70	62.0	0.166	1.00	0.868	-	0.0850	-	-
27-Mar-18	190	-	-	-	-	-	-	-	-	-
28-Mar-18	190	-	-	-	-	-	-	-	-	-
29-Mar-18	200	7.00	-	-	-	-	-	-	-	-
30-Mar-18	200	-	-	-	-	-	-	-	-	-
31-Mar-18	200	-	-	-	-	-	-	-	-	-
1-Apr-18	200	-	-	-	-	-	-	-	-	-
2-Apr-18	190	6.50	56.0	0.0720	1.00	0.512	<0.000500	0.0870	0.0439	0.00130
3-Apr-18	200	-	-	-	-	-	-	-	-	-
4-Apr-18	200	-	-	-	-	-	-	-	-	-
5-Apr-18	200	-	-	-	-	-	-	-	-	-
6-Apr-18	200	-	-	-	-	-	-	-	-	-
7-Apr-18	200	-	-	-	-	-	-	-	-	-
8-Apr-18	200	-	-	-	-	-	-	-	-	-
9-Apr-18	200	7.40	61.0	0.0780	<1.00	0.579	-	0.0740	-	-
10-Apr-18	200	-	-	-	-	-	-	-	-	-
11-Apr-18	400	-	-	-	-	-	-	-	-	-
12-Apr-18	400	-	-	-	-	-	-	-	-	-
13-Apr-18	400	-	-	-	-	-	-	-	-	-
14-Apr-18	400	-	-	-	-	-	-	-	-	-
15-Apr-18	400	-	-	-	-	-	-	-	-	-
16-Apr-18	400	7.00	59.0	0.0420	1.00	0.609	-	0.0510	-	-
17-Apr-18	400	-	-	-	-	-	-	-	-	-
18-Apr-18	400	-	-	-	-	-	-	-	-	-
19-Apr-18	200	-	-	-	-	-	-	-	-	-
20-Apr-18	100	-	-	-	-	-	-	-	-	-

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table D.5: Water Quality at TOMP Station CL-06 (Effluent), Stanleigh TMA, 2015 to 2019

Date	Flow (L/s)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	TSS (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
21-Apr-18	400	-	-	-	-	-	-	-	-	-
22-Apr-18	400	-	-	-	-	-	-	-	-	-
23-Apr-18	400	6.90	57.0	0.238	<1.00	1.14	-	0.0420	-	-
24-Apr-18	400	-	-	-	-	-	-	-	-	-
25-Apr-18	400	-	-	-	-	-	-	-	-	-
26-Apr-18	400	-	-	-	-	-	-	-	-	-
27-Apr-18	400	-	-	-	-	-	-	-	-	-
28-Apr-18	400	-	-	-	-	-	-	-	-	-
29-Apr-18	400	-	-	-	-	-	-	-	-	-
30-Apr-18	400	6.90	38.0	0.190	1.00	1.23	-	0.0530	-	-
1-May-18	400	-	-	-	-	-	-	-	-	-
2-May-18	400	-	-	-	-	-	-	-	-	-
3-May-18	400	6.80	-	-	-	-	-	-	-	-
4-May-18	500	-	-	-	-	-	-	-	-	-
5-May-18	500	-	-	-	-	-	-	-	-	-
6-May-18	500	-	-	-	-	-	-	-	-	-
7-May-18	500	6.80	33.0	0.162	<1.00	0.873	<0.000500	0.0410	0.0289	0.000919
8-May-18	500	-	-	-	-	-	-	-	-	-
9-May-18	500	-	-	-	-	-	-	-	-	-
10-May-18	500	7.20	-	-	-	-	-	-	-	-
11-May-18	500	-	-	-	-	-	-	-	-	-
12-May-18	500	-	-	-	-	-	-	-	-	-
13-May-18	500	-	-	-	-	-	-	-	-	-
14-May-18	500	7.10	56.0	0.404	1.00	1.97	-	0.0720	-	-
15-May-18	500	-	-	-	-	-	-	-	-	-
16-May-18	500	-	-	-	-	-	-	-	-	-
17-May-18	500	6.80	-	0.434	-	-	-	-	-	-
18-May-18	500	-	-	-	-	-	-	-	-	-
19-May-18	500	-	-	-	-	-	-	-	-	-
20-May-18	250	-	-	-	-	-	-	-	-	-
21-May-18	125	-	-	-	-	-	-	-	-	-
23-May-18	400	-	-	-	-	-	-	-	-	-
24-May-18	400	-	-	-	-	-	-	-	-	-
25-May-18	380	-	-	-	-	-	-	-	-	-
26-May-18	380	6.90	54.0	0.164	1.00	0.859	-	0.0700	-	-
27-May-18	380	-	-	-	-	-	-	-	-	-
28-May-18	380	-	-	-	-	-	-	-	-	-
29-May-18	400	-	-	-	-	-	-	-	-	-
30-May-18	400	6.80	56.0	0.137	1.00	0.802	-	0.0570	-	-
31-May-18	400	-	-	-	-	-	-	-	-	-
1-Jun-18	400	-	-	-	-	-	-	-	-	-
2-Jun-18	355	-	-	-	-	-	-	-	-	-
3-Jun-18	355	-	-	-	-	-	-	-	-	-
4-Jun-18	355	6.60	53.0	0.164	2.00	0.882	<0.000500	0.0600	0.0568	0.00133
5-Jun-18	355	-	-	-	-	-	-	-	-	-
6-Jun-18	355	-	-	-	-	-	-	-	-	-
7-Jun-18	355	7.00	-	-	-	-	-	-	-	-
8-Jun-18	355	-	-	-	-	-	-	-	-	-
9-Jun-18	355	-	-	-	-	-	-	-	-	-
10-Jun-18	355	-	-	-	-	-	-	-	-	-
11-Jun-18	355	7.30	52.0	0.264	1.00	1.33	-	0.0460	-	-
12-Jun-18	355	-	-	-	-	-	-	-	-	-
13-Jun-18	355	-	-	-	-	-	-	-	-	-
14-Jun-18	355	7.20	-	-	-	-	-	-	-	-
15-Jun-18	355	-	-	-	-	-	-	-	-	-
16-Jun-18	355	-	-	-	-	-	-	-	-	-
17-Jun-18	355	-	-	-	-	-	-	-	-	-
18-Jun-18	355	7.20	52.0	0.364	1.00	1.88	-	0.0350	-	-
19-Jun-18	355	-	-	-	-	-	-	-	-	-
20-Jun-18	178	-	-	-	-	-	-	-	-	-
21-Jun-18	89.0	-	-	-	-	-	-	-	-	-
3-Oct-18	300	-	-	-	-	-	-	-	-	-
4-Oct-18	300	7.30	-	0.122	1.00	-	-	-	-	-
5-Oct-18	300	-	-	-	-	-	-	-	-	-
6-Oct-18	300	-	-	-	-	-	-	-	-	-
7-Oct-18	300	-	-	-	-	-	-	-	-	-
8-Oct-18	300	-	-	-	-	-	-	-	-	-
9-Oct-18	300	7.30	52.0	0.186	<1.00	1.13	-	0.0430	-	-
10-Oct-18	300	-	-	-	-	-	-	-	-	-
11-Oct-18	300	-	-	-	-	-	-	-	-	-
12-Oct-18	300	-	-	-	-	-	-	-	-	-
13-Oct-18	300	-	-	-	-	-	-	-	-	-
14-Oct-18	300	-	-	-	-	-	-	-	-	-
15-Oct-18	300	7.20	52.0	0.241	1.00	1.48	<0.000500	0.0410	0.0315	0.00235
16-Oct-18	500	-	-	-	-	-	-	-	-	-
17-Oct-18	500	-	-	-	-	-	-	-	-	-
18-Oct-18	500	7.20	-	-	-	-	-	-	-	-
19-Oct-18	500	-	-	-	-	-	-	-	-	-
20-Oct-18	450	-	-	-	-	-	-	-	-	-
21-Oct-18	450	-	-	-	-	-	-	-	-	-
22-Oct-18	450	7.10	53.0	0.338	<1.00	1.77	-	0.0380	-	-
23-Oct-18	450	-	-	-	-	-	-	-	-	-
24-Oct-18	450	-	-	-	-	-	-	-	-	-
25-Oct-18	450	7.00	-	-	-	-	-	-	-	-
26-Oct-18	450	-	-	-	-	-	-	-	-	-
27-Oct-18	450	-	-	-	-	-	-	-	-	-
28-Oct-18	450	-	-	-	-	-	-	-	-	-
29-Oct-18	450	-	-	-	-	-	-	-	-	-
30-Oct-18	225	-	-	-	-	-	-	-	-	-
6-Nov-18	400	7.10	-	-	1.00	-	-	-	-	-
7-Nov-18	400	-	-	-	1.00	-	-	-	-	-
8-Nov-18	400	7.00	52.0	0.286	<1.00	1.68	<0.0000870	0.0320	0.0271	0.00151
9-Nov-18	400	7.00	-	-	1.00	-	-	-	-	-
10-Nov-18	400	7.10	-	-	<1.00	-	-	-	-	-
11-Nov-18	400	7.00	-	-	1.00	-	-	-	-	-
12-Nov-18	400	7.00	52.0	0.294	2.00	1.08	<0.000500	0.0200	0.0255	0.00151
13-Nov-18	400	7.00	-	-	1.00	-	-	-	-	-
14-Nov-18	400	7.00	-	-	2.00	-	-	-	-	-
15-Nov-18	400	7.00	53.0	0.251	2.00	0.817	<0.000500	0.0490	0.0273	0.00170
16-Nov-18	400	7.00	-	-	1.00	-	-	-	-	-
17-Nov-18	400	6.80	-	-	1.00	-	-	-	-	-
18-Nov-18	400	6.80	-	-	<1.00	-	-	-	-	-

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table D.5: Water Quality at TOMP Station CL-06 (Effluent), Stanleigh TMA, 2015 to 2019

Date	Flow (L/s)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	TSS (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
19-Nov-18	400	6.80	55.0	0.271	2.00	1.08	<0.000500	0.0360	0.0276	0.00167
20-Nov-18	400	6.80	-	-	2.00	-	-	-	-	-
21-Nov-18	400	7.00	-	-	2.00	-	-	-	-	-
22-Nov-18	400	7.10	55.0	0.232	2.00	1.10	<0.000500	0.0280	0.0224	0.00143
23-Nov-18	400	7.10	-	-	2.00	-	-	-	-	-
24-Nov-18	400	7.10	-	-	1.00	-	-	-	-	-
25-Nov-18	400	7.10	-	-	1.00	-	-	-	-	-
26-Nov-18	400	6.90	54.0	0.171	1.00	1.03	<0.000500	0.0260	0.0243	0.00131
27-Nov-18	200	-	-	-	-	-	-	-	-	-
28-Nov-18	100	-	-	-	-	-	-	-	-	-
1-Dec-18	400	-	-	-	-	-	-	-	-	-
2-Dec-18	400	-	-	-	-	-	-	-	-	-
3-Dec-18	400	6.70	53.0	0.185	1.00	0.956	<0.000500	0.0270	0.0254	0.00153
4-Dec-18	400	7.10	-	-	-	-	-	-	-	-
5-Dec-18	400	7.10	-	-	-	-	-	-	-	-
6-Dec-18	400	7.00	53.0	0.208	1.00	1.27	<0.000500	0.0280	0.0244	0.00146
7-Dec-18	400	7.20	-	-	-	-	-	-	-	-
8-Dec-18	400	-	-	-	-	-	-	-	-	-
9-Dec-18	400	-	-	-	-	-	-	-	-	-
10-Dec-18	400	6.80	55.0	0.231	1.00	1.36	-	0.0270	-	-
11-Dec-18	400	6.80	-	-	-	-	-	-	-	-
12-Dec-18	400	6.80	-	-	-	-	-	-	-	-
13-Dec-18	400	6.80	-	0.241	-	-	-	-	-	-
14-Dec-18	400	-	-	-	-	-	-	-	-	-
15-Dec-18	400	-	-	-	-	-	-	-	-	-
16-Dec-18	400	-	-	-	-	-	-	-	-	-
17-Dec-18	400	-	-	-	-	-	-	-	-	-
18-Dec-18	200	-	-	-	-	-	-	-	-	-
19-Dec-18	100	-	-	-	-	-	-	-	-	-
21-Dec-18	250	-	-	-	-	-	-	-	-	-
22-Dec-18	250	-	-	-	-	-	-	-	-	-
23-Dec-18	250	-	-	-	-	-	-	-	-	-
24-Dec-18	250	-	-	-	-	-	-	-	-	-
25-Dec-18	250	-	-	-	-	-	-	-	-	-
26-Dec-18	250	-	-	-	-	-	-	-	-	-
27-Dec-18	250	6.60	-	0.168	2.00	0.158	-	-	-	-
28-Dec-18	250	6.70	-	0.121	-	-	-	-	-	-
29-Dec-18	250	-	-	-	-	-	-	-	-	-
30-Dec-18	250	-	-	-	-	-	-	-	-	-
31-Dec-18	250	-	-	-	-	-	-	-	-	-
1-Jan-19	250	-	-	-	-	-	-	-	-	-
2-Jan-19	250	6.70	-	0.170	2.00	1.09	-	-	-	-
3-Jan-19	250	6.90	-	0.144	-	-	-	-	-	-
4-Jan-19	250	-	-	-	-	-	-	-	-	-
5-Jan-19	400	-	-	-	-	-	-	-	-	-
6-Jan-19	400	-	-	-	-	-	-	-	-	-
7-Jan-19	400	6.80	55.0	0.150	1.00	0.824	<0.000500	0.0190	0.0244	0.00118
8-Jan-19	400	-	-	-	-	-	-	-	-	-
9-Jan-19	400	-	-	-	-	-	-	-	-	-
10-Jan-19	400	6.70	-	0.177	-	-	-	-	-	-
11-Jan-19	400	-	-	-	-	-	-	-	-	-
12-Jan-19	400	-	-	-	-	-	-	-	-	-
13-Jan-19	400	-	-	-	-	-	-	-	-	-
14-Jan-19	400	6.80	-	0.142	1.00	0.433	-	-	-	-
15-Jan-19	400	-	-	-	-	-	-	-	-	-
16-Jan-19	400	-	-	-	-	-	-	-	-	-
17-Jan-19	475	6.80	-	0.155	-	-	-	-	-	-
18-Jan-19	475	-	-	-	-	-	-	-	-	-
19-Jan-19	475	-	-	-	-	-	-	-	-	-
20-Jan-19	475	-	-	-	-	-	-	-	-	-
21-Jan-19	475	6.80	-	0.203	1.00	0.641	-	-	-	-
22-Jan-19	475	-	-	-	-	-	-	-	-	-
23-Jan-19	475	-	-	-	-	-	-	-	-	-
24-Jan-19	475	6.80	-	0.219	-	-	-	-	-	-
25-Jan-19	475	-	-	-	-	-	-	-	-	-
26-Jan-19	475	-	-	-	-	-	-	-	-	-
27-Jan-19	475	-	-	-	-	-	-	-	-	-
28-Jan-19	475	-	-	-	-	-	-	-	-	-
29-Jan-19	475	6.80	-	0.227	1.00	0.574	-	-	-	-
30-Jan-19	475	-	-	-	-	-	-	-	-	-
31-Jan-19	475	6.80	-	0.246	-	-	-	-	-	-
1-Feb-19	475	-	-	-	-	-	-	-	-	-
2-Feb-19	475	-	-	-	-	-	-	-	-	-
3-Feb-19	475	-	-	-	-	-	-	-	-	-
4-Feb-19	475	6.70	57.0	0.233	2.00	0.697	<0.000500	<0.0200	0.0250	0.00110
5-Feb-19	475	-	-	-	-	-	-	-	-	-
6-Feb-19	475	-	-	-	-	-	-	-	-	-
7-Feb-19	400	6.80	-	0.178	-	-	-	-	-	-
8-Feb-19	400	-	-	-	-	-	-	-	-	-
9-Feb-19	400	-	-	-	-	-	-	-	-	-
10-Feb-19	400	-	-	-	-	-	-	-	-	-
11-Feb-19	400	6.70	-	0.190	1.00	0.780	-	-	-	-
12-Feb-19	400	-	-	-	-	-	-	-	-	-
13-Feb-19	400	-	-	-	-	-	-	-	-	-
14-Feb-19	400	6.70	-	0.224	-	-	-	-	-	-
15-Feb-19	400	-	-	-	-	-	-	-	-	-
16-Feb-19	400	-	-	-	-	-	-	-	-	-
17-Feb-19	400	-	-	-	-	-	-	-	-	-
18-Feb-19	400	-	-	-	-	-	-	-	-	-
19-Feb-19	400	6.80	-	0.146	2.00	0.355	-	-	-	-
20-Feb-19	400	-	-	-	-	-	-	-	-	-
21-Feb-19	400	6.60	-	0.219	-	-	-	-	-	-
22-Feb-19	400	-	-	-	-	-	-	-	-	-
23-Feb-19	400	-	-	-	-	-	-	-	-	-
24-Feb-19	400	-	-	-	-	-	-	-	-	-
25-Feb-19	400	6.70	-	0.178	1.00	0.637	-	-	-	-
26-Feb-19	400	-	-	-	-	-	-	-	-	-
27-Feb-19	400	-	-	-	-	-	-	-	-	-
28-Feb-19	475	6.60	-	0.246	-	-	-	-	-	-
1-Mar-19	475	-	-	-	-	-	-	-	-	-
2-Mar-19	475	-	-	-	-	-	-	-	-	-
3-Mar-19	475	-	-	-	-	-	-	-	-	-

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table D.5: Water Quality at TOMP Station CL-06 (Effluent), Stanleigh TMA, 2015 to 2019

Date	Flow (L/s)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	TSS (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
4-Mar-19	475	6.60	57.0	0.179	1.00	0.643	<0.000500	<0.0200	0.0230	0.00110
5-Mar-19	475	-	-	-	-	-	-	-	-	-
6-Mar-19	475	-	-	-	-	-	-	-	-	-
7-Mar-19	475	6.70	-	0.232	-	-	-	-	-	-
8-Mar-19	475	-	-	-	-	-	-	-	-	-
9-Mar-19	475	-	-	-	-	-	-	-	-	-
10-Mar-19	475	-	-	-	-	-	-	-	-	-
11-Mar-19	475	6.80	58.0	0.211	2.00	0.850	-	-	-	-
12-Mar-19	475	-	-	-	-	-	-	-	-	-
13-Mar-19	475	-	-	-	-	-	-	-	-	-
14-Mar-19	475	6.90	-	0.204	-	-	-	-	-	-
15-Mar-19	475	-	-	-	-	-	-	-	-	-
16-Mar-19	475	-	-	-	-	-	-	-	-	-
17-Mar-19	475	-	-	-	-	-	-	-	-	-
18-Mar-19	475	6.80	-	0.142	1.00	0.623	-	-	-	-
19-Mar-19	475	-	-	-	-	-	-	-	-	-
20-Mar-19	475	-	-	-	-	-	-	-	-	-
21-Mar-19	475	6.70	-	0.156	-	-	-	-	-	-
22-Mar-19	475	-	-	-	-	-	-	-	-	-
23-Mar-19	475	-	-	-	-	-	-	-	-	-
24-Mar-19	475	-	-	-	-	-	-	-	-	-
25-Mar-19	475	7.00	-	0.138	1.00	0.476	-	-	-	-
26-Mar-19	475	-	-	-	-	-	-	-	-	-
27-Mar-19	475	-	-	-	-	-	-	-	-	-
28-Mar-19	475	6.90	-	0.148	-	-	-	-	-	-
29-Mar-19	475	-	-	-	-	-	-	-	-	-
30-Mar-19	475	-	-	-	-	-	-	-	-	-
31-Mar-19	475	-	-	-	-	-	-	-	-	-
1-Apr-19	475	6.80	-	0.149	<1.00	0.422	-	-	-	-
2-Apr-19	475	-	-	-	-	-	-	-	-	-
3-Apr-19	475	-	-	-	-	-	-	-	-	-
4-Apr-19	475	6.80	-	0.143	-	-	-	-	-	-
5-Apr-19	475	-	-	-	-	-	-	-	-	-
6-Apr-19	475	-	-	-	-	-	-	-	-	-
7-Apr-19	475	-	-	-	-	-	-	-	-	-
8-Apr-19	475	6.80	-	0.201	1.00	0.572	-	-	-	-
9-Apr-19	475	-	-	-	-	-	-	-	-	-
10-Apr-19	475	-	-	-	-	-	-	-	-	-
11-Apr-19	475	6.80	-	0.160	-	-	-	-	-	-
12-Apr-19	475	-	-	-	-	-	-	-	-	-
13-Apr-19	475	-	-	-	-	-	-	-	-	-
14-Apr-19	475	-	-	-	-	-	-	-	-	-
15-Apr-19	475	6.70	-	0.181	1.00	0.324	-	-	-	-
16-Apr-19	475	-	-	-	-	-	-	-	-	-
17-Apr-19	475	6.70	-	0.187	-	-	-	-	-	-
18-Apr-19	475	-	-	-	-	-	-	-	-	-
19-Apr-19	475	-	-	-	-	-	-	-	-	-
20-Apr-19	475	-	-	-	-	-	-	-	-	-
21-Apr-19	475	-	-	-	-	-	-	-	-	-
22-Apr-19	475	6.60	28.0	0.121	<1.00	0.225	<0.000500	0.0380	0.0230	0.00100
23-Apr-19	475	-	-	-	-	-	-	-	-	-
24-Apr-19	475	-	-	-	-	-	-	-	-	-
25-Apr-19	475	6.50	-	0.0750	-	-	-	-	-	-
26-Apr-19	475	-	-	-	-	-	-	-	-	-
27-Apr-19	475	-	-	-	-	-	-	-	-	-
28-Apr-19	475	-	-	-	-	-	-	-	-	-
29-Apr-19	475	6.60	-	0.140	1.00	0.392	-	-	-	-
30-Apr-19	475	-	-	-	-	-	-	-	-	-
1-May-19	475	-	-	-	-	-	-	-	-	-
2-May-19	475	6.80	-	0.186	-	-	-	-	-	-
3-May-19	475	-	-	-	-	-	-	-	-	-
4-May-19	475	-	-	-	-	-	-	-	-	-
5-May-19	475	-	-	-	-	-	-	-	-	-
6-May-19	475	7.00	35.0	0.188	2.00	0.903	0.000364	0.120	0.0502	0.00157
7-May-19	475	-	-	-	-	-	-	-	-	-
8-May-19	475	-	-	-	-	-	-	-	-	-
9-May-19	475	7.10	-	-	-	-	-	-	-	-
10-May-19	475	-	-	-	-	-	-	-	-	-
11-May-19	475	-	-	-	-	-	-	-	-	-
12-May-19	475	-	-	-	-	-	-	-	-	-
13-May-19	475	7.10	-	0.212	1.00	0.569	-	-	-	-
14-May-19	475	-	-	-	-	-	-	-	-	-
15-May-19	475	-	-	-	-	-	-	-	-	-
16-May-19	475	-	-	-	-	-	-	-	-	-
17-May-19	475	-	-	-	-	-	-	-	-	-
18-May-19	475	-	-	-	-	-	-	-	-	-
19-May-19	475	-	-	-	-	-	-	-	-	-
20-May-19	475	-	-	-	-	-	-	-	-	-
21-May-19	475	7.00	-	0.261	1.00	0.657	-	-	-	-
22-May-19	475	-	-	-	-	-	-	-	-	-
23-May-19	475	-	-	-	-	-	-	-	-	-
24-May-19	475	-	-	-	-	-	-	-	-	-
25-May-19	475	-	-	-	-	-	-	-	-	-
26-May-19	475	-	-	-	-	-	-	-	-	-
27-May-19	475	6.90	-	0.315	2.00	0.901	-	-	-	-
28-May-19	475	-	-	-	-	-	-	-	-	-
29-May-19	400	-	-	-	-	-	-	-	-	-
30-May-19	400	-	-	-	-	-	-	-	-	-
31-May-19	400	-	-	-	-	-	-	-	-	-
1-Jun-19	400	-	-	-	-	-	-	-	-	-
2-Jun-19	400	-	-	-	-	-	-	-	-	-
3-Jun-19	200	-	-	-	-	-	-	-	-	-
4-Jun-19	100	-	-	-	-	-	-	-	-	-
8-Jun-19	200	-	-	-	-	-	-	-	-	-
9-Jun-19	200	-	-	-	-	-	-	-	-	-
10-Jun-19	200	6.90	42.0	0.176	1.00	0.507	<0.000500	0.0350	0.0440	0.00140
11-Jun-19	200	-	-	-	-	-	-	-	-	-
12-Jun-19	200	-	-	-	-	-	-	-	-	-
13-Jun-19	200	-	-	-	-	-	-	-	-	-
14-Jun-19	200	-	-	-	-	-	-	-	-	-
15-Jun-19	200	-	-	-	-	-	-	-	-	-
16-Jun-19	200	-	-	-	-	-	-	-	-	-

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table D.5: Water Quality at TOMP Station CL-06 (Effluent), Stanleigh TMA, 2015 to 2019

Date	Flow (L/s)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	TSS (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
17-Jun-19	200	7.00	-	0.138	5.00	0.627	-	-	-	-
18-Jun-19	200	-	-	-	-	-	-	-	-	-
19-Jun-19	200	-	-	-	-	-	-	-	-	-
20-Jun-19	200	-	-	-	-	-	-	-	-	-
21-Jun-19	200	-	-	-	-	-	-	-	-	-
22-Jun-19	400	-	-	-	-	-	-	-	-	-
23-Jun-19	400	-	-	-	-	-	-	-	-	-
24-Jun-19	400	6.90	-	0.160	2.00	0.722	-	-	-	-
25-Jun-19	400	-	-	-	-	-	-	-	-	-
26-Jun-19	400	-	-	-	-	-	-	-	-	-
27-Jun-19	400	-	-	-	-	-	-	-	-	-
28-Jun-19	400	-	-	-	-	-	-	-	-	-
29-Jun-19	400	-	-	-	-	-	-	-	-	-
30-Jun-19	400	-	-	-	-	-	-	-	-	-
1-Jul-19	400	-	-	-	-	-	-	-	-	-
2-Jul-19	400	7.10	47.0	0.192	1.00	0.690	<0.000500	<0.0200	0.0320	0.00130
3-Jul-19	400	-	-	-	-	-	-	-	-	-
4-Jul-19	400	-	-	-	-	-	-	-	-	-
5-Jul-19	400	-	-	-	-	-	-	-	-	-
6-Jul-19	400	-	-	-	-	-	-	-	-	-
7-Jul-19	400	-	-	-	-	-	-	-	-	-
8-Jul-19	400	6.80	-	0.237	1.00	0.952	-	-	-	-
9-Jul-19	400	-	-	-	-	-	-	-	-	-
10-Jul-19	400	-	-	-	-	-	-	-	-	-
11-Jul-19	400	-	-	-	-	-	-	-	-	-
12-Jul-19	400	-	-	-	-	-	-	-	-	-
13-Jul-19	200	-	-	-	-	-	-	-	-	-
14-Jul-19	100	-	-	-	-	-	-	-	-	-
2-Oct-19	390	-	-	-	-	-	-	-	-	-
3-Oct-19	390	7.00	-	0.0860	1.00	0.504	-	-	-	-
4-Oct-19	380	-	-	-	-	-	-	-	-	-
5-Oct-19	390	-	-	-	-	-	-	-	-	-
6-Oct-19	390	-	-	-	-	-	-	-	-	-
7-Oct-19	380	7.00	44.0	0.116	1.00	0.688	<0.000500	0.0360	0.0740	0.00250
8-Oct-19	360	-	-	-	-	-	-	-	-	-
9-Oct-19	390	-	-	-	-	-	-	-	-	-
10-Oct-19	390	-	-	-	-	-	-	-	-	-
11-Oct-19	390	-	-	-	-	-	-	-	-	-
12-Oct-19	390	-	-	-	-	-	-	-	-	-
13-Oct-19	390	-	-	-	-	-	-	-	-	-
14-Oct-19	390	-	-	-	-	-	-	-	-	-
15-Oct-19	400	7.00	-	0.164	-	0.581	-	-	-	-
16-Oct-19	400	-	-	-	-	-	-	-	-	-
17-Oct-19	400	-	-	-	-	-	-	-	-	-
18-Oct-19	400	-	-	-	-	-	-	-	-	-
19-Oct-19	400	-	-	-	-	-	-	-	-	-
20-Oct-19	400	-	-	-	-	-	-	-	-	-
21-Oct-19	400	6.70	-	0.188	1.00	0.706	-	-	-	-
22-Oct-19	400	-	-	-	-	-	-	-	-	-
23-Oct-19	400	-	-	-	-	-	-	-	-	-
24-Oct-19	400	-	-	-	-	-	-	-	-	-
25-Oct-19	400	-	-	-	-	-	-	-	-	-
26-Oct-19	400	-	-	-	-	-	-	-	-	-
27-Oct-19	400	-	-	-	-	-	-	-	-	-
28-Oct-19	400	6.70	-	0.187	1.00	0.733	-	-	-	-
29-Oct-19	400	-	-	-	-	-	-	-	-	-
30-Oct-19	400	-	-	-	-	-	-	-	-	-
31-Oct-19	400	-	-	-	-	-	-	-	-	-
1-Nov-19	400	-	-	-	-	-	-	-	-	-
2-Nov-19	400	-	-	-	-	-	-	-	-	-
3-Nov-19	400	-	-	-	-	-	-	-	-	-
4-Nov-19	400	6.80	47.0	0.200	1.00	0.614	<0.000500	0.0270	0.0230	0.00160
5-Nov-19	400	-	-	-	-	-	-	-	-	-
6-Nov-19	400	-	-	-	-	-	-	-	-	-
7-Nov-19	400	-	-	-	-	-	-	-	-	-
8-Nov-19	400	-	-	-	-	-	-	-	-	-
9-Nov-19	400	-	-	-	-	-	-	-	-	-
10-Nov-19	400	-	-	-	-	-	-	-	-	-
11-Nov-19	400	7.00	-	0.239	1.00	0.921	-	-	-	-
12-Nov-19	400	-	-	-	-	-	-	-	-	-
13-Nov-19	400	-	-	-	-	-	-	-	-	-
14-Nov-19	400	-	-	-	-	-	-	-	-	-
15-Nov-19	400	-	-	-	-	-	-	-	-	-
16-Nov-19	400	-	-	-	-	-	-	-	-	-
17-Nov-19	400	-	-	-	-	-	-	-	-	-
18-Nov-19	400	6.90	-	0.214	1.00	0.620	-	-	-	-
19-Nov-19	400	-	-	-	-	-	-	-	-	-
20-Nov-19	400	-	-	-	-	-	-	-	-	-
21-Nov-19	400	-	-	-	-	-	-	-	-	-
22-Nov-19	400	-	-	-	-	-	-	-	-	-
23-Nov-19	400	-	-	-	-	-	-	-	-	-
24-Nov-19	400	-	-	-	-	-	-	-	-	-
25-Nov-19	400	6.60	-	0.148	<1.00	0.159	-	-	-	-
26-Nov-19	400	-	-	-	-	-	-	-	-	-
27-Nov-19	400	-	-	-	-	-	-	-	-	-
28-Nov-19	400	-	-	-	-	-	-	-	-	-
29-Nov-19	400	-	-	-	-	-	-	-	-	-
30-Nov-19	400	-	-	-	-	-	-	-	-	-
1-Dec-19	400	-	-	-	-	-	-	-	-	-
2-Dec-19	400	6.60	43.0	0.217	1.00	0.713	<0.000500	0.0340	0.0250	0.00140
3-Dec-19	400	-	-	-	-	-	-	-	-	-
4-Dec-19	400	-	-	-	-	-	-	-	-	-
5-Dec-19	400	-	-	-	-	-	-	-	-	-
6-Dec-19	400	-	-	-	-	-	-	-	-	-
7-Dec-19	400	-	-	-	-	-	-	-	-	-
8-Dec-19	400	-	-	-	-	-	-	-	-	-
9-Dec-19	400	6.70	-	0.134	1.00	0.465	-	-	-	-
10-Dec-19	400	-	-	-	-	-	-	-	-	-
11-Dec-19	400	-	-	-	-	-	-	-	-	-
12-Dec-19	400	-	-	-	-	-	-	-	-	-
13-Dec-19	400	-	-	-	-	-	-	-	-	-
14-Dec-19	400	-	-	-	-	-	-	-	-	-

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table D.5: Water Quality at TOMP Station CL-06 (Effluent), Stanleigh TMA, 2015 to 2019

Date	Flow (L/s)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	TSS (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
15-Dec-19	400	-	-	-	-	-	-	-	-	-
16-Dec-19	400	6.70	-	0.202	1.00	0.417	-	-	-	-
17-Dec-19	400	-	-	-	-	-	-	-	-	-
18-Dec-19	400	-	-	-	-	-	-	-	-	-
19-Dec-19	400	-	-	-	-	-	-	-	-	-
20-Dec-19	400	-	-	-	-	-	-	-	-	-
21-Dec-19	400	-	-	-	-	-	-	-	-	-
22-Dec-19	400	-	-	-	-	-	-	-	-	-
23-Dec-19	400	6.70	-	0.143	1.00	0.154	-	-	-	-
24-Dec-19	400	-	-	-	-	-	-	-	-	-
25-Dec-19	400	-	-	-	-	-	-	-	-	-
26-Dec-19	400	-	-	-	-	-	-	-	-	-
27-Dec-19	400	-	-	-	-	-	-	-	-	-
28-Dec-19	400	-	-	-	-	-	-	-	-	-
29-Dec-19	400	-	-	-	-	-	-	-	-	-
30-Dec-19	400	6.70	-	0.171	1.00	0.378	-	-	-	-
31-Dec-19	400	-	-	-	-	-	-	-	-	-
n	928	277	104	240	234	211	58	173	58	58
Minimum	4.00	6.50	28.0	0.0290	<1.00	0.154	<0.0000870	0.0190	0.00782	0.000919
Maximum	540	8.25	80.0	0.459	5.00	3.72	0.000500	0.803	0.0740	0.00600
Mean	361	7.14	60.3	0.217	1.35	1.47	0.000230	0.126	0.0379	0.00164
SD	99.8	0.300	9.98	0.0977	0.717	0.946	0.0000250	0.179	0.0146	0.000694
Median	400	7.20	59.5	0.190	1.00	1.03	0.000364	0.0460	0.0390	0.00150
10th Percentile	234	6.70	52.0	0.106	<1.00	0.579	<0.0000870	0.0270	0.0224	0.00110
95th Percentile	500	7.60	76.0	0.409	3.00	3.24	0.000364	0.539	0.0662	0.00250

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table D.6: Water Quality at TOMP Stations SGW3 and 5 (Groundwater), Stanleigh TMA, 2015 to 2019

Station	Date	pH	Sulphate (mg/L)	Acidity (mg/L)	Iron (mg/L)
SGW3	20-Jul-15	5.91	1,700	738	451
	17-Jun-16	5.31	1,800	687	424
	27-Jul-17	5.44	1,600	605	439
	1-Aug-18	5.58	1,500	586	394
	12-Aug-19	5.53	1,400	556	375
	n	5	5	5	5
	Minimum	5.31	1,400	556	375
	Maximum	5.91	1,800	738	451
	Mean	5.55	1,600	634	417
	SD	0.224	158	75.6	31.5
	Median	5.53	1,600	605	424
	10th Percentile	5.31	1,400	556	375
	95th Percentile	5.91	1,800	738	451
SGW5	20-Jul-15	6.90	60.0	<1.00	0.0500
	16-Jun-16	6.27	53.0	<1.00	0.322
	27-Jul-17	6.73	46.0	<1.00	0.660
	1-Aug-18	6.87	45.0	<1.00	0.0640
	12-Aug-19	6.73	38.0	<1.00	0.0840
	n	5	5	5	5
	Minimum	6.27	38.0	<1.00	0.0500
	Maximum	6.90	60.0	<1.00	0.660
	Mean	6.70	48.4	<1.00	0.236
	SD	0.253	8.38	-	0.262
	Median	6.73	46.0	<1.00	0.0840
	10th Percentile	6.27	38.0	<1.00	0.0500
	95th Percentile	6.90	60.0	<1.00	0.660

Note: "SD" = standard deviation. "n" = number of samples. "-" = SD was incalculable because there was no variability in the data.

Table D.7: Water Level at TOMP Station CL-04, Stanleigh TMA, 2015 to 2019

Date	Elevation (m)
5-Jan-15	364.71
13-Jan-15	364.67
20-Jan-15	364.66
27-Jan-15	364.59
3-Feb-15	364.57
10-Feb-15	364.51
17-Feb-15	364.49
24-Feb-15	364.44
3-Mar-15	364.40
9-Mar-15	364.39
16-Mar-15	364.34
23-Mar-15	364.28
31-Mar-15	364.22
6-Apr-15	364.20
14-Apr-15	364.22
21-Apr-15	364.37
28-Apr-15	364.40
4-May-15	364.39
11-May-15	364.34
18-May-15	364.36
25-May-15	364.33
1-Jun-15	364.36
16-Dec-15	364.93
21-Dec-15	364.99
28-Dec-15	365.03
4-Jan-16	365.02
12-Jan-16	365.03
18-Jan-16	365.02
25-Jan-16	364.99
1-Feb-16	364.99
8-Feb-16	365.00
16-Feb-16	364.99
22-Feb-16	364.96
29-Feb-16	364.93
1-Mar-16	364.92
7-Mar-16	364.88
14-Mar-16	364.87
21-Mar-16	364.96
28-Mar-16	364.97
4-Apr-16	364.99
11-Apr-16	365.00
18-Apr-16	364.99
25-Apr-16	365.01
2-May-16	365.00
9-May-16	364.97
16-May-16	364.93
24-May-16	364.86
30-May-16	364.86
6-Jun-16	364.83
13-Jun-16	364.77
20-Jun-16	364.71
5-Jul-16	364.65

Date	Elevation (m)
11-Jul-16	364.62
18-Jul-16	364.58
25-Jul-16	364.57
2-Aug-16	364.50
8-Aug-16	364.44
15-Aug-16	364.39
22-Aug-16	364.36
29-Aug-16	364.33
6-Sep-16	364.27
12-Sep-16	364.24
19-Sep-16	364.19
26-Sep-16	364.16
3-Oct-16	364.17
11-Oct-16	364.13
17-Oct-16	364.14
24-Oct-16	364.11
31-Oct-16	364.07
7-Nov-16	364.03
14-Nov-16	363.99
21-Nov-16	363.95
28-Nov-16	363.95
5-Dec-16	363.97
12-Dec-16	363.95
19-Dec-16	363.93
21-Feb-17	364.16
27-Feb-17	364.19
6-Mar-17	364.19
13-Mar-17	364.23
20-Mar-17	364.21
27-Mar-17	364.20
3-Apr-17	364.27
10-Apr-17	364.45
17-Apr-17	364.51
24-Apr-17	364.54
4-May-17	364.59
8-May-17	364.58
15-May-17	364.55
5-Jun-17	364.63
12-Jun-17	364.60
19-Jun-17	364.57
6-Jul-17	364.59
10-Jul-17	364.58
17-Jul-17	364.56
24-Jul-17	364.55
31-Jul-17	364.52
8-Aug-17	364.49
14-Aug-17	364.50
21-Aug-17	364.56
28-Aug-17	364.55
5-Sep-17	364.50
11-Sep-17	364.47
18-Sep-17	364.43

Note: "SD" = standard deviation. "n" = number of samples.

Table D.7: Water Level at TOMP Station CL-04, Stanleigh TMA, 2015 to 2019

Date	Elevation (m)
25-Sep-17	364.41
2-Oct-17	364.37
10-Oct-17	364.41
16-Oct-17	364.41
25-Oct-17	364.59
30-Oct-17	364.61
6-Nov-17	364.59
13-Nov-17	364.53
20-Nov-17	364.60
27-Nov-17	364.57
4-Dec-17	364.56
11-Dec-17	364.67
18-Dec-17	364.66
27-Dec-17	364.64
2-Jan-18	364.60
8-Jan-18	364.58
15-Jan-18	364.57
22-Jan-18	364.53
29-Jan-18	364.52
5-Feb-18	364.49
12-Feb-18	364.45
20-Feb-18	364.39
26-Feb-18	364.36
5-Mar-18	364.31
26-Mar-18	364.26
2-Apr-18	364.26
9-Apr-18	364.27
16-Apr-18	364.26
23-Apr-18	364.24
30-Apr-18	364.35
7-May-18	364.55
14-May-18	364.53
22-May-18	364.49
28-May-18	364.36
4-Jun-18	364.43
11-Jun-18	364.35
18-Jun-18	364.38
4-Oct-18	364.34
9-Oct-18	364.33
15-Oct-18	364.42
22-Oct-18	364.42
5-Nov-18	364.39
12-Nov-18	364.42
15-Nov-18	364.41
19-Nov-18	364.39
22-Nov-18	364.36
26-Nov-18	364.37
3-Dec-18	364.37
6-Dec-18	364.36
10-Dec-18	364.32

Date	Elevation (m)
24-Dec-18	364.28
31-Dec-18	364.29
7-Jan-19	364.26
14-Jan-19	364.25
21-Jan-19	364.20
28-Jan-19	364.16
4-Feb-19	364.11
11-Feb-19	364.07
19-Feb-19	364.08
25-Feb-19	364.04
4-Mar-19	364.00
11-Mar-19	363.95
18-Mar-19	363.93
25-Mar-19	363.90
1-Apr-19	363.85
8-Apr-19	363.85
15-Apr-19	363.98
22-Apr-19	364.15
29-Apr-19	364.37
6-May-19	364.38
13-May-19	364.43
21-May-19	364.44
27-May-19	364.45
10-Jun-19	364.43
17-Jun-19	364.46
24-Jun-19	364.42
2-Jul-19	364.42
8-Jul-19	364.35
3-Oct-19	364.43
7-Oct-19	364.42
15-Oct-19	364.42
21-Oct-19	364.46
28-Oct-19	364.55
4-Nov-19	364.56
11-Nov-19	364.54
18-Nov-19	364.50
25-Nov-19	364.54
2-Dec-19	364.58
9-Dec-19	364.55
16-Dec-19	364.55
23-Dec-19	364.50
30-Dec-19	364.50
n	196
Minimum	363.85
Maximum	365.03
Mean	364.46
SD	0.27363
Median	364.43
10th Percentile	364.11
95th Percentile	364.99

Note: "SD" = standard deviation. "n" = number of samples.

APPENDIX E
DENISON TMA, TOMP DATA

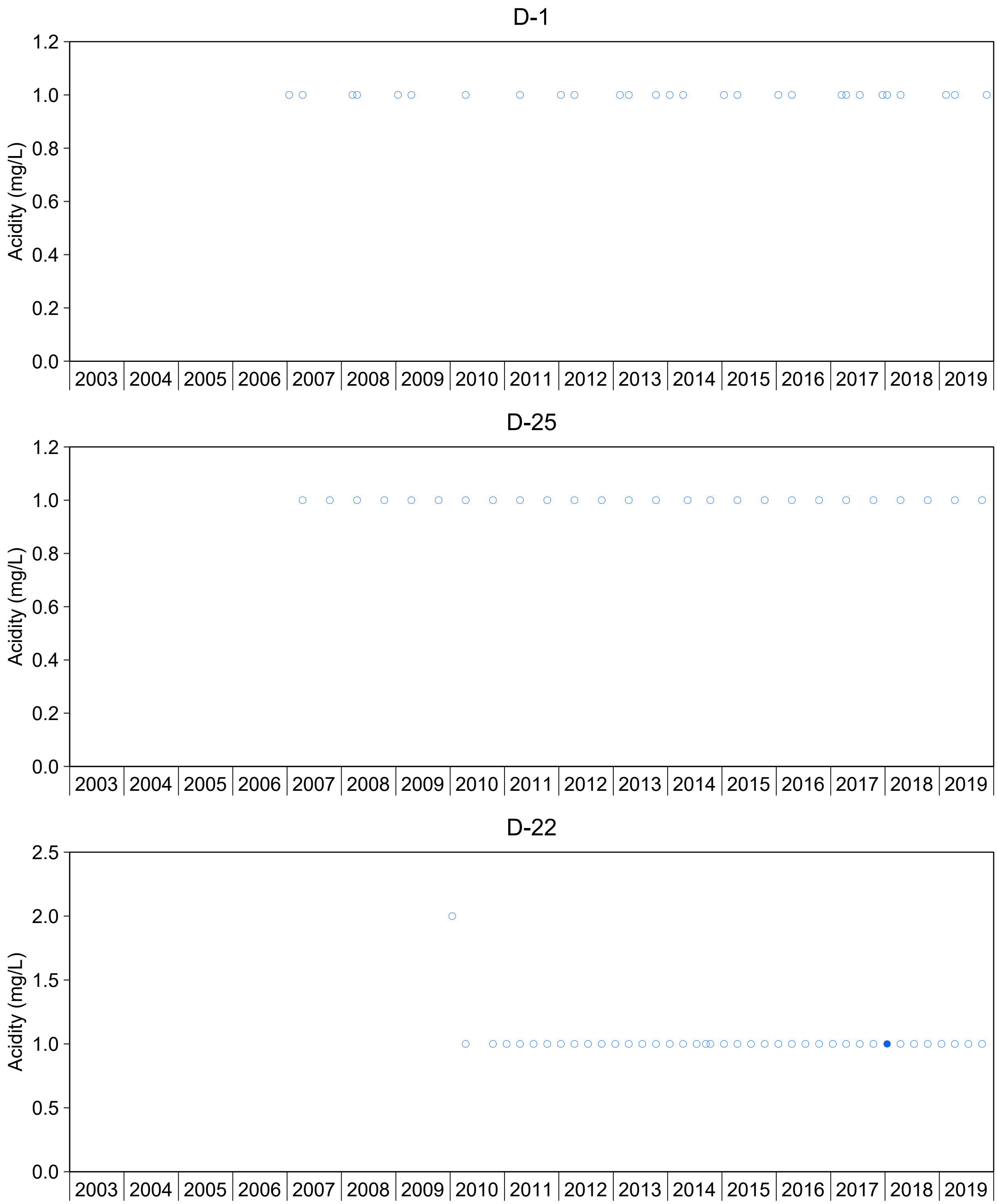


Figure E.1: Concentrations of Acidity for TOMP Water Monitoring Stations, Denison TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL.
See Table 4.6 for Seasonal Kendall trend analysis results and Appendix Tables E.3 to E.5 for raw data.
Acidity (mg/L) is not included in the trend analysis for TOMP stations D-1, D-25, and D-22 due to >50% non-detectable concentrations in the dataset.

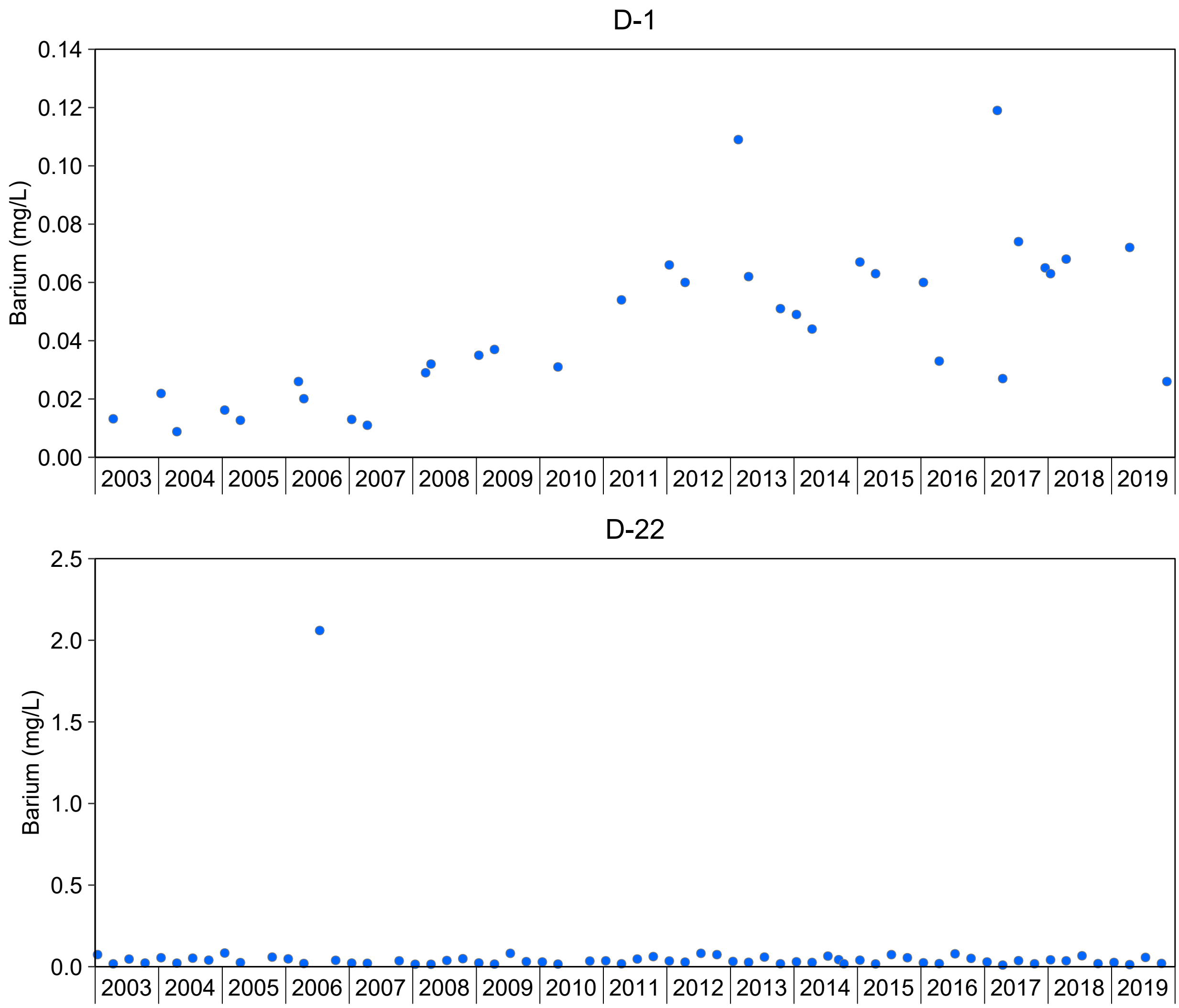


Figure E.2: Concentrations of Barium for TOMP Water Monitoring Stations, Denison TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 4.6 for Seasonal Kendall trend analysis results and Appendix Tables E.3 and E.5 for raw data.

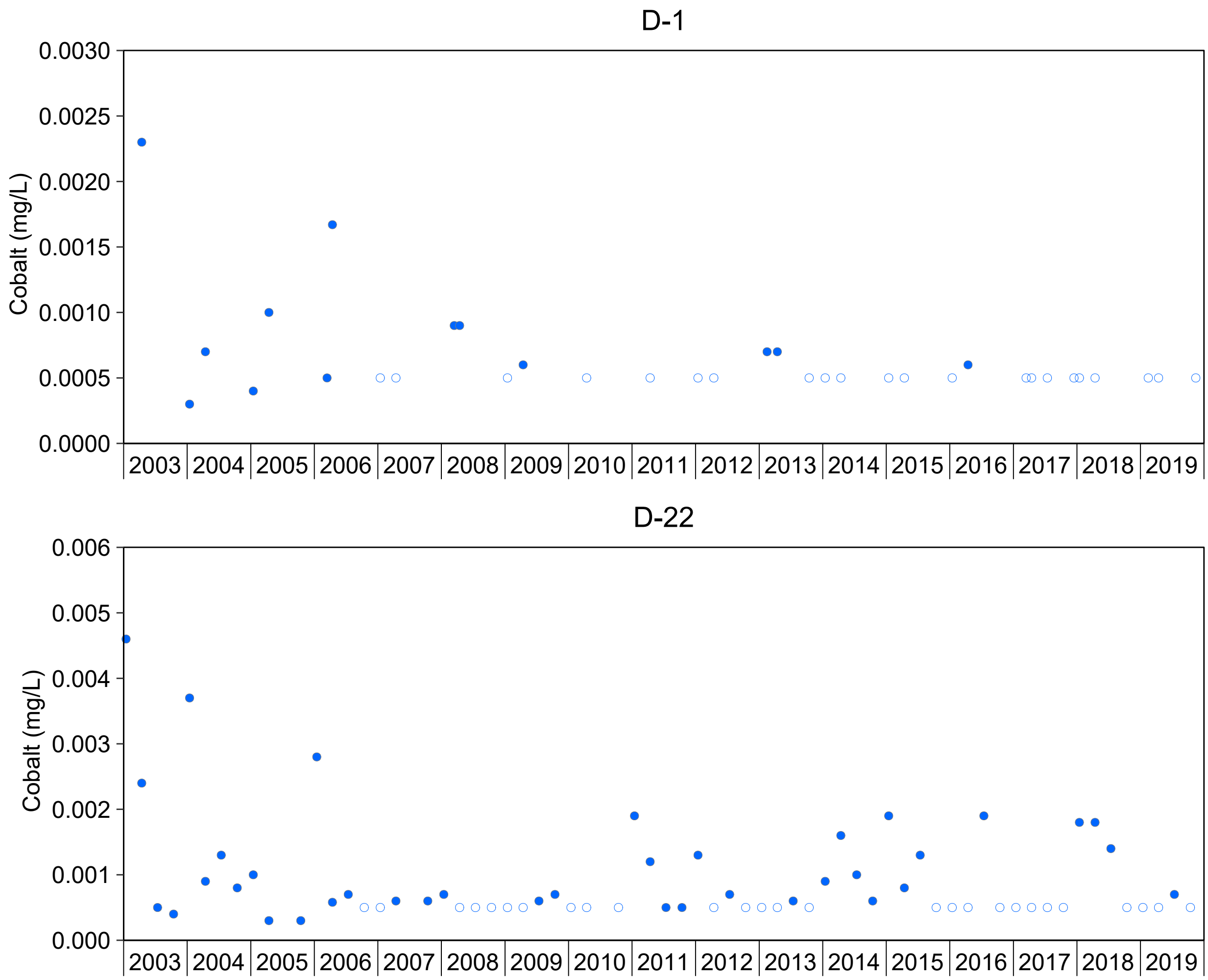


Figure E.3: Concentrations of Cobalt for TOMP Water Monitoring Stations, Denison TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL.
See Table 4.6 for Seasonal Kendall trend analysis results and Appendix Tables E.3 and E.5 for raw data.
Cobalt (mg/L) is not included in the trend analysis for TOMP station D-1 due to >50% non-detectable concentrations in the dataset.

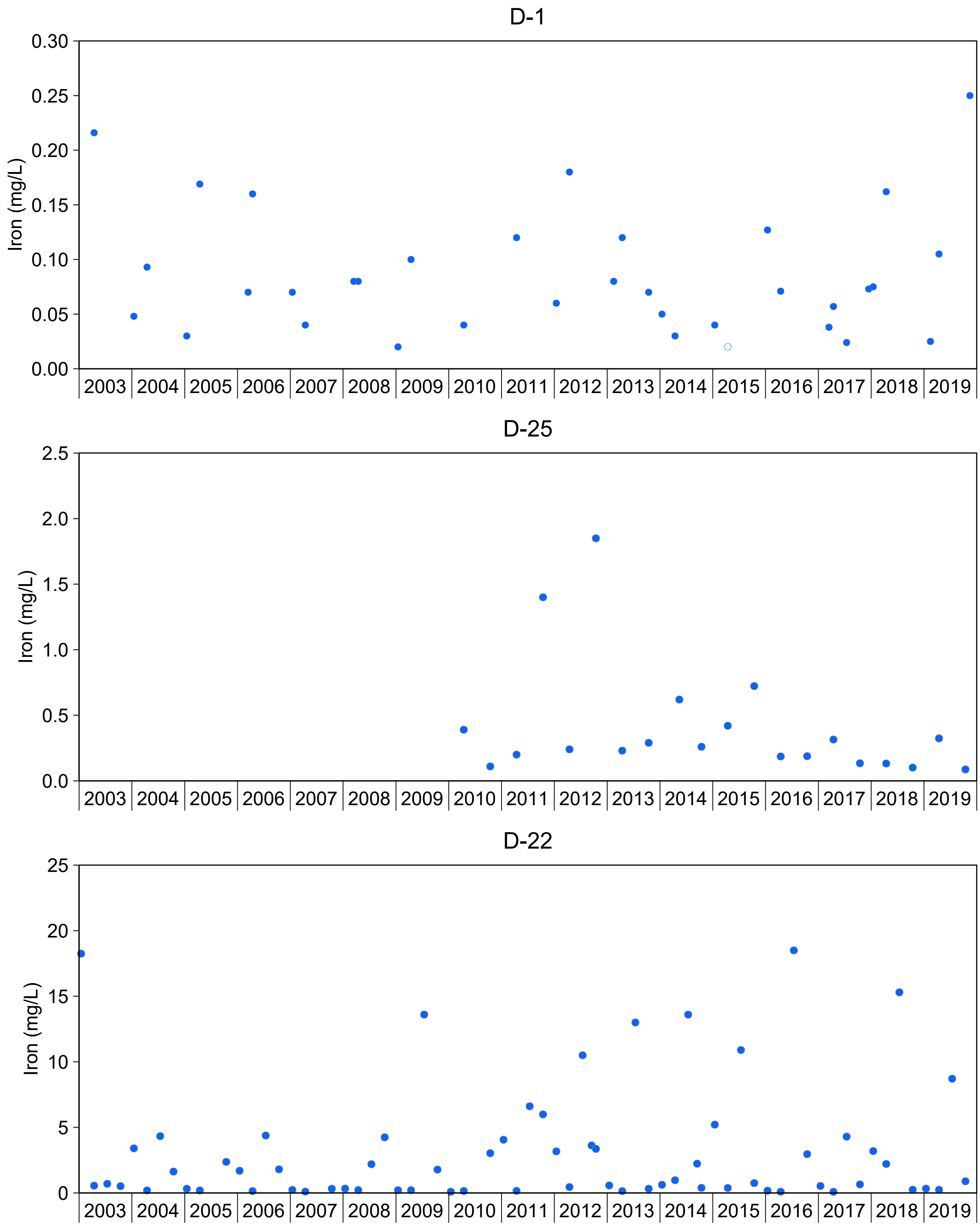


Figure E.4: Concentrations of Iron from TOMP Water Monitoring Stations, Denison TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 4.6 for Seasonal Kendall trend analysis results and Appendix Tables E.3 to E.5 for raw data.

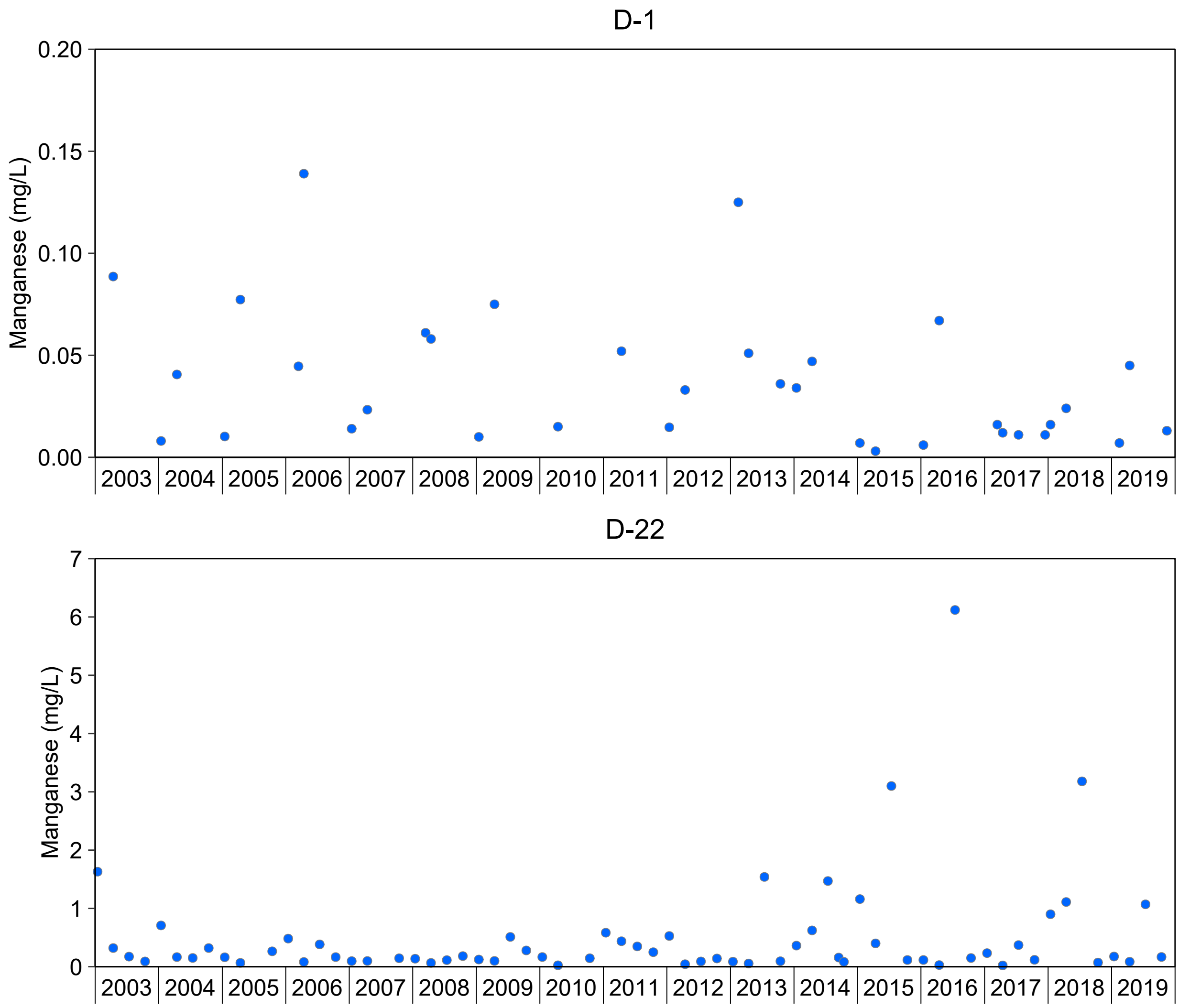


Figure E.5: Concentrations of Manganese for TOMP Water Monitoring Stations, Denison TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 4.6 for Seasonal Kendall trend analysis results and Appendix Tables E.3 and E.5 for raw data.

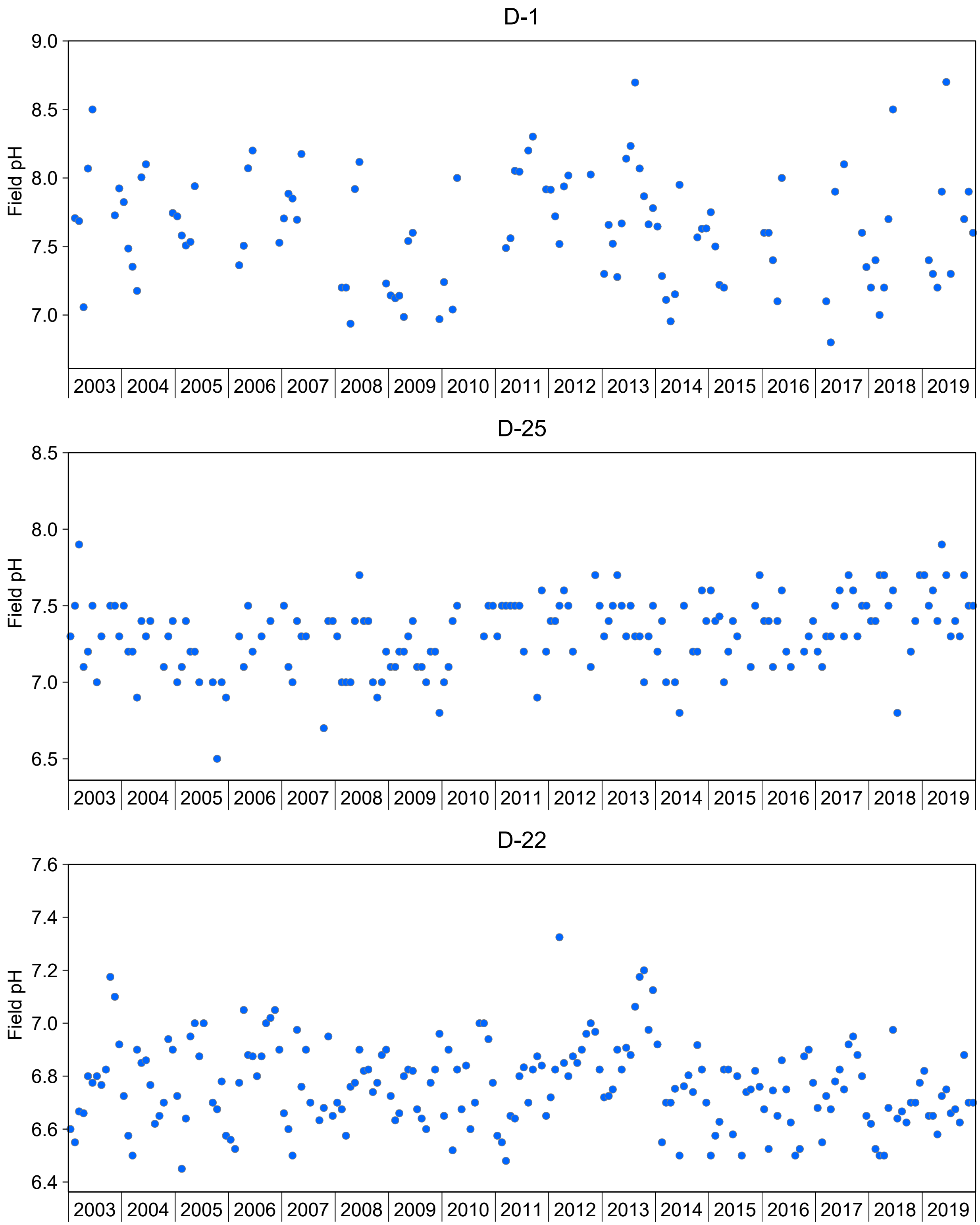


Figure E.6: Field Measurements of pH for TOMP Water Monitoring Stations, Denison TMA, 2003 to 2019

Notes: See Table 4.6 for Seasonal Kendall trend analysis results and Appendix Tables E.3 to E.5 for raw data.

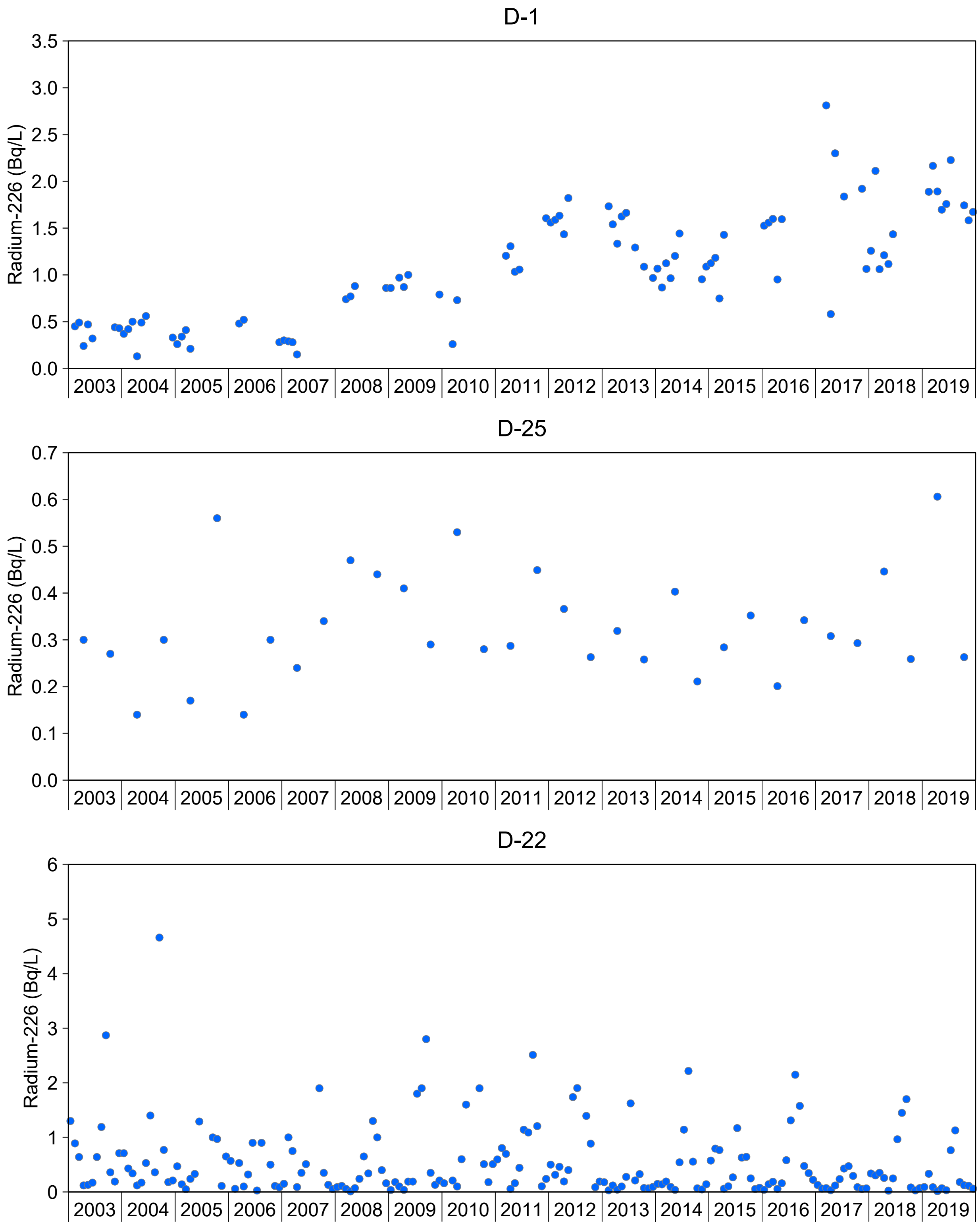


Figure E.7: Concentrations of Radium-226 for TOMP Water Monitoring Stations, Denison TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 4.6 for Seasonal Kendall trend analysis results and Appendix Tables E.3 to E.5 for raw data.

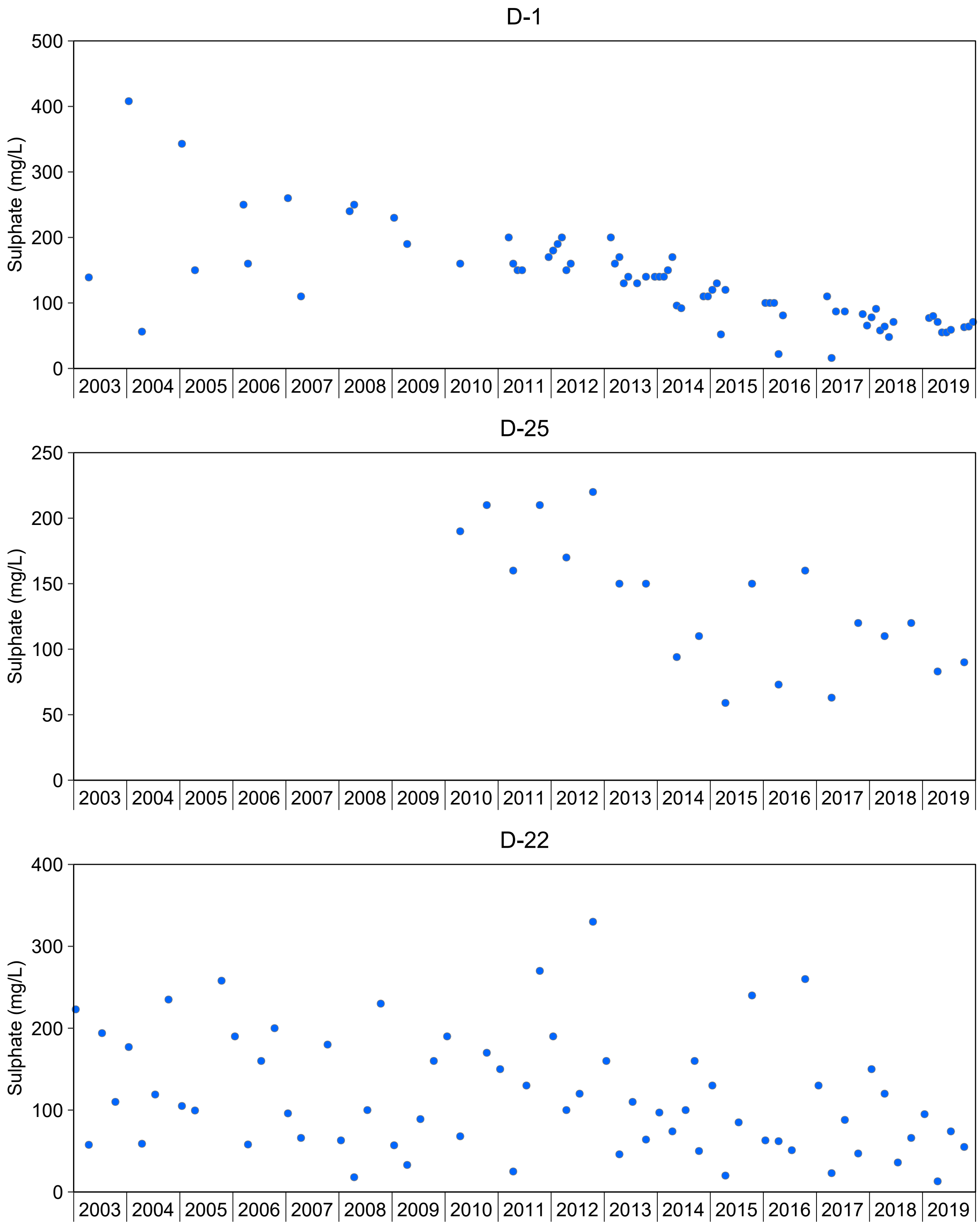


Figure E.8: Concentrations of Sulphate for TOMP Water Monitoring Stations, Denison TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL.
See Table 4.6 for Seasonal Kendall trend analysis results and Appendix Tables E.3 to E.5 for raw data.

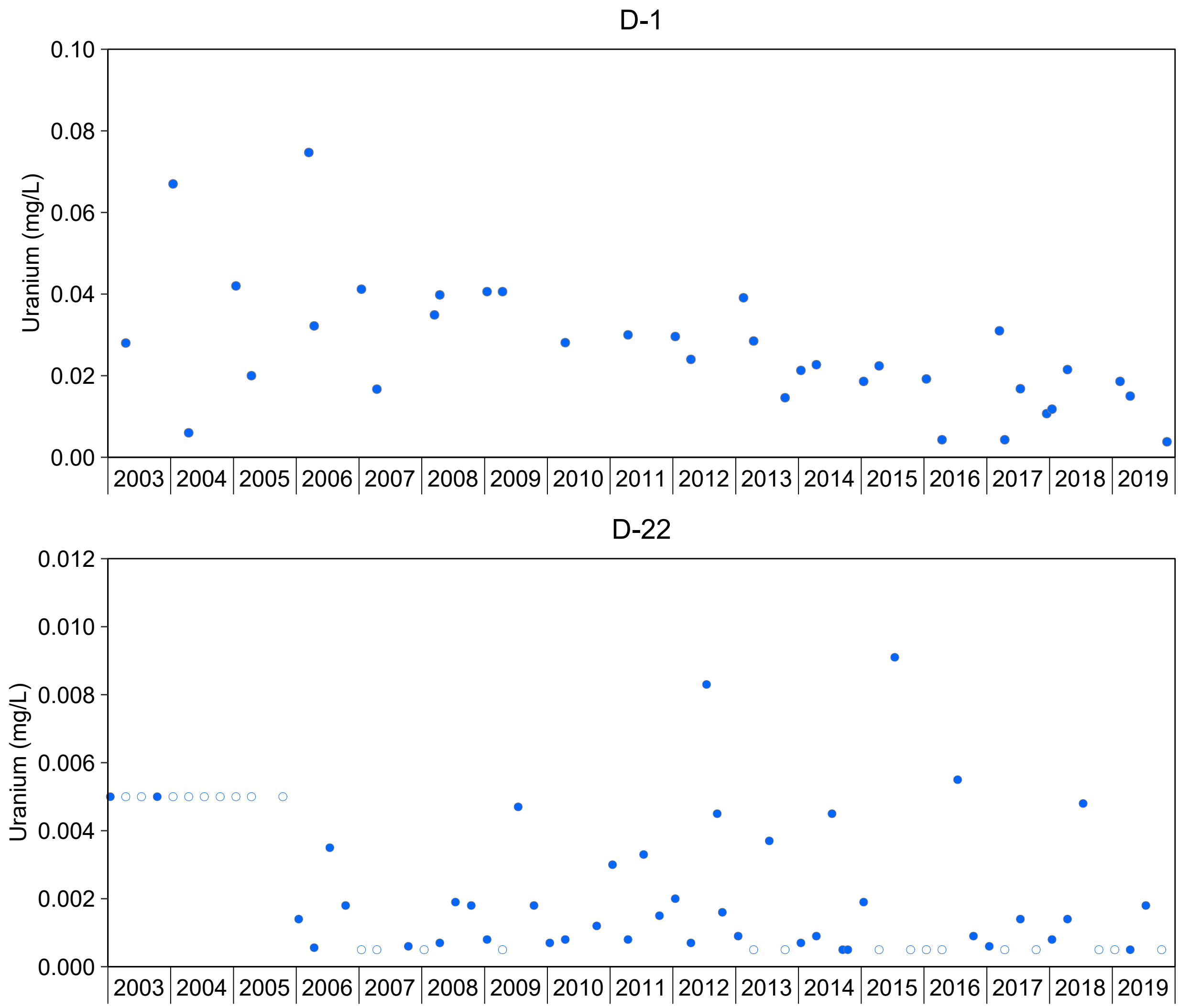


Figure E.9: Concentrations of Uranium for TOMP Water Monitoring Stations, Denison TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 4.6 for Seasonal Kendall trend analysis results and Appendix Tables E.3 and E.5 for raw data.

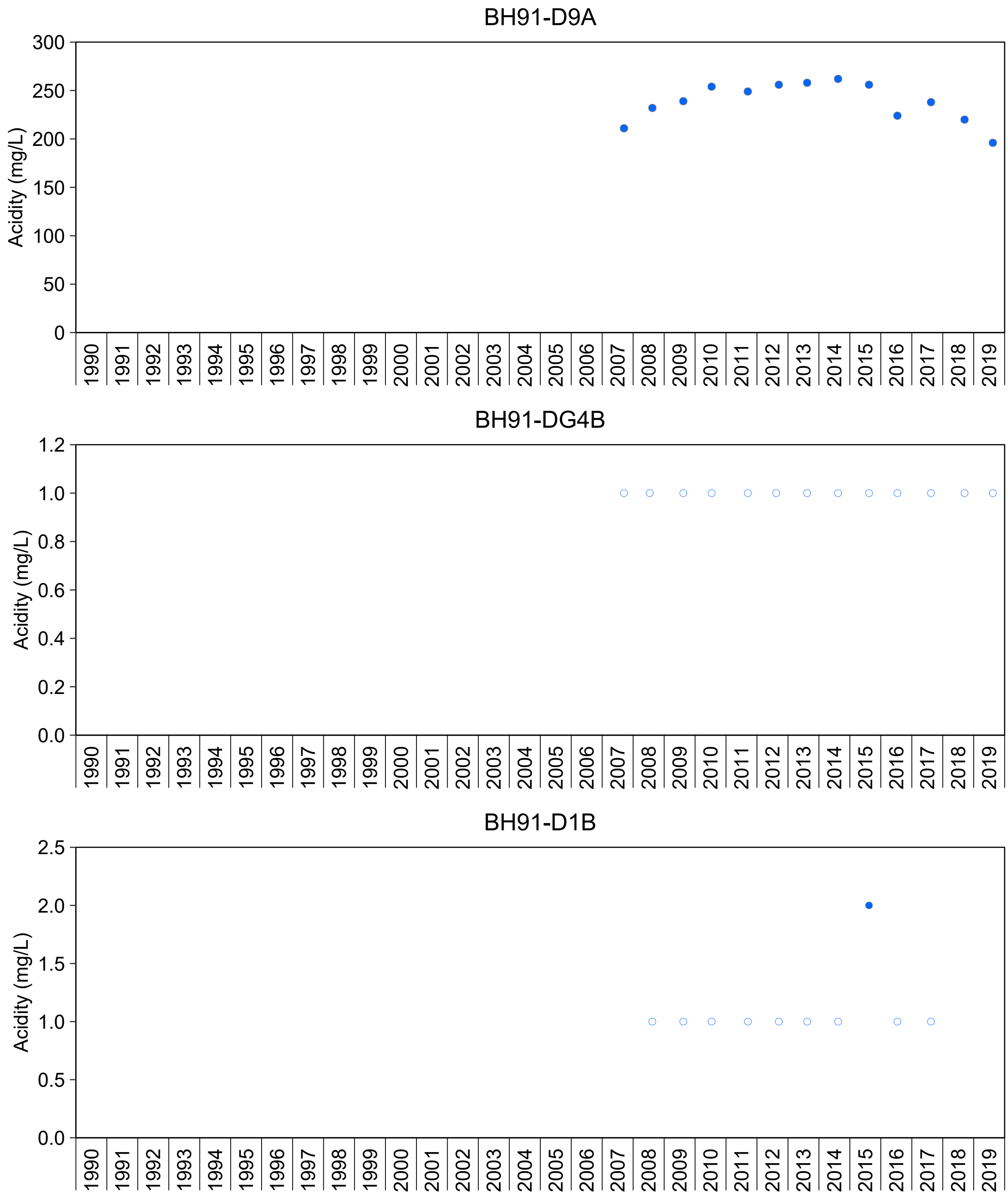


Figure E.10: Concentrations of Acidity for TOMP Groundwater Stations, Denison TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL.
Due to a change in analytical technique for acidity in 2006, acidity trends were assessed from 2007 to 2019.
See Table 4.7 for Kendall trend analysis results and Appendix Tables E.8 to E.12 for raw data. Acidity (mg/L) is not included in the trend analysis for TOMP stations BH91-DG4B, BH91-D1B, and BH91-D1A due to >50% non-detectable concentrations in the dataset.

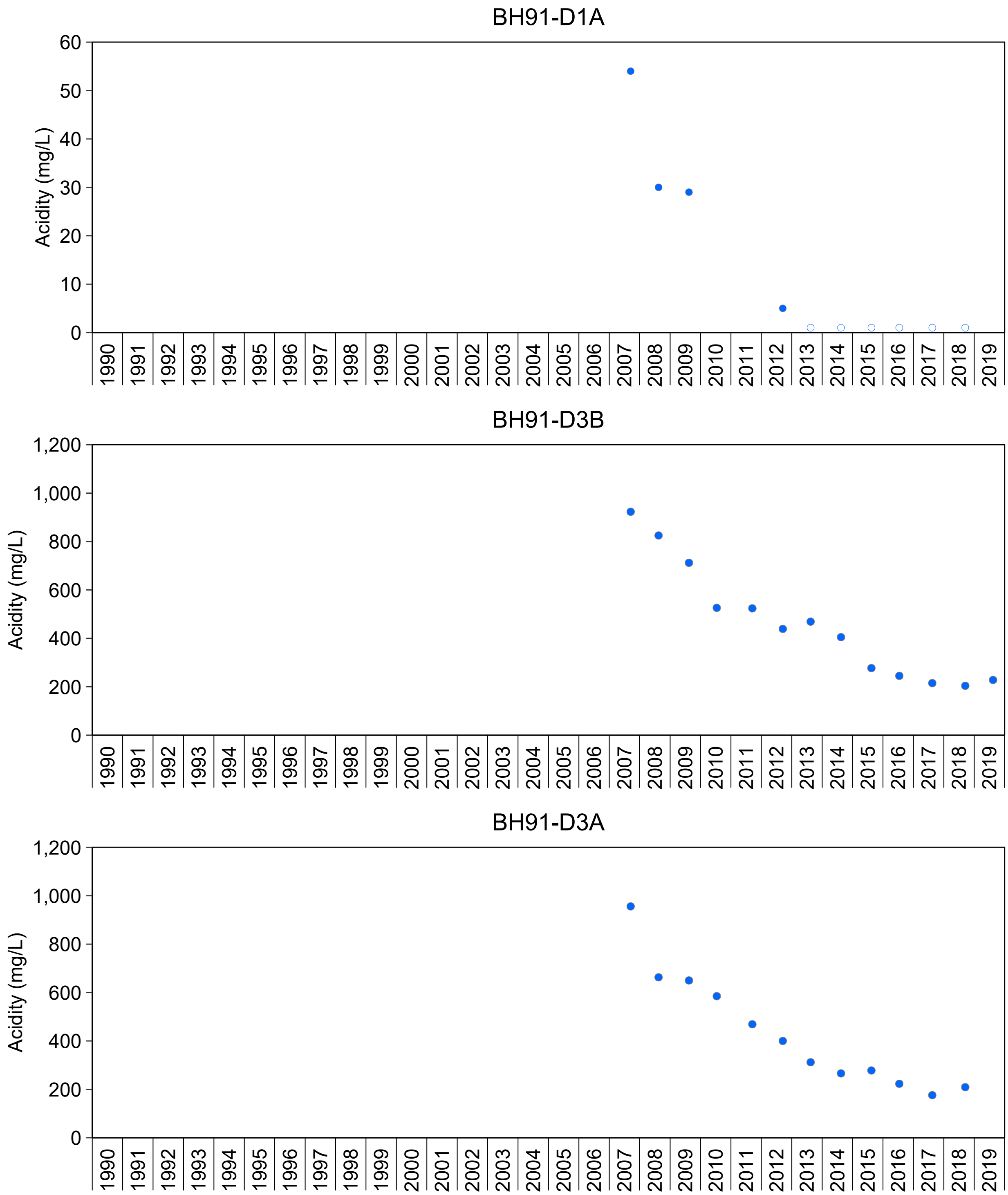


Figure E.10: Concentrations of Acidity for TOMP Groundwater Stations, Denison TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL.
Due to a change in analytical technique for acidity in 2006, acidity trends were assessed from 2007 to 2019.
See Table 4.7 for Kendall trend analysis results and Appendix Tables E.8 to E.12 for raw data. Acidity (mg/L) is not included in the trend analysis for TOMP stations BH91-DG4B, BH91-D1B, and BH91-D1A due to >50% non-detectable concentrations in the dataset.

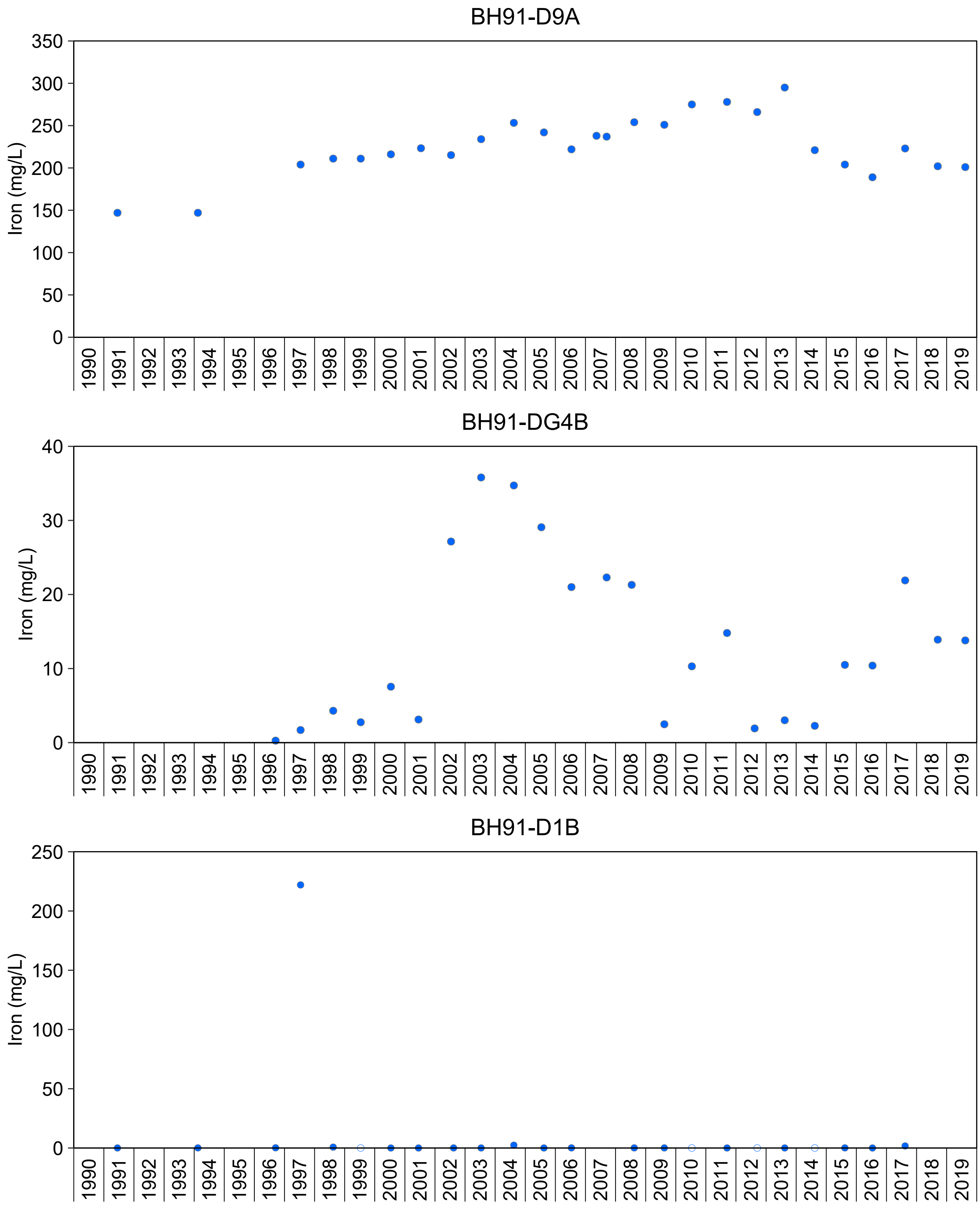


Figure E.11: Concentrations of Iron for TOMP Groundwater Stations, Denison TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 4.7 for Kendall trend analysis results and Appendix Tables E.8 to E.12 for raw data.

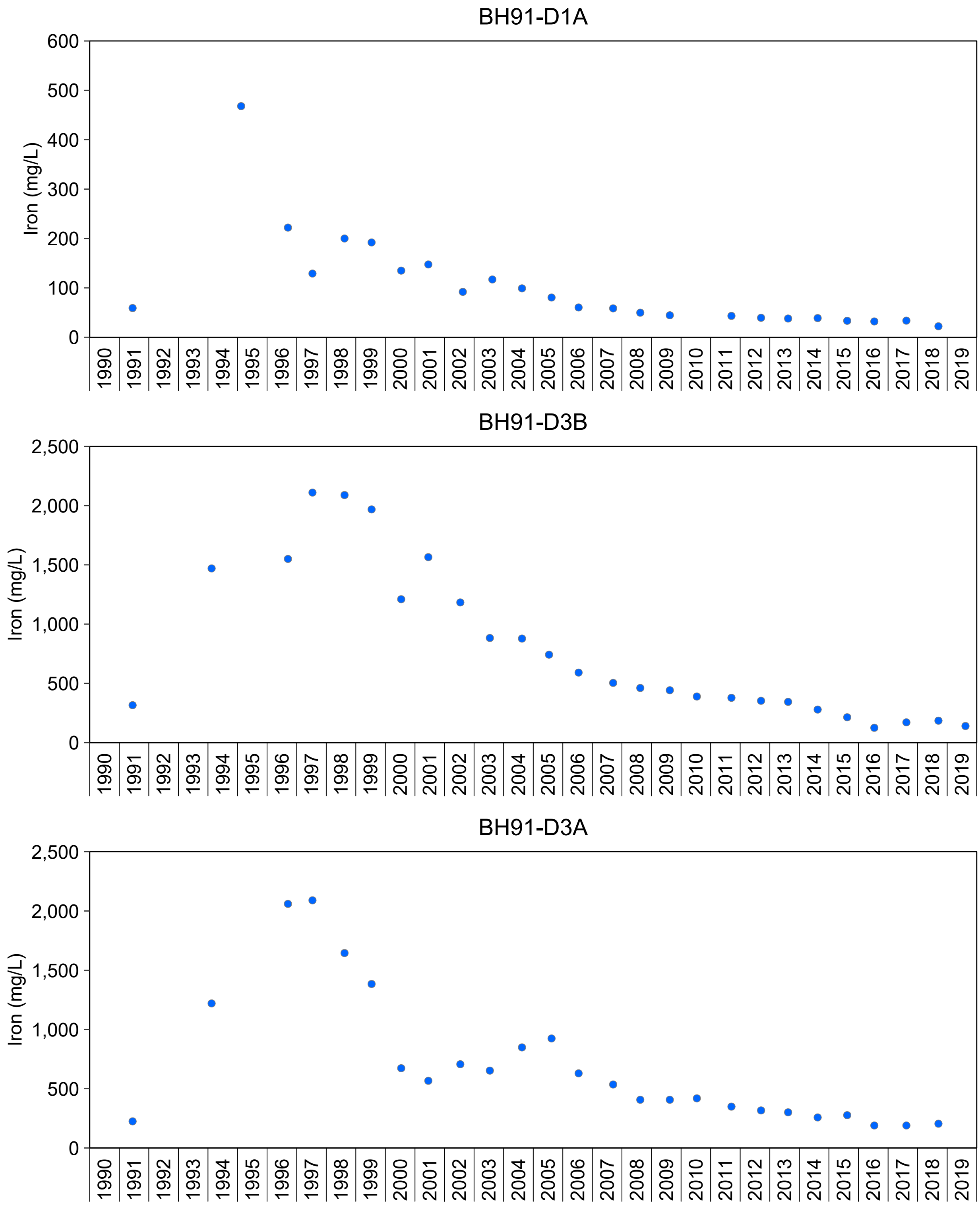


Figure E.11: Concentrations of Iron for TOMP Groundwater Stations, Denison TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 4.7 for Kendall trend analysis results and Appendix Tables E.8 to E.12 for raw data.

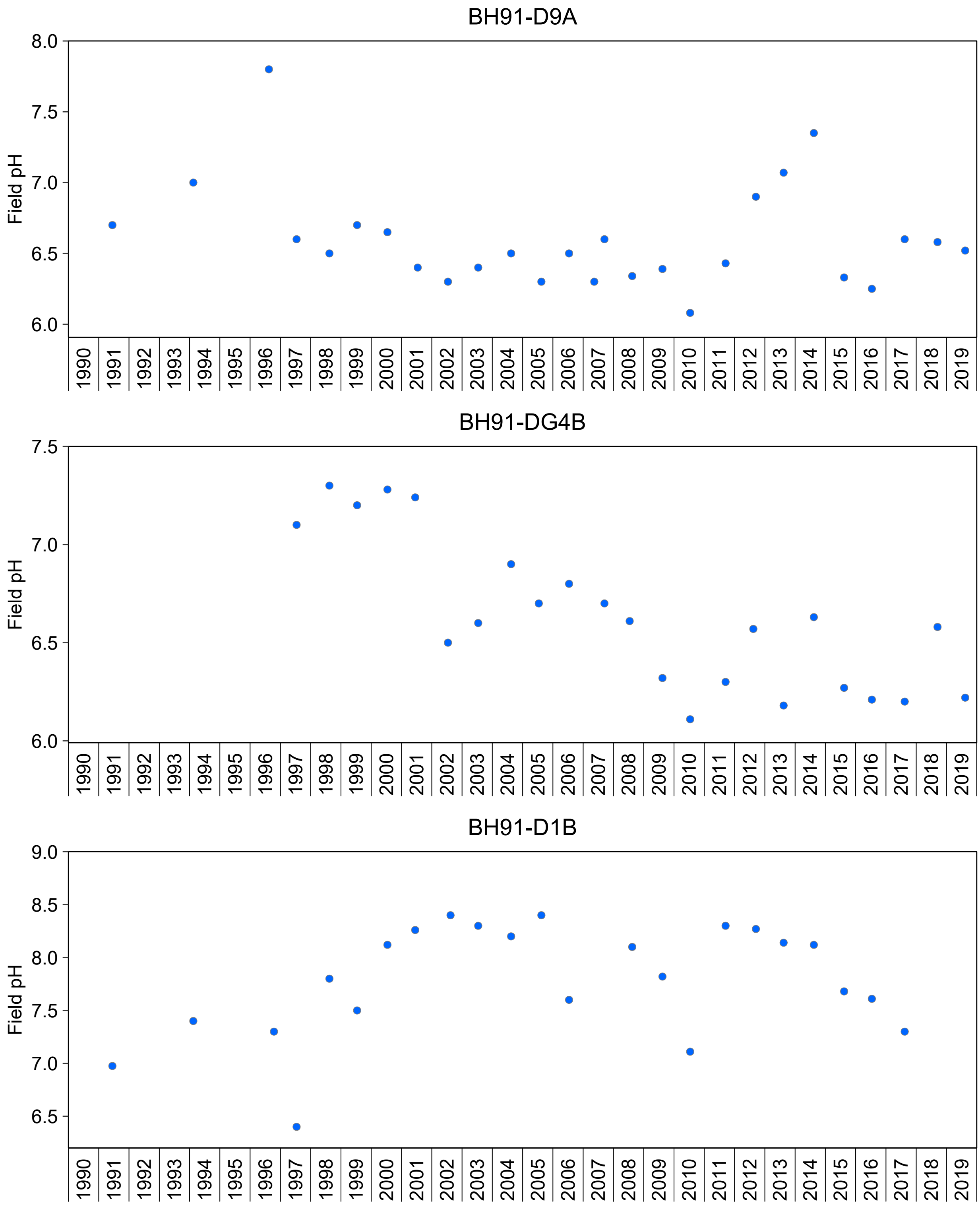


Figure E.12: Field Measurements of pH for TOMP Groundwater Stations, Denison TMA, 1990 to 2019

Notes: See Table 4.7 for Kendall trend analysis results and Appendix Tables E.8 to E.12 for raw data.

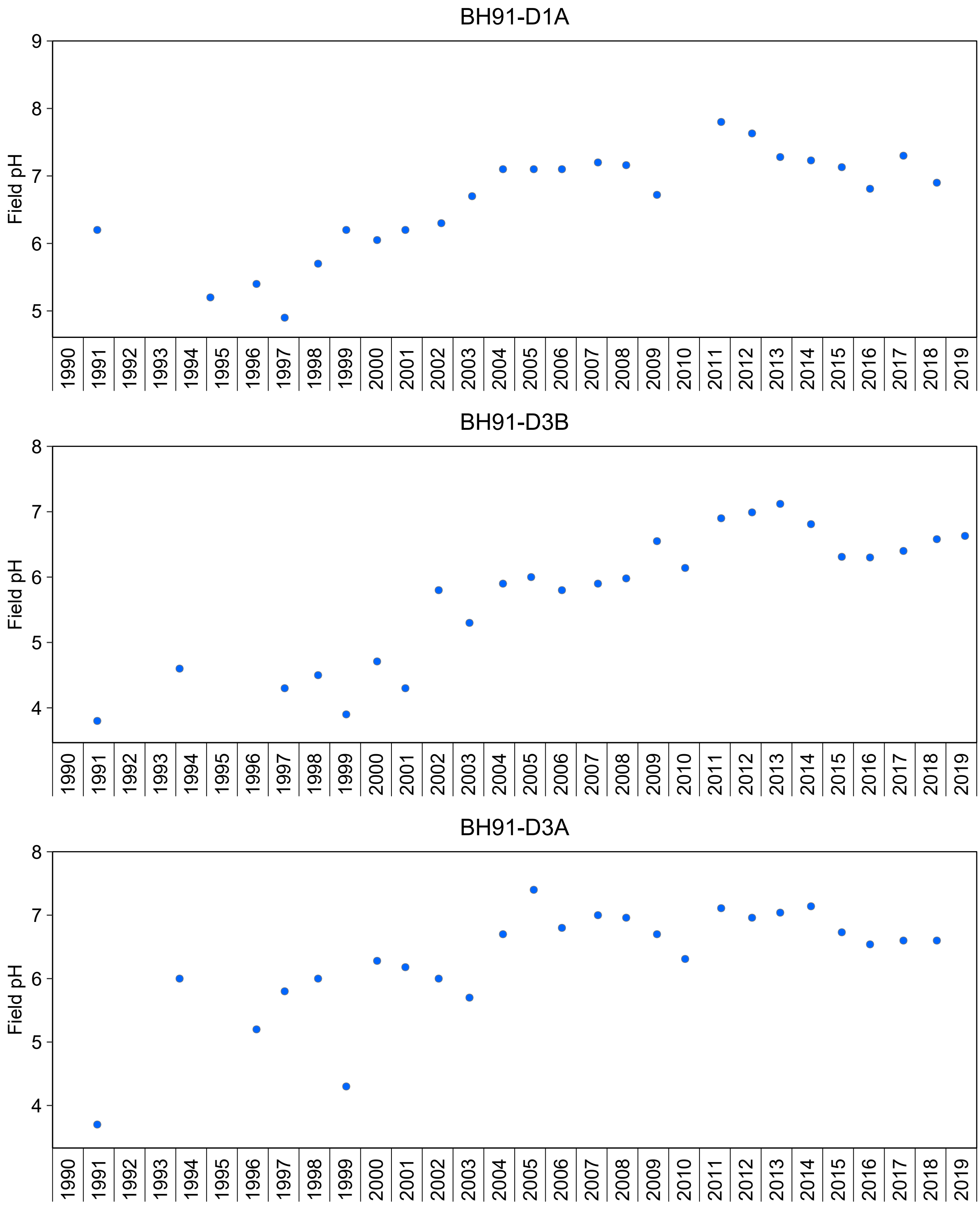


Figure E.12: Field Measurements of pH for TOMP Groundwater Stations, Denison TMA, 1990 to 2019

Notes: See Table 4.7 for Kendall trend analysis results and Appendix Tables E.8 to E.12 for raw data.

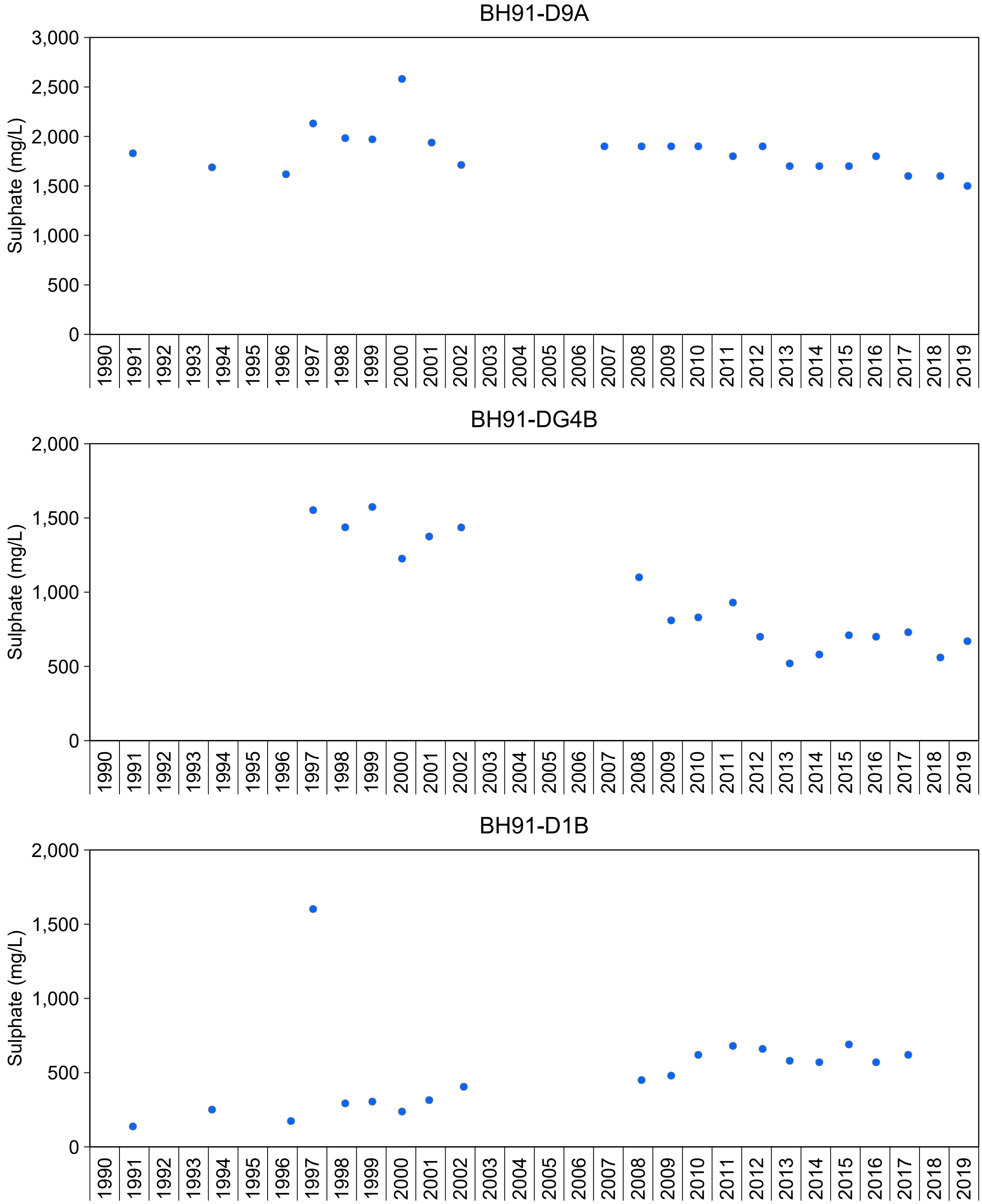


Figure E.13: Concentrations of Sulphate for TOMP Groundwater Stations, Denison TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL.
See Table 4.7 for Kendall trend analysis results and Appendix Tables E.8 to E.12 for raw data.

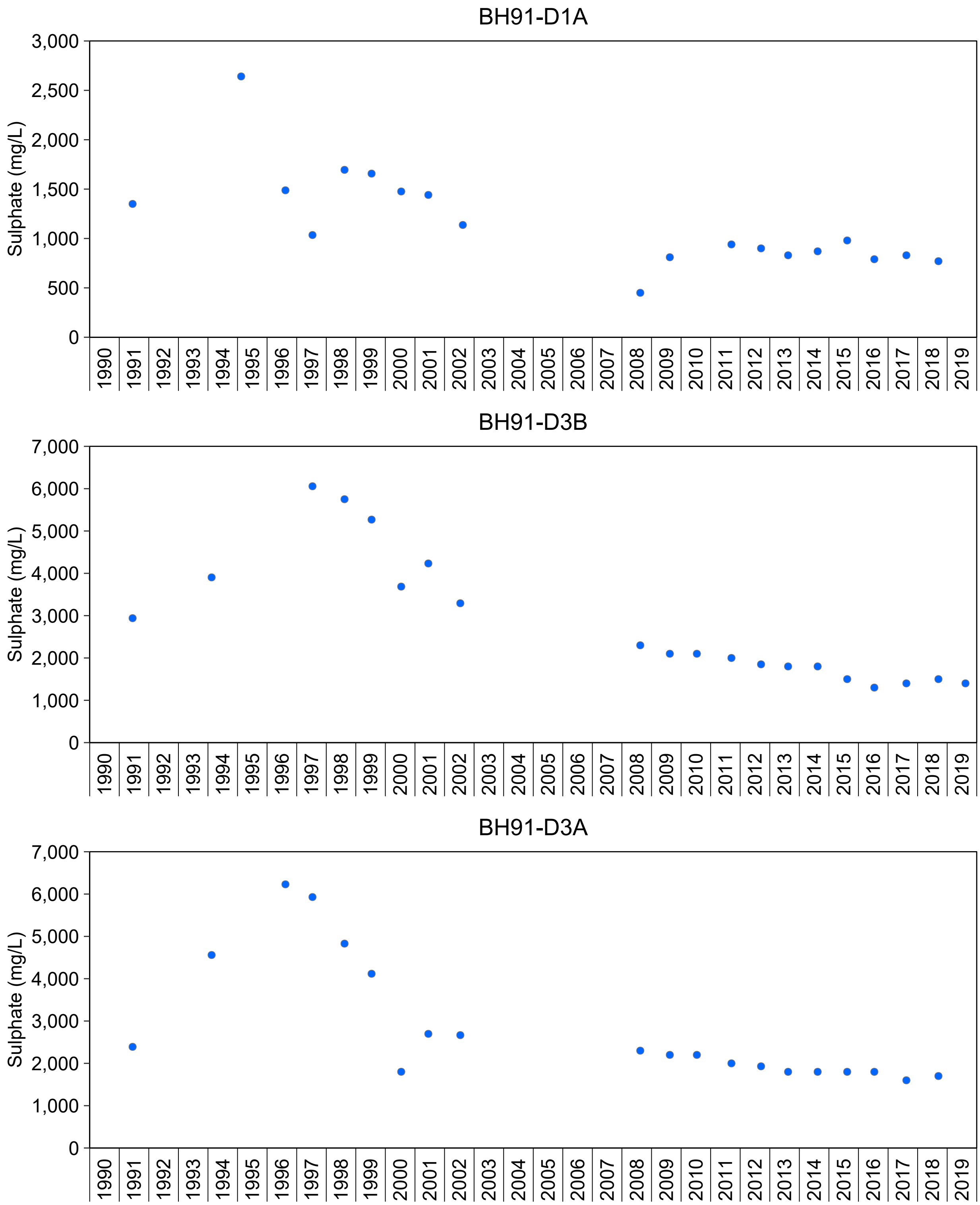


Figure E.13: Concentrations of Sulphate for TOMP Groundwater Stations, Denison TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 4.7 for Kendall trend analysis results and Appendix Tables E.8 to E.12 for raw data.

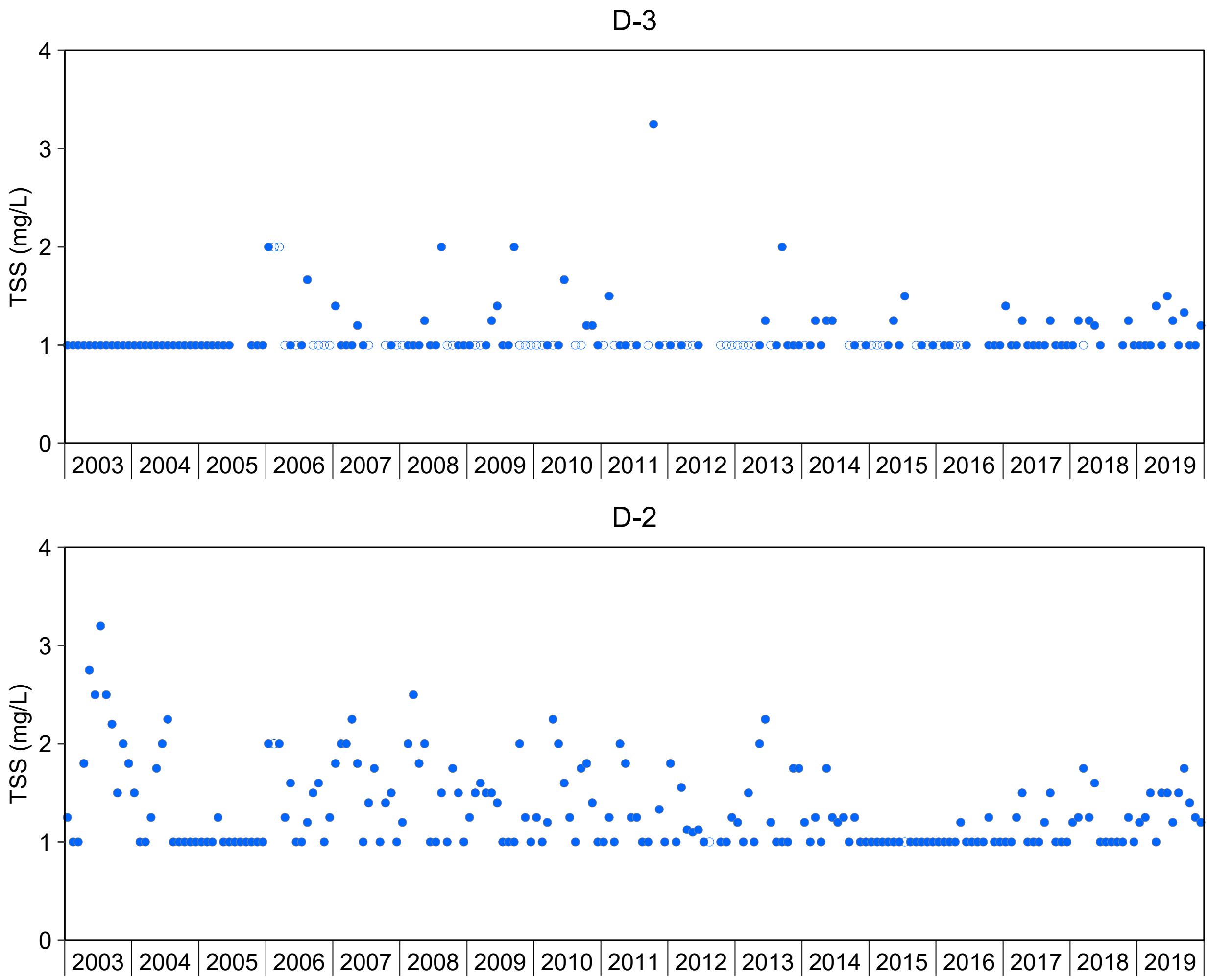


Figure E.14: Concentrations of Total Suspended Solids for TOMP Water Monitoring Stations, Denison TMA, 2003 to 2019

Notes: TSS is not included in the trend analysis for TOMP stations D-3, and D-2 because the monitoring is in support of ETP operations. Other stations at this TMA provide more meaningful information regarding trends for this parameter. Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Tables E.6 and E.7 for raw data.

Table E.1: Location of TOMP Data Tables and Figures Within this Cycle 5 SOE Report, Denison TMA

TMA	TOMP Station	Station Type/Purpose	Also a SAMP Station? [a]	Map Figures	Elevation Tables	Elevation Figures	Water Quality Data Tables (flow, acidity, barium, cobalt, iron, manganese, pH, radium-226, sulphate, uranium, conductivity, TSS, and/or treatment chemical consumption)	Comparison to EIS Predictions Figures	Lime or NaOH Consumption Figures	Barium Chloride Consumption Figures	Comparison to Discharge Criteria Figures	Trend Tables	Water Quality Data Figures										
													Acidity	Barium	Cobalt	Iron	Manganese	pH	Radium-226	Sulphate	Uranium	Conductivity	TSS
Denison	D-1	Basin performance (primary), ETP	no	4.2	E.13	4.6	E.3	4.7	4.8	4.8	na-c	4.6	E.1	E.2	E.3	E.4	E.5	E.6	E.7	E.8	E.9	na	na
	D-25	Basin performance (secondary)	no	4.2	na	na	E.4	na-p	na	na	na-c	4.6	E.1	na	na	E.4	na	E.6	E.7	E.8	na	na	na
	D-22	ETP operations	no	4.2	na	na	E.5	na-p	na	4.9	na-c	4.6	E.1	E.2	E.3	E.4	E.5	E.6	E.7	E.8	E.9	na	na
	D-3	Effluent	YES	4.1, 4.2	na	na	E.6	na-p	na	na	4.10, 4.11	4.17	na	N.1	N.2	N.3	N.4	N.5	N.6	N.7	N.8	na	E.14
	D-2	Effluent	YES	4.1, 4.2	na	na	E.7	na-p	na	na	4.12, 4.13	4.17	na	N.1	N.2	N.3	N.4	N.5	N.6	N.7	N.8	na	E.14
	BH91-D1(A,B), BH91-D3(A,B), BH91-DG4B, BH91-D9A	Groundwater	no	4.2	na	na	E.8 to E.12	na-p	na	na	na-c	4.7	E.10	na	na	E.11	na	E.12	na	E.13	na	na	na

Notes: na = parameter not measured at this station (as per study design); therefore, data presentation is not applicable. na-p = EIS Predictions do not apply to this station (as per study design); therefore, data presentation is not applicable. na-c = discharge criteria do not apply to this station (as per study design); therefore, data presentation is not applicable. na-t = at this station, only one to three parameters (elevation, pH, flow, conductivity, and/or radium-226) are monitored to support ETP operations. Other stations provide more meaningful information regarding trends for these parameters; therefore, data presentation is not applicable.

[a] Data for this TOMP station also pertain to the SAMP. Trends are assessed in the SAMP section and water quality figures are provided in the SAMP section (Table 2.6).

Table E.2: 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	25

[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.

Table E.3: **Water Quality at TOMP Station D-1 (Basin Performance - Primary, ETP operations), Denison TMA, 2015 to 2019**

Date	Elevation (m)	Flow (L/s)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	NaOH Consumption (kg per month)	Barium Chloride Consumption (kg per month)	Acidity (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
6-Jan-15	387	61.0	7.60	-	-	0	328.6	-	-	-	-	-	-
13-Jan-15	387	61.0	7.90	120	1.12	0	328.6	<1.00	0.0670	<0.000500	0.0400	0.00700	0.0186
10-Feb-15	387	54.0	7.50	130	1.18	0	232	-	-	-	-	-	-
17-Mar-15	387	30.0	7.22	52.0	0.748	0	183.2	-	-	-	-	-	-
7-Apr-15	387	14.0	7.20	120	1.43	0	206	<1.00	0.0630	<0.000500	<0.0200	0.00300	0.0224
12-Jan-16	387	108	7.60	100	1.53	0	624.7	<1.00	0.0600	<0.000500	0.127	0.00600	0.0192
9-Feb-16	387	99.0	7.60	100	1.56	0	615.3	-	-	-	-	-	-
8-Mar-16	387	48.0	7.40	100	1.60	0	733.8	-	-	-	-	-	-
12-Apr-16	387	108	7.10	22.0	0.951	0	627.4	<1.00	0.0330	0.000600	0.0710	0.0670	0.00430
10-May-16	387	150	8.00	81.0	1.60	0	630.6	-	-	-	-	-	-
14-Feb-17	387	0	7.20	97.0	2.32	0	97.02	-	-	-	-	-	-
21-Mar-17	387	67.0	7.10	110	2.81	34.65	634.3	<1.00	0.119	<0.000500	0.0380	0.0160	0.0310
11-Apr-17	387	41.0	6.80	16.0	0.581	306.3	468	<1.00	0.0270	<0.000500	0.0570	0.0120	0.00430
23-May-17	387	49.0	7.90	87.0	2.30	301.56	519.06	-	-	-	-	-	-
11-Jul-17	387	114	8.10	87.0	1.84	0	602.97	<1.00	0.0740	<0.000500	0.0240	0.0110	0.0168
14-Nov-17	387	110	7.60	83.0	1.92	0	865	-	-	-	-	-	-
12-Dec-17	387	110	7.40	57.0	0.875	0	878.9	-	-	-	-	-	-
19-Dec-17	387	108	7.30	74.0	1.25	0	878.9	<1.00	0.0650	<0.000500	0.0730	0.0110	0.0107
9-Jan-18	387	107	7.20	78.0	1.26	0	847.2	<1.00	0.0630	<0.000500	0.0750	0.0160	0.0118
13-Feb-18	387	112	7.40	91.0	2.11	106.6	781.9	-	-	-	-	-	-
13-Mar-18	387	44.0	7.00	58.0	1.06	310.6	662.7	-	-	-	-	-	-
10-Apr-18	387	43.0	7.20	64.0	1.21	473	220	<1.00	0.0680	<0.000500	0.162	0.0240	0.0215
8-May-18	387	170	7.70	48.0	1.12	661	1217.2	-	-	-	-	-	-
12-Jun-18	387	38.0	8.50	71.0	1.43	0	202.48	-	-	-	-	-	-
12-Feb-19	387	48.0	7.40	77.0	1.89	0	446.24	<1.00	-	<0.000500	0.0250	0.00700	0.0186
12-Mar-19	387	115	7.30	80.0	2.16	0	1859.5	-	-	-	-	-	-
9-Apr-19	387	157	7.20	71.0	1.89	0	2511	<1.00	0.0720	<0.000500	0.105	0.0450	0.0150
14-May-19	387	172	7.90	55.0	1.70	0	2813.1	-	-	-	-	-	-
11-Jun-19	387	197	8.70	55.0	1.76	0	2100	-	-	-	-	-	-
5-Jul-19	387	170	7.30	59.0	2.23	0	347.3	-	-	-	-	-	-
29-Oct-19	387	40.0	7.70	63.0	1.74	0	107	-	-	-	-	-	-
12-Nov-19	387	49.0	7.90	64.0	1.58	0	466.2	<1.00	0.0260	<0.000500	0.250	0.0130	0.00380
10-Dec-19	387	46.0	7.60	71.0	1.67	0	557	-	-	-	-	-	-
n	126	784	32	31	31	60	60	13	12	13	13	13	13
Minimum	387	14.0	6.80	16.0	0.581	0	0	<1.00	0.0260	<0.000500	<0.0200	0.00300	0.00380
Maximum	387	197	8.70	130	2.81	661	2,810	<1.00	0.119	0.000600	0.250	0.0670	0.0310
Mean	387	96.3	7.54	75.6	1.55	38.9	411	<1.00	0.0614	0.000508	0.0821	0.0183	0.0152
SD	0.100	46.3	0.418	26.1	0.494	122	610	-	0.0251	-	0.0659	0.0181	0.00807
Median	387	106	7.45	74.0	1.58	0	204	<1.00	0.0640	<0.000500	0.0710	0.0120	0.0168
10th Percentile	387	43.0	7.10	52.0	0.951	0	0	<1.00	0.0270	<0.000500	0.0240	0.00600	0.00430
95th Percentile	387	179	8.50	120	2.30	308	1,980	<1.00	0.119	0.000600	0.250	0.0670	0.0310

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected, or SD was incalculable because there was no variability in the data.

Table E.4: Water Quality at TOMP Station D-25 (Basin Performance - Secondary), Denison TMA, 2015 to 2019

Date	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Acidity (mg/L)	Iron (mg/L)
13-Jan-15	7.60	-	-	-	-
10-Feb-15	7.40	-	-	-	-
17-Mar-15	7.43	-	-	-	-
21-Apr-15	7.00	59.0	0.284	<1.00	0.420
12-May-15	7.20	-	-	-	-
9-Jun-15	7.40	-	-	-	-
14-Jul-15	7.30	-	-	-	-
13-Oct-15	7.10	150	0.352	<1.00	0.723
10-Nov-15	7.50	-	-	-	-
8-Dec-15	7.70	-	-	-	-
12-Jan-16	7.40	-	-	-	-
9-Feb-16	7.40	-	-	-	-
8-Mar-16	7.10	-	-	-	-
12-Apr-16	7.40	73.0	0.201	<1.00	0.186
10-May-16	7.60	-	-	-	-
15-Jun-16	7.20	-	-	-	-
12-Jul-16	7.10	-	-	-	-
6-Oct-16	7.20	160	0.342	<1.00	0.188
9-Nov-16	7.30	-	-	-	-
13-Dec-16	7.40	-	-	-	-
10-Jan-17	7.20	-	-	-	-
14-Feb-17	7.10	-	-	-	-
21-Mar-17	7.30	-	-	-	-
19-Apr-17	7.30	63.0	0.308	<1.00	0.315
9-May-17	7.50	-	-	-	-
13-Jun-17	7.60	-	-	-	-
11-Jul-17	7.30	-	-	-	-
9-Aug-17	7.70	-	-	-	-
12-Sep-17	7.60	-	-	-	-
11-Oct-17	7.30	120	0.293	<1.00	0.134
14-Nov-17	7.50	-	-	-	-
12-Dec-17	7.50	-	-	-	-
16-Jan-18	7.40	-	-	-	-
13-Feb-18	7.40	-	-	-	-
13-Mar-18	7.70	-	-	-	-
10-Apr-18	7.70	110	0.446	<1.00	0.132
9-May-18	7.50	-	-	-	-
19-Jun-18	7.60	-	-	-	-
10-Jul-18	6.80	-	-	-	-
9-Oct-18	7.20	120	0.259	<1.00	0.101
13-Nov-18	7.40	-	-	-	-
11-Dec-18	7.70	-	-	-	-
4-Jan-19	7.70	-	-	-	-
13-Feb-19	7.50	-	-	-	-
12-Mar-19	7.60	-	-	-	-
9-Apr-19	7.40	83.0	0.606	<1.00	0.324
14-May-19	7.90	-	-	-	-
11-Jun-19	7.70	-	-	-	-
9-Jul-19	7.30	-	-	-	-
13-Aug-19	7.40	-	-	-	-
10-Sep-19	7.30	-	-	-	-
8-Oct-19	7.70	90.0	0.263	<1.00	0.0870
12-Nov-19	7.50	-	-	-	-
10-Dec-19	7.50	-	-	-	-
n	54	10	10	10	10
Minimum	6.80	59.0	0.201	<1.00	0.0870
Maximum	7.90	160	0.606	<1.00	0.723
Mean	7.42	103	0.335	<1.00	0.261
SD	0.214	35.1	0.116	-	0.196
Median	7.40	100	0.300	<1.00	0.187
10th Percentile	7.10	61.0	0.230	<1.00	0.0940
95th Percentile	7.70	160	0.606	<1.00	0.723

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected, or SD was incalculable because there was no variability in the data.

Table E.5: Water Quality at TOMP Station D-22 (ETP Operations), Denison TMA, 2015 to 2019

Date	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium Chloride Consumption (kg per month)	Acidity (mg/L)	Iron (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Manganese (mg/L)	Uranium (mg/L)
6-Jan-15	6.50	-	-	49.8	-	-	-	-	-	-
13-Jan-15	6.50	130	0.575	49.8	<1.00	5.21	0.0400	0.00190	1.16	0.00190
20-Jan-15	6.50	-	-	49.8	-	-	-	-	-	-
27-Jan-15	6.50	-	-	49.8	-	-	-	-	-	-
3-Feb-15	6.60	-	-	34.6	-	-	-	-	-	-
10-Feb-15	6.60	-	0.794	34.6	-	-	-	-	-	-
17-Feb-15	6.60	-	-	34.6	-	-	-	-	-	-
24-Feb-15	6.50	-	-	34.6	-	-	-	-	-	-
3-Mar-15	6.50	-	-	65.9	-	-	-	-	-	-
17-Mar-15	6.71	-	0.768	65.9	-	-	-	-	-	-
24-Mar-15	6.80	-	-	65.9	-	-	-	-	-	-
31-Mar-15	6.50	-	-	65.9	-	-	-	-	-	-
7-Apr-15	6.90	-	-	70.08	-	-	-	-	-	-
14-Apr-15	6.90	20.0	0.0590	70.08	<1.00	0.380	0.0170	0.000800	0.400	<0.000500
21-Apr-15	6.90	-	-	70.08	-	-	-	-	-	-
28-Apr-15	6.60	-	-	70.08	-	-	-	-	-	-
5-May-15	7.10	-	-	40.6	-	-	-	-	-	-
12-May-15	7.00	-	0.104	40.6	-	-	-	-	-	-
19-May-15	6.60	-	-	40.6	-	-	-	-	-	-
26-May-15	6.60	-	-	40.6	-	-	-	-	-	-
2-Jun-15	6.70	-	-	38.1	-	-	-	-	-	-
9-Jun-15	6.60	-	0.268	38.1	-	-	-	-	-	-
16-Jun-15	6.60	-	-	38.1	-	-	-	-	-	-
23-Jun-15	6.50	-	-	38.1	-	-	-	-	-	-
29-Jun-15	6.50	-	-	38.1	-	-	-	-	-	-
7-Jul-15	6.90	-	-	33.5	-	-	-	-	-	-
14-Jul-15	6.90	85.0	1.17	33.5	<1.00	10.9	0.0740	0.00130	3.10	0.00910
21-Jul-15	6.60	-	-	33.5	-	-	-	-	-	-
25-Aug-15	6.50	-	0.629	14	-	-	-	-	-	-
1-Sep-15	6.50	-	-	61.5	-	-	-	-	-	-
8-Sep-15	6.40	-	-	61.5	-	-	-	-	-	-
15-Sep-15	6.80	-	0.643	61.5	-	-	-	-	-	-
22-Sep-15	7.00	-	-	61.5	-	-	-	-	-	-
29-Sep-15	7.00	-	-	61.5	-	-	-	-	-	-
7-Oct-15	7.00	-	-	56.2	-	-	-	-	-	-
13-Oct-15	6.70	240	0.249	56.2	<1.00	0.750	0.0550	<0.000500	0.115	<0.000500
20-Oct-15	6.70	-	-	56.2	-	-	-	-	-	-
27-Oct-15	6.60	-	-	56.2	-	-	-	-	-	-
3-Nov-15	7.08	-	-	57.9	-	-	-	-	-	-
10-Nov-15	6.90	-	0.0540	57.9	-	-	-	-	-	-
17-Nov-15	6.70	-	-	57.9	-	-	-	-	-	-
24-Nov-15	6.60	-	-	57.9	-	-	-	-	-	-
1-Dec-15	6.80	-	-	45.3	-	-	-	-	-	-
8-Dec-15	7.00	-	0.0770	45.3	-	-	-	-	-	-
15-Dec-15	6.70	-	-	45.3	-	-	-	-	-	-
22-Dec-15	6.70	-	-	45.3	-	-	-	-	-	-
29-Dec-15	6.60	-	-	45.3	-	-	-	-	-	-
5-Jan-16	6.80	-	-	73.3	-	-	-	-	-	-
12-Jan-16	6.60	63.0	0.0400	73.3	<1.00	0.173	0.0240	<0.000500	0.115	<0.000500
19-Jan-16	6.80	-	-	73.3	-	-	-	-	-	-
26-Jan-16	6.50	-	-	73.3	-	-	-	-	-	-
2-Feb-16	6.50	-	-	57.3	-	-	-	-	-	-
9-Feb-16	6.60	-	0.142	57.3	-	-	-	-	-	-
16-Feb-16	6.50	-	-	57.3	-	-	-	-	-	-
23-Feb-16	6.50	-	-	57.3	-	-	-	-	-	-
1-Mar-16	6.70	-	-	62.3	-	-	-	-	-	-
8-Mar-16	7.00	-	0.187	62.3	-	-	-	-	-	-
15-Mar-16	7.03	-	-	62.3	-	-	-	-	-	-
22-Mar-16	6.50	-	-	62.3	-	-	-	-	-	-
29-Mar-16	6.50	-	-	62.3	-	-	-	-	-	-
5-Apr-16	6.50	-	-	56	-	-	-	-	-	-
12-Apr-16	6.60	62.0	0.0560	56	<1.00	0.0930	0.0190	<0.000500	0.0280	<0.000500
19-Apr-16	6.70	-	-	56	-	-	-	-	-	-
26-Apr-16	6.80	-	-	56	-	-	-	-	-	-
3-May-16	6.50	-	-	47.1	-	-	-	-	-	-
10-May-16	7.40	-	0.159	47.1	-	-	-	-	-	-
17-May-16	7.00	-	-	47.1	-	-	-	-	-	-
24-May-16	6.50	-	-	47.1	-	-	-	-	-	-
31-May-16	6.90	-	-	47.1	-	-	-	-	-	-
7-Jun-16	7.00	-	-	47.9	-	-	-	-	-	-
14-Jun-16	6.80	-	0.582	47.9	-	-	-	-	-	-
21-Jun-16	6.70	-	-	47.9	-	-	-	-	-	-
28-Jun-16	6.50	-	-	47.9	-	-	-	-	-	-
5-Jul-16	6.70	-	-	47.5	-	-	-	-	-	-
12-Jul-16	6.60	51.0	1.31	47.5	<1.00	18.5	0.0790	0.00190	6.12	0.00550
19-Jul-16	6.70	-	-	47.5	-	-	-	-	-	-
26-Jul-16	6.50	-	-	47.5	-	-	-	-	-	-
2-Aug-16	6.50	-	-	16.7	-	-	-	-	-	-
30-Aug-16	6.50	-	2.15	16.7	-	-	-	-	-	-
6-Sep-16	6.60	-	-	41.3	-	-	-	-	-	-
13-Sep-16	6.50	-	1.58	41.3	-	-	-	-	-	-
20-Sep-16	6.50	-	-	41.3	-	-	-	-	-	-
27-Sep-16	6.50	-	-	41.3	-	-	-	-	-	-
4-Oct-16	6.90	-	-	55.8	-	-	-	-	-	-
11-Oct-16	6.60	260	0.475	55.8	<1.00	2.96	0.0510	<0.000500	0.149	0.000900

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected, or SD was incalculable because there was no variability in the data.

Table E.5: **Water Quality at TOMP Station D-22 (ETP Operations), Denison TMA, 2015 to 2019**

Date	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium Chloride Consumption (kg per month)	Acidity (mg/L)	Iron (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Manganese (mg/L)	Uranium (mg/L)
18-Oct-16	6.90	-	-	55.8	-	-	-	-	-	-
25-Oct-16	7.10	-	-	55.8	-	-	-	-	-	-
1-Nov-16	7.00	-	-	30	-	-	-	-	-	-
8-Nov-16	6.90	-	0.345	30	-	-	-	-	-	-
15-Nov-16	7.20	-	-	30	-	-	-	-	-	-
22-Nov-16	6.80	-	-	30	-	-	-	-	-	-
29-Nov-16	6.60	-	-	30	-	-	-	-	-	-
6-Dec-16	6.60	-	-	54.7	-	-	-	-	-	-
13-Dec-16	6.70	-	0.222	54.7	-	-	-	-	-	-
20-Dec-16	6.90	-	-	54.7	-	-	-	-	-	-
29-Dec-16	6.90	-	-	54.7	-	-	-	-	-	-
3-Jan-17	7.10	-	-	55.2	-	-	-	-	-	-
10-Jan-17	6.10	130	0.128	55.2	<1.00	0.530	0.0290	<0.000500	0.233	0.000600
17-Jan-17	6.60	-	-	55.2	-	-	-	-	-	-
24-Jan-17	7.00	-	-	55.2	-	-	-	-	-	-
31-Jan-17	6.60	-	-	55.2	-	-	-	-	-	-
7-Feb-17	6.50	-	-	49.6	-	-	-	-	-	-
14-Feb-17	6.60	-	0.0610	49.6	-	-	-	-	-	-
21-Feb-17	6.50	-	-	49.6	-	-	-	-	-	-
28-Feb-17	6.60	-	-	49.6	-	-	-	-	-	-
7-Mar-17	7.10	-	-	56.4	-	-	-	-	-	-
14-Mar-17	6.60	-	-	56.4	-	-	-	-	-	-
21-Mar-17	6.70	-	0.0700	56.4	-	-	-	-	-	-
28-Mar-17	6.50	-	-	56.4	-	-	-	-	-	-
4-Apr-17	6.50	-	-	55.2	-	-	-	-	-	-
11-Apr-17	6.60	23.0	0.0320	55.2	<1.00	0.0840	0.0100	<0.000500	0.0220	<0.000500
18-Apr-17	6.80	-	-	55.2	-	-	-	-	-	-
25-Apr-17	6.80	-	-	55.2	-	-	-	-	-	-
2-May-17	6.80	-	-	58.03	-	-	-	-	-	-
9-May-17	6.70	-	-	58.03	-	-	-	-	-	-
16-May-17	6.70	-	-	58.03	-	-	-	-	-	-
23-May-17	6.90	-	0.118	58.03	-	-	-	-	-	-
30-May-17	6.80	-	-	58.03	-	-	-	-	-	-
6-Jun-17	6.70	-	-	53.4	-	-	-	-	-	-
13-Jun-17	6.80	-	0.236	53.4	-	-	-	-	-	-
20-Jun-17	6.80	-	-	53.4	-	-	-	-	-	-
27-Jun-17	7.00	-	-	53.4	-	-	-	-	-	-
4-Jul-17	6.50	-	-	55.4	-	-	-	-	-	-
11-Jul-17	6.80	88.0	0.429	55.4	<1.00	4.29	0.0370	<0.000500	0.371	0.00140
18-Jul-17	6.80	-	-	55.4	-	-	-	-	-	-
25-Jul-17	6.90	-	-	55.4	-	-	-	-	-	-
1-Aug-17	6.80	-	-	53.83	-	-	-	-	-	-
8-Aug-17	6.90	-	0.472	53.83	-	-	-	-	-	-
15-Aug-17	7.00	-	-	53.83	-	-	-	-	-	-
22-Aug-17	7.00	-	-	53.83	-	-	-	-	-	-
29-Aug-17	6.90	-	-	53.83	-	-	-	-	-	-
5-Sep-17	6.90	-	-	53.57	-	-	-	-	-	-
12-Sep-17	7.10	-	0.294	53.57	-	-	-	-	-	-
19-Sep-17	7.00	-	-	53.57	-	-	-	-	-	-
26-Sep-17	6.80	-	-	53.57	-	-	-	-	-	-
3-Oct-17	6.80	-	-	53.4	-	-	-	-	-	-
10-Oct-17	7.00	47.0	0.0880	53.4	<1.00	0.651	0.0180	<0.000500	0.118	<0.000500
17-Oct-17	6.70	-	-	53.4	-	-	-	-	-	-
24-Oct-17	6.90	-	-	53.4	-	-	-	-	-	-
31-Oct-17	7.00	-	-	53.4	-	-	-	-	-	-
7-Nov-17	6.80	-	-	51.38	-	-	-	-	-	-
14-Nov-17	6.80	-	0.0540	51.38	-	-	-	-	-	-
21-Nov-17	6.90	-	-	51.38	-	-	-	-	-	-
28-Nov-17	6.70	-	-	51.38	-	-	-	-	-	-
5-Dec-17	6.60	-	-	51.5	-	-	-	-	-	-
12-Dec-17	6.60	-	0.0660	51.5	-	-	-	-	-	-
19-Dec-17	6.50	-	-	51.5	-	-	-	-	-	-
28-Dec-17	6.90	-	-	51.5	-	-	-	-	-	-
2-Jan-18	6.50	-	-	53.8	-	-	-	-	-	-
9-Jan-18	6.50	150	0.338	53.8	1.00	3.19	0.0420	0.00180	0.900	0.000800
16-Jan-18	7.00	-	-	53.8	-	-	-	-	-	-
23-Jan-18	6.50	-	-	53.8	-	-	-	-	-	-
30-Jan-18	6.60	-	-	53.8	-	-	-	-	-	-
6-Feb-18	6.50	-	-	47.6	-	-	-	-	-	-
13-Feb-18	6.50	-	0.303	47.6	-	-	-	-	-	-
20-Feb-18	6.50	-	-	47.6	-	-	-	-	-	-
27-Feb-18	6.60	-	-	47.6	-	-	-	-	-	-
6-Mar-18	6.50	-	-	52	-	-	-	-	-	-
13-Mar-18	6.50	-	0.350	52	-	-	-	-	-	-
20-Mar-18	6.50	-	-	52	-	-	-	-	-	-
27-Mar-18	6.50	-	-	52	-	-	-	-	-	-
3-Apr-18	6.50	-	-	46.7	-	-	-	-	-	-
10-Apr-18	6.50	120	0.257	46.7	<1.00	2.21	0.0360	0.00180	1.11	0.00140
17-Apr-18	6.50	-	-	46.7	-	-	-	-	-	-
24-Apr-18	6.50	-	-	46.7	-	-	-	-	-	-
1-May-18	6.60	-	-	49.9	-	-	-	-	-	-
8-May-18	6.90	-	0.0230	49.9	-	-	-	-	-	-
15-May-18	6.50	-	-	49.9	-	-	-	-	-	-
22-May-18	6.70	-	-	49.9	-	-	-	-	-	-
29-May-18	6.70	-	-	49.9	-	-	-	-	-	-

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected, or SD was incalculable because there was no variability in the data.

Table E.5: **Water Quality at TOMP Station D-22 (ETP Operations), Denison TMA, 2015 to 2019**

Date	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium Chloride Consumption (kg per month)	Acidity (mg/L)	Iron (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Manganese (mg/L)	Uranium (mg/L)
5-Jun-18	7.10	-	-	46.2	-	-	-	-	-	-
12-Jun-18	6.80	-	-	46.2	-	-	-	-	-	-
19-Jun-18	7.00	-	0.248	46.2	-	-	-	-	-	-
26-Jun-18	7.00	-	-	46.2	-	-	-	-	-	-
3-Jul-18	6.80	-	-	49.6	-	-	-	-	-	-
10-Jul-18	6.50	36.0	0.965	49.6	<1.00	15.3	0.0670	0.00140	3.18	0.00480
17-Jul-18	6.70	-	-	49.6	-	-	-	-	-	-
24-Jul-18	6.70	-	-	49.6	-	-	-	-	-	-
31-Jul-18	6.50	-	-	49.6	-	-	-	-	-	-
7-Aug-18	6.50	-	-	35.2	-	-	-	-	-	-
14-Aug-18	6.60	-	1.45	35.2	-	-	-	-	-	-
28-Aug-18	6.90	-	-	35.2	-	-	-	-	-	-
4-Sep-18	6.50	-	-	39.47	-	-	-	-	-	-
11-Sep-18	6.50	-	1.70	39.47	-	-	-	-	-	-
18-Sep-18	6.50	-	-	39.47	-	-	-	-	-	-
25-Sep-18	7.00	-	-	39.47	-	-	-	-	-	-
2-Oct-18	6.80	-	-	51.5	-	-	-	-	-	-
9-Oct-18	6.60	66.0	0.0830	51.5	<1.00	0.244	0.0190	<0.000500	0.0710	<0.000500
16-Oct-18	6.70	-	-	51.5	-	-	-	-	-	-
23-Oct-18	6.80	-	-	51.5	-	-	-	-	-	-
30-Oct-18	6.60	-	-	51.5	-	-	-	-	-	-
6-Nov-18	6.70	-	-	48.7	-	-	-	-	-	-
13-Nov-18	6.60	-	0.0280	48.7	-	-	-	-	-	-
20-Nov-18	6.90	-	-	48.7	-	-	-	-	-	-
27-Nov-18	6.60	-	-	48.7	-	-	-	-	-	-
4-Dec-18	6.60	-	-	45.3	-	-	-	-	-	-
11-Dec-18	6.80	-	0.0710	45.3	-	-	-	-	-	-
18-Dec-18	6.60	-	-	45.3	-	-	-	-	-	-
27-Dec-18	7.10	-	-	45.3	-	-	-	-	-	-
2-Jan-19	7.00	-	-	42.4	-	-	-	-	-	-
8-Jan-19	7.00	95.0	0.0900	42.4	<1.00	0.329	0.0260	<0.000500	0.175	<0.000500
15-Jan-19	6.70	-	-	42.4	-	-	-	-	-	-
22-Jan-19	6.70	-	-	42.4	-	-	-	-	-	-
29-Jan-19	6.70	-	-	42.4	-	-	-	-	-	-
5-Feb-19	6.70	-	-	36.59	-	-	-	-	-	-
12-Feb-19	6.70	-	0.333	36.59	-	-	-	-	-	-
19-Feb-19	6.70	-	-	36.59	-	-	-	-	-	-
28-Feb-19	6.50	-	-	36.59	-	-	-	-	-	-
4-Mar-19	6.70	-	-	42.3	-	-	-	-	-	-
12-Mar-19	6.70	-	0.0870	42.3	-	-	-	-	-	-
19-Mar-19	6.60	-	-	42.3	-	-	-	-	-	-
26-Mar-19	6.60	-	-	42.3	-	-	-	-	-	-
2-Apr-19	6.60	-	-	46.2	-	-	-	-	-	-
9-Apr-19	6.50	13.0	0.0140	46.2	<1.00	0.239	0.0130	<0.000500	0.0850	0.000500
16-Apr-19	6.70	-	-	46.2	-	-	-	-	-	-
22-Apr-19	6.60	-	-	46.2	-	-	-	-	-	-
30-Apr-19	6.50	-	-	46.2	-	-	-	-	-	-
7-May-19	6.50	-	-	41	-	-	-	-	-	-
14-May-19	6.60	-	0.0680	41	-	-	-	-	-	-
21-May-19	6.90	-	-	41	-	-	-	-	-	-
28-May-19	6.90	-	-	41	-	-	-	-	-	-
4-Jun-19	6.70	-	-	45.1	-	-	-	-	-	-
11-Jun-19	6.80	-	0.0320	45.1	-	-	-	-	-	-
18-Jun-19	6.90	-	-	45.1	-	-	-	-	-	-
25-Jun-19	6.60	-	-	45.1	-	-	-	-	-	-
2-Jul-19	6.70	-	-	41.9	-	-	-	-	-	-
9-Jul-19	6.80	74.0	0.765	41.9	<1.00	8.71	0.0570	0.000700	1.07	0.00180
16-Jul-19	6.60	-	-	41.9	-	-	-	-	-	-
23-Jul-19	6.70	-	-	41.9	-	-	-	-	-	-
30-Jul-19	6.50	-	-	41.9	-	-	-	-	-	-
6-Aug-19	6.50	-	-	41	-	-	-	-	-	-
13-Aug-19	6.80	-	1.13	41	-	-	-	-	-	-
20-Aug-19	6.70	-	-	41	-	-	-	-	-	-
27-Aug-19	6.70	-	-	41	-	-	-	-	-	-
3-Sep-19	6.60	-	-	44.2	-	-	-	-	-	-
10-Sep-19	6.70	-	0.181	44.2	-	-	-	-	-	-
17-Sep-19	6.60	-	-	44.2	-	-	-	-	-	-
24-Sep-19	6.60	-	-	44.2	-	-	-	-	-	-
1-Oct-19	6.90	-	-	55.3	-	-	-	-	-	-
8-Oct-19	7.10	55.0	0.123	55.3	<1.00	0.889	0.0200	<0.000500	0.167	<0.000500
15-Oct-19	7.00	-	-	55.3	-	-	-	-	-	-
22-Oct-19	6.50	-	-	55.3	-	-	-	-	-	-
29-Oct-19	6.90	-	-	55.3	-	-	-	-	-	-
5-Nov-19	6.80	-	-	48.6	-	-	-	-	-	-
12-Nov-19	6.60	-	0.113	48.6	-	-	-	-	-	-
19-Nov-19	6.70	-	-	48.6	-	-	-	-	-	-
26-Nov-19	6.70	-	-	48.6	-	-	-	-	-	-
3-Dec-19	6.70	-	-	41.7	-	-	-	-	-	-
10-Dec-19	6.70	-	0.0600	41.7	-	-	-	-	-	-
16-Dec-19	6.80	-	-	41.7	-	-	-	-	-	-
23-Dec-19	6.60	-	-	41.7	-	-	-	-	-	-
30-Dec-19	6.70	-	-	41.7	-	-	-	-	-	-
n	252	20	60	60	20	20	20	20	20	20
Minimum	6.10	13.0	0.0140	14.0	<1.00	0.0840	0.0100	<0.000500	0.0220	<0.000500
Maximum	7.40	260	2.15	73.3	1.00	18.5	0.0790	0.00190	6.12	0.00910
Mean	6.71	90.4	0.392	48.3	1.00	3.78	0.0366	0.000880	0.934	0.00166
SD	0.191	66.6	0.476	10.5	-	5.41	0.0210	0.000499	1.53	0.00230
Median	6.70	70.0	0.204	49.2	<1.00	0.820	0.0325	<0.000500	0.204	0.000550
10th Percentile	6.50	21.5	0.0470	35.9	<1.00	0.133	0.0150	<0.000500	0.0495	<0.000500
95th Percentile	7.00	250	1.51	64.1	1.00	16.9	0.0765	0.00190	4.65	0.00730

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected, or SD was incalculable because there was no variability in the data.

Table E.6: Water Quality at TOMP Station D-22 (ETP Operations), Denison TMA, 2015 to 2019

Date	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium Chloride Consumption (kg per month)	Acidity (mg/L)	Iron (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Manganese (mg/L)	Uranium (mg/L)
6-Jan-15	6.50	-	-	49.8	-	-	-	-	-	-
13-Jan-15	6.50	130	0.575	49.8	<1.00	5.21	0.0400	0.00190	1.16	0.00190
20-Jan-15	6.50	-	-	49.8	-	-	-	-	-	-
27-Jan-15	6.50	-	-	49.8	-	-	-	-	-	-
3-Feb-15	6.60	-	-	34.6	-	-	-	-	-	-
10-Feb-15	6.60	-	0.794	34.6	-	-	-	-	-	-
17-Feb-15	6.60	-	-	34.6	-	-	-	-	-	-
24-Feb-15	6.50	-	-	34.6	-	-	-	-	-	-
3-Mar-15	6.50	-	-	65.9	-	-	-	-	-	-
17-Mar-15	6.71	-	0.768	65.9	-	-	-	-	-	-
24-Mar-15	6.80	-	-	65.9	-	-	-	-	-	-
31-Mar-15	6.50	-	-	65.9	-	-	-	-	-	-
7-Apr-15	6.90	-	-	70.1	-	-	-	-	-	-
14-Apr-15	6.90	20.0	0.0590	70.1	<1.00	0.380	0.0170	0.000800	0.400	<0.000500
21-Apr-15	6.90	-	-	70.1	-	-	-	-	-	-
28-Apr-15	6.60	-	-	70.1	-	-	-	-	-	-
5-May-15	7.10	-	-	40.6	-	-	-	-	-	-
12-May-15	7.00	-	0.104	40.6	-	-	-	-	-	-
19-May-15	6.60	-	-	40.6	-	-	-	-	-	-
26-May-15	6.60	-	-	40.6	-	-	-	-	-	-
2-Jun-15	6.70	-	-	38.1	-	-	-	-	-	-
9-Jun-15	6.60	-	0.268	38.1	-	-	-	-	-	-
16-Jun-15	6.60	-	-	38.1	-	-	-	-	-	-
23-Jun-15	6.50	-	-	38.1	-	-	-	-	-	-
29-Jun-15	6.50	-	-	38.1	-	-	-	-	-	-
7-Jul-15	6.90	-	-	33.5	-	-	-	-	-	-
14-Jul-15	6.90	85.0	1.17	33.5	<1.00	10.9	0.0740	0.00130	3.10	0.00910
21-Jul-15	6.60	-	-	33.5	-	-	-	-	-	-
25-Aug-15	6.50	-	0.629	14.0	-	-	-	-	-	-
1-Sep-15	6.50	-	-	61.5	-	-	-	-	-	-
8-Sep-15	6.40	-	-	61.5	-	-	-	-	-	-
15-Sep-15	6.80	-	0.643	61.5	-	-	-	-	-	-
22-Sep-15	7.00	-	-	61.5	-	-	-	-	-	-
29-Sep-15	7.00	-	-	61.5	-	-	-	-	-	-
7-Oct-15	7.00	-	-	56.2	-	-	-	-	-	-
13-Oct-15	6.70	240	0.249	56.2	<1.00	0.750	0.0550	<0.000500	0.115	<0.000500
20-Oct-15	6.70	-	-	56.2	-	-	-	-	-	-
27-Oct-15	6.60	-	-	56.2	-	-	-	-	-	-
3-Nov-15	7.08	-	-	57.9	-	-	-	-	-	-
10-Nov-15	6.90	-	0.0540	57.9	-	-	-	-	-	-
17-Nov-15	6.70	-	-	57.9	-	-	-	-	-	-
24-Nov-15	6.60	-	-	57.9	-	-	-	-	-	-
1-Dec-15	6.80	-	-	45.3	-	-	-	-	-	-
8-Dec-15	7.00	-	0.0770	45.3	-	-	-	-	-	-
15-Dec-15	6.70	-	-	45.3	-	-	-	-	-	-
22-Dec-15	6.70	-	-	45.3	-	-	-	-	-	-
29-Dec-15	6.60	-	-	45.3	-	-	-	-	-	-
5-Jan-16	6.80	-	-	73.3	-	-	-	-	-	-
12-Jan-16	6.60	63.0	0.0400	73.3	<1.00	0.173	0.0240	<0.000500	0.115	<0.000500
19-Jan-16	6.80	-	-	73.3	-	-	-	-	-	-
26-Jan-16	6.50	-	-	73.3	-	-	-	-	-	-
2-Feb-16	6.50	-	-	57.3	-	-	-	-	-	-
9-Feb-16	6.60	-	0.142	57.3	-	-	-	-	-	-
16-Feb-16	6.50	-	-	57.3	-	-	-	-	-	-
23-Feb-16	6.50	-	-	57.3	-	-	-	-	-	-
1-Mar-16	6.70	-	-	62.3	-	-	-	-	-	-
8-Mar-16	7.00	-	0.187	62.3	-	-	-	-	-	-
15-Mar-16	7.03	-	-	62.3	-	-	-	-	-	-
22-Mar-16	6.50	-	-	62.3	-	-	-	-	-	-
29-Mar-16	6.50	-	-	62.3	-	-	-	-	-	-
5-Apr-16	6.50	-	-	56.0	-	-	-	-	-	-
12-Apr-16	6.60	62.0	0.0560	56.0	<1.00	0.0930	0.0190	<0.000500	0.0280	<0.000500
19-Apr-16	6.70	-	-	56.0	-	-	-	-	-	-
26-Apr-16	6.80	-	-	56.0	-	-	-	-	-	-
3-May-16	6.50	-	-	47.1	-	-	-	-	-	-
10-May-16	7.40	-	0.159	47.1	-	-	-	-	-	-
17-May-16	7.00	-	-	47.1	-	-	-	-	-	-
24-May-16	6.50	-	-	47.1	-	-	-	-	-	-
31-May-16	6.90	-	-	47.1	-	-	-	-	-	-
7-Jun-16	7.00	-	-	47.9	-	-	-	-	-	-
14-Jun-16	6.80	-	0.582	47.9	-	-	-	-	-	-
21-Jun-16	6.70	-	-	47.9	-	-	-	-	-	-
28-Jun-16	6.50	-	-	47.9	-	-	-	-	-	-
5-Jul-16	6.70	-	-	47.5	-	-	-	-	-	-
12-Jul-16	6.60	51.0	1.31	47.5	<1.00	18.5	0.0790	0.00190	6.12	0.00550
19-Jul-16	6.70	-	-	47.5	-	-	-	-	-	-
26-Jul-16	6.50	-	-	47.5	-	-	-	-	-	-
2-Aug-16	6.50	-	-	16.7	-	-	-	-	-	-
30-Aug-16	6.50	-	2.15	16.7	-	-	-	-	-	-
6-Sep-16	6.60	-	-	41.3	-	-	-	-	-	-
13-Sep-16	6.50	-	1.58	41.3	-	-	-	-	-	-
20-Sep-16	6.50	-	-	41.3	-	-	-	-	-	-
27-Sep-16	6.50	-	-	41.3	-	-	-	-	-	-
4-Oct-16	6.90	-	-	55.8	-	-	-	-	-	-
11-Oct-16	6.60	260	0.475	55.8	<1.00	2.96	0.0510	<0.000500	0.149	0.000900

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected, or SD was incalculable because there was no variability in the data.

Table E.6: **Water Quality at TOMP Station D-22 (ETP Operations), Denison TMA, 2015 to 2019**

Date	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium Chloride Consumption (kg per month)	Acidity (mg/L)	Iron (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Manganese (mg/L)	Uranium (mg/L)
18-Oct-16	6.90	-	-	55.8	-	-	-	-	-	-
25-Oct-16	7.10	-	-	55.8	-	-	-	-	-	-
1-Nov-16	7.00	-	-	30.0	-	-	-	-	-	-
8-Nov-16	6.90	-	0.345	30.0	-	-	-	-	-	-
15-Nov-16	7.20	-	-	30.0	-	-	-	-	-	-
22-Nov-16	6.80	-	-	30.0	-	-	-	-	-	-
29-Nov-16	6.60	-	-	30.0	-	-	-	-	-	-
6-Dec-16	6.60	-	-	54.7	-	-	-	-	-	-
13-Dec-16	6.70	-	0.222	54.7	-	-	-	-	-	-
20-Dec-16	6.90	-	-	54.7	-	-	-	-	-	-
29-Dec-16	6.90	-	-	54.7	-	-	-	-	-	-
3-Jan-17	7.10	-	-	55.2	-	-	-	-	-	-
10-Jan-17	6.10	130	0.128	55.2	<1.00	0.530	0.0290	<0.000500	0.233	0.000600
17-Jan-17	6.60	-	-	55.2	-	-	-	-	-	-
24-Jan-17	7.00	-	-	55.2	-	-	-	-	-	-
31-Jan-17	6.60	-	-	55.2	-	-	-	-	-	-
7-Feb-17	6.50	-	-	49.6	-	-	-	-	-	-
14-Feb-17	6.60	-	0.0610	49.6	-	-	-	-	-	-
21-Feb-17	6.50	-	-	49.6	-	-	-	-	-	-
28-Feb-17	6.60	-	-	49.6	-	-	-	-	-	-
7-Mar-17	7.10	-	-	56.4	-	-	-	-	-	-
14-Mar-17	6.60	-	-	56.4	-	-	-	-	-	-
21-Mar-17	6.70	-	0.0700	56.4	-	-	-	-	-	-
28-Mar-17	6.50	-	-	56.4	-	-	-	-	-	-
4-Apr-17	6.50	-	-	55.2	-	-	-	-	-	-
11-Apr-17	6.60	23.0	0.0320	55.2	<1.00	0.0840	0.0100	<0.000500	0.0220	<0.000500
18-Apr-17	6.80	-	-	55.2	-	-	-	-	-	-
25-Apr-17	6.80	-	-	55.2	-	-	-	-	-	-
2-May-17	6.80	-	-	58.0	-	-	-	-	-	-
9-May-17	6.70	-	-	58.0	-	-	-	-	-	-
16-May-17	6.70	-	-	58.0	-	-	-	-	-	-
23-May-17	6.90	-	0.118	58.0	-	-	-	-	-	-
30-May-17	6.80	-	-	58.0	-	-	-	-	-	-
6-Jun-17	6.70	-	-	53.4	-	-	-	-	-	-
13-Jun-17	6.80	-	0.236	53.4	-	-	-	-	-	-
20-Jun-17	6.80	-	-	53.4	-	-	-	-	-	-
27-Jun-17	7.00	-	-	53.4	-	-	-	-	-	-
4-Jul-17	6.50	-	-	55.4	-	-	-	-	-	-
11-Jul-17	6.80	88.0	0.429	55.4	<1.00	4.29	0.0370	<0.000500	0.371	0.00140
18-Jul-17	6.80	-	-	55.4	-	-	-	-	-	-
25-Jul-17	6.90	-	-	55.4	-	-	-	-	-	-
1-Aug-17	6.80	-	-	53.8	-	-	-	-	-	-
8-Aug-17	6.90	-	0.472	53.8	-	-	-	-	-	-
15-Aug-17	7.00	-	-	53.8	-	-	-	-	-	-
22-Aug-17	7.00	-	-	53.8	-	-	-	-	-	-
29-Aug-17	6.90	-	-	53.8	-	-	-	-	-	-
5-Sep-17	6.90	-	-	53.6	-	-	-	-	-	-
12-Sep-17	7.10	-	0.294	53.6	-	-	-	-	-	-
19-Sep-17	7.00	-	-	53.6	-	-	-	-	-	-
26-Sep-17	6.80	-	-	53.6	-	-	-	-	-	-
3-Oct-17	6.80	-	-	53.4	-	-	-	-	-	-
10-Oct-17	7.00	47.0	0.0880	53.4	<1.00	0.651	0.0180	<0.000500	0.118	<0.000500
17-Oct-17	6.70	-	-	53.4	-	-	-	-	-	-
24-Oct-17	6.90	-	-	53.4	-	-	-	-	-	-
31-Oct-17	7.00	-	-	53.4	-	-	-	-	-	-
7-Nov-17	6.80	-	-	51.4	-	-	-	-	-	-
14-Nov-17	6.80	-	0.0540	51.4	-	-	-	-	-	-
21-Nov-17	6.90	-	-	51.4	-	-	-	-	-	-
28-Nov-17	6.70	-	-	51.4	-	-	-	-	-	-
5-Dec-17	6.60	-	-	51.5	-	-	-	-	-	-
12-Dec-17	6.60	-	0.0660	51.5	-	-	-	-	-	-
19-Dec-17	6.50	-	-	51.5	-	-	-	-	-	-
28-Dec-17	6.90	-	-	51.5	-	-	-	-	-	-
2-Jan-18	6.50	-	-	53.8	-	-	-	-	-	-
9-Jan-18	6.50	150	0.338	53.8	1.00	3.19	0.0420	0.00180	0.900	0.000800
16-Jan-18	7.00	-	-	53.8	-	-	-	-	-	-
23-Jan-18	6.50	-	-	53.8	-	-	-	-	-	-
30-Jan-18	6.60	-	-	53.8	-	-	-	-	-	-
6-Feb-18	6.50	-	-	47.6	-	-	-	-	-	-
13-Feb-18	6.50	-	0.303	47.6	-	-	-	-	-	-
20-Feb-18	6.50	-	-	47.6	-	-	-	-	-	-
27-Feb-18	6.60	-	-	47.6	-	-	-	-	-	-
6-Mar-18	6.50	-	-	52.0	-	-	-	-	-	-
13-Mar-18	6.50	-	0.350	52.0	-	-	-	-	-	-
20-Mar-18	6.50	-	-	52.0	-	-	-	-	-	-
27-Mar-18	6.50	-	-	52.0	-	-	-	-	-	-
3-Apr-18	6.50	-	-	46.7	-	-	-	-	-	-
10-Apr-18	6.50	120	0.257	46.7	<1.00	2.21	0.0360	0.00180	1.11	0.00140
17-Apr-18	6.50	-	-	46.7	-	-	-	-	-	-
24-Apr-18	6.50	-	-	46.7	-	-	-	-	-	-
1-May-18	6.60	-	-	49.9	-	-	-	-	-	-
8-May-18	6.90	-	0.0230	49.9	-	-	-	-	-	-
15-May-18	6.50	-	-	49.9	-	-	-	-	-	-
22-May-18	6.70	-	-	49.9	-	-	-	-	-	-
29-May-18	6.70	-	-	49.9	-	-	-	-	-	-

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected, or SD was incalculable because there was no variability in the data.

Table E.6: Water Quality at TOMP Station D-22 (ETP Operations), Denison TMA, 2015 to 2019

Date	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium Chloride Consumption (kg per month)	Acidity (mg/L)	Iron (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Manganese (mg/L)	Uranium (mg/L)
5-Jun-18	7.10	-	-	46.2	-	-	-	-	-	-
12-Jun-18	6.80	-	-	46.2	-	-	-	-	-	-
19-Jun-18	7.00	-	0.248	46.2	-	-	-	-	-	-
26-Jun-18	7.00	-	-	46.2	-	-	-	-	-	-
3-Jul-18	6.80	-	-	49.6	-	-	-	-	-	-
10-Jul-18	6.50	36.0	0.965	49.6	<1.00	15.3	0.0670	0.00140	3.18	0.00480
17-Jul-18	6.70	-	-	49.6	-	-	-	-	-	-
24-Jul-18	6.70	-	-	49.6	-	-	-	-	-	-
31-Jul-18	6.50	-	-	49.6	-	-	-	-	-	-
7-Aug-18	6.50	-	-	35.2	-	-	-	-	-	-
14-Aug-18	6.60	-	1.45	35.2	-	-	-	-	-	-
28-Aug-18	6.90	-	-	35.2	-	-	-	-	-	-
4-Sep-18	6.50	-	-	39.5	-	-	-	-	-	-
11-Sep-18	6.50	-	1.70	39.5	-	-	-	-	-	-
18-Sep-18	6.50	-	-	39.5	-	-	-	-	-	-
25-Sep-18	7.00	-	-	39.5	-	-	-	-	-	-
2-Oct-18	6.80	-	-	51.5	-	-	-	-	-	-
9-Oct-18	6.60	66.0	0.0830	51.5	<1.00	0.244	0.0190	<0.000500	0.0710	<0.000500
16-Oct-18	6.70	-	-	51.5	-	-	-	-	-	-
23-Oct-18	6.80	-	-	51.5	-	-	-	-	-	-
30-Oct-18	6.60	-	-	51.5	-	-	-	-	-	-
6-Nov-18	6.70	-	-	48.7	-	-	-	-	-	-
13-Nov-18	6.60	-	0.0280	48.7	-	-	-	-	-	-
20-Nov-18	6.90	-	-	48.7	-	-	-	-	-	-
27-Nov-18	6.60	-	-	48.7	-	-	-	-	-	-
4-Dec-18	6.60	-	-	45.3	-	-	-	-	-	-
11-Dec-18	6.80	-	0.0710	45.3	-	-	-	-	-	-
18-Dec-18	6.60	-	-	45.3	-	-	-	-	-	-
27-Dec-18	7.10	-	-	45.3	-	-	-	-	-	-
2-Jan-19	7.00	-	-	42.4	-	-	-	-	-	-
8-Jan-19	7.00	95.0	0.0900	42.4	<1.00	0.329	0.0260	<0.000500	0.175	<0.000500
15-Jan-19	6.70	-	-	42.4	-	-	-	-	-	-
22-Jan-19	6.70	-	-	42.4	-	-	-	-	-	-
29-Jan-19	6.70	-	-	42.4	-	-	-	-	-	-
5-Feb-19	6.70	-	-	36.6	-	-	-	-	-	-
12-Feb-19	6.70	-	0.333	36.6	-	-	-	-	-	-
19-Feb-19	6.70	-	-	36.6	-	-	-	-	-	-
28-Feb-19	6.50	-	-	36.6	-	-	-	-	-	-
4-Mar-19	6.70	-	-	42.3	-	-	-	-	-	-
12-Mar-19	6.70	-	0.0870	42.3	-	-	-	-	-	-
19-Mar-19	6.60	-	-	42.3	-	-	-	-	-	-
26-Mar-19	6.60	-	-	42.3	-	-	-	-	-	-
2-Apr-19	6.60	-	-	46.2	-	-	-	-	-	-
9-Apr-19	6.50	13.0	0.0140	46.2	<1.00	0.239	0.0130	<0.000500	0.0850	0.000500
16-Apr-19	6.70	-	-	46.2	-	-	-	-	-	-
22-Apr-19	6.60	-	-	46.2	-	-	-	-	-	-
30-Apr-19	6.50	-	-	46.2	-	-	-	-	-	-
7-May-19	6.50	-	-	41.0	-	-	-	-	-	-
14-May-19	6.60	-	0.0680	41.0	-	-	-	-	-	-
21-May-19	6.90	-	-	41.0	-	-	-	-	-	-
28-May-19	6.90	-	-	41.0	-	-	-	-	-	-
4-Jun-19	6.70	-	-	45.1	-	-	-	-	-	-
11-Jun-19	6.80	-	0.0320	45.1	-	-	-	-	-	-
18-Jun-19	6.90	-	-	45.1	-	-	-	-	-	-
25-Jun-19	6.60	-	-	45.1	-	-	-	-	-	-
2-Jul-19	6.70	-	-	41.9	-	-	-	-	-	-
9-Jul-19	6.80	74.0	0.765	41.9	<1.00	8.71	0.0570	0.000700	1.07	0.00180
16-Jul-19	6.60	-	-	41.9	-	-	-	-	-	-
23-Jul-19	6.70	-	-	41.9	-	-	-	-	-	-
30-Jul-19	6.50	-	-	41.9	-	-	-	-	-	-
6-Aug-19	6.50	-	-	41.0	-	-	-	-	-	-
13-Aug-19	6.80	-	1.13	41.0	-	-	-	-	-	-
20-Aug-19	6.70	-	-	41.0	-	-	-	-	-	-
27-Aug-19	6.70	-	-	41.0	-	-	-	-	-	-
3-Sep-19	6.60	-	-	44.2	-	-	-	-	-	-
10-Sep-19	6.70	-	0.181	44.2	-	-	-	-	-	-
17-Sep-19	6.60	-	-	44.2	-	-	-	-	-	-
24-Sep-19	6.60	-	-	44.2	-	-	-	-	-	-
1-Oct-19	6.90	-	-	55.3	-	-	-	-	-	-
8-Oct-19	7.10	55.0	0.123	55.3	<1.00	0.889	0.0200	<0.000500	0.167	<0.000500
15-Oct-19	7.00	-	-	55.3	-	-	-	-	-	-
22-Oct-19	6.50	-	-	55.3	-	-	-	-	-	-
29-Oct-19	6.90	-	-	55.3	-	-	-	-	-	-
5-Nov-19	6.80	-	-	48.6	-	-	-	-	-	-
12-Nov-19	6.60	-	0.113	48.6	-	-	-	-	-	-
19-Nov-19	6.70	-	-	48.6	-	-	-	-	-	-
26-Nov-19	6.70	-	-	48.6	-	-	-	-	-	-
3-Dec-19	6.70	-	-	41.7	-	-	-	-	-	-
10-Dec-19	6.70	-	0.0600	41.7	-	-	-	-	-	-
16-Dec-19	6.80	-	-	41.7	-	-	-	-	-	-
23-Dec-19	6.60	-	-	41.7	-	-	-	-	-	-
30-Dec-19	6.70	-	-	41.7	-	-	-	-	-	-
n	252	20	60	60	20	20	20	20	20	20
Minimum	6.10	13.0	0.0140	14.0	<1.00	0.0840	0.0100	<0.000500	0.0220	<0.000500
Maximum	7.40	260	2.15	73.3	1.00	18.5	0.0790	0.00190	6.12	0.00910
Mean	6.71	90.4	0.392	48.3	1.00	3.78	0.0366	0.000880	0.934	0.00166
SD	0.191	66.6	0.476	10.5	-	5.41	0.0210	0.000499	1.53	0.00230
Median	6.70	70.0	0.204	49.2	<1.00	0.820	0.0325	<0.000500	0.204	0.000550
10th Percentile	6.50	21.5	0.0470	35.9	<1.00	0.133	0.0150	<0.000500	0.0495	<0.000500
95th Percentile	7.00	250	1.51	64.1	1.00	16.9	0.0765	0.00190	4.65	0.00730

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected, or SD was incalculable because there was no variability in the data.

Table E.7: **Water Quality at TOMP Station D-2 (Effluent), Denison TMA, 2015 to 2019**

Date	Flow (L/s)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	TSS (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
6-Jan-15	66.0	7.20	-	0.258	<1.00	-	-	-	-	-
13-Jan-15	66.0	7.20	190	0.209	1.00	0.318	0.000600	0.270	0.204	0.0301
20-Jan-15	57.0	7.10	-	0.199	1.00	-	-	-	-	-
27-Jan-15	52.0	7.10	-	0.184	<1.00	-	-	-	-	-
3-Feb-15	52.0	6.90	-	0.167	<1.00	-	-	-	-	-
10-Feb-15	52.0	7.00	180	0.151	1.00	0.238	0.000600	0.250	0.178	0.0305
17-Feb-15	46.0	7.10	-	0.147	1.00	-	-	-	-	-
24-Feb-15	41.0	7.00	-	0.123	1.00	-	-	-	-	-
3-Mar-15	41.0	7.20	-	0.116	1.00	-	-	-	-	-
9-Mar-15	39.0	6.90	-	0.0970	<1.00	-	-	-	-	-
17-Mar-15	36.0	7.06	180	0.107	1.00	0.166	0.000600	0.310	0.208	0.0304
24-Mar-15	39.0	7.00	-	0.108	<1.00	-	-	-	-	-
31-Mar-15	36.0	6.90	-	0.106	<1.00	-	-	-	-	-
7-Apr-15	34.0	7.10	-	0.108	<1.00	-	-	-	-	-
14-Apr-15	39.0	6.70	140	0.0830	1.00	0.134	<0.000500	0.250	0.180	0.0236
21-Apr-15	60.0	6.90	-	0.0840	1.00	-	-	-	-	-
28-Apr-15	63.0	6.90	-	0.0940	<1.00	-	-	-	-	-
5-May-15	49.0	7.00	-	0.0940	<1.00	-	-	-	-	-
12-May-15	44.0	7.00	200	0.100	<1.00	0.160	0.000500	0.280	0.217	0.0283
19-May-15	23.0	6.80	-	0.0940	<1.00	-	-	-	-	-
26-May-15	52.0	7.20	-	0.102	1.00	-	-	-	-	-
2-Jun-15	52.0	7.00	-	0.102	<1.00	-	-	-	-	-
9-Jun-15	12.0	7.00	220	0.0940	1.00	0.120	0.000600	0.140	0.285	0.0326
16-Jun-15	17.0	6.90	-	0.0770	1.00	-	-	-	-	-
23-Jun-15	17.0	6.90	-	0.0770	<1.00	-	-	-	-	-
29-Jun-15	17.0	6.80	-	0.0540	<1.00	-	-	-	-	-
7-Jul-15	17.0	7.30	-	0.0670	<1.00	-	-	-	-	-
14-Jul-15	11.0	7.20	260	0.0480	<1.00	0.0770	<0.000500	0.0700	0.188	0.0399
21-Jul-15	8.00	7.20	-	0.0490	<1.00	-	-	-	-	-
28-Jul-15	7.00	7.40	-	0.0390	<1.00	-	-	-	-	-
4-Aug-15	4.00	7.10	-	0.0210	<1.00	-	-	-	-	-
11-Aug-15	8.00	7.30	290	0.0500	<1.00	0.0640	<0.000500	0.0700	0.159	0.0507
18-Aug-15	7.00	7.20	-	0.0520	1.00	-	-	-	-	-
25-Aug-15	16.0	7.40	-	0.0550	1.00	-	-	-	-	-
1-Sep-15	16.0	7.30	-	0.0800	1.00	-	-	-	-	-
8-Sep-15	12.0	7.36	-	0.0460	<1.00	-	-	-	-	-
15-Sep-15	17.0	7.40	300	0.0390	<1.00	0.0510	<0.000500	0.0740	0.116	0.0465
22-Sep-15	17.0	7.20	-	0.0450	<1.00	-	-	-	-	-
29-Sep-15	17.0	7.40	-	0.0390	<1.00	-	-	-	-	-
7-Oct-15	17.0	7.50	-	0.162	1.00	-	-	-	-	-
13-Oct-15	12.0	7.20	310	0.157	<1.00	0.139	0.000600	0.108	0.244	0.0619
20-Oct-15	9.00	7.00	-	0.199	1.00	-	-	-	-	-
27-Oct-15	17.0	7.10	-	0.158	<1.00	-	-	-	-	-
3-Nov-15	23.0	7.24	-	0.186	1.00	-	-	-	-	-
10-Nov-15	23.0	7.40	-	0.166	1.00	-	-	-	-	-
17-Nov-15	17.0	7.40	320	0.157	<1.00	0.120	0.00100	0.152	0.273	0.0629
24-Nov-15	27.0	7.40	-	0.166	1.00	-	-	-	-	-
1-Dec-15	25.0	7.50	-	0.126	1.00	-	-	-	-	-
8-Dec-15	19.0	7.40	310	0.0900	<1.00	0.0940	0.00110	0.155	0.290	0.0622
15-Dec-15	75.0	7.50	-	0.138	<1.00	-	-	-	-	-
22-Dec-15	133	7.60	-	0.195	<1.00	-	-	-	-	-
29-Dec-15	97.0	7.50	-	0.234	<1.00	-	-	-	-	-
5-Jan-16	84.0	7.40	-	0.356	<1.00	-	-	-	-	-
12-Jan-16	153	7.20	190	0.266	<1.00	0.319	0.000800	0.289	0.164	0.0354
19-Jan-16	75.0	7.10	-	0.223	1.00	-	-	-	-	-
26-Jan-16	81.0	7.10	-	0.244	<1.00	-	-	-	-	-
2-Feb-16	81.0	7.00	-	0.272	1.00	-	-	-	-	-
9-Feb-16	72.0	7.00	180	0.223	<1.00	0.272	0.000600	0.373	0.141	0.0313
16-Feb-16	75.0	7.00	-	0.242	1.00	-	-	-	-	-
23-Feb-16	69.0	7.00	-	0.232	<1.00	-	-	-	-	-
1-Mar-16	57.0	6.90	-	0.217	<1.00	-	-	-	-	-
8-Mar-16	52.0	7.00	180	0.133	<1.00	0.289	0.000600	0.447	0.127	0.0310
15-Mar-16	173	6.91	-	0.319	<1.00	-	-	-	-	-
22-Mar-16	115	6.60	-	0.412	<1.00	-	-	-	-	-
29-Mar-16	118	6.70	-	0.421	1.00	-	-	-	-	-
5-Apr-16	84.0	7.10	-	0.386	1.00	-	-	-	-	-
12-Apr-16	36.0	7.10	130	0.402	<1.00	0.565	<0.000500	0.339	0.111	0.0223
19-Apr-16	87.0	6.90	-	0.301	<1.00	-	-	-	-	-
26-Apr-16	52.0	7.00	-	0.268	1.00	-	-	-	-	-
3-May-16	72.0	7.00	-	0.248	2.00	-	-	-	-	-
10-May-16	126	7.60	150	0.249	1.00	0.376	0.000700	0.360	0.198	0.0251
17-May-16	97.0	7.20	-	0.174	1.00	-	-	-	-	-
24-May-16	19.0	7.10	-	0.157	<1.00	-	-	-	-	-
31-May-16	17.0	6.90	-	0.107	<1.00	-	-	-	-	-
7-Jun-16	17.0	7.00	-	0.103	1.00	-	-	-	-	-
14-Jun-16	12.0	7.00	200	0.0900	1.00	0.161	<0.000500	0.151	0.103	0.0294
21-Jun-16	32.0	7.10	-	0.101	<1.00	-	-	-	-	-
28-Jun-16	14.0	7.00	-	0.0840	<1.00	-	-	-	-	-
5-Jul-16	17.0	7.10	-	0.0430	<1.00	-	-	-	-	-
12-Jul-16	9.00	7.10	220	0.0610	1.00	0.103	<0.000500	0.0700	0.0830	0.0370
19-Jul-16	17.0	7.10	-	0.0600	1.00	-	-	-	-	-
26-Jul-16	9.00	7.00	-	0.0590	1.00	-	-	-	-	-
2-Aug-16	9.00	7.00	-	0.0430	1.00	-	-	-	-	-
9-Aug-16	5.00	7.30	260	0.0330	1.00	0.0850	<0.000500	0.0630	0.0760	0.0450
16-Aug-16	7.00	7.00	-	0.0440	<1.00	-	-	-	-	-
23-Aug-16	9.00	6.90	-	0.0440	1.00	-	-	-	-	-

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table E.7: Water Quality at TOMP Station D-2 (Effluent), Denison TMA, 2015 to 2019

Date	Flow (L/s)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	TSS (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
30-Aug-16	9.00	6.90	-	0.0500	<1.00	-	-	-	-	-
6-Sep-16	9.00	7.10	-	0.0370	<1.00	-	-	-	-	-
13-Sep-16	9.00	7.00	280	0.0400	1.00	0.0720	<0.000500	0.0840	0.0720	0.0504
20-Sep-16	9.00	7.20	-	0.0310	1.00	-	-	-	-	-
27-Sep-16	12.0	7.30	-	0.0580	1.00	-	-	-	-	-
4-Oct-16	17.0	7.30	-	0.0450	<1.00	-	-	-	-	-
11-Oct-16	19.0	7.30	300	0.0820	<1.00	0.0700	<0.000500	0.0860	0.146	0.0518
18-Oct-16	17.0	7.30	-	0.0770	2.00	-	-	-	-	-
25-Oct-16	17.0	7.10	-	0.0890	1.00	-	-	-	-	-
1-Nov-16	17.0	7.20	-	0.122	1.00	-	-	-	-	-
8-Nov-16	17.0	7.10	310	0.0880	1.00	0.0800	0.000600	0.116	0.152	0.0586
15-Nov-16	17.0	7.60	-	0.0850	<1.00	-	-	-	-	-
22-Nov-16	9.00	7.20	-	0.0890	<1.00	-	-	-	-	-
29-Nov-16	0.160	7.00	-	0.0840	1.00	-	-	-	-	-
6-Dec-16	17.0	7.10	-	0.0960	1.00	-	-	-	-	-
13-Dec-16	17.0	7.20	330	0.0700	<1.00	0.0790	0.000900	0.214	0.212	0.0579
20-Dec-16	21.0	7.10	-	0.0570	<1.00	-	-	-	-	-
29-Dec-16	17.0	7.10	-	0.0110	<1.00	-	-	-	-	-
3-Jan-17	27.0	7.00	-	0.0250	<1.00	-	-	-	-	-
10-Jan-17	17.0	6.90	320	0.0450	<1.00	0.0570	0.000900	0.313	0.214	0.0550
17-Jan-17	17.0	7.10	-	0.0430	1.00	-	-	-	-	-
24-Jan-17	27.0	6.80	-	0.0270	<1.00	-	-	-	-	-
31-Jan-17	17.0	7.00	-	0.0320	1.00	-	-	-	-	-
7-Feb-17	9.00	6.80	-	0.0190	<1.00	-	-	-	-	-
14-Feb-17	9.00	7.10	320	0.0460	1.00	0.0670	0.00110	0.437	0.251	0.0615
21-Feb-17	17.0	6.80	-	0.0600	1.00	-	-	-	-	-
28-Feb-17	39.0	7.10	-	0.0880	1.00	-	-	-	-	-
7-Mar-17	66.0	6.90	-	0.0200	<1.00	-	-	-	-	-
14-Mar-17	173	7.00	-	0.306	1.00	-	-	-	-	-
21-Mar-17	240	7.00	200	0.292	1.00	0.409	0.000700	0.540	0.168	0.0414
28-Mar-17	97.0	7.20	-	0.252	2.00	-	-	-	-	-
4-Apr-17	81.0	7.00	-	0.128	2.00	-	-	-	-	-
11-Apr-17	194	7.00	140	0.174	1.00	0.261	0.000700	0.609	0.172	0.0239
18-Apr-17	115	7.00	-	0.148	1.00	-	-	-	-	-
25-Apr-17	52.0	7.20	-	0.168	2.00	-	-	-	-	-
2-May-17	66.0	7.30	-	0.165	1.00	-	-	-	-	-
9-May-17	39.0	7.50	-	0.164	1.00	-	-	-	-	-
16-May-17	39.0	7.40	-	0.113	1.00	-	-	-	-	-
23-May-17	52.0	7.50	240	0.121	1.00	0.161	0.000600	0.315	0.182	0.0393
30-May-17	39.0	7.40	-	0.145	1.00	-	-	-	-	-
6-Jun-17	87.0	7.60	-	0.124	1.00	-	-	-	-	-
13-Jun-17	17.0	7.50	220	0.150	<1.00	0.217	<0.000500	0.151	0.129	0.0375
20-Jun-17	52.0	7.50	-	0.133	1.00	-	-	-	-	-
27-Jun-17	52.0	7.60	-	0.150	<1.00	-	-	-	-	-
4-Jul-17	115	7.40	-	0.116	1.00	-	-	-	-	-
11-Jul-17	69.0	7.30	200	0.108	1.00	0.235	<0.000500	0.126	0.117	0.0335
18-Jul-17	72.0	7.50	-	0.143	1.00	-	-	-	-	-
25-Jul-17	9.00	7.40	-	0.113	<1.00	-	-	-	-	-
1-Aug-17	17.0	7.40	-	0.0690	1.00	-	-	-	-	-
8-Aug-17	17.0	7.20	220	0.100	<1.00	0.147	<0.000500	0.139	0.0890	0.0326
15-Aug-17	21.0	7.40	-	0.0780	1.00	-	-	-	-	-
22-Aug-17	21.0	7.40	-	0.0970	2.00	-	-	-	-	-
29-Aug-17	17.0	7.40	-	0.0680	<1.00	-	-	-	-	-
5-Sep-17	17.0	7.40	-	0.0650	1.00	-	-	-	-	-
12-Sep-17	14.0	7.50	240	0.0640	2.00	0.105	<0.000500	0.200	0.125	0.0388
19-Sep-17	14.0	7.40	-	0.0460	<1.00	-	-	-	-	-
26-Sep-17	14.0	7.50	-	0.0340	2.00	-	-	-	-	-
3-Oct-17	12.0	7.30	-	0.0420	1.00	-	-	-	-	-
12-Oct-17	16.0	7.40	270	0.0550	<1.00	0.0970	<0.000500	0.120	0.109	0.0399
17-Oct-17	21.0	7.00	-	0.109	<1.00	-	-	-	-	-
25-Oct-17	203	7.50	-	0.180	1.00	-	-	-	-	-
31-Oct-17	81.0	7.20	-	0.194	<1.00	-	-	-	-	-
7-Nov-17	81.0	7.20	-	0.149	<1.00	-	-	-	-	-
14-Nov-17	81.0	7.50	210	0.205	<1.00	0.333	0.000600	0.134	0.178	0.0328
21-Nov-17	81.0	7.40	-	0.149	1.00	-	-	-	-	-
28-Nov-17	81.0	7.40	-	0.156	<1.00	-	-	-	-	-
5-Dec-17	194	7.20	-	0.185	<1.00	-	-	-	-	-
12-Dec-17	81.0	7.30	190	0.231	1.00	0.370	0.000600	0.204	0.150	0.0318
19-Dec-17	39.0	7.30	-	0.239	1.00	-	-	-	-	-
27-Dec-17	52.0	7.40	-	0.273	1.00	-	-	-	-	-
2-Jan-18	87.0	7.00	-	0.233	2.00	-	-	-	-	-
9-Jan-18	87.0	7.10	160	0.230	1.00	0.451	0.000500	0.449	0.123	0.0241
16-Jan-18	66.0	7.20	-	0.264	1.00	-	-	-	-	-
23-Jan-18	66.0	7.20	-	0.299	1.00	-	-	-	-	-
30-Jan-18	87.0	7.10	-	0.357	1.00	-	-	-	-	-
6-Feb-18	73.0	7.10	-	0.344	1.00	-	-	-	-	-
13-Feb-18	87.0	7.20	140	0.338	1.00	0.533	0.000500	0.569	0.144	0.0195
20-Feb-18	39.0	7.30	-	0.405	1.00	-	-	-	-	-
27-Feb-18	87.0	7.30	-	0.390	2.00	-	-	-	-	-
6-Mar-18	60.0	7.40	-	0.422	1.00	-	-	-	-	-
13-Mar-18	39.0	7.30	140	0.289	2.00	0.454	0.000500	0.593	0.125	0.0196
20-Mar-18	39.0	7.30	-	0.199	2.00	0.395	-	-	-	-
27-Mar-18	39.0	7.20	-	0.186	2.00	0.314	-	-	-	-
3-Apr-18	39.0	7.30	-	0.140	1.00	0.340	-	-	-	-
10-Apr-18	39.0	7.20	150	0.126	2.00	0.343	0.000500	0.455	0.186	0.0234
17-Apr-18	60.0	7.00	-	0.115	<1.00	0.300	-	-	-	-

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table E.7: Water Quality at TOMP Station D-2 (Effluent), Denison TMA, 2015 to 2019

Date	Flow (L/s)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	TSS (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
24-Apr-18	87.0	7.20	-	0.184	1.00	0.541	-	-	-	-
1-May-18	97.0	7.10	-	0.231	<1.00	0.742	-	-	-	-
8-May-18	115	7.00	98.0	0.203	1.00	0.450	<0.000500	0.334	0.161	0.0134
15-May-18	115	7.30	-	0.283	2.00	0.537	-	-	-	-
22-May-18	97.0	7.60	-	0.287	2.00	0.546	-	-	-	-
29-May-18	97.0	7.50	-	0.374	2.00	0.580	-	-	-	-
5-Jun-18	29.0	7.30	-	0.214	1.00	0.381	-	-	-	-
12-Jun-18	27.0	7.40	-	0.161	1.00	0.319	-	-	-	-
19-Jun-18	17.0	7.30	170	0.113	1.00	0.293	<0.000500	0.142	0.153	0.0198
26-Jun-18	16.0	7.40	-	0.114	1.00	0.250	-	-	-	-
3-Jul-18	16.0	7.30	-	0.116	1.00	0.273	-	-	-	-
10-Jul-18	14.0	7.00	190	0.0730	<1.00	0.228	<0.000500	0.130	0.0970	0.0283
17-Jul-18	16.0	7.00	-	0.0530	1.00	0.213	-	-	-	-
24-Jul-18	13.0	7.30	-	0.0710	<1.00	0.162	-	-	-	-
31-Jul-18	9.00	7.20	-	0.0580	<1.00	0.181	-	-	-	-
7-Aug-18	12.0	7.30	-	0.0440	1.00	0.113	-	-	-	-
14-Aug-18	9.00	7.30	240	0.0380	1.00	0.107	<0.000500	0.0800	0.116	0.0360
21-Aug-18	8.00	7.20	-	0.0400	1.00	0.108	-	-	-	-
28-Aug-18	9.00	7.20	-	0.0380	<1.00	0.100	-	-	-	-
4-Sep-18	9.00	7.10	-	0.0400	<1.00	0.0980	-	-	-	-
11-Sep-18	9.00	7.00	230	0.0470	1.00	0.0790	<0.000500	0.0830	0.0730	0.0357
18-Sep-18	9.00	7.10	-	0.0290	1.00	0.0750	-	-	-	-
25-Sep-18	9.00	7.10	-	0.0530	1.00	0.0890	-	-	-	-
2-Oct-18	27.0	7.20	-	0.0620	1.00	0.0840	-	-	-	-
9-Oct-18	19.0	7.00	240	0.132	1.00	0.107	0.000700	0.123	0.234	0.0467
16-Oct-18	27.0	7.30	-	0.199	1.00	-	-	-	-	-
23-Oct-18	23.0	7.20	-	0.152	1.00	-	-	-	-	-
30-Oct-18	27.0	7.20	-	0.117	1.00	-	-	-	-	-
6-Nov-18	17.0	7.20	-	0.118	<1.00	-	-	-	-	-
13-Nov-18	17.0	7.30	250	0.108	2.00	0.100	0.000800	0.168	0.238	0.0475
20-Nov-18	23.0	7.00	-	0.0590	1.00	-	-	-	-	-
27-Nov-18	17.0	7.50	-	0.0320	<1.00	-	-	-	-	-
4-Dec-18	19.0	7.40	270	0.0380	<1.00	0.0460	0.000700	0.107	0.228	0.0507
11-Dec-18	17.0	7.30	-	0.0440	1.00	-	-	-	-	-
18-Dec-18	16.0	7.30	-	0.0490	1.00	-	-	-	-	-
27-Dec-18	14.0	6.90	-	0.0510	1.00	-	-	-	-	-
2-Jan-19	16.0	6.90	-	0.0520	1.00	-	-	-	-	-
8-Jan-19	17.0	7.00	260	0.0460	1.00	0.0560	0.000800	0.206	0.260	0.0472
15-Jan-19	17.0	7.20	-	0.0410	1.00	-	-	-	-	-
22-Jan-19	17.0	7.20	-	0.0440	<1.00	-	-	-	-	-
29-Jan-19	17.0	7.30	-	0.0340	2.00	-	-	-	-	-
5-Feb-19	9.00	7.10	-	0.0340	1.00	-	-	-	-	-
12-Feb-19	14.0	7.10	240	0.0550	1.00	0.0810	0.000900	0.176	0.429	0.0555
19-Feb-19	17.0	7.20	-	0.133	2.00	-	-	-	-	-
26-Feb-19	97.0	7.30	-	0.198	1.00	-	-	-	-	-
4-Mar-19	97.0	7.30	-	0.300	2.00	-	-	-	-	-
12-Mar-19	66.0	7.40	150	0.276	2.00	0.474	0.000700	0.544	0.198	0.0299
19-Mar-19	52.0	7.40	-	0.220	1.00	0.517	-	-	-	-
26-Mar-19	89.0	7.40	-	0.270	1.00	0.588	-	-	-	-
2-Apr-19	104	7.30	-	0.226	<1.00	0.663	-	-	-	-
9-Apr-19	194	7.40	150	0.300	1.00	0.616	0.000700	0.341	0.223	0.0225
16-Apr-19	115	7.30	-	0.401	1.00	0.859	-	-	-	-
22-Apr-19	173	7.10	-	0.263	1.00	-	-	-	-	-
29-Apr-19	340	6.90	-	0.304	1.00	1.13	-	-	-	-
7-May-19	203	6.90	-	0.132	2.00	0.724	-	-	-	-
14-May-19	153	7.30	120	0.126	1.00	0.368	0.000500	0.216	0.226	0.0176
21-May-19	173	7.50	-	0.128	2.00	0.481	-	-	-	-
28-May-19	133	7.60	-	0.171	<1.00	0.604	-	-	-	-
4-Jun-19	97.0	7.60	-	0.204	2.00	0.840	-	-	-	-
11-Jun-19	122	7.60	130	0.260	2.00	0.696	0.000500	0.213	0.201	0.0197
17-Jun-19	97.0	7.60	-	0.240	1.00	0.663	-	-	-	-
25-Jun-19	133	7.10	-	0.243	1.00	0.707	-	-	-	-
2-Jul-19	122	7.10	-	0.240	1.00	0.760	-	-	-	-
9-Jul-19	39.0	7.40	120	0.212	2.00	0.667	<0.000500	0.122	0.129	0.0176
16-Jul-19	23.0	7.00	-	0.150	1.00	0.524	-	-	-	-
23-Jul-19	16.0	7.40	-	0.122	1.00	0.372	-	-	-	-
30-Jul-19	16.0	7.00	-	0.0950	1.00	0.384	-	-	-	-
6-Aug-19	14.0	7.20	-	0.0820	2.00	0.289	-	-	-	-
13-Aug-19	14.0	7.20	160	0.0680	1.00	0.221	<0.000500	0.0890	0.0840	0.0230
20-Aug-19	12.0	7.10	-	0.0320	1.00	0.185	-	-	-	-
27-Aug-19	16.0	7.00	-	0.0430	2.00	0.198	-	-	-	-
3-Sep-19	9.00	7.30	-	0.0440	3.00	0.219	-	-	-	-
10-Sep-19	14.0	7.00	190	0.0470	1.00	0.118	<0.000500	0.0780	0.0450	0.0334
17-Sep-19	16.0	7.40	-	0.0390	2.00	0.108	-	-	-	-
24-Sep-19	17.0	7.40	-	0.0380	1.00	0.0760	-	-	-	-
1-Oct-19	27.0	7.10	-	0.0510	2.00	0.111	-	-	-	-
8-Oct-19	17.0	7.30	230	0.0740	1.00	0.102	<0.000500	0.105	0.191	0.0447
15-Oct-19	21.0	7.00	-	0.0810	1.00	0.0950	-	-	-	-
22-Oct-19	130	6.70	-	0.100	2.00	0.131	-	-	-	-
29-Oct-19	113	7.30	-	0.245	1.00	0.223	-	-	-	-
5-Nov-19	106	7.00	-	0.111	1.00	0.134	-	-	-	-
12-Nov-19	39.0	7.20	220	0.140	2.00	0.200	0.000800	0.206	0.241	0.0458
19-Nov-19	49.0	7.20	-	0.127	1.00	0.211	-	-	-	-
26-Nov-19	66.0	7.20	-	0.170	1.00	0.308	-	-	-	-
3-Dec-19	52.0	7.20	-	0.195	1.00	0.378	-	-	-	-
10-Dec-19	57.0	7.10	180	0.222	1.00	0.460	0.000600	0.362	0.182	0.0325
16-Dec-19	52.0	7.00	-	0.265	1.00	0.446	-	-	-	-
23-Dec-19	66.0	7.20	-	0.224	2.00	0.433	-	-	-	-
30-Dec-19	72.0	7.10	-	0.146	1.00	0.366	-	-	-	-
n	261	261	60	261	261	115	60	60	60	60
Minimum	0.160	6.60	98.0	0.0110	<1.00	0.0460	<0.000500	0.0630	0.0450	0.0134
Maximum	340	7.60	330	0.422	3.00	1.13	0.00110	0.609	0.429	0.0629
Mean	49.4	7.19	214	0.140	1.14	0.299	0.000612	0.232	0.172	0.0366
SD	48.6	0.203	60.9	0.0954	0.357	0.221	0.000158	0.150	0.0672	0.0131
Median	27.0	7.20	205	0.116	1.00	0.235	0.000500	0.188	0.170	0.0334
10th Percentile	9.00	6.90	140	0.0400	<1.00	0.0790	<0.000500	0.0790	0.0865	0.0197
95th Percentile	133	7.50	320	0.319	2.00	0.724	0.000950	0.556	0.279	0.0617

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table E.8: Water Quality at TOMP Station BH91-D1A (Groundwater), Denison TMA, 2015 to 2019

Date	pH	Sulphate (mg/L)	Acidity (mg/L)	Iron (mg/L)
26-Aug-15	7.13	980	<1.00	33.3
14-Jul-16	6.81	790	<1.00	32.0
31-Aug-17	7.30	830	<1.00	33.6
10-Sep-18	6.90	770	<1.00	22.2
n	4	4	4	4
Minimum	6.81	770	<1.00	22.2
Maximum	7.30	980	<1.00	33.6
Mean	7.04	842	<1.00	30.3
SD	0.222	95.0	-	5.43
Median	7.02	810	<1.00	32.6
10th Percentile	6.81	770	<1.00	22.2
95th Percentile	7.30	980	<1.00	33.6

Note: "SD" = standard deviation. "n" = number of samples. "-" = SD was incalculable because there was no variability in the data.

Table E.9: Water Quality at TOMP Station BH91-D1B (Groundwater), Denison TMA, 2015 to 2019

Date	pH	Sulphate (mg/L)	Acidity (mg/L)	Iron (mg/L)
18-Aug-15	7.68	690	2.00	0.100
14-Jul-16	7.61	570	<1.00	0.0200
31-Aug-17	7.30	620	<1.00	1.73
n	3	3	3	3
Minimum	7.30	570	<1.00	0.0200
Maximum	7.68	690	2.00	1.73
Mean	7.53	627	1.33	0.617
SD	0.202	60.3	-	0.965
Median	7.61	620	<1.00	0.100
10th Percentile	7.30	570	<1.00	0.0200
95th Percentile	7.68	690	2.00	1.73

Note: "SD" = standard deviation. "n" = number of samples. "-" = SD was incalculable because there was no variability in the data.

Table E.10: Water Quality at TOMP Station BH91-D3B (Groundwater), Denison TMA, 2015 to 2019

Date	pH	Sulphate (mg/L)	Acidity (mg/L)	Iron (mg/L)
25-Aug-15	6.31	1,500	277	214
14-Jul-16	6.30	1,300	245	125
31-Aug-17	6.40	1,400	215	171
5-Sep-18	6.58	1,500	204	185
26-Aug-19	6.63	1,400	228	140
n	5	5	5	5
Minimum	6.30	1,300	204	125
Maximum	6.63	1,500	277	214
Mean	6.44	1,420	234	167
SD	0.153	83.7	28.6	35.5
Median	6.40	1,400	228	171
10th Percentile	6.30	1,300	204	125
95th Percentile	6.63	1,500	277	214

Note: "SD" = standard deviation. "n" = number of samples.

Table E.11: Water Quality at TOMP Station BH91-DG4B (Groundwater), Denison TMA, 2015 to 2019

Date	pH	Sulphate (mg/L)	Acidity (mg/L)	Iron (mg/L)
12-Aug-15	6.27	710	<1.00	10.5
13-Jul-16	6.21	700	<1.00	10.4
17-Aug-17	6.20	730	<1.00	21.9
5-Sep-18	6.58	560	<1.00	13.9
27-Aug-19	6.22	670	<1.00	13.8
n	5	5	5	5
Minimum	6.20	560	<1.00	10.4
Maximum	6.58	730	<1.00	21.9
Mean	6.30	674	<1.00	14.1
SD	0.161	67.3	-	4.68
Median	6.22	700	<1.00	13.8
10th Percentile	6.20	560	<1.00	10.4
95th Percentile	6.58	730	<1.00	21.9

Note: "SD" = standard deviation. "n" = number of samples. "-" = SD was incalculable because there was no variability in the data.

Table E.12: Water Quality at TOMP Station BH91-D9A (Groundwater), Denison TMA, 2015 to 2019

Date	pH	Sulphate (mg/L)	Acidity (mg/L)	Iron (mg/L)
27-Aug-15	6.33	1,700	256	204
11-Jul-16	6.25	1,800	224	189
31-Aug-17	6.60	1,600	238	223
6-Sep-18	6.58	1,600	220	202
29-Aug-19	6.52	1,500	196	201
n	5	5	5	5
Minimum	6.25	1,500	196	189
Maximum	6.60	1,800	256	223
Mean	6.46	1,640	227	204
SD	0.157	114	22.3	12.2
Median	6.52	1,600	224	202
10th Percentile	6.25	1,500	196	189
95th Percentile	6.60	1,800	256	223

Note: "SD" = standard deviation. "n" = number of samples.

Table E.13: Water Level at TOMP Station D-1, Denison TMA, 2015 to 2019

Date	Elevation (m)
6-Jan-15	386.97
13-Jan-15	386.95
20-Jan-15	386.94
27-Jan-15	386.93
3-Feb-15	386.90
10-Feb-15	386.90
17-Feb-15	386.90
24-Feb-15	386.89
3-Mar-15	386.88
10-Mar-15	386.88
17-Mar-15	386.88
24-Mar-15	386.86
31-Mar-15	386.87
7-Apr-15	386.87
14-Apr-15	386.97
21-Apr-15	387.02
28-Apr-15	387.03
5-May-15	387.02
12-May-15	387.03
19-May-15	387.04
26-May-15	387.01
2-Jun-15	387.04
9-Jun-15	387.03
16-Jun-15	387.03
23-Jun-15	387.01
29-Jun-15	386.97
7-Jul-15	386.94
14-Jul-15	386.91
21-Jul-15	386.87
28-Jul-15	386.81
4-Aug-15	386.79
11-Aug-15	386.78
18-Aug-15	386.73
25-Aug-15	386.78
1-Sep-15	386.77
8-Sep-15	386.75
15-Sep-15	386.76
22-Sep-15	386.81
29-Sep-15	386.79
7-Oct-15	386.75
13-Oct-15	386.76
20-Oct-15	386.75
27-Oct-15	386.75
3-Nov-15	386.85
10-Nov-15	386.87
17-Nov-15	386.90
24-Nov-15	386.96
1-Dec-15	386.96
8-Dec-15	387.01
15-Dec-15	387.15
22-Dec-15	387.13
29-Dec-15	387.18
5-Jan-16	387.18
12-Jan-16	387.17
19-Jan-16	387.15
26-Jan-16	387.11
2-Feb-16	387.10

Date	Elevation (m)
9-Feb-16	387.11
16-Feb-16	387.08
23-Feb-16	387.07
1-Mar-16	387.07
8-Mar-16	387.06
15-Mar-16	387.06
22-Mar-16	387.12
29-Mar-16	387.09
5-Apr-16	387.12
12-Apr-16	387.13
19-Apr-16	387.14
26-Apr-16	387.15
3-May-16	387.12
10-May-16	387.08
17-May-16	387.03
24-May-16	386.99
31-May-16	387.01
7-Jun-16	387.00
14-Jun-16	386.98
21-Jun-16	386.93
28-Jun-16	386.89
5-Jul-16	386.87
12-Jul-16	386.85
19-Jul-16	386.81
26-Jul-16	386.82
2-Aug-16	386.79
9-Aug-16	386.72
16-Aug-16	386.72
23-Aug-16	386.70
30-Aug-16	386.74
6-Sep-16	386.70
13-Sep-16	386.66
20-Sep-16	386.69
27-Sep-16	386.72
4-Oct-16	386.70
11-Oct-16	386.71
18-Oct-16	386.75
25-Oct-16	386.72
1-Nov-16	386.73
8-Nov-16	386.73
15-Nov-16	386.71
22-Nov-16	386.73
29-Nov-16	386.75
6-Dec-16	386.76
13-Dec-16	386.78
20-Dec-16	386.78
29-Dec-16	386.80
3-Jan-17	386.80
10-Jan-17	386.80
17-Jan-17	386.84
24-Jan-17	386.85
31-Jan-17	386.85
7-Feb-17	386.79
14-Feb-17	386.89
21-Feb-17	386.90
28-Feb-17	386.92
7-Mar-17	386.96

Date	Elevation (m)
14-Mar-17	386.94
21-Mar-17	386.91
28-Mar-17	386.95
4-Apr-17	386.99
11-Apr-17	387.05
18-Apr-17	387.09
25-Apr-17	387.08
2-May-17	387.10
9-May-17	387.08
16-May-17	387.06
23-May-17	387.07
30-May-17	387.09
6-Jun-17	387.07
13-Jun-17	387.04
20-Jun-17	387.03
27-Jun-17	386.96
4-Jul-17	386.98
11-Jul-17	386.96
18-Jul-17	386.92
25-Jul-17	386.91
1-Aug-17	386.91
8-Aug-17	386.90
15-Aug-17	386.94
22-Aug-17	387.00
29-Aug-17	386.98
5-Sep-17	386.96
12-Sep-17	386.96
19-Sep-17	386.93
26-Sep-17	386.95
3-Oct-17	386.93
12-Oct-17	386.97
17-Oct-17	386.99
24-Oct-17	387.01
31-Oct-17	387.14
7-Nov-17	387.08
14-Nov-17	387.09
21-Nov-17	387.12
28-Nov-17	387.09
5-Dec-17	387.15
12-Dec-17	387.16
19-Dec-17	387.14
26-Dec-17	387.12
2-Jan-18	387.09
9-Jan-18	387.07
16-Jan-18	387.07
23-Jan-18	387.07
30-Jan-18	387.04
6-Feb-18	387.03
13-Feb-18	387.00
20-Feb-18	386.98
27-Feb-18	386.96
6-Mar-18	386.94
13-Mar-18	386.94
20-Mar-18	386.92
27-Mar-18	386.91
3-Apr-18	386.90
10-Apr-18	386.92

Note: "SD" = standard deviation. "n" = number of samples.

Table E.13: Water Level at TOMP Station D-1, Denison TMA, 2015 to 2019

Date	Elevation (m)
17-Apr-18	386.94
24-Apr-18	386.93
1-May-18	387.01
8-May-18	387.04
15-May-18	387.04
22-May-18	386.98
29-May-18	386.93
5-Jun-18	386.90
12-Jun-18	386.86
19-Jun-18	386.89
26-Jun-18	386.85
3-Jul-18	386.83
10-Jul-18	386.77
17-Jul-18	386.73
24-Jul-18	386.72
31-Jul-18	386.74
7-Aug-18	386.74
14-Aug-18	386.70
21-Aug-18	386.67
28-Aug-18	386.65
4-Sep-18	386.66
11-Sep-18	386.64
18-Sep-18	386.62
25-Sep-18	386.63
2-Oct-18	386.65
9-Oct-18	386.73
16-Oct-18	386.85
23-Oct-18	386.85
30-Oct-18	386.87
6-Nov-18	386.88
13-Nov-18	386.90
20-Nov-18	386.90
27-Nov-18	386.94
4-Dec-18	386.93
11-Dec-18	386.94
18-Dec-18	386.93
25-Dec-18	386.93
2-Jan-19	386.97
8-Jan-19	386.98
15-Jan-19	387.00
22-Jan-19	387.00
29-Jan-19	387.04
5-Feb-19	387.04
12-Feb-19	387.05
19-Feb-19	387.06
28-Feb-19	387.08
4-Mar-19	387.07
12-Mar-19	387.05
19-Mar-19	387.06
26-Mar-19	387.05
2-Apr-19	387.02
9-Apr-19	387.05
16-Apr-19	387.06
22-Apr-19	387.13
30-Apr-19	387.19
7-May-19	387.17

Date	Elevation (m)
14-May-19	387.17
21-May-19	387.17
28-May-19	387.16
4-Jun-19	387.09
11-Jun-19	387.07
18-Jun-19	387.03
25-Jun-19	386.98
2-Jul-19	386.93
5-Jul-19	386.89
16-Jul-19	386.91
23-Jul-19	386.86
30-Jul-19	386.86
6-Aug-19	386.82
13-Aug-19	386.84
20-Aug-19	386.82
27-Aug-19	386.80
3-Sep-19	386.79
10-Sep-19	386.82
17-Sep-19	386.82
24-Sep-19	386.85
1-Oct-19	386.90
8-Oct-19	386.90
15-Oct-19	386.93
22-Oct-19	387.02
29-Oct-19	387.06
5-Nov-19	387.08
12-Nov-19	387.10
19-Nov-19	387.10
26-Nov-19	387.14
3-Dec-19	387.16
10-Dec-19	387.15
16-Dec-19	387.15
23-Dec-19	387.15
30-Dec-19	387.16
n	126
Minimum	386.57
Maximum	387.19
Mean	387.04
SD	0.099990
Median	387.06
10th Percentile	386.90
95th Percentile	387.17

Note: "SD" = standard deviation. "n" = number of samples.

APPENDIX F

SPANISH-AMERICAN TMA, TOMP DATA

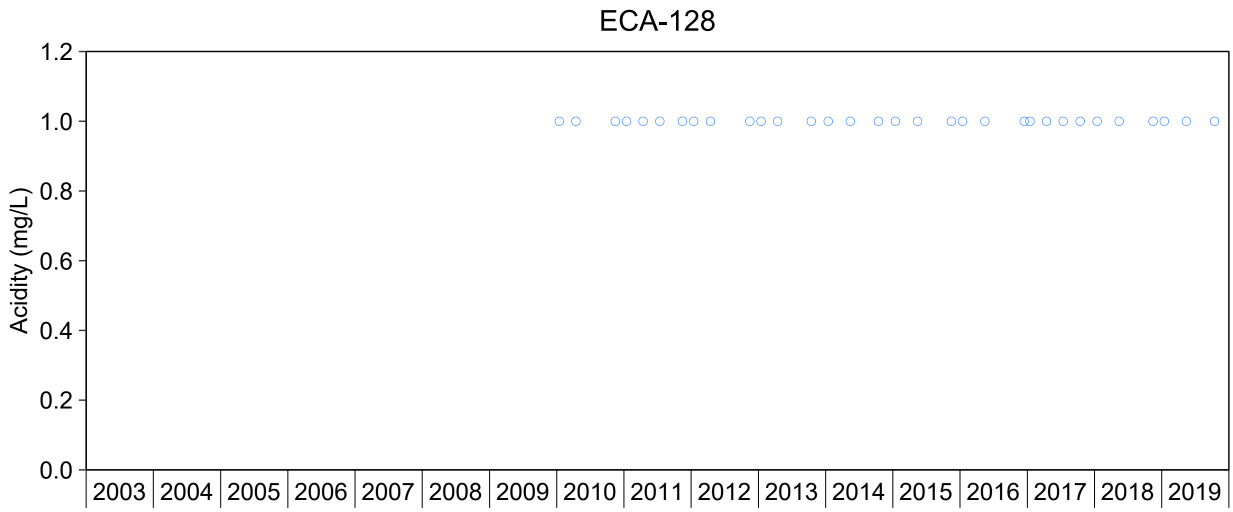


Figure F.1: Concentrations of Acidity for TOMP Water Monitoring Stations, Spanish-American TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 4.8 for Seasonal Kendall trend analysis results and Appendix Table F.2 for raw data. Acidity (mg/L) is not included in the trend analysis for TOMP station ECA-128 due to >50% non-detectable concentrations in the dataset.

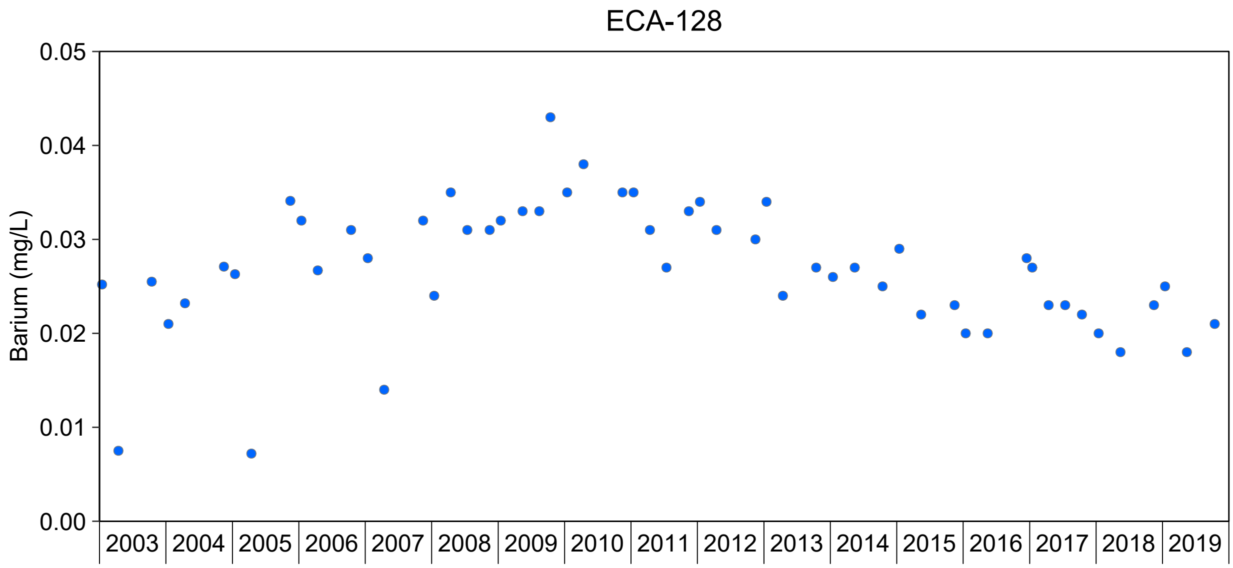


Figure F.2: Concentrations of Barium for TOMP Water Monitoring Stations, Spanish-American TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 4.8 for Seasonal Kendall trend analysis results and Appendix Table F.2 for raw data.

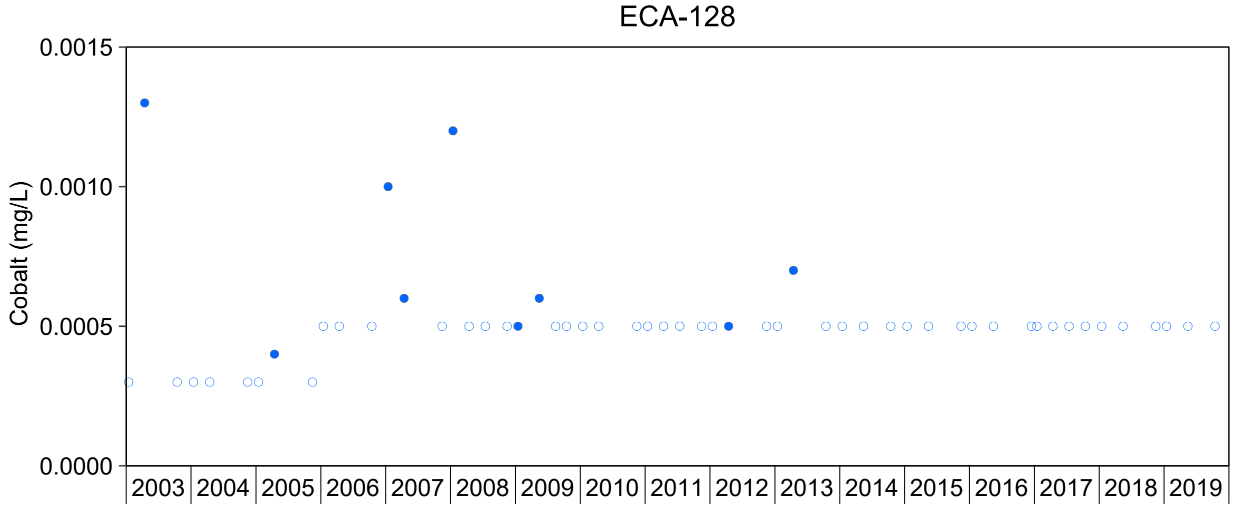


Figure F.3: Concentrations of Cobalt for TOMP Water Monitoring Stations, Spanish-American TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 4.8 for Seasonal Kendall trend analysis results and Appendix Table F.2 for raw data. Cobalt (mg/L) is not included in the trend analysis for TOMP station ECA-128 due to >50% non-detectable concentrations in the dataset.

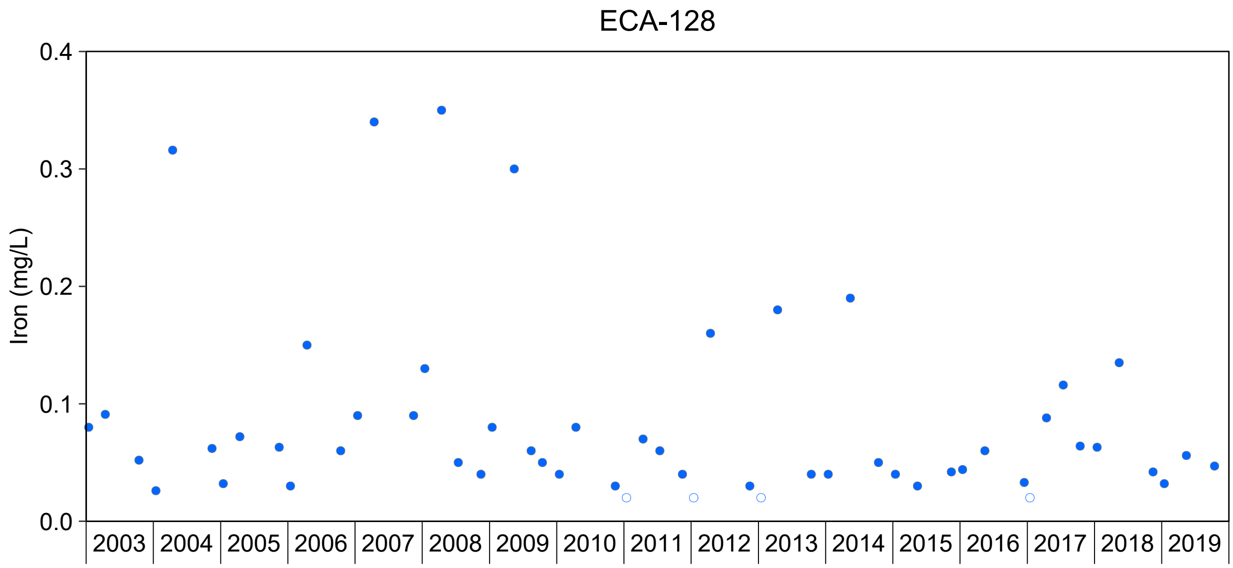


Figure F.4: Concentrations of Iron for TOMP Water Monitoring Stations, Spanish-American TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 4.8 for Seasonal Kendall trend analysis results and Appendix Table F.2 for raw data.

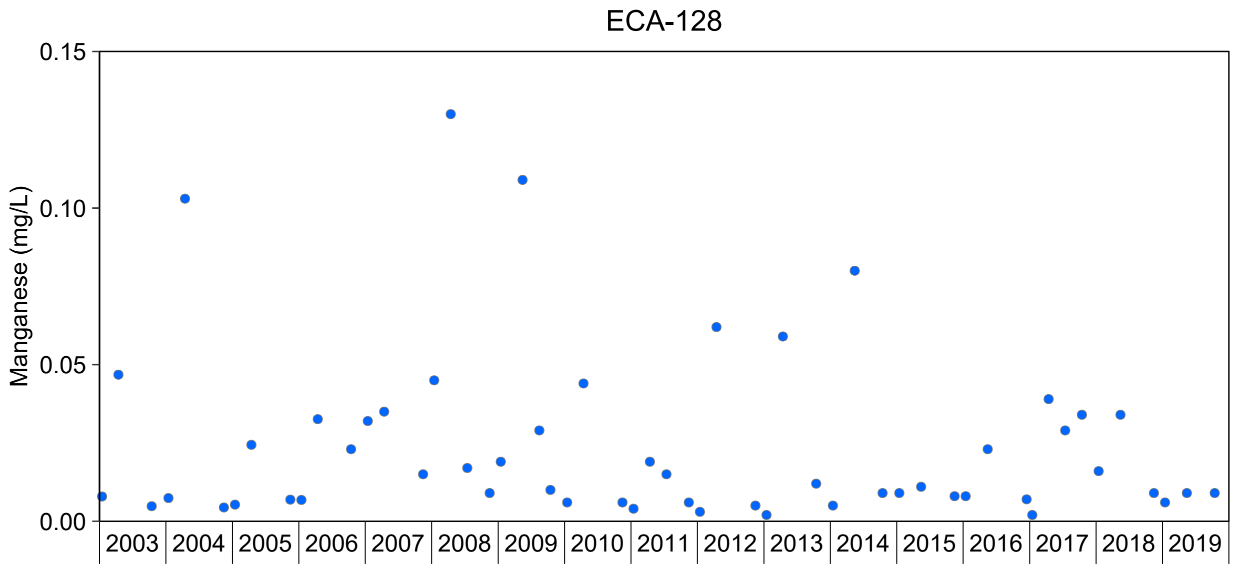


Figure F.5: Concentrations of Manganese for TOMP Water Monitoring Stations, Spanish-American TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL.
See Table 4.8 for Seasonal Kendall trend analysis results and Appendix Table F.2 for raw data.

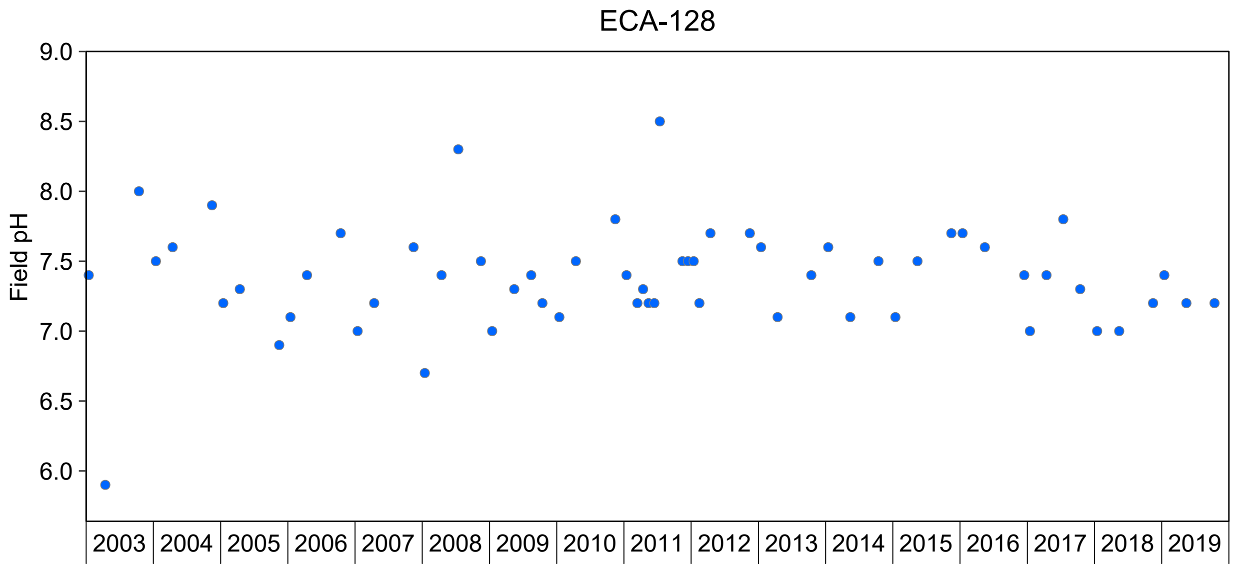


Figure F.6: Field Measurements of pH for TOMP Water Monitoring Stations, Spanish-American TMA, 2003 to 2019

Notes: See Table 4.8 for Seasonal Kendall trend analysis results and Appendix Table F.2 for raw data.

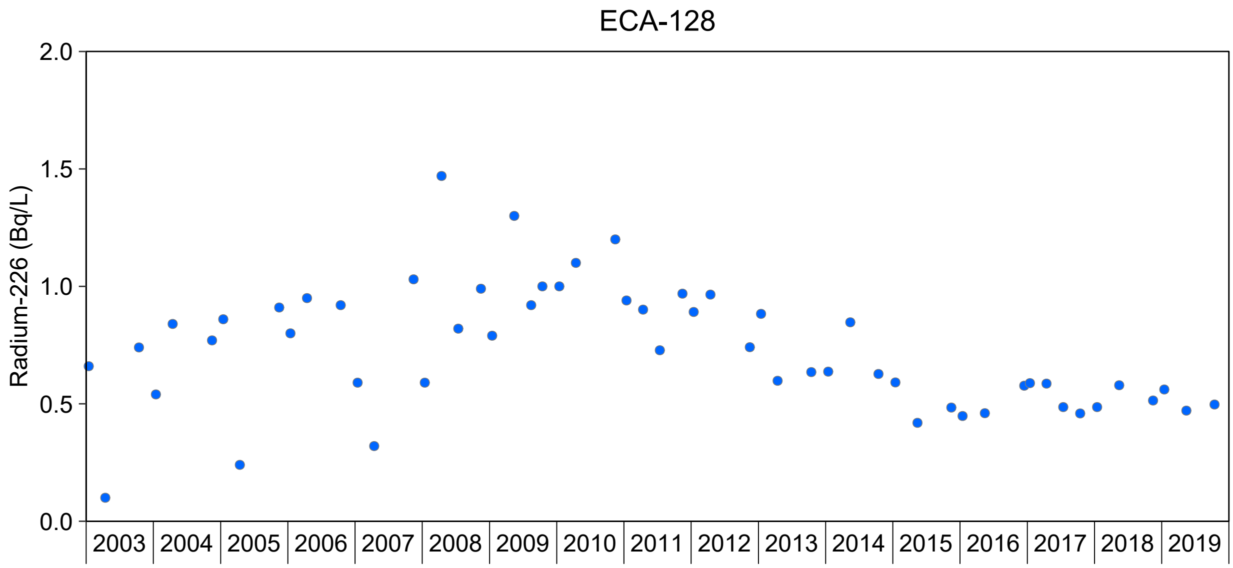


Figure F.7: Concentrations of Radium-226 for TOMP Water Monitoring Stations, Spanish-American TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 4.8 for Seasonal Kendall trend analysis results and Appendix Table F.2 for raw data.

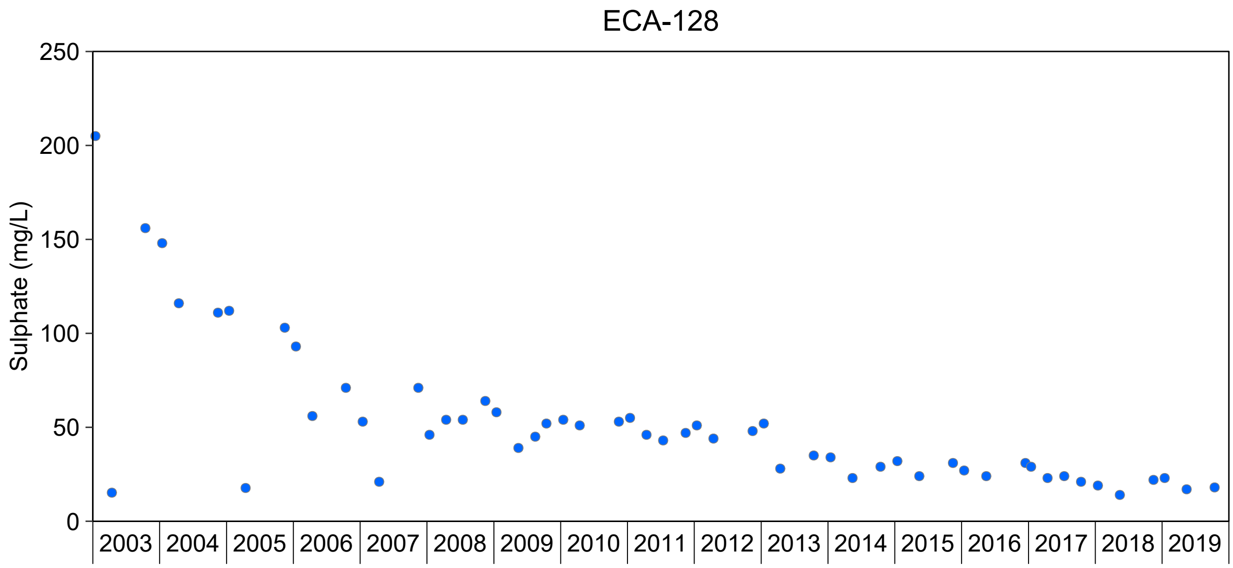


Figure F.8: Concentrations of Sulphate for TOMP Water Monitoring Stations, Spanish-American TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 4.8 for Seasonal Kendall trend analysis results and Appendix Table F.2 for raw data.

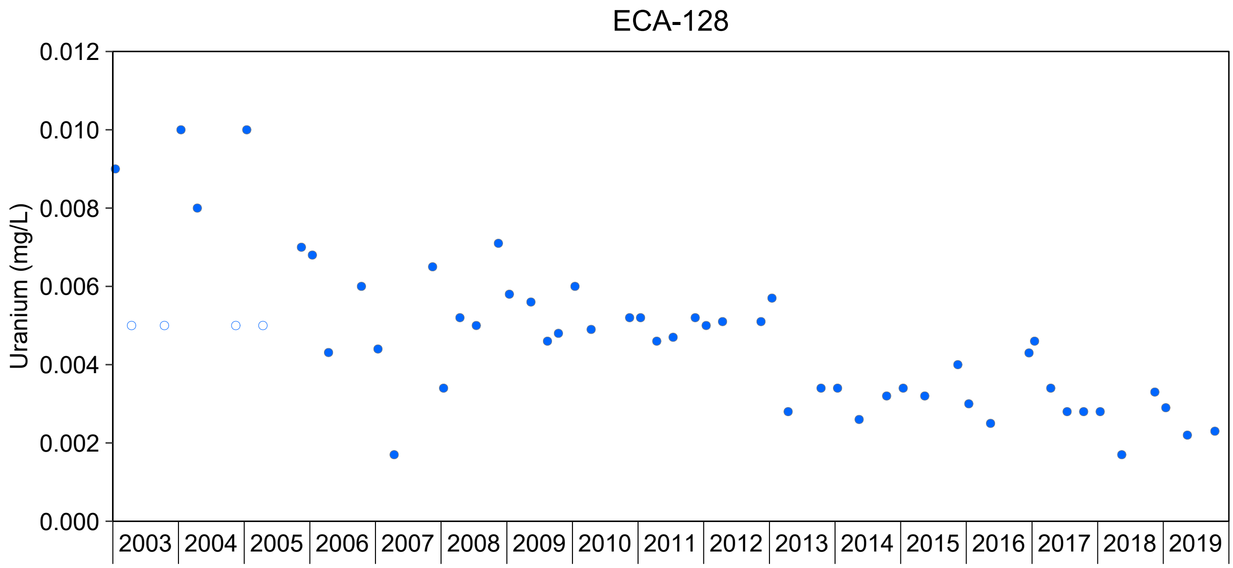


Figure F.9: Concentrations of Uranium for TOMP Water Monitoring Stations, Spanish-American TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 4.8 for Seasonal Kendall trend analysis results and Appendix Table F.2 for raw data.

Table F.1: Location of TOMP Data Tables and Figures Within this Cycle 5 SOE Report, Spanish-American TMA

TMA	TOMP Station	Station Type/Purpose	Also a SAMP Station?	Map Figures	Elevation Tables	Elevation Figures	Water Quality Data Tables (flow, acidity, barium, cobalt, iron, manganese, pH, radium-226, sulphate, uranium, conductivity, TSS, and/or treatment chemical consumption)	Comparison to EIS Predictions Figures	Lime or NaOH Consumption Figures	Barium Chloride Consumption Figures	Comparison to Discharge Criteria Figures	Trend Tables	Water Quality Data Figures										
													Acidity	Barium	Cobalt	Iron	Manganese	pH	Radium-226	Sulphate	Uranium	Conductivity	TSS
Spanish-American	ECA-128	Basin performance (primary)	no	4.1, 4.3	F.3	4.14	F.2	na-p	na	na	na-c	4.8	F.1	F.2	F.3	F.4	F.5	F.6	F.7	F.8	F.9	na	na

Notes: na = parameter not measured at this station (as per study design); therefore, data presentation is not applicable. na-p = EIS Predictions do not apply to this station (as per study design); therefore, data presentation is not applicable. na-c = discharge criteria do not apply to this station (as per study design); therefore, data presentation is not applicable.

Table F.2: Water Quality at TOMP Station ECA-128 (Basin Performance - Primary), Spanish-American TMA, 2015 to 2019

Date	Elevation (m)	Flow (L/s)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Acidity (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
14-Jan-15	-	5.00	7.10	32.0	0.591	<1.00	0.0290	<0.000500	0.0400	0.00900	0.00340
25-May-15	412	<1.00	7.50	24.0	0.419	<1.00	0.0220	<0.000500	0.0300	0.0110	0.00320
10-Nov-15	412	6.40	7.70	31.0	0.484	<1.00	0.0230	<0.000500	0.0420	0.00800	0.00400
12-Jan-16	-	-	7.70	27.0	0.448	<1.00	0.0200	<0.000500	0.0440	0.00800	0.00300
3-May-16	412	5.10	7.60	24.0	0.460	<1.00	0.0200	<0.000500	0.0600	0.0230	0.00250
13-Dec-16	-	<1.00	7.40	31.0	0.577	<1.00	0.0280	<0.000500	0.0330	0.00700	0.00430
17-Jan-17	-	2.00	7.00	29.0	0.588	<1.00	0.0270	<0.000500	<0.0200	0.00200	0.00460
27-Apr-17	412	10.0	7.40	23.0	0.586	<1.00	0.0230	<0.000500	0.0880	0.0390	0.00340
12-Jul-17	412	<1.00	7.80	24.0	0.486	<1.00	0.0230	<0.000500	0.116	0.0290	0.00280
10-Oct-17	412	10.0	7.30	21.0	0.459	<1.00	0.0220	<0.000500	0.0640	0.0340	0.00280
11-Jan-18	-	5.00	7.00	19.0	0.486	<1.00	0.0200	<0.000500	0.0630	0.0160	0.00280
8-May-18	412	10.0	7.00	14.0	0.579	<1.00	0.0180	<0.000500	0.135	0.0340	0.00170
13-Nov-18	412	20.0	7.20	22.0	0.514	<1.00	0.0230	<0.000500	0.0420	0.00900	0.00330
7-Jan-19	-	4.00	7.40	23.0	0.561	<1.00	0.0250	<0.000500	0.0320	0.00600	0.00290
27-May-19	412	2.00	7.20	17.0	0.471	<1.00	0.0180	<0.000500	0.0560	0.00900	0.00220
28-Oct-19	412	40.0	7.20	18.0	0.497	<1.00	0.0210	<0.000500	0.0470	0.00900	0.00230
n	32	15	16	16	16	16	16	16	16	16	16
Minimum	412	<1.00	7.00	14.0	0.419	<1.00	0.0180	<0.000500	<0.0200	0.00200	0.00170
Maximum	412	40.0	7.80	32.0	0.591	<1.00	0.0290	<0.000500	0.135	0.0390	0.00460
Mean	412	8.17	7.34	23.7	0.513	<1.00	0.0226	<0.000500	0.0570	0.0158	0.00308
SD	0.0896	10.1	0.263	5.29	0.0583	-	0.00328	-	0.0309	0.0119	0.000766
Median	412	5.00	7.35	23.5	0.492	<1.00	0.0225	<0.000500	0.0455	0.00900	0.00295
10th Percentile	412	<1.00	7.00	17.0	0.448	<1.00	0.0180	<0.000500	0.0300	0.00600	0.00220
95th Percentile	412	40.0	7.80	32.0	0.591	<1.00	0.0290	<0.000500	0.135	0.0390	0.00460

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected, or SD was incalculable because there was no variability in the data.

Table F.3: Water Level at TOMP Station ECA-128, Spanish-American TMA, 2015 to 2019

Date	Elevation (m)
25-May-15	411.95
8-Jun-15	411.96
21-Jul-15	411.81
14-Aug-15	411.72
16-Sep-15	411.74
8-Oct-15	411.78
10-Nov-15	411.96
9-Dec-15	411.95
3-May-16	411.96
14-Jun-16	411.92
14-Jul-16	411.80
17-Aug-16	411.72
27-Sep-16	411.75
25-Oct-16	411.81
9-Nov-16	411.82
27-Apr-17	411.95
23-May-17	411.99
14-Jun-17	411.96
12-Jul-17	411.79
9-Aug-17	411.81
12-Sep-17	411.80
10-Oct-17	411.84
8-May-18	411.85
13-Jun-18	411.81
16-Jul-18	411.70
17-Aug-18	411.67
24-Sep-18	411.63
29-Oct-18	411.82
13-Nov-18	411.85
27-May-19	411.91
11-Jun-19	411.91
9-Jul-19	411.80
20-Aug-19	411.76
11-Sep-19	411.80
28-Oct-19	411.93
13-Nov-19	411.81
n	32
Minimum	411.67
Maximum	411.99
Mean	411.85
SD	0.089622
Median	411.82
10th Percentile	411.72
95th Percentile	411.96

Note: "SD" = standard deviation. "n" = number of samples.

APPENDIX G
QUIRKE TMA, TOMP DATA

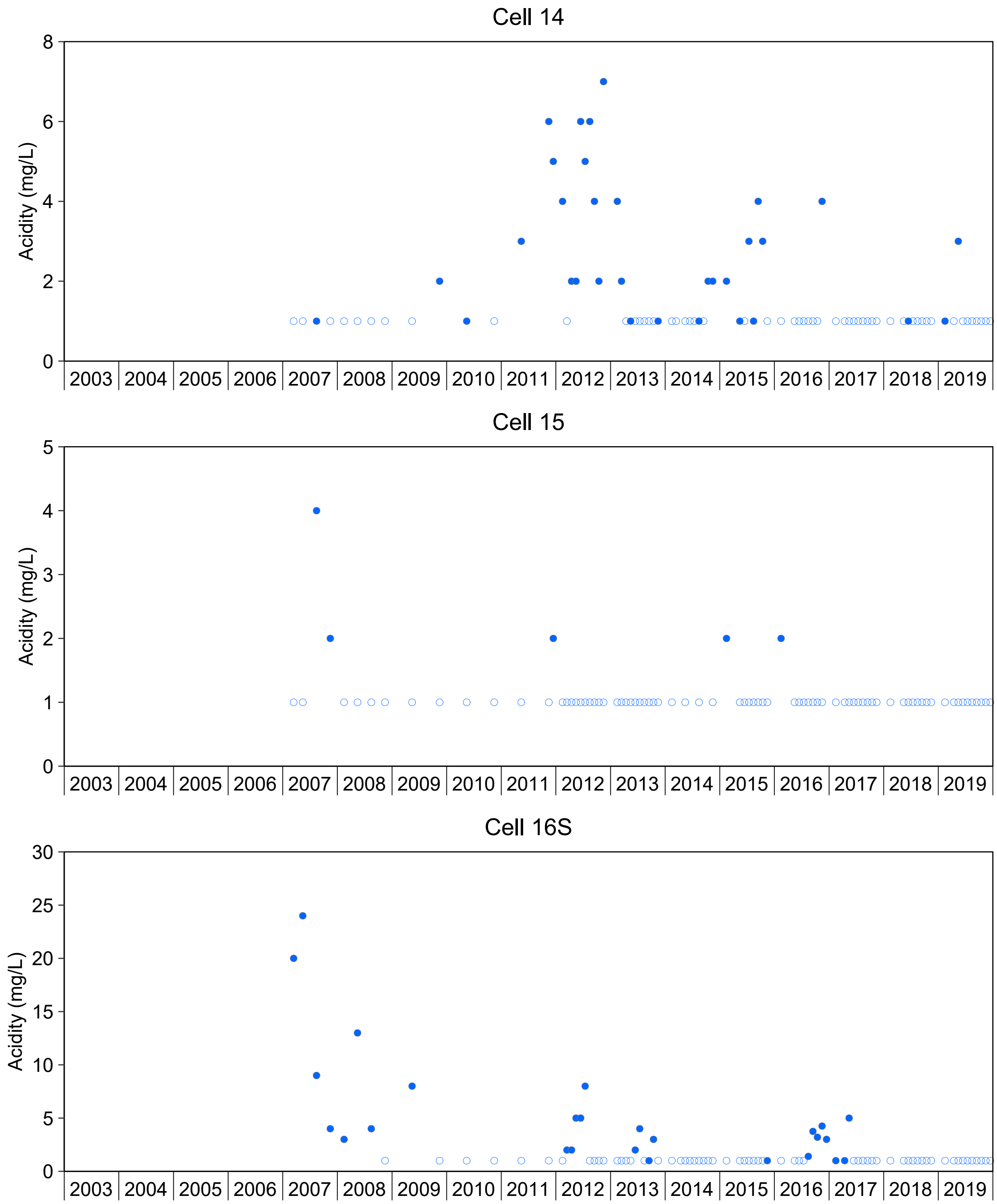


Figure G.1: Concentrations of Acidity for TOMP Water Monitoring Stations, Quirke TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 4.9 for Seasonal Kendall trend analysis results and Appendix Tables G.3 to G.7 for raw data. Acidity (mg/L) is not included in the trend analysis for TOMP stations Cell 14, Cell 15, and Cell 16S due to >50% non-detectable concentrations in the dataset.

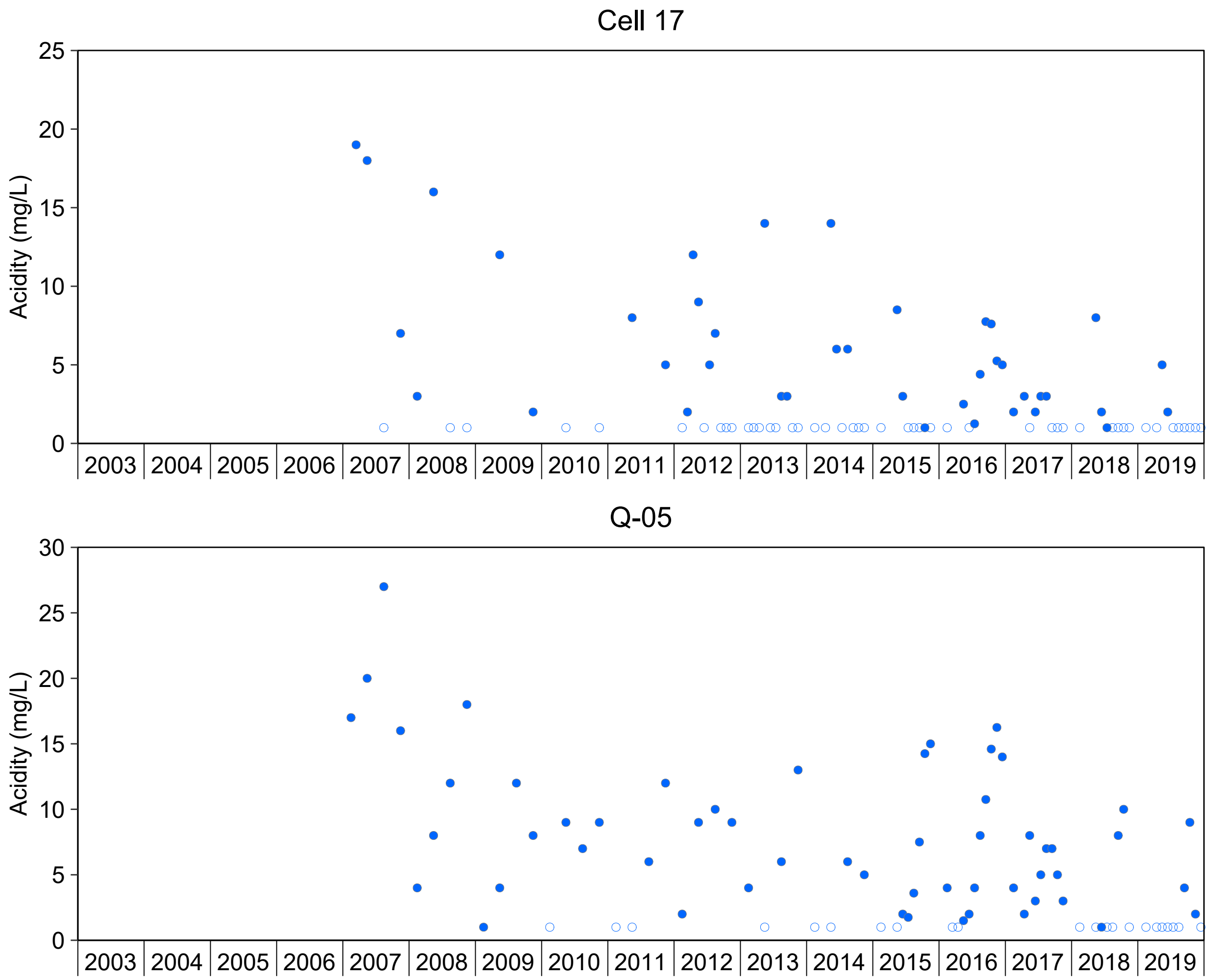


Figure G.1: Concentrations of Acidity for TOMP Water Monitoring Stations, Quirke TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 4.9 for Seasonal Kendall trend analysis results and Appendix Tables G.3 to G.7 for raw data. Acidity (mg/L) is not included in the trend analysis for TOMP stations Cell 14, Cell 15, and Cell 16S due to >50% non-detectable concentrations in the dataset.

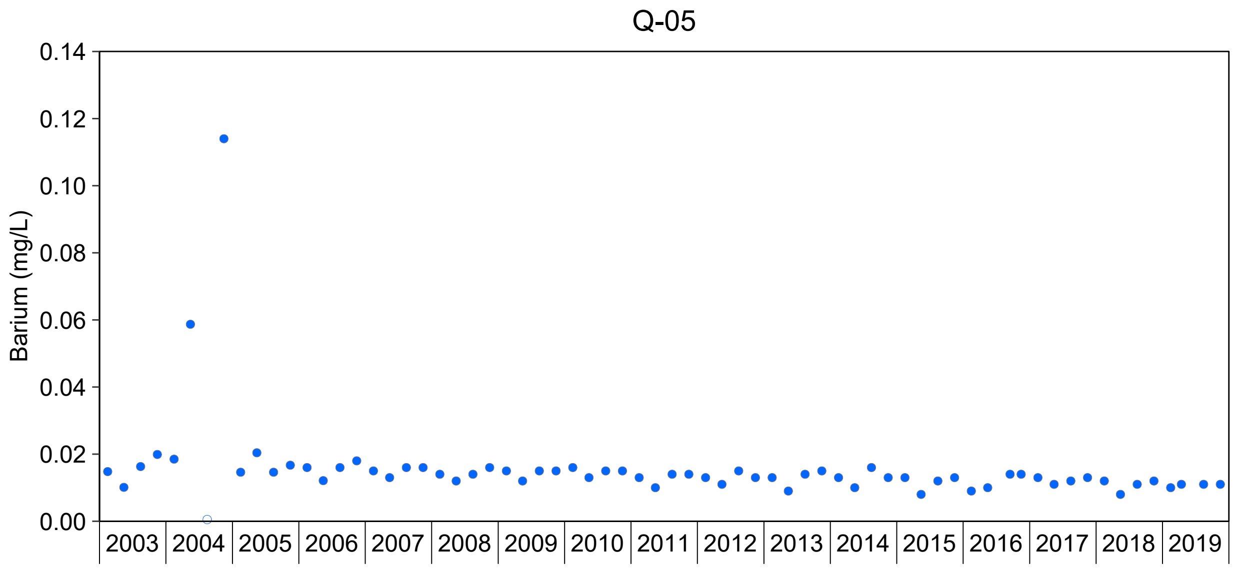


Figure G.2: Concentrations of Barium for TOMP Water Monitoring Stations, Quirke TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 4.9 for Seasonal Kendall trend analysis results and Appendix Tables G.7 for raw data.

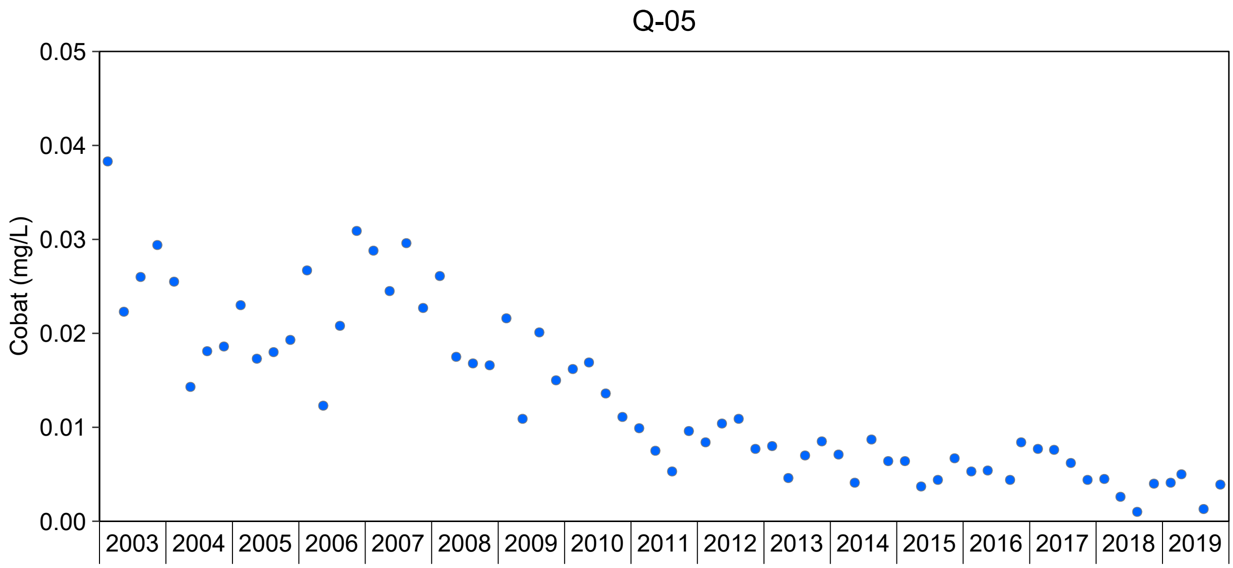


Figure G.3: Concentrations of Cobalt for TOMP Water Monitoring Stations, Quirke TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 4.9 for Seasonal Kendall trend analysis results and Appendix Tables G.7 for raw data.

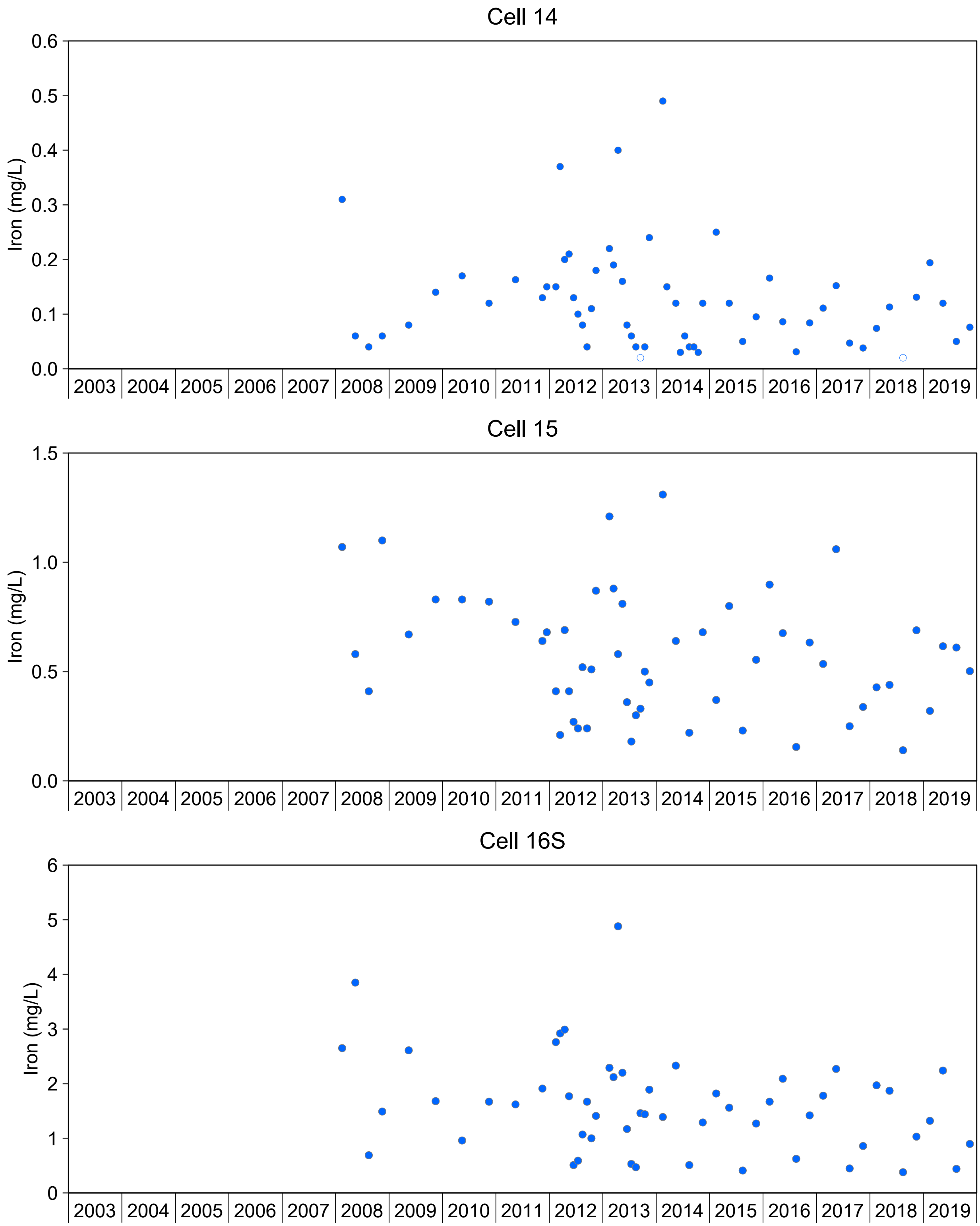
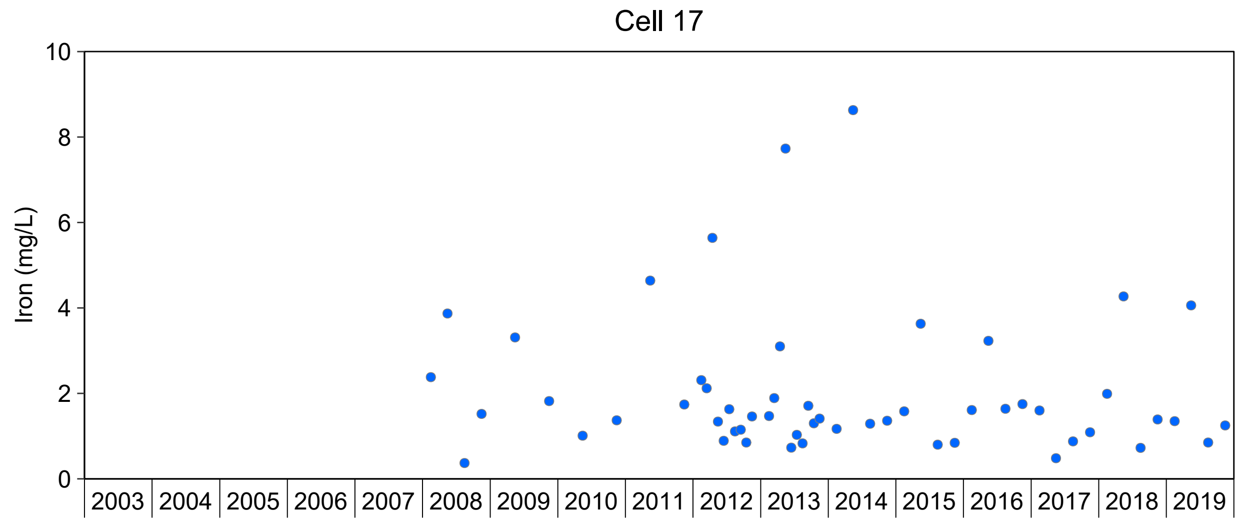


Figure G.4: Concentrations of Iron for TOMP Water Monitoring Stations, Quirke TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 4.9 for Seasonal Kendall trend analysis results and Appendix Tables G.3 to G.7 for raw data.



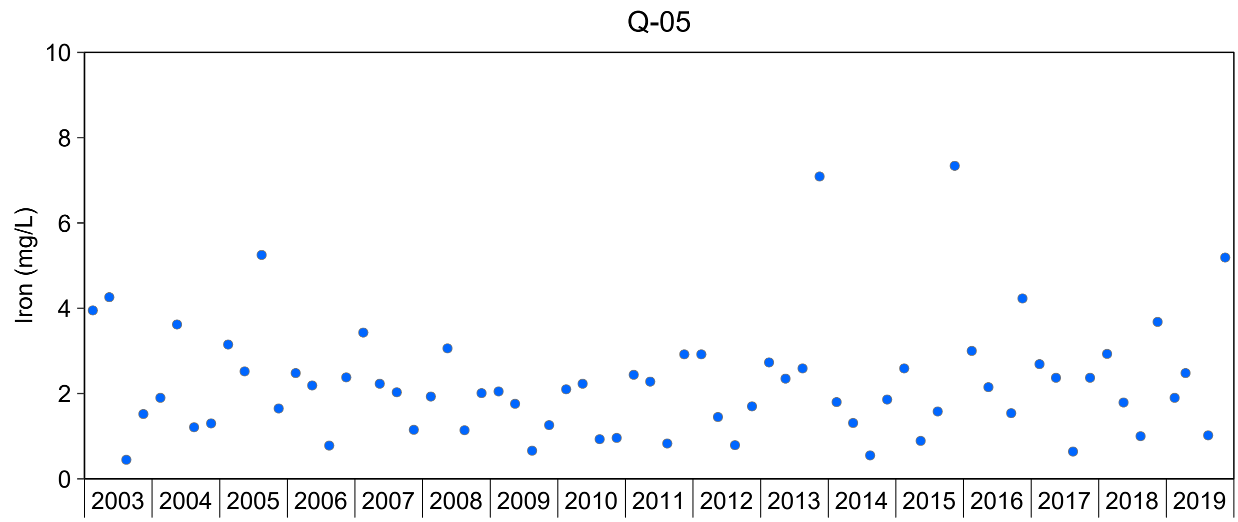


Figure G.4: Concentrations of Iron for TOMP Water Monitoring Stations, Quirke TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 4.9 for Seasonal Kendall trend analysis results and Appendix Tables G.3 to G.7 for raw data.

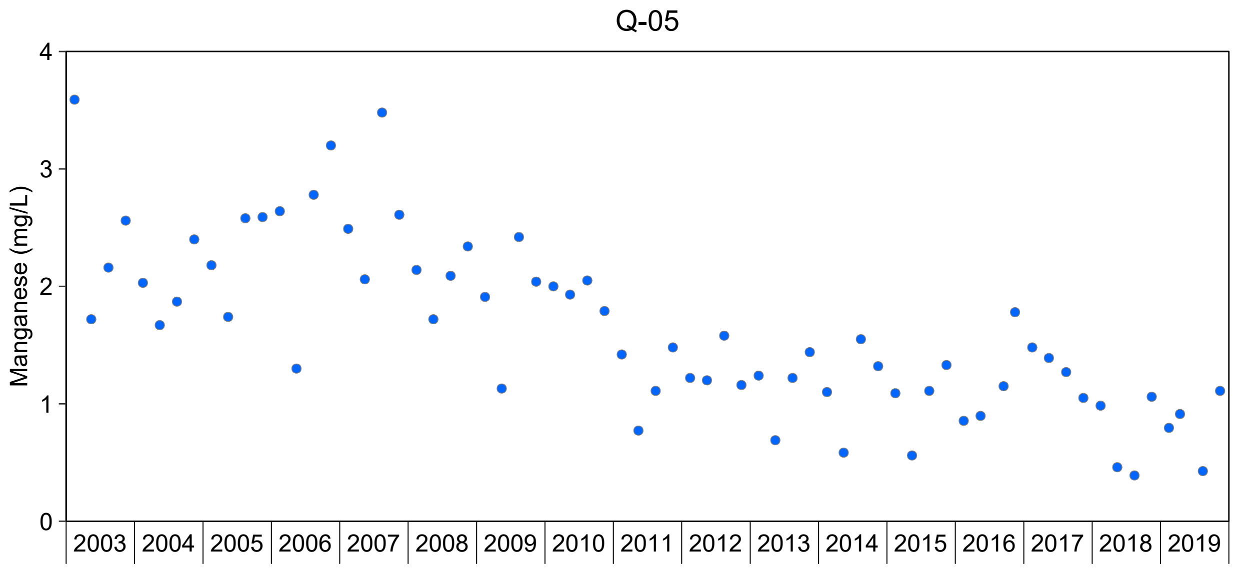


Figure G.5: Concentrations of Manganese for TOMP Water Monitoring Stations, Quirke TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 4.9 for Seasonal Kendall trend analysis results and Appendix Tables G.7 for raw data.

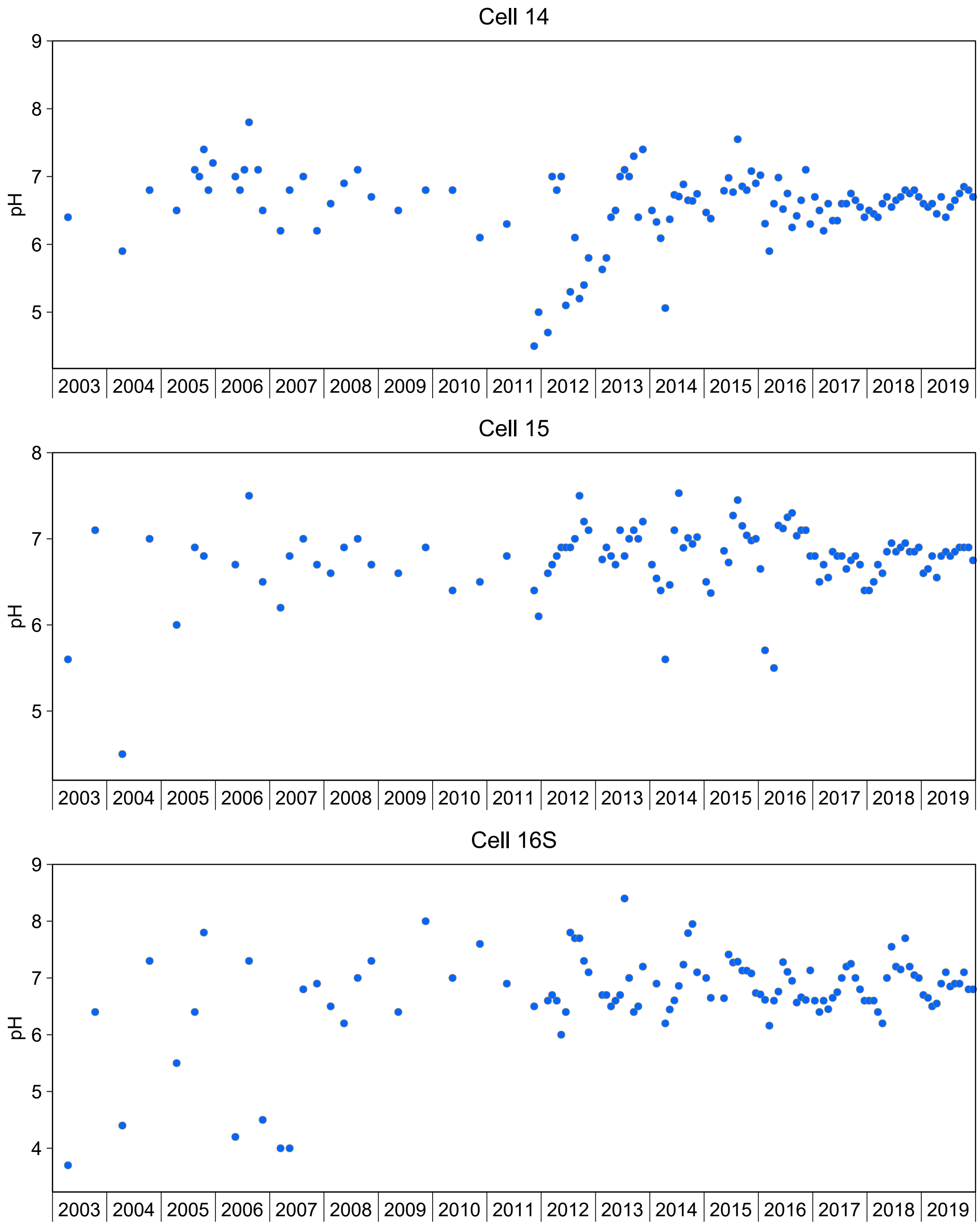
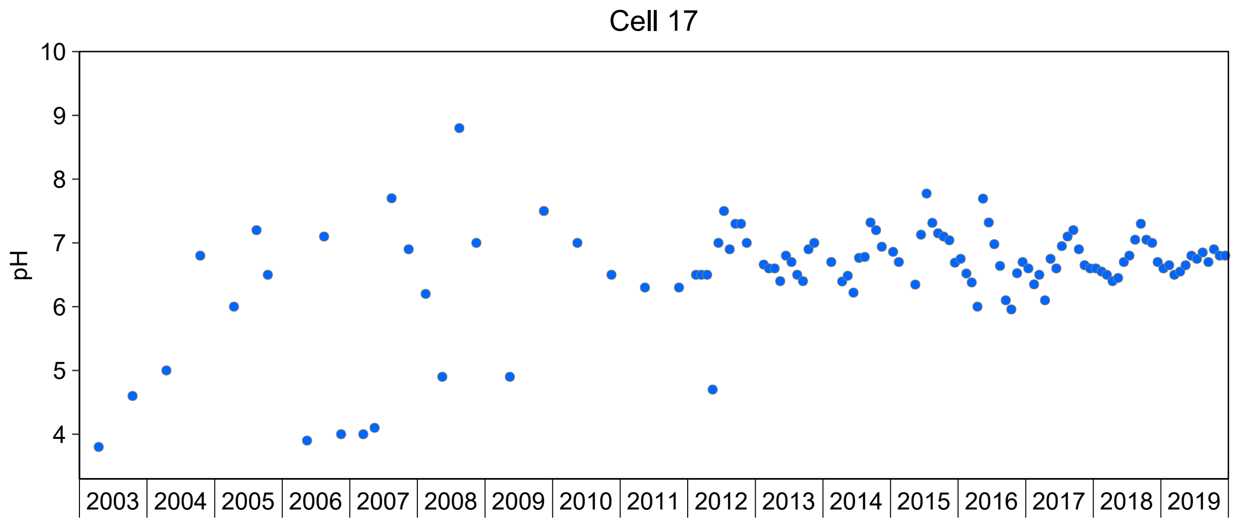


Figure G.6: Field Measurements of pH for TOMP Water Monitoring Stations, Quirke TMA, 2003 to 2019

Notes: See Table 4.9 for Seasonal Kendall trend analysis results and Appendix Tables G.3 to G.7 for raw data.



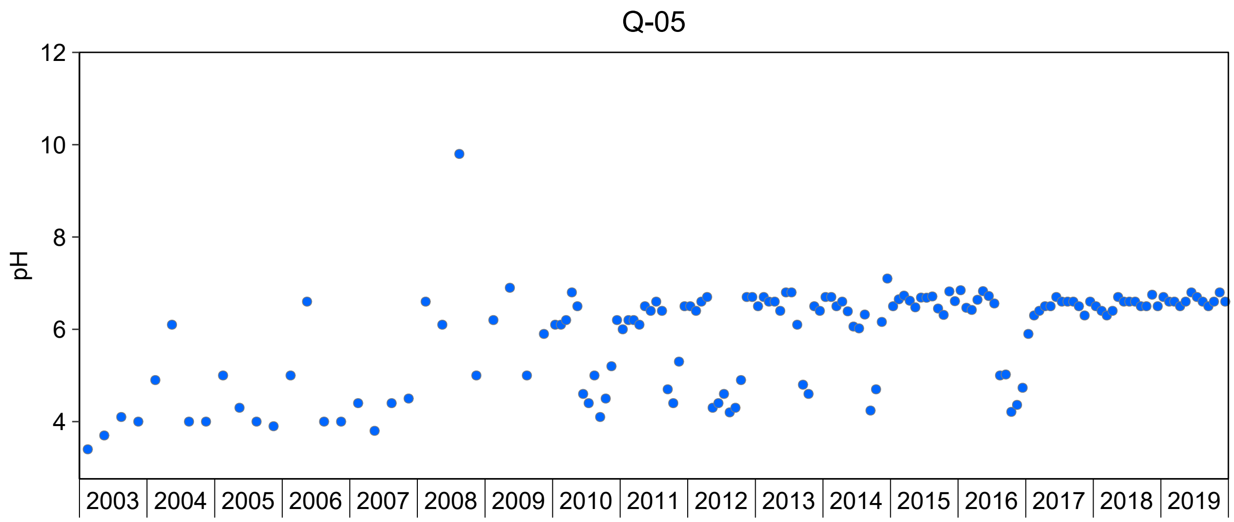


Figure G.6: Field Measurements of pH for TOMP Water Monitoring Stations, Quirke TMA, 2003 to 2019

Notes: See Table 4.9 for Seasonal Kendall trend analysis results and Appendix Tables G.3 to G.7 for raw data.

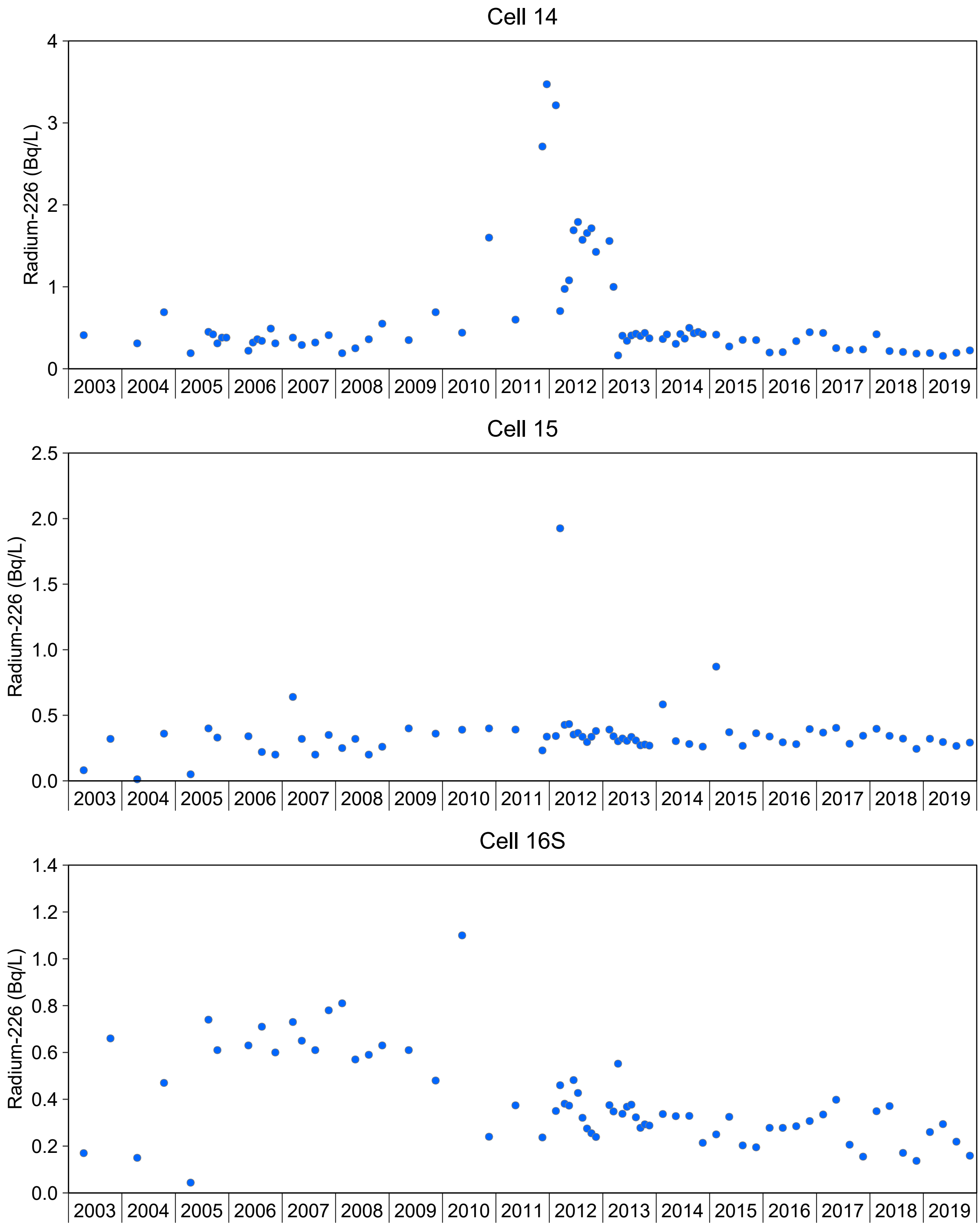


Figure G.7: Concentrations of Radium-226 for TOMP Water Monitoring Stations, Quirke TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL.
See Table 4.9 for Seasonal Kendall trend analysis results and Appendix Tables G.3 to G.7 for raw data.

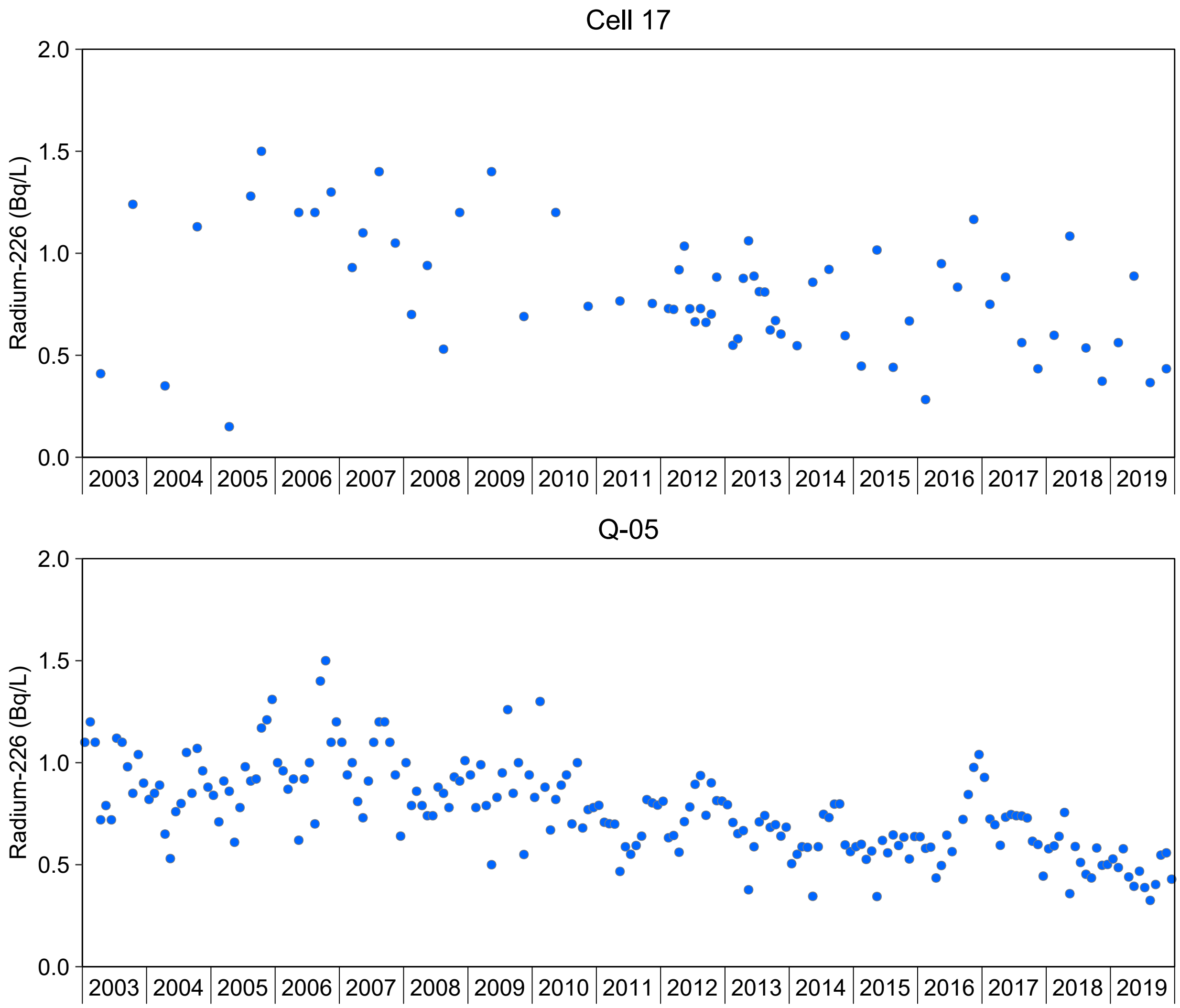


Figure G.7: Concentrations of Radium-226 for TOMP Water Monitoring Stations, Quirke TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 4.9 for Seasonal Kendall trend analysis results and Appendix Tables G.3 to G.7 for raw data.

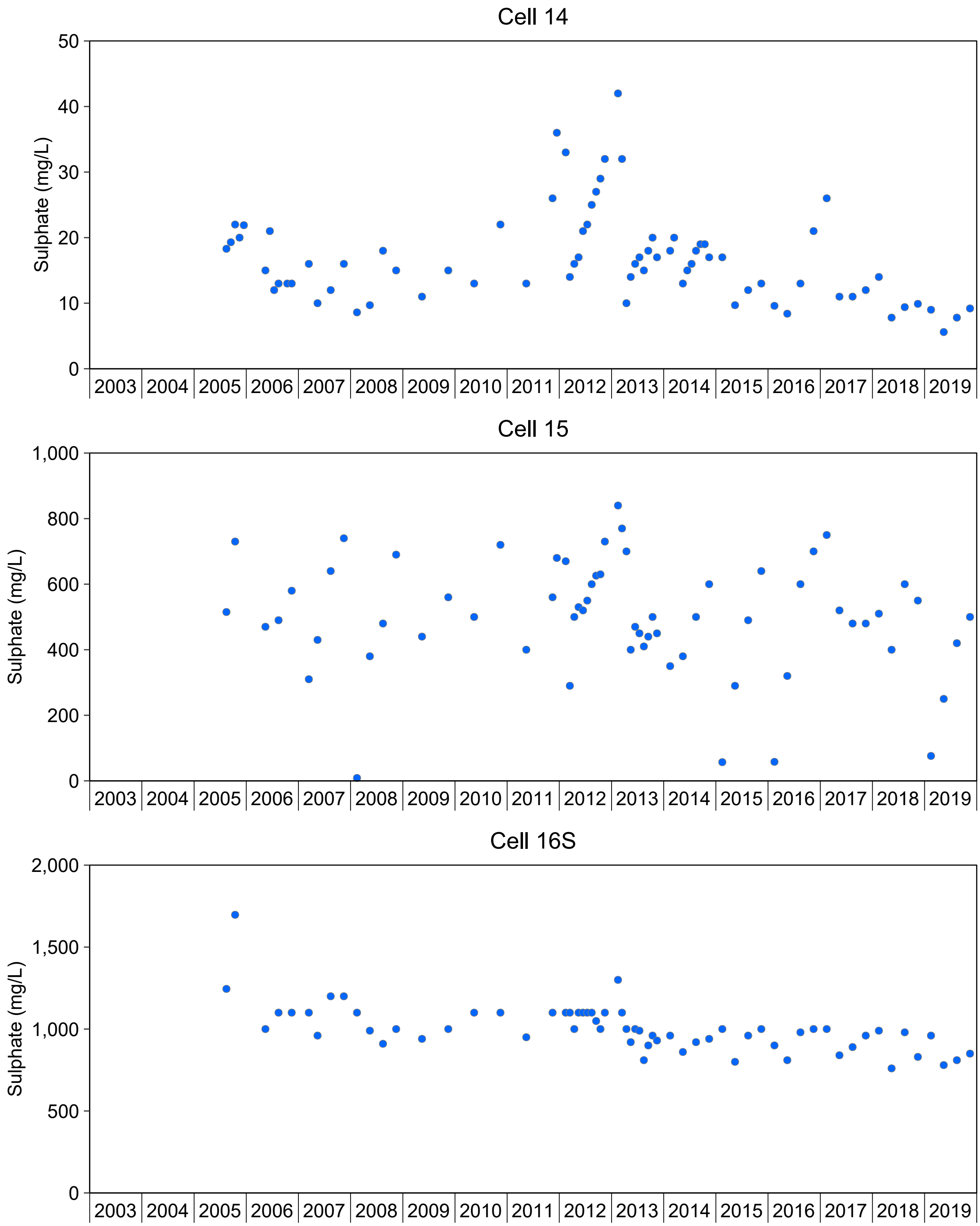
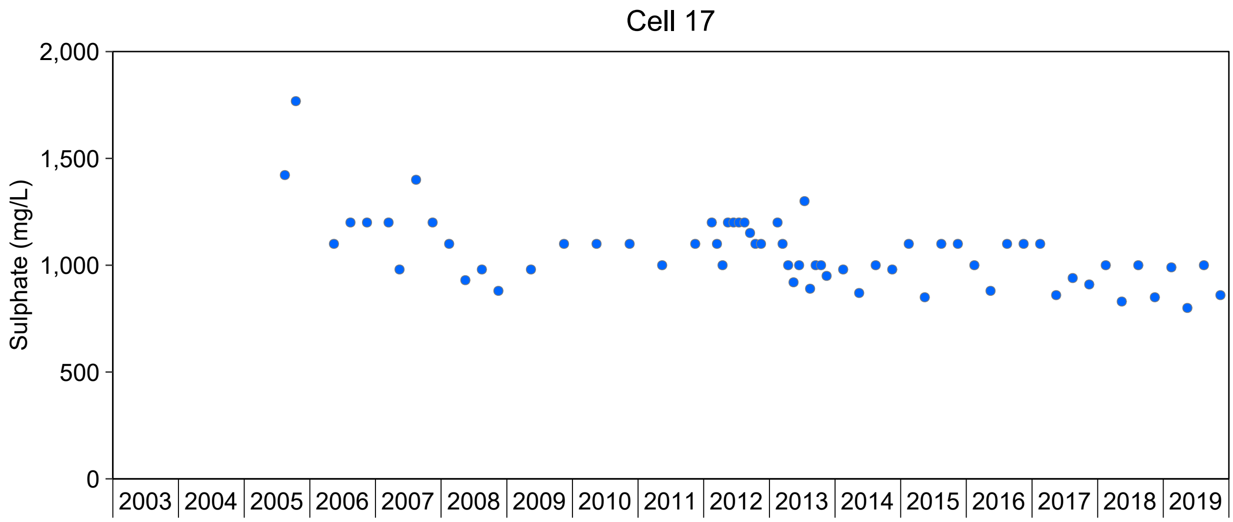


Figure G.8: Concentrations of Sulphate for TOMP Water Monitoring Stations, Quirke TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 4.9 for Seasonal Kendall trend analysis results and Appendix Tables G.3 to G.7 for raw data.



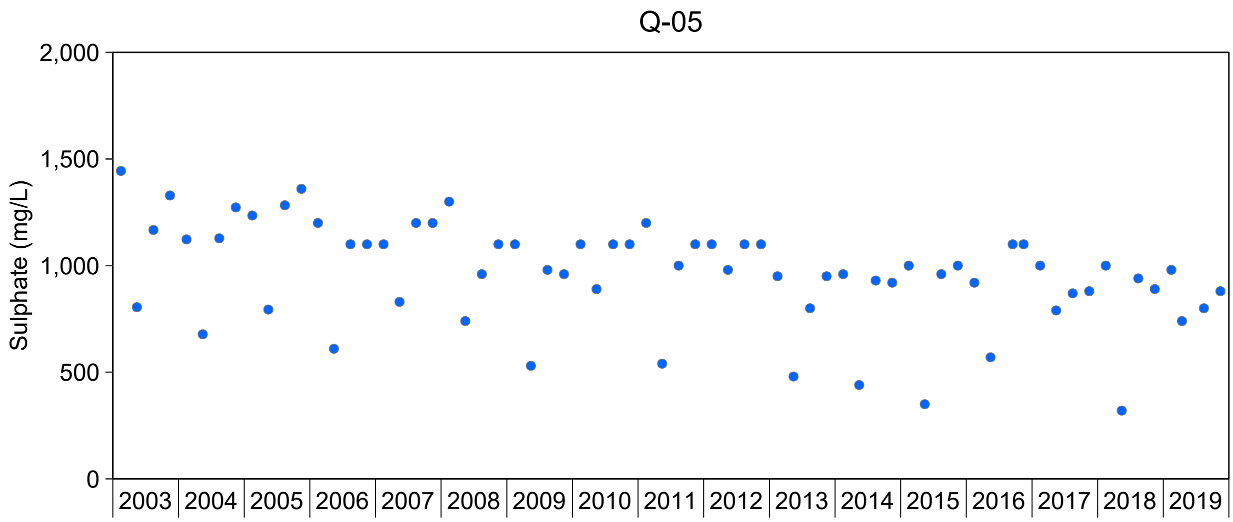


Figure G.8: Concentrations of Sulphate for TOMP Water Monitoring Stations, Quirke TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 4.9 for Seasonal Kendall trend analysis results and Appendix Tables G.3 to G.7 for raw data.

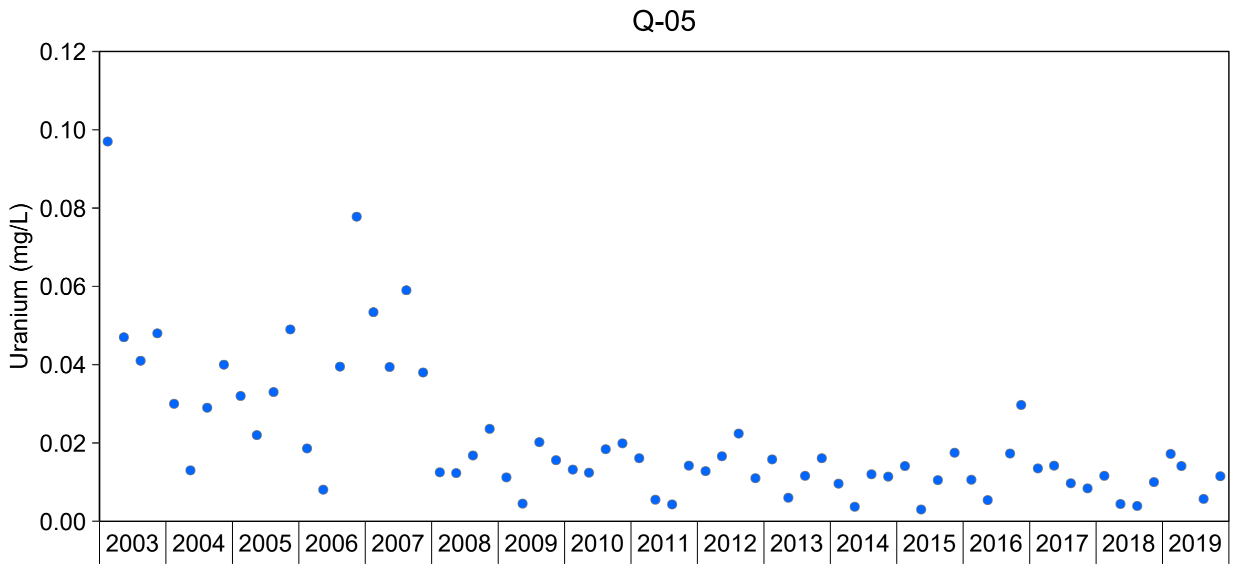


Figure G.9: Concentrations of Uranium for TOMP Water Monitoring Stations, Quirke TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 4.9 for Seasonal Kendall trend analysis results and Appendix Tables G.7 for raw data.

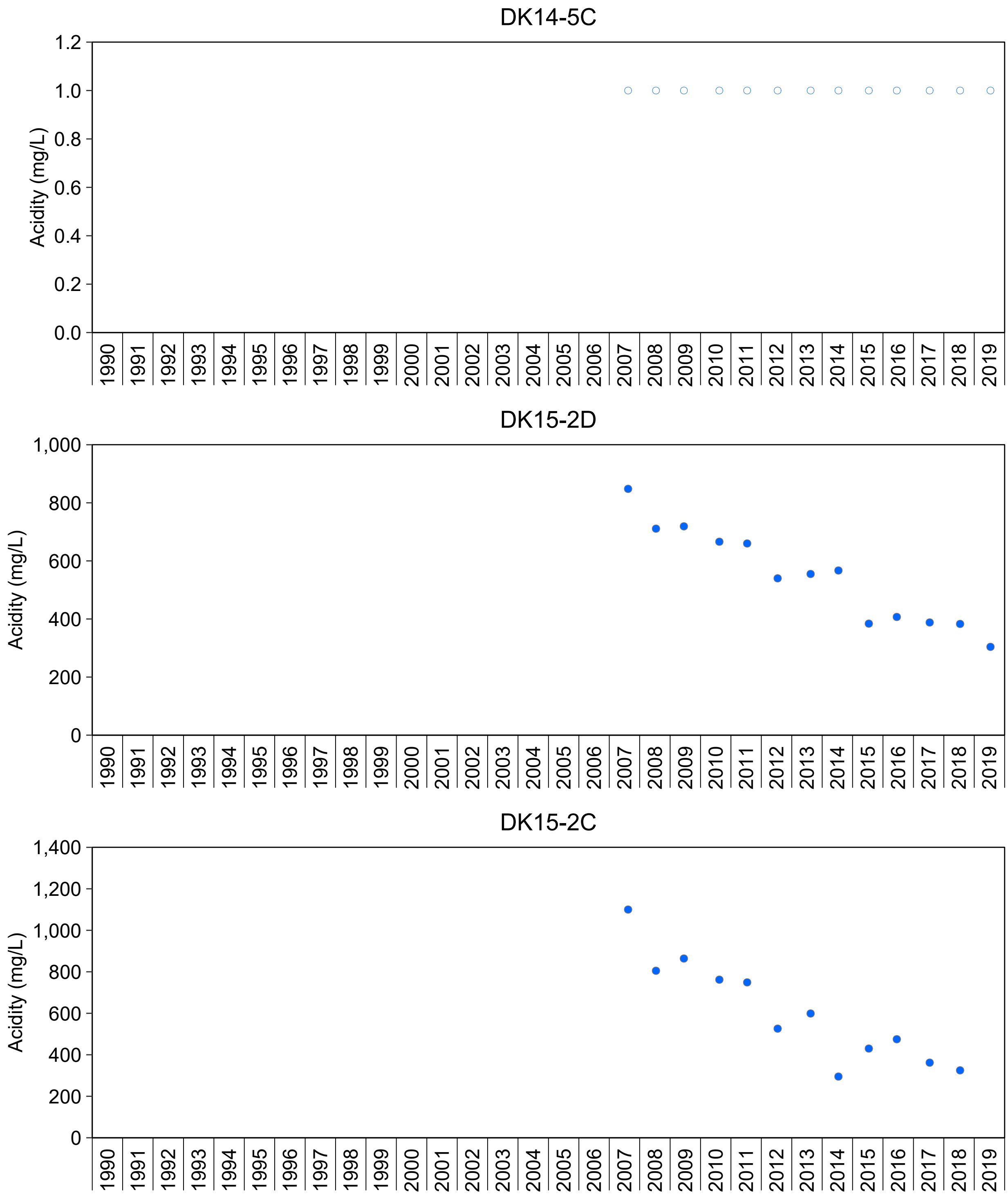


Figure G.10: Concentrations of Acidity for TOMP Pore Water Stations, Quirke TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Due to a change in analytical technique for acidity in 2006, acidity trends were assessed from 2007 to 2019. See Table 4.10 for Kendall trend analysis results and Appendix Tables G.12 to G.16 for raw data. Acidity (mg/L) is not included in the trend analysis for TOMP stations DK14-5C, DK16-2C, DK16-2B, DK17-2D, and DK17-2C due to >50% non-detectable concentrations in the dataset.

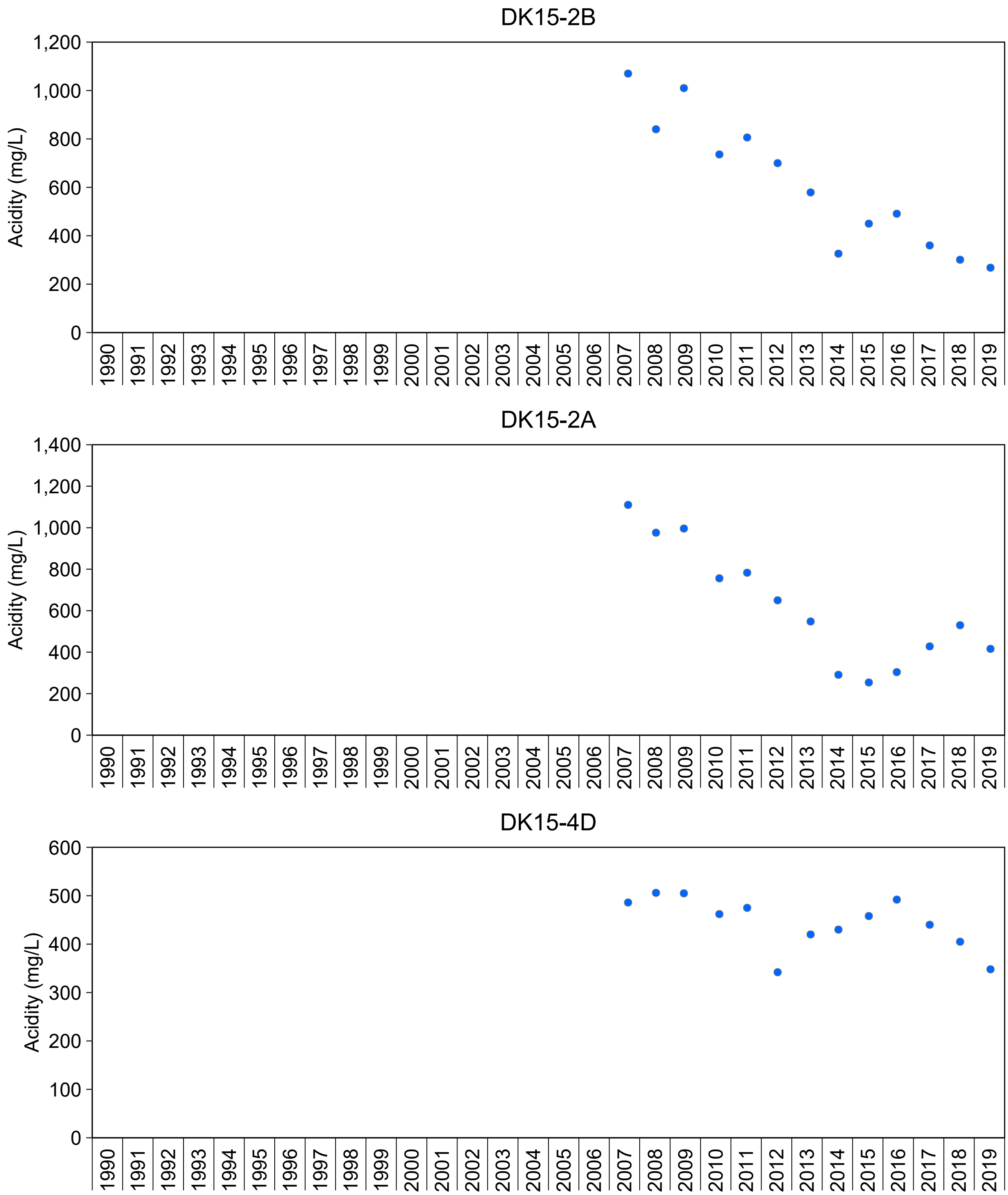


Figure G.10: Concentrations of Acidity for TOMP Pore Water Stations, Quirke TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Due to a change in analytical technique for acidity in 2006, acidity trends were assessed from 2007 to 2019. See Table 4.10 for Kendall trend analysis results and Appendix Tables G.12 to G.16 for raw data. Acidity (mg/L) is not included in the trend analysis for TOMP stations DK14-5C, DK16-2C, DK16-2B, DK17-2D, and DK17-2C due to >50% non-detectable concentrations in the dataset.

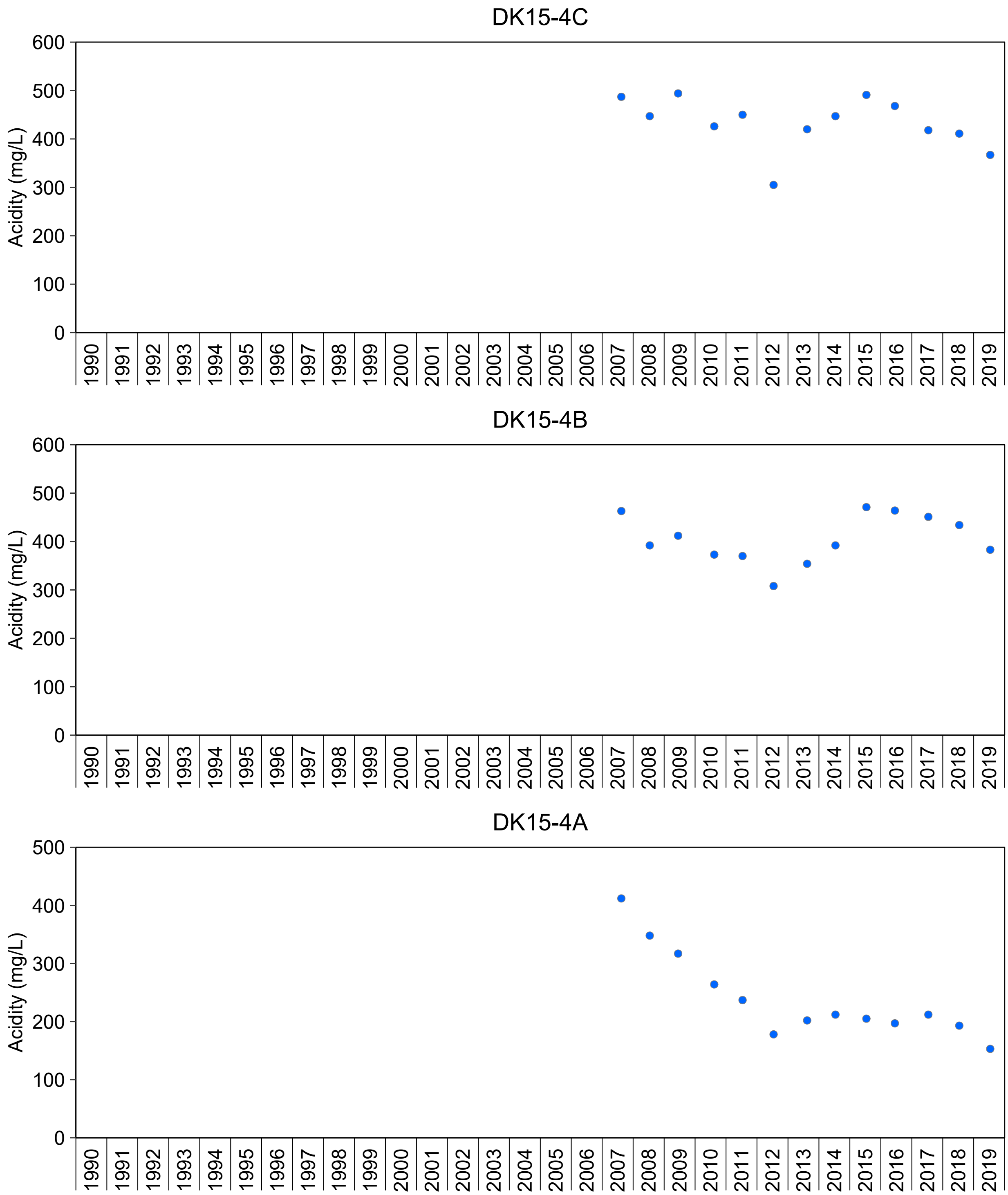


Figure G.10: Concentrations of Acidity for TOMP Pore Water Stations, Quirke TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Due to a change in analytical technique for acidity in 2006, acidity trends were assessed from 2007 to 2019. See Table 4.10 for Kendall trend analysis results and Appendix Tables G.12 to G.16 for raw data. Acidity (mg/L) is not included in the trend analysis for TOMP stations DK14-5C, DK16-2C, DK16-2B, DK17-2D, and DK17-2C due to >50% non-detectable concentrations in the dataset.

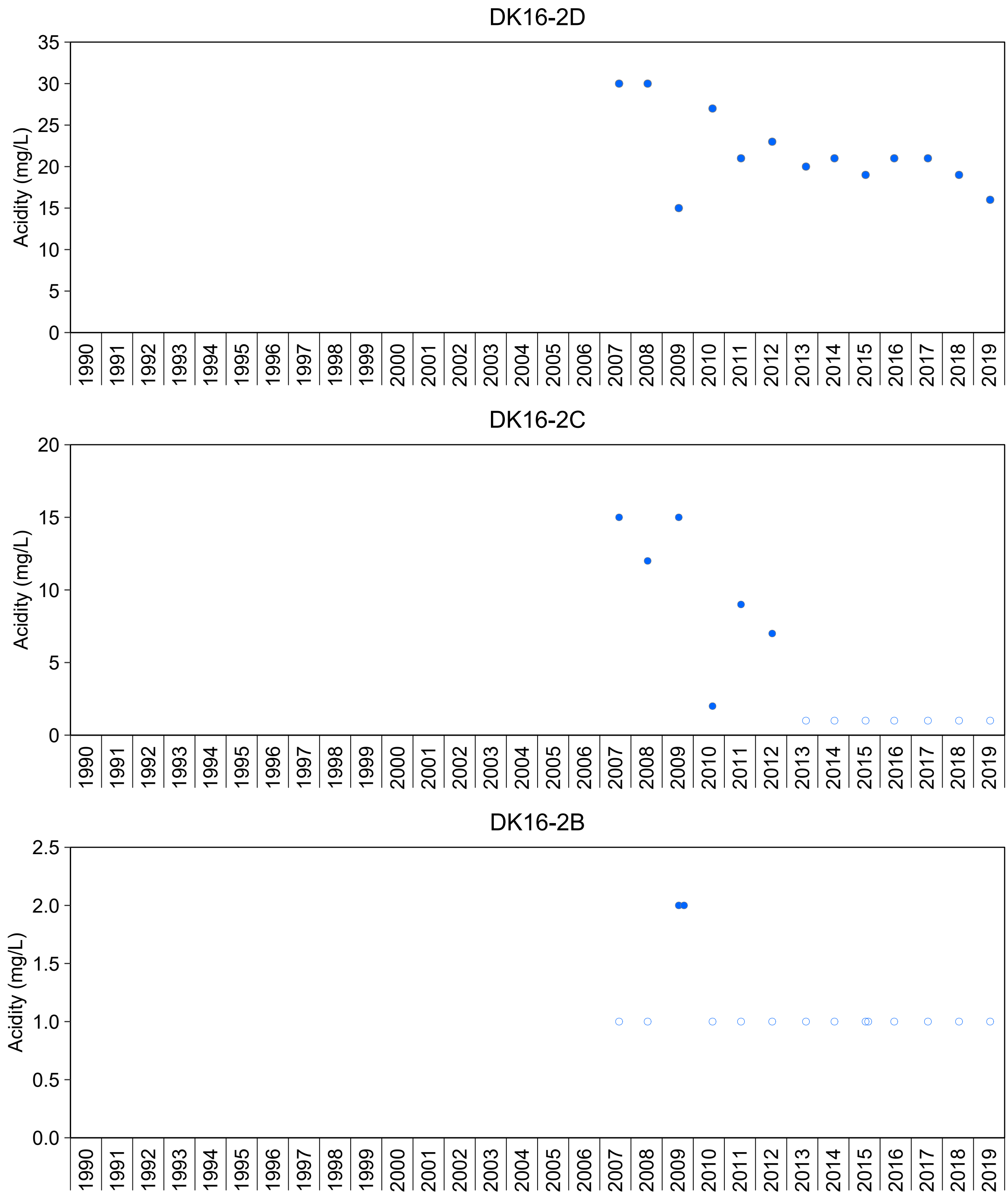


Figure G.10: Concentrations of Acidity for TOMP Pore Water Stations, Quirke TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Due to a change in analytical technique for acidity in 2006, acidity trends were assessed from 2007 to 2019. See Table 4.10 for Kendall trend analysis results and Appendix Tables G.12 to G.16 for raw data. Acidity (mg/L) is not included in the trend analysis for TOMP stations DK14-5C, DK16-2C, DK16-2B, DK17-2D, and DK17-2C due to >50% non-detectable concentrations in the dataset.

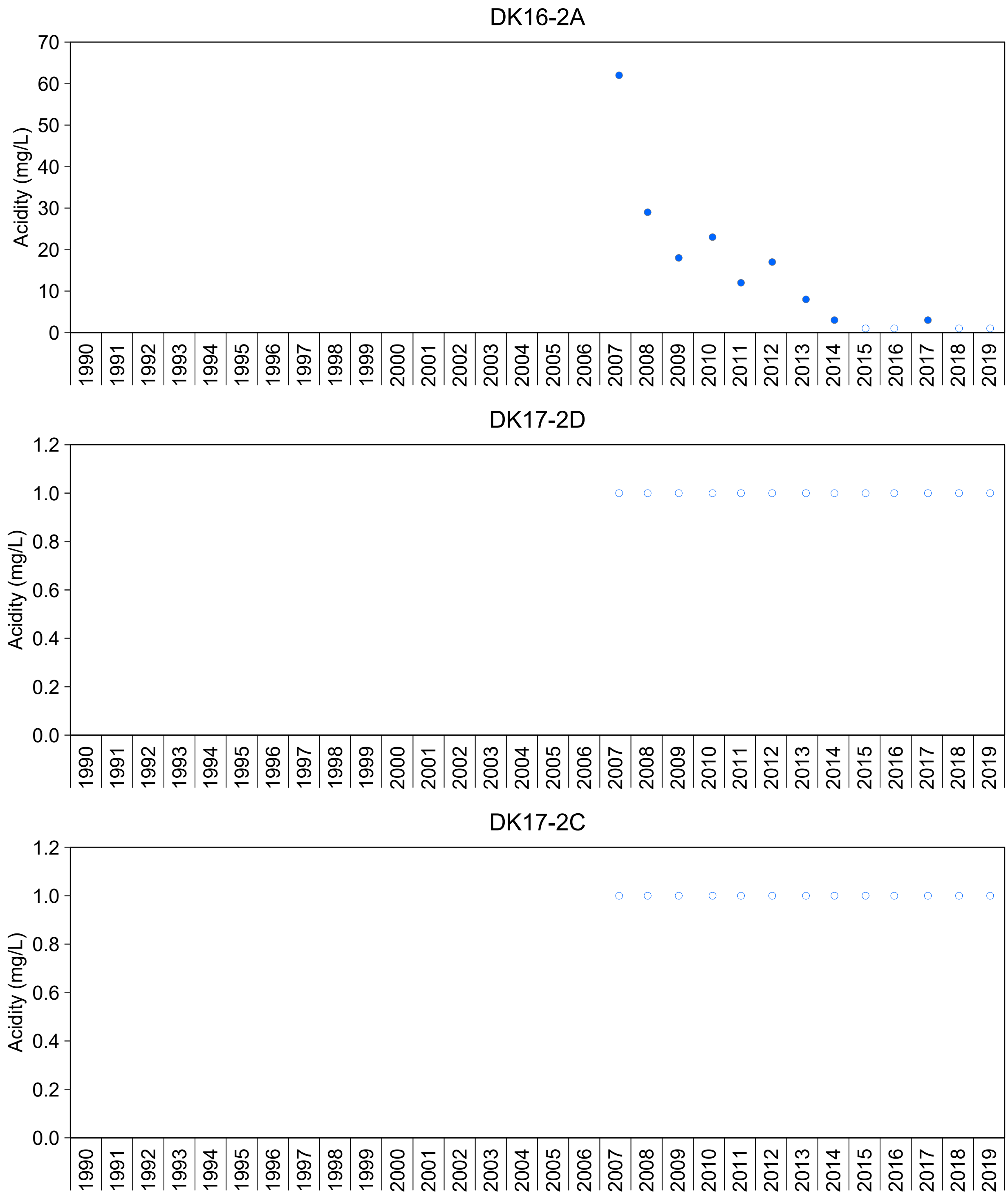
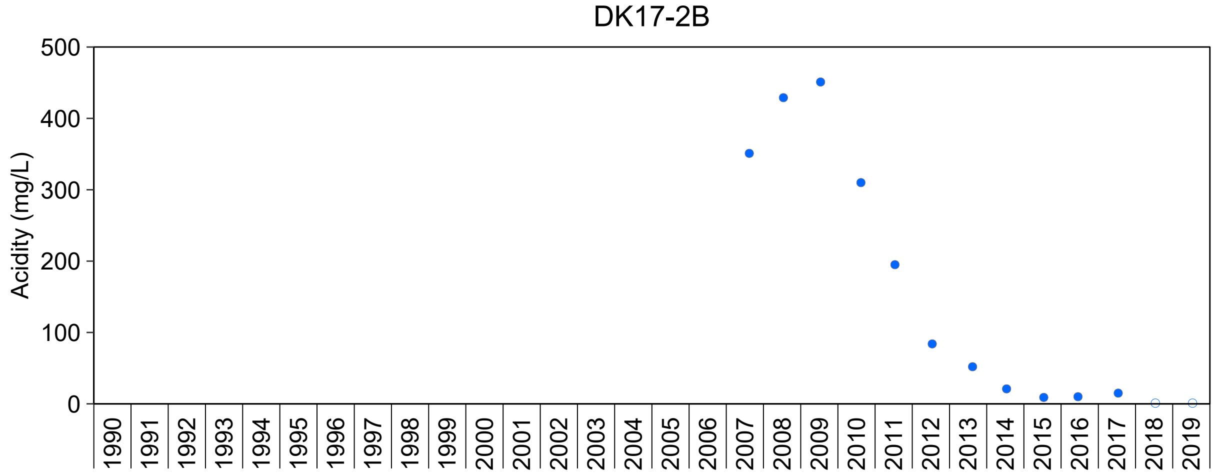


Figure G.10: Concentrations of Acidity for TOMP Pore Water Stations, Quirke TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Due to a change in analytical technique for acidity in 2006, acidity trends were assessed from 2007 to 2019. See Table 4.10 for Kendall trend analysis results and Appendix Tables G.12 to G.16 for raw data. Acidity (mg/L) is not included in the trend analysis for TOMP stations DK14-5C, DK16-2C, DK16-2B, DK17-2D, and DK17-2C due to >50% non-detectable concentrations in the dataset.



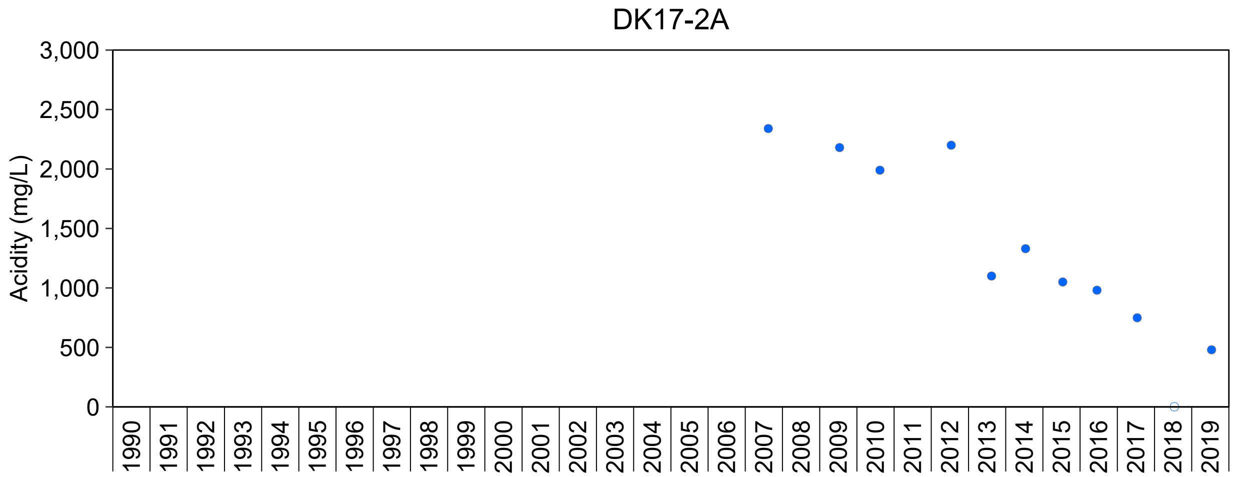


Figure G.10: Concentrations of Acidity for TOMP Pore Water Stations, Quirke TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Due to a change in analytical technique for acidity in 2006, acidity trends were assessed from 2007 to 2019.
See Table 4.10 for Kendall trend analysis results and Appendix Tables G.12 to G.16 for raw data. Acidity (mg/L) is not included in the trend analysis for TOMP stations DK14-5C, DK16-2C, DK16-2B, DK17-2D, and DK17-2C due to >50% non-detectable concentrations in the dataset.

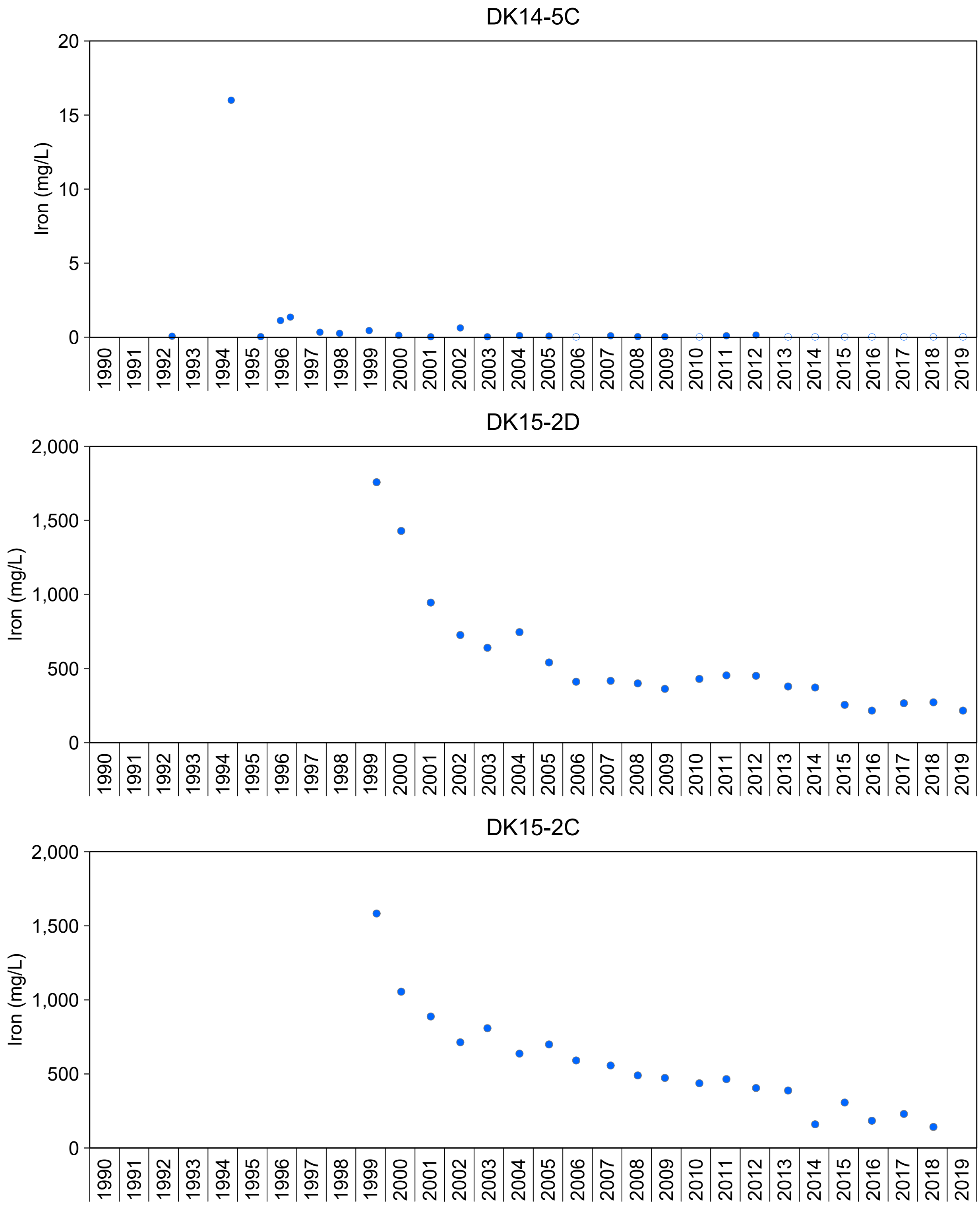


Figure G.11: Concentrations of Iron for TOMP Pore Water Stations, Quirke TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 4.10 for Kendall trend analysis results and Appendix Tables G.12 to G.16 for raw data.

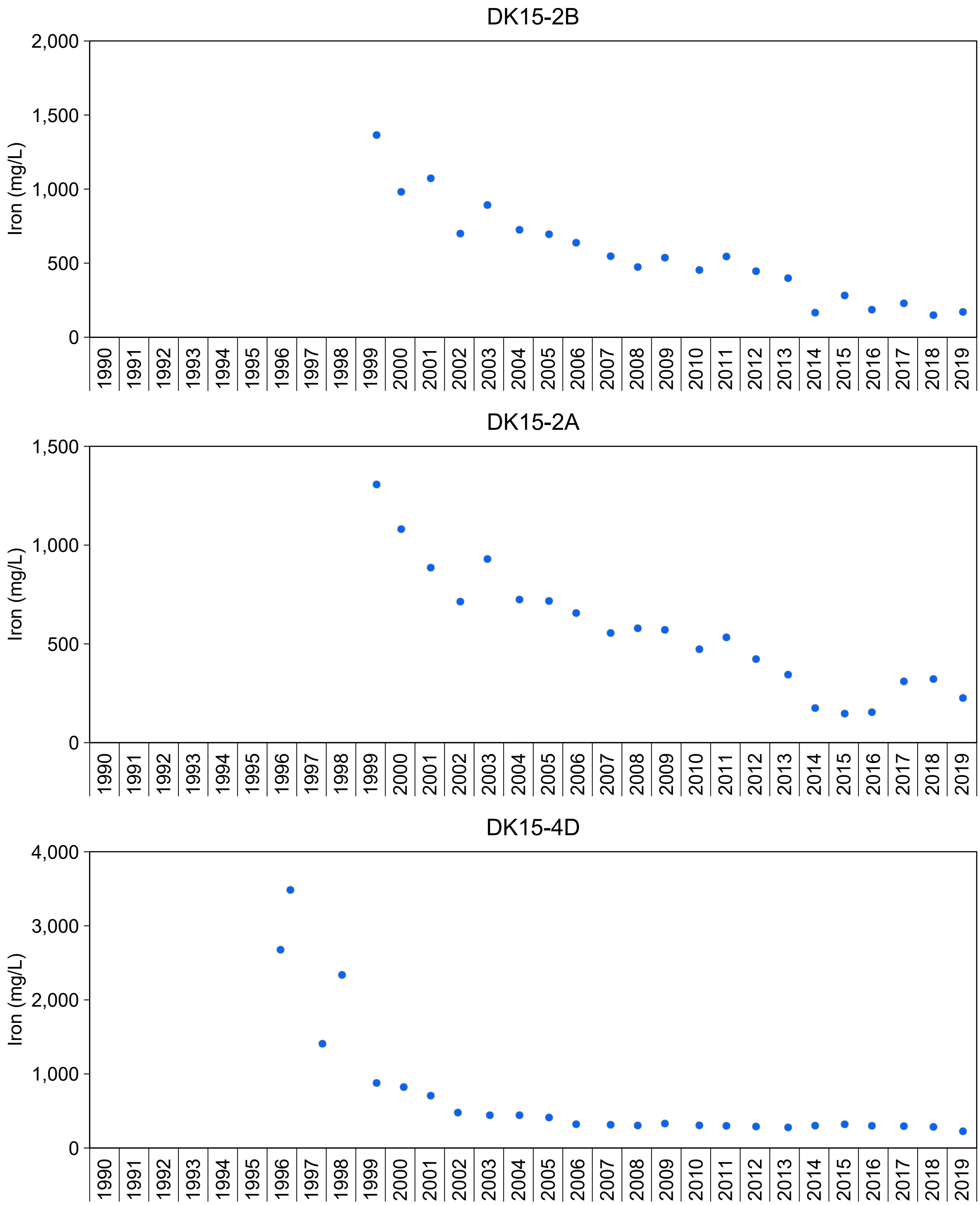
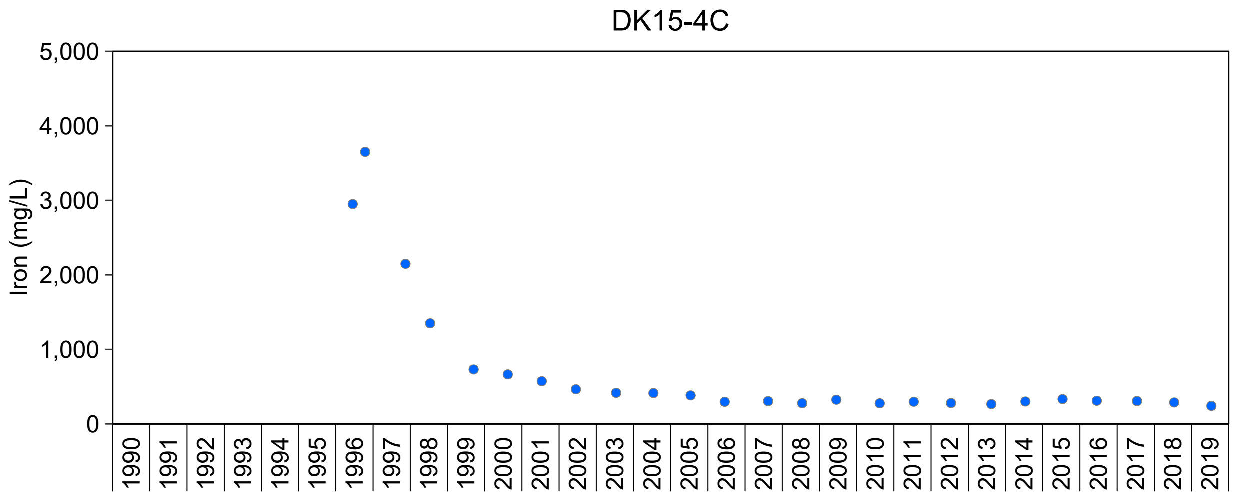
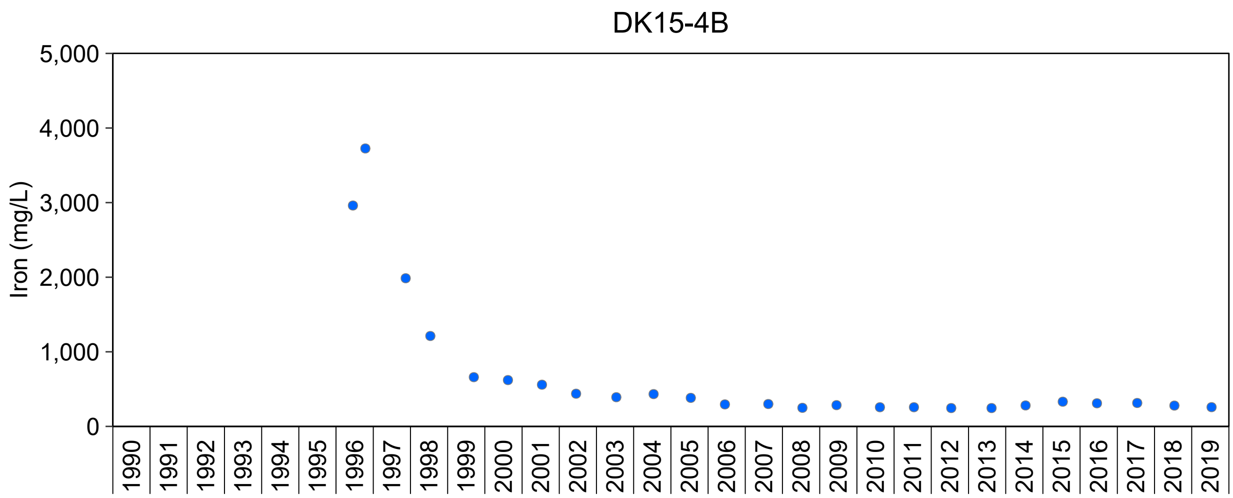


Figure G.11: Concentrations of Iron for TOMP Pore Water Stations, Quirke TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 4.10 for Kendall trend analysis results and Appendix Tables G.12 to G.16 for raw data.





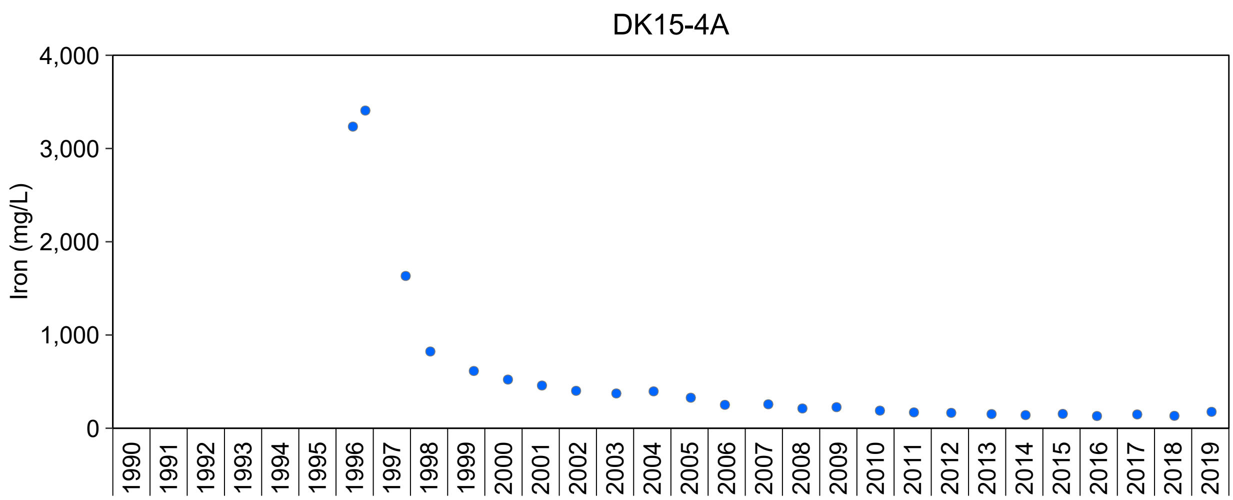


Figure G.11: Concentrations of Iron for TOMP Pore Water Stations, Quirke TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 4.10 for Kendall trend analysis results and Appendix Tables G.12 to G.16 for raw data.

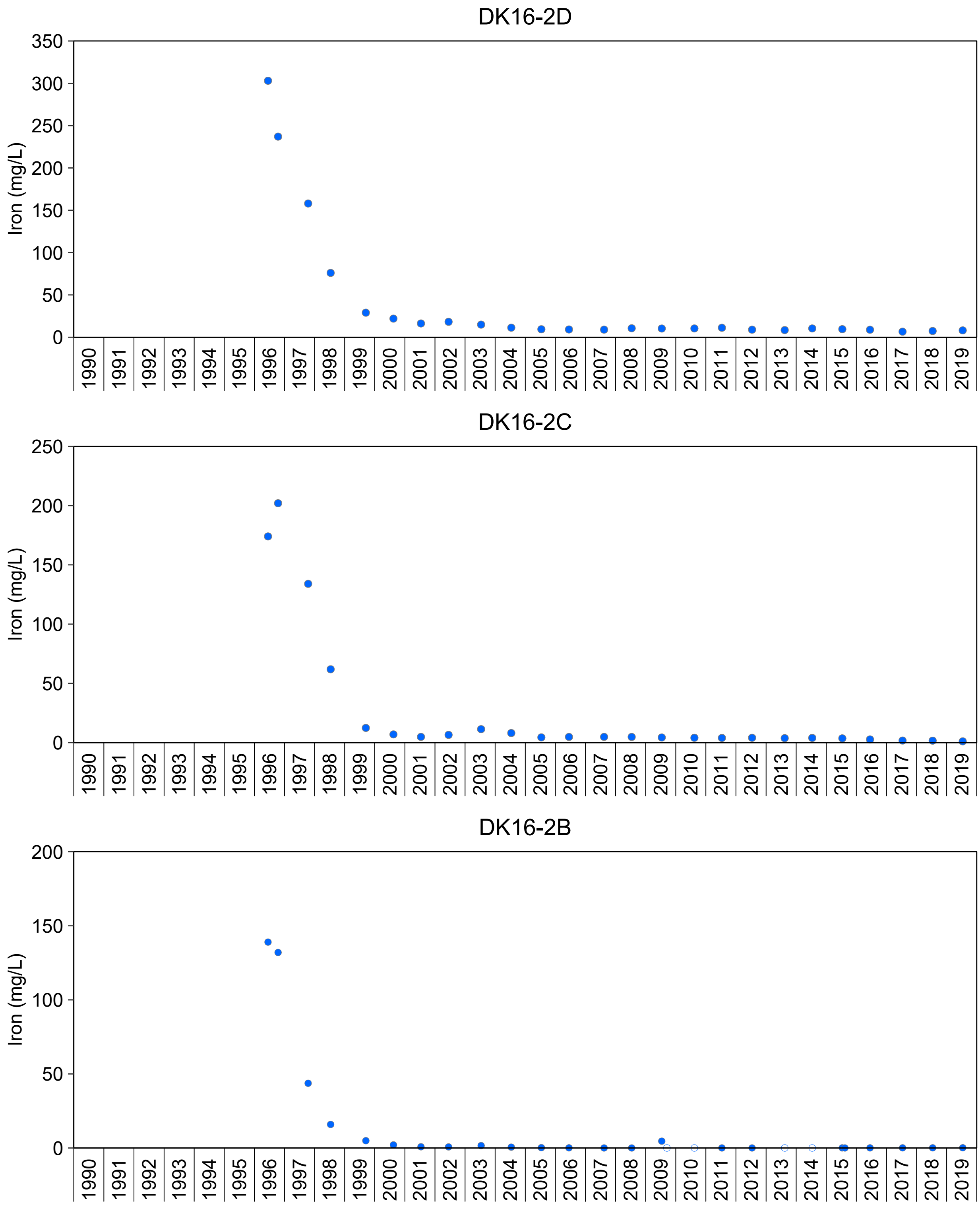


Figure G.11: Concentrations of Iron for TOMP Pore Water Stations, Quirke TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 4.10 for Kendall trend analysis results and Appendix Tables G.12 to G.16 for raw data.

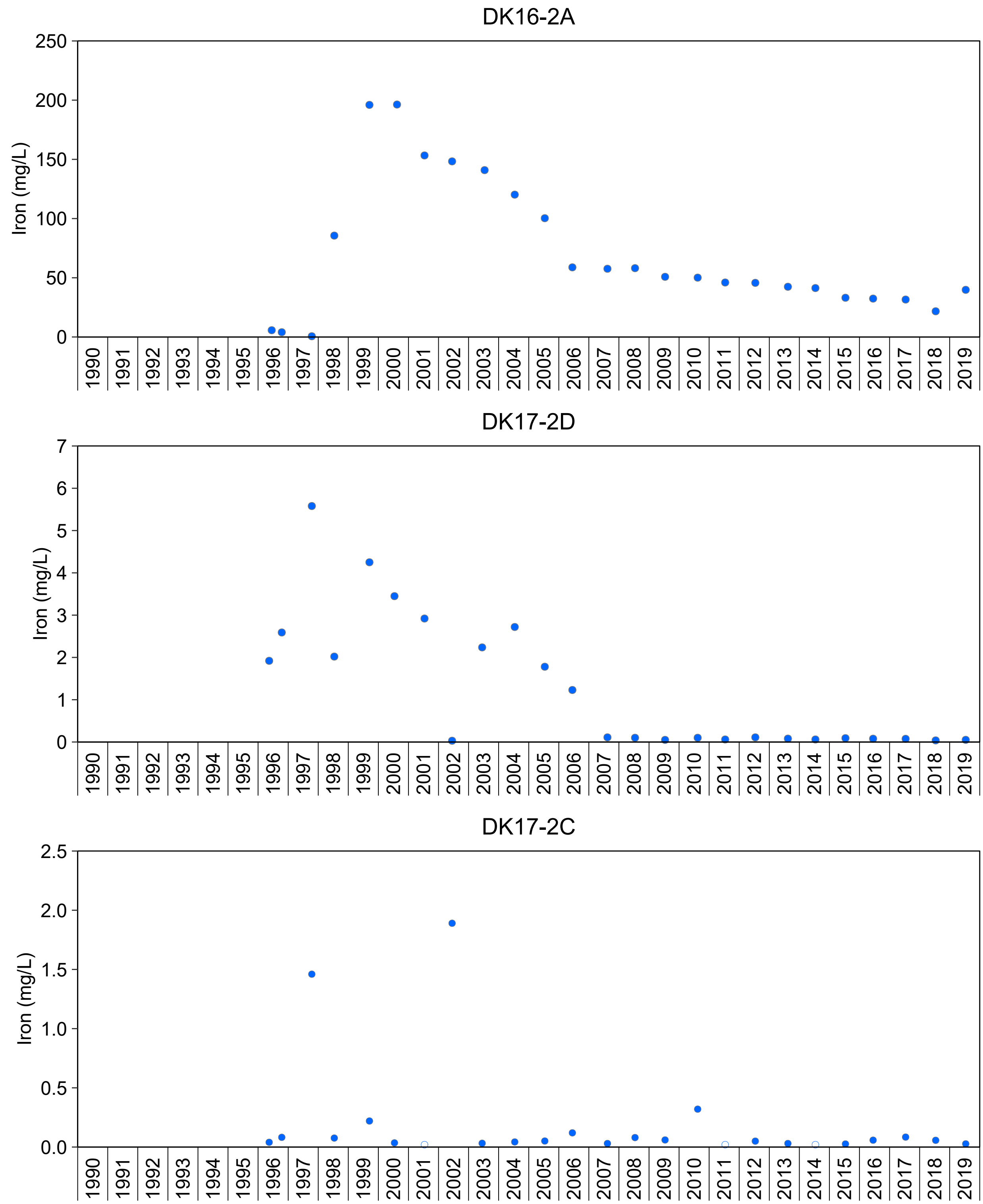


Figure G.11: Concentrations of Iron for TOMP Pore Water Stations, Quirke TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 4.10 for Kendall trend analysis results and Appendix Tables G.12 to G.16 for raw data.

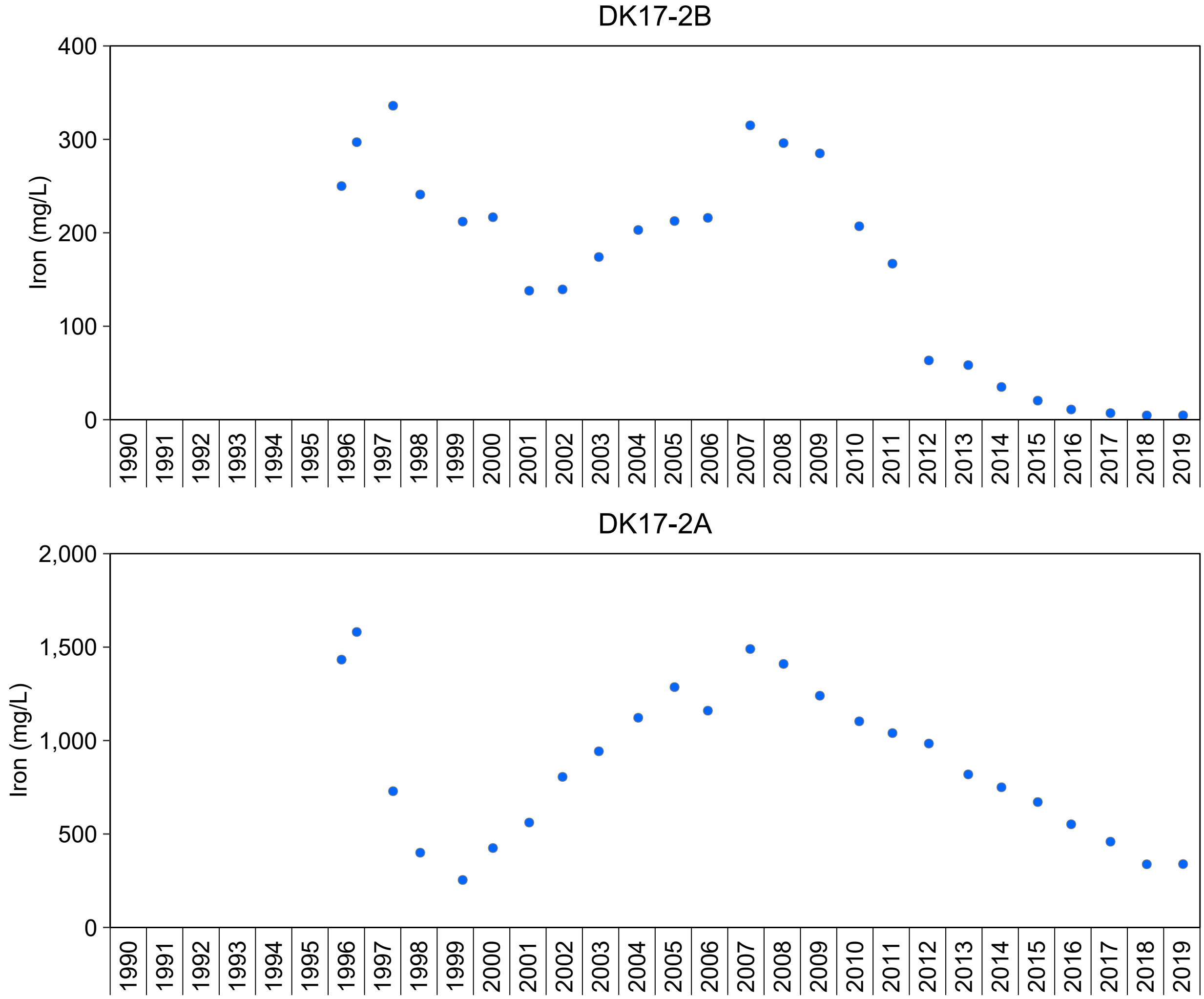


Figure G.11: Concentrations of Iron for TOMP Pore Water Stations, Quirke TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 4.10 for Kendall trend analysis results and Appendix Tables G.12 to G.16 for raw data.

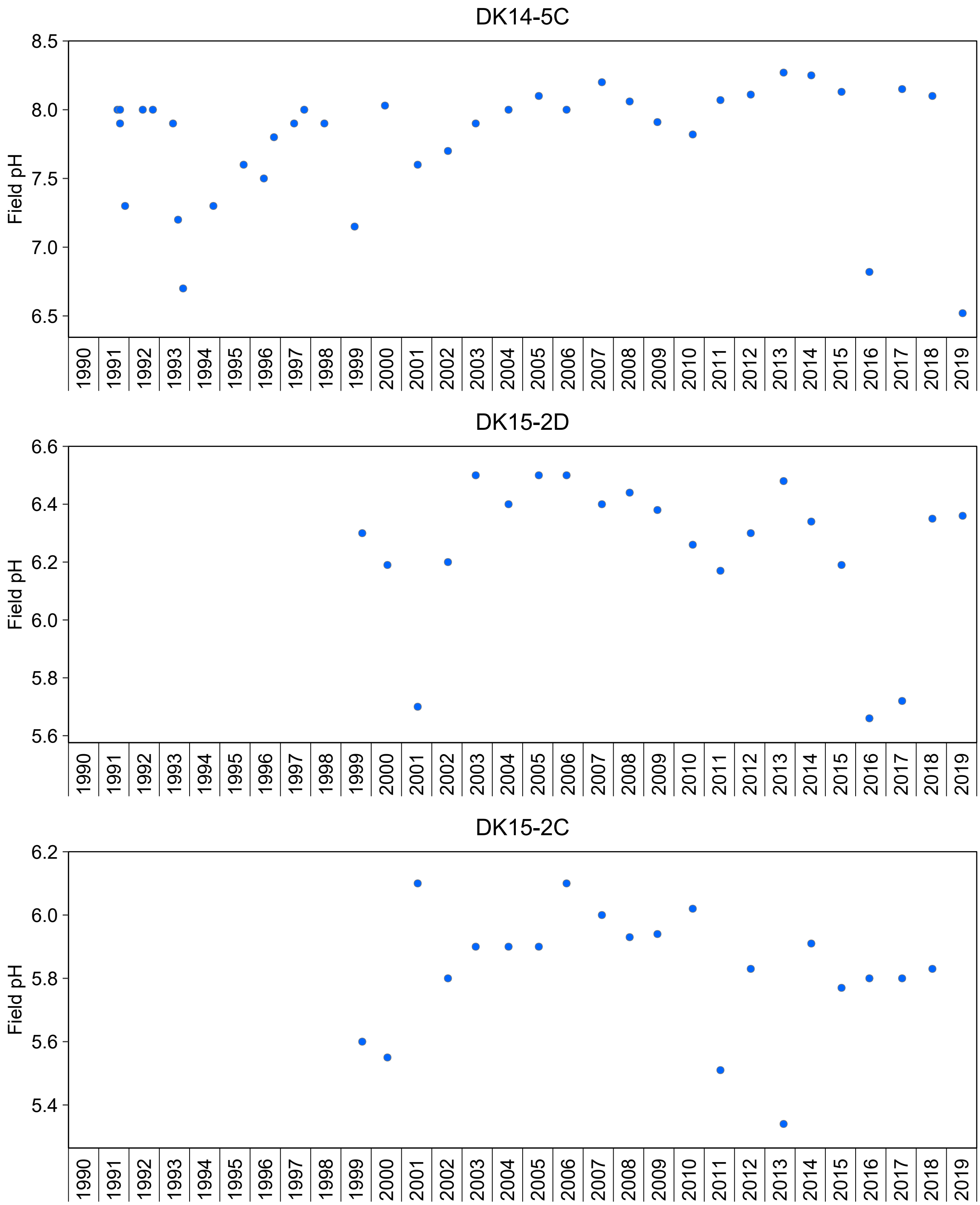


Figure G.12: Field Measurements of pH for TOMP Pore Water Stations, Quirke TMA, 1990 to 2019

Notes: See Table 4.10 for Kendall trend analysis results and Appendix Tables G.12 to G.16 for raw data.

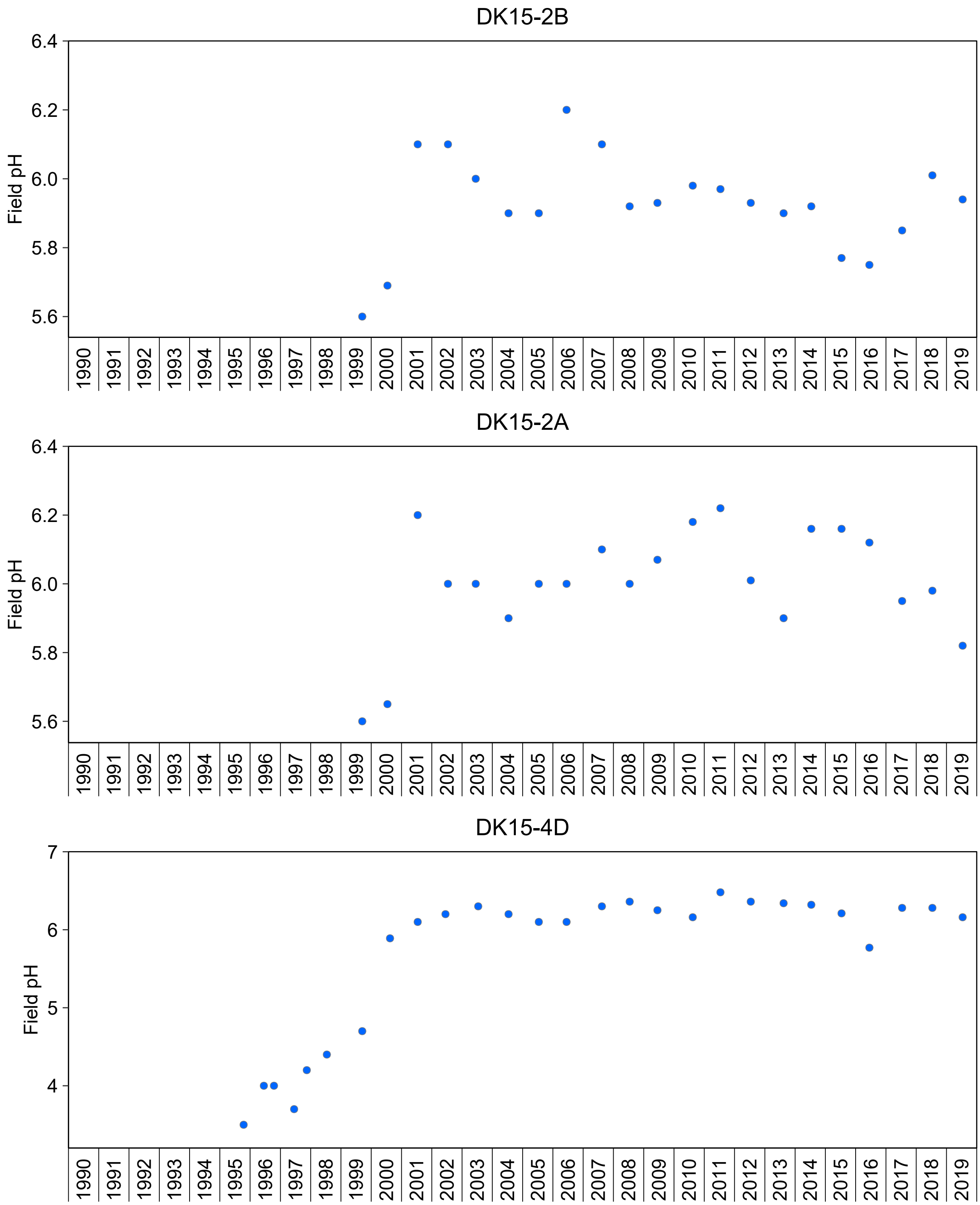


Figure G.12: Field Measurements of pH for TOMP Pore Water Stations, Quirke TMA, 1990 to 2019

Notes: See Table 4.10 for Kendall trend analysis results and Appendix Tables G.12 to G.16 for raw data.

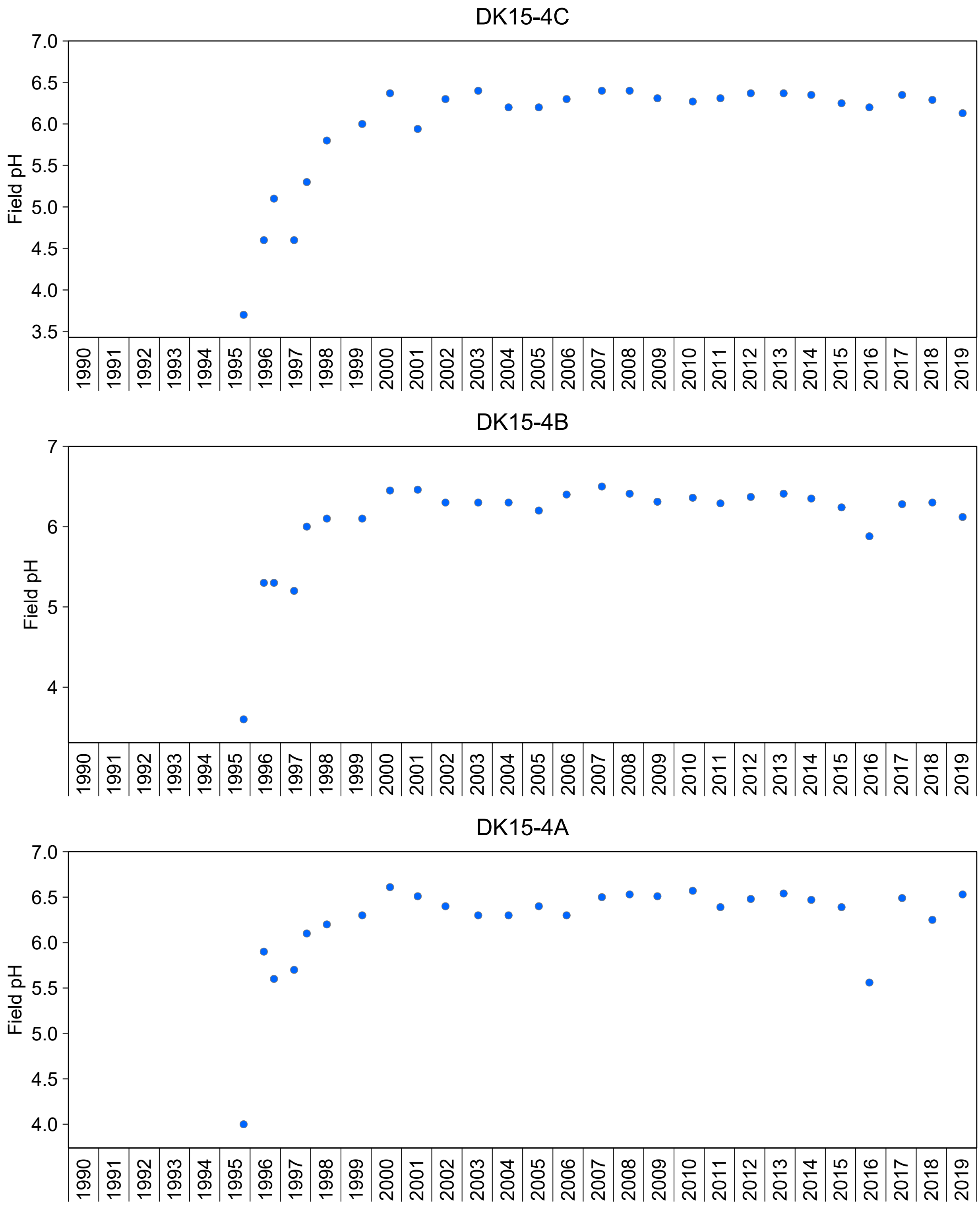


Figure G.12: Field Measurements of pH for TOMP Pore Water Stations, Quirke TMA, 1990 to 2019

Notes: See Table 4.10 for Kendall trend analysis results and Appendix Tables G.12 to G.16 for raw data.

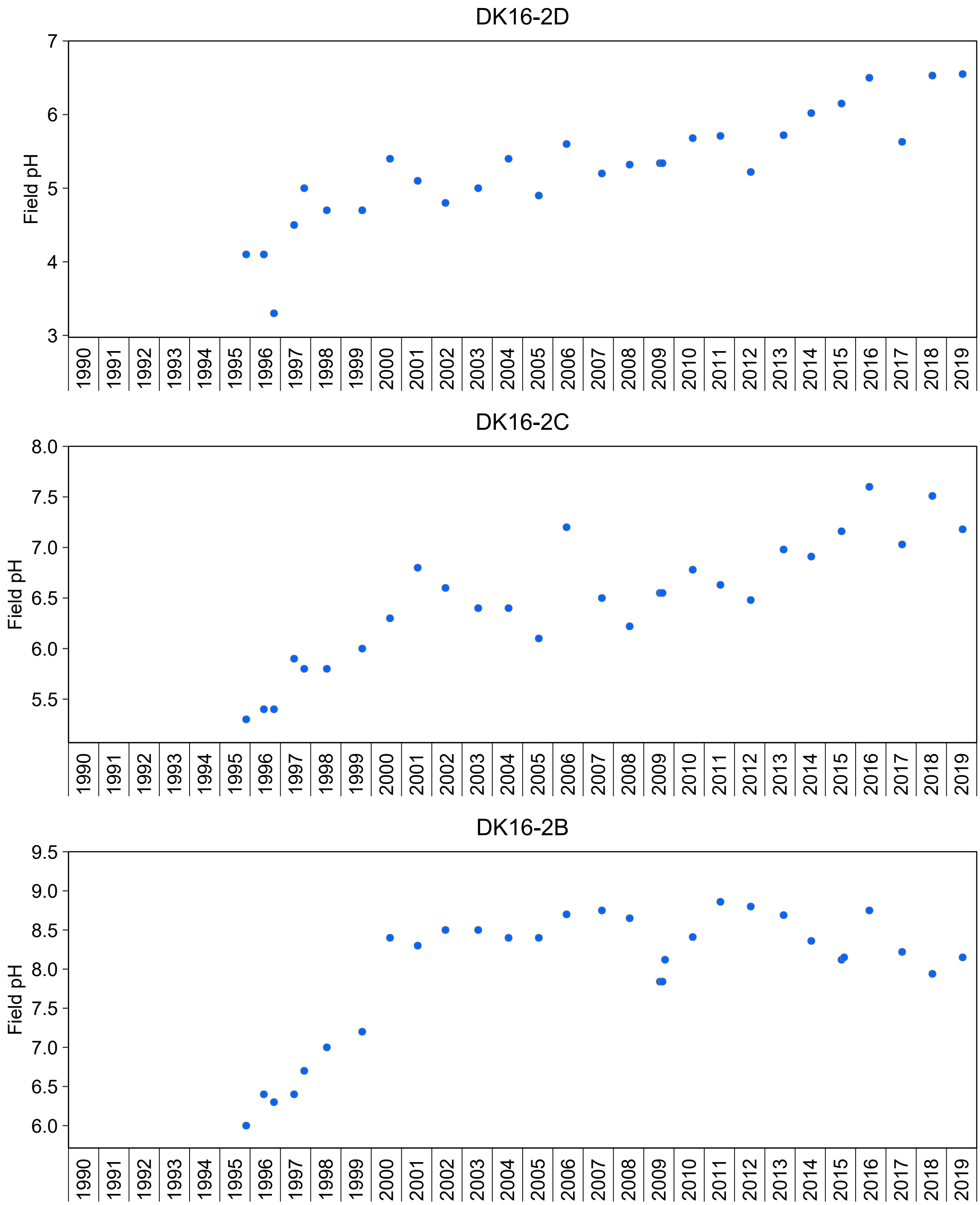


Figure G.12: Field Measurements of pH for TOMP Pore Water Stations, Quirke TMA, 1990 to 2019

Notes: See Table 4.10 for Kendall trend analysis results and Appendix Tables G.12 to G.16 for raw data.

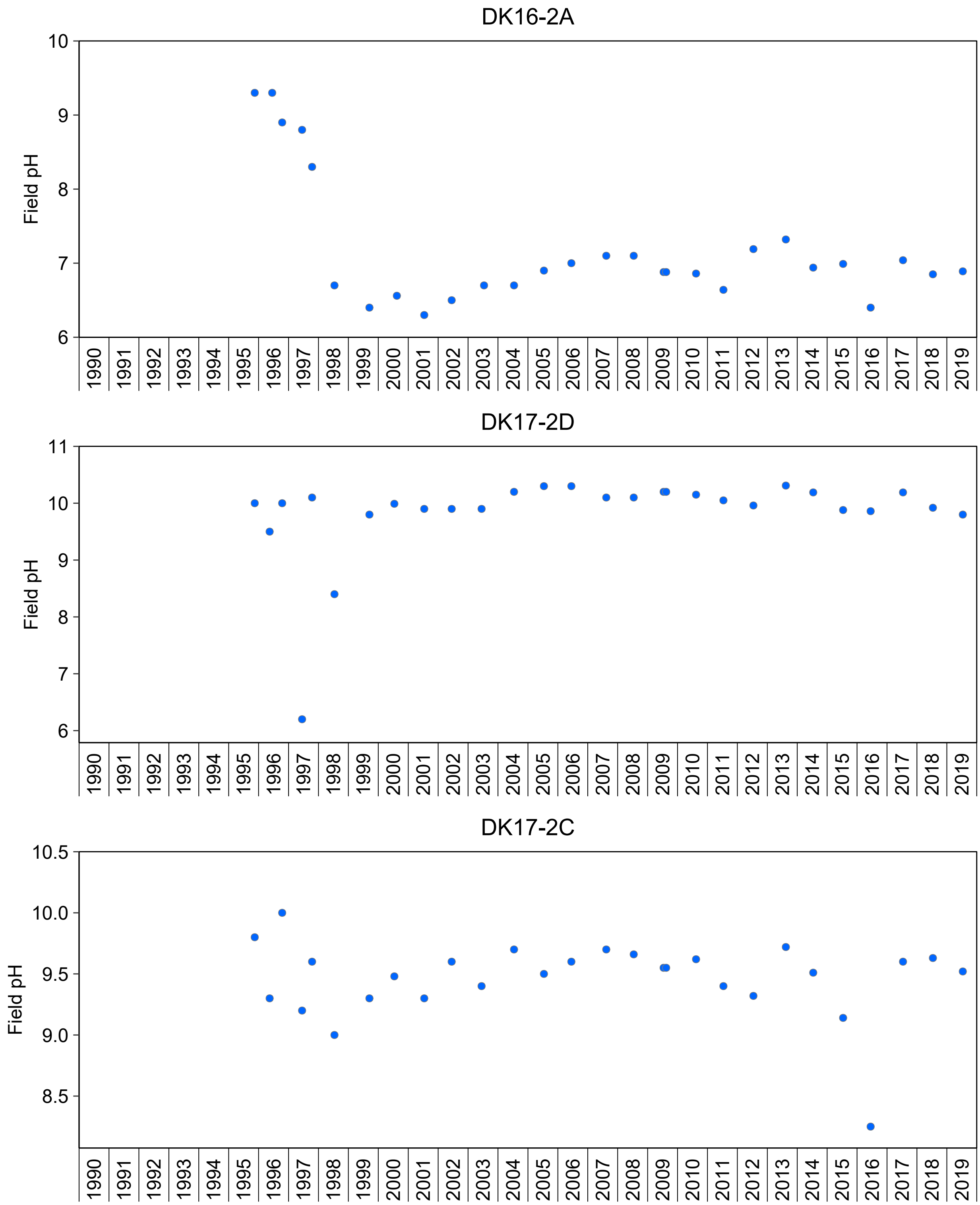


Figure G.12: Field Measurements of pH for TOMP Pore Water Stations, Quirke TMA, 1990 to 2019

Notes: See Table 4.10 for Kendall trend analysis results and Appendix Tables G.12 to G.16 for raw data.

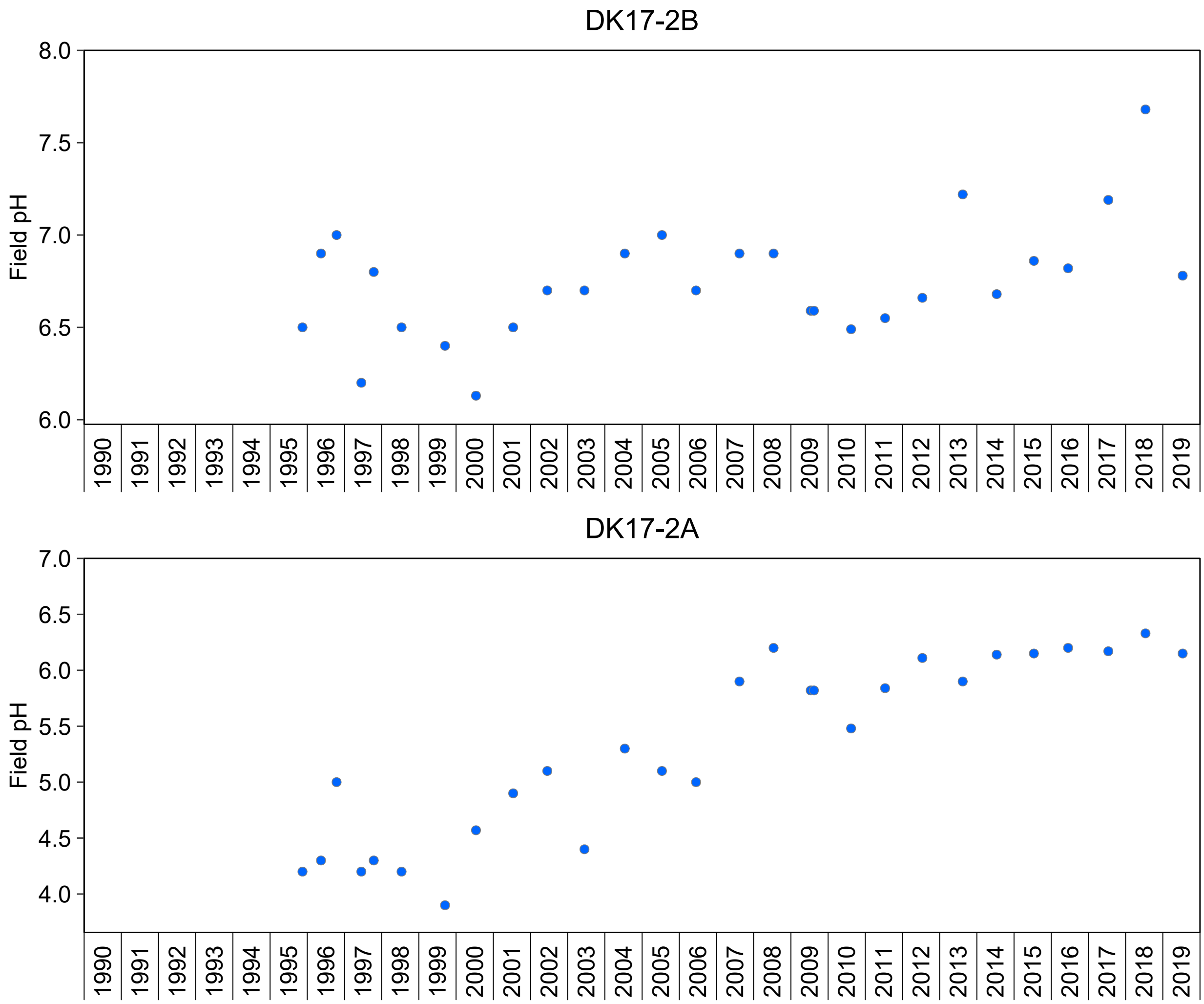


Figure G.12: Field Measurements of pH for TOMP Pore Water Stations, Quirke TMA, 1990 to 2019

Notes: See Table 4.10 for Kendall trend analysis results and Appendix Tables G.12 to G.16 for raw data.

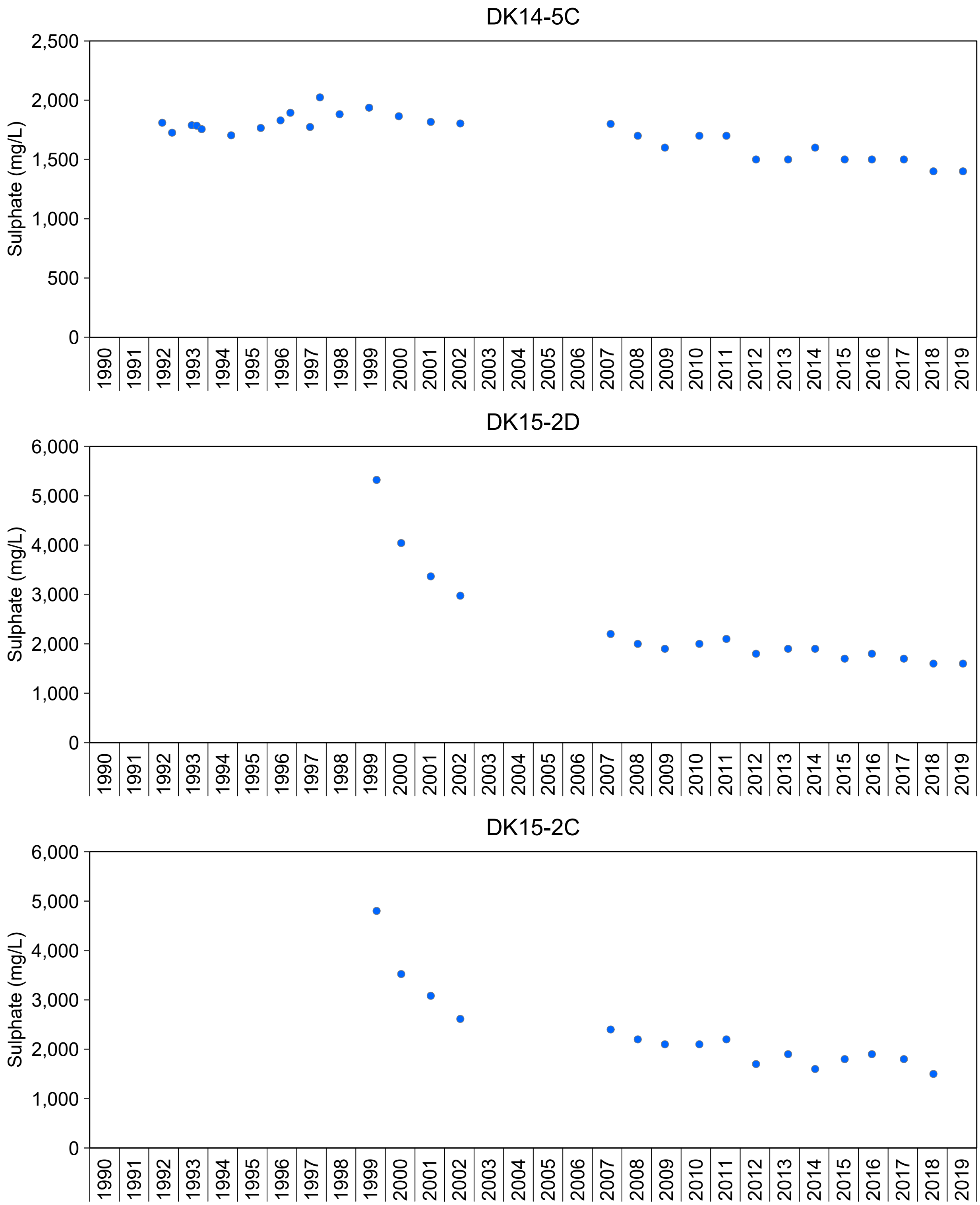


Figure G.13: Concentrations of Sulphate for TOMP Pore Water Stations, Quirke TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 4.10 for Kendall trend analysis results and Appendix Tables G.12 to G.16 for raw data.

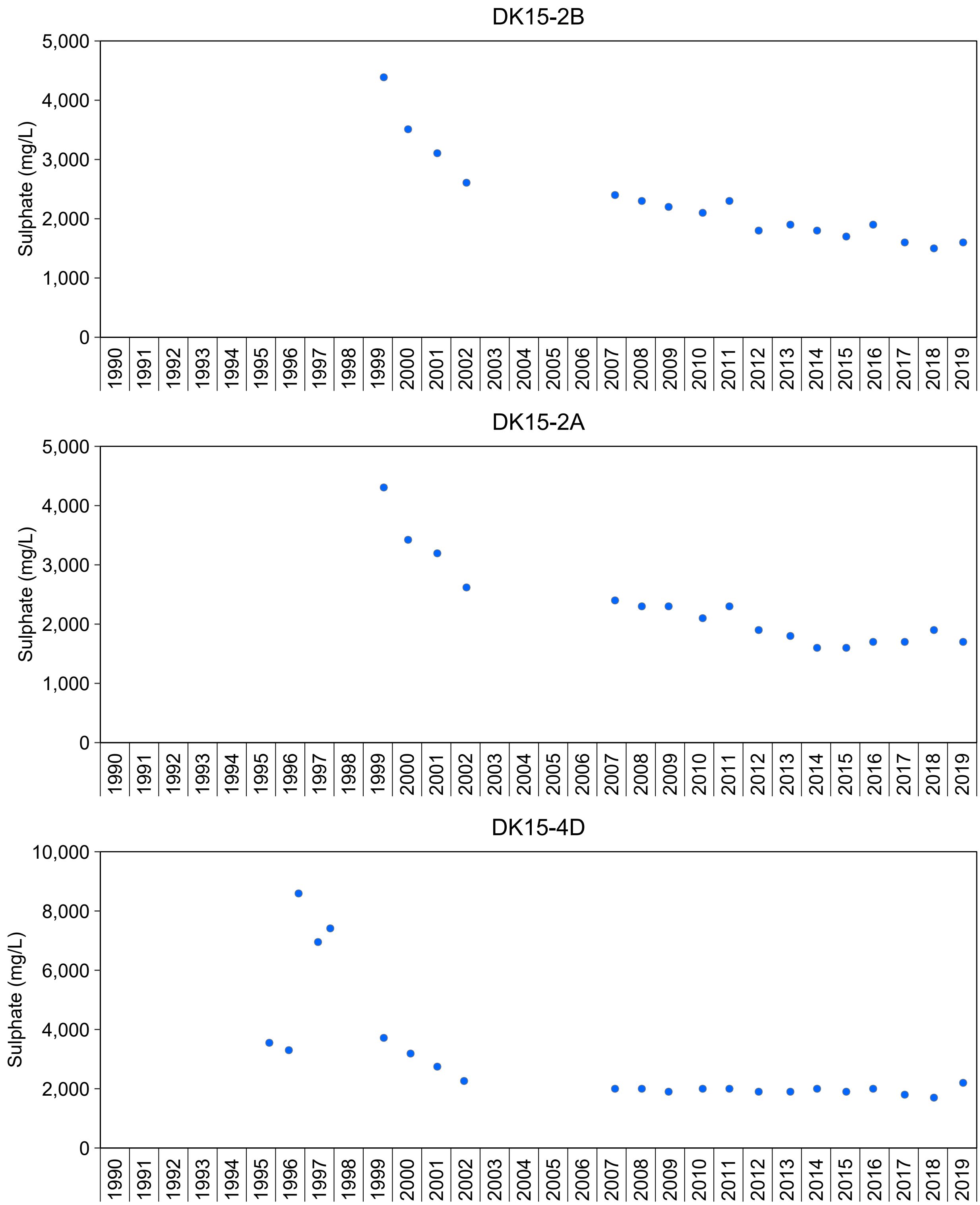


Figure G.13: Concentrations of Sulphate for TOMP Pore Water Stations, Quirke TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 4.10 for Kendall trend analysis results and Appendix Tables G.12 to G.16 for raw data.

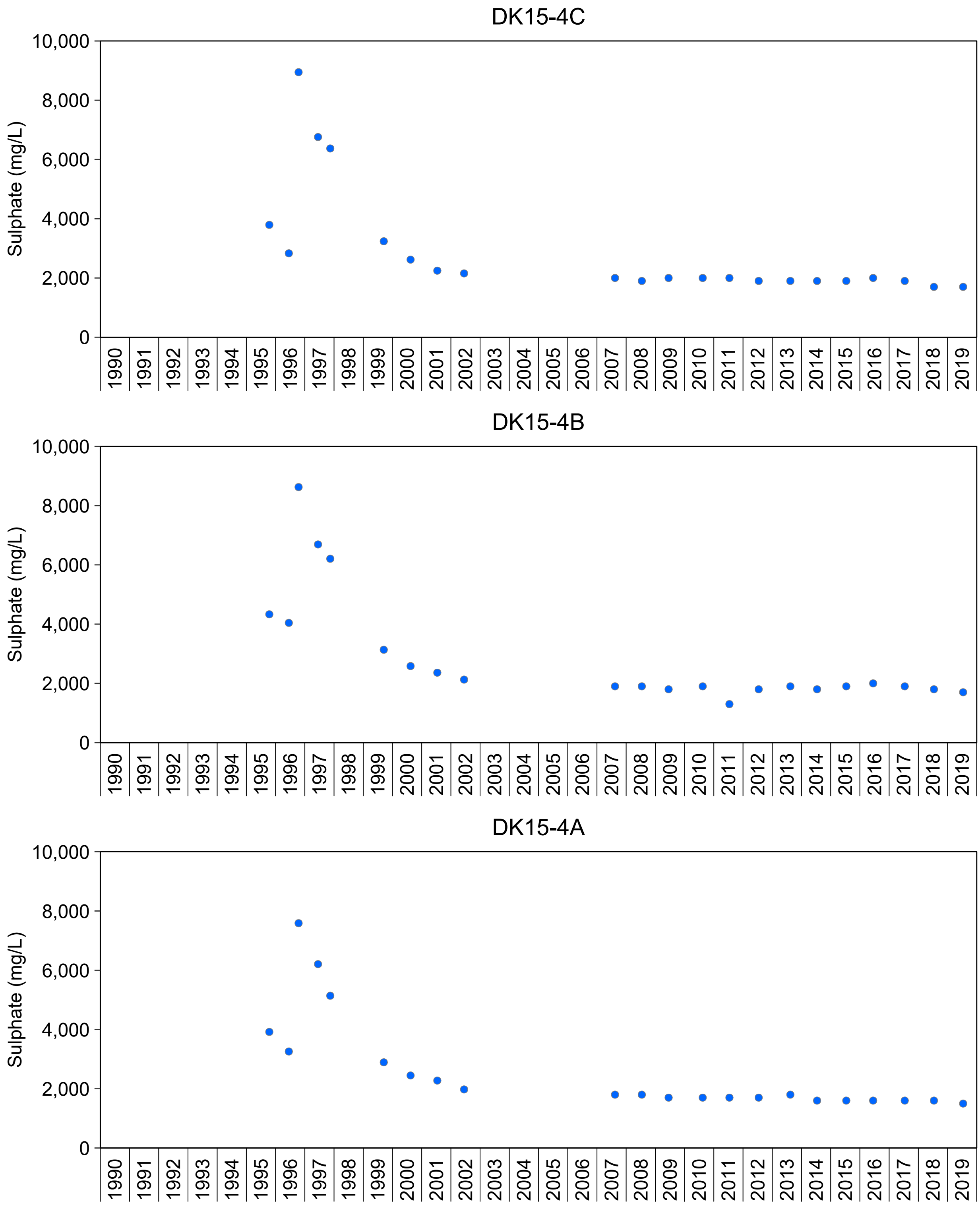
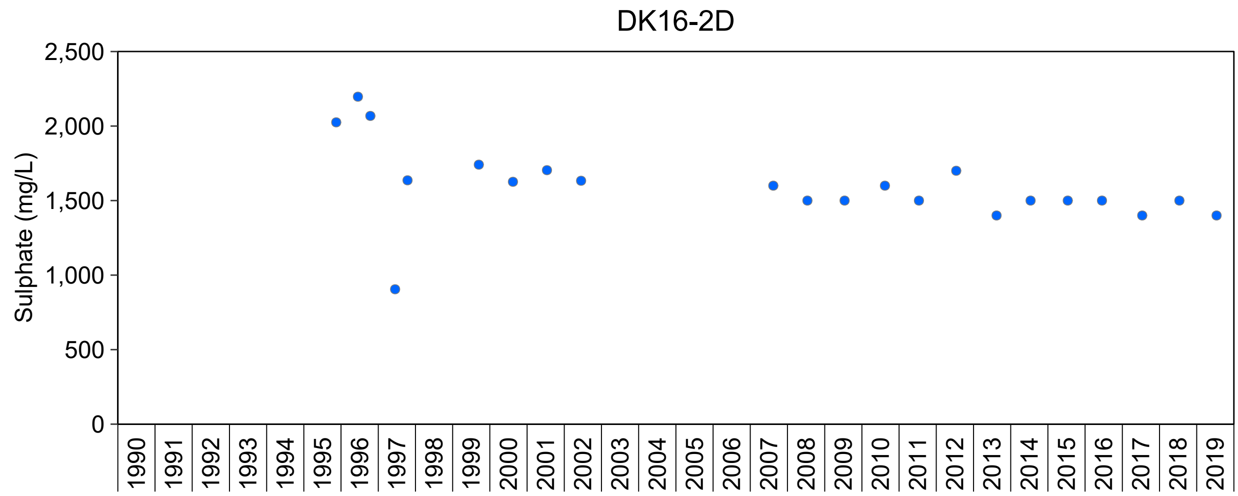
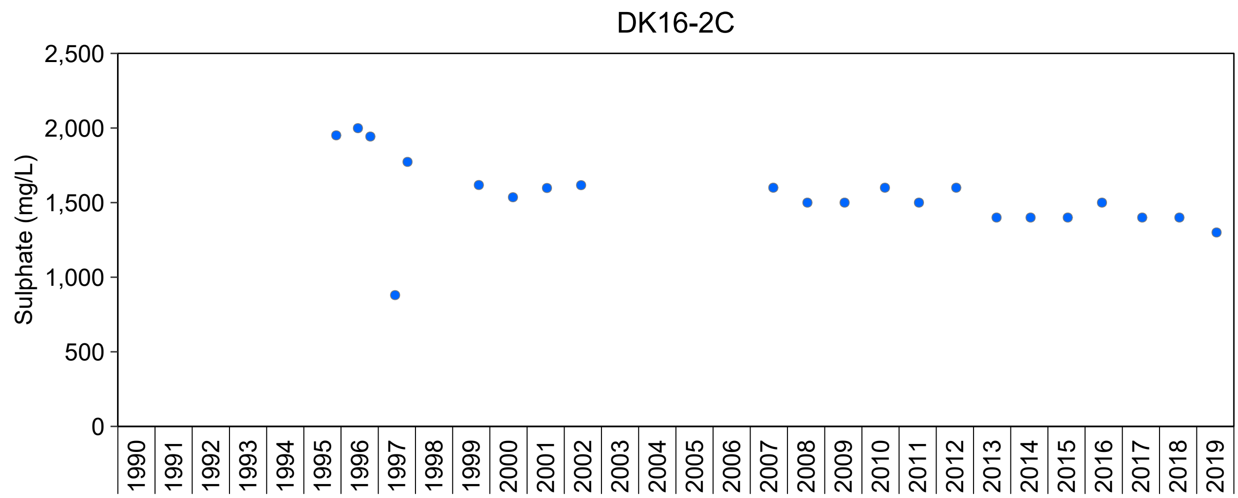


Figure G.13: Concentrations of Sulphate for TOMP Pore Water Stations, Quirke TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 4.10 for Kendall trend analysis results and Appendix Tables G.12 to G.16 for raw data.





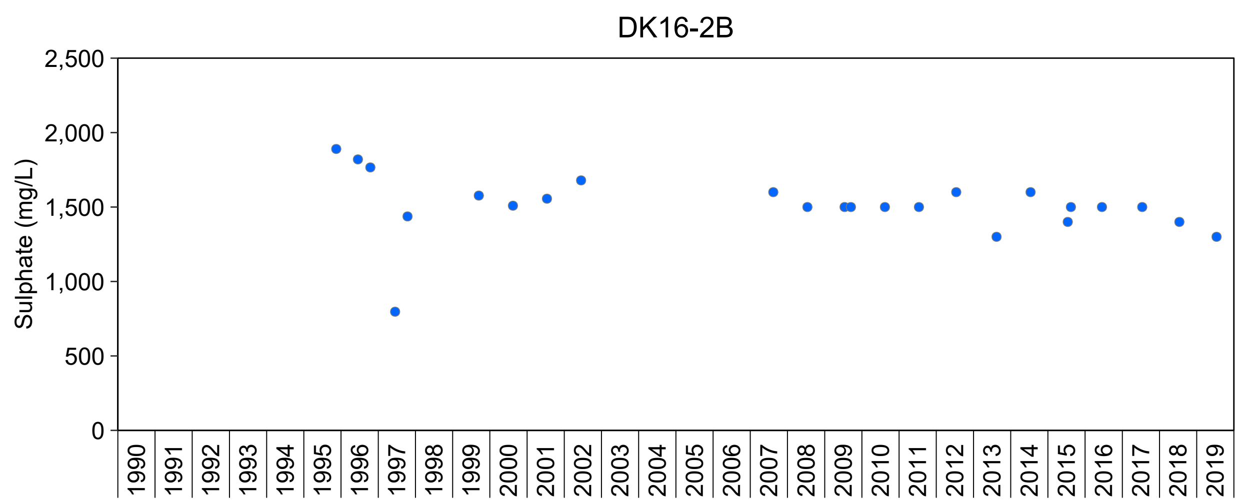


Figure G.13: Concentrations of Sulphate for TOMP Pore Water Stations, Quirke TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 4.10 for Kendall trend analysis results and Appendix Tables G.12 to G.16 for raw data.

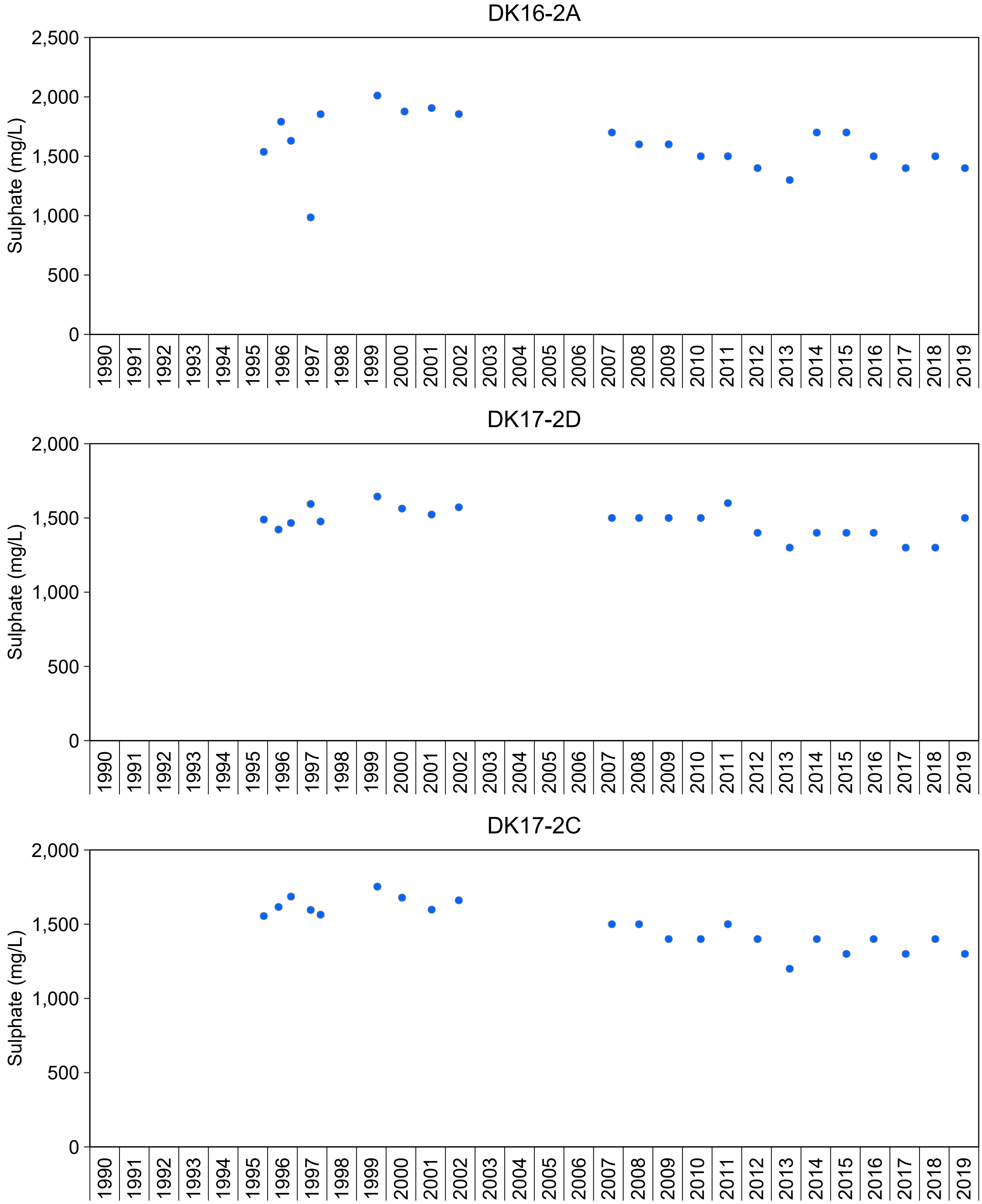


Figure G.13: Concentrations of Sulphate for TOMP Pore Water Stations, Quirke TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 4.10 for Kendall trend analysis results and Appendix Tables G.12 to G.16 for raw data.

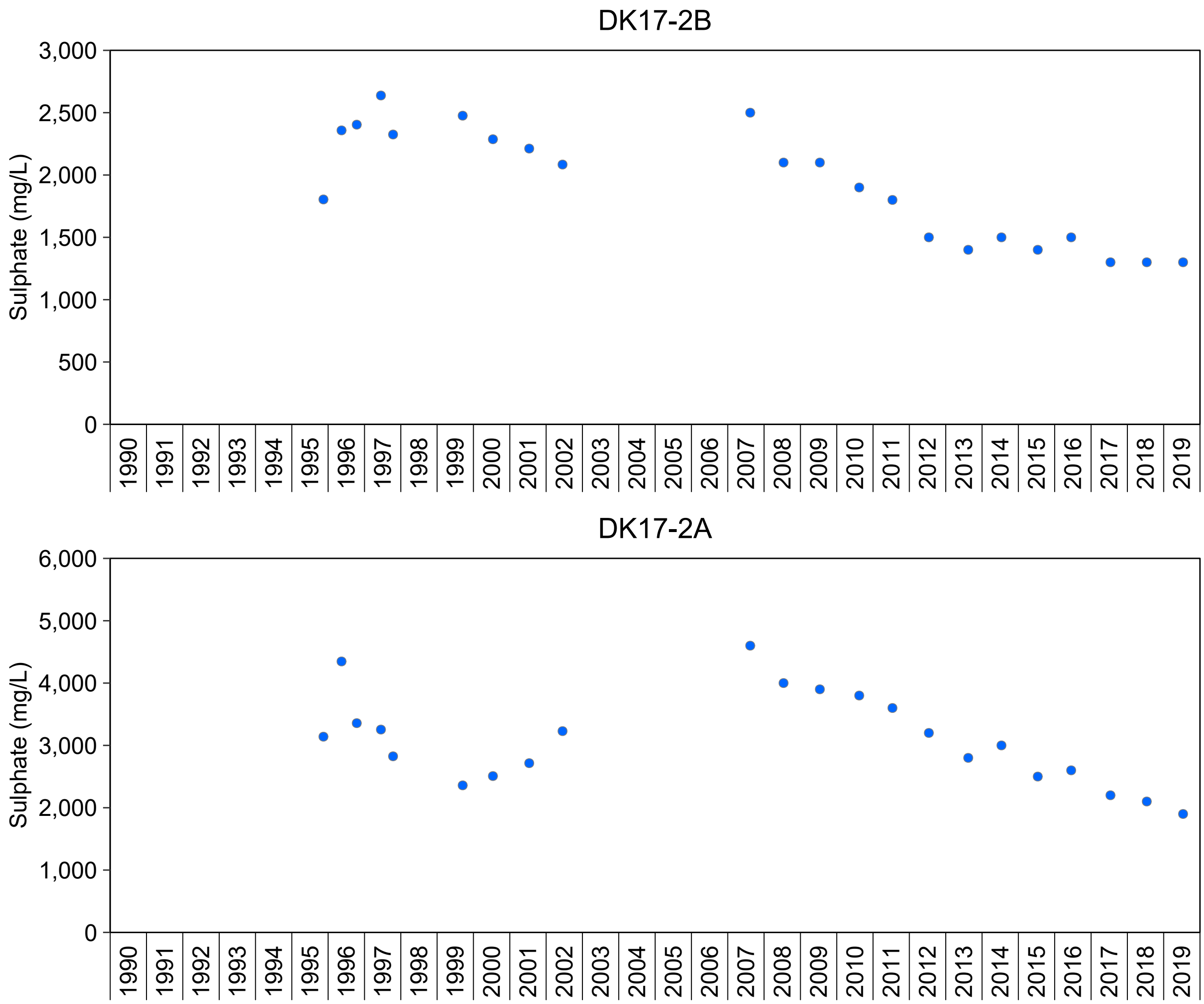


Figure G.13: Concentrations of Sulphate for TOMP Pore Water Stations, Quirke TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 4.10 for Kendall trend analysis results and Appendix Tables G.12 to G.16 for raw data.

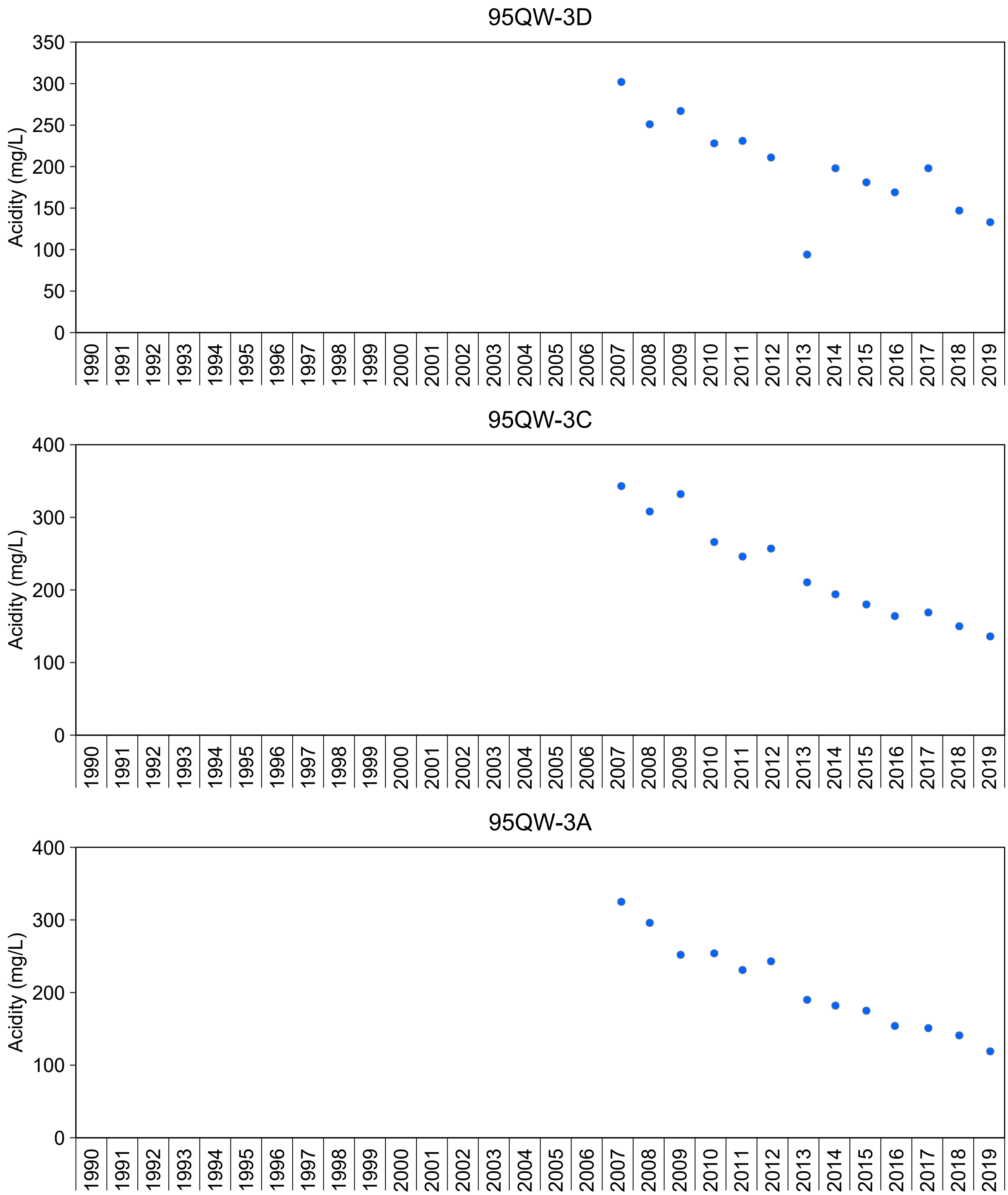


Figure G.14: Time Series Plots for Acidity Concentrations from TOMP Groundwater Stations, Quirke TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 4.11 for Kendall trend analysis results and Appendix Tables G.17 to G.20 for raw data. Acidity (mg/L) is not included in the trend analysis for TOMP stations 95QW-4, 95QW-5D, QPW1-1, QPW1-4, and QPW1-8 due to >50% non-detectable concentrations in the dataset.

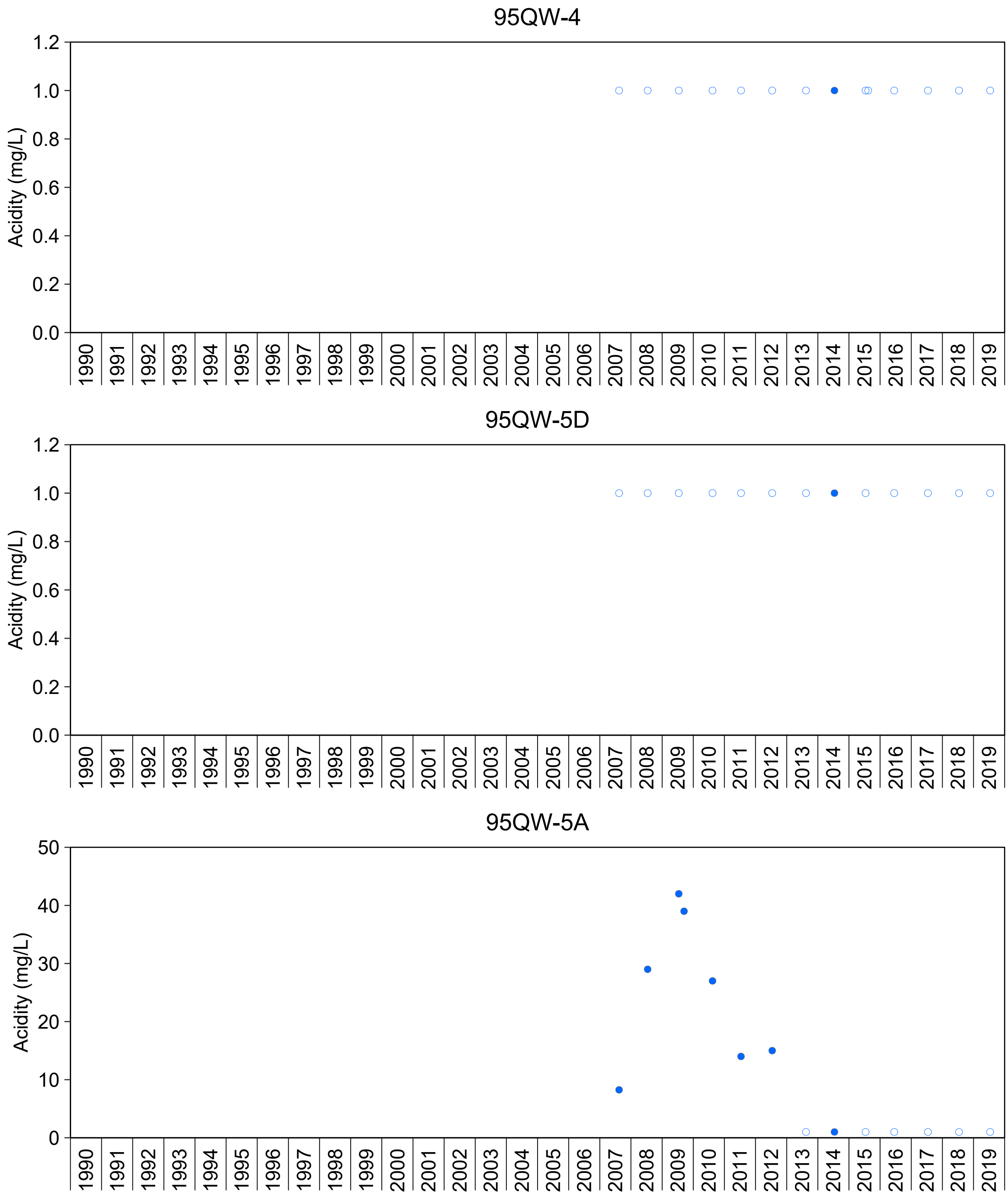


Figure G.14: Time Series Plots for Acidity Concentrations from TOMP Groundwater Stations, Quirke TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 4.11 for Kendall trend analysis results and Appendix Tables G.17 to G.20 for raw data. Acidity (mg/L) is not included in the trend analysis for TOMP stations 95QW-4, 95QW-5D, QPW1-1, QPW1-4, and QPW1-8 due to >50% non-detectable concentrations in the dataset.

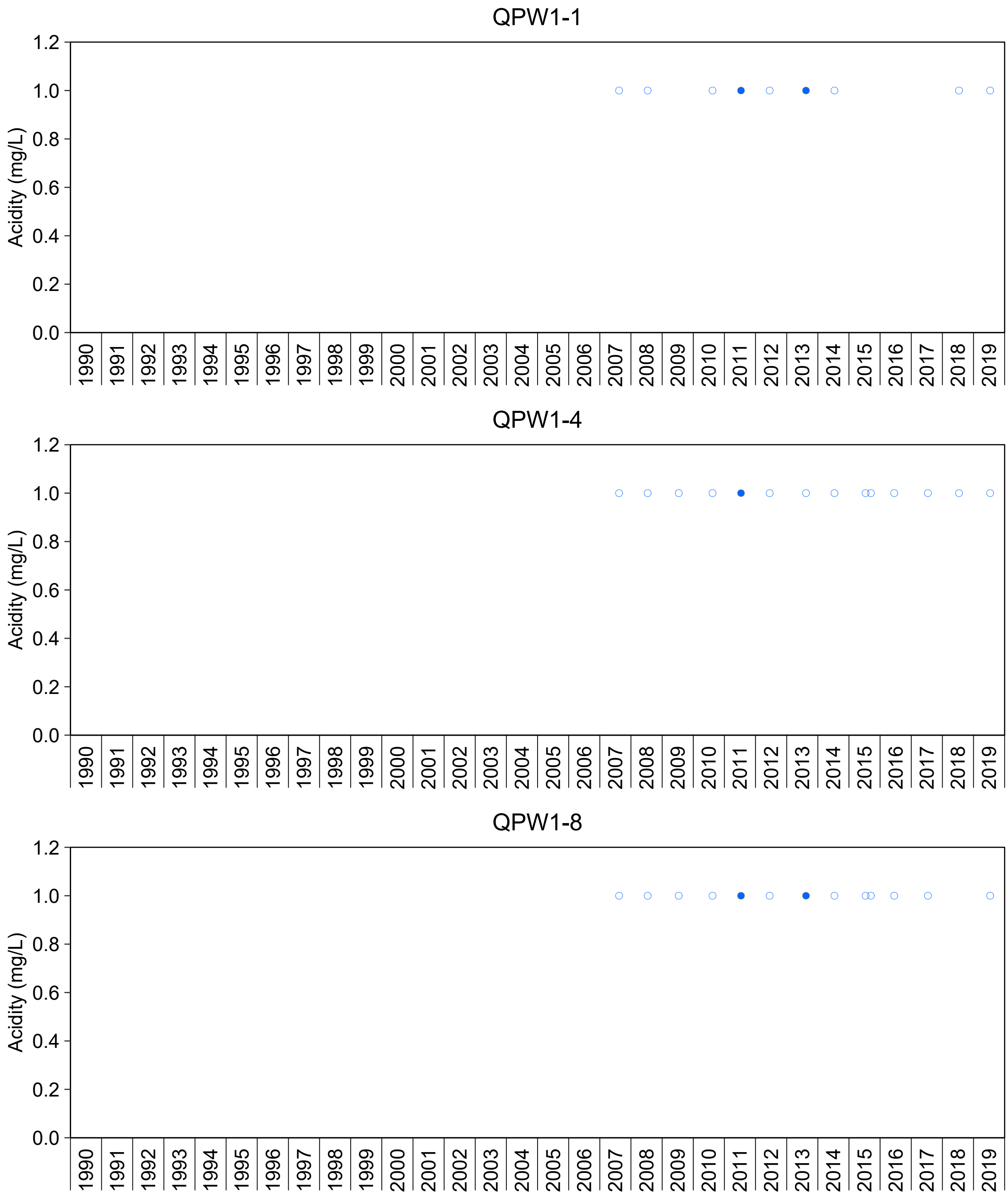


Figure G.14: Time Series Plots for Acidity Concentrations from TOMP Groundwater Stations, Quirke TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 4.11 for Kendall trend analysis results and Appendix Tables G.17 to G.20 for raw data. Acidity (mg/L) is not included in the trend analysis for TOMP stations 95QW-4, 95QW-5D, QPW1-1, QPW1-4, and QPW1-8 due to >50% non-detectable concentrations in the dataset.

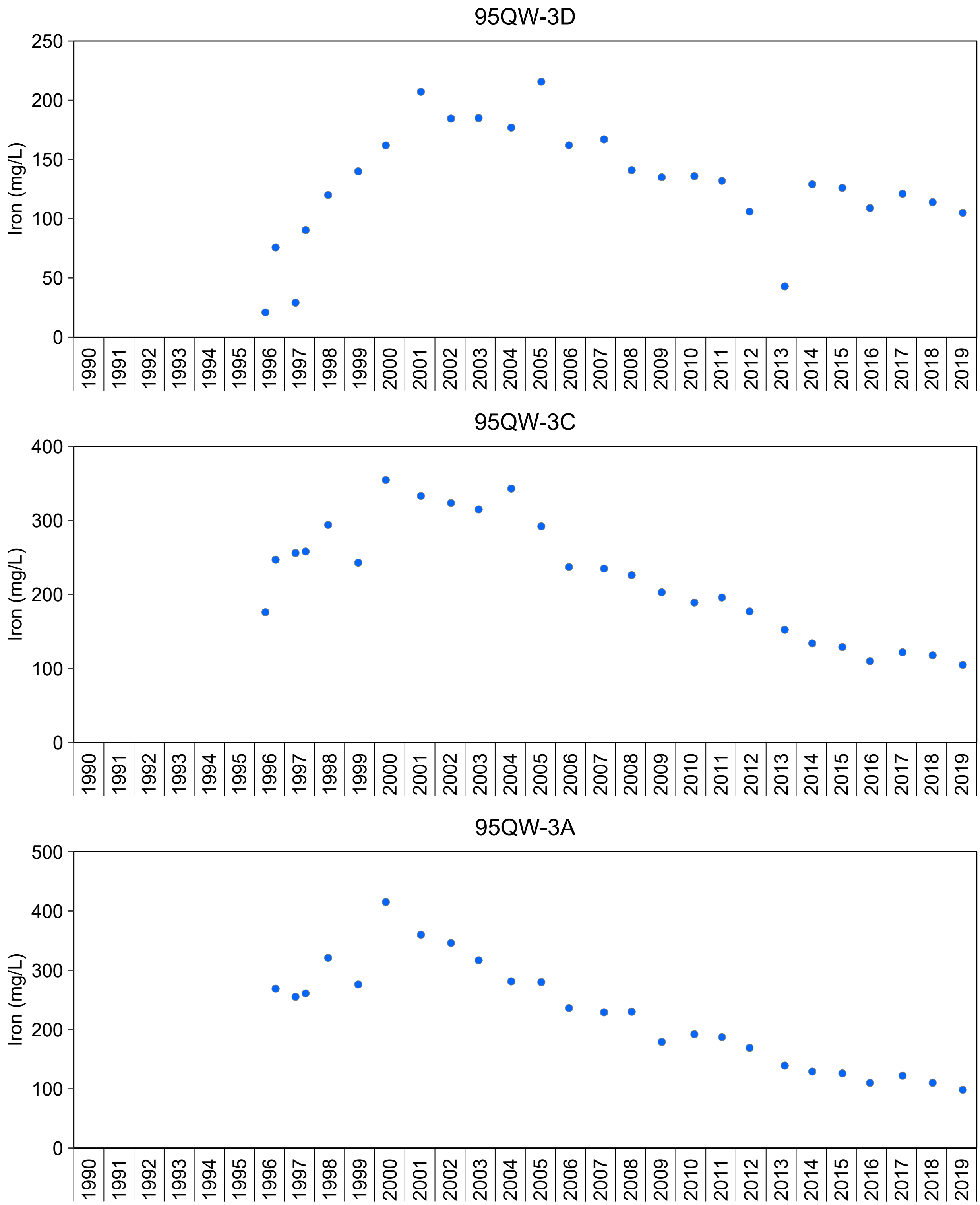


Figure G.15: Concentrations of Iron for TOMP Groundwater Stations, Quirke TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 4.11 for Kendall trend analysis results and Appendix Tables G.17 to G.20 for raw data.

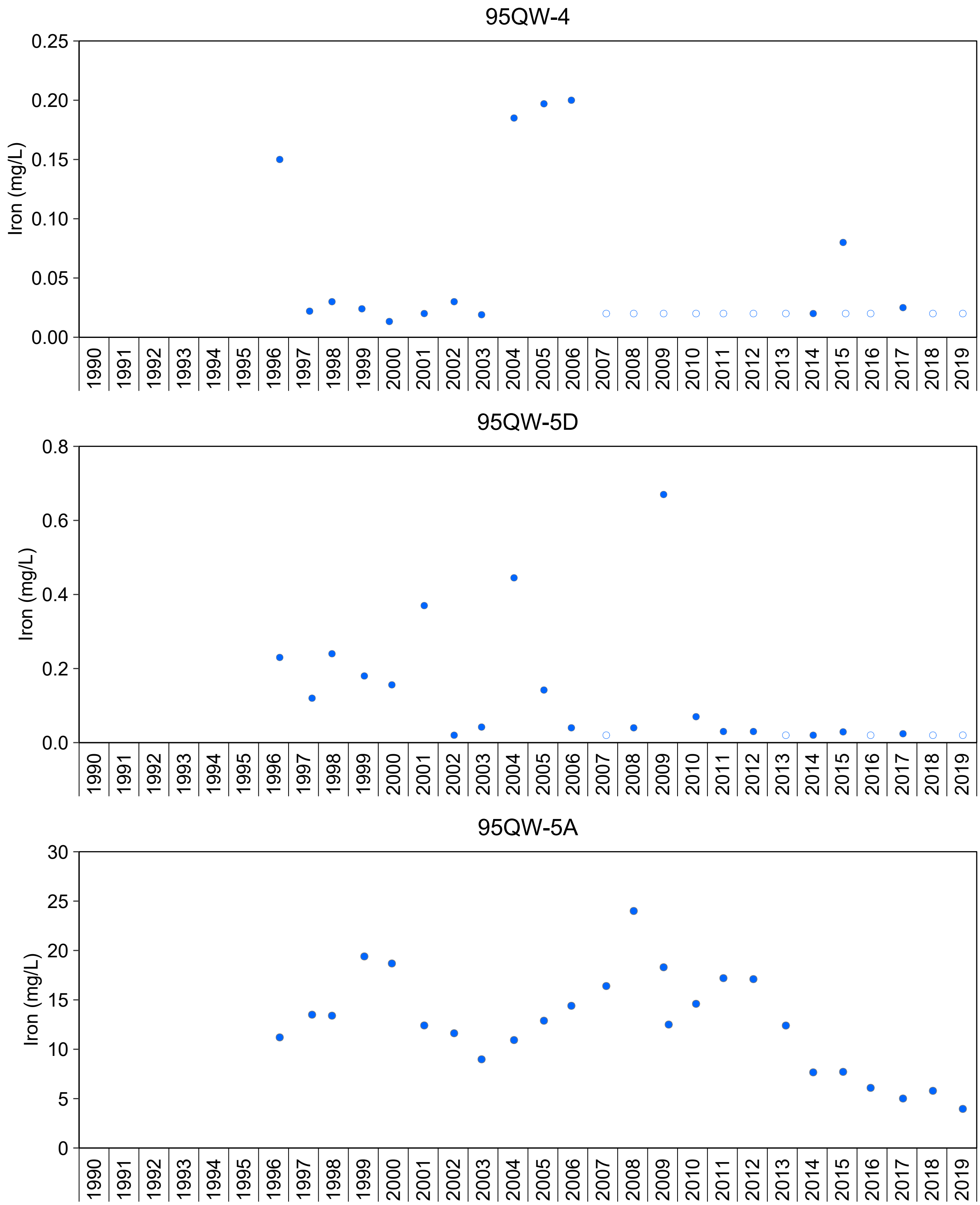


Figure G.15: Concentrations of Iron for TOMP Groundwater Stations, Quirke TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 4.11 for Kendall trend analysis results and Appendix Tables G.17 to G.20 for raw data.

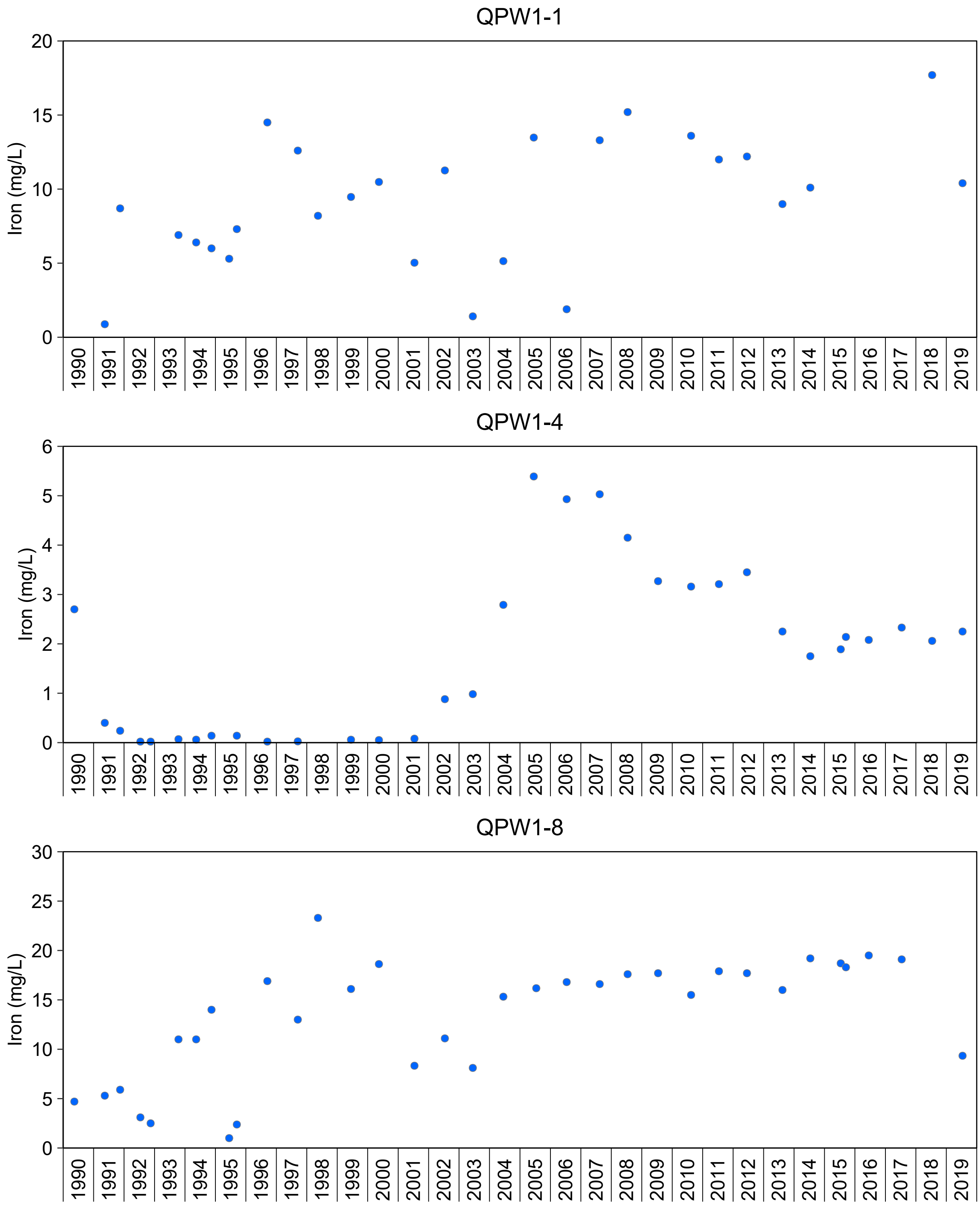


Figure G.15: Concentrations of Iron for TOMP Groundwater Stations, Quirke TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 4.11 for Kendall trend analysis results and Appendix Tables G.17 to G.20 for raw data.

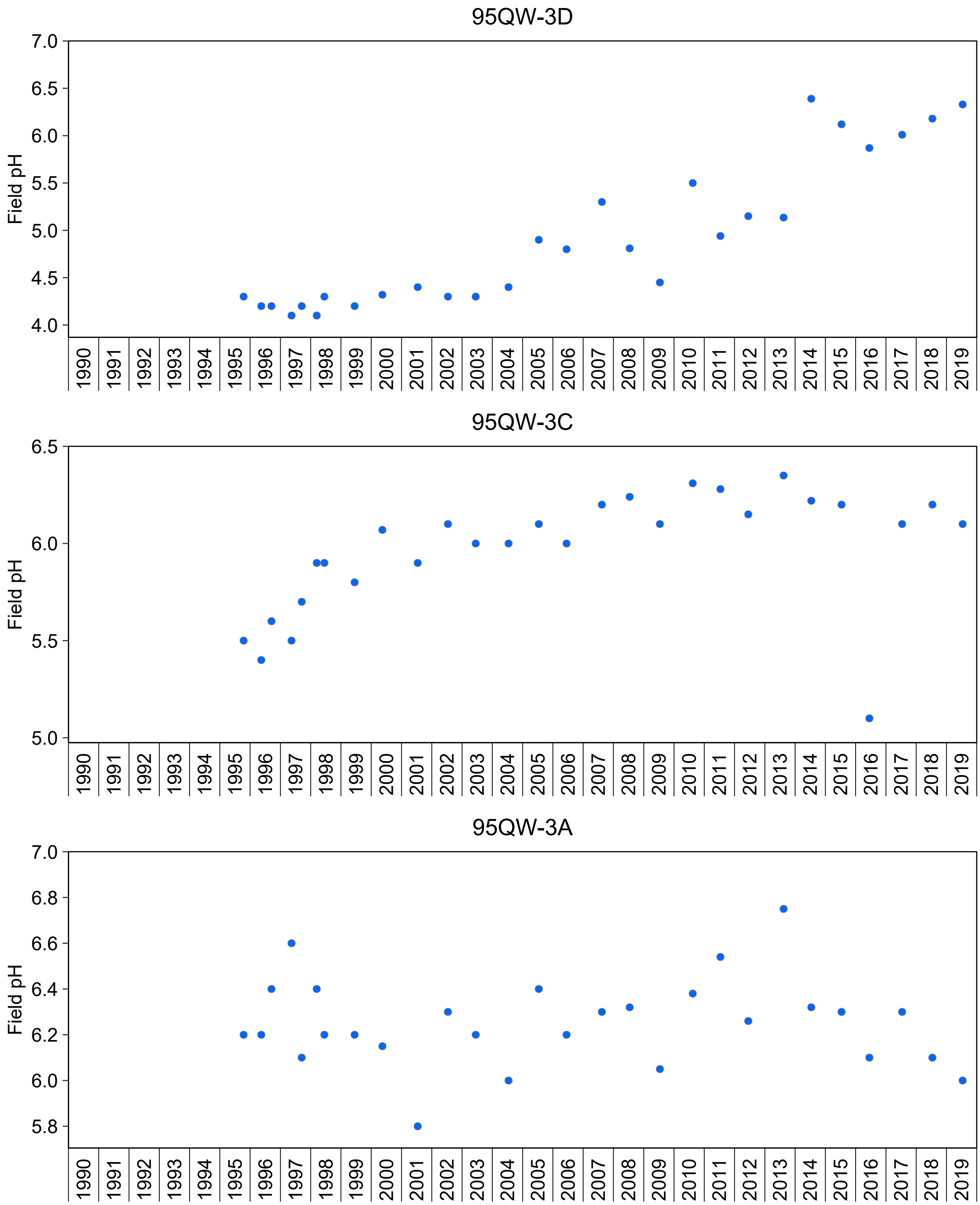


Figure G.16: Field Measurements of pH for TOMP Groundwater Stations, Quirke TMA, 1990 to 2019

Notes: See Table 4.11 for Kendall trend analysis results and Appendix Tables G.17 to G.20 for raw data.

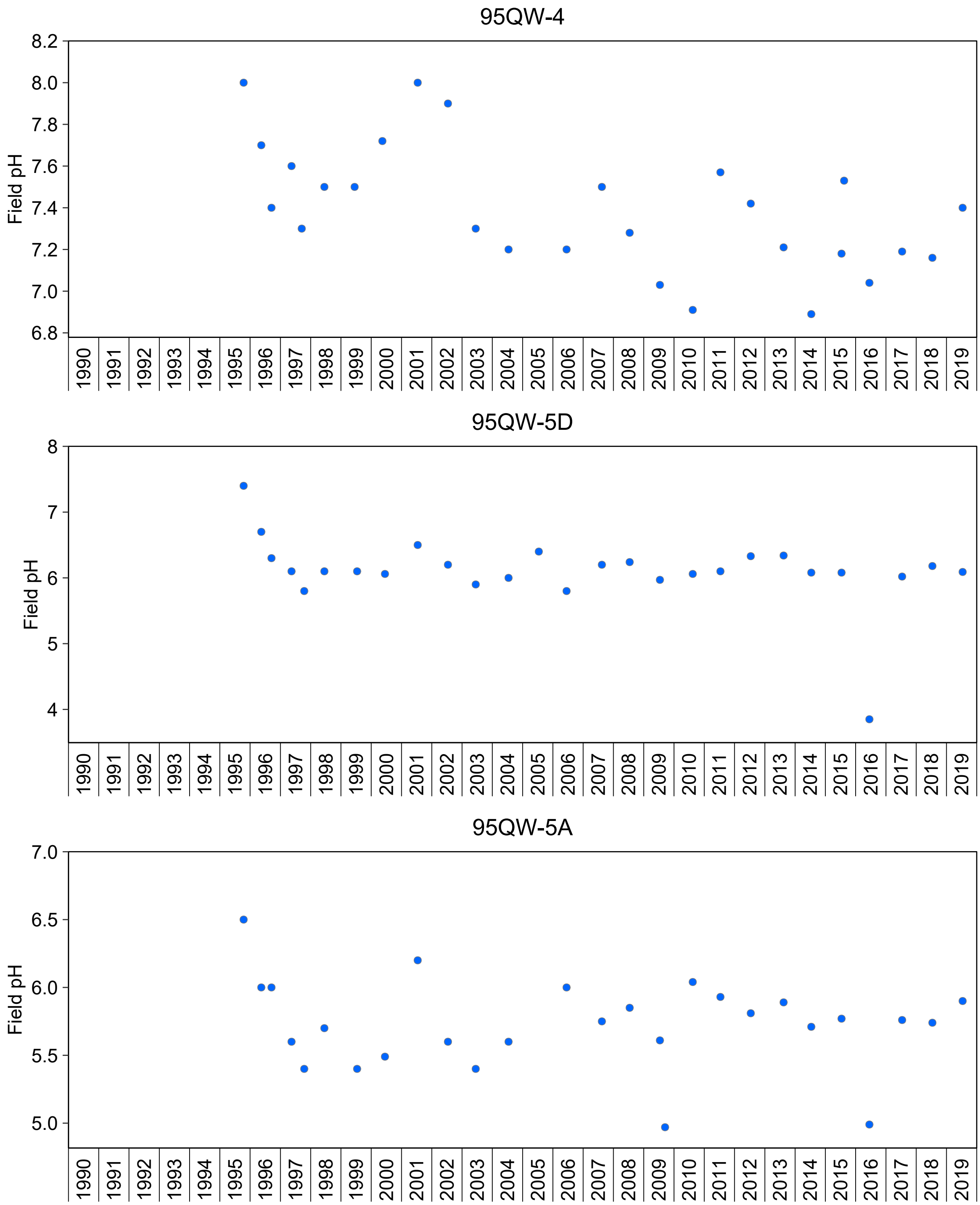


Figure G.16: Field Measurements of pH for TOMP Groundwater Stations, Quirke TMA, 1990 to 2019

Notes: See Table 4.11 for Kendall trend analysis results and Appendix Tables G.17 to G.20 for raw data.

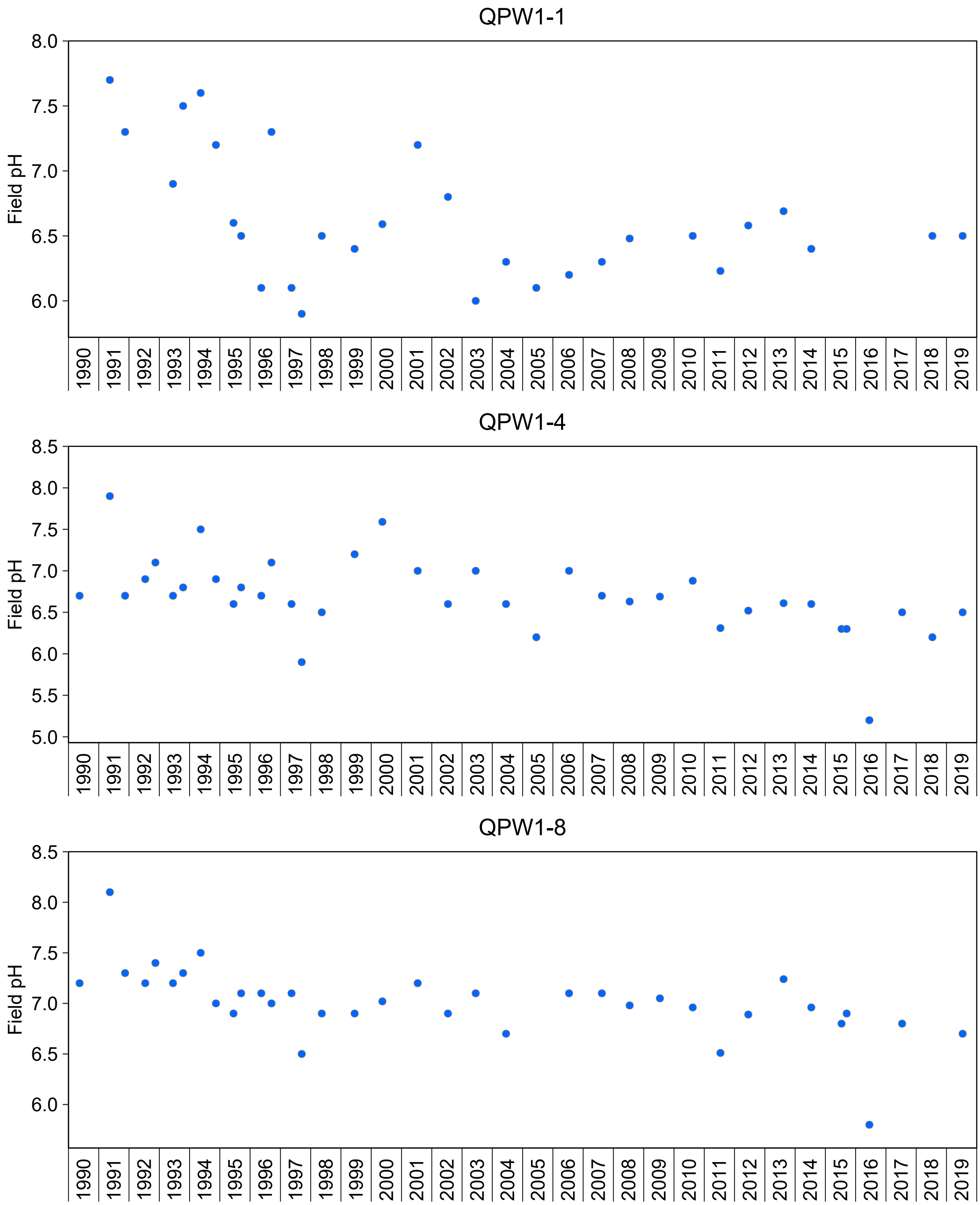


Figure G.16: Field Measurements of pH for TOMP Groundwater Stations, Quirke TMA, 1990 to 2019

Notes: See Table 4.11 for Kendall trend analysis results and Appendix Tables G.17 to G.20 for raw data.

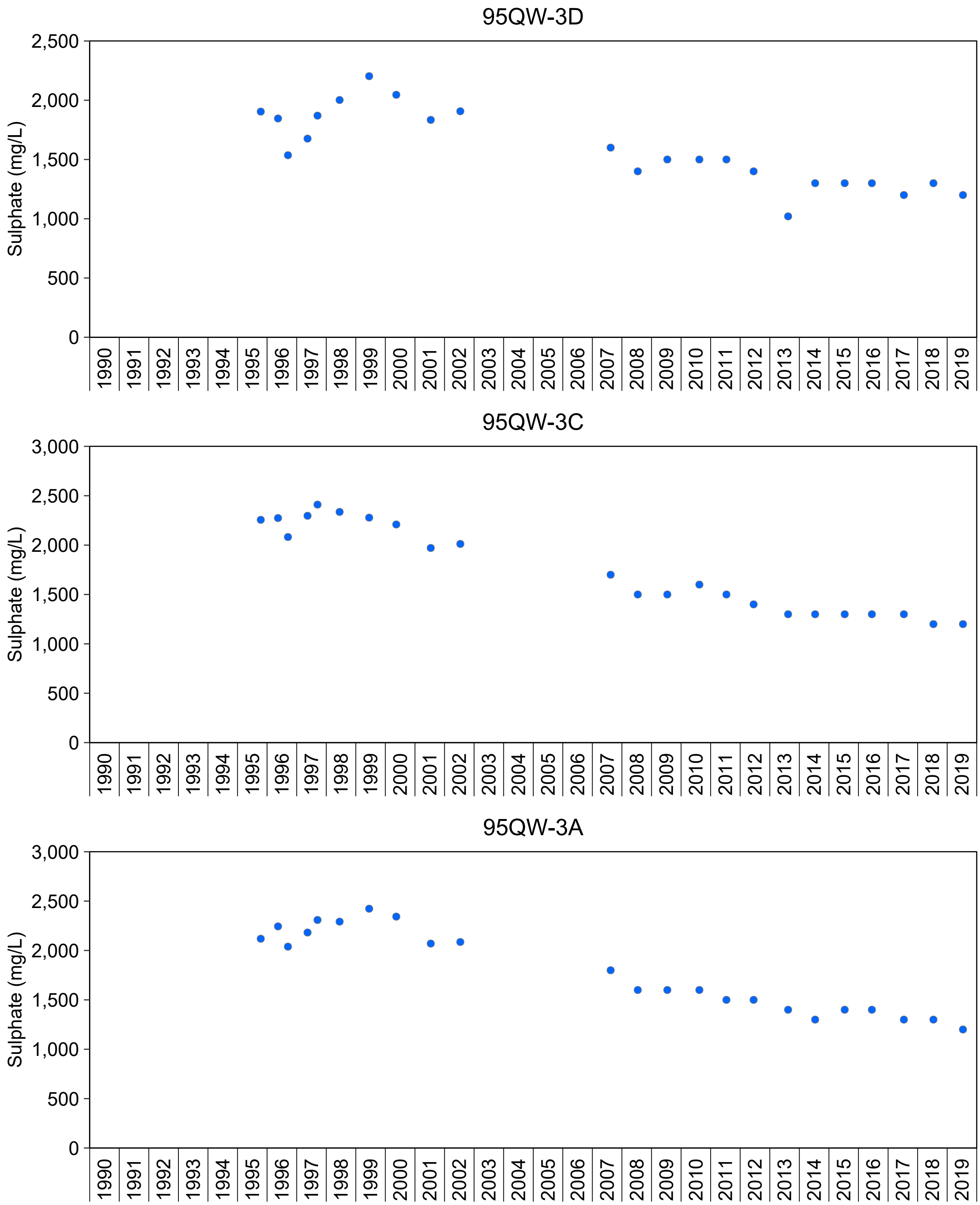


Figure G.17: Concentrations of Sulphate for TOMP Groundwater Stations, Quirke TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL.
See Table 4.11 for Kendall trend analysis results and Appendix Tables G.17 to G.20 for raw data.

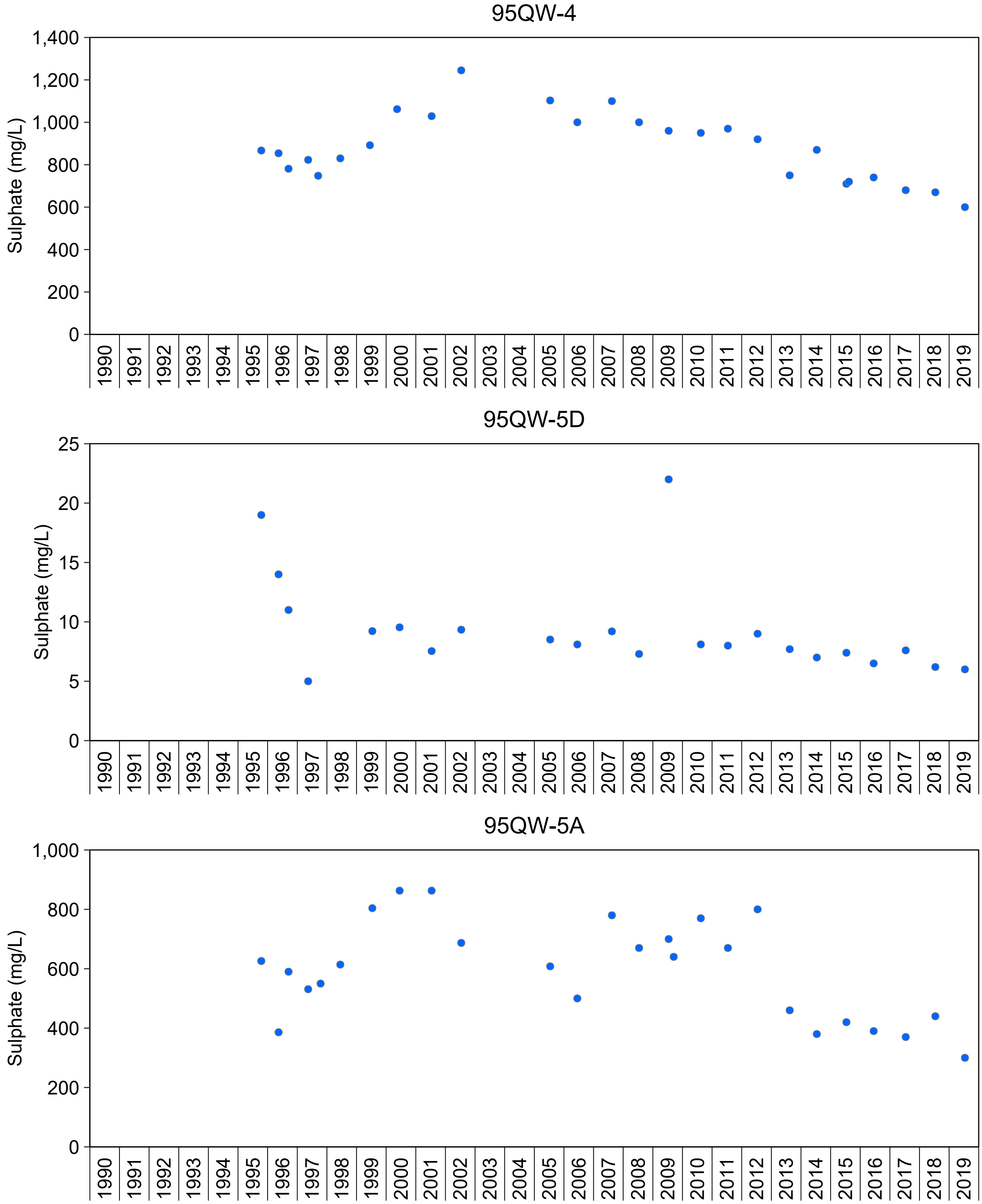


Figure G.17: Concentrations of Sulphate for TOMP Groundwater Stations, Quirke TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL.
See Table 4.11 for Kendall trend analysis results and Appendix Tables G.17 to G.20 for raw data.

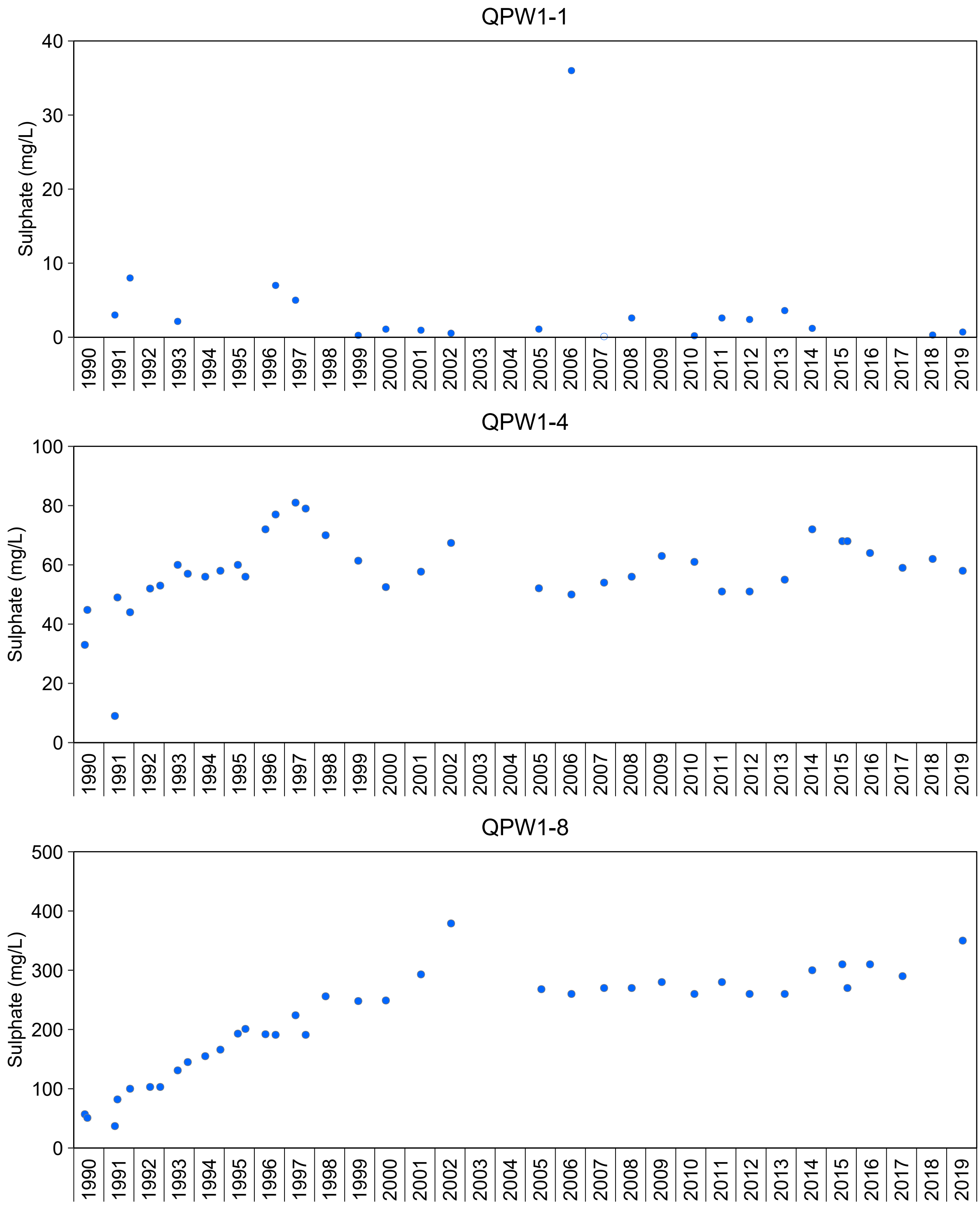


Figure G.17: Concentrations of Sulphate for TOMP Groundwater Stations, Quirke TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL.
See Table 4.11 for Kendall trend analysis results and Appendix Tables G.17 to G.20 for raw data.

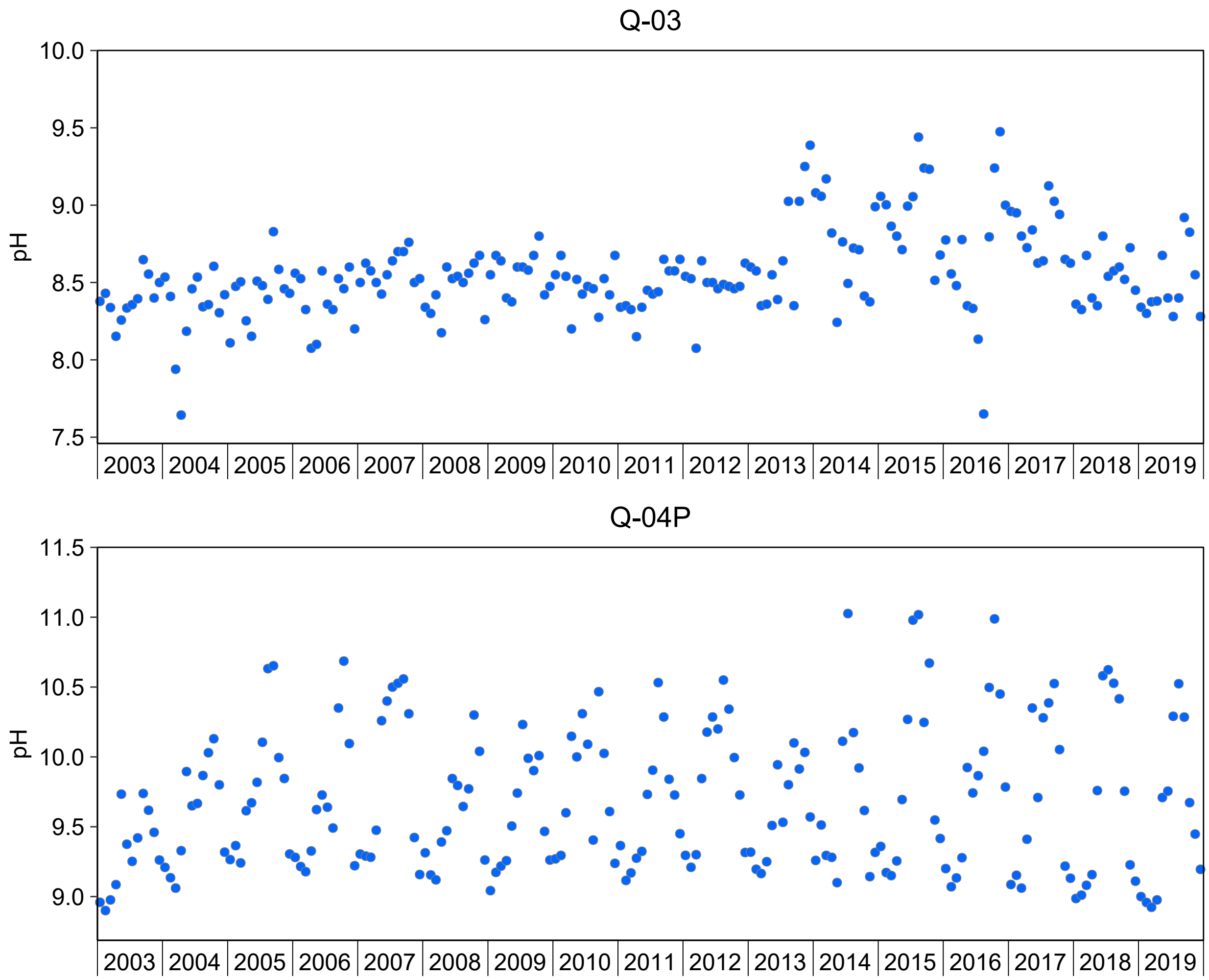


Figure G.18: TField Measurements of pH for TOMP Water Monitoring Stations, Quirke TMA, 2003 to 2019

Notes: pH is not included in the trend analysis for TOMP stations Q-03, and Q-04P because the monitoring is in support of ETP operations. Other stations at this TMA provide more meaningful information regarding trends for this parameter. Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Tables G.8 to G.9 for raw data.

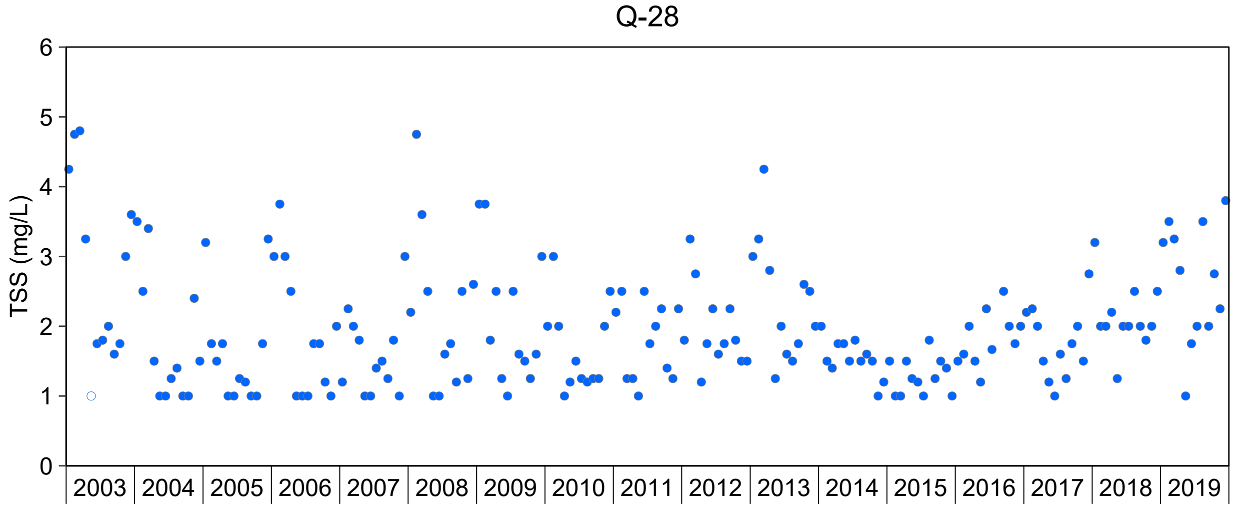


Figure G.19: Concentrations of Total Suspended Solids Measurements for TOMP Water Monitoring Stations, Quirke TMA, 2003 to 2019

Notes: TSS is not included in the trend analysis for TOMP station Q-28 because the monitoring is in support of ETP operations. Other stations at this TMA provide more meaningful information regarding trends for this parameter. Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Table G.10 for raw data.

Table G.1: Location of TOMP Data Tables and Figures Within this Cycle 5 SOE Report, Quirke TMA

TMA	TOMP Station	Station Type/Purpose	Also a SAMP Station? [a]	Map Figures	Elevation Tables	Elevation Figures	Water Quality Data Tables (flow, acidity, barium, cobalt, iron, manganese, pH, radium-226, sulphate, uranium, conductivity, TSS, and/or treatment chemical consumption)	Comparison to EIS Predictions Figures	Lime or NaOH Consumption Figures	Barium Chloride Consumption Figures	Comparison to Discharge Criteria Figures	Trend Tables	Water Quality Data Figures										
													Acidity	Barium	Cobalt	Iron	Manganese	pH	Radium-226	Sulphate	Uranium	Conductivity	TSS
Quirke	Cell 14, Cell 15, Cell 16S, Cell 17	Basin performance (secondary)	no	4.4	G.21 to G.24	4.15	G.3 to G.6	na-p	na	na	na-c	4.9	G.1	na	na	G.4	na	G.6	G.7	G.8	na	na	na
	Q-05	Basin performance (primary), ETP Influent	no	4.4	G.25	4.15	G.7	4.16	4.18	4.18	na-c	4.9	G.1	G.2	G.3	G.4	G.5	G.6	G.7	G.8	G.9	na	na
	Q-03	ETP operations	no	4.4	na	na	G.8	na-p	na	na	na-c	na-t	na	na	na	na	na	G.18	na	na	na	na	na
	Q-04P	ETP operations	no	4.4	na	na	G.9	na-p	na	na	na-c	na-t	na	na	na	na	na	G.18	na	na	na	na	na
	Q-28	Effluent	YES	4.1, 4.4	na	na	G.10	na-p	na	na	4.19, 4.20	4.17	na	N.1	N.2	N.3	N.4	N.5	N.6	N.7	N.8	na	G.19
	Q-29	Perimeter monitoring	no	4.4	G.26	4.15	G.11	na-p	na	na	na-c	na-t	S	na	na	S	na	S	S	S	na	na	na
	90DK-14-5C; DK15-2(A-D); DK15-4(A-D); DK16-2(A-D); DK17-2(A-D)	Pore water	no	4.4	na	na	G.12 to G.16	4.17	na	na	na-c	4.1	G.10	na	na	G.11	na	G.12	na	G.13	na	na	na
	QPW1-(1,4,8); 95QW-3(A,C,D); 95QW-4; 95QW-5(A,D)	Groundwater	no	4.4	na	na	G.17 to G.20	na-p	na	na	na-c	4.11	G.14	na	na	G.15	na	G.16	na	G.17	na	na	na

Notes: na = parameter not measured at this station (as per study design); therefore, data presentation is not applicable. na-p = EIS Predictions do not apply to this station (as per study design); therefore, data presentation is not applicable. na-c = discharge criteria do not apply to this station (as per study design); therefore, data presentation is not applicable. na-t = at this station, only one to three parameters (elevation, pH, flow, conductivity, and/or radium-226) are monitored to support ETP operations. Other stations provide more meaningful information regarding trends for these parameters; therefore, data presentation is not applicable.

[a] Data for this TOMP station also pertain to the SAMP. Trends are assessed in the SAMP section and water quality figures are provided in the SAMP section (Table 2.6).

Table G.2: Quirke Final Point of Control Discharge Criteria (Q-28)

Parameter[a]	Units	Discharge Criteria			Action Level	Internal Investigation
		Grab Sample[b]	Monthly Mean[c]	Composite[d]		
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[e,f]	Bq/L	1.11	0.37	0.74	0.37	0.2

[a] Copper, lead, nickel, and zinc monitoring discontinued in January 2010 as per regulatory approval of Cycle 3 design.
[b] Samples to be collected during periods of discharge.
[c] Arithmetic mean of twelve consecutive samples.
[d] Consists of 3 equal volumes collected at equal time intervals over a 7 to 24 hour period.
[e] Discharge criteria are for dissolved radium-226, while measured and reported values are for total radium-226.
[f] Radium-226 criterion are waived if total radium-226 average annual loading is < 30 Bq/s.

Table G.3: Water Quality at TOMP Station Cell 14 (Basin Performance - Secondary), Quirke TMA, 2015 to 2019

Date	Elevation (m)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Acidity (mg/L)	Iron (mg/L)
28-Jan-15	-	6.47	-	-	-	-
9-Feb-15	-	6.38	17.0	0.416	2.00	0.250
12-May-15	378	7.07	9.70	0.272	1.00	0.120
28-May-15	378	6.51	-	-	-	-
8-Jun-15	-	6.75	-	-	<1.00	-
29-Jun-15	378	7.21	-	-	-	-
13-Jul-15	-	6.34	-	-	3.00	-
28-Jul-15	378	7.20	-	-	-	-
10-Aug-15	378	7.40	12.0	0.352	1.00	0.0500
27-Aug-15	378	7.70	-	-	-	-
14-Sep-15	-	6.60	-	-	4.00	-
28-Sep-15	378	7.11	-	-	-	-
13-Oct-15	-	7.29	-	-	3.00	-
28-Oct-15	377	6.31	-	-	-	-
9-Nov-15	378	7.55	13.0	0.350	<1.00	0.0950
28-Nov-15	378	6.61	-	-	-	-
28-Dec-15	378	6.90	-	-	-	-
28-Jan-16	-	7.02	-	-	-	-
8-Feb-16	378	6.01	9.60	0.198	<1.00	0.166
26-Feb-16	-	6.60	-	-	-	-
28-Mar-16	-	5.90	-	-	-	-
28-Apr-16	378	6.60	-	-	-	-
9-May-16	378	6.35	8.40	0.203	<1.00	0.0860
27-May-16	378	7.62	-	-	-	-
13-Jun-16	-	6.24	-	-	<1.00	-
28-Jun-16	378	6.80	-	-	-	-
11-Jul-16	-	6.90	-	-	<1.00	-
28-Jul-16	378	6.60	-	-	-	-
8-Aug-16	377	6.00	13.0	0.337	<1.00	0.0310
29-Aug-16	378	6.50	-	-	-	-
12-Sep-16	-	6.30	-	-	<1.00	-
28-Sep-16	377	6.54	-	-	-	-
11-Oct-16	-	6.60	-	-	<1.00	-
27-Oct-16	377	6.70	-	-	-	-
15-Nov-16	377	6.70	21.0	0.446	4.00	0.0840
28-Nov-16	377	7.50	-	-	-	-
29-Dec-16	-	6.30	-	-	-	-
30-Jan-17	-	6.70	-	-	-	-
13-Feb-17	-	6.60	26.0	0.437	<1.00	0.111
28-Feb-17	-	6.40	-	-	-	-
28-Mar-17	-	6.20	-	-	-	-
10-Apr-17	-	6.30	-	-	<1.00	-
28-Apr-17	378	6.90	-	-	-	-
8-May-17	378	6.30	11.0	0.252	<1.00	0.152
28-May-17	378	6.40	-	-	-	-
12-Jun-17	-	6.40	-	-	<1.00	-
28-Jun-17	378	6.30	-	-	-	-
10-Jul-17	-	6.20	-	-	<1.00	-
27-Jul-17	378	7.00	-	-	-	-
14-Aug-17	378	6.60	11.0	0.228	<1.00	0.0470
28-Aug-17	378	6.60	-	-	-	-
11-Sep-17	-	6.80	-	-	<1.00	-
28-Sep-17	378	6.70	-	-	-	-
10-Oct-17	-	6.60	-	-	<1.00	-
28-Oct-17	378	6.70	-	-	-	-
13-Nov-17	-	6.40	12.0	0.236	<1.00	0.0380
28-Nov-17	-	6.70	-	-	-	-
28-Dec-17	-	6.40	-	-	-	-
28-Jan-18	-	6.50	-	-	-	-
12-Feb-18	-	6.50	14.0	0.421	<1.00	0.0740
28-Feb-18	-	6.40	-	-	-	-
28-Mar-18	-	6.40	-	-	-	-
28-Apr-18	-	6.60	-	-	-	-
17-May-18	378	6.70	7.80	0.216	<1.00	0.113
28-May-18	378	6.70	-	-	-	-
11-Jun-18	-	6.70	-	-	1.00	-
28-Jun-18	378	6.40	-	-	-	-
9-Jul-18	-	6.50	-	-	<1.00	-

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table G.3: Water Quality at TOMP Station Cell 14 (Basin Performance - Secondary), Quirke TMA, 2015 to 2019

Date	Elevation (m)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Acidity (mg/L)	Iron (mg/L)
28-Jul-18	378	6.80	-	-	-	-
13-Aug-18	378	6.70	9.40	0.205	<1.00	<0.0200
28-Aug-18	378	6.70	-	-	-	-
10-Sep-18	-	6.80	-	-	<1.00	-
28-Sep-18	377	6.80	-	-	-	-
9-Oct-18	-	6.70	-	-	<1.00	-
26-Oct-18	378	6.80	-	-	-	-
12-Nov-18	378	6.90	9.90	0.185	<1.00	0.131
28-Nov-18	378	6.70	-	-	-	-
28-Dec-18	-	6.70	-	-	-	-
28-Jan-19	-	6.60	-	-	-	-
11-Feb-19	-	6.40	9.00	0.192	1.00	0.194
28-Feb-19	-	6.70	-	-	-	-
27-Mar-19	-	6.60	-	-	-	-
24-Apr-19	-	6.30	-	-	<1.00	-
26-Apr-19	378	6.60	-	-	-	-
13-May-19	378	6.90	5.60	0.157	3.00	0.120
28-May-19	378	6.50	-	-	-	-
10-Jun-19	-	6.40	-	-	<1.00	-
28-Jun-19	378	6.40	-	-	-	-
8-Jul-19	-	6.50	-	-	<1.00	-
26-Jul-19	378	6.60	-	-	-	-
12-Aug-19	378	6.60	7.80	0.195	<1.00	0.0500
28-Aug-19	378	6.70	-	-	-	-
9-Sep-19	-	6.70	-	-	<1.00	-
23-Sep-19	378	6.80	-	-	-	-
15-Oct-19	-	6.80	-	-	<1.00	-
28-Oct-19	378	6.90	-	-	-	-
11-Nov-19	-	6.80	9.20	0.224	<1.00	0.0760
27-Nov-19	378	6.80	-	-	-	-
9-Dec-19	-	6.70	-	-	<1.00	-
30-Dec-19	-	6.70	-	-	-	-
n	53	100	20	20	43	20
Minimum	377	5.90	5.60	0.157	<1.00	<0.0200
Maximum	378	7.70	26.0	0.446	4.00	0.250
Mean	378	6.65	11.8	0.276	1.30	0.100
SD	0.199	0.325	4.80	0.0956	0.836	0.0578
Median	378	6.60	10.4	0.232	<1.00	0.0905
10th Percentile	377	6.30	7.80	0.188	<1.00	0.0345
95th Percentile	378	7.35	23.5	0.442	3.00	0.222

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table G.4: Water Quality at TOMP Station Cell 15 (Basin Performance - Secondary), Quirke TMA, 2015 to 2019

Date	Elevation (m)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Acidity (mg/L)	Iron (mg/L)
28-Jan-15	-	6.50	-	-	-	-
9-Feb-15	-	6.37	57.0	0.871	2.00	0.370
12-May-15	374	6.60	290	0.371	<1.00	0.800
28-May-15	374	7.12	-	-	-	-
8-Jun-15	-	6.26	-	-	<1.00	-
29-Jun-15	373	7.19	-	-	-	-
13-Jul-15	-	7.24	-	-	<1.00	-
28-Jul-15	373	7.30	-	-	-	-
10-Aug-15	373	7.40	490	0.267	<1.00	0.230
27-Aug-15	373	7.50	-	-	-	-
14-Sep-15	-	7.30	-	-	<1.00	-
28-Sep-15	373	7.00	-	-	-	-
13-Oct-15	-	7.22	-	-	<1.00	-
28-Oct-15	373	6.86	-	-	-	-
9-Nov-15	373	7.38	640	0.363	<1.00	0.554
28-Nov-15	373	6.58	-	-	-	-
28-Dec-15	373	7.00	-	-	-	-
28-Jan-16	-	6.65	-	-	-	-
8-Feb-16	374	5.71	58.0	0.338	2.00	0.898
26-Feb-16	-	5.70	-	-	-	-
28-Apr-16	374	5.50	-	-	-	-
9-May-16	374	6.91	320	0.294	<1.00	0.676
27-May-16	374	7.40	-	-	-	-
13-Jun-16	-	7.14	-	-	<1.00	-
28-Jun-16	373	7.10	-	-	-	-
11-Jul-16	-	7.30	-	-	<1.00	-
28-Jul-16	373	7.20	-	-	-	-
8-Aug-16	373	7.40	600	0.280	<1.00	0.155
29-Aug-16	373	7.20	-	-	-	-
12-Sep-16	-	7.10	-	-	<1.00	-
28-Sep-16	373	6.97	-	-	-	-
11-Oct-16	-	7.10	-	-	<1.00	-
27-Oct-16	373	7.10	-	-	-	-
15-Nov-16	373	7.00	700	0.395	<1.00	0.633
28-Nov-16	373	7.20	-	-	-	-
29-Dec-16	-	6.80	-	-	-	-
30-Jan-17	-	6.80	-	-	-	-
13-Feb-17	-	6.50	750	0.368	<1.00	0.535
28-Feb-17	-	6.50	-	-	-	-
28-Mar-17	-	6.70	-	-	-	-
10-Apr-17	-	6.40	-	-	<1.00	-
28-Apr-17	373	6.70	-	-	-	-
8-May-17	373	6.80	520	0.404	<1.00	1.06
28-May-17	374	6.90	-	-	-	-
12-Jun-17	-	6.80	-	-	<1.00	-
28-Jun-17	374	6.80	-	-	-	-
10-Jul-17	-	6.70	-	-	<1.00	-
27-Jul-17	374	6.90	-	-	-	-
14-Aug-17	374	6.60	480	0.283	<1.00	0.250
28-Aug-17	374	6.70	-	-	-	-
11-Sep-17	-	6.70	-	-	<1.00	-
28-Sep-17	374	6.80	-	-	-	-
10-Oct-17	-	6.80	-	-	<1.00	-
28-Oct-17	374	6.80	-	-	-	-
13-Nov-17	374	6.50	480	0.344	<1.00	0.338
28-Nov-17	374	6.90	-	-	-	-
28-Dec-17	-	6.40	-	-	-	-
28-Jan-18	-	6.40	-	-	-	-
12-Feb-18	-	6.70	510	0.397	<1.00	0.428
28-Feb-18	-	6.30	-	-	-	-
28-Mar-18	-	6.70	-	-	-	-
28-Apr-18	-	6.60	-	-	-	-
17-May-18	373	6.70	400	0.343	<1.00	0.439
28-May-18	373	7.00	-	-	-	-
11-Jun-18	-	6.90	-	-	<1.00	-
28-Jun-18	373	7.00	-	-	-	-
9-Jul-18	-	6.80	-	-	<1.00	-
28-Jul-18	373	6.90	-	-	-	-
13-Aug-18	373	6.90	600	0.322	<1.00	0.140
28-Aug-18	373	6.90	-	-	-	-
10-Sep-18	-	6.90	-	-	<1.00	-
28-Sep-18	373	7.00	-	-	-	-
9-Oct-18	-	6.90	-	-	<1.00	-
26-Oct-18	373	6.80	-	-	-	-
12-Nov-18	373	7.00	550	0.244	<1.00	0.689
28-Nov-18	373	6.70	-	-	-	-
28-Dec-18	-	6.90	-	-	-	-
28-Jan-19	-	6.60	-	-	-	-
11-Feb-19	-	6.60	76.0	0.321	<1.00	0.320
28-Feb-19	-	6.70	-	-	-	-
27-Mar-19	-	6.80	-	-	-	-
24-Apr-19	-	6.30	-	-	<1.00	-
26-Apr-19	374	6.80	-	-	-	-
13-May-19	374	6.90	250	0.296	<1.00	0.616
28-May-19	374	6.70	-	-	-	-
10-Jun-19	-	6.90	-	-	<1.00	-
28-Jun-19	374	6.80	-	-	-	-
8-Jul-19	-	6.80	-	-	<1.00	-
26-Jul-19	373	6.80	-	-	-	-
12-Aug-19	373	6.90	420	0.266	<1.00	0.610
28-Aug-19	373	6.80	-	-	-	-
9-Sep-19	-	6.90	-	-	<1.00	-
23-Sep-19	373	6.90	-	-	-	-
15-Oct-19	-	6.90	-	-	<1.00	-
28-Oct-19	373	6.90	-	-	-	-
11-Nov-19	373	6.90	500	0.292	<1.00	0.502
27-Nov-19	374	6.90	-	-	-	-
9-Dec-19	-	6.70	-	-	<1.00	-
30-Dec-19	-	6.80	-	-	-	-
n	56	99	20	20	43	20
Minimum	373	5.50	57.0	0.244	<1.00	0.140
Maximum	374	7.50	750	0.871	2.00	1.06
Mean	373	6.82	435	0.353	1.05	0.512
SD	0.370	0.335	204	0.131	-	0.245
Median	373	6.80	485	0.330	<1.00	0.518
10th Percentile	373	6.40	67.0	0.266	<1.00	0.192
95th Percentile	374	7.38	725	0.638	<1.00	0.979

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected, or SD was incalculable because there was no variability in the data.

Table G.5: Water Quality at TOMP Station Cell 16 S (Basin Performance - Secondary), Quirke TMA, 2015 to 2019

Date	Elevation (m)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Acidity (mg/L)	Iron (mg/L)
28-Jan-15	-	7.00	-	-	-	-
9-Feb-15	-	6.65	1,000	0.250	<1.00	1.82
12-May-15	370	6.45	800	0.325	<1.00	1.56
25-May-15	-	6.59	-	-	<1.00	-
28-May-15	370	6.89	-	-	-	-
1-Jun-15	-	7.01	-	-	<1.00	-
4-Jun-15	-	7.04	-	-	-	-
8-Jun-15	-	8.00	-	-	<1.00	-
11-Jun-15	-	7.17	-	-	-	-
15-Jun-15	-	7.52	-	-	<1.00	-
18-Jun-15	-	7.60	-	-	-	-
22-Jun-15	-	7.89	-	-	<1.00	-
25-Jun-15	-	7.04	-	-	-	-
29-Jun-15	370	7.45	-	-	<1.00	-
2-Jul-15	-	7.50	-	-	-	-
6-Jul-15	-	7.30	-	-	<1.00	-
9-Jul-15	-	7.30	-	-	-	-
13-Jul-15	-	6.95	-	-	<1.00	-
16-Jul-15	-	7.30	-	-	-	-
20-Jul-15	-	7.10	-	-	<1.00	-
23-Jul-15	-	7.20	-	-	-	-
27-Jul-15	-	7.20	-	-	<1.00	-
28-Jul-15	370	7.60	-	-	-	-
30-Jul-15	-	7.27	-	-	-	-
4-Aug-15	-	7.40	-	-	<1.00	-
6-Aug-15	-	7.40	-	-	-	-
10-Aug-15	370	7.30	960	0.203	<1.00	0.410
13-Aug-15	-	7.40	-	-	-	-
17-Aug-15	-	7.20	-	-	<1.00	-
20-Aug-15	-	7.18	-	-	-	-
24-Aug-15	-	7.30	-	-	<1.00	-
27-Aug-15	370	7.20	-	-	-	-
31-Aug-15	-	7.20	-	-	<1.00	-
3-Sep-15	-	7.20	-	-	-	-
8-Sep-15	-	7.18	-	-	<1.00	-
10-Sep-15	-	7.17	-	-	-	-
14-Sep-15	-	7.10	-	-	<1.00	-
17-Sep-15	-	7.08	-	-	-	-
21-Sep-15	-	7.10	-	-	<1.00	-
24-Sep-15	-	7.20	-	-	-	-
28-Sep-15	370	7.01	-	-	<1.00	-
1-Oct-15	-	7.16	-	-	-	-
5-Oct-15	-	7.20	-	-	<1.00	-
8-Oct-15	-	7.21	-	-	-	-
13-Oct-15	-	7.18	-	-	<1.00	-
15-Oct-15	-	7.32	-	-	-	-
19-Oct-15	-	7.13	-	-	<1.00	-
22-Oct-15	-	7.10	-	-	-	-
26-Oct-15	-	7.03	-	-	<1.00	-
28-Oct-15	370	6.86	-	-	-	-
29-Oct-15	-	7.10	-	-	-	-
2-Nov-15	-	7.15	-	-	<1.00	-
5-Nov-15	-	7.21	-	-	-	-
9-Nov-15	370	7.16	1,000	0.195	1.00	1.27
12-Nov-15	-	7.26	-	-	-	-
16-Nov-15	-	7.20	-	-	<1.00	-
19-Nov-15	-	7.04	-	-	-	-
23-Nov-15	-	6.95	-	-	<1.00	-
28-Nov-15	370	6.67	-	-	-	-
3-Dec-15	-	6.67	-	-	-	-
28-Dec-15	370	6.80	-	-	-	-

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table G.5: Water Quality at TOMP Station Cell 16 S (Basin Performance - Secondary), Quirke TMA, 2015 to 2019

Date	Elevation (m)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Acidity (mg/L)	Iron (mg/L)
28-Jan-16	-	6.71	-	-	-	-
8-Feb-16	370	6.63	900	0.278	<1.00	1.67
26-Feb-16	-	6.60	-	-	-	-
28-Mar-16	-	6.16	-	-	-	-
28-Apr-16	370	6.60	-	-	-	-
5-May-16	-	6.64	-	-	-	-
9-May-16	370	6.57	810	0.278	<1.00	2.09
12-May-16	-	6.66	-	-	-	-
16-May-16	-	6.54	-	-	<1.00	-
19-May-16	-	6.80	-	-	-	-
24-May-16	-	6.84	-	-	<1.00	-
26-May-16	-	6.93	-	-	-	-
27-May-16	370	7.09	-	-	-	-
31-May-16	-	6.77	-	-	<1.00	-
2-Jun-16	-	6.83	-	-	-	-
6-Jun-16	-	7.15	-	-	<1.00	-
9-Jun-16	-	8.23	-	-	-	-
13-Jun-16	-	7.15	-	-	<1.00	-
16-Jun-16	-	7.21	-	-	-	-
20-Jun-16	-	7.22	-	-	<1.00	-
23-Jun-16	-	7.30	-	-	-	-
27-Jun-16	-	7.20	-	-	<1.00	-
28-Jun-16	370	7.30	-	-	-	-
30-Jun-16	-	7.20	-	-	-	-
4-Jul-16	-	7.20	-	-	<1.00	-
7-Jul-16	-	7.20	-	-	-	-
11-Jul-16	-	7.20	-	-	<1.00	-
14-Jul-16	-	7.10	-	-	-	-
18-Jul-16	-	7.10	-	-	<1.00	-
21-Jul-16	-	6.94	-	-	-	-
25-Jul-16	-	7.02	-	-	<1.00	-
28-Jul-16	370	7.10	-	-	-	-
2-Aug-16	-	7.00	-	-	<1.00	-
4-Aug-16	-	6.90	-	-	-	-
8-Aug-16	370	7.00	980	0.285	<1.00	0.624
11-Aug-16	-	6.94	-	-	-	-
15-Aug-16	-	7.00	-	-	<1.00	-
18-Aug-16	-	7.00	-	-	-	-
22-Aug-16	-	7.00	-	-	<1.00	-
25-Aug-16	-	6.80	-	-	-	-
29-Aug-16	370	6.90	-	-	3.00	-
1-Sep-16	-	6.90	-	-	-	-
6-Sep-16	-	6.78	-	-	2.00	-
8-Sep-16	-	6.90	-	-	-	-
12-Sep-16	-	4.60	-	-	2.00	-
15-Sep-16	-	6.80	-	-	-	-
19-Sep-16	-	6.70	-	-	5.00	-
22-Sep-16	-	6.80	-	-	-	-
26-Sep-16	-	6.69	-	-	6.00	-
28-Sep-16	370	6.70	-	-	-	-
29-Sep-16	-	6.80	-	-	-	-
3-Oct-16	-	6.54	-	-	2.00	-
6-Oct-16	-	6.70	-	-	-	-
11-Oct-16	-	6.60	-	-	3.00	-
13-Oct-16	-	6.60	-	-	-	-
17-Oct-16	-	6.60	-	-	4.00	-
20-Oct-16	-	6.70	-	-	-	-
24-Oct-16	-	6.90	-	-	2.00	-
27-Oct-16	370	6.50	-	-	-	-
31-Oct-16	-	6.80	-	-	5.00	-
3-Nov-16	-	6.50	-	-	-	-
7-Nov-16	-	6.90	-	-	3.00	-
11-Nov-16	-	6.50	-	-	-	-
15-Nov-16	370	6.50	1,000	0.307	8.00	1.42
17-Nov-16	-	6.50	-	-	-	-
21-Nov-16	-	6.50	-	-	3.00	-
24-Nov-16	-	6.80	-	-	-	-
28-Nov-16	370	6.70	-	-	3.00	-
1-Dec-16	-	8.20	-	-	-	-
5-Dec-16	-	6.60	-	-	3.00	-
29-Dec-16	-	6.60	-	-	-	-

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table G.5: Water Quality at TOMP Station Cell 16 S (Basin Performance - Secondary), Quirke TMA, 2015 to 2019

Date	Elevation (m)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Acidity (mg/L)	Iron (mg/L)
30-Jan-17	-	6.60	-	-	-	-
13-Feb-17	-	6.50	1,000	0.335	1.00	1.78
28-Feb-17	-	6.30	-	-	-	-
28-Mar-17	-	6.60	-	-	-	-
10-Apr-17	-	6.40	-	-	1.00	-
28-Apr-17	370	6.50	-	-	-	-
8-May-17	370	6.60	840	0.398	5.00	2.27
28-May-17	370	6.70	-	-	-	-
12-Jun-17	-	6.70	-	-	<1.00	-
28-Jun-17	370	6.80	-	-	-	-
10-Jul-17	-	6.90	-	-	<1.00	-
27-Jul-17	370	7.10	-	-	-	-
14-Aug-17	370	7.00	890	0.206	<1.00	0.448
28-Aug-17	370	7.40	-	-	-	-
11-Sep-17	-	7.20	-	-	<1.00	-
28-Sep-17	370	7.30	-	-	-	-
10-Oct-17	-	7.00	-	-	<1.00	-
28-Oct-17	370	7.00	-	-	-	-
13-Nov-17	370	6.80	960	0.155	<1.00	0.859
28-Nov-17	370	6.80	-	-	-	-
28-Dec-17	-	6.60	-	-	-	-
28-Jan-18	-	6.60	-	-	-	-
12-Feb-18	-	6.60	990	0.349	<1.00	1.97
28-Feb-18	-	6.60	-	-	-	-
28-Mar-18	-	6.40	-	-	-	-
28-Apr-18	-	6.20	-	-	-	-
17-May-18	370	6.60	760	0.371	<1.00	1.87
28-May-18	370	7.40	-	-	-	-
11-Jun-18	-	7.00	-	-	<1.00	-
28-Jun-18	370	8.10	-	-	-	-
9-Jul-18	-	7.10	-	-	<1.00	-
28-Jul-18	370	7.30	-	-	-	-
13-Aug-18	370	7.20	980	0.171	<1.00	0.379
28-Aug-18	370	7.10	-	-	-	-
10-Sep-18	-	7.90	-	-	<1.00	-
28-Sep-18	370	7.50	-	-	-	-
9-Oct-18	-	7.10	-	-	<1.00	-
26-Oct-18	370	7.30	-	-	-	-
12-Nov-18	370	7.10	830	0.137	<1.00	1.03
28-Nov-18	370	7.00	-	-	-	-
28-Dec-18	-	7.00	-	-	-	-
28-Jan-19	-	6.70	-	-	-	-
11-Feb-19	-	6.70	960	0.260	<1.00	1.32
28-Feb-19	-	6.60	-	-	-	-
27-Mar-19	-	6.50	-	-	-	-
24-Apr-19	-	6.30	-	-	<1.00	-
26-Apr-19	370	6.80	-	-	-	-
13-May-19	370	7.00	780	0.294	<1.00	2.24
28-May-19	370	6.80	-	-	-	-
10-Jun-19	-	7.40	-	-	<1.00	-
28-Jun-19	370	6.80	-	-	-	-
8-Jul-19	-	6.90	-	-	<1.00	-
26-Jul-19	370	6.80	-	-	-	-
12-Aug-19	370	6.90	810	0.219	<1.00	0.440
28-Aug-19	370	6.90	-	-	-	-
9-Sep-19	-	6.90	-	-	<1.00	-
23-Sep-19	370	6.90	-	-	-	-
15-Oct-19	-	7.30	-	-	<1.00	-
28-Oct-19	370	6.90	-	-	-	-
11-Nov-19	370	6.80	850	0.159	<1.00	0.897
27-Nov-19	370	6.80	-	-	-	-
9-Dec-19	-	6.70	-	-	<1.00	-
30-Dec-19	-	6.90	-	-	-	-
n	55	195	20	20	88	20
Minimum	370	4.60	760	0.137	<1.00	0.379
Maximum	370	8.23	1,000	0.398	8.00	2.27
Mean	370	6.96	905	0.259	1.49	1.32
SD	0.0631	0.387	86.6	0.0762	1.29	0.646
Median	370	7.00	930	0.269	<1.00	1.37
10th Percentile	370	6.57	790	0.157	<1.00	0.425
95th Percentile	370	7.50	1,000	0.384	5.00	2.26

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table G.6: Water Quality at TOMP Station Cell 17 (Basin Performance - Secondary), Quirke TMA, 2015 to 2019

Date	Elevation (m)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Acidity (mg/L)	Iron (mg/L)
28-Jan-15	-	6.86	-	-	-	-
9-Feb-15	-	6.70	1,100	0.447	<1.00	1.58
12-May-15	366	6.51	850	1.02	11.0	3.63
25-May-15	-	6.41	-	-	6.00	-
28-May-15	366	6.12	-	-	-	-
1-Jun-15	-	6.46	-	-	6.00	-
4-Jun-15	-	6.46	-	-	-	-
8-Jun-15	-	6.85	-	-	5.00	-
11-Jun-15	-	7.48	-	-	-	-
15-Jun-15	-	7.30	-	-	<1.00	-
18-Jun-15	-	7.00	-	-	-	-
22-Jun-15	-	6.71	-	-	2.00	-
25-Jun-15	-	6.97	-	-	-	-
29-Jun-15	366	8.93	-	-	<1.00	-
2-Jul-15	-	9.10	-	-	-	-
6-Jul-15	-	8.60	-	-	<1.00	-
9-Jul-15	-	8.20	-	-	-	-
13-Jul-15	-	7.44	-	-	<1.00	-
16-Jul-15	-	7.40	-	-	-	-
20-Jul-15	-	7.50	-	-	<1.00	-
23-Jul-15	-	7.30	-	-	-	-
27-Jul-15	-	7.50	-	-	<1.00	-
28-Jul-15	366	7.40	-	-	-	-
30-Jul-15	-	7.30	-	-	-	-
4-Aug-15	-	7.30	-	-	<1.00	-
6-Aug-15	-	7.40	-	-	-	-
10-Aug-15	366	7.30	1,100	0.441	<1.00	0.800
13-Aug-15	-	7.30	-	-	-	-
17-Aug-15	-	7.20	-	-	<1.00	-
20-Aug-15	-	7.13	-	-	-	-
24-Aug-15	-	7.60	-	-	<1.00	-
27-Aug-15	366	7.40	-	-	-	-
31-Aug-15	-	7.20	-	-	<1.00	-
3-Sep-15	-	7.20	-	-	-	-
8-Sep-15	-	7.22	-	-	<1.00	-
10-Sep-15	-	7.54	-	-	-	-
14-Sep-15	-	7.10	-	-	<1.00	-
17-Sep-15	-	7.05	-	-	-	-
21-Sep-15	-	7.10	-	-	<1.00	-
24-Sep-15	-	7.00	-	-	-	-
28-Sep-15	366	7.00	-	-	<1.00	-
1-Oct-15	-	7.08	-	-	-	-
5-Oct-15	-	7.10	-	-	1.00	-
8-Oct-15	-	7.40	-	-	-	-
13-Oct-15	-	6.81	-	-	<1.00	-
15-Oct-15	-	7.40	-	-	-	-
19-Oct-15	-	7.15	-	-	<1.00	-
22-Oct-15	-	7.10	-	-	-	-
26-Oct-15	-	6.94	-	-	<1.00	-
28-Oct-15	366	6.82	-	-	-	-
29-Oct-15	-	7.20	-	-	-	-
2-Nov-15	-	6.78	-	-	<1.00	-
5-Nov-15	-	7.41	-	-	-	-
9-Nov-15	366	7.20	1,100	0.668	<1.00	0.843
12-Nov-15	-	7.19	-	-	-	-
16-Nov-15	-	7.10	-	-	<1.00	-
19-Nov-15	-	7.04	-	-	-	-
23-Nov-15	-	6.93	-	-	<1.00	-
28-Nov-15	366	6.68	-	-	-	-
3-Dec-15	-	6.68	-	-	-	-
28-Dec-15	366	6.70	-	-	-	-
28-Jan-16	-	6.75	-	-	-	-
8-Feb-16	366	6.64	1,000	0.283	<1.00	1.61
26-Feb-16	-	6.40	-	-	-	-
28-Jan-16	-	6.75	-	-	-	-
8-Feb-16	366	6.64	1,000	0.283	<1.00	1.61
26-Feb-16	-	6.40	-	-	-	-
28-Mar-16	-	6.38	-	-	-	-
28-Apr-16	366	6.00	-	-	-	-
5-May-16	-	6.16	-	-	-	-
9-May-16	366	5.74	880	0.949	7.00	3.23
12-May-16	-	5.54	-	-	-	-
16-May-16	-	9.51	-	-	<1.00	-
19-May-16	-	9.38	-	-	-	-
24-May-16	-	8.73	-	-	<1.00	-
26-May-16	-	8.25	-	-	-	-
27-May-16	366	8.20	-	-	-	-
31-May-16	-	7.74	-	-	<1.00	-
2-Jun-16	-	7.41	-	-	-	-
6-Jun-16	-	7.42	-	-	<1.00	-
9-Jun-16	-	7.47	-	-	-	-
13-Jun-16	-	7.28	-	-	<1.00	-
16-Jun-16	-	7.25	-	-	-	-
20-Jun-16	-	7.27	-	-	<1.00	-
23-Jun-16	-	7.30	-	-	-	-
27-Jun-16	-	7.20	-	-	<1.00	-
28-Jun-16	366	7.30	-	-	-	-
30-Jun-16	-	7.30	-	-	-	-
4-Jul-16	-	7.20	-	-	<1.00	-
7-Jul-16	-	7.20	-	-	-	-
11-Jul-16	-	7.00	-	-	<1.00	-
14-Jul-16	-	7.10	-	-	-	-
18-Jul-16	-	7.00	-	-	<1.00	-
21-Jul-16	-	6.89	-	-	-	-
25-Jul-16	-	6.65	-	-	2.00	-
28-Jul-16	366	6.80	-	-	-	-
2-Aug-16	-	6.80	-	-	2.00	-
4-Aug-16	-	6.60	-	-	-	-
8-Aug-16	366	6.30	1,100	0.834	3.00	1.64
11-Aug-16	-	6.82	-	-	-	-
15-Aug-16	-	6.40	-	-	6.00	-
18-Aug-16	-	7.63	-	-	-	-
22-Aug-16	-	6.50	-	-	5.00	-
25-Aug-16	-	6.40	-	-	-	-

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table G.6: **Water Quality at TOMP Station Cell 17 (Basin Performance - Secondary), Quirke TMA, 2015 to 2019**

Date	Elevation (m)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Acidity (mg/L)	Iron (mg/L)
29-Aug-16	366	6.30	-	-	6.00	-
1-Sep-16	-	6.30	-	-	-	-
6-Sep-16	-	6.02	-	-	7.00	-
8-Sep-16	-	6.10	-	-	-	-
12-Sep-16	-	5.90	-	-	6.00	-
15-Sep-16	-	6.40	-	-	-	-
19-Sep-16	-	5.90	-	-	8.00	-
22-Sep-16	-	6.40	-	-	-	-
26-Sep-16	-	5.77	-	-	10.0	-
28-Sep-16	366	5.81	-	-	-	-
29-Sep-16	-	6.40	-	-	-	-
3-Oct-16	-	5.61	-	-	7.00	-
6-Oct-16	-	5.90	-	-	-	-
11-Oct-16	-	6.00	-	-	7.00	-
13-Oct-16	-	5.70	-	-	-	-
17-Oct-16	-	5.70	-	-	7.00	-
20-Oct-16	-	5.80	-	-	-	-
24-Oct-16	-	6.70	-	-	8.00	-
27-Oct-16	366	5.60	-	-	-	-
31-Oct-16	-	6.60	-	-	9.00	-
3-Nov-16	-	6.00	-	-	-	-
7-Nov-16	-	6.20	-	-	8.00	-
11-Nov-16	-	6.30	-	-	-	-
15-Nov-16	366	6.50	1,100	1.17	11.0	1.75
17-Nov-16	-	6.40	-	-	-	-
21-Nov-16	-	6.80	-	-	<1.00	-
24-Nov-16	-	7.10	-	-	-	-
28-Nov-16	366	6.90	-	-	<1.00	-
1-Dec-16	-	6.90	-	-	-	-
5-Dec-16	-	6.60	-	-	5.00	-
29-Dec-16	-	6.60	-	-	-	-
30-Jan-17	-	6.60	-	-	-	-
13-Feb-17	-	6.30	1,100	0.750	2.00	1.60
28-Feb-17	-	6.40	-	-	-	-
28-Mar-17	-	6.50	-	-	-	-
10-Apr-17	-	6.50	-	-	3.00	-
28-Apr-17	366	5.70	-	-	-	-
8-May-17	366	6.80	860	0.883	<1.00	0.483
28-May-17	366	6.70	-	-	-	-
12-Jun-17	-	6.60	-	-	2.00	-
28-Jun-17	366	6.60	-	-	-	-
10-Jul-17	-	6.70	-	-	3.00	-
27-Jul-17	366	7.20	-	-	-	-
14-Aug-17	366	6.70	940	0.562	3.00	0.877
28-Aug-17	366	7.50	-	-	-	-
11-Sep-17	-	7.10	-	-	<1.00	-
28-Sep-17	366	7.30	-	-	-	-
10-Oct-17	-	6.90	-	-	<1.00	-
28-Oct-17	366	6.90	-	-	-	-
13-Nov-17	366	6.60	910	0.434	<1.00	1.09
28-Nov-17	366	6.70	-	-	-	-
28-Dec-17	-	6.60	-	-	-	-
28-Jan-18	-	6.60	-	-	-	-
12-Feb-18	-	6.50	1,000	0.598	<1.00	1.99
28-Feb-18	-	6.60	-	-	-	-
28-Mar-18	-	6.50	-	-	-	-
28-Apr-18	-	6.40	-	-	-	-
17-May-18	366	6.50	830	1.08	8.00	4.27
28-May-18	366	6.40	-	-	-	-
11-Jun-18	-	6.70	-	-	2.00	-
28-Jun-18	366	6.70	-	-	-	-
9-Jul-18	-	6.70	-	-	1.00	-
28-Jul-18	366	6.90	-	-	-	-
13-Aug-18	366	6.90	1,000	0.536	<1.00	0.725
28-Aug-18	366	7.20	-	-	-	-
10-Sep-18	-	7.40	-	-	<1.00	-
28-Sep-18	366	7.20	-	-	-	-
9-Oct-18	-	7.00	-	-	<1.00	-
26-Oct-18	366	7.10	-	-	-	-
12-Nov-18	366	7.10	850	0.373	<1.00	1.39
28-Nov-18	366	6.90	-	-	-	-
28-Dec-18	-	6.70	-	-	-	-
28-Jan-19	-	6.60	-	-	-	-
11-Feb-19	-	6.70	990	0.562	<1.00	1.35
28-Feb-19	-	6.60	-	-	-	-
27-Mar-19	-	6.50	-	-	-	-
24-Apr-19	-	6.30	-	-	<1.00	-
26-Apr-19	366	6.80	-	-	-	-
13-May-19	366	6.70	800	0.888	5.00	4.06
28-May-19	366	6.60	-	-	-	-
10-Jun-19	-	6.70	-	-	2.00	-
28-Jun-19	366	6.90	-	-	-	-
8-Jul-19	-	6.80	-	-	<1.00	-
26-Jul-19	366	6.70	-	-	-	-
12-Aug-19	366	6.90	1,000	0.366	<1.00	0.850
28-Aug-19	366	6.80	-	-	-	-
9-Sep-19	-	6.70	-	-	<1.00	-
23-Sep-19	366	6.70	-	-	-	-
15-Oct-19	-	6.90	-	-	<1.00	-
28-Oct-19	366	6.90	-	-	-	-
11-Nov-19	366	6.80	860	0.434	<1.00	1.25
27-Nov-19	366	6.80	-	-	-	-
9-Dec-19	-	6.70	-	-	<1.00	-
30-Dec-19	-	6.90	-	-	-	-
n	56	195	20	20	88	20
Minimum	366	5.54	800	0.283	<1.00	0.483
Maximum	366	9.51	1,100	1.17	11.0	4.27
Mean	366	6.87	968	0.664	2.72	1.75
SD	0.0579	0.627	107	0.265	2.81	1.14
Median	366	6.80	995	0.580	<1.00	1.48
10th Percentile	366	6.16	840	0.369	<1.00	0.762
95th Percentile	366	7.74	1,100	1.12	8.00	4.16

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table G.7: **Water Quality at TOMP Station Q-05 (Basin Performance - Primary, ETP Operations), Quirke TMA, 2015 to 2019**

Date	Elevation (m)	Flow (L/s)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Lime consumption (kg per month)	Barium Chloride consumption (kg per day)	Acidity (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
12-Jan-15	364	115	6.50	-	0.588	3.08	187.39	-	-	-	-	-	-
9-Feb-15	364	90.0	6.65	1,000	0.600	2.64	141.5	<1.00	0.0130	0.00640	2.59	1.09	0.0141
10-Mar-15	364	115	6.73	-	0.526	2.92	159.63	-	-	-	-	-	-
13-Apr-15	364	95.0	6.62	-	0.567	3.08	166.64	-	-	-	-	-	-
11-May-15	364	115	6.68	350	0.344	4.86	197	<1.00	0.00800	0.00370	0.890	0.560	0.00300
25-May-15	364	110	6.63	-	-	4.86	197	<1.00	-	-	-	-	-
28-May-15	-	110	6.12	-	-	4.86	197	-	-	-	-	-	-
1-Jun-15	364	110	6.65	-	-	2.88	132.03	<1.00	-	-	-	-	-
4-Jun-15	-	110	6.44	-	-	2.88	132.03	-	-	-	-	-	-
8-Jun-15	364	110	6.83	-	0.619	2.88	132.03	-	-	-	-	-	-
11-Jun-15	-	75.0	6.41	-	-	2.88	132.03	-	-	-	-	-	-
15-Jun-15	364	75.0	6.90	-	-	2.88	132.03	2.00	-	-	-	-	-
22-Jun-15	364	78.0	6.78	-	-	2.88	132.03	3.00	-	-	-	-	-
25-Jun-15	-	75.0	6.73	-	-	2.88	132.03	-	-	-	-	-	-
29-Jun-15	364	77.0	6.76	-	-	2.88	132.03	2.00	-	-	-	-	-
2-Jul-15	-	50.0	6.90	-	-	3	107.79	-	-	-	-	-	-
6-Jul-15	364	50.0	6.80	-	-	3	107.79	<1.00	-	-	-	-	-
9-Jul-15	-	49.0	6.80	-	-	3	107.79	-	-	-	-	-	-
13-Jul-15	364	50.0	6.66	-	0.558	3	107.79	2.00	-	-	-	-	-
16-Jul-15	-	50.0	6.70	-	-	3	107.79	-	-	-	-	-	-
20-Jul-15	364	54.0	6.50	-	-	3	107.79	2.00	-	-	-	-	-
24-Jul-15	-	52.0	6.40	-	-	3	107.79	-	-	-	-	-	-
27-Jul-15	364	51.0	6.70	-	-	3	107.79	2.00	-	-	-	-	-
30-Jul-15	-	53.0	6.70	-	-	3	107.79	-	-	-	-	-	-
31-Jul-15	-	54.0	-	-	-	3	107.79	-	-	-	-	-	-
4-Aug-15	364	54.0	6.70	-	-	2.2	83.3	4.00	-	-	-	-	-
6-Aug-15	-	54.0	6.70	-	-	2.2	83.3	-	-	-	-	-	-
10-Aug-15	364	54.0	6.50	960	0.646	2.2	83.3	4.00	0.0120	0.00440	1.58	1.11	0.0105
13-Aug-15	-	41.0	6.70	-	-	2.2	83.3	-	-	-	-	-	-
17-Aug-15	364	42.0	6.70	-	-	2.2	83.3	<1.00	-	-	-	-	-
20-Aug-15	-	41.0	6.81	-	-	2.2	83.3	-	-	-	-	-	-
24-Aug-15	364	41.0	6.70	-	-	2.2	83.3	4.00	-	-	-	-	-
27-Aug-15	-	60.0	6.90	-	-	2.2	83.3	-	-	-	-	-	-
31-Aug-15	364	59.0	6.70	-	-	2.2	83.3	5.00	-	-	-	-	-
3-Sep-15	-	60.0	6.70	-	-	2.7	152.8	-	-	-	-	-	-
8-Sep-15	364	64.0	6.81	-	-	2.7	152.8	3.00	-	-	-	-	-
10-Sep-15	-	64.0	6.95	-	-	2.7	152.8	-	-	-	-	-	-
14-Sep-15	364	65.0	5.80	-	0.594	2.7	152.8	7.00	-	-	-	-	-
17-Sep-15	-	82.0	6.50	-	-	2.7	152.8	-	-	-	-	-	-
21-Sep-15	364	84.0	6.40	-	-	2.7	152.8	16.0	-	-	-	-	-
24-Sep-15	-	111	6.10	-	-	2.7	152.8	-	-	-	-	-	-
28-Sep-15	364	111	6.34	-	-	2.7	152.8	4.00	-	-	-	-	-
1-Oct-15	-	111	6.29	-	-	3.2	180.6	-	-	-	-	-	-
5-Oct-15	364	100	6.20	-	-	3.2	180.6	8.00	-	-	-	-	-
8-Oct-15	-	82.0	5.44	-	-	3.2	180.6	-	-	-	-	-	-
13-Oct-15	364	82.0	6.12	-	0.635	3.2	180.6	16.0	-	-	-	-	-
15-Oct-15	-	84.0	6.00	-	-	3.2	180.6	-	-	-	-	-	-
19-Oct-15	364	86.0	6.70	-	-	3.2	180.6	15.0	-	-	-	-	-
22-Oct-15	-	72.0	6.90	-	-	3.2	180.6	-	-	-	-	-	-
26-Oct-15	364	75.0	6.56	-	-	3.2	180.6	18.0	-	-	-	-	-
29-Oct-15	-	85.0	6.60	-	-	3.2	180.6	-	-	-	-	-	-
2-Nov-15	364	107	6.68	-	-	4.2	180.6	16.0	-	-	-	-	-
5-Nov-15	-	107	6.69	-	-	4.2	180.6	-	-	-	-	-	-
9-Nov-15	364	139	6.65	1,000	0.528	4.2	180.6	16.0	0.0130	0.00670	7.34	1.33	0.0175
12-Nov-15	-	136	6.63	-	-	4.2	180.6	-	-	-	-	-	-
16-Nov-15	364	138	6.86	-	-	4.2	180.6	15.0	-	-	-	-	-
19-Nov-15	-	138	6.92	-	-	4.2	180.6	-	-	-	-	-	-
23-Nov-15	364	138	6.93	-	-	4.2	180.6	13.0	-	-	-	-	-
30-Nov-15	364	138	7.21	-	-	4.2	180.6	-	-	-	-	-	-
14-Dec-15	364	160	6.61	-	0.638	2.7	201.39	-	-	-	-	-	-
4-Jan-16	364	180	6.90	-	-	3.4	263.9	-	-	-	-	-	-
12-Jan-16	364	180	6.75	-	0.637	3.4	263.9	-	-	-	-	-	-
28-Jan-16	-	111	6.89	-	-	3.4	263.9	-	-	-	-	-	-
1-Feb-16	364	111	6.84	-	-	1.8	229.2	-	-	-	-	-	-
8-Feb-16	364	109	6.26	920	0.580	1.8	229.2	4.00	0.00900	0.00530	3.00	0.855	0.0106
26-Feb-16	-	158	6.30	-	-	1.8	229.2	-	-	-	-	-	-
7-Mar-16	364	150	6.25	-	-	3.38	243.1	<1.00	-	-	-	-	-
14-Mar-16	364	155	6.27	-	0.586	3.38	243.1	-	-	-	-	-	-
17-Mar-16	-	155	6.46	-	-	3.38	243.1	-	-	-	-	-	-
21-Mar-16	364	150	6.56	-	-	3.38	243.1	-	-	-	-	-	-
28-Mar-16	364	153	6.56	-	-	3.38	243.1	-	-	-	-	-	-
4-Apr-16	364	155	6.56	-	-	3.4	277.8	<1.00	-	-	-	-	-
11-Apr-16	364	148	6.59	-	0.435	3.4	277.8	-	-	-	-	-	-
21-Apr-16	-	143	6.61	-	-	3.4	277.8	-	-	-	-	-	-
28-Apr-16	-	105	6.80	-	-	3.4	277.8	-	-	-	-	-	-
2-May-16	364	106	6.89	-	-	3.4	179.5	-	-	-	-	-	-
5-May-16	-	104	6.66	-	-	3.4	179.5	-	-	-	-	-	-
9-May-16	364	104	6.54	570	0.496	3.4	179.5	<1.00	0.0100	0.00540	2.15	0.897	0.00540
12-May-16	-	74.0	6.43	-	-	3.4	179.5	-	-	-	-	-	-
16-May-16	364	47.0	6.66	-	-	3.4	179.5	3.00	-	-	-	-	-
19-May-16	-	49.0	6.66	-	-	3.4	179.5	-	-	-	-	-	-
24-May-16	364	59.0	6.84	-	-	3.4	179.5	<1.00	-	-	-	-	-
26-May-16	-	62.0	6.98	-	-	3.4	179.5	-	-	-	-	-	-
31-May-16	364	67.0	7.78	-	-	3.4	179.5	<1.00	-	-	-	-	-
2-Jun-16	-	67.0	7.07	-	-	3.6	119.3	-	-	-	-	-	-
6-Jun-16	364	84.0	6.76	-	-	3.6	119.3	1.00	-	-	-	-	-
9-Jun-16	-	84.0	6.55	-	-	3.6	119.3	-	-	-	-	-	-

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table G.7: Water Quality at TOMP Station Q-05 (Basin Performance - Primary, ETP Operations), Quirke TMA, 2015 to 2019

Date	Elevation (m)	Flow (L/s)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Lime consumption (kg per month)	Barium Chloride consumption (kg per day)	Acidity (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
13-Jun-16	364	84.0	6.61	-	0.645	3.6	119.3	2.00	-	-	-	-	-
16-Jun-16	-	84.0	6.70	-	-	3.6	119.3	-	-	-	-	-	-
20-Jun-16	364	79.0	6.90	-	-	3.6	119.3	1.00	-	-	-	-	-
23-Jun-16	-	100	6.50	-	-	3.6	119.3	-	-	-	-	-	-
27-Jun-16	364	99.0	6.70	-	-	3.6	119.3	4.00	-	-	-	-	-
30-Jun-16	-	99.0	6.70	-	-	3.6	119.3	-	-	-	-	-	-
5-Jul-16	364	100	6.30	-	-	2	124.3	5.00	-	-	-	-	-
7-Jul-16	-	103	6.70	-	-	2	124.3	-	-	-	-	-	-
11-Jul-16	364	102	6.80	-	0.564	2	124.3	4.00	-	-	-	-	-
14-Jul-16	-	100	6.40	-	-	2	124.3	-	-	-	-	-	-
18-Jul-16	364	100	6.60	-	-	2	124.3	3.00	-	-	-	-	-
29-Aug-16	364	107	5.00	-	-	0	23.5	8.00	-	-	-	-	-
1-Sep-16	-	80.0	6.10	-	-	3.6	130	-	-	-	-	-	-
6-Sep-16	364	80.0	4.52	-	-	3.6	130	10.0	-	-	-	-	-
8-Sep-16	-	80.0	5.50	-	-	3.6	130	-	-	-	-	-	-
12-Sep-16	364	50.0	5.60	1,100	0.722	3.6	130	9.00	0.0140	0.00440	1.54	1.15	0.0173
15-Sep-16	-	50.0	5.40	-	-	3.6	130	-	-	-	-	-	-
19-Sep-16	364	55.0	4.20	-	-	3.6	130	11.0	-	-	-	-	-
22-Sep-16	-	59.0	4.80	-	-	3.6	130	-	-	-	-	-	-
26-Sep-16	364	66.0	4.27	-	-	3.6	130	13.0	-	-	-	-	-
29-Sep-16	-	80.0	4.80	-	-	3.6	130	-	-	-	-	-	-
3-Oct-16	364	86.0	4.00	-	-	4.5	161.2	11.0	-	-	-	-	-
6-Oct-16	-	84.0	4.20	-	-	4.5	161.2	-	-	-	-	-	-
11-Oct-16	364	85.0	4.10	-	0.844	4.5	161.2	14.0	-	-	-	-	-
13-Oct-16	-	83.0	4.10	-	-	4.5	161.2	-	-	-	-	-	-
17-Oct-16	364	86.0	4.00	-	-	4.5	161.2	14.0	-	-	-	-	-
20-Oct-16	-	104	3.90	-	-	4.5	161.2	-	-	-	-	-	-
24-Oct-16	364	100	4.90	-	-	4.5	161.2	15.0	-	-	-	-	-
27-Oct-16	-	99.0	4.00	-	-	4.5	161.2	-	-	-	-	-	-
31-Oct-16	364	100	4.70	-	-	4.5	161.2	19.0	-	-	-	-	-
3-Nov-16	-	100	4.20	-	-	3.6	114.4	-	-	-	-	-	-
7-Nov-16	364	99.0	4.30	-	-	3.6	114.4	15.0	-	-	-	-	-
10-Nov-16	-	100	4.20	-	-	3.6	114.4	-	-	-	-	-	-
14-Nov-16	364	98.0	4.40	1,100	0.977	3.6	114.4	21.0	0.0140	0.00840	4.23	1.78	0.0297
17-Nov-16	-	99.0	4.70	-	-	3.6	114.4	-	-	-	-	-	-
21-Nov-16	364	101	4.20	-	-	3.6	114.4	16.0	-	-	-	-	-
24-Nov-16	-	74.0	4.60	-	-	3.6	114.4	-	-	-	-	-	-
28-Nov-16	364	73.0	4.30	-	-	3.6	114.4	13.0	-	-	-	-	-
1-Dec-16	-	76.0	4.20	-	-	4.3	145.6	-	-	-	-	-	-
5-Dec-16	364	78.0	4.30	-	-	4.3	145.6	14.0	-	-	-	-	-
12-Dec-16	364	111	5.70	-	1.04	4.3	145.6	-	-	-	-	-	-
9-Jan-17	364	80.0	5.90	-	0.928	2.7	213.2	-	-	-	-	-	-
13-Feb-17	364	110	6.30	1,000	0.724	3	187.2	4.00	0.0130	0.00770	2.69	1.48	0.0135
16-Mar-17	364	100	6.40	-	0.696	3.1	218.4	-	-	-	-	-	-
10-Apr-17	364	160	6.50	-	0.595	5.3	192.4	2.00	-	-	-	-	-
8-May-17	364	100	6.50	790	0.733	3.6	234	8.00	0.0110	0.00760	2.37	1.39	0.0142
13-Jun-17	364	120	6.70	-	0.746	3.6	140.4	3.00	-	-	-	-	-
10-Jul-17	364	120	6.60	-	0.740	3.6	140.4	5.00	-	-	-	-	-
14-Aug-17	364	120	6.60	870	0.739	3.6	130	7.00	0.0120	0.00620	0.640	1.27	0.00970
11-Sep-17	364	95.0	6.60	-	0.729	3.6	104	7.00	-	-	-	-	-
10-Oct-17	364	106	6.50	-	0.615	3.6	135.2	5.00	-	-	-	-	-
13-Nov-17	364	146	6.30	880	0.599	2.5	116.4	3.00	0.0130	0.00440	2.37	1.05	0.00840
11-Dec-17	364	180	6.60	-	0.444	3.1	286	-	-	-	-	-	-
8-Jan-18	364	110	6.50	-	0.578	2.7	151	-	-	-	-	-	-
12-Feb-18	364	100	6.40	1,000	0.592	2.2	151	<1.00	0.0120	0.00450	2.93	0.984	0.0116
12-Mar-18	364	80.0	6.30	-	0.639	2.2	140.4	-	-	-	-	-	-
9-Apr-18	364	90.0	6.40	-	0.756	4.1	130	-	-	-	-	-	-
14-May-18	364	90.0	6.70	320	0.358	3.6	145.6	<1.00	0.00800	0.00260	1.79	0.460	0.00440
11-Jun-18	364	65.0	6.60	-	0.589	3.6	130	1.00	-	-	-	-	-
9-Jul-18	364	50.0	6.60	-	0.511	3.6	114.4	<1.00	-	-	-	-	-
13-Aug-18	364	90.0	6.60	940	0.453	3.6	104	<1.00	0.0110	0.00100	1.00	0.390	0.00390
10-Sep-18	364	70.0	6.50	-	0.435	3.6	104	8.00	-	-	-	-	-
9-Oct-18	364	145	6.50	-	0.582	3.6	244	10.0	-	-	-	-	-
5-Nov-18	364	130	6.70	890	0.497	2.2	218.4	<1.00	0.0120	0.00400	3.68	1.06	0.0100
12-Nov-18	364	130	6.80	-	-	2.2	218.4	<1.00	-	-	-	-	-
10-Dec-18	364	100	6.50	-	0.501	2.2	192.4	-	-	-	-	-	-
14-Jan-19	364	100	6.70	-	0.528	1.3	197.6	-	-	-	-	-	-
11-Feb-19	364	110	6.60	980	0.486	3.4	172	<1.00	0.0100	0.00410	1.90	0.795	0.0172
11-Mar-19	364	100	6.60	-	0.578	4.1	218	-	-	-	-	-	-
15-Apr-19	-	170	6.60	-	-	5.1	208	<1.00	-	-	-	-	-
16-Apr-19	364	170	6.40	740	0.440	5.1	208	<1.00	0.0110	0.00500	2.48	0.913	0.0141
13-May-19	364	135	6.60	-	0.394	5	182	<1.00	-	-	-	-	-
10-Jun-19	364	180	6.80	-	0.468	3.3	172	<1.00	-	-	-	-	-
8-Jul-19	364	85.0	6.70	-	0.388	3.3	140	<1.00	-	-	-	-	-
12-Aug-19	364	60.0	6.60	800	0.325	3.3	130	<1.00	0.0110	0.00130	1.02	0.427	0.00570
9-Sep-19	364	120	6.50	-	0.403	4.7	146	4.00	-	-	-	-	-
15-Oct-19	364	140	6.60	-	0.547	3.5	166.4	9.00	-	-	-	-	-
11-Nov-19	364	100	6.80	880	0.558	3.5	161.2	2.00	0.0110	0.00390	5.19	1.11	0.0115
9-Dec-19	364	150	6.60	-	0.429	4.7	177	<1.00	-	-	-	-	-
n	256	1568	165	20	59	60	60	86	20	20	20	20	20
Minimum	364	40.0	3.90	320	0.325	0	23.5	<1.00	0.00800	0.00100	0.640	0.390	0.00300
Maximum	364	200	7.78	1,100	1.04	5.30	286	21.0	0.0140	0.00840	7.34	1.78	0.0297
Mean	364	111	6.24	854	0.588	3.30	165	5.93	0.0114	0.00485	2.57	1.01	0.0116
SD	0.115	33.9	0.857	216	0.146	0.926	49.3	5.69	0.00176	0.00196	1.60	0.363	0.00618
Median	364	108	6.60	905	0.582	3.40	160	4.00	0.0115	0.00445	2.37	1.06	0.0110
10th Percentile	364	68.0	4.40	460	0.403	2.20	111	<1.00	0.00850	0.00195	0.945	0.444	0.00415
95th Percentile	364	175	6.90	1,100	0.928	4.93	254	16.0	0.0140	0.00805	6.26	1.63	0.0236

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table G.8: Water Quality at TOMP Station Q-03 (ETP Operations), Quirke TMA, 2015 to 2019

Date	pH
5-Jan-15	8.89
12-Jan-15	9.04
19-Jan-15	9.10
26-Jan-15	9.20
2-Feb-15	9.05
9-Feb-15	9.00
17-Feb-15	8.96
23-Feb-15	9.00
2-Mar-15	8.83
10-Mar-15	8.89
16-Mar-15	8.60
23-Mar-15	9.00
30-Mar-15	9.00
6-Apr-15	8.90
13-Apr-15	8.90
20-Apr-15	8.80
27-Apr-15	8.60
4-May-15	8.40
11-May-15	8.55
19-May-15	8.70
25-May-15	9.20
1-Jun-15	8.95
8-Jun-15	8.87
15-Jun-15	9.00
22-Jun-15	9.01
29-Jun-15	9.14
6-Jul-15	8.50
13-Jul-15	9.42
20-Jul-15	9.40
27-Jul-15	8.90
4-Aug-15	9.40
10-Aug-15	9.60
17-Aug-15	9.50
24-Aug-15	9.50
31-Aug-15	9.20
8-Sep-15	9.34
14-Sep-15	9.50
21-Sep-15	9.20
28-Sep-15	8.92
5-Oct-15	9.10
13-Oct-15	9.23
19-Oct-15	9.33
26-Oct-15	9.27
2-Nov-15	8.97
9-Nov-15	8.40
16-Nov-15	7.84
23-Nov-15	8.27
30-Nov-15	9.09
7-Dec-15	9.19
14-Dec-15	8.98
21-Dec-15	8.14
28-Dec-15	8.40
4-Jan-16	8.60
12-Jan-16	8.91
18-Jan-16	8.78
25-Jan-16	8.81
1-Feb-16	8.85
8-Feb-16	8.70
16-Feb-16	8.66
22-Feb-16	8.60
29-Feb-16	7.97
7-Mar-16	8.23
14-Mar-16	8.59
21-Mar-16	8.63
28-Mar-16	8.47
4-Apr-16	8.75
11-Apr-16	8.80
18-Apr-16	8.75
25-Apr-16	8.81
2-May-16	8.79
9-May-16	8.27
16-May-16	8.22
24-May-16	8.42
31-May-16	8.05
6-Jun-16	8.35
13-Jun-16	8.50
20-Jun-16	8.38
27-Jun-16	8.10
5-Jul-16	7.70
11-Jul-16	8.50
18-Jul-16	8.20
25-Jul-16	-
2-Aug-16	7.20
8-Aug-16	-
15-Aug-16	8.10
22-Aug-16	-
29-Aug-16	-
6-Sep-16	8.86
12-Sep-16	8.50
19-Sep-16	8.80
26-Sep-16	9.02
3-Oct-16	9.30
11-Oct-16	9.30
17-Oct-16	9.40

Date	pH
24-Oct-16	9.10
31-Oct-16	9.10
7-Nov-16	9.50
14-Nov-16	9.40
21-Nov-16	9.40
28-Nov-16	9.60
5-Dec-16	8.70
12-Dec-16	8.80
19-Dec-16	9.30
29-Dec-16	9.20
2-Jan-17	9.30
9-Jan-17	9.00
16-Jan-17	8.70
23-Jan-17	8.80
30-Jan-17	9.00
6-Feb-17	9.00
13-Feb-17	9.20
21-Feb-17	8.80
27-Feb-17	8.80
6-Mar-17	8.70
16-Mar-17	8.70
20-Mar-17	8.90
27-Mar-17	8.90
3-Apr-17	8.40
10-Apr-17	8.90
17-Apr-17	9.00
24-Apr-17	8.60
1-May-17	8.80
8-May-17	8.50
15-May-17	9.20
23-May-17	9.00
29-May-17	8.70
5-Jun-17	8.50
12-Jun-17	8.70
19-Jun-17	8.50
26-Jun-17	8.80
4-Jul-17	8.90
10-Jul-17	8.40
17-Jul-17	8.60
24-Jul-17	8.60
31-Jul-17	8.70
8-Aug-17	9.10
14-Aug-17	9.10
21-Aug-17	9.30
28-Aug-17	9.00
5-Sep-17	9.00
11-Sep-17	8.80
18-Sep-17	9.00
25-Sep-17	9.30
2-Oct-17	9.10
10-Oct-17	8.80
16-Oct-17	9.10
23-Oct-17	9.30
30-Oct-17	8.40
6-Nov-17	8.80
13-Nov-17	9.00
20-Nov-17	8.60
27-Nov-17	8.20
4-Dec-17	8.80
11-Dec-17	8.70
18-Dec-17	8.40
27-Dec-17	8.60
2-Jan-18	8.20
8-Jan-18	8.30
15-Jan-18	8.40
22-Jan-18	8.60
29-Jan-18	8.30
5-Feb-18	8.70
12-Feb-18	8.40
20-Feb-18	8.20
26-Feb-18	8.00
5-Mar-18	8.60
12-Mar-18	8.80
19-Mar-18	8.80
26-Mar-18	8.50
2-Apr-18	8.50
9-Apr-18	8.70
16-Apr-18	8.60
23-Apr-18	7.90
30-Apr-18	8.30
7-May-18	8.50
14-May-18	8.20
23-May-18	8.50
28-May-18	8.20
4-Jun-18	8.80
11-Jun-18	8.60
18-Jun-18	8.60
25-Jun-18	9.20
3-Jul-18	8.90
9-Jul-18	8.30
16-Jul-18	8.40
23-Jul-18	8.70
30-Jul-18	8.40
7-Aug-18	8.80

Date	pH
13-Aug-18	8.40
20-Aug-18	8.60
27-Aug-18	8.50
4-Sep-18	8.40
10-Sep-18	8.50
17-Sep-18	8.70
24-Sep-18	8.80
1-Oct-18	8.60
9-Oct-18	8.40
15-Oct-18	7.70
22-Oct-18	8.90
29-Oct-18	9.00
5-Nov-18	8.90
12-Nov-18	8.60
19-Nov-18	8.60
26-Nov-18	8.80
3-Dec-18	7.90
10-Dec-18	8.10
17-Dec-18	9.00
24-Dec-18	8.80
2-Jan-19	8.40
7-Jan-19	8.30
14-Jan-19	8.40
21-Jan-19	8.60
28-Jan-19	8.00
4-Feb-19	8.50
11-Feb-19	7.90
19-Feb-19	8.40
25-Feb-19	8.40
4-Mar-19	8.10
11-Mar-19	8.60
18-Mar-19	8.30
25-Mar-19	8.50
1-Apr-19	8.30
8-Apr-19	8.50
15-Apr-19	8.50
22-Apr-19	8.50
29-Apr-19	8.10
6-May-19	8.50
13-May-19	8.90
21-May-19	8.70
27-May-19	8.60
3-Jun-19	8.00
10-Jun-19	8.90
17-Jun-19	8.50
24-Jun-19	8.20
2-Jul-19	8.20
8-Jul-19	8.30
15-Jul-19	8.40
22-Jul-19	8.30
29-Jul-19	8.20
6-Aug-19	8.60
12-Aug-19	8.30
19-Aug-19	8.30
26-Aug-19	8.40
3-Sep-19	8.60
9-Sep-19	8.70
16-Sep-19	9.00
23-Sep-19	9.10
30-Sep-19	9.20
7-Oct-19	9.00
15-Oct-19	8.80
21-Oct-19	9.20
28-Oct-19	8.30
4-Nov-19	8.50
11-Nov-19	8.50
18-Nov-19	8.90
25-Nov-19	8.30
2-Dec-19	8.30
9-Dec-19	8.30
16-Dec-19	8.50
23-Dec-19	8.10
30-Dec-19	8.20
n	257
Minimum	7.20
Maximum	9.60
Mean	8.69
SD	0.395
Median	8.70
10th Percentile	8.20
95th Percentile	9.34

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table G.9: Water Quality at TOMP Station Q-04P (ETP Operations), Quirke TMA, 2015 to 2019

Date	pH
2-Jan-15	9.30
5-Jan-15	9.40
6-Jan-15	9.34
7-Jan-15	9.30
8-Jan-15	9.30
9-Jan-15	9.30
12-Jan-15	9.30
13-Jan-15	9.30
14-Jan-15	9.30
15-Jan-15	9.40
16-Jan-15	9.40
19-Jan-15	9.70
20-Jan-15	9.30
21-Jan-15	9.40
22-Jan-15	9.30
23-Jan-15	9.40
26-Jan-15	9.50
27-Jan-15	9.40
28-Jan-15	9.40
29-Jan-15	9.40
30-Jan-15	9.10
2-Feb-15	9.14
3-Feb-15	9.10
4-Feb-15	9.03
5-Feb-15	9.20
6-Feb-15	9.20
9-Feb-15	9.20
10-Feb-15	9.17
11-Feb-15	9.20
12-Feb-15	9.20
13-Feb-15	9.30
17-Feb-15	9.30
18-Feb-15	9.20
19-Feb-15	9.17
20-Feb-15	9.16
23-Feb-15	9.10
24-Feb-15	9.20
25-Feb-15	9.10
26-Feb-15	9.20
27-Feb-15	9.10
2-Mar-15	9.10
3-Mar-15	9.41
4-Mar-15	9.20
5-Mar-15	9.14
6-Mar-15	9.16
9-Mar-15	9.00
10-Mar-15	9.00
11-Mar-15	9.00
12-Mar-15	9.00
13-Mar-15	9.00
16-Mar-15	9.00
17-Mar-15	8.90
18-Mar-15	9.30
19-Mar-15	9.40
20-Mar-15	9.10
23-Mar-15	9.20
24-Mar-15	9.30
25-Mar-15	9.30
26-Mar-15	9.30
27-Mar-15	9.10
30-Mar-15	9.30
31-Mar-15	9.10
1-Apr-15	9.06
2-Apr-15	9.10
6-Apr-15	9.30
7-Apr-15	9.20
8-Apr-15	9.10
9-Apr-15	9.10
10-Apr-15	9.10
13-Apr-15	9.50
14-Apr-15	9.60
15-Apr-15	9.50
16-Apr-15	9.60
17-Apr-15	9.70
20-Apr-15	9.40
21-Apr-15	9.60
22-Apr-15	9.10
23-Apr-15	8.80
24-Apr-15	8.90
27-Apr-15	8.80
28-Apr-15	9.10
29-Apr-15	9.40
30-Apr-15	9.40
1-May-15	9.40
4-May-15	9.30
5-May-15	9.80
6-May-15	9.70
7-May-15	10.0
8-May-15	9.50
11-May-15	9.60
12-May-15	9.60
13-May-15	9.74
14-May-15	9.97
15-May-15	9.80
19-May-15	9.80
20-May-15	9.80
21-May-15	9.70
22-May-15	9.70
25-May-15	9.60
26-May-15	9.60
27-May-15	9.64
28-May-15	9.74
29-May-15	9.90

Date	pH
1-Jun-15	8.95
2-Jun-15	8.90
3-Jun-15	9.94
4-Jun-15	9.80
5-Jun-15	9.90
8-Jun-15	9.84
9-Jun-15	9.90
10-Jun-15	10.4
11-Jun-15	10.5
12-Jun-15	10.4
15-Jun-15	10.5
16-Jun-15	10.5
17-Jun-15	10.8
18-Jun-15	10.8
19-Jun-15	10.5
22-Jun-15	10.6
23-Jun-15	10.6
24-Jun-15	10.7
25-Jun-15	10.6
26-Jun-15	10.6
29-Jun-15	10.6
30-Jun-15	10.5
2-Jul-15	10.9
3-Jul-15	11.0
6-Jul-15	11.0
7-Jul-15	10.9
8-Jul-15	11.0
9-Jul-15	11.0
10-Jul-15	11.0
13-Jul-15	10.9
14-Jul-15	10.9
15-Jul-15	10.9
16-Jul-15	11.0
17-Jul-15	11.0
20-Jul-15	11.0
21-Jul-15	11.0
22-Jul-15	10.9
23-Jul-15	11.1
24-Jul-15	11.0
27-Jul-15	10.9
28-Jul-15	11.0
29-Jul-15	11.0
30-Jul-15	11.1
31-Jul-15	11.0
4-Aug-15	11.1
5-Aug-15	11.1
6-Aug-15	11.1
7-Aug-15	11.1
10-Aug-15	11.0
11-Aug-15	11.1
12-Aug-15	11.1
13-Aug-15	11.1
14-Aug-15	11.1
17-Aug-15	11.1
18-Aug-15	11.1
19-Aug-15	11.2
20-Aug-15	11.1
21-Aug-15	10.9
24-Aug-15	11.1
25-Aug-15	10.9
26-Aug-15	10.7
27-Aug-15	10.8
28-Aug-15	10.8
31-Aug-15	10.9
1-Sep-15	10.8
2-Sep-15	10.8
3-Sep-15	10.9
4-Sep-15	10.9
8-Sep-15	10.9
9-Sep-15	10.9
10-Sep-15	10.9
11-Sep-15	10.8
14-Sep-15	11.1
15-Sep-15	10.0
16-Sep-15	10.0
17-Sep-15	9.92
18-Sep-15	9.70
21-Sep-15	9.90
22-Sep-15	9.30
23-Sep-15	9.54
24-Sep-15	9.40
25-Sep-15	9.60
28-Sep-15	9.94
29-Sep-15	9.87
30-Sep-15	9.93
1-Oct-15	9.93
2-Oct-15	10.0
5-Oct-15	10.1
6-Oct-15	10.4
7-Oct-15	10.7
8-Oct-15	10.8
9-Oct-15	10.5
13-Oct-15	10.9
14-Oct-15	10.8
15-Oct-15	11.0
16-Oct-15	11.2
19-Oct-15	11.0
20-Oct-15	10.9
21-Oct-15	11.0
22-Oct-15	11.2
23-Oct-15	11.0
26-Oct-15	10.8
27-Oct-15	10.7

Date	pH
28-Oct-15	11.0
29-Oct-15	10.8
30-Oct-15	9.40
2-Nov-15	9.42
3-Nov-15	9.53
4-Nov-15	9.52
5-Nov-15	9.53
6-Nov-15	9.57
9-Nov-15	8.80
10-Nov-15	9.17
11-Nov-15	9.03
12-Nov-15	9.03
13-Nov-15	9.10
16-Nov-15	9.02
17-Nov-15	9.17
18-Nov-15	9.66
19-Nov-15	9.74
20-Nov-15	9.78
23-Nov-15	10.2
24-Nov-15	10.3
25-Nov-15	9.94
26-Nov-15	9.97
27-Nov-15	9.91
30-Nov-15	10.1
1-Dec-15	9.93
2-Dec-15	9.91
3-Dec-15	9.92
4-Dec-15	10.0
7-Dec-15	9.86
8-Dec-15	9.61
9-Dec-15	9.57
10-Dec-15	9.56
11-Dec-15	9.50
14-Dec-15	9.43
15-Dec-15	9.16
16-Dec-15	9.10
17-Dec-15	9.20
18-Dec-15	9.00
21-Dec-15	9.11
22-Dec-15	9.14
23-Dec-15	9.10
24-Dec-15	9.10
28-Dec-15	9.30
29-Dec-15	9.20
30-Dec-15	9.20
31-Dec-15	9.20
4-Jan-16	9.10
5-Jan-16	9.10
6-Jan-16	9.21
7-Jan-16	9.13
8-Jan-16	9.10
11-Jan-16	9.08
12-Jan-16	9.10
13-Jan-16	9.17
14-Jan-16	9.20
15-Jan-16	9.40
18-Jan-16	9.33
19-Jan-16	9.36
20-Jan-16	9.30
21-Jan-16	9.25
22-Jan-16	9.29
25-Jan-16	9.11
26-Jan-16	9.05
27-Jan-16	9.10
28-Jan-16	9.26
29-Jan-16	9.37
1-Feb-16	9.27
2-Feb-16	9.20
3-Feb-16	9.10
4-Feb-16	9.20
5-Feb-16	9.28
8-Feb-16	9.23
9-Feb-16	9.13
10-Feb-16	9.10
11-Feb-16	9.08
12-Feb-16	9.20
16-Feb-16	9.20
17-Feb-16	9.10
18-Feb-16	9.10
19-Feb-16	9.02
22-Feb-16	9.00
23-Feb-16	8.80
24-Feb-16	8.90
25-Feb-16	8.90
26-Feb-16	8.80
29-Feb-16	8.80
1-Mar-16	9.07
2-Mar-16	9.03
3-Mar-16	8.99
4-Mar-16	8.97
7-Mar-16	9.00
8-Mar-16	9.23
9-Mar-16	9.10
10-Mar-16	9.11
11-Mar-16	9.06
14-Mar-16	9.12
15-Mar-16	9.18
16-Mar-16	9.09
17-Mar-16	9.21
18-Mar-16	9.24
21-Mar-16	9.22
22-Mar-16	9.30
23-Mar-16	9.10

Note: "SD" = standard deviation. "n" = number of samples.

Table G.9: Water Quality at TOMP Station Q-04P (ETP Operations), Quirke TMA, 2015 to 2019

Date	pH
24-Mar-16	9.20
28-Mar-16	9.05
29-Mar-16	9.22
30-Mar-16	9.18
31-Mar-16	9.27
1-Apr-16	9.24
4-Apr-16	9.24
5-Apr-16	9.21
6-Apr-16	9.14
7-Apr-16	9.05
8-Apr-16	9.23
11-Apr-16	9.19
12-Apr-16	8.98
13-Apr-16	9.08
14-Apr-16	9.26
15-Apr-16	9.15
18-Apr-16	9.28
19-Apr-16	9.21
20-Apr-16	9.23
21-Apr-16	9.36
22-Apr-16	9.28
25-Apr-16	9.68
26-Apr-16	9.50
27-Apr-16	9.43
28-Apr-16	9.50
29-Apr-16	9.60
2-May-16	9.64
3-May-16	9.63
4-May-16	9.48
5-May-16	9.33
6-May-16	9.31
9-May-16	9.34
10-May-16	9.65
11-May-16	9.72
12-May-16	9.74
13-May-16	10.2
16-May-16	10.1
17-May-16	10.2
18-May-16	10.3
19-May-16	10.2
20-May-16	10.0
24-May-16	10.0
25-May-16	9.86
26-May-16	9.92
27-May-16	9.93
31-May-16	11.9
1-Jun-16	9.88
2-Jun-16	9.94
3-Jun-16	9.70
6-Jun-16	9.69
7-Jun-16	9.65
8-Jun-16	9.76
9-Jun-16	9.77
10-Jun-16	9.90
13-Jun-16	9.82
14-Jun-16	9.84
15-Jun-16	9.89
16-Jun-16	9.83
17-Jun-16	9.79
20-Jun-16	9.82
22-Jun-16	9.60
23-Jun-16	9.60
24-Jun-16	9.60
27-Jun-16	9.60
28-Jun-16	9.60
29-Jun-16	9.60
30-Jun-16	9.70
4-Jul-16	9.40
5-Jul-16	9.70
6-Jul-16	9.60
7-Jul-16	10.1
8-Jul-16	9.80
11-Jul-16	9.80
12-Jul-16	9.82
13-Jul-16	9.90
14-Jul-16	10.1
15-Jul-16	10.1
18-Jul-16	10.2
25-Aug-16	10.2
26-Aug-16	10.0
29-Aug-16	9.70
30-Aug-16	9.80
31-Aug-16	10.5
1-Sep-16	10.2
2-Sep-16	10.1
6-Sep-16	9.69
7-Sep-16	9.60
8-Sep-16	9.70
9-Sep-16	9.80
12-Sep-16	10.3
13-Sep-16	10.2
14-Sep-16	10.4
15-Sep-16	10.7
16-Sep-16	10.9
19-Sep-16	10.9
20-Sep-16	11.0
21-Sep-16	10.9
22-Sep-16	10.9
23-Sep-16	10.9
26-Sep-16	11.2
27-Sep-16	10.7
28-Sep-16	10.8

Date	pH
29-Sep-16	10.7
30-Sep-16	10.9
3-Oct-16	11.0
4-Oct-16	11.1
5-Oct-16	11.1
6-Oct-16	11.1
7-Oct-16	11.1
11-Oct-16	11.1
12-Oct-16	11.2
13-Oct-16	11.3
14-Oct-16	11.3
17-Oct-16	11.3
18-Oct-16	11.0
19-Oct-16	10.7
20-Oct-16	10.6
21-Oct-16	10.7
24-Oct-16	10.9
25-Oct-16	10.9
26-Oct-16	10.9
27-Oct-16	10.9
28-Oct-16	10.9
31-Oct-16	10.7
1-Nov-16	10.9
2-Nov-16	10.5
3-Nov-16	10.6
4-Nov-16	10.6
7-Nov-16	10.6
8-Nov-16	10.6
9-Nov-16	10.6
10-Nov-16	10.4
11-Nov-16	10.3
14-Nov-16	10.4
15-Nov-16	10.4
16-Nov-16	10.2
17-Nov-16	10.3
18-Nov-16	10.2
21-Nov-16	10.2
22-Nov-16	10.9
23-Nov-16	10.8
24-Nov-16	10.9
25-Nov-16	10.9
28-Nov-16	10.0
29-Nov-16	9.80
30-Nov-16	9.80
1-Dec-16	9.80
2-Dec-16	9.60
5-Dec-16	10.1
6-Dec-16	9.50
7-Dec-16	9.50
8-Dec-16	9.50
9-Dec-16	9.50
12-Dec-16	9.40
13-Dec-16	10.2
14-Dec-16	10.3
15-Dec-16	10.2
16-Dec-16	10.4
19-Dec-16	10.2
20-Dec-16	9.80
21-Dec-16	9.90
22-Dec-16	9.80
23-Dec-16	9.80
29-Dec-16	9.20
30-Dec-16	9.20
2-Jan-17	8.90
3-Jan-17	8.90
4-Jan-17	9.00
5-Jan-17	8.90
6-Jan-17	9.10
9-Jan-17	8.90
10-Jan-17	8.90
11-Jan-17	9.00
12-Jan-17	9.00
13-Jan-17	9.00
16-Jan-17	8.90
17-Jan-17	9.20
18-Jan-17	9.10
19-Jan-17	9.00
20-Jan-17	9.20
23-Jan-17	9.10
24-Jan-17	9.30
25-Jan-17	9.40
26-Jan-17	9.30
27-Jan-17	9.40
30-Jan-17	9.20
31-Jan-17	9.20
1-Feb-17	9.20
2-Feb-17	9.20
3-Feb-17	9.20
6-Feb-17	9.20
7-Feb-17	9.20
8-Feb-17	9.20
9-Feb-17	9.20
10-Feb-17	9.10
13-Feb-17	9.40
14-Feb-17	9.10
15-Feb-17	9.20
16-Feb-17	9.00
17-Feb-17	9.20
21-Feb-17	9.10
22-Feb-17	9.10
23-Feb-17	9.20
24-Feb-17	9.20

Date	pH
27-Feb-17	9.20
28-Feb-17	8.70
1-Mar-17	8.90
2-Mar-17	8.90
3-Mar-17	9.00
6-Mar-17	8.90
7-Mar-17	9.00
8-Mar-17	9.00
9-Mar-17	9.20
10-Mar-17	9.00
13-Mar-17	8.90
14-Mar-17	9.00
15-Mar-17	8.90
16-Mar-17	9.40
17-Mar-17	9.40
20-Mar-17	9.10
21-Mar-17	9.20
22-Mar-17	9.00
23-Mar-17	9.20
24-Mar-17	9.20
27-Mar-17	8.80
28-Mar-17	9.20
29-Mar-17	9.30
30-Mar-17	8.80
31-Mar-17	9.10
3-Apr-17	9.00
4-Apr-17	8.90
5-Apr-17	9.20
6-Apr-17	9.20
7-Apr-17	9.50
10-Apr-17	9.80
11-Apr-17	9.40
12-Apr-17	9.50
13-Apr-17	9.20
17-Apr-17	8.90
18-Apr-17	9.10
19-Apr-17	9.30
20-Apr-17	9.40
21-Apr-17	9.30
24-Apr-17	9.80
25-Apr-17	9.90
26-Apr-17	9.70
27-Apr-17	9.80
28-Apr-17	9.90
1-May-17	9.90
2-May-17	10.1
3-May-17	10.1
4-May-17	9.80
5-May-17	10.6
8-May-17	10.3
9-May-17	10.3
10-May-17	10.6
11-May-17	10.7
12-May-17	10.4
15-May-17	10.8
16-May-17	10.7
17-May-17	10.6
18-May-17	10.6
19-May-17	10.7
23-May-17	10.2
24-May-17	10.8
25-May-17	10.2
26-May-17	10.5
29-May-17	9.80
30-May-17	10.1
31-May-17	9.90
1-Jun-17	9.80
2-Jun-17	9.70
5-Jun-17	10.7
6-Jun-17	10.6
7-Jun-17	10.6
8-Jun-17	9.10
9-Jun-17	9.00
12-Jun-17	9.20
13-Jun-17	9.10
14-Jun-17	9.20
15-Jun-17	9.40
16-Jun-17	9.60
19-Jun-17	9.60
20-Jun-17	9.80
21-Jun-17	9.80
22-Jun-17	9.80
23-Jun-17	9.80
26-Jun-17	9.80
27-Jun-17	9.80
28-Jun-17	9.80
29-Jun-17	9.70
30-Jun-17	9.70
4-Jul-17	9.90
5-Jul-17	9.70
6-Jul-17	9.60
7-Jul-17	9.80
10-Jul-17	9.70
11-Jul-17	9.90
12-Jul-17	10.0
13-Jul-17	9.90
14-Jul-17	10.3
17-Jul-17	10.0
18-Jul-17	10.7
19-Jul-17	10.7
20-Jul-17	10.6
21-Jul-17	10.7

Note: "SD" = standard deviation. "n" = number of samples.

Table G.9: Water Quality at TOMP Station Q-04P (ETP Operations), Quirke TMA, 2015 to 2019

Date	pH	Date	pH	Date	pH
24-Jul-17	10.5	18-Dec-17	9.00	16-May-18	10.0
25-Jul-17	10.7	19-Dec-17	8.90	17-May-18	10.0
26-Jul-17	10.7	20-Dec-17	8.90	18-May-18	9.90
27-Jul-17	10.7	21-Dec-17	8.90	22-May-18	9.90
28-Jul-17	10.8	22-Dec-17	8.90	23-May-18	9.80
31-Jul-17	10.7	27-Dec-17	8.80	24-May-18	9.90
1-Aug-17	10.7	28-Dec-17	9.90	25-May-18	9.90
2-Aug-17	10.7	29-Dec-17	9.00	28-May-18	9.90
3-Aug-17	10.7	2-Jan-18	8.90	29-May-18	9.80
4-Aug-17	10.7	3-Jan-18	8.90	30-May-18	10.1
8-Aug-17	10.6	4-Jan-18	9.30	31-May-18	10.4
9-Aug-17	10.6	5-Jan-18	9.00	1-Jun-18	10.3
10-Aug-17	10.6	8-Jan-18	9.00	4-Jun-18	10.4
11-Aug-17	10.5	9-Jan-18	9.00	5-Jun-18	10.4
14-Aug-17	10.5	10-Jan-18	9.20	6-Jun-18	10.9
15-Aug-17	10.5	11-Jan-18	9.10	7-Jun-18	10.7
16-Aug-17	10.6	12-Jan-18	8.90	8-Jun-18	10.6
17-Aug-17	10.5	15-Jan-18	9.00	11-Jun-18	10.7
18-Aug-17	10.5	16-Jan-18	8.80	12-Jun-18	10.6
21-Aug-17	10.2	17-Jan-18	8.90	13-Jun-18	10.8
22-Aug-17	9.80	18-Jan-18	8.90	14-Jun-18	10.8
23-Aug-17	9.80	19-Jan-18	8.80	15-Jun-18	10.5
24-Aug-17	10.2	22-Jan-18	9.00	18-Jun-18	10.5
25-Aug-17	10.3	23-Jan-18	9.00	19-Jun-18	10.6
28-Aug-17	10.1	24-Jan-18	8.90	20-Jun-18	10.6
29-Aug-17	10.1	25-Jan-18	8.80	21-Jun-18	10.6
30-Aug-17	10.2	26-Jan-18	8.90	22-Jun-18	10.6
31-Aug-17	10.1	29-Jan-18	9.20	25-Jun-18	10.5
1-Sep-17	10.1	30-Jan-18	9.10	26-Jun-18	10.6
5-Sep-17	10.5	31-Jan-18	9.10	27-Jun-18	10.4
6-Sep-17	10.5	1-Feb-18	9.30	28-Jun-18	10.4
7-Sep-17	10.4	2-Feb-18	9.20	29-Jun-18	10.7
8-Sep-17	10.5	5-Feb-18	9.30	3-Jul-18	10.4
11-Sep-17	10.4	6-Feb-18	9.20	4-Jul-18	10.5
12-Sep-17	10.5	7-Feb-18	9.20	5-Jul-18	10.5
13-Sep-17	10.7	8-Feb-18	9.30	6-Jul-18	10.5
14-Sep-17	10.5	9-Feb-18	9.00	9-Jul-18	10.7
15-Sep-17	10.5	12-Feb-18	9.00	10-Jul-18	10.6
18-Sep-17	10.5	13-Feb-18	8.90	11-Jul-18	10.5
19-Sep-17	10.4	14-Feb-18	9.10	12-Jul-18	10.5
20-Sep-17	10.7	15-Feb-18	9.00	13-Jul-18	10.6
21-Sep-17	10.6	16-Feb-18	8.90	16-Jul-18	10.6
22-Sep-17	10.6	20-Feb-18	8.50	17-Jul-18	10.4
25-Sep-17	10.6	21-Feb-18	8.50	18-Jul-18	10.5
26-Sep-17	10.6	22-Feb-18	8.90	19-Jul-18	10.8
27-Sep-17	10.6	23-Feb-18	8.80	20-Jul-18	10.9
28-Sep-17	10.6	26-Feb-18	8.90	23-Jul-18	10.9
29-Sep-17	10.7	27-Feb-18	9.10	24-Jul-18	10.9
2-Oct-17	10.7	28-Feb-18	9.10	25-Jul-18	10.9
3-Oct-17	10.7	1-Mar-18	9.10	26-Jul-18	10.6
4-Oct-17	10.8	2-Mar-18	9.10	27-Jul-18	10.6
5-Oct-17	10.8	5-Mar-18	9.00	30-Jul-18	10.6
6-Oct-17	10.8	6-Mar-18	9.00	31-Jul-18	10.6
10-Oct-17	10.5	7-Mar-18	9.00	1-Aug-18	10.6
11-Oct-17	10.5	8-Mar-18	9.00	2-Aug-18	10.6
12-Oct-17	10.7	9-Mar-18	9.40	3-Aug-18	10.5
13-Oct-17	10.6	12-Mar-18	9.40	6-Aug-18	10.6
16-Oct-17	9.90	13-Mar-18	9.40	7-Aug-18	10.6
17-Oct-17	9.60	14-Mar-18	9.20	9-Aug-18	10.5
18-Oct-17	9.90	15-Mar-18	9.20	10-Aug-18	10.7
19-Oct-17	9.70	16-Mar-18	9.30	13-Aug-18	10.5
20-Oct-17	9.80	19-Mar-18	9.20	14-Aug-18	10.6
23-Oct-17	9.80	20-Mar-18	9.10	15-Aug-18	10.6
24-Oct-17	9.60	21-Mar-18	8.90	16-Aug-18	10.5
25-Oct-17	9.80	22-Mar-18	8.80	17-Aug-18	10.5
26-Oct-17	9.40	23-Mar-18	8.90	20-Aug-18	10.2
27-Oct-17	9.20	26-Mar-18	8.90	21-Aug-18	10.6
30-Oct-17	9.20	27-Mar-18	8.80	22-Aug-18	10.5
31-Oct-17	9.10	28-Mar-18	9.00	23-Aug-18	10.5
1-Nov-17	9.20	29-Mar-18	9.00	24-Aug-18	10.8
2-Nov-17	9.30	2-Apr-18	9.40	27-Aug-18	10.5
3-Nov-17	9.20	3-Apr-18	9.50	28-Aug-18	10.5
6-Nov-17	9.20	4-Apr-18	9.40	29-Aug-18	10.2
7-Nov-17	9.30	5-Apr-18	9.50	30-Aug-18	10.5
8-Nov-17	9.20	6-Apr-18	9.20	31-Aug-18	10.5
9-Nov-17	9.40	9-Apr-18	9.20	4-Sep-18	10.3
10-Nov-17	9.40	10-Apr-18	9.00	5-Sep-18	9.90
13-Nov-17	9.50	11-Apr-18	9.00	6-Sep-18	10.0
14-Nov-17	9.50	12-Apr-18	9.10	7-Sep-18	10.0
15-Nov-17	9.40	13-Apr-18	9.00	10-Sep-18	10.7
16-Nov-17	9.20	16-Apr-18	8.90	11-Sep-18	10.7
17-Nov-17	9.00	17-Apr-18	9.00	12-Sep-18	10.6
20-Nov-17	9.00	18-Apr-18	9.00	13-Sep-18	10.6
21-Nov-17	9.10	19-Apr-18	9.00	14-Sep-18	10.6
22-Nov-17	8.90	20-Apr-18	9.00	17-Sep-18	10.5
23-Nov-17	9.10	23-Apr-18	9.00	18-Sep-18	10.5
24-Nov-17	8.90	24-Apr-18	9.20	19-Sep-18	10.5
27-Nov-17	9.10	25-Apr-18	9.20	20-Sep-18	10.4
28-Nov-17	9.10	26-Apr-18	9.20	21-Sep-18	10.6
29-Nov-17	9.40	27-Apr-18	9.30	24-Sep-18	10.5
30-Nov-17	9.40	30-Apr-18	9.20	25-Sep-18	10.4
1-Dec-17	9.50	1-May-18	9.70	26-Sep-18	10.5
4-Dec-17	9.30	2-May-18	9.30	27-Sep-18	10.5
5-Dec-17	9.60	3-May-18	9.20	28-Sep-18	10.1
6-Dec-17	9.30	4-May-18	9.30	1-Oct-18	10.3
7-Dec-17	9.00	7-May-18	9.20	2-Oct-18	10.3
8-Dec-17	9.20	8-May-18	9.60	3-Oct-18	10.2
11-Dec-17	9.00	9-May-18	9.70	4-Oct-18	9.50
12-Dec-17	9.00	10-May-18	9.60	5-Oct-18	9.50
13-Dec-17	9.20	11-May-18	9.40	9-Oct-18	9.50
14-Dec-17	9.20	14-May-18	10.1	10-Oct-18	9.50
15-Dec-17	8.90	15-May-18	10.0	11-Oct-18	9.50

Note: "SD" = standard deviation. "n" = number of samples.

Table G.9: Water Quality at TOMP Station Q-04P (ETP Operations), Quirke TMA, 2015 to 2019

Date	pH
12-Oct-18	9.20
15-Oct-18	9.60
16-Oct-18	9.60
17-Oct-18	9.50
18-Oct-18	9.80
19-Oct-18	9.70
22-Oct-18	9.70
23-Oct-18	9.70
24-Oct-18	9.80
25-Oct-18	9.80
26-Oct-18	9.70
29-Oct-18	10.1
30-Oct-18	10.1
31-Oct-18	10.0
1-Nov-18	9.60
2-Nov-18	9.50
5-Nov-18	9.40
6-Nov-18	9.40
7-Nov-18	9.10
8-Nov-18	9.20
9-Nov-18	9.30
12-Nov-18	9.30
13-Nov-18	8.30
14-Nov-18	9.40
15-Nov-18	9.40
16-Nov-18	9.40
19-Nov-18	9.40
20-Nov-18	9.40
21-Nov-18	9.40
22-Nov-18	9.30
23-Nov-18	9.50
26-Nov-18	9.10
27-Nov-18	9.10
28-Nov-18	8.80
29-Nov-18	9.00
30-Nov-18	8.70
3-Dec-18	8.70
4-Dec-18	8.90
5-Dec-18	9.20
6-Dec-18	9.10
7-Dec-18	9.40
10-Dec-18	9.30
11-Dec-18	9.40
12-Dec-18	9.40
13-Dec-18	9.20
14-Dec-18	9.30
17-Dec-18	9.20
18-Dec-18	9.20
19-Dec-18	9.20
20-Dec-18	9.00
21-Dec-18	9.10
24-Dec-18	8.90
27-Dec-18	8.90
28-Dec-18	8.90
31-Dec-18	8.80
2-Jan-19	8.80
3-Jan-19	8.90
4-Jan-19	8.80
7-Jan-19	8.80
8-Jan-19	8.80
9-Jan-19	8.70
10-Jan-19	8.90
11-Jan-19	9.20
14-Jan-19	9.10
15-Jan-19	9.10
16-Jan-19	9.10
17-Jan-19	9.20
18-Jan-19	9.10
21-Jan-19	9.30
22-Jan-19	9.20
23-Jan-19	9.10
24-Jan-19	9.00
25-Jan-19	8.90
28-Jan-19	9.00
29-Jan-19	8.90
30-Jan-19	9.00
31-Jan-19	9.10
1-Feb-19	8.90
4-Feb-19	9.00
5-Feb-19	9.00
6-Feb-19	9.00
7-Feb-19	9.10
8-Feb-19	8.80
11-Feb-19	9.20
12-Feb-19	9.00
13-Feb-19	9.10
14-Feb-19	9.10
15-Feb-19	9.20
19-Feb-19	8.60
20-Feb-19	8.60
21-Feb-19	9.00
22-Feb-19	8.90
25-Feb-19	9.10
26-Feb-19	9.00
27-Feb-19	8.90
28-Feb-19	8.70
1-Mar-19	8.70
4-Mar-19	8.80
5-Mar-19	8.80
6-Mar-19	8.70
7-Mar-19	8.80
8-Mar-19	9.20
11-Mar-19	9.20
12-Mar-19	9.10
13-Mar-19	9.30

Date	pH
14-Mar-19	9.10
15-Mar-19	8.80
18-Mar-19	8.60
19-Mar-19	8.70
20-Mar-19	8.90
21-Mar-19	8.90
22-Mar-19	9.00
25-Mar-19	9.00
26-Mar-19	8.90
27-Mar-19	9.10
28-Mar-19	8.90
29-Mar-19	8.90
1-Apr-19	9.00
2-Apr-19	9.00
3-Apr-19	9.50
4-Apr-19	9.10
5-Apr-19	8.80
8-Apr-19	9.00
9-Apr-19	8.70
10-Apr-19	8.60
11-Apr-19	8.80
12-Apr-19	9.10
15-Apr-19	9.40
16-Apr-19	9.20
17-Apr-19	8.60
18-Apr-19	8.80
22-Apr-19	9.10
23-Apr-19	9.00
24-Apr-19	9.10
25-Apr-19	9.20
26-Apr-19	8.70
29-Apr-19	8.80
30-Apr-19	9.00
1-May-19	9.00
2-May-19	9.00
3-May-19	9.30
6-May-19	9.30
7-May-19	10.0
8-May-19	10.0
9-May-19	10.0
10-May-19	10.0
13-May-19	9.90
14-May-19	9.90
15-May-19	9.90
16-May-19	9.90
17-May-19	10.0
21-May-19	9.70
22-May-19	9.80
23-May-19	9.80
24-May-19	9.50
27-May-19	9.40
28-May-19	9.90
29-May-19	9.80
30-May-19	9.70
31-May-19	9.80
3-Jun-19	9.80
4-Jun-19	9.60
5-Jun-19	9.60
6-Jun-19	9.70
7-Jun-19	9.70
10-Jun-19	9.70
11-Jun-19	9.50
12-Jun-19	9.60
13-Jun-19	9.60
14-Jun-19	9.70
17-Jun-19	9.80
18-Jun-19	10.6
19-Jun-19	10.7
20-Jun-19	9.50
21-Jun-19	9.60
24-Jun-19	9.60
25-Jun-19	9.70
26-Jun-19	9.80
27-Jun-19	9.70
28-Jun-19	9.60
2-Jul-19	9.70
3-Jul-19	10.3
4-Jul-19	10.2
5-Jul-19	10.1
8-Jul-19	10.1
9-Jul-19	10.2
10-Jul-19	10.1
11-Jul-19	10.2
12-Jul-19	10.2
15-Jul-19	10.2
16-Jul-19	10.2
17-Jul-19	10.2
18-Jul-19	10.2
19-Jul-19	10.2
22-Jul-19	10.6
23-Jul-19	10.6
24-Jul-19	10.5
25-Jul-19	10.5
26-Jul-19	10.5
29-Jul-19	10.6
30-Jul-19	10.5
31-Jul-19	10.5
1-Aug-19	10.5
2-Aug-19	10.5
6-Aug-19	10.5
7-Aug-19	10.5
8-Aug-19	10.5
9-Aug-19	10.5
12-Aug-19	10.5
13-Aug-19	10.5

Date	pH
14-Aug-19	10.5
15-Aug-19	10.6
16-Aug-19	10.5
19-Aug-19	10.5
20-Aug-19	10.5
21-Aug-19	10.4
22-Aug-19	10.4
23-Aug-19	10.5
26-Aug-19	10.6
27-Aug-19	10.6
28-Aug-19	10.6
29-Aug-19	10.7
30-Aug-19	10.6
3-Sep-19	10.6
4-Sep-19	10.3
5-Sep-19	10.5
6-Sep-19	10.4
9-Sep-19	10.1
10-Sep-19	10.2
11-Sep-19	10.2
12-Sep-19	10.1
13-Sep-19	10.2
16-Sep-19	10.3
17-Sep-19	10.2
18-Sep-19	10.2
19-Sep-19	10.2
20-Sep-19	10.3
23-Sep-19	10.3
24-Sep-19	10.4
25-Sep-19	10.3
26-Sep-19	10.3
27-Sep-19	10.3
30-Sep-19	10.3
1-Oct-19	10.0
2-Oct-19	10.1
3-Oct-19	9.90
4-Oct-19	9.80
7-Oct-19	9.80
8-Oct-19	9.90
9-Oct-19	9.80
10-Oct-19	9.90
11-Oct-19	9.90
15-Oct-19	9.90
16-Oct-19	9.90
17-Oct-19	9.60
18-Oct-19	9.50
21-Oct-19	9.60
22-Oct-19	9.50
23-Oct-19	9.40
24-Oct-19	9.40
25-Oct-19	9.40
28-Oct-19	9.30
29-Oct-19	9.40
30-Oct-19	9.40
31-Oct-19	9.40
1-Nov-19	9.30
4-Nov-19	9.40
5-Nov-19	9.40
6-Nov-19	9.30
7-Nov-19	9.40
8-Nov-19	10.3
11-Nov-19	10.2
12-Nov-19	10.0
13-Nov-19	9.90
14-Nov-19	10.0
15-Nov-19	9.70
18-Nov-19	9.40
19-Nov-19	9.20
20-Nov-19	9.10
21-Nov-19	9.00
22-Nov-19	9.10
25-Nov-19	9.10
26-Nov-19	9.10
27-Nov-19	9.10
28-Nov-19	9.20
29-Nov-19	9.20
2-Dec-19	9.10
3-Dec-19	9.10
4-Dec-19	9.10
5-Dec-19	9.10
6-Dec-19	9.10
9-Dec-19	9.00
10-Dec-19	9.20
11-Dec-19	9.20
12-Dec-19	9.20
13-Dec-19	9.20
16-Dec-19	9.10
17-Dec-19	9.30
18-Dec-19	9.30
19-Dec-19	9.20
20-Dec-19	9.30
23-Dec-19	9.30
24-Dec-19	9.30
27-Dec-19	9.20
30-Dec-19	9.30
31-Dec-19	9.30
n	1227
Minimum	8.30
Maximum	11.9
Mean	9.73
SD	0.681
Median	9.60
10th Percentile	9.00
95th Percentile	10.9

Note: "SD" = standard deviation. "n" = number of samples.

Table G.10: Water Quality at TOMP Station Q-28 (Effluent), Quirke TMA, 2015 to 2019

Date	Flow (L/s)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	TSS (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
5-Jan-15	114	7.48	-	0.0730	2.00	-	-	-	-	-
12-Jan-15	115	7.40	980	0.0630	2.00	0.0920	0.00500	0.708	1.13	0.0145
19-Jan-15	95.0	7.40	-	0.0410	1.00	-	-	-	-	-
26-Jan-15	90.0	7.30	-	0.0370	<1.00	-	-	-	-	-
2-Feb-15	95.0	7.45	-	0.0430	1.00	-	-	-	-	-
9-Feb-15	90.0	7.41	1,000	0.0510	1.00	0.0630	0.00490	0.560	1.01	0.0155
17-Feb-15	95.0	7.48	-	0.0420	1.00	-	-	-	-	-
23-Feb-15	93.0	7.37	-	0.0430	1.00	-	-	-	-	-
2-Mar-15	88.0	7.16	-	0.0430	1.00	-	-	-	-	-
10-Mar-15	115	7.50	1,000	0.0630	1.00	0.0750	0.00470	0.520	0.891	0.0168
16-Mar-15	111	7.20	-	0.0740	1.00	-	-	-	-	-
23-Mar-15	99.0	7.30	-	0.0460	1.00	-	-	-	-	-
30-Mar-15	94.0	7.70	-	0.0610	1.00	-	-	-	-	-
6-Apr-15	95.0	7.50	-	0.0860	<1.00	-	-	-	-	-
13-Apr-15	95.0	7.20	800	0.0600	2.00	0.0670	0.00520	0.610	1.03	0.0152
20-Apr-15	70.0	7.00	-	0.0390	1.00	-	-	-	-	-
27-Apr-15	140	7.00	-	0.150	2.00	-	-	-	-	-
4-May-15	100	7.13	-	0.0510	<1.00	-	-	-	-	-
11-May-15	115	7.10	650	0.0510	1.00	0.0950	0.00280	0.360	0.602	0.0122
19-May-15	115	7.05	-	0.0570	2.00	-	-	-	-	-
25-May-15	110	7.40	-	0.0590	1.00	-	-	-	-	-
1-Jun-15	110	7.37	-	0.0780	1.00	-	-	-	-	-
8-Jun-15	110	7.00	640	0.0690	1.00	0.104	0.00270	0.700	0.581	0.0108
15-Jun-15	75.0	7.15	-	0.0620	1.00	-	-	-	-	-
22-Jun-15	78.0	7.01	-	0.0530	2.00	-	-	-	-	-
29-Jun-15	77.0	7.32	-	0.0380	1.00	-	-	-	-	-
6-Jul-15	50.0	7.00	-	0.0380	<1.00	-	-	-	-	-
13-Jul-15	30.0	6.94	840	0.0480	1.00	0.0420	0.00190	0.730	0.499	0.0115
20-Jul-15	54.0	7.20	-	0.0360	1.00	-	-	-	-	-
27-Jul-15	51.0	6.90	-	0.0320	1.00	-	-	-	-	-
4-Aug-15	54.0	7.00	-	0.0130	1.00	-	-	-	-	-
10-Aug-15	54.0	7.00	890	0.0360	1.00	0.0240	0.00140	0.600	0.380	0.0100
17-Aug-15	42.0	7.00	-	0.0410	2.00	-	-	-	-	-
24-Aug-15	41.0	7.00	-	0.0270	2.00	-	-	-	-	-
31-Aug-15	59.0	6.90	-	0.0360	3.00	-	-	-	-	-
8-Sep-15	64.0	6.96	-	0.0290	1.00	-	-	-	-	-
14-Sep-15	65.0	7.20	930	0.0370	2.00	0.0310	0.00140	0.680	0.357	0.0127
21-Sep-15	84.0	7.00	-	0.0430	1.00	-	-	-	-	-
28-Sep-15	111	7.06	-	0.0660	1.00	-	-	-	-	-
5-Oct-15	111	7.00	-	0.0700	1.00	-	-	-	-	-
13-Oct-15	82.0	7.41	980	0.0540	2.00	0.0740	0.00220	0.660	0.439	0.0144
19-Oct-15	86.0	7.00	-	0.0430	1.00	-	-	-	-	-
26-Oct-15	75.0	7.00	-	0.0350	2.00	-	-	-	-	-
2-Nov-15	107	7.20	-	0.0290	2.00	-	-	-	-	-
9-Nov-15	139	7.00	1,000	0.0430	1.00	0.0740	0.00240	0.496	0.491	0.0110
16-Nov-15	138	7.01	-	0.0440	1.00	-	-	-	-	-
23-Nov-15	138	7.04	-	0.0370	2.00	-	-	-	-	-
30-Nov-15	138	7.47	-	0.0590	1.00	-	-	-	-	-
7-Dec-15	138	7.92	-	0.0580	1.00	-	-	-	-	-
14-Dec-15	160	7.70	890	0.0590	1.00	0.0790	0.00270	0.526	0.689	0.00930
21-Dec-15	185	7.04	-	0.0640	1.00	-	-	-	-	-
28-Dec-15	180	7.00	-	0.0680	1.00	-	-	-	-	-
4-Jan-16	180	7.10	-	0.0840	1.00	-	-	-	-	-
12-Jan-16	180	7.82	870	0.0740	2.00	0.101	0.00420	0.750	0.927	0.00740
18-Jan-16	155	7.52	-	0.0770	1.00	-	-	-	-	-
25-Jan-16	155	8.08	-	0.0770	2.00	-	-	-	-	-
1-Feb-16	111	7.21	-	0.0680	2.00	-	-	-	-	-
8-Feb-16	109	7.26	910	0.0630	1.00	0.0750	0.00440	0.800	0.951	0.0107
16-Feb-16	109	7.20	-	0.0550	2.00	-	-	-	-	-
22-Feb-16	130	7.00	-	0.0880	1.00	-	-	-	-	-
29-Feb-16	158	7.02	-	0.0660	2.00	-	-	-	-	-
7-Mar-16	150	7.12	-	0.0870	3.00	-	-	-	-	-
14-Mar-16	155	7.45	920	0.102	2.00	0.100	0.00660	0.660	1.16	0.00900
21-Mar-16	150	7.18	-	0.0650	2.00	-	-	-	-	-
28-Mar-16	153	7.51	-	0.0940	1.00	-	-	-	-	-
4-Apr-16	155	7.52	-	0.0850	1.00	-	-	-	-	-
11-Apr-16	148	7.72	730	0.0760	3.00	0.147	0.00440	0.621	0.845	0.00980
18-Apr-16	143	7.41	-	0.0900	1.00	-	-	-	-	-
25-Apr-16	109	7.37	-	0.0740	<1.00	-	-	-	-	-
2-May-16	106	7.34	-	0.0510	1.00	-	-	-	-	-
9-May-16	104	7.34	570	0.0500	1.00	0.120	0.00320	0.332	0.727	0.00970
16-May-16	47.0	7.30	-	0.0260	<1.00	-	-	-	-	-
24-May-16	59.0	7.56	-	0.0350	1.00	-	-	-	-	-
31-May-16	67.0	7.35	-	0.0340	2.00	-	-	-	-	-
6-Jun-16	84.0	7.12	-	0.0380	2.00	-	-	-	-	-
13-Jun-16	84.0	7.38	730	0.0460	2.00	0.0680	0.00210	0.484	0.504	0.0112
20-Jun-16	79.0	7.45	-	0.0450	3.00	-	-	-	-	-
27-Jun-16	99.0	7.20	-	0.0450	2.00	-	-	-	-	-
5-Jul-16	40.0	7.30	-	0.0260	1.00	-	-	-	-	-
11-Jul-16	102	7.10	820	0.0540	2.00	0.0630	0.00190	0.439	0.538	0.0104
18-Jul-16	100	7.10	-	0.0650	2.00	-	-	-	-	-
6-Sep-16	107	7.06	-	0.0270	4.00	-	-	-	-	-
12-Sep-16	80.0	7.10	1,000	0.0750	2.00	0.0590	0.00140	0.558	0.369	0.0189
19-Sep-16	55.0	7.10	-	0.0520	2.00	-	-	-	-	-
26-Sep-16	66.0	7.18	-	0.0330	2.00	-	-	-	-	-
3-Oct-16	86.0	7.08	-	0.0350	2.00	-	-	-	-	-

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table G.10: Water Quality at TOMP Station Q-28 (Effluent), Quirke TMA, 2015 to 2019

Date	Flow (L/s)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	TSS (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
11-Oct-16	85.0	7.10	970	0.0620	1.00	0.0620	0.00160	0.692	0.345	0.0177
17-Oct-16	86.0	7.00	-	0.0860	3.00	-	-	-	-	-
24-Oct-16	100	7.20	-	0.0610	2.00	-	-	-	-	-
31-Oct-16	100	7.40	-	0.0730	2.00	-	-	-	-	-
7-Nov-16	99.0	7.50	-	0.114	2.00	-	-	-	-	-
14-Nov-16	98.0	7.40	1,000	0.121	2.00	0.0690	0.00190	0.345	0.411	0.0143
21-Nov-16	101	7.50	-	0.0970	1.00	-	-	-	-	-
28-Nov-16	73.0	8.20	-	0.0760	2.00	-	-	-	-	-
5-Dec-16	78.0	7.10	-	0.0860	2.00	-	-	-	-	-
12-Dec-16	111	7.00	1,100	0.169	2.00	0.0840	0.00390	0.623	1.01	0.0117
19-Dec-16	80.0	7.30	-	0.122	2.00	-	-	-	-	-
29-Dec-16	80.0	8.30	-	0.0610	2.00	-	-	-	-	-
2-Jan-17	80.0	8.10	-	0.0440	1.00	-	-	-	-	-
3-Jan-17	80.0	-	-	-	-	-	-	-	-	-
4-Jan-17	80.0	-	-	-	-	-	-	-	-	-
5-Jan-17	80.0	-	-	-	-	-	-	-	-	-
6-Jan-17	82.0	-	-	-	-	-	-	-	-	-
7-Jan-17	80.0	-	-	-	-	-	-	-	-	-
8-Jan-17	80.0	-	-	-	-	-	-	-	-	-
9-Jan-17	83.0	7.70	1,000	0.0670	2.00	0.0750	0.00410	0.731	1.03	0.0130
10-Jan-17	80.0	-	-	-	-	-	-	-	-	-
11-Jan-17	80.0	-	-	-	-	-	-	-	-	-
12-Jan-17	95.0	-	-	-	-	-	-	-	-	-
13-Jan-17	96.0	-	-	-	-	-	-	-	-	-
14-Jan-17	95.0	-	-	-	-	-	-	-	-	-
15-Jan-17	95.0	-	-	-	-	-	-	-	-	-
16-Jan-17	95.0	7.60	-	0.0980	2.00	-	-	-	-	-
17-Jan-17	110	-	-	-	-	-	-	-	-	-
18-Jan-17	110	-	-	-	-	-	-	-	-	-
19-Jan-17	110	-	-	-	-	-	-	-	-	-
20-Jan-17	110	-	-	-	-	-	-	-	-	-
21-Jan-17	110	-	-	-	-	-	-	-	-	-
22-Jan-17	110	-	-	-	-	-	-	-	-	-
23-Jan-17	110	7.80	-	0.100	3.00	-	-	-	-	-
24-Jan-17	110	-	-	-	-	-	-	-	-	-
25-Jan-17	110	-	-	-	-	-	-	-	-	-
26-Jan-17	110	-	-	-	-	-	-	-	-	-
27-Jan-17	110	-	-	-	-	-	-	-	-	-
28-Jan-17	110	-	-	-	-	-	-	-	-	-
29-Jan-17	110	-	-	-	-	-	-	-	-	-
30-Jan-17	110	7.70	-	0.111	3.00	-	-	-	-	-
31-Jan-17	111	-	-	-	-	-	-	-	-	-
1-Feb-17	110	-	-	-	-	-	-	-	-	-
2-Feb-17	112	-	-	-	-	-	-	-	-	-
3-Feb-17	109	-	-	-	-	-	-	-	-	-
4-Feb-17	110	-	-	-	-	-	-	-	-	-
5-Feb-17	110	-	-	-	-	-	-	-	-	-
6-Feb-17	110	8.00	-	0.104	1.00	-	-	-	-	-
7-Feb-17	110	-	-	-	-	-	-	-	-	-
8-Feb-17	108	-	-	-	-	-	-	-	-	-
9-Feb-17	110	-	-	-	-	-	-	-	-	-
10-Feb-17	110	-	-	-	-	-	-	-	-	-
11-Feb-17	110	-	-	-	-	-	-	-	-	-
12-Feb-17	110	-	-	-	-	-	-	-	-	-
13-Feb-17	110	7.70	1,000	0.100	3.00	0.0740	0.00450	0.770	1.21	0.0139
14-Feb-17	110	-	-	-	-	-	-	-	-	-
15-Feb-17	111	-	-	-	-	-	-	-	-	-
16-Feb-17	110	-	-	-	-	-	-	-	-	-
17-Feb-17	110	-	-	-	-	-	-	-	-	-
18-Feb-17	110	-	-	-	-	-	-	-	-	-
19-Feb-17	110	-	-	-	-	-	-	-	-	-
20-Feb-17	110	-	-	-	-	-	-	-	-	-
21-Feb-17	110	7.80	-	0.102	1.00	-	-	-	-	-
22-Feb-17	108	-	-	-	-	-	-	-	-	-
23-Feb-17	110	-	-	-	-	-	-	-	-	-
24-Feb-17	110	-	-	-	-	-	-	-	-	-
25-Feb-17	110	-	-	-	-	-	-	-	-	-
26-Feb-17	110	-	-	-	-	-	-	-	-	-
27-Feb-17	108	7.60	-	0.0920	4.00	-	-	-	-	-
28-Feb-17	110	-	-	-	-	-	-	-	-	-
1-Mar-17	138	-	-	-	-	-	-	-	-	-
2-Mar-17	132	-	-	-	-	-	-	-	-	-
3-Mar-17	133	-	-	-	-	-	-	-	-	-
4-Mar-17	130	-	-	-	-	-	-	-	-	-
5-Mar-17	130	-	-	-	-	-	-	-	-	-
6-Mar-17	131	7.40	-	0.0860	2.00	-	-	-	-	-
7-Mar-17	130	-	-	-	-	-	-	-	-	-
8-Mar-17	130	-	-	-	-	-	-	-	-	-
9-Mar-17	132	-	-	-	-	-	-	-	-	-
10-Mar-17	131	-	-	-	-	-	-	-	-	-
11-Mar-17	128	-	-	-	-	-	-	-	-	-
12-Mar-17	127	-	-	-	-	-	-	-	-	-
13-Mar-17	133	-	-	-	-	-	-	-	-	-
14-Mar-17	131	-	-	-	-	-	-	-	-	-
15-Mar-17	129	-	-	-	-	-	-	-	-	-
16-Mar-17	130	7.50	940	0.133	2.00	0.0800	0.00630	1.01	1.42	0.0130

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table G.10: Water Quality at TOMP Station Q-28 (Effluent), Quirke TMA, 2015 to 2019

Date	Flow (L/s)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	TSS (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
17-Mar-17	110	-	-	-	-	-	-	-	-	-
18-Mar-17	110	-	-	-	-	-	-	-	-	-
19-Mar-17	110	-	-	-	-	-	-	-	-	-
20-Mar-17	100	7.90	-	0.114	2.00	-	-	-	-	-
21-Mar-17	100	-	-	-	-	-	-	-	-	-
22-Mar-17	100	-	-	-	-	-	-	-	-	-
23-Mar-17	97.0	-	-	-	-	-	-	-	-	-
24-Mar-17	100	-	-	-	-	-	-	-	-	-
25-Mar-17	100	-	-	-	-	-	-	-	-	-
26-Mar-17	100	-	-	-	-	-	-	-	-	-
27-Mar-17	100	7.30	-	0.0990	2.00	-	-	-	-	-
28-Mar-17	100	-	-	-	-	-	-	-	-	-
29-Mar-17	100	-	-	-	-	-	-	-	-	-
30-Mar-17	100	-	-	-	-	-	-	-	-	-
31-Mar-17	125	-	-	-	-	-	-	-	-	-
1-Apr-17	125	-	-	-	-	-	-	-	-	-
2-Apr-17	125	-	-	-	-	-	-	-	-	-
3-Apr-17	127	7.30	-	0.117	2.00	-	-	-	-	-
4-Apr-17	125	-	-	-	-	-	-	-	-	-
5-Apr-17	140	-	-	-	-	-	-	-	-	-
6-Apr-17	160	-	-	-	-	-	-	-	-	-
7-Apr-17	160	-	-	-	-	-	-	-	-	-
8-Apr-17	160	-	-	-	-	-	-	-	-	-
9-Apr-17	160	-	-	-	-	-	-	-	-	-
10-Apr-17	160	7.50	650	0.146	2.00	0.0970	0.00310	0.442	0.826	0.00940
11-Apr-17	160	-	-	-	-	-	-	-	-	-
12-Apr-17	160	-	-	-	-	-	-	-	-	-
13-Apr-17	157	-	-	-	-	-	-	-	-	-
14-Apr-17	157	-	-	-	-	-	-	-	-	-
15-Apr-17	157	-	-	-	-	-	-	-	-	-
16-Apr-17	157	-	-	-	-	-	-	-	-	-
17-Apr-17	160	8.20	-	0.154	1.00	-	-	-	-	-
18-Apr-17	160	-	-	-	-	-	-	-	-	-
19-Apr-17	160	-	-	-	-	-	-	-	-	-
20-Apr-17	155	-	-	-	-	-	-	-	-	-
21-Apr-17	155	-	-	-	-	-	-	-	-	-
22-Apr-17	155	-	-	-	-	-	-	-	-	-
23-Apr-17	155	-	-	-	-	-	-	-	-	-
24-Apr-17	120	7.40	-	0.126	1.00	-	-	-	-	-
25-Apr-17	115	-	-	-	-	-	-	-	-	-
26-Apr-17	110	-	-	-	-	-	-	-	-	-
27-Apr-17	110	-	-	-	-	-	-	-	-	-
28-Apr-17	112	-	-	-	-	-	-	-	-	-
29-Apr-17	110	-	-	-	-	-	-	-	-	-
30-Apr-17	112	-	-	-	-	-	-	-	-	-
1-May-17	113	7.00	-	0.0920	1.00	-	-	-	-	-
2-May-17	112	-	-	-	-	-	-	-	-	-
3-May-17	112	-	-	-	-	-	-	-	-	-
4-May-17	113	-	-	-	-	-	-	-	-	-
5-May-17	115	-	-	-	-	-	-	-	-	-
6-May-17	80.0	-	-	-	-	-	-	-	-	-
7-May-17	80.0	-	-	-	-	-	-	-	-	-
8-May-17	80.0	7.10	620	0.0470	1.00	0.0880	0.00200	0.331	0.615	0.0111
9-May-17	100	-	-	-	-	-	-	-	-	-
10-May-17	97.0	-	-	-	-	-	-	-	-	-
11-May-17	100	-	-	-	-	-	-	-	-	-
12-May-17	100	-	-	-	-	-	-	-	-	-
13-May-17	100	-	-	-	-	-	-	-	-	-
14-May-17	100	-	-	-	-	-	-	-	-	-
15-May-17	100	7.20	-	0.0640	2.00	-	-	-	-	-
16-May-17	100	-	-	-	-	-	-	-	-	-
17-May-17	100	-	-	-	-	-	-	-	-	-
18-May-17	100	-	-	-	-	-	-	-	-	-
19-May-17	100	-	-	-	-	-	-	-	-	-
20-May-17	100	-	-	-	-	-	-	-	-	-
21-May-17	100	-	-	-	-	-	-	-	-	-
22-May-17	100	-	-	-	-	-	-	-	-	-
23-May-17	100	7.20	-	0.0800	1.00	-	-	-	-	-
24-May-17	100	-	-	-	-	-	-	-	-	-
25-May-17	60.0	-	-	-	-	-	-	-	-	-
26-May-17	95.0	-	-	-	-	-	-	-	-	-
27-May-17	95.0	-	-	-	-	-	-	-	-	-
28-May-17	95.0	-	-	-	-	-	-	-	-	-
29-May-17	95.0	7.30	-	0.0810	1.00	-	-	-	-	-
30-May-17	115	-	-	-	-	-	-	-	-	-
31-May-17	120	-	-	-	-	-	-	-	-	-
1-Jun-17	120	-	-	-	-	-	-	-	-	-
2-Jun-17	140	-	-	-	-	-	-	-	-	-
3-Jun-17	140	-	-	-	-	-	-	-	-	-
4-Jun-17	140	-	-	-	-	-	-	-	-	-
5-Jun-17	140	7.40	-	0.114	1.00	-	-	-	-	-
6-Jun-17	50.0	-	-	-	-	-	-	-	-	-
7-Jun-17	49.0	-	-	-	-	-	-	-	-	-
8-Jun-17	50.0	-	-	-	-	-	-	-	-	-
9-Jun-17	120	-	-	-	-	-	-	-	-	-
10-Jun-17	120	-	-	-	-	-	-	-	-	-

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table G.10: Water Quality at TOMP Station Q-28 (Effluent), Quirke TMA, 2015 to 2019

Date	Flow (L/s)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	TSS (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
11-Jun-17	120	-	-	-	-	-	-	-	-	-
12-Jun-17	50.0	-	-	-	-	-	-	-	-	-
13-Jun-17	120	7.10	740	0.0680	1.00	0.0820	0.00160	0.382	0.388	0.0111
14-Jun-17	122	-	-	-	-	-	-	-	-	-
15-Jun-17	120	-	-	-	-	-	-	-	-	-
16-Jun-17	120	-	-	-	-	-	-	-	-	-
17-Jun-17	120	-	-	-	-	-	-	-	-	-
18-Jun-17	120	-	-	-	-	-	-	-	-	-
19-Jun-17	120	7.00	-	0.0920	1.00	-	-	-	-	-
20-Jun-17	120	-	-	-	-	-	-	-	-	-
21-Jun-17	120	-	-	-	-	-	-	-	-	-
22-Jun-17	120	-	-	-	-	-	-	-	-	-
23-Jun-17	123	-	-	-	-	-	-	-	-	-
24-Jun-17	120	-	-	-	-	-	-	-	-	-
25-Jun-17	120	-	-	-	-	-	-	-	-	-
26-Jun-17	124	7.30	-	0.154	1.00	-	-	-	-	-
27-Jun-17	123	-	-	-	-	-	-	-	-	-
28-Jun-17	120	-	-	-	-	-	-	-	-	-
29-Jun-17	120	-	-	-	-	-	-	-	-	-
30-Jun-17	120	-	-	-	-	-	-	-	-	-
1-Jul-17	120	-	-	-	-	-	-	-	-	-
2-Jul-17	120	-	-	-	-	-	-	-	-	-
3-Jul-17	120	-	-	-	-	-	-	-	-	-
4-Jul-17	120	7.20	-	0.135	1.00	-	-	-	-	-
5-Jul-17	117	-	-	-	-	-	-	-	-	-
6-Jul-17	118	-	-	-	-	-	-	-	-	-
7-Jul-17	118	-	-	-	-	-	-	-	-	-
8-Jul-17	120	-	-	-	-	-	-	-	-	-
9-Jul-17	120	-	-	-	-	-	-	-	-	-
10-Jul-17	120	7.10	840	0.131	1.00	0.0890	0.00130	0.286	0.435	0.0119
11-Jul-17	120	-	-	-	-	-	-	-	-	-
12-Jul-17	100	-	-	-	-	-	-	-	-	-
13-Jul-17	100	-	-	-	-	-	-	-	-	-
14-Jul-17	100	-	-	-	-	-	-	-	-	-
15-Jul-17	100	-	-	-	-	-	-	-	-	-
16-Jul-17	100	-	-	-	-	-	-	-	-	-
17-Jul-17	100	7.10	-	0.0970	2.00	-	-	-	-	-
18-Jul-17	100	-	-	-	-	-	-	-	-	-
19-Jul-17	70.0	-	-	-	-	-	-	-	-	-
20-Jul-17	70.0	-	-	-	-	-	-	-	-	-
21-Jul-17	70.0	-	-	-	-	-	-	-	-	-
22-Jul-17	70.0	-	-	-	-	-	-	-	-	-
23-Jul-17	70.0	-	-	-	-	-	-	-	-	-
24-Jul-17	70.0	7.00	-	0.0770	2.00	-	-	-	-	-
25-Jul-17	90.0	-	-	-	-	-	-	-	-	-
26-Jul-17	91.0	-	-	-	-	-	-	-	-	-
27-Jul-17	92.0	-	-	-	-	-	-	-	-	-
28-Jul-17	90.0	-	-	-	-	-	-	-	-	-
29-Jul-17	90.0	-	-	-	-	-	-	-	-	-
30-Jul-17	90.0	-	-	-	-	-	-	-	-	-
31-Jul-17	95.0	7.10	-	0.0960	2.00	-	-	-	-	-
1-Aug-17	90.0	-	-	-	-	-	-	-	-	-
2-Aug-17	93.0	-	-	-	-	-	-	-	-	-
3-Aug-17	90.0	-	-	-	-	-	-	-	-	-
4-Aug-17	90.0	-	-	-	-	-	-	-	-	-
5-Aug-17	110	-	-	-	-	-	-	-	-	-
6-Aug-17	110	-	-	-	-	-	-	-	-	-
7-Aug-17	110	-	-	-	-	-	-	-	-	-
8-Aug-17	110	7.30	-	0.0870	2.00	-	-	-	-	-
9-Aug-17	110	-	-	-	-	-	-	-	-	-
10-Aug-17	110	-	-	-	-	-	-	-	-	-
11-Aug-17	110	-	-	-	-	-	-	-	-	-
12-Aug-17	120	-	-	-	-	-	-	-	-	-
13-Aug-17	120	-	-	-	-	-	-	-	-	-
14-Aug-17	120	7.10	830	0.124	1.00	0.0780	0.00140	0.444	0.418	0.0128
15-Aug-17	120	-	-	-	-	-	-	-	-	-
16-Aug-17	120	-	-	-	-	-	-	-	-	-
17-Aug-17	120	-	-	-	-	-	-	-	-	-
18-Aug-17	120	-	-	-	-	-	-	-	-	-
19-Aug-17	120	-	-	-	-	-	-	-	-	-
20-Aug-17	120	-	-	-	-	-	-	-	-	-
21-Aug-17	120	7.60	-	0.126	1.00	-	-	-	-	-
22-Aug-17	140	-	-	-	-	-	-	-	-	-
23-Aug-17	150	-	-	-	-	-	-	-	-	-
24-Aug-17	150	-	-	-	-	-	-	-	-	-
25-Aug-17	120	-	-	-	-	-	-	-	-	-
26-Aug-17	120	-	-	-	-	-	-	-	-	-
27-Aug-17	120	-	-	-	-	-	-	-	-	-
28-Aug-17	120	7.60	-	0.158	<1.00	-	-	-	-	-
29-Aug-17	120	-	-	-	-	-	-	-	-	-
30-Aug-17	120	-	-	-	-	-	-	-	-	-
31-Aug-17	120	-	-	-	-	-	-	-	-	-
1-Sep-17	120	-	-	-	-	-	-	-	-	-
2-Sep-17	120	-	-	-	-	-	-	-	-	-
3-Sep-17	120	-	-	-	-	-	-	-	-	-
4-Sep-17	120	-	-	-	-	-	-	-	-	-

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table G.10: **Water Quality at TOMP Station Q-28 (Effluent), Quirke TMA, 2015 to 2019**

Date	Flow (L/s)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	TSS (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
5-Sep-17	120	7.40	-	0.137	1.00	-	-	-	-	-
6-Sep-17	95.0	-	-	-	-	-	-	-	-	-
7-Sep-17	95.0	-	-	-	-	-	-	-	-	-
8-Sep-17	95.0	-	-	-	-	-	-	-	-	-
9-Sep-17	95.0	-	-	-	-	-	-	-	-	-
10-Sep-17	95.0	-	-	-	-	-	-	-	-	-
11-Sep-17	95.0	7.20	850	0.110	2.00	0.0830	0.00140	0.351	0.353	0.0130
12-Sep-17	95.0	-	-	-	-	-	-	-	-	-
13-Sep-17	95.0	-	-	-	-	-	-	-	-	-
14-Sep-17	95.0	-	-	-	-	-	-	-	-	-
15-Sep-17	95.0	-	-	-	-	-	-	-	-	-
16-Sep-17	95.0	-	-	-	-	-	-	-	-	-
17-Sep-17	95.0	-	-	-	-	-	-	-	-	-
18-Sep-17	95.0	7.10	-	0.114	3.00	-	-	-	-	-
19-Sep-17	95.0	-	-	-	-	-	-	-	-	-
20-Sep-17	95.0	-	-	-	-	-	-	-	-	-
21-Sep-17	95.0	-	-	-	-	-	-	-	-	-
22-Sep-17	95.0	-	-	-	-	-	-	-	-	-
23-Sep-17	95.0	-	-	-	-	-	-	-	-	-
24-Sep-17	95.0	-	-	-	-	-	-	-	-	-
25-Sep-17	97.0	7.70	-	0.0980	1.00	-	-	-	-	-
26-Sep-17	98.0	-	-	-	-	-	-	-	-	-
27-Sep-17	100	-	-	-	-	-	-	-	-	-
28-Sep-17	98.0	-	-	-	-	-	-	-	-	-
29-Sep-17	100	-	-	-	-	-	-	-	-	-
30-Sep-17	100	-	-	-	-	-	-	-	-	-
1-Oct-17	100	-	-	-	-	-	-	-	-	-
2-Oct-17	100	7.20	-	0.0920	2.00	-	-	-	-	-
3-Oct-17	100	-	-	-	-	-	-	-	-	-
4-Oct-17	78.0	-	-	-	-	-	-	-	-	-
5-Oct-17	80.0	-	-	-	-	-	-	-	-	-
6-Oct-17	80.0	-	-	-	-	-	-	-	-	-
7-Oct-17	80.0	-	-	-	-	-	-	-	-	-
8-Oct-17	80.0	-	-	-	-	-	-	-	-	-
9-Oct-17	80.0	-	-	-	-	-	-	-	-	-
10-Oct-17	80.0	7.20	880	0.197	3.00	0.0610	0.00160	0.441	0.392	0.0116
11-Oct-17	107	-	-	-	-	-	-	-	-	-
12-Oct-17	103	-	-	-	-	-	-	-	-	-
13-Oct-17	105	-	-	-	-	-	-	-	-	-
14-Oct-17	107	-	-	-	-	-	-	-	-	-
15-Oct-17	107	-	-	-	-	-	-	-	-	-
16-Oct-17	107	7.10	-	0.0780	2.00	-	-	-	-	-
17-Oct-17	140	-	-	-	-	-	-	-	-	-
18-Oct-17	160	-	-	-	-	-	-	-	-	-
19-Oct-17	160	-	-	-	-	-	-	-	-	-
20-Oct-17	165	-	-	-	-	-	-	-	-	-
21-Oct-17	165	-	-	-	-	-	-	-	-	-
22-Oct-17	165	-	-	-	-	-	-	-	-	-
23-Oct-17	160	8.40	-	0.135	2.00	-	-	-	-	-
24-Oct-17	162	-	-	-	-	-	-	-	-	-
25-Oct-17	170	-	-	-	-	-	-	-	-	-
26-Oct-17	190	-	-	-	-	-	-	-	-	-
27-Oct-17	188	-	-	-	-	-	-	-	-	-
28-Oct-17	188	-	-	-	-	-	-	-	-	-
29-Oct-17	188	-	-	-	-	-	-	-	-	-
30-Oct-17	188	7.50	-	0.197	1.00	-	-	-	-	-
31-Oct-17	189	-	-	-	-	-	-	-	-	-
1-Nov-17	186	-	-	-	-	-	-	-	-	-
2-Nov-17	190	-	-	-	-	-	-	-	-	-
3-Nov-17	150	-	-	-	-	-	-	-	-	-
4-Nov-17	150	-	-	-	-	-	-	-	-	-
5-Nov-17	150	-	-	-	-	-	-	-	-	-
6-Nov-17	150	7.20	-	0.167	1.00	-	-	-	-	-
7-Nov-17	148	-	-	-	-	-	-	-	-	-
8-Nov-17	150	-	-	-	-	-	-	-	-	-
9-Nov-17	150	-	-	-	-	-	-	-	-	-
10-Nov-17	148	-	-	-	-	-	-	-	-	-
11-Nov-17	148	-	-	-	-	-	-	-	-	-
12-Nov-17	148	-	-	-	-	-	-	-	-	-
13-Nov-17	146	7.70	880	0.120	1.00	0.112	0.00260	0.276	0.793	0.00720
14-Nov-17	150	-	-	-	-	-	-	-	-	-
15-Nov-17	150	-	-	-	-	-	-	-	-	-
16-Nov-17	135	-	-	-	-	-	-	-	-	-
17-Nov-17	135	-	-	-	-	-	-	-	-	-
18-Nov-17	135	-	-	-	-	-	-	-	-	-
19-Nov-17	135	-	-	-	-	-	-	-	-	-
20-Nov-17	135	7.50	-	0.108	2.00	-	-	-	-	-
21-Nov-17	135	-	-	-	-	-	-	-	-	-
22-Nov-17	135	-	-	-	-	-	-	-	-	-
23-Nov-17	133	-	-	-	-	-	-	-	-	-
24-Nov-17	135	-	-	-	-	-	-	-	-	-
25-Nov-17	135	-	-	-	-	-	-	-	-	-
26-Nov-17	135	-	-	-	-	-	-	-	-	-
27-Nov-17	135	7.10	-	0.100	2.00	-	-	-	-	-
28-Nov-17	135	-	-	-	-	-	-	-	-	-
29-Nov-17	135	-	-	-	-	-	-	-	-	-

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table G.10: Water Quality at TOMP Station Q-28 (Effluent), Quirke TMA, 2015 to 2019

Date	Flow (L/s)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	TSS (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
30-Nov-17	134	-	-	-	-	-	-	-	-	-
1-Dec-17	135	-	-	-	-	-	-	-	-	-
2-Dec-17	135	-	-	-	-	-	-	-	-	-
3-Dec-17	135	-	-	-	-	-	-	-	-	-
4-Dec-17	135	7.40	-	0.0990	2.00	-	-	-	-	-
5-Dec-17	135	-	-	-	-	-	-	-	-	-
6-Dec-17	135	-	-	-	-	-	-	-	-	-
7-Dec-17	185	-	-	-	-	-	-	-	-	-
8-Dec-17	185	-	-	-	-	-	-	-	-	-
9-Dec-17	185	-	-	-	-	-	-	-	-	-
10-Dec-17	185	-	-	-	-	-	-	-	-	-
11-Dec-17	180	7.40	850	0.132	2.00	0.116	0.00300	0.565	0.769	0.00880
12-Dec-17	185	-	-	-	-	-	-	-	-	-
13-Dec-17	185	-	-	-	-	-	-	-	-	-
14-Dec-17	185	-	-	-	-	-	-	-	-	-
15-Dec-17	185	-	-	-	-	-	-	-	-	-
16-Dec-17	185	-	-	-	-	-	-	-	-	-
17-Dec-17	185	-	-	-	-	-	-	-	-	-
18-Dec-17	180	7.50	-	0.132	3.00	-	-	-	-	-
19-Dec-17	120	-	-	-	-	-	-	-	-	-
20-Dec-17	140	-	-	-	-	-	-	-	-	-
21-Dec-17	145	-	-	-	-	-	-	-	-	-
22-Dec-17	146	-	-	-	-	-	-	-	-	-
23-Dec-17	150	-	-	-	-	-	-	-	-	-
24-Dec-17	150	-	-	-	-	-	-	-	-	-
25-Dec-17	150	-	-	-	-	-	-	-	-	-
26-Dec-17	145	8.30	-	0.146	4.00	-	-	-	-	-
27-Dec-17	145	-	-	-	-	-	-	-	-	-
28-Dec-17	145	-	-	-	-	-	-	-	-	-
29-Dec-17	150	-	-	-	-	-	-	-	-	-
30-Dec-17	145	-	-	-	-	-	-	-	-	-
31-Dec-17	145	-	-	-	-	-	-	-	-	-
1-Jan-18	140	-	-	-	-	-	-	-	-	-
2-Jan-18	140	7.40	-	0.138	3.00	-	-	-	-	-
3-Jan-18	140	-	-	-	-	-	-	-	-	-
4-Jan-18	140	-	-	-	-	-	-	-	-	-
5-Jan-18	110	-	-	-	-	-	-	-	-	-
6-Jan-18	110	-	-	-	-	-	-	-	-	-
7-Jan-18	110	-	-	-	-	-	-	-	-	-
8-Jan-18	110	7.50	880	0.110	4.00	0.0990	0.00370	0.885	0.823	0.0121
9-Jan-18	110	-	-	-	-	-	-	-	-	-
10-Jan-18	105	-	-	-	-	-	-	-	-	-
11-Jan-18	110	-	-	-	-	-	-	-	-	-
12-Jan-18	130	-	-	-	-	-	-	-	-	-
13-Jan-18	130	-	-	-	-	-	-	-	-	-
14-Jan-18	130	-	-	-	-	-	-	-	-	-
15-Jan-18	130	7.50	-	0.145	3.00	-	-	-	-	-
16-Jan-18	130	-	-	-	-	-	-	-	-	-
17-Jan-18	130	-	-	-	-	-	-	-	-	-
18-Jan-18	130	-	-	-	-	-	-	-	-	-
19-Jan-18	130	-	-	-	-	-	-	-	-	-
20-Jan-18	130	-	-	-	-	-	-	-	-	-
21-Jan-18	130	-	-	-	-	-	-	-	-	-
22-Jan-18	130	8.10	-	0.146	3.00	-	-	-	-	-
23-Jan-18	130	-	-	-	-	-	-	-	-	-
24-Jan-18	130	-	-	-	-	-	-	-	-	-
25-Jan-18	130	-	-	-	-	-	-	-	-	-
26-Jan-18	130	-	-	-	-	-	-	-	-	-
27-Jan-18	130	-	-	-	-	-	-	-	-	-
28-Jan-18	130	-	-	-	-	-	-	-	-	-
29-Jan-18	130	7.70	-	0.147	3.00	-	-	-	-	-
30-Jan-18	103	-	-	-	-	-	-	-	-	-
31-Jan-18	100	-	-	-	-	-	-	-	-	-
1-Feb-18	100	-	-	-	-	-	-	-	-	-
2-Feb-18	100	-	-	-	-	-	-	-	-	-
3-Feb-18	100	-	-	-	-	-	-	-	-	-
4-Feb-18	100	-	-	-	-	-	-	-	-	-
5-Feb-18	100	7.70	-	0.0990	2.00	-	-	-	-	-
6-Feb-18	100	-	-	-	-	-	-	-	-	-
7-Feb-18	100	-	-	-	-	-	-	-	-	-
8-Feb-18	100	-	-	-	-	-	-	-	-	-
9-Feb-18	100	-	-	-	-	-	-	-	-	-
10-Feb-18	100	-	-	-	-	-	-	-	-	-
11-Feb-18	100	-	-	-	-	-	-	-	-	-
12-Feb-18	100	7.50	960	0.0990	2.00	0.0880	0.00330	0.458	0.960	0.0130
13-Feb-18	100	-	-	-	-	-	-	-	-	-
14-Feb-18	100	-	-	-	-	-	-	-	-	-
15-Feb-18	100	-	-	-	-	-	-	-	-	-
16-Feb-18	100	-	-	-	-	-	-	-	-	-
17-Feb-18	100	-	-	-	-	-	-	-	-	-
18-Feb-18	100	-	-	-	-	-	-	-	-	-
19-Feb-18	100	-	-	-	-	-	-	-	-	-
20-Feb-18	100	7.50	-	0.0790	2.00	-	-	-	-	-
21-Feb-18	100	-	-	-	-	-	-	-	-	-
22-Feb-18	100	-	-	-	-	-	-	-	-	-
23-Feb-18	50.0	-	-	-	-	-	-	-	-	-

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table G.10: Water Quality at TOMP Station Q-28 (Effluent), Quirke TMA, 2015 to 2019

Date	Flow (L/s)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	TSS (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
24-Feb-18	100	-	-	-	-	-	-	-	-	-
25-Feb-18	100	-	-	-	-	-	-	-	-	-
26-Feb-18	100	7.00	-	0.0990	2.00	-	-	-	-	-
27-Feb-18	100	-	-	-	-	-	-	-	-	-
28-Feb-18	100	-	-	-	-	-	-	-	-	-
1-Mar-18	100	-	-	-	-	-	-	-	-	-
2-Mar-18	100	-	-	-	-	-	-	-	-	-
3-Mar-18	100	-	-	-	-	-	-	-	-	-
4-Mar-18	100	-	-	-	-	-	-	-	-	-
5-Mar-18	100	7.80	-	0.117	2.00	-	-	-	-	-
6-Mar-18	100	-	-	-	-	-	-	-	-	-
7-Mar-18	100	-	-	-	-	-	-	-	-	-
8-Mar-18	100	-	-	-	-	-	-	-	-	-
9-Mar-18	80.0	-	-	-	-	-	-	-	-	-
10-Mar-18	80.0	-	-	-	-	-	-	-	-	-
11-Mar-18	80.0	-	-	-	-	-	-	-	-	-
12-Mar-18	80.0	7.70	970	0.0850	2.00	0.109	0.00440	0.655	1.15	0.0163
13-Mar-18	80.0	-	-	-	-	-	-	-	-	-
14-Mar-18	90.0	-	-	-	-	-	-	-	-	-
15-Mar-18	90.0	-	-	-	-	-	-	-	-	-
16-Mar-18	90.0	-	-	-	-	-	-	-	-	-
17-Mar-18	90.0	-	-	-	-	-	-	-	-	-
18-Mar-18	90.0	-	-	-	-	-	-	-	-	-
19-Mar-18	90.0	7.90	-	0.0850	2.00	-	-	-	-	-
20-Mar-18	90.0	-	-	-	-	-	-	-	-	-
21-Mar-18	90.0	-	-	-	-	-	-	-	-	-
22-Mar-18	90.0	-	-	-	-	-	-	-	-	-
23-Mar-18	90.0	-	-	-	-	-	-	-	-	-
24-Mar-18	90.0	-	-	-	-	-	-	-	-	-
25-Mar-18	90.0	-	-	-	-	-	-	-	-	-
26-Mar-18	88.0	7.70	-	0.0850	2.00	-	-	-	-	-
27-Mar-18	90.0	-	-	-	-	-	-	-	-	-
28-Mar-18	90.0	-	-	-	-	-	-	-	-	-
29-Mar-18	90.0	-	-	-	-	-	-	-	-	-
30-Mar-18	90.0	-	-	-	-	-	-	-	-	-
31-Mar-18	90.0	-	-	-	-	-	-	-	-	-
1-Apr-18	90.0	-	-	-	-	-	-	-	-	-
2-Apr-18	90.0	7.50	-	0.115	3.00	-	-	-	-	-
3-Apr-18	90.0	-	-	-	-	-	-	-	-	-
4-Apr-18	90.0	-	-	-	-	-	-	-	-	-
5-Apr-18	90.0	-	-	-	-	-	-	-	-	-
6-Apr-18	90.0	-	-	-	-	-	-	-	-	-
7-Apr-18	90.0	-	-	-	-	-	-	-	-	-
8-Apr-18	90.0	-	-	-	-	-	-	-	-	-
9-Apr-18	90.0	7.50	900	0.0980	1.00	0.0850	0.00330	0.449	0.808	0.0159
10-Apr-18	90.0	-	-	-	-	-	-	-	-	-
11-Apr-18	110	-	-	-	-	-	-	-	-	-
12-Apr-18	110	-	-	-	-	-	-	-	-	-
13-Apr-18	110	-	-	-	-	-	-	-	-	-
14-Apr-18	110	-	-	-	-	-	-	-	-	-
15-Apr-18	110	-	-	-	-	-	-	-	-	-
16-Apr-18	110	7.90	-	0.151	2.00	-	-	-	-	-
17-Apr-18	110	-	-	-	-	-	-	-	-	-
18-Apr-18	110	-	-	-	-	-	-	-	-	-
19-Apr-18	110	-	-	-	-	-	-	-	-	-
20-Apr-18	110	-	-	-	-	-	-	-	-	-
21-Apr-18	110	-	-	-	-	-	-	-	-	-
22-Apr-18	110	-	-	-	-	-	-	-	-	-
23-Apr-18	110	7.10	-	0.135	3.00	-	-	-	-	-
24-Apr-18	110	-	-	-	-	-	-	-	-	-
25-Apr-18	130	-	-	-	-	-	-	-	-	-
26-Apr-18	130	-	-	-	-	-	-	-	-	-
27-Apr-18	130	-	-	-	-	-	-	-	-	-
28-Apr-18	130	-	-	-	-	-	-	-	-	-
29-Apr-18	130	-	-	-	-	-	-	-	-	-
30-Apr-18	130	7.00	-	0.0930	2.00	-	-	-	-	-
1-May-18	130	-	-	-	-	-	-	-	-	-
2-May-18	130	-	-	-	-	-	-	-	-	-
3-May-18	165	-	-	-	-	-	-	-	-	-
4-May-18	165	-	-	-	-	-	-	-	-	-
5-May-18	190	-	-	-	-	-	-	-	-	-
6-May-18	190	-	-	-	-	-	-	-	-	-
7-May-18	190	7.40	-	0.157	1.00	-	-	-	-	-
8-May-18	190	-	-	-	-	-	-	-	-	-
9-May-18	140	-	-	-	-	-	-	-	-	-
10-May-18	140	-	-	-	-	-	-	-	-	-
11-May-18	140	-	-	-	-	-	-	-	-	-
12-May-18	140	-	-	-	-	-	-	-	-	-
13-May-18	140	-	-	-	-	-	-	-	-	-
14-May-18	140	-	-	-	-	-	-	-	-	-
15-May-18	90.0	7.20	550	0.133	1.00	0.105	0.00180	0.194	0.523	0.0125
16-May-18	90.0	-	-	-	-	-	-	-	-	-
17-May-18	90.0	-	-	-	-	-	-	-	-	-
18-May-18	90.0	-	-	-	-	-	-	-	-	-
19-May-18	90.0	-	-	-	-	-	-	-	-	-
20-May-18	90.0	-	-	-	-	-	-	-	-	-

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table G.10: Water Quality at TOMP Station Q-28 (Effluent), Quirke TMA, 2015 to 2019

Date	Flow (L/s)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	TSS (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
21-May-18	90.0	-	-	-	-	-	-	-	-	-
22-May-18	90.0	7.30	-	0.0780	1.00	-	-	-	-	-
23-May-18	90.0	-	-	-	-	-	-	-	-	-
24-May-18	90.0	-	-	-	-	-	-	-	-	-
25-May-18	90.0	-	-	-	-	-	-	-	-	-
26-May-18	90.0	-	-	-	-	-	-	-	-	-
27-May-18	90.0	-	-	-	-	-	-	-	-	-
28-May-18	90.0	7.20	-	0.0660	2.00	-	-	-	-	-
29-May-18	90.0	-	-	-	-	-	-	-	-	-
30-May-18	90.0	-	-	-	-	-	-	-	-	-
31-May-18	90.0	-	-	-	-	-	-	-	-	-
1-Jun-18	93.0	-	-	-	-	-	-	-	-	-
2-Jun-18	90.0	-	-	-	-	-	-	-	-	-
3-Jun-18	90.0	-	-	-	-	-	-	-	-	-
4-Jun-18	90.0	7.30	560	0.0660	2.00	0.0930	0.000900	0.229	0.317	0.0136
5-Jun-18	95.0	-	-	-	-	-	-	-	-	-
6-Jun-18	90.0	-	-	-	-	-	-	-	-	-
7-Jun-18	65.0	-	-	-	-	-	-	-	-	-
8-Jun-18	65.0	-	-	-	-	-	-	-	-	-
9-Jun-18	65.0	-	-	-	-	-	-	-	-	-
10-Jun-18	65.0	-	-	-	-	-	-	-	-	-
11-Jun-18	65.0	7.20	-	0.0630	1.00	-	-	-	-	-
12-Jun-18	65.0	-	-	-	-	-	-	-	-	-
13-Jun-18	65.0	-	-	-	-	-	-	-	-	-
14-Jun-18	65.0	-	-	-	-	-	-	-	-	-
15-Jun-18	65.0	-	-	-	-	-	-	-	-	-
16-Jun-18	90.0	-	-	-	-	-	-	-	-	-
17-Jun-18	90.0	-	-	-	-	-	-	-	-	-
18-Jun-18	90.0	7.20	-	0.0560	4.00	-	-	-	-	-
19-Jun-18	90.0	-	-	-	-	-	-	-	-	-
20-Jun-18	90.0	-	-	-	-	-	-	-	-	-
21-Jun-18	90.0	-	-	-	-	-	-	-	-	-
22-Jun-18	90.0	-	-	-	-	-	-	-	-	-
23-Jun-18	90.0	-	-	-	-	-	-	-	-	-
24-Jun-18	90.0	-	-	-	-	-	-	-	-	-
25-Jun-18	90.0	7.50	-	0.0530	1.00	-	-	-	-	-
26-Jun-18	90.0	-	-	-	-	-	-	-	-	-
27-Jun-18	90.0	-	-	-	-	-	-	-	-	-
28-Jun-18	90.0	-	-	-	-	-	-	-	-	-
29-Jun-18	90.0	-	-	-	-	-	-	-	-	-
30-Jun-18	60.0	-	-	-	-	-	-	-	-	-
1-Jul-18	60.0	-	-	-	-	-	-	-	-	-
2-Jul-18	60.0	-	-	-	-	-	-	-	-	-
3-Jul-18	60.0	7.30	-	0.0560	2.00	-	-	-	-	-
4-Jul-18	60.0	-	-	-	-	-	-	-	-	-
5-Jul-18	60.0	-	-	-	-	-	-	-	-	-
6-Jul-18	60.0	-	-	-	-	-	-	-	-	-
7-Jul-18	60.0	-	-	-	-	-	-	-	-	-
8-Jul-18	60.0	-	-	-	-	-	-	-	-	-
9-Jul-18	60.0	7.10	730	0.0440	2.00	0.0370	0.000600	0.187	0.279	0.0141
10-Jul-18	50.0	-	-	-	-	-	-	-	-	-
11-Jul-18	50.0	-	-	-	-	-	-	-	-	-
12-Jul-18	50.0	-	-	-	-	-	-	-	-	-
13-Jul-18	50.0	-	-	-	-	-	-	-	-	-
14-Jul-18	50.0	-	-	-	-	-	-	-	-	-
15-Jul-18	50.0	-	-	-	-	-	-	-	-	-
16-Jul-18	50.0	7.30	-	0.0250	2.00	-	-	-	-	-
17-Jul-18	50.0	-	-	-	-	-	-	-	-	-
18-Jul-18	50.0	-	-	-	-	-	-	-	-	-
19-Jul-18	50.0	-	-	-	-	-	-	-	-	-
20-Jul-18	50.0	-	-	-	-	-	-	-	-	-
21-Jul-18	50.0	-	-	-	-	-	-	-	-	-
22-Jul-18	50.0	-	-	-	-	-	-	-	-	-
23-Jul-18	50.0	7.20	-	0.0190	2.00	-	-	-	-	-
24-Jul-18	50.0	-	-	-	-	-	-	-	-	-
25-Jul-18	50.0	-	-	-	-	-	-	-	-	-
26-Jul-18	50.0	-	-	-	-	-	-	-	-	-
27-Jul-18	70.0	-	-	-	-	-	-	-	-	-
28-Jul-18	70.0	-	-	-	-	-	-	-	-	-
29-Jul-18	70.0	-	-	-	-	-	-	-	-	-
30-Jul-18	70.0	7.10	-	0.0270	2.00	-	-	-	-	-
31-Jul-18	70.0	-	-	-	-	-	-	-	-	-
1-Aug-18	90.0	-	-	-	-	-	-	-	-	-
2-Aug-18	90.0	-	-	-	-	-	-	-	-	-
3-Aug-18	90.0	-	-	-	-	-	-	-	-	-
4-Aug-18	90.0	-	-	-	-	-	-	-	-	-
5-Aug-18	90.0	-	-	-	-	-	-	-	-	-
6-Aug-18	90.0	-	-	-	-	-	-	-	-	-
7-Aug-18	90.0	7.20	-	0.0560	2.00	-	-	-	-	-
8-Aug-18	45.0	-	-	-	-	-	-	-	-	-
9-Aug-18	23.0	-	-	-	-	-	-	-	-	-
10-Aug-18	90.0	-	-	-	-	-	-	-	-	-
11-Aug-18	90.0	-	-	-	-	-	-	-	-	-
12-Aug-18	90.0	-	-	-	-	-	-	-	-	-
13-Aug-18	90.0	7.10	880	0.0360	3.00	0.0490	0.000800	0.330	0.252	0.0152
14-Aug-18	90.0	-	-	-	-	-	-	-	-	-

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table G.10: Water Quality at TOMP Station Q-28 (Effluent), Quirke TMA, 2015 to 2019

Date	Flow (L/s)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	TSS (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
15-Aug-18	90.0	-	-	-	-	-	-	-	-	-
16-Aug-18	90.0	-	-	-	-	-	-	-	-	-
17-Aug-18	90.0	-	-	-	-	-	-	-	-	-
18-Aug-18	83.0	-	-	-	-	-	-	-	-	-
19-Aug-18	83.0	-	-	-	-	-	-	-	-	-
20-Aug-18	83.0	7.30	-	0.0410	3.00	-	-	-	-	-
21-Aug-18	83.0	-	-	-	-	-	-	-	-	-
22-Aug-18	60.0	-	-	-	-	-	-	-	-	-
23-Aug-18	60.0	-	-	-	-	-	-	-	-	-
24-Aug-18	60.0	-	-	-	-	-	-	-	-	-
25-Aug-18	50.0	-	-	-	-	-	-	-	-	-
26-Aug-18	50.0	-	-	-	-	-	-	-	-	-
27-Aug-18	50.0	7.10	-	0.0330	2.00	-	-	-	-	-
28-Aug-18	50.0	-	-	-	-	-	-	-	-	-
29-Aug-18	50.0	-	-	-	-	-	-	-	-	-
30-Aug-18	70.0	-	-	-	-	-	-	-	-	-
31-Aug-18	70.0	-	-	-	-	-	-	-	-	-
1-Sep-18	70.0	-	-	-	-	-	-	-	-	-
2-Sep-18	70.0	-	-	-	-	-	-	-	-	-
3-Sep-18	70.0	-	-	-	-	-	-	-	-	-
4-Sep-18	70.0	7.10	-	0.0560	1.00	-	-	-	-	-
5-Sep-18	70.0	-	-	-	-	-	-	-	-	-
6-Sep-18	100	-	-	-	-	-	-	-	-	-
7-Sep-18	100	-	-	-	-	-	-	-	-	-
8-Sep-18	100	-	-	-	-	-	-	-	-	-
9-Sep-18	100	-	-	-	-	-	-	-	-	-
10-Sep-18	100	7.20	860	0.0410	2.00	0.0710	0.000700	0.320	0.215	0.0123
11-Sep-18	70.0	-	-	-	-	-	-	-	-	-
12-Sep-18	70.0	-	-	-	-	-	-	-	-	-
13-Sep-18	70.0	-	-	-	-	-	-	-	-	-
14-Sep-18	70.0	-	-	-	-	-	-	-	-	-
15-Sep-18	70.0	-	-	-	-	-	-	-	-	-
16-Sep-18	70.0	-	-	-	-	-	-	-	-	-
17-Sep-18	70.0	7.20	-	0.0490	2.00	-	-	-	-	-
18-Sep-18	70.0	-	-	-	-	-	-	-	-	-
19-Sep-18	70.0	-	-	-	-	-	-	-	-	-
20-Sep-18	70.0	-	-	-	-	-	-	-	-	-
21-Sep-18	70.0	-	-	-	-	-	-	-	-	-
22-Sep-18	70.0	-	-	-	-	-	-	-	-	-
23-Sep-18	70.0	-	-	-	-	-	-	-	-	-
24-Sep-18	70.0	7.10	-	0.0450	3.00	-	-	-	-	-
25-Sep-18	70.0	-	-	-	-	-	-	-	-	-
26-Sep-18	70.0	-	-	-	-	-	-	-	-	-
27-Sep-18	70.0	-	-	-	-	-	-	-	-	-
28-Sep-18	70.0	-	-	-	-	-	-	-	-	-
29-Sep-18	100	-	-	-	-	-	-	-	-	-
30-Sep-18	100	-	-	-	-	-	-	-	-	-
1-Oct-18	100	7.00	-	0.0400	2.00	-	-	-	-	-
2-Oct-18	100	-	-	-	-	-	-	-	-	-
3-Oct-18	100	-	-	-	-	-	-	-	-	-
4-Oct-18	100	-	-	-	-	-	-	-	-	-
5-Oct-18	145	-	-	-	-	-	-	-	-	-
6-Oct-18	145	-	-	-	-	-	-	-	-	-
7-Oct-18	145	-	-	-	-	-	-	-	-	-
8-Oct-18	145	-	-	-	-	-	-	-	-	-
9-Oct-18	145	7.10	890	0.0930	2.00	0.0970	0.00100	0.367	0.273	0.0109
10-Oct-18	145	-	-	-	-	-	-	-	-	-
11-Oct-18	145	-	-	-	-	-	-	-	-	-
12-Oct-18	170	-	-	-	-	-	-	-	-	-
13-Oct-18	170	-	-	-	-	-	-	-	-	-
14-Oct-18	170	-	-	-	-	-	-	-	-	-
15-Oct-18	170	7.70	-	0.135	2.00	-	-	-	-	-
16-Oct-18	170	-	-	-	-	-	-	-	-	-
17-Oct-18	170	-	-	-	-	-	-	-	-	-
18-Oct-18	170	-	-	-	-	-	-	-	-	-
19-Oct-18	170	-	-	-	-	-	-	-	-	-
20-Oct-18	170	-	-	-	-	-	-	-	-	-
21-Oct-18	170	-	-	-	-	-	-	-	-	-
22-Oct-18	170	7.20	-	0.0890	1.00	-	-	-	-	-
23-Oct-18	170	-	-	-	-	-	-	-	-	-
24-Oct-18	170	-	-	-	-	-	-	-	-	-
25-Oct-18	170	-	-	-	-	-	-	-	-	-
26-Oct-18	170	-	-	-	-	-	-	-	-	-
27-Oct-18	170	-	-	-	-	-	-	-	-	-
28-Oct-18	170	-	-	-	-	-	-	-	-	-
29-Oct-18	170	7.90	-	0.0980	2.00	-	-	-	-	-
30-Oct-18	120	-	-	-	-	-	-	-	-	-
31-Oct-18	120	-	-	-	-	-	-	-	-	-
1-Nov-18	130	-	-	-	-	-	-	-	-	-
2-Nov-18	130	-	-	-	-	-	-	-	-	-
3-Nov-18	125	-	-	-	-	-	-	-	-	-
4-Nov-18	125	-	-	-	-	-	-	-	-	-
5-Nov-18	130	8.00	870	0.0700	2.00	0.109	0.00130	0.302	0.588	0.00920
6-Nov-18	130	-	-	-	-	-	-	-	-	-
7-Nov-18	130	-	-	-	-	-	-	-	-	-
8-Nov-18	130	-	-	-	-	-	-	-	-	-

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table G.10: Water Quality at TOMP Station Q-28 (Effluent), Quirke TMA, 2015 to 2019

Date	Flow (L/s)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	TSS (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
9-Nov-18	130	-	-	-	-	-	-	-	-	-
10-Nov-18	130	-	-	-	-	-	-	-	-	-
11-Nov-18	130	-	-	-	-	-	-	-	-	-
12-Nov-18	130	7.30	880	0.0580	2.00	0.104	0.00190	0.370	0.703	0.00820
13-Nov-18	130	-	-	-	-	-	-	-	-	-
14-Nov-18	130	-	-	-	-	-	-	-	-	-
15-Nov-18	130	-	-	-	-	-	-	-	-	-
16-Nov-18	130	-	-	-	-	-	-	-	-	-
17-Nov-18	130	-	-	-	-	-	-	-	-	-
18-Nov-18	130	-	-	-	-	-	-	-	-	-
19-Nov-18	130	7.40	-	0.0530	2.00	-	-	-	-	-
20-Nov-18	130	-	-	-	-	-	-	-	-	-
21-Nov-18	130	-	-	-	-	-	-	-	-	-
22-Nov-18	130	-	-	-	-	-	-	-	-	-
23-Nov-18	130	-	-	-	-	-	-	-	-	-
24-Nov-18	130	-	-	-	-	-	-	-	-	-
25-Nov-18	130	-	-	-	-	-	-	-	-	-
26-Nov-18	130	7.90	-	0.0790	2.00	-	-	-	-	-
27-Nov-18	130	-	-	-	-	-	-	-	-	-
28-Nov-18	130	-	-	-	-	-	-	-	-	-
29-Nov-18	130	-	-	-	-	-	-	-	-	-
30-Nov-18	130	-	-	-	-	-	-	-	-	-
1-Dec-18	130	-	-	-	-	-	-	-	-	-
2-Dec-18	130	-	-	-	-	-	-	-	-	-
3-Dec-18	130	7.20	-	0.0740	3.00	-	-	-	-	-
4-Dec-18	130	-	-	-	-	-	-	-	-	-
5-Dec-18	100	-	-	-	-	-	-	-	-	-
6-Dec-18	100	-	-	-	-	-	-	-	-	-
7-Dec-18	100	-	-	-	-	-	-	-	-	-
8-Dec-18	100	-	-	-	-	-	-	-	-	-
9-Dec-18	100	-	-	-	-	-	-	-	-	-
10-Dec-18	100	7.10	960	0.0790	3.00	0.103	0.00330	0.566	0.923	0.00980
11-Dec-18	100	-	-	-	-	-	-	-	-	-
12-Dec-18	100	-	-	-	-	-	-	-	-	-
13-Dec-18	100	-	-	-	-	-	-	-	-	-
14-Dec-18	100	-	-	-	-	-	-	-	-	-
15-Dec-18	100	-	-	-	-	-	-	-	-	-
16-Dec-18	100	-	-	-	-	-	-	-	-	-
17-Dec-18	100	8.00	-	0.0650	2.00	-	-	-	-	-
18-Dec-18	100	-	-	-	-	-	-	-	-	-
19-Dec-18	100	-	-	-	-	-	-	-	-	-
20-Dec-18	100	-	-	-	-	-	-	-	-	-
21-Dec-18	100	-	-	-	-	-	-	-	-	-
22-Dec-18	100	-	-	-	-	-	-	-	-	-
23-Dec-18	100	-	-	-	-	-	-	-	-	-
24-Dec-18	100	-	-	-	-	-	-	-	-	-
25-Dec-18	100	-	-	-	-	-	-	-	-	-
26-Dec-18	100	-	-	-	-	-	-	-	-	-
27-Dec-18	100	7.80	-	0.0510	2.00	-	-	-	-	-
28-Dec-18	100	-	-	-	-	-	-	-	-	-
29-Dec-18	100	-	-	-	-	-	-	-	-	-
30-Dec-18	100	-	-	-	-	-	-	-	-	-
31-Dec-18	100	-	-	-	-	-	-	-	-	-
1-Jan-19	100	-	-	-	-	-	-	-	-	-
2-Jan-19	100	7.50	-	0.0760	3.00	-	-	-	-	-
3-Jan-19	100	-	-	-	-	-	-	-	-	-
4-Jan-19	100	-	-	-	-	-	-	-	-	-
5-Jan-19	100	-	-	-	-	-	-	-	-	-
6-Jan-19	100	-	-	-	-	-	-	-	-	-
7-Jan-19	100	7.30	-	0.0640	2.00	-	-	-	-	-
8-Jan-19	100	-	-	-	-	-	-	-	-	-
9-Jan-19	100	-	-	-	-	-	-	-	-	-
10-Jan-19	100	-	-	-	-	-	-	-	-	-
11-Jan-19	100	-	-	-	-	-	-	-	-	-
12-Jan-19	100	-	-	-	-	-	-	-	-	-
13-Jan-19	100	-	-	-	-	-	-	-	-	-
14-Jan-19	100	7.40	950	0.0660	3.00	0.119	0.00340	0.664	0.930	0.0142
15-Jan-19	100	-	-	-	-	-	-	-	-	-
16-Jan-19	100	-	-	-	-	-	-	-	-	-
17-Jan-19	100	-	-	-	-	-	-	-	-	-
18-Jan-19	100	-	-	-	-	-	-	-	-	-
19-Jan-19	100	-	-	-	-	-	-	-	-	-
20-Jan-19	100	-	-	-	-	-	-	-	-	-
21-Jan-19	100	7.60	-	0.0670	3.00	-	-	-	-	-
22-Jan-19	100	-	-	-	-	-	-	-	-	-
23-Jan-19	100	-	-	-	-	-	-	-	-	-
24-Jan-19	130	-	-	-	-	-	-	-	-	-
25-Jan-19	130	-	-	-	-	-	-	-	-	-
26-Jan-19	130	-	-	-	-	-	-	-	-	-
27-Jan-19	130	-	-	-	-	-	-	-	-	-
28-Jan-19	130	7.50	-	0.0500	5.00	-	-	-	-	-
29-Jan-19	130	-	-	-	-	-	-	-	-	-
30-Jan-19	130	-	-	-	-	-	-	-	-	-
31-Jan-19	130	-	-	-	-	-	-	-	-	-
1-Feb-19	130	-	-	-	-	-	-	-	-	-
2-Feb-19	130	-	-	-	-	-	-	-	-	-

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table G.10: Water Quality at TOMP Station Q-28 (Effluent), Quirke TMA, 2015 to 2019

Date	Flow (L/s)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	TSS (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
3-Feb-19	130	-	-	-	-	-	-	-	-	-
4-Feb-19	130	7.60	-	0.103	3.00	-	-	-	-	-
5-Feb-19	130	-	-	-	-	-	-	-	-	-
6-Feb-19	110	-	-	-	-	-	-	-	-	-
7-Feb-19	110	-	-	-	-	-	-	-	-	-
8-Feb-19	110	-	-	-	-	-	-	-	-	-
9-Feb-19	110	-	-	-	-	-	-	-	-	-
10-Feb-19	110	-	-	-	-	-	-	-	-	-
11-Feb-19	110	7.20	960	0.0840	3.00	0.0980	0.00350	0.553	0.870	0.0201
12-Feb-19	110	-	-	-	-	-	-	-	-	-
13-Feb-19	110	-	-	-	-	-	-	-	-	-
14-Feb-19	110	-	-	-	-	-	-	-	-	-
15-Feb-19	110	-	-	-	-	-	-	-	-	-
16-Feb-19	110	-	-	-	-	-	-	-	-	-
17-Feb-19	110	-	-	-	-	-	-	-	-	-
18-Feb-19	110	-	-	-	-	-	-	-	-	-
19-Feb-19	110	7.40	-	0.0980	4.00	-	-	-	-	-
20-Feb-19	150	-	-	-	-	-	-	-	-	-
21-Feb-19	150	-	-	-	-	-	-	-	-	-
22-Feb-19	150	-	-	-	-	-	-	-	-	-
23-Feb-19	150	-	-	-	-	-	-	-	-	-
24-Feb-19	150	-	-	-	-	-	-	-	-	-
25-Feb-19	150	7.60	-	0.127	4.00	-	-	-	-	-
26-Feb-19	150	-	-	-	-	-	-	-	-	-
27-Feb-19	150	-	-	-	-	-	-	-	-	-
28-Feb-19	150	-	-	-	-	-	-	-	-	-
1-Mar-19	150	-	-	-	-	-	-	-	-	-
2-Mar-19	150	-	-	-	-	-	-	-	-	-
3-Mar-19	150	-	-	-	-	-	-	-	-	-
4-Mar-19	150	7.50	-	0.0860	4.00	-	-	-	-	-
5-Mar-19	150	-	-	-	-	-	-	-	-	-
6-Mar-19	150	-	-	-	-	-	-	-	-	-
7-Mar-19	150	-	-	-	-	-	-	-	-	-
8-Mar-19	150	-	-	-	-	-	-	-	-	-
9-Mar-19	100	-	-	-	-	-	-	-	-	-
10-Mar-19	100	-	-	-	-	-	-	-	-	-
11-Mar-19	100	7.40	950	0.0920	3.00	0.0800	0.00350	0.656	0.778	0.0178
12-Mar-19	100	-	-	-	-	-	-	-	-	-
13-Mar-19	100	-	-	-	-	-	-	-	-	-
14-Mar-19	100	-	-	-	-	-	-	-	-	-
15-Mar-19	100	-	-	-	-	-	-	-	-	-
16-Mar-19	100	-	-	-	-	-	-	-	-	-
17-Mar-19	100	-	-	-	-	-	-	-	-	-
18-Mar-19	100	7.30	-	0.0940	4.00	-	-	-	-	-
19-Mar-19	135	-	-	-	-	-	-	-	-	-
20-Mar-19	135	-	-	-	-	-	-	-	-	-
21-Mar-19	135	-	-	-	-	-	-	-	-	-
22-Mar-19	135	-	-	-	-	-	-	-	-	-
23-Mar-19	135	-	-	-	-	-	-	-	-	-
24-Mar-19	135	-	-	-	-	-	-	-	-	-
25-Mar-19	135	7.60	-	0.142	2.00	-	-	-	-	-
26-Mar-19	135	-	-	-	-	-	-	-	-	-
27-Mar-19	135	-	-	-	-	-	-	-	-	-
28-Mar-19	135	-	-	-	-	-	-	-	-	-
29-Mar-19	135	-	-	-	-	-	-	-	-	-
30-Mar-19	135	-	-	-	-	-	-	-	-	-
31-Mar-19	135	-	-	-	-	-	-	-	-	-
1-Apr-19	130	7.60	-	0.108	3.00	-	-	-	-	-
2-Apr-19	130	-	-	-	-	-	-	-	-	-
3-Apr-19	130	-	-	-	-	-	-	-	-	-
4-Apr-19	80.0	-	-	-	-	-	-	-	-	-
5-Apr-19	100	-	-	-	-	-	-	-	-	-
6-Apr-19	100	-	-	-	-	-	-	-	-	-
7-Apr-19	100	-	-	-	-	-	-	-	-	-
8-Apr-19	100	7.30	-	0.0840	3.00	-	-	-	-	-
9-Apr-19	120	-	-	-	-	-	-	-	-	-
10-Apr-19	150	-	-	-	-	-	-	-	-	-
11-Apr-19	178	-	-	-	-	-	-	-	-	-
12-Apr-19	170	-	-	-	-	-	-	-	-	-
13-Apr-19	170	-	-	-	-	-	-	-	-	-
14-Apr-19	170	-	-	-	-	-	-	-	-	-
15-Apr-19	170	-	-	-	-	-	-	-	-	-
16-Apr-19	170	8.10	760	0.155	3.00	0.108	0.00350	0.576	0.881	0.0166
17-Apr-19	170	-	-	-	-	-	-	-	-	-
18-Apr-19	170	-	-	-	-	-	-	-	-	-
19-Apr-19	170	-	-	-	-	-	-	-	-	-
20-Apr-19	170	-	-	-	-	-	-	-	-	-
21-Apr-19	170	-	-	-	-	-	-	-	-	-
22-Apr-19	170	7.40	-	0.167	3.00	-	-	-	-	-
23-Apr-19	200	-	-	-	-	-	-	-	-	-
24-Apr-19	200	-	-	-	-	-	-	-	-	-
25-Apr-19	200	-	-	-	-	-	-	-	-	-
26-Apr-19	200	-	-	-	-	-	-	-	-	-
27-Apr-19	200	-	-	-	-	-	-	-	-	-
28-Apr-19	200	-	-	-	-	-	-	-	-	-
29-Apr-19	200	7.10	-	0.149	2.00	-	-	-	-	-

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table G.10: Water Quality at TOMP Station Q-28 (Effluent), Quirke TMA, 2015 to 2019

Date	Flow (L/s)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	TSS (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
30-Apr-19	200	-	-	-	-	-	-	-	-	-
1-May-19	200	-	-	-	-	-	-	-	-	-
2-May-19	200	-	-	-	-	-	-	-	-	-
3-May-19	200	-	-	-	-	-	-	-	-	-
4-May-19	200	-	-	-	-	-	-	-	-	-
5-May-19	200	-	-	-	-	-	-	-	-	-
6-May-19	200	7.30	-	0.161	1.00	-	-	-	-	-
7-May-19	200	-	-	-	-	-	-	-	-	-
8-May-19	130	-	-	-	-	-	-	-	-	-
9-May-19	130	-	-	-	-	-	-	-	-	-
10-May-19	135	-	-	-	-	-	-	-	-	-
11-May-19	130	-	-	-	-	-	-	-	-	-
12-May-19	130	-	-	-	-	-	-	-	-	-
13-May-19	135	7.40	380	0.148	1.00	0.145	0.00120	0.219	0.326	0.00770
14-May-19	130	-	-	-	-	-	-	-	-	-
15-May-19	130	-	-	-	-	-	-	-	-	-
16-May-19	135	-	-	-	-	-	-	-	-	-
17-May-19	135	-	-	-	-	-	-	-	-	-
18-May-19	130	-	-	-	-	-	-	-	-	-
19-May-19	130	-	-	-	-	-	-	-	-	-
20-May-19	130	-	-	-	-	-	-	-	-	-
21-May-19	130	7.40	-	0.135	1.00	-	-	-	-	-
22-May-19	160	-	-	-	-	-	-	-	-	-
23-May-19	160	-	-	-	-	-	-	-	-	-
24-May-19	160	-	-	-	-	-	-	-	-	-
25-May-19	180	-	-	-	-	-	-	-	-	-
26-May-19	180	-	-	-	-	-	-	-	-	-
27-May-19	180	7.20	-	0.168	<1.00	-	-	-	-	-
28-May-19	180	-	-	-	-	-	-	-	-	-
29-May-19	115	-	-	-	-	-	-	-	-	-
30-May-19	115	-	-	-	-	-	-	-	-	-
31-May-19	115	-	-	-	-	-	-	-	-	-
1-Jun-19	115	-	-	-	-	-	-	-	-	-
2-Jun-19	115	-	-	-	-	-	-	-	-	-
3-Jun-19	115	7.20	-	0.123	2.00	-	-	-	-	-
4-Jun-19	115	-	-	-	-	-	-	-	-	-
5-Jun-19	160	-	-	-	-	-	-	-	-	-
6-Jun-19	157	-	-	-	-	-	-	-	-	-
7-Jun-19	160	-	-	-	-	-	-	-	-	-
8-Jun-19	160	-	-	-	-	-	-	-	-	-
9-Jun-19	160	-	-	-	-	-	-	-	-	-
10-Jun-19	160	7.90	630	0.153	1.00	0.143	0.000900	0.167	0.310	0.00710
11-Jun-19	180	-	-	-	-	-	-	-	-	-
12-Jun-19	180	-	-	-	-	-	-	-	-	-
13-Jun-19	180	-	-	-	-	-	-	-	-	-
14-Jun-19	180	-	-	-	-	-	-	-	-	-
15-Jun-19	120	-	-	-	-	-	-	-	-	-
16-Jun-19	120	-	-	-	-	-	-	-	-	-
17-Jun-19	120	7.50	-	0.101	2.00	-	-	-	-	-
18-Jun-19	60.0	-	-	-	-	-	-	-	-	-
19-Jun-19	50.0	-	-	-	-	-	-	-	-	-
20-Jun-19	25.0	-	-	-	-	-	-	-	-	-
21-Jun-19	120	-	-	-	-	-	-	-	-	-
22-Jun-19	120	-	-	-	-	-	-	-	-	-
23-Jun-19	120	-	-	-	-	-	-	-	-	-
24-Jun-19	120	7.30	-	0.0680	2.00	-	-	-	-	-
25-Jun-19	120	-	-	-	-	-	-	-	-	-
26-Jun-19	120	-	-	-	-	-	-	-	-	-
27-Jun-19	120	-	-	-	-	-	-	-	-	-
28-Jun-19	120	-	-	-	-	-	-	-	-	-
29-Jun-19	120	-	-	-	-	-	-	-	-	-
30-Jun-19	120	-	-	-	-	-	-	-	-	-
1-Jul-19	120	-	-	-	-	-	-	-	-	-
2-Jul-19	120	7.30	-	0.0680	2.00	-	-	-	-	-
3-Jul-19	120	-	-	-	-	-	-	-	-	-
4-Jul-19	85.0	-	-	-	-	-	-	-	-	-
5-Jul-19	85.0	-	-	-	-	-	-	-	-	-
6-Jul-19	85.0	-	-	-	-	-	-	-	-	-
7-Jul-19	85.0	-	-	-	-	-	-	-	-	-
8-Jul-19	85.0	7.20	750	0.0450	2.00	0.0639	0.00110	0.390	0.429	0.0115
9-Jul-19	85.0	-	-	-	-	-	-	-	-	-
10-Jul-19	85.0	-	-	-	-	-	-	-	-	-
11-Jul-19	85.0	-	-	-	-	-	-	-	-	-
12-Jul-19	85.0	-	-	-	-	-	-	-	-	-
13-Jul-19	85.0	-	-	-	-	-	-	-	-	-
14-Jul-19	85.0	-	-	-	-	-	-	-	-	-
15-Jul-19	85.0	7.30	-	0.0400	2.00	-	-	-	-	-
16-Jul-19	85.0	-	-	-	-	-	-	-	-	-
17-Jul-19	85.0	-	-	-	-	-	-	-	-	-
18-Jul-19	85.0	-	-	-	-	-	-	-	-	-
19-Jul-19	85.0	-	-	-	-	-	-	-	-	-
20-Jul-19	85.0	-	-	-	-	-	-	-	-	-
21-Jul-19	85.0	-	-	-	-	-	-	-	-	-
22-Jul-19	85.0	7.30	-	0.0440	2.00	-	-	-	-	-
23-Jul-19	60.0	-	-	-	-	-	-	-	-	-
24-Jul-19	60.0	-	-	-	-	-	-	-	-	-

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table G.10: Water Quality at TOMP Station Q-28 (Effluent), Quirke TMA, 2015 to 2019

Date	Flow (L/s)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	TSS (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
25-Jul-19	60.0	-	-	-	-	-	-	-	-	-
26-Jul-19	60.0	-	-	-	-	-	-	-	-	-
27-Jul-19	60.0	-	-	-	-	-	-	-	-	-
28-Jul-19	60.0	-	-	-	-	-	-	-	-	-
29-Jul-19	60.0	7.10	-	0.0340	2.00	-	-	-	-	-
30-Jul-19	60.0	-	-	-	-	-	-	-	-	-
31-Jul-19	60.0	-	-	-	-	-	-	-	-	-
1-Aug-19	60.0	-	-	-	-	-	-	-	-	-
2-Aug-19	60.0	-	-	-	-	-	-	-	-	-
3-Aug-19	60.0	-	-	-	-	-	-	-	-	-
4-Aug-19	60.0	-	-	-	-	-	-	-	-	-
5-Aug-19	60.0	-	-	-	-	-	-	-	-	-
6-Aug-19	60.0	7.50	-	0.0220	3.00	-	-	-	-	-
7-Aug-19	60.0	-	-	-	-	-	-	-	-	-
8-Aug-19	60.0	-	-	-	-	-	-	-	-	-
9-Aug-19	60.0	-	-	-	-	-	-	-	-	-
10-Aug-19	60.0	-	-	-	-	-	-	-	-	-
11-Aug-19	60.0	-	-	-	-	-	-	-	-	-
12-Aug-19	60.0	7.00	740	0.0270	2.00	0.0380	0.00130	0.420	0.492	0.0144
13-Aug-19	60.0	-	-	-	-	-	-	-	-	-
14-Aug-19	60.0	-	-	-	-	-	-	-	-	-
15-Aug-19	60.0	-	-	-	-	-	-	-	-	-
16-Aug-19	60.0	-	-	-	-	-	-	-	-	-
17-Aug-19	60.0	-	-	-	-	-	-	-	-	-
18-Aug-19	60.0	-	-	-	-	-	-	-	-	-
19-Aug-19	60.0	7.00	-	0.0290	3.00	-	-	-	-	-
20-Aug-19	60.0	-	-	-	-	-	-	-	-	-
21-Aug-19	60.0	-	-	-	-	-	-	-	-	-
22-Aug-19	80.0	-	-	-	-	-	-	-	-	-
23-Aug-19	80.0	-	-	-	-	-	-	-	-	-
24-Aug-19	80.0	-	-	-	-	-	-	-	-	-
25-Aug-19	80.0	-	-	-	-	-	-	-	-	-
26-Aug-19	80.0	7.00	-	0.0350	6.00	-	-	-	-	-
27-Aug-19	80.0	-	-	-	-	-	-	-	-	-
28-Aug-19	80.0	-	-	-	-	-	-	-	-	-
29-Aug-19	80.0	-	-	-	-	-	-	-	-	-
30-Aug-19	80.0	-	-	-	-	-	-	-	-	-
31-Aug-19	80.0	-	-	-	-	-	-	-	-	-
1-Sep-19	80.0	-	-	-	-	-	-	-	-	-
2-Sep-19	80.0	-	-	-	-	-	-	-	-	-
3-Sep-19	80.0	7.00	-	0.0340	2.00	-	-	-	-	-
4-Sep-19	80.0	-	-	-	-	-	-	-	-	-
5-Sep-19	100	-	-	-	-	-	-	-	-	-
6-Sep-19	100	-	-	-	-	-	-	-	-	-
7-Sep-19	100	-	-	-	-	-	-	-	-	-
8-Sep-19	100	-	-	-	-	-	-	-	-	-
9-Sep-19	100	7.10	860	0.0410	2.00	0.0570	0.00130	0.520	0.323	0.0133
10-Sep-19	120	-	-	-	-	-	-	-	-	-
11-Sep-19	120	-	-	-	-	-	-	-	-	-
12-Sep-19	120	-	-	-	-	-	-	-	-	-
13-Sep-19	120	-	-	-	-	-	-	-	-	-
14-Sep-19	120	-	-	-	-	-	-	-	-	-
15-Sep-19	120	-	-	-	-	-	-	-	-	-
16-Sep-19	120	7.20	-	0.0560	2.00	-	-	-	-	-
17-Sep-19	120	-	-	-	-	-	-	-	-	-
18-Sep-19	120	-	-	-	-	-	-	-	-	-
19-Sep-19	120	-	-	-	-	-	-	-	-	-
20-Sep-19	120	-	-	-	-	-	-	-	-	-
21-Sep-19	100	-	-	-	-	-	-	-	-	-
22-Sep-19	100	-	-	-	-	-	-	-	-	-
23-Sep-19	100	7.30	-	0.0650	2.00	-	-	-	-	-
24-Sep-19	100	-	-	-	-	-	-	-	-	-
25-Sep-19	100	-	-	-	-	-	-	-	-	-
26-Sep-19	100	-	-	-	-	-	-	-	-	-
27-Sep-19	100	-	-	-	-	-	-	-	-	-
28-Sep-19	100	-	-	-	-	-	-	-	-	-
29-Sep-19	100	-	-	-	-	-	-	-	-	-
30-Sep-19	100	7.30	-	0.0610	2.00	-	-	-	-	-
1-Oct-19	120	-	-	-	-	-	-	-	-	-
2-Oct-19	120	-	-	-	-	-	-	-	-	-
3-Oct-19	120	-	-	-	-	-	-	-	-	-
4-Oct-19	140	-	-	-	-	-	-	-	-	-
5-Oct-19	140	-	-	-	-	-	-	-	-	-
6-Oct-19	140	-	-	-	-	-	-	-	-	-
7-Oct-19	140	7.30	-	0.0560	2.00	-	-	-	-	-
8-Oct-19	140	-	-	-	-	-	-	-	-	-
9-Oct-19	140	-	-	-	-	-	-	-	-	-
10-Oct-19	140	-	-	-	-	-	-	-	-	-
11-Oct-19	140	-	-	-	-	-	-	-	-	-
12-Oct-19	140	-	-	-	-	-	-	-	-	-
13-Oct-19	140	-	-	-	-	-	-	-	-	-
14-Oct-19	140	-	-	-	-	-	-	-	-	-
15-Oct-19	140	7.10	890	0.0790	2.00	0.0970	0.00130	0.446	0.336	0.00940
16-Oct-19	140	-	-	-	-	-	-	-	-	-
17-Oct-19	140	-	-	-	-	-	-	-	-	-
18-Oct-19	160	-	-	-	-	-	-	-	-	-

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table G.10: Water Quality at TOMP Station Q-28 (Effluent), Quirke TMA, 2015 to 2019

Date	Flow (L/s)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	TSS (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
19-Oct-19	160	-	-	-	-	-	-	-	-	-
20-Oct-19	160	-	-	-	-	-	-	-	-	-
21-Oct-19	160	7.80	-	0.104	5.00	-	-	-	-	-
22-Oct-19	160	-	-	-	-	-	-	-	-	-
23-Oct-19	160	-	-	-	-	-	-	-	-	-
24-Oct-19	175	-	-	-	-	-	-	-	-	-
25-Oct-19	175	-	-	-	-	-	-	-	-	-
26-Oct-19	175	-	-	-	-	-	-	-	-	-
27-Oct-19	175	-	-	-	-	-	-	-	-	-
28-Oct-19	175	7.20	-	0.140	2.00	-	-	-	-	-
29-Oct-19	175	-	-	-	-	-	-	-	-	-
30-Oct-19	175	-	-	-	-	-	-	-	-	-
31-Oct-19	175	-	-	-	-	-	-	-	-	-
1-Nov-19	175	-	-	-	-	-	-	-	-	-
2-Nov-19	175	-	-	-	-	-	-	-	-	-
3-Nov-19	175	-	-	-	-	-	-	-	-	-
4-Nov-19	175	7.20	-	0.162	2.00	-	-	-	-	-
5-Nov-19	175	-	-	-	-	-	-	-	-	-
6-Nov-19	175	-	-	-	-	-	-	-	-	-
7-Nov-19	175	-	-	-	-	-	-	-	-	-
8-Nov-19	175	-	-	-	-	-	-	-	-	-
9-Nov-19	100	-	-	-	-	-	-	-	-	-
10-Nov-19	100	-	-	-	-	-	-	-	-	-
11-Nov-19	100	7.30	900	0.137	2.00	0.121	0.00190	0.406	0.726	0.00800
12-Nov-19	100	-	-	-	-	-	-	-	-	-
13-Nov-19	125	-	-	-	-	-	-	-	-	-
14-Nov-19	125	-	-	-	-	-	-	-	-	-
15-Nov-19	125	-	-	-	-	-	-	-	-	-
16-Nov-19	125	-	-	-	-	-	-	-	-	-
17-Nov-19	125	-	-	-	-	-	-	-	-	-
18-Nov-19	125	8.20	-	0.136	3.00	-	-	-	-	-
19-Nov-19	125	-	-	-	-	-	-	-	-	-
20-Nov-19	125	-	-	-	-	-	-	-	-	-
21-Nov-19	125	-	-	-	-	-	-	-	-	-
22-Nov-19	125	-	-	-	-	-	-	-	-	-
23-Nov-19	125	-	-	-	-	-	-	-	-	-
24-Nov-19	125	-	-	-	-	-	-	-	-	-
25-Nov-19	125	7.50	-	0.116	2.00	-	-	-	-	-
26-Nov-19	150	-	-	-	-	-	-	-	-	-
27-Nov-19	150	-	-	-	-	-	-	-	-	-
28-Nov-19	150	-	-	-	-	-	-	-	-	-
29-Nov-19	150	-	-	-	-	-	-	-	-	-
30-Nov-19	150	-	-	-	-	-	-	-	-	-
1-Dec-19	150	-	-	-	-	-	-	-	-	-
2-Dec-19	150	7.70	-	0.130	3.00	-	-	-	-	-
3-Dec-19	150	-	-	-	-	-	-	-	-	-
4-Dec-19	150	-	-	-	-	-	-	-	-	-
5-Dec-19	150	-	-	-	-	-	-	-	-	-
6-Dec-19	150	-	-	-	-	-	-	-	-	-
7-Dec-19	150	-	-	-	-	-	-	-	-	-
8-Dec-19	150	-	-	-	-	-	-	-	-	-
9-Dec-19	150	7.50	870	0.132	4.00	0.127	0.00260	0.734	0.904	0.00970
10-Dec-19	150	-	-	-	-	-	-	-	-	-
11-Dec-19	150	-	-	-	-	-	-	-	-	-
12-Dec-19	150	-	-	-	-	-	-	-	-	-
13-Dec-19	150	-	-	-	-	-	-	-	-	-
14-Dec-19	150	-	-	-	-	-	-	-	-	-
15-Dec-19	150	-	-	-	-	-	-	-	-	-
16-Dec-19	150	7.60	-	0.167	4.00	-	-	-	-	-
17-Dec-19	150	-	-	-	-	-	-	-	-	-
18-Dec-19	120	-	-	-	-	-	-	-	-	-
19-Dec-19	120	-	-	-	-	-	-	-	-	-
20-Dec-19	120	-	-	-	-	-	-	-	-	-
21-Dec-19	120	-	-	-	-	-	-	-	-	-
22-Dec-19	120	-	-	-	-	-	-	-	-	-
23-Dec-19	120	7.60	-	0.104	4.00	-	-	-	-	-
24-Dec-19	120	-	-	-	-	-	-	-	-	-
25-Dec-19	120	-	-	-	-	-	-	-	-	-
26-Dec-19	120	-	-	-	-	-	-	-	-	-
27-Dec-19	120	-	-	-	-	-	-	-	-	-
28-Dec-19	120	-	-	-	-	-	-	-	-	-
29-Dec-19	120	-	-	-	-	-	-	-	-	-
30-Dec-19	120	7.70	-	0.107	4.00	-	-	-	-	-
31-Dec-19	120	-	-	-	-	-	-	-	-	-
n	1193	255	60	256	255	60	60	60	60	60
Minimum	23.0	6.90	380	0.0130	<1.00	0.0240	0.000600	0.167	0.215	0.00710
Maximum	200	8.40	1,100	0.197	6.00	0.147	0.00660	1.01	1.42	0.0201
Mean	114	7.36	847	0.0819	1.93	0.0858	0.00264	0.509	0.661	0.0122
SD	33.5	0.302	141	0.0392	0.909	0.0269	0.00145	0.185	0.295	0.00300
Median	110	7.30	880	0.0755	2.00	0.0845	0.00230	0.508	0.608	0.0120
10th Percentile	70.0	7.00	635	0.0360	1.00	0.0530	0.00105	0.281	0.320	0.00850
95th Percentile	175	8.00	1,000	0.154	4.00	0.135	0.00510	0.785	1.15	0.0178

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table G.11: Water Quality at TOMP Station Q-29 (Perimeter Monitoring), Quirke TMA, 2015 to 2019

Date	Elevation (m)	Flow (L/s)
2-Jan-15	-	54.0
5-Jan-15	379	50.0
6-Jan-15	-	50.0
7-Jan-15	-	50.0
8-Jan-15	-	50.0
9-Jan-15	-	50.0
12-Jan-15	-	50.0
13-Jan-15	-	50.0
14-Jan-15	379	50.0
15-Jan-15	-	50.0
16-Jan-15	-	50.0
19-Jan-15	-	50.0
20-Jan-15	-	50.0
21-Jan-15	379	50.0
22-Jan-15	-	50.0
23-Jan-15	-	50.0
26-Jan-15	-	50.0
27-Jan-15	379	50.0
28-Jan-15	-	50.0
29-Jan-15	-	50.0
30-Jan-15	-	50.0
2-Feb-15	379	50.0
3-Feb-15	-	50.0
4-Feb-15	-	50.0
5-Feb-15	-	40.0
6-Feb-15	-	40.0
9-Feb-15	379	40.0
10-Feb-15	-	40.0
11-Feb-15	-	40.0
12-Feb-15	-	40.0
13-Feb-15	-	40.0
17-Feb-15	379	40.0
18-Feb-15	-	40.0
19-Feb-15	-	40.0
20-Feb-15	-	40.0
23-Feb-15	379	40.0
24-Feb-15	-	40.0
25-Feb-15	-	40.0
26-Feb-15	-	40.0
27-Feb-15	-	40.0
2-Mar-15	379	40.0
3-Mar-15	-	40.0
4-Mar-15	-	40.0
5-Mar-15	-	40.0
6-Mar-15	-	40.0
28-May-15	-	30.0
29-May-15	-	30.0
1-Jun-15	380	40.0
2-Jun-15	-	40.0
3-Jun-15	-	50.0
4-Jun-15	-	50.0
5-Jun-15	-	50.0
8-Jun-15	380	50.0

Date	Elevation (m)	Flow (L/s)
9-Jun-15	-	50.0
10-Jun-15	-	50.0
11-Jun-15	-	50.0
12-Jun-15	-	80.0
15-Jun-15	380	75.0
16-Jun-15	-	80.0
17-Jun-15	-	80.0
18-Jun-15	-	80.0
19-Jun-15	-	80.0
22-Jun-15	380	80.0
23-Jun-15	-	80.0
24-Jun-15	-	80.0
25-Jun-15	-	82.0
26-Jun-15	-	80.0
29-Jun-15	380	80.0
30-Jun-15	-	80.0
2-Jul-15	-	80.0
3-Jul-15	-	100
6-Jul-15	379	100
7-Jul-15	-	100
8-Jul-15	-	100
9-Jul-15	-	90.0
10-Jul-15	-	50.0
13-Jul-15	379	46.0
14-Jul-15	-	46.0
15-Jul-15	-	46.0
16-Jul-15	-	42.0
17-Jul-15	-	45.0
20-Jul-15	379	40.0
21-Jul-15	-	43.0
22-Jul-15	-	40.0
23-Jul-15	-	40.0
24-Jul-15	-	40.0
27-Jul-15	379	40.0
28-Jul-15	-	40.0
29-Jul-15	-	40.0
30-Jul-15	-	40.0
31-Jul-15	-	40.0
4-Aug-15	379	37.0
5-Aug-15	-	37.0
6-Aug-15	-	43.0
7-Aug-15	-	48.0
10-Aug-15	379	48.0
11-Aug-15	-	48.0
12-Aug-15	-	48.0
13-Aug-15	-	48.0
14-Aug-15	-	48.0
17-Aug-15	379	45.0
18-Aug-15	-	45.0
19-Aug-15	-	45.0
20-Aug-15	-	45.0
21-Aug-15	-	25.0
24-Aug-15	379	21.0

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table G.11: Water Quality at TOMP Station Q-29 (Perimeter Monitoring), Quirke TMA, 2015 to 2019

Date	Elevation (m)	Flow (L/s)
25-Aug-15	-	21.0
26-Aug-15	-	21.0
27-Aug-15	-	21.0
28-Aug-15	-	21.0
31-Aug-15	379	19.0
1-Sep-15	-	19.0
2-Sep-15	-	19.0
3-Sep-15	-	19.0
4-Sep-15	-	19.0
22-Oct-15	-	50.0
23-Oct-15	-	50.0
26-Oct-15	379	50.0
27-Oct-15	-	50.0
28-Oct-15	-	50.0
29-Oct-15	-	50.0
30-Oct-15	-	50.0
2-Nov-15	379	57.0
3-Nov-15	-	55.0
4-Nov-15	-	60.0
5-Nov-15	-	60.0
6-Nov-15	-	63.0
9-Nov-15	379	63.0
10-Nov-15	-	63.0
11-Nov-15	-	60.0
12-Nov-15	-	60.0
13-Nov-15	-	60.0
16-Nov-15	379	60.0
17-Nov-15	-	57.0
18-Nov-15	-	60.0
19-Nov-15	-	60.0
20-Nov-15	-	63.0
23-Nov-15	379	100
24-Nov-15	-	100
25-Nov-15	-	100
26-Nov-15	-	100
27-Nov-15	-	100
30-Nov-15	379	100
1-Dec-15	-	100
2-Dec-15	-	100
3-Dec-15	-	100
4-Dec-15	-	100
7-Dec-15	379	100
8-Dec-15	-	100
9-Dec-15	-	100
10-Dec-15	-	100
11-Dec-15	-	100
14-Dec-15	380	100
15-Dec-15	-	100
16-Dec-15	-	100
17-Dec-15	-	100
18-Dec-15	-	100
21-Dec-15	380	100
22-Dec-15	-	100
23-Dec-15	-	100
24-Dec-15	-	100
28-Dec-15	380	100
29-Dec-15	-	100
30-Dec-15	-	100
31-Dec-15	-	100
4-Jan-16	380	100

#NAME?

Date	Elevation (m)	Flow (L/s)
5-Jan-16	-	93.0
6-Jan-16	-	91.0
7-Jan-16	-	91.0
19-Apr-16	-	100
20-Apr-16	-	100
21-Apr-16	-	100
22-Apr-16	-	100
25-Apr-16	380	100
26-Apr-16	-	97.0
3-May-16	-	25.0
4-May-16	-	25.0
5-May-16	-	25.0
6-May-16	-	25.0
9-May-16	380	25.0
10-May-16	-	25.0
11-May-16	-	25.0
12-May-16	-	25.0
13-May-16	-	25.0
16-May-16	380	25.0
17-May-16	-	25.0
18-May-16	-	25.0
19-May-16	-	25.0
20-May-16	-	27.0
24-May-16	380	25.0
25-May-16	-	25.0
26-May-16	-	25.0
27-May-16	-	25.0
30-May-16	-	23.0
31-May-16	380	25.0
1-Jun-16	-	25.0
2-Jun-16	-	25.0
3-Jun-16	-	21.0
6-Jun-16	380	25.0
7-Jun-16	-	25.0
8-Jun-16	-	25.0
9-Jun-16	-	25.0
10-Jun-16	-	25.0
13-Jun-16	380	25.0
14-Jun-16	-	25.0
15-Jun-16	-	25.0
16-Jun-16	-	25.0
17-Jun-16	-	25.0
20-Jun-16	380	25.0
21-Jun-16	-	25.0
22-Jun-16	-	25.0
23-Jun-16	-	25.0
24-Jun-16	-	25.0
27-Jun-16	379	25.0
28-Jun-16	-	25.0
29-Jun-16	-	25.0
30-Jun-16	-	25.0
4-Jul-16	-	25.0
5-Jul-16	379	25.0
6-Jul-16	-	25.0
7-Jul-16	-	25.0
8-Jul-16	-	25.0
11-Jul-16	379	25.0
12-Jul-16	-	25.0
13-Jul-16	-	25.0
14-Jul-16	-	25.0

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table G.11: Water Quality at TOMP Station Q-29 (Perimeter Monitoring), Quirke TMA, 2015 to 2019

Date	Elevation (m)	Flow (L/s)
15-Jul-16	-	50.0
18-Jul-16	379	50.0
19-Jul-16	-	50.0
20-Jul-16	-	50.0
21-Jul-16	-	50.0
22-Jul-16	-	50.0
25-Jul-16	379	51.0
26-Jul-16	-	51.0
27-Jul-16	-	50.0
28-Jul-16	-	50.0
29-Jul-16	-	50.0
2-Aug-16	379	50.0
3-Aug-16	-	50.0
4-Aug-16	-	50.0
5-Aug-16	-	50.0
8-Aug-16	379	45.0
9-Aug-16	-	45.0
10-Aug-16	-	45.0
11-Aug-16	-	50.0
12-Aug-16	-	45.0
15-Aug-16	379	40.0
16-Aug-16	-	40.0
17-Aug-16	-	40.0
18-Aug-16	-	40.0
19-Aug-16	-	40.0
22-Aug-16	379	40.0
23-Aug-16	-	40.0
24-Aug-16	-	40.0
25-Aug-16	-	40.0
26-Aug-16	-	40.0
29-Aug-16	379	40.0
30-Aug-16	-	25.0
31-Aug-16	-	25.0
1-Sep-16	-	25.0
2-Sep-16	-	25.0
6-Sep-16	379	25.0
7-Sep-16	-	23.0
8-Sep-16	-	23.0
9-Sep-16	-	23.0
12-Sep-16	379	23.0
13-Sep-16	-	23.0
14-Sep-16	-	23.0
15-Sep-16	-	23.0
16-Sep-16	-	23.0
19-Sep-16	379	23.0
20-Sep-16	-	23.0
21-Sep-16	-	23.0
22-Sep-16	-	23.0
23-Sep-16	-	23.0
26-Sep-16	379	23.0
27-Sep-16	-	23.0
28-Sep-16	-	23.0
29-Sep-16	-	23.0
30-Sep-16	-	23.0
3-Oct-16	378	23.0
4-Oct-16	-	23.0
5-Oct-16	-	21.0
6-Oct-16	-	21.0
7-Oct-16	-	23.0
11-Oct-16	379	21.0
12-Oct-16	-	21.0
13-Oct-16	-	21.0

Date	Elevation (m)	Flow (L/s)
14-Oct-16	-	21.0
17-Oct-16	379	21.0
18-Oct-16	-	20.0
19-Oct-16	-	20.0
20-Oct-16	-	21.0
21-Oct-16	-	21.0
24-Oct-16	379	19.0
25-Oct-16	-	19.0
26-Oct-16	-	19.0
27-Oct-16	-	19.0
28-Oct-16	-	19.0
31-Oct-16	379	19.0
1-Nov-16	-	19.0
2-Nov-16	-	19.0
3-Nov-16	-	19.0
4-Nov-16	-	19.0
7-Nov-16	379	19.0
8-Nov-16	-	19.0
9-Nov-16	-	19.0
10-Nov-16	-	18.0
11-Nov-16	-	18.0
14-Nov-16	379	19.0
15-Nov-16	-	19.0
16-Nov-16	-	19.0
17-Nov-16	-	19.0
18-Nov-16	-	19.0
21-Nov-16	379	19.0
22-Nov-16	-	19.0
23-Nov-16	-	19.0
24-Nov-16	-	19.0
25-Nov-16	-	19.0
28-Nov-16	379	19.0
29-Nov-16	-	19.0
30-Nov-16	-	19.0
1-Dec-16	-	19.0
2-Dec-16	-	19.0
5-Dec-16	379	19.0
6-Dec-16	-	19.0
7-Dec-16	-	19.0
8-Dec-16	-	19.0
9-Dec-16	-	19.0
12-Dec-16	379	21.0
13-Dec-16	-	21.0
14-Dec-16	-	21.0
15-Dec-16	-	21.0
16-Dec-16	-	21.0
19-Dec-16	379	21.0
20-Dec-16	-	19.0
21-Dec-16	-	21.0
22-Dec-16	-	19.0
23-Dec-16	-	21.0
29-Dec-16	379	21.0
30-Dec-16	-	21.0
1-Jan-17	-	21.0
2-Jan-17	379	21.0
3-Jan-17	-	21.0
4-Jan-17	-	21.0
5-Jan-17	-	21.0
6-Jan-17	-	21.0
7-Jan-17	-	21.0
8-Jan-17	-	21.0
9-Jan-17	379	21.0

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table G.11: Water Quality at TOMP Station Q-29 (Perimeter Monitoring), Quirke TMA, 2015 to 2019

Date	Elevation (m)	Flow (L/s)
10-Jan-17	-	21.0
11-Jan-17	-	21.0
12-Jan-17	-	21.0
13-Jan-17	-	21.0
14-Jan-17	-	21.0
15-Jan-17	-	21.0
16-Jan-17	379	21.0
17-Jan-17	-	21.0
18-Jan-17	-	21.0
19-Jan-17	-	21.0
20-Jan-17	-	21.0
21-Jan-17	-	21.0
22-Jan-17	-	21.0
23-Jan-17	379	21.0
24-Jan-17	-	21.0
25-Jan-17	-	21.0
26-Jan-17	-	21.0
27-Jan-17	-	21.0
28-Jan-17	-	21.0
29-Jan-17	-	21.0
30-Jan-17	379	21.0
31-Jan-17	-	21.0
1-Feb-17	-	21.0
2-Feb-17	-	21.0
3-Feb-17	-	21.0
4-Feb-17	-	21.0
5-Feb-17	-	21.0
6-Feb-17	379	23.0
7-Feb-17	-	23.0
8-Feb-17	-	23.0
9-Feb-17	-	48.0
10-Feb-17	-	48.0
11-Feb-17	-	48.0
12-Feb-17	-	48.0
13-Feb-17	379	48.0
14-Feb-17	-	51.0
15-Feb-17	-	51.0
16-Feb-17	-	51.0
17-Feb-17	-	51.0
18-Feb-17	-	51.0
19-Feb-17	-	51.0
20-Feb-17	-	51.0
21-Feb-17	379	51.0
22-Feb-17	-	25.0
23-Feb-17	-	25.0
24-Feb-17	-	25.0
25-Feb-17	-	25.0
26-Feb-17	-	25.0
27-Feb-17	379	25.0
28-Feb-17	-	25.0
1-Mar-17	-	48.0
2-Mar-17	-	48.0
3-Mar-17	-	48.0
4-Mar-17	-	48.0
5-Mar-17	-	48.0
6-Mar-17	379	48.0
7-Mar-17	-	48.0
8-Mar-17	-	48.0
9-Mar-17	-	48.0
10-Mar-17	-	51.0
11-Mar-17	-	51.0
12-Mar-17	-	51.0

Date	Elevation (m)	Flow (L/s)
13-Mar-17	-	48.0
14-Mar-17	-	48.0
15-Mar-17	-	48.0
16-Mar-17	379	48.0
17-Mar-17	-	48.0
18-Mar-17	-	48.0
19-Mar-17	-	48.0
20-Mar-17	379	51.0
21-Mar-17	-	53.0
22-Mar-17	-	48.0
23-Mar-17	-	63.0
24-Mar-17	-	63.0
25-Mar-17	-	63.0
26-Mar-17	-	63.0
27-Mar-17	379	63.0
28-Mar-17	-	63.0
29-Mar-17	-	100
30-Mar-17	-	100
31-Mar-17	-	100
1-Apr-17	-	100
2-Apr-17	-	100
3-Apr-17	380	100
4-Apr-17	-	100
5-Apr-17	-	100
6-Apr-17	-	100
7-Apr-17	-	100
8-Apr-17	-	100
9-Apr-17	-	100
10-Apr-17	380	100
11-Apr-17	-	100
12-Apr-17	-	100
13-Apr-17	-	100
14-Apr-17	-	100
15-Apr-17	-	100
16-Apr-17	-	100
17-Apr-17	380	100
18-Apr-17	-	100
19-Apr-17	-	100
20-Apr-17	-	100
21-Apr-17	-	100
22-Apr-17	-	100
23-Apr-17	-	100
24-Apr-17	380	100
25-Apr-17	-	100
26-Apr-17	-	100
27-Apr-17	-	100
28-Apr-17	-	97.0
29-Apr-17	-	100
30-Apr-17	-	100
1-May-17	380	100
2-May-17	380	100
3-May-17	-	100
4-May-17	-	100
5-May-17	-	100
6-May-17	-	100
7-May-17	-	100
8-May-17	380	100
9-May-17	-	100
10-May-17	-	100
11-May-17	-	100
12-May-17	-	100
13-May-17	-	100

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table G.11: Water Quality at TOMP Station Q-29 (Perimeter Monitoring), Quirke TMA, 2015 to 2019

Date	Elevation (m)	Flow (L/s)
14-May-17	-	100
15-May-17	379	100
16-May-17	-	100
17-May-17	-	100
18-May-17	-	100
19-May-17	-	100
20-May-17	-	100
21-May-17	-	100
22-May-17	-	100
23-May-17	379	100
24-May-17	-	100
25-May-17	-	100
26-May-17	-	100
27-May-17	-	100
28-May-17	-	100
29-May-17	379	100
30-May-17	-	97.0
31-May-17	-	100
1-Jun-17	-	100
2-Jun-17	-	100
3-Jun-17	-	50.0
10-Jul-17	380	25.0
11-Jul-17	-	25.0
12-Jul-17	-	25.0
13-Jul-17	-	25.0
14-Jul-17	-	25.0
15-Jul-17	-	25.0
16-Jul-17	-	25.0
17-Jul-17	380	25.0
18-Jul-17	-	25.0
19-Jul-17	-	25.0
20-Jul-17	-	25.0
21-Jul-17	-	50.0
22-Jul-17	-	50.0
23-Jul-17	-	50.0
24-Jul-17	380	50.0
25-Jul-17	-	50.0
26-Jul-17	-	51.0
27-Jul-17	-	51.0
28-Jul-17	-	51.0
29-Jul-17	-	50.0
30-Jul-17	-	50.0
31-Jul-17	380	50.0
1-Aug-17	-	50.0
2-Aug-17	-	50.0
3-Aug-17	-	50.0
4-Aug-17	-	100
5-Aug-17	-	100
6-Aug-17	-	100
7-Aug-17	-	100
8-Aug-17	379	100
9-Aug-17	-	100
10-Aug-17	-	100
11-Aug-17	-	100
12-Aug-17	-	100
13-Aug-17	-	100
14-Aug-17	379	100
15-Aug-17	-	100
16-Aug-17	-	100
17-Aug-17	-	100
18-Aug-17	-	100
19-Aug-17	-	100
20-Aug-17	-	100
21-Aug-17	379	100
22-Aug-17	-	100
23-Aug-17	-	100
24-Aug-17	-	100
25-Aug-17	-	100
26-Aug-17	-	100
27-Aug-17	-	100
28-Aug-17	379	100
29-Aug-17	-	100
30-Aug-17	-	50.0
31-Aug-17	-	50.0
1-Sep-17	-	50.0
2-Sep-17	-	50.0
3-Sep-17	-	50.0
4-Sep-17	-	50.0
5-Sep-17	379	50.0
6-Sep-17	-	50.0
7-Sep-17	-	50.0
8-Sep-17	-	50.0
9-Sep-17	-	50.0
10-Sep-17	-	50.0
11-Sep-17	379	50.0
12-Sep-17	-	50.0
13-Sep-17	-	50.0
14-Sep-17	-	50.0
15-Sep-17	-	50.0
16-Sep-17	-	50.0
17-Sep-17	-	50.0
18-Sep-17	379	50.0
19-Sep-17	-	50.0
20-Sep-17	-	25.0
21-Sep-17	-	25.0
22-Sep-17	-	25.0
23-Sep-17	-	25.0
24-Sep-17	-	25.0
25-Sep-17	379	25.0
26-Sep-17	-	25.0
27-Sep-17	-	25.0
28-Sep-17	-	25.0
29-Sep-17	-	25.0
30-Sep-17	-	25.0
1-Oct-17	-	25.0
2-Oct-17	379	25.0
3-Oct-17	-	25.0
4-Oct-17	-	25.0
5-Oct-17	-	25.0
6-Oct-17	-	25.0
7-Oct-17	-	25.0
8-Oct-17	-	25.0
9-Oct-17	-	25.0
10-Oct-17	379	25.0
11-Oct-17	-	25.0
12-Oct-17	-	25.0
13-Oct-17	-	25.0
14-Oct-17	-	25.0
15-Oct-17	-	25.0
16-Oct-17	379	25.0
17-Oct-17	-	25.0
18-Oct-17	-	25.0
19-Oct-17	-	25.0
20-Oct-17	-	25.0

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table G.11: Water Quality at TOMP Station Q-29 (Perimeter Monitoring), Quirke TMA, 2015 to 2019

Date	Elevation (m)	Flow (L/s)
21-Oct-17	-	25.0
22-Oct-17	-	25.0
23-Oct-17	380	27.0
24-Oct-17	-	100
2-Apr-18	380	50.0
3-Apr-18	-	50.0
4-Apr-18	-	50.0
5-Apr-18	-	50.0
6-Apr-18	-	50.0
7-Apr-18	-	50.0
8-Apr-18	-	50.0
9-Apr-18	380	50.0
10-Apr-18	-	50.0
11-Apr-18	-	50.0
12-Apr-18	-	50.0
13-Apr-18	-	50.0
14-Apr-18	-	50.0
15-Apr-18	-	50.0
16-Apr-18	380	50.0
17-Apr-18	-	50.0
18-Apr-18	-	50.0
19-Apr-18	-	50.0
20-Apr-18	-	50.0
21-Apr-18	-	50.0
22-Apr-18	-	50.0
23-Apr-18	380	50.0
24-Apr-18	-	50.0
25-Apr-18	-	50.0
26-Apr-18	-	50.0
27-Apr-18	-	50.0
28-Apr-18	-	50.0
29-Apr-18	-	50.0
30-Apr-18	380	50.0
1-May-18	-	100
2-May-18	-	100
3-May-18	-	100
4-May-18	-	100
5-May-18	-	100
6-May-18	-	100
7-May-18	380	100
8-May-18	-	100
9-May-18	-	100
10-May-18	-	100
11-May-18	-	100
12-May-18	-	100
13-May-18	-	100
14-May-18	380	100
15-May-18	-	100
16-May-18	-	100
17-May-18	-	100
18-May-18	-	100
19-May-18	-	100
20-May-18	-	100
21-May-18	-	100
22-May-18	-	100
23-May-18	379	100
24-May-18	-	50.0
25-May-18	-	50.0
26-May-18	-	50.0
27-May-18	-	50.0
28-May-18	379	50.0
29-May-18	-	50.0

Date	Elevation (m)	Flow (L/s)
30-May-18	-	50.0
31-May-18	-	50.0
1-Jun-18	-	50.0
2-Jun-18	-	50.0
3-Jun-18	-	50.0
4-Jun-18	379	50.0
5-Jun-18	-	50.0
6-Jun-18	-	50.0
7-Jun-18	-	50.0
8-Jun-18	-	50.0
9-Jun-18	-	50.0
10-Jun-18	-	50.0
11-Jun-18	379	50.0
12-Jun-18	-	50.0
13-Jun-18	-	50.0
14-Jun-18	-	50.0
15-Jun-18	-	50.0
16-Jun-18	-	50.0
17-Jun-18	-	50.0
18-Jun-18	379	50.0
19-Jun-18	-	50.0
20-Jun-18	-	50.0
21-Jun-18	-	50.0
22-Jun-18	-	50.0
23-Jun-18	-	50.0
24-Jun-18	-	50.0
25-Jun-18	379	50.0
26-Jun-18	-	50.0
27-Jun-18	-	50.0
28-Jun-18	-	50.0
29-Jun-18	-	50.0
30-Jun-18	-	50.0
1-Jul-18	-	50.0
2-Jul-18	-	50.0
3-Jul-18	379	50.0
4-Jul-18	-	50.0
5-Jul-18	-	50.0
6-Jul-18	-	50.0
7-Jul-18	-	50.0
8-Jul-18	-	50.0
9-Jul-18	379	50.0
10-Jul-18	-	50.0
11-Jul-18	-	50.0
12-Jul-18	-	50.0
13-Jul-18	-	50.0
14-Jul-18	-	50.0
15-Jul-18	-	50.0
16-Jul-18	379	50.0
17-Jul-18	-	25.0
18-Jul-18	-	25.0
19-Jul-18	-	25.0
20-Jul-18	-	25.0
21-Jul-18	-	25.0
22-Jul-18	-	25.0
23-Jul-18	379	25.0
24-Jul-18	-	25.0
25-Jul-18	-	25.0
26-Jul-18	-	25.0
27-Jul-18	-	25.0
28-Jul-18	-	25.0
29-Jul-18	-	25.0
30-Jul-18	379	25.0

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table G.11: Water Quality at TOMP Station Q-29 (Perimeter Monitoring), Quirke TMA, 2015 to 2019

Date	Elevation (m)	Flow (L/s)
31-Jul-18	-	25.0
1-Aug-18	-	25.0
2-Aug-18	-	25.0
3-Aug-18	-	25.0
4-Aug-18	-	25.0
5-Aug-18	-	25.0
6-Aug-18	-	25.0
7-Aug-18	378	25.0
9-Oct-18	379	50.0
10-Oct-18	-	50.0
11-Oct-18	-	50.0
12-Oct-18	-	100
13-Oct-18	-	100
14-Oct-18	-	100
15-Oct-18	380	100
16-Oct-18	-	100
17-Oct-18	-	100
18-Oct-18	-	100
19-Oct-18	-	100
20-Oct-18	-	100
21-Oct-18	-	100
22-Oct-18	380	100
23-Oct-18	-	100
24-Oct-18	-	100
25-Oct-18	-	100
26-Oct-18	-	100
27-Oct-18	-	100
28-Oct-18	-	100
29-Oct-18	380	100
30-Oct-18	-	100
31-Oct-18	-	100
1-Nov-18	-	100
2-Nov-18	-	100
3-Nov-18	-	100
4-Nov-18	-	100
5-Nov-18	379	100
6-Nov-18	-	100
7-Nov-18	-	100
8-Nov-18	-	100
9-Nov-18	-	100
10-Nov-18	-	100
11-Nov-18	-	100
12-Nov-18	379	100
13-Nov-18	-	100
14-Nov-18	-	100
15-Nov-18	-	100
16-Nov-18	-	100
17-Nov-18	-	100
18-Nov-18	-	100
19-Nov-18	379	100
20-Nov-18	-	100
21-Nov-18	-	100
22-Nov-18	-	100
23-Nov-18	-	100
24-Nov-18	-	100
25-Nov-18	-	100
26-Nov-18	379	100
27-Nov-18	-	100
28-Nov-18	-	100
29-Nov-18	-	100
30-Nov-18	-	100
1-Dec-18	-	100
2-Dec-18	-	100

Date	Elevation (m)	Flow (L/s)
3-Dec-18	379	100
4-Dec-18	-	50.0
5-Dec-18	-	50.0
6-Dec-18	-	50.0
7-Dec-18	-	50.0
8-Dec-18	-	50.0
9-Dec-18	-	50.0
10-Dec-18	379	50.0
11-Dec-18	-	50.0
12-Dec-18	-	50.0
13-Dec-18	-	50.0
14-Dec-18	-	50.0
15-Dec-18	-	50.0
16-Dec-18	-	50.0
17-Dec-18	379	50.0
18-Dec-18	-	50.0
19-Dec-18	-	25.0
20-Dec-18	-	25.0
21-Dec-18	-	25.0
22-Dec-18	-	25.0
23-Dec-18	-	25.0
24-Dec-18	-	25.0
25-Dec-18	-	25.0
26-Dec-18	-	25.0
27-Dec-18	379	25.0
28-Dec-18	-	25.0
29-Dec-18	-	25.0
30-Dec-18	-	25.0
31-Dec-18	379	25.0
1-Jan-19	-	25.0
2-Jan-19	-	25.0
3-Jan-19	-	25.0
4-Jan-19	-	25.0
5-Jan-19	-	25.0
6-Jan-19	-	25.0
7-Jan-19	379	25.0
8-Jan-19	-	25.0
9-Jan-19	-	25.0
10-Jan-19	-	50.0
11-Jan-19	-	50.0
12-Jan-19	-	50.0
13-Jan-19	-	50.0
14-Jan-19	-	50.0
15-Jan-19	379	50.0
16-Jan-19	-	50.0
17-Jan-19	-	50.0
18-Jan-19	-	50.0
19-Jan-19	-	50.0
20-Jan-19	-	50.0
21-Jan-19	379	50.0
22-Jan-19	-	50.0
23-Jan-19	-	50.0
24-Jan-19	-	50.0
25-Jan-19	-	50.0
26-Jan-19	-	50.0
27-Jan-19	-	50.0
28-Jan-19	379	50.0
29-Jan-19	-	50.0
30-Jan-19	-	50.0
31-Jan-19	-	50.0
1-Feb-19	-	50.0
2-Feb-19	-	50.0
3-Feb-19	-	50.0

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table G.11: Water Quality at TOMP Station Q-29 (Perimeter Monitoring), Quirke TMA, 2015 to 2019

Date	Elevation (m)	Flow (L/s)
4-Feb-19	379	50.0
5-Feb-19	-	50.0
6-Feb-19	-	50.0
7-Feb-19	-	50.0
8-Feb-19	-	50.0
9-Feb-19	-	50.0
10-Feb-19	-	50.0
11-Feb-19	379	50.0
12-Feb-19	-	50.0
13-Feb-19	-	50.0
14-Feb-19	-	50.0
15-Feb-19	-	50.0
16-Feb-19	-	50.0
17-Feb-19	-	50.0
18-Feb-19	-	50.0
2-Jul-19	380	50.0
3-Jul-19	-	50.0
4-Jul-19	-	50.0
5-Jul-19	-	50.0
6-Jul-19	-	50.0
7-Jul-19	-	50.0
8-Jul-19	379	50.0
9-Jul-19	-	50.0
10-Jul-19	-	50.0
11-Jul-19	-	50.0
12-Jul-19	-	50.0
13-Jul-19	-	50.0
14-Jul-19	-	50.0
15-Jul-19	379	50.0
16-Jul-19	-	50.0
17-Jul-19	-	50.0
18-Jul-19	-	50.0
19-Jul-19	-	50.0
20-Jul-19	-	50.0
21-Jul-19	-	50.0
22-Jul-19	379	50.0
23-Jul-19	-	50.0
24-Jul-19	-	50.0
25-Jul-19	-	50.0
26-Jul-19	-	50.0
27-Jul-19	-	50.0
28-Jul-19	-	50.0
29-Jul-19	379	50.0
30-Jul-19	-	50.0
31-Jul-19	-	50.0
1-Aug-19	-	50.0
2-Aug-19	-	50.0
3-Aug-19	-	50.0
4-Aug-19	-	50.0
5-Aug-19	-	50.0
6-Aug-19	379	50.0
7-Aug-19	-	50.0
8-Aug-19	-	50.0
9-Aug-19	-	50.0
10-Aug-19	-	50.0
11-Aug-19	-	50.0
12-Aug-19	379	50.0
13-Aug-19	-	50.0
14-Aug-19	-	50.0
15-Aug-19	-	50.0
16-Aug-19	-	50.0

Date	Elevation (m)	Flow (L/s)
17-Aug-19	-	50.0
18-Aug-19	-	50.0
19-Aug-19	379	50.0
20-Aug-19	-	50.0
21-Aug-19	-	50.0
22-Aug-19	-	50.0
23-Aug-19	-	50.0
24-Aug-19	-	50.0
25-Aug-19	-	50.0
26-Aug-19	379	50.0
27-Aug-19	-	50.0
28-Aug-19	-	50.0
29-Aug-19	-	50.0
30-Aug-19	-	50.0
31-Aug-19	-	50.0
1-Sep-19	-	50.0
2-Sep-19	-	50.0
3-Sep-19	379	25.0
4-Sep-19	-	25.0
5-Sep-19	-	25.0
6-Sep-19	-	25.0
7-Sep-19	-	25.0
8-Sep-19	-	25.0
9-Sep-19	379	25.0
10-Sep-19	-	25.0
11-Sep-19	-	25.0
12-Sep-19	-	25.0
13-Sep-19	-	25.0
14-Sep-19	-	25.0
15-Sep-19	-	25.0
16-Sep-19	379	25.0
17-Sep-19	-	25.0
18-Sep-19	-	25.0
19-Sep-19	-	25.0
20-Sep-19	-	25.0
21-Sep-19	-	25.0
22-Sep-19	-	25.0
23-Sep-19	379	25.0
24-Sep-19	-	25.0
25-Sep-19	-	25.0
26-Sep-19	-	25.0
27-Sep-19	-	25.0
28-Sep-19	-	25.0
29-Sep-19	-	25.0
30-Sep-19	379	25.0
1-Oct-19	-	25.0
2-Oct-19	-	25.0
3-Oct-19	-	25.0
4-Oct-19	-	50.0
5-Oct-19	-	50.0
6-Oct-19	-	50.0
7-Oct-19	379	50.0
8-Oct-19	-	50.0
9-Oct-19	-	50.0
10-Oct-19	-	50.0
11-Oct-19	-	50.0
12-Oct-19	-	50.0
13-Oct-19	-	50.0
14-Oct-19	-	50.0
15-Oct-19	379	50.0
16-Oct-19	-	50.0

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table G.11: Water Quality at TOMP Station Q-29 (Perimeter Monitoring), Quirke TMA, 2015 to 2019

Date	Elevation (m)	Flow (L/s)
17-Oct-19	-	50.0
18-Oct-19	-	50.0
19-Oct-19	-	50.0
20-Oct-19	-	50.0
21-Oct-19	379	50.0
22-Oct-19	-	50.0
23-Oct-19	-	100
24-Oct-19	-	100
25-Oct-19	-	100
26-Oct-19	-	100
27-Oct-19	-	100
28-Oct-19	380	100
29-Oct-19	-	100
30-Oct-19	-	100
31-Oct-19	-	100
1-Nov-19	-	100
2-Nov-19	-	100
3-Nov-19	-	100
4-Nov-19	380	100
5-Nov-19	-	100
6-Nov-19	-	100
7-Nov-19	-	100
8-Nov-19	-	100
9-Nov-19	-	100
10-Nov-19	-	100
11-Nov-19	379	100
12-Nov-19	-	100
13-Nov-19	-	100
14-Nov-19	-	100
15-Nov-19	-	100
16-Nov-19	-	100
17-Nov-19	-	100
18-Nov-19	379	100
19-Nov-19	-	100
20-Nov-19	-	100
21-Nov-19	-	100
22-Nov-19	-	100
23-Nov-19	-	100
24-Nov-19	-	100
25-Nov-19	379	100
26-Nov-19	-	100
27-Nov-19	-	100
n	168	1012
Minimum	378	18.0
Maximum	380	100
Mean	379	54.0
SD	0.310	28.9
Median	379	50.0
10th Percentile	379	21.0
95th Percentile	380	100

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table G.12: Water Quality at TOMP Station DK-14-5C (Pore Water), Quirke TMA, 2015 to 2019

Date	pH	Sulphate (mg/L)	Acidity (mg/L)	Iron (mg/L)
22-Jul-15	8.13	1,500	<1.00	<0.0200
15-Jun-16	6.82	1,500	<1.00	<0.0200
18-Jul-17	8.15	1,500	<1.00	<0.0200
17-Jul-18	8.10	1,400	<1.00	<0.0200
30-Jul-19	6.52	1,400	<1.00	<0.0200
n	5	5	5	5
Minimum	6.52	1,400	<1.00	<0.0200
Maximum	8.15	1,500	<1.00	<0.0200
Mean	7.54	1,460	<1.00	<0.0200
SD	0.805	54.8	-	-
Median	8.10	1,500	<1.00	<0.0200
10th Percentile	6.52	1,400	<1.00	<0.0200
95th Percentile	8.15	1,500	<1.00	<0.0200

Note: "SD" = standard deviation. "n" = number of samples. "-" = SD was incalculable because there was no variability in the data.

Table G.13: Water Quality at TOMP Stations DK-15-2 A, B, C, D (Pore Water), Quirke TMA, 2015 to 2019

Station	Date	pH	Sulphate (mg/L)	Acidity (mg/L)	Iron (mg/L)
DK-15-2A	27-Jul-15	6.16	1,600	254	147
	9-Jun-16	6.12	1,700	304	154
	17-Jul-17	5.95	1,700	428	310
	16-Jul-18	5.98	1,900	530	322
	25-Jul-19	5.82	1,700	416	226
	n	5	5	5	5
	Minimum	5.82	1,600	254	147
	Maximum	6.16	1,900	530	322
	Mean	6.01	1,720	386	232
	SD	0.137	110	109	83.0
	Median	5.98	1,700	416	226
	10th Percentile	5.82	1,600	254	147
	95th Percentile	6.16	1,900	530	322
DK-15-2B	27-Jul-15	5.77	1,700	450	282
	9-Jun-16	5.75	1,900	491	186
	17-Jul-17	5.85	1,600	360	229
	16-Jul-18	6.01	1,500	301	149
	29-Jul-19	5.94	1,600	268	171
	n	5	5	5	5
	Minimum	5.75	1,500	268	149
	Maximum	6.01	1,900	491	282
	Mean	5.86	1,660	374	203
	SD	0.111	152	95.2	52.8
	Median	5.85	1,600	360	186
	10th Percentile	5.75	1,500	268	149
	95th Percentile	6.01	1,900	491	282
DK-15-2C	27-Jul-15	5.77	1,800	430	307
	9-Jun-16	5.80	1,900	475	184
	17-Jul-17	5.80	1,800	362	230
	16-Jul-18	5.83	1,500	325	142
	n	4	4	4	4
	Minimum	5.77	1,500	325	142
	Maximum	5.83	1,900	475	307
	Mean	5.80	1,750	398	216
	SD	0.0245	173	67.3	70.7
	Median	5.80	1,800	396	207
	10th Percentile	5.77	1,500	325	142
	95th Percentile	5.83	1,900	475	307
DK-15-2D	27-Jul-15	6.19	1,700	384	255
	9-Jun-16	5.66	1,800	407	216
	17-Jul-17	5.72	1,700	388	266
	16-Jul-18	6.35	1,600	383	272
	29-Jul-19	6.36	1,600	304	216
	n	5	5	5	5
	Minimum	5.66	1,600	304	216
	Maximum	6.36	1,800	407	272
	Mean	6.06	1,680	373	245
	SD	0.342	83.7	39.9	27.2
	Median	6.19	1,700	384	255
	10th Percentile	5.66	1,600	304	216
	95th Percentile	6.36	1,800	407	272

Note: "SD" = standard deviation. "n" = number of samples.

Table G.14: Water Quality at TOMP Stations DK-15-4 A, B, C, D (Pore Water), Quirke TMA, 2015 to 2019

Station	Date	pH	Sulphate (mg/L)	Acidity (mg/L)	Iron (mg/L)
DK-15-4A	27-Jul-15	6.39	1,600	205	154
	14-Jun-16	5.56	1,600	197	131
	18-Jul-17	6.49	1,600	212	148
	17-Jul-18	6.25	1,600	193	133
	24-Jul-19	6.53	1,500	153	176
	n	5	5	5	5
	Minimum	5.56	1,500	153	131
	Maximum	6.53	1,600	212	176
	Mean	6.24	1,580	192	148
	SD	0.397	44.7	23.0	18.3
	Median	6.39	1,600	197	148
	10th Percentile	5.56	1,500	153	131
	95th Percentile	6.53	1,600	212	176
DK-15-4B	27-Jul-15	6.24	1,900	471	331
	14-Jun-16	5.88	2,000	464	310
	18-Jul-17	6.28	1,900	451	314
	17-Jul-18	6.30	1,800	434	279
	25-Jul-19	6.12	1,700	383	258
	n	5	5	5	5
	Minimum	5.88	1,700	383	258
	Maximum	6.30	2,000	471	331
	Mean	6.16	1,860	441	298
	SD	0.173	114	35.1	29.4
	Median	6.24	1,900	451	310
	10th Percentile	5.88	1,700	383	258
	95th Percentile	6.30	2,000	471	331
DK-15-4C	27-Jul-15	6.25	1,900	491	333
	14-Jun-16	6.20	2,000	468	311
	18-Jul-17	6.35	1,900	418	307
	17-Jul-18	6.29	1,700	411	288
	25-Jul-19	6.13	1,700	367	242
	n	5	5	5	5
	Minimum	6.13	1,700	367	242
	Maximum	6.35	2,000	491	333
	Mean	6.24	1,840	431	296
	SD	0.0841	134	49.1	34.3
	Median	6.25	1,900	418	307
	10th Percentile	6.13	1,700	367	242
	95th Percentile	6.35	2,000	491	333
DK-15-4D	27-Jul-15	6.21	1,900	458	320
	14-Jun-16	5.77	2,000	492	300
	18-Jul-17	6.28	1,800	440	295
	17-Jul-18	6.28	1,700	405	285
	25-Jul-19	6.16	2,200	348	226
	n	5	5	5	5
	Minimum	5.77	1,700	348	226
	Maximum	6.28	2,200	492	320
	Mean	6.14	1,920	429	285
	SD	0.213	192	54.9	35.5
	Median	6.21	1,900	440	295
	10th Percentile	5.77	1,700	348	226
	95th Percentile	6.28	2,200	492	320

Note: "SD" = standard deviation. "n" = number of samples.

Table G.15: Water Quality at TOMP Stations DK-16-2 A, B, C, D (Pore Water), Quirke TMA, 2015 to 2019

Station	Date	pH	Sulphate (mg/L)	Acidity (mg/L)	Iron (mg/L)
DK-16-2A	21-Jul-15	6.99	1,700	<1.00	33.1
	9-Jun-16	6.40	1,500	<1.00	32.4
	18-Jul-17	7.04	1,400	3.00	31.6
	19-Jul-18	6.85	1,500	<1.00	21.7
	24-Jul-19	6.89	1,400	<1.00	39.8
	n	5	5	5	5
	Minimum	6.40	1,400	<1.00	21.7
	Maximum	7.04	1,700	3.00	39.8
	Mean	6.83	1,500	1.40	31.7
	SD	0.254	122	-	6.48
	Median	6.89	1,500	<1.00	32.4
	10th Percentile	6.40	1,400	<1.00	21.7
	95th Percentile	7.04	1,700	3.00	39.8
DK-16-2B	21-Jul-15	8.12	1,400	<1.00	0.0700
	24-Aug-15	8.15	1,500	<1.00	0.0300
	9-Jun-16	8.75	1,500	<1.00	0.0800
	18-Jul-17	8.22	1,500	<1.00	0.0950
	19-Jul-18	7.94	1,400	<1.00	0.108
	24-Jul-19	8.15	1,300	<1.00	0.143
	n	6	6	6	6
	Minimum	7.94	1,300	<1.00	0.0300
	Maximum	8.75	1,500	<1.00	0.143
	Mean	8.22	1,430	<1.00	0.0877
	SD	0.275	81.6	-	0.0380
	Median	8.15	1,450	<1.00	0.0875
	10th Percentile	7.94	1,300	<1.00	0.0300
	95th Percentile	8.75	1,500	<1.00	0.143
DK-16-2C	21-Jul-15	7.16	1,400	<1.00	3.62
	9-Jun-16	7.60	1,500	<1.00	2.67
	18-Jul-17	7.03	1,400	<1.00	1.76
	19-Jul-18	7.51	1,400	<1.00	1.66
	24-Jul-19	7.18	1,300	<1.00	1.08
	n	5	5	5	5
	Minimum	7.03	1,300	<1.00	1.08
	Maximum	7.60	1,500	<1.00	3.62
	Mean	7.30	1,400	<1.00	2.16
	SD	0.245	70.7	-	0.996
	Median	7.18	1,400	<1.00	1.76
	10th Percentile	7.03	1,300	<1.00	1.08
	95th Percentile	7.60	1,500	<1.00	3.62
DK-16-2D	21-Jul-15	6.15	1,500	19.0	9.54
	9-Jun-16	6.50	1,500	21.0	8.86
	18-Jul-17	5.63	1,400	21.0	6.59
	19-Jul-18	6.53	1,500	19.0	7.37
	24-Jul-19	6.55	1,400	16.0	8.10
	n	5	5	5	5
	Minimum	5.63	1,400	16.0	6.59
	Maximum	6.55	1,500	21.0	9.54
	Mean	6.27	1,460	19.2	8.09
	SD	0.395	54.8	2.05	1.17
	Median	6.50	1,500	19.0	8.10
	10th Percentile	5.63	1,400	16.0	6.59
	95th Percentile	6.55	1,500	21.0	9.54

Note: "SD" = standard deviation. "n" = number of samples. "-" = SD was incalculable because there was no variability in the data.

Table G.16: Water Quality at TOMP Stations DK-17-2 A, B, C, D (Pore Water), Quirke TMA, 2015 to 2019

Station	Date	pH	Sulphate (mg/L)	Acidity (mg/L)	Iron (mg/L)
DK-17-2A	28-Jul-15	6.15	2,500	1,050	671
	13-Jun-16	6.20	2,600	981	552
	19-Jul-17	6.17	2,200	749	459
	19-Jul-18	6.33	2,100	<1.00	338
	23-Jul-19	6.15	1,900	480	339
	n	5	5	5	5
	Minimum	6.15	1,900	<1.00	338
	Maximum	6.33	2,600	1,050	671
	Mean	6.20	2,260	652	472
	SD	0.0755	288	278	143
	Median	6.17	2,200	749	459
	10th Percentile	6.15	1,900	<480	338
	95th Percentile	6.33	2,600	1,050	671
DK-17-2B	28-Jul-15	6.86	1,400	9.00	20.4
	13-Jun-16	6.82	1,500	10.0	10.9
	19-Jul-17	7.19	1,300	15.0	7.02
	19-Jul-18	7.68	1,300	<1.00	4.57
	23-Jul-19	6.78	1,300	<1.00	4.66
	n	5	5	5	5
	Minimum	6.78	1,300	<1.00	4.57
	Maximum	7.68	1,500	15.0	20.4
	Mean	7.07	1,360	7.20	9.51
	SD	0.380	89.4	2.86	6.61
	Median	6.86	1,300	9.00	7.02
	10th Percentile	6.78	1,300	<1.00	4.57
	95th Percentile	7.68	1,500	15.0	20.4
DK-17-2C	29-Jul-15	9.14	1,300	<1.00	0.0260
	13-Jun-16	8.25	1,400	<1.00	0.0580
	19-Jul-17	9.60	1,300	<1.00	0.0840
	19-Jul-18	9.63	1,400	<1.00	0.0570
	24-Jul-19	9.52	1,300	<1.00	0.0270
	n	5	5	5	5
	Minimum	8.25	1,300	<1.00	0.0260
	Maximum	9.63	1,400	<1.00	0.0840
	Mean	9.23	1,340	<1.00	0.0504
	SD	0.581	54.8	-	0.0244
	Median	9.52	1,300	<1.00	0.0570
	10th Percentile	8.25	1,300	<1.00	0.0260
	95th Percentile	9.63	1,400	<1.00	0.0840
DK-17-2D	29-Jul-15	9.88	1,400	<1.00	0.0910
	13-Jun-16	9.86	1,400	<1.00	0.0780
	19-Jul-17	10.2	1,300	<1.00	0.0750
	19-Jul-18	9.92	1,300	<1.00	0.0380
	23-Jul-19	9.80	1,500	<1.00	0.0510
	n	5	5	5	5
	Minimum	9.80	1,300	<1.00	0.0380
	Maximum	10.2	1,500	<1.00	0.0910
	Mean	9.93	1,380	<1.00	0.0666
	SD	0.152	83.7	-	0.0215
	Median	9.88	1,400	<1.00	0.0750
	10th Percentile	9.80	1,300	<1.00	0.0380
	95th Percentile	10.2	1,500	<1.00	0.0910

Note: "SD" = standard deviation. "n" = number of samples. "-" = SD was incalculable because there was no variability in the data.

Table G.17: Water Quality at TOMP Stations QPW-1-1,4,8 (Groundwater), Quirke TMA, 2015 to 2019

Station	Date	pH	Sulphate (mg/L)	Acidity (mg/L)	Iron (mg/L)
QPW1-1	19-Jul-18	6.50	0.300	<1.00	17.7
	30-Jul-19	6.50	0.700	<1.00	10.4
	n	2	2	2	2
	Minimum	6.50	0.300	<1.00	10.4
	Maximum	6.50	0.700	<1.00	17.7
	Mean	6.50	0.500	<1.00	14.0
	SD	-	0.283	-	5.16
	Median	6.50	0.500	<1.00	14.0
	10th Percentile	6.50	0.300	<1.00	10.4
	95th Percentile	6.50	0.700	<1.00	17.7
QPW1-4	28-Jul-15	6.30	68.0	<1.00	1.89
	2-Sep-15	6.30	68.0	<1.00	2.14
	15-Jun-16	5.20	64.0	<1.00	2.08
	20-Jul-17	6.50	59.0	<1.00	2.33
	18-Jul-18	6.20	62.0	<1.00	2.06
	30-Jul-19	6.50	58.0	<1.00	2.25
	n	6	6	6	6
	Minimum	5.20	58.0	<1.00	1.89
	Maximum	6.50	68.0	<1.00	2.33
	Mean	6.17	63.2	<1.00	2.12
	SD	0.489	4.31	-	0.154
	Median	6.30	63.0	<1.00	2.11
	10th Percentile	5.20	58.0	<1.00	1.89
	95th Percentile	6.50	68.0	<1.00	2.33
QPW1-8	28-Jul-15	6.80	310	<1.00	18.7
	2-Sep-15	6.90	270	<1.00	18.3
	16-Jun-16	5.80	310	<1.00	19.5
	20-Jul-17	6.80	290	<1.00	19.1
	30-Jul-19	6.70	350	<1.00	9.34
	n	5	5	5	5
	Minimum	5.80	270	<1.00	9.34
	Maximum	6.90	350	<1.00	19.5
	Mean	6.60	306	<1.00	17.0
	SD	0.453	29.7	-	4.30
	Median	6.80	310	<1.00	18.7
	10th Percentile	5.80	270	<1.00	9.34
	95th Percentile	6.90	350	<1.00	19.5

Note: "SD" = standard deviation. "n" = number of samples. "-" = SD was incalculable because there was no variability in the data.

Table G.18: Water Quality at TOMP Stations 95-QW-3 A, C, D (Groundwater), Quirke TMA, 2015 to 2019

Station	Date	pH	Sulphate (mg/L)	Acidity (mg/L)	Iron (mg/L)
95QW-3-A	28-Jul-15	6.30	1,400	175	126
	14-Jun-16	6.10	1,400	154	110
	24-Jul-17	6.30	1,300	151	122
	18-Jul-18	6.10	1,300	141	110
	25-Jul-19	6.00	1,200	119	98.2
	n	5	5	5	5
	Minimum	6.00	1,200	119	98.2
	Maximum	6.30	1,400	175	126
	Mean	6.16	1,320	148	113
	SD	0.134	83.7	20.4	11.0
	Median	6.10	1,300	151	110
	10th Percentile	6.00	1,200	119	98.2
	95th Percentile	6.30	1,400	175	126
95QW-3-C	28-Jul-15	6.20	1,300	180	129
	14-Jun-16	5.10	1,300	164	110
	24-Jul-17	6.10	1,300	169	122
	18-Jul-18	6.20	1,200	150	118
	25-Jul-19	6.10	1,200	136	105
	n	5	5	5	5
	Minimum	5.10	1,200	136	105
	Maximum	6.20	1,300	180	129
	Mean	5.94	1,260	160	117
	SD	0.472	54.8	17.1	9.52
	Median	6.10	1,300	164	118
	10th Percentile	5.10	1,200	136	105
	95th Percentile	6.20	1,300	180	129
95QW-3-D	28-Jul-15	6.12	1,300	181	126
	14-Jun-16	5.87	1,300	169	109
	20-Jul-17	6.01	1,200	198	121
	18-Jul-18	6.18	1,300	147	114
	25-Jul-19	6.33	1,200	133	105
	n	5	5	5	5
	Minimum	5.87	1,200	133	105
	Maximum	6.33	1,300	198	126
	Mean	6.10	1,260	166	115
	SD	0.174	54.8	26.0	8.57
	Median	6.12	1,300	169	114
	10th Percentile	5.87	1,200	133	105
	95th Percentile	6.33	1,300	198	126

Note: "SD" = standard deviation. "n" = number of samples.

Table G.19: Water Quality at TOMP Station 95QW-4 (Groundwater), Quirke TMA, 2015 to 2019

Date	pH	Sulphate (mg/L)	Acidity (mg/L)	Iron (mg/L)
28-Jul-15	7.18	710	<1.00	0.0800
24-Aug-15	7.53	720	<1.00	<0.0200
15-Jun-16	7.04	740	<1.00	<0.0200
25-Jul-17	7.19	680	<1.00	0.0250
19-Jul-18	7.16	670	<1.00	<0.0200
23-Jul-19	7.4	600	<1.00	<0.0200
n	6	6	6	6
Minimum	7.04	600	<1.00	<0.0200
Maximum	7.53	740	<1.00	0.0800
Mean	7.25	687	<1.00	0.0308
SD	0.180	49.7	-	0.0290
Median	7.18	695	<1.00	<0.0200
10th Percentile	7.04	600	<1.00	<0.0200
95th Percentile	7.53	740	<1.00	0.0800

Note: "SD" = standard deviation. "n" = number of samples. "-" = SD was incalculable because there was no variability in the data.

Table G.20: Water Quality at TOMP Stations 95QW-5 A, D (Groundwater), Quirke TMA, 2015 to 2019

Station	Date	pH	Sulphate (mg/L)	Acidity (mg/L)	Iron (mg/L)
95QW-5A	29-Jul-15	5.77	420	<1.00	7.71
	15-Jun-16	4.99	390	<1.00	6.09
	24-Jul-17	5.76	370	<1.00	5.01
	18-Jul-18	5.74	440	<1.00	5.79
	29-Jul-19	5.90	300	<1.00	3.96
	n	5	5	5	5
	Minimum	4.99	300	<1.00	3.96
	Maximum	5.90	440	<1.00	7.71
	Mean	5.63	384	<1.00	5.71
	SD	0.364	54.1	-	1.39
	Median	5.76	390	<1.00	5.79
	10th Percentile	4.99	300	<1.00	3.96
	95th Percentile	5.90	440	<1.00	7.71
95QW-5D	29-Jul-15	6.08	7.40	<1.00	0.0290
	15-Jun-16	3.85	6.50	<1.00	<0.0200
	24-Jul-17	6.02	7.60	<1.00	0.0240
	18-Jul-18	6.18	6.20	<1.00	<0.0200
	29-Jul-19	6.09	6.00	<1.00	<0.0200
	n	5	5	5	5
	Minimum	3.85	6.00	<1.00	<0.0200
	Maximum	6.18	7.60	<1.00	0.0290
	Mean	5.64	6.74	<1.00	0.0226
	SD	1.00	0.720	-	0.00283
	Median	6.08	6.50	<1.00	<0.0200
	10th Percentile	3.85	6.00	<1.00	<0.0200
	95th Percentile	6.18	7.60	<1.00	0.0290

Note: "SD" = standard deviation. "n" = number of samples. "-" = SD was incalculable because there was no variability in the data.

Table G.21: Water Level at TOMP Station Cell 14, Quirke TMA, 2015 to 2019

Date	Elevation (m)
28-Apr-15	377.79
12-May-15	377.72
28-May-15	377.70
29-Jun-15	377.77
28-Jul-15	377.74
10-Aug-15	377.68
27-Aug-15	377.69
28-Sep-15	377.57
28-Oct-15	377.45
9-Nov-15	377.59
28-Nov-15	377.84
28-Dec-15	378.11
8-Feb-16	377.86
28-Apr-16	377.86
9-May-16	377.82
27-May-16	377.75
28-Jun-16	377.62
28-Jul-16	377.52
8-Aug-16	377.49
29-Aug-16	377.50
28-Sep-16	377.45
27-Oct-16	377.44
15-Nov-16	377.38
28-Nov-16	377.38
28-Apr-17	378.01
8-May-17	378.05
28-May-17	378.10
28-Jun-17	377.89
27-Jul-17	377.87
14-Aug-17	377.96
28-Aug-17	378.02
28-Sep-17	377.92
28-Oct-17	378.00
17-May-18	377.88
28-May-18	377.92
28-Jun-18	377.87
28-Jul-18	377.78
13-Aug-18	377.70
28-Aug-18	377.59
28-Sep-18	377.47
26-Oct-18	377.76
12-Nov-18	377.93
28-Nov-18	378.04
26-Apr-19	377.96
13-May-19	377.92
28-May-19	377.88
28-Jun-19	377.74
26-Jul-19	377.68
12-Aug-19	377.73
28-Aug-19	377.72
23-Sep-19	377.74
28-Oct-19	377.97
27-Nov-19	378.14
n	53
Minimum	377.38
Maximum	378.14
Mean	377.77
SD	0.19925
Median	377.77
10th Percentile	377.47
95th Percentile	378.10

Note: "SD" = standard deviation. "n" = number of samples.

Table G.22: Water Level at TOMP Station Cell 15, Quirke TMA, 2015 to 2019

Date	Elevation (m)
28-Apr-15	373.78
12-May-15	373.74
28-May-15	373.67
29-Jun-15	373.47
28-Jul-15	373.18
10-Aug-15	373.08
27-Aug-15	373.03
28-Sep-15	372.93
28-Oct-15	372.82
9-Nov-15	372.88
28-Nov-15	372.94
28-Dec-15	373.41
8-Feb-16	373.79
28-Apr-16	373.74
9-May-16	373.69
27-May-16	373.58
28-Jun-16	373.33
28-Jul-16	373.11
8-Aug-16	372.99
29-Aug-16	372.92
28-Sep-16	372.80
27-Oct-16	372.76
15-Nov-16	372.72
28-Nov-16	372.69
28-Apr-17	373.10
8-May-17	373.18
28-May-17	373.63
28-Jun-17	373.79
27-Jul-17	373.67
14-Aug-17	373.59
28-Aug-17	373.68
28-Sep-17	373.68
28-Oct-17	373.77
13-Nov-17	373.79
28-Nov-17	373.81
17-May-18	373.42
28-May-18	373.39
28-Jun-18	373.23
28-Jul-18	373.01
13-Aug-18	372.93
28-Aug-18	372.83
28-Sep-18	372.76
26-Oct-18	372.94

Date	Elevation (m)
12-Nov-18	372.98
28-Nov-18	373.15
26-Apr-19	373.88
13-May-19	373.86
28-May-19	373.83
28-Jun-19	373.68
26-Jul-19	373.42
12-Aug-19	373.33
28-Aug-19	373.21
23-Sep-19	373.16
28-Oct-19	373.23
11-Nov-19	373.39
27-Nov-19	373.71
n	56
Minimum	372.69
Maximum	373.88
Mean	373.32
SD	0.36983
Median	373.33
10th Percentile	372.82
95th Percentile	373.83

Note: "SD" = standard deviation. "n" = number of samples.

Table G.23: Water Level at TOMP Station Cell 16 S, Quirke TMA, 2015 to 2019

Date	Elevation (m)
12-May-15	369.96
28-May-15	369.95
29-Jun-15	369.90
28-Jul-15	369.82
10-Aug-15	369.81
27-Aug-15	369.85
28-Sep-15	369.89
28-Oct-15	369.89
9-Nov-15	369.95
28-Nov-15	369.98
28-Dec-15	370.06
8-Feb-16	370.07
28-Apr-16	370.00
9-May-16	369.99
27-May-16	369.95
28-Jun-16	369.88
28-Jul-16	369.87
8-Aug-16	369.84
29-Aug-16	369.87
28-Sep-16	369.92
27-Oct-16	369.92
15-Nov-16	369.92
28-Nov-16	369.92
28-Apr-17	370.00
8-May-17	369.96
28-May-17	370.00
28-Jun-17	369.94
27-Jul-17	369.96
14-Aug-17	369.94
28-Aug-17	369.93
28-Sep-17	369.91
28-Oct-17	370.03
13-Nov-17	369.96
28-Nov-17	370.00

Date	Elevation (m)
17-May-18	369.93
28-May-18	369.92
28-Jun-18	369.86
28-Jul-18	369.84
13-Aug-18	369.83
28-Aug-18	369.82
28-Sep-18	369.88
26-Oct-18	369.96
12-Nov-18	369.96
28-Nov-18	369.96
26-Apr-19	370.00
13-May-19	370.03
28-May-19	370.01
28-Jun-19	369.96
26-Jul-19	369.88
12-Aug-19	369.88
28-Aug-19	369.88
23-Sep-19	369.94
28-Oct-19	370.01
11-Nov-19	369.98
27-Nov-19	369.99
n	55
Minimum	369.81
Maximum	370.07
Mean	369.93
SD	0.063055
Median	369.94
10th Percentile	369.84
95th Percentile	370.03

Note: "SD" = standard deviation. "n" = number of samples.

Table G.24: Water Level at TOMP Station Cell 17, Quirke TMA, 2015 to 2019

Date	Elevation (m)
28-Apr-15	365.97
12-May-15	365.93
28-May-15	365.93
29-Jun-15	365.90
28-Jul-15	365.82
10-Aug-15	365.82
27-Aug-15	365.83
28-Sep-15	365.84
28-Oct-15	365.86
9-Nov-15	365.92
28-Nov-15	365.90
28-Dec-15	365.94
8-Feb-16	365.99
28-Apr-16	365.92
9-May-16	365.89
27-May-16	365.88
28-Jun-16	365.85
28-Jul-16	365.82
8-Aug-16	365.80
29-Aug-16	365.84
28-Sep-16	365.85
27-Oct-16	365.83
15-Nov-16	365.82
28-Nov-16	365.83
28-Apr-17	365.95
8-May-17	365.91
28-May-17	365.95
28-Jun-17	365.92
27-Jul-17	365.93
14-Aug-17	365.90
28-Aug-17	365.89
28-Sep-17	365.85
28-Oct-17	366.00
13-Nov-17	365.93
28-Nov-17	365.92
17-May-18	365.91
28-May-18	365.90
28-Jun-18	365.85
28-Jul-18	365.84
13-Aug-18	365.84
28-Aug-18	365.83
28-Sep-18	365.92
26-Oct-18	365.96
12-Nov-18	365.94
28-Nov-18	365.90
26-Apr-19	366.06
13-May-19	366.01
28-May-19	365.99
28-Jun-19	365.93
26-Jul-19	365.87
12-Aug-19	365.94
28-Aug-19	365.84
23-Sep-19	365.83
28-Oct-19	365.94
11-Nov-19	365.91
27-Nov-19	365.95

n	56
Minimum	365.80
Maximum	366.06
Mean	365.90
SD	0.057853
Median	365.90
10th Percentile	365.83
95th Percentile	366.00

Note: "SD" = standard deviation. "n" = number of samples.

Table G.25: Water Level at TOMP Station Q-05, Quirke TMA, 2015 to 2019

Date	Elevation (m)	Date	Elevation (m)	Date	Elevation (m)
5-Jan-15	364.04	14-Dec-15	364.37	29-Dec-16	364.19
12-Jan-15	364.02	21-Dec-15	364.47	2-Jan-17	364.22
19-Jan-15	364.03	28-Dec-15	364.42	9-Jan-17	364.27
26-Jan-15	364.02	4-Jan-16	364.36	16-Jan-17	364.34
2-Feb-15	364.05	12-Jan-16	364.20	23-Jan-17	364.31
9-Feb-15	364.06	18-Jan-16	364.16	30-Jan-17	364.27
17-Feb-15	364.04	25-Jan-16	364.10	6-Feb-17	364.21
23-Feb-15	364.06	1-Feb-16	364.16	13-Feb-17	364.19
2-Mar-15	364.06	8-Feb-16	364.32	21-Feb-17	364.14
10-Mar-15	364.03	16-Feb-16	364.42	27-Feb-17	364.17
16-Mar-15	363.96	22-Feb-16	364.40	6-Mar-17	364.08
23-Mar-15	364.00	29-Feb-16	364.30	16-Mar-17	364.00
30-Mar-15	363.99	7-Mar-16	364.15	20-Mar-17	363.99
6-Apr-15	363.98	14-Mar-16	364.08	27-Mar-17	364.03
13-Apr-15	364.06	21-Mar-16	364.09	3-Apr-17	364.10
20-Apr-15	364.30	28-Mar-16	364.01	10-Apr-17	364.15
27-Apr-15	364.36	4-Apr-16	363.99	17-Apr-17	364.14
4-May-15	364.34	11-Apr-16	363.94	24-Apr-17	364.02
11-May-15	364.27	18-Apr-16	363.90	1-May-17	364.05
19-May-15	364.24	25-Apr-16	363.93	8-May-17	364.09
25-May-15	364.15	2-May-16	363.92	15-May-17	364.01
1-Jun-15	364.13	9-May-16	363.87	23-May-17	364.07
8-Jun-15	364.02	16-May-16	363.95	29-May-17	364.16
15-Jun-15	364.06	24-May-16	364.02	5-Jun-17	364.11
22-Jun-15	363.99	31-May-16	364.19	13-Jun-17	364.26
29-Jun-15	364.04	6-Jun-16	364.19	19-Jun-17	364.19
6-Jul-15	364.02	13-Jun-16	364.14	26-Jun-17	364.10
13-Jul-15	364.06	20-Jun-16	364.09	4-Jul-17	364.11
20-Jul-15	364.04	27-Jun-16	364.03	10-Jul-17	364.03
27-Jul-15	364.01	5-Jul-16	363.96	17-Jul-17	364.00
4-Aug-15	363.95	11-Jul-16	363.79	24-Jul-17	364.09
10-Aug-15	363.94	18-Jul-16	363.67	31-Jul-17	364.15
17-Aug-15	363.95	29-Aug-16	364.25	8-Aug-17	364.14
24-Aug-15	364.05	6-Sep-16	364.05	14-Aug-17	364.19
31-Aug-15	364.10	12-Sep-16	363.97	21-Aug-17	364.22
8-Sep-15	364.16	19-Sep-16	363.99	28-Aug-17	364.17
14-Sep-15	364.19	26-Sep-16	364.07	5-Sep-17	364.07
21-Sep-15	364.28	3-Oct-16	364.15	11-Sep-17	364.10
28-Sep-15	364.21	11-Oct-16	364.20	18-Sep-17	364.08
5-Oct-15	364.10	17-Oct-16	364.36	25-Sep-17	364.08
13-Oct-15	364.09	24-Oct-16	364.31	2-Oct-17	364.05
19-Oct-15	364.06	31-Oct-16	364.23	10-Oct-17	364.21
26-Oct-15	364.13	7-Nov-16	364.17	16-Oct-17	364.28
2-Nov-15	364.27	14-Nov-16	364.09	23-Oct-17	364.14
9-Nov-15	364.32	21-Nov-16	363.99	30-Oct-17	364.27
16-Nov-15	364.31	28-Nov-16	364.00	6-Nov-17	364.20
23-Nov-15	364.35	5-Dec-16	364.12	13-Nov-17	364.13
30-Nov-15	364.37	12-Dec-16	364.05	20-Nov-17	364.25
7-Dec-15	364.34	19-Dec-16	364.10	27-Nov-17	364.20

Note: "SD" = standard deviation. "n" = number of samples.

Table G.25: Water Level at TOMP Station Q-05, Quirke TMA, 2015 to 2019

Date	Elevation (m)
4-Dec-17	364.20
11-Dec-17	364.29
18-Dec-17	364.17
27-Dec-17	364.14
2-Jan-18	364.10
8-Jan-18	364.10
15-Jan-18	364.13
22-Jan-18	364.06
29-Jan-18	364.01
5-Feb-18	364.06
12-Feb-18	364.06
20-Feb-18	364.04
26-Feb-18	364.10
5-Mar-18	364.07
12-Mar-18	364.11
19-Mar-18	364.14
26-Mar-18	364.13
2-Apr-18	364.15
9-Apr-18	364.19
16-Apr-18	364.17
23-Apr-18	364.18
30-Apr-18	364.25
7-May-18	364.30
14-May-18	364.20
22-May-18	364.24
28-May-18	364.21
4-Jun-18	364.20
11-Jun-18	364.20
18-Jun-18	364.28
25-Jun-18	364.21
3-Jul-18	364.17
9-Jul-18	364.15
16-Jul-18	364.18
23-Jul-18	364.22
30-Jul-18	364.27
7-Aug-18	364.23
13-Aug-18	364.21
20-Aug-18	364.12
27-Aug-18	364.10
4-Sep-18	364.14
10-Sep-18	364.07
17-Sep-18	364.07
24-Sep-18	364.08
1-Oct-18	364.14
9-Oct-18	364.24
15-Oct-18	364.34
22-Oct-18	364.30

Date	Elevation (m)
29-Oct-18	364.15
5-Nov-18	364.13
12-Nov-18	364.22
19-Nov-18	364.20
26-Nov-18	364.18
3-Dec-18	364.14
10-Dec-18	364.14
17-Dec-18	364.15
24-Dec-18	364.16
31-Dec-18	364.17
7-Jan-19	364.19
14-Jan-19	364.25
21-Jan-19	364.28
28-Jan-19	364.29
4-Feb-19	364.22
11-Feb-19	364.24
19-Feb-19	364.30
25-Feb-19	364.23
4-Mar-19	364.11
11-Mar-19	364.06
18-Mar-19	364.17
25-Mar-19	364.09
1-Apr-19	364.02
8-Apr-19	364.07
16-Apr-19	364.08
22-Apr-19	364.17
29-Apr-19	364.25
6-May-19	364.13
13-May-19	364.20
21-May-19	364.29
27-May-19	364.27
3-Jun-19	364.26
10-Jun-19	364.15
17-Jun-19	364.02
24-Jun-19	364.10
2-Jul-19	364.06
8-Jul-19	364.03
15-Jul-19	364.06
22-Jul-19	364.01
29-Jul-19	364.03
6-Aug-19	364.06
12-Aug-19	364.11
19-Aug-19	364.19
26-Aug-19	364.20
3-Sep-19	364.21
9-Sep-19	364.23
16-Sep-19	364.17

Date	Elevation (m)
23-Sep-19	364.12
30-Sep-19	364.13
7-Oct-19	364.24
15-Oct-19	364.20
21-Oct-19	364.22
28-Oct-19	364.23
4-Nov-19	364.15
11-Nov-19	364.12
18-Nov-19	364.15
25-Nov-19	364.24
2-Dec-19	364.22
9-Dec-19	364.15
16-Dec-19	364.12
23-Dec-19	364.13
30-Dec-19	364.17
n	256
Minimum	363.67
Maximum	364.47
Mean	364.14
SD	0.11457
Median	364.14
10th Percentile	364.01
95th Percentile	364.34

Note: "SD" = standard deviation. "n" = number of samples.

Table G.26: Water Level at TOMP Station Q-29, Quirke TMA, 2015 to 2019

Date	Elevation (m)	Date	Elevation (m)	Date	Elevation (m)
5-Jan-15	379.44	2-Aug-16	379.09	24-Jul-17	379.70
14-Jan-15	379.43	8-Aug-16	379.00	31-Jul-17	379.62
21-Jan-15	379.37	15-Aug-16	378.92	8-Aug-17	379.42
27-Jan-15	379.30	22-Aug-16	378.87	14-Aug-17	379.36
2-Feb-15	379.27	29-Aug-16	378.83	21-Aug-17	379.36
9-Feb-15	379.23	6-Sep-16	378.74	28-Aug-17	379.28
17-Feb-15	379.19	12-Sep-16	378.73	5-Sep-17	379.18
23-Feb-15	379.15	19-Sep-16	378.69	11-Sep-17	379.12
2-Mar-15	379.11	26-Sep-16	378.72	18-Sep-17	379.06
1-Jun-15	379.82	3-Oct-16	378.44	25-Sep-17	379.01
8-Jun-15	379.77	11-Oct-16	378.64	2-Oct-17	378.95
15-Jun-15	379.72	17-Oct-16	378.64	10-Oct-17	379.01
22-Jun-15	379.57	24-Oct-16	378.73	16-Oct-17	379.07
29-Jun-15	379.50	31-Oct-16	378.73	23-Oct-17	379.53
6-Jul-15	379.32	7-Nov-16	378.73	2-Apr-18	379.57
13-Jul-15	379.22	14-Nov-16	378.72	9-Apr-18	379.51
20-Jul-15	379.10	21-Nov-16	378.74	16-Apr-18	379.50
27-Jul-15	379.03	28-Nov-16	378.75	23-Apr-18	379.50
4-Aug-15	378.93	5-Dec-16	378.84	30-Apr-18	379.73
10-Aug-15	378.87	12-Dec-16	378.91	7-May-18	379.65
17-Aug-15	378.79	19-Dec-16	378.94	14-May-18	379.53
24-Aug-15	378.79	29-Dec-16	378.97	23-May-18	379.39
31-Aug-15	378.75	2-Jan-17	378.97	28-May-18	379.37
26-Oct-15	378.75	9-Jan-17	378.99	4-Jun-18	379.32
2-Nov-15	378.97	16-Jan-17	379.00	11-Jun-18	379.25
9-Nov-15	379.17	23-Jan-17	379.00	18-Jun-18	379.22
16-Nov-15	379.24	30-Jan-17	379.06	25-Jun-18	379.12
23-Nov-15	379.33	6-Feb-17	379.13	3-Jul-18	379.00
30-Nov-15	379.45	13-Feb-17	379.13	9-Jul-18	378.91
7-Dec-15	379.41	21-Feb-17	379.05	16-Jul-18	378.81
14-Dec-15	379.52	27-Feb-17	379.22	23-Jul-18	378.78
21-Dec-15	379.56	6-Mar-17	379.22	30-Jul-18	378.74
28-Dec-15	379.56	16-Mar-17	379.37	7-Aug-18	378.49
4-Jan-16	379.57	20-Mar-17	379.39	9-Oct-18	379.18
25-Apr-16	379.60	27-Mar-17	379.37	15-Oct-18	379.57
9-May-16	379.68	3-Apr-17	379.55	22-Oct-18	379.54
16-May-16	379.68	10-Apr-17	379.65	29-Oct-18	379.50
24-May-16	379.61	17-Apr-17	379.62	5-Nov-18	379.40
31-May-16	379.60	24-Apr-17	379.61	12-Nov-18	379.48
6-Jun-16	379.62	1-May-17	379.58	19-Nov-18	379.44
13-Jun-16	379.58	2-May-17	379.57	26-Nov-18	379.37
20-Jun-16	379.53	8-May-17	379.60	3-Dec-18	379.33
27-Jun-16	379.44	15-May-17	379.48	10-Dec-18	379.31
5-Jul-16	379.38	23-May-17	379.46	17-Dec-18	379.29
11-Jul-16	379.34	29-May-17	379.44	27-Dec-18	379.01
18-Jul-16	379.27	10-Jul-17	379.77	31-Dec-18	379.32
25-Jul-16	379.20	17-Jul-17	379.73	7-Jan-19	379.44

Note: "SD" = standard deviation. "n" = number of samples.

Table G.26: Water Level at TOMP Station Q-29, Quirke TMA, 2015 to 2019

Date	Elevation (m)
15-Jan-19	379.29
21-Jan-19	379.30
28-Jan-19	379.27
4-Feb-19	379.20
11-Feb-19	379.16
2-Jul-19	379.52
8-Jul-19	379.41
15-Jul-19	379.33
22-Jul-19	379.24
29-Jul-19	379.15
6-Aug-19	379.07
12-Aug-19	379.06
19-Aug-19	378.99
26-Aug-19	378.89
3-Sep-19	378.81
9-Sep-19	378.82
16-Sep-19	378.83
23-Sep-19	378.82
30-Sep-19	378.90
7-Oct-19	379.02
15-Oct-19	379.13
21-Oct-19	379.35
28-Oct-19	379.54
4-Nov-19	379.53
11-Nov-19	379.46
18-Nov-19	379.38
25-Nov-19	379.48
n	168
Minimum	378.44
Maximum	379.82
Mean	379.23
SD	0.31005
Median	379.27
10th Percentile	378.75
95th Percentile	379.68

Note: "SD" = standard deviation. "n" = number of samples.

APPENDIX H

PANEL TMA, TOMP DATA

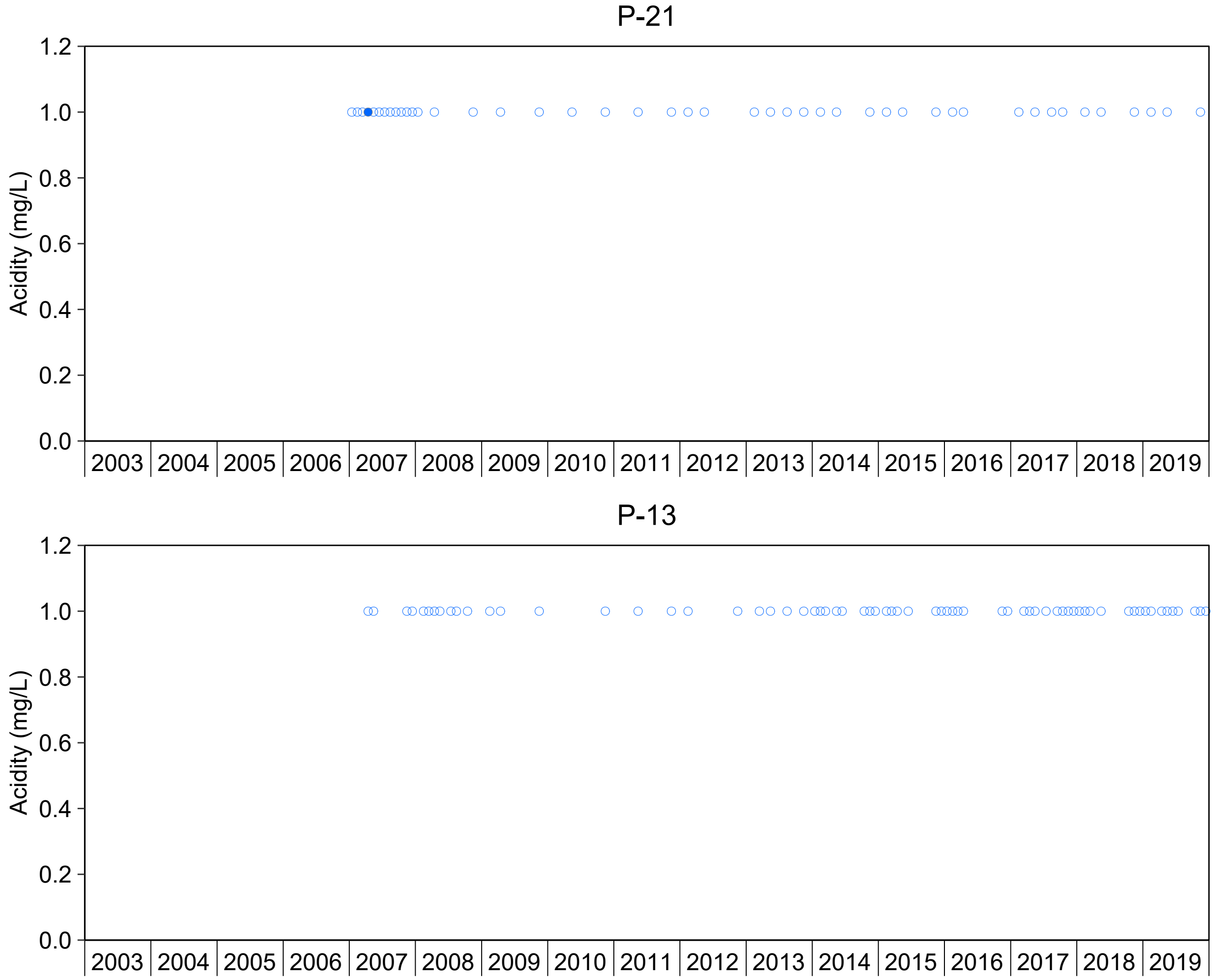


Figure H.1: Concentrations of Acidity for TOMP Water Monitoring Stations, Panel TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 4.12 for Seasonal Kendall trend analysis results and Appendix Tables H.3 and H.4 for raw data. Acidity (mg/L) is not included in the trend analysis for TOMP stations P-21, and P-13 due to >50% non-detectable concentrations in the dataset.

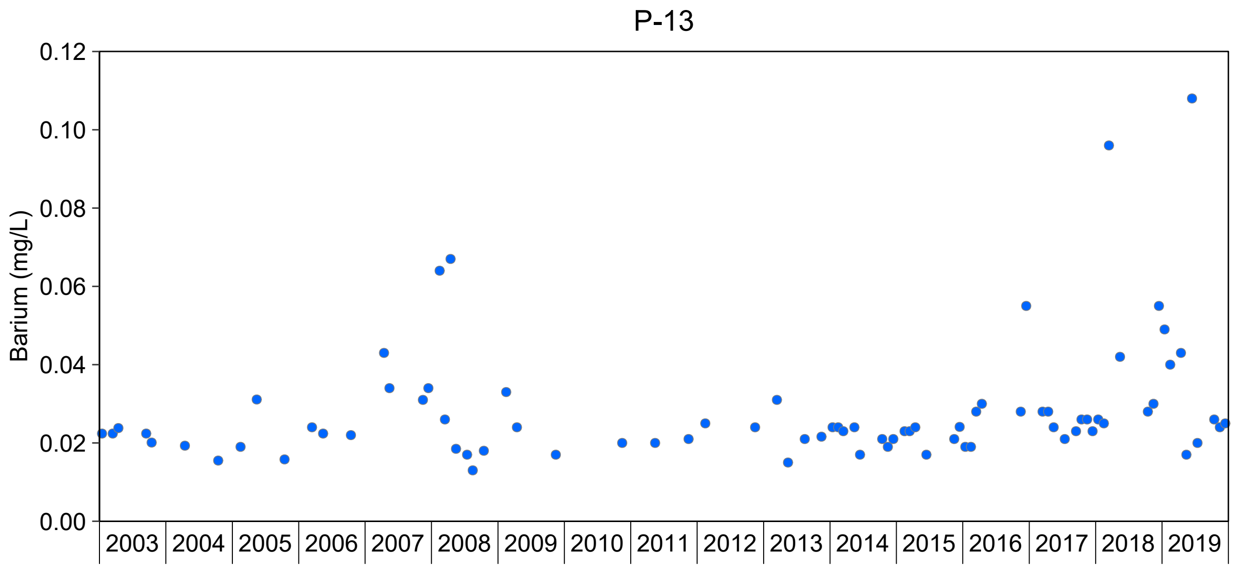


Figure H.2: Concentrations of Barium for TOMP Water Monitoring Stations, Panel TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 4.12 for Seasonal Kendall trend analysis results and Appendix Table H.4 for raw data.

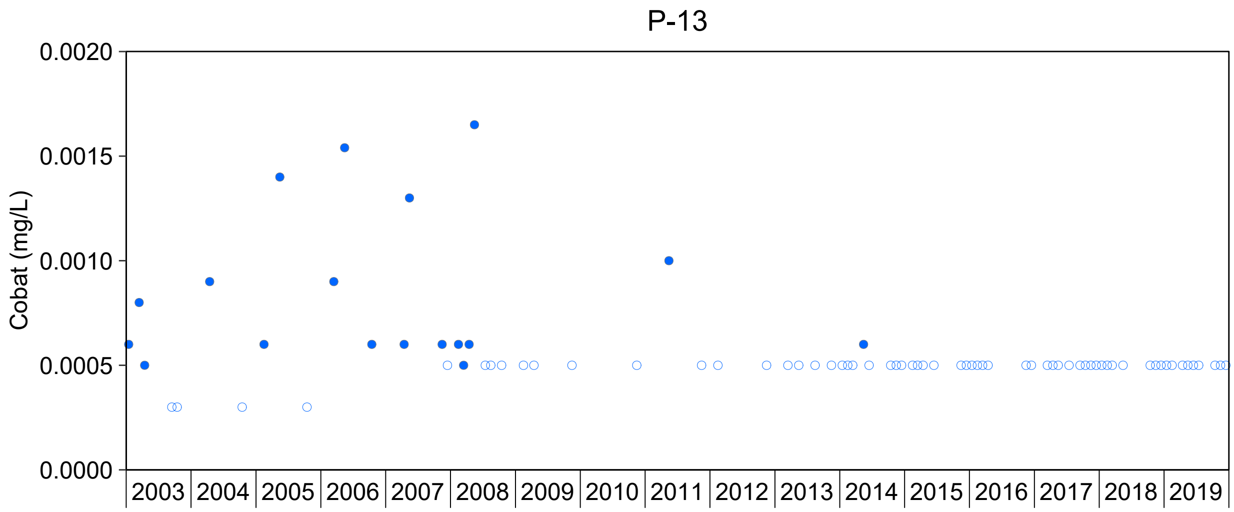


Figure H.3: Concentrations of Cobalt for TOMP Water Monitoring Stations, Panel TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 4.12 for Seasonal Kendall trend analysis results and Appendix Table H.4 for raw data. Cobalt (mg/L) is not included in the trend analysis for TOMP station P-13 due to >50% non-detectable concentrations in the dataset.

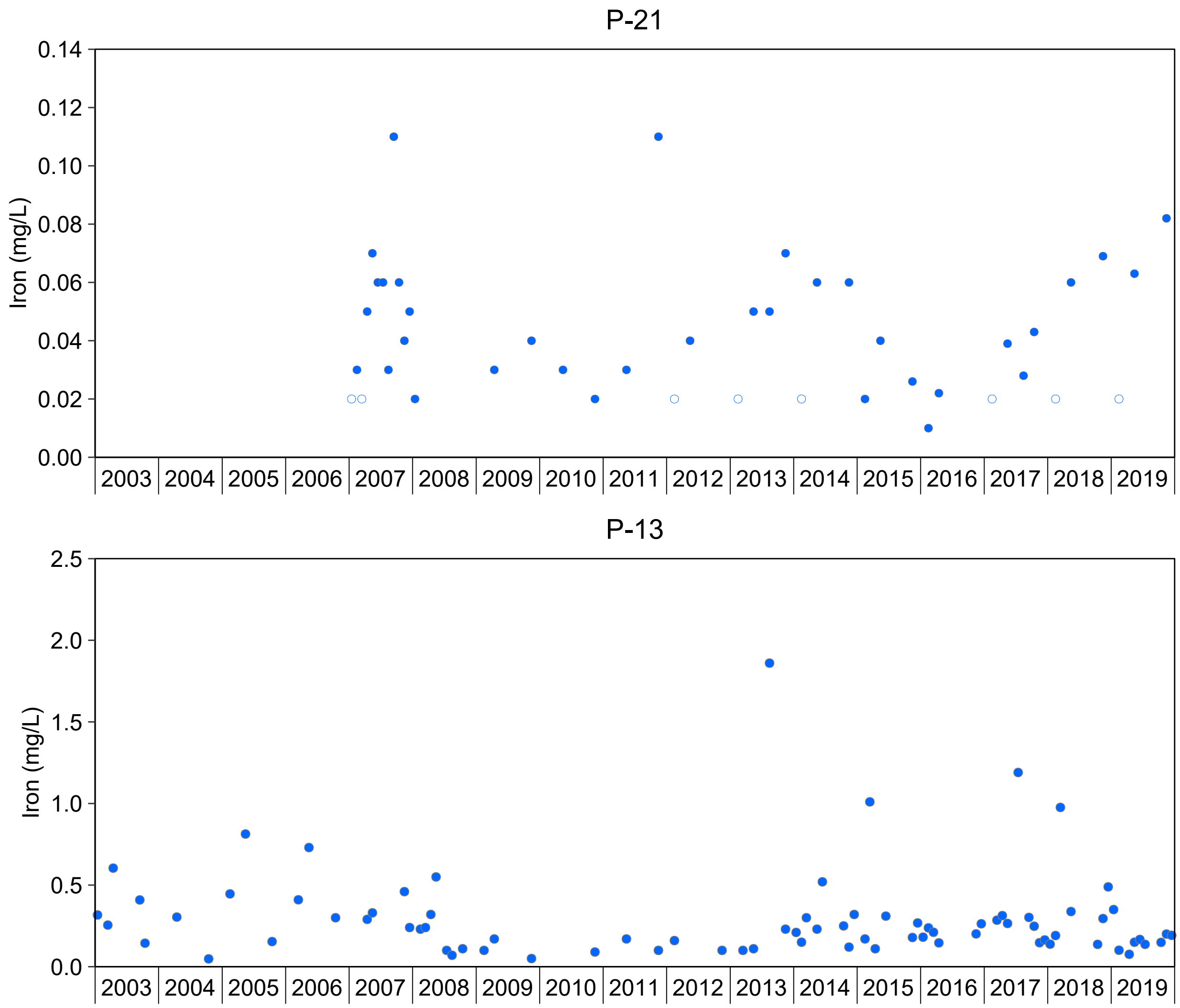


Figure H.4: Concentrations of Iron for TOMP Water Monitoring Stations, Panel TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 4.12 for Seasonal Kendall trend analysis results and Appendix Tables H.3 and H.4 for raw data.

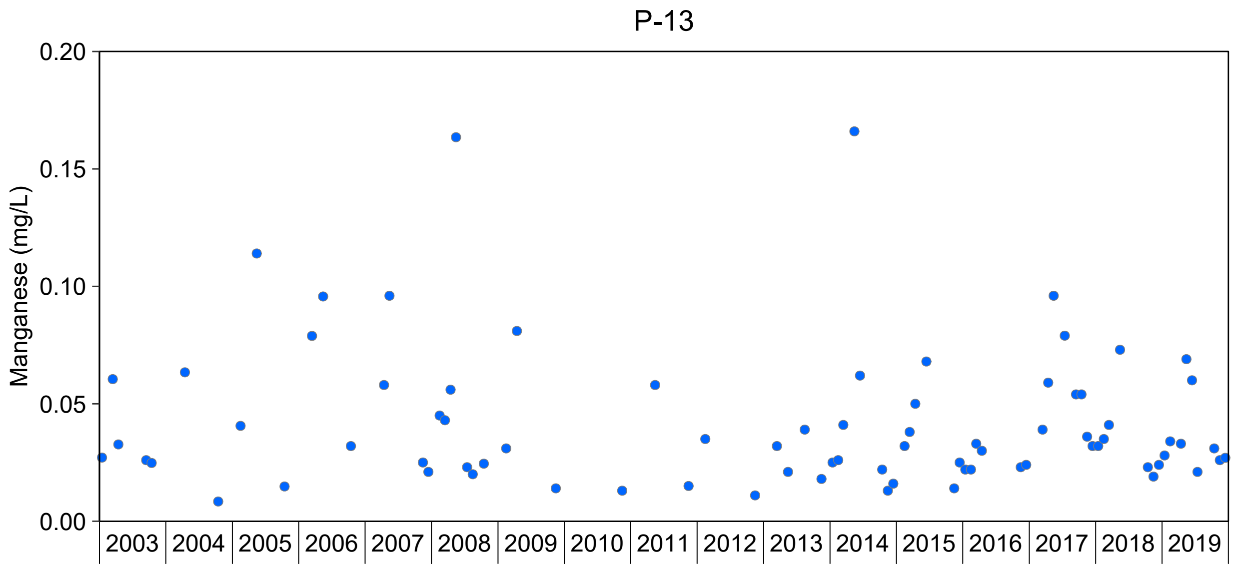


Figure H.5: Concentrations of Manganese for TOMP Water Monitoring Stations, Panel TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 4.12 for Seasonal Kendall trend analysis results and Appendix Table H.4 for raw data.

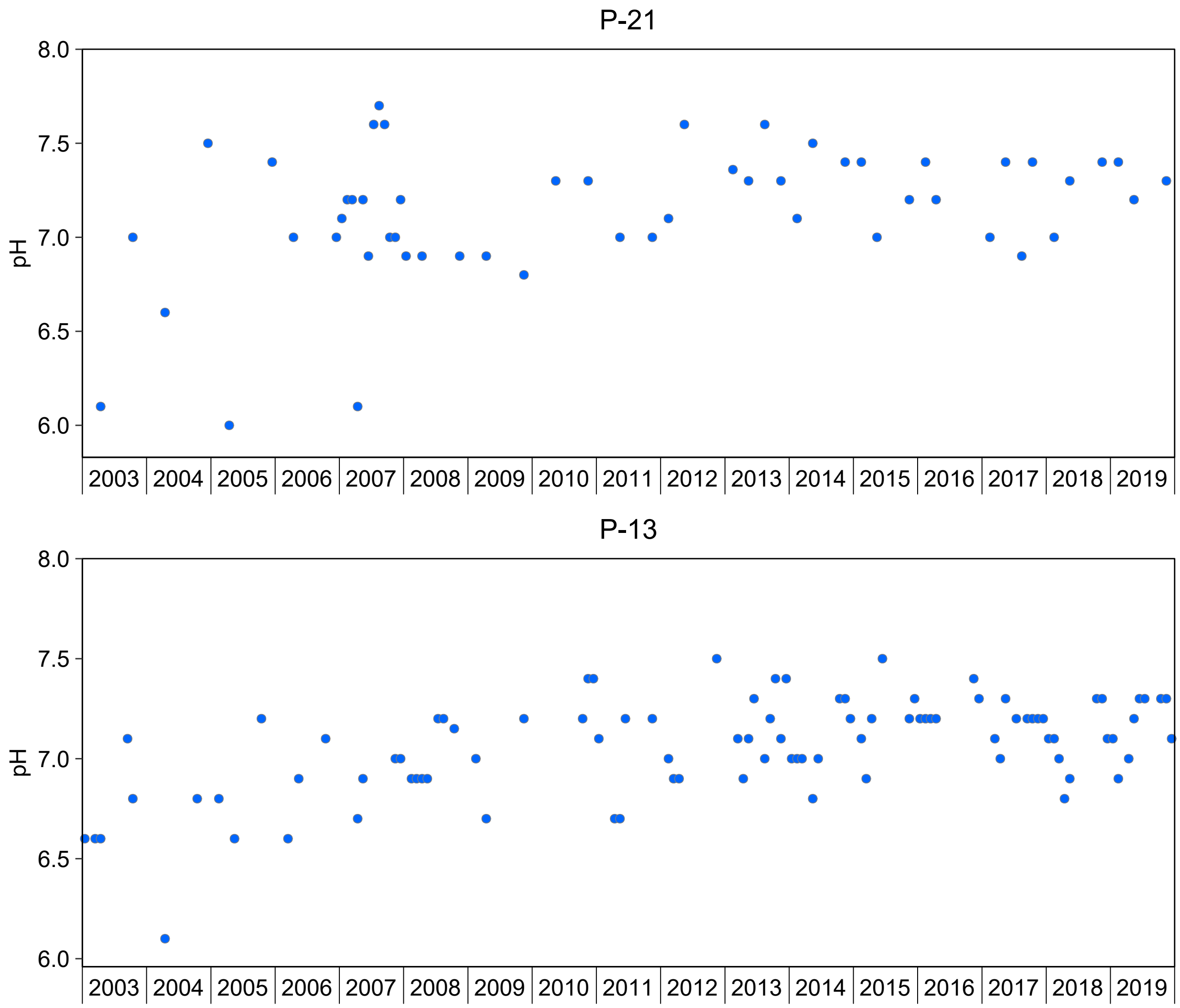


Figure H.6: Field Measurements of pH for TOMP Water Monitoring Stations, Panel TMA, 2003 to 2019

Notes: See Table 4.12 for Seasonal Kendall trend analysis results and Appendix Tables H.3 and H.4 for raw data.

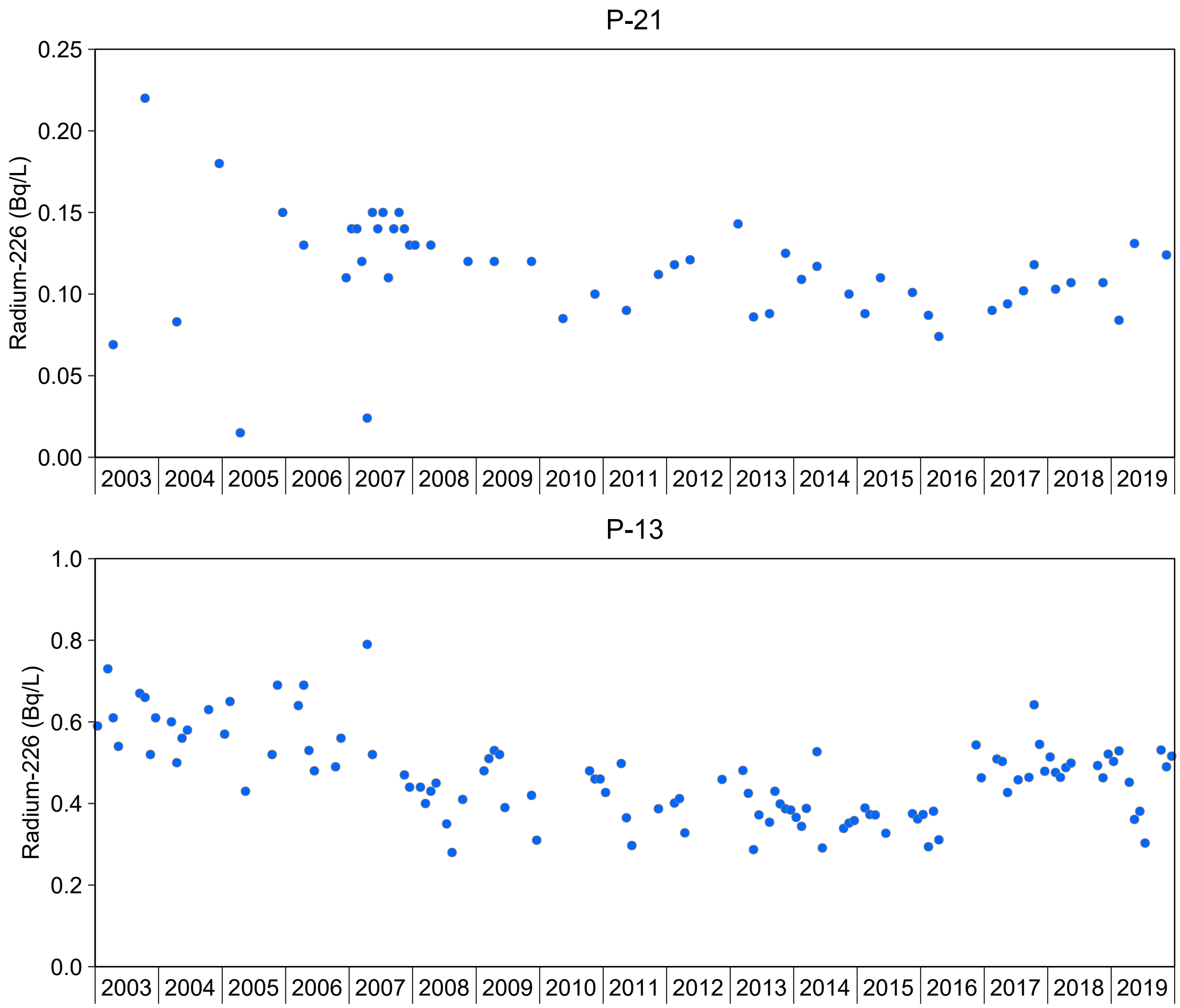


Figure H.7: Concentrations of Radium-226 for TOMP Water Monitoring Stations, Panel TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 4.12 for Seasonal Kendall trend analysis results and Appendix Tables H.3 and H.4 for raw data.

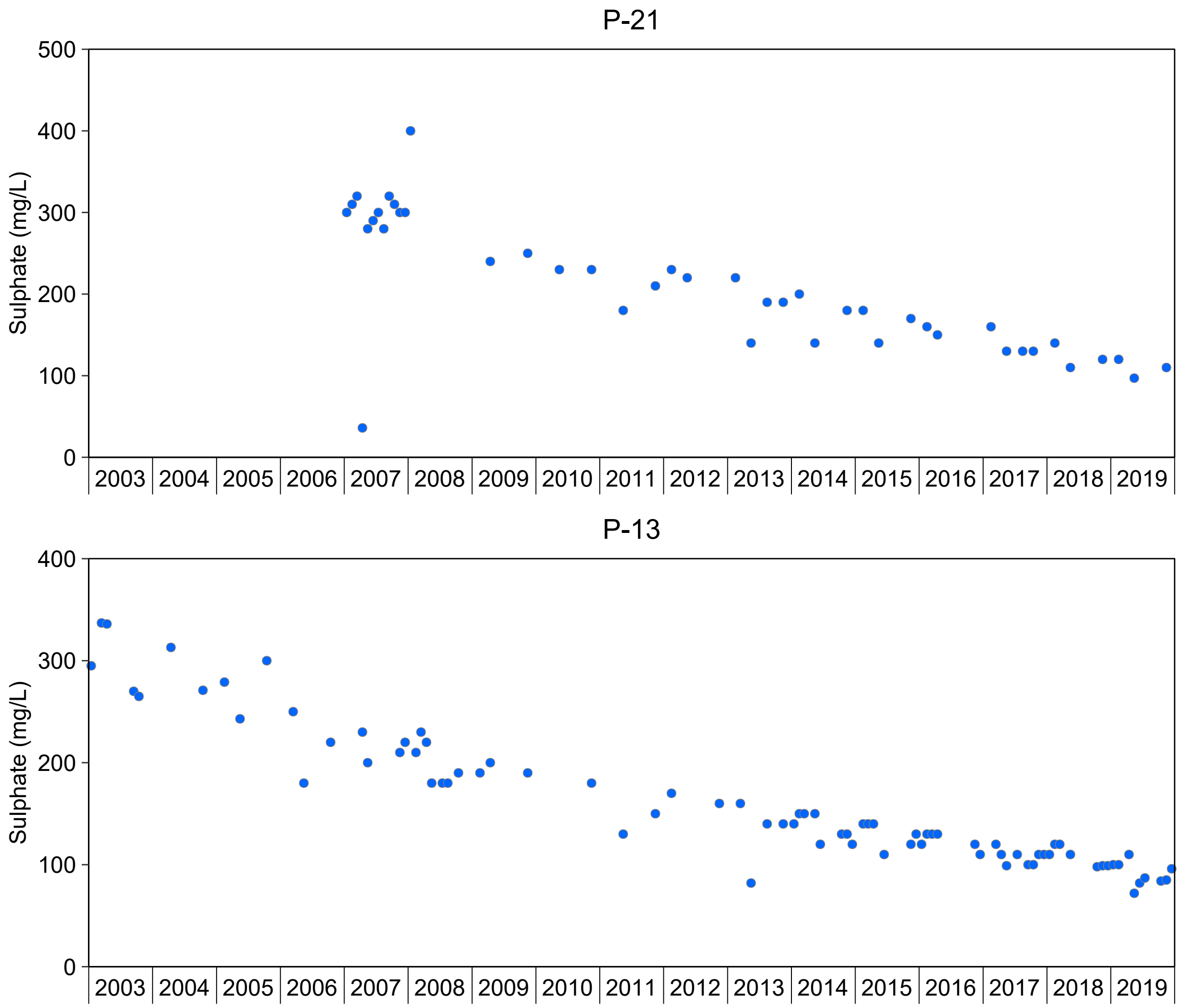


Figure H.8: Concentrations of Sulphate for TOMP Water Monitoring Stations, Panel TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 4.12 for Seasonal Kendall trend analysis results and Appendix Tables H.3 and H.4 for raw data.

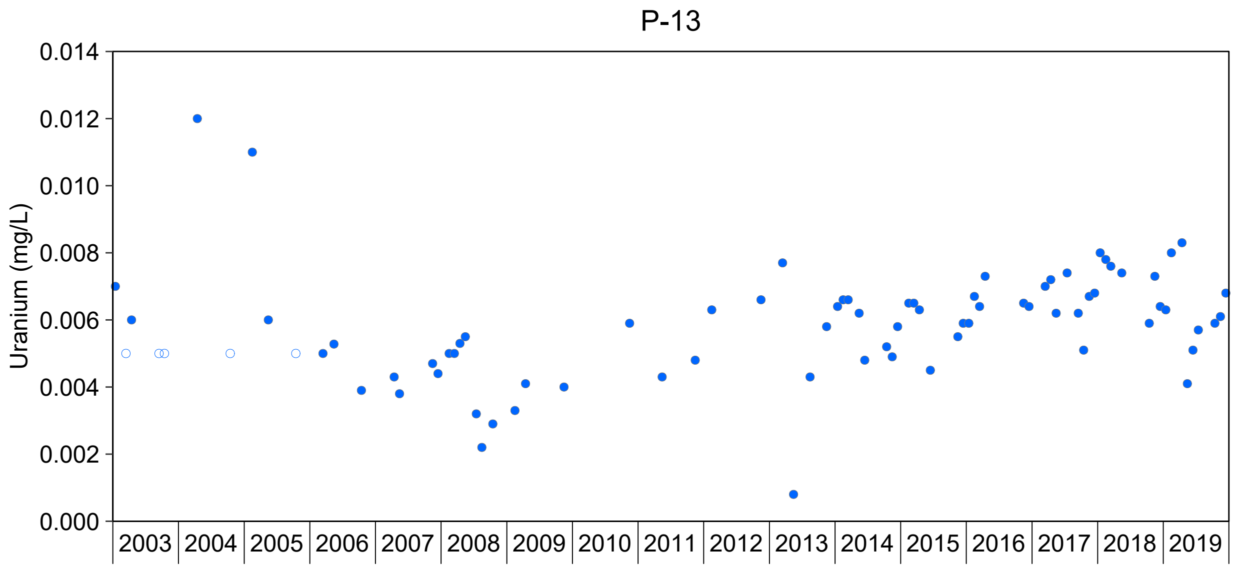


Figure H.9: Concentrations of Uranium for TOMP Water Monitoring Stations, Panel TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 4.12 for Seasonal Kendall trend analysis results and Appendix Table H.4 for raw data.

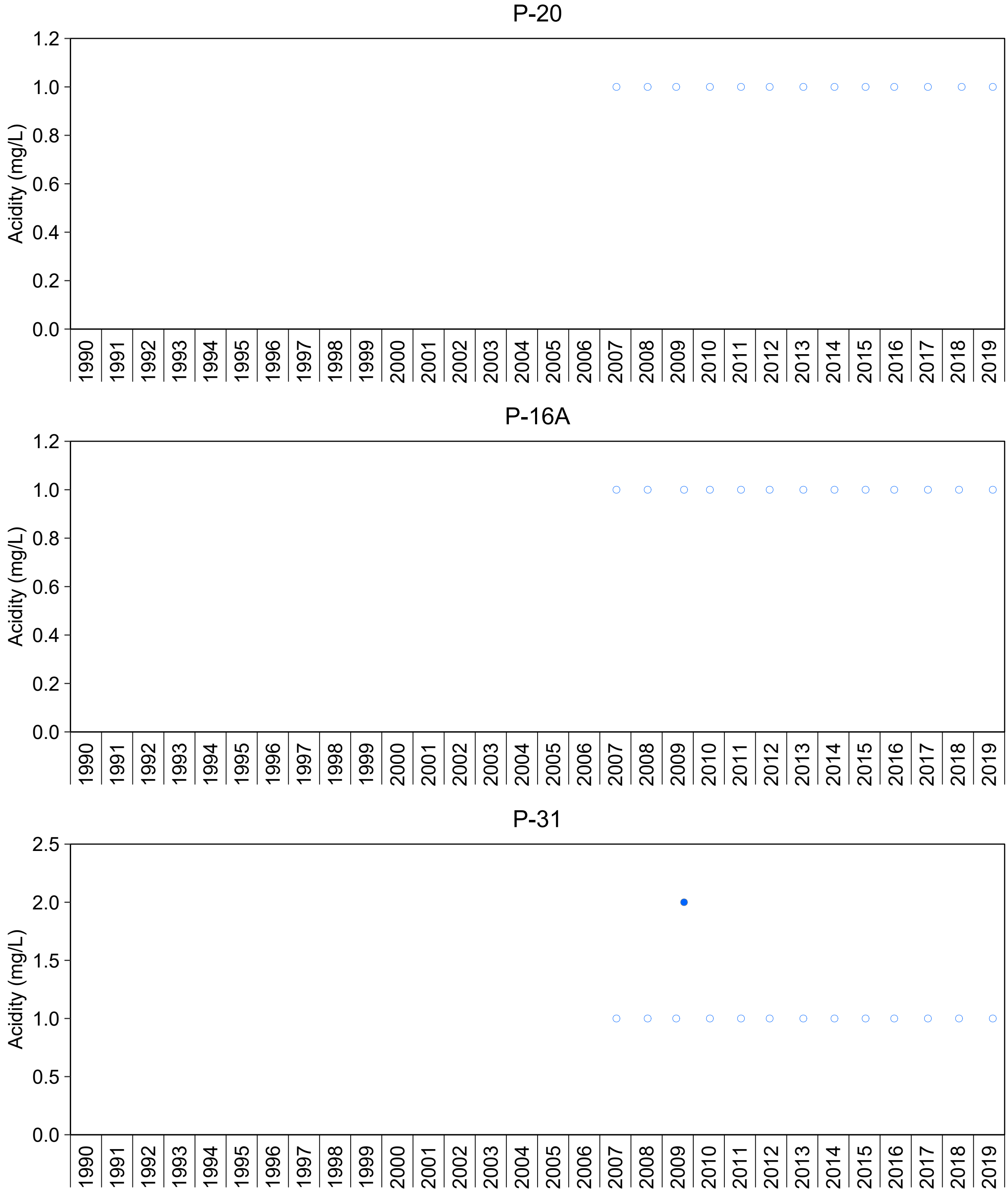


Figure H.10: Concentrations of Acidity for TOMP Groundwater Stations, Panel TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Due to a change in analytical technique for acidity in 2006, acidity trends were assessed from 2007 to 2019. See Table 4.13 for Kendall trend analysis results and Appendix Tables H.8 to H.10 for raw data. Acidity (mg/L) is not included in the trend analysis for TOMP stations P-20, P-16A, and P-31 due to >50% non-detectable concentrations in the dataset.

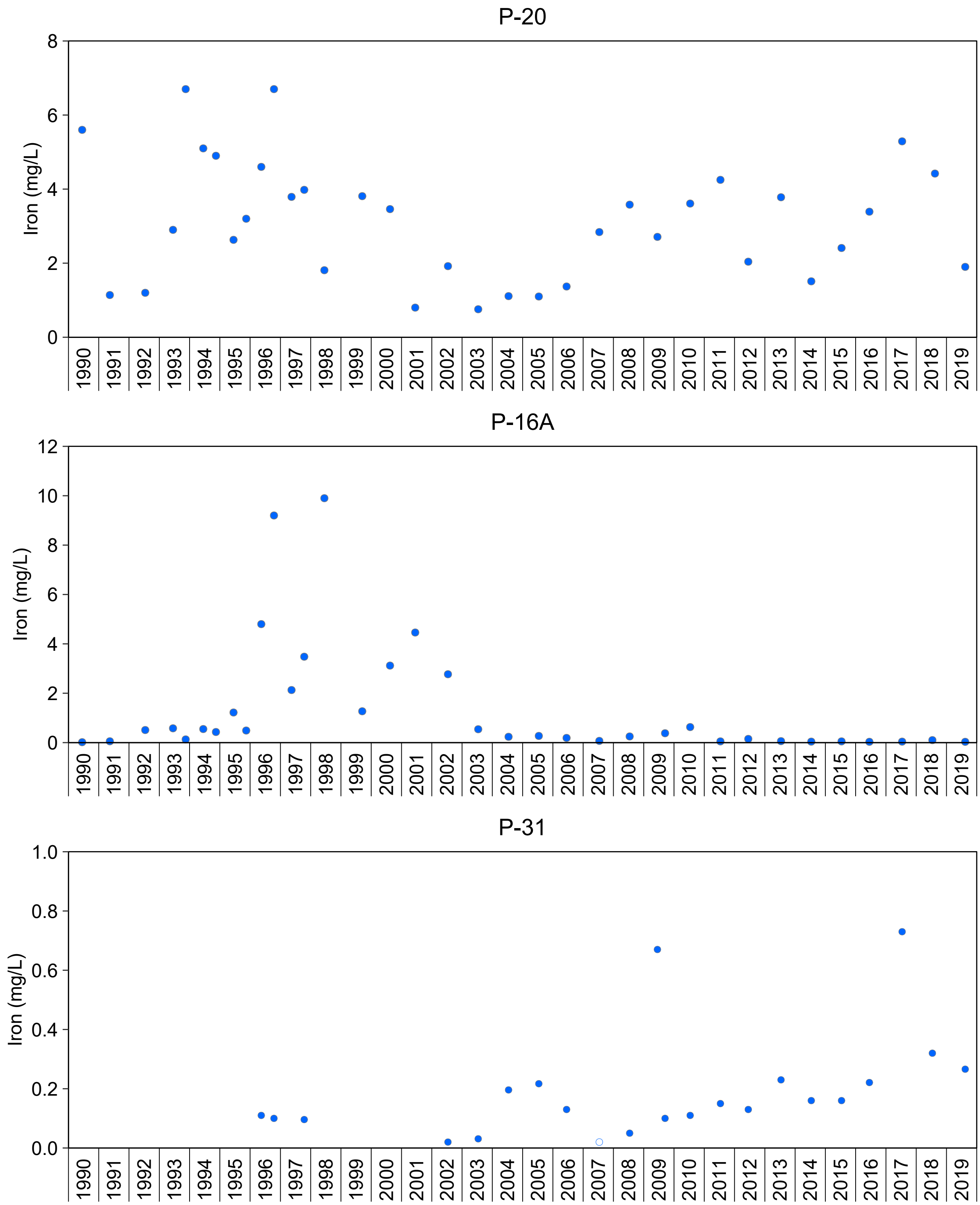


Figure H.11: Concentrations of Iron for TOMP Groundwater Stations, Panel TMA, 1990 to 2019

Notes: See Table 4.13 for Kendall trend analysis results and Appendix Tables H.8 to H.10 for raw data.

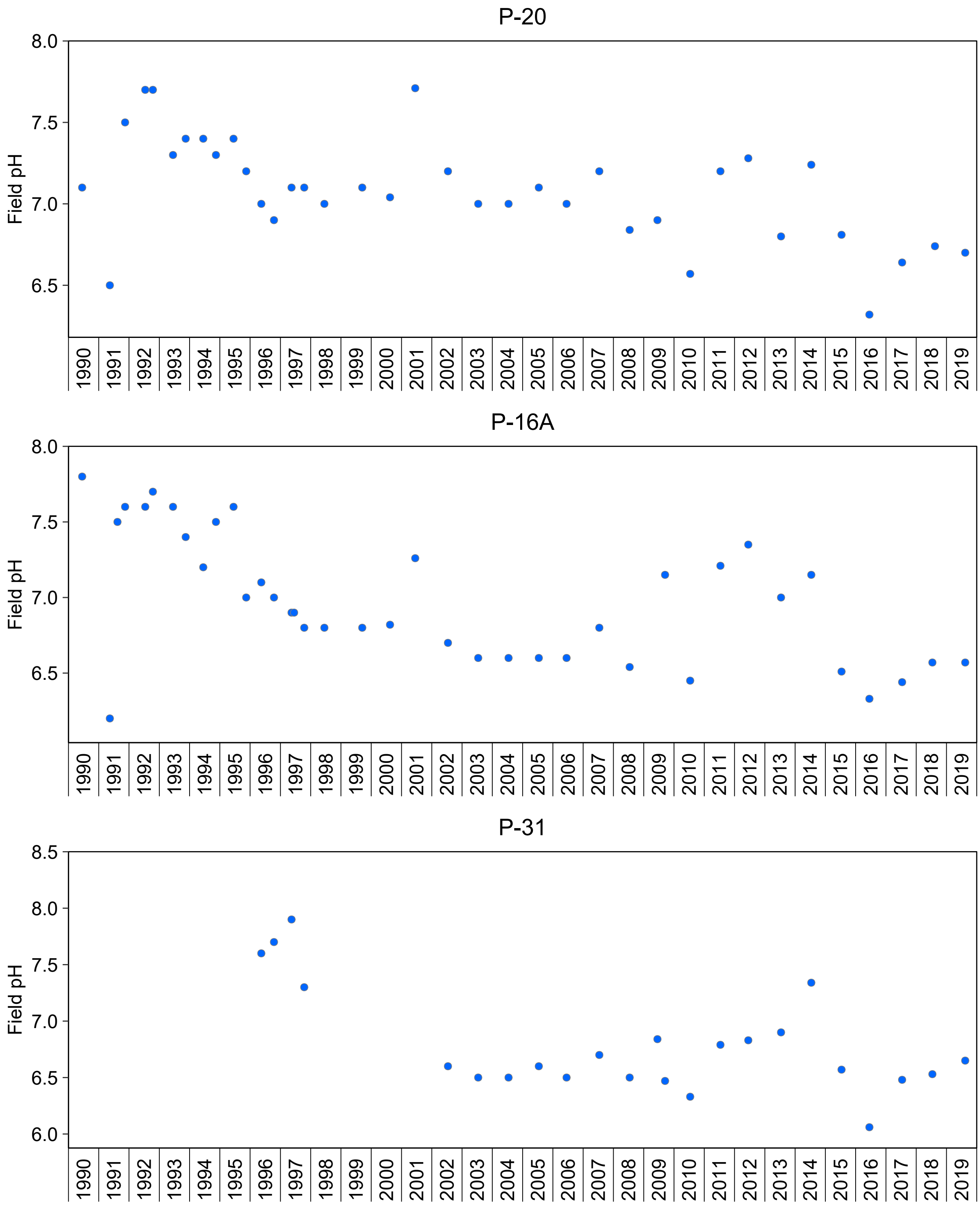


Figure H.12: Field Measurements of pH for TOMP Groundwater Stations, Panel TMA, 1990 to 2019

Notes: See Table 4.13 for Kendall trend analysis results and Appendix Tables H.8 to H.10 for raw data.

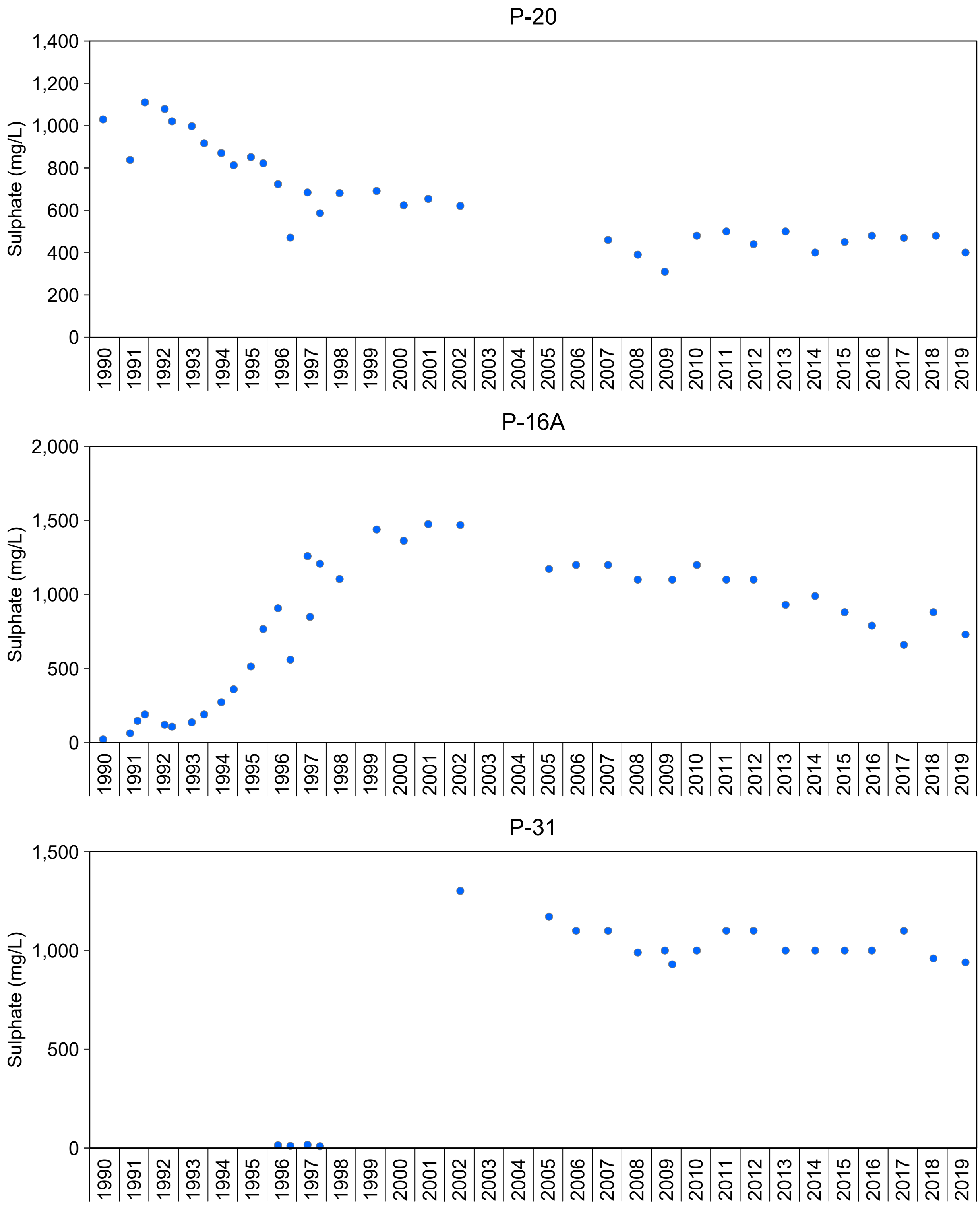


Figure H.13: Concentrations of Sulphate for TOMP Groundwater Stations, Panel TMA, 1990 to 2019

Notes: See Table 4.13 for Kendall trend analysis results and Appendix Tables H.8 to H.10 for raw data.

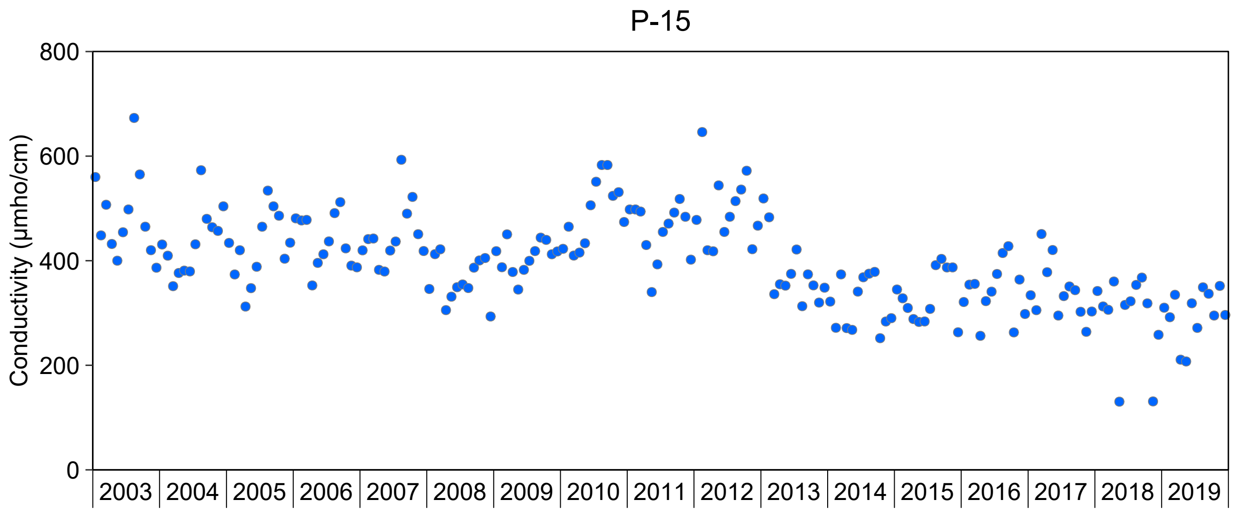


Figure H.14: Concentrations of Conductivity for TOMP Water Monitoring Stations, Panel TMA, 2003 to 2019

Notes: Conductivity is not included in the trend analysis for TOMP station P-15 because the monitoring is in support of ETP operations. Other stations at this TMA provide more meaningful information regarding trends for this parameter. Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Table H.7 for raw data.

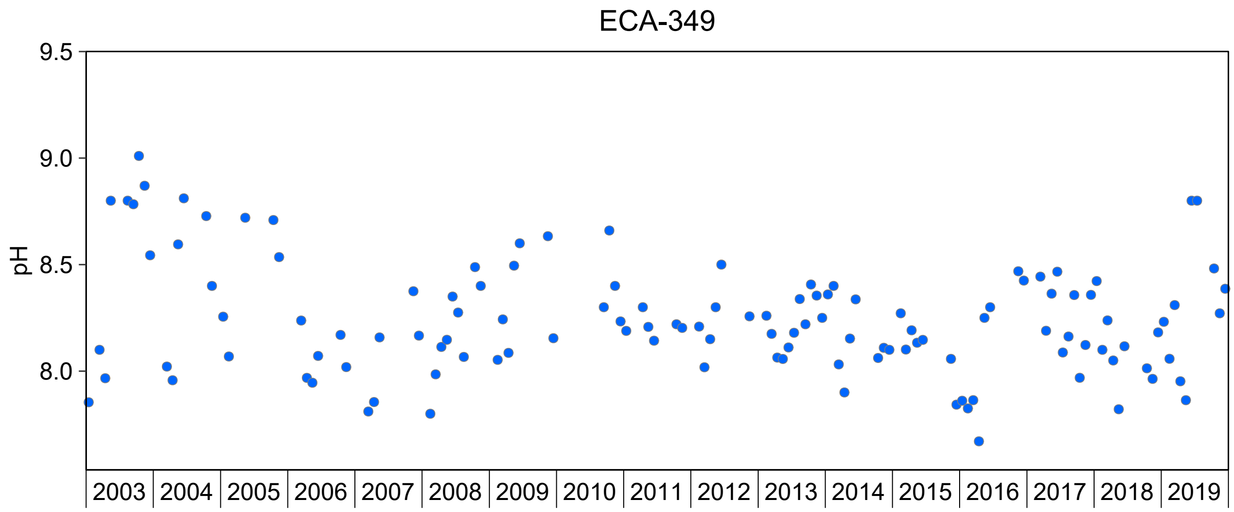


Figure H.15: Field Measurements of pH for TOMP Water Monitoring Stations, Panel TMA, 2003 to 2019

Notes: pH is not included in the trend analysis for TOMP station ECA-349 because the monitoring is in support of ETP operations. Other stations at this TMA provide more meaningful information regarding trends for this parameter. Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Table H.5 for raw data.

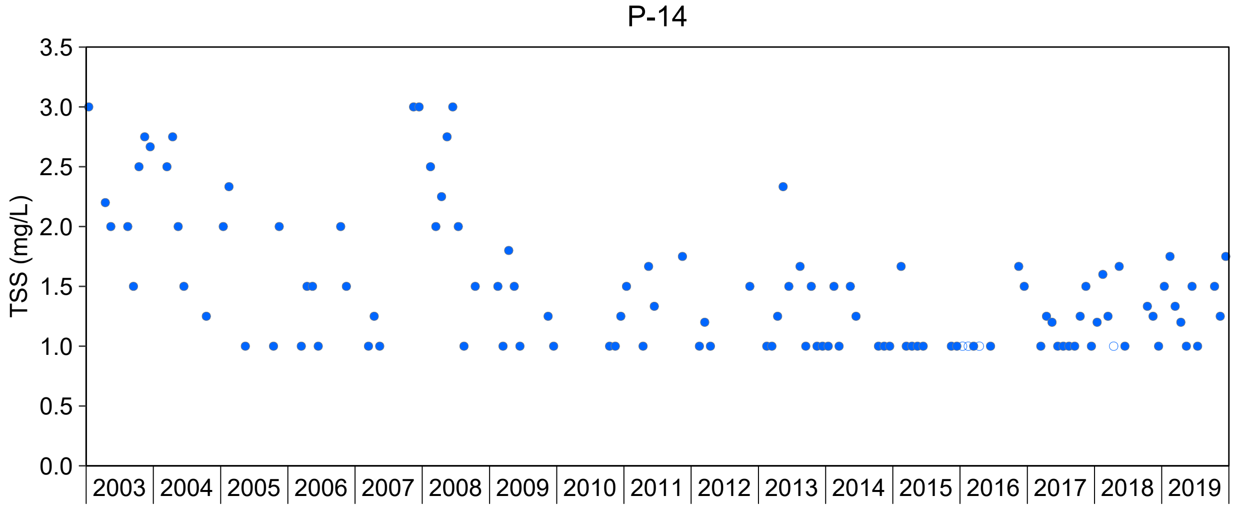


Figure H.16: Concentrations of Total Suspended Solids for TOMP Water Monitoring Stations, Panel TMA, 2003 to 2019

Notes: TSS is not included in the trend analysis for TOMP station P-14 because the monitoring is in support of ETP operations. Other stations at this TMA provide more meaningful information regarding trends for this parameter. Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Table H.6 for raw data.

Table H.1: Location of TOMP Data Tables and Figures Within this Cycle 5 SOE Report, Panel TMA

TMA	TOMP Station	Station Type/Purpose	Also a SAMP Station? [a]	Map Figures	Elevation Tables	Elevation Figures	Water Quality Data Tables (flow, acidity, barium, cobalt, iron, manganese, pH, radium-226, sulphate, uranium, conductivity, TSS, and/or treatment chemical consumption)	Comparison to EIS Predictions Figures	Lime or NaOH Consumption Figures	Barium Chloride Consumption Figures	Comparison to Discharge Criteria Figures	Trend Tables	Water Quality Data Figures										
													Acidity	Barium	Cobalt	Iron	Manganese	pH	Radium-226	Sulphate	Uranium	Conductivity	TSS
Panel	P-21	Basin performance (secondary)	no	4.5	H.11	4.21	H.3	na-p	na	na	na-c	4.12	H.1	na	na	H.4	na	H.6	H.7	H.8	na	na	na
	P-13	Basin performance (primary), ETP operations	no	4.5	H.12	4.21	H.4	4.22	4.23	4.23	na-c	4.12	H.1	H.2	H.3	H.4	H.5	H.6	H.7	H.8	H.9	na	na
	ECA-349	ETP operations	no	4.5	na	na	H.5	na-p	na	na	na-c	na-t	na	na	na	na	na	H.15	na	na	na	na	na
	P-14	Effluent	YES	4.1, 4.5	na	na	H.6	na-p	na	na	4.24, 4.25	4.17	na	N.1	N.2	N.3	N.4	N.5	N.6	N.7	N.8	na	H.16
	P-15	Perimeter	no	4.5	na	na	H.7	na-p	na	na	na-c	na-t	na	na	na	na	na	na	na	na	na	H.14	na
	P-16A, P-20, P-31	Groundwater	no	4.5	na	na	H.8 to H.10	na-p	na	na	na-c	4.13	H.10	na	na	H.11	na	H.12	na	H.13	na	na	na

Notes: na = parameter not measured at this station (as per study design); therefore, data presentation is not applicable. na-p = EIS Predictions do not apply to this station (as per study design); therefore, data presentation is not applicable. na-c = discharge criteria do not apply to this station (as per study design); therefore, data presentation is not applicable. na-t = at this station, only one to three parameters (elevation, pH, flow, conductivity, and/or radium-226) are monitored to support ETP operations. Other stations provide more meaningful information regarding trends for these parameters; therefore, data presentation is not applicable.

[a] Data for this TOMP station also pertain to the SAMP. Trends are assessed in the SAMP section and water quality figures are provided in the SAMP section (Table 2.6).

Table H.2: Panel Final Point of Control (P-14) Discharge Criteria

Parameter[a]	Units	Discharge Criteria			Action Level	Internal Investigation
		Grab Sample[b]	Monthly Mean[c]	Composite[d]		
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[e,f]	Bq/L	1.11	0.37	0.74	0.37	0.2
Total Suspended Solids	mg/L	50	25	37.5	30	7.5

[a] Copper, lead, nickel, and zinc monitoring discontinued in January 2010 as per regulatory approval of Cycle 3 design.
[b] Samples to be collected during periods of discharge.
[c] Arithmetic mean of twelve consecutive samples.
[d] Consists of 3 equal volumes collected at equal intervals over a 7 to 24 hour period.
[e] Radium-226 criterion are waived if total radium-226 average annual loading is < 12 Bq/s.
[f] Discharge criteria are for dissolved radium-226, while measured and reported values are for total radium-226.

Table H.3: **Water Quality at TOMP Station P-21 (Basin Performance - Secondary), Panel TMA, 2015 to 2019**

Date	Elevation (m)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Acidity (mg/L)	Iron (mg/L)
12-Feb-15	394	7.40	180	0.0880	<1.00	0.0200
11-May-15	394	7.00	140	0.110	<1.00	0.0400
9-Nov-15	393	7.20	170	0.101	<1.00	0.0260
4-Feb-16	394	7.40	160	0.0870	<1.00	0.0100
11-Apr-16	394	7.20	150	0.0740	<1.00	0.0220
13-Feb-17	394	7.00	160	0.0900	<1.00	<0.0200
15-May-17	394	7.40	130	0.0940	<1.00	0.0390
14-Aug-17	394	6.90	130	0.102	<1.00	0.0280
16-Oct-17	393	7.40	130	0.118	<1.00	0.0430
12-Feb-18	393	7.00	140	0.103	<1.00	<0.0200
15-May-18	393	7.30	110	0.107	<1.00	0.0600
19-Nov-18	393	7.40	120	0.107	<1.00	0.0690
11-Feb-19	393	7.40	120	0.0840	<1.00	<0.0200
13-May-19	394	7.20	97.0	0.131	<1.00	0.0630
11-Nov-19	393	7.30	110	0.124	<1.00	0.0820
n	78	15	15	15	15	15
Minimum	393	6.90	97.0	0.0740	<1.00	0.0100
Maximum	394	7.40	180	0.131	<1.00	0.0820
Mean	393	7.23	136	0.101	<1.00	0.0355
SD	0.149	0.180	23.8	0.0156	-	0.0240
Median	393	7.30	130	0.102	<1.00	0.0280
10th Percentile	393	7.00	110	0.0840	<1.00	0.0100
95th Percentile	394	7.40	180	0.131	<1.00	0.0820

Note: "SD" = standard deviation. "n" = number of samples. "-" = SD was incalculable because there was no variability in the data.

Table H.4: Water Quality at TOMP Station P-13 (Basin Performance - Primary, ETP Operations), Panel TMA, 2015 to 2019

Date	Elevation (m)	Flow (L/s)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Lime Consumption (kg per month)	Barium Chloride Consumption (kg per day)	Acidity (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
12-Feb-15	380	50.0	7.10	140	0.389	0.56	525	<1.00	0.0230	<0.000500	0.170	0.0320	0.00650
18-Mar-15	380	50.0	6.90	140	0.373	0.59	500	<1.00	0.0230	<0.000500	1.01	0.0380	0.00650
13-Apr-15	380	47.0	7.20	140	0.372	0.22	450	<1.00	0.0240	<0.000500	0.110	0.0500	0.00630
8-Jun-15	380	64.0	7.50	110	0.327	0	450	<1.00	0.0170	<0.000500	0.310	0.0680	0.00450
9-Nov-15	380	100	7.20	120	0.375	0	1050	<1.00	0.0210	<0.000500	0.179	0.0140	0.00550
21-Dec-15	380	140	7.30	130	0.362	0	600	<1.00	0.0241	<0.000500	0.268	0.0250	0.00590
12-Jan-16	380	143	7.20	120	0.373	0.52	1250	<1.00	0.0190	<0.000500	0.181	0.0220	0.00590
4-Feb-16	380	119	7.20	130	0.294	0	300	<1.00	0.0190	<0.000500	0.238	0.0220	0.00670
21-Mar-16	380	100	7.20	130	0.381	0.53	700	<1.00	0.0280	<0.000500	0.211	0.0330	0.00640
11-Apr-16	380	100	7.20	130	0.311	1.21	675	<1.00	0.0300	<0.000500	0.146	0.0300	0.00730
14-Nov-16	380	78.0	7.40	-	0.534	0	825	-	-	-	-	-	-
21-Nov-16	380	95.0	7.40	120	0.553	0	825	<1.00	0.0280	<0.000500	0.201	0.0230	0.00650
12-Dec-16	380	85.0	7.30	110	0.463	0	200	<1.00	0.0550	<0.000500	0.263	0.0240	0.00640
20-Mar-17	380	59.0	7.10	120	0.509	1.1	925	<1.00	0.0280	<0.000500	0.285	0.0390	0.00700
10-Apr-17	380	63.0	7.00	110	0.503	1.3	825	<1.00	0.0280	<0.000500	0.313	0.0590	0.00720
15-May-17	380	61.0	7.30	99.0	0.427	0	1175	<1.00	0.0240	<0.000500	0.265	0.0960	0.00620
10-Jul-17	380	80.0	7.20	110	0.458	0	225	<1.00	0.0210	<0.000500	1.19	0.0790	0.00740
11-Sep-17	380	80.0	7.20	100	0.464	0	525	<1.00	0.0230	<0.000500	0.302	0.0540	0.00620
16-Oct-17	380	80.0	7.20	100	0.642	0.8	675	<1.00	0.0260	<0.000500	0.248	0.0540	0.00510
13-Nov-17	380	100	7.20	110	0.545	0	675	<1.00	0.0260	<0.000500	0.147	0.0360	0.00670
11-Dec-17	380	80.0	7.20	110	0.479	0.9	1025	<1.00	0.0230	<0.000500	0.164	0.0320	0.00680
8-Jan-18	380	50.0	7.10	110	0.514	0	600	<1.00	0.0260	<0.000500	0.138	0.0320	0.00800
12-Feb-18	380	50.0	7.10	120	0.476	0.8	675	<1.00	0.0250	<0.000500	0.191	0.0350	0.00780
12-Mar-18	380	30.0	7.00	120	0.464	0	625	<1.00	0.0960	<0.000500	0.976	0.0410	0.00760
30-Apr-18	380	30.0	6.80	-	0.488	0	225	-	-	-	-	-	-
7-May-18	380	100	6.90	110	0.499	1	850	<1.00	0.0420	<0.000500	0.338	0.0730	0.00740
29-Oct-18	380	75.0	7.30	98.0	0.493	0.8	375	<1.00	0.0280	<0.000500	0.137	0.0230	0.00590
19-Nov-18	380	100	7.30	99.0	0.463	0	1125	<1.00	0.0300	<0.000500	0.295	0.0190	0.00730
10-Dec-18	380	55.0	7.10	99.0	0.521	0	500	<1.00	0.0550	<0.000500	0.489	0.0240	0.00640
14-Jan-19	380	40.0	7.10	100	0.503	0.65	475	<1.00	0.0490	<0.000500	0.350	0.0280	0.00630
11-Feb-19	380	80.0	6.90	100	0.529	1.1	700	<1.00	0.0400	<0.000500	0.101	0.0340	0.00800
15-Apr-19	380	120	7.00	110	0.452	1.4	1050	<1.00	0.0430	<0.000500	0.0760	0.0330	0.00830
13-May-19	380	150	7.20	72.0	0.361	1.08	1125	<1.00	0.0170	<0.000500	0.150	0.0690	0.00410
10-Jun-19	380	60.0	7.30	82.0	0.381	0	975	<1.00	0.108	<0.000500	0.167	0.0600	0.00510
2-Jul-19	380	60.0	7.30	87.0	0.303	0	75	<1.00	0.0200	<0.000500	0.137	0.0210	0.00570
22-Oct-19	380	120	7.30	84.0	0.531	0.98	1050	<1.00	0.0260	<0.000500	0.149	0.0310	0.00590
11-Nov-19	380	80.0	7.30	85.0	0.490	0	1313	<1.00	0.0240	<0.000500	0.200	0.0260	0.00610
16-Dec-19	380	40.0	7.10	96.0	0.516	0	750	<1.00	0.0250	<0.000500	0.192	0.0270	0.00680
n	134	850	38	36	38	60	60	36	36	36	36	36	36
Minimum	380	30.0	6.80	72.0	0.294	0	0	<1.00	0.0170	<0.000500	0.0760	0.0140	0.00410
Maximum	380	174	7.50	140	0.642	1.40	1,310	<1.00	0.108	<0.000500	1.19	0.0960	0.00830
Mean	380	79.2	7.17	110	0.450	0.272	451	<1.00	0.0323	<0.000500	0.286	0.0391	0.00649
SD	0.200	31.7	0.152	17.0	0.0809	0.437	412	-	0.0197	-	0.252	0.0193	0.000952
Median	380	75.0	7.20	110	0.464	0	450	<1.00	0.0260	<0.000500	0.200	0.0325	0.00645
10th Percentile	380	40.0	6.90	85.0	0.327	0	0	<1.00	0.0190	<0.000500	0.137	0.0220	0.00510
95th Percentile	380	150	7.40	140	0.553	1.16	1,150	<1.00	0.0960	<0.000500	1.01	0.0790	0.00800

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected, or SD was incalculable because there was no variability in the data.

Table H.5: **Water Quality at TOMP Station ECA-349 (ETP Operations), Panel TMA, 2015 to 2019**

Date	pH	Date	pH	Date	pH	Date	pH
9-Feb-15	8.30	4-Jan-16	7.80	15-Mar-17	8.10	18-Oct-17	7.80
10-Feb-15	8.50	5-Jan-16	7.73	16-Mar-17	8.20	19-Oct-17	8.00
11-Feb-15	8.40	6-Jan-16	7.78	17-Mar-17	8.20	20-Oct-17	8.00
12-Feb-15	8.30	7-Jan-16	7.80	20-Mar-17	8.20	23-Oct-17	7.90
13-Feb-15	8.50	8-Jan-16	7.73	21-Mar-17	8.40	24-Oct-17	7.90
17-Feb-15	8.30	11-Jan-16	7.90	22-Mar-17	8.40	25-Oct-17	7.90
18-Feb-15	8.60	12-Jan-16	7.80	23-Mar-17	8.50	26-Oct-17	7.70
19-Feb-15	8.50	13-Jan-16	7.86	24-Mar-17	8.50	27-Oct-17	7.90
20-Feb-15	8.00	14-Jan-16	7.78	27-Mar-17	8.40	30-Oct-17	7.90
23-Feb-15	8.20	15-Jan-16	7.90	28-Mar-17	8.50	31-Oct-17	8.00
24-Feb-15	8.10	18-Jan-16	7.80	29-Mar-17	8.30	1-Nov-17	7.90
25-Feb-15	8.10	19-Jan-16	8.19	30-Mar-17	8.60	2-Nov-17	8.10
26-Feb-15	8.00	20-Jan-16	7.82	31-Mar-17	8.40	3-Nov-17	8.00
27-Feb-15	8.00	21-Jan-16	7.80	3-Apr-17	8.50	6-Nov-17	8.00
2-Mar-15	8.00	22-Jan-16	8.09	4-Apr-17	8.60	7-Nov-17	8.10
3-Mar-15	8.10	25-Jan-16	7.90	5-Apr-17	8.50	8-Nov-17	8.10
4-Mar-15	8.00	26-Jan-16	7.80	6-Apr-17	8.40	9-Nov-17	8.10
5-Mar-15	8.10	27-Jan-16	7.84	7-Apr-17	8.40	10-Nov-17	8.10
6-Mar-15	8.10	28-Jan-16	8.00	10-Apr-17	8.20	13-Nov-17	8.10
9-Mar-15	8.00	29-Jan-16	7.90	11-Apr-17	8.40	14-Nov-17	7.70
10-Mar-15	8.10	1-Feb-16	7.83	12-Apr-17	8.50	15-Nov-17	8.10
11-Mar-15	8.10	2-Feb-16	7.79	13-Apr-17	7.90	16-Nov-17	8.00
12-Mar-15	8.10	3-Feb-16	7.78	17-Apr-17	7.80	17-Nov-17	8.00
13-Mar-15	8.20	4-Feb-16	7.90	18-Apr-17	8.10	20-Nov-17	8.30
16-Mar-15	8.00	9-Mar-16	8.10	19-Apr-17	7.90	21-Nov-17	8.10
17-Mar-15	8.10	10-Mar-16	8.30	20-Apr-17	8.00	22-Nov-17	8.30
18-Mar-15	8.10	11-Mar-16	8.03	21-Apr-17	8.20	23-Nov-17	8.40
19-Mar-15	8.09	14-Mar-16	8.38	24-Apr-17	8.00	24-Nov-17	8.30
20-Mar-15	8.14	15-Mar-16	7.96	25-Apr-17	8.10	27-Nov-17	8.30
23-Mar-15	8.20	16-Mar-16	7.85	26-Apr-17	8.00	28-Nov-17	8.30
24-Mar-15	8.10	17-Mar-16	7.62	27-Apr-17	8.00	29-Nov-17	8.30
25-Mar-15	8.10	18-Mar-16	7.78	28-Apr-17	8.10	30-Nov-17	8.10
26-Mar-15	8.20	21-Mar-16	7.70	1-May-17	7.80	1-Dec-17	8.30
27-Mar-15	8.20	22-Mar-16	7.70	2-May-17	8.20	4-Dec-17	8.30
30-Mar-15	8.10	23-Mar-16	7.70	3-May-17	8.40	5-Dec-17	8.30
31-Mar-15	8.10	24-Mar-16	7.70	4-May-17	8.40	6-Dec-17	8.30
1-Apr-15	8.30	28-Mar-16	7.80	5-May-17	8.20	7-Dec-17	8.30
2-Apr-15	8.30	29-Mar-16	7.80	8-May-17	8.10	8-Dec-17	8.30
6-Apr-15	8.20	30-Mar-16	7.70	9-May-17	8.40	11-Dec-17	8.50
7-Apr-15	8.20	31-Mar-16	7.70	10-May-17	8.50	12-Dec-17	8.40
8-Apr-15	8.20	1-Apr-16	7.70	11-May-17	8.40	13-Dec-17	8.40
9-Apr-15	8.20	4-Apr-16	7.70	12-May-17	8.20	14-Dec-17	8.30
10-Apr-15	8.20	5-Apr-16	7.70	15-May-17	8.50	15-Dec-17	8.40
13-Apr-15	8.10	6-Apr-16	7.70	16-May-17	8.50	18-Dec-17	8.40
14-Apr-15	8.20	7-Apr-16	7.70	17-May-17	8.30	19-Dec-17	8.50
15-Apr-15	8.20	8-Apr-16	7.70	18-May-17	8.30	20-Dec-17	8.50
16-Apr-15	8.10	11-Apr-16	7.70	19-May-17	8.40	21-Dec-17	8.50
17-Apr-15	8.10	12-Apr-16	7.70	23-May-17	8.60	22-Dec-17	8.60
22-May-15	8.00	13-Apr-16	7.58	24-May-17	8.30	27-Dec-17	8.10
25-May-15	8.20	14-Apr-16	7.70	25-May-17	8.30	28-Dec-17	8.30
26-May-15	8.20	15-Apr-16	7.42	26-May-17	8.70	29-Dec-17	8.10
27-May-15	8.20	18-Apr-16	7.70	29-May-17	8.60	2-Jan-18	8.40
28-May-15	8.10	19-Apr-16	7.70	30-May-17	8.50	3-Jan-18	8.30
29-May-15	8.10	20-Apr-16	7.70	31-May-17	8.40	4-Jan-18	8.50
1-Jun-15	8.30	21-Apr-16	7.60	1-Jun-17	8.70	5-Jan-18	8.50
2-Jun-15	8.30	22-Apr-16	7.70	2-Jun-17	8.60	8-Jan-18	8.50
3-Jun-15	8.20	25-Apr-16	7.70	5-Jun-17	8.50	9-Jan-18	8.50
4-Jun-15	8.10	30-May-16	8.20	6-Jun-17	8.30	10-Jan-18	8.50
5-Jun-15	8.20	31-May-16	8.30	7-Jun-17	8.20	11-Jan-18	8.50
8-Jun-15	8.20	1-Jun-16	8.30	8-Jun-17	8.50	12-Jan-18	8.30
9-Jun-15	8.10	2-Jun-16	8.30	6-Jul-17	8.10	15-Jan-18	8.50
10-Jun-15	8.10	3-Jun-16	8.30	7-Jul-17	8.20	16-Jan-18	8.50
11-Jun-15	8.10	9-Nov-16	8.70	10-Jul-17	7.90	17-Jan-18	8.50
12-Jun-15	8.20	10-Nov-16	8.30	11-Jul-17	8.10	18-Jan-18	8.60
15-Jun-15	8.20	11-Nov-16	8.40	12-Jul-17	8.10	19-Jan-18	8.50
16-Jun-15	8.20	14-Nov-16	8.40	13-Jul-17	8.10	22-Jan-18	8.80
17-Jun-15	8.00	15-Nov-16	8.50	14-Jul-17	8.10	23-Jan-18	8.40
18-Jun-15	8.00	16-Nov-16	8.30	17-Jul-17	8.10	24-Jan-18	8.20
19-Jun-15	8.00	17-Nov-16	8.80	22-Aug-17	8.00	25-Jan-18	8.40
2-Nov-15	8.10	18-Nov-16	8.70	23-Aug-17	8.10	26-Jan-18	8.20
3-Nov-15	8.37	21-Nov-16	8.30	24-Aug-17	8.30	29-Jan-18	8.30
4-Nov-15	8.10	22-Nov-16	8.40	25-Aug-17	8.00	30-Jan-18	8.10
5-Nov-15	8.00	23-Nov-16	8.20	28-Aug-17	8.00	31-Jan-18	8.30
6-Nov-15	8.20	24-Nov-16	8.60	29-Aug-17	8.30	1-Feb-18	8.30
9-Nov-15	8.10	25-Nov-16	8.50	30-Aug-17	8.30	2-Feb-18	8.10
10-Nov-15	8.01	28-Nov-16	8.40	31-Aug-17	8.30	5-Feb-18	8.20
11-Nov-15	8.00	29-Nov-16	8.50	1-Sep-17	8.40	6-Feb-18	8.30
12-Nov-15	7.87	30-Nov-16	8.50	5-Sep-17	8.30	7-Feb-18	8.00
13-Nov-15	7.97	1-Dec-16	8.40	6-Sep-17	8.40	8-Feb-18	8.00
16-Nov-15	7.91	2-Dec-16	8.30	7-Sep-17	8.40	9-Feb-18	8.20
17-Nov-15	8.17	5-Dec-16	8.40	8-Sep-17	8.40	12-Feb-18	7.90
18-Nov-15	8.32	6-Dec-16	8.40	11-Sep-17	8.30	13-Feb-18	8.00
19-Nov-15	7.95	7-Dec-16	8.40	12-Sep-17	8.40	14-Feb-18	7.80
20-Nov-15	7.95	8-Dec-16	8.30	13-Sep-17	8.40	15-Feb-18	8.00
23-Nov-15	7.90	9-Dec-16	8.60	14-Sep-17	8.30	16-Feb-18	7.90
16-Dec-15	7.90	12-Dec-16	8.60	15-Sep-17	8.30	20-Feb-18	7.90
17-Dec-15	7.87	1-Mar-17	8.60	18-Sep-17	8.30	21-Feb-18	7.90
18-Dec-15	7.80	2-Mar-17	8.60	19-Sep-17	8.30	22-Feb-18	8.40
21-Dec-15	7.80	3-Mar-17	8.70	20-Sep-17	8.40	23-Feb-18	8.30
22-Dec-15	7.80	6-Mar-17	8.30	21-Sep-17	8.40	26-Feb-18	8.00
23-Dec-15	7.80	7-Mar-17	8.60	10-Oct-17	8.20	27-Feb-18	8.20
24-Dec-15	7.80	8-Mar-17	8.60	11-Oct-17	8.00	28-Feb-18	8.50
28-Dec-15	7.80	9-Mar-17	8.50	12-Oct-17	8.10	1-Mar-18	8.20
29-Dec-15	7.90	10-Mar-17	8.50	13-Oct-17	8.00	2-Mar-18	8.30
30-Dec-15	7.90	13-Mar-17	8.50	16-Oct-17	8.30	5-Mar-18	8.40
31-Dec-15	7.90	14-Mar-17	8.60	17-Oct-17	7.90	6-Mar-18	8.50

Note: "SD" = standard deviation. "n" = number of samples.

Table H.5: Water Quality at TOMP Station ECA-349 (ETP Operations), Panel TMA, 2015 to 2019

Date	pH
7-Mar-18	8.50
8-Mar-18	8.30
9-Mar-18	8.30
12-Mar-18	8.40
13-Mar-18	8.40
14-Mar-18	8.30
15-Mar-18	8.30
16-Mar-18	8.10
19-Mar-18	8.10
20-Mar-18	8.00
21-Mar-18	8.20
22-Mar-18	8.30
23-Mar-18	8.30
26-Mar-18	8.10
27-Mar-18	8.00
28-Mar-18	8.00
29-Mar-18	8.00
27-Apr-18	8.10
30-Apr-18	8.00
1-May-18	8.00
2-May-18	8.10
3-May-18	8.00
4-May-18	7.50
7-May-18	7.70
8-May-18	7.70
9-May-18	7.70
10-May-18	7.80
11-May-18	7.80
14-May-18	7.80
15-May-18	7.70
16-May-18	7.70
17-May-18	7.80
18-May-18	7.90
22-May-18	7.70
23-May-18	7.80
24-May-18	7.80
25-May-18	7.80
28-May-18	8.30
22-Jun-18	8.00
25-Jun-18	8.30
26-Jun-18	7.70
27-Jun-18	8.00
28-Jun-18	8.10
29-Jun-18	8.60
11-Oct-18	8.20
12-Oct-18	8.00
15-Oct-18	8.00
16-Oct-18	7.90
17-Oct-18	7.90
18-Oct-18	8.20
19-Oct-18	8.10
22-Oct-18	7.90
23-Oct-18	7.90
24-Oct-18	8.00
25-Oct-18	7.90
26-Oct-18	7.90
29-Oct-18	8.10
30-Oct-18	8.10
31-Oct-18	8.10
1-Nov-18	8.20
2-Nov-18	8.10
5-Nov-18	8.00
6-Nov-18	8.10
7-Nov-18	8.10
8-Nov-18	8.10
9-Nov-18	8.10
12-Nov-18	8.10
13-Nov-18	7.90
14-Nov-18	7.80
15-Nov-18	7.80
16-Nov-18	7.90
19-Nov-18	7.90
20-Nov-18	7.80
21-Nov-18	7.90
22-Nov-18	7.90
23-Nov-18	8.00
26-Nov-18	7.90
27-Nov-18	8.00
28-Nov-18	7.90
29-Nov-18	7.80
30-Nov-18	7.90
3-Dec-18	7.90
4-Dec-18	7.90
5-Dec-18	8.00
6-Dec-18	8.00
7-Dec-18	7.90
10-Dec-18	8.40
11-Dec-18	8.40
12-Dec-18	8.50
13-Dec-18	8.30
14-Dec-18	8.30
17-Dec-18	8.40
7-Jan-19	8.20
8-Jan-19	8.30
9-Jan-19	8.50
10-Jan-19	8.40
11-Jan-19	8.30
14-Jan-19	8.50
15-Jan-19	8.30
16-Jan-19	8.40
17-Jan-19	8.10
18-Jan-19	8.10
21-Jan-19	8.10
22-Jan-19	8.00
23-Jan-19	8.20
24-Jan-19	8.10
25-Jan-19	8.00
28-Jan-19	8.20
29-Jan-19	8.20
30-Jan-19	8.20
31-Jan-19	8.30
1-Feb-19	8.00
4-Feb-19	8.10
5-Feb-19	8.00
6-Feb-19	8.00
7-Feb-19	8.00
8-Feb-19	8.10
11-Feb-19	8.10
12-Feb-19	8.00
13-Feb-19	8.20
14-Feb-19	7.60
15-Feb-19	8.00
19-Feb-19	8.20
20-Feb-19	8.00
21-Feb-19	8.00
22-Feb-19	8.00
25-Feb-19	8.20
26-Feb-19	8.20
27-Feb-19	8.20
28-Feb-19	8.20
1-Mar-19	8.20
4-Mar-19	8.20
5-Mar-19	8.30
6-Mar-19	8.20
7-Mar-19	8.20
8-Mar-19	8.20
26-Mar-19	8.30
27-Mar-19	8.50
28-Mar-19	8.50
29-Mar-19	8.50
1-Apr-19	8.50
2-Apr-19	8.50
3-Apr-19	8.60
4-Apr-19	8.10
5-Apr-19	8.50
8-Apr-19	8.10
9-Apr-19	8.20
10-Apr-19	8.20
11-Apr-19	8.00
12-Apr-19	7.90
15-Apr-19	7.60
16-Apr-19	7.50
17-Apr-19	7.80
18-Apr-19	7.70
22-Apr-19	7.70
23-Apr-19	7.80
24-Apr-19	7.60
25-Apr-19	7.70
26-Apr-19	7.70
29-Apr-19	7.70
30-Apr-19	7.60
1-May-19	7.70
2-May-19	7.60
3-May-19	7.70
6-May-19	7.70
7-May-19	7.80
8-May-19	7.70
9-May-19	7.70
10-May-19	7.70
13-May-19	7.60
14-May-19	7.80
15-May-19	7.80
16-May-19	7.70
17-May-19	7.80
21-May-19	7.70
22-May-19	7.90
23-May-19	8.30
24-May-19	8.20
27-May-19	8.20
28-May-19	8.10
29-May-19	8.10
30-May-19	8.10
31-May-19	8.10
3-Jun-19	8.80
4-Jun-19	8.80
5-Jun-19	8.80
6-Jun-19	8.80
7-Jun-19	8.80
10-Jun-19	8.70
11-Jun-19	8.80
12-Jun-19	8.80
13-Jun-19	8.90
14-Jun-19	8.80
17-Jun-19	8.80
18-Jun-19	8.80
19-Jun-19	8.80
20-Jun-19	8.90
21-Jun-19	8.80
24-Jun-19	8.80
25-Jun-19	8.70
26-Jun-19	8.80
27-Jun-19	8.80
28-Jun-19	8.80
2-Jul-19	8.80
3-Jul-19	8.80
4-Jul-19	8.80
5-Jul-19	8.80
1-Oct-19	8.40
2-Oct-19	8.90
3-Oct-19	8.90
4-Oct-19	8.80
7-Oct-19	8.80
8-Oct-19	8.80
9-Oct-19	8.80
10-Oct-19	8.90
11-Oct-19	8.80
15-Oct-19	8.80
16-Oct-19	8.80
17-Oct-19	8.70
18-Oct-19	8.00
21-Oct-19	8.20
22-Oct-19	8.20
23-Oct-19	8.10
24-Oct-19	8.10
25-Oct-19	8.10
28-Oct-19	8.10
29-Oct-19	8.10
30-Oct-19	8.10
31-Oct-19	8.20
1-Nov-19	8.10
4-Nov-19	8.40
5-Nov-19	8.30
6-Nov-19	8.30
7-Nov-19	8.30
8-Nov-19	8.30
11-Nov-19	8.30
12-Nov-19	8.30
13-Nov-19	8.20
14-Nov-19	8.30
15-Nov-19	8.30
18-Nov-19	8.30
19-Nov-19	8.30
20-Nov-19	8.10
21-Nov-19	8.30
22-Nov-19	8.30
25-Nov-19	8.10
26-Nov-19	8.30
27-Nov-19	8.30
28-Nov-19	8.30
29-Nov-19	8.30
6-Dec-19	8.50
9-Dec-19	8.50
10-Dec-19	8.50
11-Dec-19	8.60
12-Dec-19	8.60
13-Dec-19	8.50
16-Dec-19	8.50
17-Dec-19	8.30
18-Dec-19	8.50
19-Dec-19	8.50
20-Dec-19	8.30
24-Dec-19	8.20
27-Dec-19	8.20
30-Dec-19	8.10
31-Dec-19	8.00
n	649
Minimum	7.42
Maximum	8.90
Mean	8.17
SD	0.296
Median	8.20
10th Percentile	7.80
95th Percentile	8.80

Note: "SD" = standard deviation. "n" = number of samples.

Table H.6: Water Quality at TOMP Station P-14 (Effluent), Panel TMA, 2015 to 2019

Date	Flow (L/s)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	TSS (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
12-Feb-15	50.0	7.40	140	0.137	<1.00	1.22	<0.000500	0.0500	0.0180	0.00750
17-Feb-15	50.0	7.50	-	0.0270	3.00	1.09	-	-	-	-
23-Feb-15	50.0	7.40	-	0.145	<1.00	1.10	-	-	-	-
2-Mar-15	48.0	7.60	-	0.226	<1.00	1.64	-	-	-	-
9-Mar-15	50.0	7.80	-	0.218	<1.00	1.63	-	-	-	-
17-Mar-15	53.0	7.51	140	0.245	1.00	1.68	<0.000500	0.0500	0.0260	0.00710
23-Mar-15	47.0	7.40	-	0.226	<1.00	1.95	-	-	-	-
30-Mar-15	49.0	7.40	-	0.0660	1.00	0.885	-	-	-	-
6-Apr-15	48.0	7.50	-	0.0540	<1.00	0.885	-	-	-	-
13-Apr-15	47.0	7.70	140	0.0400	1.00	0.810	<0.000500	0.0300	0.0290	0.00680
25-May-15	50.0	7.50	120	0.0330	1.00	0.338	<0.000500	<0.0200	0.0140	0.0113
1-Jun-15	65.0	7.60	-	0.0700	1.00	0.557	-	-	-	-
8-Jun-15	64.0	7.40	110	0.0790	1.00	0.652	<0.000500	0.0300	0.0420	0.00740
15-Jun-15	63.0	7.30	-	0.0600	1.00	0.627	-	-	-	-
5-Nov-15	100	7.60	-	0.0870	1.00	0.501	-	-	-	-
9-Nov-15	100	7.40	120	0.0150	1.00	0.533	<0.000500	0.0270	0.0110	0.0121
16-Nov-15	120	7.38	-	0.128	1.00	0.522	-	-	-	-
23-Nov-15	118	7.40	-	0.153	<1.00	0.598	-	-	-	-
18-Dec-15	123	7.50	-	0.0650	<1.00	0.551	-	-	-	-
21-Dec-15	120	7.30	120	0.182	<1.00	1.26	<0.000500	0.0660	0.0170	0.00660
28-Dec-15	150	7.30	-	0.220	1.00	1.20	-	-	-	-
6-Jan-16	148	7.63	-	0.220	<1.00	1.38	-	-	-	-
12-Jan-16	143	7.30	120	0.287	<1.00	1.68	<0.000500	0.0950	0.0200	0.00600
18-Jan-16	133	7.30	-	0.243	<1.00	1.38	-	-	-	-
27-Jan-16	130	7.59	-	0.224	<1.00	1.74	-	-	-	-
1-Feb-16	122	7.53	-	0.209	<1.00	1.71	-	-	-	-
4-Feb-16	119	7.30	130	0.256	<1.00	1.73	<0.000500	0.0730	0.0200	0.00710
14-Mar-16	48.0	7.79	-	0.0610	<1.00	0.657	-	-	-	-
21-Mar-16	100	7.40	120	0.0850	1.00	0.812	<0.000500	0.0420	0.0230	0.00710
28-Mar-16	100	7.40	-	0.0980	1.00	0.726	-	-	-	-
4-Apr-16	100	7.40	-	0.192	<1.00	1.17	-	-	-	-
11-Apr-16	100	7.60	120	0.252	<1.00	1.32	<0.000500	0.0380	0.0320	0.00810
18-Apr-16	150	7.30	-	0.263	<1.00	1.25	-	-	-	-
25-Apr-16	120	7.50	-	0.205	<1.00	1.47	-	-	-	-
31-May-16	120	-	-	-	-	-	-	-	-	-
2-Jun-16	120	7.50	-	0.129	1.00	0.970	-	-	-	-
14-Nov-16	78.0	7.70	-	0.161	1.00	0.684	-	0.0290	-	-
21-Nov-16	95.0	7.50	120	0.110	3.00	0.776	<0.000500	0.0430	0.0130	0.0106
28-Nov-16	90.0	7.40	-	0.201	1.00	0.796	-	-	-	-
5-Dec-16	90.0	7.30	-	0.147	1.00	0.721	-	-	-	-
12-Dec-16	85.0	7.50	120	0.115	2.00	0.654	<0.000500	0.0570	0.0190	0.00650
3-Mar-17	58.0	-	-	-	-	-	-	-	-	-
4-Mar-17	60.0	-	-	-	-	-	-	-	-	-
5-Mar-17	60.0	-	-	-	-	-	-	-	-	-
6-Mar-17	58.0	7.40	-	0.110	<1.00	0.582	-	-	-	-
7-Mar-17	60.0	-	-	-	-	-	-	-	-	-
8-Mar-17	60.0	-	-	-	-	-	-	-	-	-
9-Mar-17	60.0	-	-	-	-	-	-	-	-	-
10-Mar-17	60.0	-	-	-	-	-	-	-	-	-
11-Mar-17	60.0	-	-	-	-	-	-	-	-	-
12-Mar-17	60.0	-	-	-	-	-	-	-	-	-
13-Mar-17	60.0	7.50	-	0.112	<1.00	-	-	-	-	-
14-Mar-17	60.0	-	-	-	-	-	-	-	-	-
15-Mar-17	60.0	-	-	-	-	-	-	-	-	-
16-Mar-17	60.0	-	-	-	-	-	-	-	-	-
17-Mar-17	60.0	-	-	-	-	-	-	-	-	-
18-Mar-17	60.0	-	-	-	-	-	-	-	-	-
19-Mar-17	60.0	-	-	-	-	-	-	-	-	-
20-Mar-17	59.0	7.30	110	0.292	<1.00	0.605	<0.000500	0.0470	0.0260	0.00760
21-Mar-17	60.0	-	-	-	-	-	-	-	-	-
22-Mar-17	58.0	-	-	-	-	-	-	-	-	-
23-Mar-17	58.0	-	-	-	-	-	-	-	-	-
24-Mar-17	56.0	-	-	-	-	-	-	-	-	-
25-Mar-17	56.0	-	-	-	-	-	-	-	-	-
26-Mar-17	56.0	-	-	-	-	-	-	-	-	-
27-Mar-17	57.0	7.60	-	0.0990	1.00	-	-	-	-	-
28-Mar-17	57.0	-	-	-	-	-	-	-	-	-
29-Mar-17	57.0	-	-	-	-	-	-	-	-	-
30-Mar-17	58.0	-	-	-	-	-	-	-	-	-
31-Mar-17	58.0	-	-	-	-	-	-	-	-	-
1-Apr-17	58.0	-	-	-	-	-	-	-	-	-
2-Apr-17	58.0	-	-	-	-	-	-	-	-	-
3-Apr-17	57.0	7.80	-	0.197	1.00	-	-	-	-	-
4-Apr-17	60.0	-	-	-	-	-	-	-	-	-
5-Apr-17	61.0	-	-	-	-	-	-	-	-	-
6-Apr-17	61.0	-	-	-	-	-	-	-	-	-
7-Apr-17	62.0	-	-	-	-	-	-	-	-	-
8-Apr-17	62.0	-	-	-	-	-	-	-	-	-
9-Apr-17	62.0	-	-	-	-	-	-	-	-	-
10-Apr-17	63.0	7.50	100	0.273	1.00	1.19	<0.000500	0.0780	0.0370	0.00770
11-Apr-17	63.0	-	-	-	-	-	-	-	-	-
12-Apr-17	64.0	-	-	-	-	-	-	-	-	-
13-Apr-17	60.0	-	-	-	-	-	-	-	-	-
14-Apr-17	100	-	-	-	-	-	-	-	-	-
15-Apr-17	100	-	-	-	-	-	-	-	-	-
16-Apr-17	100	-	-	-	-	-	-	-	-	-
17-Apr-17	100	7.40	-	0.237	2.00	-	-	-	-	-
18-Apr-17	120	-	-	-	-	-	-	-	-	-
19-Apr-17	120	-	-	-	-	-	-	-	-	-
20-Apr-17	120	-	-	-	-	-	-	-	-	-
21-Apr-17	120	-	-	-	-	-	-	-	-	-
22-Apr-17	120	-	-	-	-	-	-	-	-	-
23-Apr-17	120	-	-	-	-	-	-	-	-	-
24-Apr-17	120	7.40	-	0.253	1.00	-	-	-	-	-
25-Apr-17	120	-	-	-	-	-	-	-	-	-
26-Apr-17	120	-	-	-	-	-	-	-	-	-
27-Apr-17	120	-	-	-	-	-	-	-	-	-
28-Apr-17	120	-	-	-	-	-	-	-	-	-
29-Apr-17	120	-	-	-	-	-	-	-	-	-
30-Apr-17	117	-	-	-	-	-	-	-	-	-
1-May-17	117	7.50	-	0.296	1.00	-	-	-	-	-
2-May-17	117	-	-	-	-	-	-	-	-	-

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected, or SD was incalculable because there was no variability in the data.

Table H.6: Water Quality at TOMP Station P-14 (Effluent), Panel TMA, 2015 to 2019

Date	Flow (L/s)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	TSS (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
3-May-17	117	-	-	-	-	-	-	-	-	-
4-May-17	115	-	-	-	-	-	-	-	-	-
5-May-17	120	-	-	-	-	-	-	-	-	-
6-May-17	120	-	-	-	-	-	-	-	-	-
7-May-17	120	-	-	-	-	-	-	-	-	-
8-May-17	100	7.50	-	0.273	1.00	-	-	-	-	-
9-May-17	100	-	-	-	-	-	-	-	-	-
10-May-17	62.0	-	-	-	-	-	-	-	-	-
11-May-17	62.0	-	-	-	-	-	-	-	-	-
12-May-17	62.0	-	-	-	-	-	-	-	-	-
13-May-17	62.0	-	-	-	-	-	-	-	-	-
14-May-17	62.0	-	-	-	-	-	-	-	-	-
15-May-17	61.0	7.40	100	0.0990	2.00	0.790	<0.000500	0.0660	0.0860	0.00700
16-May-17	60.0	-	-	-	-	-	-	-	-	-
17-May-17	60.0	-	-	-	-	-	-	-	-	-
18-May-17	62.0	-	-	-	-	-	-	-	-	-
19-May-17	62.0	-	-	-	-	-	-	-	-	-
20-May-17	60.0	-	-	-	-	-	-	-	-	-
21-May-17	60.0	-	-	-	-	-	-	-	-	-
22-May-17	60.0	-	-	-	-	-	-	-	-	-
23-May-17	60.0	7.40	-	0.0780	1.00	-	-	-	-	-
24-May-17	60.0	-	-	-	-	-	-	-	-	-
25-May-17	60.0	-	-	-	-	-	-	-	-	-
26-May-17	60.0	-	-	-	-	-	-	-	-	-
27-May-17	60.0	-	-	-	-	-	-	-	-	-
28-May-17	60.0	-	-	-	-	-	-	-	-	-
29-May-17	61.0	7.50	-	0.0960	1.00	-	-	-	-	-
30-May-17	60.0	-	-	-	-	-	-	-	-	-
31-May-17	61.0	-	-	-	-	-	-	-	-	-
1-Jun-17	62.0	-	-	-	-	-	-	-	-	-
2-Jun-17	60.0	-	-	-	-	-	-	-	-	-
3-Jun-17	60.0	-	-	-	-	-	-	-	-	-
4-Jun-17	75.0	-	-	-	-	-	-	-	-	-
5-Jun-17	75.0	7.40	-	0.139	1.00	-	-	-	-	-
6-Jun-17	75.0	-	-	-	-	-	-	-	-	-
7-Jun-17	75.0	-	-	-	-	-	-	-	-	-
8-Jun-17	75.0	-	-	-	-	-	-	-	-	-
9-Jun-17	38.0	-	-	-	-	-	-	-	-	-
10-Jun-17	19.0	-	-	-	-	-	-	-	-	-
7-Jul-17	80.0	-	-	-	-	-	-	-	-	-
8-Jul-17	80.0	-	-	-	-	-	-	-	-	-
9-Jul-17	80.0	-	-	-	-	-	-	-	-	-
10-Jul-17	80.0	7.50	100	0.119	<1.00	0.675	<0.000500	<0.0200	0.0150	0.0102
11-Jul-17	80.0	-	-	-	-	-	-	-	-	-
12-Jul-17	80.0	-	-	-	-	-	-	-	-	-
13-Jul-17	80.0	-	-	-	-	-	-	-	-	-
14-Jul-17	80.0	-	-	-	-	-	-	-	-	-
15-Jul-17	80.0	-	-	-	-	-	-	-	-	-
16-Jul-17	80.0	-	-	-	-	-	-	-	-	-
17-Jul-17	80.0	7.50	-	0.220	1.00	-	-	-	-	-
18-Jul-17	40.0	-	-	-	-	-	-	-	-	-
19-Jul-17	20.0	-	-	-	-	-	-	-	-	-
23-Aug-17	83.0	-	-	-	-	-	-	-	-	-
24-Aug-17	83.0	7.50	-	0.119	1.00	-	-	-	-	-
25-Aug-17	82.0	-	-	-	-	-	-	-	-	-
26-Aug-17	80.0	-	-	-	-	-	-	-	-	-
27-Aug-17	80.0	-	-	-	-	-	-	-	-	-
28-Aug-17	80.0	7.50	100	0.190	<1.00	1.55	<0.000500	0.0410	0.0230	0.0179
29-Aug-17	80.0	-	-	-	-	-	-	-	-	-
30-Aug-17	80.0	-	-	-	-	-	-	-	-	-
31-Aug-17	80.0	-	-	-	-	-	-	-	-	-
1-Sep-17	80.0	-	-	-	-	-	-	-	-	-
2-Sep-17	80.0	-	-	-	-	-	-	-	-	-
3-Sep-17	80.0	-	-	-	-	-	-	-	-	-
4-Sep-17	80.0	-	-	-	-	-	-	-	-	-
5-Sep-17	80.0	7.50	-	0.320	1.00	-	-	-	-	-
6-Sep-17	80.0	-	-	-	-	-	-	-	-	-
7-Sep-17	80.0	-	-	-	-	-	-	-	-	-
8-Sep-17	80.0	-	-	-	-	-	-	-	-	-
9-Sep-17	80.0	-	-	-	-	-	-	-	-	-
10-Sep-17	80.0	-	-	-	-	-	-	-	-	-
11-Sep-17	80.0	7.40	100	0.300	1.00	1.15	<0.000500	0.0630	0.0260	0.00700
12-Sep-17	80.0	-	-	-	-	-	-	-	-	-
13-Sep-17	85.0	-	-	-	-	-	-	-	-	-
14-Sep-17	85.0	-	-	-	-	-	-	-	-	-
15-Sep-17	85.0	-	-	-	-	-	-	-	-	-
16-Sep-17	85.0	-	-	-	-	-	-	-	-	-
17-Sep-17	85.0	-	-	-	-	-	-	-	-	-
18-Sep-17	84.0	7.40	-	0.278	1.00	-	-	-	-	-
19-Sep-17	84.0	-	-	-	-	-	-	-	-	-
20-Sep-17	50.0	-	-	-	-	-	-	-	-	-
21-Sep-17	50.0	-	-	-	-	-	-	-	-	-
22-Sep-17	25.0	-	-	-	-	-	-	-	-	-
23-Sep-17	13.0	-	-	-	-	-	-	-	-	-
9-Oct-17	80.0	-	-	-	-	-	-	-	-	-
10-Oct-17	80.0	7.70	-	0.132	1.00	-	-	-	-	-
11-Oct-17	81.0	-	-	-	-	-	-	-	-	-
12-Oct-17	81.0	-	-	-	-	-	-	-	-	-
13-Oct-17	81.0	-	-	-	-	-	-	-	-	-
14-Oct-17	81.0	-	-	-	-	-	-	-	-	-
15-Oct-17	81.0	-	-	-	-	-	-	-	-	-
16-Oct-17	80.0	7.30	100	0.199	1.00	0.0130	<0.000500	0.0480	0.0430	0.0159
17-Oct-17	80.0	-	-	-	-	-	-	-	-	-
18-Oct-17	110	-	-	-	-	-	-	-	-	-
19-Oct-17	114	-	-	-	-	-	-	-	-	-
20-Oct-17	113	-	-	-	-	-	-	-	-	-
21-Oct-17	113	-	-	-	-	-	-	-	-	-
22-Oct-17	113	-	-	-	-	-	-	-	-	-
23-Oct-17	112	7.30	-	0.211	2.00	-	-	-	-	-
24-Oct-17	126	-	-	-	-	-	-	-	-	-
25-Oct-17	128	-	-	-	-	-	-	-	-	-
26-Oct-17	150	-	-	-	-	-	-	-	-	-

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected, or SD was incalculable because there was no variability in the data.

Table H.6: Water Quality at TOMP Station P-14 (Effluent), Panel TMA, 2015 to 2019

Date	Flow (L/s)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	TSS (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
27-Oct-17	163	-	-	-	-	-	-	-	-	-
28-Oct-17	163	-	-	-	-	-	-	-	-	-
29-Oct-17	163	-	-	-	-	-	-	-	-	-
30-Oct-17	163	7.30	-	0.256	1.00	-	-	-	-	-
31-Oct-17	129	-	-	-	-	-	-	-	-	-
1-Nov-17	128	-	-	-	-	-	-	-	-	-
2-Nov-17	127	-	-	-	-	-	-	-	-	-
3-Nov-17	127	-	-	-	-	-	-	-	-	-
4-Nov-17	100	-	-	-	-	-	-	-	-	-
5-Nov-17	100	-	-	-	-	-	-	-	-	-
6-Nov-17	103	7.20	-	0.199	2.00	-	-	-	-	-
7-Nov-17	103	-	-	-	-	-	-	-	-	-
8-Nov-17	103	-	-	-	-	-	-	-	-	-
9-Nov-17	103	-	-	-	-	-	-	-	-	-
10-Nov-17	101	-	-	-	-	-	-	-	-	-
11-Nov-17	101	-	-	-	-	-	-	-	-	-
12-Nov-17	100	-	-	-	-	-	-	-	-	-
13-Nov-17	100	7.60	110	0.160	2.00	0.867	<0.000500	0.0600	0.0300	0.00660
14-Nov-17	100	-	-	-	-	-	-	-	-	-
15-Nov-17	100	-	-	-	-	-	-	-	-	-
16-Nov-17	100	-	-	-	-	-	-	-	-	-
17-Nov-17	100	-	-	-	-	-	-	-	-	-
18-Nov-17	100	-	-	-	-	-	-	-	-	-
19-Nov-17	100	-	-	-	-	-	-	-	-	-
20-Nov-17	100	7.40	-	0.339	1.00	-	-	-	-	-
21-Nov-17	100	-	-	-	-	-	-	-	-	-
22-Nov-17	100	-	-	-	-	-	-	-	-	-
23-Nov-17	98.0	-	-	-	-	-	-	-	-	-
24-Nov-17	100	-	-	-	-	-	-	-	-	-
25-Nov-17	100	-	-	-	-	-	-	-	-	-
26-Nov-17	100	-	-	-	-	-	-	-	-	-
27-Nov-17	100	7.20	-	0.341	1.00	-	-	-	-	-
28-Nov-17	100	-	-	-	-	-	-	-	-	-
29-Nov-17	100	-	-	-	-	-	-	-	-	-
30-Nov-17	100	-	-	-	-	-	-	-	-	-
1-Dec-17	100	-	-	-	-	-	-	-	-	-
2-Dec-17	100	-	-	-	-	-	-	-	-	-
3-Dec-17	100	-	-	-	-	-	-	-	-	-
4-Dec-17	98.0	7.50	-	0.368	1.00	-	-	-	-	-
5-Dec-17	100	-	-	-	-	-	-	-	-	-
6-Dec-17	100	-	-	-	-	-	-	-	-	-
7-Dec-17	100	-	-	-	-	-	-	-	-	-
8-Dec-17	100	-	-	-	-	-	-	-	-	-
9-Dec-17	80.0	-	-	-	-	-	-	-	-	-
10-Dec-17	80.0	-	-	-	-	-	-	-	-	-
11-Dec-17	80.0	7.50	110	0.336	1.00	1.87	<0.000500	0.0660	0.0280	0.00720
12-Dec-17	80.0	-	-	-	-	-	-	-	-	-
13-Dec-17	80.0	-	-	-	-	-	-	-	-	-
14-Dec-17	80.0	-	-	-	-	-	-	-	-	-
15-Dec-17	80.0	-	-	-	-	-	-	-	-	-
16-Dec-17	80.0	-	-	-	-	-	-	-	-	-
17-Dec-17	80.0	-	-	-	-	-	-	-	-	-
18-Dec-17	40.0	-	-	-	-	-	-	-	-	-
19-Dec-17	80.0	7.40	-	0.313	1.00	-	-	-	-	-
20-Dec-17	80.0	-	-	-	-	-	-	-	-	-
21-Dec-17	80.0	-	-	-	-	-	-	-	-	-
22-Dec-17	80.0	-	-	-	-	-	-	-	-	-
23-Dec-17	80.0	-	-	-	-	-	-	-	-	-
24-Dec-17	80.0	-	-	-	-	-	-	-	-	-
25-Dec-17	80.0	-	-	-	-	-	-	-	-	-
26-Dec-17	80.0	-	-	-	-	-	-	-	-	-
27-Dec-17	80.0	8.10	-	0.382	1.00	-	-	-	-	-
28-Dec-17	80.0	-	-	-	-	-	-	-	-	-
29-Dec-17	80.0	-	-	-	-	-	-	-	-	-
30-Dec-17	80.0	-	-	-	-	-	-	-	-	-
31-Dec-17	80.0	-	-	-	-	-	-	-	-	-
1-Jan-18	80.0	-	-	-	-	-	-	-	-	-
2-Jan-18	80.0	7.50	-	0.381	1.00	-	-	-	-	-
3-Jan-18	80.0	-	-	-	-	-	-	-	-	-
4-Jan-18	50.0	-	-	-	-	-	-	-	-	-
5-Jan-18	50.0	-	-	-	-	-	-	-	-	-
6-Jan-18	50.0	-	-	-	-	-	-	-	-	-
7-Jan-18	50.0	-	-	-	-	-	-	-	-	-
8-Jan-18	50.0	7.50	110	0.354	<1.00	2.12	<0.000500	0.0480	0.0290	0.00780
9-Jan-18	50.0	-	-	-	-	-	-	-	-	-
10-Jan-18	50.0	-	-	-	-	-	-	-	-	-
11-Jan-18	50.0	-	-	-	-	-	-	-	-	-
12-Jan-18	30.0	-	-	-	-	-	-	-	-	-
13-Jan-18	30.0	-	-	-	-	-	-	-	-	-
14-Jan-18	30.0	-	-	-	-	-	-	-	-	-
15-Jan-18	30.0	7.50	-	0.323	<1.00	-	-	-	-	-
16-Jan-18	30.0	-	-	-	-	-	-	-	-	-
17-Jan-18	30.0	-	-	-	-	-	-	-	-	-
18-Jan-18	30.0	-	-	-	-	-	-	-	-	-
19-Jan-18	30.0	-	-	-	-	-	-	-	-	-
20-Jan-18	30.0	-	-	-	-	-	-	-	-	-
21-Jan-18	30.0	-	-	-	-	-	-	-	-	-
22-Jan-18	30.0	8.40	-	0.305	1.00	-	-	-	-	-
23-Jan-18	30.0	-	-	-	-	-	-	-	-	-
24-Jan-18	30.0	-	-	-	-	-	-	-	-	-
25-Jan-18	30.0	-	-	-	-	-	-	-	-	-
26-Jan-18	30.0	-	-	-	-	-	-	-	-	-
27-Jan-18	30.0	-	-	-	-	-	-	-	-	-
28-Jan-18	30.0	-	-	-	-	-	-	-	-	-
29-Jan-18	30.0	7.40	-	0.252	2.00	-	-	-	-	-
30-Jan-18	30.0	-	-	-	-	-	-	-	-	-
31-Jan-18	30.0	-	-	-	-	-	-	-	-	-
1-Feb-18	30.0	-	-	-	-	-	-	-	-	-
2-Feb-18	50.0	-	-	-	-	-	-	-	-	-
3-Feb-18	50.0	-	-	-	-	-	-	-	-	-
4-Feb-18	50.0	-	-	-	-	-	-	-	-	-
5-Feb-18	50.0	7.70	-	0.119	2.00	-	-	-	-	-

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected, or SD was incalculable because there was no variability in the data.

Table H.6: **Water Quality at TOMP Station P-14 (Effluent), Panel TMA, 2015 to 2019**

Date	Flow (L/s)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	TSS (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
6-Feb-18	50.0	-	-	-	-	-	-	-	-	-
7-Feb-18	50.0	7.80	-	0.169	3.00	-	-	-	-	-
8-Feb-18	50.0	-	-	-	-	-	-	-	-	-
9-Feb-18	50.0	-	-	-	-	-	-	-	-	-
10-Feb-18	50.0	-	-	-	-	-	-	-	-	-
11-Feb-18	50.0	-	-	-	-	-	-	-	-	-
12-Feb-18	50.0	7.30	110	0.281	1.00	2.10	<0.000500	0.0310	0.0290	0.00770
13-Feb-18	50.0	-	-	-	-	-	-	-	-	-
14-Feb-18	75.0	-	-	-	-	-	-	-	-	-
15-Feb-18	75.0	-	-	-	-	-	-	-	-	-
16-Feb-18	75.0	-	-	-	-	-	-	-	-	-
17-Feb-18	75.0	-	-	-	-	-	-	-	-	-
18-Feb-18	75.0	-	-	-	-	-	-	-	-	-
19-Feb-18	75.0	-	-	-	-	-	-	-	-	-
20-Feb-18	75.0	7.80	-	0.415	1.00	-	-	-	-	-
21-Feb-18	75.0	-	-	-	-	-	-	-	-	-
22-Feb-18	73.0	-	-	-	-	-	-	-	-	-
23-Feb-18	35.0	-	-	-	-	-	-	-	-	-
24-Feb-18	30.0	-	-	-	-	-	-	-	-	-
25-Feb-18	30.0	-	-	-	-	-	-	-	-	-
26-Feb-18	30.0	7.40	-	0.370	<1.00	-	-	-	-	-
27-Feb-18	30.0	-	-	-	-	-	-	-	-	-
28-Feb-18	30.0	-	-	-	-	-	-	-	-	-
1-Mar-18	30.0	-	-	-	-	-	-	-	-	-
2-Mar-18	30.0	-	-	-	-	-	-	-	-	-
3-Mar-18	30.0	-	-	-	-	-	-	-	-	-
4-Mar-18	30.0	-	-	-	-	-	-	-	-	-
5-Mar-18	30.0	7.80	-	0.229	1.00	-	-	-	-	-
6-Mar-18	30.0	-	-	-	-	-	-	-	-	-
7-Mar-18	30.0	-	-	-	-	-	-	-	-	-
8-Mar-18	30.0	-	-	-	-	-	-	-	-	-
9-Mar-18	30.0	-	-	-	-	-	-	-	-	-
10-Mar-18	30.0	-	-	-	-	-	-	-	-	-
11-Mar-18	30.0	-	-	-	-	-	-	-	-	-
12-Mar-18	30.0	7.80	110	0.0610	2.00	1.44	<0.000500	0.0290	0.0320	0.00870
13-Mar-18	30.0	-	-	-	-	-	-	-	-	-
14-Mar-18	30.0	-	-	-	-	-	-	-	-	-
15-Mar-18	30.0	-	-	-	-	-	-	-	-	-
16-Mar-18	30.0	-	-	-	-	-	-	-	-	-
17-Mar-18	30.0	-	-	-	-	-	-	-	-	-
18-Mar-18	30.0	-	-	-	-	-	-	-	-	-
19-Mar-18	30.0	7.80	-	0.0670	1.00	-	-	-	-	-
20-Mar-18	30.0	-	-	-	-	-	-	-	-	-
21-Mar-18	30.0	-	-	-	-	-	-	-	-	-
22-Mar-18	30.0	-	-	-	-	-	-	-	-	-
23-Mar-18	30.0	-	-	-	-	-	-	-	-	-
24-Mar-18	30.0	-	-	-	-	-	-	-	-	-
25-Mar-18	30.0	-	-	-	-	-	-	-	-	-
26-Mar-18	30.0	8.00	-	0.0360	1.00	-	-	-	-	-
27-Mar-18	30.0	-	-	-	-	-	-	-	-	-
28-Mar-18	30.0	-	-	-	-	-	-	-	-	-
29-Mar-18	30.0	-	-	-	-	-	-	-	-	-
30-Mar-18	15.0	-	-	-	-	-	-	-	-	-
31-Mar-18	8.00	-	-	-	-	-	-	-	-	-
28-Apr-18	30.0	-	-	-	-	-	-	-	-	-
29-Apr-18	30.0	-	-	-	-	-	-	-	-	-
30-Apr-18	30.0	7.20	99.0	0.0150	<1.00	0.551	<0.000500	<0.0200	0.0254	0.00776
1-May-18	34.0	-	-	-	-	-	-	-	-	-
2-May-18	80.0	-	-	-	-	-	-	-	-	-
3-May-18	80.0	-	-	-	-	-	-	-	-	-
4-May-18	80.0	-	-	-	-	-	-	-	-	-
5-May-18	100	-	-	-	-	-	-	-	-	-
6-May-18	100	-	-	-	-	-	-	-	-	-
7-May-18	100	7.50	89.0	0.199	1.00	1.26	<0.000500	0.0800	0.0680	0.00780
8-May-18	100	-	-	-	-	-	-	-	-	-
9-May-18	100	-	-	-	-	-	-	-	-	-
10-May-18	100	-	-	-	-	-	-	-	-	-
11-May-18	100	-	-	-	-	-	-	-	-	-
12-May-18	100	-	-	-	-	-	-	-	-	-
13-May-18	100	-	-	-	-	-	-	-	-	-
14-May-18	100	7.50	-	0.335	1.00	-	-	-	-	-
15-May-18	100	-	-	-	-	-	-	-	-	-
16-May-18	100	-	-	-	-	-	-	-	-	-
17-May-18	100	-	-	-	-	-	-	-	-	-
18-May-18	100	-	-	-	-	-	-	-	-	-
19-May-18	100	-	-	-	-	-	-	-	-	-
20-May-18	70.0	-	-	-	-	-	-	-	-	-
21-May-18	70.0	-	-	-	-	-	-	-	-	-
22-May-18	70.0	7.70	-	0.321	3.00	-	-	-	-	-
23-May-18	70.0	-	-	-	-	-	-	-	-	-
24-May-18	70.0	-	-	-	-	-	-	-	-	-
25-May-18	65.0	-	-	-	-	-	-	-	-	-
26-May-18	65.0	-	-	-	-	-	-	-	-	-
27-May-18	65.0	-	-	-	-	-	-	-	-	-
28-May-18	35.0	-	-	-	-	-	-	-	-	-
29-May-18	35.0	-	-	-	-	-	-	-	-	-
30-May-18	18.0	-	-	-	-	-	-	-	-	-
23-Jun-18	70.0	-	-	-	-	-	-	-	-	-
24-Jun-18	70.0	-	-	-	-	-	-	-	-	-
25-Jun-18	70.0	7.60	89.0	0.0690	1.00	0.717	<0.000500	<0.0200	0.0180	0.00890
26-Jun-18	70.0	-	-	-	-	-	-	-	-	-
27-Jun-18	70.0	-	-	-	-	-	-	-	-	-
28-Jun-18	70.0	-	-	-	-	-	-	-	-	-
29-Jun-18	70.0	-	-	-	-	-	-	-	-	-
30-Jun-18	70.0	-	-	-	-	-	-	-	-	-
1-Jul-18	35.0	-	-	-	-	-	-	-	-	-
2-Jul-18	17.0	-	-	-	-	-	-	-	-	-
11-Oct-18	25.0	-	-	-	-	-	-	-	-	-
12-Oct-18	50.0	-	-	-	-	-	-	-	-	-
13-Oct-18	75.0	-	-	-	-	-	-	-	-	-
14-Oct-18	75.0	-	-	-	-	-	-	-	-	-
15-Oct-18	75.0	7.50	-	0.140	1.00	-	-	-	-	-

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected, or SD was incalculable because there was no variability in the data.

Table H.6: Water Quality at TOMP Station P-14 (Effluent), Panel TMA, 2015 to 2019

Date	Flow (L/s)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	TSS (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
16-Oct-18	75.0	-	-	-	-	-	-	-	-	-
17-Oct-18	75.0	-	-	-	-	-	-	-	-	-
18-Oct-18	70.0	-	-	-	-	-	-	-	-	-
19-Oct-18	70.0	-	-	-	-	-	-	-	-	-
20-Oct-18	71.0	-	-	-	-	-	-	-	-	-
21-Oct-18	71.0	-	-	-	-	-	-	-	-	-
22-Oct-18	75.0	7.50	-	0.139	1.00	-	-	-	-	-
23-Oct-18	75.0	-	-	-	-	-	-	-	-	-
24-Oct-18	75.0	-	-	-	-	-	-	-	-	-
25-Oct-18	75.0	-	-	-	-	-	-	-	-	-
26-Oct-18	75.0	-	-	-	-	-	-	-	-	-
27-Oct-18	75.0	-	-	-	-	-	-	-	-	-
28-Oct-18	75.0	-	-	-	-	-	-	-	-	-
29-Oct-18	75.0	7.30	97.0	0.176	2.00	0.629	<0.000500	0.0370	0.0180	0.00680
30-Oct-18	75.0	-	-	-	-	-	-	-	-	-
31-Oct-18	75.0	-	-	-	-	-	-	-	-	-
1-Nov-18	75.0	-	-	-	-	-	-	-	-	-
2-Nov-18	75.0	-	-	-	-	-	-	-	-	-
3-Nov-18	75.0	-	-	-	-	-	-	-	-	-
4-Nov-18	75.0	-	-	-	-	-	-	-	-	-
5-Nov-18	75.0	7.40	-	0.180	1.00	-	-	-	-	-
6-Nov-18	75.0	-	-	-	-	-	-	-	-	-
7-Nov-18	75.0	-	-	-	-	-	-	-	-	-
8-Nov-18	75.0	-	-	-	-	-	-	-	-	-
9-Nov-18	75.0	-	-	-	-	-	-	-	-	-
10-Nov-18	75.0	-	-	-	-	-	-	-	-	-
11-Nov-18	75.0	-	-	-	-	-	-	-	-	-
12-Nov-18	75.0	7.50	-	0.159	2.00	-	-	-	-	-
13-Nov-18	75.0	-	-	-	-	-	-	-	-	-
14-Nov-18	100	-	-	-	-	-	-	-	-	-
15-Nov-18	100	-	-	-	-	-	-	-	-	-
16-Nov-18	100	-	-	-	-	-	-	-	-	-
17-Nov-18	100	-	-	-	-	-	-	-	-	-
18-Nov-18	100	-	-	-	-	-	-	-	-	-
19-Nov-18	100	7.30	98.0	0.177	1.00	0.978	<0.000500	0.0400	0.0160	0.00710
20-Nov-18	100	-	-	-	-	-	-	-	-	-
21-Nov-18	100	-	-	-	-	-	-	-	-	-
22-Nov-18	100	-	-	-	-	-	-	-	-	-
23-Nov-18	100	-	-	-	-	-	-	-	-	-
24-Nov-18	100	-	-	-	-	-	-	-	-	-
25-Nov-18	100	-	-	-	-	-	-	-	-	-
26-Nov-18	100	7.40	-	0.203	1.00	-	-	-	-	-
27-Nov-18	100	-	-	-	-	-	-	-	-	-
28-Nov-18	100	-	-	-	-	-	-	-	-	-
29-Nov-18	100	-	-	-	-	-	-	-	-	-
30-Nov-18	100	-	-	-	-	-	-	-	-	-
1-Dec-18	100	-	-	-	-	-	-	-	-	-
2-Dec-18	100	-	-	-	-	-	-	-	-	-
3-Dec-18	100	7.30	-	0.314	1.00	-	-	-	-	-
4-Dec-18	100	-	-	-	-	-	-	-	-	-
5-Dec-18	100	-	-	-	-	-	-	-	-	-
6-Dec-18	100	-	-	-	-	-	-	-	-	-
7-Dec-18	100	-	-	-	-	-	-	-	-	-
8-Dec-18	100	-	-	-	-	-	-	-	-	-
9-Dec-18	55.0	-	-	-	-	-	-	-	-	-
10-Dec-18	55.0	7.30	100	0.310	1.00	1.64	<0.000500	0.0360	0.0160	0.00670
11-Dec-18	55.0	-	-	-	-	-	-	-	-	-
12-Dec-18	55.0	-	-	-	-	-	-	-	-	-
13-Dec-18	55.0	-	-	-	-	-	-	-	-	-
14-Dec-18	55.0	-	-	-	-	-	-	-	-	-
15-Dec-18	40.0	-	-	-	-	-	-	-	-	-
16-Dec-18	40.0	-	-	-	-	-	-	-	-	-
17-Dec-18	40.0	-	-	-	-	-	-	-	-	-
18-Dec-18	20.0	-	-	-	-	-	-	-	-	-
19-Dec-18	10.0	-	-	-	-	-	-	-	-	-
8-Jan-19	40.0	-	-	-	-	-	-	-	-	-
9-Jan-19	40.0	-	-	-	-	-	-	-	-	-
10-Jan-19	40.0	7.50	-	0.0900	1.00	-	-	-	-	-
11-Jan-19	40.0	-	-	-	-	-	-	-	-	-
12-Jan-19	40.0	-	-	-	-	-	-	-	-	-
13-Jan-19	40.0	-	-	-	-	-	-	-	-	-
14-Jan-19	40.0	7.40	100	0.0850	2.00	0.882	<0.000500	0.0470	0.0180	0.00680
15-Jan-19	40.0	-	-	-	-	-	-	-	-	-
16-Jan-19	40.0	-	-	-	-	-	-	-	-	-
17-Jan-19	60.0	-	-	-	-	-	-	-	-	-
18-Jan-19	60.0	-	-	-	-	-	-	-	-	-
19-Jan-19	60.0	-	-	-	-	-	-	-	-	-
20-Jan-19	60.0	-	-	-	-	-	-	-	-	-
21-Jan-19	60.0	7.40	-	0.0960	1.00	-	-	-	-	-
22-Jan-19	60.0	-	-	-	-	-	-	-	-	-
23-Jan-19	60.0	-	-	-	-	-	-	-	-	-
24-Jan-19	60.0	-	-	-	-	-	-	-	-	-
25-Jan-19	60.0	-	-	-	-	-	-	-	-	-
26-Jan-19	60.0	-	-	-	-	-	-	-	-	-
27-Jan-19	60.0	-	-	-	-	-	-	-	-	-
28-Jan-19	60.0	7.40	-	0.146	2.00	-	-	-	-	-
29-Jan-19	60.0	-	-	-	-	-	-	-	-	-
30-Jan-19	60.0	-	-	-	-	-	-	-	-	-
31-Jan-19	60.0	-	-	-	-	-	-	-	-	-
1-Feb-19	60.0	-	-	-	-	-	-	-	-	-
2-Feb-19	60.0	-	-	-	-	-	-	-	-	-
3-Feb-19	60.0	-	-	-	-	-	-	-	-	-
4-Feb-19	60.0	7.50	-	0.114	1.00	0.937	-	-	-	-
5-Feb-19	60.0	-	-	-	-	-	-	-	-	-
6-Feb-19	60.0	-	-	-	-	-	-	-	-	-
7-Feb-19	60.0	-	-	-	-	-	-	-	-	-
8-Feb-19	60.0	-	-	-	-	-	-	-	-	-
9-Feb-19	60.0	-	-	-	-	-	-	-	-	-
10-Feb-19	60.0	-	-	-	-	-	-	-	-	-
11-Feb-19	60.0	7.60	96.0	0.135	1.00	0.972	<0.000500	0.0350	0.0240	0.00810
12-Feb-19	80.0	-	-	-	-	-	-	-	-	-
13-Feb-19	80.0	-	-	-	-	-	-	-	-	-
14-Feb-19	80.0	-	-	-	-	-	-	-	-	-
15-Feb-19	80.0	-	-	-	-	-	-	-	-	-
16-Feb-19	45.0	-	-	-	-	-	-	-	-	-
17-Feb-19	45.0	-	-	-	-	-	-	-	-	-

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected, or SD was incalculable because there was no variability in the data.

Table H.6: Water Quality at TOMP Station P-14 (Effluent), Panel TMA, 2015 to 2019

Date	Flow (L/s)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	TSS (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
18-Feb-19	45.0	-	-	-	-	-	-	-	-	-
19-Feb-19	45.0	7.30	-	0.0930	4.00	0.619	-	-	-	-
20-Feb-19	45.0	-	-	-	-	-	-	-	-	-
21-Feb-19	45.0	-	-	-	-	-	-	-	-	-
22-Feb-19	45.0	-	-	-	-	-	-	-	-	-
23-Feb-19	80.0	-	-	-	-	-	-	-	-	-
24-Feb-19	80.0	-	-	-	-	-	-	-	-	-
25-Feb-19	80.0	7.40	-	0.156	<3.00	0.823	-	-	-	-
26-Feb-19	80.0	-	-	-	-	-	-	-	-	-
27-Feb-19	80.0	-	-	-	-	-	-	-	-	-
28-Feb-19	80.0	-	-	-	-	-	-	-	-	-
1-Mar-19	80.0	-	-	-	-	-	-	-	-	-
2-Mar-19	80.0	-	-	-	-	-	-	-	-	-
3-Mar-19	80.0	-	-	-	-	-	-	-	-	-
4-Mar-19	80.0	7.50	-	0.144	2.00	0.894	-	-	-	-
5-Mar-19	80.0	-	-	-	-	-	-	-	-	-
6-Mar-19	80.0	-	-	-	-	-	-	-	-	-
7-Mar-19	80.0	-	-	-	-	-	-	-	-	-
8-Mar-19	80.0	7.50	110	0.0450	1.00	0.959	<0.000500	0.0260	0.0160	0.00630
9-Mar-19	40.0	-	-	-	-	-	-	-	-	-
10-Mar-19	20.0	-	-	-	-	-	-	-	-	-
27-Mar-19	50.0	-	-	-	-	-	-	-	-	-
28-Mar-19	50.0	7.40	-	0.0960	1.00	0.754	-	-	-	-
29-Mar-19	50.0	-	-	-	-	-	-	-	-	-
30-Mar-19	50.0	-	-	-	-	-	-	-	-	-
31-Mar-19	50.0	-	-	-	-	-	-	-	-	-
1-Apr-19	50.0	7.60	-	0.101	1.00	0.974	-	-	-	-
2-Apr-19	50.0	-	-	-	-	-	-	-	-	-
3-Apr-19	53.0	-	-	-	-	-	-	-	-	-
4-Apr-19	53.0	-	-	-	-	-	-	-	-	-
5-Apr-19	53.0	-	-	-	-	-	-	-	-	-
6-Apr-19	50.0	-	-	-	-	-	-	-	-	-
7-Apr-19	50.0	-	-	-	-	-	-	-	-	-
8-Apr-19	55.0	7.90	-	0.103	2.00	0.851	-	-	-	-
9-Apr-19	56.0	-	-	-	-	-	-	-	-	-
10-Apr-19	70.0	-	-	-	-	-	-	-	-	-
11-Apr-19	90.0	-	-	-	-	-	-	-	-	-
12-Apr-19	90.0	-	-	-	-	-	-	-	-	-
13-Apr-19	120	-	-	-	-	-	-	-	-	-
14-Apr-19	120	-	-	-	-	-	-	-	-	-
15-Apr-19	120	7.40	100	0.135	1.00	0.982	<0.000500	0.0290	0.0260	0.00810
16-Apr-19	120	-	-	-	-	-	-	-	-	-
17-Apr-19	120	-	-	-	-	-	-	-	-	-
18-Apr-19	120	-	-	-	-	-	-	-	-	-
19-Apr-19	126	-	-	-	-	-	-	-	-	-
20-Apr-19	127	-	-	-	-	-	-	-	-	-
21-Apr-19	129	-	-	-	-	-	-	-	-	-
22-Apr-19	130	7.60	-	0.221	1.00	1.45	-	-	-	-
23-Apr-19	150	-	-	-	-	-	-	-	-	-
24-Apr-19	150	-	-	-	-	-	-	-	-	-
25-Apr-19	150	-	-	-	-	-	-	-	-	-
26-Apr-19	150	-	-	-	-	-	-	-	-	-
27-Apr-19	156	-	-	-	-	-	-	-	-	-
28-Apr-19	156	-	-	-	-	-	-	-	-	-
29-Apr-19	150	7.50	-	0.251	1.00	1.46	-	-	-	-
30-Apr-19	150	-	-	-	-	-	-	-	-	-
1-May-19	150	-	-	-	-	-	-	-	-	-
2-May-19	150	-	-	-	-	-	-	-	-	-
3-May-19	150	-	-	-	-	-	-	-	-	-
4-May-19	150	-	-	-	-	-	-	-	-	-
5-May-19	150	-	-	-	-	-	-	-	-	-
6-May-19	150	7.60	-	0.264	<1.00	1.89	-	-	-	-
7-May-19	150	-	-	-	-	-	-	-	-	-
8-May-19	150	-	-	-	-	-	-	-	-	-
9-May-19	150	-	-	-	-	-	-	-	-	-
10-May-19	150	-	-	-	-	-	-	-	-	-
11-May-19	150	-	-	-	-	-	-	-	-	-
12-May-19	150	-	-	-	-	-	-	-	-	-
13-May-19	150	7.40	67.0	0.298	1.00	1.70	<0.000500	0.103	0.0550	0.00450
14-May-19	150	-	-	-	-	-	-	-	-	-
15-May-19	150	-	-	-	-	-	-	-	-	-
16-May-19	150	-	-	-	-	-	-	-	-	-
17-May-19	150	-	-	-	-	-	-	-	-	-
18-May-19	150	-	-	-	-	-	-	-	-	-
19-May-19	150	-	-	-	-	-	-	-	-	-
20-May-19	150	-	-	-	-	-	-	-	-	-
21-May-19	150	7.40	-	0.269	1.00	1.44	-	-	-	-
22-May-19	150	-	-	-	-	-	-	-	-	-
23-May-19	150	-	-	-	-	-	-	-	-	-
24-May-19	100	-	-	-	-	-	-	-	-	-
25-May-19	100	-	-	-	-	-	-	-	-	-
26-May-19	100	-	-	-	-	-	-	-	-	-
27-May-19	100	7.40	-	0.321	1.00	1.64	-	-	-	-
28-May-19	100	-	-	-	-	-	-	-	-	-
29-May-19	100	-	-	-	-	-	-	-	-	-
30-May-19	100	-	-	-	-	-	-	-	-	-
31-May-19	100	-	-	-	-	-	-	-	-	-
1-Jun-19	100	-	-	-	-	-	-	-	-	-
2-Jun-19	60.0	-	-	-	-	-	-	-	-	-
3-Jun-19	60.0	7.50	-	0.226	1.00	2.56	-	-	-	-
4-Jun-19	60.0	-	-	-	-	-	-	-	-	-
5-Jun-19	62.0	-	-	-	-	-	-	-	-	-
6-Jun-19	63.0	-	-	-	-	-	-	-	-	-
7-Jun-19	63.0	-	-	-	-	-	-	-	-	-
8-Jun-19	60.0	-	-	-	-	-	-	-	-	-
9-Jun-19	60.0	-	-	-	-	-	-	-	-	-
10-Jun-19	60.0	7.70	80.0	0.161	2.00	2.32	<0.000500	0.0220	0.0350	0.00640
11-Jun-19	60.0	-	-	-	-	-	-	-	-	-
12-Jun-19	62.0	-	-	-	-	-	-	-	-	-
13-Jun-19	60.0	-	-	-	-	-	-	-	-	-
14-Jun-19	60.0	-	-	-	-	-	-	-	-	-
15-Jun-19	60.0	-	-	-	-	-	-	-	-	-
16-Jun-19	60.0	-	-	-	-	-	-	-	-	-
17-Jun-19	60.0	7.60	-	0.176	2.00	2.11	-	-	-	-
18-Jun-19	60.0	-	-	-	-	-	-	-	-	-
19-Jun-19	60.0	-	-	-	-	-	-	-	-	-
20-Jun-19	60.0	-	-	-	-	-	-	-	-	-
21-Jun-19	60.0	-	-	-	-	-	-	-	-	-
22-Jun-19	60.0	-	-	-	-	-	-	-	-	-
23-Jun-19	60.0	-	-	-	-	-	-	-	-	-

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected, or SD was incalculable because there was no variability in the data.

Table H.6: **Water Quality at TOMP Station P-14 (Effluent), Panel TMA, 2015 to 2019**

Date	Flow (L/s)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	TSS (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
24-Jun-19	60.0	7.90	-	0.143	1.00	1.97	-	-	-	-
25-Jun-19	30.0	-	-	-	-	-	-	-	-	-
26-Jun-19	60.0	-	-	-	-	-	-	-	-	-
27-Jun-19	60.0	-	-	-	-	-	-	-	-	-
28-Jun-19	60.0	-	-	-	-	-	-	-	-	-
29-Jun-19	60.0	-	-	-	-	-	-	-	-	-
30-Jun-19	60.0	-	-	-	-	-	-	-	-	-
1-Jul-19	60.0	-	-	-	-	-	-	-	-	-
2-Jul-19	60.0	7.60	86.0	0.119	1.00	1.81	<0.000500	0.0210	0.0190	0.00750
3-Jul-19	60.0	-	-	-	-	-	-	-	-	-
4-Jul-19	60.0	-	-	-	-	-	-	-	-	-
5-Jul-19	60.0	-	-	-	-	-	-	-	-	-
6-Jul-19	30.0	-	-	-	-	-	-	-	-	-
7-Jul-19	15.0	-	-	-	-	-	-	-	-	-
5-Oct-19	60.0	-	-	-	-	-	-	-	-	-
6-Oct-19	60.0	-	-	-	-	-	-	-	-	-
7-Oct-19	60.0	7.70	-	0.125	1.00	0.872	-	-	-	-
8-Oct-19	60.0	-	-	-	-	-	-	-	-	-
9-Oct-19	60.0	-	-	-	-	-	-	-	-	-
10-Oct-19	60.0	-	-	-	-	-	-	-	-	-
11-Oct-19	60.0	-	-	-	-	-	-	-	-	-
12-Oct-19	60.0	-	-	-	-	-	-	-	-	-
13-Oct-19	60.0	-	-	-	-	-	-	-	-	-
14-Oct-19	60.0	-	-	-	-	-	-	-	-	-
15-Oct-19	80.0	7.60	-	0.150	2.00	0.819	-	-	-	-
16-Oct-19	80.0	-	-	-	-	-	-	-	-	-
17-Oct-19	80.0	-	-	-	-	-	-	-	-	-
18-Oct-19	100	-	-	-	-	-	-	-	-	-
19-Oct-19	120	-	-	-	-	-	-	-	-	-
20-Oct-19	120	-	-	-	-	-	-	-	-	-
21-Oct-19	120	-	-	-	-	-	-	-	-	-
22-Oct-19	120	7.30	81.0	0.237	2.00	1.11	<0.000500	0.0840	0.0480	0.00770
23-Oct-19	120	-	-	-	-	-	-	-	-	-
24-Oct-19	120	-	-	-	-	-	-	-	-	-
25-Oct-19	120	-	-	-	-	-	-	-	-	-
26-Oct-19	120	-	-	-	-	-	-	-	-	-
27-Oct-19	120	-	-	-	-	-	-	-	-	-
28-Oct-19	120	7.60	-	0.365	1.00	1.42	-	-	-	-
29-Oct-19	120	-	-	-	-	-	-	-	-	-
30-Oct-19	120	-	-	-	-	-	-	-	-	-
31-Oct-19	120	-	-	-	-	-	-	-	-	-
1-Nov-19	120	-	-	-	-	-	-	-	-	-
2-Nov-19	120	-	-	-	-	-	-	-	-	-
3-Nov-19	80.0	-	-	-	-	-	-	-	-	-
4-Nov-19	80.0	7.70	-	0.339	1.00	1.94	-	-	-	-
5-Nov-19	80.0	-	-	-	-	-	-	-	-	-
6-Nov-19	80.0	-	-	-	-	-	-	-	-	-
7-Nov-19	80.0	-	-	-	-	-	-	-	-	-
8-Nov-19	80.0	-	-	-	-	-	-	-	-	-
9-Nov-19	80.0	-	-	-	-	-	-	-	-	-
10-Nov-19	80.0	-	-	-	-	-	-	-	-	-
11-Nov-19	80.0	7.60	88.0	0.262	1.00	2.36	<0.000500	0.0970	0.0290	0.00650
12-Nov-19	80.0	-	-	-	-	-	-	-	-	-
13-Nov-19	80.0	-	-	-	-	-	-	-	-	-
14-Nov-19	80.0	-	-	-	-	-	-	-	-	-
15-Nov-19	80.0	-	-	-	-	-	-	-	-	-
16-Nov-19	80.0	-	-	-	-	-	-	-	-	-
17-Nov-19	80.0	-	-	-	-	-	-	-	-	-
18-Nov-19	80.0	7.40	-	0.338	2.00	2.92	-	-	-	-
19-Nov-19	80.0	-	-	-	-	-	-	-	-	-
20-Nov-19	80.0	-	-	-	-	-	-	-	-	-
21-Nov-19	80.0	-	-	-	-	-	-	-	-	-
22-Nov-19	80.0	-	-	-	-	-	-	-	-	-
23-Nov-19	80.0	-	-	-	-	-	-	-	-	-
24-Nov-19	80.0	-	-	-	-	-	-	-	-	-
25-Nov-19	80.0	7.40	-	0.399	1.00	2.41	-	-	-	-
26-Nov-19	80.0	-	-	-	-	-	-	-	-	-
27-Nov-19	80.0	-	-	-	-	-	-	-	-	-
28-Nov-19	80.0	-	-	-	-	-	-	-	-	-
29-Nov-19	80.0	-	-	-	-	-	-	-	-	-
30-Nov-19	40.0	-	-	-	-	-	-	-	-	-
1-Dec-19	20.0	-	-	-	-	-	-	-	-	-
7-Dec-19	40.0	-	-	-	-	-	-	-	-	-
8-Dec-19	40.0	-	-	-	-	-	-	-	-	-
9-Dec-19	40.0	7.50	-	0.221	1.00	3.11	-	-	-	-
10-Dec-19	40.0	-	-	-	-	-	-	-	-	-
11-Dec-19	40.0	-	-	-	-	-	-	-	-	-
12-Dec-19	40.0	-	-	-	-	-	-	-	-	-
13-Dec-19	40.0	-	-	-	-	-	-	-	-	-
14-Dec-19	40.0	-	-	-	-	-	-	-	-	-
15-Dec-19	40.0	-	-	-	-	-	-	-	-	-
16-Dec-19	40.0	7.60	84.0	0.0700	3.00	1.13	<0.000500	0.0430	0.0250	0.00730
17-Dec-19	40.0	-	-	-	-	-	-	-	-	-
18-Dec-19	40.0	-	-	-	-	-	-	-	-	-
19-Dec-19	40.0	-	-	-	-	-	-	-	-	-
20-Dec-19	40.0	-	-	-	-	-	-	-	-	-
21-Dec-19	20.0	-	-	-	-	-	-	-	-	-
22-Dec-19	10.0	-	-	-	-	-	-	-	-	-
24-Dec-19	60.0	-	-	-	-	-	-	-	-	-
25-Dec-19	60.0	-	-	-	-	-	-	-	-	-
26-Dec-19	60.0	-	-	-	-	-	-	-	-	-
27-Dec-19	60.0	7.60	-	0.0880	1.00	1.17	-	-	-	-
28-Dec-19	60.0	-	-	-	-	-	-	-	-	-
29-Dec-19	60.0	-	-	-	-	-	-	-	-	-
30-Dec-19	60.0	7.90	-	0.115	2.00	1.08	-	-	-	-
31-Dec-19	60.0	-	-	-	-	-	-	-	-	-
n	720	138	41	138	138	93	41	42	41	41
Minimum	8.00	7.20	67.0	0.0150	<1.00	0.0130	<0.000500	<0.0200	0.0110	0.00450
Maximum	163	8.40	140	0.415	4.00	3.11	<0.000500	0.103	0.0860	0.0179
Mean	75.8	7.51	106	0.189	1.25	1.21	<0.000500	0.0473	0.0279	0.00804
SD	32.0	0.182	16.6	0.0975	0.553	0.593	-	0.0226	0.0149	0.00247
Median	75.0	7.50	100	0.178	1.00	1.10	<0.000500	0.0425	0.0254	0.00740
10th Percentile	30.0	7.30	86.0	0.0670	<1.00	0.598	<0.000500	0.0210	0.0160	0.00650
95th Percentile	150	7.80	140	0.365	2.00	2.36	<0.000500	0.0950	0.0550	0.0121

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected, or SD was incalculable because there was no variability in the data.

Table H.7: Water Quality at TOMP Station P-15 (Perimeter), Panel TMA, 2015 to 2019

Date	Conductivity (µmho/cm)
12-Jan-15	345
12-Feb-15	328
23-Mar-15	310
15-Apr-15	288
19-May-15	283
8-Jun-15	284
13-Jul-15	308
11-Aug-15	392
2-Sep-15	403
13-Oct-15	387
9-Nov-15	387
21-Dec-15	263
12-Jan-16	321
4-Feb-16	354
21-Mar-16	356
11-Apr-16	256
24-May-16	323
13-Jun-16	341
11-Jul-16	375
10-Aug-16	415
13-Sep-16	428
24-Oct-16	263
21-Nov-16	364
12-Dec-16	298
9-Jan-17	334
22-Feb-17	305
20-Mar-17	451
10-Apr-17	378
15-May-17	420
19-Jun-17	295
10-Jul-17	332
16-Aug-17	351
11-Sep-17	344
16-Oct-17	302
13-Nov-17	264
12-Dec-17	303
9-Jan-18	342
12-Feb-18	312
12-Mar-18	306
23-Apr-18	360
15-May-18	130
11-Jun-18	315
9-Jul-18	322
13-Aug-18	354
10-Sep-18	368
29-Oct-18	318
19-Nov-18	131
12-Dec-18	258
14-Jan-19	310
11-Feb-19	292
11-Mar-19	335
15-Apr-19	211
14-May-19	207
10-Jun-19	319
2-Jul-19	272
19-Aug-19	349
9-Sep-19	337
8-Oct-19	295
11-Nov-19	352
10-Dec-19	296
n	60
Minimum	130
Maximum	451
Mean	321
SD	60.3
Median	322
10th Percentile	261
95th Percentile	418

Note: "SD" = standard deviation. "n" = number of samples.

Table H.8: Water Quality at TOMP Station P-16A (Groundwater), Panel TMA, 2015 to 2019

Date	pH	Sulphate (mg/L)	Acidity (mg/L)	Iron (mg/L)
22-Jul-15	6.51	880	<1.00	0.0500
17-Jun-16	6.33	790	<1.00	0.0330
27-Jul-17	6.44	660	<1.00	0.0400
31-Jul-18	6.57	880	<1.00	0.101
6-Aug-19	6.57	730	<1.00	0.0320
n	5	5	5	5
Minimum	6.33	660	<1.00	0.0320
Maximum	6.57	880	<1.00	0.101
Mean	6.48	788	<1.00	0.0512
SD	0.101	95.8	-	0.0288
Median	6.51	790	<1.00	0.0400
10th Percentile	6.33	660	<1.00	0.0320
95th Percentile	6.57	880	<1.00	0.101

Note: "SD" = standard deviation. "n" = number of samples. "-" = SD was incalculable because there was no variability in the data.

Table H.9: Water Quality at TOMP Station P-20 (Groundwater), Panel TMA, 2015 to 2019

Date	pH	Sulphate (mg/L)	Acidity (mg/L)	Iron (mg/L)
22-Jul-15	6.81	450	<1.00	2.41
16-Jun-16	6.32	480	<1.00	3.39
26-Jul-17	6.64	470	<1.00	5.29
1-Aug-18	6.74	480	<1.00	4.42
7-Aug-19	6.70	400	<1.00	1.90
n	5	5	5	5
Minimum	6.32	400	<1.00	1.90
Maximum	6.81	480	<1.00	5.29
Mean	6.64	456	<1.00	3.48
SD	0.190	33.6	-	1.40
Median	6.70	470	<1.00	3.39
10th Percentile	6.32	400	<1.00	1.90
95th Percentile	6.81	480	<1.00	5.29

Note: "SD" = standard deviation. "n" = number of samples. "-" = SD was incalculable because there was no variability in the data.

Table H.10: Water Quality at TOMP Station P-31 (Groundwater), Panel TMA, 2015 to 2019

Date	pH	Sulphate (mg/L)	Acidity (mg/L)	Iron (mg/L)
21-Jul-15	6.57	1,000	<1.00	0.160
16-Jun-16	6.06	1,000	<1.00	0.221
26-Jul-17	6.48	1,100	<1.00	0.730
31-Jul-18	6.53	960	<1.00	0.320
6-Aug-19	6.65	940	<1.00	0.266
n	5	5	5	5
Minimum	6.06	940	<1.00	0.160
Maximum	6.65	1,100	<1.00	0.730
Mean	6.46	1,000	<1.00	0.339
SD	0.231	61.6	-	0.226
Median	6.53	1,000	<1.00	0.266
10th Percentile	6.06	940	<1.00	0.160
95th Percentile	6.65	1,100	<1.00	0.730

Note: "SD" = standard deviation. "n" = number of samples. "-" = SD was incalculable because there was no variability in the data.

Table H.11: Water Level at TOMP Station P-21, Panel TMA, 2015 to 2019

Date	Elevation (m)
26-Jan-15	393.54
12-Feb-15	393.53
27-Feb-15	393.52
30-Mar-15	393.52
28-Apr-15	393.62
11-May-15	393.59
28-May-15	393.60
29-Jun-15	393.52
28-Jul-15	393.41
28-Aug-15	393.35
28-Sep-15	393.38
28-Oct-15	393.34
9-Nov-15	393.46
28-Nov-15	393.57
28-Dec-15	393.67
28-Jan-16	393.58
4-Feb-16	393.57
22-Feb-16	393.54
28-Mar-16	393.61
11-Apr-16	393.60
28-Apr-16	393.59
24-May-16	393.50
28-Jun-16	393.46
28-Jul-16	393.40
29-Aug-16	393.36
28-Sep-16	393.32
24-Oct-16	393.38
21-Nov-16	393.37
28-Nov-16	393.37
29-Dec-16	393.47
30-Jan-17	393.53
13-Feb-17	393.56
28-Feb-17	393.58
28-Mar-17	393.57
28-Apr-17	393.66
15-May-17	393.59
28-May-17	393.60
29-Jun-17	393.54
28-Jul-17	393.50
14-Aug-17	393.54
28-Aug-17	393.55
28-Sep-17	393.31
16-Oct-17	393.32

Date	Elevation (m)
28-Oct-17	393.44
28-Nov-17	393.30
28-Dec-17	393.31
28-Jan-18	393.30
12-Feb-18	393.28
26-Feb-18	393.28
28-Mar-18	393.27
28-Apr-18	393.32
15-May-18	393.40
28-May-18	393.31
28-Jun-18	393.28
28-Jul-18	393.20
13-Aug-18	393.22
27-Aug-18	393.20
28-Sep-18	393.12
26-Oct-18	393.29
19-Nov-18	393.30
28-Nov-18	393.28
24-Dec-18	393.30
28-Jan-19	393.29
11-Feb-19	393.28
28-Feb-19	393.29
26-Mar-19	393.30
28-Apr-19	393.53
13-May-19	393.51
28-May-19	393.39
26-Jun-19	393.30
22-Jul-19	393.28
12-Aug-19	393.26
26-Aug-19	393.22
28-Sep-19	393.29
28-Oct-19	393.32
11-Nov-19	393.30
27-Nov-19	393.32
28-Dec-19	393.42
n	78
Minimum	393.12
Maximum	393.67
Mean	393.41
SD	0.13462
Median	393.39
10th Percentile	393.28
95th Percentile	393.60

Note: "SD" = standard deviation. "n" = number of samples.

Table H.12: Water Level at TOMP Station P-13, Panel TMA, 2015 to 2019

Date	Elevation (m)
12-Feb-15	380.13
17-Feb-15	380.09
23-Feb-15	380.04
2-Mar-15	379.97
9-Mar-15	379.91
18-Mar-15	379.97
23-Mar-15	379.80
30-Mar-15	379.75
6-Apr-15	379.70
13-Apr-15	379.72
25-May-15	380.30
1-Jun-15	380.33
8-Jun-15	380.30
15-Jun-15	380.27
2-Nov-15	380.23
9-Nov-15	380.13
16-Nov-15	380.02
21-Dec-15	380.27
28-Dec-15	380.24
4-Jan-16	380.18
12-Jan-16	380.01
18-Jan-16	379.86
25-Jan-16	379.73
1-Feb-16	379.68
4-Feb-16	379.66
14-Mar-16	379.98
21-Mar-16	380.02
28-Mar-16	380.00
4-Apr-16	379.99
11-Apr-16	379.97
18-Apr-16	379.89
25-Apr-16	379.98
30-May-16	380.22
9-Nov-16	380.14
14-Nov-16	380.06
21-Nov-16	379.85
28-Nov-16	379.71
5-Dec-16	379.66
12-Dec-16	379.57
6-Mar-17	380.03
13-Mar-17	380.04
20-Mar-17	380.00
27-Mar-17	379.99
3-Apr-17	380.03
10-Apr-17	380.17
17-Apr-17	380.34
24-Apr-17	380.33
1-May-17	380.27
8-May-17	380.22

Date	Elevation (m)
15-May-17	380.18
23-May-17	380.17
29-May-17	380.18
5-Jun-17	380.16
10-Jul-17	380.24
17-Jul-17	380.14
28-Aug-17	380.24
5-Sep-17	380.17
11-Sep-17	380.21
18-Sep-17	380.19
10-Oct-17	380.32
16-Oct-17	380.30
23-Oct-17	380.23
30-Oct-17	380.29
6-Nov-17	380.25
13-Nov-17	380.20
20-Nov-17	380.25
27-Nov-17	380.21
4-Dec-17	380.17
11-Dec-17	380.22
18-Dec-17	380.12
27-Dec-17	380.09
2-Jan-18	380.00
8-Jan-18	379.98
15-Jan-18	380.03
22-Jan-18	380.03
29-Jan-18	380.01
5-Feb-18	380.01
12-Feb-18	379.93
20-Feb-18	379.80
26-Feb-18	379.81
5-Mar-18	379.78
12-Mar-18	379.76
19-Mar-18	379.72
26-Mar-18	379.69
30-Apr-18	380.08
7-May-18	380.29
14-May-18	380.23
22-May-18	380.19
28-May-18	380.18
25-Jun-18	380.26
15-Oct-18	380.32
22-Oct-18	380.31
29-Oct-18	380.25
5-Nov-18	380.18
12-Nov-18	380.19
19-Nov-18	380.11
26-Nov-18	380.04
3-Dec-18	379.87

Date	Elevation (m)
10-Dec-18	379.80
17-Dec-18	379.76
7-Jan-19	379.94
14-Jan-19	379.93
21-Jan-19	379.88
28-Jan-19	379.86
4-Feb-19	379.81
11-Feb-19	379.79
19-Feb-19	379.77
25-Feb-19	379.74
4-Mar-19	379.67
1-Apr-19	379.82
8-Apr-19	379.82
15-Apr-19	379.89
22-Apr-19	380.16
29-Apr-19	380.26
6-May-19	380.18
13-May-19	380.20
21-May-19	380.18
27-May-19	380.22
3-Jun-19	380.20
10-Jun-19	380.24
17-Jun-19	380.27
24-Jun-19	380.22
2-Jul-19	380.23
7-Oct-19	380.30
15-Oct-19	380.28
22-Oct-19	380.30
28-Oct-19	380.30
4-Nov-19	380.27
11-Nov-19	380.29
18-Nov-19	380.15
25-Nov-19	380.25
9-Dec-19	380.30
16-Dec-19	380.27
30-Dec-19	380.25
n	134
Minimum	379.57
Maximum	380.34
Mean	380.07
SD	0.20014
Median	380.14
10th Percentile	379.76
95th Percentile	380.30

Note: "SD" = standard deviation. "n" = number of samples.

APPENDIX I

LACNOR AND NORDIC TMAS, TOMP DATA

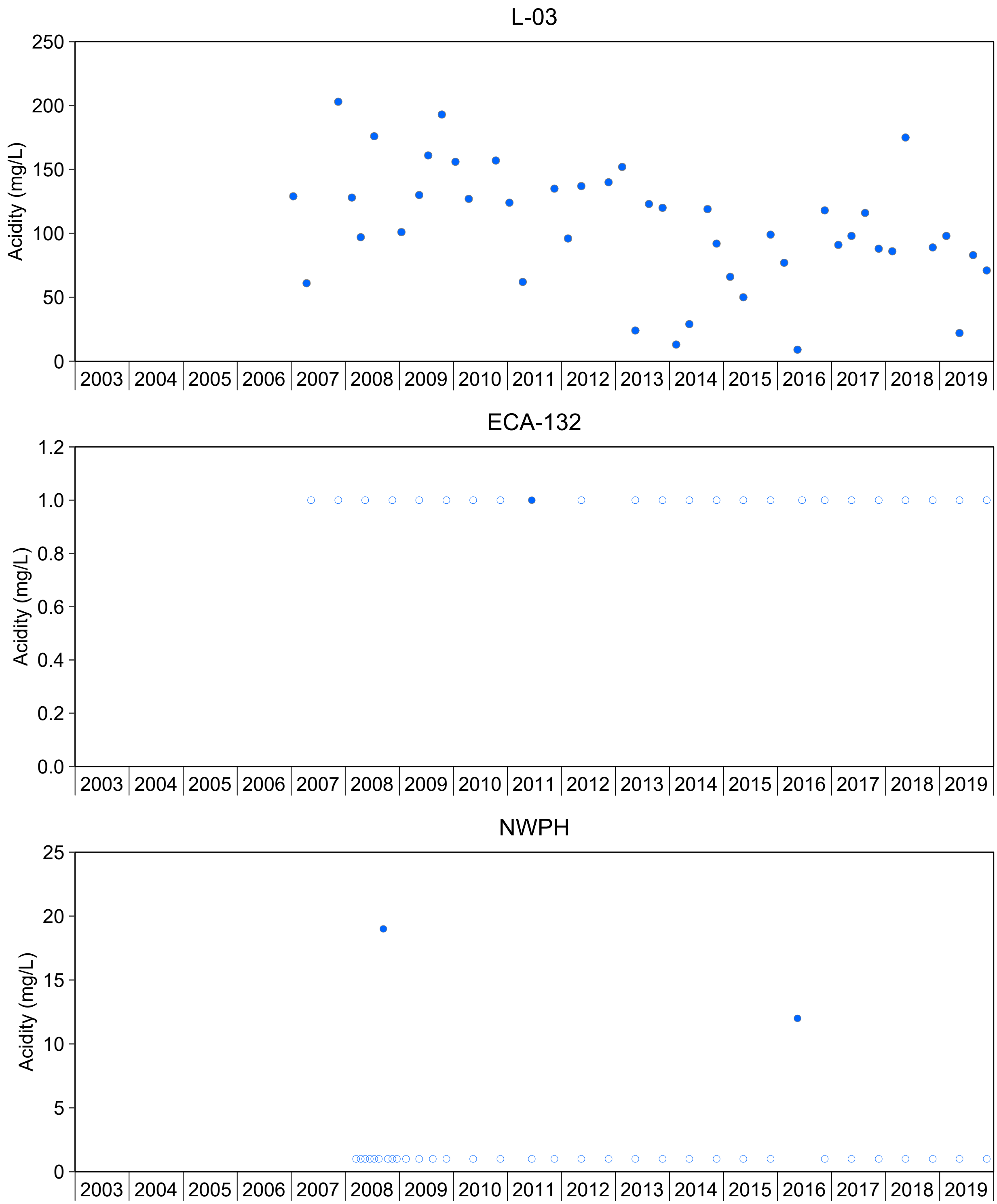


Figure I.1: Concentrations of Acidity for TOMP Water Monitoring Stations, Lacnor/Nordic TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 6.4 for Seasonal Kendall trend analysis results and Appendix Tables I.3 to I.15 for raw data. Acidity (mg/L) is not included in the trend analysis for TOMP stations ECA-132, NWPH, CPW, N-20, ECA-131, and N-19 due to >50% non-detectable concentrations in the dataset.

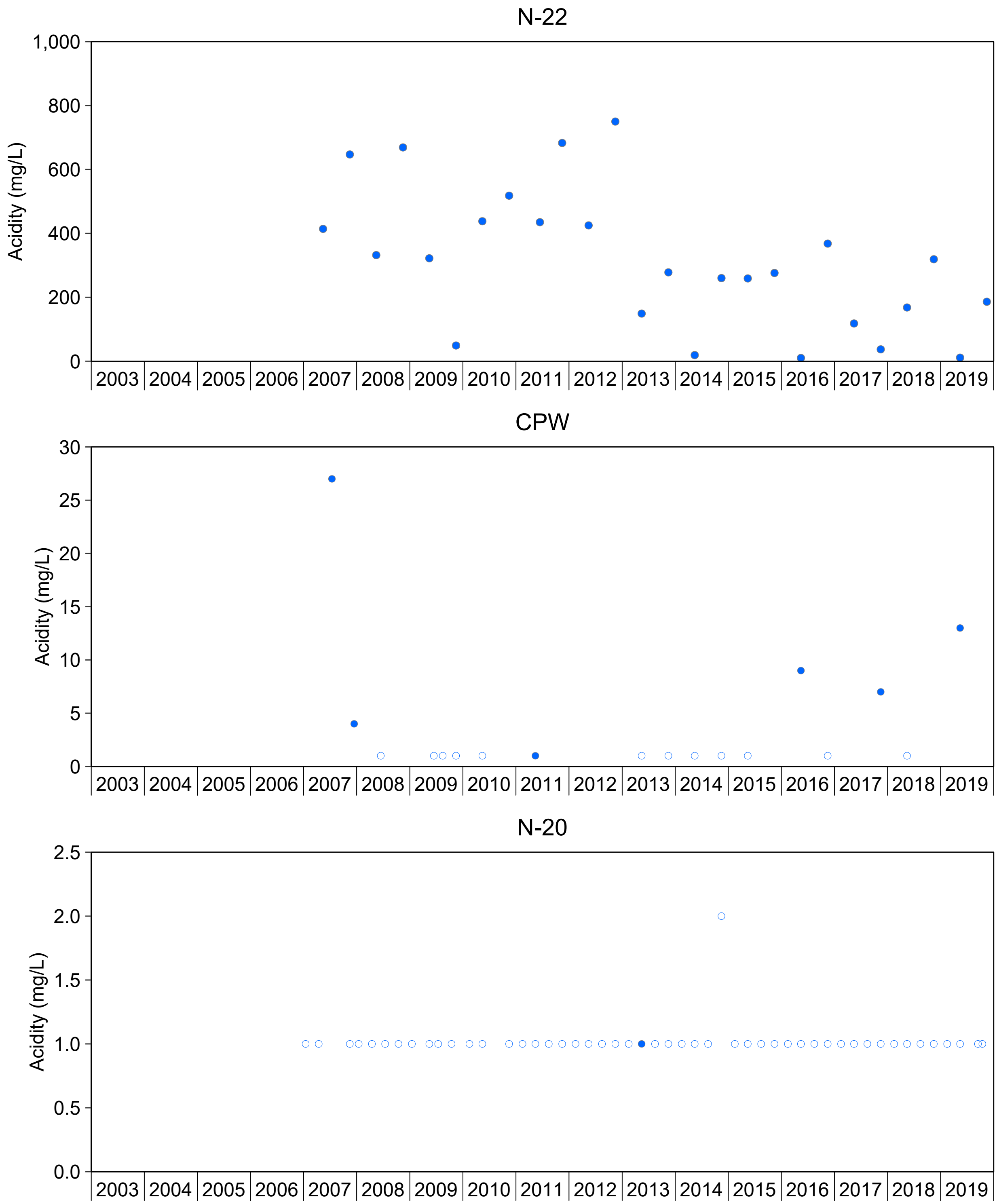
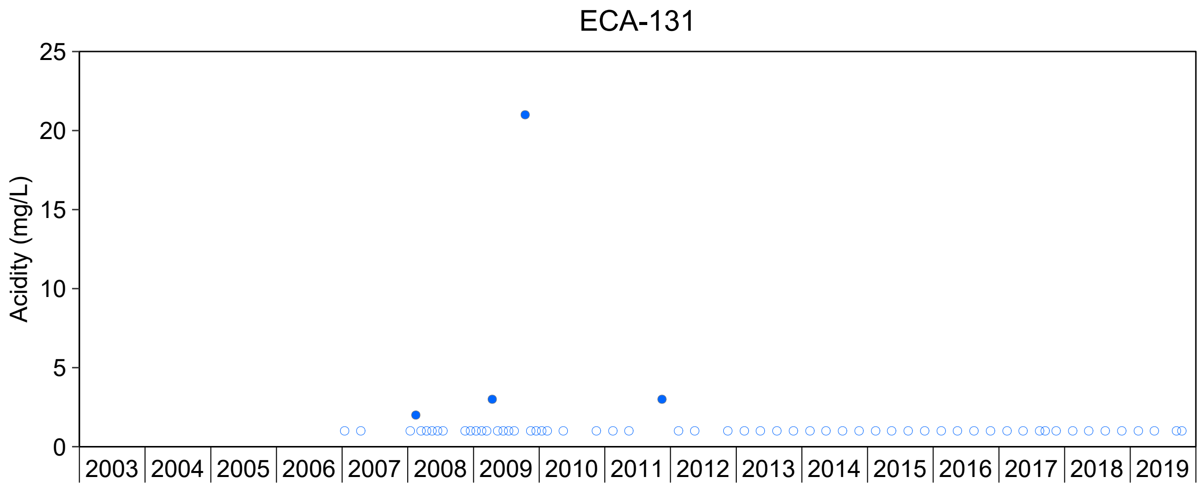
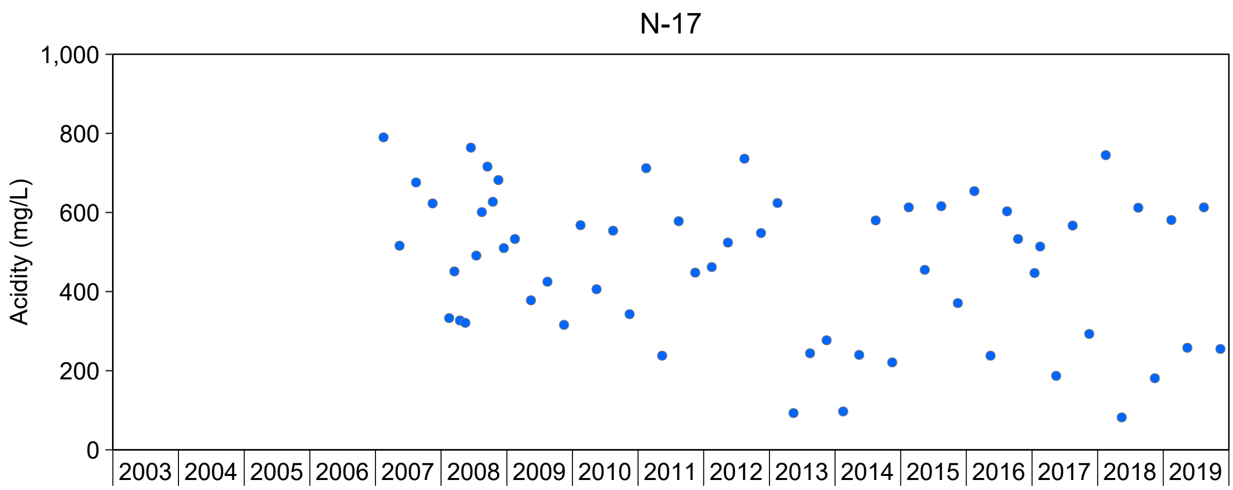


Figure I.1: Concentrations of Acidity for TOMP Water Monitoring Stations, Lacnor/Nordic TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 6.4 for Seasonal Kendall trend analysis results and Appendix Tables I.3 to I.15 for raw data. Acidity (mg/L) is not included in the trend analysis for TOMP stations ECA-132, NWPH, CPW, N-20, ECA-131, and N-19 due to >50% non-detectable concentrations in the dataset.





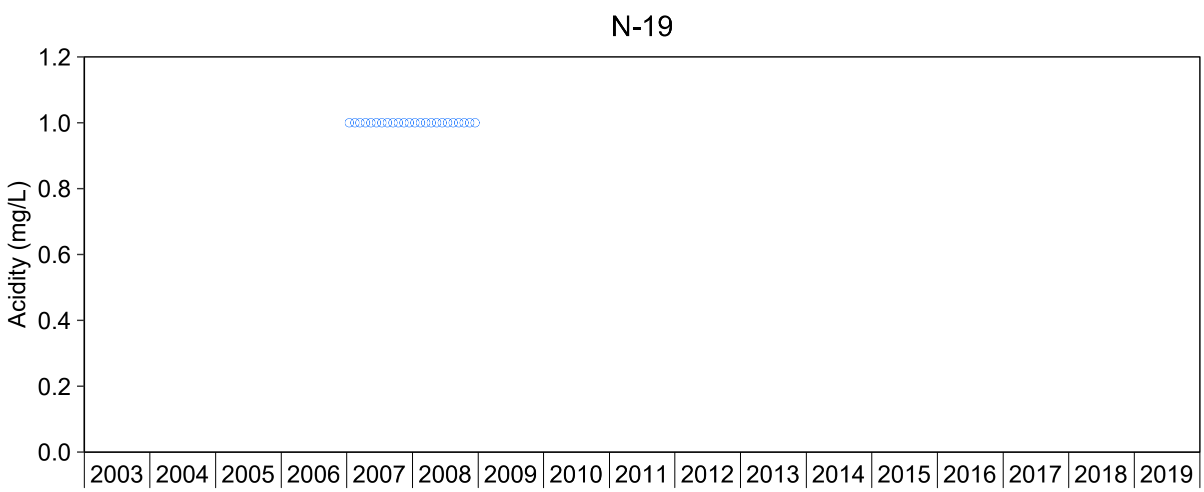


Figure I.1: Time Series Plots for Acidity Concentrations from TOMP Water Monitoring Stations, Lacnor/Nordic TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 6.4 for Seasonal Kendall trend analysis results and Appendix Tables I.3 to I.15 for raw data. Acidity (mg/L) is not included in the trend analysis for TOMP stations ECA-132, NWPH, CPW, N-20, ECA-131, and N-19 due to >50% non-detectable concentrations in the dataset.

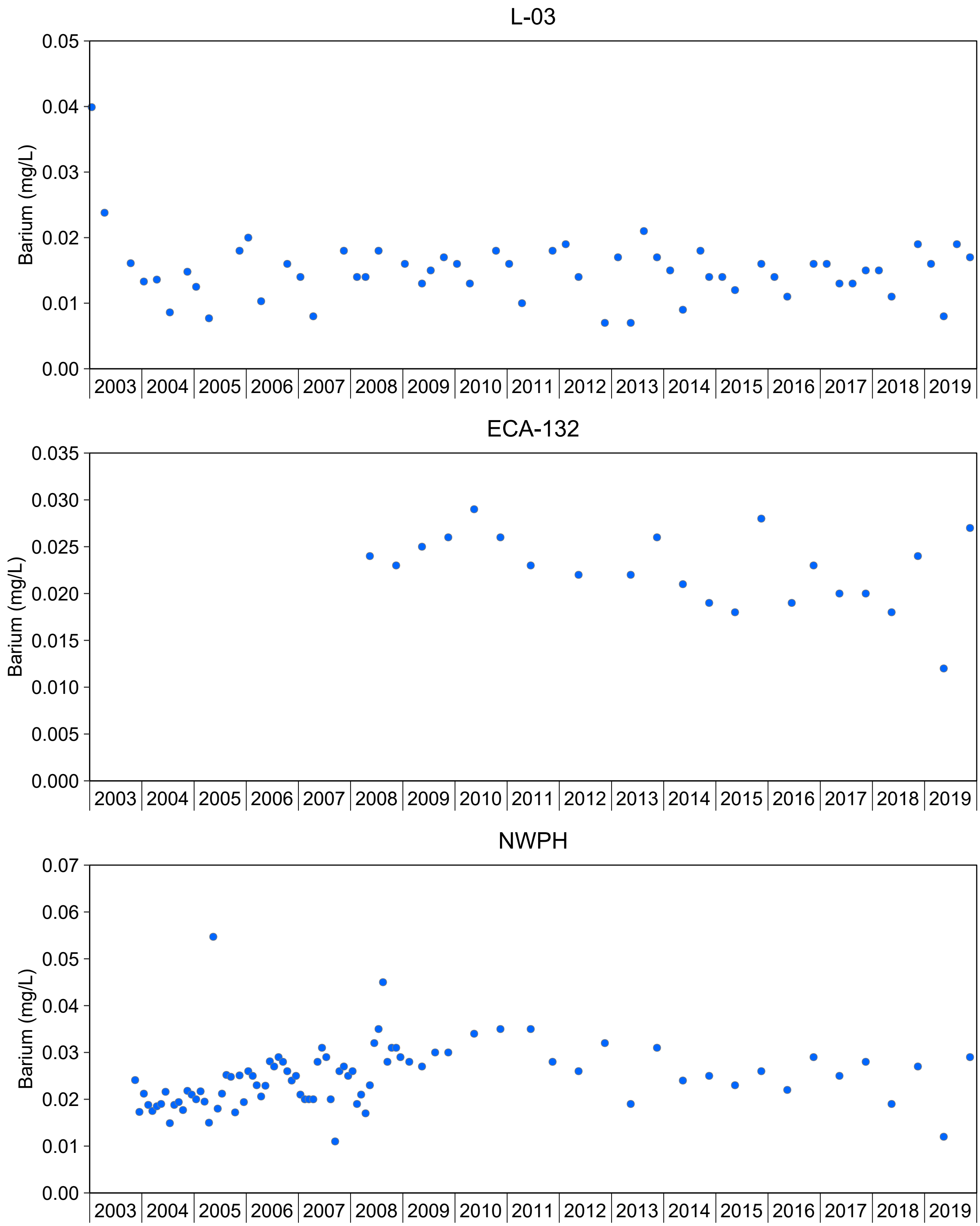


Figure I.2: Concentrations of Barium for TOMP Water Monitoring Stations, Lacnor/Nordic TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 6.4 for Seasonal Kendall trend analysis results and Appendix Tables I.3 to I.15 for raw data.

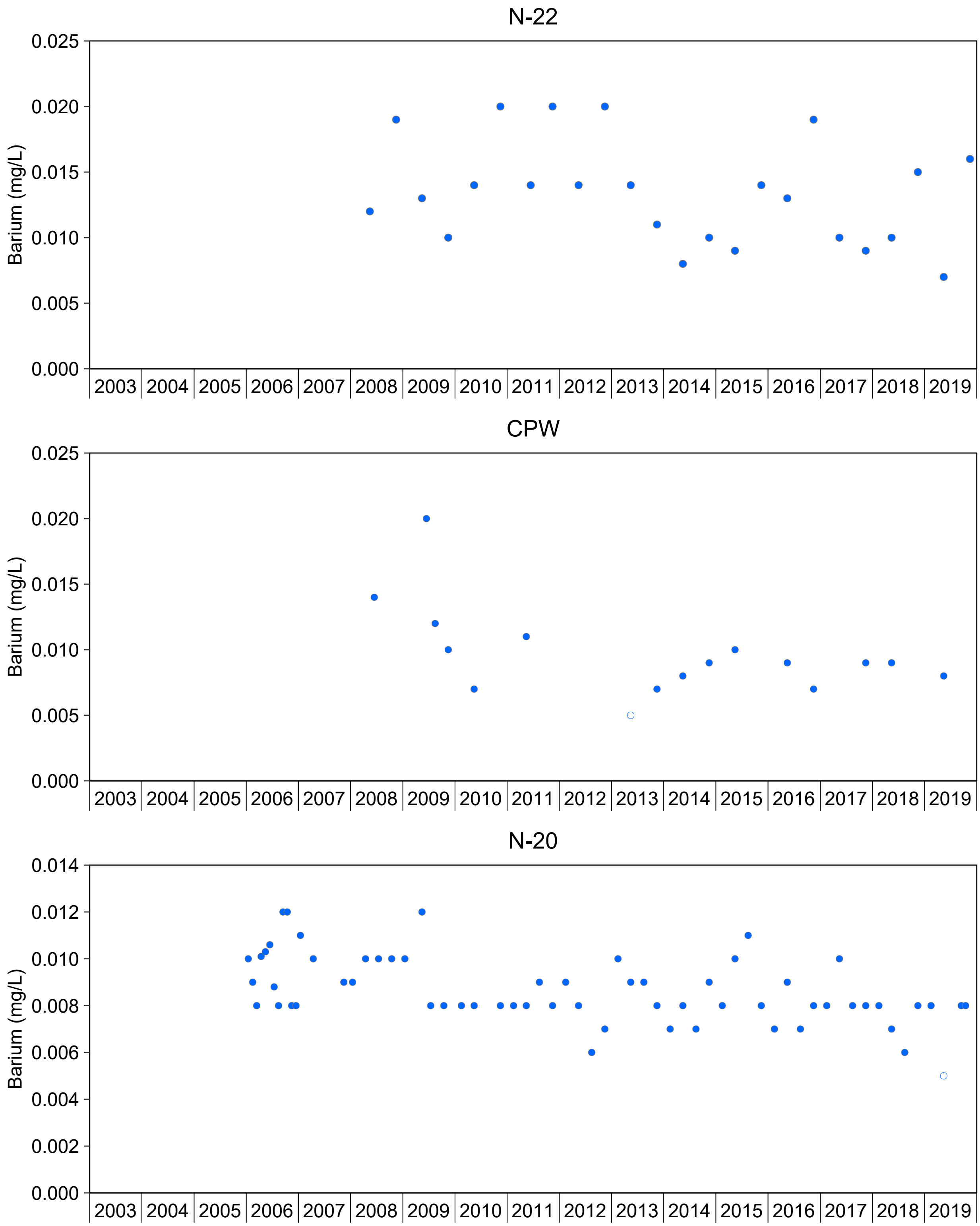


Figure I.2: Concentrations of Barium for TOMP Water Monitoring Stations, Lacnor/Nordic TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 6.4 for Seasonal Kendall trend analysis results and Appendix Tables I.3 to I.15 for raw data.

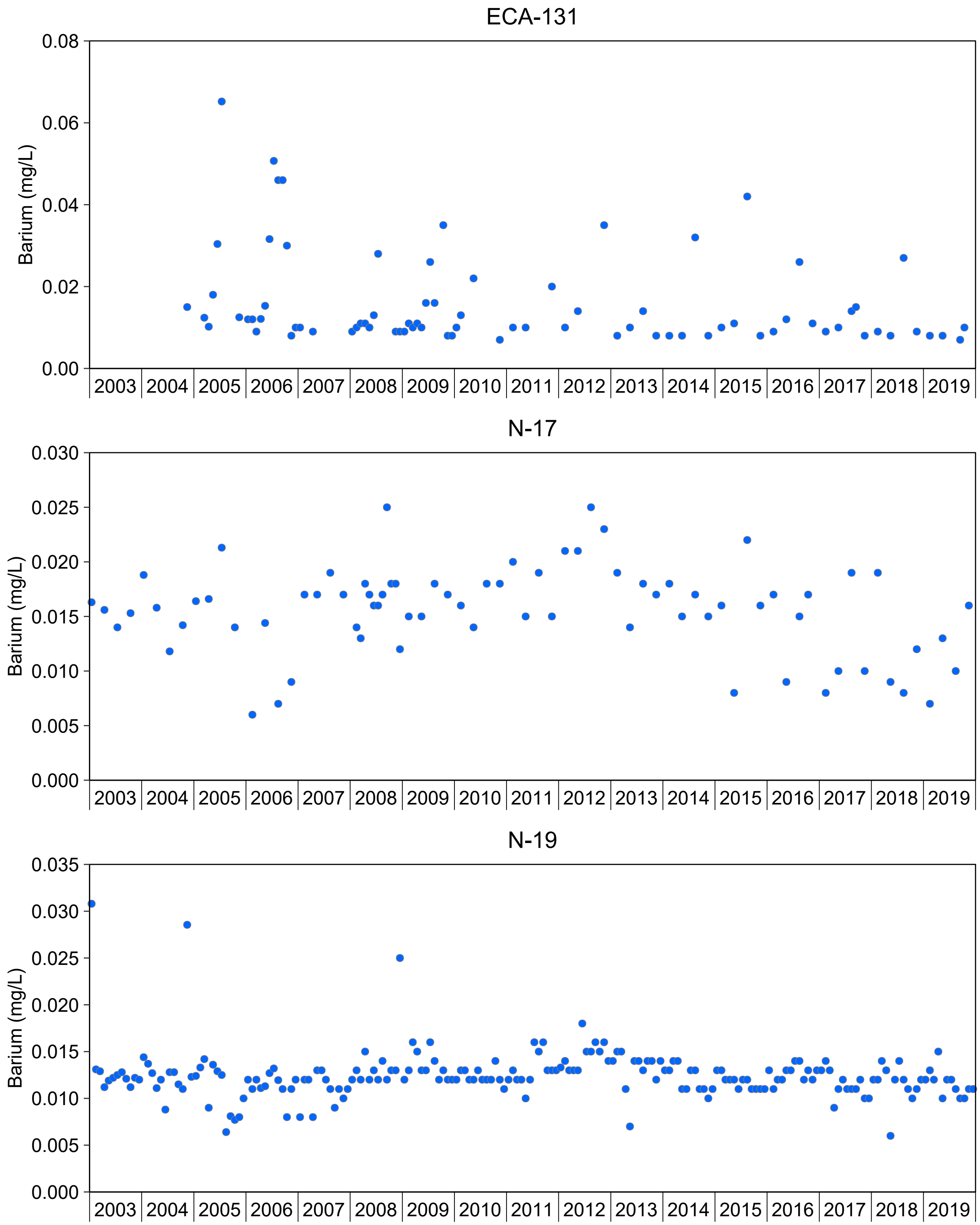


Figure I.2: Concentrations of Barium for TOMP Water Monitoring Stations, Lacnor/Nordic TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 6.4 for Seasonal Kendall trend analysis results and Appendix Tables I.3 to I.15 for raw data.

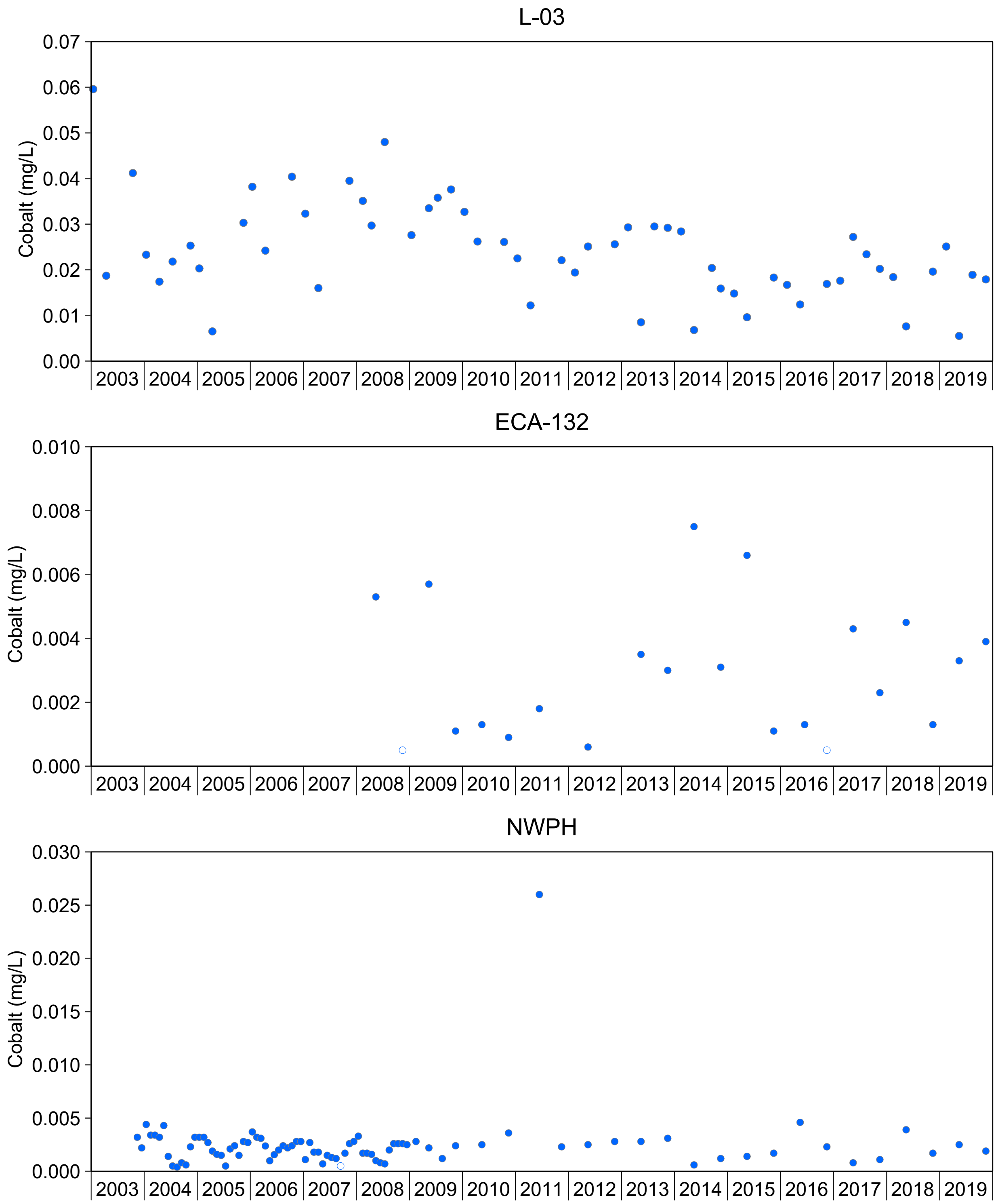


Figure I.3: Concentrations of Cobat for TOMP Water Monitoring Stations, Lacnor/ Nordic TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 6.4 for Seasonal Kendall trend analysis results and Appendix Tables I.3 to I.15 for raw data. Cobalt (mg/L) is not included in the trend analysis for TOMP station ECA-131 due to >50% non-detectable concentrations in the dataset.

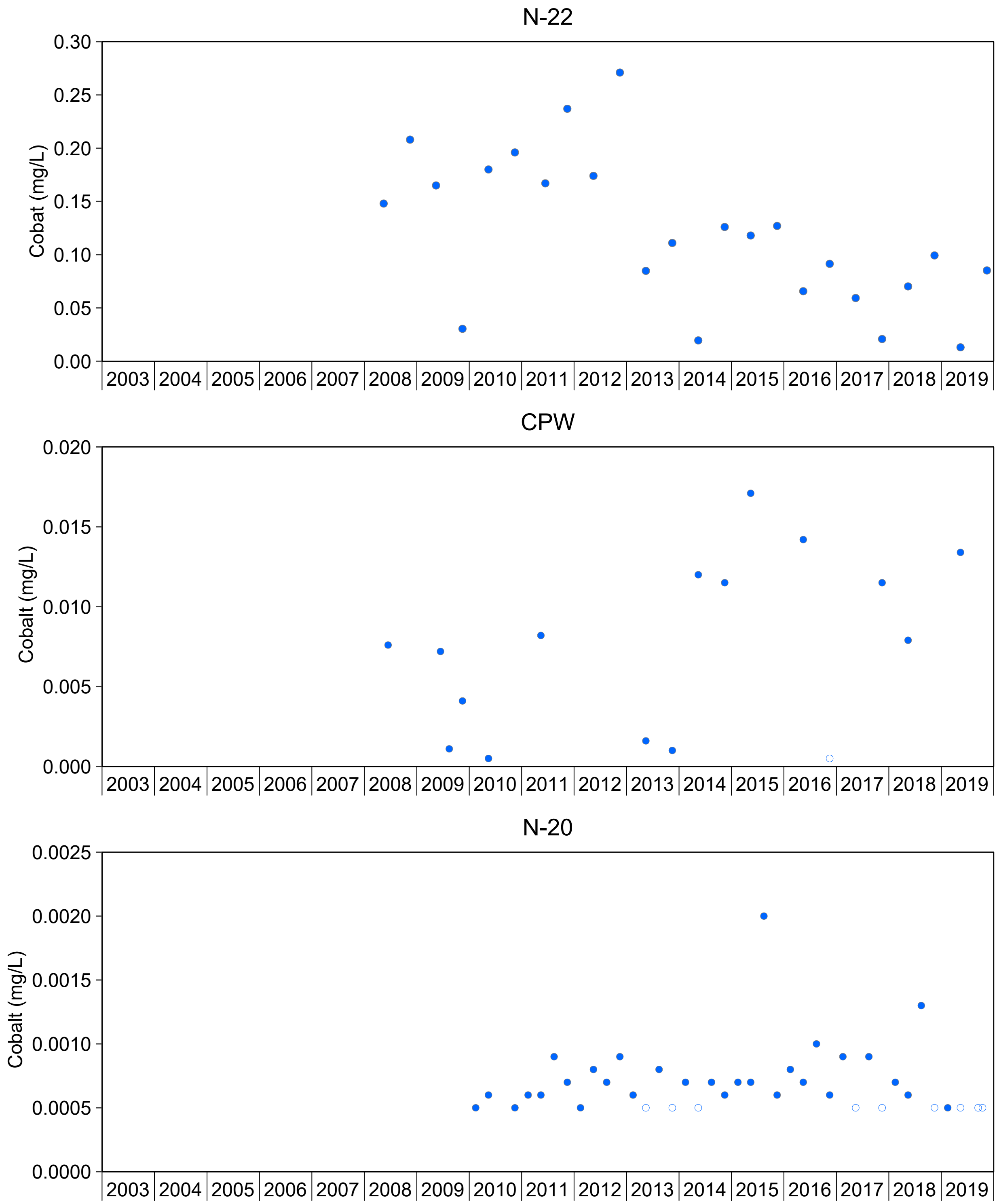


Figure I.3: Concentrations of Cobalt for TOMP Water Monitoring Stations, Lacnor/ Nordic TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 6.4 for Seasonal Kendall trend analysis results and Appendix Tables I.3 to I.15 for raw data. Cobalt (mg/L) is not included in the trend analysis for TOMP station ECA-131 due to >50% non-detectable concentrations in the dataset.

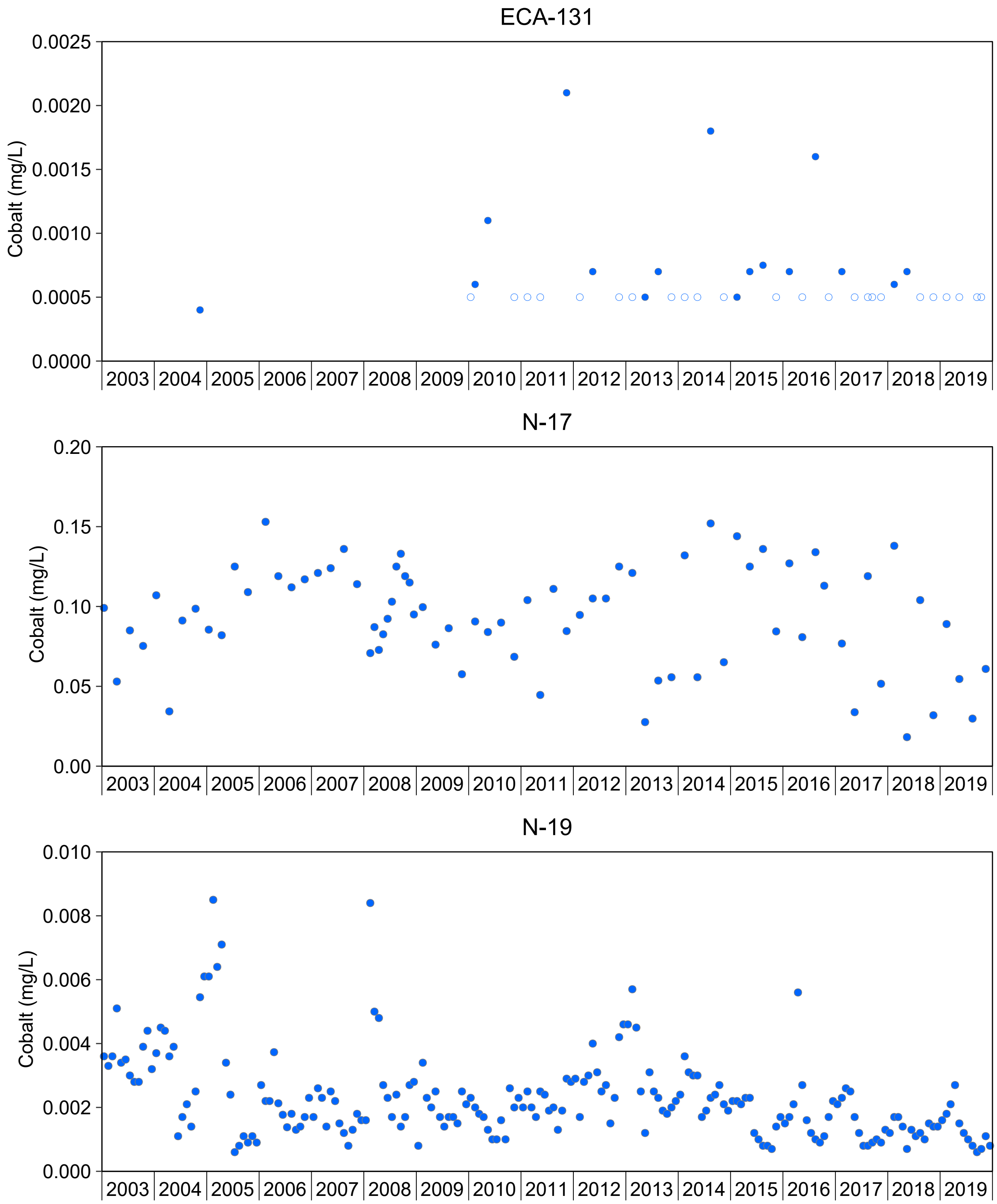


Figure I.3: Concentrations of Cobalt for TOMP Water Monitoring Stations, Lacnor/ Nordic TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 6.4 for Seasonal Kendall trend analysis results and Appendix Tables I.3 to I.15 for raw data. Cobalt (mg/L) is not included in the trend analysis for TOMP station ECA-131 due to >50% non-detectable concentrations in the dataset.

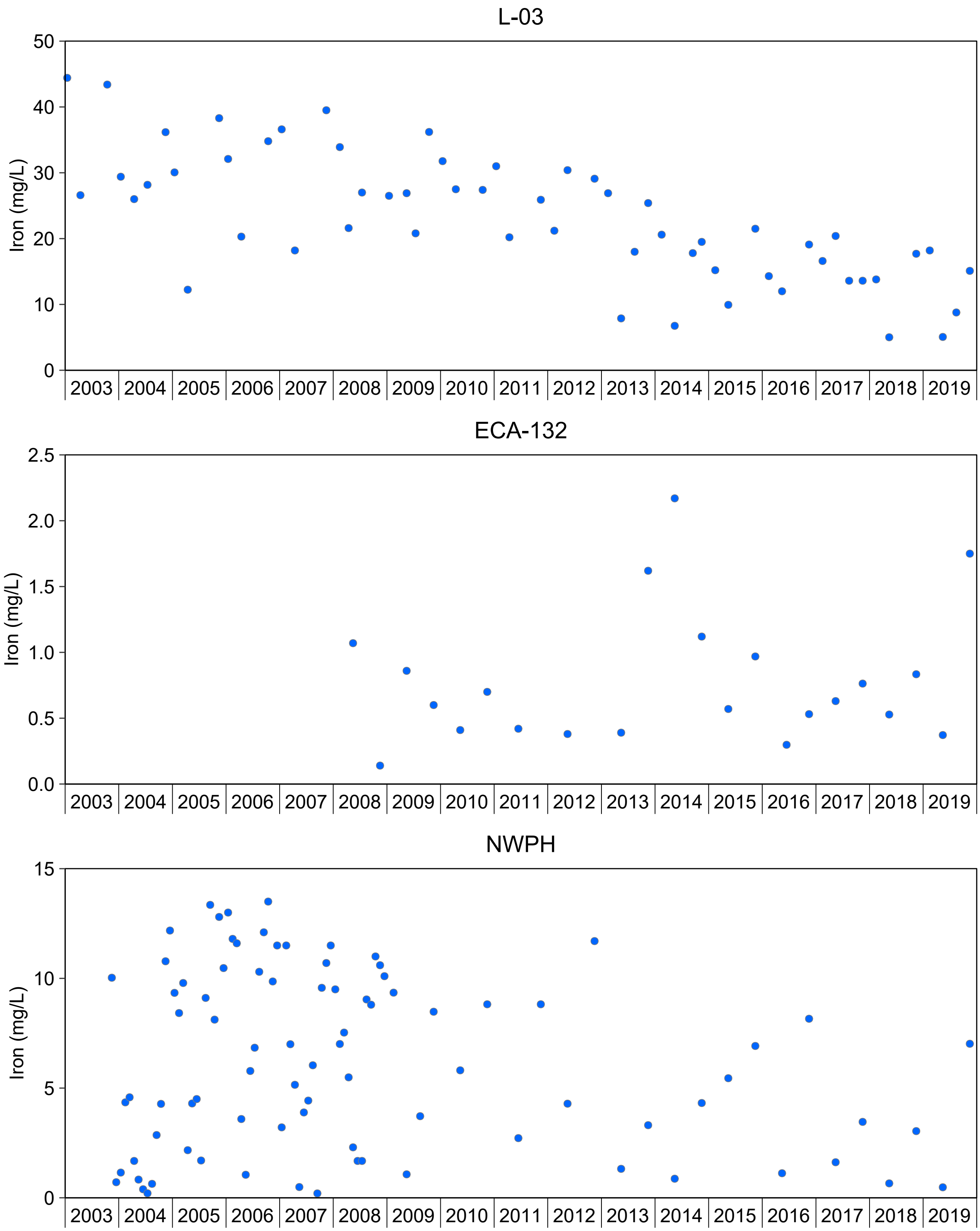


Figure I.4: Concentrations of Iron for TOMP Water Monitoring Stations, Lacnor/Nordic TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 6.4 for Seasonal Kendall trend analysis results and Appendix Tables I.3 to I.15 for raw data.

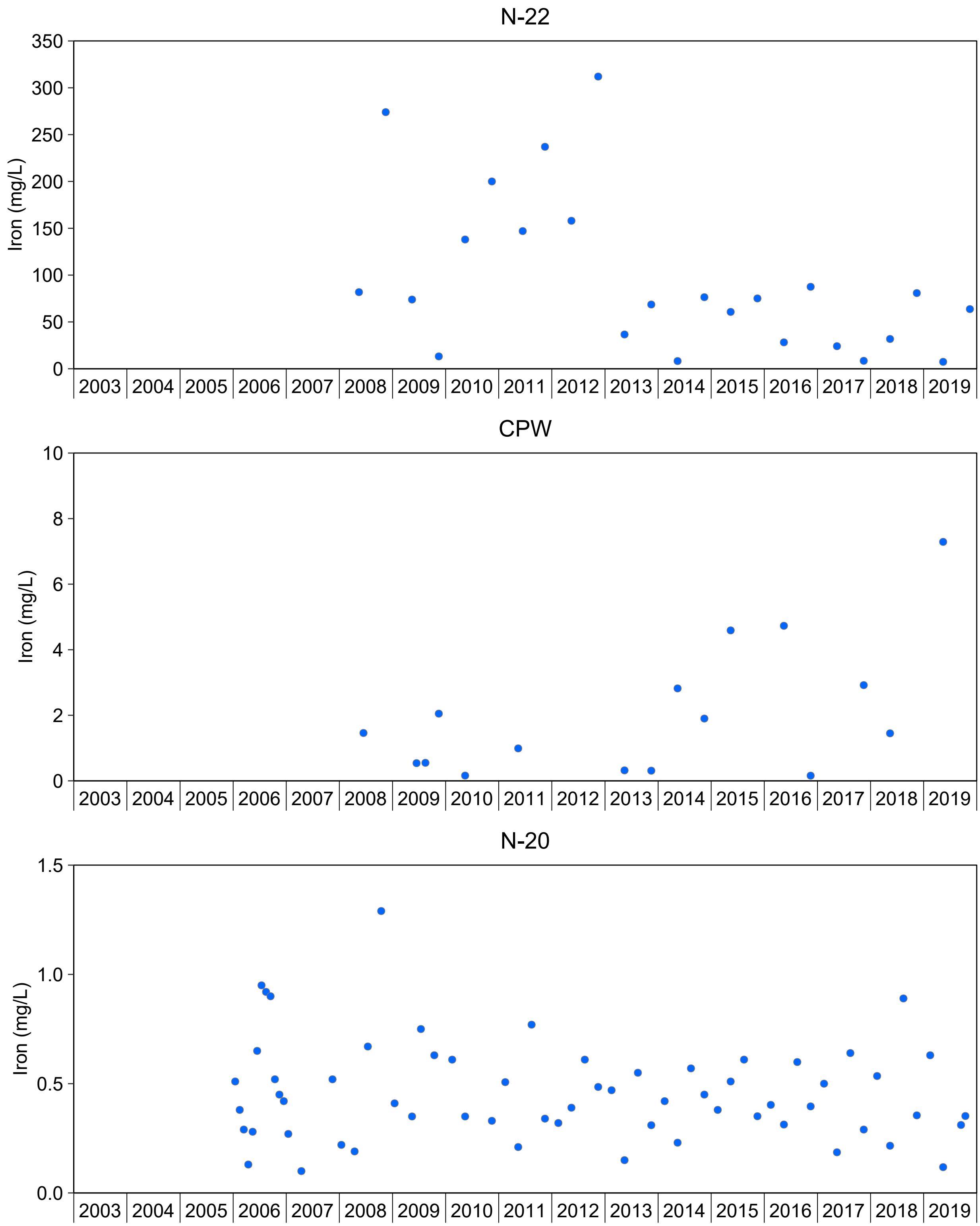


Figure I.4: Concentrations of Iron for TOMP Water Monitoring Stations, Lacnor/Nordic TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 6.4 for Seasonal Kendall trend analysis results and Appendix Tables I.3 to I.15 for raw data.

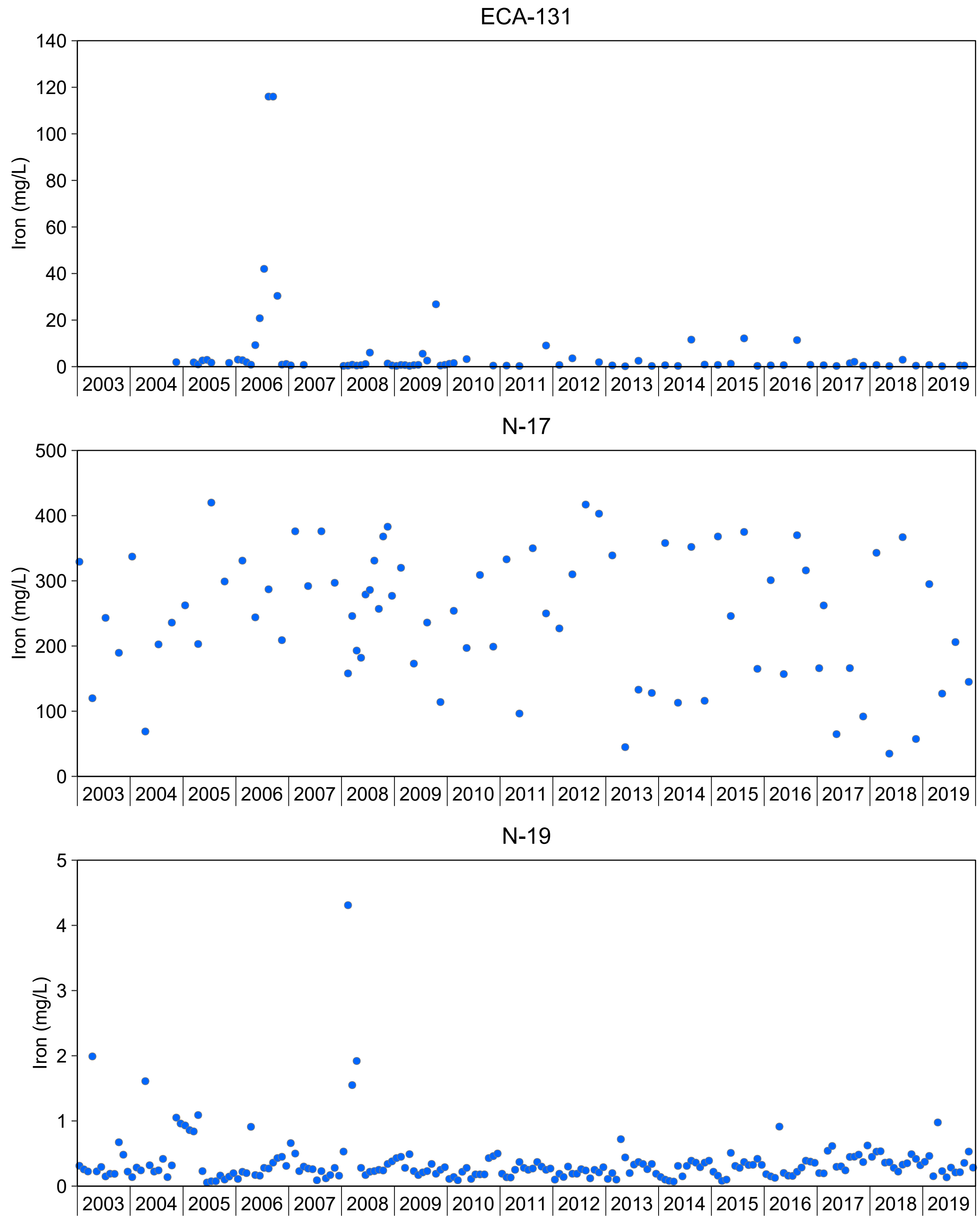


Figure I.4: Concentrations of Iron for TOMP Water Monitoring Stations, Lacnor/Nordic TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 6.4 for Seasonal Kendall trend analysis results and Appendix Tables I.3 to I.15 for raw data.

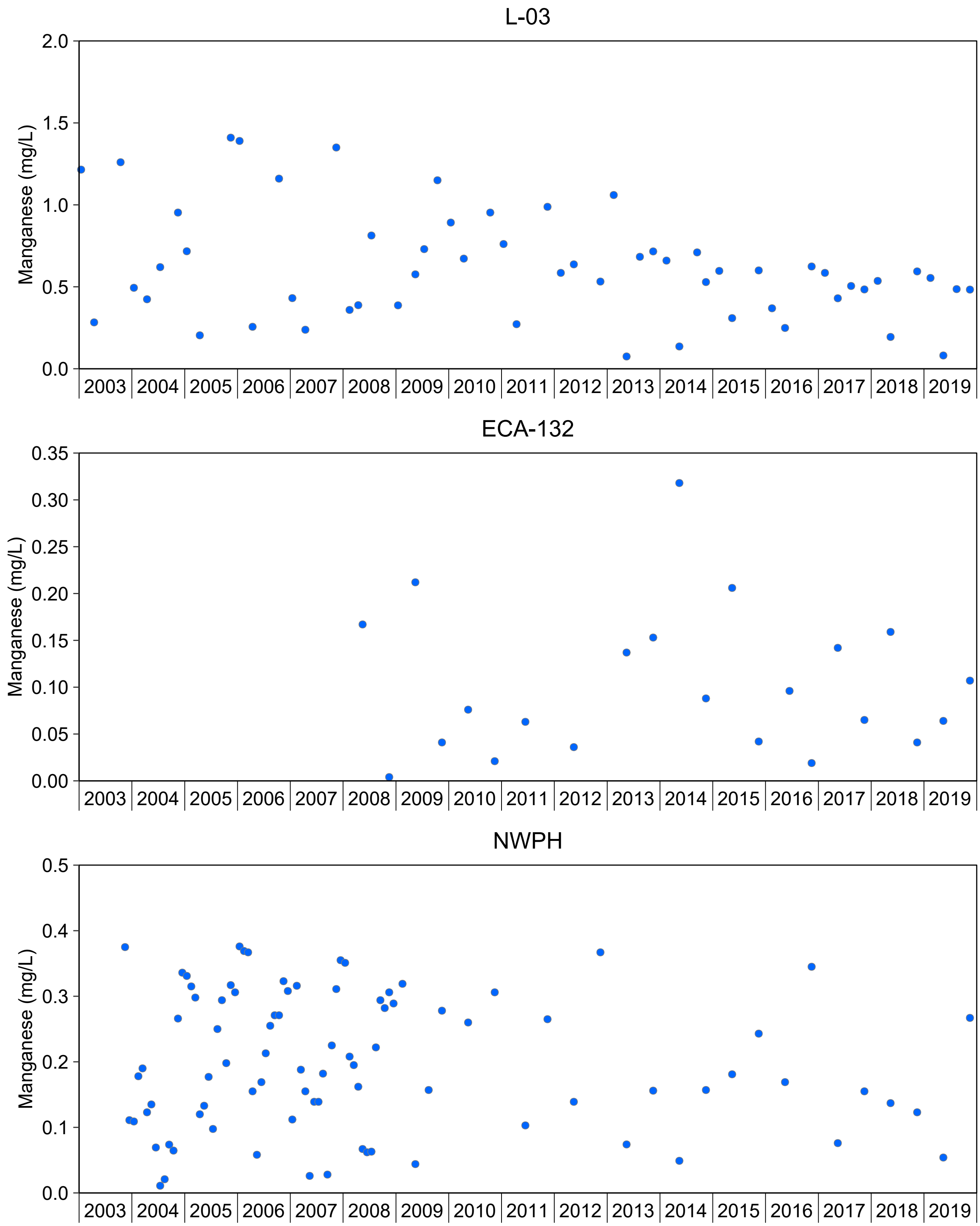


Figure I.5: Concentrations of Manganese for TOMP Water Monitoring Stations, Lacnor/ Nordic TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 6.4 for Seasonal Kendall trend analysis results and Appendix Tables I.3 to I.15 for raw data.

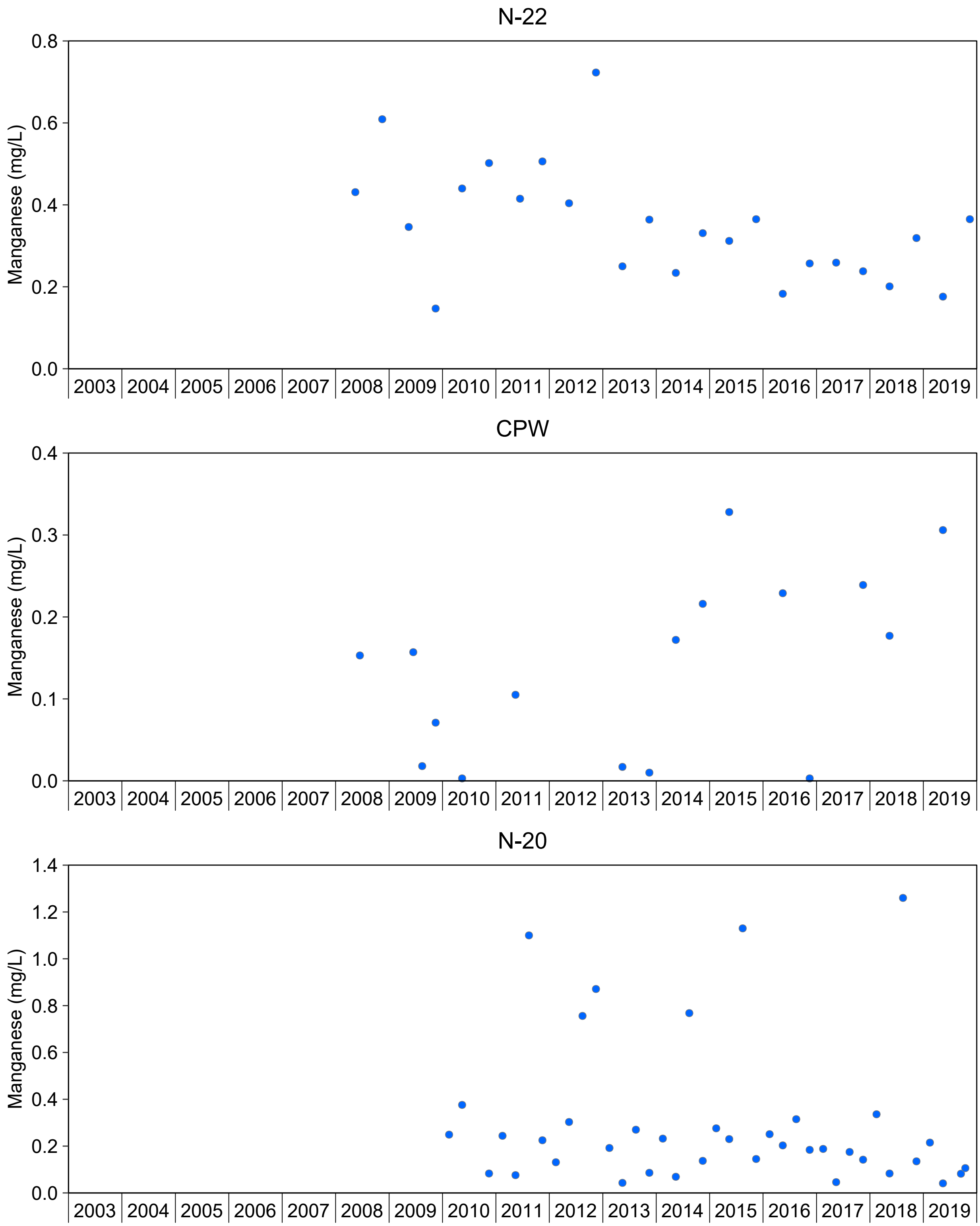


Figure I.5: Concentrations of Manganese for TOMP Water Monitoring Stations, Lacnor/ Nordic TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 6.4 for Seasonal Kendall trend analysis results and Appendix Tables I.3 to I.15 for raw data.

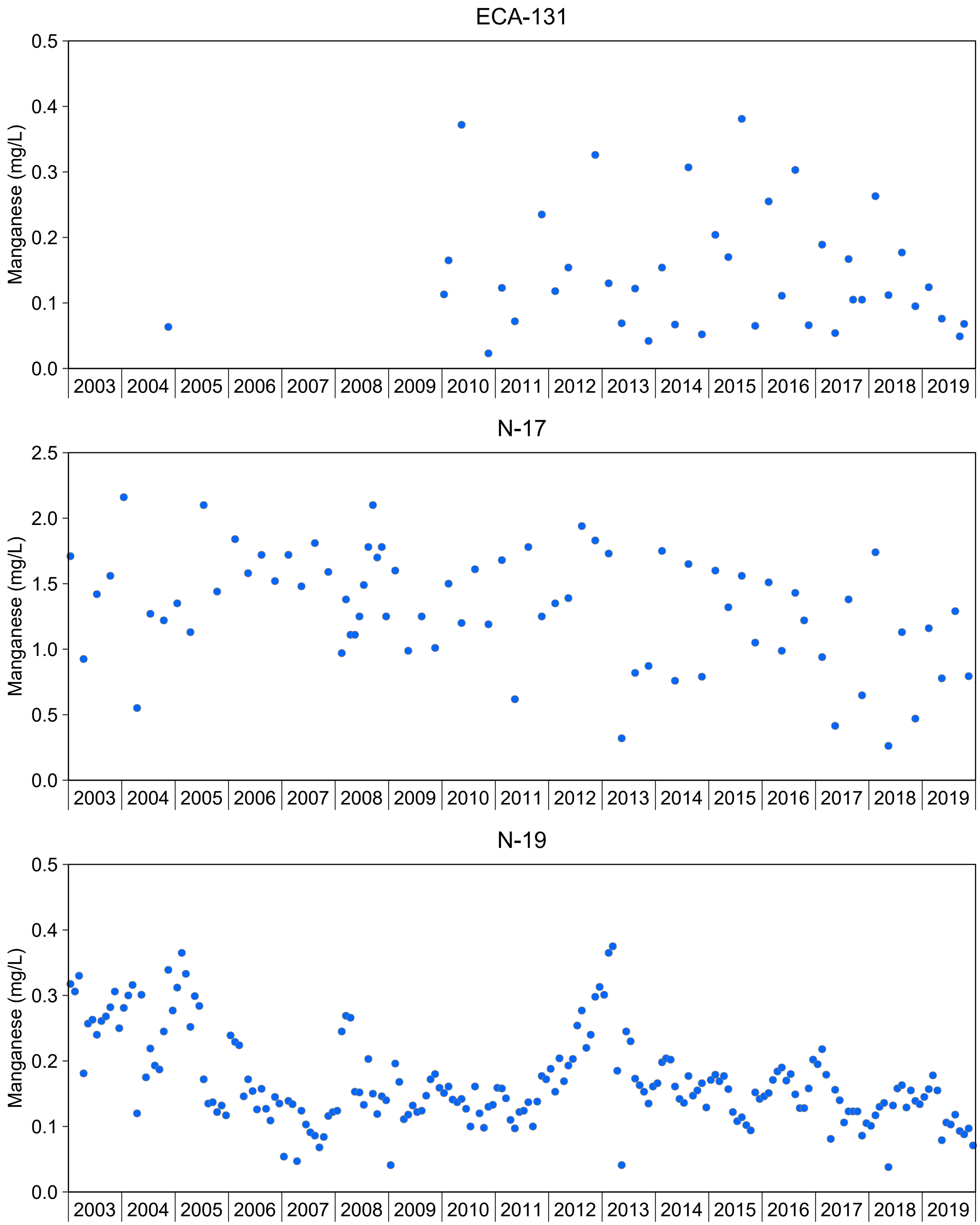


Figure I.5: Concentrations of Manganese for TOMP Water Monitoring Stations, Lacnor/ Nordic TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 6.4 for Seasonal Kendall trend analysis results and Appendix Tables I.3 to I.15 for raw data.

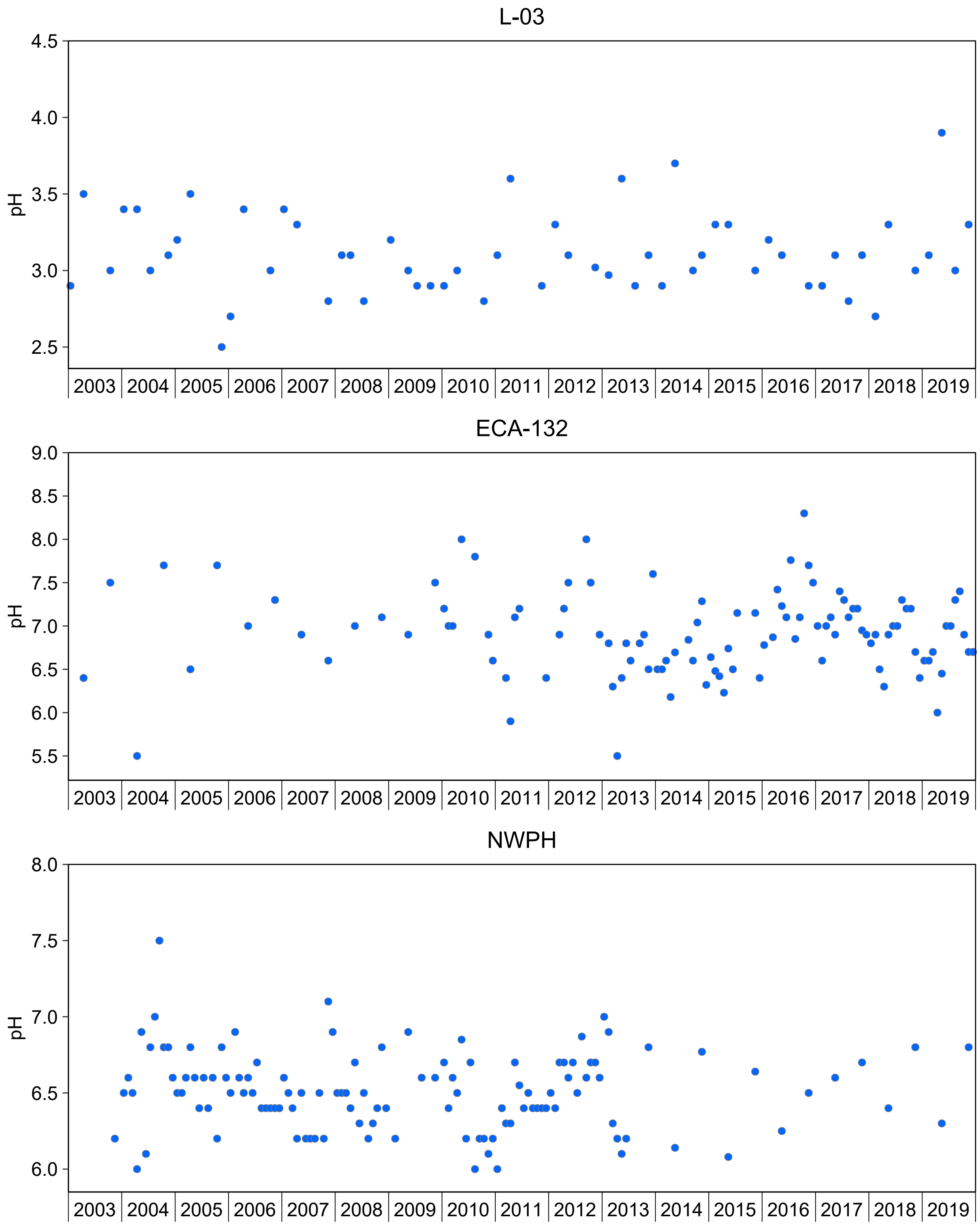


Figure I.6: Field Measurements of pH for TOMP Water Monitoring Stations, Lacnor/ Nordic TMA, 2003 to 2019

Notes: See Table 6.4 for Seasonal Kendall trend analysis results and Appendix Tables I.3 to I.15 for raw data.

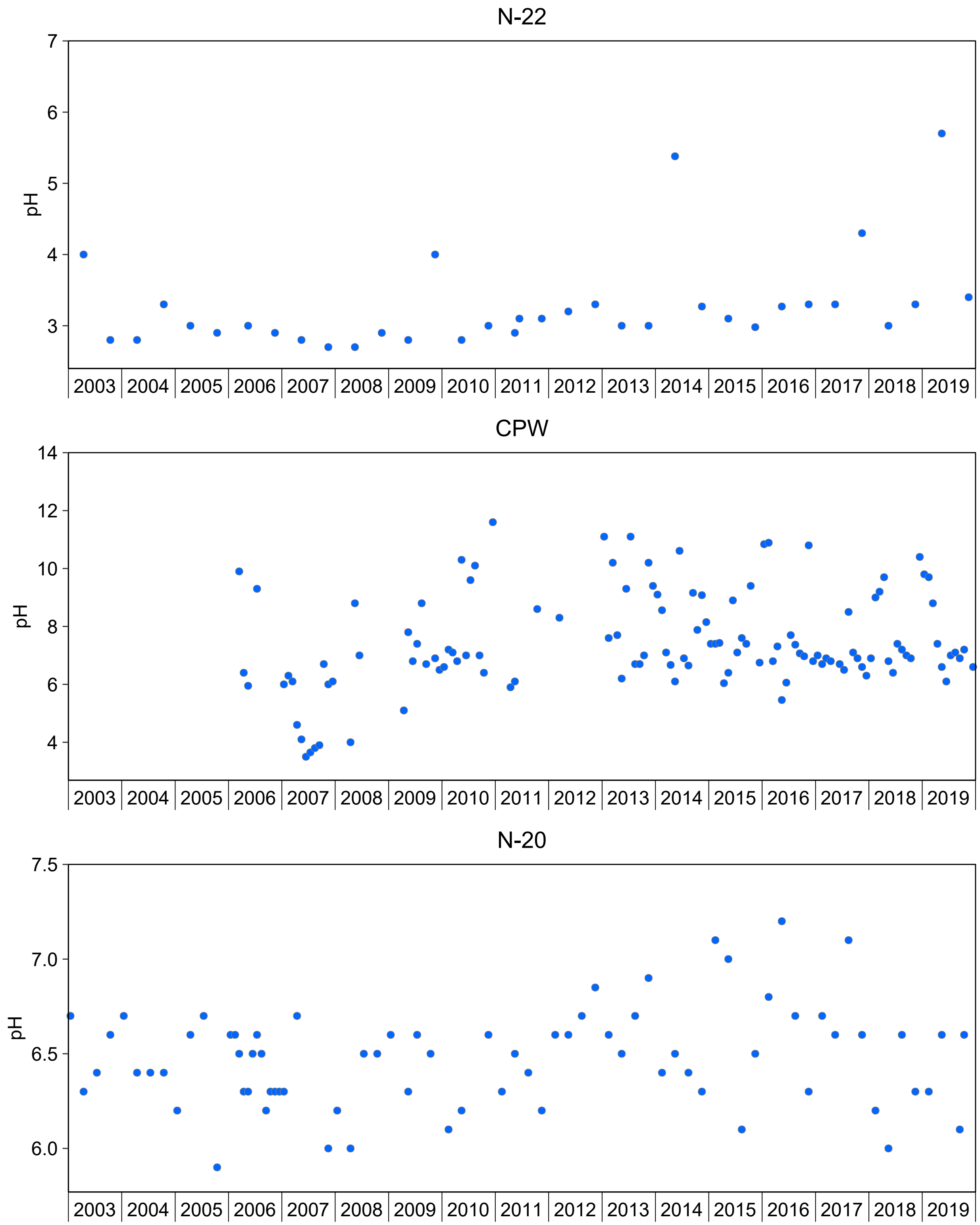


Figure I.6: Field Measurements of pH for TOMP Water Monitoring Stations, Lacnor/ Nordic TMA, 2003 to 2019

Notes: See Table 6.4 for Seasonal Kendall trend analysis results and Appendix Tables I.3 to I.15 for raw data.

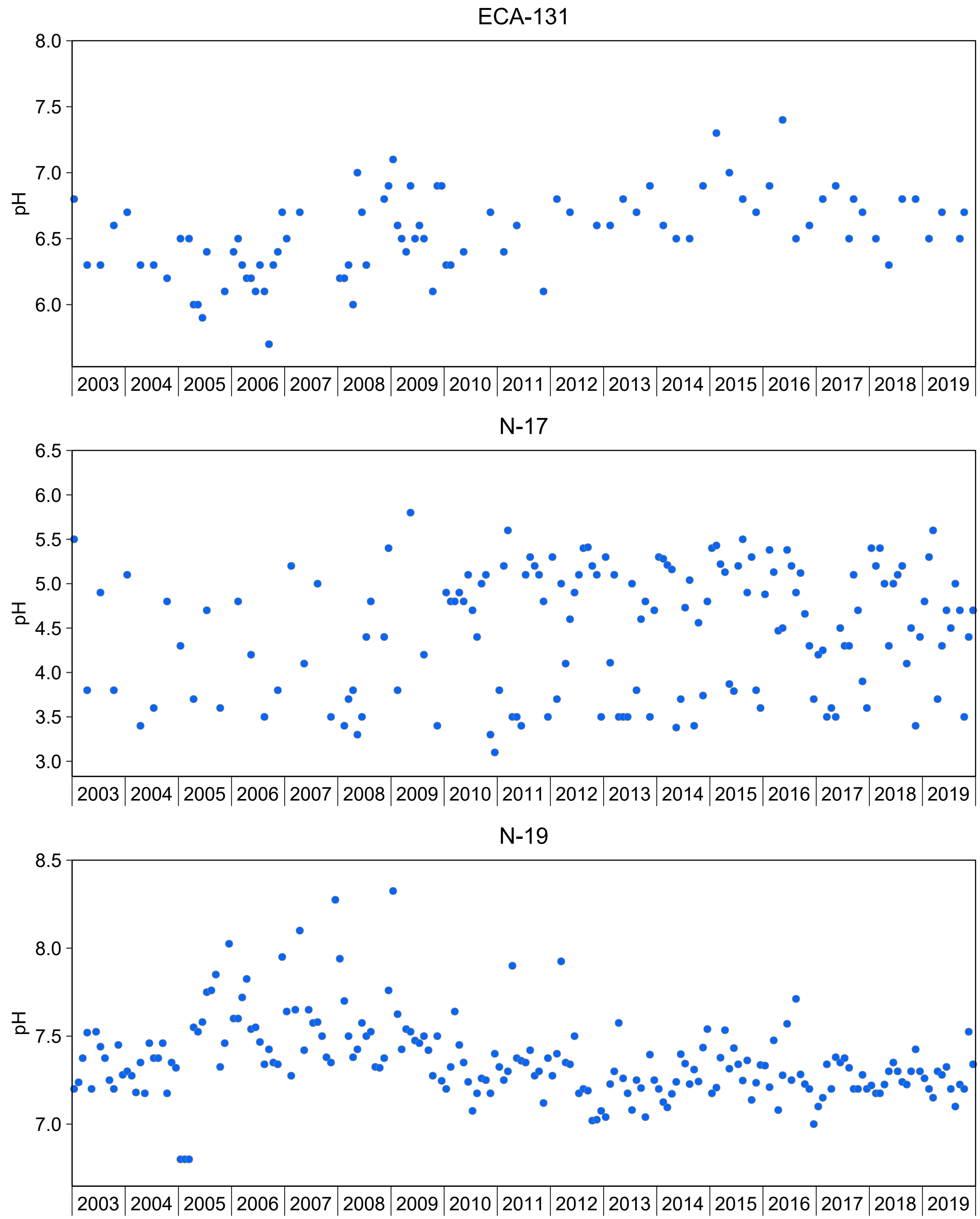


Figure I.6: Field Measurements of pH for TOMP Water Monitoring Stations, Lacnor/ Nordic TMA, 2003 to 2019

Notes: See Table 6.4 for Seasonal Kendall trend analysis results and Appendix Tables I.3 to I.15 for raw data.

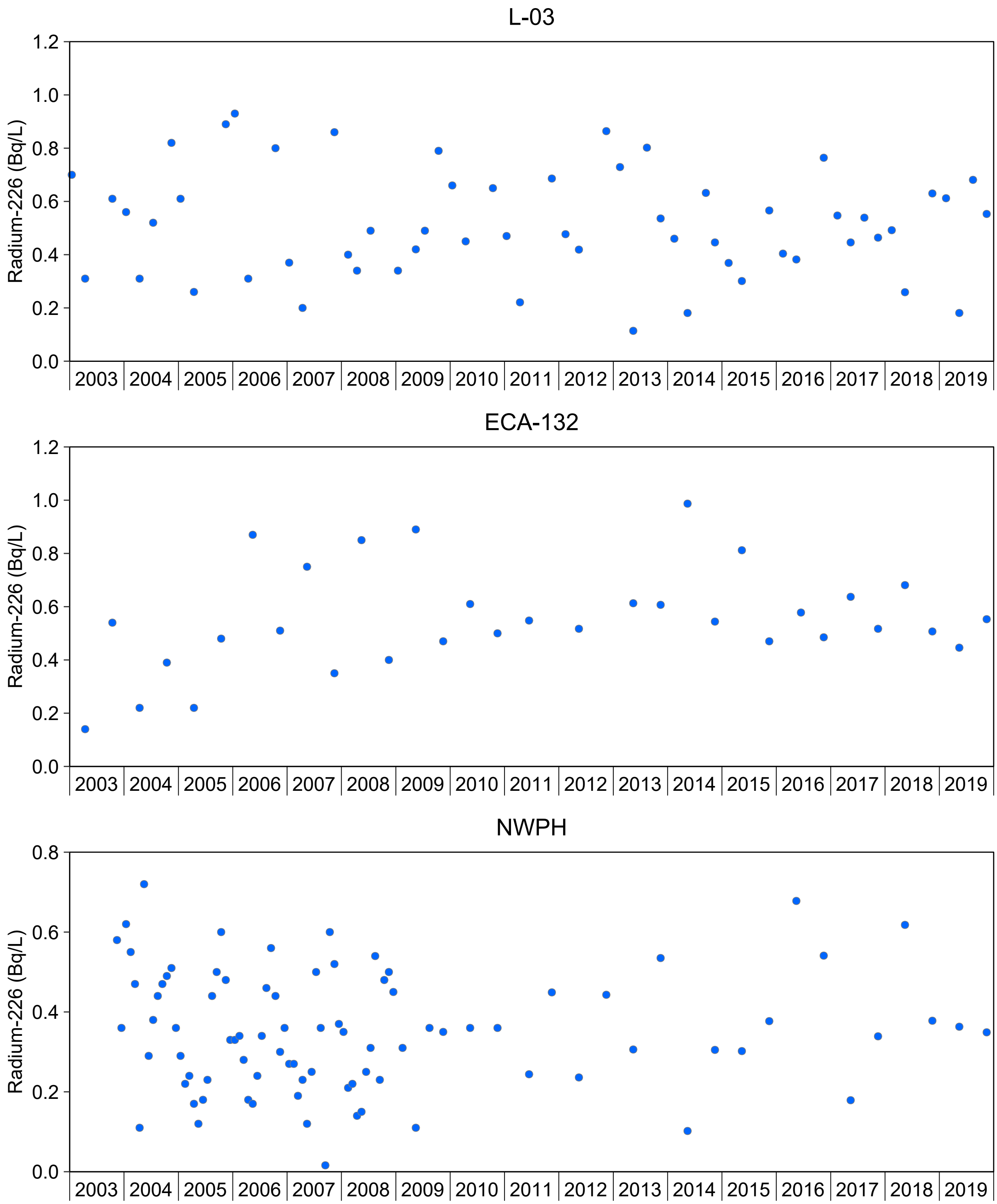


Figure I.7: Concentrations of Radium-226 for TOMP Water Monitoring Stations, Lacnor/ Nordic TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 6.4 for Seasonal Kendall trend analysis results and Appendix Tables I.3 to I.15 for raw data. Radium-226 (Bq/L) is not included in the trend analysis for TOMP station N-20 due to >50% non-detectable concentrations in the dataset.

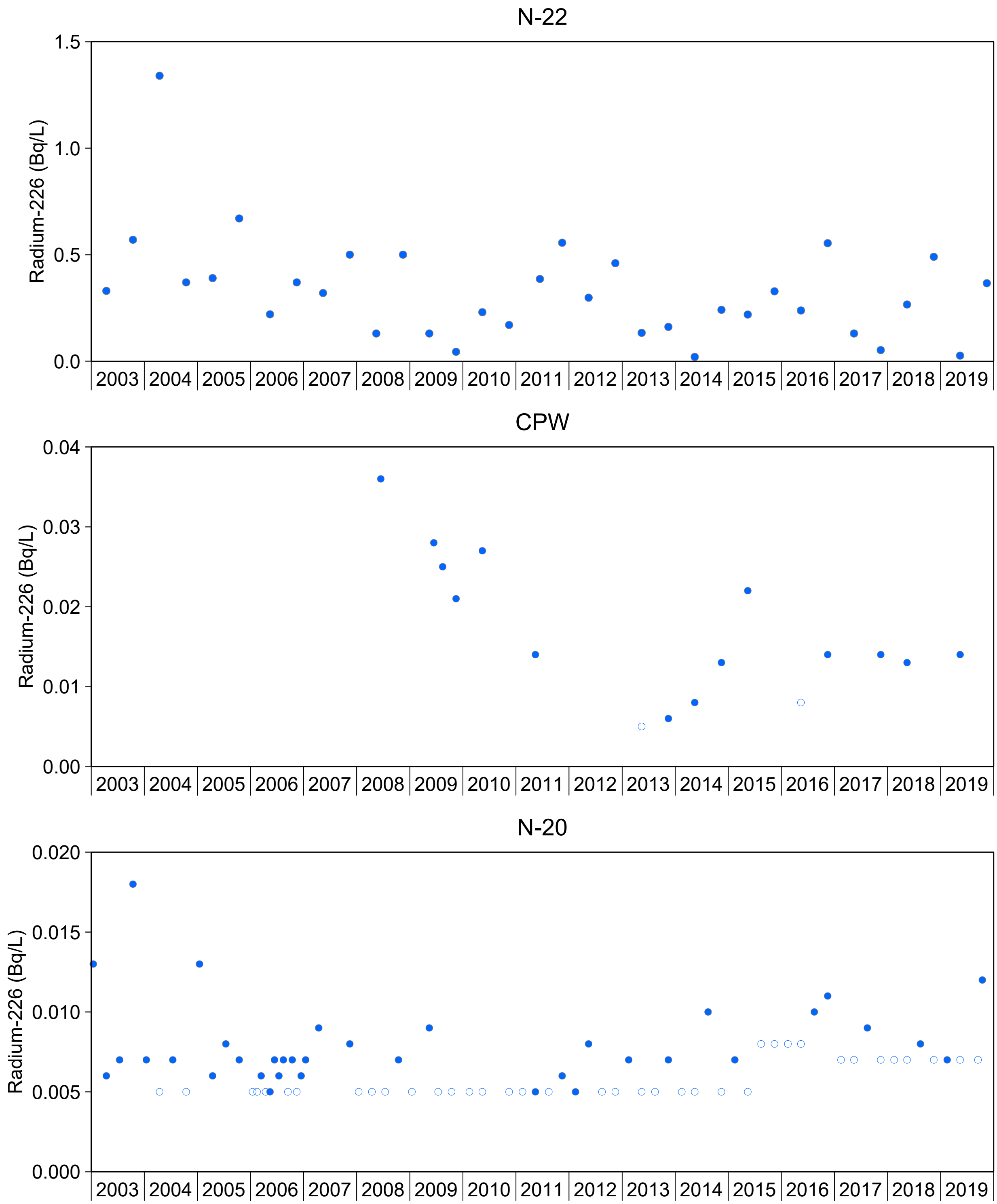


Figure I.7: Concentrations of Radium-226 for TOMP Water Monitoring Stations, Lacnor/ Nordic TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 6.4 for Seasonal Kendall trend analysis results and Appendix Tables I.3 to I.15 for raw data. Radium-226 (Bq/L) is not included in the trend analysis for TOMP station N-20 due to >50% non-detectable concentrations in the dataset.

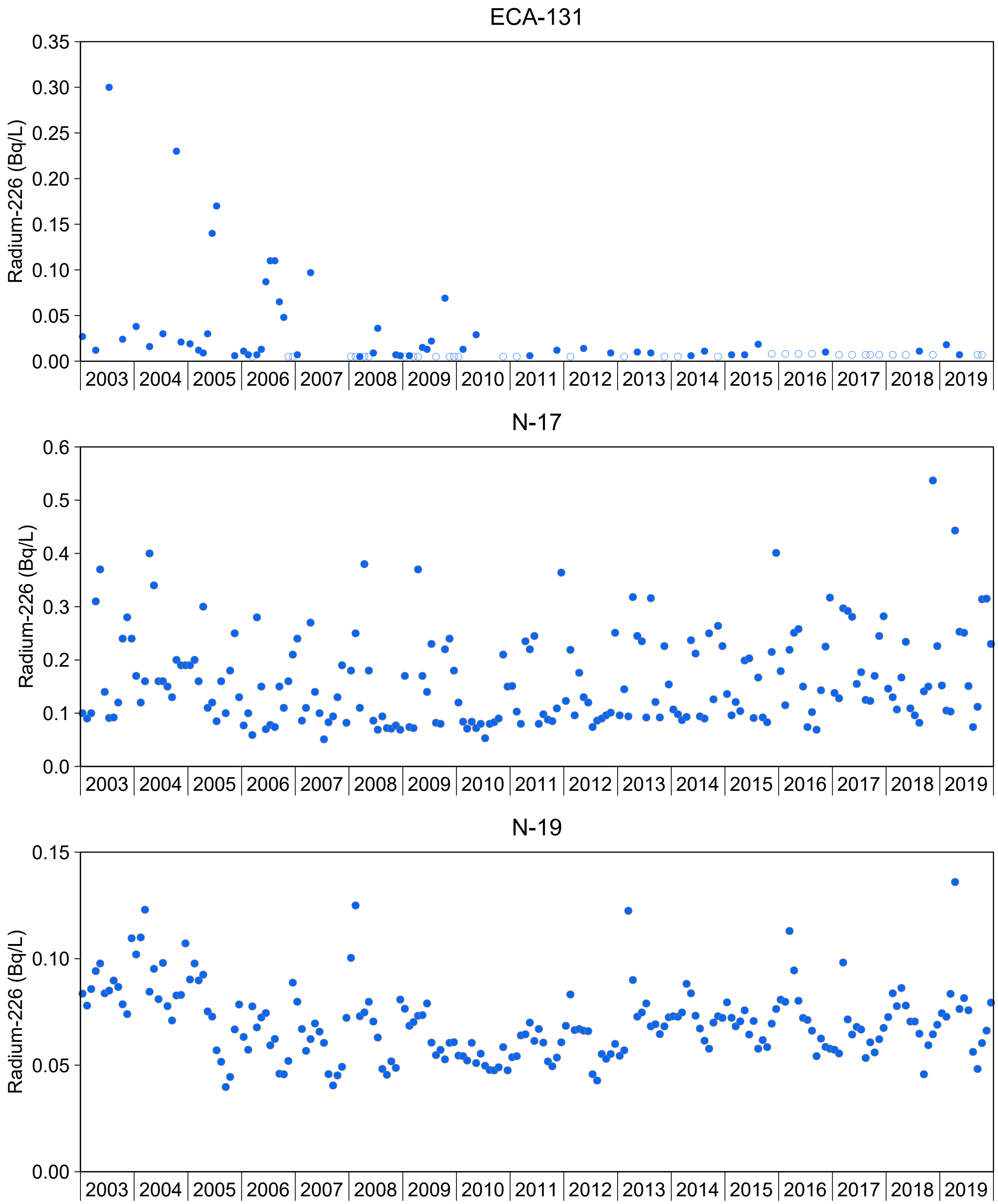


Figure I.7: Concentrations of Radium-226 for TOMP Water Monitoring Stations, Lacnor/ Nordic TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 6.4 for Seasonal Kendall trend analysis results and Appendix Tables I.3 to I.15 for raw data. Radium-226 (Bq/L) is not included in the trend analysis for TOMP station N-20 due to >50% non-detectable concentrations in the dataset.

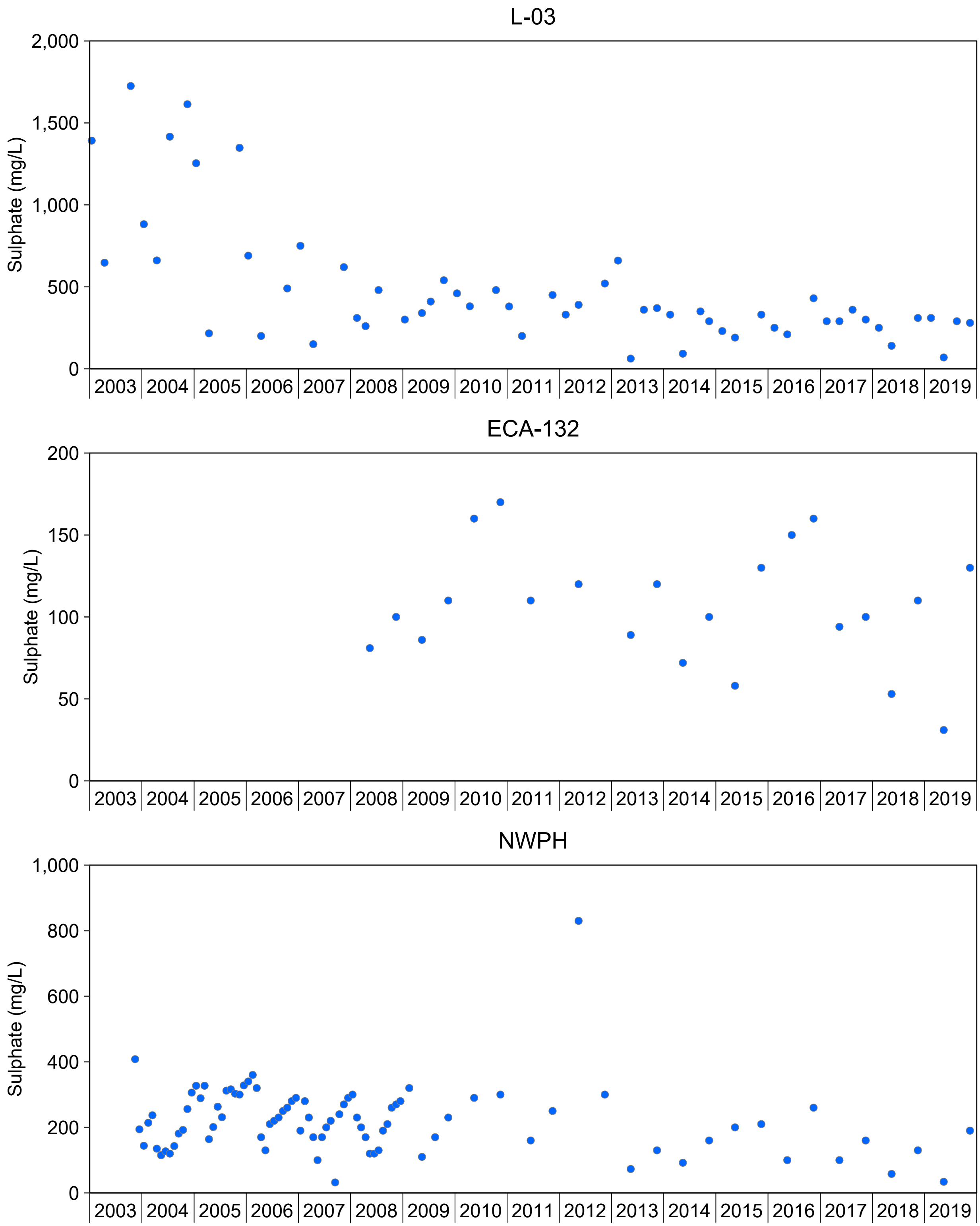


Figure I.8: Concentrations of Sulphate for TOMP Water Monitoring Stations, Lacnor/ Nordic TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 6.4 for Seasonal Kendall trend analysis results and Appendix Tables I.3 to I.15 for raw data.

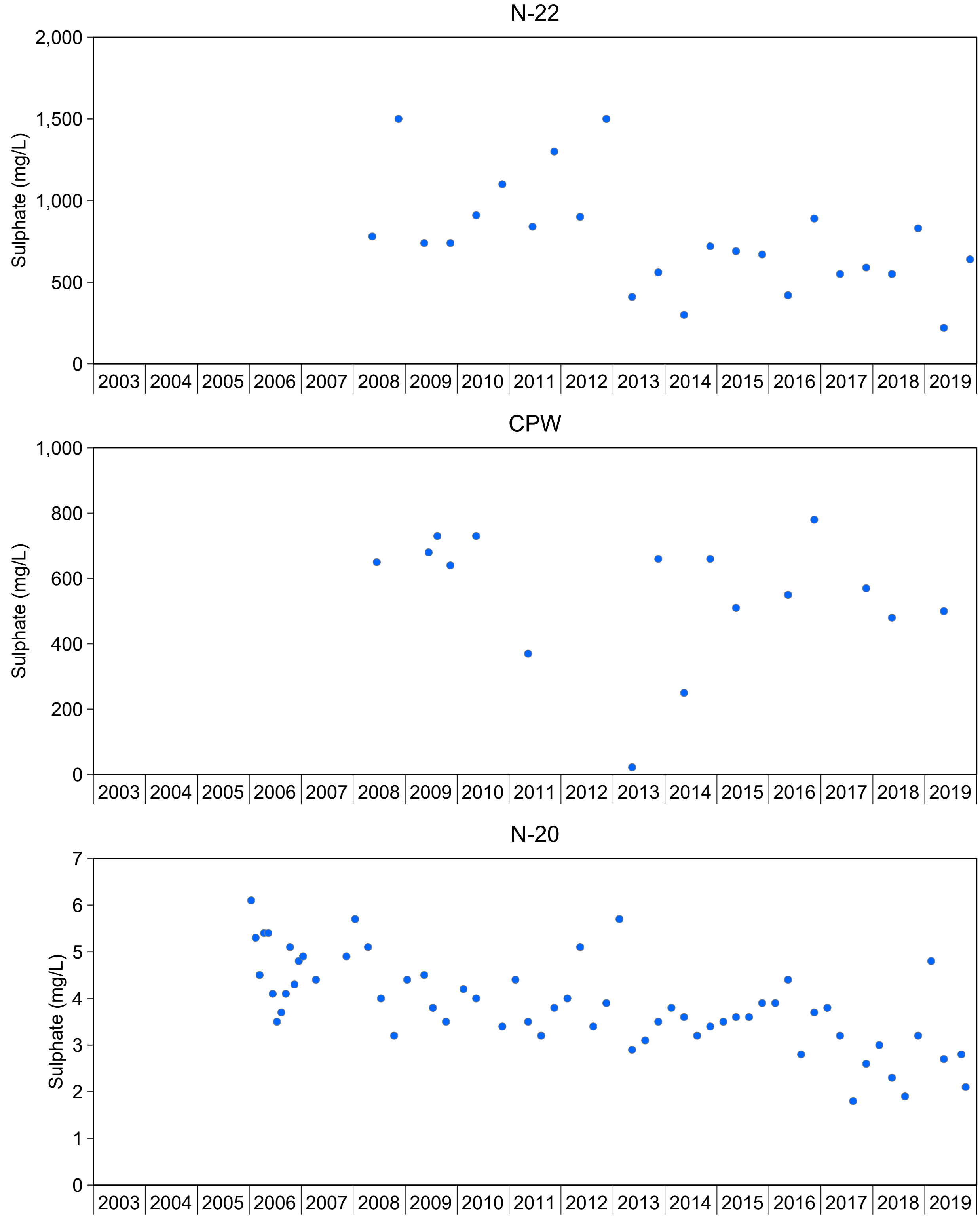


Figure I.8: Concentrations of Sulphate for TOMP Water Monitoring Stations, Lacnor/ Nordic TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 6.4 for Seasonal Kendall trend analysis results and Appendix Tables I.3 to I.15 for raw data.

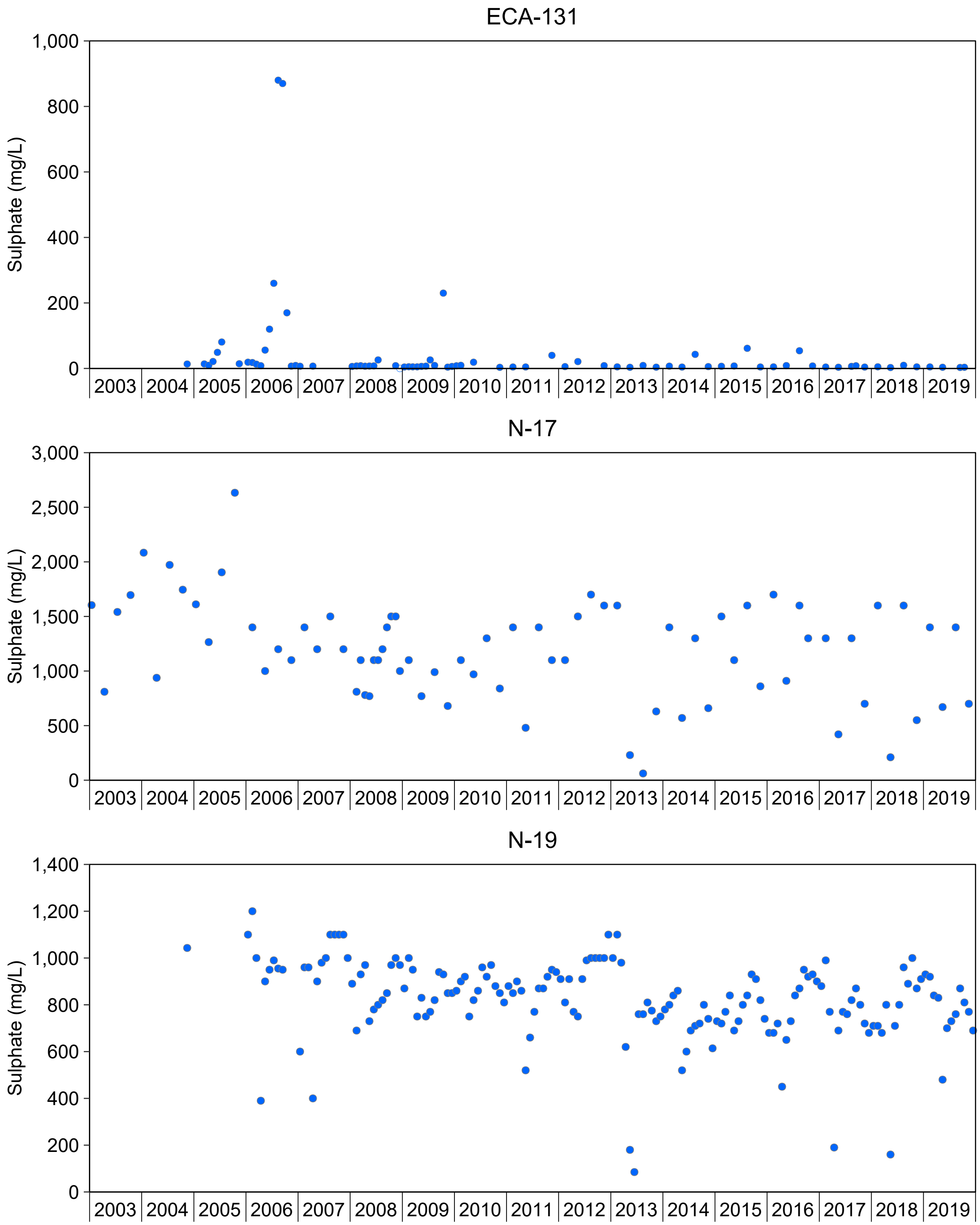


Figure I.8: Concentrations of Sulphate for TOMP Water Monitoring Stations, Lacnor/ Nordic TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 6.4 for Seasonal Kendall trend analysis results and Appendix Tables I.3 to I.15 for raw data.

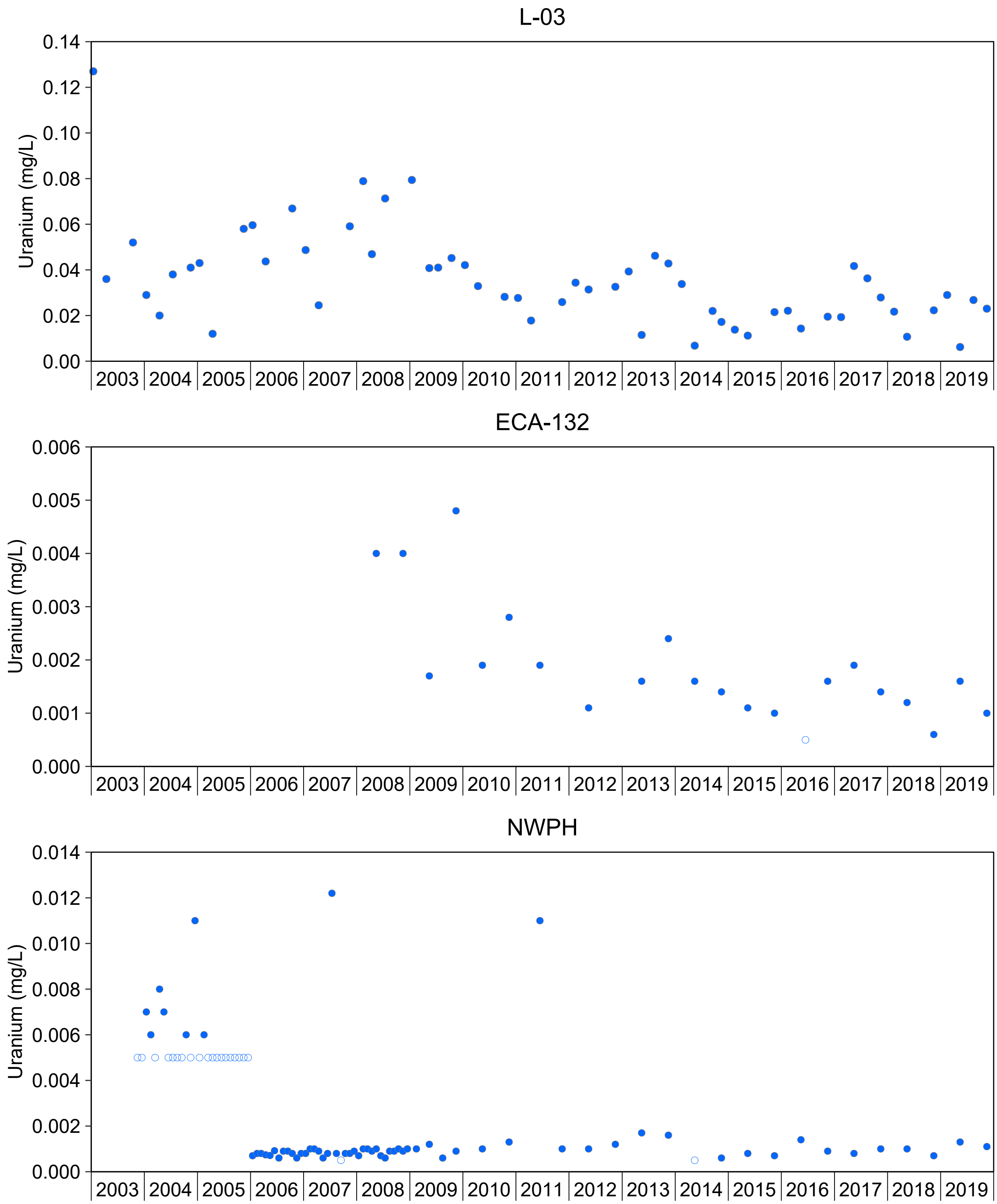


Figure I.9: Concentrations of Uranium for TOMP Water Monitoring Stations, Lacnor/ Nordic TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 6.4 for Seasonal Kendall trend analysis results and Appendix Tables I.3 to I.15 for raw data. Uranium (mg/L) is not included in the trend analysis for TOMP stations CPW, N-20, and ECA-131 due to >50% non-detectable concentrations in the dataset.

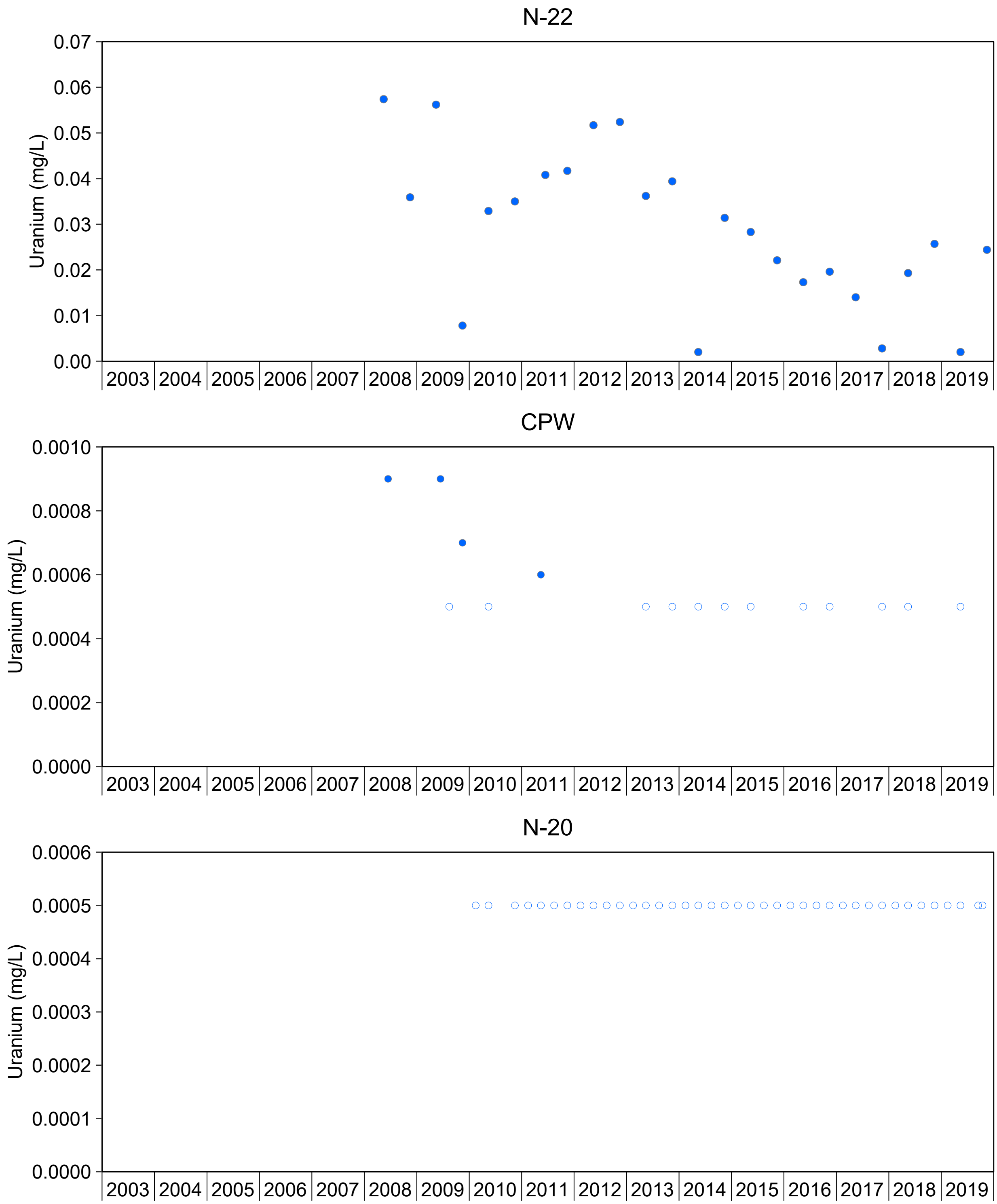


Figure I.9: Concentrations of Uranium for TOMP Water Monitoring Stations, Lacnor/ Nordic TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 6.4 for Seasonal Kendall trend analysis results and Appendix Tables I.3 to I.15 for raw data. Uranium (mg/L) is not included in the trend analysis for TOMP stations CPW, N-20, and ECA-131 due to >50% non-detectable concentrations in the dataset.

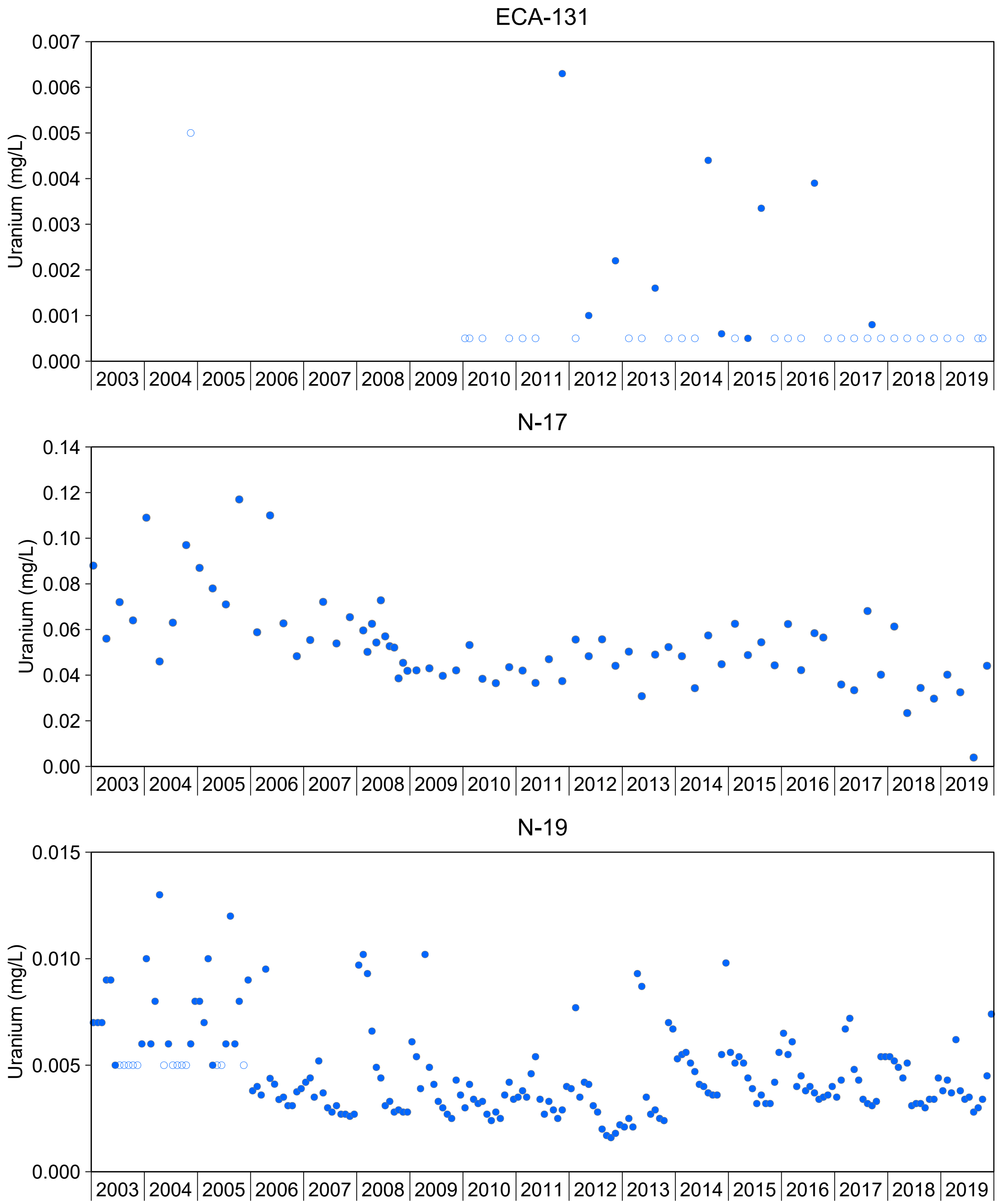


Figure I.9: Concentrations of Uranium for TOMP Water Monitoring Stations, Lacnor/ Nordic TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 6.4 for Seasonal Kendall trend analysis results and Appendix Tables I.3 to I.15 for raw data. Uranium (mg/L) is not included in the trend analysis for TOMP stations CPW, N-20, and ECA-131 due to >50% non-detectable concentrations in the dataset.

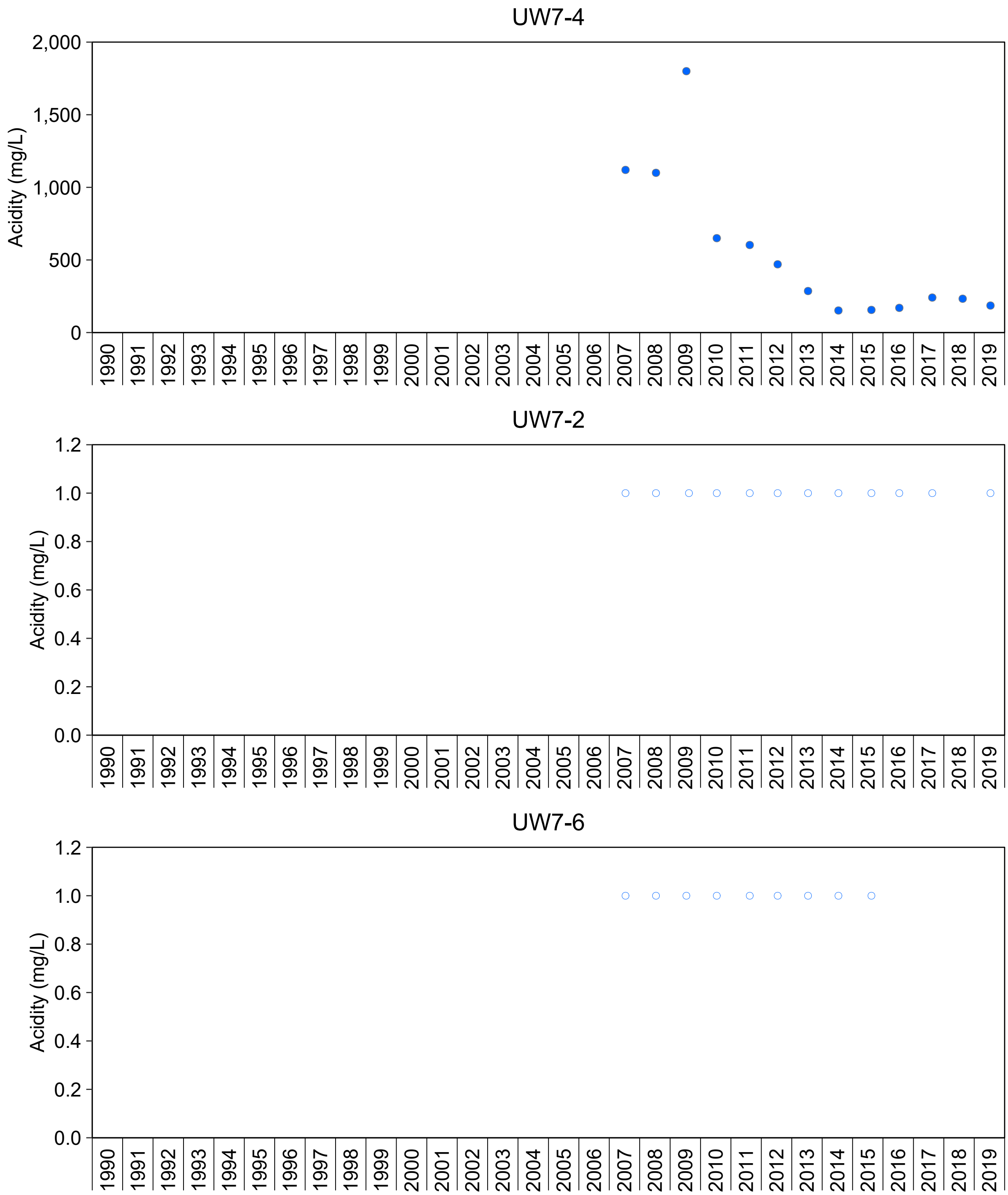


Figure I.10: Concentrations of Acidity for TOMP Pore Water Stations, Lacnor/Nordic TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Due to a change in analytical technique for acidity in 2006, acidity trends were assessed from 2007 to 2019. See Table 6.5 for Kendall trend analysis results and Appendix Tables I.17 to I.18 for raw data. Acidity (mg/L) is not included in the trend analysis for TOMP stations UW7-2, and UW7-6 due to >50% non-detectable concentrations in the dataset.

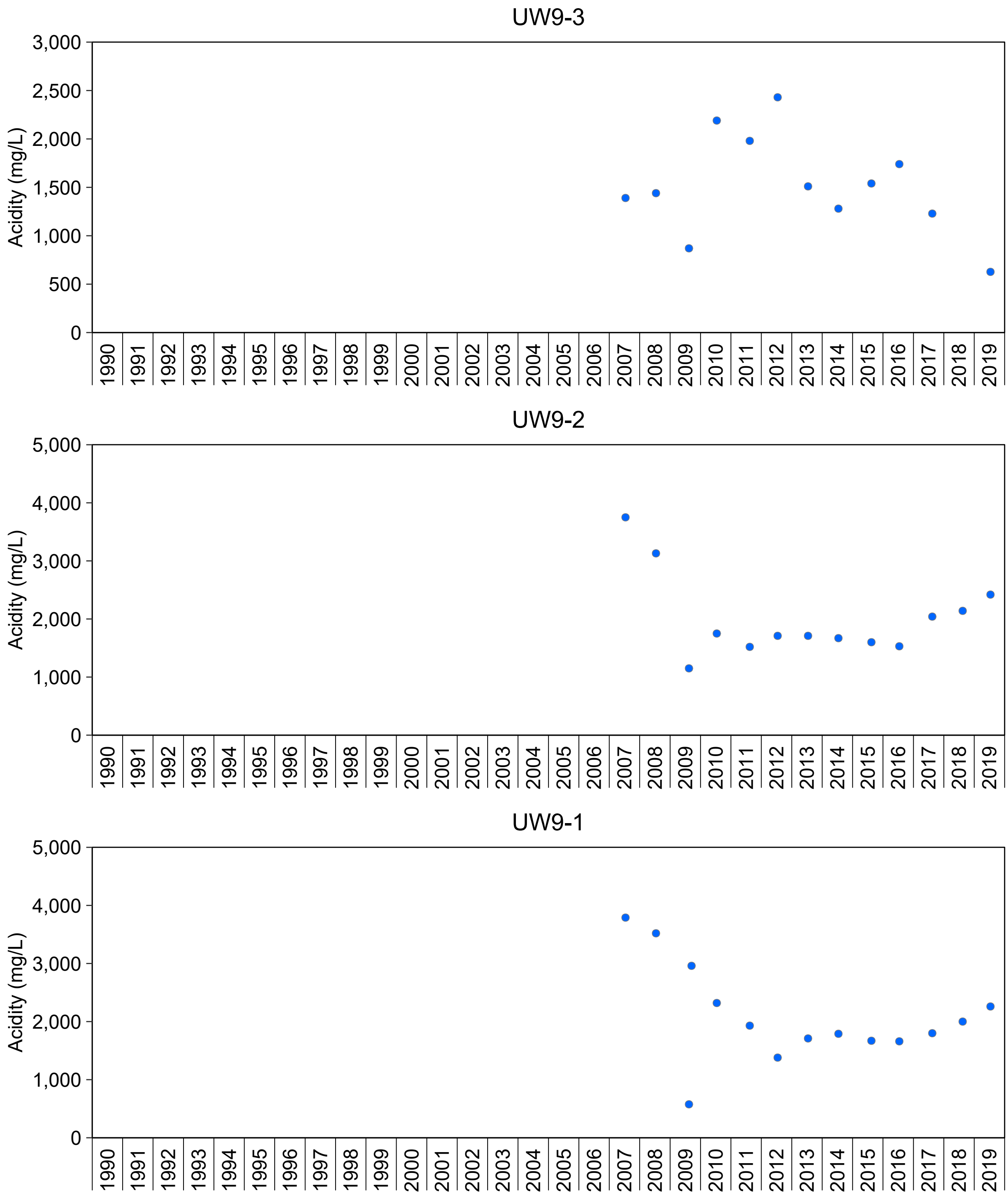


Figure I.10: Concentrations of Acidity for TOMP Pore Water Stations, Lacnor/Nordic TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Due to a change in analytical technique for acidity in 2006, acidity trends were assessed from 2007 to 2019. See TTable 6.5 for Kendall trend analysis results and Appendix Tables I.17 to I.18 for raw data. Acidity (mg/L) is not included in the trend analysis for TOMP stations UW7-2, and UW7-6 due to >50% non-detectable concentrations in the dataset.

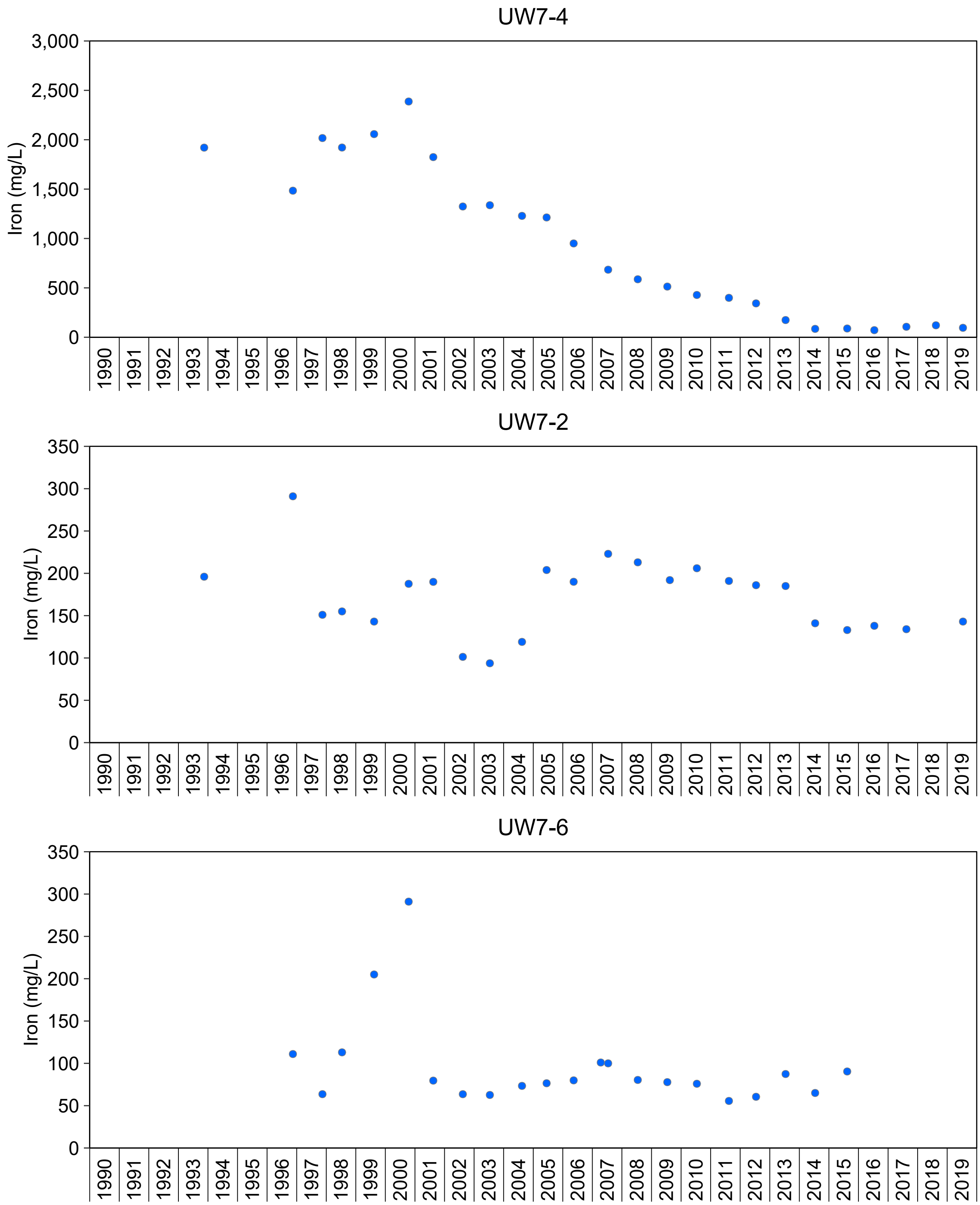


Figure I.11: Concentrations of Iron for TOMP Pore Water Stations, Lacnor/Nordic TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 6.5 for Kendall trend analysis results and Appendix Tables I.17 to I.18 for raw data.

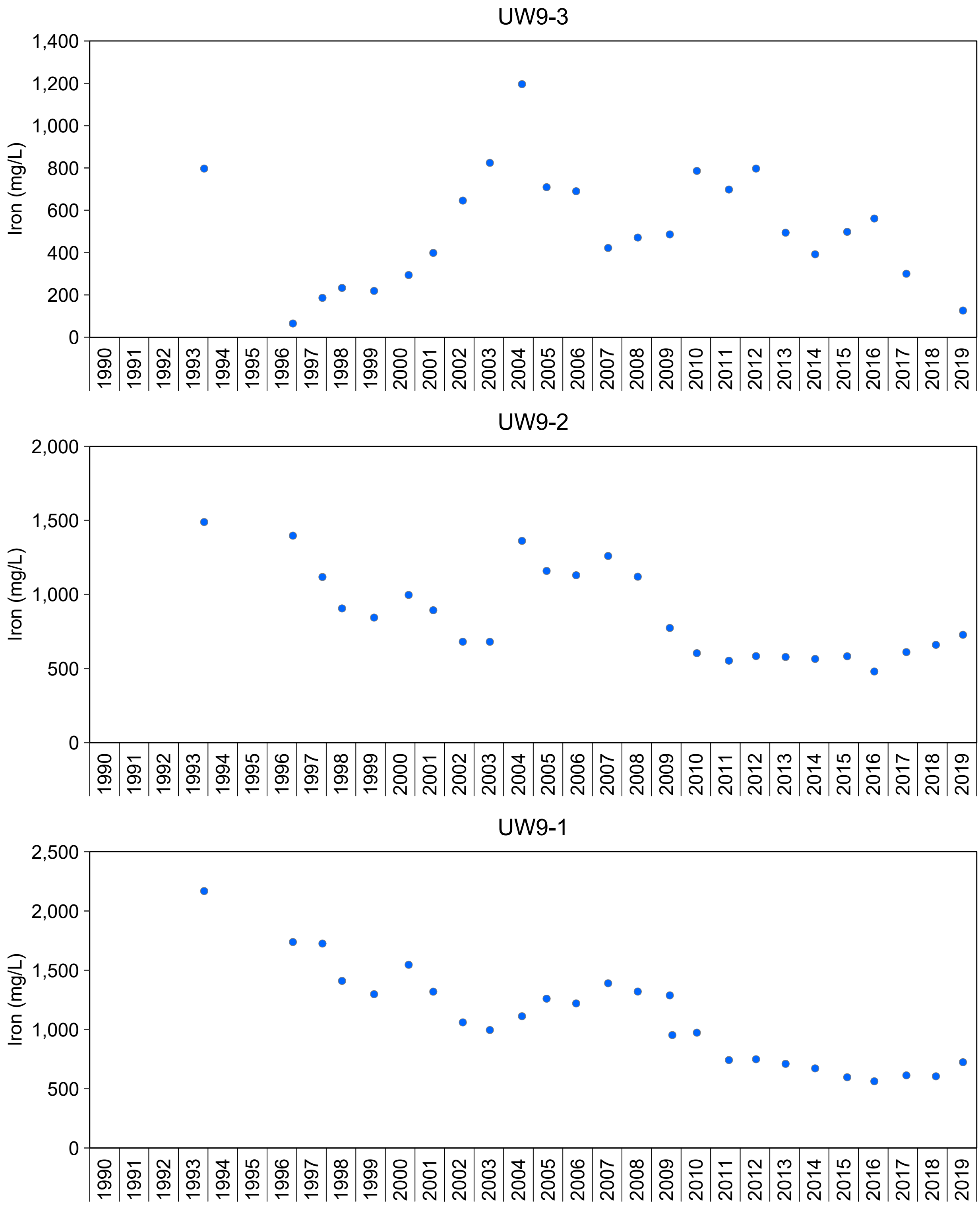


Figure I.11: Concentrations of Iron for TOMP Pore Water Stations, Lacnor/Nordic TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 6.5 for Kendall trend analysis results and Appendix Tables I.17 to I.18 for raw data.

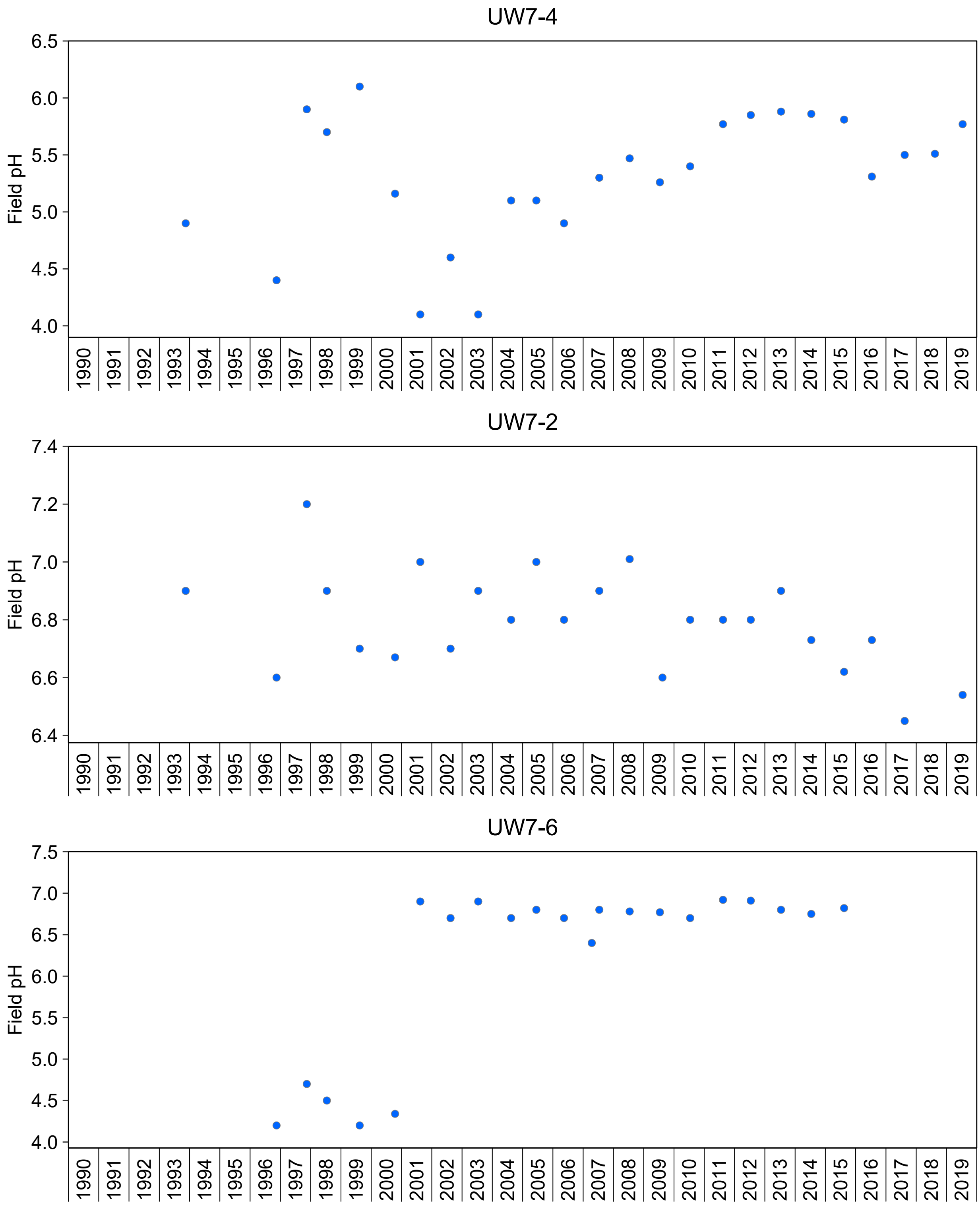


Figure I.12: Field Measurements of pH for TOMP Pore Water Stations, Lacnor/Nordic TMA, 1990 to 2019

Notes: See Table 6.5 for Kendall trend analysis results and Appendix Tables I.17 to I.18 for raw data.

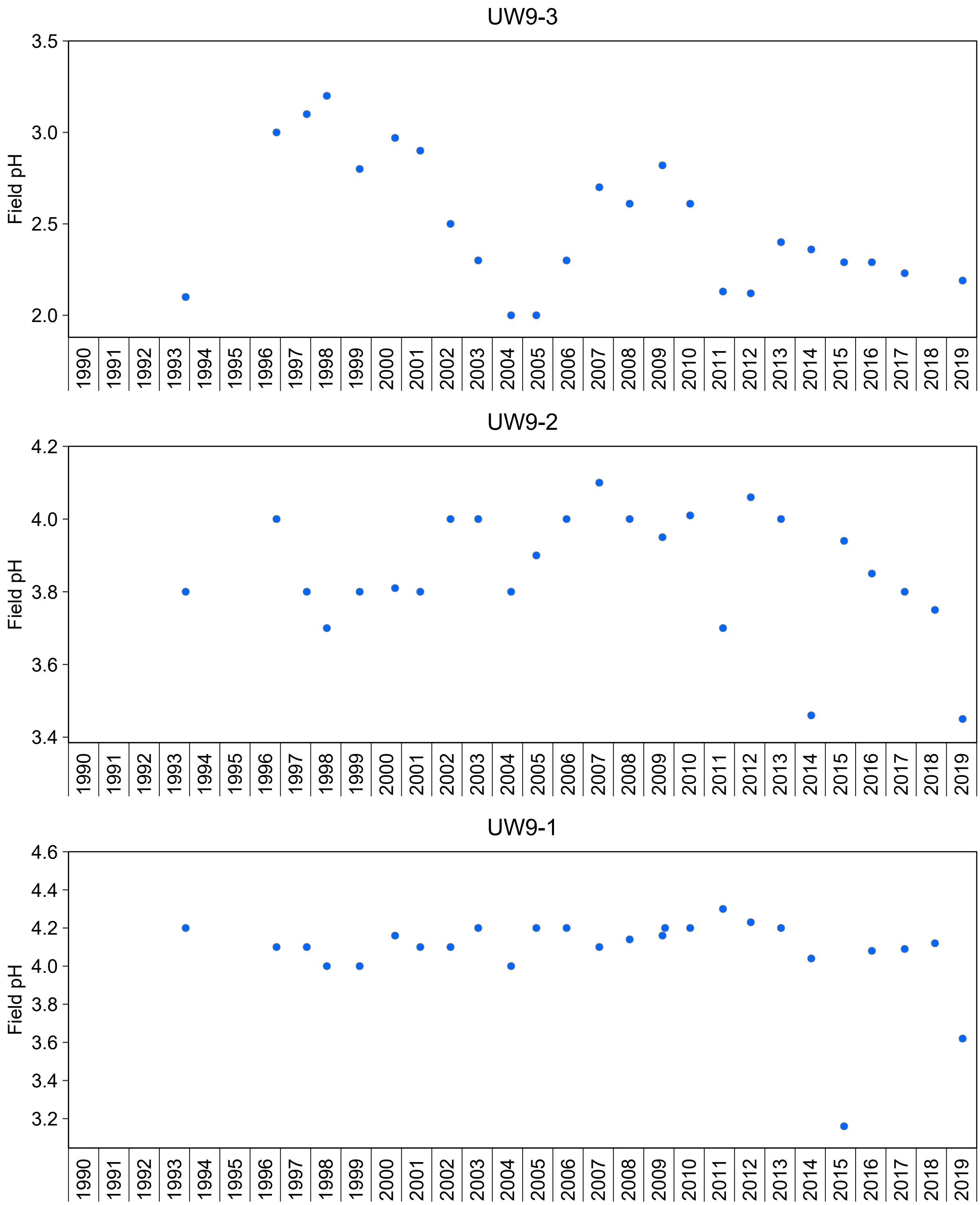


Figure I.12: Field Measurements of pH for TOMP Pore Water Stations, Lacnor/Nordic TMA, 1990 to 2019

Notes: See Table 6.5 for Kendall trend analysis results and Appendix Tables I.17 to I.18 for raw data.

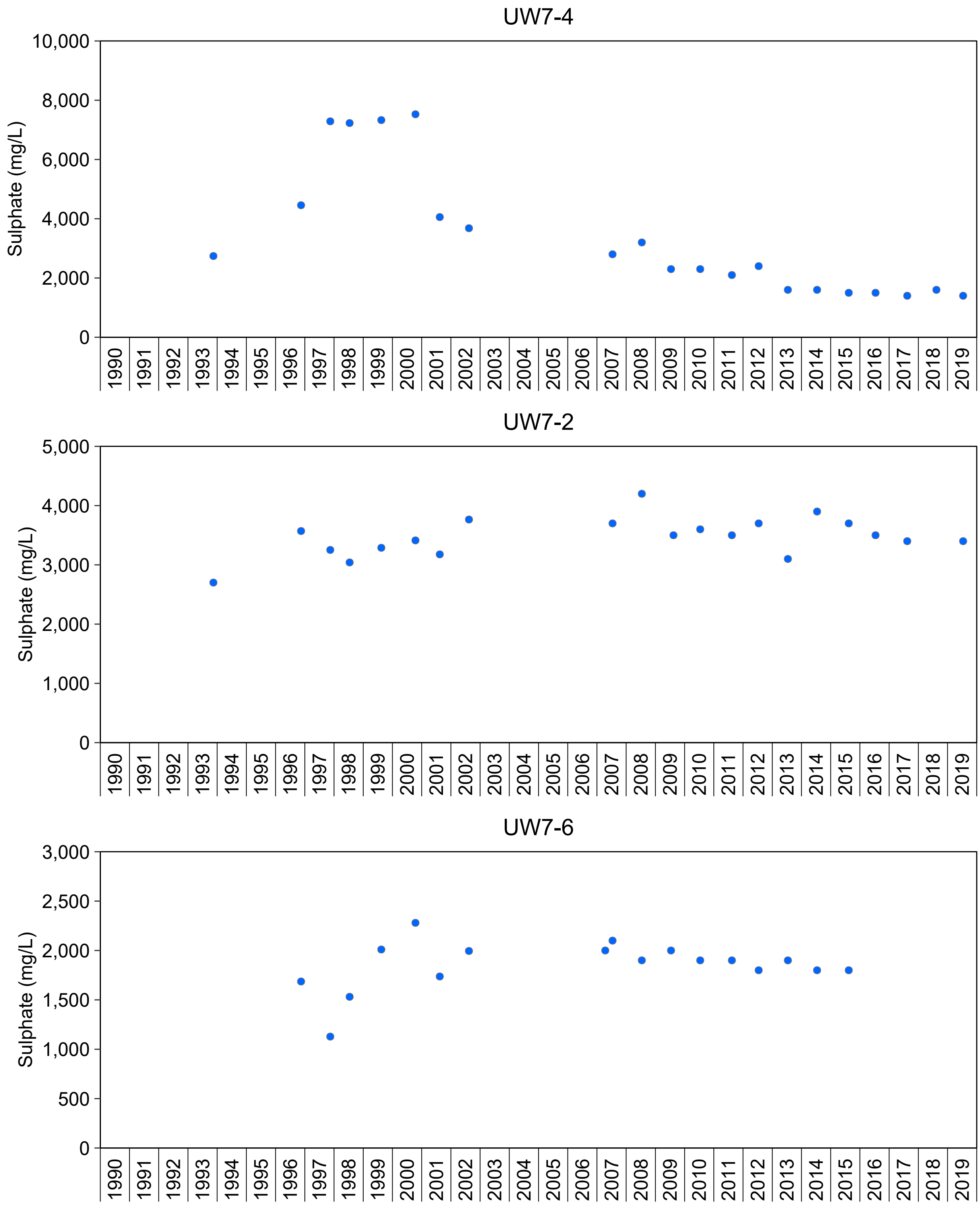


Figure I.13: Concentrations of Sulphate for TOMP Pore Water Stations, Lacnor/Nordic TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL.
See Table 6.5 for Kendall trend analysis results and Appendix Tables I.17 to I.18 for raw data.

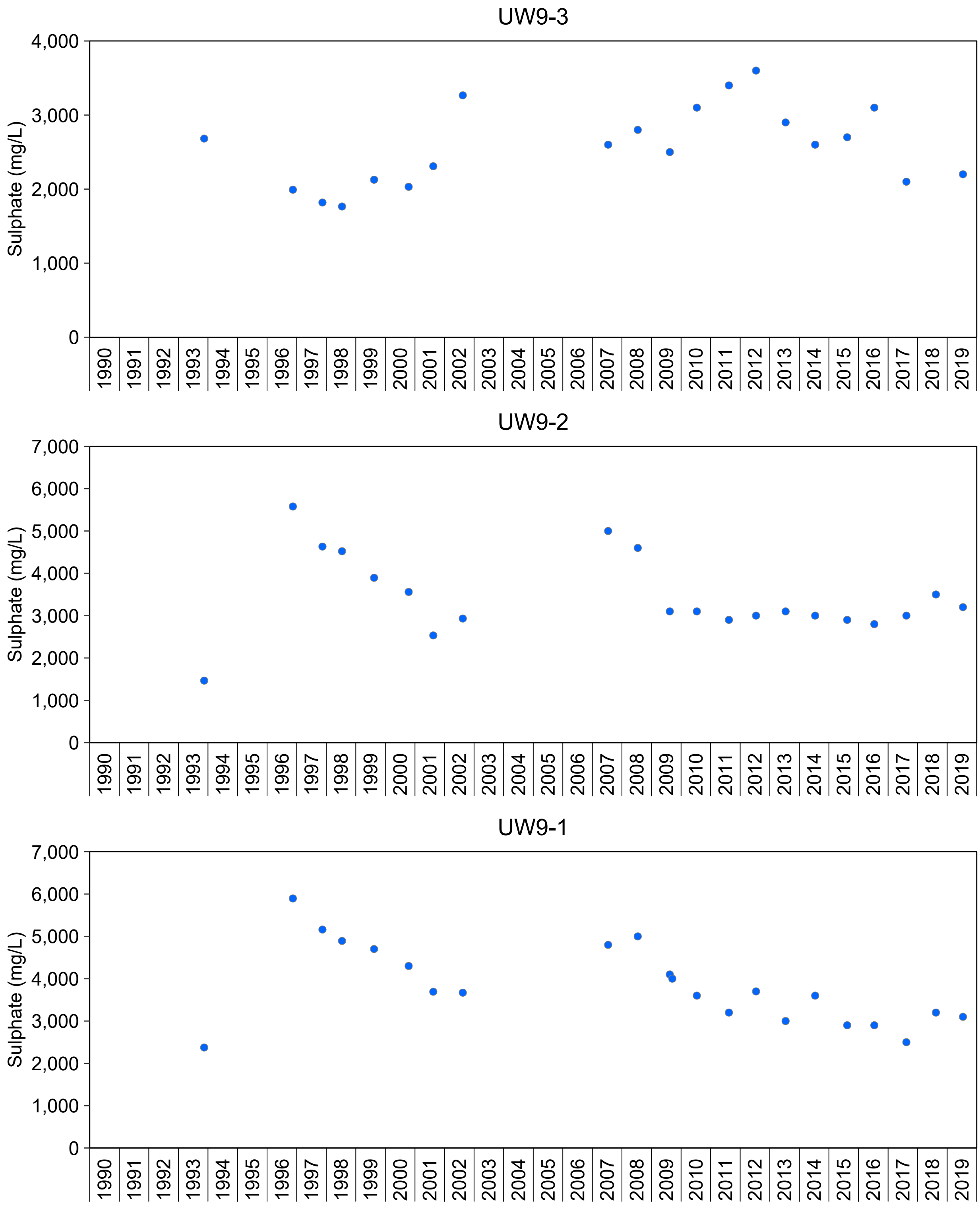


Figure I.13: Concentrations of Sulphate for TOMP Pore Water Stations, Lacnor/Nordic TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL.
See Table Table 6.5 for Kendall trend analysis results and Appendix Tables I.17 to I.18 for raw data.

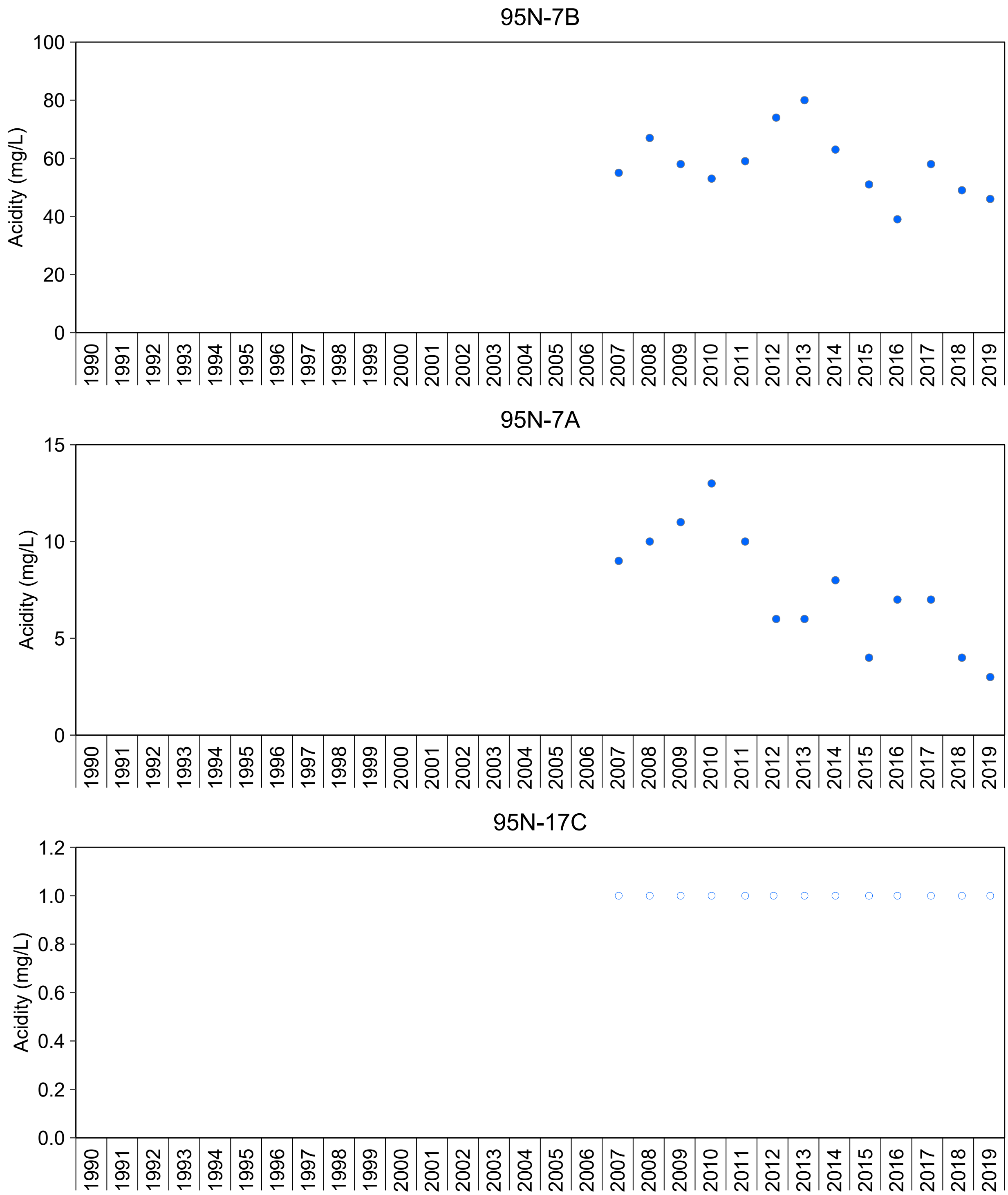
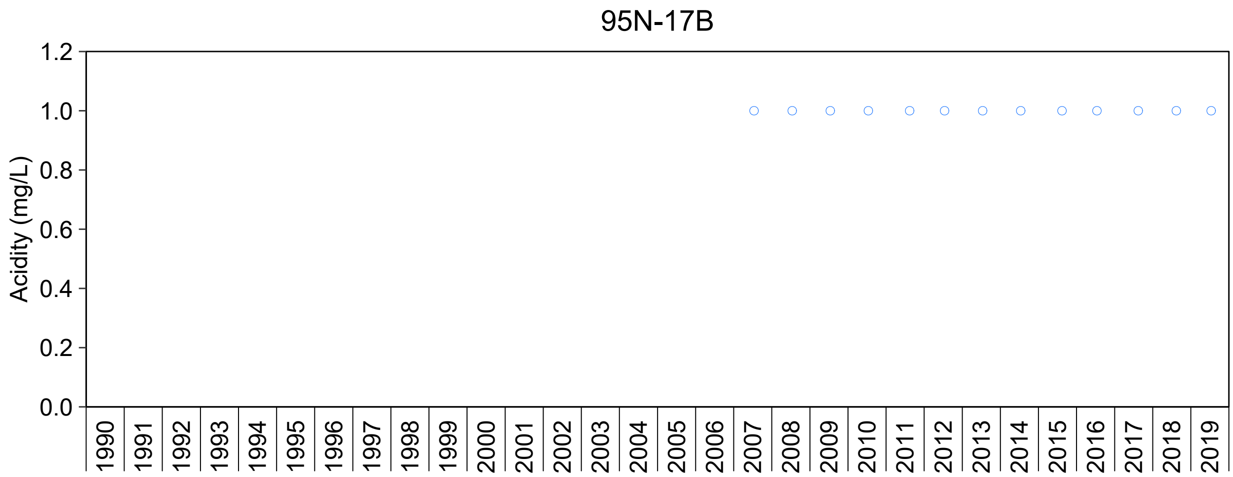
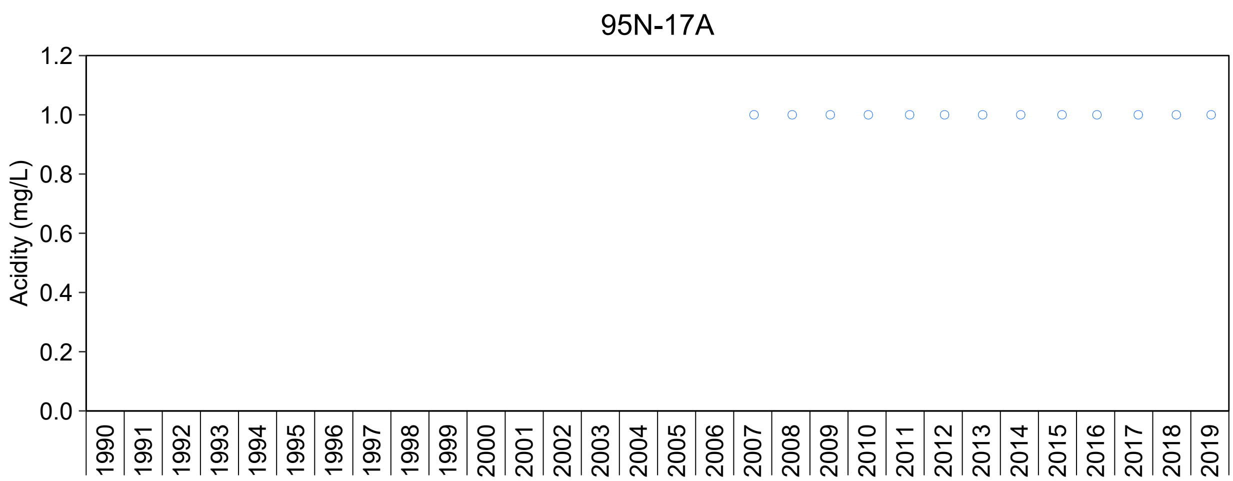


Figure I.14: Concentrations of Acidity for TOMP Groundwater Stations, Lacnor/Nordic TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Due to a change in analytical technique for acidity in 2006, acidity trends were assessed from 2007 to 2019. See Table 6.6 for Kendall trend analysis results and Appendix Tables I.19 to I.29 for raw data. Acidity (mg/L) is not included in the trend analysis for TOMP stations 95N-17C, 95N-17B, 95N-17A, 95N-14C, 95N-14B, 95N-14A, M-12-9, M-13-9, M-14-9, M-14-6, 95N-12B, and 95N-12A due to >50% non-detectable concentrations in the dataset.





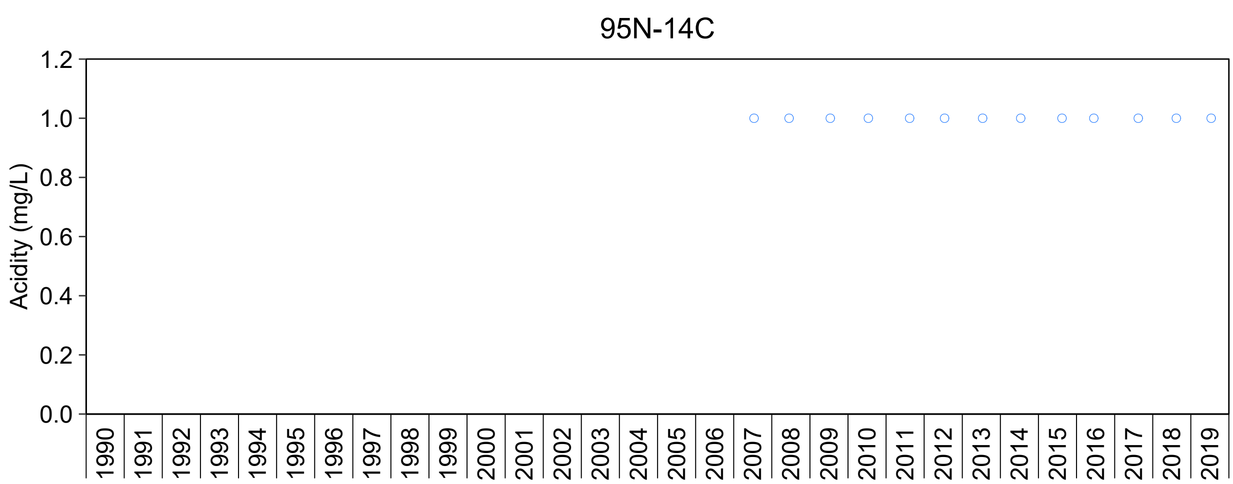


Figure I.14: Concentrations of Acidity for TOMP Groundwater Stations, Lacnor/Nordic TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Due to a change in analytical technique for acidity in 2006, acidity trends were assessed from 2007 to 2019. See Table 6.6 for Kendall trend analysis results and Appendix Tables I.19 to I.29 for raw data. Acidity (mg/L) is not included in the trend analysis for TOMP stations 95N-17C, 95N-17B, 95N-17A, 95N-14C, 95N-14B, 95N-14A, M-12-9, M-13-9, M-14-9, M-14-6, 95N-12B, and 95N-12A due to >50% non-detectable concentrations in the dataset.

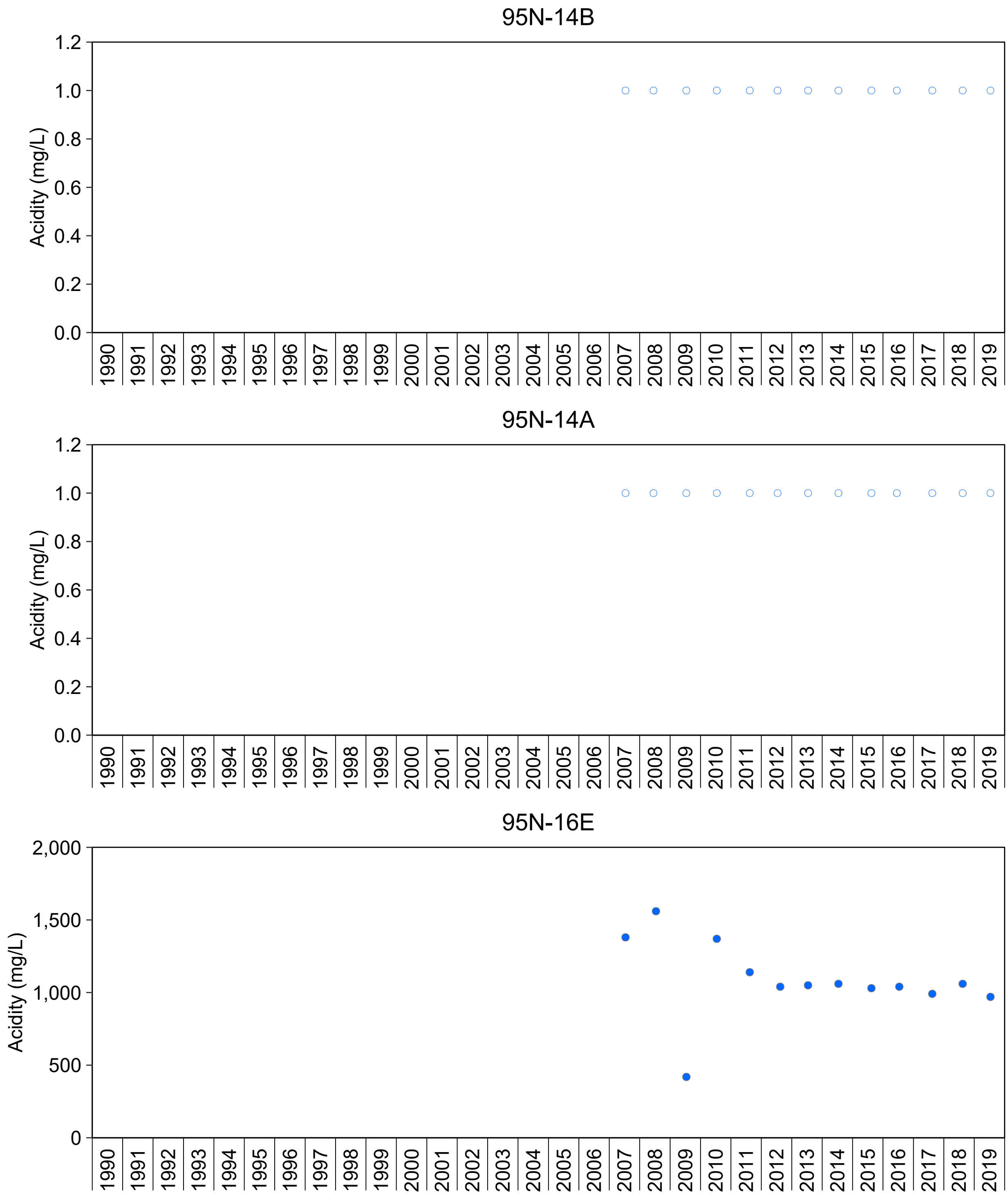


Figure I.14: Concentrations of Acidity for TOMP Groundwater Stations, Lacnor/Nordic TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Due to a change in analytical technique for acidity in 2006, acidity trends were assessed from 2007 to 2019. See Table 6.6 for Kendall trend analysis results and Appendix Tables I.19 to I.29 for raw data. Acidity (mg/L) is not included in the trend analysis for TOMP stations 95N-17C, 95N-17B, 95N-17A, 95N-14C, 95N-14B, 95N-14A, M-12-9, M-13-9, M-14-9, M-14-6, 95N-12B, and 95N-12A due to >50% non-detectable concentrations in the dataset.

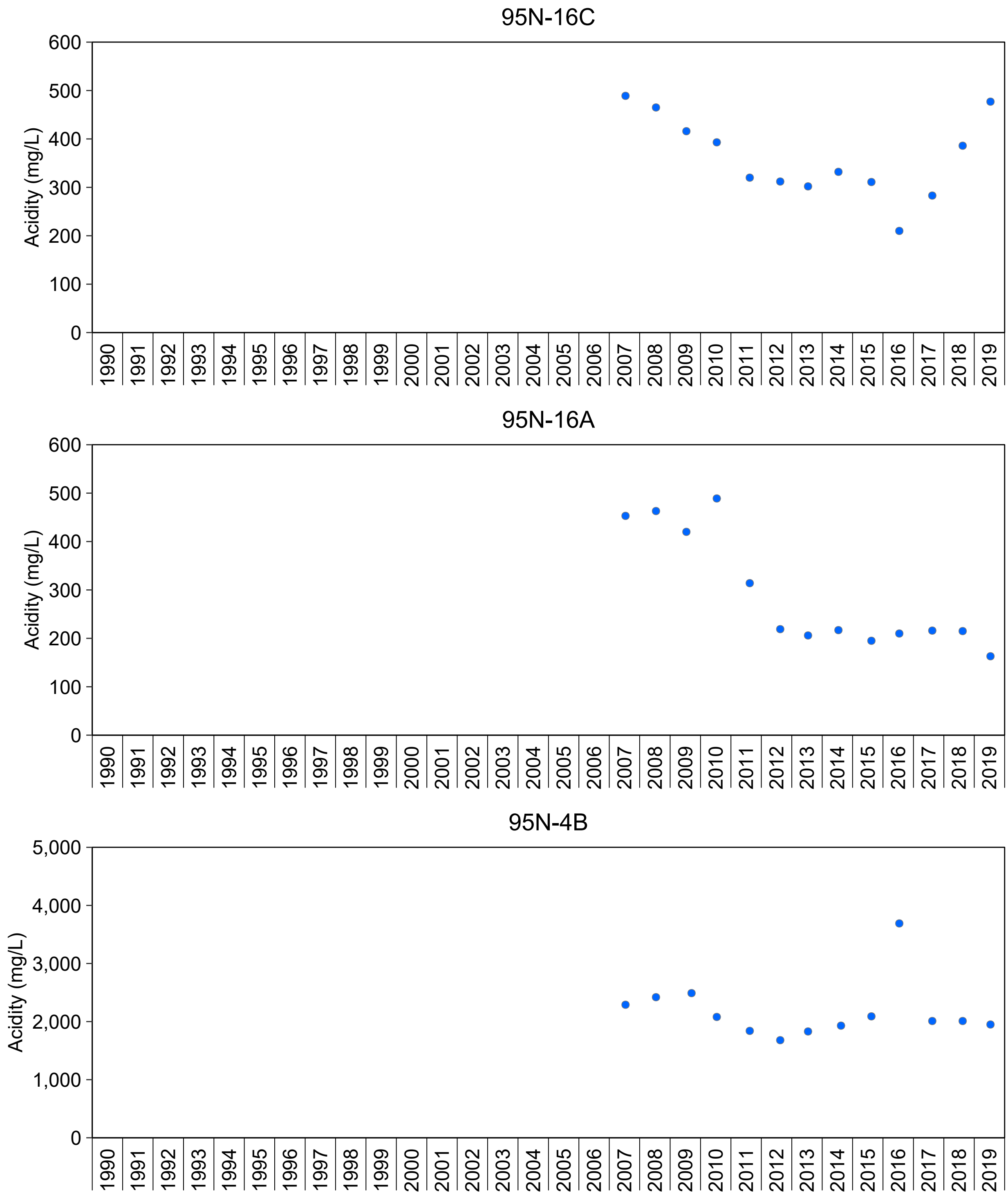


Figure I.14: Concentrations of Acidity for TOMP Groundwater Stations, Lacnor/Nordic TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Due to a change in analytical technique for acidity in 2006, acidity trends were assessed from 2007 to 2019. See Table 6.6 for Kendall trend analysis results and Appendix Tables I.19 to I.29 for raw data. Acidity (mg/L) is not included in the trend analysis for TOMP stations 95N-17C, 95N-17B, 95N-17A, 95N-14C, 95N-14B, 95N-14A, M-12-9, M-13-9, M-14-9, M-14-6, 95N-12B, and 95N-12A due to >50% non-detectable concentrations in the dataset.

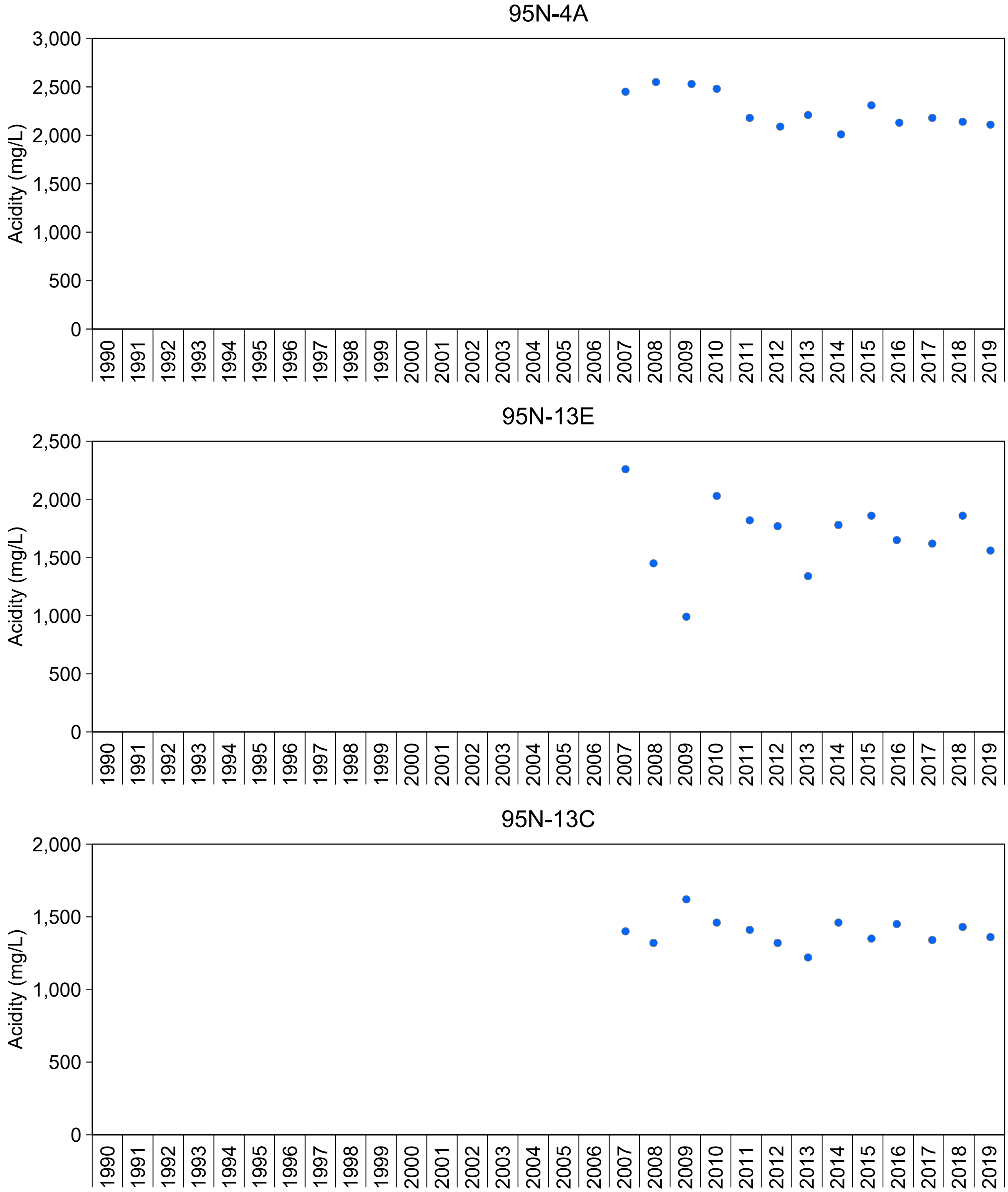


Figure I.14: Concentrations of Acidity for TOMP Groundwater Stations, Lacnor/Nordic TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Due to a change in analytical technique for acidity in 2006, acidity trends were assessed from 2007 to 2019. See Table 6.6 for Kendall trend analysis results and Appendix Tables I.19 to I.29 for raw data. Acidity (mg/L) is not included in the trend analysis for TOMP stations 95N-17C, 95N-17B, 95N-17A, 95N-14C, 95N-14B, 95N-14A, M-12-9, M-13-9, M-14-9, M-14-6, 95N-12B, and 95N-12A due to >50% non-detectable concentrations in the dataset.

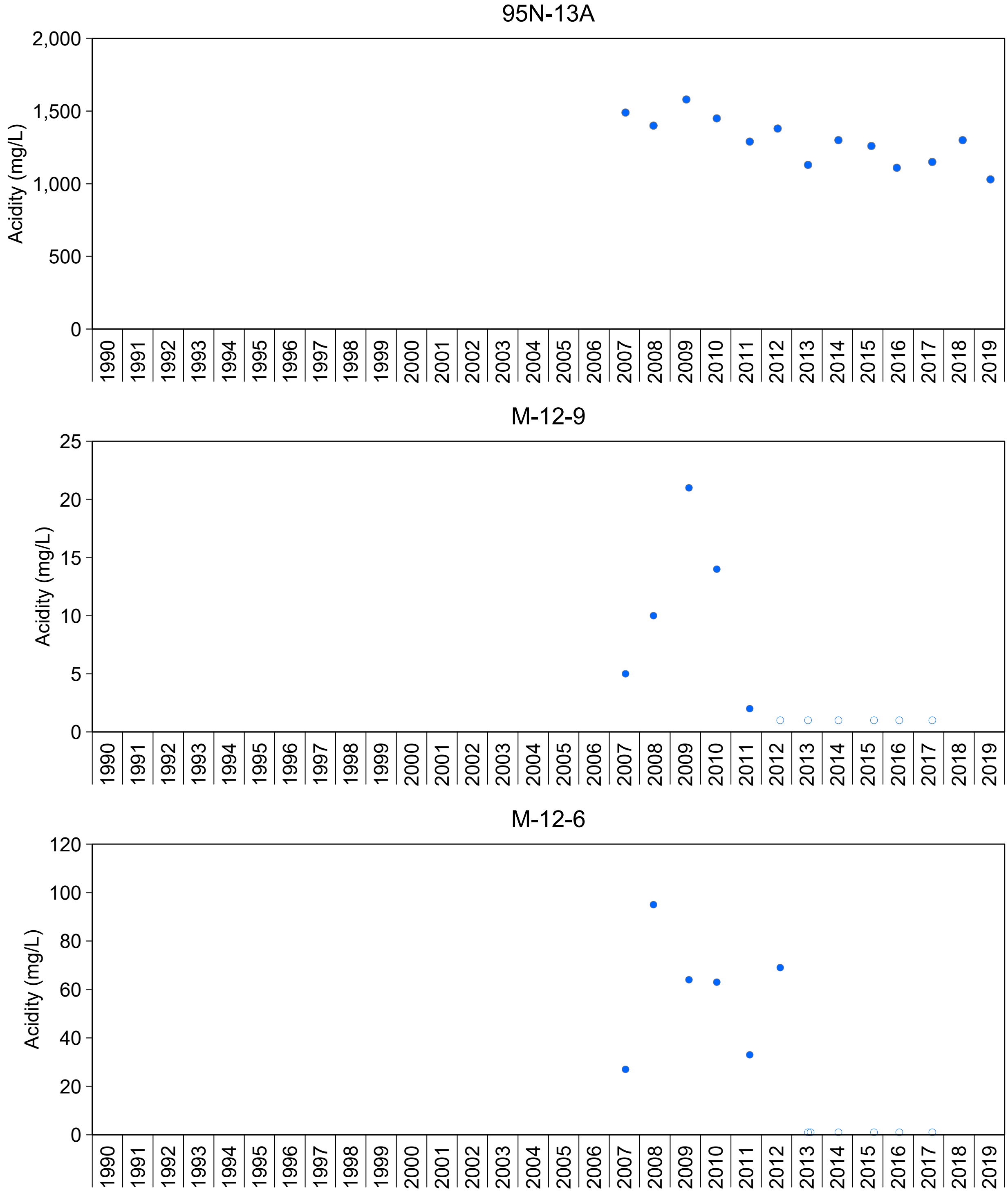


Figure I.14: Concentrations of Acidity for TOMP Groundwater Stations, Lacnor/Nordic TMA, 1990 to 2019

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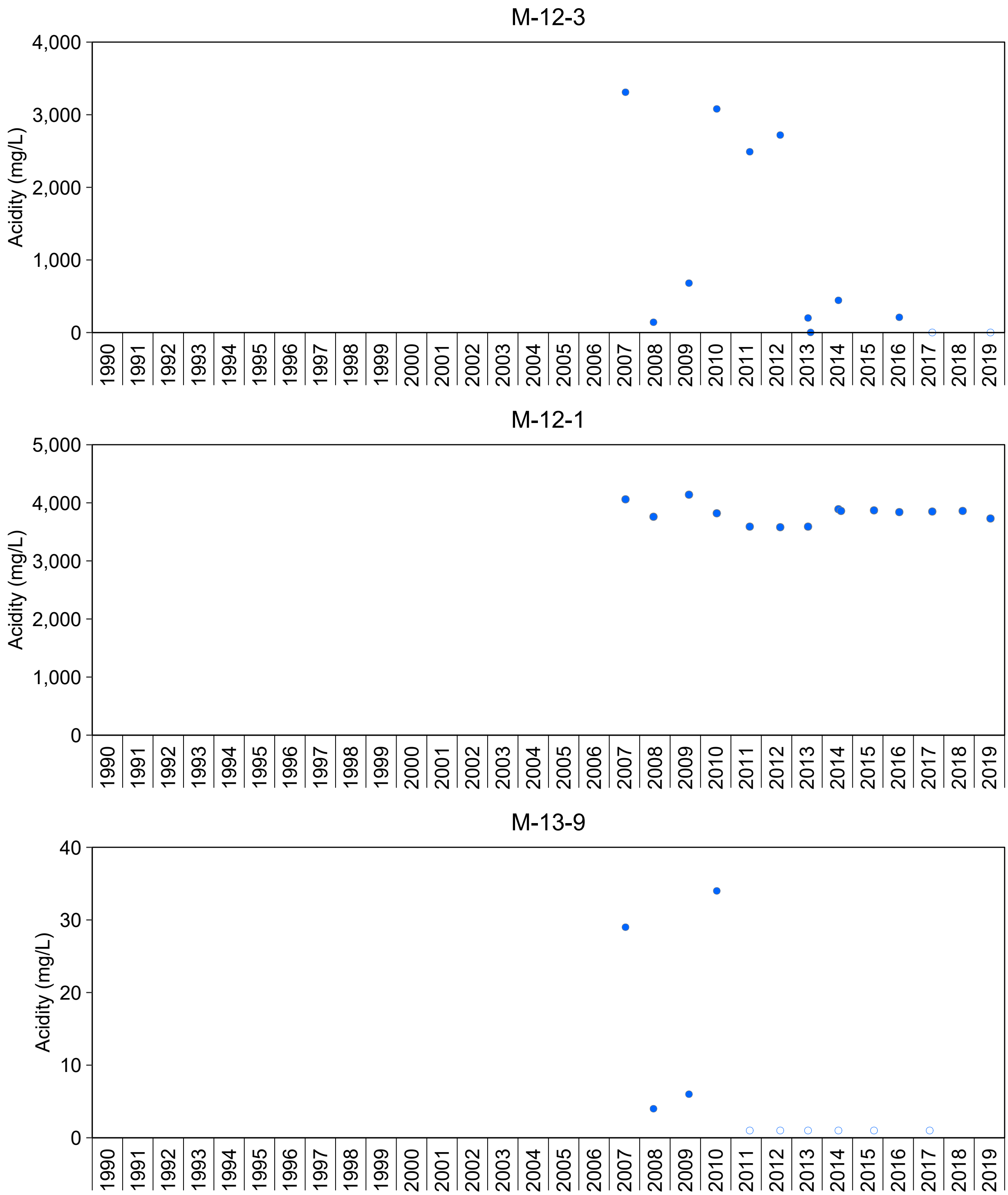

Figure I.14: Concentrations of Acidity for TOMP Groundwater Stations, Lacnor/Nordic TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Due to a change in analytical technique for acidity in 2006, acidity trends were assessed from 2007 to 2019. See Table 6.6 for Kendall trend analysis results and Appendix Tables I.19 to I.29 for raw data. Acidity (mg/L) is not included in the trend analysis for TOMP stations 95N-17C, 95N-17B, 95N-17A, 95N-14C, 95N-14B, 95N-14A, M-12-9, M-13-9, M-14-9, M-14-6, 95N-12B, and 95N-12A due to >50% non-detectable concentrations in the dataset.

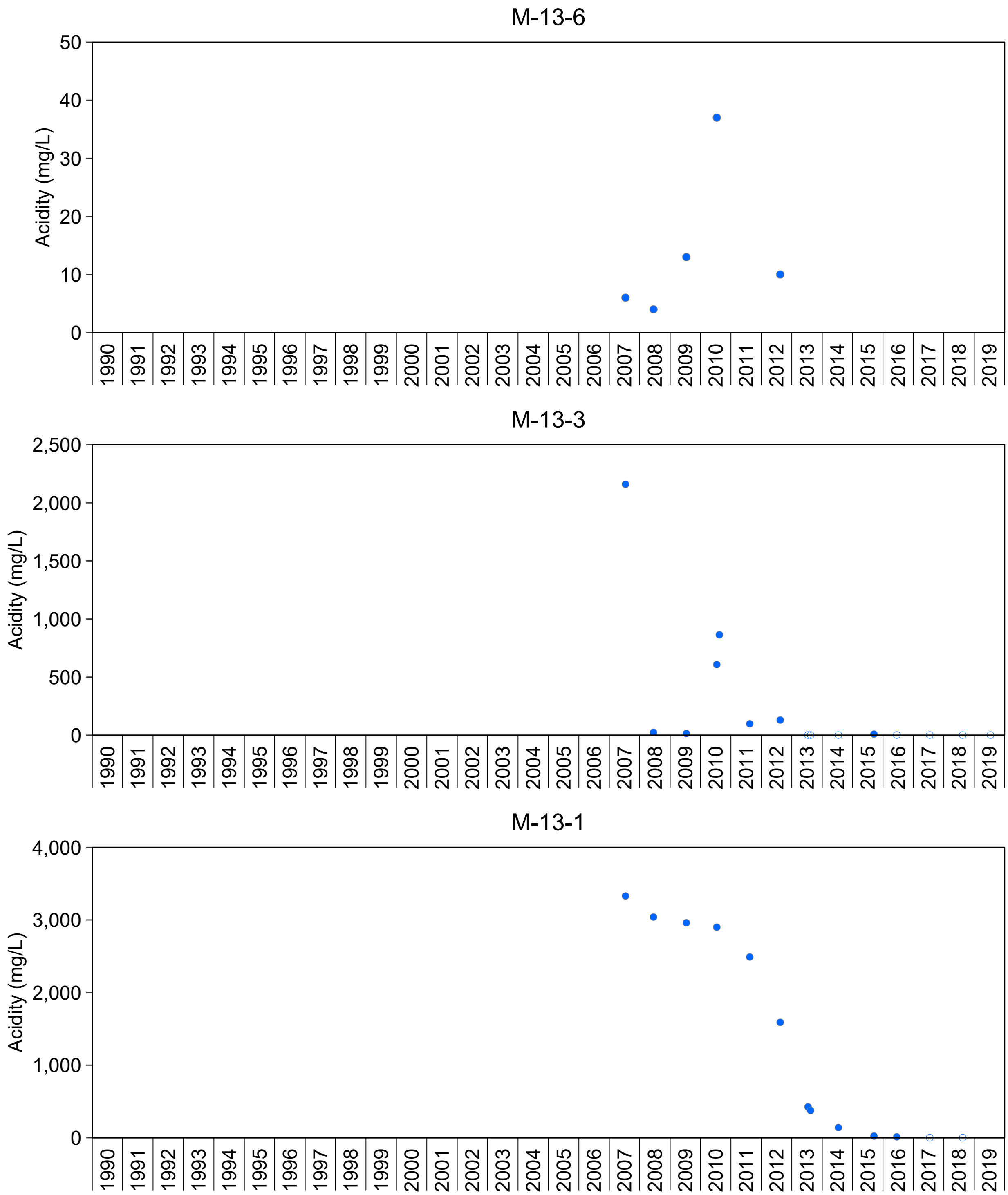

Figure I.14: Concentrations of Acidity for TOMP Groundwater Stations, Lacnor/Nordic TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Due to a change in analytical technique for acidity in 2006, acidity trends were assessed from 2007 to 2019. See Table 6.6 for Kendall trend analysis results and Appendix Tables I.19 to I.29 for raw data. Acidity (mg/L) is not included in the trend analysis for TOMP stations 95N-17C, 95N-17B, 95N-17A, 95N-14C, 95N-14B, 95N-14A, M-12-9, M-13-9, M-14-9, M-14-6, 95N-12B, and 95N-12A due to >50% non-detectable concentrations in the dataset.

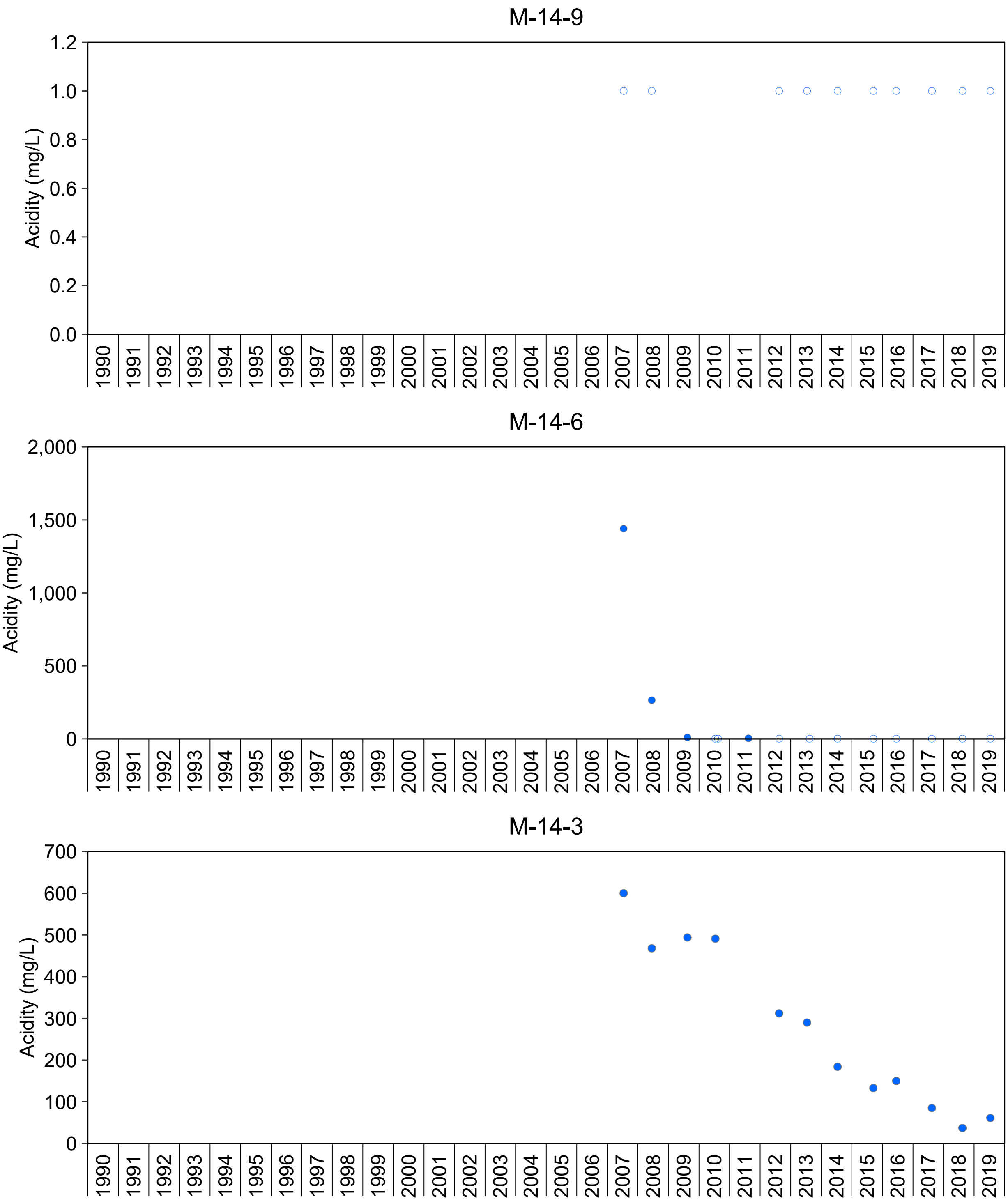

Figure I.14: Concentrations of Acidity for TOMP Groundwater Stations, Lacnor/Nordic TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Due to a change in analytical technique for acidity in 2006, acidity trends were assessed from 2007 to 2019. See Table 6.6 for Kendall trend analysis results and Appendix Tables I.19 to I.29 for raw data. Acidity (mg/L) is not included in the trend analysis for TOMP stations 95N-17C, 95N-17B, 95N-17A, 95N-14C, 95N-14B, 95N-14A, M-12-9, M-13-9, M-14-9, M-14-6, 95N-12B, and 95N-12A due to >50% non-detectable concentrations in the dataset.

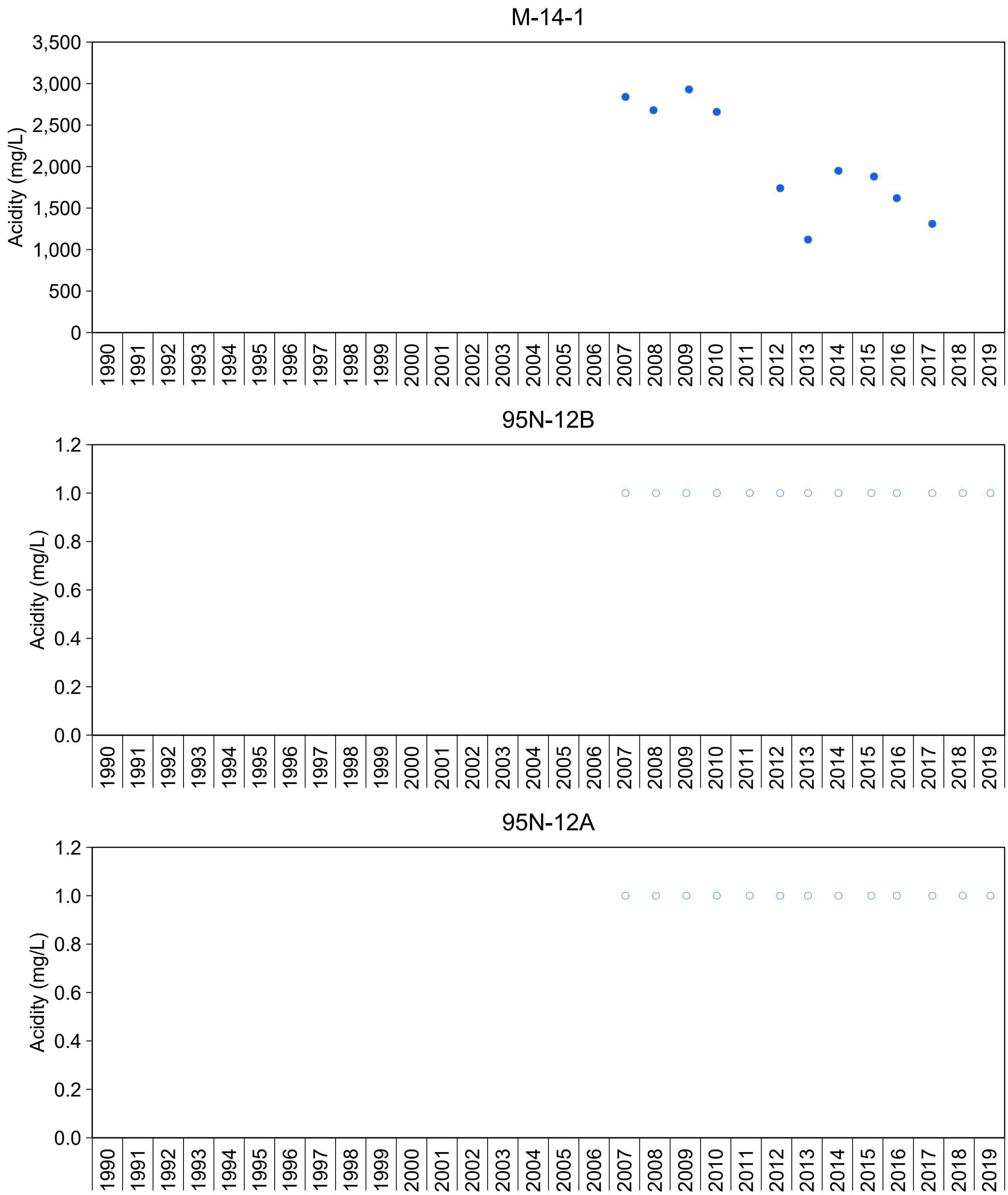

Figure I.14: Concentrations of Acidity for TOMP Groundwater Stations, Lacnor/Nordic TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Due to a change in analytical technique for acidity in 2006, acidity trends were assessed from 2007 to 2019. See Table 6.6 for Kendall trend analysis results and Appendix Tables I.19 to I.29 for raw data. Acidity (mg/L) is not included in the trend analysis for TOMP stations 95N-17C, 95N-17B, 95N-17A, 95N-14C, 95N-14B, 95N-14A, M-12-9, M-13-9, M-14-9, M-14-6, 95N-12B, and 95N-12A due to >50% non-detectable concentrations in the dataset.

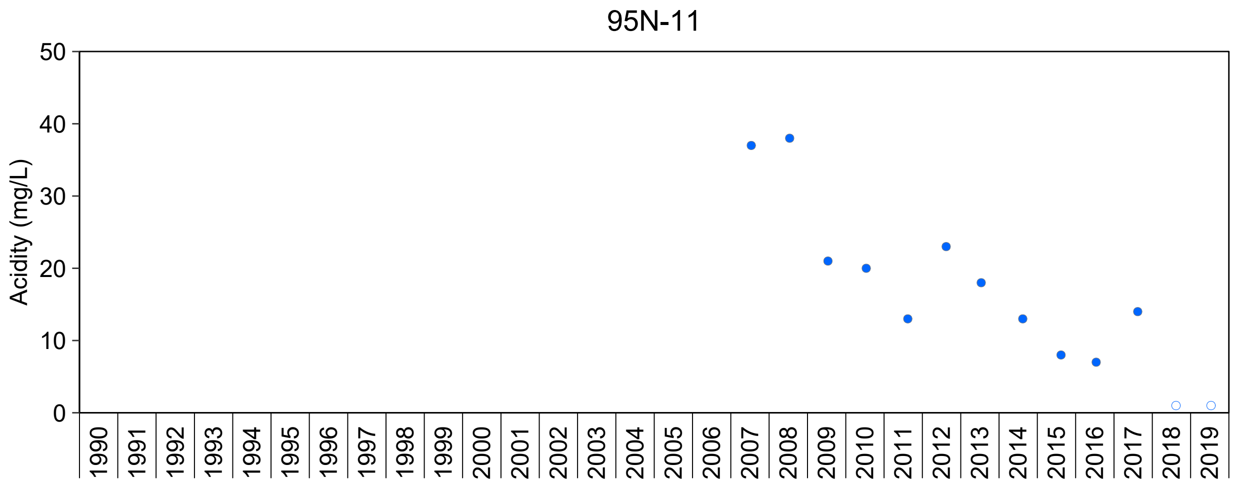

Figure I.14: Concentrations of Acidity for TOMP Groundwater Stations, Lacnor/Nordic TMA, 1990 to 2019

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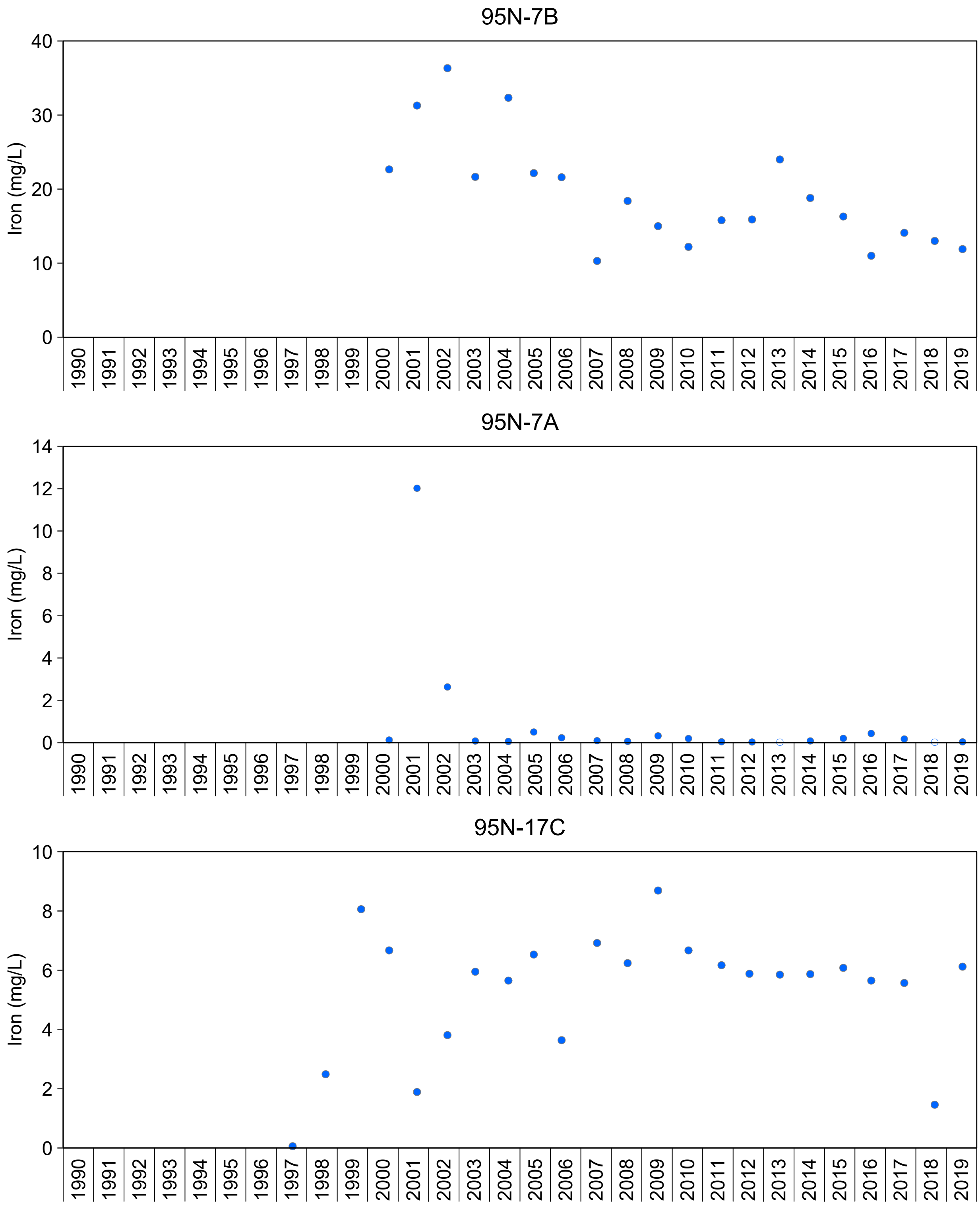

Figure I.15: Concentrations of Iron for TOMP Groundwater Stations, Lacnor/Nordic TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 6.6 for Kendall trend analysis results and Appendix Tables I.19 to I.29 for raw data.

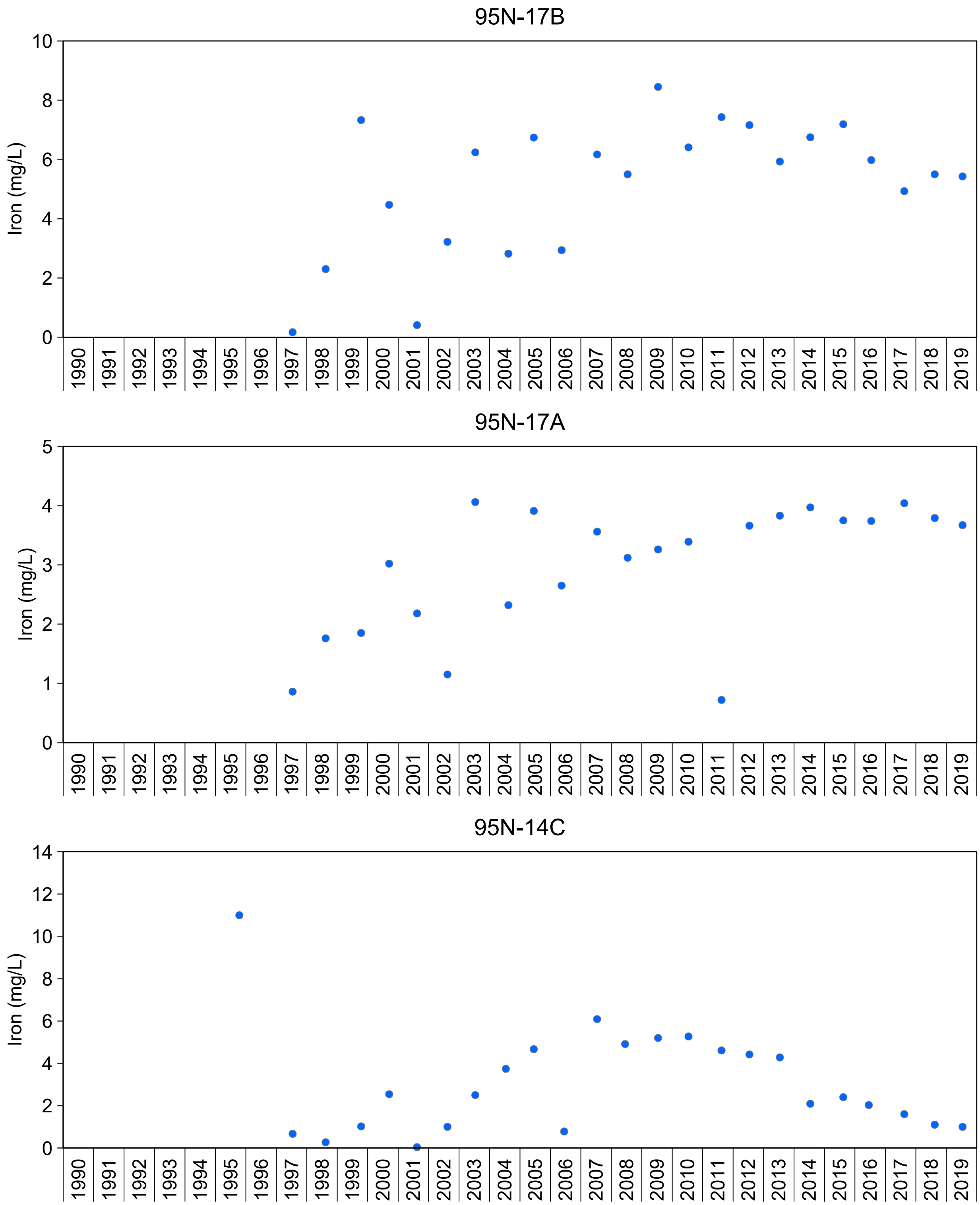

Figure I.15: Concentrations of Iron for TOMP Groundwater Stations, Lacnor/Nordic TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 6.6 for Kendall trend analysis results and Appendix Tables I.19 to I.29 for raw data.

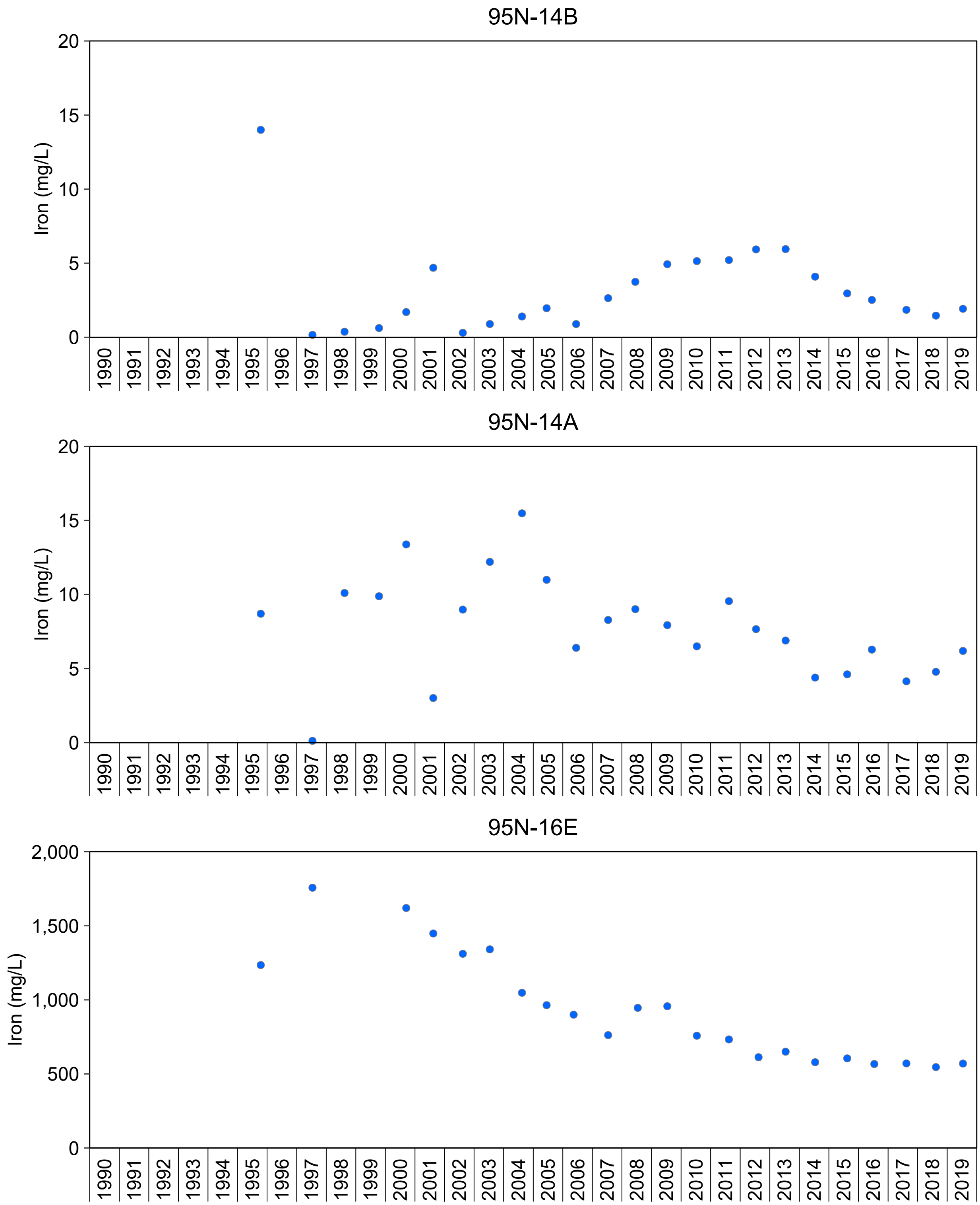

Figure I.15: Concentrations of Iron for TOMP Groundwater Stations, Lacnor/Nordic TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 6.6 for Kendall trend analysis results and Appendix Tables I.19 to I.29 for raw data.

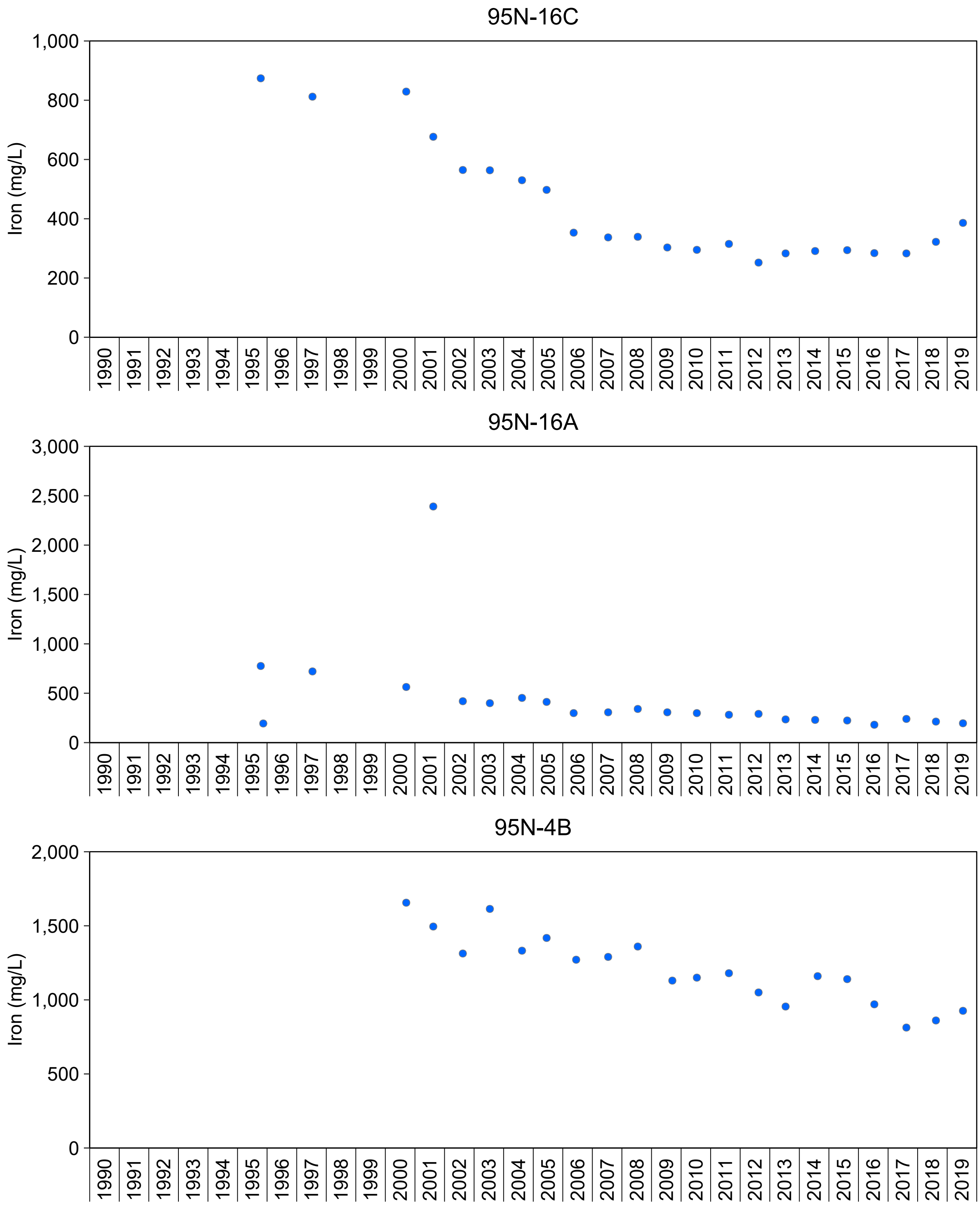

Figure I.15: Concentrations of Iron for TOMP Groundwater Stations, Lacnor/Nordic TMA, 1990 to 2019

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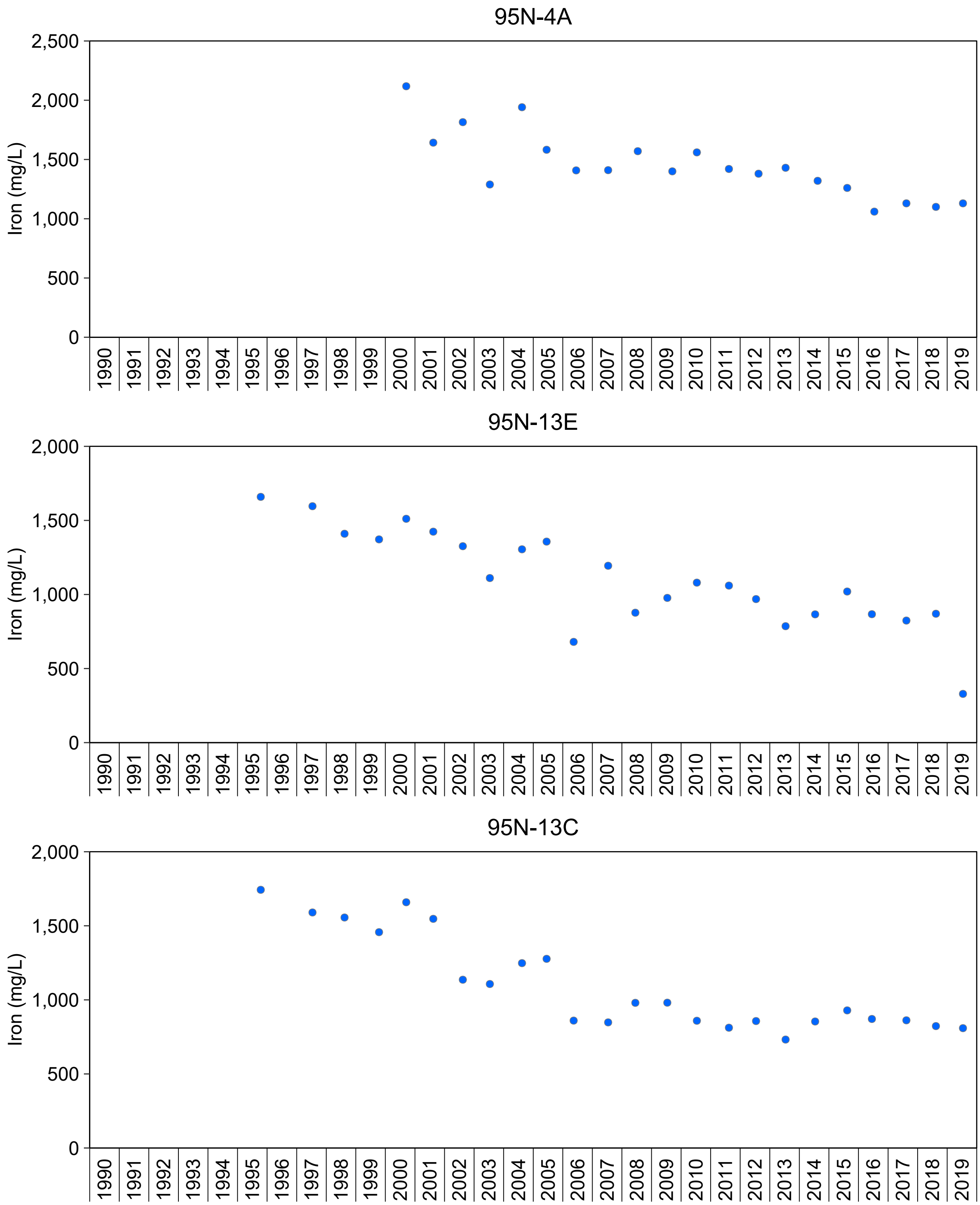

Figure I.15: Concentrations of Iron for TOMP Groundwater Stations, Lacnor/Nordic TMA, 1990 to 2019

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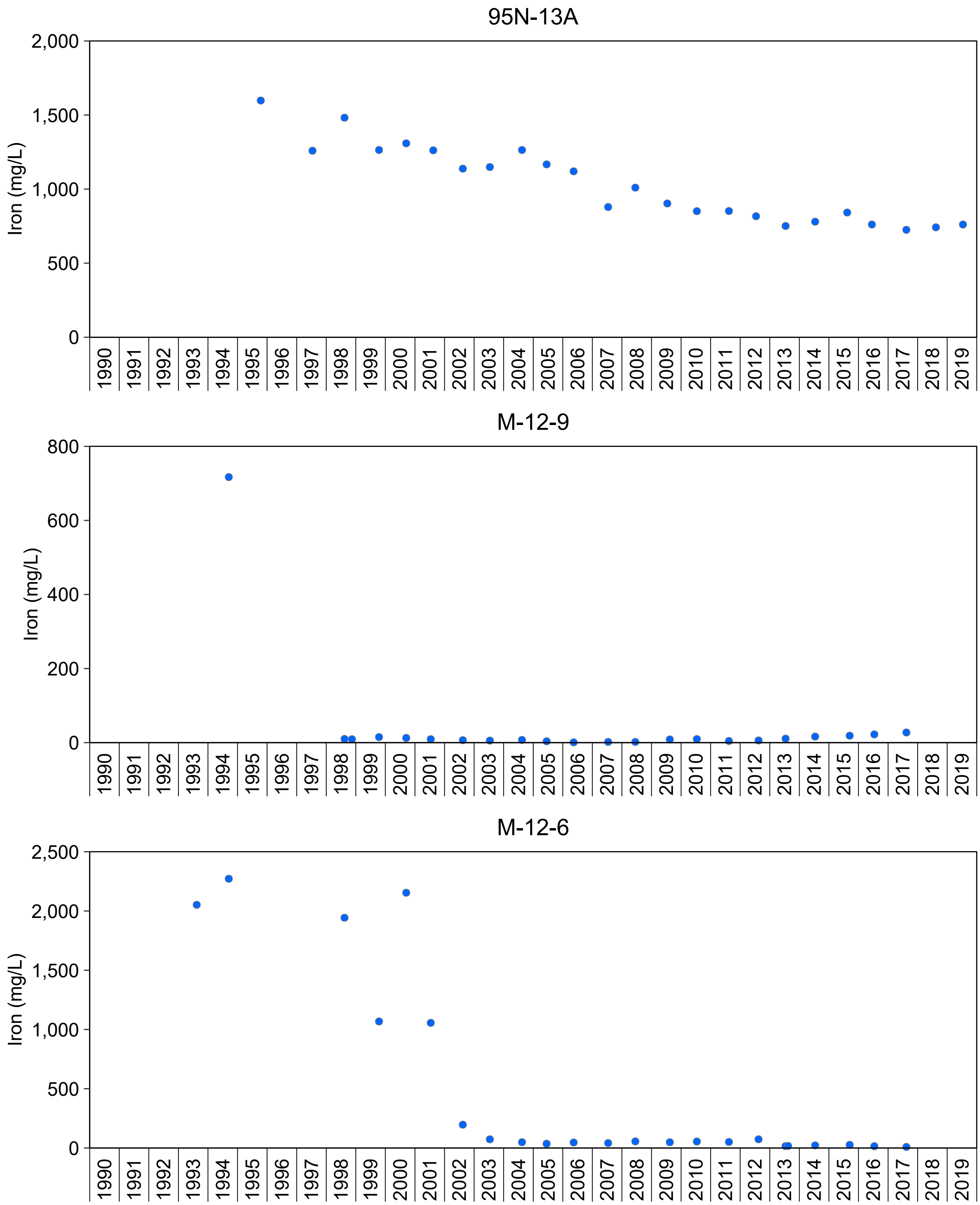

Figure I.15: Concentrations of Iron for TOMP Groundwater Stations, Lacnor/Nordic TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 6.6 for Kendall trend analysis results and Appendix Tables I.19 to I.29 for raw data.

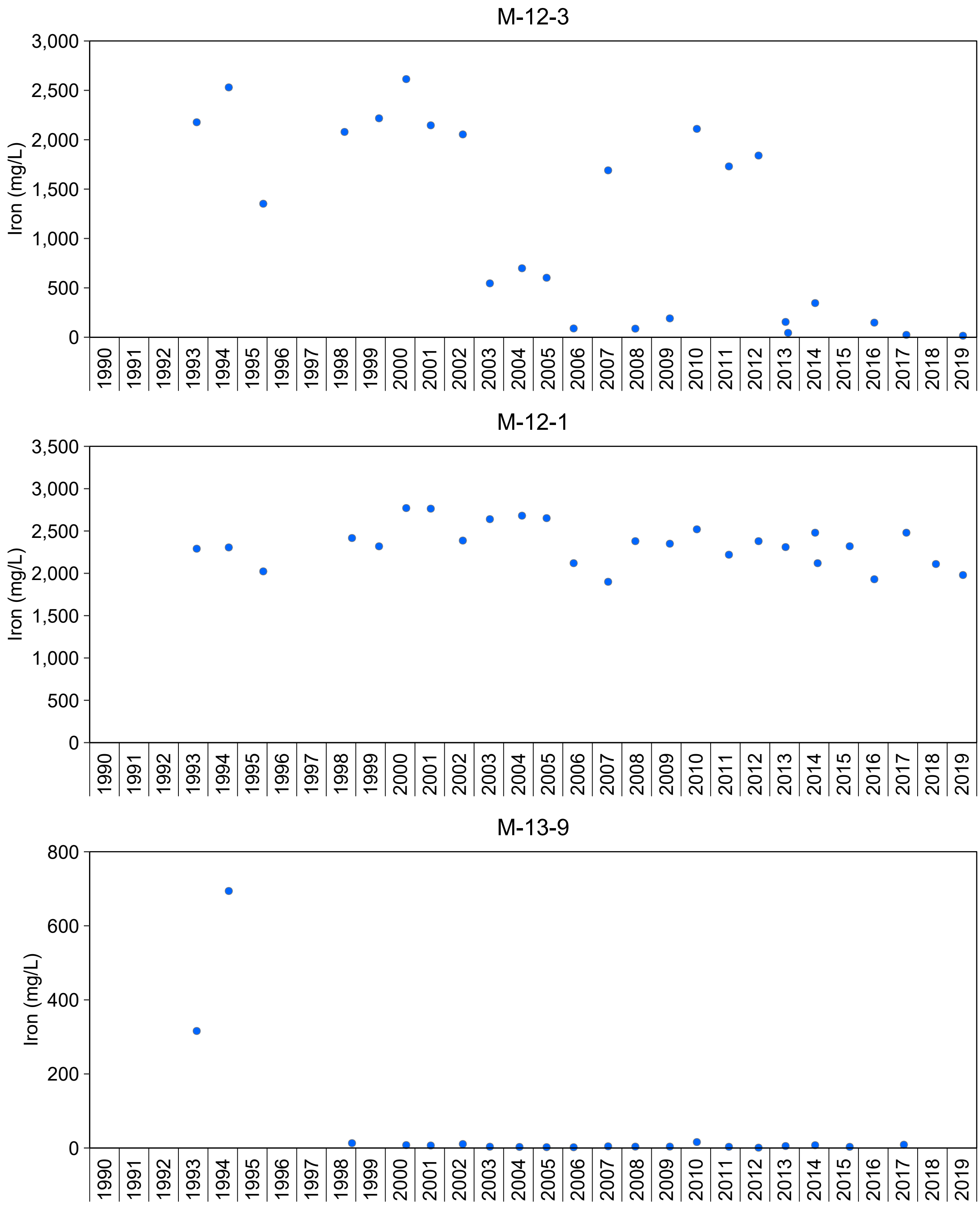

Figure I.15: Concentrations of Iron for TOMP Groundwater Stations, Lacnor/Nordic TMA, 1990 to 2019

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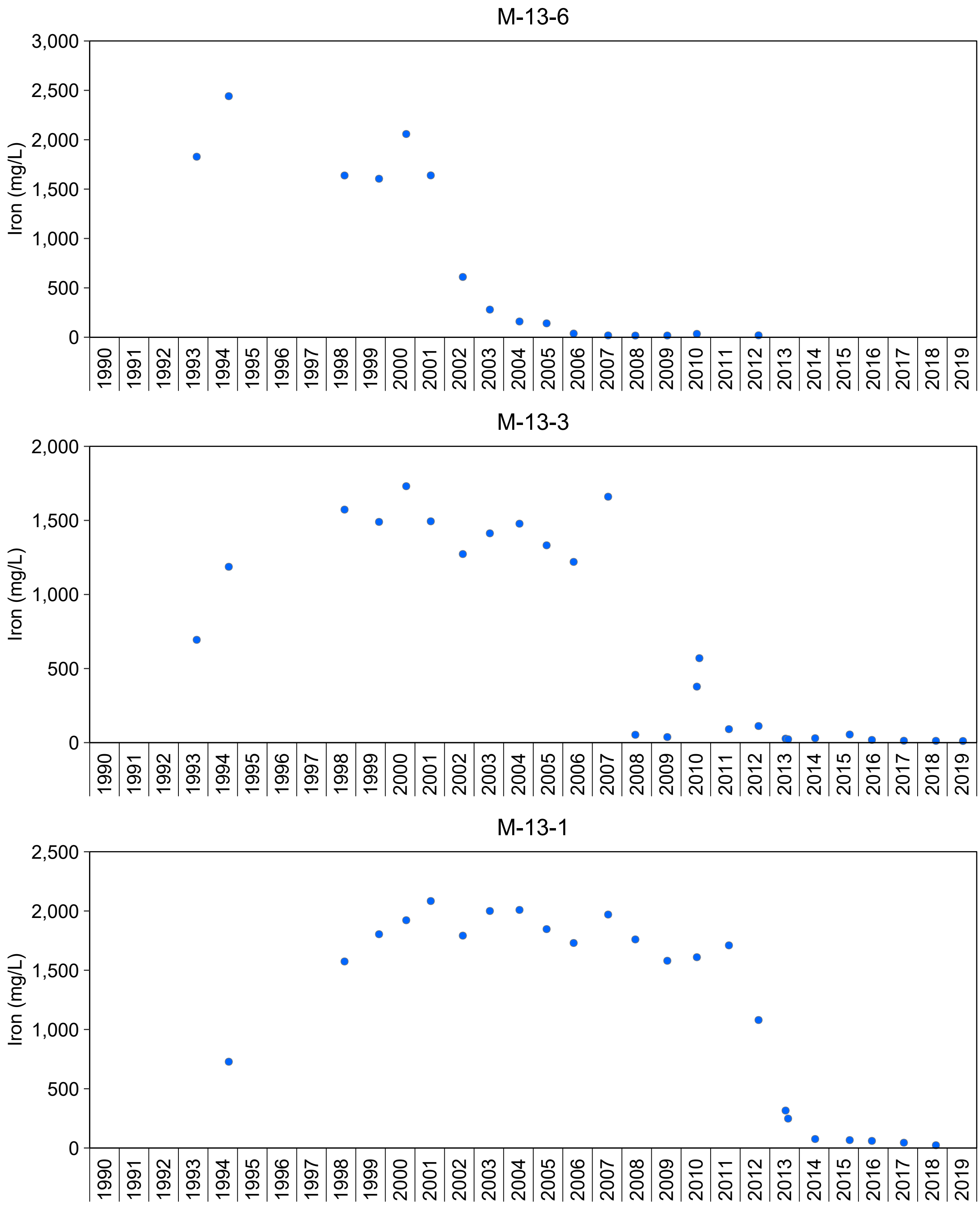

Figure I.15: Concentrations of Iron for TOMP Groundwater Stations, Lacnor/Nordic TMA, 1990 to 2019

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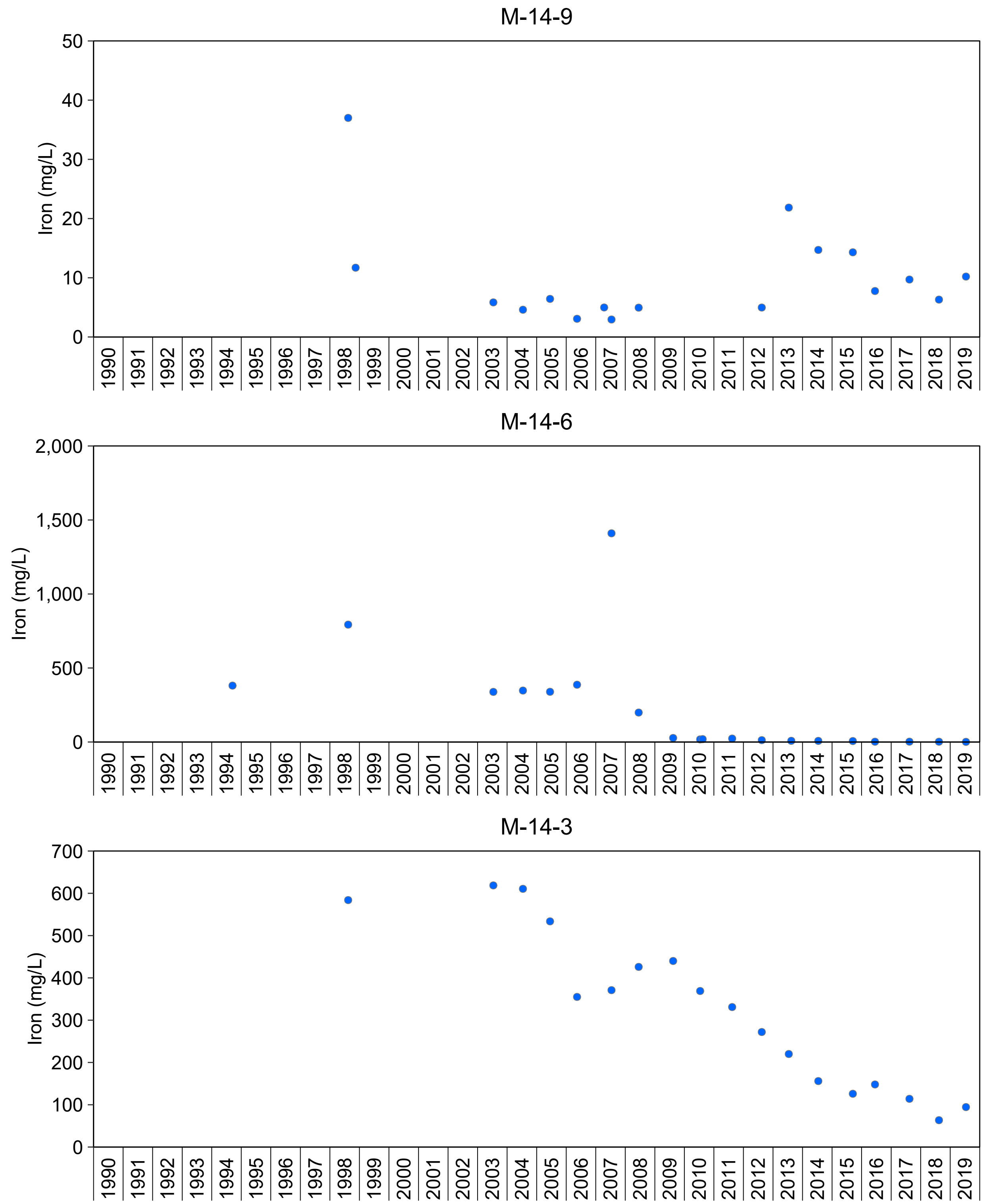

Figure I.15: Concentrations of Iron for TOMP Groundwater Stations, Lacnor/Nordic TMA, 1990 to 2019

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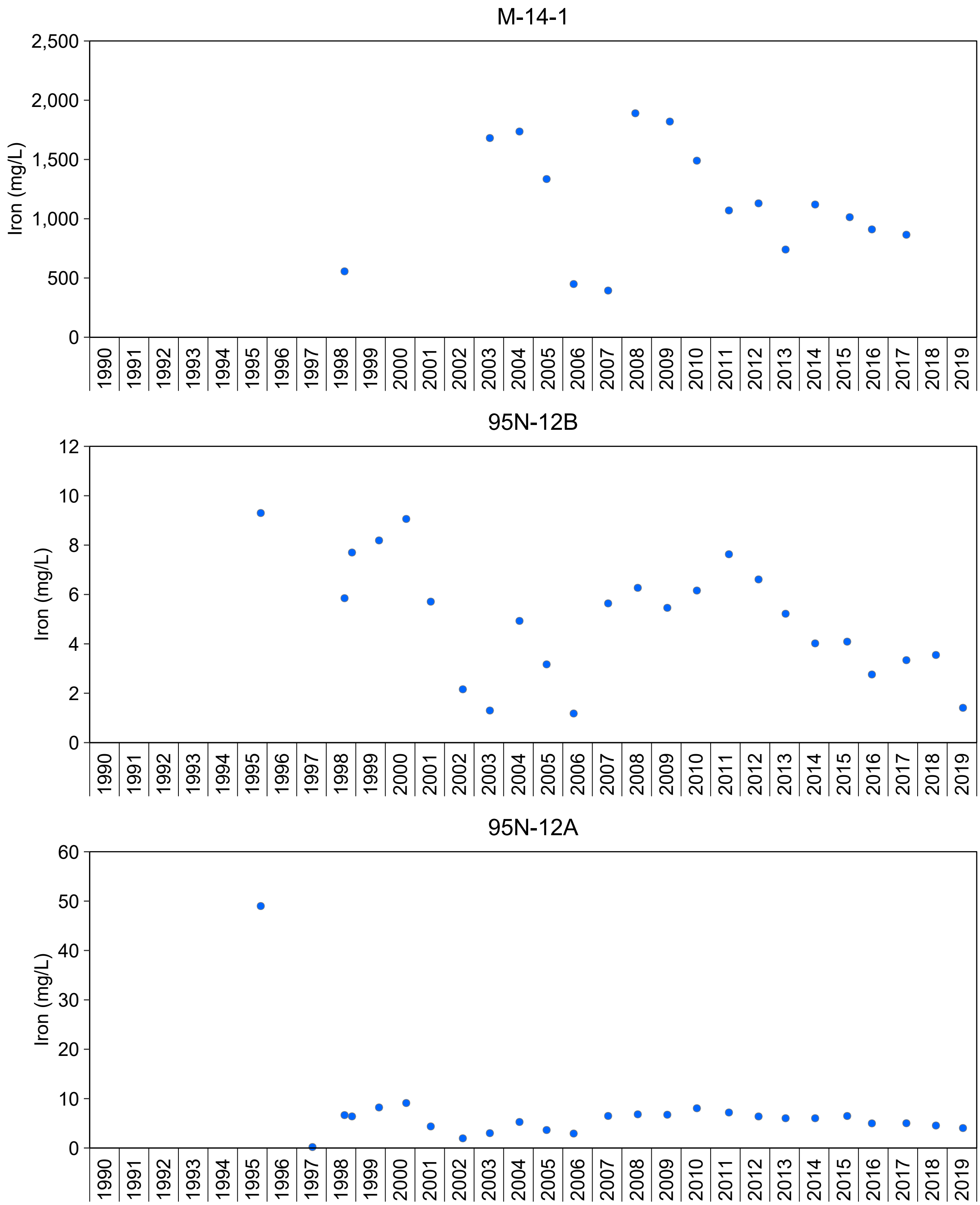

Figure I.15: Concentrations of Iron for TOMP Groundwater Stations, Lacnor/Nordic TMA, 1990 to 2019

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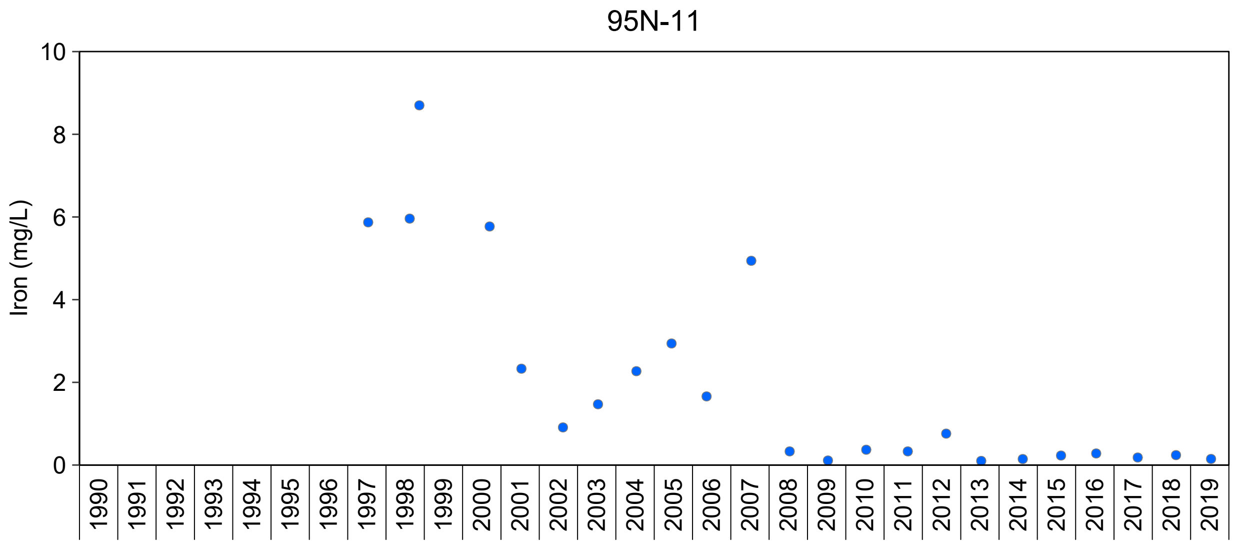

Figure I.15: Concentrations of Iron for TOMP Groundwater Stations, Lacnor/Nordic TMA, 1990 to 2019

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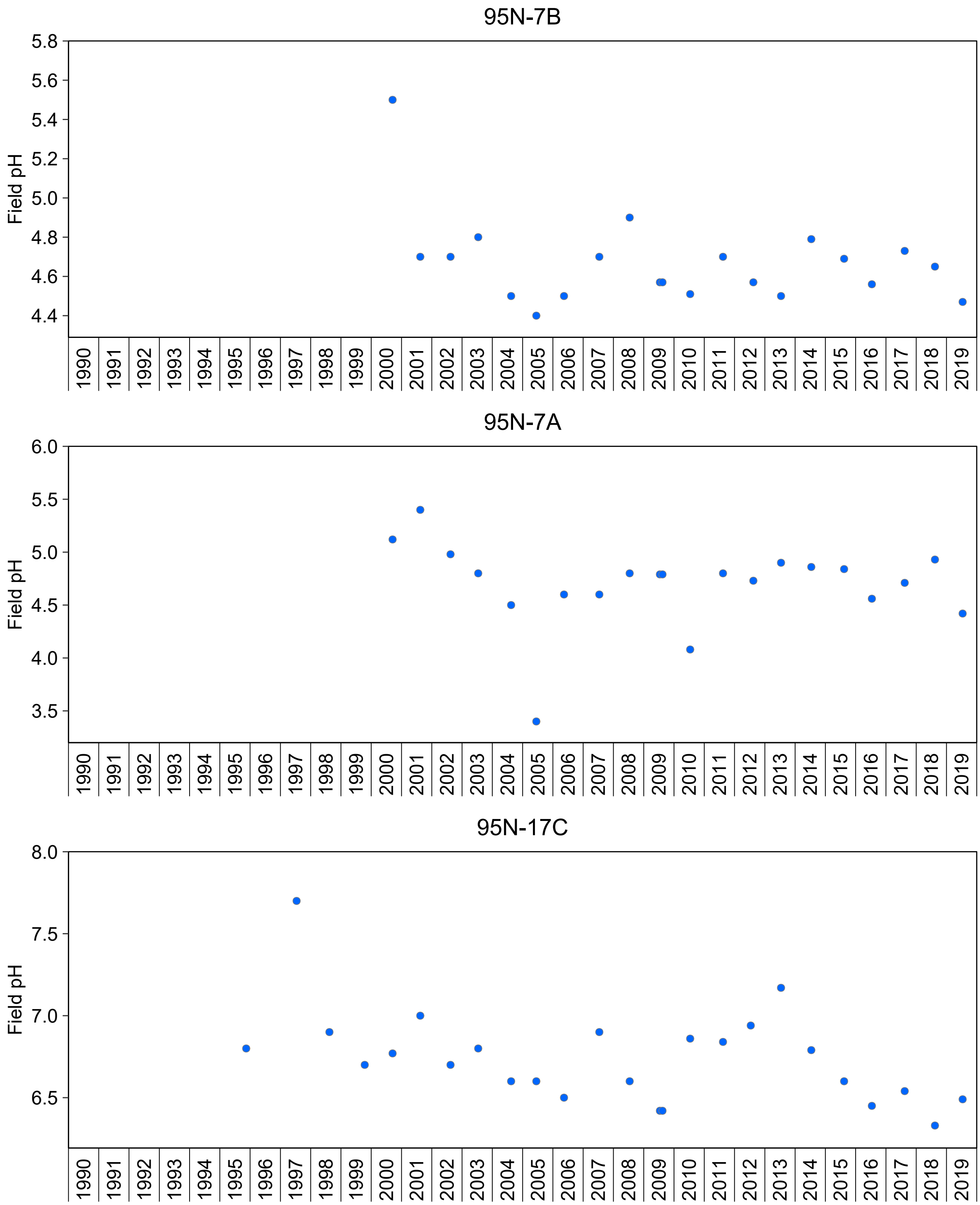

Figure I.16: Field Measurements of pH for TOMP Groundwater Stations, Lacnor/Nordic TMA, 1990 to 2019

Notes: See Table 6.6 for Kendall trend analysis results and Appendix Tables I.19 to I.29 for raw data.

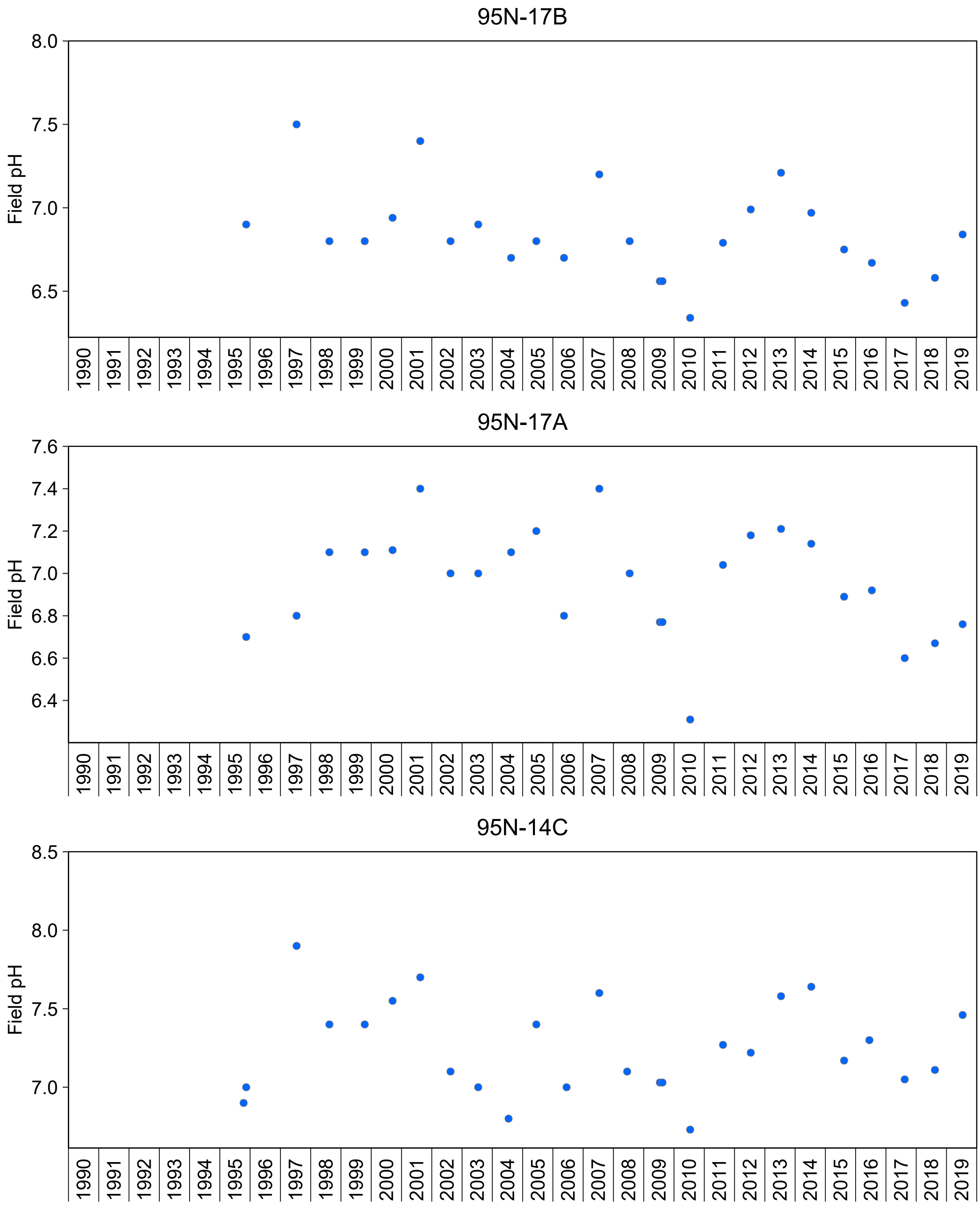

Figure I.16: Field Measurements of pH for TOMP Groundwater Stations, Lacnor/Nordic TMA, 1990 to 2019

Notes: See Table 6.6 for Kendall trend analysis results and Appendix Tables I.19 to I.29for raw data.

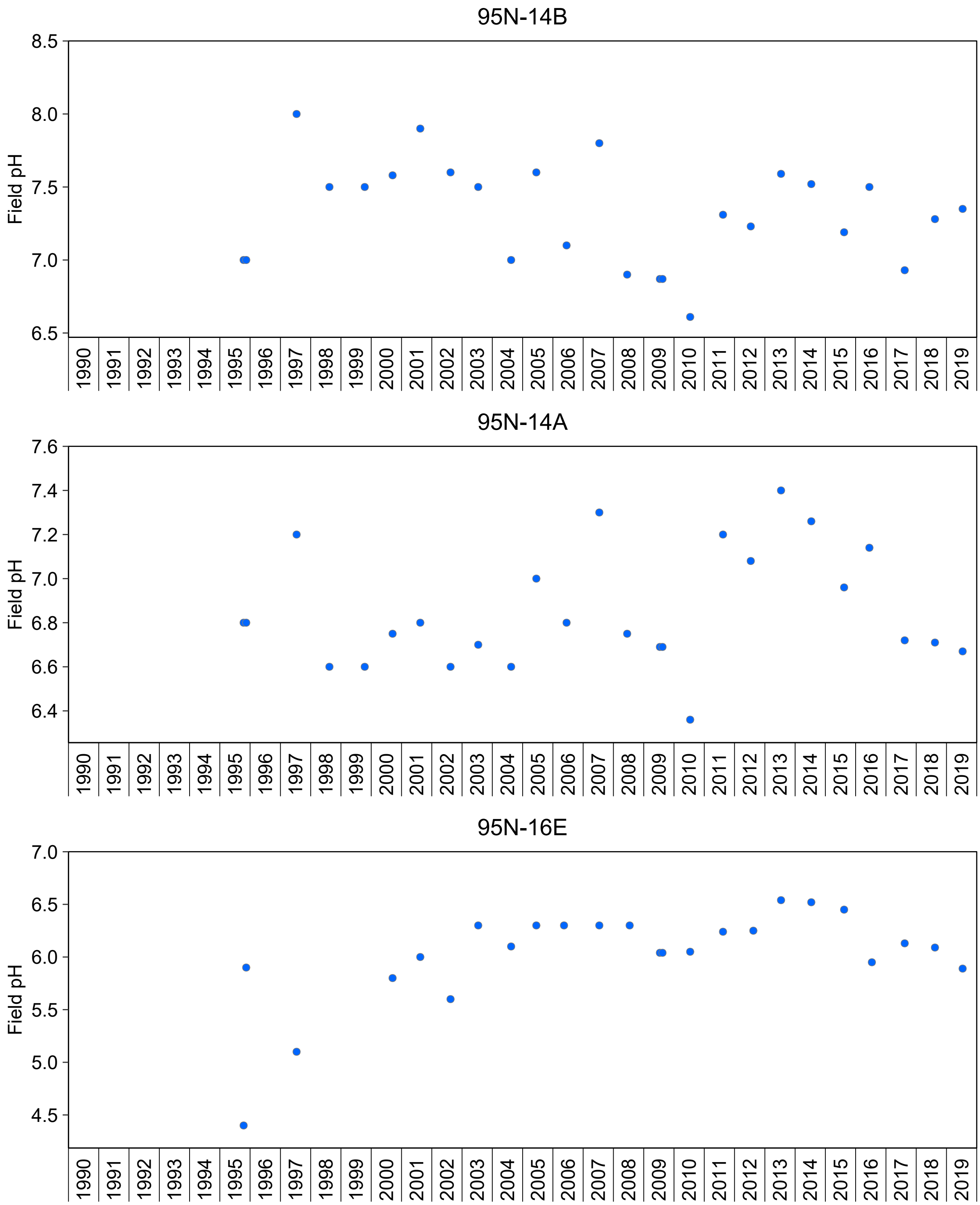

Figure I.16: Field Measurements of pH for TOMP Groundwater Stations, Lacnor/Nordic TMA, 1990 to 2019

Notes: See Table 6.6 for Kendall trend analysis results and Appendix Tables I.19 to I.29 for raw data.

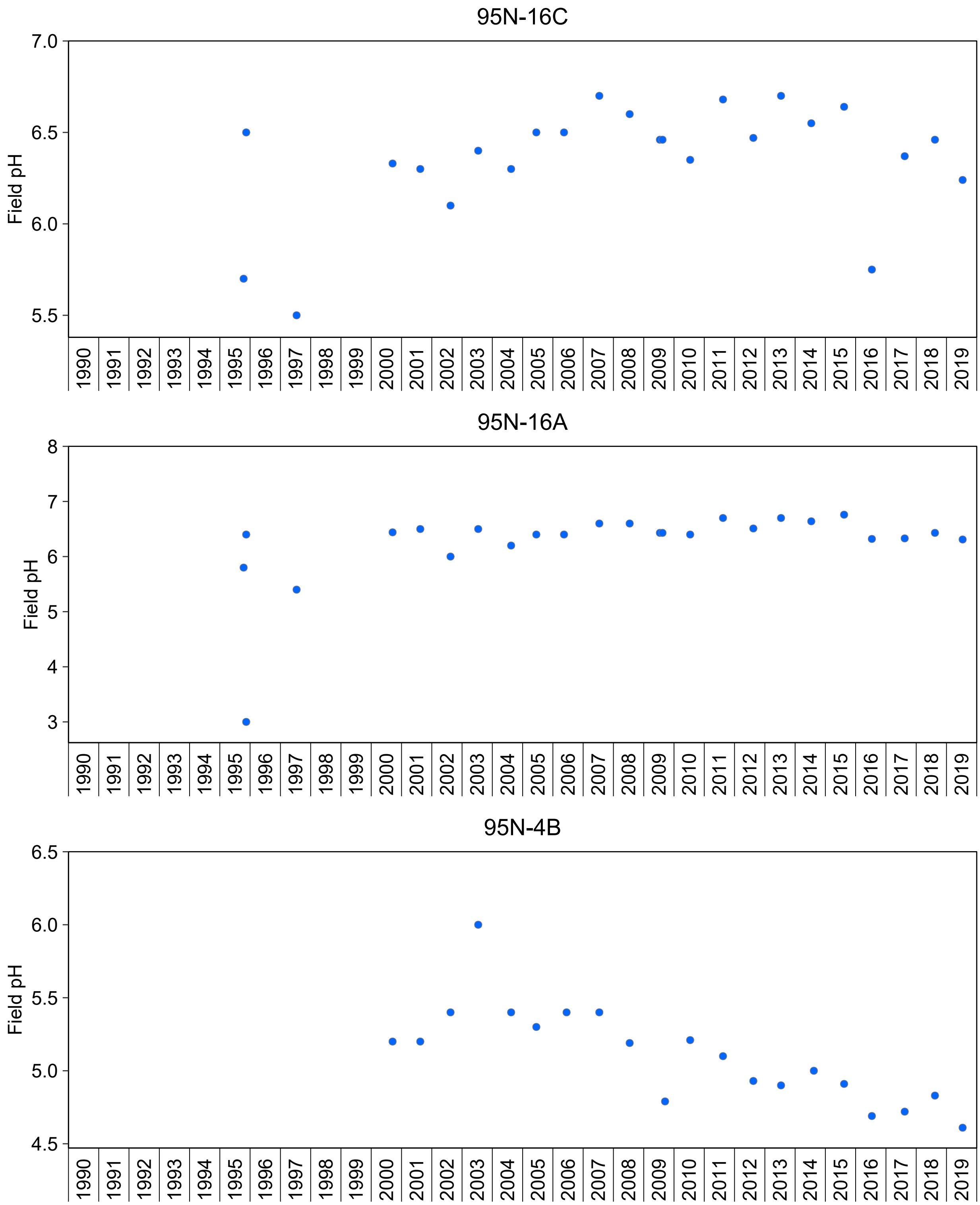

Figure I.16: Field Measurements of pH for TOMP Groundwater Stations, Lacnor/Nordic TMA, 1990 to 2019

Notes: See Table 6.6 for Kendall trend analysis results and Appendix Tables I.19 to I.29 for raw data.

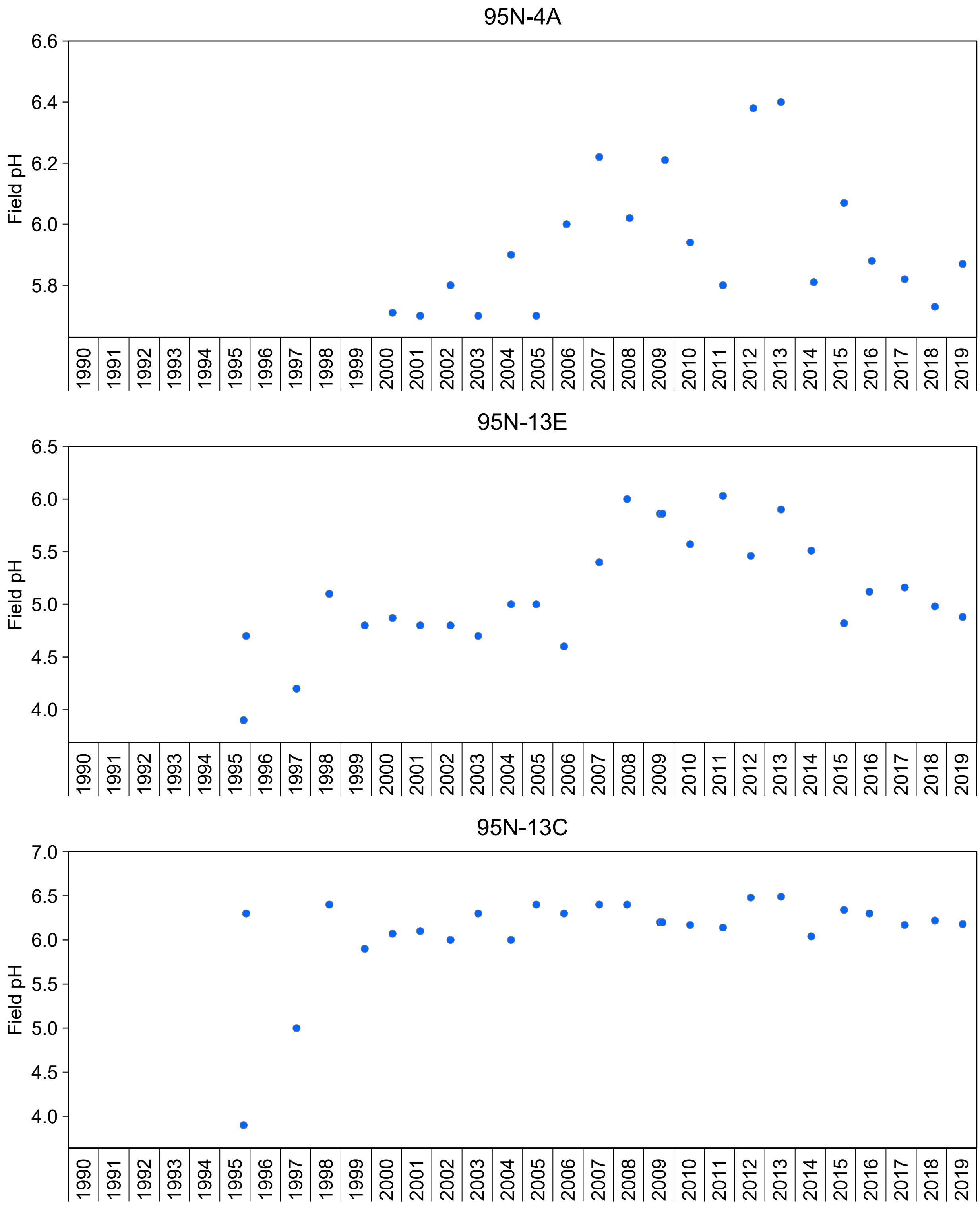

Figure I.16: Field Measurements of pH for TOMP Groundwater Stations, Lacnor/Nordic TMA, 1990 to 2019

Notes: See Table 6.6 for Kendall trend analysis results and Appendix Tables I.19 to I.29 for raw data.

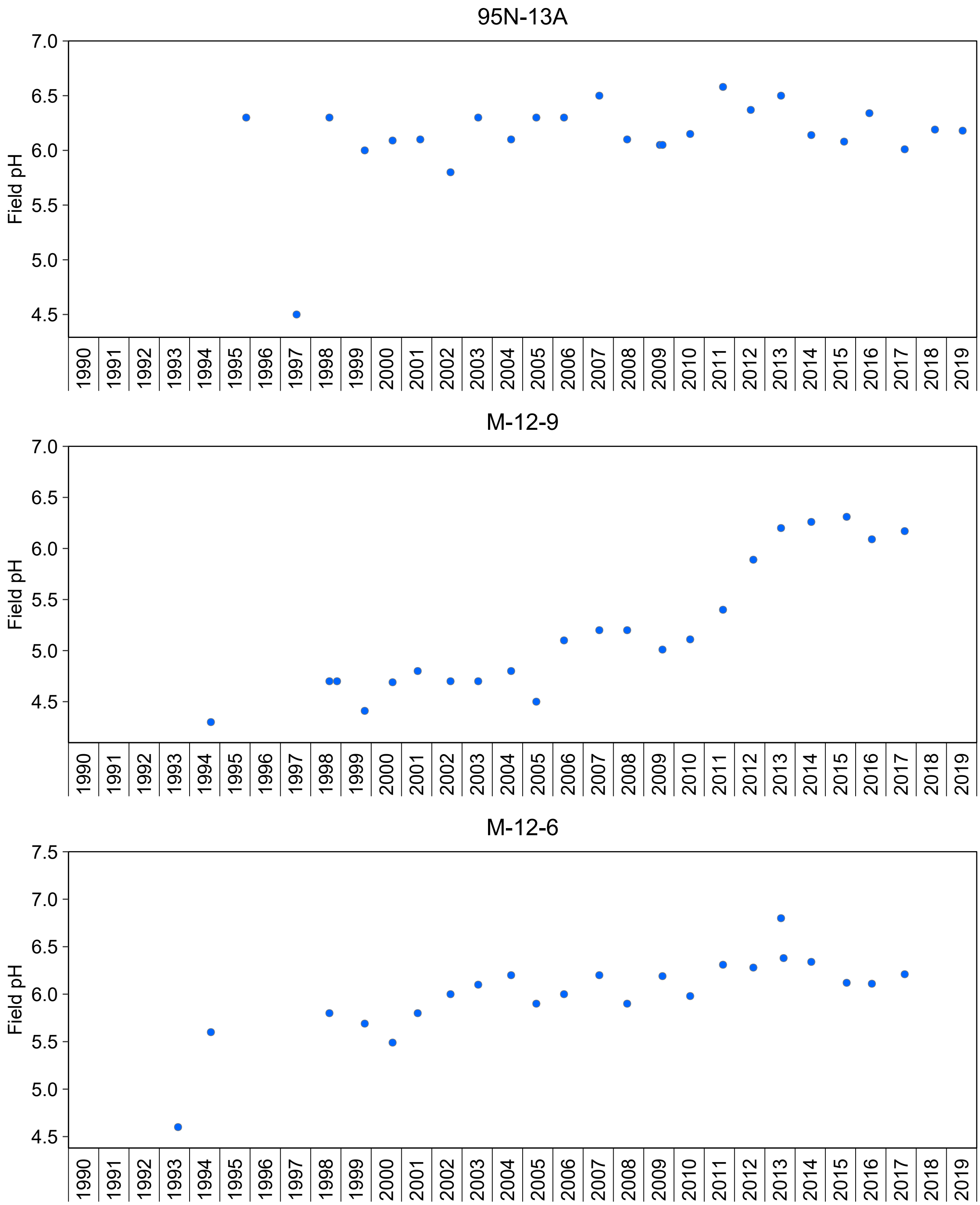

Figure I.16: Field Measurements of pH for TOMP Groundwater Stations, Lacnor/Nordic TMA, 1990 to 2019

Notes: See Table 6.6 for Kendall trend analysis results and Appendix Tables I.19 to I.29 for raw data.

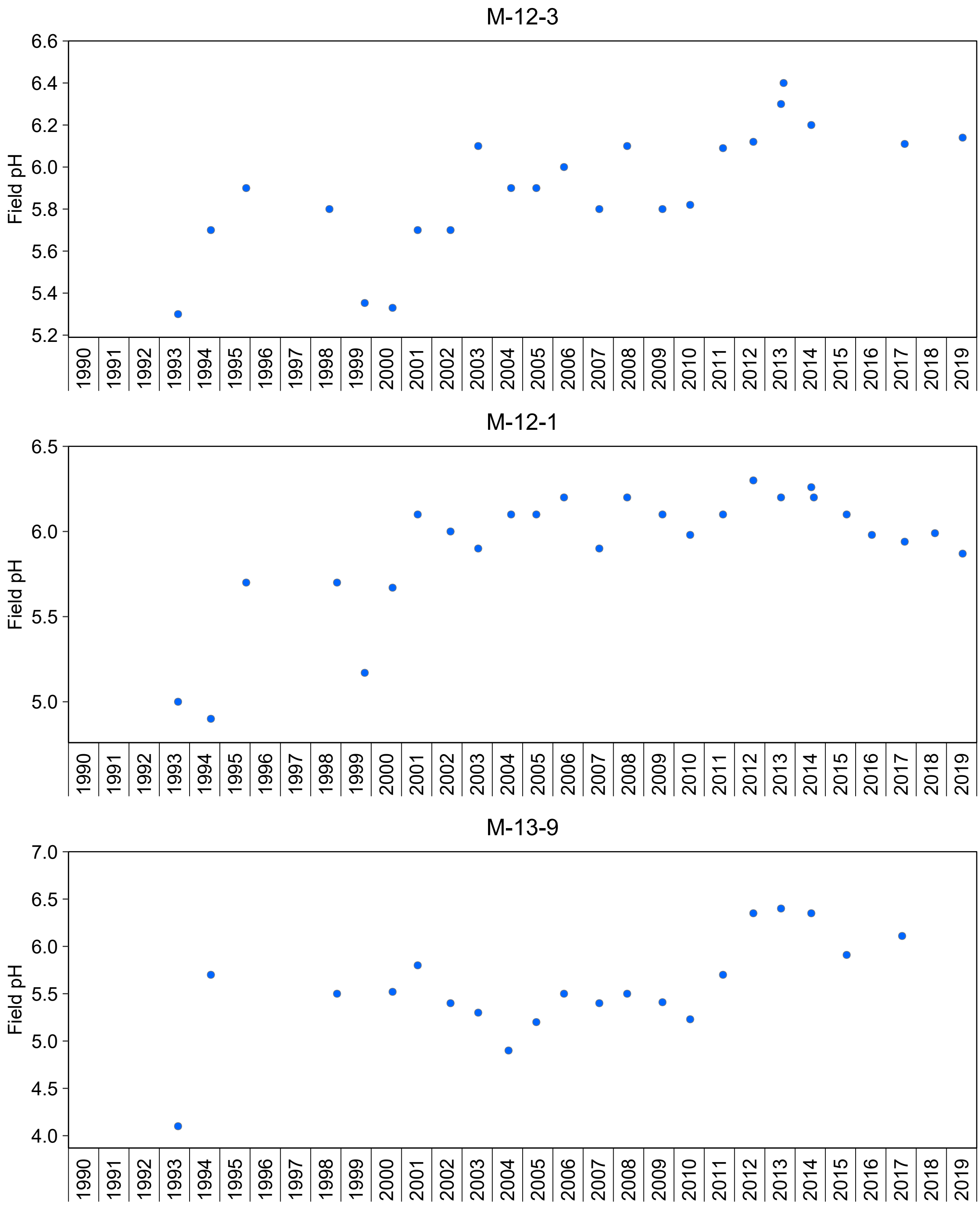

Figure I.16: Field Measurements of pH for TOMP Groundwater Stations, Lacnor/Nordic TMA, 1990 to 2019

Notes: See Table 6.6 for Kendall trend analysis results and Appendix Tables I.19 to I.29 for raw data.

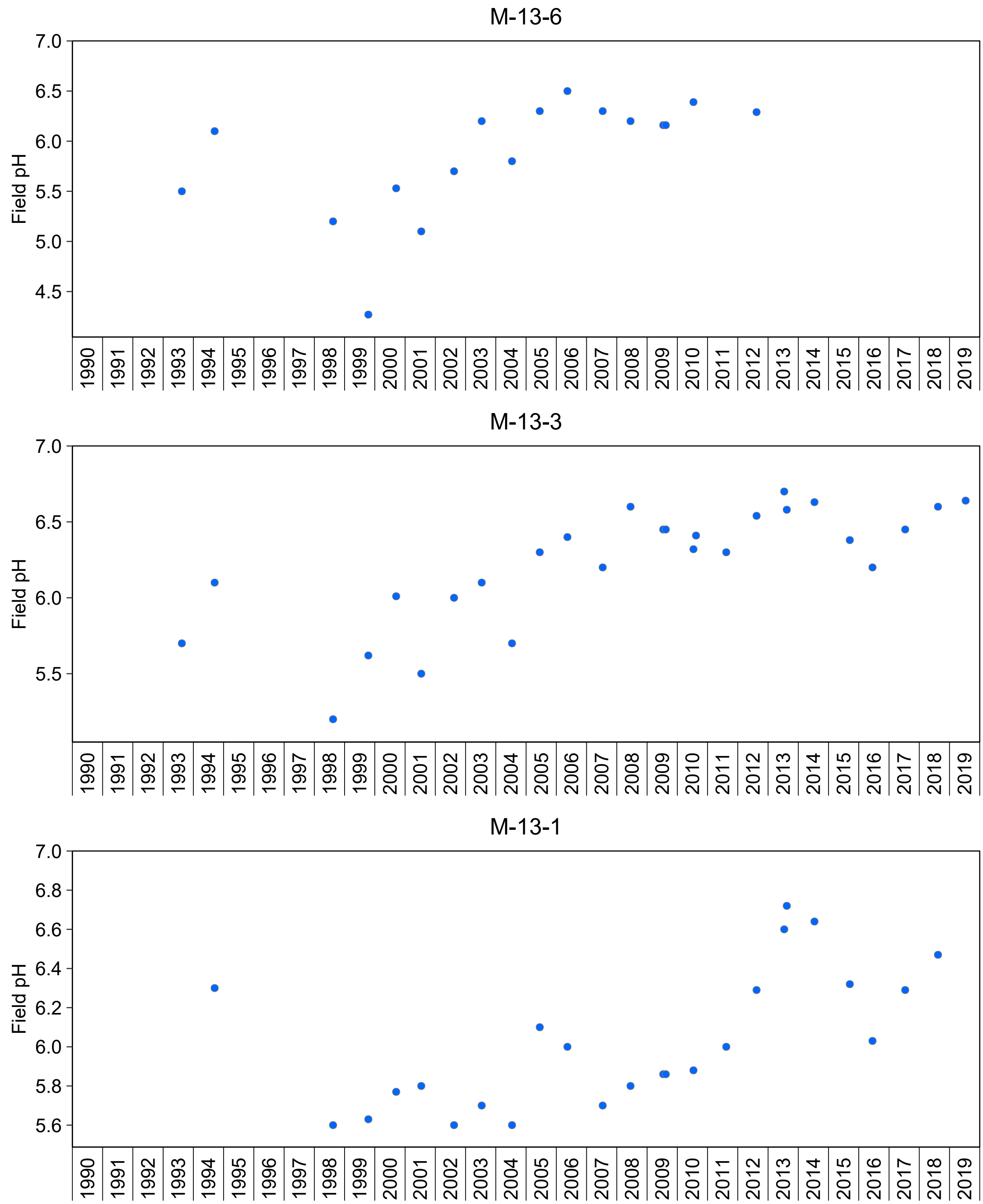

Figure I.16: Field Measurements of pH for TOMP Groundwater Stations, Lacnor/Nordic TMA, 1990 to 2019

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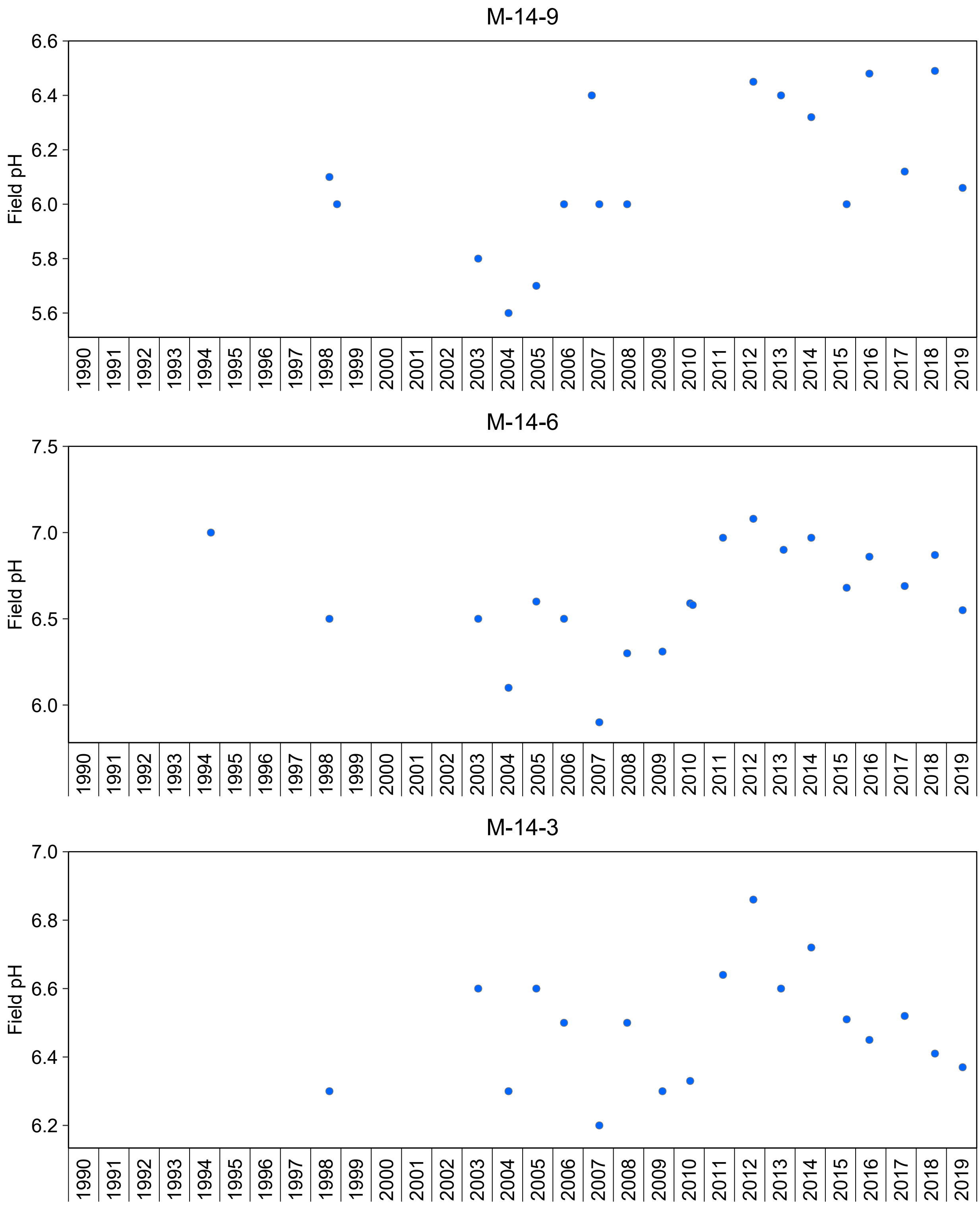

Figure I.16: Field Measurements of pH for TOMP Groundwater Stations, Lacnor/Nordic TMA, 1990 to 2019

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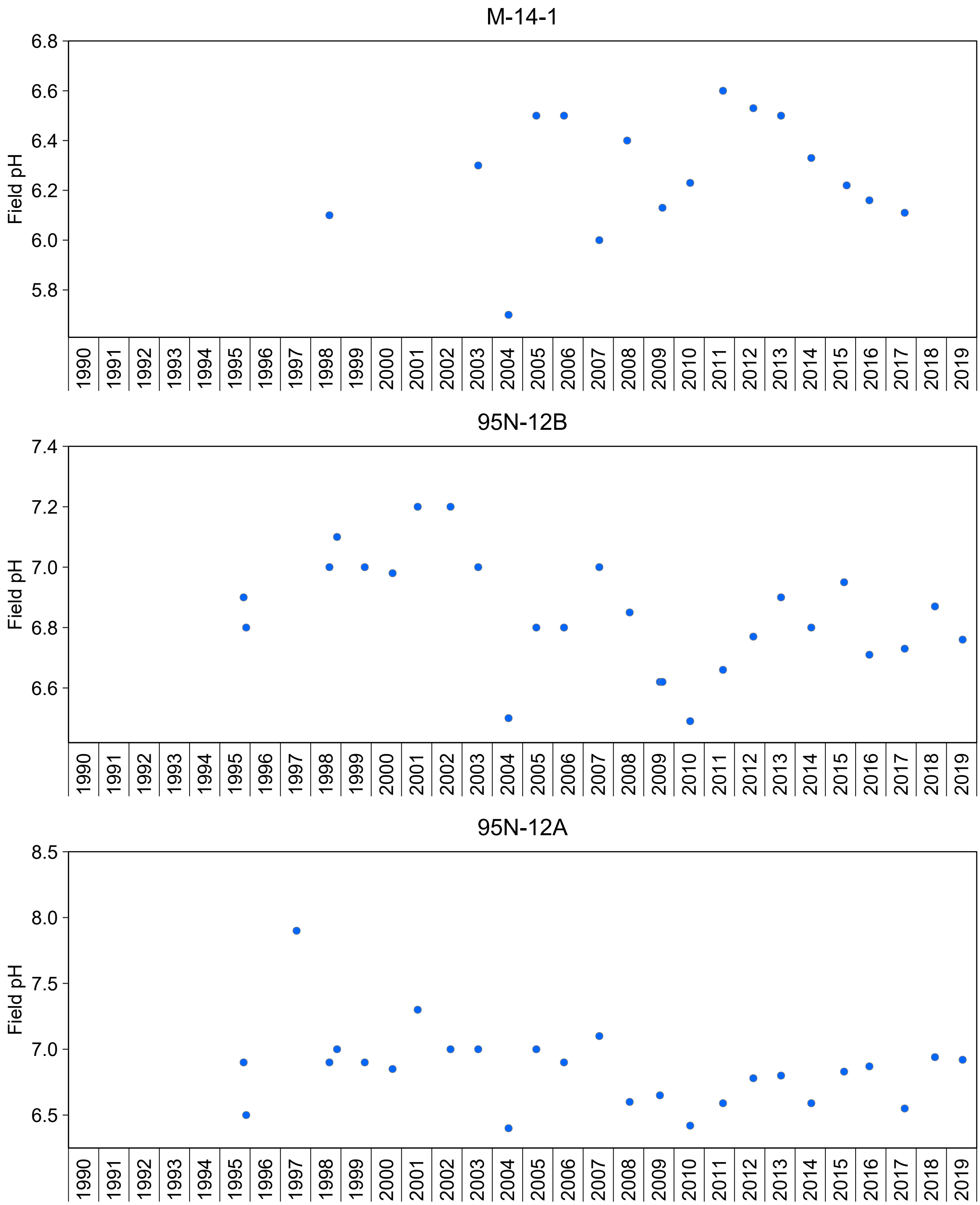

Figure I.16: Field Measurements of pH for TOMP Groundwater Stations, Lacnor/Nordic TMA, 1990 to 2019

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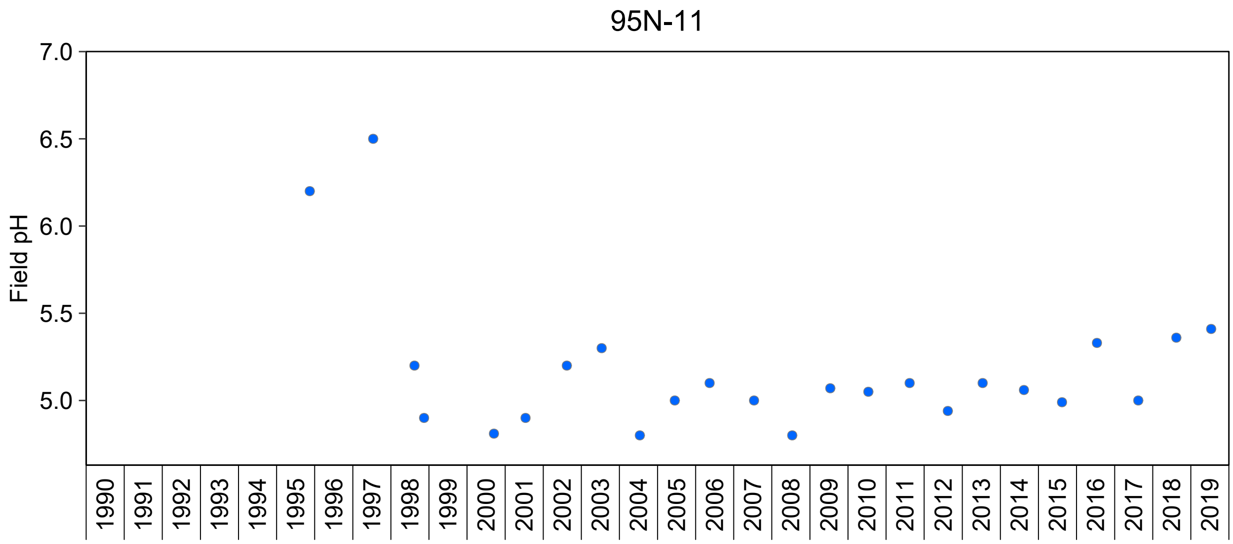

Figure I.16: Field Measurements of pH for TOMP Groundwater Stations, Lacnor/Nordic TMA, 1990 to 2019

Notes: See Table 6.6 for Kendall trend analysis results and Appendix Tables I.19 to I.29 for raw data.

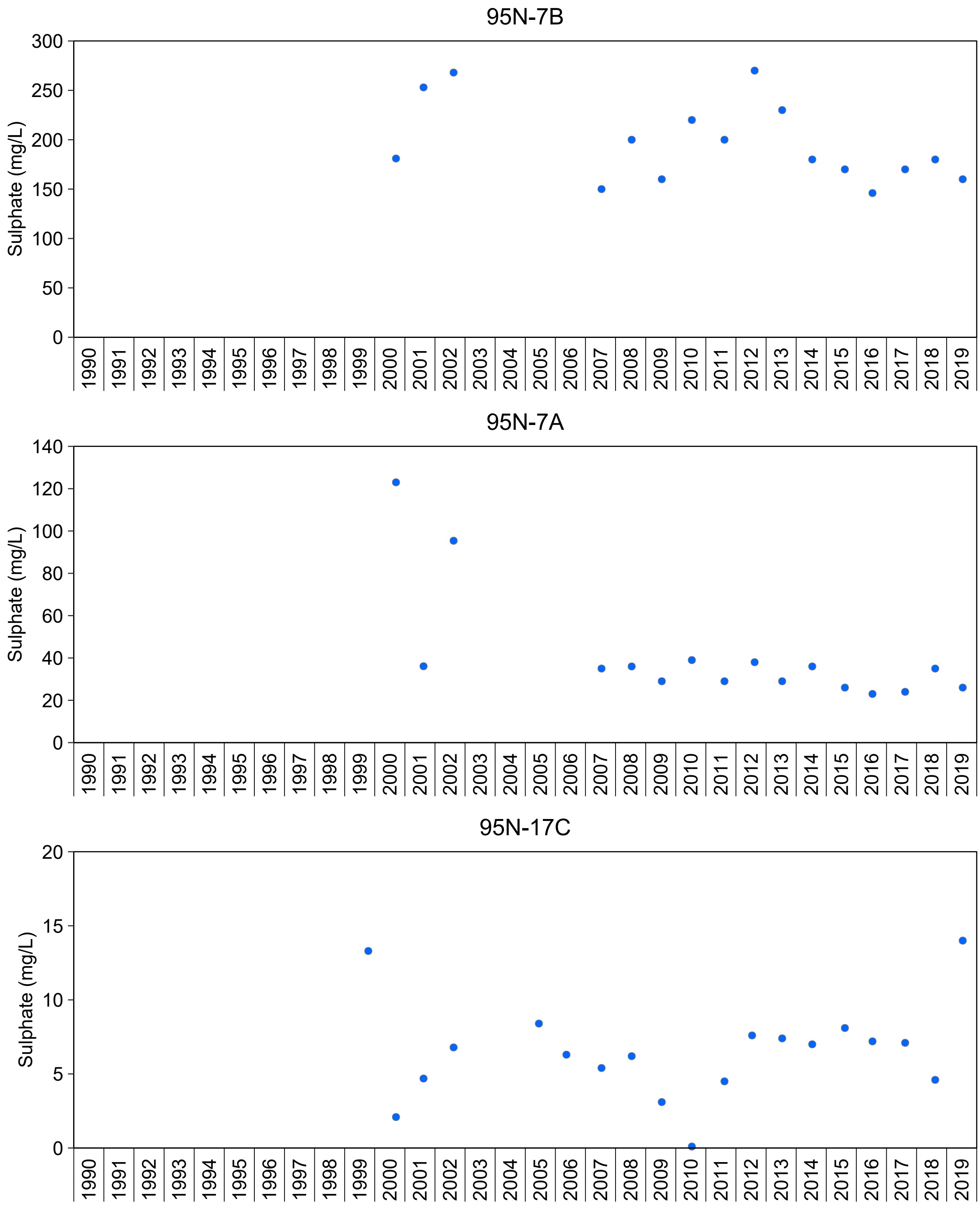

Figure I.17: Concentrations of Sulphate for TOMP Groundwater Stations, Lacnor/Nordic TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL.
See Table 6.6 for Kendall trend analysis results and Appendix Tables I.19 to I.29 for raw data.

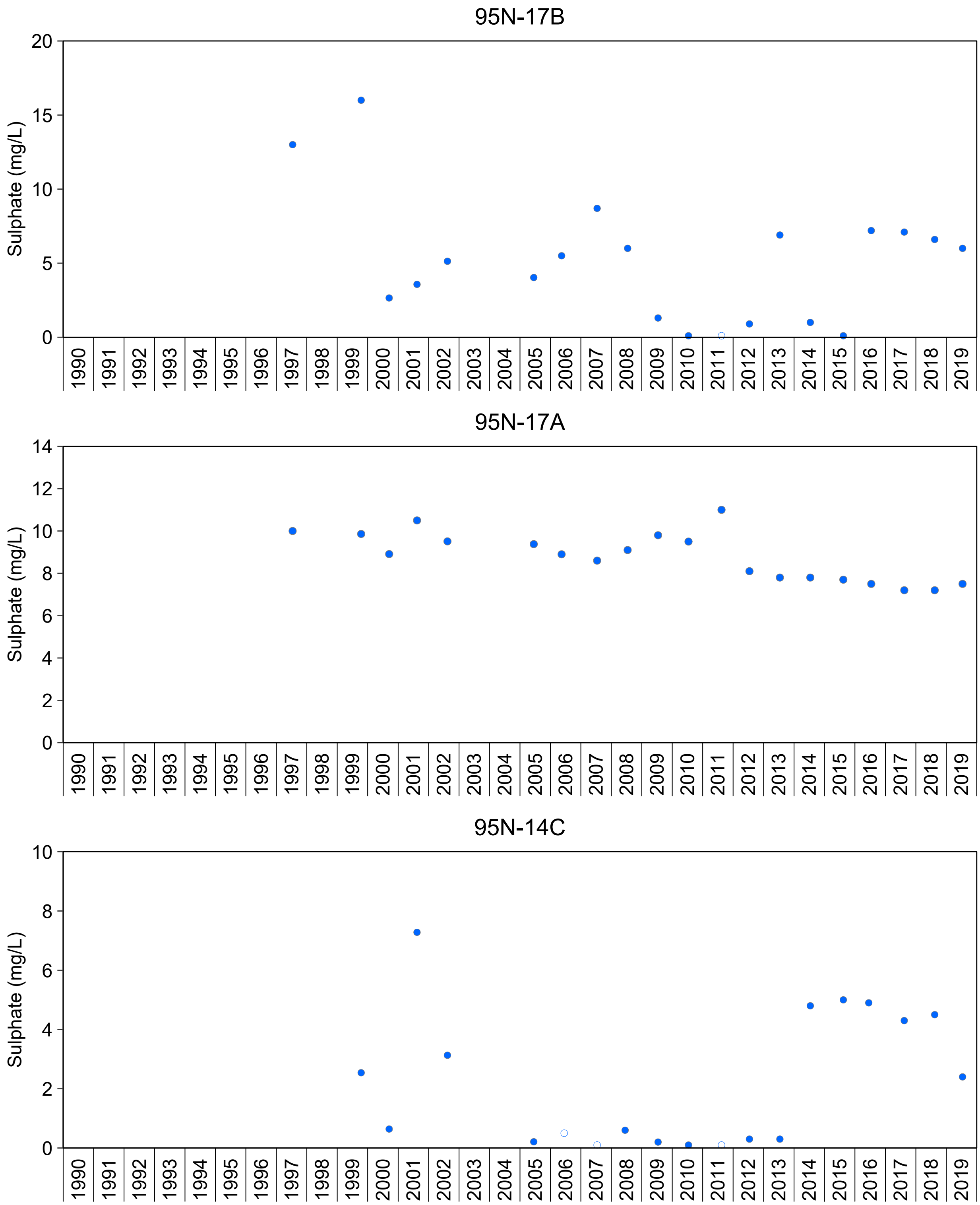

Figure I.17: Concentrations of Sulphate for TOMP Groundwater Stations, Lacnor/Nordic TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL.
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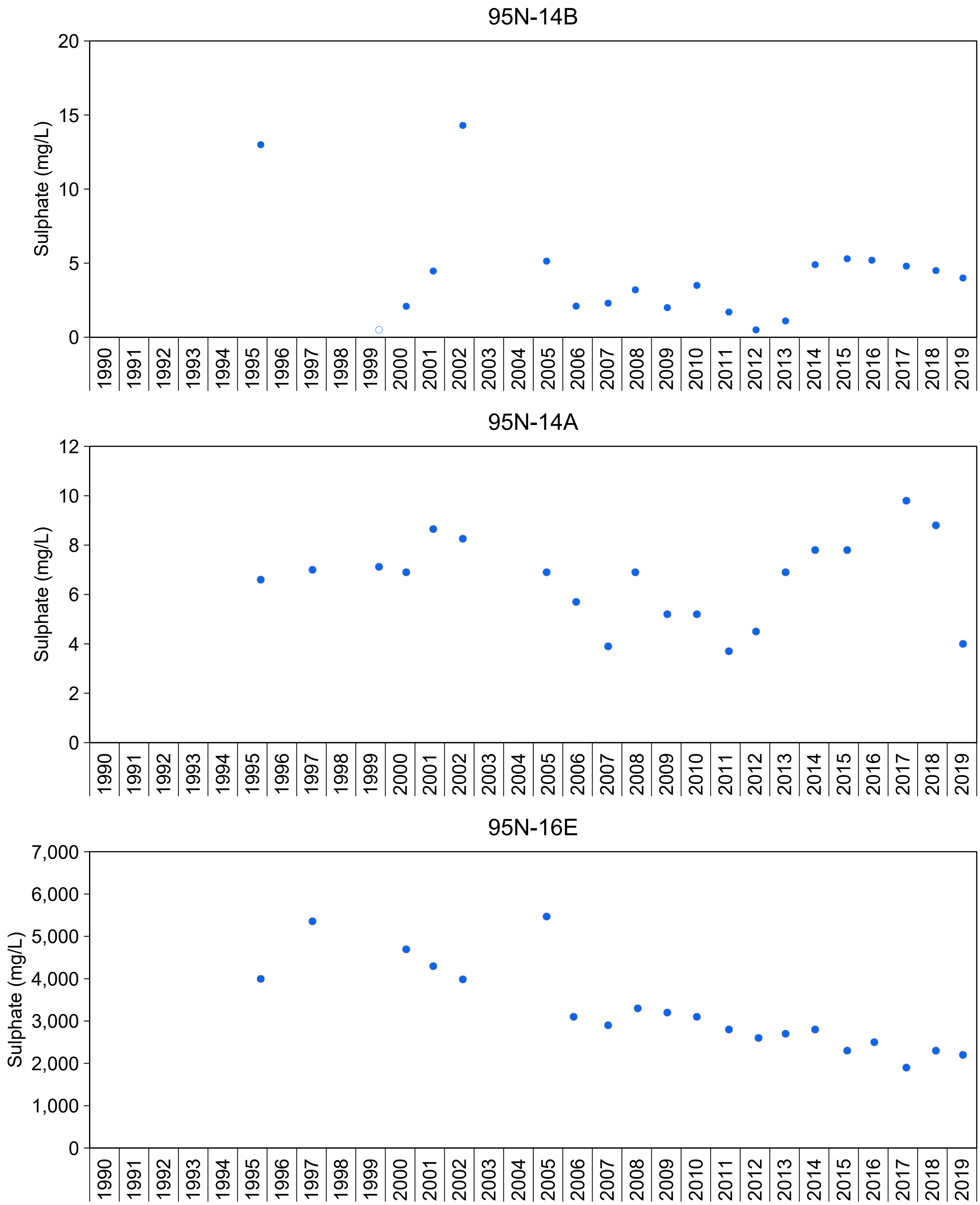

Figure I.17: Concentrations of Sulphate for TOMP Groundwater Stations, Lacnor/Nordic TMA, 1990 to 2019

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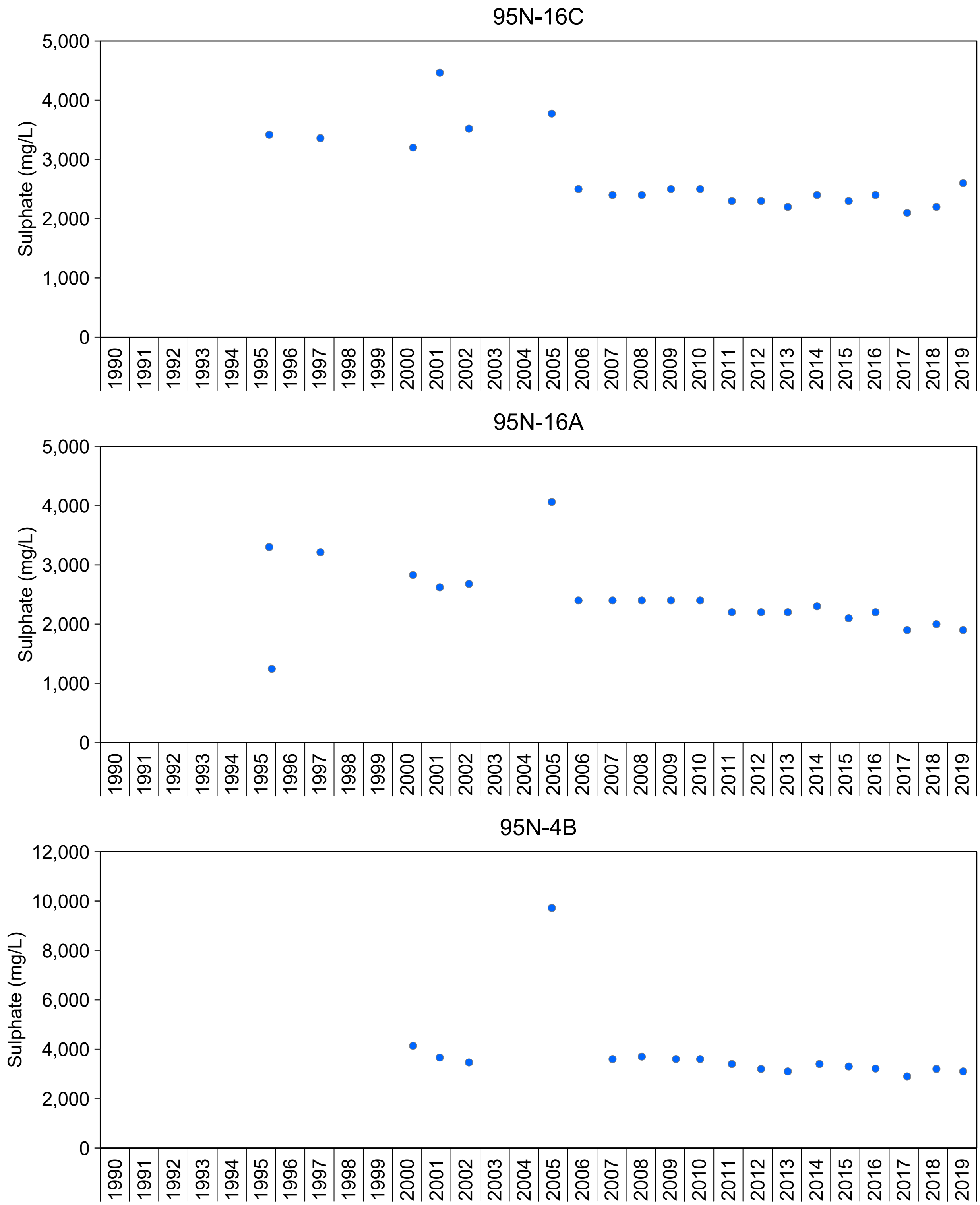

Figure I.17: Concentrations of Sulphate for TOMP Groundwater Stations, Lacnor/Nordic TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL.
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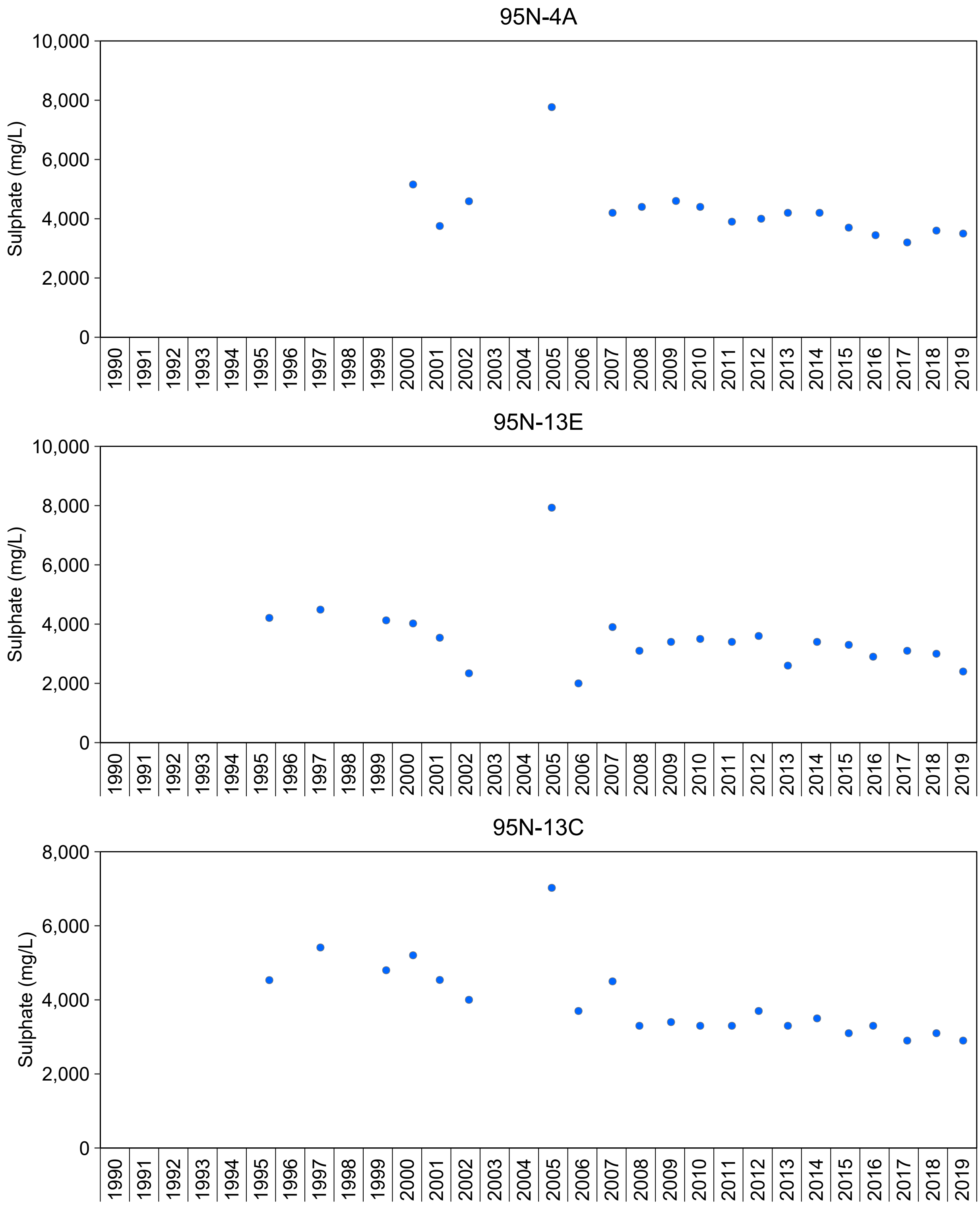

Figure I.17: Concentrations of Sulphate for TOMP Groundwater Stations, Lacnor/Nordic TMA, 1990 to 2019

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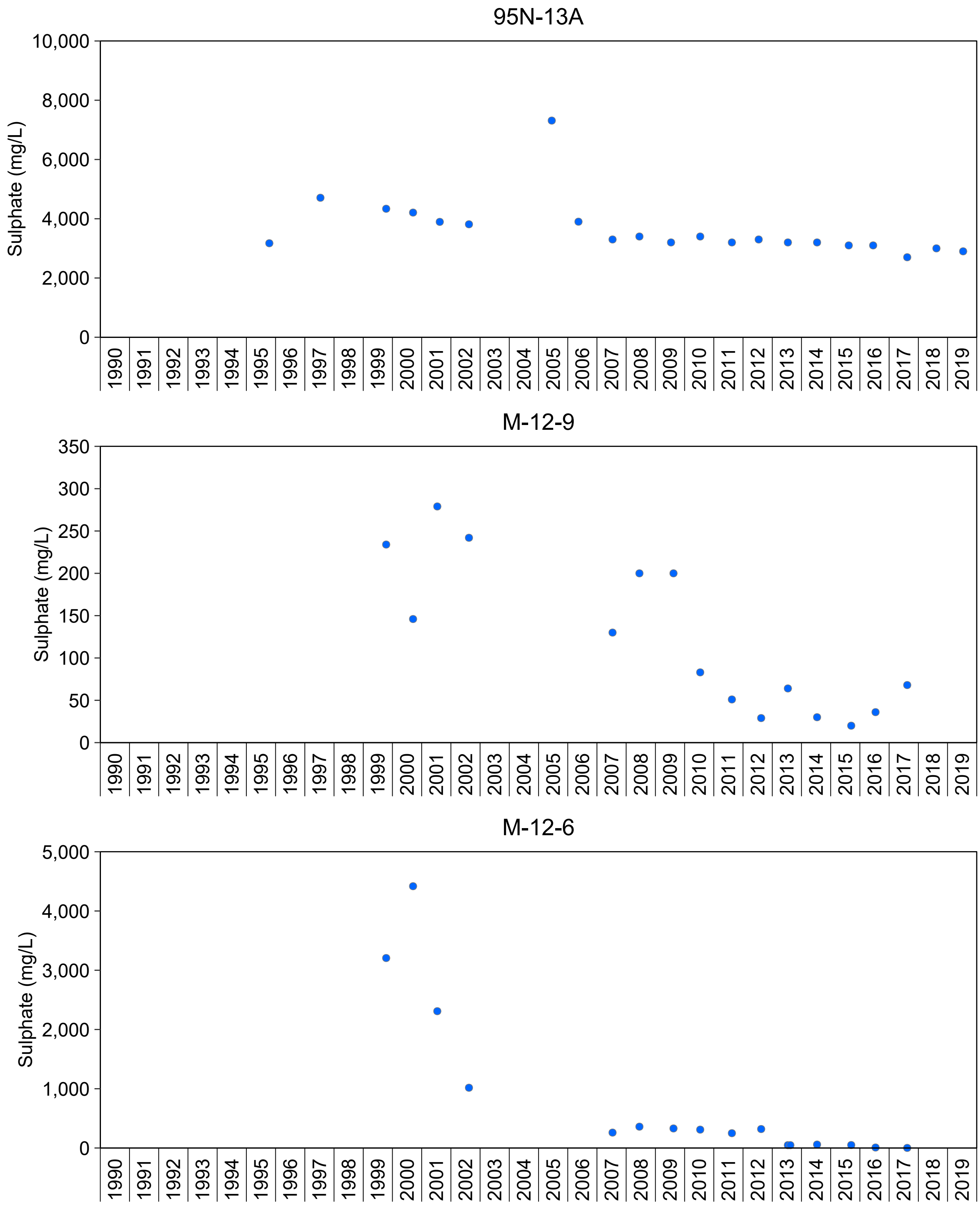

Figure I.17: Concentrations of Sulphate for TOMP Groundwater Stations, Lacnor/Nordic TMA, 1990 to 2019

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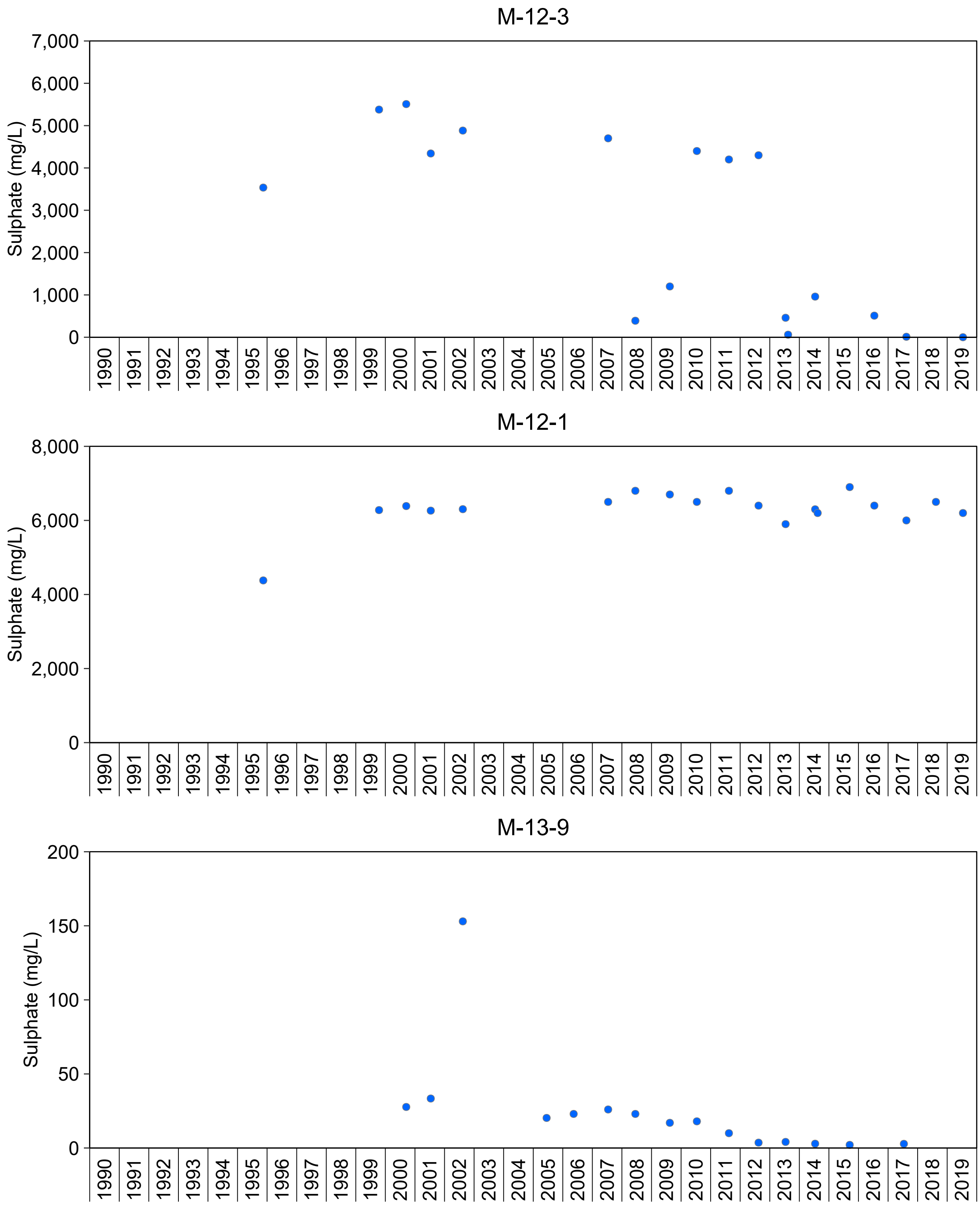

Figure I.17: Concentrations of Sulphate for TOMP Groundwater Stations, Lacnor/Nordic TMA, 1990 to 2019

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See Table 6.6 for Kendall trend analysis results and Appendix Tables I.19 to I.29 for raw data.

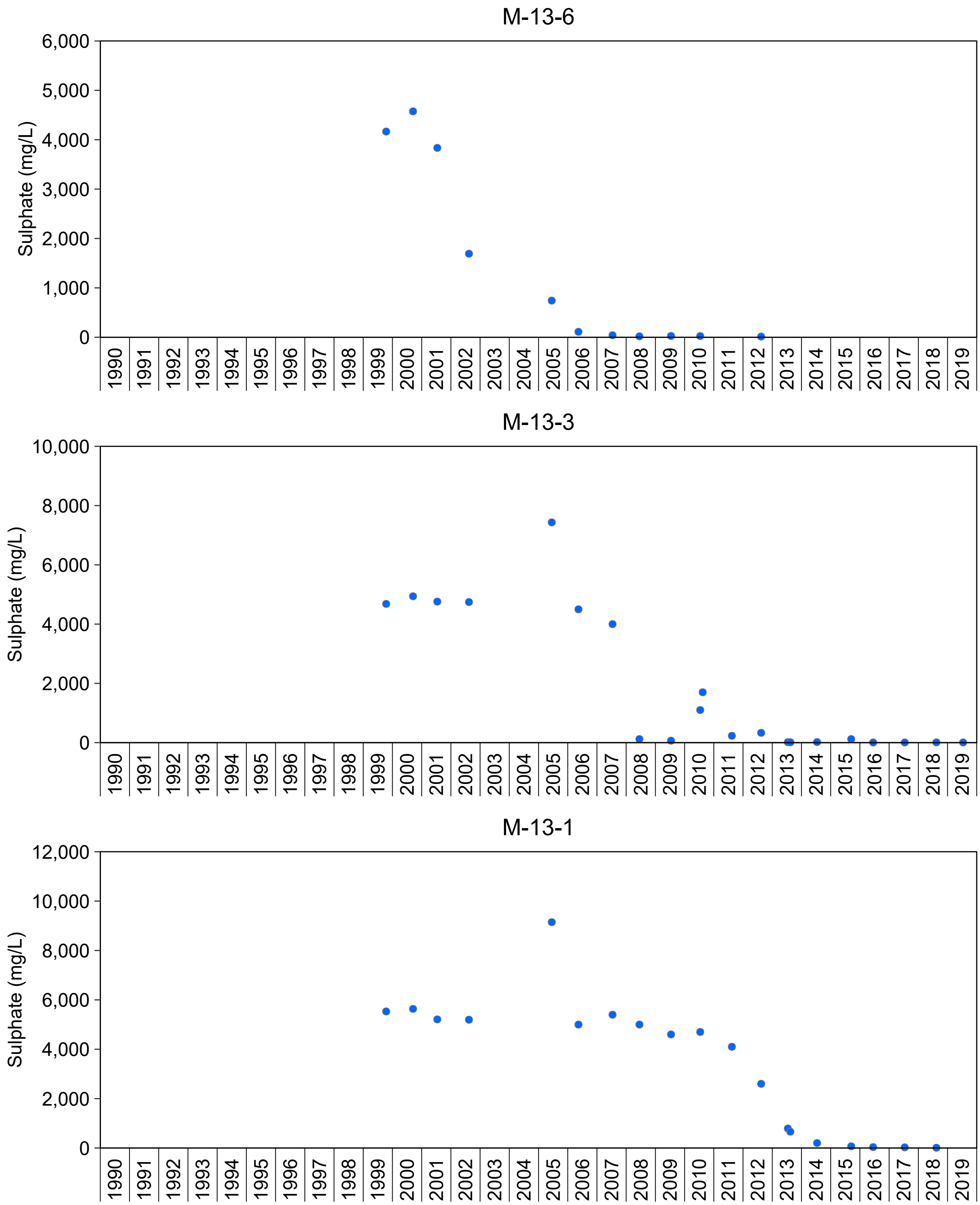

Figure I.17: Concentrations of Sulphate for TOMP Groundwater Stations, Lacnor/Nordic TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL.
See Table 6.6 for Kendall trend analysis results and Appendix Tables I.19 to I.29 for raw data.

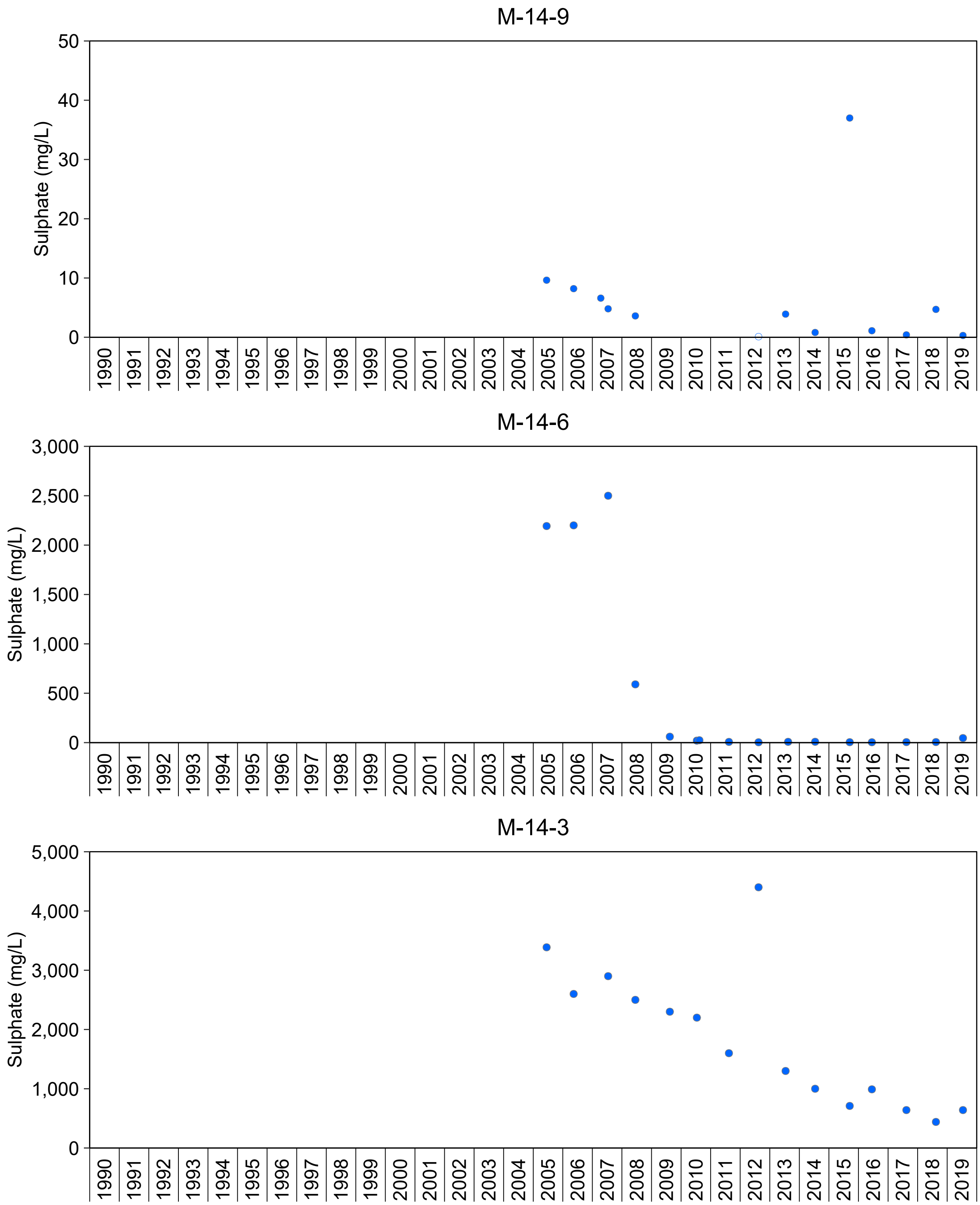

Figure I.17: Concentrations of Sulphate for TOMP Groundwater Stations, Lacnor/Nordic TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL.
See Table 6.6 for Kendall trend analysis results and Appendix Tables I.19 to I.29 for raw data.

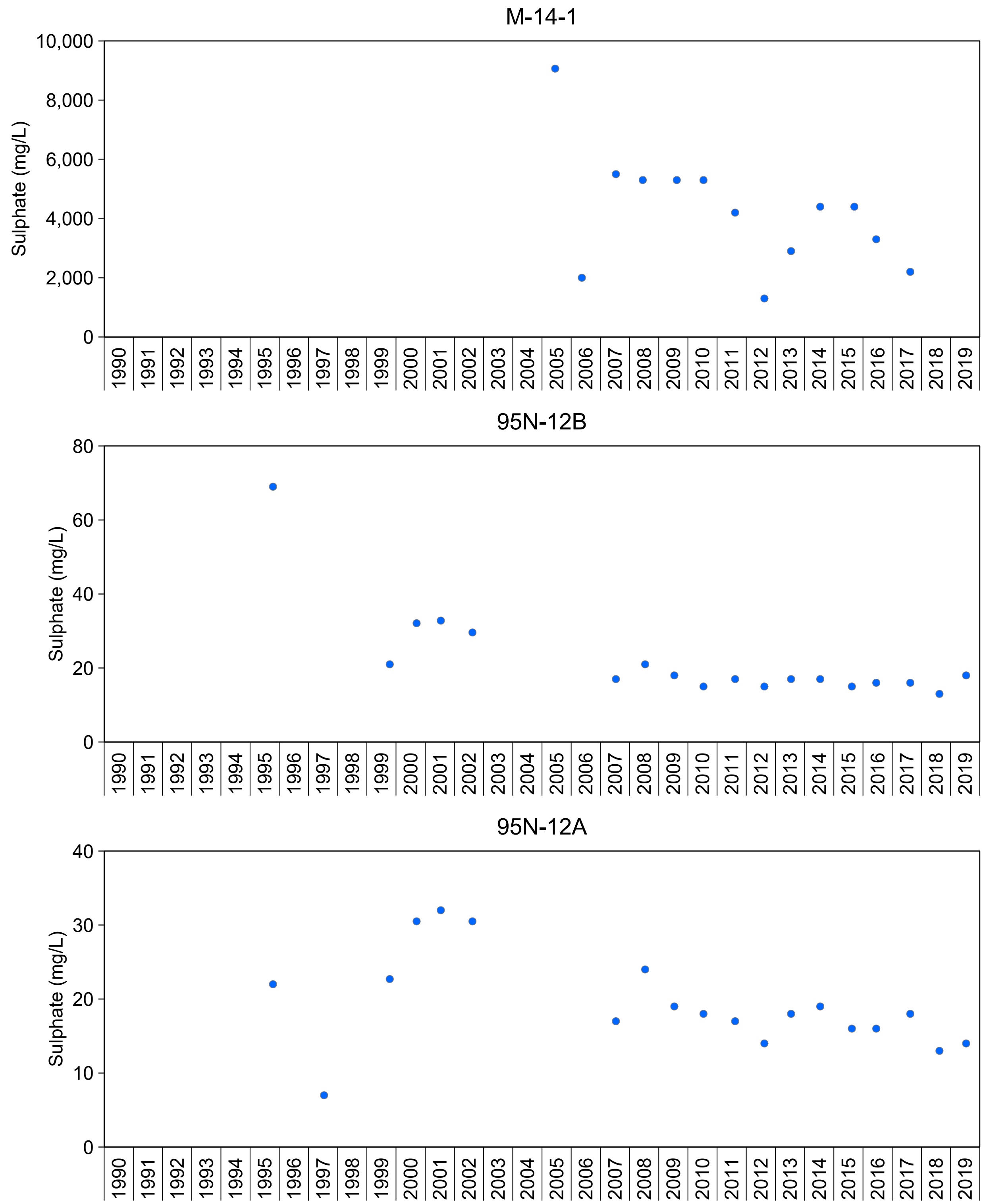

Figure I.17: Concentrations of Sulphate for TOMP Groundwater Stations, Lacnor/Nordic TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL.
See Table 6.6 for Kendall trend analysis results and Appendix Tables I.19 to I.29 for raw data.

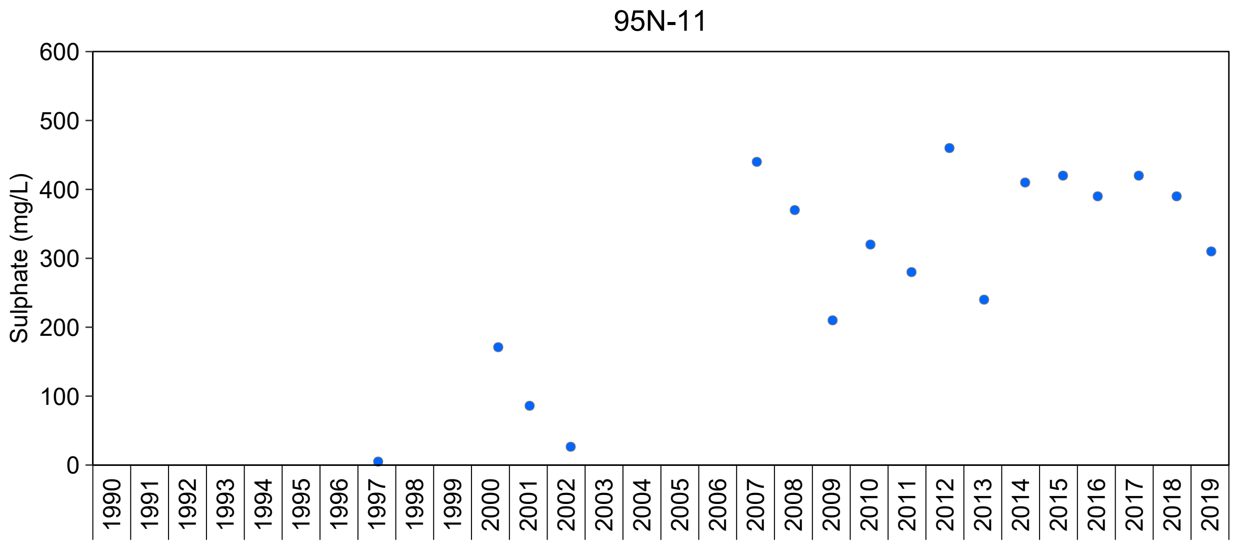

Figure I.17: Concentrations of Sulphate for TOMP Groundwater Stations, Lacnor/Nordic TMA, 1990 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL.
See Table 6.6 for Kendall trend analysis results and Appendix Tables I.19 to I.29 for raw data.

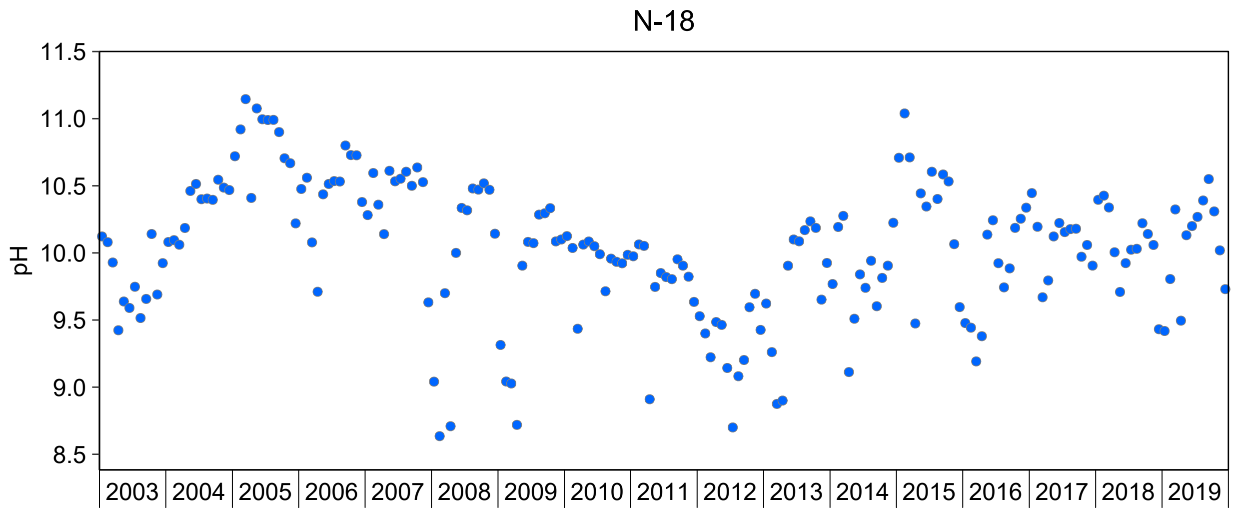

Figure I.18: Time Series Plots for pH Measurements from TOMP Water Monitoring Stations, Lacnor/Nordic TMA, 2003 to 2019

Notes: pH is not included in the trend analysis for TOMP station N-18 because the monitoring is in support of ETP operations. Other stations at this TMA provide more meaningful information regarding trends for this parameter. Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Table I.16 for raw data.

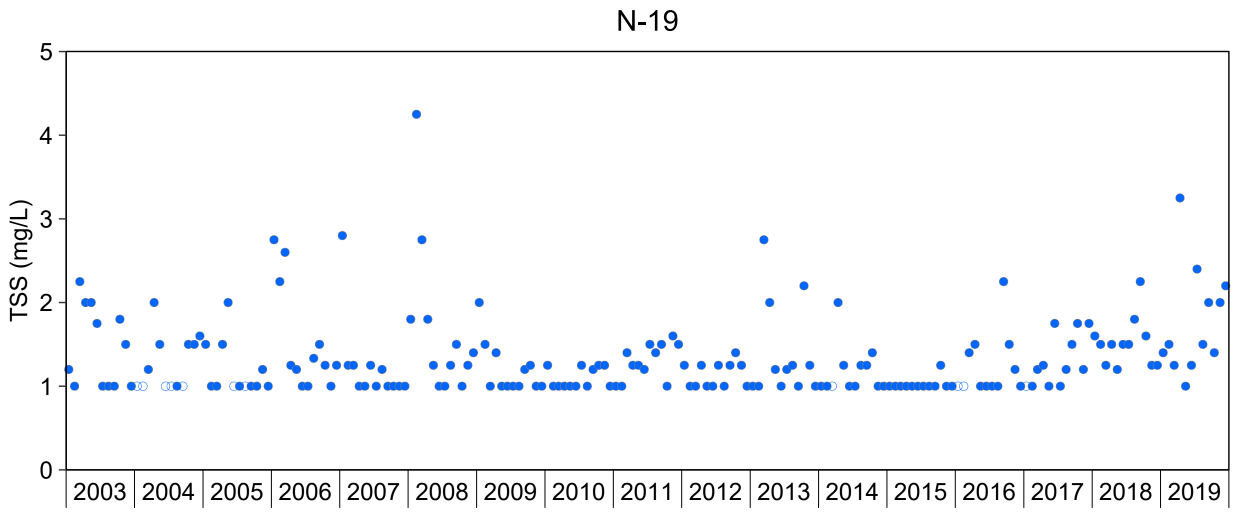

Figure I.19: Concentrations of Total Suspended Solids for TOMP Water Monitoring Stations, Lacnor/Nordic TMA, 2003 to 2019

Notes: TSS is not included in the trend analysis for TOMP station N-19 because the monitoring is in support of ETP operations. Other stations at this TMA provide more meaningful information regarding trends for this parameter. Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Table I.15 for raw data.

Table I.1: Location of TOMP Data Tables and Figures Within this Cycle 5 SOE Report, Lacnor and Nordic TMAs

TMA	TOMP Station	Station Type/Purpose	Also a SAMP Station?	Map Figures	Elevation Tables	Elevation Figures	Water Quality Data Tables (flow, acidity, barium, cobalt, iron, manganese, pH, radium-226, sulphate, uranium, conductivity, TSS, and/or treatment chemical consumption)	Comparison to EIS Predictions Figures	Lime or NaOH Consumption Figures	Barium Chloride Consumption Figures	Comparison to Discharge Criteria Figures	Trend Tables	Water Quality Data Figures										
													Acidity	Barium	Cobalt	Iron	Manganese	pH	Radium-226	Sulphate	Uranium	Conductivity	TSS
Lacnor/Nordic	L-03	Basin performance (primary)	no	6.2	I.30	6.3	I.3	na-p	na	na	na-c	6.4	I.1	I.2	I.3	I.4	I.5	I.6	I.7	I.8	I.9	na	na
	ECA-132	Basin performance (secondary)	no	6.2	I.31	6.3	I.4 to I.5	na-p	na	na	na-c	6.4	I.1	I.2	I.3	I.4	I.5	I.6	I.7	I.8	I.9	na	na
	NWPH	Basin performance (secondary)	no	6.2	na	na	I.6 to I.7	na-p	na	na	na-c	6.4	I.1	I.2	I.3	I.4	I.5	I.6	I.7	I.8	I.9	na	na
	N-22	Basin performance (secondary)	no	6.2	na	na	I.8 to I.9	na-p	na	na	na-c	6.4	I.1	I.2	I.3	I.4	I.5	I.6	I.7	I.8	I.9	na	na
	CPW	Basin performance (secondary)	no	6.2	I.32	6.3	I.10 to I.11	na-p	na	na	na-c	6.4	I.1	I.2	I.3	I.4	I.5	I.6	I.7	I.8	I.9	na	na
	N-20	Basin performance (secondary)	no	6.2	na	na	I.12	na-p	na	na	na-c	6.4	I.1	I.2	I.3	I.4	I.5	I.6	I.7	I.8	I.9	na	na
	ECA-131	Basin performance (secondary)	no	6.2	na	na	I.13	na-p	na	na	na-c	6.4	I.1	I.2	I.3	I.4	I.5	I.6	I.7	I.8	I.9	na	na
	N-17	Basin performance (primary), ETP operations	no	6.2	na	na	I.14	na-p	6.4	na	na-c	6.4	I.1	I.2	I.3	I.4	I.5	I.6	I.7	I.8	I.9	na	na
	N-19	Effluent	no	6.2	na	na	I.15	na-p	na	na	6.5, 6.6	6.4	na	I.2	I.3	I.4	I.5	I.6	I.7	I.8	I.9	na	I.19
	N-18	ETP operations	no	6.2	na	na	I.16	na-p	na	na	na-c	na-t	na	na	na	na	na	I.18	na	na	na	na	na
	UW7-(2,4,6); UW9-(1,2,3)	Pore water	no	6.2	na	na	I.17 to I.18	na-p	na	na	na-c	6.5	I.10	na	na	I.11	na	I.12	na	I.13	na	na	na
	M-12-(1,3,6,9); M-13-(1,3,6,9); M-14-(1,3,6,9); 95N-4(A,B); 95N-7(A,B); 95N-11; 95N-12(A,B); 95N-13(A,C,E); 95N-14(A,B,C); 95N-16(A,C,E); 95N-17(A,B,C)	Groundwater	no	6.2	na	na	I.19 to I.29	na-p	na	na	na-c	6.6	I.14	na	na	I.15	na	I.16	na	I.17	na	na	na

Notes: na = parameter not measured at this station (as per study design); therefore, data presentation is not applicable. na-p = EIS Predictions do not apply to this station (as per study design); therefore, data presentation is not applicable. na-c = discharge criteria do not apply to this station (as per study design); therefore, data presentation is not applicable. na-t = at this station, only one to three parameters (elevation, pH, flow, conductivity, and/or radium-226) are monitored to support ETP operations. Other stations provide more meaningful information regarding trends for these parameters; therefore, data presentation is not applicable.

Table I.2: Nordic Final Point of Control (N-19) Discharge Criteria

Parameter	Units	Discharge Criteria[a]		Action Level	Internal Investigation
		Grab Sample[b]	Mean Monthly [c]		
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	1.1	0.37	0.37	0.2
Iron[d]	mg/L	10	1.0[e]	5	2

[a] Discharge criteria revised as per December 2009 CofA amendment as these are generally more restrictive than CNSC license.

[b] Samples to be collected during periods of discharge.

[c] Arithmetic mean of twelve consecutive samples.

[d] The discharge criteria for iron were updated by the Environmental Compliance Approval (ECA) amendment for the Nordic Facility, September 2020 (MECP 2020). Since this update was approved after the study period, the updated criteria will be used in the Cycle 6 report.

[e] Arithmetic mean of all grab samples collected during calendar month.

Table I.3: Water Quality at TOMP Station L-03 (Basin Performance - Primary), Lacnor/Nordic TMA, 2015 to 2019

Date	Elevation (m)	Flow (L/s)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Acidity (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
4-Feb-15	-	9.10	3.30	230	0.369	66.0	0.0140	0.0148	15.2	0.597	0.0138
6-May-15	374	25.6	3.30	190	0.301	50.0	0.0120	0.00960	9.94	0.309	0.0112
25-Nov-15	374	35.7	3.00	330	0.566	99.0	0.0160	0.0183	21.5	0.600	0.0215
3-Feb-16	374	16.6	3.20	250	0.404	77.0	0.0140	0.0167	14.3	0.369	0.0221
4-May-16	374	35.7	3.10	210	0.382	9.00	0.0110	0.0124	12.0	0.249	0.0143
2-Nov-16	374	30.5	2.90	430	0.764	118	0.0160	0.0169	19.1	0.624	0.0195
8-Feb-17	374	16.6	2.90	290	0.547	91.0	0.0160	0.0176	16.6	0.585	0.0193
3-May-17	374	158	3.10	290	0.446	98.0	0.0130	0.0272	20.4	0.430	0.0417
2-Aug-17	374	2.00	2.80	360	0.539	116	0.0130	0.0234	13.6	0.505	0.0363
1-Nov-17	374	25.0	3.10	300	0.464	88.0	0.0150	0.0202	13.6	0.484	0.0279
8-Feb-18	374	35.7	2.70	250	0.492	86.0	0.0150	0.0184	13.8	0.536	0.0217
14-May-18	374	9.10	3.30	140	0.259	175	0.0110	0.00760	5.01	0.194	0.0107
7-Nov-18	375	141	3.00	310	0.630	89.0	0.0190	0.0196	17.7	0.594	0.0223
1-May-19	374	72.2	3.90	69.0	0.181	22.0	0.00800	0.00550	5.06	0.0810	0.00620
7-Feb-19	374	5.90	3.10	310	0.612	98.0	0.0160	0.0251	18.2	0.554	0.0290
7-Aug-19	374	25.6	3.00	290	0.681	83.0	0.0190	0.0189	8.78	0.486	0.0268
6-Nov-19	374	27.0	3.30	280	0.553	71.0	0.0170	0.0179	15.1	0.483	0.0230
n	39	17	17	17	17	17	17	17	17	17	17
Minimum	374	2.00	2.70	69.0	0.181	9.00	0.00800	0.00550	5.01	0.0810	0.00620
Maximum	375	158	3.90	430	0.764	175	0.0190	0.0272	21.5	0.624	0.0417
Mean	374	39.5	3.12	266	0.482	84.5	0.0144	0.0171	14.1	0.452	0.0216
SD	0.158	44.5	0.270	83.7	0.154	37.4	0.00290	0.00580	4.83	0.159	0.00913
Median	374	25.6	3.10	290	0.492	88.0	0.0150	0.0179	14.3	0.486	0.0217
10th Percentile	374	5.90	2.80	140	0.259	22.0	0.0110	0.00760	5.06	0.194	0.0107
95th Percentile	374	158	3.90	430	0.764	175	0.0190	0.0272	21.5	0.624	0.0417

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table I.4: Water Quality at TOMP Station ECA-132 (Basin Performance - Secondary), Lacnor/Nordic TMA, 2015 to 2019

Date	Elevation (m)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Acidity (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
28-Jan-15	342	6.64	-	-	-	-	-	-	-	-
28-Feb-15	342	6.48	-	-	-	-	-	-	-	-
28-Mar-15	341	6.42	-	-	-	-	-	-	-	-
28-Apr-15	342	6.23	-	-	-	-	-	-	-	-
6-May-15	-	6.69	58.0	0.812	<1.00	0.0180	0.00660	0.570	0.206	0.00110
28-May-15	342	6.79	-	-	-	-	-	-	-	-
30-Jun-15	342	6.50	-	-	-	-	-	-	-	-
28-Jul-15	341	7.15	-	-	-	-	-	-	-	-
4-Nov-15	-	7.15	130	0.470	<1.00	0.0280	0.00110	0.969	0.0420	0.00100
28-Dec-15	342	6.40	-	-	-	-	-	-	-	-
28-Jan-16	342	6.78	-	-	-	-	-	-	-	-
28-Mar-16	342	6.87	-	-	-	-	-	-	-	-
28-Apr-16	342	7.42	-	-	-	-	-	-	-	-
27-May-16	342	7.23	-	-	-	-	-	-	-	-
29-Jun-16	-	7.10	150	0.578	<1.00	0.0190	0.00130	0.298	0.0960	<0.000500
28-Jul-16	341	7.76	-	-	-	-	-	-	-	-
29-Aug-16	341	6.85	-	-	-	-	-	-	-	-
28-Sep-16	341	7.10	-	-	-	-	-	-	-	-
28-Oct-16	341	8.30	-	-	-	-	-	-	-	-
2-Nov-16	-	7.70	160	0.485	<1.00	0.0230	<0.000500	0.531	0.0190	0.00160
29-Dec-16	341	7.50	-	-	-	-	-	-	-	-
30-Jan-17	341	7.00	-	-	-	-	-	-	-	-
28-Feb-17	342	6.60	-	-	-	-	-	-	-	-
28-Mar-17	342	7.00	-	-	-	-	-	-	-	-
28-Apr-17	342	7.10	-	-	-	-	-	-	-	-
3-May-17	-	6.90	94.0	0.637	<1.00	0.0200	0.00430	0.630	0.142	0.00190
28-May-17	342	6.90	-	-	-	-	-	-	-	-
28-Jun-17	342	7.40	-	-	-	-	-	-	-	-
28-Jul-17	342	7.30	-	-	-	-	-	-	-	-
28-Aug-17	342	7.10	-	-	-	-	-	-	-	-
28-Sep-17	341	7.20	-	-	-	-	-	-	-	-
28-Oct-17	342	7.20	-	-	-	-	-	-	-	-
1-Nov-17	-	6.80	100	0.517	<1.00	0.0200	0.00230	0.763	0.0650	0.00140
28-Nov-17	342	7.10	-	-	-	-	-	-	-	-
28-Dec-17	342	6.90	-	-	-	-	-	-	-	-
28-Jan-18	342	6.80	-	-	-	-	-	-	-	-
28-Feb-18	341	6.90	-	-	-	-	-	-	-	-
28-Mar-18	341	6.50	-	-	-	-	-	-	-	-
28-Apr-18	342	6.30	-	-	-	-	-	-	-	-
14-May-18	-	6.40	53.0	0.681	<1.00	0.0180	0.00450	0.528	0.159	0.00120
28-May-18	342	7.40	-	-	-	-	-	-	-	-
28-Jun-18	342	7.00	-	-	-	-	-	-	-	-
28-Jul-18	342	7.00	-	-	-	-	-	-	-	-
28-Aug-18	342	7.30	-	-	-	-	-	-	-	-
28-Sep-18	342	7.20	-	-	-	-	-	-	-	-
28-Oct-18	342	7.20	-	-	-	-	-	-	-	-
7-Nov-18	-	6.60	110	0.507	<1.00	0.0240	0.00130	0.834	0.0410	0.000600
28-Nov-18	341	6.80	-	-	-	-	-	-	-	-
28-Dec-18	341	6.40	-	-	-	-	-	-	-	-
28-Jan-19	342	6.60	-	-	-	-	-	-	-	-
28-Feb-19	342	6.60	-	-	-	-	-	-	-	-
28-Mar-19	341	6.70	-	-	-	-	-	-	-	-
28-Apr-19	343	6.00	-	-	-	-	-	-	-	-
1-May-19	-	5.90	31.0	0.446	<1.00	0.0120	0.00330	0.372	0.0640	0.00160
28-May-19	342	7.00	-	-	-	-	-	-	-	-
28-Jun-19	342	7.00	-	-	-	-	-	-	-	-
28-Jul-19	341	7.00	-	-	-	-	-	-	-	-
28-Aug-19	341	7.30	-	-	-	-	-	-	-	-
25-Sep-19	341	7.40	-	-	-	-	-	-	-	-
28-Oct-19	341	6.90	-	-	-	-	-	-	-	-
6-Nov-19	-	6.70	130	0.553	<1.00	0.0270	0.00390	1.75	0.107	0.00100
28-Dec-19	342	6.70	-	-	-	-	-	-	-	-
n	52	62	10	10	10	10	10	10	10	10
Minimum	341	5.90	31.0	0.446	<1.00	0.0120	<0.000500	0.298	0.0190	<0.000500
Maximum	343	8.30	160	0.812	<1.00	0.0280	0.00660	1.75	0.206	0.00190
Mean	342	6.92	102	0.569	<1.00	0.0209	0.00291	0.724	0.0941	0.00119
SD	0.368	0.420	43.1	0.113	-	0.00475	0.00188	0.414	0.0597	0.000432
Median	342	6.90	105	0.535	<1.00	0.0200	0.00280	0.600	0.0805	0.00115
10th Percentile	341	6.40	42.0	0.458	<1.00	0.0150	0.000800	0.335	0.0300	0.000550
95th Percentile	342	7.50	160	0.812	<1.00	0.0280	0.00660	1.75	0.206	0.00190

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected, or SD was incalculable because there was no variability in the data. Monthly discharge data from TOMP Station ECA-132 are provided in Table I.5.

Table I.5: Monthly Discharge at TOMP Station ECA-132 (Basin Performance - Secondary), Lacnor/Nordic TMA, 2015 to 2019

Date	Monthly discharge (L/month)
28-Jan-15	13,900,000
28-Feb-15	12,600,000
28-Mar-15	13,900,000
28-Apr-15	13,500,000
28-May-15	13,900,000
30-Jun-15	11,200,000
28-Jul-15	0
28-Dec-15	7,900,000
28-Jan-16	0
28-Mar-16	6,510,000
28-Apr-16	13,500,000
27-May-16	8,310,000
28-Jul-16	0
29-Aug-16	0
28-Sep-16	0
28-Oct-16	0
29-Dec-16	0
30-Jan-17	0
28-Feb-17	0
28-Mar-17	10,300,000
28-Apr-17	45,600,000
28-May-17	3,800,000
28-Jun-17	0
28-Jul-17	0
28-Aug-17	7,870,000
28-Sep-17	12,900,000
28-Oct-17	8,560,000
28-Nov-17	10,700,000
28-Dec-17	5,220,000
28-Jan-18	6,840,000
28-Feb-18	3,140,000
28-Mar-18	1,800,000
28-Apr-18	0
28-May-18	6,900,000
28-Jun-18	0
28-Jul-18	0
28-Aug-18	0
28-Sep-18	0
28-Oct-18	4,060,000
28-Nov-18	9,870,000
28-Dec-18	491,000
28-Jan-19	0
28-Feb-19	0
28-Mar-19	9,370,000
28-Apr-19	11,900,000
28-May-19	19,000,000
28-Jun-19	17,400,000
28-Jul-19	17,400,000
28-Aug-19	3,140,000
25-Sep-19	1,550,000
28-Oct-19	0
28-Dec-19	3,080,000
n	52
Minimum	0
Maximum	45,600,000
Mean	6,470,000
SD	8,060,000
Median	3,930,000
10th Percentile	0
95th Percentile	17,400,000

Note: "SD" = standard deviation. "n" = number of samples. Water quality data from TOMP Station ECA-132 for other parameters are provided in Table I.4.

Table I.6: Water Quality at TOMP Station NWPH (Basin Performance - Secondary), Lacnor/Nordic TMA, 2015 to 2019

Date	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Acidity (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
6-May-15	6.08	200	0.302	<1.00	0.0230	0.00140	5.45	0.181	0.000800
4-Nov-15	6.64	210	0.377	<1.00	0.0260	0.00170	6.92	0.243	0.000700
4-May-16	6.25	100	0.678	12.0	0.0220	0.00460	1.12	0.169	0.00140
2-Nov-16	6.50	260	0.541	<1.00	0.0290	0.00230	8.16	0.345	0.000900
3-May-17	6.60	100	0.179	<1.00	0.0250	0.000800	1.62	0.0760	0.000800
1-Nov-17	6.70	160	0.339	<1.00	0.0280	0.00110	3.46	0.155	0.00100
14-May-18	6.40	58.0	0.618	<1.00	0.0190	0.00390	0.658	0.137	0.00100
7-Nov-18	6.80	130	0.378	<1.00	0.0270	0.00170	3.04	0.123	0.000700
1-May-19	6.30	34.0	0.363	<1.00	0.0120	0.00250	0.479	0.0540	0.00130
6-Nov-19	6.80	190	0.349	<1.00	0.0290	0.00190	7.02	0.267	0.00110
n	10	10	10	10	10	10	10	10	10
Minimum	6.08	34.0	0.179	<1.00	0.0120	0.000800	0.479	0.0540	0.000700
Maximum	6.80	260	0.678	12.0	0.0290	0.00460	8.16	0.345	0.00140
Mean	6.51	144	0.412	2.10	0.0240	0.00219	3.79	0.175	0.000970
SD	0.244	72.2	0.153	-	0.00531	0.00121	2.89	0.0889	0.000241
Median	6.55	145	0.370	<1.00	0.0255	0.00180	3.25	0.162	0.000950
10th Percentile	6.16	46.0	0.241	<1.00	0.0155	0.000950	0.569	0.0650	0.000700
95th Percentile	6.80	260	0.678	12.0	0.0290	0.00460	8.16	0.345	0.00140

Note: "SD" = standard deviation. "n" = number of samples. "-" = SD was incalculable because there was no variability in the data. Monthly discharge data from TOMP Station NWPH are provided in Table I.7.

Table I.7: Monthly Discharge at TOMP Station NWPH (Basin Performance - Secondary), Lacnor/Nordic TMA, 2015 to 2019

Date	Monthly discharge (L/month)
28-Jan-15	8,500,000
28-Feb-15	8,300,000
28-Mar-15	14,500,000
28-Apr-15	12,100,000
28-May-15	9,000,000
30-Jun-15	22,400,000
28-Jul-15	12,000,000
28-Aug-15	5,310,000
28-Sep-15	5,380,000
28-Oct-15	4,250,000
28-Nov-15	6,960,000
28-Dec-15	16,300,000
28-Jan-16	28,500,000
26-Feb-16	25,100,000
28-Mar-16	24,800,000
28-Apr-16	25,600,000
27-May-16	11,700,000
28-Jun-16	5,420,000
28-Jul-16	4,900,000
29-Aug-16	4,910,000
28-Sep-16	4,550,000
28-Oct-16	5,010,000
28-Nov-16	4,550,000
29-Dec-16	4,800,000
30-Jan-17	4,740,000
28-Feb-17	4,490,000
28-Mar-17	5,640,000
28-Apr-17	21,800,000
28-May-17	8,730,000
28-Jun-17	11,500,000
28-Jul-17	10,800,000
28-Aug-17	10,600,000
28-Sep-17	7,470,000
28-Oct-17	6,760,000

Date	Monthly discharge (L/month)
28-Nov-17	16,600,000
28-Dec-17	25,700,000
28-Jan-18	27,100,000
28-Feb-18	16,900,000
28-Mar-18	9,540,000
28-Apr-18	5,010,000
28-May-18	16,100,000
28-Jun-18	8,780,000
28-Jul-18	7,330,000
28-Aug-18	5,450,000
28-Sep-18	5,900,000
28-Oct-18	6,020,000
28-Nov-18	16,500,000
28-Dec-18	7,910,000
28-Jan-19	4,950,000
28-Feb-19	4,490,000
28-Mar-19	6,990,000
28-Apr-19	12,300,000
28-May-19	33,000,000
28-Jun-19	17,400,000
28-Jul-19	9,880,000
28-Aug-19	9,230,000
25-Sep-19	6,640,000
28-Oct-19	4,780,000
27-Nov-19	5,150,000
28-Dec-19	11,800,000
n	60
Minimum	4,250,000
Maximum	33,000,000
Mean	11,100,000
SD	7,380,000
Median	8,620,000
10th Percentile	4,760,000
95th Percentile	26,400,000

Note: "SD" = standard deviation. "n" = number of samples. Water quality data from TOMP Station NWPH for other parameters are provided in Table I.6.

Table I.8: Water Quality at TOMP Station N-22 (Basin Performance - Secondary), Lacnor/Nordic TMA, 2015 to 2019

Date	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Acidity (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
6-May-15	3.10	690	0.219	259	0.00900	0.118	60.7	0.312	0.0283
4-Nov-15	2.98	670	0.328	276	0.0140	0.127	75.1	0.365	0.0221
4-May-16	3.27	420	0.238	10.0	0.0130	0.0657	28.2	0.183	0.0173
2-Nov-16	3.30	890	0.554	368	0.0190	0.0914	87.5	0.257	0.0196
3-May-17	3.30	550	0.130	118	0.0100	0.0593	24.1	0.259	0.0140
1-Nov-17	4.30	590	0.0520	37.0	0.00900	0.0208	8.48	0.238	0.00280
14-May-18	3.00	550	0.266	168	0.0100	0.0702	31.8	0.201	0.0193
7-Nov-18	3.30	830	0.490	319	0.0150	0.0993	80.8	0.319	0.0257
1-May-19	5.70	220	0.0260	11.0	0.00700	0.0130	7.39	0.176	0.00200
6-Nov-19	3.40	640	0.366	186	0.0160	0.0852	63.7	0.365	0.0244
n	10	10	10	10	10	10	10	10	10
Minimum	2.98	220	0.0260	10.0	0.00700	0.0130	7.39	0.176	0.00200
Maximum	5.70	890	0.554	368	0.0190	0.127	87.5	0.365	0.0283
Mean	3.56	605	0.267	175	0.0122	0.0750	46.8	0.268	0.0176
SD	0.837	192	0.174	130	0.00379	0.0375	30.2	0.0704	0.00900
Median	3.30	615	0.252	177	0.0115	0.0777	46.2	0.258	0.0195
10th Percentile	2.99	320	0.0390	10.5	0.00800	0.0169	7.94	0.180	0.00240
95th Percentile	5.70	890	0.554	368	0.0190	0.127	87.5	0.365	0.0283

Note: "SD" = standard deviation. "n" = number of samples. Monthly discharge data from TOMP Station N-22 are provided in Table J.9.

Table I.9: Monthly Discharge at TOMP Station N-22 (Basin Performance - Secondary), Lacnor/Nordic TMA, 2015 to 2019

Date	Monthly discharge (L/month)
28-Jan-15	1,820,000
28-Feb-15	970,000
28-Mar-15	703,000
28-Apr-15	3,120,000
28-May-15	2,220,000
30-Jun-15	1,350,000
28-Jul-15	700,000
28-Aug-15	712,000
28-Sep-15	710,000
28-Oct-15	539,000
28-Nov-15	2,450,000
28-Dec-15	5,420,000
28-Jan-16	2,110,000
26-Feb-16	917,000
28-Mar-16	2,450,000
28-Apr-16	4,510,000
27-May-16	1,410,000
28-Jun-16	771,000
28-Jul-16	632,000
29-Aug-16	518,000
28-Sep-16	444,000
28-Oct-16	615,000
28-Nov-16	1,410,000
29-Dec-16	776,000
30-Jan-17	775,000
28-Feb-17	766,000
28-Mar-17	2,370,000
28-Apr-17	6,550,000
28-May-17	1,300,000
28-Jun-17	1,730,000
28-Jul-17	1,430,000
28-Aug-17	1,350,000
28-Sep-17	952,000
28-Oct-17	2,190,000
28-Nov-17	3,430,000
28-Dec-17	2,990,000
28-Jan-18	1,550,000
28-Feb-18	890,000
28-Mar-18	649,000

Date	Monthly discharge (L/month)
28-Apr-18	1,490,000
28-May-18	3,680,000
28-Jun-18	1,250,000
28-Jul-18	968,000
28-Aug-18	635,000
28-Sep-18	706,000
28-Oct-18	973,000
28-Nov-18	2,020,000
28-Dec-18	1,330,000
28-Jan-19	1,010,000
28-Feb-19	823,000
28-Mar-19	1,330,000
28-Apr-19	5,790,000
28-May-19	5,860,000
28-Jun-19	2,050,000
28-Jul-19	1,070,000
28-Aug-19	811,000
25-Sep-19	616,000
28-Oct-19	1,850,000
27-Nov-19	2,490,000
28-Dec-19	2,020,000
n	60
Minimum	444,000
Maximum	6,550,000
Mean	1,750,000
SD	1,420,000
Median	1,330,000
10th Percentile	634,000
95th Percentile	5,600,000

Note: "SD" = standard deviation. "n" = number of samples. Water quality data from TOMP Station N-22 for other parameters are provided in Table I.8.

Table I.10: Water Quality at TOMP Station CPW (Basin Performance - Secondary), Lacnor/Nordic TMA, 2015 to 2019

Date	Elevation (m)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Acidity (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
7-Jan-15	335	7.40	-	-	-	-	-	-	-	-
4-Feb-15	335	7.40	-	-	-	-	-	-	-	-
4-Mar-15	335	7.43	-	-	-	-	-	-	-	-
24-Apr-15	-	6.04	-	-	-	-	-	-	-	-
6-May-15	335	6.40	510	0.0220	<1.00	0.0100	0.0171	4.59	0.328	<0.000500
3-Jun-15	335	8.90	-	-	-	-	-	-	-	-
8-Jul-15	335	7.10	-	-	-	-	-	-	-	-
5-Aug-15	334	7.60	-	-	-	-	-	-	-	-
2-Sep-15	334	7.40	-	-	-	-	-	-	-	-
8-Oct-15	334	9.40	-	-	-	-	-	-	-	-
4-Nov-15	335	6.81	750	0.0110	<1.00	0.00700	0.00710	2.60	0.122	0.00100
2-Dec-15	335	6.75	-	-	-	-	-	-	-	-
6-Jan-16	335	10.8	-	-	-	-	-	-	-	-
3-Feb-16	335	10.9	-	-	-	-	-	-	-	-
2-Mar-16	335	6.80	-	-	-	-	-	-	-	-
6-Apr-16	335	7.75	-	-	-	-	-	-	-	-
28-Apr-16	335	6.87	-	-	-	-	-	-	-	-
4-May-16	335	5.46	550	<0.00800	9.00	0.00900	0.0142	4.73	0.229	<0.000500
1-Jun-16	335	6.06	-	-	-	-	-	-	-	-
7-Jul-16	334	7.70	-	-	-	-	-	-	-	-
3-Aug-16	334	7.37	-	-	-	-	-	-	-	-
7-Sep-16	334	7.07	-	-	-	-	-	-	-	-
5-Oct-16	334	6.97	-	-	-	-	-	-	-	-
2-Nov-16	335	10.8	780	0.0140	<1.00	0.00700	<0.000500	0.158	0.00300	<0.000500
7-Dec-16	335	6.80	-	-	-	-	-	-	-	-
4-Jan-17	335	7.00	-	-	-	-	-	-	-	-
8-Feb-17	335	6.70	-	-	-	-	-	-	-	-
2-Mar-17	335	6.90	-	-	-	-	-	-	-	-
5-Apr-17	335	6.80	-	-	-	-	-	-	-	-
3-May-17	335	6.90	660	0.0300	<1.00	0.00900	0.0177	3.96	0.438	<0.000500
7-Jun-17	335	6.70	-	-	-	-	-	-	-	-
5-Jul-17	335	6.50	-	-	-	-	-	-	-	-
2-Aug-17	335	8.50	-	-	-	-	-	-	-	-
6-Sep-17	335	7.10	-	-	-	-	-	-	-	-
4-Oct-17	335	6.90	-	-	-	-	-	-	-	-
1-Nov-17	335	6.60	570	0.0140	7.00	0.00900	0.0115	2.92	0.239	<0.000500
6-Dec-17	365	6.30	-	-	-	-	-	-	-	-
4-Jan-18	335	6.90	-	-	-	-	-	-	-	-
7-Feb-18	335	9.00	-	-	-	-	-	-	-	-
7-Mar-18	335	9.20	-	-	-	-	-	-	-	-
5-Apr-18	335	9.70	-	-	-	-	-	-	-	-
14-May-18	335	6.80	480	0.0130	<1.00	0.00900	0.00790	1.45	0.177	<0.000500
6-Jun-18	335	6.40	-	-	-	-	-	-	-	-
5-Jul-18	334	7.40	-	-	-	-	-	-	-	-
1-Aug-18	334	7.20	-	-	-	-	-	-	-	-
5-Sep-18	334	7.00	-	-	-	-	-	-	-	-
3-Oct-18	334	6.90	-	-	-	-	-	-	-	-
7-Nov-18	335	10.7	650	0.0150	<1.00	0.00700	0.000500	0.234	0.00500	<0.000500
5-Dec-18	335	10.4	-	-	-	-	-	-	-	-
2-Jan-19	335	9.80	-	-	-	-	-	-	-	-
6-Feb-19	335	9.70	-	-	-	-	-	-	-	-
13-Mar-19	335	8.80	-	-	-	-	-	-	-	-
3-Apr-19	335	7.40	-	-	-	-	-	-	-	-
22-May-19	335	6.60	500	0.0140	13.0	0.00800	0.0134	7.29	0.306	<0.000500
5-Jun-19	335	6.10	-	-	-	-	-	-	-	-
3-Jul-19	335	7.00	-	-	-	-	-	-	-	-
7-Aug-19	334	7.10	-	-	-	-	-	-	-	-
4-Sep-19	334	6.90	-	-	-	-	-	-	-	-
2-Oct-19	335	7.20	-	-	-	-	-	-	-	-
6-Nov-19	335	6.80	540	0.0210	<1.00	0.0100	0.0105	1.65	0.288	<0.000500
4-Dec-19	335	6.60	-	-	-	-	-	-	-	-
n	58	57	6	6	6	6	6	6	6	6
Minimum	334	5.46	480	<0.00800	<1.00	0.00700	<0.000500	0.158	0.00300	<0.000500
Maximum	365	10.9	780	0.0220	13.0	0.0100	0.0171	7.29	0.328	<0.000500
Mean	335	7.53	565	0.0142	5.33	0.00867	0.0108	3.52	0.214	<0.000500
SD	3.95	1.31	110	0.00354	2.71	0.00103	0.00373	2.56	0.117	-
Median	335	7.07	530	0.0140	4.00	0.00900	0.0124	3.76	0.234	<0.000500
10th Percentile	334	6.40	480	<0.0130	<1.00	0.00700	<0.00790	0.158	0.00300	<0.000500
95th Percentile	335	10.8	780	0.0220	13.0	0.0100	0.0171	7.29	0.328	<0.000500

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected, or SD was incalculable because there was no variability in the data. Monthly discharge data from TOMP Station CPW are provided in Table I.11.

Table I.11: **Monthly Discharge at TOMP Station CPW (Basin Performance - Secondary), Lacnor/Nordic TMA, 2015 to 2019**

Date	Monthly discharge (L/month)
28-Jan-15	346,000
28-Feb-15	0
28-Mar-15	0
28-Apr-15	1,210,000
28-May-15	346,000
30-Jun-15	0
28-Jul-15	0
28-Nov-15	455,000
28-Dec-15	1,960,000
28-Jan-16	380,000
28-Mar-16	612,000
28-Apr-16	1,240,000
4-May-16	0
28-Jul-16	0
29-Aug-16	0
28-Sep-16	0
28-Oct-16	0
28-Nov-16	482,000
29-Dec-16	0
30-Jan-17	0
28-Feb-17	0
28-Mar-17	1,260,000
28-Apr-17	2,640,000
28-May-17	341,000
28-Jun-17	154,000
28-Jul-17	175,000
28-Aug-17	163,000
28-Sep-17	0
28-Oct-17	1,020,000
28-Nov-17	668,000
28-Dec-17	1,050,000
28-Jan-18	0
28-Apr-18	531,000
28-May-18	1,410,000
28-Jun-18	0

Date	Monthly discharge (L/month)
28-Jul-18	0
28-Aug-18	0
28-Sep-18	0
28-Oct-18	0
28-Nov-18	382,000
28-Dec-18	163,000
28-Jan-19	0
28-Feb-19	0
28-Mar-19	344,000
28-Apr-19	3,330,000
28-May-19	1,410,000
28-Jun-19	325,000
28-Jul-19	0
28-Aug-19	0
25-Sep-19	0
28-Oct-19	679,000
27-Nov-19	648,000
28-Dec-19	476,000
n	53
Minimum	0
Maximum	3,330,000
Mean	457,000
SD	696,000
Median	163,000
10th Percentile	0
95th Percentile	1,960,000

Note: "SD" = standard deviation. "n" = number of samples. Water quality data from TOMP Station CPW are pr
Table I.10.

Table I.12: Water Quality at TOMP Station N-20 (Basin Performance - Secondary), Lacnor/Nordic TMA, 2015 to 2019

Date	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Acidity (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
4-Feb-15	7.10	3.50	0.00700	<1.00	0.00800	0.000700	0.380	0.276	<0.000500
6-May-15	7.00	3.60	<0.00500	<1.00	0.0100	0.000700	0.510	0.230	<0.000500
5-Aug-15	6.10	3.60	<0.00800	<1.00	0.0110	0.00200	0.610	1.13	<0.000500
25-Nov-15	6.50	3.90	<0.00800	<1.00	0.00800	0.000600	0.351	0.145	<0.000500
3-Feb-16	6.80	3.90	<0.00800	<1.00	0.00700	0.000800	0.403	0.251	<0.000500
4-May-16	7.20	4.40	<0.00800	<1.00	0.00900	0.000700	0.313	0.203	<0.000500
3-Aug-16	6.70	2.80	0.0100	<1.00	0.00700	0.00100	0.599	0.315	<0.000500
2-Nov-16	6.30	3.70	0.0110	<1.00	0.00800	0.000600	0.396	0.184	<0.000500
8-Feb-17	6.70	3.80	<0.00700	<1.00	0.00800	0.000900	0.500	0.188	<0.000500
3-May-17	6.60	3.20	<0.00700	<1.00	0.0100	<0.000500	0.186	0.0460	<0.000500
2-Aug-17	7.10	1.80	0.00900	<1.00	0.00800	0.000900	0.640	0.175	<0.000500
1-Nov-17	6.60	2.60	<0.00700	<1.00	0.00800	<0.000500	0.290	0.142	<0.000500
8-Feb-18	6.20	3.00	<0.00700	<1.00	0.00800	0.000700	0.535	0.336	<0.000500
2-May-18	6.00	2.30	<0.00700	<1.00	0.00700	0.000600	0.216	0.0830	<0.000500
1-Aug-18	6.60	1.90	0.00800	<1.00	0.00600	0.00130	0.890	1.26	<0.000500
14-Nov-18	6.30	3.20	<0.00700	<1.00	0.00800	<0.000500	0.355	0.135	<0.000500
7-Feb-19	6.30	4.80	0.00700	<1.00	0.00800	0.000500	0.630	0.215	<0.000500
1-May-19	6.60	2.70	<0.00700	<1.00	<0.00500	<0.000500	0.118	0.0410	<0.000500
12-Sep-19	6.10	2.80	<0.00700	<1.00	0.00800	<0.000500	0.311	0.0820	<0.000500
17-Oct-19	6.60	2.10	0.0120	<1.00	0.00800	<0.000500	0.352	0.106	<0.000500
n	20	20	20	20	20	20	20	20	20
Minimum	6.00	1.80	<0.00500	<1.00	<0.00500	<0.000500	0.118	0.0410	<0.000500
Maximum	7.20	4.80	0.0120	<1.00	0.0110	0.00200	0.890	1.26	<0.000500
Mean	6.57	3.18	0.00652	<1.00	0.00800	0.000750	0.429	0.277	<0.000500
SD	0.353	0.815	0.00160	-	0.00124	0.000366	0.185	0.325	-
Median	6.60	3.20	<0.00700	<1.00	0.00800	0.000650	0.388	0.186	<0.000500
10th Percentile	6.10	2.00	<0.00700	<1.00	0.00650	<0.000500	0.201	0.0640	<0.000500
95th Percentile	7.15	4.60	0.0115	<1.00	0.0105	0.00165	0.765	1.19	<0.000500

Note: "SD" = standard deviation. "n" = number of samples. "-" = SD was incalculable because there was no variability in the data.

Table I.13: Water Quality at Station ECA-131 (Basin Performance - Secondary), Lacnor/Nordic TMA, 2015 to 2019

Date	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Acidity (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
4-Feb-15	7.30	6.60	0.00700	<1.00	0.0100	0.000500	0.740	0.204	<0.000500
6-May-15	7.00	7.60	0.00700	<1.00	0.0110	0.000700	1.26	0.170	0.000500
5-Aug-15	6.80	100	0.0230	<1.00	0.0400	0.00100	18.1	0.470	0.00480
25-Aug-15	6.80	23.0	0.0140	<1.00	0.0440	0.000500	6.20	0.292	0.00190
25-Nov-15	6.70	4.40	<0.00800	<1.00	0.00800	<0.000500	0.319	0.0650	<0.000500
3-Feb-16	6.90	4.80	<0.00800	<1.00	0.00900	0.000700	0.554	0.255	<0.000500
4-May-16	7.40	8.70	<0.00800	<1.00	0.0120	<0.000500	0.664	0.111	<0.000500
3-Aug-16	6.50	54.0	<0.00800	<1.00	0.0260	0.00160	11.4	0.303	0.00390
2-Nov-16	6.60	7.60	0.0100	<1.00	0.0110	<0.000500	0.794	0.0660	<0.000500
8-Feb-17	6.80	4.30	<0.00700	<1.00	0.00900	0.000700	0.618	0.189	<0.000500
3-May-17	6.90	3.70	<0.00700	<1.00	0.0100	<0.000500	0.288	0.0540	<0.000500
2-Aug-17	6.50	6.30	<0.00700	<1.00	0.0140	<0.000500	1.47	0.167	<0.000500
6-Sep-17	6.80	8.20	<0.00700	<1.00	0.0150	<0.000500	2.08	0.105	0.000800
1-Nov-17	6.70	4.20	<0.00700	<1.00	0.00800	<0.000500	0.393	0.105	<0.000500
8-Feb-18	6.50	5.00	<0.00700	<1.00	0.00900	0.000600	0.716	0.263	<0.000500
2-May-18	6.30	2.80	<0.00700	<1.00	0.00800	0.000700	0.272	0.112	<0.000500
1-Aug-18	6.80	9.60	0.0110	<1.00	0.0270	<0.000500	2.97	0.177	<0.000500
14-Nov-18	6.80	4.70	<0.00700	<1.00	0.00900	<0.000500	0.407	0.0950	<0.000500
7-Feb-19	6.50	4.60	0.0180	<1.00	0.00800	<0.000500	0.716	0.124	<0.000500
1-May-19	6.70	3.60	0.00700	<1.00	0.00800	<0.000500	0.218	0.0760	<0.000500
12-Sep-19	6.50	3.00	<0.00700	<1.00	0.00700	<0.000500	0.473	0.0490	<0.000500
17-Oct-19	6.70	3.60	<0.00700	<1.00	0.0100	<0.000500	0.466	0.0680	<0.000500
n	22	22	22	22	22	22	22	22	22
Minimum	6.30	2.80	<0.00700	<1.00	0.00700	<0.000500	0.218	0.0490	<0.000500
Maximum	7.40	100	0.0230	<1.00	0.0440	0.00160	18.1	0.470	0.00480
Mean	6.75	12.7	0.00886	<1.00	0.0142	0.000614	2.32	0.160	0.000927
SD	0.258	22.4	0.00441	-	0.0104	0.000262	4.36	0.105	0.00126
Median	6.75	4.90	<0.00700	<1.00	0.0100	<0.000500	0.690	0.118	<0.000500
10th Percentile	6.50	3.60	<0.00700	<1.00	0.00800	<0.000500	0.288	0.0650	<0.000500
95th Percentile	7.30	54.0	0.0180	<1.00	0.0400	0.00100	11.4	0.303	0.00390

Note: "SD" = standard deviation. "n" = number of samples. "-" = SD was incalculable because there was no variability in the data.

Table I.14: Water Quality at TOMP Station N-17 (Basin Performance - Primary, ETP Operations), Lacnor/Nordic TMA, 2015 to 2019

Date	Flow (L/s)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Lime Consumption (kg per month)	Acidity (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
7-Jan-15	53.0	5.40	-	0.136	97.4	-	-	-	-	-	-
4-Feb-15	34.0	5.43	1,500	0.0960	62.09	613	0.0160	0.144	368	1.60	0.0625
4-Mar-15	30.0	5.22	-	0.121	76.29	-	-	-	-	-	-
1-Apr-15	27.0	5.13	-	0.104	63.77	-	-	-	-	-	-
6-May-15	54.0	3.87	1,100	0.199	76.71	455	0.00800	0.125	246	1.32	0.0488
3-Jun-15	60.0	3.79	-	0.203	70.14	-	-	-	-	-	-
8-Jul-15	38.0	5.20	-	0.0910	53.08	-	-	-	-	-	-
5-Aug-15	20.0	5.50	1,600	0.167	57.76	616	0.0220	0.136	375	1.56	0.0544
2-Sep-15	26.0	4.90	-	0.0920	50.13	-	-	-	-	-	-
7-Oct-15	36.0	5.30	-	0.0830	56.8	-	-	-	-	-	-
25-Nov-15	67.0	3.80	860	0.215	72.5	371	0.0160	0.0844	165	1.05	0.0443
16-Dec-15	380	3.60	-	0.401	89.2	-	-	-	-	-	-
6-Jan-16	50.0	4.88	-	0.179	43.9	-	-	-	-	-	-
3-Feb-16	42.3	5.38	1,700	0.115	49.7	654	0.0170	0.127	301	1.51	0.0624
2-Mar-16	26.0	5.13	-	0.219	71.8	-	-	-	-	-	-
6-Apr-16	98.1	4.47	-	0.251	72.6	-	-	-	-	-	-
4-May-16	73.6	4.50	910	0.258	59.22	238	0.00900	0.0808	157	0.988	0.0422
1-Jun-16	37.7	5.38	-	0.150	54.38	-	-	-	-	-	-
6-Jul-16	27.0	5.20	-	0.0740	38.1	-	-	-	-	-	-
3-Aug-16	21.0	4.90	1,600	0.102	53.7	603	0.0150	0.134	370	1.43	0.0584
7-Sep-16	22.0	5.12	-	0.0690	37.5	-	-	-	-	-	-
5-Oct-16	35.6	4.66	1,300	0.143	71.4	533	0.0170	0.113	316	1.22	0.0565
2-Nov-16	40.0	4.30	-	0.225	45.5	-	-	-	-	-	-
7-Dec-16	48.0	3.70	-	0.317	59.5	-	-	-	-	-	-
4-Jan-17	42.0	4.70	-	0.138	43.2	-	-	-	-	-	-
30-Jan-17	44.0	3.70	-	-	43.2	447	-	-	166	-	-
2-Feb-17	39.0	4.20	-	-	58.3	501	-	-	273	-	-
8-Feb-17	32.0	4.40	1,300	0.128	58.3	520	0.00800	0.0768	189	0.940	0.0359
15-Feb-17	27.0	4.70	-	-	58.3	552	-	-	331	-	-
22-Feb-17	42.0	3.70	-	-	58.3	483	-	-	256	-	-
1-Mar-17	73.0	3.50	-	0.297	68.8	-	-	-	-	-	-
5-Apr-17	582	3.60	-	0.292	79.82	-	-	-	-	-	-
3-May-17	149	3.50	420	0.281	62.4	187	0.0100	0.0338	64.8	0.415	0.0334
7-Jun-17	38.0	4.50	-	0.155	66.3	-	-	-	-	-	-
5-Jul-17	50.0	4.30	-	0.177	66.5	-	-	-	-	-	-
2-Aug-17	30.0	4.30	1,300	0.125	67.9	567	0.0190	0.119	166	1.38	0.0681
6-Sep-17	36.0	5.10	-	0.123	51.7	-	-	-	-	-	-
4-Oct-17	32.0	4.70	-	0.170	86.6	-	-	-	-	-	-
1-Nov-17	96.0	3.90	700	0.245	70.7	293	0.0100	0.0516	91.9	0.648	0.0402
6-Dec-17	266	3.60	-	0.282	66.5	-	-	-	-	-	-
3-Jan-18	30.0	5.40	-	0.146	63.9	-	-	-	-	-	-
7-Feb-18	30.0	5.20	1,600	0.130	40.8	745	0.0190	0.138	343	1.74	0.0613
7-Mar-18	29.0	5.40	-	0.107	49.2	-	-	-	-	-	-
4-Apr-18	27.0	5.00	-	0.167	58.3	-	-	-	-	-	-
2-May-18	211	4.30	210	0.234	58.8	82.0	0.00900	0.0182	34.9	0.262	0.0234
6-Jun-18	39.0	5.00	-	0.109	43.3	-	-	-	-	-	-
5-Jul-18	23.0	5.10	-	0.0960	34.1	-	-	-	-	-	-
1-Aug-18	21.0	5.20	1,600	0.0820	46.3	612	0.00800	0.104	367	1.13	0.0344
5-Sep-18	30.0	4.10	-	0.141	29.9	-	-	-	-	-	-
3-Oct-18	25.0	4.50	-	0.150	74.9	-	-	-	-	-	-
7-Nov-18	160	3.40	550	0.537	63.7	181	0.0120	0.0319	57.4	0.470	0.0297
5-Dec-18	46.0	4.40	-	0.226	45.2	-	-	-	-	-	-
2-Jan-19	48.0	4.80	-	0.152	36.8	-	-	-	-	-	-
6-Feb-19	36.0	5.30	1,400	0.105	29.2	581	0.00700	0.0890	295	1.16	0.0402
13-Mar-19	35.0	5.60	-	0.103	53.6	-	-	-	-	-	-
3-Apr-19	66.0	3.70	-	0.443	85.4	-	-	-	-	-	-
8-May-19	78.0	4.30	670	0.253	66.1	258	0.0130	0.0546	127	0.778	0.0325
5-Jun-19	59.0	4.70	-	0.251	66.3	-	-	-	-	-	-
3-Jul-19	54.0	4.50	-	0.151	59.3	-	-	-	-	-	-
7-Aug-19	43.0	5.00	1,400	0.0740	37.5	613	0.0100	0.0298	206	1.29	0.00390
4-Sep-19	41.0	4.70	-	0.112	43.7	-	-	-	-	-	-
2-Oct-19	86.0	3.50	-	0.314	72.9	-	-	-	-	-	-
6-Nov-19	94.0	4.40	700	0.315	69.9	255	0.0160	0.0609	145	0.794	0.0441
4-Dec-19	78.0	4.70	-	0.230	50.7	-	-	-	-	-	-
n	1597	64	20	60	60	24	20	20	24	20	20
Minimum	11.0	3.40	210	0.0690	29.2	82.0	0.00700	0.0182	34.9	0.262	0.00390
Maximum	725	5.60	1,700	0.537	97.4	745	0.0220	0.144	375	1.74	0.0681
Mean	65.3	4.58	1,120	0.184	59.2	457	0.0130	0.0876	225	1.08	0.0438
SD	69.4	0.633	457	0.0955	15.1	180	0.00451	0.0414	109	0.419	0.0158
Median	43.0	4.70	1,300	0.152	59.3	510	0.0125	0.0867	226	1.14	0.0432
10th Percentile	26.0	3.60	485	0.0915	37.8	187	0.00800	0.0309	64.8	0.442	0.0266
95th Percentile	198	5.40	1,650	0.359	86.0	654	0.0205	0.141	370	1.67	0.0653

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table I.15: Water Quality at TOMP Station N-19 (Effluent), Lacnor/Nordic TMA, 2015 to 2019

Date	Flow (L/s)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	TSS (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
7-Jan-15	53.0	7.20	730	0.0770	<1.00	0.0130	0.00220	0.220	0.171	0.00560
14-Jan-15	56.0	7.20	-	0.0880	1.00	-	-	-	-	-
21-Jan-15	39.0	7.10	-	0.0840	<1.00	-	-	-	-	-
27-Jan-15	35.0	7.20	-	0.0690	<1.00	-	-	-	-	-
4-Feb-15	34.0	7.15	720	0.0750	1.00	0.0130	0.00220	0.160	0.179	0.00510
11-Feb-15	35.0	7.15	-	0.0720	1.00	-	-	-	-	-
18-Feb-15	32.0	7.23	-	0.0720	<1.00	-	-	-	-	-
25-Feb-15	26.0	7.30	-	0.0700	<1.00	-	-	-	-	-
4-Mar-15	30.0	7.21	770	0.0630	<1.00	0.0120	0.00210	0.0800	0.169	0.00540
11-Mar-15	28.0	7.50	-	0.0640	<1.00	-	-	-	-	-
18-Mar-15	30.0	7.40	-	0.0760	1.00	-	-	-	-	-
25-Mar-15	30.0	7.40	-	0.0700	<1.00	-	-	-	-	-
1-Apr-15	27.0	7.37	840	0.0640	<1.00	0.0120	0.00230	0.100	0.177	0.00510
8-Apr-15	45.0	7.30	-	0.0680	1.00	-	-	-	-	-
15-Apr-15	370	8.60	-	0.0900	<1.00	-	-	-	-	-
22-Apr-15	273	7.20	-	0.0640	1.00	-	-	-	-	-
29-Apr-15	74.0	7.20	-	0.0670	<1.00	-	-	-	-	-
6-May-15	54.0	7.14	690	0.0900	1.00	0.0120	0.00230	0.510	0.157	0.00440
12-May-15	129	7.38	-	0.0630	<1.00	-	-	-	-	-
20-May-15	45.0	7.50	-	0.0730	<1.00	-	-	-	-	-
27-May-15	87.0	7.24	-	0.0770	1.00	-	-	-	-	-
3-Jun-15	60.0	7.46	730	0.0600	1.00	0.0110	0.00120	0.310	0.122	0.00390
10-Jun-15	100	7.00	-	0.0560	1.00	-	-	-	-	-
17-Jun-15	56.0	7.60	-	0.0770	1.00	-	-	-	-	-
24-Jun-15	50.0	7.70	-	0.0600	1.00	-	-	-	-	-
29-Jun-15	40.0	7.40	-	0.0690	<1.00	-	-	-	-	-
8-Jul-15	38.0	7.50	800	0.0550	1.00	0.0120	0.00100	0.280	0.108	0.00320
15-Jul-15	34.0	7.20	-	0.0710	1.00	-	-	-	-	-
22-Jul-15	30.0	7.38	-	0.0750	1.00	-	-	-	-	-
29-Jul-15	30.0	7.28	-	0.0820	1.00	-	-	-	-	-
5-Aug-15	20.0	7.10	840	0.0610	1.00	0.0120	0.000800	0.370	0.114	0.00360
12-Aug-15	19.0	7.30	-	0.0570	1.00	-	-	-	-	-
17-Aug-15	26.3	7.38	-	0.0610	1.00	-	-	-	-	-
24-Aug-15	30.0	7.21	-	0.0520	1.00	-	-	-	-	-
2-Sep-15	26.0	7.20	930	0.0550	1.00	0.0110	0.000800	0.323	0.102	0.00320
8-Sep-15	26.0	7.87	-	0.0560	<1.00	-	-	-	-	-
16-Sep-15	33.0	7.14	-	0.0610	1.00	-	-	-	-	-
23-Sep-15	37.0	7.44	-	0.0720	<1.00	-	-	-	-	-
30-Sep-15	40.0	7.16	-	0.0650	1.00	-	-	-	-	-
7-Oct-15	36.0	7.28	910	0.0620	<1.00	0.0110	0.000700	0.327	0.0940	0.00320
14-Oct-15	30.0	7.07	-	0.0620	2.00	-	-	-	-	-
21-Oct-15	35.0	7.10	-	0.0450	<1.00	-	-	-	-	-
28-Oct-15	31.0	7.10	-	0.0650	<1.00	-	-	-	-	-
4-Nov-15	109	7.21	-	0.0650	1.00	-	-	-	-	-
11-Nov-15	91.0	7.30	-	0.0710	1.00	-	-	-	-	-
18-Nov-15	84.0	7.23	-	0.0680	<1.00	-	-	-	-	-
25-Nov-15	67.0	7.20	820	0.0740	1.00	0.0110	0.00140	0.419	0.152	0.00420
2-Dec-15	90.0	7.27	-	0.0730	1.00	-	-	-	-	-
9-Dec-15	61.0	7.41	-	0.0940	1.00	-	-	-	-	-
16-Dec-15	380	7.36	740	0.0680	<1.00	0.0110	0.00170	0.326	0.142	0.00560
22-Dec-15	154	7.24	-	0.0790	1.00	-	-	-	-	-
28-Dec-15	100	7.40	-	0.0680	<1.00	-	-	-	-	-
6-Jan-16	50.0	7.23	680	0.0740	<1.00	0.0130	0.00150	0.184	0.146	0.00650
13-Jan-16	46.0	7.40	-	0.0770	<1.00	-	-	-	-	-
20-Jan-16	38.1	7.66	-	0.0800	<1.00	-	-	-	-	-
27-Jan-16	36.0	7.04	-	0.0920	<1.00	-	-	-	-	-
3-Feb-16	42.3	7.31	680	0.0740	<2.00	0.0110	0.00170	0.150	0.151	0.00550
10-Feb-16	31.4	7.30	-	0.0760	<1.00	-	-	-	-	-
17-Feb-16	28.0	7.13	-	0.0760	<1.00	-	-	-	-	-
24-Feb-16	31.0	7.10	-	0.0930	<1.00	-	-	-	-	-
2-Mar-16	26.0	7.00	720	0.0690	<1.00	0.0120	0.00210	0.127	0.171	0.00610
9-Mar-16	33.0	7.17	-	0.101	<1.00	-	-	-	-	-
16-Mar-16	333	8.71	-	0.117	<1.00	-	-	-	-	-
23-Mar-16	100	7.10	-	0.135	2.00	-	-	-	-	-
30-Mar-16	148	7.40	-	0.143	2.00	-	-	-	-	-
6-Apr-16	98.1	7.10	450	0.125	2.00	0.0120	0.00560	1.84	0.184	0.00400
13-Apr-16	58.0	6.91	-	0.120	2.00	-	-	1.11	-	-
20-Apr-16	231	7.16	-	0.0580	<1.00	-	-	0.398	-	-
27-Apr-16	87.3	7.15	-	0.0750	<1.00	-	-	0.304	-	-
4-May-16	73.6	7.15	650	0.0820	<1.00	0.0130	0.00270	0.256	0.190	0.00450
11-May-16	44.4	7.22	-	0.0730	1.00	-	-	0.148	-	-
18-May-16	43.7	7.37	-	0.0790	1.00	-	-	-	-	-
25-May-16	34.4	7.37	-	0.0870	1.00	-	-	-	-	-
1-Jun-16	37.7	7.45	730	0.0850	1.00	0.0130	0.00160	0.160	0.170	0.00380
8-Jun-16	33.2	7.38	-	0.0650	1.00	-	-	-	-	-
15-Jun-16	28.6	7.40	-	0.0650	1.00	-	-	-	-	-
22-Jun-16	26.0	8.02	-	0.0740	1.00	-	-	-	-	-
29-Jun-16	23.0	7.60	-	0.0720	1.00	-	-	-	-	-
6-Jul-16	27.0	7.20	840	0.0680	<1.00	0.0140	0.00120	0.156	0.180	0.00400
13-Jul-16	25.0	7.30	-	0.0680	1.00	-	-	-	-	-
20-Jul-16	23.0	7.30	-	0.0810	1.00	-	-	-	-	-
27-Jul-16	27.0	7.20	-	0.0680	1.00	-	-	-	-	-
3-Aug-16	21.0	7.50	870	0.0740	1.00	0.0140	0.00100	0.220	0.149	0.00370
10-Aug-16	22.0	7.56	-	0.0790	1.00	-	-	-	-	-
17-Aug-16	37.5	7.78	-	0.0680	1.00	-	-	-	-	-
24-Aug-16	37.3	7.83	-	0.0580	<2.00	-	-	-	-	-
31-Aug-16	23.0	7.89	-	0.0520	1.00	-	-	-	-	-
7-Sep-16	22.0	7.04	950	0.0600	2.00	0.0120	0.000900	0.285	0.128	0.00340
14-Sep-16	20.0	7.83	-	0.0500	3.00	-	-	-	-	-
21-Sep-16	23.0	7.16	-	0.0530	2.00	-	-	-	-	-
28-Sep-16	44.0	7.10	-	0.0540	2.00	-	-	-	-	-
5-Oct-16	35.6	7.21	920	0.0620	1.00	0.0130	0.00110	0.390	0.128	0.00350
12-Oct-16	35.0	7.30	-	0.0630	1.00	-	-	-	-	-
19-Oct-16	91.0	7.10	-	0.0580	2.00	-	-	-	-	-
26-Oct-16	40.0	7.30	-	0.0670	2.00	-	-	-	-	-
2-Nov-16	40.0	7.20	930	0.0570	1.00	0.0120	0.00170	0.376	0.158	0.00360
9-Nov-16	40.0	7.50	-	0.0520	2.00	-	-	-	-	-
16-Nov-16	39.0	7.20	-	0.0590	1.00	-	-	-	-	-
23-Nov-16	30.0	7.20	-	0.0520	1.00	-	-	-	-	-
30-Nov-16	58.0	6.90	-	0.0730	1.00	-	-	-	-	-
7-Dec-16	48.0	7.00	900	0.0470	1.00	0.0130	0.00220	0.358	0.202	0.00400
14-Dec-16	38.0	6.90	-	0.0560	<1.00	-	-	-	-	-

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table I.15: Water Quality at TOMP Station N-19 (Effluent), Lacnor/Nordic TMA, 2015 to 2019

Date	Flow (L/s)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	TSS (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
21-Dec-16	45.0	7.00	-	0.0620	<1.00	-	-	-	-	-
29-Dec-16	45.0	7.10	-	0.0660	<1.00	-	-	-	-	-
4-Jan-17	42.0	7.10	880	0.0610	<1.00	0.0130	0.00210	0.200	0.195	0.00350
11-Jan-17	42.0	7.10	-	0.0610	<1.00	-	-	-	-	-
18-Jan-17	43.0	7.10	-	0.0510	<1.00	-	-	-	-	-
25-Jan-17	40.0	7.10	-	0.0560	<1.00	-	-	-	-	-
1-Feb-17	40.0	7.20	-	0.0550	1.00	-	-	-	-	-
8-Feb-17	32.0	7.00	990	0.0570	<1.00	0.0140	0.00230	0.196	0.218	0.00430
15-Feb-17	27.0	7.20	-	0.0500	<1.00	-	-	-	-	-
22-Feb-17	42.0	7.20	-	0.0600	1.00	-	-	-	-	-
1-Mar-17	73.0	7.50	770	0.108	1.00	0.0130	0.00260	0.542	0.179	0.00670
8-Mar-17	144	7.20	-	0.0740	2.00	-	-	-	-	-
15-Mar-17	49.0	7.30	-	0.110	1.00	-	-	-	-	-
22-Mar-17	42.0	7.30	-	0.118	1.00	-	-	-	-	-
29-Mar-17	160	7.40	-	0.0810	1.00	-	-	-	-	-
5-Apr-17	582	7.30	190	0.0900	1.00	0.00900	0.00250	0.832	0.0810	0.00720
12-Apr-17	193	7.00	-	0.0630	2.00	-	-	-	-	-
19-Apr-17	124	7.20	-	0.0560	1.00	-	-	0.398	-	-
26-Apr-17	62.0	7.30	-	0.0770	1.00	-	-	-	-	-
3-May-17	149	7.50	690	0.0680	1.00	0.0110	0.00170	0.296	0.156	0.00480
10-May-17	53.0	7.50	-	0.0620	<1.00	-	-	-	-	-
17-May-17	38.0	7.40	-	0.0680	<1.00	-	-	-	-	-
24-May-17	66.0	7.20	-	0.0580	1.00	-	-	-	-	-
31-May-17	78.0	7.30	-	0.0660	1.00	-	-	-	-	-
7-Jun-17	38.0	7.30	770	0.0740	4.00	0.0120	0.00120	0.303	0.140	0.00430
14-Jun-17	39.0	7.20	-	0.0610	1.00	-	-	-	-	-
21-Jun-17	57.0	7.40	-	0.0560	1.00	-	-	-	-	-
28-Jun-17	47.0	7.50	-	0.0810	1.00	-	-	-	-	-
5-Jul-17	50.0	7.40	760	0.0730	1.00	0.0110	0.000800	0.242	0.106	0.00340
12-Jul-17	57.0	7.30	-	0.0640	1.00	-	-	-	-	-
19-Jul-17	31.0	7.40	-	0.0650	1.00	-	-	-	-	-
26-Jul-17	52.0	7.40	-	0.0650	1.00	-	-	-	-	-
2-Aug-17	30.0	7.30	820	0.0510	1.00	0.0110	0.000800	0.448	0.123	0.00320
9-Aug-17	29.0	7.30	-	0.0530	1.00	-	-	-	-	-
16-Aug-17	46.0	7.30	-	0.0500	2.00	-	-	-	-	-
23-Aug-17	84.0	7.40	-	0.0640	1.00	-	-	-	-	-
30-Aug-17	43.0	7.30	-	0.0490	1.00	-	-	-	-	-
6-Sep-17	36.0	7.20	870	0.0700	1.00	0.0110	0.000900	0.451	0.123	0.00310
13-Sep-17	36.0	7.20	-	0.0530	2.00	-	-	-	-	-
20-Sep-17	32.0	7.20	-	0.0530	1.00	-	-	-	-	-
27-Sep-17	34.0	7.20	-	0.0670	2.00	-	-	-	-	-
4-Oct-17	32.0	7.20	800	0.0460	1.00	0.0120	0.00100	0.483	0.123	0.00330
11-Oct-17	50.0	7.20	-	0.0610	2.00	-	-	-	-	-
18-Oct-17	95.0	7.20	-	0.0640	2.00	-	-	-	-	-
25-Oct-17	430	7.20	-	0.0530	2.00	-	-	-	-	-
1-Nov-17	96.0	7.40	720	0.0620	1.00	0.0100	0.000900	0.369	0.0860	0.00540
8-Nov-17	77.0	7.30	-	0.0640	1.00	-	-	-	-	-
15-Nov-17	72.0	7.30	-	0.0600	1.00	-	-	-	-	-
22-Nov-17	88.0	7.30	-	0.0570	1.00	-	-	-	-	-
29-Nov-17	75.0	7.10	-	0.0680	2.00	-	-	-	-	-
6-Dec-17	266	7.30	680	0.0570	3.00	0.0100	0.00130	0.798	0.105	0.00540
13-Dec-17	75.0	7.40	-	0.0640	2.00	-	-	-	-	-
20-Dec-17	40.0	7.20	-	0.0730	1.00	-	-	0.449	-	-
27-Dec-17	35.0	6.90	-	0.0760	1.00	-	-	-	-	-
3-Jan-18	30.0	7.20	710	0.0650	2.00	0.0120	0.00120	0.449	0.101	0.00540
10-Jan-18	27.0	7.00	-	0.0780	2.00	-	-	-	-	-
17-Jan-18	45.0	7.30	-	0.0800	1.00	-	-	-	-	-
24-Jan-18	30.0	7.30	-	0.0640	1.00	-	-	-	-	-
31-Jan-18	32.0	7.30	-	0.0760	2.00	-	-	-	-	-
7-Feb-18	30.0	7.10	710	0.0960	1.00	0.0120	0.00170	0.529	0.117	0.00520
14-Feb-18	29.0	7.20	-	0.0840	3.00	-	-	-	-	-
21-Feb-18	27.0	7.20	-	0.0670	1.00	-	-	-	-	-
28-Feb-18	27.0	7.20	-	0.0880	1.00	-	-	-	-	-
7-Mar-18	29.0	7.20	680	0.0930	1.00	0.0140	0.00170	0.535	0.130	0.00490
14-Mar-18	28.0	7.30	-	0.0810	1.00	-	-	-	-	-
20-Mar-18	24.0	7.10	-	0.0760	1.00	-	-	-	-	-
28-Mar-18	27.0	7.10	-	0.0610	2.00	-	-	-	-	-
4-Apr-18	27.0	7.10	800	0.0710	1.00	0.0130	0.00140	0.360	0.136	0.00440
11-Apr-18	33.0	7.20	-	0.0820	<1.00	-	-	-	-	-
18-Apr-18	33.0	7.30	-	0.0780	<1.00	-	-	-	-	-
24-Apr-18	154	7.30	-	0.114	3.00	-	-	-	-	-
2-May-18	211	7.30	160	0.0510	<1.00	0.00600	0.000700	0.367	0.0380	0.00510
9-May-18	105	7.20	-	0.0870	2.00	-	-	-	-	-
16-May-18	56.0	7.30	-	0.0840	1.00	-	-	-	-	-
23-May-18	37.0	7.30	-	0.0880	1.00	-	-	-	-	-
30-May-18	35.0	7.40	-	0.0800	<1.00	-	-	-	-	-
6-Jun-18	39.0	7.50	710	0.0640	2.00	0.0120	0.00130	0.280	0.132	0.00310
13-Jun-18	39.0	7.40	-	0.0670	2.00	-	-	-	-	-
21-Jun-18	36.0	7.30	-	0.0910	<1.00	-	-	-	-	-
27-Jun-18	29.0	7.20	-	0.0600	1.00	-	-	-	-	-
5-Jul-18	23.0	7.30	800	0.0680	1.00	0.0140	0.00110	0.223	0.158	0.00320
11-Jul-18	22.0	7.30	-	0.0790	1.00	-	-	-	-	-
18-Jul-18	23.0	7.30	-	0.0720	2.00	-	-	-	-	-
25-Jul-18	23.0	7.30	-	0.0630	2.00	-	-	-	-	-
1-Aug-18	21.0	7.30	960	0.0640	1.00	0.0120	0.00120	0.329	0.163	0.00320
8-Aug-18	19.0	7.50	-	0.0710	2.00	-	-	-	-	-
15-Aug-18	24.0	7.30	-	0.0630	2.00	-	-	-	-	-
22-Aug-18	22.0	7.10	-	0.0680	2.00	-	-	-	-	-
29-Aug-18	27.0	7.00	-	0.0580	2.00	-	-	-	-	-
5-Sep-18	30.0	7.20	890	0.0480	2.00	0.0110	0.00100	0.351	0.129	0.00300
12-Sep-18	25.0	7.30	-	0.0510	1.00	-	-	-	-	-
19-Sep-18	29.0	7.20	-	0.0420	3.00	-	-	-	-	-
25-Sep-18	36.0	7.20	-	0.0420	3.00	-	-	-	-	-
3-Oct-18	25.0	7.20	1,000	0.0590	1.00	0.0100	0.00150	0.490	0.155	0.00340
10-Oct-18	60.0	7.20	-	0.0550	2.00	-	-	-	-	-
17-Oct-18	111	7.40	-	0.0600	1.00	-	-	-	-	-
24-Oct-18	71.0	7.40	-	0.0570	2.00	-	-	-	-	-
31-Oct-18	49.0	7.30	-	0.0660	2.00	-	-	-	-	-
7-Nov-18	160	7.20	870	0.0770	1.00	0.0110	0.00140	0.418	0.139	0.00340
14-Nov-18	61.0	7.30	-	0.0600	1.00	-	-	-	-	-
21-Nov-18	48.0	7.30	-	0.0580	1.00	-	-	-	-	-
28-Nov-18	70.0	7.90	-	0.0630	2.00	-	-	-	-	-
5-Dec-18	46.0	7.50	910	0.0700	2.00	0.0120	0.00140	0.320	0.134	0.00440
12-Dec-18	38.0	7.30	-	0.0650	1.00	-	-	-	-	-

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table I.15: Water Quality at TOMP Station N-19 (Effluent), Lacnor/Nordic TMA, 2015 to 2019

Date	Flow (L/s)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	TSS (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
19-Dec-18	34.0	7.20	-	0.0750	1.00	-	-	-	-	-
27-Dec-18	43.0	7.20	-	0.0660	1.00	-	-	-	-	-
2-Jan-19	48.0	7.20	930	0.0590	1.00	0.0120	0.00160	0.373	0.145	0.00380
9-Jan-19	42.0	7.50	-	0.0670	1.00	-	-	-	-	-
16-Jan-19	35.0	7.20	-	0.0820	1.00	-	-	-	-	-
23-Jan-19	39.0	7.20	-	0.0920	2.00	-	-	-	-	-
30-Jan-19	33.0	7.20	-	0.0720	2.00	-	-	-	-	-
6-Feb-19	36.0	7.20	920	0.0750	1.00	0.0130	0.00180	0.463	0.157	0.00430
13-Feb-19	34.0	7.10	-	0.0820	1.00	-	-	-	-	-
20-Feb-19	37.0	7.40	-	0.0720	2.00	-	-	-	-	-
27-Feb-19	38.0	7.10	-	0.0620	2.00	-	-	-	-	-
4-Mar-19	37.0	7.10	-	0.0800	1.00	-	-	-	-	-
13-Mar-19	35.0	7.30	840	0.0680	1.00	0.0120	0.00210	0.152	0.178	0.00370
20-Mar-19	44.0	7.00	-	0.0780	1.00	-	-	-	-	-
27-Mar-19	51.0	7.20	-	0.108	2.00	-	-	-	-	-
3-Apr-19	66.0	7.20	830	0.144	4.00	0.0150	0.00270	0.977	0.155	0.00620
10-Apr-19	320	7.40	-	0.220	4.00	-	-	-	-	-
17-Apr-19	220	7.00	-	0.121	3.00	-	-	-	-	-
22-Apr-19	350	7.60	-	0.0590	2.00	-	-	-	-	-
1-May-19	127	7.20	-	0.0740	<1.00	-	-	-	-	-
8-May-19	78.0	7.30	480	0.0710	1.00	0.0100	0.00150	0.230	0.0790	0.00380
15-May-19	70.0	7.20	-	0.0690	<1.00	-	-	-	-	-
22-May-19	78.0	7.40	-	0.0930	1.00	-	-	-	-	-
29-May-19	109	7.30	-	0.0750	1.00	-	-	-	-	-
5-Jun-19	59.0	7.40	700	0.0860	2.00	0.0120	0.00120	0.135	0.106	0.00340
12-Jun-19	57.0	7.30	-	0.0870	<1.00	-	-	-	-	-
19-Jun-19	52.0	7.30	-	0.0880	<1.00	-	-	-	-	-
26-Jun-19	133	7.30	-	0.0650	1.00	-	-	-	-	-
3-Jul-19	54.0	7.20	730	0.0980	2.00	0.0120	0.00100	0.284	0.103	0.00350
10-Jul-19	52.0	7.30	-	0.0760	4.00	-	-	-	-	-
17-Jul-19	46.0	7.20	-	0.0800	2.00	-	-	-	-	-
24-Jul-19	46.0	7.10	-	0.0670	2.00	-	-	-	-	-
31-Jul-19	44.0	7.20	-	0.0580	2.00	-	-	-	-	-
7-Aug-19	43.0	7.10	760	0.0630	2.00	0.0110	0.000800	0.210	0.118	0.00280
14-Aug-19	45.0	7.10	-	0.0530	2.00	-	-	-	-	-
21-Aug-19	45.0	7.10	-	0.0550	1.00	-	-	-	-	-
28-Aug-19	42.0	7.10	-	0.0540	1.00	-	-	-	-	-
4-Sep-19	41.0	7.20	870	0.0580	2.00	0.0100	0.000600	0.214	0.0930	0.00300
11-Sep-19	38.0	7.20	-	0.0390	2.00	-	-	-	-	-
18-Sep-19	36.0	7.20	-	0.0510	2.00	-	-	-	-	-
25-Sep-19	45.0	7.30	-	0.0450	2.00	-	-	-	-	-
2-Oct-19	86.0	7.10	810	0.0580	1.00	0.0100	0.000700	0.356	0.0880	0.00340
9-Oct-19	47.0	7.20	-	0.0530	1.00	-	-	-	-	-
16-Oct-19	176	6.90	-	0.0540	2.00	-	-	-	-	-
23-Oct-19	240	7.40	-	0.0620	1.00	-	-	-	-	-
30-Oct-19	105	7.40	-	0.0750	2.00	-	-	-	-	-
6-Nov-19	94.0	7.30	770	0.0640	<2.00	0.0110	0.00110	0.530	0.0970	0.00450
13-Nov-19	52.0	7.40	-	0.0730	2.00	-	-	-	-	-
20-Nov-19	66.0	7.30	-	0.0690	2.00	-	-	-	-	-
27-Nov-19	117	8.10	-	0.0590	2.00	-	-	-	-	-
4-Dec-19	78.0	8.20	690	0.0740	1.00	0.0110	0.000800	0.284	0.0710	0.00740
11-Dec-19	60.0	7.40	-	0.0920	3.00	-	-	-	-	-
18-Dec-19	50.0	7.10	-	0.0840	3.00	-	-	-	-	-
23-Dec-19	49.0	7.00	-	0.0740	2.00	-	-	-	-	-
30-Dec-19	56.0	7.00	-	0.0730	2.00	-	-	-	-	-
n	1199	261	60	261	261	60	60	66	60	60
Minimum	12.0	6.90	160	0.0390	<1.00	0.00600	0.000600	0.0800	0.0380	0.00280
Maximum	700	8.71	1,000	0.220	4.00	0.0150	0.00560	1.84	0.218	0.00740
Mean	66.0	7.28	772	0.0709	1.36	0.0118	0.00153	0.375	0.137	0.00430
SD	65.6	0.225	156	0.0188	0.627	0.00144	0.000783	0.264	0.0362	0.00113
Median	45.0	7.24	785	0.0680	1.00	0.0120	0.00140	0.326	0.138	0.00400
10th Percentile	27.0	7.10	680	0.0530	<1.00	0.0100	0.000800	0.152	0.0905	0.00320
95th Percentile	181	7.60	955	0.101	2.00	0.0140	0.00265	0.832	0.192	0.00660

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table I.16: Water Quality at TOMP Station N-18 (ETP Operations), Lacnor/Nordic TMA, 2015 to 2019

Date	pH
2-Jan-15	9.80
5-Jan-15	10.5
6-Jan-15	10.5
7-Jan-15	10.4
8-Jan-15	10.7
9-Jan-15	10.7
12-Jan-15	10.7
13-Jan-15	10.9
14-Jan-15	11.1
15-Jan-15	10.7
16-Jan-15	10.9
19-Jan-15	10.8
20-Jan-15	10.9
21-Jan-15	10.6
22-Jan-15	10.9
23-Jan-15	10.9
26-Jan-15	10.7
27-Jan-15	10.9
28-Jan-15	10.7
29-Jan-15	10.8
30-Jan-15	10.8
2-Feb-15	10.8
3-Feb-15	10.9
4-Feb-15	11.1
5-Feb-15	10.9
6-Feb-15	11.0
9-Feb-15	11.0
10-Feb-15	11.1
11-Feb-15	11.0
12-Feb-15	11.0
13-Feb-15	11.1
17-Feb-15	11.0
18-Feb-15	11.1
19-Feb-15	11.3
20-Feb-15	11.1
23-Feb-15	10.9
24-Feb-15	11.1
25-Feb-15	11.2
26-Feb-15	11.1
27-Feb-15	11.1
2-Mar-15	11.0
3-Mar-15	10.9
4-Mar-15	11.3
5-Mar-15	11.0
6-Mar-15	10.7
9-Mar-15	11.0
10-Mar-15	10.9
11-Mar-15	10.9
12-Mar-15	10.5
13-Mar-15	10.5
16-Mar-15	9.70
17-Mar-15	10.6
18-Mar-15	10.6
19-Mar-15	10.8
20-Mar-15	10.9
23-Mar-15	10.9
24-Mar-15	10.0
25-Mar-15	10.3
26-Mar-15	11.0
27-Mar-15	10.9
30-Mar-15	10.5
31-Mar-15	10.7
1-Apr-15	10.7

Date	pH
2-Apr-15	10.6
6-Apr-15	10.3
7-Apr-15	10.8
8-Apr-15	10.1
9-Apr-15	10.4
10-Apr-15	9.80
13-Apr-15	7.60
14-Apr-15	8.50
15-Apr-15	9.20
16-Apr-15	8.40
17-Apr-15	9.50
20-Apr-15	7.30
21-Apr-15	8.60
22-Apr-15	9.10
23-Apr-15	8.60
24-Apr-15	9.00
27-Apr-15	10.0
28-Apr-15	10.1
29-Apr-15	10.2
30-Apr-15	10.2
1-May-15	10.1
4-May-15	10.2
5-May-15	10.2
6-May-15	10.6
7-May-15	10.6
8-May-15	10.6
11-May-15	10.3
12-May-15	9.90
13-May-15	10.4
14-May-15	10.4
15-May-15	10.5
19-May-15	10.6
20-May-15	10.7
21-May-15	10.5
22-May-15	10.6
25-May-15	10.5
26-May-15	10.5
27-May-15	10.6
28-May-15	10.6
29-May-15	10.5
1-Jun-15	9.80
2-Jun-15	10.1
3-Jun-15	9.80
4-Jun-15	9.80
5-Jun-15	9.90
8-Jun-15	10.2
9-Jun-15	10.5
10-Jun-15	9.80
11-Jun-15	9.80
12-Jun-15	10.3
15-Jun-15	10.3
16-Jun-15	10.6
17-Jun-15	10.6
18-Jun-15	10.6
19-Jun-15	10.9
22-Jun-15	10.8
23-Jun-15	10.8
24-Jun-15	10.9
25-Jun-15	10.6
26-Jun-15	10.4
29-Jun-15	10.5
30-Jun-15	10.6
2-Jul-15	10.6

Date	pH
3-Jul-15	10.7
6-Jul-15	10.7
7-Jul-15	10.4
8-Jul-15	10.7
9-Jul-15	10.7
10-Jul-15	10.7
13-Jul-15	10.6
14-Jul-15	10.7
15-Jul-15	10.9
16-Jul-15	10.8
17-Jul-15	10.8
20-Jul-15	9.50
21-Jul-15	11.5
22-Jul-15	10.4
23-Jul-15	10.2
24-Jul-15	10.6
27-Jul-15	10.6
28-Jul-15	10.5
29-Jul-15	10.3
30-Jul-15	10.4
31-Jul-15	11.0
4-Aug-15	10.0
5-Aug-15	10.8
6-Aug-15	10.7
7-Aug-15	8.50
10-Aug-15	10.4
11-Aug-15	10.5
12-Aug-15	10.5
13-Aug-15	10.4
14-Aug-15	10.3
17-Aug-15	10.5
18-Aug-15	10.4
19-Aug-15	10.6
20-Aug-15	10.8
21-Aug-15	10.2
24-Aug-15	10.5
25-Aug-15	10.3
26-Aug-15	10.6
27-Aug-15	10.7
28-Aug-15	10.7
31-Aug-15	10.6
1-Sep-15	10.8
2-Sep-15	10.6
3-Sep-15	10.7
4-Sep-15	10.6
8-Sep-15	10.8
9-Sep-15	10.8
10-Sep-15	10.7
11-Sep-15	10.6
14-Sep-15	10.7
15-Sep-15	10.7
16-Sep-15	10.7
17-Sep-15	10.7
18-Sep-15	10.3
21-Sep-15	10.3
22-Sep-15	10.3
23-Sep-15	10.6
24-Sep-15	10.4
25-Sep-15	10.5
28-Sep-15	10.6
29-Sep-15	10.5
30-Sep-15	10.3
1-Oct-15	9.38

Date	pH
2-Oct-15	10.8
5-Oct-15	10.5
6-Oct-15	10.7
7-Oct-15	10.7
8-Oct-15	11.1
9-Oct-15	10.6
13-Oct-15	10.4
14-Oct-15	10.7
15-Oct-15	10.8
16-Oct-15	10.7
19-Oct-15	10.0
20-Oct-15	10.8
21-Oct-15	10.6
22-Oct-15	10.8
23-Oct-15	11.0
26-Oct-15	10.4
27-Oct-15	10.7
28-Oct-15	10.1
29-Oct-15	10.7
30-Oct-15	9.86
2-Nov-15	10.0
3-Nov-15	9.80
4-Nov-15	9.71
5-Nov-15	10.2
6-Nov-15	9.60
9-Nov-15	9.90
10-Nov-15	9.92
11-Nov-15	10.5
12-Nov-15	10.1
13-Nov-15	9.30
16-Nov-15	10.2
17-Nov-15	10.2
18-Nov-15	10.3
19-Nov-15	10.0
20-Nov-15	9.51
23-Nov-15	10.6
24-Nov-15	11.6
25-Nov-15	10.2
26-Nov-15	10.3
27-Nov-15	10.0
30-Nov-15	9.42
1-Dec-15	9.70
2-Dec-15	9.64
3-Dec-15	10.8
4-Dec-15	10.2
7-Dec-15	9.22
8-Dec-15	9.96
9-Dec-15	10.3
10-Dec-15	10.2
11-Dec-15	10.9
14-Dec-15	9.70
15-Dec-15	9.54
16-Dec-15	9.03
17-Dec-15	9.30
18-Dec-15	9.33
21-Dec-15	9.07
22-Dec-15	9.34
23-Dec-15	9.41
24-Dec-15	9.30
28-Dec-15	9.00
29-Dec-15	9.00
30-Dec-15	9.20
31-Dec-15	9.00

Note: "SD" = standard deviation. "n" = number of samples.

Table I.16: Water Quality at TOMP Station N-18 (ETP Operations), Lacnor/Nordic TMA, 2015 to 2019

Date	pH	Date	pH	Date	pH	Date	pH
4-Jan-16	9.30	4-Apr-16	8.82	4-Jul-16	10.0	3-Oct-16	9.60
5-Jan-16	9.50	5-Apr-16	8.82	5-Jul-16	10.1	4-Oct-16	10.3
6-Jan-16	9.50	6-Apr-16	9.11	6-Jul-16	10.0	5-Oct-16	10.1
7-Jan-16	9.36	7-Apr-16	9.48	7-Jul-16	9.90	6-Oct-16	10.2
8-Jan-16	9.30	8-Apr-16	9.50	8-Jul-16	9.80	7-Oct-16	9.90
11-Jan-16	9.38	11-Apr-16	9.65	11-Jul-16	9.80	11-Oct-16	10.3
12-Jan-16	9.12	12-Apr-16	11.2	12-Jul-16	10.0	12-Oct-16	10.3
13-Jan-16	9.39	13-Apr-16	10.0	13-Jul-16	9.60	13-Oct-16	10.2
14-Jan-16	9.68	14-Apr-16	9.48	14-Jul-16	9.90	14-Oct-16	10.2
15-Jan-16	9.30	15-Apr-16	10.1	15-Jul-16	10.2	17-Oct-16	10.1
18-Jan-16	9.27	18-Apr-16	8.44	18-Jul-16	9.81	18-Oct-16	10.3
19-Jan-16	9.51	19-Apr-16	8.54	19-Jul-16	10.1	19-Oct-16	10.2
20-Jan-16	9.56	20-Apr-16	8.67	20-Jul-16	9.90	20-Oct-16	10.2
21-Jan-16	9.35	21-Apr-16	8.34	21-Jul-16	9.54	21-Oct-16	10.0
22-Jan-16	9.60	22-Apr-16	9.00	22-Jul-16	9.93	24-Oct-16	10.3
25-Jan-16	9.66	25-Apr-16	9.46	25-Jul-16	10.2	25-Oct-16	10.3
26-Jan-16	9.76	26-Apr-16	9.73	26-Jul-16	9.92	26-Oct-16	10.3
27-Jan-16	9.56	27-Apr-16	9.95	27-Jul-16	9.95	27-Oct-16	10.2
28-Jan-16	9.61	28-Apr-16	10.1	28-Jul-16	9.95	28-Oct-16	10.3
29-Jan-16	9.84	29-Apr-16	10.0	29-Jul-16	9.87	31-Oct-16	10.5
1-Feb-16	9.37	2-May-16	10.0	2-Aug-16	10.1	1-Nov-16	10.3
2-Feb-16	9.32	3-May-16	9.63	3-Aug-16	9.20	2-Nov-16	10.3
3-Feb-16	9.36	4-May-16	9.43	4-Aug-16	9.80	3-Nov-16	10.2
4-Feb-16	9.42	5-May-16	10.0	5-Aug-16	10.0	4-Nov-16	10.4
5-Feb-16	9.20	6-May-16	10.2	8-Aug-16	10.0	7-Nov-16	10.2
8-Feb-16	9.20	9-May-16	10.3	9-Aug-16	10.1	8-Nov-16	10.2
9-Feb-16	9.21	10-May-16	10.6	10-Aug-16	10.1	9-Nov-16	10.1
10-Feb-16	9.27	11-May-16	9.98	11-Aug-16	10.1	10-Nov-16	10.1
11-Feb-16	9.27	12-May-16	10.2	12-Aug-16	10.1	11-Nov-16	10.3
12-Feb-16	9.40	13-May-16	10.1	15-Aug-16	9.40	14-Nov-16	10.2
16-Feb-16	9.34	16-May-16	10.3	16-Aug-16	9.70	15-Nov-16	10.1
17-Feb-16	9.36	17-May-16	9.79	17-Aug-16	9.97	16-Nov-16	10.3
18-Feb-16	9.48	18-May-16	10.5	18-Aug-16	10.1	17-Nov-16	10.2
19-Feb-16	9.78	19-May-16	10.3	19-Aug-16	9.80	18-Nov-16	10.2
22-Feb-16	9.75	20-May-16	10.2	22-Aug-16	9.72	21-Nov-16	10.5
23-Feb-16	9.72	24-May-16	10.1	23-Aug-16	9.60	22-Nov-16	10.5
24-Feb-16	9.50	25-May-16	9.56	24-Aug-16	9.20	23-Nov-16	10.1
25-Feb-16	9.80	26-May-16	10.1	25-Aug-16	9.34	24-Nov-16	10.0
26-Feb-16	9.60	27-May-16	10.5	26-Aug-16	9.16	25-Nov-16	10.4
29-Feb-16	9.51	30-May-16	10.8	29-Aug-16	9.90	28-Nov-16	10.3
1-Mar-16	9.63	31-May-16	10.1	30-Aug-16	9.40	29-Nov-16	10.4
2-Mar-16	10.0	1-Jun-16	10.4	31-Aug-16	9.50	30-Nov-16	10.3
3-Mar-16	9.85	2-Jun-16	9.50	1-Sep-16	9.50	1-Dec-16	10.0
4-Mar-16	9.72	3-Jun-16	10.2	2-Sep-16	9.53	2-Dec-16	10.3
7-Mar-16	10.1	6-Jun-16	10.8	6-Sep-16	9.50	5-Dec-16	10.3
8-Mar-16	9.98	7-Jun-16	10.8	7-Sep-16	9.48	6-Dec-16	10.1
9-Mar-16	9.72	8-Jun-16	10.8	8-Sep-16	9.60	7-Dec-16	10.5
10-Mar-16	10.1	9-Jun-16	10.2	9-Sep-16	9.33	8-Dec-16	10.1
11-Mar-16	10.1	10-Jun-16	10.2	12-Sep-16	9.62	9-Dec-16	10.2
14-Mar-16	8.86	13-Jun-16	10.9	13-Sep-16	9.43	12-Dec-16	10.3
15-Mar-16	8.97	14-Jun-16	10.2	14-Sep-16	9.65	13-Dec-16	10.4
16-Mar-16	7.95	15-Jun-16	10.6	15-Sep-16	9.58	14-Dec-16	10.3
17-Mar-16	8.63	16-Jun-16	10.2	16-Sep-16	9.80	15-Dec-16	10.4
18-Mar-16	8.07	17-Jun-16	10.3	19-Sep-16	10.4	16-Dec-16	10.5
21-Mar-16	8.57	20-Jun-16	10.4	20-Sep-16	10.5	19-Dec-16	10.4
22-Mar-16	8.50	21-Jun-16	10.6	21-Sep-16	10.3	20-Dec-16	10.4
23-Mar-16	9.00	22-Jun-16	9.55	22-Sep-16	10.6	21-Dec-16	10.1
24-Mar-16	9.51	23-Jun-16	9.81	23-Sep-16	10.5	22-Dec-16	10.2
28-Mar-16	8.75	24-Jun-16	10.2	26-Sep-16	10.1	23-Dec-16	10.6
29-Mar-16	8.62	27-Jun-16	9.90	27-Sep-16	10.0	29-Dec-16	10.7
30-Mar-16	8.85	28-Jun-16	10.2	28-Sep-16	10.0	30-Dec-16	10.6
31-Mar-16	8.83	29-Jun-16	9.90	29-Sep-16	10.0	2-Jan-17	10.6
1-Apr-16	8.54	30-Jun-16	9.80	30-Sep-16	10.2	3-Jan-17	10.4

Note: "SD" = standard deviation. "n" = number of samples.

Table I.16: Water Quality at TOMP Station N-18 (ETP Operations), Lacnor/Nordic TMA, 2015 to 2019

Date	pH	Date	pH	Date	pH	Date	pH
4-Jan-17	10.3	4-Apr-17	9.00	5-Jul-17	10.1	4-Oct-17	10.2
5-Jan-17	10.4	5-Apr-17	8.90	6-Jul-17	10.2	5-Oct-17	10.2
6-Jan-17	10.7	6-Apr-17	9.20	7-Jul-17	10.1	6-Oct-17	10.2
9-Jan-17	10.3	7-Apr-17	9.50	10-Jul-17	10.2	10-Oct-17	10.0
10-Jan-17	10.3	10-Apr-17	9.60	11-Jul-17	10.1	11-Oct-17	10.4
11-Jan-17	10.4	11-Apr-17	9.60	12-Jul-17	10.0	12-Oct-17	9.80
12-Jan-17	10.6	12-Apr-17	9.80	13-Jul-17	10.0	13-Oct-17	10.0
13-Jan-17	10.3	13-Apr-17	9.80	14-Jul-17	10.2	16-Oct-17	9.80
16-Jan-17	10.4	17-Apr-17	10.0	17-Jul-17	10.2	17-Oct-17	9.90
17-Jan-17	10.5	18-Apr-17	10.2	18-Jul-17	10.4	18-Oct-17	10.0
18-Jan-17	10.6	19-Apr-17	10.0	19-Jul-17	10.2	19-Oct-17	10.4
19-Jan-17	10.5	20-Apr-17	10.4	20-Jul-17	10.2	20-Oct-17	10.5
20-Jan-17	10.5	21-Apr-17	10.3	21-Jul-17	10.2	23-Oct-17	10.0
23-Jan-17	10.5	24-Apr-17	10.2	24-Jul-17	10.1	24-Oct-17	9.40
24-Jan-17	10.3	25-Apr-17	10.0	25-Jul-17	10.4	25-Oct-17	9.30
25-Jan-17	10.6	26-Apr-17	10.0	26-Jul-17	10.3	26-Oct-17	9.80
26-Jan-17	10.2	27-Apr-17	10.3	27-Jul-17	10.2	27-Oct-17	9.70
27-Jan-17	10.4	28-Apr-17	10.3	28-Jul-17	10.3	30-Oct-17	9.70
30-Jan-17	10.6	1-May-17	10.0	31-Jul-17	10.0	31-Oct-17	9.80
31-Jan-17	10.4	2-May-17	10.1	1-Aug-17	10.0	1-Nov-17	9.60
1-Feb-17	10.6	3-May-17	10.2	2-Aug-17	10.1	2-Nov-17	10.0
2-Feb-17	10.3	4-May-17	10.0	3-Aug-17	10.4	3-Nov-17	10.0
3-Feb-17	10.2	5-May-17	10.3	4-Aug-17	10.1	6-Nov-17	10.1
6-Feb-17	10.4	8-May-17	10.1	8-Aug-17	10.3	7-Nov-17	10.1
7-Feb-17	10.5	9-May-17	10.2	9-Aug-17	10.4	8-Nov-17	10.2
8-Feb-17	10.3	10-May-17	10.2	10-Aug-17	10.3	9-Nov-17	10.2
9-Feb-17	10.5	11-May-17	10.2	11-Aug-17	10.2	10-Nov-17	10.0
10-Feb-17	10.2	12-May-17	9.90	14-Aug-17	10.1	13-Nov-17	10.2
13-Feb-17	10.2	15-May-17	10.1	15-Aug-17	10.0	14-Nov-17	10.0
14-Feb-17	10.1	16-May-17	10.0	16-Aug-17	10.3	15-Nov-17	10.1
15-Feb-17	10.6	17-May-17	9.90	17-Aug-17	10.0	16-Nov-17	10.2
16-Feb-17	10.2	18-May-17	10.0	18-Aug-17	10.1	17-Nov-17	9.80
17-Feb-17	10.6	19-May-17	10.2	21-Aug-17	10.3	20-Nov-17	10.5
21-Feb-17	10.2	23-May-17	10.1	22-Aug-17	10.0	21-Nov-17	9.70
22-Feb-17	10.2	24-May-17	10.1	23-Aug-17	10.4	22-Nov-17	10.2
23-Feb-17	10.4	25-May-17	10.2	24-Aug-17	9.90	23-Nov-17	10.1
24-Feb-17	9.70	26-May-17	10.4	25-Aug-17	10.3	24-Nov-17	9.90
27-Feb-17	9.20	29-May-17	10.1	28-Aug-17	10.3	27-Nov-17	10.2
28-Feb-17	9.30	30-May-17	10.1	29-Aug-17	10.2	28-Nov-17	10.1
1-Mar-17	9.50	31-May-17	10.3	30-Aug-17	10.3	29-Nov-17	10.2
2-Mar-17	9.70	1-Jun-17	10.1	31-Aug-17	9.90	30-Nov-17	9.90
3-Mar-17	9.70	2-Jun-17	10.1	1-Sep-17	10.4	1-Dec-17	10.2
6-Mar-17	10.3	5-Jun-17	10.1	5-Sep-17	10.3	4-Dec-17	10.2
7-Mar-17	9.60	6-Jun-17	10.1	6-Sep-17	10.3	5-Dec-17	9.00
8-Mar-17	9.20	7-Jun-17	10.5	7-Sep-17	10.1	6-Dec-17	9.10
9-Mar-17	8.60	8-Jun-17	10.0	8-Sep-17	10.3	7-Dec-17	8.80
10-Mar-17	9.00	9-Jun-17	10.0	11-Sep-17	10.0	8-Dec-17	8.90
13-Mar-17	9.70	12-Jun-17	10.2	12-Sep-17	10.0	11-Dec-17	10.6
14-Mar-17	9.90	13-Jun-17	10.3	13-Sep-17	10.0	12-Dec-17	9.60
15-Mar-17	10.0	14-Jun-17	10.2	14-Sep-17	10.3	13-Dec-17	10.2
16-Mar-17	10.2	15-Jun-17	10.3	15-Sep-17	10.1	14-Dec-17	9.80
17-Mar-17	10.0	16-Jun-17	10.4	18-Sep-17	10.3	15-Dec-17	9.80
20-Mar-17	10.3	19-Jun-17	10.2	19-Sep-17	10.2	18-Dec-17	10.4
21-Mar-17	10.8	20-Jun-17	10.2	20-Sep-17	10.3	19-Dec-17	10.3
22-Mar-17	10.4	21-Jun-17	10.2	21-Sep-17	10.0	20-Dec-17	10.2
23-Mar-17	10.0	22-Jun-17	10.4	22-Sep-17	10.4	21-Dec-17	10.2
24-Mar-17	10.5	23-Jun-17	10.4	25-Sep-17	10.1	22-Dec-17	10.3
27-Mar-17	9.40	26-Jun-17	10.1	26-Sep-17	10.0	27-Dec-17	10.0
28-Mar-17	9.30	27-Jun-17	10.4	27-Sep-17	10.3	28-Dec-17	10.5
29-Mar-17	9.20	28-Jun-17	10.0	28-Sep-17	10.3	29-Dec-17	10.1
30-Mar-17	8.30	29-Jun-17	10.3	29-Sep-17	9.90	2-Jan-18	10.4
31-Mar-17	8.80	30-Jun-17	10.4	2-Oct-17	10.2	3-Jan-18	10.6
3-Apr-17	9.00	4-Jul-17	9.70	3-Oct-17	10.1	4-Jan-18	10.6

Note: "SD" = standard deviation. "n" = number of samples.

Table I.16: Water Quality at TOMP Station N-18 (ETP Operations), Lacnor/Nordic TMA, 2015 to 2019

Date	pH
5-Jan-18	10.4
8-Jan-18	10.5
9-Jan-18	10.7
10-Jan-18	10.7
11-Jan-18	10.6
12-Jan-18	10.6
15-Jan-18	10.5
16-Jan-18	10.2
17-Jan-18	10.5
18-Jan-18	10.3
19-Jan-18	10.3
22-Jan-18	10.7
23-Jan-18	10.3
24-Jan-18	10.2
25-Jan-18	10.3
26-Jan-18	10.3
29-Jan-18	10.1
30-Jan-18	10.1
31-Jan-18	9.80
1-Feb-18	10.6
2-Feb-18	10.5
5-Feb-18	10.4
6-Feb-18	10.6
7-Feb-18	10.3
8-Feb-18	10.5
9-Feb-18	10.4
12-Feb-18	10.3
13-Feb-18	9.90
14-Feb-18	10.4
15-Feb-18	10.4
16-Feb-18	10.5
20-Feb-18	10.4
21-Feb-18	10.6
22-Feb-18	10.6
23-Feb-18	10.5
26-Feb-18	10.5
27-Feb-18	10.5
28-Feb-18	10.2
1-Mar-18	10.2
2-Mar-18	10.5
5-Mar-18	10.2
6-Mar-18	10.2
7-Mar-18	10.1
8-Mar-18	10.3
9-Mar-18	10.3
12-Mar-18	10.2
13-Mar-18	10.5
14-Mar-18	10.1
15-Mar-18	10.6
16-Mar-18	10.2
19-Mar-18	10.6
20-Mar-18	10.4
21-Mar-18	10.4
22-Mar-18	10.6
23-Mar-18	10.4
26-Mar-18	10.4
27-Mar-18	10.2
28-Mar-18	10.3
29-Mar-18	10.4
2-Apr-18	10.2
3-Apr-18	10.2
4-Apr-18	10.4
5-Apr-18	10.1
6-Apr-18	10.3
9-Apr-18	10.2
10-Apr-18	10.6
11-Apr-18	10.6
12-Apr-18	10.4
13-Apr-18	10.3
16-Apr-18	10.6
17-Apr-18	10.3
18-Apr-18	10.4
19-Apr-18	10.2
20-Apr-18	10.2
23-Apr-18	10.2
24-Apr-18	9.60
25-Apr-18	8.70
26-Apr-18	8.70
27-Apr-18	8.90
30-Apr-18	9.00
1-May-18	8.90
2-May-18	9.00
3-May-18	8.70
4-May-18	8.80
7-May-18	9.00
8-May-18	9.40
9-May-18	9.70
10-May-18	9.90
11-May-18	9.90
14-May-18	10.0
15-May-18	10.3
16-May-18	10.2
17-May-18	10.0
18-May-18	10.0
22-May-18	10.1
23-May-18	10.1
24-May-18	10.2
25-May-18	9.90
28-May-18	10.2
29-May-18	10.0
30-May-18	10.2
31-May-18	9.10
1-Jun-18	9.80
4-Jun-18	9.80
5-Jun-18	10.2
6-Jun-18	10.0
7-Jun-18	9.90
8-Jun-18	10.0
11-Jun-18	10.3
12-Jun-18	10.2
13-Jun-18	9.70
14-Jun-18	9.90
15-Jun-18	10.0
18-Jun-18	9.80
19-Jun-18	9.80
20-Jun-18	9.70
21-Jun-18	10.3
22-Jun-18	9.90
25-Jun-18	9.90
26-Jun-18	10.3
27-Jun-18	9.60
28-Jun-18	9.70
29-Jun-18	9.60
3-Jul-18	10.1
4-Jul-18	10.0
5-Jul-18	9.80
6-Jul-18	10.1
9-Jul-18	10.0
10-Jul-18	10.0
11-Jul-18	10.2
12-Jul-18	10.2
13-Jul-18	9.90
16-Jul-18	9.90
17-Jul-18	10.0
18-Jul-18	9.70
19-Jul-18	9.80
20-Jul-18	10.1
23-Jul-18	10.1
24-Jul-18	9.90
25-Jul-18	10.1
26-Jul-18	10.1
27-Jul-18	10.3
30-Jul-18	10.1
31-Jul-18	10.1
1-Aug-18	9.90
2-Aug-18	9.80
3-Aug-18	9.80
6-Aug-18	9.90
7-Aug-18	9.70
8-Aug-18	10.2
9-Aug-18	10.0
10-Aug-18	10.1
13-Aug-18	9.90
14-Aug-18	10.0
15-Aug-18	9.90
16-Aug-18	9.70
17-Aug-18	10.0
20-Aug-18	9.90
21-Aug-18	9.60
22-Aug-18	10.0
23-Aug-18	10.2
24-Aug-18	10.1
27-Aug-18	10.4
28-Aug-18	10.5
29-Aug-18	10.4
30-Aug-18	10.4
31-Aug-18	10.3
4-Sep-18	10.0
5-Sep-18	10.2
6-Sep-18	10.2
7-Sep-18	10.5
10-Sep-18	10.3
11-Sep-18	10.2
12-Sep-18	10.0
13-Sep-18	10.5
14-Sep-18	10.2
17-Sep-18	10.1
18-Sep-18	10.2
19-Sep-18	10.3
20-Sep-18	10.1
21-Sep-18	10.4
24-Sep-18	10.3
25-Sep-18	10.2
26-Sep-18	10.1
27-Sep-18	10.2
28-Sep-18	10.2
1-Oct-18	10.1
2-Oct-18	10.1
3-Oct-18	10.1
4-Oct-18	10.0
5-Oct-18	9.90
9-Oct-18	10.2
10-Oct-18	10.5
11-Oct-18	9.90
12-Oct-18	10.0
15-Oct-18	9.90
16-Oct-18	10.0
17-Oct-18	10.3
18-Oct-18	10.3
19-Oct-18	10.3
22-Oct-18	10.0
23-Oct-18	10.2
24-Oct-18	10.3
25-Oct-18	10.4
26-Oct-18	10.3
29-Oct-18	10.2
30-Oct-18	10.1
31-Oct-18	10.0
1-Nov-18	10.1
2-Nov-18	10.3
5-Nov-18	10.0
6-Nov-18	10.0
7-Nov-18	9.90
8-Nov-18	10.2
9-Nov-18	10.3
12-Nov-18	10.2
13-Nov-18	10.2
14-Nov-18	10.3
15-Nov-18	10.2
16-Nov-18	10.2
19-Nov-18	10.2
20-Nov-18	10.3
21-Nov-18	10.0
22-Nov-18	10.3
23-Nov-18	10.2
26-Nov-18	9.80
27-Nov-18	9.80
28-Nov-18	9.80
29-Nov-18	9.60
30-Nov-18	9.40
3-Dec-18	9.50
4-Dec-18	9.70
5-Dec-18	9.50
6-Dec-18	9.10
7-Dec-18	9.50
10-Dec-18	9.40
11-Dec-18	9.30
12-Dec-18	9.40
13-Dec-18	9.60
14-Dec-18	9.50
17-Dec-18	9.20
18-Dec-18	9.40
19-Dec-18	9.30
20-Dec-18	9.20
21-Dec-18	9.60
24-Dec-18	9.40
27-Dec-18	9.60
28-Dec-18	9.40
31-Dec-18	9.60
2-Jan-19	9.70
3-Jan-19	9.60
4-Jan-19	9.60

Note: "SD" = standard deviation. "n" = number of samples.

Table I.16: Water Quality at TOMP Station N-18 (ETP Operations), Lacnor/Nordic TMA, 2015 to 2019

Date	pH	Date	pH	Date	pH	Date	pH
7-Jan-19	9.30	8-Apr-19	10.3	10-Jul-19	10.2	10-Oct-19	10.7
8-Jan-19	9.60	9-Apr-19	8.90	11-Jul-19	10.4	11-Oct-19	10.2
9-Jan-19	9.50	10-Apr-19	8.60	12-Jul-19	10.4	15-Oct-19	10.3
10-Jan-19	9.70	11-Apr-19	8.50	15-Jul-19	10.2	16-Oct-19	10.3
11-Jan-19	9.60	12-Apr-19	8.60	16-Jul-19	10.3	17-Oct-19	10.1
14-Jan-19	9.20	15-Apr-19	8.20	17-Jul-19	10.4	18-Oct-19	10.5
15-Jan-19	9.20	16-Apr-19	8.70	18-Jul-19	10.0	21-Oct-19	10.4
16-Jan-19	9.40	17-Apr-19	9.00	19-Jul-19	10.2	22-Oct-19	10.2
17-Jan-19	9.50	18-Apr-19	9.80	22-Jul-19	10.2	23-Oct-19	9.90
18-Jan-19	9.40	22-Apr-19	9.50	23-Jul-19	10.3	24-Oct-19	10.0
21-Jan-19	9.70	23-Apr-19	9.50	24-Jul-19	10.3	25-Oct-19	9.90
22-Jan-19	9.20	24-Apr-19	9.40	25-Jul-19	10.2	28-Oct-19	10.2
23-Jan-19	9.20	25-Apr-19	9.50	26-Jul-19	10.2	29-Oct-19	10.2
24-Jan-19	9.30	26-Apr-19	9.70	29-Jul-19	10.3	30-Oct-19	10.2
25-Jan-19	9.10	29-Apr-19	10.1	30-Jul-19	10.3	31-Oct-19	10.2
28-Jan-19	9.30	30-Apr-19	10.1	31-Jul-19	10.5	1-Nov-19	10.2
29-Jan-19	9.40	1-May-19	10.1	1-Aug-19	10.5	4-Nov-19	10.3
30-Jan-19	9.20	2-May-19	10.1	2-Aug-19	10.4	5-Nov-19	10.5
31-Jan-19	9.50	3-May-19	10.3	6-Aug-19	10.4	6-Nov-19	10.5
1-Feb-19	9.60	6-May-19	10.3	7-Aug-19	10.3	7-Nov-19	10.5
4-Feb-19	9.30	7-May-19	10.1	8-Aug-19	10.6	8-Nov-19	10.3
5-Feb-19	9.50	8-May-19	10.3	9-Aug-19	10.5	11-Nov-19	10.2
6-Feb-19	10.0	9-May-19	9.90	12-Aug-19	10.3	12-Nov-19	10.2
7-Feb-19	9.70	10-May-19	9.90	13-Aug-19	10.4	13-Nov-19	10.2
8-Feb-19	9.60	13-May-19	9.80	14-Aug-19	10.4	14-Nov-19	10.3
11-Feb-19	9.40	14-May-19	10.1	15-Aug-19	10.3	15-Nov-19	10.2
12-Feb-19	10.0	15-May-19	10.0	16-Aug-19	10.6	18-Nov-19	10.2
13-Feb-19	9.70	16-May-19	10.2	19-Aug-19	10.6	19-Nov-19	10.3
14-Feb-19	9.70	17-May-19	10.0	20-Aug-19	10.3	20-Nov-19	10.2
15-Feb-19	9.60	21-May-19	10.2	21-Aug-19	10.3	21-Nov-19	10.1
19-Feb-19	10.2	22-May-19	10.4	22-Aug-19	10.3	22-Nov-19	9.10
20-Feb-19	10.0	23-May-19	10.1	23-Aug-19	10.3	25-Nov-19	9.70
21-Feb-19	9.90	24-May-19	10.4	26-Aug-19	10.6	26-Nov-19	9.60
22-Feb-19	9.90	27-May-19	10.3	27-Aug-19	10.3	27-Nov-19	9.70
25-Feb-19	9.80	28-May-19	10.2	28-Aug-19	10.4	28-Nov-19	9.20
26-Feb-19	10.2	29-May-19	10.0	29-Aug-19	10.2	29-Nov-19	8.90
27-Feb-19	10.1	30-May-19	10.2	30-Aug-19	10.2	2-Dec-19	9.10
28-Feb-19	10.1	31-May-19	10.0	3-Sep-19	10.6	3-Dec-19	9.10
1-Mar-19	10.2	3-Jun-19	10.0	4-Sep-19	10.5	4-Dec-19	9.20
4-Mar-19	9.90	4-Jun-19	10.0	5-Sep-19	10.6	5-Dec-19	9.00
5-Mar-19	10.5	5-Jun-19	9.90	6-Sep-19	10.6	6-Dec-19	9.10
6-Mar-19	10.3	6-Jun-19	10.2	9-Sep-19	10.7	9-Dec-19	8.80
7-Mar-19	10.6	7-Jun-19	10.1	10-Sep-19	10.6	10-Dec-19	9.20
8-Mar-19	10.2	10-Jun-19	10.2	11-Sep-19	10.7	11-Dec-19	9.40
11-Mar-19	10.5	11-Jun-19	10.4	12-Sep-19	10.7	12-Dec-19	10.1
12-Mar-19	10.3	12-Jun-19	10.3	13-Sep-19	10.5	13-Dec-19	9.80
13-Mar-19	10.3	13-Jun-19	10.3	16-Sep-19	10.6	16-Dec-19	9.90
14-Mar-19	10.0	14-Jun-19	10.3	17-Sep-19	10.7	17-Dec-19	9.90
15-Mar-19	10.2	17-Jun-19	10.1	18-Sep-19	10.4	18-Dec-19	10.0
18-Mar-19	10.2	18-Jun-19	10.3	19-Sep-19	10.6	19-Dec-19	10.3
19-Mar-19	10.4	19-Jun-19	10.2	20-Sep-19	10.5	20-Dec-19	10.4
20-Mar-19	10.2	20-Jun-19	10.3	23-Sep-19	10.5	23-Dec-19	10.0
21-Mar-19	10.5	21-Jun-19	10.1	24-Sep-19	10.6	24-Dec-19	10.2
22-Mar-19	10.4	24-Jun-19	10.2	25-Sep-19	10.5	27-Dec-19	10.5
25-Mar-19	10.3	25-Jun-19	10.3	26-Sep-19	10.4	30-Dec-19	10.4
26-Mar-19	10.4	26-Jun-19	10.2	27-Sep-19	10.4	31-Dec-19	10.2
27-Mar-19	10.5	27-Jun-19	10.3	30-Sep-19	10.3	**n**	1256
28-Mar-19	10.6	28-Jun-19	10.3	1-Oct-19	10.5	**Minimum**	7.30
29-Mar-19	10.3	2-Jul-19	10.1	2-Oct-19	10.5	**Maximum**	11.6
1-Apr-19	10.4	3-Jul-19	10.3	3-Oct-19	10.7	**Mean**	10.1
2-Apr-19	10.1	4-Jul-19	10.3	4-Oct-19	10.6	**SD**	0.520
3-Apr-19	10.4	5-Jul-19	10.4	7-Oct-19	10.5	**Median**	10.2
4-Apr-19	10.1	8-Jul-19	10.3	8-Oct-19	10.5	**10th Percentile**	9.38
5-Apr-19	10.0	9-Jul-19	10.1	9-Oct-19	10.2	**95th Percentile**	10.8

Note: "SD" = standard deviation. "n" = number of samples.

Table I.16: Water Quality at TOMP Station N-18 (ETP Operations), Lacnor/Nordic TMA, 2015 to 2019

Date	pH	Date	pH	Date	pH	Date	pH
2-Jan-15	9.80	2-Apr-15	10.6	3-Jul-15	10.7	2-Oct-15	10.8
5-Jan-15	10.5	6-Apr-15	10.3	6-Jul-15	10.7	5-Oct-15	10.5
6-Jan-15	10.5	7-Apr-15	10.8	7-Jul-15	10.4	6-Oct-15	10.7
7-Jan-15	10.4	8-Apr-15	10.1	8-Jul-15	10.7	7-Oct-15	10.7
8-Jan-15	10.7	9-Apr-15	10.4	9-Jul-15	10.7	8-Oct-15	11.1
9-Jan-15	10.7	10-Apr-15	9.80	10-Jul-15	10.7	9-Oct-15	10.6
12-Jan-15	10.7	13-Apr-15	7.60	13-Jul-15	10.6	13-Oct-15	10.4
13-Jan-15	10.9	14-Apr-15	8.50	14-Jul-15	10.7	14-Oct-15	10.7
14-Jan-15	11.1	15-Apr-15	9.20	15-Jul-15	10.9	15-Oct-15	10.8
15-Jan-15	10.7	16-Apr-15	8.40	16-Jul-15	10.8	16-Oct-15	10.7
16-Jan-15	10.9	17-Apr-15	9.50	17-Jul-15	10.8	19-Oct-15	10.0
19-Jan-15	10.8	20-Apr-15	7.30	20-Jul-15	9.50	20-Oct-15	10.8
20-Jan-15	10.9	21-Apr-15	8.60	21-Jul-15	11.5	21-Oct-15	10.6
21-Jan-15	10.6	22-Apr-15	9.10	22-Jul-15	10.4	22-Oct-15	10.8
22-Jan-15	10.9	23-Apr-15	8.60	23-Jul-15	10.2	23-Oct-15	11.0
23-Jan-15	10.9	24-Apr-15	9.00	24-Jul-15	10.6	26-Oct-15	10.4
26-Jan-15	10.7	27-Apr-15	10.0	27-Jul-15	10.6	27-Oct-15	10.7
27-Jan-15	10.9	28-Apr-15	10.1	28-Jul-15	10.5	28-Oct-15	10.1
28-Jan-15	10.7	29-Apr-15	10.2	29-Jul-15	10.3	29-Oct-15	10.7
29-Jan-15	10.8	30-Apr-15	10.2	30-Jul-15	10.4	30-Oct-15	9.86
30-Jan-15	10.8	1-May-15	10.1	31-Jul-15	11.0	2-Nov-15	10.0
2-Feb-15	10.8	4-May-15	10.2	4-Aug-15	10.0	3-Nov-15	9.80
3-Feb-15	10.9	5-May-15	10.2	5-Aug-15	10.8	4-Nov-15	9.71
4-Feb-15	11.1	6-May-15	10.6	6-Aug-15	10.7	5-Nov-15	10.2
5-Feb-15	10.9	7-May-15	10.6	7-Aug-15	8.50	6-Nov-15	9.60
6-Feb-15	11.0	8-May-15	10.6	10-Aug-15	10.4	9-Nov-15	9.90
9-Feb-15	11.0	11-May-15	10.3	11-Aug-15	10.5	10-Nov-15	9.92
10-Feb-15	11.1	12-May-15	9.90	12-Aug-15	10.5	11-Nov-15	10.5
11-Feb-15	11.0	13-May-15	10.4	13-Aug-15	10.4	12-Nov-15	10.1
12-Feb-15	11.0	14-May-15	10.4	14-Aug-15	10.3	13-Nov-15	9.30
13-Feb-15	11.1	15-May-15	10.5	17-Aug-15	10.5	16-Nov-15	10.2
17-Feb-15	11.0	19-May-15	10.6	18-Aug-15	10.4	17-Nov-15	10.2
18-Feb-15	11.1	20-May-15	10.7	19-Aug-15	10.6	18-Nov-15	10.3
19-Feb-15	11.3	21-May-15	10.5	20-Aug-15	10.8	19-Nov-15	10.0
20-Feb-15	11.1	22-May-15	10.6	21-Aug-15	10.2	20-Nov-15	9.51
23-Feb-15	10.9	25-May-15	10.5	24-Aug-15	10.5	23-Nov-15	10.6
24-Feb-15	11.1	26-May-15	10.5	25-Aug-15	10.3	24-Nov-15	11.6
25-Feb-15	11.2	27-May-15	10.6	26-Aug-15	10.6	25-Nov-15	10.2
26-Feb-15	11.1	28-May-15	10.6	27-Aug-15	10.7	26-Nov-15	10.3
27-Feb-15	11.1	29-May-15	10.5	28-Aug-15	10.7	27-Nov-15	10.0
2-Mar-15	11.0	1-Jun-15	9.80	31-Aug-15	10.6	30-Nov-15	9.42
3-Mar-15	10.9	2-Jun-15	10.1	1-Sep-15	10.8	1-Dec-15	9.70
4-Mar-15	11.3	3-Jun-15	9.80	2-Sep-15	10.6	2-Dec-15	9.64
5-Mar-15	11.0	4-Jun-15	9.80	3-Sep-15	10.7	3-Dec-15	10.8
6-Mar-15	10.7	5-Jun-15	9.90	4-Sep-15	10.6	4-Dec-15	10.2
9-Mar-15	11.0	8-Jun-15	10.2	8-Sep-15	10.8	7-Dec-15	9.22
10-Mar-15	10.9	9-Jun-15	10.5	9-Sep-15	10.8	8-Dec-15	9.96
11-Mar-15	10.9	10-Jun-15	9.80	10-Sep-15	10.7	9-Dec-15	10.3
12-Mar-15	10.5	11-Jun-15	9.80	11-Sep-15	10.6	10-Dec-15	10.2
13-Mar-15	10.5	12-Jun-15	10.3	14-Sep-15	10.7	11-Dec-15	10.9
16-Mar-15	9.70	15-Jun-15	10.3	15-Sep-15	10.7	14-Dec-15	9.70
17-Mar-15	10.6	16-Jun-15	10.6	16-Sep-15	10.7	15-Dec-15	9.54
18-Mar-15	10.6	17-Jun-15	10.6	17-Sep-15	10.7	16-Dec-15	9.03
19-Mar-15	10.8	18-Jun-15	10.6	18-Sep-15	10.3	17-Dec-15	9.30
20-Mar-15	10.9	19-Jun-15	10.9	21-Sep-15	10.3	18-Dec-15	9.33
23-Mar-15	10.9	22-Jun-15	10.8	22-Sep-15	10.3	21-Dec-15	9.07
24-Mar-15	10.0	23-Jun-15	10.8	23-Sep-15	10.6	22-Dec-15	9.34
25-Mar-15	10.3	24-Jun-15	10.9	24-Sep-15	10.4	23-Dec-15	9.41
26-Mar-15	11.0	25-Jun-15	10.6	25-Sep-15	10.5	24-Dec-15	9.30
27-Mar-15	10.9	26-Jun-15	10.4	28-Sep-15	10.6	28-Dec-15	9.00
30-Mar-15	10.5	29-Jun-15	10.5	29-Sep-15	10.5	29-Dec-15	9.00
31-Mar-15	10.7	30-Jun-15	10.6	30-Sep-15	10.3	30-Dec-15	9.20
1-Apr-15	10.7	2-Jul-15	10.6	1-Oct-15	9.38	31-Dec-15	9.00

Note: "SD" = standard deviation. "n" = number of samples.

Table I.16: Water Quality at TOMP Station N-18 (ETP Operations), Lacnor/Nordic TMA, 2015 to 2019

Date	pH
4-Jan-16	9.30
5-Jan-16	9.50
6-Jan-16	9.50
7-Jan-16	9.36
8-Jan-16	9.30
11-Jan-16	9.38
12-Jan-16	9.12
13-Jan-16	9.39
14-Jan-16	9.68
15-Jan-16	9.30
18-Jan-16	9.27
19-Jan-16	9.51
20-Jan-16	9.56
21-Jan-16	9.35
22-Jan-16	9.60
25-Jan-16	9.66
26-Jan-16	9.76
27-Jan-16	9.56
28-Jan-16	9.61
29-Jan-16	9.84
1-Feb-16	9.37
2-Feb-16	9.32
3-Feb-16	9.36
4-Feb-16	9.42
5-Feb-16	9.20
8-Feb-16	9.20
9-Feb-16	9.21
10-Feb-16	9.27
11-Feb-16	9.27
12-Feb-16	9.40
16-Feb-16	9.34
17-Feb-16	9.36
18-Feb-16	9.48
19-Feb-16	9.78
22-Feb-16	9.75
23-Feb-16	9.72
24-Feb-16	9.50
25-Feb-16	9.80
26-Feb-16	9.60
29-Feb-16	9.51
1-Mar-16	9.63
2-Mar-16	10.0
3-Mar-16	9.85
4-Mar-16	9.72
7-Mar-16	10.1
8-Mar-16	9.98
9-Mar-16	9.72
10-Mar-16	10.1
11-Mar-16	10.1
14-Mar-16	8.86
15-Mar-16	8.97
16-Mar-16	7.95
17-Mar-16	8.63
18-Mar-16	8.07
21-Mar-16	8.57
22-Mar-16	8.50
23-Mar-16	9.00
24-Mar-16	9.51
28-Mar-16	8.75
29-Mar-16	8.62
30-Mar-16	8.85
31-Mar-16	8.83
1-Apr-16	8.54
4-Apr-16	8.82
5-Apr-16	8.82
6-Apr-16	9.11
7-Apr-16	9.48
8-Apr-16	9.50
11-Apr-16	9.65
12-Apr-16	11.2
13-Apr-16	10.0
14-Apr-16	9.48
15-Apr-16	10.1
18-Apr-16	8.44
19-Apr-16	8.54
20-Apr-16	8.67
21-Apr-16	8.34
22-Apr-16	9.00
25-Apr-16	9.46
26-Apr-16	9.73
27-Apr-16	9.95
28-Apr-16	10.1
29-Apr-16	10.0
2-May-16	10.0
3-May-16	9.63
4-May-16	9.43
5-May-16	10.0
6-May-16	10.2
9-May-16	10.3
10-May-16	10.6
11-May-16	9.98
12-May-16	10.2
13-May-16	10.1
16-May-16	10.3
17-May-16	9.79
18-May-16	10.5
19-May-16	10.3
20-May-16	10.2
24-May-16	10.1
25-May-16	9.56
26-May-16	10.1
27-May-16	10.5
30-May-16	10.8
31-May-16	10.1
1-Jun-16	10.4
2-Jun-16	9.50
3-Jun-16	10.2
6-Jun-16	10.8
7-Jun-16	10.8
8-Jun-16	10.8
9-Jun-16	10.2
10-Jun-16	10.2
13-Jun-16	10.9
14-Jun-16	10.2
15-Jun-16	10.6
16-Jun-16	10.2
17-Jun-16	10.3
20-Jun-16	10.4
21-Jun-16	10.6
22-Jun-16	9.55
23-Jun-16	9.81
24-Jun-16	10.2
27-Jun-16	9.90
28-Jun-16	10.2
29-Jun-16	9.90
30-Jun-16	9.80
4-Jul-16	10.0
5-Jul-16	10.1
6-Jul-16	10.0
7-Jul-16	9.90
8-Jul-16	9.80
11-Jul-16	9.80
12-Jul-16	10.0
13-Jul-16	9.60
14-Jul-16	9.90
15-Jul-16	10.2
18-Jul-16	9.81
19-Jul-16	10.1
20-Jul-16	9.90
21-Jul-16	9.54
22-Jul-16	9.93
25-Jul-16	10.2
26-Jul-16	9.92
27-Jul-16	9.95
28-Jul-16	9.95
29-Jul-16	9.87
2-Aug-16	10.1
3-Aug-16	9.20
4-Aug-16	9.80
5-Aug-16	10.0
8-Aug-16	10.0
9-Aug-16	10.1
10-Aug-16	10.1
11-Aug-16	10.1
12-Aug-16	10.1
15-Aug-16	9.40
16-Aug-16	9.70
17-Aug-16	9.97
18-Aug-16	10.1
19-Aug-16	9.80
22-Aug-16	9.72
23-Aug-16	9.60
24-Aug-16	9.20
25-Aug-16	9.34
26-Aug-16	9.16
29-Aug-16	9.90
30-Aug-16	9.40
31-Aug-16	9.50
1-Sep-16	9.50
2-Sep-16	9.53
6-Sep-16	9.50
7-Sep-16	9.48
8-Sep-16	9.60
9-Sep-16	9.33
12-Sep-16	9.62
13-Sep-16	9.43
14-Sep-16	9.65
15-Sep-16	9.58
16-Sep-16	9.80
19-Sep-16	10.4
20-Sep-16	10.5
21-Sep-16	10.3
22-Sep-16	10.6
23-Sep-16	10.5
26-Sep-16	10.1
27-Sep-16	10.0
28-Sep-16	10.0
29-Sep-16	10.0
30-Sep-16	10.2
3-Oct-16	9.60
4-Oct-16	10.3
5-Oct-16	10.1
6-Oct-16	10.2
7-Oct-16	9.90
11-Oct-16	10.3
12-Oct-16	10.3
13-Oct-16	10.2
14-Oct-16	10.2
17-Oct-16	10.1
18-Oct-16	10.3
19-Oct-16	10.2
20-Oct-16	10.2
21-Oct-16	10.0
24-Oct-16	10.3
25-Oct-16	10.3
26-Oct-16	10.3
27-Oct-16	10.2
28-Oct-16	10.3
31-Oct-16	10.5
1-Nov-16	10.3
2-Nov-16	10.3
3-Nov-16	10.2
4-Nov-16	10.4
7-Nov-16	10.2
8-Nov-16	10.2
9-Nov-16	10.1
10-Nov-16	10.1
11-Nov-16	10.3
14-Nov-16	10.2
15-Nov-16	10.1
16-Nov-16	10.3
17-Nov-16	10.2
18-Nov-16	10.2
21-Nov-16	10.5
22-Nov-16	10.5
23-Nov-16	10.1
24-Nov-16	10.0
25-Nov-16	10.4
28-Nov-16	10.3
29-Nov-16	10.4
30-Nov-16	10.3
1-Dec-16	10.0
2-Dec-16	10.3
5-Dec-16	10.3
6-Dec-16	10.1
7-Dec-16	10.5
8-Dec-16	10.1
9-Dec-16	10.2
12-Dec-16	10.3
13-Dec-16	10.4
14-Dec-16	10.3
15-Dec-16	10.4
16-Dec-16	10.5
19-Dec-16	10.4
20-Dec-16	10.4
21-Dec-16	10.1
22-Dec-16	10.2
23-Dec-16	10.6
29-Dec-16	10.7
30-Dec-16	10.6
2-Jan-17	10.6
3-Jan-17	10.4

Note: "SD" = standard deviation. "n" = number of samples.

Table I.16: Water Quality at TOMP Station N-18 (ETP Operations), Lacnor/Nordic TMA, 2015 to 2019

Date	pH
4-Jan-17	10.3
5-Jan-17	10.4
6-Jan-17	10.7
9-Jan-17	10.3
10-Jan-17	10.3
11-Jan-17	10.4
12-Jan-17	10.6
13-Jan-17	10.3
16-Jan-17	10.4
17-Jan-17	10.5
18-Jan-17	10.6
19-Jan-17	10.5
20-Jan-17	10.5
23-Jan-17	10.5
24-Jan-17	10.3
25-Jan-17	10.6
26-Jan-17	10.2
27-Jan-17	10.4
30-Jan-17	10.6
31-Jan-17	10.4
1-Feb-17	10.6
2-Feb-17	10.3
3-Feb-17	10.2
6-Feb-17	10.4
7-Feb-17	10.5
8-Feb-17	10.3
9-Feb-17	10.5
10-Feb-17	10.2
13-Feb-17	10.2
14-Feb-17	10.1
15-Feb-17	10.6
16-Feb-17	10.2
17-Feb-17	10.6
21-Feb-17	10.2
22-Feb-17	10.2
23-Feb-17	10.4
24-Feb-17	9.70
27-Feb-17	9.20
28-Feb-17	9.30
1-Mar-17	9.50
2-Mar-17	9.70
3-Mar-17	9.70
6-Mar-17	10.3
7-Mar-17	9.60
8-Mar-17	9.20
9-Mar-17	8.60
10-Mar-17	9.00
13-Mar-17	9.70
14-Mar-17	9.90
15-Mar-17	10.0
16-Mar-17	10.2
17-Mar-17	10.0
20-Mar-17	10.3
21-Mar-17	10.8
22-Mar-17	10.4
23-Mar-17	10.0
24-Mar-17	10.5
27-Mar-17	9.40
28-Mar-17	9.30
29-Mar-17	9.20
30-Mar-17	8.30
31-Mar-17	8.80
3-Apr-17	9.00

Date	pH
4-Apr-17	9.00
5-Apr-17	8.90
6-Apr-17	9.20
7-Apr-17	9.50
10-Apr-17	9.60
11-Apr-17	9.60
12-Apr-17	9.80
13-Apr-17	9.80
17-Apr-17	10.0
18-Apr-17	10.2
19-Apr-17	10.0
20-Apr-17	10.4
21-Apr-17	10.3
24-Apr-17	10.2
25-Apr-17	10.0
26-Apr-17	10.0
27-Apr-17	10.3
28-Apr-17	10.3
1-May-17	10.0
2-May-17	10.1
3-May-17	10.2
4-May-17	10.0
5-May-17	10.3
8-May-17	10.1
9-May-17	10.2
10-May-17	10.2
11-May-17	10.2
12-May-17	9.90
15-May-17	10.1
16-May-17	10.0
17-May-17	9.90
18-May-17	10.0
19-May-17	10.2
23-May-17	10.1
24-May-17	10.1
25-May-17	10.2
26-May-17	10.4
29-May-17	10.1
30-May-17	10.1
31-May-17	10.3
1-Jun-17	10.1
2-Jun-17	10.1
5-Jun-17	10.1
6-Jun-17	10.1
7-Jun-17	10.5
8-Jun-17	10.0
9-Jun-17	10.0
12-Jun-17	10.2
13-Jun-17	10.3
14-Jun-17	10.2
15-Jun-17	10.3
16-Jun-17	10.4
19-Jun-17	10.2
20-Jun-17	10.2
21-Jun-17	10.2
22-Jun-17	10.4
23-Jun-17	10.4
26-Jun-17	10.1
27-Jun-17	10.4
28-Jun-17	10.0
29-Jun-17	10.3
30-Jun-17	10.4
4-Jul-17	9.70

Date	pH
5-Jul-17	10.1
6-Jul-17	10.2
7-Jul-17	10.1
10-Jul-17	10.2
11-Jul-17	10.1
12-Jul-17	10.0
13-Jul-17	10.0
14-Jul-17	10.2
17-Jul-17	10.2
18-Jul-17	10.4
19-Jul-17	10.2
20-Jul-17	10.2
21-Jul-17	10.2
24-Jul-17	10.1
25-Jul-17	10.4
26-Jul-17	10.3
27-Jul-17	10.2
28-Jul-17	10.3
31-Jul-17	10.0
1-Aug-17	10.0
2-Aug-17	10.1
3-Aug-17	10.4
4-Aug-17	10.1
8-Aug-17	10.3
9-Aug-17	10.4
10-Aug-17	10.3
11-Aug-17	10.2
14-Aug-17	10.1
15-Aug-17	10.0
16-Aug-17	10.3
17-Aug-17	10.0
18-Aug-17	10.1
21-Aug-17	10.3
22-Aug-17	10.0
23-Aug-17	10.4
24-Aug-17	9.90
25-Aug-17	10.3
28-Aug-17	10.3
29-Aug-17	10.2
30-Aug-17	10.3
31-Aug-17	9.90
1-Sep-17	10.4
5-Sep-17	10.3
6-Sep-17	10.3
7-Sep-17	10.1
8-Sep-17	10.3
11-Sep-17	10.0
12-Sep-17	10.0
13-Sep-17	10.0
14-Sep-17	10.3
15-Sep-17	10.1
18-Sep-17	10.3
19-Sep-17	10.2
20-Sep-17	10.3
21-Sep-17	10.0
22-Sep-17	10.4
25-Sep-17	10.1
26-Sep-17	10.0
27-Sep-17	10.3
28-Sep-17	10.3
29-Sep-17	9.90
2-Oct-17	10.2
3-Oct-17	10.1

Date	pH
4-Oct-17	10.2
5-Oct-17	10.2
6-Oct-17	10.2
10-Oct-17	10.0
11-Oct-17	10.4
12-Oct-17	9.80
13-Oct-17	10.0
16-Oct-17	9.80
17-Oct-17	9.90
18-Oct-17	10.0
19-Oct-17	10.4
20-Oct-17	10.5
23-Oct-17	10.0
24-Oct-17	9.40
25-Oct-17	9.30
26-Oct-17	9.80
27-Oct-17	9.70
30-Oct-17	9.70
31-Oct-17	9.80
1-Nov-17	9.60
2-Nov-17	10.0
3-Nov-17	10.0
6-Nov-17	10.1
7-Nov-17	10.1
8-Nov-17	10.2
9-Nov-17	10.2
10-Nov-17	10.0
13-Nov-17	10.2
14-Nov-17	10.0
15-Nov-17	10.1
16-Nov-17	10.2
17-Nov-17	9.80
20-Nov-17	10.5
21-Nov-17	9.70
22-Nov-17	10.2
23-Nov-17	10.1
24-Nov-17	9.90
27-Nov-17	10.2
28-Nov-17	10.1
29-Nov-17	10.2
30-Nov-17	9.90
1-Dec-17	10.2
4-Dec-17	10.2
5-Dec-17	9.00
6-Dec-17	9.10
7-Dec-17	8.80
8-Dec-17	8.90
11-Dec-17	10.6
12-Dec-17	9.60
13-Dec-17	10.2
14-Dec-17	9.80
15-Dec-17	9.80
18-Dec-17	10.4
19-Dec-17	10.3
20-Dec-17	10.2
21-Dec-17	10.2
22-Dec-17	10.3
27-Dec-17	10.0
28-Dec-17	10.5
29-Dec-17	10.1
2-Jan-18	10.4
3-Jan-18	10.6
4-Jan-18	10.6

Note: "SD" = standard deviation. "n" = number of samples.

Table I.16: Water Quality at TOMP Station N-18 (ETP Operations), Lacnor/Nordic TMA, 2015 to 2019

Date	pH	Date	pH	Date	pH	Date	pH
5-Jan-18	10.4	6-Apr-18	10.3	6-Jul-18	10.1	4-Oct-18	10.0
8-Jan-18	10.5	9-Apr-18	10.2	9-Jul-18	10.0	5-Oct-18	9.90
9-Jan-18	10.7	10-Apr-18	10.6	10-Jul-18	10.0	9-Oct-18	10.2
10-Jan-18	10.7	11-Apr-18	10.6	11-Jul-18	10.2	10-Oct-18	10.5
11-Jan-18	10.6	12-Apr-18	10.4	12-Jul-18	10.2	11-Oct-18	9.90
12-Jan-18	10.6	13-Apr-18	10.3	13-Jul-18	9.90	12-Oct-18	10.0
15-Jan-18	10.5	16-Apr-18	10.6	16-Jul-18	9.90	15-Oct-18	9.90
16-Jan-18	10.2	17-Apr-18	10.3	17-Jul-18	10.0	16-Oct-18	10.0
17-Jan-18	10.5	18-Apr-18	10.4	18-Jul-18	9.70	17-Oct-18	10.3
18-Jan-18	10.3	19-Apr-18	10.2	19-Jul-18	9.80	18-Oct-18	10.3
19-Jan-18	10.3	20-Apr-18	10.2	20-Jul-18	10.1	19-Oct-18	10.3
22-Jan-18	10.7	23-Apr-18	10.2	23-Jul-18	10.1	22-Oct-18	10.0
23-Jan-18	10.3	24-Apr-18	9.60	24-Jul-18	9.90	23-Oct-18	10.2
24-Jan-18	10.2	25-Apr-18	8.70	25-Jul-18	10.1	24-Oct-18	10.3
25-Jan-18	10.3	26-Apr-18	8.70	26-Jul-18	10.1	25-Oct-18	10.4
26-Jan-18	10.3	27-Apr-18	8.90	27-Jul-18	10.3	26-Oct-18	10.3
29-Jan-18	10.1	30-Apr-18	9.00	30-Jul-18	10.1	29-Oct-18	10.2
30-Jan-18	10.1	1-May-18	8.90	31-Jul-18	10.1	30-Oct-18	10.1
31-Jan-18	9.80	2-May-18	9.00	1-Aug-18	9.90	31-Oct-18	10.0
1-Feb-18	10.6	3-May-18	8.70	2-Aug-18	9.80	1-Nov-18	10.1
2-Feb-18	10.5	4-May-18	8.80	3-Aug-18	9.80	2-Nov-18	10.3
5-Feb-18	10.4	7-May-18	9.00	6-Aug-18	9.90	5-Nov-18	10.0
6-Feb-18	10.6	8-May-18	9.40	7-Aug-18	9.70	6-Nov-18	10.0
7-Feb-18	10.3	9-May-18	9.70	8-Aug-18	10.2	7-Nov-18	9.90
8-Feb-18	10.5	10-May-18	9.90	9-Aug-18	10.0	8-Nov-18	10.2
9-Feb-18	10.4	11-May-18	9.90	10-Aug-18	10.1	9-Nov-18	10.3
12-Feb-18	10.3	14-May-18	10.0	13-Aug-18	9.90	12-Nov-18	10.2
13-Feb-18	9.90	15-May-18	10.3	14-Aug-18	10.0	13-Nov-18	10.2
14-Feb-18	10.4	16-May-18	10.2	15-Aug-18	9.90	14-Nov-18	10.3
15-Feb-18	10.4	17-May-18	10.0	16-Aug-18	9.70	15-Nov-18	10.2
16-Feb-18	10.5	18-May-18	10.0	17-Aug-18	10.0	16-Nov-18	10.2
20-Feb-18	10.4	22-May-18	10.1	20-Aug-18	9.90	19-Nov-18	10.2
21-Feb-18	10.6	23-May-18	10.1	21-Aug-18	9.60	20-Nov-18	10.3
22-Feb-18	10.6	24-May-18	10.2	22-Aug-18	10.0	21-Nov-18	10.0
23-Feb-18	10.5	25-May-18	9.90	23-Aug-18	10.2	22-Nov-18	10.3
26-Feb-18	10.5	28-May-18	10.2	24-Aug-18	10.1	23-Nov-18	10.2
27-Feb-18	10.5	29-May-18	10.0	27-Aug-18	10.4	26-Nov-18	9.80
28-Feb-18	10.2	30-May-18	10.2	28-Aug-18	10.5	27-Nov-18	9.80
1-Mar-18	10.2	31-May-18	9.10	29-Aug-18	10.4	28-Nov-18	9.80
2-Mar-18	10.5	1-Jun-18	9.80	30-Aug-18	10.4	29-Nov-18	9.60
5-Mar-18	10.2	4-Jun-18	9.80	31-Aug-18	10.3	30-Nov-18	9.40
6-Mar-18	10.2	5-Jun-18	10.2	4-Sep-18	10.0	3-Dec-18	9.50
7-Mar-18	10.1	6-Jun-18	10.0	5-Sep-18	10.2	4-Dec-18	9.70
8-Mar-18	10.3	7-Jun-18	9.90	6-Sep-18	10.2	5-Dec-18	9.50
9-Mar-18	10.3	8-Jun-18	10.0	7-Sep-18	10.5	6-Dec-18	9.10
12-Mar-18	10.2	11-Jun-18	10.3	10-Sep-18	10.3	7-Dec-18	9.50
13-Mar-18	10.5	12-Jun-18	10.2	11-Sep-18	10.2	10-Dec-18	9.40
14-Mar-18	10.1	13-Jun-18	9.70	12-Sep-18	10.0	11-Dec-18	9.30
15-Mar-18	10.6	14-Jun-18	9.90	13-Sep-18	10.5	12-Dec-18	9.40
16-Mar-18	10.2	15-Jun-18	10.0	14-Sep-18	10.2	13-Dec-18	9.60
19-Mar-18	10.6	18-Jun-18	9.80	17-Sep-18	10.1	14-Dec-18	9.50
20-Mar-18	10.4	19-Jun-18	9.80	18-Sep-18	10.2	17-Dec-18	9.20
21-Mar-18	10.4	20-Jun-18	9.70	19-Sep-18	10.3	18-Dec-18	9.40
22-Mar-18	10.6	21-Jun-18	10.3	20-Sep-18	10.1	19-Dec-18	9.30
23-Mar-18	10.4	22-Jun-18	9.90	21-Sep-18	10.4	20-Dec-18	9.20
26-Mar-18	10.4	25-Jun-18	9.90	24-Sep-18	10.3	21-Dec-18	9.60
27-Mar-18	10.2	26-Jun-18	10.3	25-Sep-18	10.2	24-Dec-18	9.40
28-Mar-18	10.3	27-Jun-18	9.60	26-Sep-18	10.1	27-Dec-18	9.60
29-Mar-18	10.4	28-Jun-18	9.70	27-Sep-18	10.2	28-Dec-18	9.40
2-Apr-18	10.2	29-Jun-18	9.60	28-Sep-18	10.2	31-Dec-18	9.60
3-Apr-18	10.2	3-Jul-18	10.1	1-Oct-18	10.1	2-Jan-19	9.70
4-Apr-18	10.4	4-Jul-18	10.0	2-Oct-18	10.1	3-Jan-19	9.60
5-Apr-18	10.1	5-Jul-18	9.80	3-Oct-18	10.1	4-Jan-19	9.60

Note: "SD" = standard deviation. "n" = number of samples.

Table I.16: Water Quality at TOMP Station N-18 (ETP Operations), Lacnor/Nordic TMA, 2015 to 2019

Date	pH	Date	pH	Date	pH	Date	pH
7-Jan-19	9.30	8-Apr-19	10.3	10-Jul-19	10.2	10-Oct-19	10.7
8-Jan-19	9.60	9-Apr-19	8.90	11-Jul-19	10.4	11-Oct-19	10.2
9-Jan-19	9.50	10-Apr-19	8.60	12-Jul-19	10.4	15-Oct-19	10.3
10-Jan-19	9.70	11-Apr-19	8.50	15-Jul-19	10.2	16-Oct-19	10.3
11-Jan-19	9.60	12-Apr-19	8.60	16-Jul-19	10.3	17-Oct-19	10.1
14-Jan-19	9.20	15-Apr-19	8.20	17-Jul-19	10.4	18-Oct-19	10.5
15-Jan-19	9.20	16-Apr-19	8.70	18-Jul-19	10.0	21-Oct-19	10.4
16-Jan-19	9.40	17-Apr-19	9.00	19-Jul-19	10.2	22-Oct-19	10.2
17-Jan-19	9.50	18-Apr-19	9.80	22-Jul-19	10.2	23-Oct-19	9.90
18-Jan-19	9.40	22-Apr-19	9.50	23-Jul-19	10.3	24-Oct-19	10.0
21-Jan-19	9.70	23-Apr-19	9.50	24-Jul-19	10.3	25-Oct-19	9.90
22-Jan-19	9.20	24-Apr-19	9.40	25-Jul-19	10.2	28-Oct-19	10.2
23-Jan-19	9.20	25-Apr-19	9.50	26-Jul-19	10.2	29-Oct-19	10.2
24-Jan-19	9.30	26-Apr-19	9.70	29-Jul-19	10.3	30-Oct-19	10.2
25-Jan-19	9.10	29-Apr-19	10.1	30-Jul-19	10.3	31-Oct-19	10.2
28-Jan-19	9.30	30-Apr-19	10.1	31-Jul-19	10.5	1-Nov-19	10.2
29-Jan-19	9.40	1-May-19	10.1	1-Aug-19	10.5	4-Nov-19	10.3
30-Jan-19	9.20	2-May-19	10.1	2-Aug-19	10.4	5-Nov-19	10.5
31-Jan-19	9.50	3-May-19	10.3	6-Aug-19	10.4	6-Nov-19	10.5
1-Feb-19	9.60	6-May-19	10.3	7-Aug-19	10.3	7-Nov-19	10.5
4-Feb-19	9.30	7-May-19	10.1	8-Aug-19	10.6	8-Nov-19	10.3
5-Feb-19	9.50	8-May-19	10.3	9-Aug-19	10.5	11-Nov-19	10.2
6-Feb-19	10.0	9-May-19	9.90	12-Aug-19	10.3	12-Nov-19	10.2
7-Feb-19	9.70	10-May-19	9.90	13-Aug-19	10.4	13-Nov-19	10.2
8-Feb-19	9.60	13-May-19	9.80	14-Aug-19	10.4	14-Nov-19	10.3
11-Feb-19	9.40	14-May-19	10.1	15-Aug-19	10.3	15-Nov-19	10.2
12-Feb-19	10.0	15-May-19	10.0	16-Aug-19	10.6	18-Nov-19	10.2
13-Feb-19	9.70	16-May-19	10.2	19-Aug-19	10.6	19-Nov-19	10.3
14-Feb-19	9.70	17-May-19	10.0	20-Aug-19	10.3	20-Nov-19	10.2
15-Feb-19	9.60	21-May-19	10.2	21-Aug-19	10.3	21-Nov-19	10.1
19-Feb-19	10.2	22-May-19	10.4	22-Aug-19	10.3	22-Nov-19	9.10
20-Feb-19	10.0	23-May-19	10.1	23-Aug-19	10.3	25-Nov-19	9.70
21-Feb-19	9.90	24-May-19	10.4	26-Aug-19	10.6	26-Nov-19	9.60
22-Feb-19	9.90	27-May-19	10.3	27-Aug-19	10.3	27-Nov-19	9.70
25-Feb-19	9.80	28-May-19	10.2	28-Aug-19	10.4	28-Nov-19	9.20
26-Feb-19	10.2	29-May-19	10.0	29-Aug-19	10.2	29-Nov-19	8.90
27-Feb-19	10.1	30-May-19	10.2	30-Aug-19	10.2	2-Dec-19	9.10
28-Feb-19	10.1	31-May-19	10.0	3-Sep-19	10.6	3-Dec-19	9.10
1-Mar-19	10.2	3-Jun-19	10.0	4-Sep-19	10.5	4-Dec-19	9.20
4-Mar-19	9.90	4-Jun-19	10.0	5-Sep-19	10.6	5-Dec-19	9.00
5-Mar-19	10.5	5-Jun-19	9.90	6-Sep-19	10.6	6-Dec-19	9.10
6-Mar-19	10.3	6-Jun-19	10.2	9-Sep-19	10.7	9-Dec-19	8.80
7-Mar-19	10.6	7-Jun-19	10.1	10-Sep-19	10.6	10-Dec-19	9.20
8-Mar-19	10.2	10-Jun-19	10.2	11-Sep-19	10.7	11-Dec-19	9.40
11-Mar-19	10.5	11-Jun-19	10.4	12-Sep-19	10.7	12-Dec-19	10.1
12-Mar-19	10.3	12-Jun-19	10.3	13-Sep-19	10.5	13-Dec-19	9.80
13-Mar-19	10.3	13-Jun-19	10.3	16-Sep-19	10.6	16-Dec-19	9.90
14-Mar-19	10.0	14-Jun-19	10.3	17-Sep-19	10.7	17-Dec-19	9.90
15-Mar-19	10.2	17-Jun-19	10.1	18-Sep-19	10.4	18-Dec-19	10.0
18-Mar-19	10.2	18-Jun-19	10.3	19-Sep-19	10.6	19-Dec-19	10.3
19-Mar-19	10.4	19-Jun-19	10.2	20-Sep-19	10.5	20-Dec-19	10.4
20-Mar-19	10.2	20-Jun-19	10.3	23-Sep-19	10.5	23-Dec-19	10.0
21-Mar-19	10.5	21-Jun-19	10.1	24-Sep-19	10.6	24-Dec-19	10.2
22-Mar-19	10.4	24-Jun-19	10.2	25-Sep-19	10.5	27-Dec-19	10.5
25-Mar-19	10.3	25-Jun-19	10.3	26-Sep-19	10.4	30-Dec-19	10.4
26-Mar-19	10.4	26-Jun-19	10.2	27-Sep-19	10.4	31-Dec-19	10.2
27-Mar-19	10.5	27-Jun-19	10.3	30-Sep-19	10.3	**n**	1256
28-Mar-19	10.6	28-Jun-19	10.3	1-Oct-19	10.5	**Minimum**	7.30
29-Mar-19	10.3	2-Jul-19	10.1	2-Oct-19	10.5	**Maximum**	11.6
1-Apr-19	10.4	3-Jul-19	10.3	3-Oct-19	10.7	**Mean**	10.1
2-Apr-19	10.1	4-Jul-19	10.3	4-Oct-19	10.6	**SD**	0.520
3-Apr-19	10.4	5-Jul-19	10.4	7-Oct-19	10.5	**Median**	10.2
4-Apr-19	10.1	8-Jul-19	10.3	8-Oct-19	10.5	**10th Percentile**	9.38
5-Apr-19	10.0	9-Jul-19	10.1	9-Oct-19	10.2	**95th Percentile**	10.8

Note: "SD" = standard deviation. "n" = number of samples.

Table I.17: Water Quality at TOMP Stations UW7-2, 4 and 6 (Pore Water), Lacnor/Nordic TMA, 2015 to 2019

Station	Date	Acidity (mg/L)	Iron (mg/L)	pH	Sulphate (mg/L)
UNW7-2	11-Aug-15	<1.00	133	6.62	3,700
	6-Jul-16	<1.00	138	6.73	3,500
	9-Aug-17	<1.00	134	6.45	3,400
	18-Jul-19	<1.00	143	6.54	3,400
	n	4	4	4	4
	Minimum	<1.00	133	6.45	3,400
	Maximum	<1.00	143	6.73	3,700
	Mean	<1.00	137	6.58	3,500
	SD	-	4.55	0.119	141
	Median	<1.00	136	6.58	3,450
	10th Percentile	<1.00	133	6.45	3,400
	95th Percentile	<1.00	143	6.73	3,700
UNW7-4	10-Aug-15	156	88.6	5.81	1,500
	6-Jul-16	170	71.8	5.31	1,500
	9-Aug-17	241	106	5.50	1,400
	14-Aug-18	233	121	5.51	1,600
	17-Jul-19	186	95.6	5.77	1,400
	n	5	5	5	5
	Minimum	156	71.8	5.31	1,400
	Maximum	241	121	5.81	1,600
	Mean	197	96.6	5.58	1,480
	SD	38.0	18.5	0.208	83.7
	Median	186	95.6	5.51	1,500
	10th Percentile	156	71.8	5.31	1,400
	95th Percentile	241	121	5.81	1,600
UNW7-6	8-Jul-16	<1.00	90.4	6.82	1,800
	9-Aug-17	-	-	-	-
	7-Feb-15	-	-	-	-
	n	1	1	1	1
	Minimum	<1.00	90.4	6.82	1,800
	Maximum	<1.00	90.4	6.82	1,800
	Mean	<1.00	90.4	6.82	1,800
	SD	-	-	-	-
	Median	<1.00	90.4	6.82	1,800
	10th Percentile	<1.00	90.4	6.82	1,800
	95th Percentile	<1.00	90.4	6.82	1,800

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected, or SD was incalculable because there was no variability in the data.

Table I.18: Water Quality at TOMP Stations UW9-1, 2 and 3 (Pore Water), Lacnor/Nordic TMA, 2015 to 2019

Station	Date	pH	Sulphate (mg/L)	Acidity (mg/L)	Iron (mg/L)
UNW9-1	11-Aug-15	3.16	2,900	1,670	597
	6-Jul-16	4.08	2,900	1,660	563
	9-Aug-17	4.09	2,500	1,800	613
	14-Aug-18	4.12	3,200	2,000	605
	18-Jul-19	3.62	3,100	2,260	724
	n	5	5	5	5
	Minimum	3.16	2,500	1,660	563
	Maximum	4.12	3,200	2,260	724
	Mean	3.81	2,920	1,880	620
	SD	0.420	268	254	61.0
	Median	4.08	2,900	1,800	605
	10th Percentile	3.16	2,500	1,660	563
	95th Percentile	4.12	3,200	2,260	724
UNW9-2	11-Aug-15	3.94	2,900	1,600	583
	6-Jul-16	3.85	2,800	1,530	480
	9-Aug-17	3.80	3,000	2,040	611
	14-Aug-18	3.75	3,500	2,140	660
	18-Jul-19	3.45	3,200	2,420	728
	n	5	5	5	5
	Minimum	3.45	2,800	1,530	480
	Maximum	3.94	3,500	2,420	728
	Mean	3.76	3,080	1,950	612
	SD	0.186	277	376	92.2
	Median	3.80	3,000	2,040	611
	10th Percentile	3.45	2,800	1,530	480
	95th Percentile	3.94	3,500	2,420	728
UNW9-3	11-Aug-15	2.29	2,700	1,540	498
	6-Jul-16	2.29	3,100	1,740	561
	9-Aug-17	2.23	2,100	1,230	300
	18-Jul-19	2.19	2,200	627	126
	n	4	4	4	4
	Minimum	2.19	2,100	627	126
	Maximum	2.29	3,100	1,740	561
	Mean	2.25	2,520	1,280	371
	SD	0.0490	465	486	198
	Median	2.26	2,450	1,380	399
	10th Percentile	2.19	2,100	627	126
	95th Percentile	2.29	3,100	1,740	561

Note: "SD" = standard deviation. "n" = number of samples.

Table I.19: Water Quality at TOMP Stations M-12-1, 3, 6, and 9 (Groundwater), Lacnor/Nordic TMA, 2015 to 2019

Station	Date	pH	Sulphate (mg/L)	Acidity (mg/L)	Iron (mg/L)
M-12-1	8-Sep-15	6.10	6,900	3,870	2,320
	7-Jul-16	5.98	6,400	3,840	1,930
	3-Aug-17	5.94	6,000	3,850	2,480
	13-Aug-18	5.99	6,500	3,860	2,110
	22-Jul-19	5.87	6,200	3,730	1,980
	n	5	5	5	5
	Minimum	5.87	6,000	3,730	1,930
	Maximum	6.10	6,900	3,870	2,480
	Mean	5.98	6,400	3,830	2,160
	SD	0.0838	339	57.0	232
	Median	5.98	6,400	3,850	2,110
	10th Percentile	5.87	6,000	3,730	1,930
	95th Percentile	6.10	6,900	3,870	2,480
M-12-3	7-Jul-16	-	510	210	148
	3-Aug-17	6.11	11.0	<1.00	24.0
	15-Jul-19	6.14	0.500	<1.00	15.2
	n	2	3	3	3
	Minimum	6.11	0.500	<1.00	15.2
	Maximum	6.14	510	210	148
	Mean	6.12	174	70.7	62.4
	SD	0.0212	291	-	74.3
	Median	6.12	11.0	<1.00	24.0
	10th Percentile	6.11	0.500	<1.00	15.2
	95th Percentile	6.14	510	210	148
M-12-6	8-Sep-15	6.12	50.0	<1.00	26.8
	7-Jul-16	6.11	8.20	<1.00	15.2
	3-Aug-17	6.21	1.50	<1.00	9.01
	n	3	3	3	3
	Minimum	6.11	1.50	<1.00	9.01
	Maximum	6.21	50.0	<1.00	26.8
	Mean	6.15	19.9	<1.00	17.0
	SD	0.0551	26.3	-	9.03
	Median	6.12	8.20	<1.00	15.2
	10th Percentile	6.11	1.50	<1.00	9.01
	95th Percentile	6.21	50.0	<1.00	26.8
M-12-9	8-Sep-15	6.31	20.0	<1.00	18.7
	7-Jul-16	6.09	36.0	<1.00	22.2
	3-Aug-17	6.17	68.0	<1.00	27.4
	n	3	3	3	3
	Minimum	6.09	20.0	<1.00	18.7
	Maximum	6.31	68.0	<1.00	27.4
	Mean	6.19	41.3	<1.00	22.8
	SD	0.111	24.4	-	4.38
	Median	6.17	36.0	<1.00	22.2
	10th Percentile	6.09	20.0	<1.00	18.7
	95th Percentile	6.31	68.0	<1.00	27.4

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected, or SD was incalculable because there was no variability in the data.

Table I.20: Water Quality at TOMP Stations M-13-1, 3, 6, and 9 (Groundwater), Lacnor/Nordic TMA, 2015 to 2019

Station	Date	pH	Sulphate (mg/L)	Acidity (mg/L)	Iron (mg/L)
M-13-1	9-Sep-15	6.32	69.0	24.0	66.7
	21-Jun-16	6.03	37.0	13.0	60.0
	31-Jul-17	6.29	28.0	<1.00	44.6
	9-Aug-18	6.47	12.0	<1.00	23.4
	n	4	4	4	4
	Minimum	6.03	12.0	<1.00	23.4
	Maximum	6.47	69.0	24.0	66.7
	Mean	6.28	36.5	9.75	48.7
	SD	0.183	24.0	6.74	19.2
	Median	6.30	32.5	7.00	52.3
	10th Percentile	6.03	12.0	<1.00	23.4
	95th Percentile	6.47	69.0	24.0	66.7
M-13-3	9-Sep-15	6.38	120	9.00	54.8
	21-Jun-16	6.20	5.60	<1.00	18.2
	31-Jul-17	6.45	5.90	<1.00	12.7
	9-Aug-18	6.60	9.60	<1.00	12.0
	10-Jul-19	6.64	5.80	<1.00	10.9
	n	5	5	5	5
	Minimum	6.20	5.60	<1.00	10.9
	Maximum	6.64	120	9.00	54.8
	Mean	6.45	29.4	2.60	21.7
	SD	0.177	50.7	-	18.7
	Median	6.45	5.90	<1.00	12.7
	10th Percentile	6.20	5.60	<1.00	10.9
	95th Percentile	6.64	120	9.00	54.8
M-13-6 [a]	9-Sep-15	-	-	-	-
	21-Jun-16	-	-	-	-
	31-Jul-17	-	-	-	-
	9-Aug-18	-	-	-	-
	10-Jul-19	-	-	-	-
	n	0	0	0	0
	Minimum	-	-	-	-
	Maximum	-	-	-	-
	Mean	-	-	-	-
	SD	-	-	-	-
	Median	-	-	-	-
	10th Percentile	-	-	-	-
	95th Percentile	-	-	-	-
M-13-9 [b]	10-Sep-15	5.91	2.10	<1.00	3.13
	31-Jul-17	6.11	2.80	<1.00	8.84
	n	2	2	2	2
	Minimum	5.91	2.10	<1.00	3.13
	Maximum	6.11	2.80	<1.00	8.84
	Mean	6.01	2.45	<1.00	5.98
	SD	0.141	0.495	-	4.04
	Median	6.01	2.45	<1.00	5.98
	10th Percentile	5.91	2.10	<1.00	3.13
	95th Percentile	6.11	2.80	<1.00	8.84

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected, or SD was incalculable because there was no variability in the data.

[a] Groundwater well was dry when sampling was attempted in 2015, 2016, 2017, 2018, and 2019, therefore no samples were collected.

[b] Groundwater well was dry when sampling was attempted in 2016, 2018, and 2019, therefore no samples were collected.

Table I.21: Water Quality at TOMP Stations M-14-1, 3, 6, and 9 (Groundwater), Lacnor/Nordic TMA, 2015 to 2019

Station	Date	pH	Sulphate (mg/L)	Acidity (mg/L)	Iron (mg/L)
M-14-1	14-Sep-15	6.22	4,400	1,880	1,010
	20-Jun-16	6.16	3,300	1,620	910
	1-Aug-17	6.11	2,200	1,310	865
	n	3	3	3	3
	Minimum	6.11	2,200	1,310	865
	Maximum	6.22	4,400	1,880	1,010
	Mean	6.16	3,300	1,600	929
	SD	0.0551	1,100	285	75.9
	Median	6.16	3,300	1,620	910
	10th Percentile	6.11	2,200	1,310	865
	95th Percentile	6.22	4,400	1,880	1,010
M-14-3	2-Sep-15	6.51	710	133	126
	20-Jun-16	6.45	990	150	148
	1-Aug-17	6.52	640	85.0	114
	15-Aug-18	6.41	440	37.0	63.5
	11-Jul-19	6.37	640	61.0	94.5
	n	5	5	5	5
	Minimum	6.37	440	37.0	63.5
	Maximum	6.52	990	150	148
	Mean	6.45	684	93.2	109
	SD	0.0642	199	47.6	32.1
	Median	6.45	640	85.0	114
	10th Percentile	6.37	440	37.0	63.5
	95th Percentile	6.52	990	150	148
M-14-6	14-Sep-15	6.68	4.50	<1.00	6.47
	21-Jun-16	6.86	3.80	<1.00	1.96
	1-Aug-17	6.69	5.20	<1.00	2.12
	15-Aug-18	6.87	5.70	<1.00	1.92
	11-Jul-19	6.55	46.0	<1.00	0.871
	n	5	5	5	5
	Minimum	6.55	3.80	<1.00	0.871
	Maximum	6.87	46.0	<1.00	6.47
	Mean	6.73	13.0	<1.00	2.67
	SD	0.135	18.4	-	2.18
	Median	6.69	5.20	<1.00	1.96
	10th Percentile	6.55	3.80	<1.00	0.871
	95th Percentile	6.87	46.0	<1.00	6.47
M-14-9	14-Sep-15	6.00	37.0	<1.00	14.3
	21-Jun-16	6.48	1.10	<1.00	7.76
	1-Aug-17	6.12	0.400	<1.00	9.70
	15-Aug-18	6.49	4.70	<1.00	6.31
	11-Jul-19	6.06	0.300	<1.00	10.2
	n	5	5	5	5
	Minimum	6.00	0.300	<1.00	6.31
	Maximum	6.49	37.0	<1.00	14.3
	Mean	6.23	8.70	<1.00	9.65
	SD	0.237	15.9	-	3.03
	Median	6.12	1.10	<1.00	9.70
	10th Percentile	6.00	0.300	<1.00	6.31
	95th Percentile	6.49	37.0	<1.00	14.3

Note: "SD" = standard deviation. "n" = number of samples. "-" = SD was incalculable because there was no variability in the data.

Table I.22: Water Quality at TOMP Stations 95N-4A and B (Groundwater), Lacnor/Nordic TMA, 2015 to 2019

Station	Date	pH	Sulphate (mg/L)	Acidity (mg/L)	Iron (mg/L)
95N-4A	11-Aug-15	6.07	3,700	2,310	1,260
	8-Jul-16	5.88	3,440	2,130	1,060
	8-Aug-17	5.82	3,200	2,180	1,130
	13-Aug-18	5.73	3,600	2,140	1,100
	22-Jul-19	5.87	3,500	2,110	1,130
	n	5	5	5	5
	Minimum	5.73	3,200	2,110	1,060
	Maximum	6.07	3,700	2,310	1,260
	Mean	5.87	3,490	2,170	1,140
	SD	0.125	189	80.2	75.0
	Median	5.87	3,500	2,140	1,130
	10th Percentile	5.73	3,200	2,110	1,060
	95th Percentile	6.07	3,700	2,310	1,260
95N-4B	11-Aug-15	4.91	3,300	2,090	1,140
	8-Jul-16	4.69	3,220	3,690	970
	8-Aug-17	4.72	2,900	2,010	813
	13-Aug-18	4.83	3,200	2,010	861
	22-Jul-19	4.61	3,100	1,950	926
	n	5	5	5	5
	Minimum	4.61	2,900	1,950	813
	Maximum	4.91	3,300	3,690	1,140
	Mean	4.75	3,140	2,350	942
	SD	0.118	153	751	126
	Median	4.72	3,200	2,010	926
	10th Percentile	4.61	2,900	1,950	813
	95th Percentile	4.91	3,300	3,690	1,140

Note: "SD" = standard deviation. "n" = number of samples.

Table I.23: Water Quality at TOMP Stations 95N-7A and B (Groundwater), Lacnor/Nordic TMA, 2015 to 2019

Station	Date	pH	Sulphate (mg/L)	Acidity (mg/L)	Iron (mg/L)
95N-7A	11-Aug-15	4.84	26.0	4.00	0.200
	8-Jul-16	4.56	23.0	7.00	0.432
	8-Aug-17	4.71	24.0	7.00	0.172
	7-Aug-18	4.93	35.0	4.00	<0.0200
	18-Jul-19	4.42	26.0	3.00	0.0360
	n	5	5	5	5
	Minimum	4.42	23.0	3.00	<0.0200
	Maximum	4.93	35.0	7.00	0.432
	Mean	4.69	26.8	5.00	0.172
	SD	0.206	4.76	1.87	0.168
	Median	4.71	26.0	4.00	0.172
	10th Percentile	4.42	23.0	3.00	<0.0360
	95th Percentile	4.93	35.0	7.00	0.432
95N-7B	11-Aug-15	4.69	170	51.0	16.3
	8-Jul-16	4.56	146	39.0	11.0
	8-Aug-17	4.73	170	58.0	14.1
	7-Aug-18	4.65	180	49.0	13.0
	18-Jul-19	4.47	160	46.0	11.9
	n	5	5	5	5
	Minimum	4.47	146	39.0	11.0
	Maximum	4.73	180	58.0	16.3
	Mean	4.62	165	48.6	13.3
	SD	0.105	12.9	6.95	2.06
	Median	4.65	170	49.0	13.0
	10th Percentile	4.47	146	39.0	11.0
	95th Percentile	4.73	180	58.0	16.3

Note: "SD" = standard deviation. "n" = number of samples.

Table I.24: Water Quality at TOMP Station 95N-11 (Groundwater), Lacnor/Nordic TMA, 2015 to 2019

Date	pH	Sulphate (mg/L)	Acidity (mg/L)	Iron (mg/L)
11-Aug-15	4.99	420	8.00	0.230
5-Jul-16	5.33	390	7.00	0.280
1-Aug-17	5.00	420	14.0	0.182
9-Aug-18	5.36	390	<1.00	0.240
9-Jul-19	5.41	310	<1.00	0.147
n	5	5	5	5
Minimum	4.99	310	<1.00	0.147
Maximum	5.41	420	14.0	0.280
Mean	5.22	386	6.20	0.216
SD	0.206	45.1	3.34	0.0519
Median	5.33	390	7.00	0.230
10th Percentile	4.99	310	<1.00	0.147
95th Percentile	5.41	420	14.0	0.280

Note: "SD" = standard deviation. "n" = number of samples.

Table I.25: Water Quality at TOMP Stations 95N-12A and B (Groundwater), Lacnor/Nordic TMA, 2015 to 2019

Station	Date	pH	Sulphate (mg/L)	Acidity (mg/L)	Iron (mg/L)
95N-12A	11-Aug-15	6.83	16.0	<1.00	6.48
	22-Jun-16	6.87	16.0	<1.00	4.99
	1-Aug-17	6.55	18.0	<1.00	5.02
	9-Aug-18	6.94	13.0	<1.00	4.55
	8-Jul-19	6.92	14.0	<1.00	4.04
	n	5	5	5	5
	Minimum	6.55	13.0	<1.00	4.04
	Maximum	6.94	18.0	<1.00	6.48
	Mean	6.82	15.4	<1.00	5.02
	SD	0.158	1.95	-	0.910
	Median	6.87	16.0	<1.00	4.99
	10th Percentile	6.55	13.0	<1.00	4.04
	95th Percentile	6.94	18.0	<1.00	6.48
95N-12B	11-Aug-15	6.95	15.0	<1.00	4.09
	22-Jun-16	6.71	16.0	<1.00	2.76
	1-Aug-17	6.73	16.0	<1.00	3.34
	9-Aug-18	6.87	13.0	<1.00	3.55
	8-Jul-19	6.76	18.0	<1.00	1.41
	n	5	5	5	5
	Minimum	6.71	13.0	<1.00	1.41
	Maximum	6.95	18.0	<1.00	4.09
	Mean	6.80	15.6	<1.00	3.03
	SD	0.102	1.82	-	1.02
	Median	6.76	16.0	<1.00	3.34
	10th Percentile	6.71	13.0	<1.00	1.41
	95th Percentile	6.95	18.0	<1.00	4.09

Note: "SD" = standard deviation. "n" = number of samples. "-" = SD was incalculable because there was no variability in the data.

Table I.26: Water Quality at TOMP Stations 95N-13A, C, and E (Groundwater), Lacnor/Nordic TMA, 2015 to 2019

Station	Date	pH	Sulphate (mg/L)	Acidity (mg/L)	Iron (mg/L)
95N-13A	11-Aug-15	6.08	3,100	1,260	842
	23-Jun-16	6.34	3,100	1,110	761
	8-Aug-17	6.01	2,700	1,150	725
	7-Aug-18	6.19	3,000	1,300	742
	16-Jul-19	6.18	2,900	1,030	761
	n	5	5	5	5
	Minimum	6.01	2,700	1,030	725
	Maximum	6.34	3,100	1,300	842
	Mean	6.16	2,960	1,170	766
	SD	0.125	167	110	45.0
	Median	6.18	3,000	1,150	761
	10th Percentile	6.01	2,700	1,030	725
	95th Percentile	6.34	3,100	1,300	842
95N-13C	10-Aug-15	6.34	3,100	1,350	929
	23-Jun-16	6.30	3,300	1,450	871
	8-Aug-17	6.17	2,900	1,340	862
	7-Aug-18	6.22	3,100	1,430	823
	16-Jul-19	6.18	2,900	1,360	809
	n	5	5	5	5
	Minimum	6.17	2,900	1,340	809
	Maximum	6.34	3,300	1,450	929
	Mean	6.24	3,060	1,390	859
	SD	0.0750	167	50.3	47.0
	Median	6.22	3,100	1,360	862
	10th Percentile	6.17	2,900	1,340	809
	95th Percentile	6.34	3,300	1,450	929
95N-13E	10-Aug-15	4.82	3,300	1,860	1,020
	23-Jun-16	5.12	2,900	1,650	867
	8-Aug-17	5.16	3,100	1,620	824
	8-Aug-18	4.98	3,000	1,860	870
	16-Jul-19	4.88	2,400	1,560	329
	n	5	5	5	5
	Minimum	4.82	2,400	1,560	329
	Maximum	5.16	3,300	1,860	1,020
	Mean	4.99	2,940	1,710	782
	SD	0.147	336	141	264
	Median	4.98	3,000	1,650	867
	10th Percentile	4.82	2,400	1,560	329
	95th Percentile	5.16	3,300	1,860	1,020

Note: "SD" = standard deviation. "n" = number of samples.

Table I.27: Water Quality at TOMP Stations 95N-12A,B, and C (Groundwater), Lacnor/Nordic TMA, 2015 to 2019

Station	Date	pH	Sulphate (mg/L)	Acidity (mg/L)	Iron (mg/L)
95N-14A	12-Aug-15	6.96	7.80	<1.00	4.61
	23-Jun-16	7.14	-	<1.00	6.28
	9-Aug-17	6.72	9.80	<1.00	4.14
	8-Aug-18	6.71	8.80	<1.00	4.78
	9-Jul-19	6.67	4.00	<1.00	6.19
	n	5	4	5	5
	Minimum	6.67	4.00	<1.00	4.14
	Maximum	7.14	9.80	<1.00	6.28
	Mean	6.84	7.60	<1.00	5.20
	SD	0.203	2.54	-	0.974
	Median	6.72	8.30	<1.00	4.78
	10th Percentile	6.67	4.00	<1.00	4.14
	95th Percentile	7.14	9.80	<1.00	6.28
95N-14B	12-Aug-15	7.19	5.30	<1.00	2.96
	23-Jun-16	7.50	5.20	<1.00	2.52
	9-Aug-17	6.93	4.80	<1.00	1.85
	8-Aug-18	7.28	4.50	<1.00	1.46
	9-Jul-19	7.35	4.00	<1.00	1.92
	n	5	5	5	5
	Minimum	6.93	4.00	<1.00	1.46
	Maximum	7.50	5.30	<1.00	2.96
	Mean	7.25	4.76	<1.00	2.14
	SD	0.212	0.532	-	0.594
	Median	7.28	4.80	<1.00	1.92
	10th Percentile	6.93	4.00	<1.00	1.46
	95th Percentile	7.50	5.30	<1.00	2.96
95N-14C	12-Aug-15	7.17	5.00	<1.00	2.40
	23-Jun-16	7.30	4.90	<1.00	2.03
	9-Aug-17	7.05	4.30	<1.00	1.60
	8-Aug-18	7.11	4.50	<1.00	1.10
	9-Jul-19	7.46	2.40	<1.00	0.997
	n	5	5	5	5
	Minimum	7.05	2.40	<1.00	0.997
	Maximum	7.46	5.00	<1.00	2.40
	Mean	7.22	4.22	<1.00	1.63
	SD	0.164	1.06	-	0.599
	Median	7.17	4.50	<1.00	1.60
	10th Percentile	7.05	2.40	<1.00	0.997
	95th Percentile	7.46	5.00	<1.00	2.40

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected, or SD was incalculable because there was no variability in the data.

Table I.28: Water Quality at TOMP Stations 95N-16A,C, and E (Groundwater), Lacnor/Nordic TMA, 2015 to 2019

Station	Date	pH	Sulphate (mg/L)	Acidity (mg/L)	Iron (mg/L)
95N-16A	11-Aug-15	6.76	2,100	195	224
	6-Jul-16	6.32	2,200	210	181
	8-Aug-17	6.33	1,900	216	240
	7-Aug-18	6.43	2,000	215	213
	17-Jul-19	6.31	1,900	163	196
	n	5	5	5	5
	Minimum	6.31	1,900	163	181
	Maximum	6.76	2,200	216	240
	Mean	6.43	2,020	200	211
	SD	0.191	130	22.2	23.1
	Median	6.33	2,000	210	213
	10th Percentile	6.31	1,900	163	181
	95th Percentile	6.76	2,200	216	240
95N-16C	11-Aug-15	6.64	2,300	311	294
	6-Jul-16	5.75	2,400	210	284
	8-Aug-17	6.37	2,100	283	283
	7-Aug-18	6.46	2,200	386	322
	17-Jul-19	6.24	2,600	477	386
	n	5	5	5	5
	Minimum	5.75	2,100	210	283
	Maximum	6.64	2,600	477	386
	Mean	6.29	2,320	333	314
	SD	0.336	192	102	43.3
	Median	6.37	2,300	311	294
	10th Percentile	5.75	2,100	210	283
	95th Percentile	6.64	2,600	477	386
95N-16E	11-Aug-15	6.45	2,300	1,030	605
	6-Jul-16	5.95	2,500	1,040	567
	8-Aug-17	6.13	1,900	991	571
	7-Aug-18	6.09	2,300	1,060	546
	17-Jul-19	5.89	2,200	970	570
	n	5	5	5	5
	Minimum	5.89	1,900	970	546
	Maximum	6.45	2,500	1,060	605
	Mean	6.10	2,240	1,020	572
	SD	0.218	219	36.8	21.2
	Median	6.09	2,300	1,030	570
	10th Percentile	5.89	1,900	970	546
	95th Percentile	6.45	2,500	1,060	605

Note: "SD" = standard deviation. "n" = number of samples.

Table I.29: Water Quality at TOMP Stations 95N-17A,B, and C (Groundwater), Lacnor/Nordic TMA, 2015 to 2019

Station	Date	pH	Sulphate (mg/L)	Acidity (mg/L)	Iron (mg/L)
95N-17A	12-Aug-15	6.89	7.70	<1.00	3.75
	5-Jul-16	6.92	7.50	<1.00	3.74
	9-Aug-17	6.60	7.20	<1.00	4.04
	7-Aug-18	6.67	7.20	<1.00	3.79
	9-Jul-19	6.76	7.50	<1.00	3.67
	n	5	5	5	5
	Minimum	6.60	7.20	<1.00	3.67
	Maximum	6.92	7.70	<1.00	4.04
	Mean	6.77	7.42	<1.00	3.80
	SD	0.138	0.217	-	0.142
	Median	6.76	7.50	<1.00	3.75
	10th Percentile	6.60	7.20	<1.00	3.67
	95th Percentile	6.92	7.70	<1.00	4.04
95N-17B	12-Aug-15	6.75	0.100	<1.00	7.19
	5-Jul-16	6.67	7.20	<1.00	5.98
	9-Aug-17	6.43	7.10	<1.00	4.93
	7-Aug-18	6.58	6.60	<1.00	5.50
	9-Jul-19	6.84	6.00	<1.00	5.43
	n	5	5	5	5
	Minimum	6.43	0.100	<1.00	4.93
	Maximum	6.84	7.20	<1.00	7.19
	Mean	6.65	5.40	<1.00	5.81
	SD	0.158	3.00	-	0.859
	Median	6.67	6.60	<1.00	5.50
	10th Percentile	6.43	0.100	<1.00	4.93
	95th Percentile	6.84	7.20	<1.00	7.19
95N-17C	12-Aug-15	6.60	8.10	<1.00	6.08
	5-Jul-16	6.45	7.20	<1.00	5.65
	9-Aug-17	6.54	7.10	<1.00	5.57
	8-Aug-18	6.33	4.60	<1.00	1.46
	10-Jul-19	6.49	14.0	<1.00	6.12
	n	5	5	5	5
	Minimum	6.33	4.60	<1.00	1.46
	Maximum	6.60	14.0	<1.00	6.12
	Mean	6.48	8.20	<1.00	4.98
	SD	0.102	3.49	-	1.98
	Median	6.49	7.20	<1.00	5.65
	10th Percentile	6.33	4.60	<1.00	1.46
	95th Percentile	6.60	14.0	<1.00	6.12

Note: "SD" = standard deviation. "n" = number of samples. "-" = SD was incalculable because there was no variability in the data.

Table I.30: Water Quality at TOMP Station L-03, Lacnor/Nordic TMA, 2015 to 2019

Date	Elevation (m)
6-May-15	374.13
5-Jun-15	374.14
15-Jul-15	374.10
6-Aug-15	374.00
8-Oct-15	374.09
25-Nov-15	374.13
17-Dec-15	374.24
3-Feb-16	374.17
4-May-16	374.14
1-Jun-16	374.21
7-Jul-16	374.10
5-Aug-16	374.07
25-Oct-16	374.13
2-Nov-16	374.13
8-Feb-17	374.02
24-Apr-17	374.15
3-May-17	374.20
19-Jun-17	374.44
5-Jul-17	374.39
2-Aug-17	374.21
6-Sep-17	374.16
5-Oct-17	374.14
1-Nov-17	374.21
12-Dec-17	374.19
8-Feb-18	374.15
14-May-18	374.22
7-Jun-18	374.34
5-Jul-18	374.13
15-Aug-18	374.03
4-Oct-18	374.18
7-Nov-18	374.94
7-Feb-19	374.01
1-May-19	374.15
5-Jun-19	374.34
17-Jul-19	374.33
7-Aug-19	374.16
5-Sep-19	374.08
3-Oct-19	374.13
6-Nov-19	374.13
n	39
Minimum	374.00
Maximum	374.94
Mean	374.18
SD	0.15801
Median	374.15
10th Percentile	374.03
95th Percentile	374.44

Note: "SD" = standard deviation. "n" = number of samples.

Table I.31: Water Level at Station TOMP ECA-132, Lacnor/Nordic TMA, 2015 to 2019

Date	Elevation (m)
28-Jan-15	341.97
28-Feb-15	341.62
28-Mar-15	341.16
28-Apr-15	341.87
28-May-15	341.92
30-Jun-15	341.67
28-Jul-15	341.35
28-Dec-15	342.44
28-Jan-16	341.99
28-Mar-16	341.90
28-Apr-16	341.83
27-May-16	341.71
28-Jul-16	341.38
29-Aug-16	341.11
28-Sep-16	341.13
28-Oct-16	341.08
29-Dec-16	341.35
30-Jan-17	341.44
28-Feb-17	341.62
28-Mar-17	341.84
28-Apr-17	342.05
28-May-17	342.07
28-Jun-17	342.05
28-Jul-17	342.03
28-Aug-17	341.89
28-Sep-17	341.40
28-Oct-17	341.85
28-Nov-17	341.98
28-Dec-17	341.91
28-Jan-18	341.54
28-Feb-18	341.29
28-Mar-18	341.18
28-Apr-18	341.88
28-May-18	342.00
28-Jun-18	341.86
28-Jul-18	341.55
28-Aug-18	341.71
28-Sep-18	341.64
28-Oct-18	341.55
28-Nov-18	341.32
28-Dec-18	341.43
28-Jan-19	341.52
28-Feb-19	341.61
28-Mar-19	341.31
28-Apr-19	342.62
28-May-19	342.23
28-Jun-19	341.75
28-Jul-19	341.29
28-Aug-19	341.02
25-Sep-19	340.95
28-Oct-19	341.35
28-Dec-19	342.00
n	52
Minimum	340.95
Maximum	342.62
Mean	341.66
SD	0.36814
Median	341.66
10th Percentile	341.16
95th Percentile	342.23

Note: "SD" = standard deviation. "n" = number of samples.

Table I.32: Water Level at Station TOMP CPW, Lacnor/Nordic TMA, 2015 to 2019

Date	Elevation (m)	Date	Elevation (m)
7-Jan-15	334.60	4-Jan-18	334.54
4-Feb-15	334.59	7-Feb-18	334.56
4-Mar-15	334.58	7-Mar-18	334.56
1-Apr-15	334.60	5-Apr-18	334.61
6-May-15	334.60	14-May-18	334.59
3-Jun-15	334.57	6-Jun-18	334.60
8-Jul-15	334.52	5-Jul-18	334.45
28-Jul-15	334.44	1-Aug-18	334.37
5-Aug-15	334.38	5-Sep-18	334.39
2-Sep-15	334.37	3-Oct-18	334.41
8-Oct-15	334.44	5-Dec-18	334.60
2-Dec-15	334.63	2-Jan-19	334.57
6-Jan-16	334.67	6-Feb-19	334.57
3-Feb-16	334.62	13-Mar-19	334.61
2-Mar-16	334.62	3-Apr-19	334.61
6-Apr-16	334.62	22-May-19	334.57
28-Apr-16	334.59	5-Jun-19	334.62
4-May-16	334.60	3-Jul-19	334.57
1-Jun-16	334.56	7-Aug-19	334.48
7-Jul-16	334.41	4-Sep-19	334.46
3-Aug-16	334.37	2-Oct-19	334.57
7-Sep-16	334.33	4-Dec-19	334.58
5-Oct-16	334.43	**n**	58
2-Nov-16	334.52	**Minimum**	334.33
7-Dec-16	334.53	**Maximum**	364.62
4-Jan-17	334.57	**Mean**	335.06
8-Feb-17	334.58	**SD**	3.9502
2-Mar-17	334.62	**Median**	334.57
5-Apr-17	334.63	**10th Percentile**	334.39
7-Jun-17	334.60	**95th Percentile**	334.64
5-Jul-17	334.64		
2-Aug-17	334.58		
6-Sep-17	334.56		
4-Oct-17	334.53		
1-Nov-17	334.56		
6-Dec-17	364.62		

Note: "SD" = standard deviation. "n" = number of samples.

APPENDIX J

PRONTO TMA, TOMP DATA

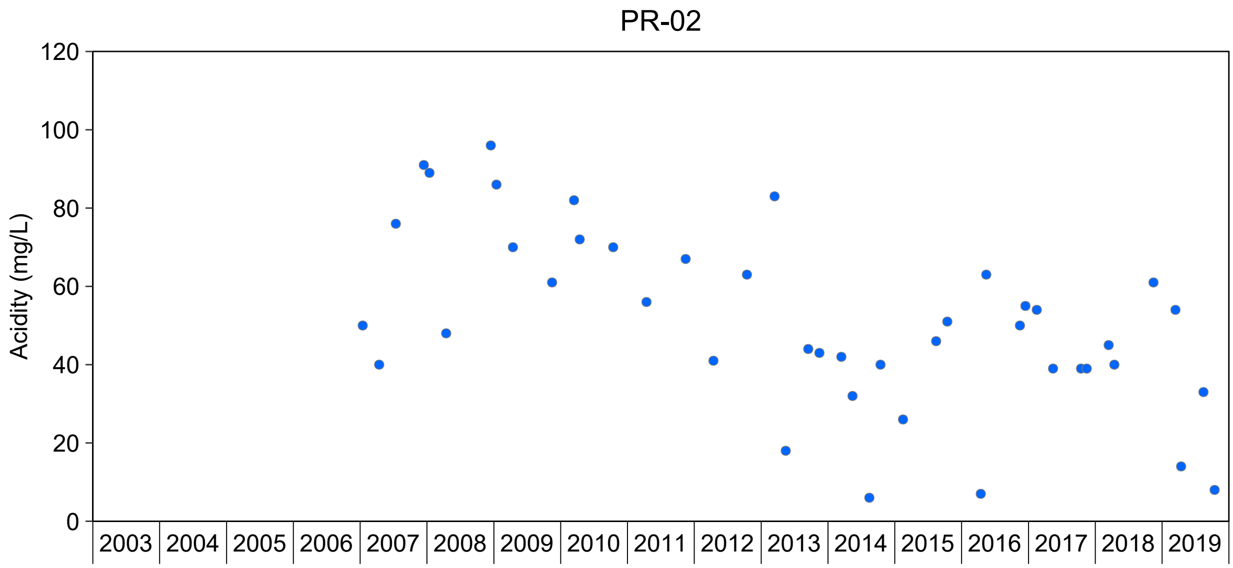

Figure J.1: Concentration of Acidity for TOMP Water Monitoring Stations, Pronto TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 7.3 for Seasonal Kendall trend analysis results and Appendix Table J.3 for raw data.

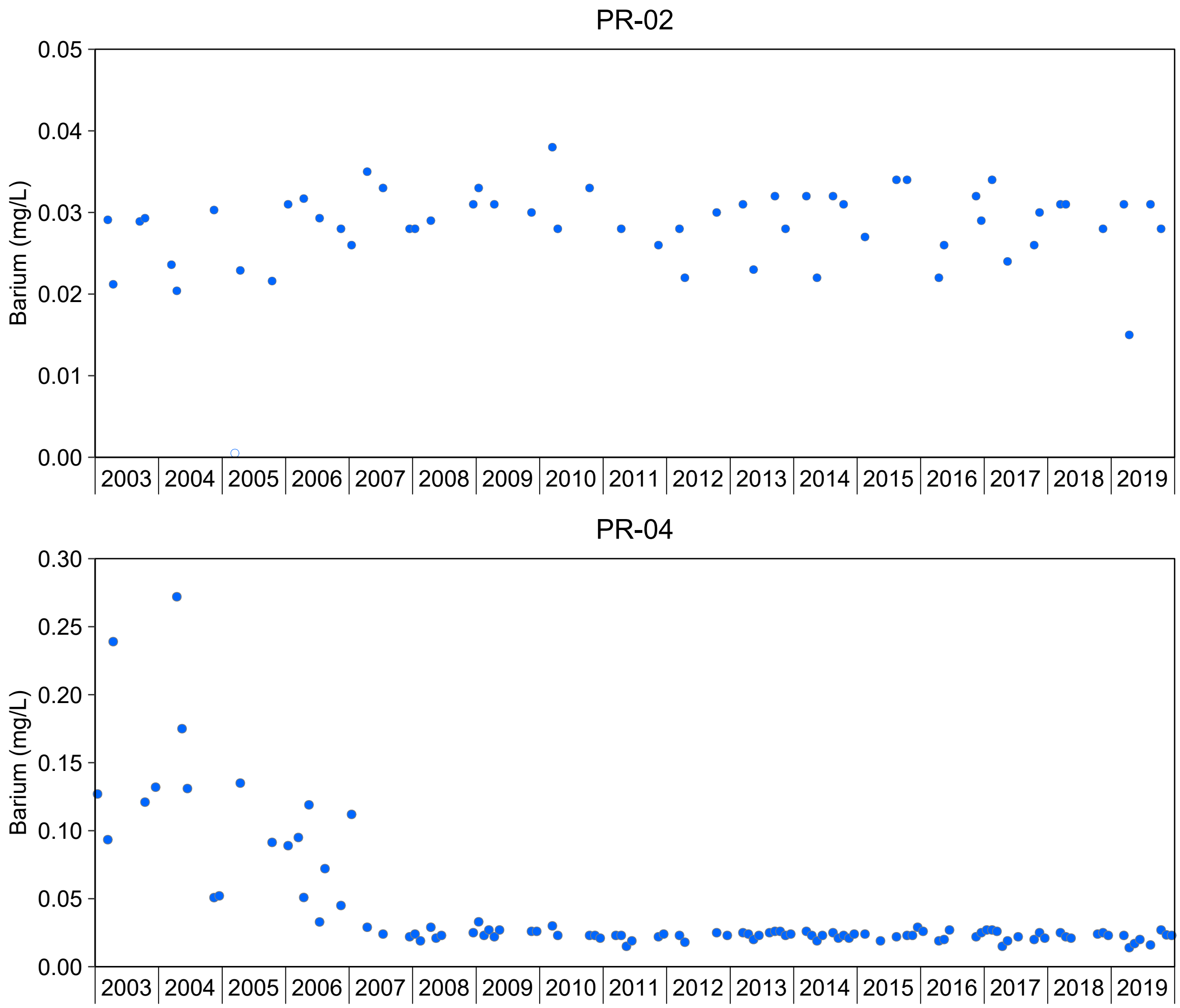

Figure J.2: Concentrations of Barium for TOMP Water Monitoring Stations, Pronto TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 7.3 for Seasonal Kendall trend analysis results and Appendix Tables J.3 and J.5 for raw data.

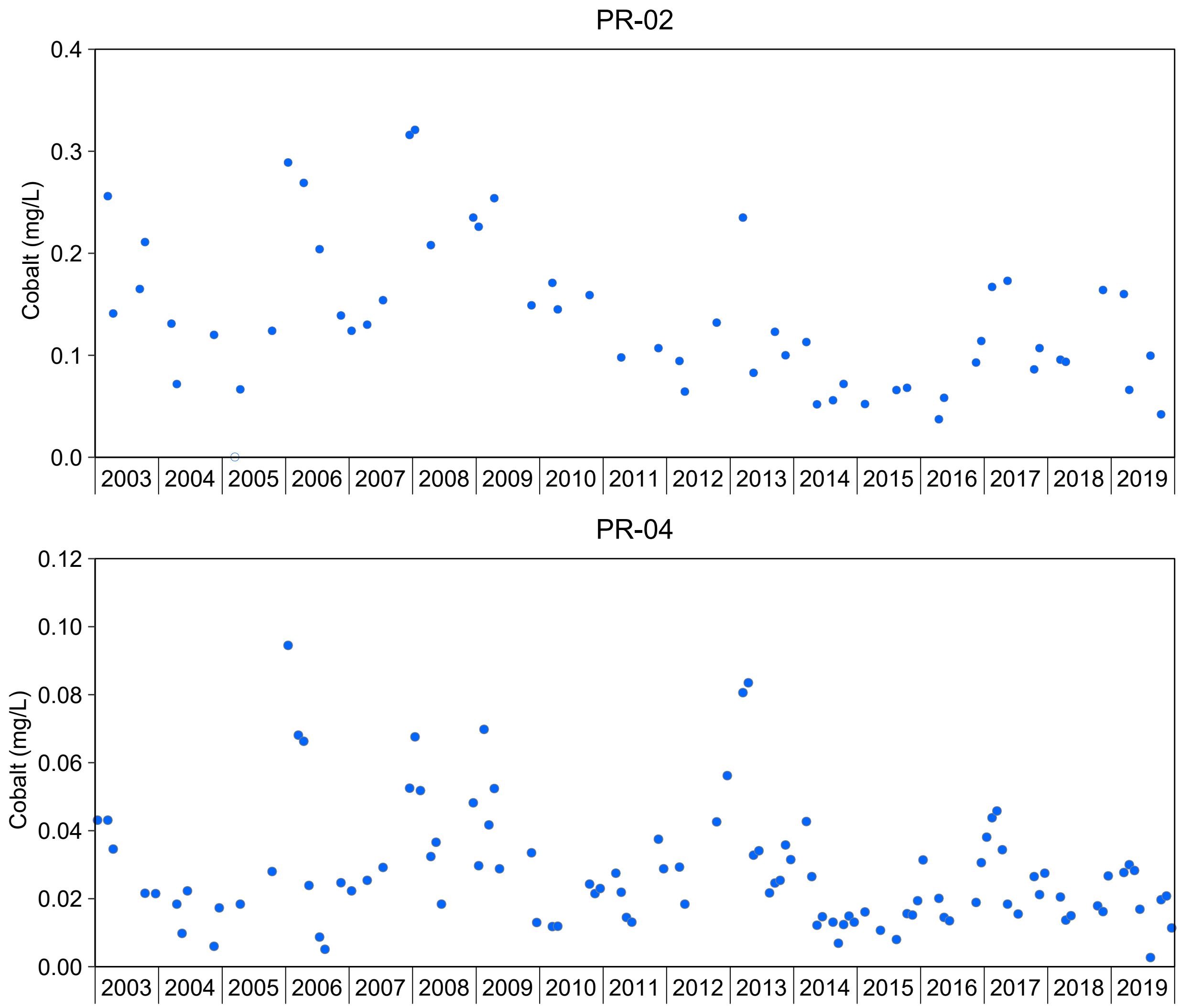

Figure J.3: Concentrations of Cobalt for TOMP Water Monitoring Stations, Pronto TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 7.3 for Seasonal Kendall trend analysis results and Appendix Tables J.3 and J.5 for raw data.

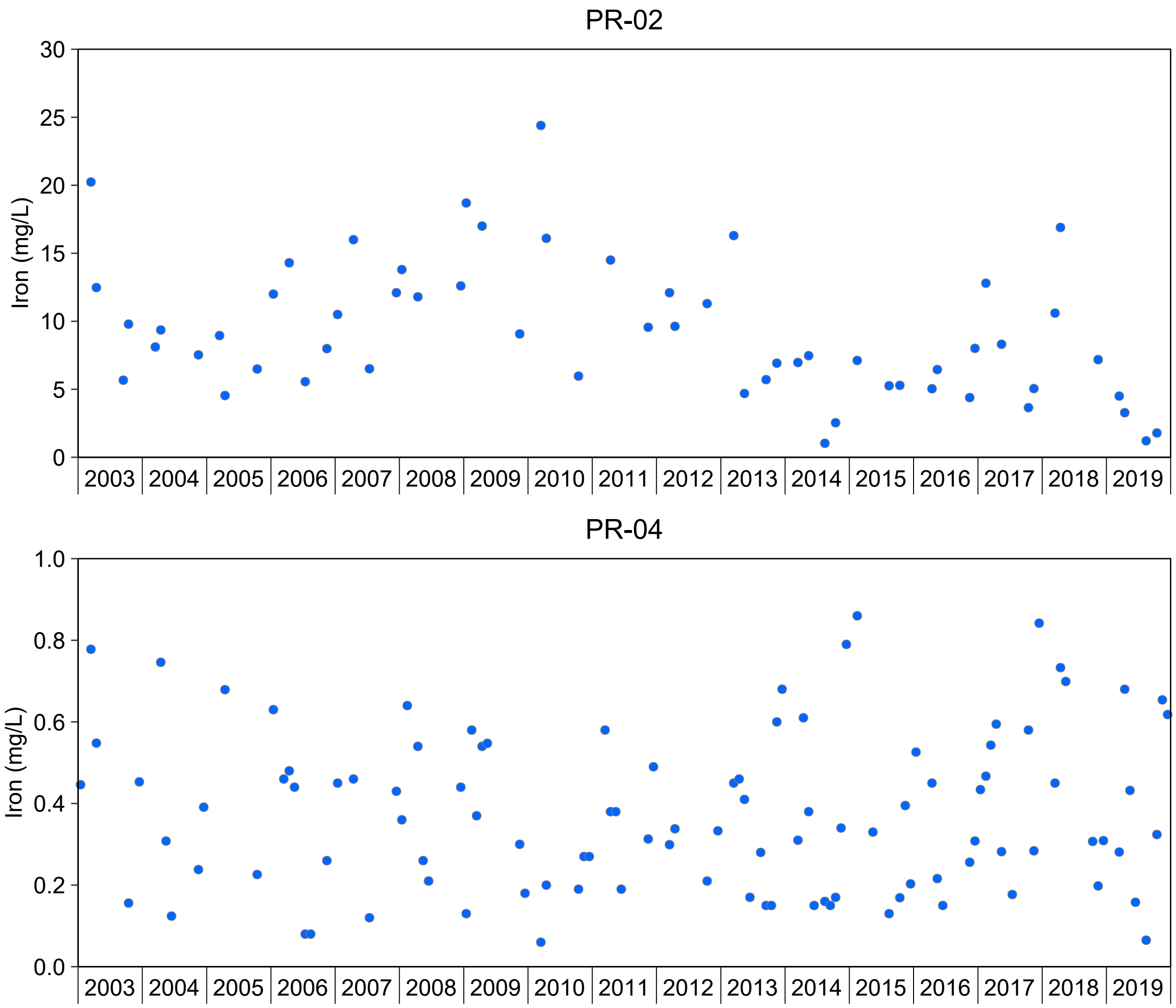

Figure J.4: Concentrations of Iron for TOMP Water Monitoring Stations, Pronto TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 7.3 for Seasonal Kendall trend analysis results and Appendix Tables J.3 and J.5 for raw data.

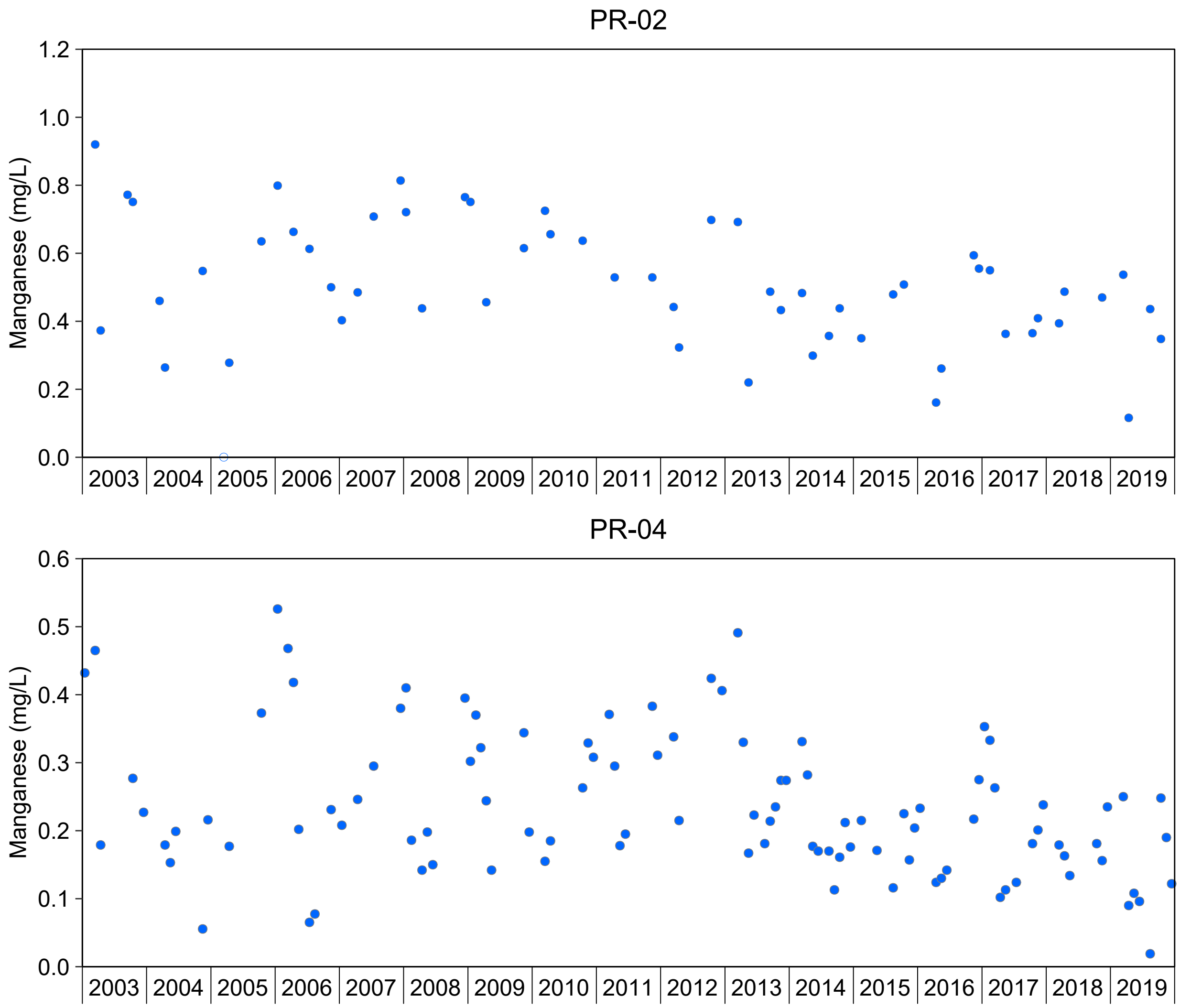

Figure J.5: Concentrations of Manganese for TOMP Water Monitoring Stations, Pronto TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 7.3 for Seasonal Kendall trend analysis results and Appendix Tables J.3 and J.5 for raw data.

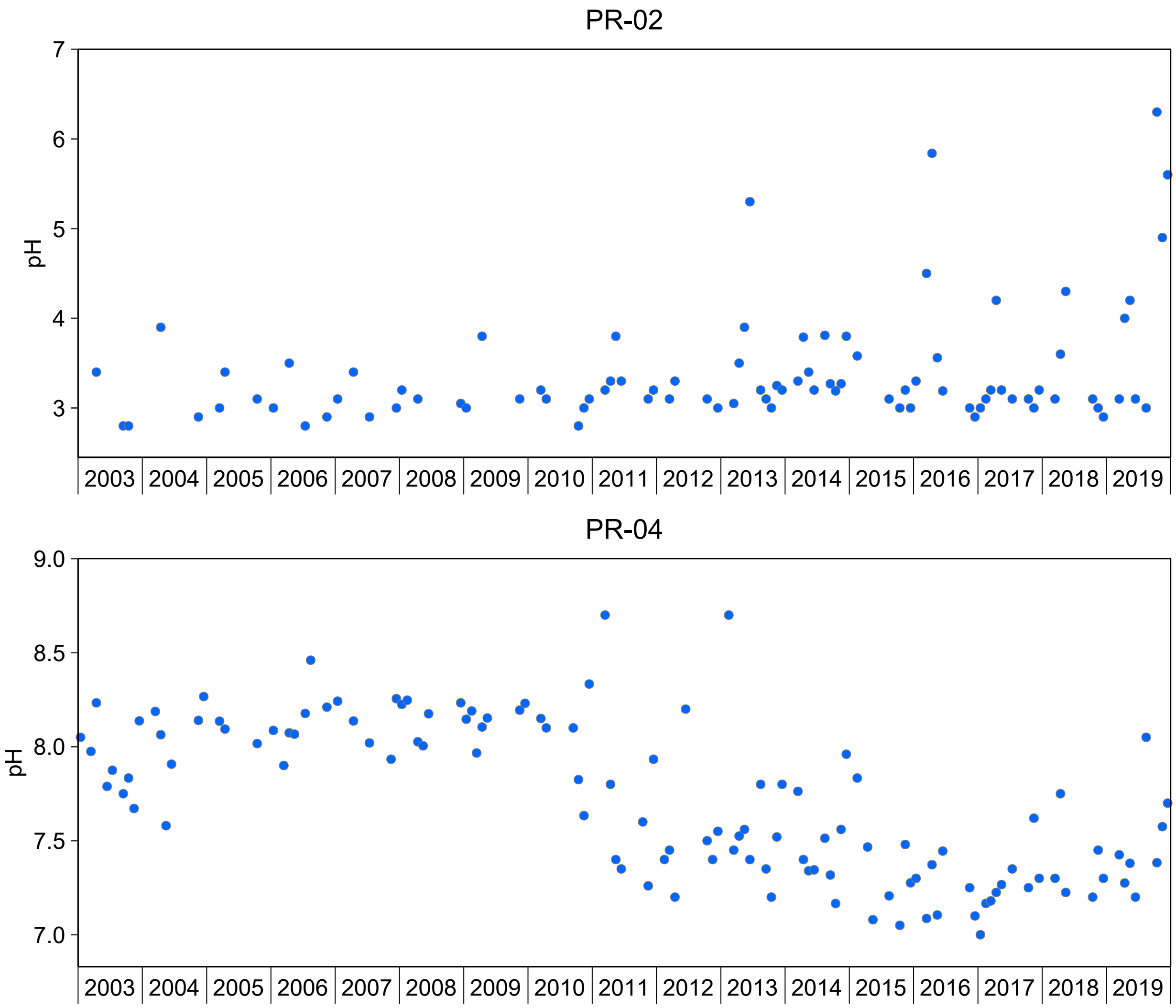

Figure J.6: Field Measurements of pH for TOMP Water Monitoring Stations, Pronto TMA, 2003 to 2019

Notes: See Table 7.3 for Seasonal Kendall trend analysis results and Appendix Tables J.3 and J.5 for raw data.

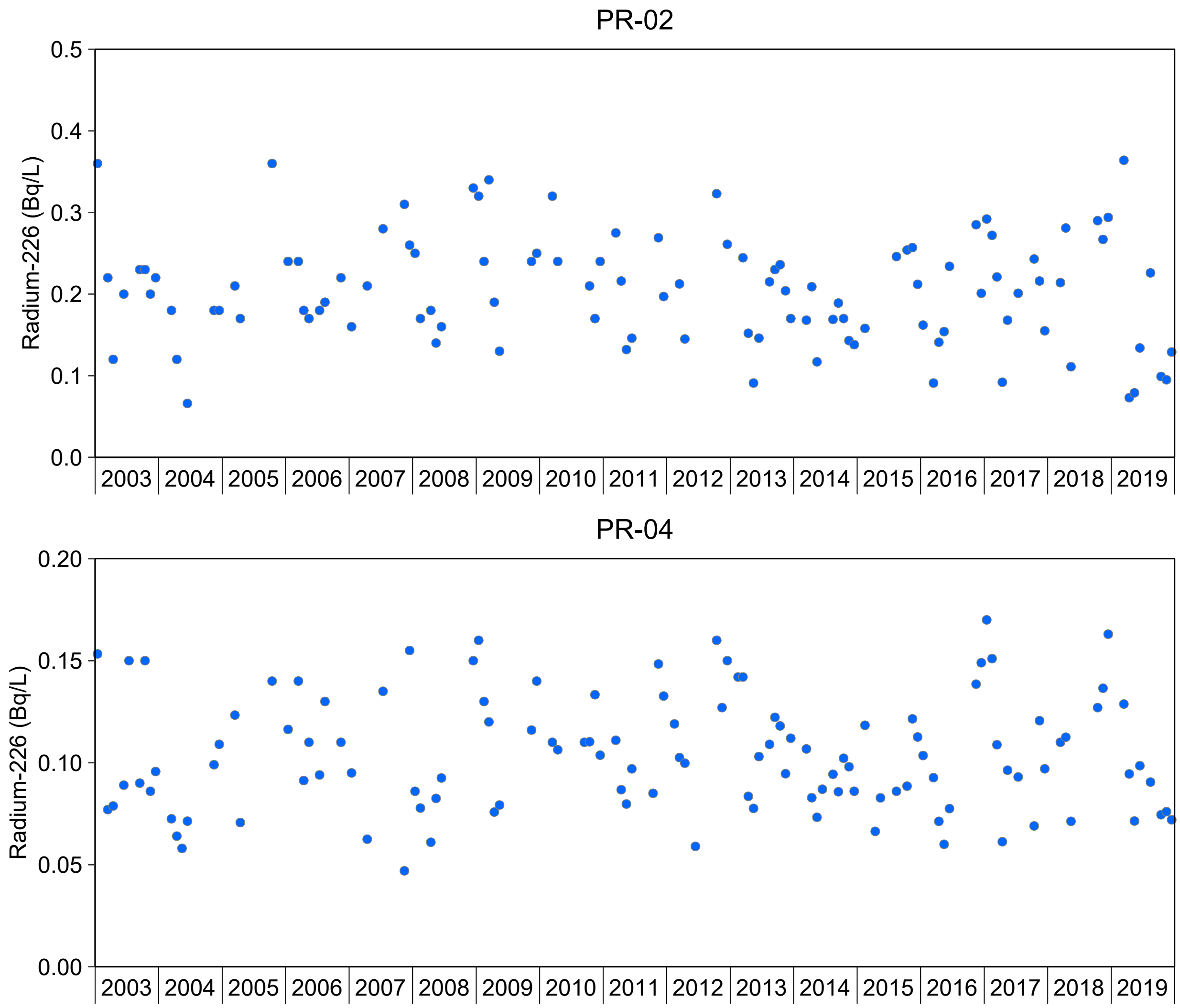

Figure J.7: Concentrations of Radium-226 for TOMP Water Monitoring Stations, Pronto TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Table 7.3 for Seasonal Kendall trend analysis results and Appendix Tables J.3 and J.5 for raw data.

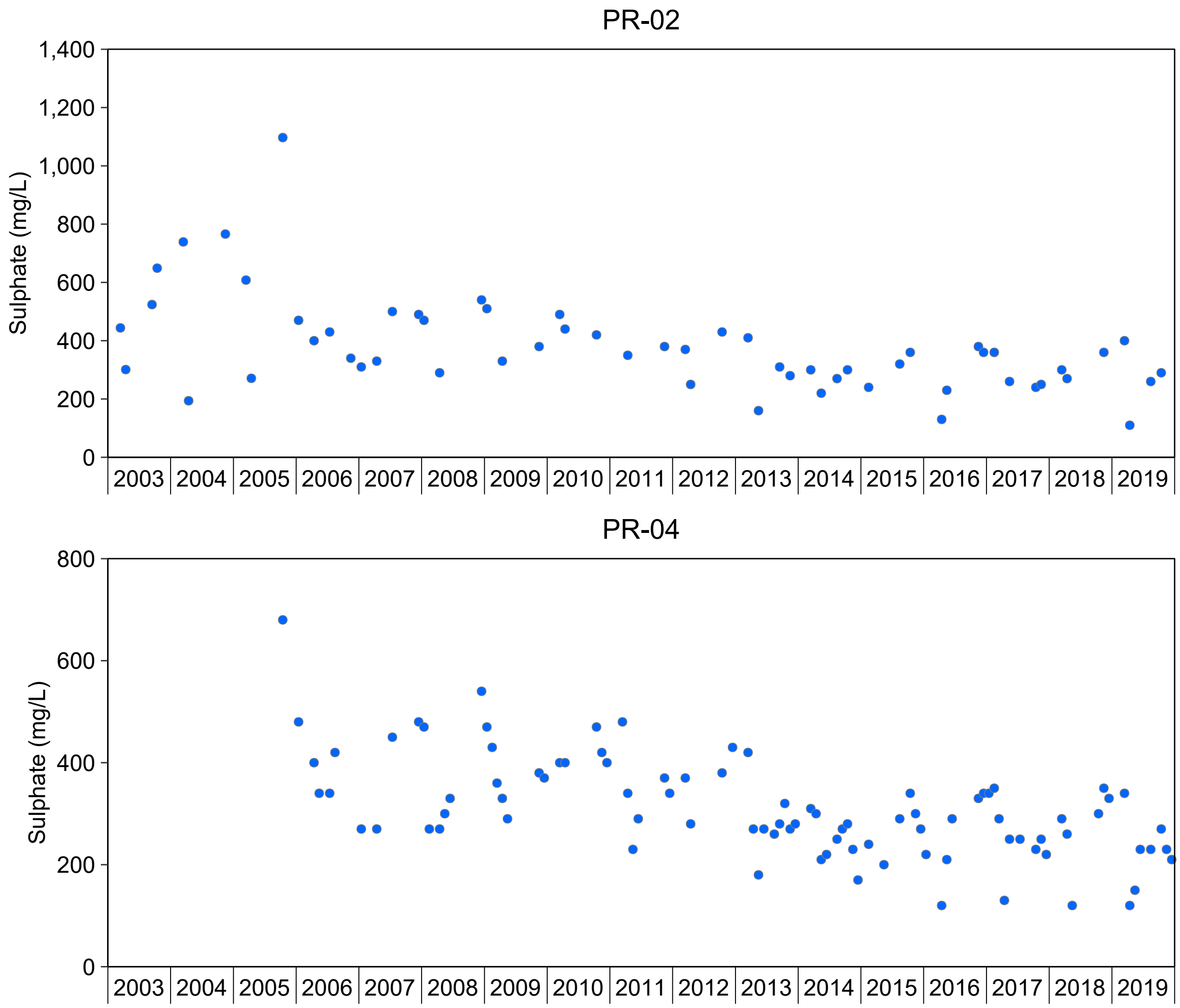

Figure J.8: Concentrations of Sulphate for TOMP Water Monitoring Stations, Pronto TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL.
See Table 7.3 for Seasonal Kendall trend analysis results and Appendix Tables J.3 and J.5 for raw data.

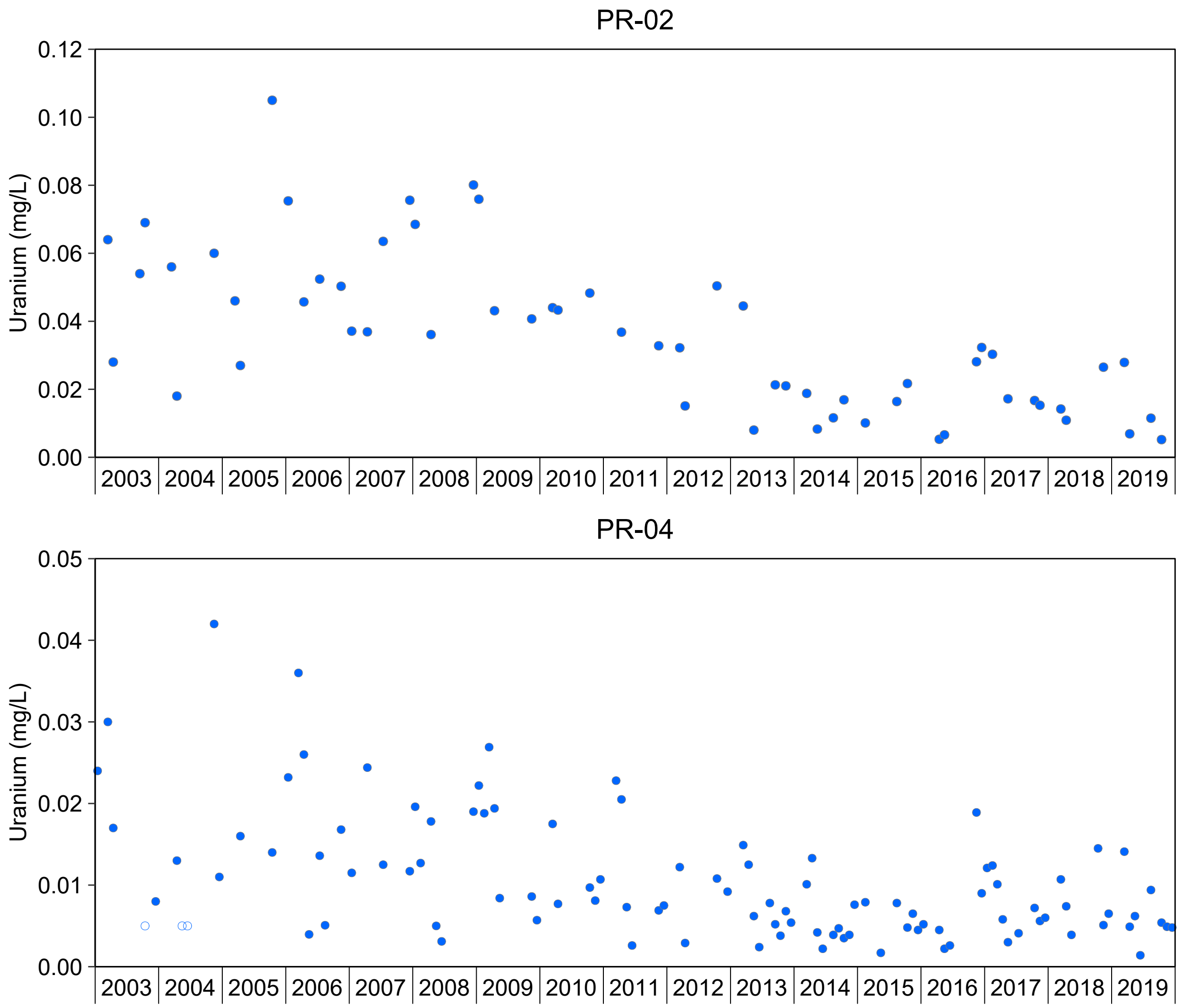

Figure J.9: Concentration of Uranium for TOMP Water Monitoring Stations, Pronto TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL.
See Table 7.3 for Seasonal Kendall trend analysis results and Appendix Tables J.3 and J.5 for raw data.

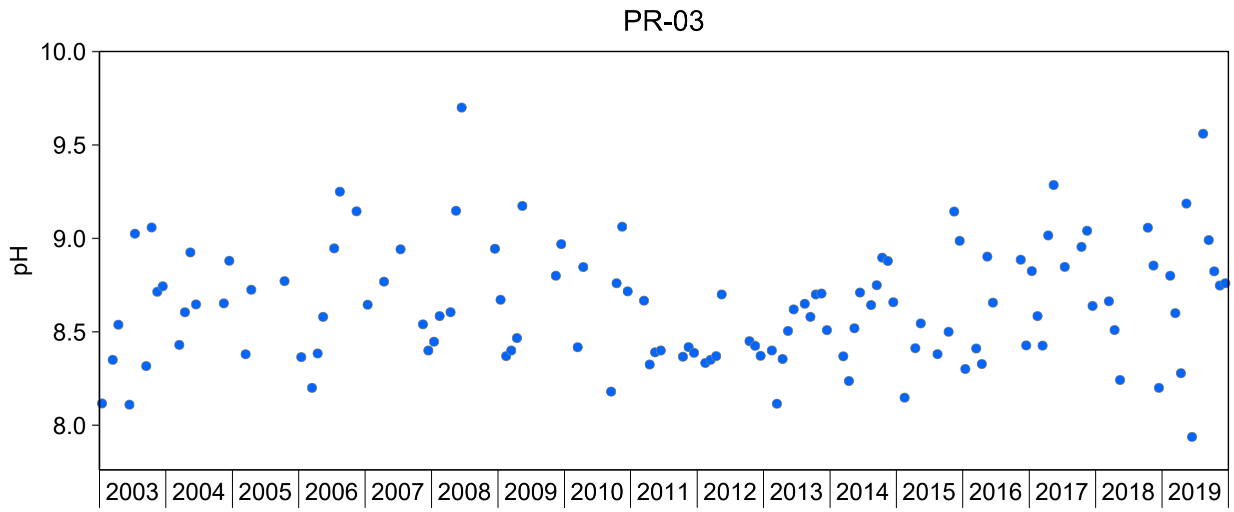

Figure J.10: Field Measurements of pH for TOMP Water Monitoring Stations, Pronto TMA, 2003 to 2019

Notes: pH is not included in the trend analysis for TOMP station PR-03 because the monitoring is in support of ETP operations. Other stations at this TMA provide more meaningful information regarding trends for this parameter. Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Table J.4 for raw data.

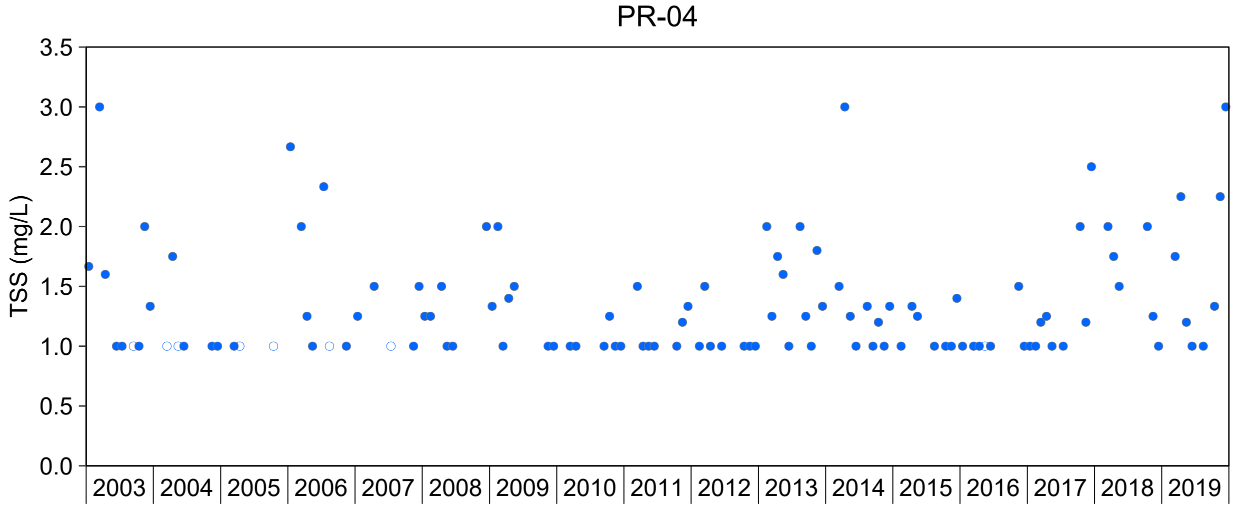

Figure J.11: Concentrations of Total Suspended Solids for TOMP Water Monitoring Stations, Pronto TMA, 2003 to 2019

Notes: TSS is not included in the trend analysis for TOMP station PR-04 because the monitoring is in support of ETP operations. Other stations at this TMA provide more meaningful information regarding trends for this parameter. Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Table J.5 for raw data.

Table J.1: Location of TOMP Data Tables and Figures Within this Cycle 5 SOE Report, Pronto TMA

TMA	TOMP Station	Station Type/Purpose	Also a SAMP Station?	Map Figures	Elevation Tables	Elevation Figures	Water Quality Data Tables (flow, acidity, barium, cobalt, iron, manganese, pH, radium-226, sulphate, uranium, conductivity, TSS, and/or treatment chemical consumption)	Comparison to EIS Predictions Figures	Lime or NaOH Consumption Figures	Barium Chloride Consumption Figures	Comparison to Discharge Criteria Figures	Trend Tables	Water Quality Data Figures										
													Acidity	Barium	Cobalt	Iron	Manganese	pH	Radium-226	Sulphate	Uranium	Conductivity	TSS
Pronto	PR-02	Basin performance (primary), ETP operations	no	7.1	J.6	7.2	J.3	na-p	7.4	7.4	na-c	7.3	J.1	J.2	J.3	J.4	J.5	J.6	J.7	J.8	J.9	na	na
	PR-03	ETP operations	no	7.1	na	na	J.4	na-p	na	na	na-c	na-t	na	na	na	na	na	J.10	na	na	na	na	na
	PR-04	Effluent	no	7.1	na	na	J.5	na-p	na	na	7.4, 7.5	7.3	J.1	J.2	J.3	J.4	J.5	J.6	J.7	J.8	J.9	na	J.11

Notes: na = parameter not measured at this station (as per study design); therefore, data presentation is not applicable. na-p = EIS Predictions do not apply to this station (as per study design); therefore, data presentation is not applicable. na-c = discharge criteria do not apply to this station (as per study design); therefore, data presentation is not applicable. na-t = at this station, only one to three parameters (elevation, pH, flow, conductivity, and/or radium-226) are monitored to support ETP operations. Other stations provide more meaningful information regarding trends for these parameters; therefore, data presentation is not applicable.

Table J.2: Pronto Final Point of Control (PR-04) Discharge Criteria

Parameter[a]	Units	Discharge Criteria		Action Level	Internal Investigation
		Grab Sample[b]	Monthly Mean[c]		
pH	pH units	6.0-9.5	-	<6.5 or >9.0	<7.0 or >8.5
Dissolved Radium-226[d]	Bq/L	1.1	0.37	0.37	0.2
Iron	mg/L	-	1	1	0.5
Total Suspended Solids	mg/L	-	15	10	7.5

Note: "-" = no applicable discharge criterion.

[a] Copper, lead, nickel, and zinc monitoring discontinued in January 2010 as per regulatory approval of Cycle 3 design.

[b] Samples to be collected during periods of discharge.

[c] Arithmetic mean of all grab samples collected within a given month.

[d] 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.

Table J.3: Water Quality at TOMP Station PR-02 (Basin Performance - Primary, ETP Operations), Pronto TMA, 2015 to 2019

Date	Elevation (m)	Flow (L/s)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Lime Consumption (kg per month)	Barium Chloride Consumption (kg per month)	Acidity (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
11-Feb-15	197	97.0	3.58	240	0.158	4.63	0	26.0	0.0270	0.0522	7.12	0.350	0.0101
12-Aug-15	197	72.0	3.10	320	0.246	3.95	0	46.0	0.0340	0.0659	5.26	0.479	0.0164
14-Oct-15	196	75.0	3.00	360	0.254	6.22	0	51.0	0.0340	0.0681	5.29	0.508	0.0217
18-Nov-15	197	108	3.20	-	0.257	5	0	-	-	-	-	-	-
2-Dec-15	198	139	3.00	-	0.212	8.64	0	-	-	-	-	-	-
6-Jan-16	197	147	3.30	-	0.162	5.4	0	-	-	-	-	-	-
30-Mar-16	198	170	4.50	-	0.0910	5.78	0	-	-	-	-	-	-
19-Apr-16	-	145	5.84	130	0.141	5.8	0	7.00	0.0220	0.0373	5.04	0.161	0.00530
4-May-16	197	93.8	3.56	230	0.154	1.79	0	63.0	0.0260	0.0583	6.45	0.261	0.00660
15-Jun-16	197	88.1	3.19	-	0.234	3.01	0	-	-	-	-	-	-
9-Nov-16	197	73.0	3.00	380	0.285	0	0	50.0	0.0320	0.0929	4.39	0.594	0.0281
7-Dec-16	197	102	2.90	360	0.201	7.8	0	55.0	0.0290	0.114	8.01	0.555	0.0323
30-Jan-17	197	80.0	3.00	-	0.292	2	0	-	-	-	-	-	-
15-Feb-17	197	83.0	3.10	360	0.272	8	0	54.0	0.0340	0.167	12.8	0.550	0.0303
1-Mar-17	197	130	3.20	-	0.221	11.2	0	-	-	-	-	-	-
5-Apr-17	197	160	4.20	-	0.0920	5.64	0	-	-	-	-	-	-
1-May-17	197	103	3.20	260	0.168	6.1	0	39.0	0.0240	0.173	8.31	0.363	0.0172
12-Jul-17	197	120	3.10	-	0.201	5.9	0	-	-	-	-	-	-
25-Oct-17	198	145	3.10	240	0.243	6.6	0	39.0	0.0260	0.0862	3.65	0.365	0.0167
2-Nov-17	198	138	3.00	250	0.216	6	0	39.0	0.0300	0.107	5.05	0.409	0.0153
6-Dec-17	197	140	3.20	-	0.155	6.2	0	-	-	-	-	-	-
21-Mar-18	197	80.0	3.10	300	0.214	1.9	0	45.0	0.0310	0.0957	10.6	0.394	0.0142
4-Apr-18	197	82.0	3.60	270	0.281	5.6	0	40.0	0.0310	0.0936	16.9	0.487	0.0109
2-May-18	197	165	4.30	-	0.111	3	0	-	-	-	-	-	-
31-Oct-18	197	60.0	3.10	-	0.290	2	0	-	-	-	-	-	-
22-Nov-18	197	100	3.00	360	0.267	7.8	0	61.0	0.0280	0.164	7.18	0.470	0.0265
5-Dec-18	197	98.0	2.90	-	0.294	3	0	-	-	-	-	-	-
4-Mar-19	197	80.0	3.10	400	0.364	8.5	0	54.0	0.0310	0.160	4.50	0.537	0.0279
22-Apr-19	198	213	4.00	110	0.0730	9.5	0	14.0	0.0150	0.0661	3.28	0.116	0.00690
1-May-19	198	201	4.20	-	0.0790	9.7	0	-	-	-	-	-	-
5-Jun-19	197	150	3.10	-	0.134	3	0	-	-	-	-	-	-
21-Aug-19	197	80.0	3.00	260	0.226	0	0	33.0	0.0310	0.0996	1.21	0.436	0.0115
16-Oct-19	197	140	6.30	290	0.0990	3.4	0	8.00	0.0280	0.0421	1.79	0.348	0.00520
6-Nov-19	197	160	4.90	-	0.0950	3.6	0	-	-	-	-	-	-
4-Dec-19	196	120	5.60	-	0.129	0	0	-	-	-	-	-	-
n	121	735	35	18	35	60	60	18	18	18	18	18	18
Minimum	196	25.0	2.90	110	0.0730	0	0	7.00	0.0150	0.0373	1.21	0.116	0.00520
Maximum	198	215	6.30	400	0.364	11.2	0	63.0	0.0340	0.173	16.9	0.594	0.0323
Mean	197	118	3.58	284	0.197	3.17	0	40.2	0.0285	0.0968	6.49	0.410	0.0168
SD	0.343	36.1	0.884	80.7	0.0754	3.28	-	17.0	0.00479	0.0437	3.88	0.132	0.00900
Median	197	116	3.19	280	0.212	2.59	0	42.5	0.0295	0.0932	5.27	0.422	0.0159
10th Percentile	197	80.0	3.00	130	0.0920	0	0	8.00	0.0220	0.0421	1.79	0.161	0.00530
95th Percentile	198	179	5.84	400	0.294	9.07	0	63.0	0.0340	0.173	16.9	0.594	0.0323

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected, or SD was incalculable because there was no variability in the data.

Table J.4: Water Quality at TOMP Station PR-03 (ETP Operations), Pronto TMA, 2015 to 2019

Date	pH
4-Feb-15	8.30
5-Feb-15	8.40
6-Feb-15	8.45
9-Feb-15	8.00
10-Feb-15	8.30
11-Feb-15	8.30
12-Feb-15	8.20
13-Feb-15	8.20
17-Feb-15	8.20
18-Feb-15	8.08
19-Feb-15	8.10
20-Feb-15	7.90
23-Feb-15	8.03
24-Feb-15	7.90
25-Feb-15	8.00
26-Feb-15	8.00
14-Apr-15	8.40
15-Apr-15	8.70
16-Apr-15	8.30
17-Apr-15	8.30
20-Apr-15	8.40
21-Apr-15	8.40
22-Apr-15	8.30
23-Apr-15	8.60
24-Apr-15	8.50
27-Apr-15	8.26
28-Apr-15	8.40
29-Apr-15	8.40
30-Apr-15	8.40
1-May-15	8.30
4-May-15	8.20
5-May-15	8.40
6-May-15	8.30
7-May-15	8.60
8-May-15	8.60
11-May-15	8.40
12-May-15	8.50
13-May-15	8.40
14-May-15	8.50
15-May-15	8.70
19-May-15	8.70
20-May-15	8.62
21-May-15	8.60
22-May-15	8.70
25-May-15	8.50
26-May-15	8.56
27-May-15	8.80
28-May-15	8.78
29-May-15	8.74
4-Aug-15	8.50
5-Aug-15	8.46
6-Aug-15	8.56
7-Aug-15	8.40
10-Aug-15	8.60
11-Aug-15	8.55
12-Aug-15	8.50
13-Aug-15	8.50
14-Aug-15	8.30
17-Aug-15	8.46
18-Aug-15	8.40
19-Aug-15	8.23
20-Aug-15	8.30
21-Aug-15	8.06
24-Aug-15	8.03
25-Aug-15	8.30
26-Aug-15	8.30
27-Aug-15	8.40
5-Oct-15	8.19
6-Oct-15	7.90
7-Oct-15	8.40
8-Oct-15	8.60
9-Oct-15	8.40
13-Oct-15	8.21
14-Oct-15	8.60
15-Oct-15	8.90
16-Oct-15	9.30
16-Nov-15	9.05
17-Nov-15	9.10
18-Nov-15	9.01
19-Nov-15	9.20
20-Nov-15	9.00
23-Nov-15	9.00
24-Nov-15	9.30
25-Nov-15	9.14
26-Nov-15	9.10
27-Nov-15	9.60
30-Nov-15	9.08
1-Dec-15	9.07
2-Dec-15	8.87
3-Dec-15	9.10
4-Dec-15	9.15
7-Dec-15	9.12
8-Dec-15	8.97
9-Dec-15	9.00
10-Dec-15	8.70
11-Dec-15	9.10
14-Dec-15	8.84
15-Dec-15	8.82
16-Dec-15	9.04
17-Dec-15	8.70
18-Dec-15	9.05
21-Dec-15	9.10
22-Dec-15	9.08
23-Dec-15	9.10
24-Dec-15	9.20
28-Dec-15	9.30
29-Dec-15	9.30
30-Dec-15	8.60
31-Dec-15	8.50

Date	pH
4-Jan-16	8.34
5-Jan-16	8.30
6-Jan-16	8.40
7-Jan-16	8.30
8-Jan-16	8.30
11-Jan-16	8.32
12-Jan-16	8.43
13-Jan-16	8.20
14-Jan-16	8.26
15-Jan-16	8.40
18-Jan-16	8.10
19-Jan-16	8.32
20-Jan-16	8.30
21-Jan-16	8.24
22-Jan-16	8.25
25-Jan-16	8.21
26-Jan-16	8.25
27-Jan-16	8.40
28-Jan-16	8.40
14-Mar-16	8.81
15-Mar-16	8.52
16-Mar-16	9.07
17-Mar-16	8.48
18-Mar-16	8.99
21-Mar-16	8.50
22-Mar-16	7.80
23-Mar-16	8.00
24-Mar-16	8.00
28-Mar-16	8.03
29-Mar-16	8.35
30-Mar-16	8.40
31-Mar-16	8.39
1-Apr-16	8.47
4-Apr-16	8.49
5-Apr-16	8.20
6-Apr-16	8.39
7-Apr-16	8.16
8-Apr-16	8.10
11-Apr-16	8.31
12-Apr-16	8.11
13-Apr-16	8.40
14-Apr-16	8.14
15-Apr-16	8.30
18-Apr-16	8.12
19-Apr-16	8.32
20-Apr-16	8.28
21-Apr-16	8.40
22-Apr-16	8.80
25-Apr-16	8.33
26-Apr-16	8.30
27-Apr-16	8.10
28-Apr-16	8.67
29-Apr-16	8.49
2-May-16	8.43
3-May-16	8.45
4-May-16	9.38
5-May-16	8.55
6-May-16	8.90
9-May-16	8.91
10-May-16	9.30
11-May-16	9.30
6-Jun-16	8.70
7-Jun-16	8.60
8-Jun-16	8.70
9-Jun-16	8.70
10-Jun-16	8.64
13-Jun-16	8.64
14-Jun-16	8.62
15-Jun-16	8.70
16-Jun-16	8.56
17-Jun-16	8.70
1-Nov-16	9.00
2-Nov-16	8.80
3-Nov-16	8.80
4-Nov-16	8.90
7-Nov-16	8.90
8-Nov-16	8.90
9-Nov-16	8.80
10-Nov-16	8.80
11-Nov-16	8.80
14-Nov-16	9.20
15-Nov-16	8.90
16-Nov-16	8.80
17-Nov-16	8.90
18-Nov-16	8.90
5-Dec-16	8.20
6-Dec-16	8.50
7-Dec-16	8.50
8-Dec-16	8.70
14-Dec-16	8.30
15-Dec-16	8.20
16-Dec-16	8.30
19-Dec-16	8.30
20-Dec-16	8.40
21-Dec-16	8.60
22-Dec-16	8.70
26-Jan-17	8.60
27-Jan-17	8.80
30-Jan-17	8.90
31-Jan-17	9.00
1-Feb-17	8.80
2-Feb-17	8.80
3-Feb-17	8.90
6-Feb-17	8.70
7-Feb-17	8.70
8-Feb-17	8.70
9-Feb-17	8.80
10-Feb-17	8.90
13-Feb-17	8.30

Date	pH
14-Feb-17	8.30
15-Feb-17	8.30
16-Feb-17	8.40
17-Feb-17	8.70
21-Feb-17	8.60
22-Feb-17	8.30
23-Feb-17	8.50
24-Feb-17	8.20
27-Feb-17	8.60
28-Feb-17	8.60
1-Mar-17	8.40
2-Mar-17	8.80
3-Mar-17	8.30
6-Mar-17	8.30
7-Mar-17	8.70
8-Mar-17	8.20
9-Mar-17	8.60
10-Mar-17	8.50
13-Mar-17	8.20
14-Mar-17	8.40
15-Mar-17	8.30
16-Mar-17	8.30
17-Mar-17	8.40
20-Mar-17	8.40
21-Mar-17	8.30
22-Mar-17	8.30
23-Mar-17	8.10
24-Mar-17	8.30
27-Mar-17	8.20
28-Mar-17	8.30
29-Mar-17	8.80
30-Mar-17	8.80
31-Mar-17	8.90
3-Apr-17	8.80
4-Apr-17	8.80
5-Apr-17	8.90
6-Apr-17	8.90
7-Apr-17	8.30
10-Apr-17	9.20
11-Apr-17	8.90
12-Apr-17	8.70
13-Apr-17	8.90
17-Apr-17	9.10
18-Apr-17	9.40
19-Apr-17	9.20
20-Apr-17	9.30
21-Apr-17	9.20
24-Apr-17	9.30
25-Apr-17	9.00
26-Apr-17	9.00
27-Apr-17	9.20
28-Apr-17	9.20
1-May-17	9.20
2-May-17	9.10
3-May-17	9.20
4-May-17	9.20
5-May-17	9.30
8-May-17	9.30
9-May-17	9.20
10-May-17	9.10
11-May-17	9.40
12-May-17	9.40
15-May-17	9.40
16-May-17	9.40
17-May-17	9.50
18-May-17	9.30
5-Jul-17	9.00
6-Jul-17	9.00
7-Jul-17	8.80
10-Jul-17	8.80
11-Jul-17	8.70
12-Jul-17	8.80
13-Jul-17	8.90
14-Jul-17	8.80
17-Jul-17	8.90
18-Jul-17	8.70
19-Jul-17	8.70
20-Jul-17	8.70
21-Jul-17	9.00
24-Jul-17	8.90
25-Jul-17	8.80
26-Jul-17	8.80
27-Jul-17	8.80
28-Jul-17	9.00
31-Jul-17	9.00
17-Oct-17	8.80
18-Oct-17	8.90
19-Oct-17	8.70
20-Oct-17	8.80
23-Oct-17	8.70
24-Oct-17	8.70
25-Oct-17	9.20
26-Oct-17	9.20
27-Oct-17	9.10
30-Oct-17	9.20
31-Oct-17	9.20
1-Nov-17	9.40
2-Nov-17	9.10
3-Nov-17	9.20
6-Nov-17	9.20
7-Nov-17	9.30
8-Nov-17	9.20
9-Nov-17	9.40
10-Nov-17	9.30
13-Nov-17	9.10
14-Nov-17	9.00
15-Nov-17	9.00
16-Nov-17	9.20
17-Nov-17	9.10

Date	pH
20-Nov-17	9.20
21-Nov-17	9.20
22-Nov-17	9.10
23-Nov-17	8.60
24-Nov-17	8.80
27-Nov-17	8.60
28-Nov-17	8.60
29-Nov-17	8.60
30-Nov-17	8.70
1-Dec-17	8.70
4-Dec-17	8.40
5-Dec-17	8.60
6-Dec-17	8.40
7-Dec-17	8.40
8-Dec-17	8.40
11-Dec-17	8.70
12-Dec-17	8.60
13-Dec-17	8.80
14-Dec-17	8.80
15-Dec-17	8.80
18-Dec-17	8.80
19-Dec-17	8.90
15-Mar-18	8.90
16-Mar-18	8.70
19-Mar-18	8.60
20-Mar-18	8.60
21-Mar-18	8.70
22-Mar-18	8.50
23-Mar-18	8.80
26-Mar-18	8.70
27-Mar-18	8.60
28-Mar-18	8.50
29-Mar-18	8.70
2-Apr-18	8.60
3-Apr-18	8.80
4-Apr-18	8.50
5-Apr-18	8.80
6-Apr-18	8.60
9-Apr-18	8.80
10-Apr-18	8.50
11-Apr-18	8.70
12-Apr-18	8.60
13-Apr-18	8.60
16-Apr-18	8.60
17-Apr-18	8.70
18-Apr-18	8.70
19-Apr-18	8.90
20-Apr-18	8.80
23-Apr-18	8.80
24-Apr-18	7.70
25-Apr-18	7.70
26-Apr-18	8.00
27-Apr-18	8.30
30-Apr-18	8.00
1-May-18	8.20
2-May-18	8.40
3-May-18	8.10
4-May-18	8.40
7-May-18	8.10
8-May-18	8.00
9-May-18	8.30
10-May-18	8.00
11-May-18	8.30
14-May-18	8.00
15-May-18	8.00
16-May-18	8.10
17-May-18	8.40
18-May-18	8.40
22-May-18	8.50
23-May-18	8.20
24-May-18	8.30
25-May-18	8.60
28-May-18	8.30
23-Oct-18	9.00
24-Oct-18	8.90
25-Oct-18	8.90
26-Oct-18	8.80
29-Oct-18	8.90
30-Oct-18	9.00
31-Oct-18	9.90
1-Nov-18	9.40
2-Nov-18	9.40
5-Nov-18	9.30
6-Nov-18	9.30
7-Nov-18	9.30
8-Nov-18	9.30
9-Nov-18	9.30
12-Nov-18	9.30
13-Nov-18	9.20
14-Nov-18	9.30
15-Nov-18	9.30
16-Nov-18	9.40
19-Nov-18	9.20
20-Nov-18	9.00
21-Nov-18	9.10
22-Nov-18	7.80
23-Nov-18	8.00
26-Nov-18	7.90
27-Nov-18	8.00
28-Nov-18	8.00
29-Nov-18	8.00
30-Nov-18	8.00
3-Dec-18	8.00
4-Dec-18	8.20
5-Dec-18	8.40
6-Dec-18	8.40
7-Dec-18	8.30
10-Dec-18	8.00
11-Dec-18	8.10

Note: "SD" = standard deviation. "n" = number of samples.

Table J.4: Water Quality at TOMP Station PR-03 (ETP Operations), Pronto TMA, 2015 to 2019

Date	pH
28-Feb-19	8.80
1-Mar-19	8.50
4-Mar-19	8.50
5-Mar-19	8.50
6-Mar-19	8.80
7-Mar-19	8.70
8-Mar-19	8.80
11-Mar-19	8.60
12-Mar-19	8.70
13-Mar-19	8.60
14-Mar-19	8.50
15-Mar-19	8.50
18-Mar-19	8.00
19-Mar-19	8.80
20-Mar-19	8.30
21-Mar-19	8.70
22-Mar-19	8.70
25-Mar-19	8.70
26-Mar-19	8.70
27-Mar-19	8.70
28-Mar-19	8.60
29-Mar-19	8.70
1-Apr-19	8.50
2-Apr-19	7.50
3-Apr-19	8.20
4-Apr-19	8.20
5-Apr-19	8.20
8-Apr-19	8.10
9-Apr-19	7.70
10-Apr-19	7.80
11-Apr-19	7.90
12-Apr-19	8.25
15-Apr-19	7.90
16-Apr-19	7.80
17-Apr-19	8.60
18-Apr-19	8.80
22-Apr-19	8.60
23-Apr-19	8.50
24-Apr-19	8.70
25-Apr-19	8.60
26-Apr-19	8.70
29-Apr-19	8.70
30-Apr-19	8.60
1-May-19	8.50
2-May-19	8.70
3-May-19	8.70
6-May-19	8.80
7-May-19	8.60
8-May-19	8.80
9-May-19	8.90
10-May-19	8.70
13-May-19	8.80
14-May-19	8.80
15-May-19	9.50
16-May-19	9.50
17-May-19	9.60
21-May-19	9.50
22-May-19	9.60
23-May-19	9.40
24-May-19	9.60
27-May-19	9.60
28-May-19	9.60
29-May-19	9.60
30-May-19	9.70
31-May-19	9.60
3-Jun-19	8.00
4-Jun-19	8.10
5-Jun-19	8.00
6-Jun-19	8.00
7-Jun-19	8.10
10-Jun-19	7.30
11-Jun-19	8.00
12-Jun-19	8.00
15-Aug-19	9.70
16-Aug-19	9.80
19-Aug-19	9.60
20-Aug-19	9.50
21-Aug-19	9.50
22-Aug-19	9.50
23-Aug-19	9.60
26-Aug-19	9.50
27-Aug-19	9.50
28-Aug-19	9.40
5-Sep-19	9.20
6-Sep-19	9.50
9-Sep-19	8.70
10-Sep-19	8.90
11-Sep-19	8.70
12-Sep-19	8.90
13-Sep-19	9.10
16-Sep-19	8.80
17-Sep-19	8.90
18-Sep-19	8.90
19-Sep-19	9.30
2-Oct-19	9.00
3-Oct-19	9.00
4-Oct-19	8.80
7-Oct-19	8.60
8-Oct-19	8.50
9-Oct-19	8.60
10-Oct-19	8.70
11-Oct-19	8.60
15-Oct-19	8.60
16-Oct-19	8.50
17-Oct-19	8.80
18-Oct-19	8.90
21-Oct-19	8.90
22-Oct-19	9.00
23-Oct-19	9.10
24-Oct-19	8.90
25-Oct-19	9.10
28-Oct-19	8.90
29-Oct-19	8.90
30-Oct-19	8.90
31-Oct-19	9.00
1-Nov-19	8.90
4-Nov-19	9.00
5-Nov-19	8.90
6-Nov-19	9.00
7-Nov-19	8.90
8-Nov-19	8.90
11-Nov-19	8.90
12-Nov-19	8.90
13-Nov-19	8.90
14-Nov-19	8.70
15-Nov-19	8.10
18-Nov-19	8.60
19-Nov-19	8.70
20-Nov-19	8.60
21-Nov-19	8.50
22-Nov-19	8.60
25-Nov-19	8.50
26-Nov-19	8.50
27-Nov-19	8.80
28-Nov-19	9.10
29-Nov-19	8.70
2-Dec-19	8.80
3-Dec-19	8.70
4-Dec-19	8.90
5-Dec-19	8.60
6-Dec-19	8.80
n	577
Minimum	7.30
Maximum	9.90
Mean	8.68
SD	0.422
Median	8.70
10th Percentile	8.11
95th Percentile	9.40

Note: "SD" = standard deviation. "n" = number of samples.

Table J.5: Water Quality at TOMP Station PR-04 (Effluent), Pronto TMA, 2015 to 2019

Date	Flow (L/s)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	TSS (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
11-Feb-15	97.0	8.20	240	0.158	1.00	0.0240	0.0161	0.860	0.215	0.00790
19-Feb-15	95.0	7.80	-	0.102	1.00	-	-	-	-	-
25-Feb-15	76.0	7.50	-	0.0950	<1.00	-	-	-	-	-
17-Apr-15	150	7.30	-	0.0670	2.00	-	-	-	-	-
22-Apr-15	178	7.60	-	0.0650	1.00	-	-	-	-	-
29-Apr-15	161	7.50	-	0.0670	1.00	-	-	-	-	-
6-May-15	140	7.20	200	0.0670	2.00	0.0190	0.0107	0.330	0.171	0.00170
13-May-15	117	7.00	-	0.0810	<1.00	-	-	-	-	-
20-May-15	96.0	7.12	-	0.0920	1.00	-	-	-	-	-
27-May-15	88.0	7.00	-	0.0910	1.00	-	-	-	-	-
12-Aug-15	72.0	7.20	290	0.0910	<1.00	0.0220	0.00800	0.130	0.116	0.00780
17-Aug-15	66.0	7.42	-	0.0790	1.00	-	-	-	-	-
26-Aug-15	71.0	7.00	-	0.0880	<1.00	-	-	-	-	-
7-Oct-15	98.0	7.10	-	0.0590	1.00	-	-	-	-	-
14-Oct-15	75.0	7.00	340	0.118	1.00	0.0230	0.0156	0.169	0.225	0.00480
18-Nov-15	108	7.50	300	0.126	1.00	0.0230	0.0152	0.395	0.157	0.00650
25-Nov-15	103	7.46	-	0.117	<1.00	-	-	-	-	-
2-Dec-15	139	7.05	270	0.125	1.00	0.0290	0.0194	0.203	0.204	0.00450
9-Dec-15	129	7.80	-	0.122	<1.00	-	-	-	-	-
16-Dec-15	175	7.00	-	0.122	2.00	-	-	-	-	-
22-Dec-15	174	7.23	-	0.108	2.00	-	-	-	-	-
28-Dec-15	170	7.30	-	0.0860	<1.00	-	-	-	-	-
6-Jan-16	147	7.30	220	0.103	1.00	0.0260	0.0314	0.526	0.233	0.00520
13-Jan-16	133	7.60	-	0.0970	<1.00	-	-	-	-	-
20-Jan-16	115	7.10	-	0.108	1.00	-	-	-	-	-
27-Jan-16	95.0	7.20	-	0.106	<1.00	-	-	-	-	-
16-Mar-16	152	6.87	-	0.0700	<1.00	-	-	-	-	-
23-Mar-16	181	7.05	-	0.111	1.00	-	-	-	-	-
30-Mar-16	170	7.34	-	0.0970	<1.00	-	-	-	-	-
6-Apr-16	168	8.04	-	0.0760	1.00	-	-	-	-	-
13-Apr-16	150	7.00	120	0.0740	1.00	0.0190	0.0201	0.450	0.124	0.00450
20-Apr-16	143	7.29	-	0.0700	1.00	-	-	-	-	-
27-Apr-16	137	7.16	-	0.0650	1.00	-	-	-	-	-
4-May-16	93.8	7.11	210	0.0600	<1.00	0.0200	0.0145	0.216	0.130	0.00220
11-May-16	25.0	7.10	-	-	-	-	-	-	-	-
8-Jun-16	96.0	7.60	-	0.0550	1.00	-	-	-	-	-
15-Jun-16	88.1	7.29	290	0.100	1.00	0.0270	0.0135	0.150	0.142	0.00260
9-Nov-16	73.0	7.30	330	0.141	2.00	0.0220	0.0189	0.256	0.217	0.0189
16-Nov-16	68.0	7.20	-	0.136	1.00	-	-	-	-	-
7-Dec-16	102	7.00	340	0.131	1.00	0.0250	0.0306	0.308	0.275	0.00900
15-Dec-16	100	7.00	-	0.158	1.00	-	-	-	-	-
21-Dec-16	98.0	7.30	-	0.158	1.00	-	-	-	-	-
30-Jan-17	80.0	7.00	340	0.170	1.00	0.0270	0.0381	0.434	0.353	0.0121
8-Feb-17	88.0	7.10	-	0.159	1.00	-	-	-	-	-
15-Feb-17	83.0	7.20	350	0.152	1.00	0.0270	0.0438	0.467	0.333	0.0124
22-Feb-17	85.0	7.20	-	0.142	<1.00	-	-	-	-	-
1-Mar-17	130	7.10	290	0.138	2.00	0.0260	0.0458	0.543	0.263	0.0101
8-Mar-17	138	7.20	-	0.120	1.00	-	-	-	-	-
15-Mar-17	124	7.30	-	0.106	<1.00	-	-	-	-	-
22-Mar-17	106	7.20	-	0.0980	<1.00	-	-	-	-	-
29-Mar-17	116	7.10	-	0.0820	1.00	-	-	-	-	-
5-Apr-17	160	7.10	130	0.0630	2.00	0.0150	0.0344	0.883	0.102	0.00580
12-Apr-17	163	7.30	-	0.0500	1.00	-	-	-	-	-
19-Apr-17	120	7.30	-	0.0560	1.00	-	-	0.306	-	-
26-Apr-17	112	7.20	-	0.0760	1.00	-	-	-	-	-
1-May-17	103	7.10	250	0.0780	1.00	0.0190	0.0184	0.282	0.113	0.00300
10-May-17	99.0	7.10	-	0.103	1.00	-	-	-	-	-
17-May-17	99.0	7.60	-	0.108	<1.00	-	-	-	-	-
7-Jul-17	100	7.40	-	0.0550	1.00	-	-	-	-	-
12-Jul-17	120	7.40	250	0.0930	1.00	0.0220	0.0155	0.177	0.124	0.00410
19-Jul-17	117	7.40	-	0.105	1.00	-	-	-	-	-
26-Jul-17	113	7.20	-	0.119	1.00	-	-	-	-	-
18-Oct-17	120	7.00	-	0.0300	1.00	-	-	-	-	-
25-Oct-17	145	7.50	230	0.108	3.00	0.0200	0.0265	0.580	0.181	0.00720
2-Nov-17	138	7.70	250	0.127	1.00	0.0250	0.0212	0.284	0.201	0.00560
8-Nov-17	130	7.70	-	0.123	1.00	-	-	-	-	-
15-Nov-17	116	7.70	-	0.133	1.00	-	-	-	-	-
22-Nov-17	128	7.60	-	0.110	1.00	-	-	-	-	-
29-Nov-17	149	7.40	-	0.110	2.00	-	-	-	-	-
6-Dec-17	140	7.20	220	0.0920	3.00	0.0210	0.0275	0.842	0.238	0.00600
13-Dec-17	120	7.40	-	0.102	2.00	-	-	-	-	-
21-Mar-18	80.0	7.10	290	0.130	2.00	0.0250	0.0205	0.450	0.179	0.0107
28-Mar-18	83.0	7.50	-	0.0900	2.00	-	-	-	-	-
4-Apr-18	82.0	7.80	260	0.113	2.00	0.0220	0.0137	0.800	0.163	0.00740
11-Apr-18	78.0	7.70	-	0.121	2.00	-	-	-	-	-
18-Apr-18	60.0	7.60	-	0.108	2.00	-	-	0.666	-	-
24-Apr-18	150	7.90	-	0.108	1.00	-	-	-	-	-

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table J.5: Water Quality at TOMP Station PR-04 (Effluent), Pronto TMA, 2015 to 2019

Date	Flow (L/s)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	TSS (mg/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
2-May-18	165	7.20	120	0.0690	1.00	0.0210	0.0150	0.699	0.134	0.00390
9-May-18	168	7.20	-	0.0690	2.00	-	-	-	-	-
16-May-18	149	7.40	-	0.0610	2.00	-	-	-	-	-
23-May-18	122	7.10	-	0.0860	1.00	-	-	-	-	-
31-Oct-18	60.0	7.20	300	0.127	2.00	0.0240	0.0179	0.307	0.181	0.0145
7-Nov-18	60.0	7.20	-	0.147	1.00	-	-	-	-	-
14-Nov-18	60.0	7.20	-	0.130	1.00	-	-	-	-	-
21-Nov-18	60.0	8.30	350	0.115	1.00	0.0250	0.0162	0.198	0.156	0.00510
28-Nov-18	100	7.10	-	0.154	2.00	-	-	-	-	-
5-Dec-18	98.0	7.30	330	0.163	1.00	0.0230	0.0267	0.309	0.235	0.00650
4-Mar-19	80.0	7.20	340	0.115	2.00	0.0230	0.0277	0.281	0.250	0.0141
13-Mar-19	80.0	7.40	-	0.148	2.00	-	-	-	-	-
20-Mar-19	100	7.10	-	0.158	1.00	-	-	-	-	-
27-Mar-19	100	8.00	-	0.0940	2.00	-	-	-	-	-
3-Apr-19	125	7.50	-	0.147	2.00	-	-	-	-	-
10-Apr-19	180	6.90	-	0.0920	2.00	-	-	-	-	-
17-Apr-19	197	7.40	-	0.0740	3.00	-	-	-	-	-
22-Apr-19	213	7.30	120	0.0650	2.00	0.0140	0.0300	0.680	0.0900	0.00490
1-May-19	201	7.50	150	0.0670	2.00	0.0170	0.0283	0.432	0.108	0.00620
8-May-19	186	7.30	-	0.0720	1.00	-	-	-	-	-
15-May-19	190	7.30	-	0.0810	1.00	-	-	-	-	-
22-May-19	80.0	7.20	-	0.0570	1.00	-	-	-	-	-
29-May-19	80.0	7.60	-	0.0800	1.00	-	-	-	-	-
5-Jun-19	150	7.20	230	0.0920	1.00	0.0200	0.0169	0.158	0.0960	0.00140
12-Jun-19	145	7.20	-	0.105	<1.00	-	-	-	-	-
21-Aug-19	80.0	7.90	230	0.0640	1.00	0.0160	0.00270	0.0650	0.0190	0.00940
26-Aug-19	80.0	8.20	-	0.117	1.00	-	-	-	-	-
3-Oct-19	100	7.60	-	0.0570	<1.00	-	-	-	-	-
4-Oct-19	100	7.50	-	0.0540	1.00	-	-	-	-	-
9-Oct-19	140	7.40	-	0.0730	1.00	-	-	-	-	-
16-Oct-19	140	7.00	270	0.0930	2.00	0.0270	0.0197	0.324	0.248	0.00540
23-Oct-19	140	7.40	-	0.0780	2.00	-	-	-	-	-
30-Oct-19	120	7.40	-	0.0920	1.00	-	-	-	-	-
6-Nov-19	160	7.30	230	0.0700	3.00	0.0234	0.0208	0.654	0.190	0.00490
13-Nov-19	150	7.70	-	0.0710	2.00	-	-	-	-	-
20-Nov-19	123	8.00	-	0.0810	2.00	-	-	-	-	-
27-Nov-19	130	7.30	-	0.0820	2.00	-	-	-	-	-
4-Dec-19	120	7.70	210	0.0720	3.00	0.0230	0.0114	0.618	0.122	0.00480
n	557	115	35	114	114	35	35	37	35	35
Minimum	10.0	6.87	120	0.0300	<1.00	0.0140	0.00270	0.0650	0.0190	0.00140
Maximum	215	8.30	350	0.170	3.00	0.0290	0.0458	0.883	0.353	0.0189
Mean	117	7.35	254	0.0991	1.35	0.0224	0.0215	0.417	0.180	0.00689
SD	39.2	0.293	68.9	0.0306	0.565	0.00360	0.00963	0.227	0.0711	0.00391
Median	116	7.30	250	0.0960	1.00	0.0230	0.0194	0.330	0.179	0.00580
10th Percentile	76.0	7.00	130	0.0630	<1.00	0.0170	0.0114	0.158	0.102	0.00260
95th Percentile	194	8.00	350	0.158	2.00	0.0270	0.0438	0.860	0.333	0.0145

Note: "SD" = standard deviation. "n" = number of samples. "-" = no data collected.

Table J.6: Water Level at TOMP Station PR-02, Pronto TMA, 2015 to 2019

Date	Elevation (m)
4-Feb-15	197.27
11-Feb-15	197.01
18-Feb-15	196.72
25-Feb-15	196.58
16-Apr-15	197.40
22-Apr-15	197.35
29-Apr-15	197.16
6-May-15	196.95
13-May-15	196.80
20-May-15	196.62
27-May-15	196.59
5-Aug-15	197.20
12-Aug-15	197.03
19-Aug-15	196.75
26-Aug-15	196.51
7-Oct-15	196.63
14-Oct-15	196.49
18-Nov-15	196.54
25-Nov-15	197.45
2-Dec-15	197.50
16-Dec-15	197.71
22-Dec-15	197.59
28-Dec-15	197.55
6-Jan-16	197.29
13-Jan-16	197.04
20-Jan-16	196.78
27-Jan-16	196.52
16-Mar-16	197.07
23-Mar-16	197.20
30-Mar-16	197.70
6-Apr-16	197.63
13-Apr-16	197.44
20-Apr-16	197.30
27-Apr-16	197.23
4-May-16	196.98
11-May-16	196.81
8-Jun-16	196.86
15-Jun-16	196.67
3-Nov-16	196.86
9-Nov-16	196.72
16-Nov-16	196.56
7-Dec-16	196.80
14-Dec-16	196.83
21-Dec-16	196.68
30-Jan-17	197.34
8-Feb-17	197.17
15-Feb-17	196.99
22-Feb-17	196.84
1-Mar-17	197.12
8-Mar-17	197.09
15-Mar-17	196.90

Date	Elevation (m)
22-Mar-17	196.63
29-Mar-17	196.77
5-Apr-17	197.26
12-Apr-17	197.16
19-Apr-17	197.15
26-Apr-17	197.00
1-May-17	196.88
10-May-17	196.78
17-May-17	196.54
5-Jul-17	197.56
12-Jul-17	197.33
19-Jul-17	197.05
26-Jul-17	196.71
18-Oct-17	197.30
25-Oct-17	197.66
2-Nov-17	197.52
8-Nov-17	197.32
15-Nov-17	197.08
22-Nov-17	197.40
29-Nov-17	197.07
6-Dec-17	196.94
13-Dec-17	196.72
21-Mar-18	197.02
28-Mar-18	196.82
4-Apr-18	196.93
11-Apr-18	196.79
18-Apr-18	196.77
25-Apr-18	197.26
2-May-18	197.35
9-May-18	197.44
16-May-18	197.10
23-May-18	196.74
24-Oct-18	197.20
31-Oct-18	197.04
7-Nov-18	197.03
14-Nov-18	197.02
22-Nov-18	196.91
28-Nov-18	196.88
5-Dec-18	196.72
4-Mar-19	197.24
13-Mar-19	197.03
20-Mar-19	197.06
27-Mar-19	197.10
3-Apr-19	197.11
10-Apr-19	197.65
17-Apr-19	197.97
22-Apr-19	198.06
1-May-19	198.00
8-May-19	197.57
15-May-19	197.33
22-May-19	197.26

Date	Elevation (m)
22-May-19	197.26
29-May-19	197.35
5-Jun-19	197.16
12-Jun-19	196.87
15-Aug-19	197.18
21-Aug-19	197.06
26-Aug-19	197.00
11-Sep-19	196.95
18-Sep-19	196.96
3-Oct-19	197.42
4-Oct-19	197.40
9-Oct-19	197.25
16-Oct-19	197.02
23-Oct-19	197.04
30-Oct-19	197.02
6-Nov-19	196.99
13-Nov-19	196.73
20-Nov-19	196.44
27-Nov-19	196.53
4-Dec-19	196.42
n	121
Minimum	196.42
Maximum	198.06
Mean	197.06
SD	0.34290
Median	197.04
10th Percentile	196.63
95th Percentile	197.65

Note: "SD" = standard deviation. "n" = number of samples.

APPENDIX K
REFRACTORY RADIUM

APPENDIX K REFRACTORY RADIUM

In 2008, a conventional Effluent Treatment Plant (ETP) was installed at the Stanleigh TMA to replace a more complex sand-filtration treatment system. However, since 2008, spikes in radium-226 concentrations in treated effluent have been observed seasonally. These spikes have been termed 'refractory radium' because when they are occurring, the conventional treatment system appears to remove radium-226 from effluent inefficiently. The phenomenon of refractory radium-226 has been under investigation since 2015. From 2015 to present, several investigations have occurred, and hypotheses have been developed to describe and/or identify the mechanism that causes refractory radium and the possible sources of the cause/ interference. For the purposes of these investigations, the term 'refractory radium' has been defined as when the dissolved radium concentration is equal to the total radium concentration (i.e., there is no detectable particulate-radium) above a threshold[1] of 0.2 Bq/L. This threshold was based on Stanleigh effluent monitoring data (station CL-06; January 2017 to May 2019; Appendix Table D.5). In addition to the refractory radium observed at Stanleigh TMA, spikes in radium-226 in the Panel TMA effluent have also been observed and have been increasing over the last several years (Appendix Table H.6). However, investigations into the mechanism, identity, and source of the interference have not been made at Panel. Therefore, at this time, it is not currently known if the cause of these radium spikes has the same source as those at the Stanleigh TMA. The investigation for Stanleigh has been expanded where possible to include Panel.

At the Stanleigh TMA, a modified treatment method has been introduced (*ex situ* barite treatment; XSB) which has successfully decreased the concentration of radium-226 during periods of refractory radium. This treatment was developed by Tetra Tech and Meta Valent Solutions in collaboration with Rio Algom Limited. The XSB treatment involves the pre-formation of barite crystals which are then added to the influent water (water from the Stanleigh TMA, CL-04) at the ETP, whereby these crystals continue to grow (capturing radium-226) and are large enough to fall out of solution in the Settling Pond prior to discharge to McCabe Lake (at CL-06; Figure 3.3). This is different from the conventional system where barium chloride is added to the influent water at the ETP, and crystal formation as well as crystal growth must occur in the Settling Pond prior to discharge. The modified treatment protocol has been in use

[1] Below a threshold of 0.2 Bq/L, radium-226 is sufficiently treated and could not be termed refractory, irrespective of whether radium-226 was in the dissolved or particulate form.

since April 2018, although during this period, the dose efficacy of XSB has been investigated. A stable dose of 5 to 6 mg/L XSB has been in continuous use since 4th January 2019 (while the ETP was operating) and has successfully removed radium-226 from influent water throughout the period of XSB use, such that radium-226 was below the discharge criterion (Section 3.3.2.4; Appendix Table D.5).

APPENDIX L
ELLIOT LAKE SITES GROUNDWATER SUMMARY REPORT
(GOLDER 2020)

FINAL REPORT

ELLIOT LAKE SITES GROUNDWATER SUMMARY REPORT

DENISON MINES INC. AND RIO ALGOM LTD.

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19126010-R01-Rev1

December 2020

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APPENDICES

1.0 INTRODUCTION

Golder Associates Ltd. ("Golder") was retained by Denison Mines Inc. (DMI) to complete a report detailing basic conceptual hydrogeological models (CHMs) for eight tailings management areas (TMAs) in the Elliot Lake region of Northern Ontario. The eight TMAs include the Quirke, Denison, Panel, Stanleigh, Stanrock, Lacnor, Nordic and Pronto sites (hereafter referred to as the "TMA Sites"). The locations of all the TMA Sites are shown on the Key Plan on Figure 1. DMI owns the Stanrock and Denison TMA Sites and Rio Algom Limited (RAL) owns Quirke, Panel, Stanleigh, Lacnor, Nordic and Pronto TMA sites. Two additional TMAs – the Spanish-American and Milliken TMAs – are present within the vicinity of the above-noted TMAs. They are referenced where appropriate but are not treated as stand-alone TMAs for the purposes of this study.

2.0 STUDY OBJECTIVES

We understand the report is required to satisfy a request from the Canadian Nuclear Safety Commission (CNSC) in response to the Cycle 4 Serpent River Watershed State of the Environment (SOE) report. The objective of the report was to summarize the available information at each of the above-noted TMAs including:

- A summary of available data for each site, such as existing monitoring well locations, overburden and bedrock stratigraphy, estimated groundwater flow directions, and hydraulic conductivity measurements.
- CHM development for each site, outlining interpreted flow paths, potential groundwater receivers, schematic geological cross-sections (if sufficient subsurface information is available), and rates of groundwater flow (if hydraulic conductivity measurements have previously been completed).

References for all reports noted herein are listed in Section 12.0.

3.0 CURRENT SAMPLING PROGRAM

Three annual monitoring programs exist at each TMA. Monitoring occurs under the Serpent River Watershed Monitoring Program (SRWMP), Source Area Monitoring Program (SAMP) and the TMA Operational Monitoring Program (TOMP), with 15, 27, and 127 stations monitored, respectively. The monitoring stations, parameters and sample frequencies are described in Tables in Appendix A. The SAMP and TOMP programs were implemented concurrently in January 2003, while the SRWMP has been in place since 1999 (Minnow 2017). The SRWMP stations are located off-site of the TMA's along watercourses of the Serpent River Watershed. Under these programs four types of water samples are collected:

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

4.0 QUIRKE TMA

4.1 Background

The Quirke TMA site is a decommissioned uranium mine tailings management area located about 13 kilometres (km) north of the City of Elliot Lake and immediately north of Dunlop Lake (Figure 4.1) The Quirke mine and mill operated from 1956 to 1961, and again from 1968 to closure in 1990. The TMA is owned and managed by RAL. The Quirke Mine produced about 42 million tonnes of tailings along with four million tonnes of waste rock which were deposited within the TMA (Minnow 2017).

4.2 Site Setting

4.2.1 Topography & Drainage

The Quirke TMA is a flooded tailings basin with a surface area of about 184 ha. The basin is surrounded by bedrock ridges. A total of five terraced cells (Cells 14-18) comprise the TMA and are separated by low permeability, engineered dykes or dams. The five cells are graded to direct seepage flow from west to east, with the easternmost cell (Cell 18) being 14 metres (m) lower in elevation than the westernmost cell (Cell 14). Water flows downgradient from Cell 14 to Cell 18 and onward to the treatment plant and settling ponds after which it is discharged to the Serpent River (Minnow 2017).

The topography is characteristic of the Canadian Shield and may be described as rugged but of relatively low relief with elevation differences being generally in the order of 30 to 60 m or less. Topographic highs typically consist of exposed bedrock knolls or ridges and topographic lows generally contain abundant swamps, lakes or streams. The topography is dominantly controlled by the structural orientations in the underlying bedrock.

4.2.2 Regional Geology

The underlying bedrock at the TMAs discussed in this report (including Quirke) is largely Lower Proterozoic age metasediments comprised of quartzite, arkose, conglomerate and minor argillaceous strata. These rocks have been folded into a broad, westward plunging syncline known as the Quirke Syncline, which hosts the uranium deposits of the Elliot Lake area (Robertson, 1968).

The sedimentary strata preserved within the Quirke Syncline area are crosscut by Nipissing age intruded diabase dykes and sills associated with regional faulting, generally oriented northwest to southeast. Regional fault structures are oriented both northwest-southeast and east-west. These features tend to occur at 5 to 6 km intervals. Smaller scale faulting trends to be more intense (1 to 2 features per square kilometre) and, while generally steeply dipping, exhibit variable strike and persistence. Intruded diabase dykes and sills are generally associated with the faults, particularly in the areas southwest and east of Quirke Lake.

As outlined in Golder report 1991a, Quirke Lake and the Quirke TMA are located on the north limb of a synclinally folded metasedimentary rock basin, the Quirke Syncline. The bedrock consists of metamorphosed sedimentary rocks of Proterozoic age which unconformably overlie an Archean basement complex of metalvolcanic and granitic intrusive rocks which outcrop to the north of Quirke Lake.

4.2.3 Quirke TMA Geology

4.2.3.1 Overburden

As outlined in Golder 1991a, the Quirke TMA has three major types of Pleistocene deposits that have been defined; a silty sand lodgement till, silty sand and gravel ablation till with numerous boulders, and silty sand and gravel glacial outwash deposits. The glacial outwash deposits are composed of poorly graded sand and gravel and in the deep valleys marginal to the Serpent River system can attain thicknesses in excess of 30 m. In other areas near Quirke Lake, the overburden is dense to very dense silty sand lodgement till with some gravel, traces of clay and occasional cobbles and boulders. In some areas, the till is overlain or replaced by loose to compact silty to gravelly sand. Similar stratigraphy has been encountered infilling the bedrock valley along the Serpent River.

Quaternary geology mapping for the area (Figure 4.2), indicates that the TMA itself is underlain by bedrock with intermittent till deposits, while glaciofluvial outwash deposit along the Serpent River to the east, and ice-contact fan deposits to the southeast of Cell 18

4.2.3.2 Bedrock

The Archean basement rocks are exposed along the north shore area of Quirke Lake extending from Panel Mine westwards to the north of the Quirke Lake property and the Quirke Mine TMA (Golder Associates 1991a). These rocks are primarily composed of quartz monzonites, granodiorites and quartz diorites. These Algoman granites contain remnants of Keewatin metavolcanic rocks.

The metasedimentary rocks which outcrop to the immediate south of the Algoman granites are predominantly quartzite and arkose with argillites, conglomerates, siltstones and carbonates forming a sequence that ranges in thickness from about 600 m to 900 m in the area west of and under Quirke Lake. The metasedimentary rocks have been subdivided into five formations based on lithology and stratigraphy (Robertson 1968). The Quirke lithology is indicative of cyclic sedimentation commonly originating with a coarse-grained basalt unit (polymictic/oligomictic conglomerate) and grading to a fine-grained upper unit (siltstone, argillite). During periods of relative tectonic stability, the foregoing sedimentation sequence was intermittently interrupted and carbonate rocks were deposited as the Espanola Formation.

Nipissing diabase dykes and transgressive sills, which crosscut the entire sequence, were placed during a period of regional deformation known as the Hudsonian Orogeny and are evident at the east end of Quirke Lake.

The Serpent River and Quirke Lake areas are characterized by three structural elements (Golder 1991a); a major fold (Quirke Syncline), a complex network of regional and secondary faults, and a series of intruded diabase dykes and sills. The bedrock geology at the Quirke TMA is shown in Figure 4.3.

4.3 Hydrogeology

According to Golder 1991a, infiltration of groundwater into the near-surface rock is controlled by the hydraulic conductivity characteristics of the bedrock. Typically, the near-surface bedrock is variably weathered and fractured and exhibits a higher hydraulic conductivity than the more massive bedrock at depth. Thus, within the bedrock profile, groundwater movement predominantly occurs in the uppermost part of the rock, with infiltration occurring in areas of higher elevation and discharge occurring to the major surface watercourses within the valleys.

Primary groundwater flow paths at the Quirke TMA site are expected to be limited to shallow, weathered bedrock and in particular to the more permeable overburden deposits which are generally discontinuous and often limited to areas between bedrock outcropping as shown in Figure 4.2.

4.4 Water Elevations and Gradients

The five cells of the Quirke TMA are terraced and direct water from the westernmost cell (Cell 14) to the easternmost cell (Cell 18) as shown on Figure 4.4. Cell 18 is about 14 meters lower in elevation than Cell 14, creating a seepage gradient. Surface water is treated at the Effluent Treatment Plant (ETP) after Cell 18 before discharge into the settling ponds downstream of the Main Dam and eventually discharging into the Serpent River. Water is taken seasonally from Gravel Pit Lake (located north of and hydraulically connected to Cell 14) to maintain consistent surface water elevation within Cell 14. The invert elevation of the Cell 14 water overflow pipe is about 378 masl. During the reporting period between 2010 and 2014, the water levels of Cells 14 and 15 generally remained below the spillway inverts as a result of seepage through and beneath the internal dykes, while water elevations at cells 16S (referred to as cell 16 in Minnow, 2017) and 17 remained at or above the spillway invert. Water elevations in Cell 18 (about 364 masl) were generally within the operating limit levels during the 2010-2014 reporting period (Minnow 2017).

According to Golder 1991a, the regional groundwater flow pattern in the vicinity of Quirke TMA is controlled principally by the topography of the area and by the existing geological structures which transect the basin. The active groundwater flow is generally restricted to the overburden and the fractured and weathered shallow bedrock and is in an easterly direction in the vicinity of the Quirke TMA toward the Serpent River (Figure 4.4). Recent groundwater levels collected at the Quirke TMA TOMP locations between 2010 and 2019 confirmed historical levels.

The granitic basement rocks forming the north shoreline of Quirke Lake form a ridge extending to at least 90 m above the elevation of Quirke Lake. Based on existing topography and lake levels, groundwater movement in this area is predominately south and east into the Quirke Lake and the Serpent River Systems.

On the south side of Quirke Lake, groundwater gradients follow surface drainage patterns. It is inferred that groundwater movement is towards Quirke Lake from the west and southwest and from the ridge near Ouellette Lake at the east end of Quirke Lake.

4.5 Hydraulic Conductivity

4.5.1 Bedrock Hydraulic Conductivity Characteristics

Detailed investigations to determine hydraulic conductivity have been carried out in the metasedimentary rock units around the Quirke Lake basin in the 1970’s and the early 1980’s. Some testing has also been undertaken within the Archean basement rocks. Hydraulic conductivity data obtained from either conventional, constant head, Lugeon-type pressure packer tests or from falling head pneumatic packer tests were carried out for the Quirke TMA.

The hydraulic conductivity profiles indicate a variation with depth and lithology. In general, values ranging from 1×10^{-6} to 1×10^{-5} metres per second (m/s) are encountered in the upper bedrock with values decreasing to 1×10^{-8} m/s or less at depths greater than 60 m. (Golder, 1991a).

4.5.2 Overburden Hydraulic Conductivity Characteristics

Overburden within the vicinity of Serpent River and Quirke Lake varies from a well-graded silty sand till to gravelly sand. The hydraulic conductivity of the tills in this area generally range from 1×10^{-7} to 1×10^{-6} m/s for sandy till and less than 1×10^{-8} m/s for silty till. Granular deposits in the area have hydraulic conductivity values ranging from about 1×10^{-6} m/s for silty sand deposits to 1×10^{-3} m/s for the gravelly sand (Golder 1991a).

4.6 Water Quality

As part of the closure decommissioning process, surface water, pore water and groundwater within the Quirke TMA are monitored under the TOMP and SAMP programs as described in Appendix A. Data from these stations are presented in the 2010-2014 SRW Cycle 4 State of the Environment report as well as annually in the Rio Algom Limited Annual Operational Care and Maintenance Report.

4.7 MECP Water Well Information System

Golder queried the MECP water well information system for data for wells located within a 1 km radius of the TMA. No data was found.

4.8 Dams

The table below provides a summary of dams and related structures or facilities at the Quirke TMA, shown on Figure 4.4.

Dam ID, Purpose	Foundation Conditions	Gradient, Vector	No. of Associated Water Level Monitoring Points
Dam K1, tailings and water retention	Till core founded upon prepared bedrock. Dam shell founded upon native competent soil or bedrock. Grout curtain present.	About 10 m difference in head upstream to downstream (across dam, westward).	20
Dam K2, tailings and water retention		About 8 m difference in head upstream to downstream (across dam, southward).	6
Dam J, tailings and water retention		About 5.5 m difference in head upstream to downstream (across dam, southward).	11
Main Dam, tailings and water retention	Till core on bedrock at abutments. Soil-bentonite cut-off wall present in sand foundation along middle section.	About 10 m difference in head upstream to downstream (across dam, eastward).	20
Dam I, Tailings and water retention	Till core founded upon prepared bedrock. Dam shell founded upon native competent soil or bedrock. Grout curtain present.	About 5 m difference in head upstream to downstream (across dam, southwestward).	10
Dam G1, tailings and water retention	Till core founded upon prepared bedrock. Dam shell founded upon native competent soil or bedrock. Grout curtain present.	About 8 m difference in head upstream to downstream (across dam, northeastward).	8
Dam G2, tailings and water retention	Till core founded upon prepared bedrock at abutments with glacial till only in the centre portion (about 23 m thick in centre portion). Dam	About 2 m difference in head upstream to downstream (across dam, eastward).	3

Dam ID, Purpose	Foundation Conditions	Gradient, Vector	No. of Associated Water Level Monitoring Points
	shell founded upon native competent soil or bedrock.		
Dam L, freshwater retention and tailings separation	Till core founded upon prepared bedrock. Dam shell founded upon native competent soil or bedrock. Grout curtain present. Raised in 1989 by 0.6 m.	About 2.5 m difference in head upstream to downstream (across dam, southward from Gravel Pit Lake).	5
Dam M, freshwater retention	Till core founded upon prepared bedrock at abutments and keyed into granular overburden elsewhere.	About 5 m based on ground surface levels downstream adjacent to the Dam.	0
Dam H, freshwater diversion	Till core keyed into natural foundation till. Unsuitable weak and organic materials were stripped to expose competent foundation till. Dam shell founded upon native competent soil.	About 3 m based on ground surface levels downstream adjacent to the Dam.	0
Dyke 14, tailings and water retention	Embankment consists of silty sand and gravel mixed with rockfill.	About 4 m difference in head upstream to downstream (across dyke, eastward and southeastward).	18
Dyke 15, tailings and water retention	Embankment consists of silty sand and gravel mixed with rockfill. No bedrock encountered.	About 4 m difference in head upstream to downstream (across dyke, eastward and southeastward).	27
Dyke 16, tailings and water retention	Embankment consists of sand and gravel and silty sand.	About 3 m difference in head upstream to downstream (across dyke, eastward).	9

Dam ID, Purpose	Foundation Conditions	Gradient, Vector	No. of Associated Water Level Monitoring Points
Dyke 17, tailings and water retention	Embankment consists of silty sand and gravel mixed with rockfill.	About 3 m difference in head upstream to downstream (across dyke, eastward) based on operating water levels in Cell 17 and Cell 18.	0
Dam D, water and treatment solids retention	Foundation of raised dam (2013) is variable with sand and gravel with cobbles and boulders. Original dam founded in compacted granular 'B' gravel. Dam extended onto bedrock, which is exposed at north abutment.	About 2 m difference in head upstream to downstream (across dam, eastward).	0
Dam E, water and treatment solids retention	Not available. Unknown embankment fill.	About 0.5 m from Pond 3 to Pond 4 (across dam, southeastward), based on 2012 pond water levels.	0
Dyke Q-23, water retention, environmental and flow monitoring	Sand and gravel, cobbles and boulders.	About 1 m difference in head upstream to downstream (across dyke southwestward), based on 2008 pond water levels.	0

4.9 Conceptual Hydrogeological Model

Primary groundwater flow paths at the Quirke TMA site is expected to be limited to shallow, weathered bedrock and to the more permeable overburden deposits (none of which are present under the TMA) which are generally discontinuous and often limited to areas between bedrock outcropping. The inferred flow of groundwater beneath the Quirke TMA is shown schematically on Figure 4.5 in terms of flow from Cell 14 to the Serpent River. The Quirke TMA utilizes water from the Gravel Pit Lake to maintain the water levels in Cell 14 and the cascading flow toward the east. The cells are largely surrounded by topographic highs with the cells directing water flow toward the effluent treatment plant before entering the Serpent River which lies east of the TMA. Groundwater flow paths are interpreted to follow surface water flow with most groundwater discharge within the terraced TMA directed to the treatment plant. Groundwater seepage is expected in low-lying areas around the perimeter of the TMA.

5.0 DENISON TMA

5.1 Background

The Denison TMA is a decommissioned uranium mine tailings management area located about 11 km north of the City of Elliot Lake and west of Quirke Lake (Figure 1). Mining and milling operations at the Denison Mine commenced in 1957 and ceased in April 1992.

The tailings from the Denison Mine were deposited into two bedrock-lined basins, TMA-1 and TMA-2 (Figure 5.1). Between 1957 and 1959 the tailings were placed in TMA-2 (formerly Upper Williams Lake). Dam 1 was constructed at the west end of the basin to retain the solids. After the TMA-2 basin was filled in 1960, tailings were then sent to TMA-1 (Bear Cub/Long Lake Basin). A series of dams were constructed along the perimeter to contain the tailings within TMA-1 between 1960 and 1970s. A total of 59.7 million tonnes of tailings are contained within the 240-ha basin of TMA-1 and 3.3 million tonnes are contained in TMA-2.

In all, a total of 18 structures were constructed since 1957 to control and contain the tailings. The primary containments include Dam 1 at TMA-2 and Dams 9,10,16,17 and 18 at TMA-1 These dams are all engineered embankments. Dams 1 and 10 have Hypalon membranes as the seepage barrier while others are zoned earth fill embankments with compacted glacial till cores as the seepage barrier.

The Denison TMAs were decommissioned as flooded tailings following the mine closure in 1992. Occasional facility improvements resulting from monitoring and maintenance have been ongoing since 1992. Decommissioning was largely completed in 1996 (Minnow 2017).

5.1.1 Spanish American

The Spanish American mill operated from May 1958 to February 1959 and is located immediate southeast of the of the Denison TMA with all catchment and discharge reporting to Denison TMA. Milling was done at a nominal capacity of 1,800 tonnes per day using feed ore predominantly from the Spanish-American Mine but also from the Quirke and Buckles Mines. During operations 0.45 million tonnes of tailings were deposited into the Spanish-American TMA.

In 1994, approximately 90,000 m^3 of exposed tailings beaches at the eastern end of Spanish American TMA were relocated to the western end of the basin providing a nominal depth of water cover of 0.9 m at the eastern perimeter and 1.5 m in the centre of the basin. Two engineered berms (North and South Berms) were installed at the western outlet to flood the basin and confine the 0.45 ha Spanish-American TMA. Lime slurry was added to the basin during and after flooding (summers of 1994 to 1996) to achieve the target surface water pH of 7.0.

The Spanish-American outlet berms are founded on bedrock at the original basin outlet. The two berms are about 1.8 m high and separated by a bedrock knob. They are designed as overflow structures with a central till core and an erosion resistant zone on the berm crests. There is a 6 m wide spillway on the south berm.

There is no ETP at the Spanish American TMA. Drainage from the 37 ha watershed passes through the South Berm spillway to Denison TMA-1.

5.2 Site Setting

5.2.1 Topography

The topography of the TMA-1 basin is dominated by east-west trending linear bedrock ridges. The ridges rise between 5 and 43 m above the current level of the deposited tailings. The ridges are comprised of gentle southward dipping slopes and steep, rugged northward facing scarps that mimic the bedding structure of the underlying rock formations. The crests of the ridges were smoothed by glacial action.

The TMA-2 basin has similar topography to that of TMA-1. The elevation of the ridges rises to about 30 m above the west end of the basin near Dam 1. The bedrock ridges within the TMA-2 area trend northwestward, subparallel to the Spanish American Fault.

5.2.2 Drainage

According to the Golder 1992a report, the original drainage from the TMA-1 basin was generally from east to west toward the Serpent River. The TMA-1 basin was developed by depositing tailings from east to west, maintaining the original natural direction of drainage. Surface water is discharged through to the effluent treatment plant located east of Dam 18 then into the now partitioned Stollery Lake Settling Pond onward to the Serpent River. The existing drainage pattern for the lakes to the south of the basin has not been substantially altered. To allow for construction of Dam 16, the level of Upper Cinder Lake was lowered by 1.2 to 1.8 m. Little Cinder Lake is now used to create a gradient to direct seepage from the toe of Dam 10 toward the Stollery Lake Settling Pond.

The TMA-2 basin originally contained Smith Lake, which drained westward into Upper Williams Lake and then westward to the Serpent River. Development of the basin originally included the construction of Dams 1, 2, 4 and 12. Dams 2, 4 and 12 were removed and the Smith Lake drainage was subsequently diverted into TMA-1. Seepage that passes through Dam 1 is treated downstream in Lower Williams Lake and discharged into the Serpent river.

Effluent from TMA-2 flows into TMA-1 via the TMA-2 spillway. Seepage from the TMA-2 basin is treated at the Lower Williams Lake Treatment Plant and discharged to the Serpent River at Station D-3. The Denison ETP is located on the north shore of TMA-1 where effluent is treated prior to discharge to Stollery Lake Settling Pond, which then discharges into the Serpent River at Station D-2 (Minnow 2017).

5.2.3 Regional Geology

According to the Golder 1991a report, the base of the Denison TMAs are characterized by comparatively small areas of glacially derived surficial sediments and large expanses of exposed bedrock. The bedrock beneath these areas is comprised of highly indurated, gently folded metasedimentary strata of the Serpent and Gowganda Formations. These Formations are part of the Precambrian (Aphebian) aged Huronian sedimentary sequence that lies within the Quirke Syncline, a gentle westerly plunging fold structure that hosts the uranium deposits of the Elliot Lake area. The sedimentary strata preserved within the Quirke Syncline area are crosscut by Nipissing age diabase dykes and sills and various faults.

The surficial deposits (where present) and bedrock geology in the vicinity of the Denison TMA study area are shown on Figure 5.2. Details of the surficial and bedrock geology are discussed in the following sections.

5.2.4 Denison TMA Geology

5.2.4.1 Surficial Geology

According to the Golder 1992a report, the surficial deposits underlying the Denison TMAs have been subdivided into six groupings based on their surface expression and soil type. These include: a bedrock complex, areas of till veneer, till moraine, ice-contact sand and gravel deposits, areas of rock talus and spruce bog. Overburden geology mapping is shown on Figure 5.2.

Bedrock Complex

The areas surrounding the tailings basin are dominated by ridges of exposed bedrock and minor intervening areas of thin surficial deposits collectively referred to as a bedrock complex. The exposed bedrock is generally smooth and rounded with characteristic north-south orientated striations and flutings reflecting the results of glacial erosion. Structural features in the bedrock such as jointing, dykes, sedimentary contacts and faulting also tend to be enhanced as linear topographic features due to preferential ice erosion.

Surficial deposits occur locally within the bedrock complex as infill in low areas between rock knobs and ridges or as a discontinuous thin veneer over the bedrock surface. The deposits are largely comprised of silty sand to sandy till with cobbles and boulders or thin sand and gravel layers. These deposits appear to range in thickness from less than 0.3 m up to 5 m except where deeper bedrock depressions have been infilled.

Till Veneer

The areas of till veneer are limited in size. The till veneer is comprised of thin sandy to silty sand tills associated with discontinuous areas of outcropping bedrock. The contour of the terrain is generally directly controlled by the underlying bedrock. Most of these areas are extensively forested. The thickness of the till veneer does not exceed 5 m except within narrow infilled bedrock depressions.

Till Moraine

Areas of till moraine occur at the east end of the TMA-1. The till within this area is generally greater than 5 m thick and is comprised of dense to very dense, silty sand with trace to some gravel, cobbles, and boulders. The till tends to be coarser grained near the ground surface where it is likely derived from glacial ablation.

Till moraine underlies the southern end of Dam 17 and it has been extensively quarried for dam construction material in the areas to the east and south of Dam 17. Large deposits of till moraine have been excavated for borrow material in the areas bordering Quirke Lake, south of the Spanish American TMA.

Ice-contact Sand and Gravel

An extensive area of ice-contact sand and gravel deposits, including eskers, kame terraces, glaciofluvial and deltaic deposits are present west of TMA-1 (Figure 5.2). These deposits are 6 to 18 m thick.

The sand and gravel deposits also underlie portions of the Serpent River downstream of the Dunlop Lake, extend beneath Dam 10 at the west end of the TMA-1 and are inferred to underlie the central portion of the former Long Lake, now occupied by TMA-1.

Rock Talus

Areas of rock talus are limited to the flanks of the prominent rock ridge immediately south of the Denison Mine. The talus in this area comprised of angular blocks varying from less than 0.3 m up to 3 m in diameter. The talus is derived from weathering (such as joint controlled frost shattering) of the bedrock cliffs. These deposits have developed within the post-glacial period and overlie glacial deposits. Areas of rock talus also occur beneath tailings at the base of the prominent ridge on the south side of the TMA-1 extending west of Dam 16.

Spruce Bog

Numerous comparatively small spruce bogs, comprised of peat, sphagnum moss, muskeg and black spruce occur in poorly drained bedrock depressions throughout the area. Most of these bogs are in the order of 30 to 240 m in width. The largest area of bog occurs along the shore of the Serpent River west of TMA-2

5.2.4.2 Bedrock Geology

The bedrock geology of TMA-1 and TMA-2 is shown on Figure 5.3. The geological interpretation is based upon the results of previous mapping subsurface investigations (Golder 1992a).

In summary, the Denison TMAs are predominately underlain by the Gowganda Formation, a complex sedimentary sequence comprised of 9 lithological members. The Gowganda Formation unconformably overlies the Serpent Formation quartzite which outcrops around the northern and eastern perimeters of the TMAs. The identification of structural folding and faulting within the bedrock beneath the site, which may be significant with respect to the hydrogeological conditions, is largely based upon the deformation and offsetting of the various members of the Gowganda Formation and the underlying Serpent Formation, as observed during geological mapping or encountered in borehole intersections.

Serpent Formation

The Serpent Formation outcrops variably in the local area including beneath the valley to the northwest (downgradient) of TMA-2 and along the base of the ridge at the east end of the TMA-1.

The Serpent Formation is comprised almost entirely of quartzite. The quartzite includes occasional pebble conglomerate beds and thin to medium interbeds of siltstone and minor mudstone.

Weathering of the quartzite, which may influence the hydrogeological behaviour of the rock, appears to be limited to weathering along the bedding planes or frost shattering at the bedrock surface. The frost shattering is largely controlled by intersecting joints and bedding planes producing very angular, sharp rocks reflecting the very hard nature of the quartzite. Weathering of this nature was noted in the exposures in the valley below Dam 17. Elsewhere, the Serpent formation outcrops tend to be smooth features.

The contact with the overlying Gowganda Formation is characterized by a sharp change form quartzite to massive Gowganda conglomerate to a more transitional Serpent quartzite to Gowganda argillite, greywacke and arkose in the Williams Lake area. The sharp contacts between the Serpent quartzite and conglomerate, where exposed at surface tend to be open, potentially permeable features; this is inferred to be a surficial weathering phenomenon and does not represent the rock mass conditions at depth.

Gowganda Formation

The Gowganda formation has been subdivided into nine lithological members based on the results of geological mapping. The overall thickness of the Gowganda Formation varies from less than 15 m along the northern outcrop limit near TMA-2 to about 350 m beneath the south side of TMA-1.

The nine members of Gowganda Formation are variously comprised of 3 types; massive conglomerate greywacke, pink arkose and interbedded argillite and siltstone.

5.3 Hydrogeology

Details of the hydrogeological conceptualization are outlined below.

5.4 Water Elevations and Gradients

Groundwater level measurements in the Denison TMAs were obtained and reported in Golder 1992a and are summarized below. Figure 5.4 provides the inferred groundwater flow direction. Recent groundwater levels collected at the Denison TMA TOMP locations between 2010 and 2019 confirmed historical levels.

5.4.1 TMA-1 East End

Groundwater recharges or flows into TMA-1 along the southern perimeter ridge between Dam 16 and 17. Inward flow also occurs from the ridges between Dam 9 and Dam 18 along the north side of the basin.

Tailings-derived groundwater discharges from the basin at both the eastern and western ends of the basin. At the east end, discharge is interpreted to occur beneath Dam 9 and Dam 17 and through the bedrock ridge between the two dams, based on an observed seepage discharge below Dam 17 and the groundwater levels beneath the ridge. Discharge from this area would report directly to Quirke Lake as either surface runoff or as bedrock seepage.

The eastern end of the TMA-1 includes the foundation areas of Dams 9 and 17, the tailings behind the dams, and the prominent bedrock ridge separating the tailings impoundment from Quirke Lake. The Lake is about 46 m below the tailings surface.

The available ground water levels from Golder 1992a indicate that a strong downward gradient exists beneath the bedrock ridge and the adjacent tailings at the east end of TMA-1. The phreatic surface within the underlying bedrock slopes toward Quirke Lake. This, and the downward hydraulic gradients indicate that along the east end of the tailing basin, tailings-derived seepage migrates downward through the bedrock ridge towards Quirke Lake. Upward gradients locally exist at the downstream toe of the south valley of Dam 17 where tailings-derived seepage occurs.

5.4.2 TMA-1- West End

The entire west end of TMA-1 is rimmed with bedrock ridges and dams. The extreme western end of the TMA is flooded and controlled by the treatment plant intake.

According to data provided in Golder 1992a, groundwater levels within the southern ridge appear to be above the tailings basin, creating an inward hydraulic gradient.

Groundwater levels suggest that a horizontal hydraulic gradient exists through the ridge from the tailings basin to Cinder Lake. The higher water levels in the upper two piezometers likely reflect groundwater conditions associated with the surface recharge and vertically downward movement of water through fractures to the deeper zone in response to the strong downward gradients. Similar conditions exist beneath the west abutment ridge of Dam 16 based on the water levels in BH405.

The groundwater regime in the southwestern ridge suggests that it does not behave as a groundwater divide. Seepage may occur through the core of this ridge from the tailings basin to Cinder Lake, although it would be limited by the relatively low hydraulic conductivity of the rock mass.

Groundwater levels beneath the northwestern ridge are monitored in the bedrock piezometers beneath Dam 18. All the piezometers had water levels below the tailings pond level. This indicates that a hydraulic gradient exists through the ridge from the tailings basin towards Stollery Lake Settling Pond.

The long-term water level monitoring of most of the dam foundation piezometers at Dams 16 and 18 show a direct trend between rising head pond levels and rising groundwater levels. This suggests a hydraulic connection between the tailings basin and the downgradient bedrock.

There is little groundwater information available in the northern ridge between the Dam 18 and Dam 9. However, the surface drainage from TMA-2 to TMA-1 suggests that the hydraulic gradient and thus groundwater seepage within the bedrock ridges are southward from TMA-2 to TMA-1.

Strong downward hydraulic gradients exist at Dam 10. The downstream groundwater levels are controlled by a series of gravity drains at the toe of the dam. Based on water levels being below the adjacent levels of Cinder Lake, the toe drains receive the seepage from both the tailings basin and Little Cinder Lake.

5.4.3 TMA-2 Area

TMA-2 is recharged from the surrounding bedrock ridges based on historical groundwater levels (Golder 1992a). There are also potential seepage discharge pathways. The most significant of the pathways is seepage that occurs beneath Dam 1. This seepage represents the controlled dam drain discharge system, bedrock seepage beneath the dam, and seepage potentially beneath the low bedrock ridge beneath the basin. The dam has a Hypalon membrane seepage barrier. Seepage from Dam 1 discharges to the treatment plant downstream (Williams Lake Treatment Plant). An outward hydraulic gradient exists here indicating that the groundwater flows northward through the bedrock and under Dam 1 and will end up discharging within the downstream valley at the treatment plant and ultimately to the Serpent River via the settling pond.

The other potential seepage discharge pathway from TMA-2 is southeastward through the bedrock ridge where discharge could potentially occur in the valley below Dam 9. Seepage could also potentially occur along the northern branch of the Spanish-American Fault which passes beneath this area. Any seepage discharges in this area through this southeastern area would be expected to report directly to Quirke Lake. However, no obvious indications of seepage, such as springs, were noted in the potential discharge at the base of this ridge during the 1991 field mapping exercise.

5.5 Hydraulic Conductivity

The following sections outline the hydraulic conductivity values as described in Golder 1992a.

5.5.1 Tailings

5.5.1.1 TMA-1

The Hydraulic Conductivity for the tailings within TMA-1 has been divided into three zones based on the results of *in situ* testing and grain size analysis. Deposition in the basin has generally proceeded from east to west with an accompanying decrease in grain size following the same trend. The estimated hydraulic conductivity values range from 1 x 10^{-5} m/s in the eastern third, to 1 x10^{-6} m/s in the central third to 1 x10^{-7} m/s in the western end of the basin. Values are based on *in situ* test results, laboratory testing and on published data.

5.5.1.2 TMA-2

TheTMA-2 area comprises several cells separated by dykes and dams. These cells formed at various stages during the deposition and a varied tailings composition has been produced. *In situ* testing and grain size analysis have determined the hydraulic conductivity of the tailings in the three major cells. These values are: Upper Williams Lake, 1 x 10^{-6} m/s, western TMA-2 (formerly Smith Lake), 5 x 10^{-7} m/s and eastern TMA-2, 1 x 10^{-6} m/s.

5.5.2 Overburden

Within the TMA-1 basin, overburden underlies dam foundations only at Dam 10 and the Dam 17 South Valley. All other topographic low areas around the basin have been excavated to bedrock and impervious dams have been constructed directly on the bedrock surface.

5.5.2.1 Dam 10

The overburden that lies within the central portion of Dam 10 and is up to 21 m thick. The predominant material type is loose to compact, fine silty sand, grading to sandy silt with depth. There is a discontinuous layer of coarse-grained sand and gravel at the deepest portion of the dam. The hydraulic conductivity of these materials is inferred to range between 1 x 10^{-7} and 1 x 10^{-5} m/s based on grain size distribution.

5.5.2.2 Dam 17

A layer of glacial till, varying in thicknesses from between 6 and 15 m, was left in place beneath Dam 17. The *in situ* hydraulic conductivity of the till ranged from 1 x 10^{-8} to 1 x 10^{-5} m/s. The till was left in place and the dam was constructed using imported glacial till compacted to form an impervious dam core with a design permeability of 1 x 10^{-8} m/s.

Within TMA-2, no overburden deposits are present. Overburden is present at the east end of the former Smith Lake in borehole DH91-D6 where 7.3 m of silty sand and fill was encountered infilling a gap in the bedrock ridge; however, the base of this zone is about 8 m above the existing tailings level.

5.5.3 Bedrock

The bedrock beneath the TMAs is highly indurated and the hydraulic conductivity is entirely associated with secondary fracturing and faulting. The overall bedrock hydraulic conductivity of the rock mass was assessed using available test results from the site. This included packer test results from previous dam site investigations and the Golder 1992a study. The data includes 36 boreholes with a total of 432 tests carried out to depths of up to 76 m below the bedrock surface.

The results of the bedrock testing do not indicate a clear trend with depth. However, based on the analysis of the geometric mean hydraulic conductivity over various depth intervals, the conductivity in the upper 15 m of bedrock was found to be in the order of 1 x10^{-6} to 1 x10^{-5} m/s, while at depths of greater than 15 m, unstructured rock, the geometric mean is about 1 x 10^{-7} m/s. The variability of test results was also observed to decrease with depth.

The hydraulic conductivity of the eastern bedrock ridge between TMA-1 and Quirke Lake was found to be more permeable than the general bulk (unstructured) rock mass for depths greater than 15 m. This is likely due to the influence of the Spanish American Fault in this area.

The structured bedrock associated with the Spanish American Fault and major diabase dykes in the area was found to be more permeable in the upper 30 m, with typical values in the 1 x 10^{-6} to 1 x 10^{-5} m/s range. Hydraulic conductivity appears to decrease below 30 m and tends to be of the same order as the unstructured bedrock (1 x 10^{-7} m/s).

5.6 Water Quality

As part of the closure decommissioning process, surface water, pore water and groundwater within the Denison TMA are monitored under the TOMP and SAMP programs as described in Appendix A. Data from these stations are presented in the 2010-2014 SRW Cycle 4 State of the Environment report as well as annually in the Rio Algom Limited Annual Operational Care and Maintenance Report.

5.7 MECP Water Well Information System

Golder queried the MECP water well information system for data for known wells located within a 1 km radius of the TMA. No data was found.

5.8 Dams

The table below provides a summary of dams and related structures or facilities at the Denison TMAs, shown on Figure 5.4.

Dam ID, Purpose	Foundation Conditions	Gradient, Vector	No. of Associated Water Level Monitoring Points
Dam 1, tailings and water retention	Founded on prepared bedrock with Hypalon membrane as seepage barrier. zoned earth fill embankments with compacted glacial till cores as the seepage barrier	An outward hydraulic gradient exists indicating that the groundwater flows northward through the bedrock and under Dam 1 and will end up discharging within the downstream valley at the treatment plant and ultimately to the Serpent River via the settling pond.	2

Dam ID, Purpose	Foundation Conditions	Gradient, Vector	No. of Associated Water Level Monitoring Points
TMA 2 Outlet Berm, water control	Zoned earthfill embankment with compacted glacial till core.	Not known.	1
Dam 9, tailings and water retention	Zoned earthfill embankment with compacted glacial till core.	Groundwater seepage is inwards towards the main basin (TMA-1) along the southern perimeter between Dam 16 and Dam 17 and along the northern perimeter between Dam 18 and Dam 9.	1
Dam 17, tailings and water retention	Zoned earthfill embankment with compacted glacial till core.		5
Dam 16, tailings and water retention	Zoned earthfill embankment with compacted glacial till core.		0
Dam 10, tailings and water retention	Founded on glacial till with Hypalon membrane as seepage barrier.	Strong downward hydraulic gradients exist at Dam 10. Little Cinder Lake is now used to create a gradient to direct seepage from the toe of Dam 10 toward the Stollery Lake Settling Pond.	2
Dyke 8, freshwater separation and settling pond retention	Zoned earthfill embankment with compacted glacial till core.	About 2 m across dyke.	1
Dam 18, tailings and water retention	Zoned earthfill embankment with compacted glacial till core.	Groundwater seepage is inwards towards the main basin (TMA-1) along the southern perimeter between Dam 16 and Dam 17 and along the northern perimeter between Dam 18 and Dam 9.	1

5.9 Conceptual Hydrogeological Model

A CHM was developed for the Denison TMAs in Golder 1992a and is inferred to be representative of current conditions. Based on bedrock water levels and observed springs, the CHM indicates that in general, groundwater seepage is inwards towards the main basin (TMA-1) along the southern perimeter between Dam 16 and Dam 17 and along the northern perimeter between Dam 18 and Dam 9. Elsewhere, seepage is interpreted to be outwards from TMA-1 with most seepage occurring beneath Dam 10 to Stollery Lake Settling Pond and beneath Dam 17 to Quirke Lake. At TMA-2, most seepage is interpreted to occur through the south ridge towards TMA-1 with only minor amounts of seepage moving through the southeast ridge to Quirke Lake and the west ridge to the Serpent River. The inferred flow of groundwater is shown on Figure 5.4.

Improvements have been made to the Denison TMA since 1992 that may have affected groundwater flow conditions including dredging and relocating tailings into deeper water on the west side of TMA-1 and relocating tailings from TMA-2 to TMA-1 to reduce basin size of TMA-2 (1992 through 1996).

In 1996, upgrades were made to Dam 10 including construction of stability and reduction berms to improve interception of tailings pore water and reduce groundwater contamination (1996).

Additional spillways, upgrades to existing spillways, and new effluent collection ditches were also constructed between 1992 and 2014.

5.9.1 TMA-1

Groundwater recharges or flows into TMA-1 along the southern perimeter ridge between Dam 16 and 17. Inward flow also occurs from the ridges between Dam 9 and Dam 18 along the north side of the basin.

Tailings-derived groundwater discharges from the basin at both the eastern and western ends of the basin. At the east end, discharge apparently occurs beneath Dam 9 and Dam 17 and through the bedrock ridge between the two dams, based on an observed seepage discharge below Dam 17 and the groundwater levels beneath the ridge. Discharge from this area would report directly to Quirke Lake as either surface runoff or as bedrock seepage.

Groundwater discharge from the basin also apparently occurs from Dam 16, westward to Dam 10 over to the Dam 18 area. Discharge beneath Dam 16 and the prominent bedrock ridge between Dam 16 and Dam 10 would report to the Cinder Lake to drain to the Serpent river, However, there is no direct indication of any significant seepage through this area.

Seepage passing through the bedrock ridge between Dam 10 and Dam 18 and the foundation beneath Dam 18 discharges to the Stollery Lake Settling Pond, as indicated by groundwater levels. There were no obvious indications of seepage beneath this area.

Significant amounts of seepage discharge occur at Dam 10, which is consistent with the design of the structure. Seepage migrates from the tailings basin through the permeable soils beneath the Dam 10 foundation and is collected in the southern and northern toe drain systems. The southern toe drain also collects seepage from Little Cinder Lake which acts as a positive hydraulic head barrier preventing westward migration of tailings water. The seepage from both the southern and northern drains discharges into the Stollery Lake Settling Pond.

5.9.2 TMA-2

TMA-2 is recharged from the surrounding bedrock ridges based on the groundwater levels monitored during the Golder investigation in 1991. There are also potential seepage discharge pathways from this area. The most significant of the pathways is seepage that occurs beneath Dam 1. This seepage represents the controlled dam drain discharge system, bedrock seepage beneath the dam, and seepage potentially beneath the low bedrock ridge beneath the basin. Any seepage passing beneath this area reports to the Williams Lake treatment plant and ultimately discharges to the Serpent River via the settling pond.

The other potential seepage discharge pathway from TMA-2 is south eastward from the Smith Lake area through the bedrock ridge where discharge could potentially occur in the valley below Dam 9. Seepage could also potentially occur along the northern branch of the Spanish-American Fault which passes beneath this area. Any seepage discharging through this area and through the southeastern area would report directly to Quirke Lake. However, no obvious indications of seepage, such as springs, were noted in the potential discharge at the base of this ridge during the field mapping exercise.

6.0 PANEL TMA

6.1 Background

The Panel TMA is a decommissioned uranium mine tailings management area located about 16 km northeast of the City of Elliot Lake and immediately north of Quirke Lake (Figure 6.1). The TMA is comprised of two separate bedrock rimmed basins, the Main Basin and the South Basin. The two basins contain about 16 million tonnes of tailings and waste rock that were produced during two operating periods from 1958 to 1961 and again from 1979 to closure in 1991 (Minnow 2017).

The Main Basin has a total area of about 84 hectares and drains into the Southern Basin via a spillway. The Main Basin is contained by a bedrock rim along with four engineered low-permeability dams (Dams B, D, E and H). The South Basin is about 39 ha and is contained by two-low permeability dams (Dams A and F) (Minnow 2017).

A separate smaller basin is located to the east of the Main and South Basins called “Pond C”. This basin contains historical tailings and treatment solids. The “Pond C Berm” was constructed in 1999 on the east end of the basin, allowing the basin to be flooded with a minimum of 1.5 m water cover to inhibit oxidation of tailings. In 2008 the Pond C Berm was upgraded and a new overflow spillway was constructed in bedrock to increase flood conveyance capacity of Pond C (Minnow 2017).

6.2 Site Setting

6.2.1 Topography

The Panel TMA is set in undulating igneous bedrock topography with thin patchy overburden deposits. In topographic lows, there are some occurrences of overburden thickness in excess of 12 m. Enclosed depressions in the rock surface of any appreciable size contain small lakes, ponds or swamps with associated build-ups of organic material (Golder 1991b). The TMA features two separate bedrock rimmed basins, the Main Basin and the South Basin, which are separated by bedrock hills and connected via a spillway.

6.2.2 Drainage

The Main Basin of the Panel TMA (formerly Strike Lake) receives runoff from the surrounding hills and bedrock rim and subsequently discharges into the South Basin via a spillway. The two basins are separated by hilly terrain. The South Basin also receives runoff from adjacent hills and its bedrock rim. Excess water that accumulates in the South Basin flows south through an ETP prior to discharging into two lined settling ponds, which subsequently discharge to Quirke Lake.

In 1978, the construction of Dam K, Berms W1, W2, W3 and Channel Y diverted runoff from a 125-ha watershed around the northern perimeter of the Main Basin to the Rochester Creek drainage area downstream of Dam E. Channel Z, which is located to the west of the Main Basin, diverted runoff from a 31-

ha area southward towards Quirke Lake; this configuration substantially reduced the water treatment requirements during the operational period and is the configuration that remains in place.

6.2.3 Regional Geology

Regional geology at the Panel TMA is similar to that described in previous regional geology sections in this report and is characteristic of the Canadian Shield.

The surficial deposits (where present) and bedrock geology in the vicinity of the Panel TMA study area are shown on Figure 6.2. Overburden is largely restricted to topographic lows and, except for recent bog or swamp deposits, consists predominantly of fluvial or outwash silty sands and gravels or glacial outwash origin. Local deposits of essentially cohesionless silty to sandy till also occur in topographic lows or plastered on the flanks of bedrock highs. The permeability of the till is typically between 10^{-8} and 10^{-7} m/s. Details of the surficial and bedrock geology are discussed in the following sections.

6.2.4 Panel TMA Geology

The Panel TMA is set on undulating igneous bedrock topography with thin patchy overburden deposits except locally in topographic lows where overburden thicknesses in excess of 12 m occasionally occur. Enclosed depressions in the rock surface of any appreciable size contain small lakes, ponds or swamps with associated build-ups of organic detritus. Golder 1991b compiled geological information at the Panel TMA from borehole logs included in previous investigations of the dams and settling ponds; this information is summarized below.

6.2.4.1 Overburden

Available overburden mapping is shown on Figure 6.2 and indicates that the Site is dominated by bedrock outcropping and limited natural overburden has been mapped in the area.

Dam A

At Dam A, the bedrock is relatively close to the ground surface, being deepest at the location of the original watercourse. The overburden consisted of about 4 ft. (1.2 m) of very loose silt and tailings overlying about 1.2 m of cobbles and boulders mixed with peat and other organic material.

Dam B

Overburden depths of 0.6 to 1.2 m were encountered along the valley flanks and consisted of silty sand. The overburden within the valley was 9.8 to 13.7 m thick and consisted of compact sandy silt varying to sand with some silt, overlying dense to very dense sand and gravel, and gravelly sand.

Dam D

The overburden at Dam D varied from 1.2 m of tailings overlying 1.2 m of silt and a further 2.7 m of mixture of boulders and peat, to 2.1 m of tailings overlying about 0.6 m of sand and gravel.

Dam E

No significant depths of overburden were encountered over most of this dam site. Up to 6 m of grey sandy silt to silty sand were excavated from local topographic lows during dam construction in 1988.

Settling Ponds

Samples taken from hand-augured boreholes in the vicinity of the settling ponds showed overburden thicknesses from 0.6 to 4.4 m of black fibrous peat with occasional wood, overlying discontinuous thin grey silty sand deposits.

6.2.4.2 Bedrock

The area surrounding the Main Basin is underlain by granites and diorites. The granites are generally massive, reddish and vary in composition between granodiorites, granites and quartz monzonites. The diorites are massive, medium to dark greyish green and vary in composition form quartz diabase to gabbro. The rocks are predominately medium to coarse-grained with occasional porphyritic zones observed containing phenocrysts up to 35 mm long. The only other rock types in the area are diabase dykes which are generally massive, weakly foliated and greenish grey to black in colour. These dykes are generally uniform in thickness and rectilinear in trend, some being traceable for great distances.

There are two major faults running through the Main Basin. The largest and most significant (Fault A) strikes west-northwest to east-southeast and is an extension of the Nook Lake Fault. Joint Pole concentrations for the areas adjacent to the fault suggest it is vertical. To the east, the fault lies between the main basin and the south basin. Dykes are located within the fault structure on both sides of the Main Basin. The second Fault (Fault B) strikes in a northeast-southwest manner and associated joint mapping suggests a steep dip if 60 to 70 degrees towards the northwest. It is located along the northwest shore on the Main Basin and it passes under the western end of Dam E (Golder 1991b).

6.3 Hydrogeology

Golder 1991b indicates that tailings-impacted groundwater likely seeps from the northeastern and southeastern side of the Main Basin and from the vicinity of Dam A in the South Basin. The seepage is travelling in an easterly direction and is being diluted by infiltration and mixing from resident groundwater.

6.4 Water Elevations and Gradients

According to Figure 2 in Golder 1991b, the elevation of surface water in the South Basin is about 10 m lower than surface water in the Main Basin. Surface water elevations appear to decrease southward toward Quirke Lake, where the surface water elevation appears to be about 45 m lower, depending on location within Quirke Lake. In Pond C to the east of the two basins at Panel (shown on Figure 6.4), surface water levels are about 10 m lower than the South Basin. This gradient indicates that water flows to the east locally, but southward toward Quirke Lake regionally. Recent groundwater levels collected at the Panel TMA TOMP locations between 2010 and 2019 confirm historical levels.

6.5 Hydraulic Conductivity

6.5.1 Overburden

During the 1977 to 1999 site investigations, which are reported in Golder 1991b, values of overburden hydraulic conductivity were obtained by means of falling head tests carried out in the boreholes at Dam D and Dam B. Test results varied from 10^{-6} to 10^{-5} m/s. A total of 84 hydraulic conductivity tests were conducted during the dam investigations (Golder 1991b).

6.5.2 Bedrock

The unfractured granitic bedrock is intrinsically impermeable (i.e., hydraulic conductivity is less than 1×10^{-12} m/s). Groundwater flow is therefore largely controlled by fractures in the bedrock. Golder 1991b shows results of the permeability testing carried out during site investigations at dam sites B, D and E. The original basin design average permeability of 1×10^{-7} m/s was generally reached at a depth of about 18 m based on the results obtained from boreholes in the vicinity of Dam E. Below 9 m, the rock permeability was about 1×10^{-6} m/s. Permeabilities as high as 7×10^{-5} m/s were found in the upper 6 m of the bedrock. Generally, the higher permeabilities were associated with specific macroscopic structures such as fault zones and locally heavily fractured areas.

6.6 Water Quality

As part of the closure decommissioning process, surface water and groundwater within the Panel TMA are monitored under the TOMP and SAMP programs as described in Appendix A. Data from these stations are presented in the 2010-2014 SRW Cycle 4 State of the Environment report as well as annually in the Rio Algom Limited Annual Operational Care and Maintenance Report.

6.7 MECP Water Well Information System

Golder queried the MECP water well information system for data for known wells located within a 1 km radius of the TMA. No data was found.

6.8 Dams

The table below provides a summary of dams and related structures or facilities at the Panel TMA, shown on Figure 6.4.

Dam ID, Purpose	Foundation Conditions	Gradient, Vector	No. of Associated Water Level Monitoring Points
Dam B, tailings and water retention	Founded on dense till overlying bedrock. Grout curtain present.	About 8 m difference in head upstream to downstream (across dam, eastward).	10
Dam D, tailings and water retention	Founded entirely on bedrock. Pressure grouting was completed along the anchor beam and concrete cut-off wall.	About 8.0 m difference in head upstream to downstream (across dam, southward).	8
Dam E, tailings and water retention	Till core founded on prepared bedrock. Dam shell founded on native competent soil or bedrock. Grout curtain present.	About 3.0 m difference in head upstream to downstream (across dam, northward).	10
Dam H, tailings and water retention	Till core founded on prepared bedrock. Dam shell founded on native competent soil or bedrock. Bedrock surface grouted.	About 3.0 m difference in head upstream to downstream (across dam, northward).	2
Dam A, tailings and water retention	Concrete core wall founded on prepared bedrock. Bedrock pressure grouted at concrete wall. Dam embankment founded on bedrock.	About 6.0 m difference in head upstream to downstream (across dam, northeastward).	4
Dam F, tailings and water retention	Concrete core wall founded on prepared bedrock. Bedrock pressure grouted at concrete wall. Dam embankment founded on bedrock.	About 3.5 m difference in head upstream to downstream (across dam, southeastward).	4

Dam ID, Purpose	Foundation Conditions	Gradient, Vector	No. of Associated Water Level Monitoring Points
Pond C Berm, tailings and water retention	Not available. Assumed bedrock surface.	About 3 m based on ground surface levels downstream adjacent to the Dam.	0
Dam K, Berm W1, Berm W2 / W3, freshwater diversion	Glacial till core. Dam founded on prepared bedrock.	About 1 to 4 m on berms. Dam K and Berms W1, W2 and W3 act to divert water within the sub-watershed area (including Frayn Lake) of about 125 ha eastward around the Main Basin towards Rochester Creek.	0

6.9 Conceptual Hydrogeological Model

A four-layer model was presented in Golder 1991b to assess groundwater flow conditions. The relative layer thicknesses (not to scale) and their assigned permeabilities are displayed on Figure 6.5.

A decommissioned scenario was presented as part of model results. Between Dam B and the intersection of Fault B with the northern shore of the Main Basin, the outflow is estimated at 3.68 L/s. Along the southern shore of the Main Basin seepage is predicted from Dam B to a point about 425 m west of Dam D. The total seepage indicated over this area from the original model results is estimated at about 1.9 L/s of which the majority is interpreted to makes its way directly into the South Basin. The only other inferred seepage outflow is in the vicinity of Dam A in the South Basin where about 0.4 L/s is inferred to flow towards the east. An estimated total seepage rate of 4.5 L/s is predicted to occur to the east towards Pond C. Water quality of this potential seepage is monitored at P-20.

Pond C surface water is discharged eastward to the adjacent lake through an overflow spillway constructed on the Pond C Berm.

Improvements to Panel features and infrastructure have been made since development of the original CHM. These include:

- Dam H constructed, Dam D decant sealed and Main Basin Spillway cut through bedrock to submerge Main Basin tailings with minimum 1.5 m water cover in 1992. This upgrade improves flood conveyance capacity and inhibits oxidation of tailings.
- Construction of Dam F overflow spillway in the South Basin and Pond C berm. Historic Pond C Tailings submerged with minimum 1.5 m water coverage in 1999 to inhibit oxidation of tailings.
- Frost protection added to the crest of Dams B, C, and E to improve long term stability of low permeability till core of the dams.

- The Pond C berm was raised with overflow spillway constructed in bedrock in 2008 to increase flood conveyance capacity of Pond C.

These measures were largely designed to maintain water cover over the tailings to result in improved water quality. These measures are not interpreted to have materially changed the CHM described above.

7.0 STANLEIGH TMA

7.1 Background

The Stanleigh TMA is a decommissioned uranium mine tailings management area located about 5 km northeast of the City of Elliot Lake (Figure 7.1). The TMA is owned and managed by RAL. Stanleigh TMA contains 20 million tonnes of tailings from both the Milliken and Stanleigh mines and mills (Minnow 2017).

The Stanleigh TMA basin (originally Crotch Lake basin) is bounded by prominent bedrock ridges which form the perimeter of the basin. The rock ridge crest elevations generally range from 378 to 396 m, which is about 11 to 29 m above the flooded post closure condition in the east arm of the basin (Golder 1996).

The Stanleigh Mine TMA was developed in two phases. During the initial phase of operation between 1956 to 1964, about 7.4 million tonnes of tailings from the Stanleigh and Milliken Mines were deposited in the southern portion TMA (west arm of the basin). A lime and barium chloride treatment plant was constructed in the mid-1960's at the outlet of the west arm with treatment solids settling in what is now the South Arm with treated effluent discharged to McCabe Lake through a concrete structure upstream of the current Dam B (Minnow 2017).

The Stanleigh Mine and Mill facilities were reactivated during the second phase of operation beginning in 1983, with a design production capacity of 4,500 tonnes of ore per day (Golder 1996). As part of the Stanleigh mill reactivation, 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 (Minnow 2017). Five low-permeability engineered structures were constructed at bedrock lows around the basin to form the 370-ha TMA (Minnow 2017). 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 (Minnow 2017).

7.1.1 Milliken TMA

Associated with the Stanleigh TMA is the Milliken TMA, which 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. It is also downstream of Dam A at the Stanleigh TMA.

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 and fines were released and spread downstream from the mill and were deposited in the Sheriff Creek Valley. The tailings were deposited to a thickness of 0.6 m to 1.0 m and formed an exposed tailings beach. Rehabilitation of the 23 ha area included:

- Diversion of Stanleigh Dam A TMA seepage from Sheriff Lake;
- Draining and capping of coarse tailings; and
- Flooding of western area.

In the late 1970's Sheriff Creek was diverted away from Sheriff Lake with the construction of a diversion ditch and homogeneous earthfill berm (Sheriff Lake Berm) at the north end of the lake. Presently the creek is routed westward through a ditch and connects with the original creek downstream of Sheriff Lake. The water level of Sheriff Lake is maintained at an elevation above the diversion creek by an engineered concrete dam and spillway at the lake outlet. The existing dam was constructed in 1983 downstream of an old concrete dam at the same location (Sheriff Lake Dam).

Prior to 1964, Sheriff Creek downstream of the Milliken Mine Road was re-routed to the northeast to reduce contact between the water in Sheriff Creek and the coarser component of the spilled tailings. In 1978, some of the coarser tailings were covered with approximately 1 m of clean fill.

The remaining downstream area has been developed into a wetland habitat. In 1996 the beaver dam at the outlet of the wetlands was reinforced (Sheriff Creek Berm) to ensure that the tailings are maintained in a saturated condition, with the eastern portion of the historical tailings being kept flooded. In 2004, the berm crest was raised and a permanent emergency spillway added for enhanced protection against overtopping.

There is no ETP at the Milliken TMA. Drainage from the watershed passes through the Sherriff Creek Park Berm spillway to Elliot Lake.

7.2 Site Setting

7.2.1 Topography

The Stanleigh TMA basin is bounded by prominent bedrock ridges. The rock ridge crest elevations generally range from 378 to 396 m, which is about 21 to 40 m above the existing level in the east arm of the basin (Golder 1996). The area is dominated by large areas of exposed bedrock with a thin, discontinuous cover of surficial deposits. The surficial deposits consist of a thin discontinuous veneer of glacial deposits which thicken locally within the bedrock valleys.

7.2.2 Drainage

The watershed boundary of the Stanleigh Mine TMA coincides with the rock ridges surrounding the TMA basin. Surface water drainage flows from the TMA towards McCabe Lake watershed, which is situated downslope to the east of the TMA (Golder 1996).

The drainage from much of the area to the north of the TMA has been diverted southwestward or east by a series of diversion dams outside of the watershed which were constructed in the 1980’s. The drainage diversion dams effectively reduced the TMA watershed from 22 km^2 to 13.32 km^2 (Minnow 2017). Dams 9 and 10 divert flow from Lake D and Lake E east towards Popeye Lake. Dams R3 and R5 divert flow from Lake 5 and Lake 5 south-westward towards Strouth Lake.

There were originally two areas of surface water outflow from the drainage basin, situated along bedrock valleys located in the southwestern and southeastern areas of the original Crotch Lake. Surface water outflow from the basin at these locations has been cut off by the existing Dams A and B (see Figure 7.1 for dam locations).

Surface water overflow from the tailings basin currently is being conveyed to the ETP via a syphon pipeline over Dam B which then discharges into the settling pond before being discharged as final effluent to McCabe Lake.

7.2.3 Regional Geology

Regional geology in the Stanleigh and Milliken TMA areas is similar to that described in previous regional geology sections in this report and is characteristic of the Canadian Shield.

The surficial deposits (where present) and bedrock geology in the vicinity of the Stanleigh TMA study area are shown on Figure 7.2. Overburden is largely restricted to topographic lows and, except for recent bog or swamp deposits, consists predominantly of fluvial or outwash silty sands and gravels or glacial outwash origin. Local deposits of essentially cohesionless silty to sandy till also occur in topographic lows or plastered on the flanks of bedrock highs. The permeability of the till is typically between 10^{-8} and 10^{-7} m/s. Details of the surficial and bedrock geology are discussed in the following sections.

7.2.4 Stanleigh TMA Geology

The Stanleigh TMA area is dominated by large areas of exposed bedrock with a thin, discontinuous cover of surficial deposits. The bedrock consists of Precambrian age metasedimentary bedrock of the Mississagi, Bruce, Espanola, Serpent, and Gowganda Formations, which have locally been intruded by Nipissing Diabase.

Bedrock in the area is intersected by a series of dominant northwest-southeast trending and smaller scale west-east trending faults associated with diabase intrusions. The locations of the structural features (faults and dykes) in the TMA basin area, based on previous mapping of bedrock exposures, are shown on Figure 7.2. The Pecors Lake Fault is the dominant fault in the mine area. This fault trends northwest-southeast through the eastern flank of the basin and passes through McCabe Lake. Two additional northwest-southeast trending faults pass through the west arm of the TMA. One of these faults extends along the bedrock valley in the Dam A area, while the other passes through the bedrock ridge along the southern perimeter of the basin (Golder 1996).

7.2.4.1 Surficial Geology

The surficial deposits at the Stanleigh TMA consist of a thin discontinuous veneer of glacial deposits which thicken locally within the bedrock valleys. The glacial deposits are typified by silty and sandy tills and by ice-contact and outwash sand and gravel deposits. The tills generally occur as blankets over the bedrock, being thickest on the sides of valleys and in some of the valley depressions. The sand and gravel deposits tend to occur on the margins of the till areas as terraces or as valley infill material. Three principal types of deposits occur in the mine area, including bedrock mantle deposits, valley deposits and lake bottom deposits (Golder 1996).

7.3 Hydrogeology

Golder (1996) designed a three-dimensional numerical groundwater flow model that simulated equipotential contours, and areas of outward seepage for the TMA basin. The model results indicated an inward direction of groundwater flow toward the TMA from the surrounding rock rim, except for the valleys occupied by Dams A and B, where there is outward seepage flow from the TMA. At Dam A, the numerical model shows the seepage through the dam and underlying bedrock to be estimated at about 4 L/min, and which discharges to the Sheriff Lake watershed. At Dam B, the seepage through the dam and underlying bedrock, shown by the model to be about 5 L/min, flows directly to the Settling Pond and McCabe Lake watershed (Golder 1996).

Post-closure conditions of the TMA predicted by the model indicate there will be outward seepage of tailings impacted groundwater through tailings dams (Dam A, Dam A1, Dam B, and Dam C) and underlying bedrock, and the bedrock ridge forming the southern rim of the TMA. This seepage will discharge to surface water courses (lakes and creeks) in the Sheriff and McCabe lake watersheds. The model results indicated inward flow conditions will persist in the remaining area of the basin, with relatively weak inward hydraulic gradients directly beneath the Dam E area. The predicted seepage to the Sheriff Lake watershed was estimated to be 130 L/min, with 17 L/min of seepage through Dams A and A1, and with 113 L/min predicted to flow through bedrock ridge along the southern rim of the TMA. The total predicted seepage from the TMA to the McCabe Lake watershed was estimated to be 153 L/min. An estimated 23 L/min and 36L/min was predicted at Dams B and C, most of which migrates through the shallow bedrock beneath the dams, and an estimated 94 L/min predicted through the bedrock rim between the TMA and McCabe Lake, which will discharge to surface water courses within the McCabe Lake watershed. The bedrock ridges along the southern rim of the TMA represent the major pathways for seepage of tailings impacted groundwater, accounting for a total of 207 L/min of the total flux of 283 L/min to the Sheriff Lake and McCabe Lake watersheds (Golder 1996).

7.4 Water Elevations and Gradients

The regional groundwater flow pattern in the vicinity of Stanleigh TMA is controlled principally by the topography of the area and by the existing geological structures. The active groundwater flow is generally restricted to the overburden and the fractured and weathered shallow bedrock and is in an easterly direction in the vicinity of the Stanleigh TMA toward McCabe Lake (Figure 7.4). Recent groundwater levels collected at the Stanleigh TMA TOMP locations between 2010 and 2019 confirmed historical levels.

7.5 Hydraulic Conductivity

The hydraulic conductivity of the bedrock in the Stanleigh TMA was assessed based on packer testing results carried out during a hydrogeological assessment as part of the Stanleigh Mine Rehabilitation study carried out in 1978 and 1980 as well as subsequent geotechnical investigations associated with design and construction of the tailings dams. The bulk hydraulic conductivity of the bedrock interval ranges between 1 x 10^{-7} m/s and 4 x 10^{-7} m/s, with an average value of 2 x 10^{-7} m/s over the 106 m depth range (Golder 1996).

The packer testing was carried out in boreholes located in the fault-controlled valleys in the tailings dam areas or the Pecors Lake fault zone and were intentionally targeted to intersect subsurface structures (e.g., faults, dykes etc.). Accordingly, the packer test results reflect the upper range of bedrock hydraulic conductivity associated with structured bedrock within fault-controlled valleys. These results are not considered to be representative of the bulk hydraulic conductivity of the unstructured ridges forming the rim of the Stanleigh TMA, and as such are considered conservative. There are no existing packer test results for bedrock ridges surrounding the TMA, including the areas between the TMA and Sheriff and McCabe Lakes (Golder 1996).

A two-dimensional representation of the CHM was created using hydraulic conductivity values reported from the hydraulic testing results. The summary of hydraulic conductivities assigned to model layers are as follows:

- Tailings: 1 x 10^{-6} m/s
- Dams: 1 x 10^{-8} m/s
- Lake bottom sediments: 1 x10^{-8} m/s
- Bedrock (0 to 50 ft.): 2 x 10^{-7} m/s
- Grout Curtains (0 to 50 ft.): 1 x 10^{-7} m/s
- Bedrock (50 to 100 ft.): 2 x 10^{-7} m/s
- Bedrock (100 to 150 ft.): 2 x 10^{-7} m/s
- Bedrock (150 to 200 ft.): 1 x 10^{-7} m/s
- Bedrock (200 to 300 ft.): 3 x 10^{-7} m/s
- Bedrock (300 to 400 ft.): 2 x 10^{-7} m/s
- Pecors Lake Fault (0 to 400 ft.): 5 x 10^{-6} m/s
- Other Faults (0 to 400 ft.): 1 x 10^{-6} m/s

7.6 Water Quality

As part of the closure decommissioning process, surface water and groundwater within the Stanleigh TMA are monitored under the TOMP and SAMP programs as described in Appendix A. Data from these stations are presented in the 2010-2014 SRW Cycle 4 State of the Environment report as well as annually in the Rio Algom Limited Annual Operational Care and Maintenance Report.

7.7 MECP Water Well Information System

Golder queried the MECP water well information system for data for known wells located within a 1 km radius of Stanleigh and Milliken TMA's. Data for five wells was retrieved within the 1 km radius of Milliken TMA.

For the five well records received from the MECP near the Milliken TMA, two records correspond to wells that are used for domestic purposes, one well record correspond to public purpose and one well that is used for monitoring purposes. The remaining record has no status or usage information listed. The three water supply wells are installed in the bedrock between 25 and 79 metres below ground surface.

7.8 Dams

The table below provides a summary of dams and related structures or facilities at the Stanleigh TMA, shown on Figure 7.4.

Dam ID, Purpose	Foundation Conditions	Gradient, Vector	No. of Associated Water Level Monitoring Points
Dam A, tailings and water retention	Glacial till core founded on prepared bedrock. Dam shell founded on native competent soil or bedrock. Grout curtain present.	About 10 m difference in head upstream to downstream (across dam, southeastward).	7
Dam A1, tailings, landfill and water retention	Glacial till core founded on prepared bedrock. Dam shell founded on native competent soil or bedrock. Dental concrete and cut-off trench present.	About 3.0 m difference in head upstream to downstream (across dam, southwestward).	2
Dam B, tailings and water retention	Glacial till core founded on prepared bedrock. Dam shell founded on native competent soil or bedrock. Grout curtain present.	About 5.0 m difference in head upstream to downstream (across dam, eastward).	15
Dam C, tailings and water retention	Glacial till core founded on prepared bedrock. Dam shell founded on native competent soil or	About 3.5 m difference in head upstream to downstream (across dam, southeastward).	15

Dam ID, Purpose	Foundation Conditions	Gradient, Vector	No. of Associated Water Level Monitoring Points
	bedrock. Grout curtain present.		
Dam E, tailings and water retention	Glacial till core founded on prepared bedrock. Dam shell founded on native competent soil or bedrock. Grout curtain present.	Not known. Homogeneous earthfill structure of ow permeability till with outer sand and gravel erosion protection. Acts as a frost protection cap over grouted bedrock.	0
Settling Pond Dam, treated water and treatment solids retention	Till core generally founded on bedrock except where keyed into native glacial till.	Not known.	1
Dam R3, freshwater diversion	Dam founded upon cleaned and filled bedrock. Dental concrete present.	Not known.	0
Dam R5, freshwater diversion	Dam founded upon cleaned and filled bedrock. Dental concrete present.	Not known.	0
Dam R8, water retention for mining impacted area	Not available.	Not known.	0
Dam 9, freshwater diversion	Dam founded upon cleaned and filled bedrock. Dental concrete present.	Not known.	0
Dam 10, freshwater diversion	Dam founded upon cleaned and filled bedrock. Dental concrete present.	Not known.	0

7.9 Conceptual Hydrogeological Model

The Stanleigh TMA basin is a topographic depression surrounded by a bedrock rim and limited areas of thin, discontinuous surficial deposits. The bedrock is recharged in upland areas of exposed or thinly covered bedrock, such as the ridges forming the rim of the basin and discharges to surface water courses or directly to the TMA. Local geological structures including faults, dykes and shear zones represent primary pathways for groundwater flow within the bedrock.

Under existing conditions, there is predominantly inward groundwater flow to the TMA from the surrounding bedrock ridges. There is outward seepage from the TMA at Dams A and B. At Dams A and B, outward seepage of tailings-impacted groundwater from the basin occurs both through the tailings dams and through the underlying bedrock to points of discharge downgradient from the dam locations. The seepage from Dam A discharges to the Sheriff Creek watershed, while the seepage in the Dam B area discharges to the McCabe Lake watershed. Water quality of this seepage is monitored through the groundwater sampling being undertaken at SGW3 and SGW5.

There is potential that additional outward seepage from the basin at these locations is occurring and that in some areas of low basin relief, existing inward gradients to the basin may be reversed due to increased water levels in the post-closure period.

There are three primary pathways identified by which tailings impacted groundwater could migrate from the TMA to surface water receptors:

1) seepage through tailings dams;
2) seepage through bedrock beneath tailings dams; and
3) seepage through the bedrock ridges forming the perimeter of the TMA.

A two-dimensional representation of the CHM developed to simulate the pathways of tailings impacted groundwater from the TMA is shown on Figure 7.5. The CHM includes six separate bedrock layers, but does not incorporate overburden deposits, since they do not represent a pathway for seepage of tailings-impacted groundwater out of the TMA.

Bedrock layers in the CHM were assigned hydraulic conductivity values corresponding the geometric mean of the packer test results, which as indicated above should be considered conservative as the packer tests were focused on areas with potential faults. In some cases, the hydraulic conductivity values were modified to reflect the test data at the dam location. Structural features (faults, dykes, shear zones etc.) were assigned hydraulic conductivity values one to two orders of magnitude higher than those of the surrounding rock mass.

The lake bottom sediments situated in bedrock depressions in the lake bottom do not extend upward along the flanks of the adjacent bedrock ridges forming the rim of the lake basin. Where present, these materials may serve to limit the rate of seepage from the tailings to the underlying bedrock beneath the TMA and accordingly have been incorporated in the model. The model also incorporates the various tailings dams around the basin including the grout curtains beneath each of the dams to simulate of seepage through these areas. The base of the model was established at an elevation of 122 m corresponding to a depth of about 213 m below the base of the original Crotch Lake, which is inferred to be well below the potential depth of migration of tailings-impacted groundwater from the TMA.

8.0 STANROCK TMA

8.1 Background

The Stanrock TMA is a decommissioned uranium mine tailings management area located approximately 12 km northeast of the City of Elliot Lake (Figure 8.1). The Stanrock TMA contains waste tailings from the Stanrock and Can-Met mines. The Stanrock mine and mill commenced production in March of 1958 with a design capacity of 2,995 tonnes per day. The Can-Met mine and mill commenced production in October of

1957, with a design capacity of 2,720 tonnes per day (Golder 1992). Tailings were discharged into the natural basin of a small lake located immediately south of the Stanrock Mine, which became the 52-hectare Stanrock TMA. Mining occurred until 1970, and then again from 1978 until 1983. About 5.7 million tonnes of tailings were produced and stored within the TMA over the course of mine operations (Minnow 2017).

A vegetative covering of the TMA was chosen over the alternative of flooding for the decommissioning purposes. The vegetative covering was put in place between 1998 and 1999 and covers the entire TMA except for a small head pond, resulting in a relatively small amount of surface water being present at the TMA.

The area around the tailings is dominated by relatively continuous exposed bedrock ridges and intervening areas of thin surficial deposits.

8.2 Site Setting

8.2.1 Topography

The Stanrock TMA lies in the centre of a rocky peninsula surrounded by Quirke Lake on three sides. Prior to development of the Stanrock TMA basin, the area consisted of low marshy areas bounded by several rock ridges. The basin area itself included a north valley containing several swamps, and the south valley, which contained a small lake now buried by tailings. The north and south valleys were partially separated by an east-west trending bedrock ridge, the high points of which occur as outcrops within the middle of the existing tailings basins. The lowest part of the basin was in the south valley prior to deposition.

The southern and northern perimeters of the TMA are formed by bedrock ridges. The gentle south-facing slopes of the ridges represent bedding planes with steep facing scarps.

With development of the basin, a large portion of both the south and north valleys has been filled with tailings. To contain these tailings, four dams were constructed using cyclone tailings, Dam A connects the south and north perimeter ridges while Dams B, C and D are saddle dams along the southwest ridge. The tailings surface slopes gently to the east in the direction of deposition at an average slope of about 1.6 % (Golder 1992b). Due to the existing topography, Dams F, G, J, K, L and M were also constructed to contain tailings and suitably divert surface water flow at the Stanrock Site. Figures 8.1 and 8.4 show existing infrastructure and the flow paths towards such features as Beaver Lake, the Treatment Plant, Moose Lake Settling Pond and further eastward to Orient Lake.

The existing Moose Lake basin is bounded by relatively low bedrock ridges that rise about 5 to 20 m above the lake surface. Moose Lake is about 21 m above the level of Quirke Lake to the north. The ridge separating Moose Lake from Quirke Lake is about 200 to 250 m in width and the low points in the ridge are about 4 to 6 m above the Moose Lake level (Golder 1992b).

8.2.2 Drainage

Under the original (pre-tailings) drainage pattern in the Stanrock TMA, swamps in the north valley drained east into the South Valley Lake, which in turn drained into Moose Lake. Beaver lake, located south of the basin area, drained into Quirke Lake from the west (Golder 1992b).

With the construction of the dams and filling of the basin, the drainage pattern has been altered. The drainage system has been developed to direct all flow from the Stanrock basin into the holding pond for treatment. Runoff and seepage from the vegetated Stanrock TMA are collected in a head pond located in the southeast corner of the TMA next to Dam A. Water then flows through a spillway which reports to a holding pond where the treatment plant is located. The treated water then reports to the Moose Lake settling ponds then downstream to the Orient Lake polishing pond for final settling before discharging through the final point of control. Seepage from Dams B and C flows to the Dam G seepage collection pond and seepage from Dam G reports to the Dam M seepage collection pond. Dam M water is then recirculated back to the Dam G seepage collection Pond. Beaver Lake water, which is a contaminated lake located upstream of Dam G, is also siphoned into the dam G seepage collection Pond. All the water collected in the Dam G seepage collection pond is then pumped to the TMA head pond.

Containment Dams A, B, C and D retain the solid tailings held in the TMA. These dams were originally constructed as pervious structures built with spigotted tailings that did not maintain the water table in the tailings mass but instead allowed seepage to flow out while retaining the tailings solids in the basin. (Golder 1992b). Upgrades at closure were incorporated to include implementation of a till core that acts to reduce seepage and increase the phreatic surface within the tailings.

8.2.3 Regional Geology

Regional geology in the Stanrock TMA area is similar to that described in previous regional geology sections in this report and is characteristic of the Canadian Shield.

The surficial deposits (where present) and bedrock geology in the vicinity of the Stanrock TMA study area are shown on Figure 8.2. Overburden is largely restricted to topographic lows and, except for recent bog or swamp deposits, consists predominantly of fluvial or outwash silty sands and gravels or glacial outwash origin. Local deposits of essentially cohesionless silty to sandy till also occur in topographic lows or plastered on the flanks of bedrock highs. The permeability of the till is typically between 10^{-8} and 10^{-7} m/s. Details of the surficial and bedrock geology are discussed in the following sections.

8.2.4 Stanrock TMA Geology

As per the Golder 1992b report the Stanrock Mine TMA is characterized by relatively few areas of discontinuous, glacially derived surficial deposits and large areas of exposed bedrock (Figure 8.2). The bedrock beneath the area is comprised of highly indurated, gently folded metasedimentary rocks of the Serpent and Gowganda Formation. The metasedimentary rocks are Precambrian (Aphebian) in age and comprise part of the Huronian strata of the Southern (Geological) Province which are preserved within the Quirke Syncline, a gentle, westerly plunging fold structure. The metasedimentary strata are in turn crosscut by Nipissing age diabase dykes and various generations of faults.

8.2.4.1 Surficial Geology

The surficial deposits underlying the Stanrock Mine have been subdivided into six groupings based on their expression and soil type as shown on Figure 8.2. These include a bedrock complex comprised of exposed bedrock deposits, areas of till veneer, till moraine, ice-contact sand and gravel deposits and areas of rock talus. Very little overburden is identified in the immediate vicinity of the TMA.

8.2.4.2 Bedrock Geology

The Stanrock Peninsula is largely underlain by Gowganda Formation conglomerates. The Gowganda Formation unconformably overlies the Serpent Formation quartzite, which outcrops below the Gowganda formation ridges along the northern and eastern edges of the peninsula. Both formations are largely comprised of highly indurated, siliceous sedimentary rock. Carbonates and siltstones of the Espanola formation outcrop along the shore of Quirke Lake at the extreme northern edge of the peninsula

Serpent Formation

The Serpent Formation is comprised almost entirely of light grey to white and locally greyish pink, fine to medium grained, medium to thickly bedded quartzite. The quartzite includes occasional pebble conglomerate beds and thin to medium interbeds of siltstone and minor mudstone. The formation varies from about 120 to 200 m in thickness based on a review of deep exploration drilling records for the area.

Most quartzite outcrops tend to be smooth-surfaced due to glacial erosion. Weathering of the quartzite appears to be limited to bedding planes or frost shattering at the bedrock surface. The frost shattering is largely controlled by joints and bedding planes producing very angular, sharp edges blocks, reflecting the very hard nature of the quartzite.

The Serpent-Gowganda contact is not clearly exposed within the Stanrock area but is anticipated to be quite like that encountered in the Popeye Lake area to the south. At Popeye Lake, the contact varied from a sharp contact that was open where weathered surface, to transitional, tight contact associated with argillites at the base of the Gowganda Formation (Golder 1992b).

Gowganda Formation

The entire Stanrock TMA is underlain by bedrock of the Gowganda Formation. Mapping of the formation within the Stanrock Peninsula area has indicated that it is comprised of the two basal stratigraphic members, Member 1 and 2, that correlate with the Denison TMA area to the northwest. The members include the basal conglomeratic greywacke of Member 1 and the overlying arkose and fluvial conglomerate of Member 2.

8.3 Hydrogeology

The interpretation of the physical hydrogeology beneath the Stanrock Mine TMA is largely based on the results of the drilling program reported on by Golder (1992b). Borehole locations are shown on Figure 8.1. Hydrogeological trends were identified based on the results of rock coring, *in situ* hydraulic conductivity testing and water level monitoring from the various boreholes drilled in the area along with taking into account the centrally located, perched position of the tailings basin within the Stanrock Peninsula (Golder 1992b).

8.4 Water Elevations and Gradients

Groundwater levels in the Stanrock TMA taken from Golder (1992b) reflect the underlying hydraulic gradients and hence directions of groundwater flow. The groundwater levels beneath the TMA relative to the ground surface, tailings levels and surface water bodies are shown in the cross-section on Figure 8.5.

8.4.1 Tailings Pore Water Levels

The water table within the Stanrock tailings occurs relatively close to the tailings surface (prior to vegetation covering). The various piezometer installations throughout the area indicate that within the northern and central portions of the tailings, the water table occurs at between 0 and 1.5 m below surface, and generally follows the slope of the tailings surface from the northwest to the southeast (Golder 1992b).

8.4.2 Bedrock Groundwater Levels

Bedrock groundwater levels were determined within the north ridge of the tailings basin at BH91-S1 and BH91-S2. Static groundwater levels at BH91-S1 were found to occur at or slightly above the level of Nelson Lake to the north while they are some 3 to 6 m above the tailings pore water levels to the south. Therefore, the groundwater levels beneath the central portion of the north ridge appear to represent a groundwater mound or divide relative to the TMA. It is inferred that an inward hydraulic gradient to the TMA exists in bedrock.

Borehole BH91-S2 was drilled further east along the northern ridge, into a diabase dyke that cuts across the ridge. The groundwater levels encountered in this borehole indicate the occurrence of a downward hydraulic gradient.

Borehole BH91-SG2 was drilled into the bedrock beneath the original lake that occupied the southern half of the TMA. The bedrock water level is at an elevation of about 4 m below the tailings pore water level indicating the presence of downward hydraulic gradient from the tailings into the bedrock beneath this area (Golder 1992b). Between 2014 and 2018, ground water levels were recorded during the annual sampling events shown in the table below. Ground water elevations for BH91-SG2A (depth of 33.1 m) ranged between 400.41

m and 401.22 m and ranged between 404.29 and 404.57 for the shallower BH91-SG2D (depth of 4.39 m). Groundwater flow directions are shown on Figure 8.4.

Groundwater elevations taken at the Dam D bedrock ridge overlooking Beaver Lake indicate an outward hydraulic gradient in the tailings through the Dam D ridge to Beaver Lake. It is expected that an outward flow (seepage) would flow from Dam A with much of this flow being captured downgradient at the Treatment Plant but with some component discharging directly to Quirke Lake. Water levels in the Spanish-American Fault (BH91-S3) were found to be at or slightly below ground surface during the latter half of the 1991. The levels are consistent with the occurrence of the fault zone within the low, wet area along the Orient Lake.

8.5 Hydraulic Conductivity

As outlined in the Golder 1992b report the 1991 drilling program hydraulic conductivity readings were assessed for the tailings, overburden and bedrock beneath the Stanrock TMA.

8.5.1 Tailings

The hydraulic conductivity of the Stanrock tailings is divided into two areas based on grain size analysis of samples collected during the 1991 investigation and on published data. A value of 5×10^{-6} m/s was estimated for the northwestern half of the basin, while for the southeastern half of the basin, a value of 1×10^{-6} m/s was estimated. This reflects the pattern of tailings deposition within the basin from the northwest side, flowing to the southeast towards Dam A with the coarser fraction settling out first resulting in higher hydraulic conductivity values in the northwestern half of the basin.

The dams which contain the Stanrock Mine TMA were constructed of cyclone tailings which are generally comprised of the coarser sand fraction of the total tailings. Therefore, a value of 1×10^{-6} m/s was estimated for the hydraulic conductivity of the dams.

8.5.2 Overburden

Within the Stanrock Mine TMA, no significant overburden deposits (other than tailings), which could influence the hydraulic conductivity containment of the basin, were identified. The Moose Lake area is generally surrounded by bedrock ridges covered with a thin veneer of glacial till, generally less than 5 m thick. The outlet of the lake has been cut off by Dam F which contains a Hypalon membrane as a seepage barrier. Near this outlet area, a northward trending valley, filled with large boulders and glacial till deposits, was identified during field mapping. Those overburden deposits are likely to be permeable.

8.5.3 Bedrock

The bedrock beneath the Stanrock Mine TMA is highly indurated, and the hydraulic conductivity is primarily associated with secondary features such as fracturing and faulting. The results from the 1991 investigation include a general indication of the hydraulic conductivity of the rock mass beneath specific areas and include 61 *in situ* hydraulic conductivity tests.

Hydraulic conductivity testing below the bedrock surface were plotted in five separate groupings including; all Stanrock boreholes, the shallow geotechnical boreholes, the bedrock ridge (BH91-S1), the diabase dyke (BH91-S2) and the Spanish American Fault (BH91-S3).

BH91-S1 was drilled through the bedrock ridge forming the north side of the TMA. It indicates a pronounced decrease in hydraulic conductivity between 15 and 30 m below rock surface. This low hydraulic conductivity zone (1.5×10^{-8} m/s) corresponds with the massive conglomeratic greywacke sequence encountered in the borehole. The hydraulic conductivity increases to about 3×10^{-7} m/s, below a depth 38 m. This increase corresponds to with the transition from massive conglomeratic greywacke to a more bedded sequence. The results indicate that the bedded sequences are more permeable, likely due to bedding plane controlled fractured.

The diabase dyke that passes beneath the north side of the TMA is moderately permeable as indicated by a geometric mean of 1 x 10^{-6} m/s extending to depths of 30 m. The south margin of the dyke encountered at about 15 mbgs was more permeable (7 x 10^{-6} m/s) than the less-fractured core of the dyke (1 x 10^{-6} m/s).

The hydraulic conductivity test data for BH91-S3, drilled through the Spanish American Fault, indicates an order of magnitude decrease in conductivity with depth. Between 0 m to 15 m the hydraulic conductivity is 4 x 10^{-6} m/s and below 30 m it is 2 x10^{-7} m/s. At the highly fractured southern margin of the fault, hydraulic conductivity is measured to be 1 x10^{-5} m/s in the upper 24 m. The northern margin is significantly less permeable below 30 m.

8.6 Water Quality

The Stanrock TMA basin is vegetated with surface water runoff, seepage and discharge representing the influent of the TMA which leads to a holding pond and the Stanrock ETP influent station (DS-2). Water quality is also monitored downstream after the settling pond at Moose Lake (DS-6), heading to the polishing pond at Orient Lake (DS-1), and at the final point of effluent at the outlet of Orient Lake heading into Halfmoon Lake (DS-4).

As part of the closure decommissioning process, surface water, pore water and groundwater within the Stanrock TMA are monitored under the TOMP and SAMP programs as described in Appendix A. Data from these stations are presented in the 2010-2014 SRW Cycle 4 State of the Environment report as well as annually in the Rio Algom Limited Annual Operational Care and Maintenance Report.

8.7 MECP Water Well Information System

Golder queried the MECP water well information system for data for known wells located within a 1 km radius of the TMA. No data was found.

8.8 Dams

The table below provides a summary of dams and related structures or facilities at the Stanrock TMA, shown on Figure 8.4.

<table>
<tr><th>Dam ID, Purpose</th><th>Foundation Conditions</th><th>Gradient, Vector</th><th>No. of Associated Water Level Monitoring Points</th></tr>
<tr><td>Dam A, tailings and water retention</td><td rowspan="3">Cyclone tailings founded on bedrock.</td><td>About 16 m difference in head upstream to downstream (across dam, eastward).</td><td>3</td></tr>
<tr><td>Dam B, tailings retention</td><td>About 5.5 m difference in head upstream to downstream (across dam, westward).</td><td>2</td></tr>
<tr><td>Dam C, tailings retention</td><td>About 10 m difference in head upstream to downstream (across dam, southwestward).</td><td>3</td></tr>
</table>

Dam ID, Purpose	Foundation Conditions	Gradient, Vector	No. of Associated Water Level Monitoring Points
Dam D, tailings retention		About 5.0 m difference in head upstream to downstream (across dam, southward).	4
Dam F, treatment solids and water retention		Not known.	0
Dam G, water retention		Receives seepage flow southward / southeastward from Dam B and Dam C. Other seepage pathways may exist within the bedrock beneath the valley downstream of Dam G to Quirke Lake.	1
Dam J, seepage water retention		Not known.	2
Dam K, treatment solids and water retention		Not known.	0
Dam L, water retention		Not known.	2
Dam M, seepage water retention		Not known. Other seepage pathways may exist within the bedrock beneath the valley downstream of Dam G to Quirke Lake.	3

8.9 Conceptual Hydrogeologic Model

The inferred flow of groundwater beneath the Stanrock Mine TMA is shown schematically on Figure 8.5 in terms of recharge to the basin and discharge from the basin. The relative conditions of recharge and discharge are based on groundwater level monitoring in the various piezometers surrounding the basin.

Groundwater levels in the bedrock ridge along the north side of the tailings basin are above the water level in the tailings. Groundwater flow or seepage is expected to move from this ridge into (recharging) the TMA. Elsewhere around the basin, measured groundwater levels indicate outward seepage (discharge) from the tailings basin. Key areas of seepage discharge are through the dams as noted by the occurrence of seepage springs and ponds of tailings water at the downstream toes of the dams.

The majority of the seepage discharging from the Dam A area collects in surface ponds that drain as surface runoff to the treatment plant to the Moose Lake settling pond. Bedrock seepage pathways likely also exist between the Dam A area and Quirke Lake, considering the elevation difference of about 67 m between the two features.

Bedrock seepage likely occurs between the tailings and the Orient Creek drainage basin to the south as indicated by bedrock groundwater levels in the Dam D area. This seepage is probably limited to the northeastern side of the creek basin, whereas freshwater seepage would likely migrate toward the creek from the higher ground to southwest.

Bedrock seepage also likely occurs from the west end of the tailings basin toward Quirke Lake via the Spanish American fault Zone and along the diabase dyke that passes beneath the tailings westward below the mill area.

Most of the tailings seepage from Dam B and Dam C in interpreted to discharge as surface runoff that reports to the Dam G seepage collection pond. Some seepage was noted to occur below Dam G as surface runoff. Other seepage pathways may exist within the bedrock beneath the valley downstream of Dam G to Quirke Lake.

Moose Lake receives groundwater and runoff flow from the ridges rimming the lake to the north and the south. The only recognizable point of discharge is below Dam F.

9.0 LACNOR TMA

9.1 Background

The Lacnor Mine is located about 5 km northeast of the City of Elliot Lake (Figure 9.1). Mine operations commenced in 1957 and ceased in 1960 during which a total of 2. 7 million tonnes of tailings were produced. The tailings were deposited in a bedrock-rimmed basin located about 2 km east of the original mill. All the buildings on site have been demolished and the mill site has been substantially rehabilitated (Golder 1998a).

The Lacnor TMA is about 1.2 km long and about 200 m wide. The tailings surface is relatively flat with a surface elevation ranging from about 378 to 383 m from west to east. There are a series of ditches on the tailings surface to facilitate drainage towards the tailings pond at the east end. The Lacnor basin is essentially contained by the bedrock topography with Dams A and B providing containment in the valleys on the southern perimeter.

The 27 hectares TMA consists of tailings which are partially flooded with a small pond on the east end. Overflow from the tailings pond discharges via a spillway into a valley downstream of Dam A and eventually into the Nordic Main Tailings Area. Station L-03 monitors releases from the Lacnor TMA to the Nordic TMA. In addition, seepage flows through the two containment dams which also is directed to the Nordic TMA. The Lacnor effluent is treated together with runoff from the Nordic TMA at the Nordic ETP.

The Lacnor tailings basin was vegetated in the 1970s. Loss of vegetation has since occurred due to acidic conditions. In 1998 and 1999, an engineered cover was placed over the tailings which consisted of a layer of blast rock and a layer of till at the surface. The cover was revegetated in 1999 through seeding of grasses, legumes and isolated tree plantings (Golder 1998a).

9.2 Site Setting

9.2.1 Topography

Lacnor TMA watershed covers about 100 hectares of which 27 hectares is occupied by tailings. The surface elevation ranges from 383 to 378 m sloping downward to the east. The vegetation cover over the surface of the tailings is sparse. The basin is essentially contained by the bedrock topography, however, Dams A and B provide containment in the valleys on the southern perimeter.

9.2.2 Drainage

Surface water generated by precipitation from the Lacnor watershed is routed through the existing micro drainage system to the tailings pond at the east end of the basin.

Currently, the effluent from the tailings pond is discharged, via a spillway at L-03, into a valley downstream of Dam A and eventually to the Nordic TMA. Seepages through Dams A and B also report to the Nordic TMA. The Lacnor TMA drainage together with runoff from the Nordic Main Tailings Area is directed through a drainage ditch to a decant where it is discharged into the effluent collection ditch. The combined Lacnor and Nordic effluent is treated and finally discharged into the Nordic Settling Pond for clarification. The outflow from the Nordic Settling Pond enters Buckles Creek.

The spillway of the Lacnor tailings pond is partially excavated in bedrock.

9.2.3 Regional Geology

Regional geology in the Lacnor TMA area is similar to that described in previous regional geology sections in this report and is characteristic of the Canadian Shield.

Groundwater often appears to occur as a complex series of local "perched" regimes associated with the lake systems. Groundwater transport between these local regimes generally occurs through overburden-infilled bedrock lows or major discontinuities (e.g., dykes and faults) in the rock. However, the results of mining experience and geotechnical borings in the Elliot Lake area suggest that the permeability of the faults at depth is generally low, approaching that of the host rock (Golder 1998a).

In low-lying areas and in flood plains there are more extensive deposits of fluvial sediments ranging from silt to sand and gravel (Golder 1998a).

9.2.4 Lacnor TMA Geology

The Lacnor TMA is situated within a bedrock valley formerly occupied by wetlands. The basin is surrounded by ridges of exposed bedrock. The ridge along the north side of the basin rises to elevations of 420 to 440 m. The lower half of the south-facing slope is partially covered by talus. The ridge along the south side of the basin is less pronounced and rises to elevations of 400 to 410 m. It separates the Lacnor TMA from the Nordic TMA to the south. The ridge is cut by north-south trending valleys that form the drainage pathways from the basin (Golder 1998a).

The Lacnor TMA is largely underlain by quartzite of arkosic to subarkosic composition of the Mississagi Formation (Figure 9.3). The steep ridges along the north side of the Lacnor TMA are comprised of intrusive diabase sills. The sills dip northward subparallel to the dip of the metasedimentary rocks. A large diabase dyke, trending northwest-southeast occurs along the eastern side of the basin, accompanied by a smaller northerly trending diabase dyke (Golder 1998a).

The Pecors Lake Fault, a major northwest-southeast trending structure passes diagonally through the central portion of the tailings basin and erosion of fractured rock associated with this feature has created the valley into which Dam A is situated. Faulting and fracturing associated with this fault was observed in boreholes drilled in 1985 and in 1995. Results of drilling also indicate that there is a smaller diabase dyke in the Dam B valley. The large northwest-southeast trending diabase dyke that occurs along the eastern side of the basin is also related to the same structural episode as the Pecors Lake Fault. Both the faulting and parallel diabase dyking appear to post-date the intrusion of the massive diabase sills along the northern rim of the tailings basin (Golder 1998a).

9.3 Hydrogeology

The groundwater flow system in the Lacnor TMA is controlled predominantly by the bedrock ridges surrounding the basin which represent groundwater divides. Groundwater recharge is expected to occur on the north, east and southeast sides of the TMA. As the overburden thickness is limited and likely discontinuous beneath the tailings, there is no overburden aquifer which would represent a major external seepage pathway. External seepages are confined to the bedrock valleys where Dam A and Dam B are located as shown on Figure 9.4. As both dams are waste rock structures, seepage occurs through the dams as well as through their foundations and abutments. Based on field measurements, the seepage through Dams A and B is estimated to be about 5 L/s. Average annual outflow from the tailings pond has been reported by RAL to vary from about 12 L/s to 19 L/s (SENES 1995).

9.4 Water Elevations and Gradients

The phreatic surface in the tailings fluctuates seasonally but remains generally at depth of less than 1 m from the ground surface. Measured vertical seepage gradients in the tailings were generally low and downwards towards the more permeable overburden materials beneath the tailings. Near the perimeter dams, the phreatic surface is much lower and the downward seepage gradients are more pronounced. Artesian conditions prevail in the piezometers installed downgradient of the dams indicating discharging conditions (Golder 1998a).

9.5 Hydraulic Conductivity

The Lacnor tailings vary from coarse sand tailings at the western end and northern half of the basin to finer, predominantly silt sized tailings in the eastern and south-eastern parts of the basin. The hydraulic conductivity of the tailings ranges from 2×10^{-8} m/s to 5×10^{-6} m/s. The sand and gravel overburden below the tailings has a measured hydraulic conductivity of about 1×10^{-5} m/s (Golder 1998a).

In situ hydraulic conductivity tests (packer tests) were carried out within discrete bedrock intervals at BH 95-1L, 95-2L, 95-3LA, 95-4L and 95-5L. A total of thirteen (13) hydraulic conductivity tests were carried out as part of the drilling program. Results from bedrock hydraulic conductivity tests showed a range from about 1×10^{-8} m/s to 5×10^{-6} m/s. The measured hydraulic conductivity values were generally higher in the diabase dyke intersected in BH 95-2L. The unstructured Upper Mississagi Formation quartzite was found to have a hydraulic conductivity between 1×10^{-7} and 7×10^{-3} m/s. Based on our experience in Elliot Lake area, more permeable bedrock can be expected in shear zones or dyke intrusions (Golder 1998a).

9.6 Water Quality

As part of the closure decommissioning process, surface water and groundwater within the Lacnor TMA are monitored under the TOMP and SAMP programs as described in Appendix A. Data from these stations are presented in the 2010-2014 SRW Cycle 4 State of the Environment report as well as annually in the Rio Algom Limited Annual Operational Care and Maintenance Report.

9.7 MECP Water Well Information System

Golder queried the MECP water well information system for data for known wells located within a 1 km radius of the TMA. No data was found.

9.8 Dams

The table below provides a summary of dams and related structures or facilities at the Lacnor TMA, shown on Figure 9.4.

Dam ID, Purpose	Foundation Conditions	Gradient, Vector	Seepage Rate	No. of Associated Monitoring Points
Dam A, tailings retention	Founded on sand and gravel deposit in the central portion and on bedrock elsewhere. Artesian conditions exist at the downstream toe.	About 8 m difference in head upstream to downstream (across dam, southward).	Steady clear seepage at the centre of the dam and at the east abutment. Remains similar from year to year. Continuous seepage at toe of original structure, estimated to be about 5 L/s.	2
Dam B, tailings retention	Founded on sand and gravel deposit in the central portion and on bedrock elsewhere. Artesian conditions exist at the downstream toe.	About 4 m difference in head upstream to downstream (across dam, south-eastward).	Continuous seepage at original structure estimated between 1and 5 L/s, confined to the central portion of the valley. Trickle clear seepage west of the drainage ditch. Remains similar year to year.	2

9.9 Conceptual Hydrogeologic Model

The Lacnor TMA is contained within a rock rimmed basin. Groundwater flow is predominantly influenced by the surrounding bedrock ridges which act as groundwater divides and generally direct surface water and groundwater flows towards the basin. The basin is recharged on the north, southwest and east sides. Groundwater discharges from the tailings to the south and to the east, primarily as seepage under Dams A and B. Seepage together with overflow from the tailings pond drain to the Main Tailings Area of the Nordic TMA. Based on topography and the presence of the pond to the east of the Lacnor TMA, it is expected that most of the seepage would be captured and directed to the Nordic Basin, either via flow through L-03 or seepage discharge to surface water which is directed to the Nordic TMA.

The tailings at the Lacnor site vary from coarse sand tailings at the western end and northern half of the basin to finer, predominantly silt sized tailings in the eastern and southeastern parts of the basin. The hydraulic conductivity of the tailings ranges from 2×10^{-8} m/s to 5×10^{-6} m/s. The silt tailings upstream of Dams A and B is estimated to have a hydraulic conductivity of about 2 x 10^{-7} to 1 x 10^{-6} m/s based on results of grain size analysis. The sand and gravel below the tailings has a higher hydraulic conductivity, and the bedrock has a hydraulic conductivity of 3 x 10^{-9} m/s in tight bedrock to 3 x 10^{-5} m/s in fractured zones near the surface. Highly permeable rock is normally associated with faults and dykes such as the Pecors Lake Fault which passes through the Dam A valley (Golder 1998a).

A total of about 5 L/s of seepage is estimated to be discharging at the Lacnor dam sites. Of this amount, 4 L/s is estimated to be passing through Dam A and its abutments. The measured mean annual discharge for the Lacnor tailings pond for the period from 1972 to 1993 was 15 L/s (SENES, 1995). Therefore, total flow for the TMA is about 20 L/s. The outflow from the Lacnor TMA accounts for about 24 % of the effluent treated at the Nordic ETP. Some of the Lacnor runoff percolates into the Nordic Main Tailings Area and does not enter the effluent collection ditch directly. (Golder, SENES & CCL 1998).

10.0 NORDIC TMA

10.1 Background

The Nordic TMA is a decommissioned uranium mine tailings management area (TMA) located about 5 km east of the City of Elliot Lake (Figure 10.1). The TMA is owned and managed by RAL.

The Nordic Main TMA is underlain by a permeable unconsolidated sand unit. After mining operations ceased, the neutralized process water drained from the tailings resulting in unsaturated conditions in the shallow tailings that allowed oxygen and infiltrating precipitation to react with the pyrite, generating acidic drainage. The acidic water containing elevated concentrations of sulphate and iron migrated downward to the water table and then moves with groundwater to the south (EcoMetrix 2011).

An Effluent Collection Ditch (ECD) was constructed in 1971 to intercept the acidic runoff and seepage water from the Nordic TMA. The ECD directs water along the perimeter of the Nordic Main TMA and flows west to the Nordic (ETP) where it is treated prior to discharge to the Nordic Settling Pond.

Buckles Creek is located adjacent to the Nordic TMA and originates in a natural pond located to the east and flows west along the southern portion of the site. During mine operations Buckles Creek was diverted to provide water for mining and milling and runoff from the Nordic TMA was piped to the original Buckles Creek bed, resulting in radium precipitates settling in the creek bed and nearby beaver pond. After operations concluded at Nordic TMA, Buckles Creek was relocated to the current configuration to isolate the flow from the historic precipitates. The former Buckles Creek channel now consists of the historic precipitation pond and Buckles wetland that is separated and isolated from the constructed Buckles Creek Diversion Channel (BCDC) by berms (EcoMetrix 2011).

10.2 Site Setting

10.2.1 Topography

The Nordic TMA was constructed in a valley between two bedrock outcrops with dams to contain the tailings solids. The TMA is comprised of two areas, the Nordic Main and Nordic West Arm that encompass a total surface area of about 107 hectares.

10.2.2 Drainage

Seepage and runoff from Nordic Main are interpreted to be largely collected in the ECD. The ECD also collects drainage from the Lacnor TMA from the north that flows to the Nordic ETP for treatment prior to discharge into the Nordic Settling Pond. 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. Since the completion of a seepage collection system in 1989, the remaining seepage and runoff from the Nordic West Arm is collected and discharged to the Nordic Settling Pond. Trace amount of seepage likely continues to Westner Lake and the Nordic Settling Pond through the bedrock ridges.

The relocation of Buckles creek to what is now the BCDC was completed to isolate the flow and bypass the historic precipitates in the Buckles Creek and wetland area. The BCDC is parallel to the ECD along the east end of the TMA and flows south and west along a bedrock outcrop. On the southwest portion of the property, the BCDC joins with the creek draining treated effluent from the Nordic Settling Pond, and then flows south to Nordic Lake.

Site improvements have been made since closure, which have primarily focused on stability of structures, management of flow and seepage interception.

10.2.3 Regional Geology

Regional geology in the Nordic TMA area is similar to that described in previous regional geology sections in this report and is characteristic of the Canadian Shield.

Overburden is largely restricted to topographic lows and, with the exception of recent bog or swamp deposits, consists predominantly of fluvial or outwash silty sands and gravels or glacial outwash origin. Local deposits of essentially cohesionless silty to sandy till also occur in topographic lows or plastered on the flanks of bedrock highs. The permeability of the till is typically in the order of 10^{-7} to 10^{-8} m/s (Golder 1998b).

10.2.4 Nordic TMA Geology

The Nordic TMA is located in an east-west trending valley bordered on the north and south by bedrock ridges comprised of Proterozoic arenaceous metasediments. As shown on Figure 10.3, the Nordic TMA is located on the thinly laminated mudstones and muddy sandstones of the Pecors Formation part of the Hough Lake Group. Within the main valley there are several sub-valleys that have been dammed up where necessary for containment of the tailings (Golder 1998b).

The overburden near Dam A is relatively thin and bedrock is at or close to the ground surface near the mouth of the valley adjacent to Westner Lake. The overburden is a dense to very dense grey silty sand and gravel glacial till. Underlying the overburden is a moderately weathered to fresh, dark grey, finely laminated argillaceous bedrock. The rock surface exhibits weathering fractures in the upper (near surface) zone but is anticipated to be relatively unweathered below this initial depth of 0.6 to 1 m (Golder 1998b).

At Dam B, the overburden thickness is in the order of 9 to 12 m. However, the overburden cover apparently becomes much shallower toward the mouth of the valley where bedrock is evident at the Westner Lake shoreline. The overburden below the East Seepage Collection Dam is a very dense silty sand and gravel glacial till. Underlying the overburden at 10 m depth is a slightly weathered to fresh, grey Conglomeritic bedrock. The rock in this valley is generally less fractured than the rock in the west valley (Golder 1998b).

The West Arm Tailings Area is contained by interbedded argillite and quartzite bedrock. Overburden in the east-west trending valley generally consists of an upper zone of glacio-fluvial sand and silty sand overlying bouldery glacial till. The thickness of the sand deposit was reported to be up to 12 m (W.L. Wardrop, 1978). The glacial till varies in thickness from 1.5 to 2.4 m (Golder 1998b).

Near the treatment plant, the overburden is 22 m thick and consists of silt underlain by sand and gravel which, in turn, is underlain by sand and gravel till. Dams D and E are founded on the bedrock, therefore the overburden in this area is quite thin. However, between the spillway and where Buckles Creek meets the Nordic Mine Road, the bedrock forms a valley and the overburden in this area is greater than 35 m in thickness. The overburden deposit consists of glaciofluvial outwash sand and gravel overlying a basal till. The basal till is bouldery and compact, and outcrops along the edges of the gap in the southern bedrock ridge, through which Buckles Creek flows. The till is overlain by a fine to coarse-grained sand of up to 18 m in thickness. This sand unit is generally overlain by a coarser-grained sand to gravel deposit of up to 3 m in thickness. The surficial layer consists of either 0.5 to 1 m of peat which formed in the spruce swamp that covered the area prior to mining activity (Golder 1998b).

There are 4 key stratigraphic formations identified at the site at the Nordic TMA:

i) tailings;

ii) the upper medium sand unit;

iii) the underlying fine sand unit; and

iv) bedrock.

10.3 Hydrogeology

As per the Golder 1998b report the aquifers near the Nordic TMA are generally discontinuous as the majority of groundwater flow occurs in overburden-infilled bedrock lows between bedrock outcroppings. The groundwater flow paths often occur as a series of local "perched" regimes associated with the lake systems.

The sand and gravel deposits filling the bedrock lows underlying portions of the Nordic TMA form an aquifer extending from Stinson Lake in the east to the Nordic Settling Pond in the west as shown on Figure 10.2. The glacial till which underlies the aquifer consists of a compact silty sand and is discontinuous over areas of high bedrock topography. In some areas where the till is absent, the outwash sand and gravel aquifer lies directly on the bedrock surface.

Several hydrogeochemical investigations have been conducted in the tailings area and south of the tailings dam. The results of these studies indicate that a plume of tailings-derived groundwater migrated south, under the ECD, towards Buckles Creek until the ECD was deepened and lowering of the Nordic Settling Pond (1994 and 1997) to increase groundwater interception and reverse groundwater flows near the ECD (Golder 1998b).

The Nordic West Arm is contained within an east-west trending valley flanked by rock outcrops. Historically, water from the tailings area seeped through two pervious dams (Dams A and B) at the west end of the West Arm and entered Westner Lake. Since the completion of a seepage collection system in 1989, the seepage from the West Arm Tailings Area has been collected and discharged to the Nordic Settling Pond. Trace amount of seepage continue to report to Westner Lake and the Nordic Settling Pond through the bedrock ridges (Golder 1998b).

10.4 Water Elevations and Gradients

The Nordic TMA is bound to the north by an elevated bedrock outcrop. The bedrock outcrop acts as a groundwater flow boundary and all tailing and overburden flow in the vicinity of the Nordic TMA is toward Buckles Creek which is the natural drain in this area (Figure 10.4).

The effluent collection ditch is located around the tailings area to divert tailings seepage flows to the south and then west, via the treatment plant, into the Nordic Settling Pond. The Nordic TMA is well drained by the sand aquifer underlying the tailings and measured hydraulic gradients indicate that groundwater flow from the tailings is currently largely migrating towards the ECD. Based on groundwater modelling completed by EcoMetrix (2011), deepening the ECD and lowering the water level in the Nordic Settling pond resulted in better capture of the groundwater originating from the Nordic TMA. The results of groundwater flow modelling using MODFLOW suggested that seepage from the TMA is generally intercepted by the ECD (EcoMetrix 2011).

The deepening of the ECD and Nordic Settling Pond has decreased the groundwater levels in the monitoring wells near the ECD. The measured water levels indicate that gradients have been reversed just south of the ECD which has resulted in an increase in groundwater capture from the tailings.

The water elevations between the ECD and Buckles Creek exhibit a maximum in the vicinity of M-12 as shown on Figure 10.4. M-12 represents a divide with groundwater to the north of M-12 flowing towards ECD. The hydraulic gradients indicated that groundwater south of the groundwater divide is migrating toward Buckles Creek. However, calculations of groundwater flow velocities indicated that the rates of groundwater flow have decreased substantially since the deepening of the ECD and that the groundwater south of M-12, that bypassed the ECD prior to 1997, will continue to slowly discharge to Buckles Creek until the legacy plume has been flushed by clean water infiltrating in the area. It is expected that the groundwater quality will recover slowly over time (EcoMetrix 2011).

Horizontal hydraulic gradients and average groundwater flow velocities were calculated by EcoMetrix (2011) using average gradients from selected wells for the time periods of 1998 to 2009. Hydraulic gradients were between 0 and 0.001 m/m. The calculated groundwater flow velocity in the upper medium sand unit was about 10 m/year, flow in the lower fine sand was about 0.2 m/year and the flow in the till/bedrock was about 0.1 m/year. Historically, vertical gradients have measured slightly downward to negligible in previous hydrogeological investigations.

Beaver activity in the ECD, creeks and ponds in the area can affect local water levels and flow direction. Continuous monitoring is ongoing at the site in order to allow for the ECD to continue the interception of groundwater originating from the Nordic TMA.

Recent groundwater levels collected at the Nordic TMA TOMP locations between 2010 and 2019 confirmed historical levels.

10.5 Hydraulic Conductivity

A total of 11 hydraulic conductivity tests were performed in the piezometers and monitoring wells as part of a previous field investigation program. Hydraulic conductivity values were measured for the four main formations present at the Nordic TMA (the tailings, upper medium sand unit, the underlying fine sand unit and the bedrock). The hydraulic conductivity of the tailings is governed primarily by the gradation of the tailings. A test conducted in BH-1 suggested that the hydraulic conductivity of the silty sand tailings at the location was about 3×10^{-6} m/s. The calculated hydraulic conductivity values for the upper medium sand unit (outwash sand and gravel deposit) on the Nordic Valley floor, were between 1×10^{-5} and 2×10^{-5} m/s. The underlying fine sand unit was found to have a slightly lower hydraulic conductivity ranging from 2×10^{-6} to 1×10^{-5} m/s. The hydraulic conductivity of the bedrock was calculated to range from 8.2×10^{-9} and 3.3×10^{-5} m/s based on four tests carried out in the bedrock (Golder 1998b).

Previous studies have described the hydraulic conductivity values at the site with similar velocities of 1×10^{-5} m/s for the tailings, 1×10^{-4} m/s for the upper medium sand, 1×10^{-5} m/s for the lower fine sand, 1×10^{-7} m/s for the impervious till and 1×10^{-9} m/s for the bedrock (EcoMetrix 2011).

10.6 Water Quality

As part of the closure decommissioning process, surface water and groundwater within the Nordic TMA are monitored under the TOMP and SAMP programs as described in Appendix A. Data from these stations are presented in the 2010-2014 SRW Cycle 4 State of the Environment report as well as annually in the Rio Algom Limited Annual Operational Care and Maintenance Report.

10.7 MECP Water Well Information System

Golder queried the MECP water well information system for data for known wells located within a 1 km radius of the TMA. Data for four wells was retrieved. The approximate locations of these wells, as indicated in the MECP water well records, are shown on Figure 10.4.

For the four well records received from the MECP, two records correspond to wells that are used for domestic purposes and one well is used for commercial purposes. The remaining record is reported to be abandoned. The 3 water supply wells are installed in the bedrock between 76 and 107 metres below ground surface.

10.8 Dams

The table below provides a summary of dams and related structures or facilities at the Nordic TMA, shown on Figure 10.4.

Dam ID, Purpose	Foundation Conditions	Gradient, Vector	No. of Associated Monitoring Points
Dam A, seepage water retention	Dam founded either on bedrock or till deposit. No construction records	About 4 m difference in head upstream to downstream (across dam, westward).	2
Dam B, tailings retention	No construction records, and no investigation. Inferred dam is founded on granular overburden and has a max height of between 3 and 4.6 m.	About 2 m difference in head upstream to downstream (across dam, westward) based on upstream ground surface elevation and downstream pond levels.	0
Dam C, tailings retention	Founded on tailings. Tailings deposited over native sands and/or bedrock.	About 2 m difference in head upstream to downstream (across dam, westward) based on upstream tailings elevation and downstream ground surface.	2
Dam D, tailings retention	Waste rock bult with upstream method on tailings over bedrock.	About 2 m difference in head upstream to downstream (across dam, southward) based on upstream tailings elevation and downstream ground surface.	1
Dam E, tailings retention	Waste rock bult with upstream method on	About 7 m difference in head upstream to	3

Dam ID, Purpose	Foundation Conditions	Gradient, Vector	No. of Associated Monitoring Points
	tailings over bedrock. Downstream toe and berm built on native sand and gravel.	downstream (across dam, southward) based on upstream water elevation in tailings and downstream ditch ground surface.	
Dam F, tailings retention	Founded on native granular soils.	About 3 m difference in head upstream to downstream (across dam, southward) based on upstream water elevation in tailings and downstream ditch ground surface.	5
ESCP, untreated seepage water retention	Till core founded upon prepared bedrock. Dam shell founded upon native competent soil or bedrock.	About 2 m difference in head upstream to downstream (across dam, westward) based on normal operational water elevation and downstream toe ground surface.	0
WSCP, untreated seepage water retention	Till core founded upon prepared bedrock. Dam shell founded upon native competent soil or bedrock.	About 2 m difference in head upstream to downstream (across dam, westward) based on normal operational water elevation and downstream toe ground surface.	0
Coffer Pond Berm, untreated seepage water retention	Not available.	No vertical gradient. Water elevations in Westner Lake and Coffer Pond are similar.	0
Nordic Settling Pond Berm, treated water retention	No original design or construction records.	NA	0
Westner Lake Outlet Berm, fresh water retention	In-situ till excavated for cut-off trench for till core. Unsuitable surficial	NA	0

Dam ID, Purpose	Foundation Conditions	Gradient, Vector	No. of Associated Monitoring Points
	materials removed below rest of embankment.		
Ryan Lake Outlet Berm, freshwater retention	Dam founded on overburden. Dam core constructed of sand and gravel.	NA	0
Historic Precipitate Pond Berm, retains tailings slimes and precipitates	Blast rock driven down into black loam by haul traffic to form foundation.	About 1 m difference in head upstream to downstream (across berm, westward) based on pond elevation and Buckles Creek Channel.	0
Buckles Diversion Berm, diversion channel for freshwater	Silty sand and gravel overburden. Removed organic deposits.	NA	0
Buckles Wetland Berm, swamp and water retention	Fibrous peat overlying silty sand and gravel.	NA	0

10.9 Conceptual Hydrogeologic Model

As per the Golder 1998b report the Nordic TMA lies on deposits of outwash sand and gravel on the Nordic valley floor between elevated ridges of bedrock. The granular deposits are underlain by glacial till or bedrock. Total overburden depth ranges from about 8 to over 27 m. The bedrock ridges and existing dams limit the seepage from the south side of the Nordic TMA.

The groundwater flow in the vicinity of the Nordic TMA is controlled predominantly by the overburden and the bedrock ridges which form seepage barriers. The TMA is recharged by infiltration and bedrock seepages originating from the ridges flanking the north side of the tailings. The east-west bedrock ridge on which the original mill complex was situated provides hydraulic containment to the south. Flow in the Nordic Main Basin is predominantly to the south and east, with seepage occurring under Dam F and, to a lesser degree, under Dams D and E. There is relatively little seepage towards the West Arm through Dam C as no appreciable amount of pervious overburden exists at this location.

The drainage ditch north of the Nordic Main Basin collects water from the Lacnor tailings and directs it to the east, around and then back to the west along the south edge of the tailings. This seepage collection ditch also collects and intercepts seepage flowing south from the eastern portion of the West Arm Tailings and the Nordic Main Basin Tailings.

Seepage from the western portion of the West Arm is collected and discharged to the Nordic Settling Pond. With the construction of low permeability seepage control dams, seepage from the West Arm Tailings Area toward Westner Lake is predominantly through the highly impermeable bedrock.

As shown on Figure 10.5, the coarse sand dominates the groundwater flow originating from the Nordic TMA. The ECD is interpreted to largely intercept the flow as well as reverses flow direction to the immediate area south of the ECD.

11.0 PRONTO TMA

11.1 Background

The Pronto Mine is located on the north side of Highway No. 17, about 10 km east of Blind River, on the north shore of Lake Huron (Figure 11.1). The Pronto Mine was developed for uranium extraction, and tailings from the ore were discharged to the north and west of the mill (Golder 1997).

The tailings are located north of the former plant site and are covered by vegetation located in a 47-hectare natural rock basin contained by Dam A. Dam A is an original waste rock dam that was stabilized with a rockfill toe berm at closure. The 2.1 million tonnes of uranium tailings were deposited with 2 million tonnes of copper tailings covering all uranium tailings. The copper tailings cover is typically 3m deep over 40 of the 47 ha within the basin (Golder 1997). 33,000 tonnes of rock fill from adjacent residential properties were relocated to the Pronto TMA (Minnow 2017). Following the operational period, rock fill was recovered from adjacent properties until the end of 2009.

11.2 Site Setting

11.2.1 Topography

The Pronto TMA is situated on the southern edge of the Canadian Shield. The topography in this area is characterized by low rolling hills and comprised of exposed bedrock with intervening pockets of glacial soils and numerous glacially derived lakes. The elevations in the general mine area vary between 190 m and 250 m. The site consists of vegetated tailings located in a 47-hecatre natural rock basin.

11.2.2 Drainage

As outlined in the Golder 1997 report the Pronto mine site is located within the Lake Huron watershed. Prior to mining, the site drainage was westerly towards Lauzon Lake. As a result of mining activities including construction of several dams and ditches around the properties, the drainage has been significantly altered. A spillway was constructed southeast of Dam A to allow for controlled discharge of excess water. Runoff is directed to the Holding Pond (formerly Beaver Pond Lake) via a drainage ditch.

The majority of the Pronto watershed drains through the Pronto (ETP), with average annual flow through the ETP being about 42 L/s as of 1997 (Golder 1997). The remainder of surface water flow within the Pronto watershed is freshwater diversion flow on the east side of the TMA, or is non-contact water and drains towards Pronto Creek and further southward. All surface drainage reports to the North Channel of Lake Huron.

To minimize the impacts of mine effluent on Lauzon Lake, drainage from the Pronto Mine site was altered to redirect the outflow from the mine site directly to Lake Huron.

The tailings basin has been vegetated with grass. There are several ditches which direct runoff and seepage to the Holding Pond. Downstream of the Holding Pond are a settling pond and a polishing pond, all of which are separated by dams (Golder 1997). Drainage from the west and east areas of the Pronto TMA reports, via the West Spillway and East Spillway, respectively, to the Holding Pond. Water is impounded in the Holding Pond and batch-treated on an as-required basis, primarily in the spring and fall.

The Fresh Water Diversion Berm was constructed at the north-eastern limit of the East Area in 1998. This berm is intended to divert water from the pond to the east of the TMA; thereby reducing the volume of water that has to be treated at the ETP. The structure effectively reduces the area of the watershed by approximately 19.4 ha.

The Causeway Dam retains the Holding Pond. This dam has a low permeability silt core. The Holding Pond water flows through a decant structure situated, near the north abutment of the dam, to the ETP downstream of the dam.

Treated effluent from the ETP discharges into the Settling Pond. Dam D retains the Settling Pond. This dam is constructed of sand and gravel and incorporates a decant structure on the north side of the dam. The structure consists of two wing walls and a central sill that houses the stop logs that are used to control flow through the final point of discharge to the Large Beaver Pond.

Dam F is located on the western-most limit of the Pronto site and is used to retain the Large Beaver Pond and divert flow away from Lake Lauzon. The original dam was constructed of a silty sand material. Sand and gravel were later placed for erosion protection. In 1999 a rock-fill toe berm was added to the structure.

Dam E is a 2 m maximum height overflow structure located on the southern shore of the Large Beaver Pond. A 20 m wide spillway channel has been provided through the structure to convey flows to the North Channel of Lake Huron via the Diversion Channel.

The majority of the water flowing from the mine site watershed drains directly to Lake Huron, however a small amount of seepage is known to move into the Lake Lauzon watershed via Pronto Creek.

The total drainage area to the Holding Pond is about 300 ha.

11.2.3 Regional Geology

Regional geology in the Pronto TMA area is similar to that described in previous regional geology sections in this report and is characteristic of the Canadian Shield.

11.2.4 Pronto TMA Geology

The Pronto TMA is situated on the southern edge of the Canadian Shield. The topography in this area is characterized by low rolling hills and comprised of exposed bedrock with intervening pockets of glacial soils and numerous glacially derived lakes. The elevations in the general mine area vary between 190 m and 250 m (Golder 1997).

The Pronto Mine site is underlain by southern dipping (10 to 20 degrees) metasedimentary rocks of the Precambrian aged Huronian sequence including resistant quartzite, conglomerates and greywackes of the Matinenda, Mississagi, Bruce and Gowganda Formations as shown on Figure 11.3. This sequence unconformably overlies older pre Huronian (Archean) age granitic basement rocks which dominate the hinterland to the north of the mine site (Golder 1997).

The rock sequence has been intruded by diabase dykes of the Nipissing sequence that are variously controlled and localized along the fault and fracture system. Dyke margins vary from unstructured intrusive contacts to extensively sheared contacts (Golder 1997).

The rock sequence, including the Huronian metasediments, the granitic basement and the diabase dykes, have been offset along two east-west trending, southward dipping thrust faults; the Pronto Thrust Fault and the Beaver Pond Thurst fault. Each of the faults follow relatively prominent bedrock depressions that locally control surface drainage. These depressions have likely developed due to glacial erosion of the more fractured rock associated with these fault systems (Golder 1997).

The Pronto Thrust Fault extends from the Lauzon Lake in the west, though the central mine site, from where it passes beneath the foundation of Dam A to the east. The Beaver pond thrust Fault also extends from Lauzon Lake, passing to the south of the mine site beneath the Holding Pond. This fault passes beneath the foundations of Dam D and the Causeway Dam (Golder 1997).

Further to the south, the Murray Fault forms a regional structure that runs roughly parallel to Highway 17. This structure truncates the mine site rock sequence against older Archean age metavolcanic sequence along the south side of the fault (Golder 1997).

During the Pleistocene Epoch, the area was glaciated. As the ice sheet retreated, localized deposits of till, glaciofluvial sands, clays, gravels and occasional large boulders were deposited within the area, generally in the low ground between the outcrops. Within the overburden there have been reported to be stratified sand, gravel, and clay deposits which represent material accumulated in post glacial Lake Huron and / or ice dammed lakes. The deposits of overburden are relatively thin and discontinuous throughout the area (Golder 1997).

11.3 Hydrogeology

According to the Golder 1997 report, groundwater occurrence within the underlying bedrock is limited to fracture systems which, in turn, tends to be more prevalent in areas of faults or dyke intrusion.

The bedrock surface tends to be generally more fractured, hence permeable, than at depth due to weathering associated with glacial activity, frost action and to a lesser degree oxidation and dissolution of mineralization on fracture surfaces. This zone typically extends to depths of 5 m to 10 m below which the rock mass becomes less permeable. Overall, the bedrock is typically of low permeability.

Groundwater occurs within pockets of overburden between bedrock ridges. The water table in the bedrock also tends to coincide within the level of adjacent water bodies and stream courses. As, such the water table varies from several metres below ground surface within the upland areas of exposed bedrock to near ground surface within the linear bedrock depressions associated with stream courses. Correspondingly, the directions of groundwater flow in both the bedrock and overburden coincides to a large degree with the directions of the surface water flow, both following with the topography towards the Holding Pond and polishing pond (Golder 1997).

The Pronto Mine underground workings have been flooded due to surface and groundwater infiltration before the mine was sealed. The mine workings are known to discharge groundwater through the occasional exploration borehole that has connected down dip sections of the mine with low points on the ground surface. One of the boreholes is located along the north shore of the holding pond where mine water from a borehole can be seen to discharge to the pond. Due to the configuration of the underground workings relative to the ground surface, and structural relationships with the Beaver Pond Fault, all mine discharge is focused within the Holding Pond on the downstream settling basins (Golder 1997).

The tailings basin is rimmed by low permeability bedrock and the water table occurs within the tailings at depths of 1 m to 2 m below surface. Minor amounts of groundwater seepage enters the tailings basin from the upland areas of bedrock to the north and east of the basin, but the primary source of tailings groundwater recharge is direct infiltration from precipitation. Groundwater discharge from the basin is focused as seepage beneath Dams A and as surface runoff where the tailings water table meets the bedrock surface in the spillway channel. In general, seepage from the tailings basin reports to the Holding Pond and combines with surface runoff to flow through the treatment plant (Golder 1997).

There does not appear to be any significant groundwater flow pathways that extend westward from the mine site towards Lauzon Lake (Golder 1997).

Seepage that enters the Beaver Pond Thrust Fault from the mine would also be expected to discharge to the Holding Pond and to the downstream settling ponds. The fault crosses higher ground to the west of the settling pond where it would also likely have higher groundwater levels preventing westward movement of water as seepage from the ponds (Golder 1997).

The only apparent area of potential mine related seepage toward Lauzon Lake would be seepage beneath Dam F in response to the 2 m head across the dam from the polishing pond. The water quality of the polishing pond is not considered to present significant environmental concerns with respect to seepage flow westward from the polishing pond (Golder 1997).

11.4 Water Elevations and Gradients

There is a high-water table found across the site. Water levels consistently near the surface at all boreholes. Water table is typically at the same levels as adjacent ponds, lakes and streams (Golder 1997).

11.5 Hydraulic Conductivity

Golder conducted a geotechnical investigation in 1995 during which a total of 10 boreholes were drilled and 8 core penetration tests (CPT) were performed at locations shown on figure 11.1. In-situ hydraulic conductivity tests (packer tests) were carried out within packed off sections of three bedrock boreholes (BH-2, BH-3, and BH-4). A total of seven hydraulic conductivity tests were performed in the monitoring well BH-2. Test results show that the Mississagi Formation quartzite at this location is relatively tight with calculated hydraulic conductivity ranging typically from 1×10^{-8} to $1x\ 10^{-7}$ m/s. The bedrock foundation at Dam A was found to be more permeable with calculated hydraulic conductivity of between $1x\ 10^{-7}$ m/s and 8×10^{-7} m/s based on a total of five tests performed in BH-3 and BH-4 (Golder 1997).

A total of eight CPTs were also carried out as part of the investigation. The tailings were generally too coarse to generate sufficient excess pore pressure to carry out a dissipation test, which indicates that in general tailings hydraulic conductivity was greater than 1×10^{-7} m/s. Additional dissipation tests were carried out in CPT-1 at a depth of 11.4 m and CPT-7 at a depth of 8.3 m. Test results indicate a hydraulic conductivity of 7×10^{-8} m/s for the peat deposit in CPT-1 and $4\ x10^{-8}$ m/s for the native silty clay in CPT-7 (Golder 1997).

11.6 Water Quality

As part of the closure decommissioning process, surface water, pore water and groundwater within the Pronto TMA are monitored under the TOMP and SAMP programs as described in Appendix A. Data from these stations are presented in the 2010-2014 SRW Cycle 4 State of the Environment report as well as annually in the Rio Algom Limited Annual Operational Care and Maintenance Report.

11.7 MECP Water Well Information System

Golder queried the MECP water well information system for data for known wells located within a 1 km radius of the TMA. Data for six wells was retrieved. The approximate locations of these wells, as indicated in the MECP water well records, are shown on Figure 11.4.

For the six well records received from the MECP, two records correspond to wells that are used for commercial purposes, one well is for industrial purposes and one well is used for domestic purposes. The remaining two records have no status or usage information listed. The four water supply wells are installed in the bedrock between 8 and 113 metres below ground surface.

11.8 Dams

The table below provides a summary of dams and related structures or facilities at the Pronto TMA, shown on Figure 11.4.

Dam ID, Purpose	Foundation Conditions	Gradient, Vector	No. of Associated Monitoring Points
Dam A, tailings retention	Original structure upgraded in 1999, no original design records. From investigation, dam is waste rock over a silty sand and gravel starter dam.	Not known. No water cover in the upstream area.	4
Causeway Dam, untreated water retention	Dam founded on organic silt.	Not known. Water table encountered within dam embankment fill.	0
ETP Freshwater Diversion Berm, water retention	This berm was constructed of rockfill and is downstream of the road embankment.	The berm acts as a drainage control structure to retain ponded water downstream of the road embankment higher than the holding pond water level and thus prevents seepage from the holding pond.	0
Dam D, treatment solids and water retention	Glacial till core founded on prepared bedrock. Dam shell founded on native competent soil or bedrock. This dam is associated with the settling pond for treated solids and is not necessarily water-covered.	About 2 m across dam based on 1998 water levels. Settling pond is not necessarily water-covered.	0
Dam E, treated water retention	Low overflow structure with no original design records. Structure upgraded with rockfill armouring.	Spillway defined through dam crest to control downstream pond water level. This dam acts as an emergency overflow structure. There is no active water level control.	0
Dam F, treated water retention	Glacial till and rockfill. Fluvial silty sand deposit extensive	About 3.0 m difference in head upstream to	1

Dam ID, Purpose	Foundation Conditions	Gradient, Vector	No. of Associated Monitoring Points
		downstream (across dam, eastward).	
Freshwater Diversion Berm, freshwater diversion	Sandy silt core, entire width founded on bedrock. Embankment of sandy silt with rockfill shell and armouring to resist overtopping.	Not known.	0
Saddle Berm, freshwater diversion	Low earthfill berm in a depression west of the Freshwater Diversion Berm.	Normally does not impound water.	0

11.9 Conceptual Hydrogeologic Model

According to the Golder (1997) report, groundwater regime in the Pronto TMA controlled primarily by the topography and flows are directed generally southerly towards the Holding Pond and the Settling Pond as shown in Figure 11.5.

The tailings area is recharged by bedrock ridges surrounding it. Seepage from the main tailings area occurs through Dam A which saddles a narrow bedrock valley at the south east side of the TMA. The mine workings from the Pronto mine are hydraulically connected to the Holding Pond through several exploration drill holes. Due to the configuration of the underground workings relative to the ground surface, and structural relationships with the beaver pond fault, all mine water discharge is focused within the holding pond (Golder 1997).

Groundwater flow from the Holding pond is westerly and southerly following the surface drainage. Due to the absence of a continuous aquifer, most of the seepage will likely emerge as surface flow in low-lying areas such as the Settling Pond and the swamp downstream of it. Based on visual observations, seepage through the Causeway Dam is minimal with most discharge occurring to the west as treated effluent through the ETP.

The major east-west trending faults traverse the site. These fault zones could represent potential seepage pathways because of the relatively fractured rock associated with them. The Pronto Thrust Fault follows a bedrock valley situated north of the holding pond and the settling pond. Westward seepage, however, is likely inhibited by the existence of a ground water divide near BH-2. Instead, it is expected that the seepage along the fault will be easterly and into the mine workings. The Beaver Pond fault passes through the holding and settling ponds and extends to Lauzon Lake (Golder 1997).

Dam F blocks a creek draining to Lauzon Lake and diverts the treated effluent to Lake Huron. Seepage through the granular dam foundation is estimated to be about 0.1 L/sec based on a simplified Darcy Seepage calculation. The low seepage rate was confirmed by field observations (Golder 1997).

The Pronto Thrust fault intercepts the mine workings at depth (Figure 3.1 from Golder, 1997). The existence of drill holes through the fault zone suggests that the hydraulic head within the section of the fault near the mill site is comparable to the Holding Pond level. Results of from BH-2, located near the fault contact west of the mine site, indicate a groundwater level that is about 10 m higher than the Holding Pond. The groundwater divide is in part sustained by a beaver pond at this location. Accordingly, the groundwater flow is interpreted to be towards the Holding Pond (Golder 1997).

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13.0 LIMITATIONS

This report was prepared for the exclusive use of Denison Environmental Services and Rio Algom Limited. This report, which includes all tables, figures and appendices, is based on data and historical information and data obtained by Golder and others as described in this report (see References for list of previous reports).

Golder has assumed that the information provided was factual and accurate. Golder accepts no responsibility for any deficiency, misstatement or inaccuracy contained in this report as a result of omissions, misinterpretations or fraudulent acts of persons interviewed or contacted. Should any of the reports be amended, Golder should be allowed an opportunity to revisit the conclusions made in the report.

The findings and conclusions of this report are valid only as of the date of this report. If new information is discovered in future work, including excavations, borings, or other studies, Golder should be requested to re-evaluate the conclusions of this report, and to provide amendments as required.

The services performed, as described in this report, were conducted in a manner consistent with that level of care and skill normally exercised by other members of the engineering and science professions currently practicing under similar conditions, subject to the time limits and financial and physical constraints applicable to the services.

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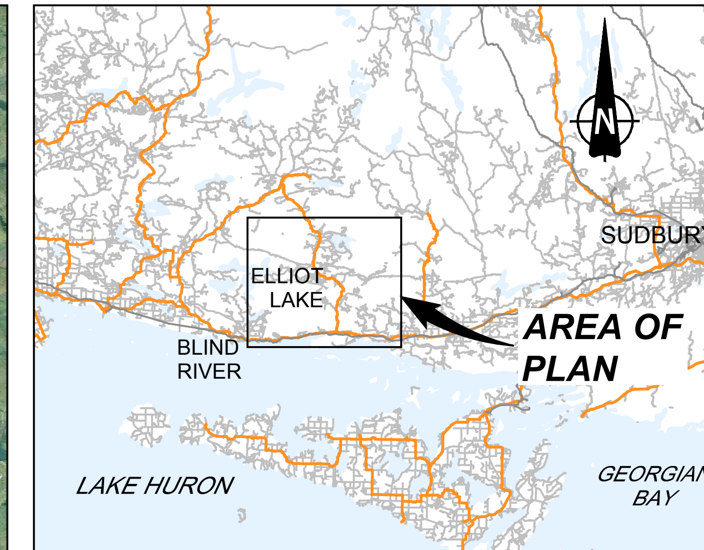
https://golderassociates.sharepoint.com/sites/111541/project files/6 deliverables/19126010-r01-rev1 reg hydrog (dec 2020).docx

Figures



KEY PLAN

REFERENCE

DRAWING BASED ON BING IMAGERY AS OF FEBRUARY 20, 2020 (IMAGE DATE UNKNOWN); AND CANMAP STREETFILES V2008.4.

NOTES

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ALL LOCATIONS ARE APPROXIMATE.

PROJECT

ELLIOT LAKE SITES GROUNDWATER REPORT
DENISON MINES CORP. AND RIO ALGOM LTD.
ELLIOT LAKE, ONTARIO

TITLE

LOCATION PLAN

GOLDER

PROJECT No.	19126010	FILE No.	19126010-R01001
		SCALE	AS SHOWN
CADD	ZJB	July 31/20	REV.
CHECK	SJH		FIGURE 1

Client: Denison Environmental Services

Original Format is Tabloid 279mm x 432mm

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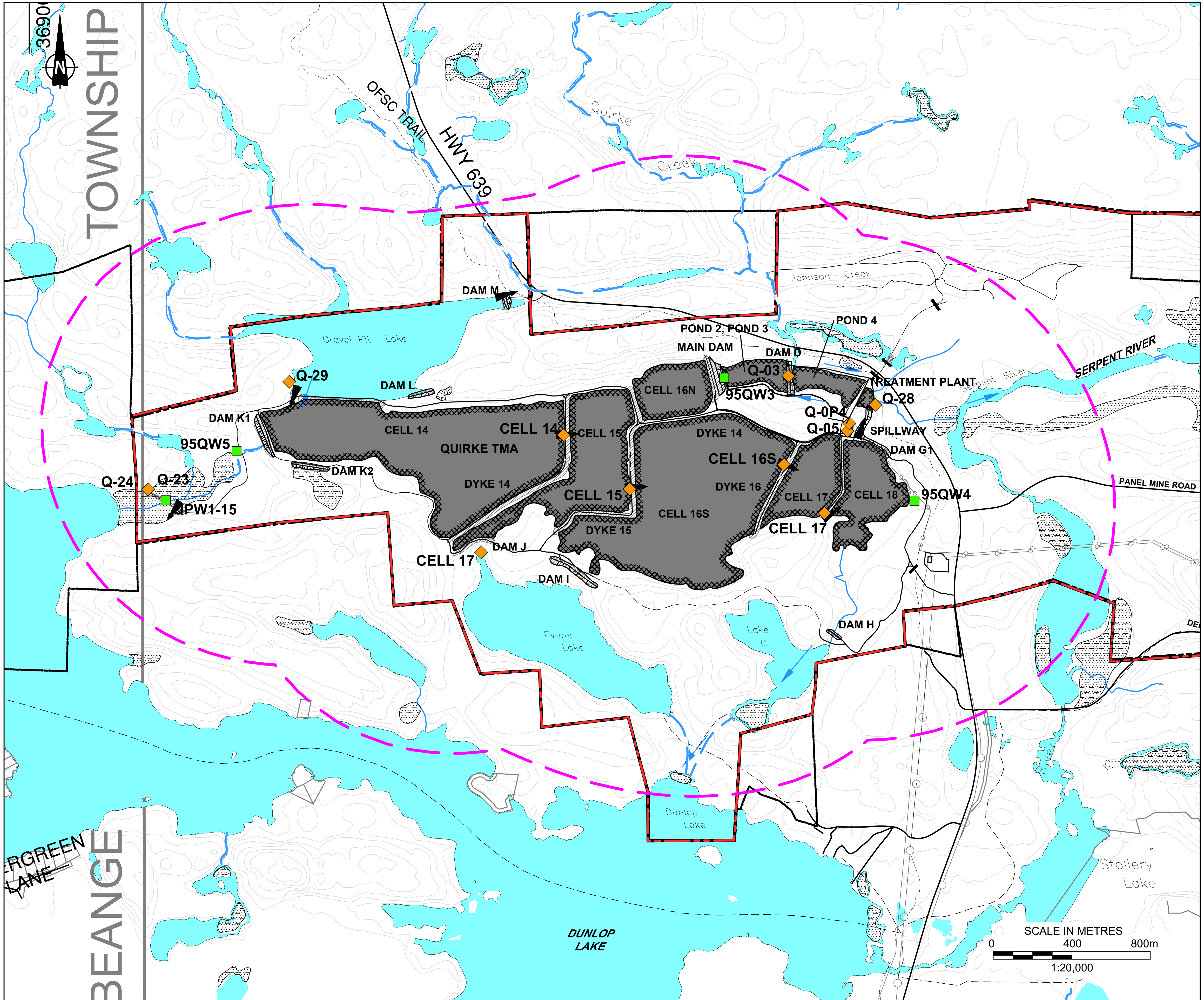
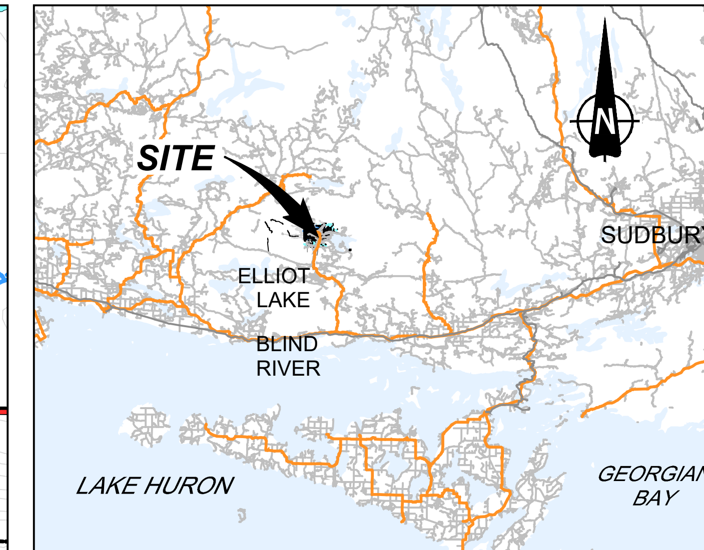
Drawing file: 19126010-R01001.dwg Jul 31, 2020 - 9:27am





KEY PLAN

LEGEND

- APPROXIMATE LIMIT OF LICENSED AREA
- APPROXIMATE CREEK/CHANNEL
- 1km BUFFER FROM TMA
- WATER COVERED TAILINGS OR TREATMENT SLUDGE
- DAM
- SWAMP
- TOMP GROUNDWATER SAMPLING STATION
- SOURCE AREA MONITORING PROGRAM (SAMP) SURFACE WATER SAMPLING STATION

REFERENCE

DRAWING BASED ON MINNOW ENVIRONMENTAL INC., SERPENT RIVER WATERSHED CYCLE 4 (2010 TO 2014) STATE OF THE ENVIRONMENT REPORT, FIGURE 3.10, NOVEMBER 2017;
BING IMAGERY AS OF DECEMBER 23 - 2019 (IMAGE DATE UNKNOWN); AND
CANMAP STREETFILES V2008.4.

NOTES

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BING IMAGERY USED FOR ILLUSTRATION PURPOSES ONLY AND NOT TO BE USED FOR MEASUREMENTS.
ALL LOCATIONS ARE APPROXIMATE.

PROJECT
ELLIOT LAKE SITES GROUNDWATER REPORT
DENISON MINES CORP. AND RIO ALGOM LTD.
ELLIOT LAKE, ONTARIO

TITLE
LOCATION PLAN (QUIRKE TMA)

GOLDER

PROJECT No.	19126010	FILE No.	19126010-R01041
CADD	Dec 10/20	SCALE	AS SHOWN
CHECK	STH	REV.	

FIGURE 4.1

LEGEND

APPROXIMATE LIMIT OF LICENSED AREA
APPROXIMATE CREEK/CHANNEL

WATER COVERED TAILINGS OR TREATMENT SLUDGE

RECENT

9 Swamp and organic deposits: peat, much, marshland

6 Glaciolacustrine coarse-grained deposits: stratifiec fine to very fine sand and sandy silt; minor gravel, silt and clay

5 Glaciofluvial outwash deposits: stratified sand and gravel; boulders

4 Ice-contact stratified drift: complexly interstratified sand and gravel; minor diamicton, silt and clay
- 4a Kames, kame terraces, eskers and leeside deposits
- 4b Subaqueous fan deposits

3 Till: silty sand to sandy diamicton; generally massive, loose

2 Bedrock-drift complex: thin (less than 1m) discontinuous drift cover over bedrock; thicker drift accumulations may localy subdue bedrock topography
- 2a mainly covered by diamicton (till)
- 2b mainly covered by sand and gravel
- 2c mainly covered by silt and lcay

PRECAMBRIAN

1 Bedrock, undifferentiated: predominantly bare outcrops with drift accumulations locallized in depressions on bedrock surface

REFERENCE

DRAWING BASED ON MINNOW ENVIRONMENTAL INC., SERPENT RIVER WATERSHED CYCLE 4 (2010 TO 2014) STATE OF THE ENVIRONMENT REPORT, FIGURE 3.10, NOVEMBER 2017;
BING IMAGERY AS OF December 23 - 2019 (IMAGE DATE UNKNOWN); AND
MINISTRY OF NORTHERN DEVELOPMENT AND MINES, QUATERNARY GEOLOGY OF ELLIOT LAKE AREA, OPEN FILE MAP 193, 1975.

NOTES

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ALL LOCATIONS ARE APPROXIMATE.

PROJECT
ELLIOT LAKE SITES GROUNDWATER REPORT
DENISON MINES CORP. AND RIO ALGOM LTD.
ELLIOT LAKE, ONTARIO

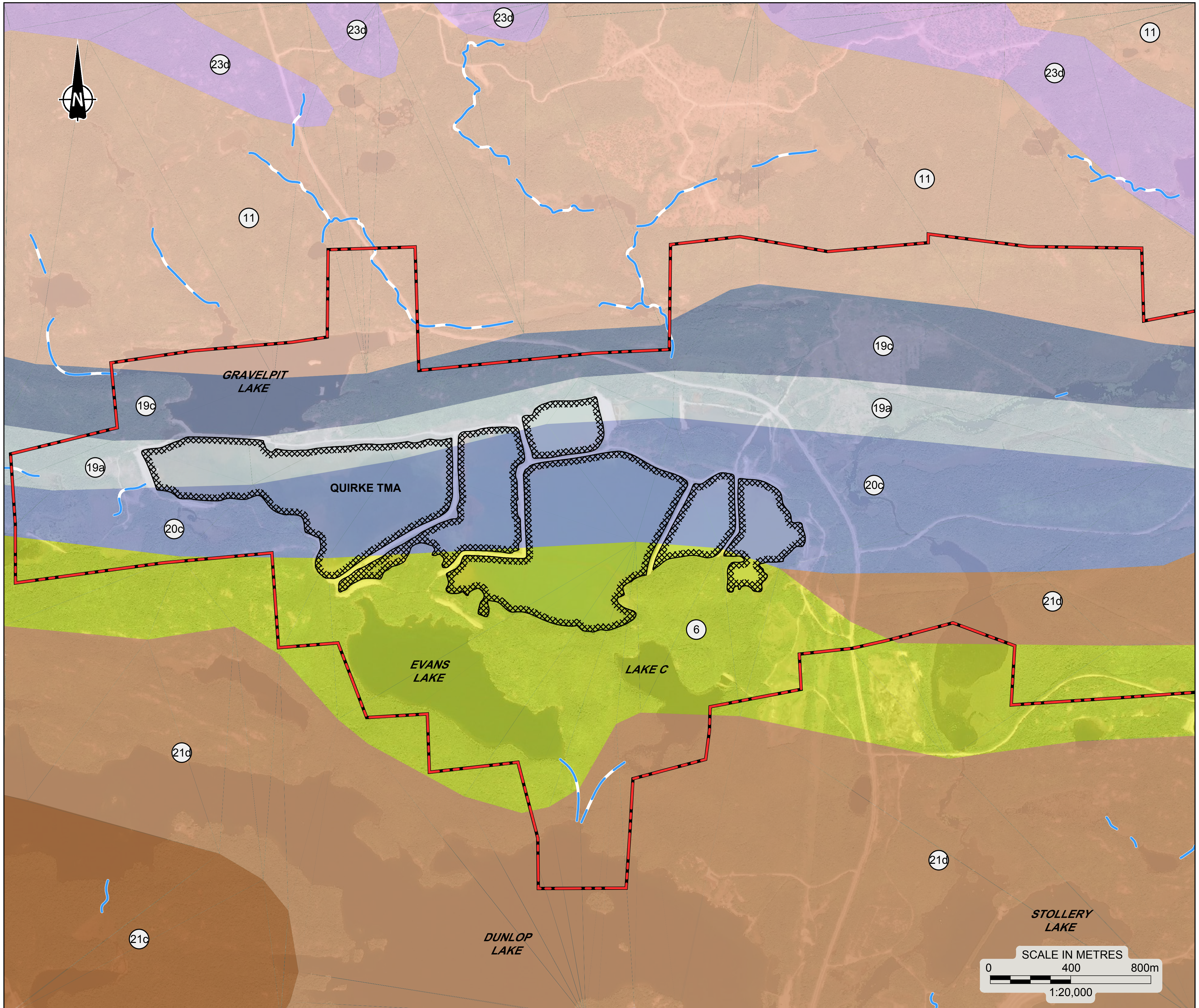
TITLE
QUATERNARY GEOLOGY (QUIRKE TMA)

GOLDER

PROJECT No.	19126010	FILE No.	19126010-R01042
CADD	ZJB/DCH	Dec 7/20	SCALE AS SHOWN
CHECK			REV.

FIGURE 4.2

Client: Denison Environmental Services
Original Format is Tabloid 279mm x 432mm
Drawing file: 19126010-R01042.dwg Dec 07, 2020 - 12:19pm



LEGEND

- APPROXIMATE LIMIT OF LICENSED AREA
- APPROXIMATE CREEK/CHANNEL
- WATER COVERED TAILINGS
- 6 Felsic to intermediate metavolcanic rocks
- 11 Gneissic tonalite suite
- 19a Hough Lake Group (Mississagi Formation)
- 19c Hough Lake Group (Ramsay Lake Formation)
- 20c Quirke Lake Group (Bruce Formation)
- 21c Cobalt Group (Lorrain Formation)
- 21d Cobalt Group (Gowganda Formation)
- 23d Mafic and related intrusive rocks

REFERENCE

DRAWING BASED ON MINNOW ENVIRONMENTAL INC., SERPENT RIVER WATERSHED CYCLE 4 (2010 TO 2014) STATE OF THE ENVIRONMENT REPORT, FIGURE 3.10, NOVEMBER 2017;
BING IMAGERY AS OF DECEMBER 24 - 2019 (IMAGE DATE UNKNOWN); AND
MINISTRY OF NORTHERN DEVELOPMENT AND MINES, ONTARIO GEOLOGIC SURVEY, MRD 126-REVISED, 1:250,000 SCALE.

NOTES

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ALL LOCATIONS ARE APPROXIMATE.

PROJECT
ELLIOT LAKE SITES GROUNDWATER REPORT
DENISON MINES CORP. AND RIO ALGOM LTD.
ELLIOT LAKE, ONTARIO

TITLE
BEDROCK GEOLOGY (QUIRKE TMA)

GOLDER

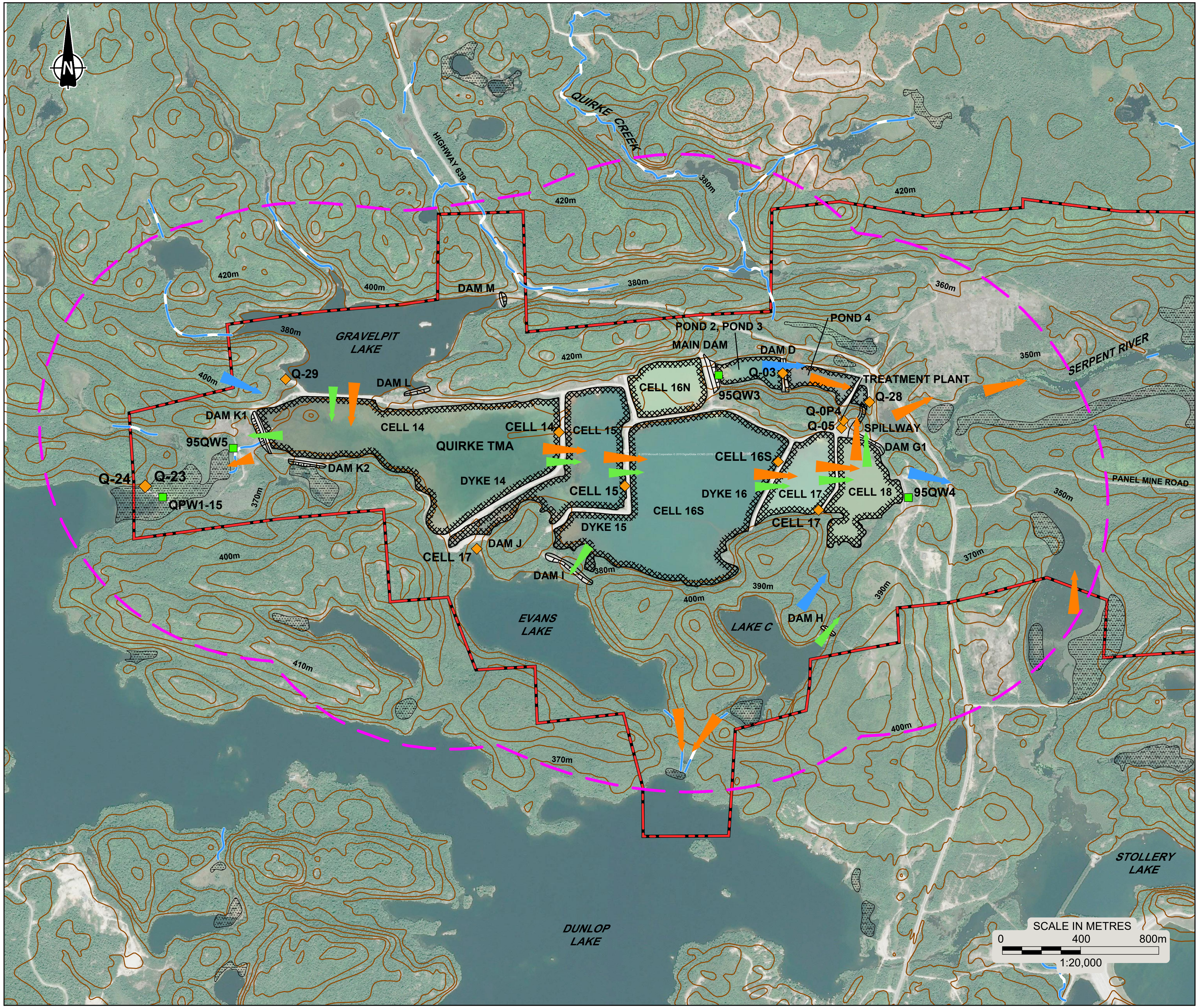
PROJECT No.	19126010	FILE No.	19126010-R01043
		SCALE	AS SHOWN
CADD	ZJB	Apr 28/20	REV.
CHECK			

FIGURE 4.3

Client: Denison Environmental Services
Original Format is Tabloid 279mm x 432mm
Drawing file: 19126010-R01043.dwg Apr 28, 2020 - 1:56pm

Client: Denison Environmental Services

Original Format is Tabloid 279mm x 432mm



LEGEND

- APPROXIMATE LIMIT OF LICENSED AREA
- APPROXIMATE CREEK/CHANNEL
- 1km BUFFER FROM TMA
- INFERRED GROUNDWATER FLOW DIRECTION
- INFERRED SURFACE WATER FLOW DIRECTION
- INFERRED SEEPAGE FLOW
- WATER COVERED TAILINGS OR TREATMENT SLUDGE
- DAM
- SWAMP
- TOMP GROUNDWATER SAMPLING STATION
- SOURCE AREA MONITORING PROGRAM (SAMP) SURFACE WATER SAMPLING STATION

REFERENCE

DRAWING BASED ON MINNOW ENVIRONMENTAL INC., SERPENT RIVER WATERSHED CYCLE 4 (2010 TO 2014) STATE OF THE ENVIRONMENT REPORT, FIGURE 3.10, NOVEMBER 2017; AND
BING IMAGERY AS OF DECEMBER 23 - 2019 (IMAGE DATE UNKNOWN),

NOTES

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ALL LOCATIONS ARE APPROXIMATE.

PROJECT

ELLIOT LAKE SITES GROUNDWATER REPORT
DENISON MINES CORP. AND RIO ALGOM LTD.
ELLIOT LAKE, ONTARIO

TITLE

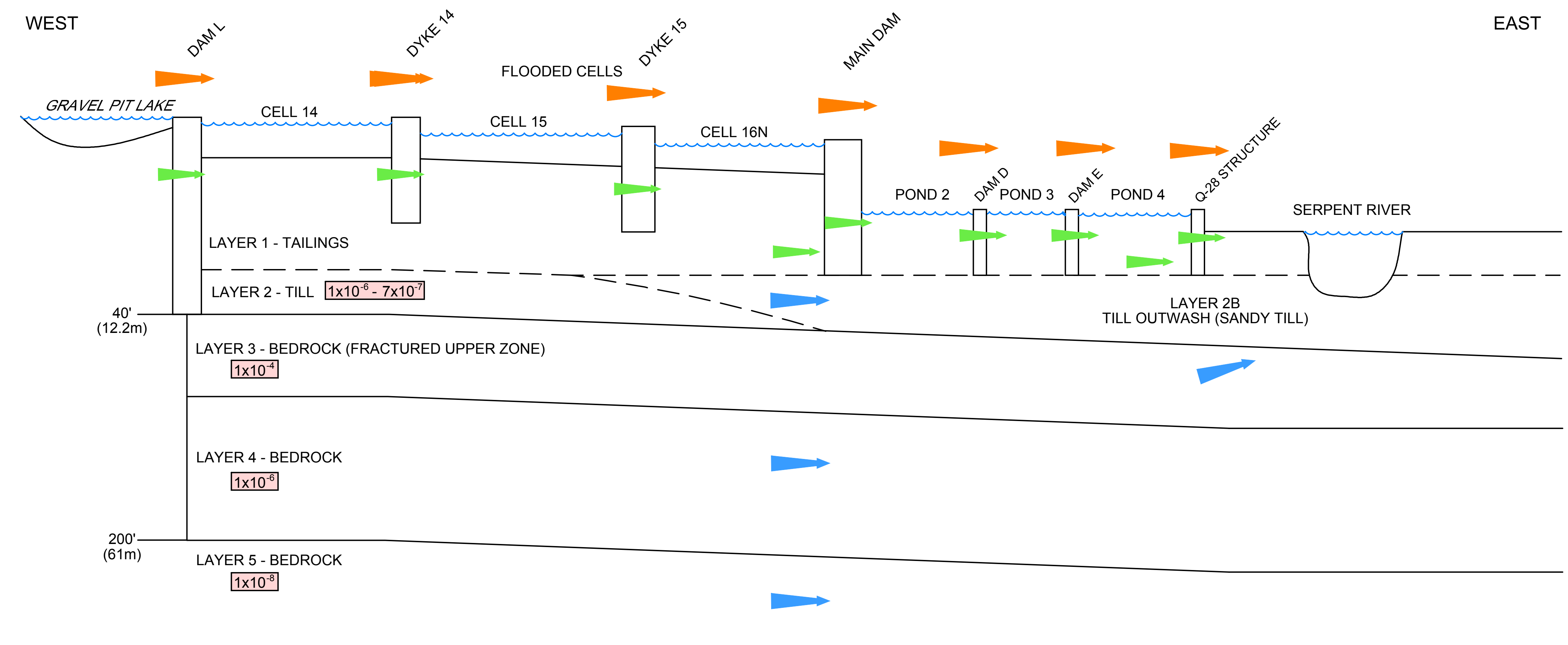
INFERRED FLOW DIRECTIONS (QUIRKE TMA)

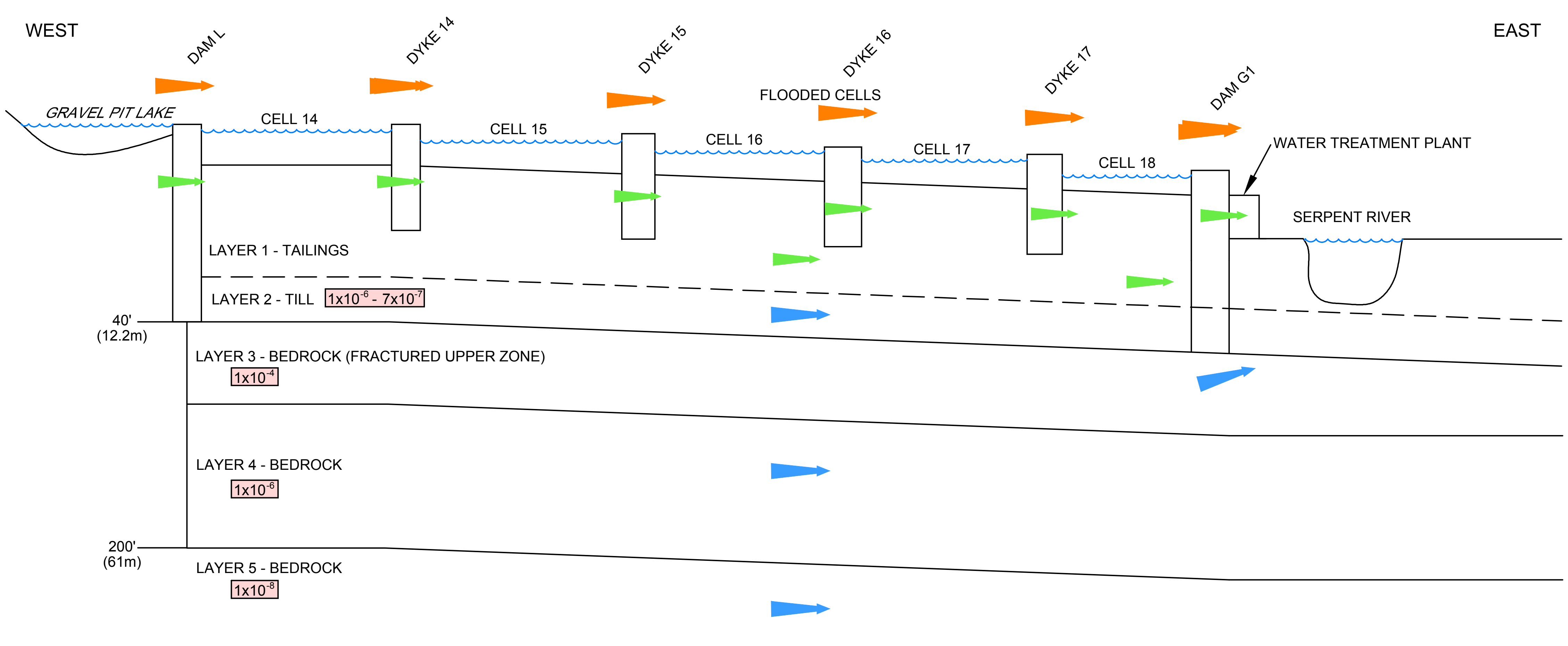
GOLDER

PROJECT No.	19126010		FILE No.	19126010–R01044
			SCALE AS SHOWN	REV.
CADD	ZJB/DCH	Dec 10/20		
CHECK				

FIGURE 4.4

Drawing file: 19126010–R01044.dwg Dec 10, 2020 – 10:44am





LEGEND

- INFERRED GROUNDWATER FLOW DIRECTION
- INFERRED SURFACE WATER FLOW DIRECTION
- INFERRED SEEPAGE FLOW
- $1x10^{-7}$ HYDRAULIC CONDUCTIVITY (K) VALUE IN (m/s) FROM HYDRAULIC TESTING

NOTES

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ALL LOCATIONS ARE APPROXIMATE.

PROJECT

ELLIOT LAKE SITES GROUNDWATER REPORT
DENISON MINES CORP. AND RIO ALGOM LTD.
ELLIOT LAKE, ONTARIO

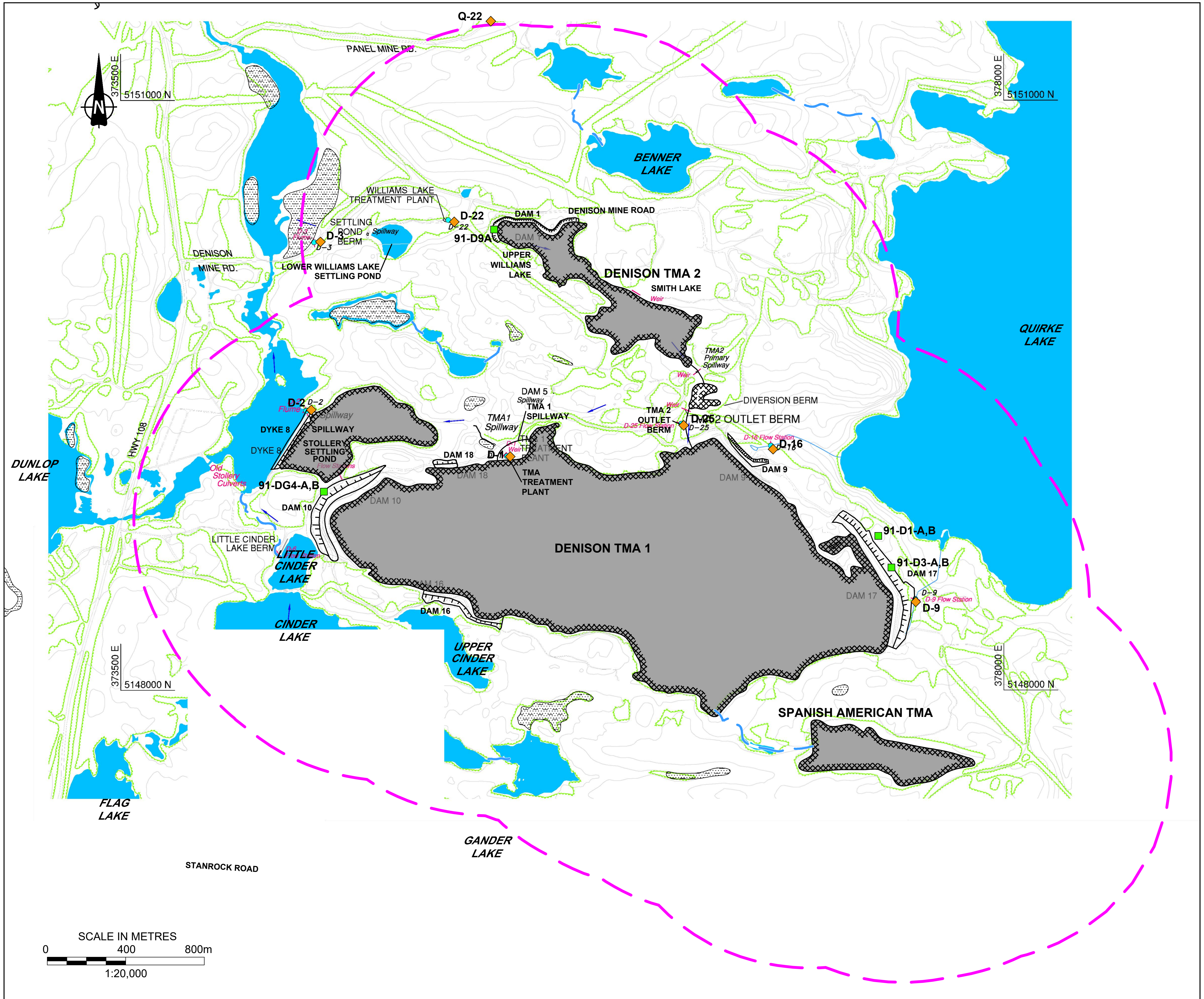
TITLE

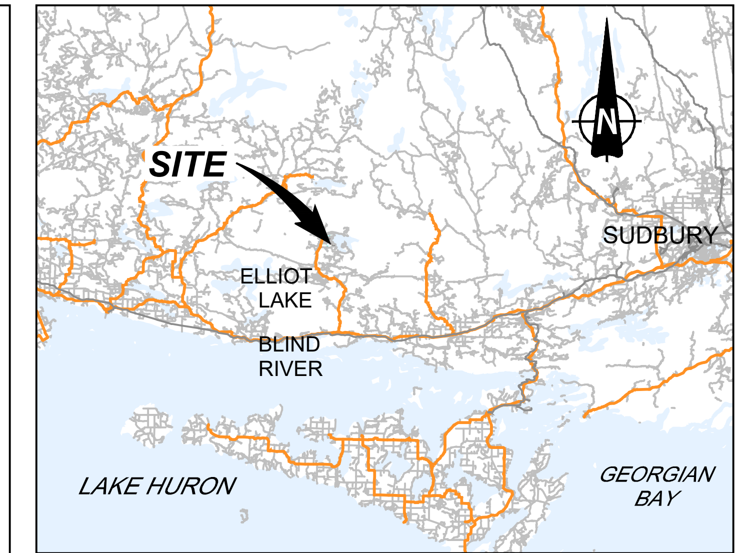
CONCEPTUAL HYDROGEOLOGICAL MODEL (QUIRKE TMA)

GOLDER

PROJECT No.	19126010	FILE No.	19126010-R01045
		SCALE	N.T.S. REV.
CADD	ZJB/DCH Dec 11/20		
CHECK	STH		

FIGURE 4.5





KEY PLAN

LEGEND

- APPROXIMATE CREEK/CHANNEL
- 1km BUFFER FROM TMA
- WATER COVERED TAILINGS
- DAM
- SWAMP
- TOMP GROUNDWATER SAMPLING STATION
- SOURCE AREA MONITORING PROGRAM (SAMP) SURFACE WATER SAMPLING STATION

REFERENCE

DRAWING BASED ON 2018 OPERATING CARE & MAINTENANCE ANNUAL REPORT, DENISON MINES INC.; DENISON SAMPLE LOCATION PLAN; BING IMAGERY AS OF DECEMBER 23 - 2019 (IMAGE DATE UNKNOWN); AND CANMAP STREETFILES V2008.4.

NOTES

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ALL LOCATIONS ARE APPROXIMATE.

PROJECT

ELLIOT LAKE SITES GROUNDWATER REPORT
DENISON MINES CORP. AND RIO ALGOM LTD.
ELLIOT LAKE, ONTARIO

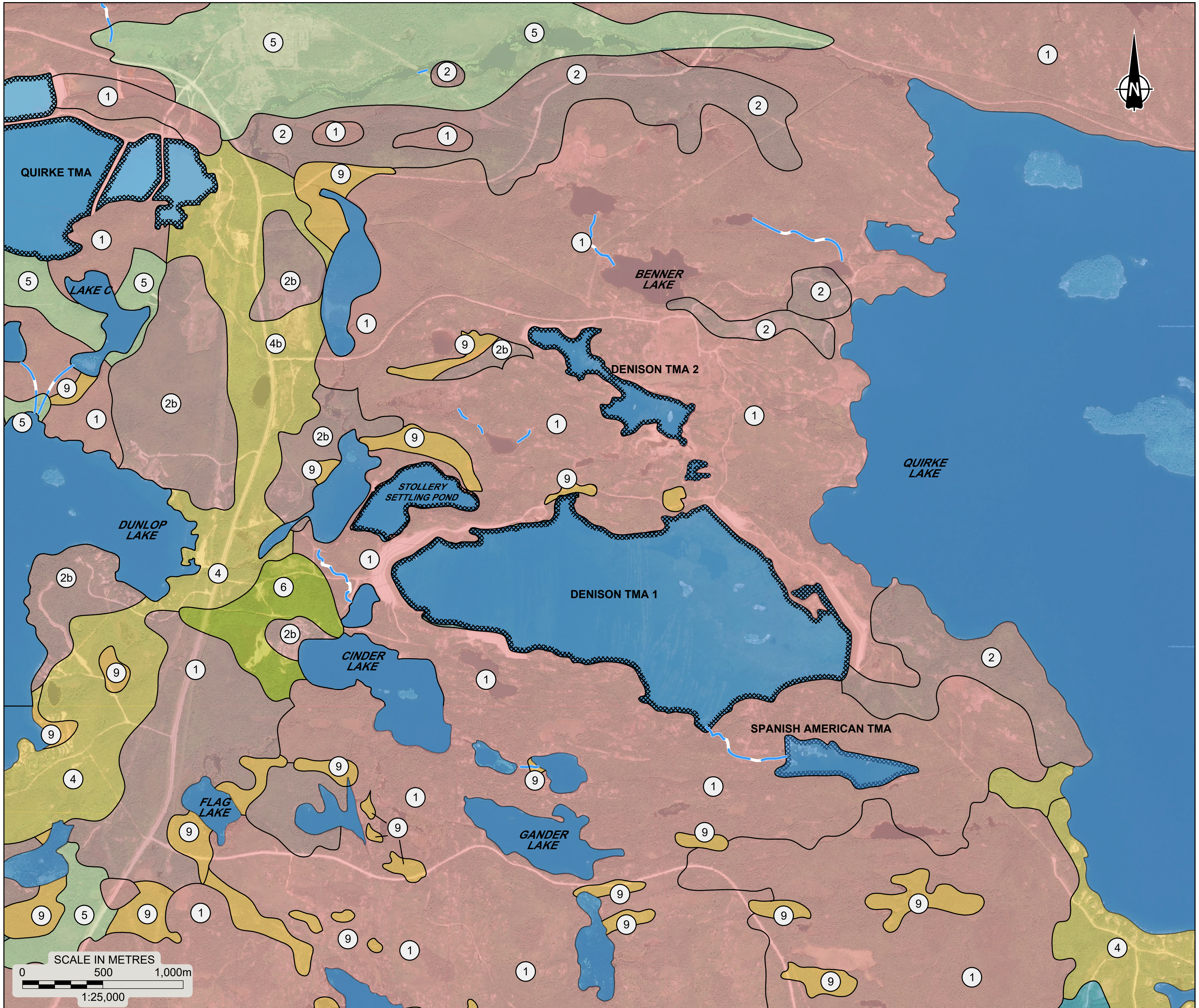
TITLE

LOCATION PLAN (DENISON TMA)

GOLDER

PROJECT No.	19126010	FILE No.	19126010-R01051
CADD	Dec 10/20	SCALE AS SHOWN	REV.
CHECK			

FIGURE 5.1



LEGEND

APPROXIMATE CREEK/CHANNEL

WATER COVERED TAILINGS

RECENT

9 Swamp and organic deposits: peat, much, marshland

6 Glaciolacustrine coarse-grained deposits: stratifiec fine to very fine sand and sandy silt; minor gravel, silt and clay

5 Glaciofluvial outwash deposits: stratified sand and gravel; boulders

4 Ice-contact stratified drift: complexly interstratified sand and gravel; minor diamicton, silt and clay
- 4a Kames, kame terraces, eskers and leeside deposits
- 4b Subaqueous fan deposits

3 Till: silty sand to sandy diamicton; generally massive, loose

2 Bedrock-drift complex: thin (less than 1m) discontinuous drift cover over bedrock; thicker drift accumulations may localy subdue bedrock topography
- 2a mainly covered by diamicton (till)
- 2b mainly covered by sand and gravel
- 2c mainly covered by silt and lcay

PRECAMBRIAN

1 Bedrock, undifferentiated: predominantly bare outcrops with drift accumulations locallized in depressions on bedrock surface

REFERENCE

DRAWING BASED ON 2018 OPERATING CARE & MAINTENANCE ANNUAL REPORT, DENISON MINES INC.; DENISON SAMPLE LOCATION PLAN;
BING IMAGERY AS OF DECEMBER 23 - 2019 (IMAGE DATE UNKNOWN); AND
MINISTRY OF NORTHERN DEVELOPMENT AND MINES, QUATERNARY GEOLOGY OF ELLIOT LAKE AREA, OPEN FILE MAP 193, 1975.

NOTES

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ALL LOCATIONS ARE APPROXIMATE.

PROJECT

ELLIOT LAKE SITES GROUNDWATER REPORT
DENISON MINES CORP. AND RIO ALGOM LTD.
ELLIOT LAKE, ONTARIO

TITLE

QUATERNARY GEOLOGY (DENISON TMA)

GOLDER

PROJECT No.	19126010	FILE No.	19126010-R01052
		SCALE	AS SHOWN	REV.
CADD	ZJB/DCH	Dec 10/20	
CHECK			

FIGURE 5.2

Drawing file: 19126010-R01052.dwg Dec 10, 2020 - 10:57am Original Format is Tabloid 279mm x 432mm Client: Denison Environmental Services

25mm
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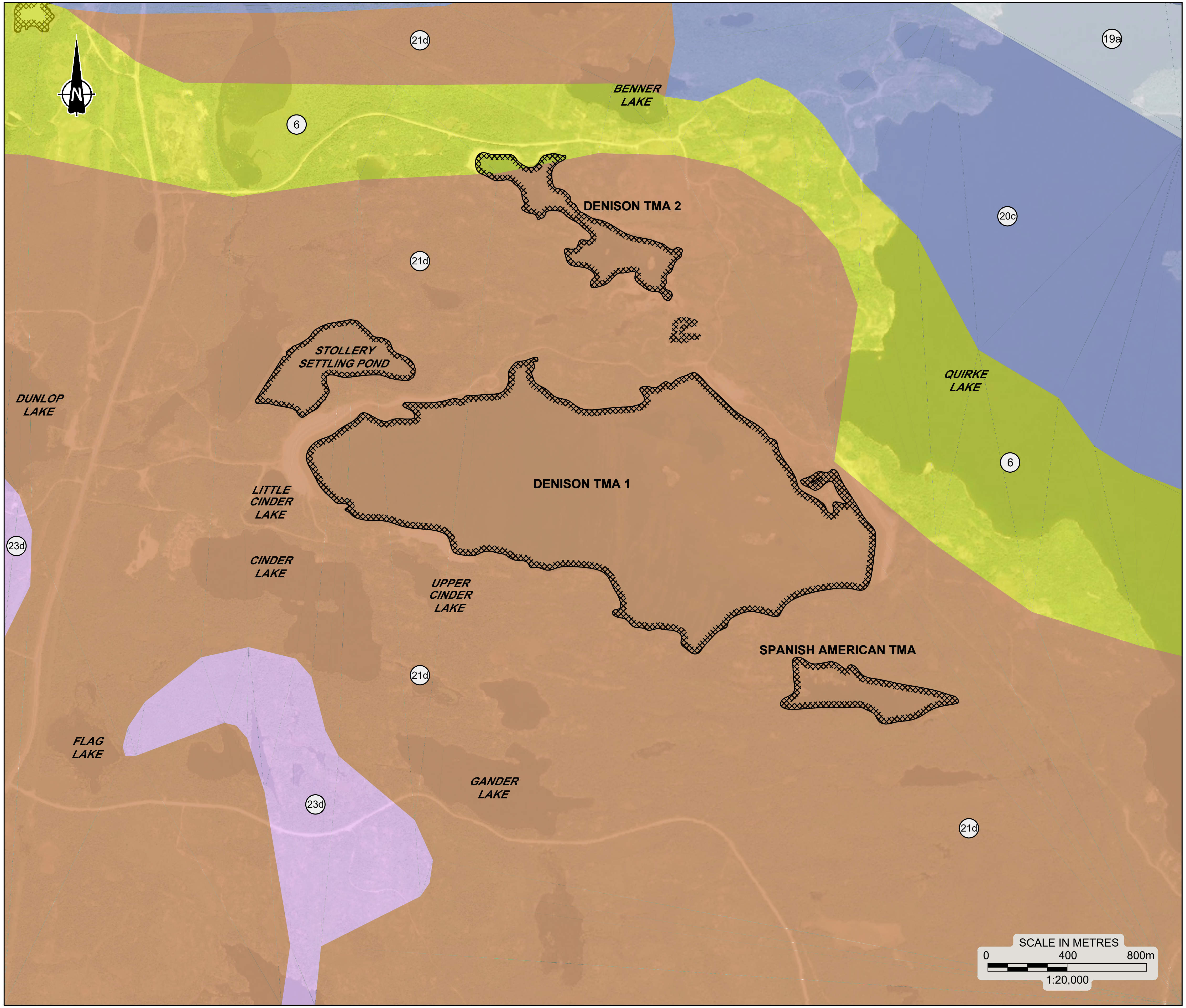

LEGEND

WATER COVERED TAILINGS

- 6 — Felsic to intermediate metavolcanic rocks
- 19a — Hough Lake Group (Mississagi Formation)
- 20c — Quirke Lake Group (Bruce Formation)
- 21d — Cobalt Group (Gowganda Formation)
- 23d — Mafic and related intrusive rocks

REFERENCE

DRAWING BASED ON MINNOW ENVIRONMENTAL INC., SERPENT RIVER WATERSHED CYCLE 4 (2010 TO 2014) STATE OF THE ENVIRONMENT REPORT, FIGURE 3.10, NOVEMBER 2017;
BING IMAGERY AS OF DECEMBER 24 - 2019 (IMAGE DATE UNKNOWN); AND
MINISTRY OF NORTHERN DEVELOPMENT AND MINES, ONTARIO GEOLOGIC SURVEY, MRD 126-REVISED, 1:250,000 SCALE.

NOTES

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ALL LOCATIONS ARE APPROXIMATE.

PROJECT

ELLIOT LAKE SITES GROUNDWATER REPORT
DENISON MINES CORP. AND RIO ALGOM LTD.
ELLIOT LAKE, ONTARIO

TITLE

BEDROCK GEOLOGY (DENISON TMA)

GOLDER

PROJECT No.	19126010	FILE No.	19126010-R01053
CADD	ZJB/DCH Dec 10/20	SCALE	AS SHOWN
CHECK		REV.	

FIGURE 5.3

LEGEND

- APPROXIMATE CREEK/CHANNEL
- 1km BUFFER FROM TMA
- INFERRED GROUNDWATER FLOW DIRECTION
- INFERRED SURFACE WATER FLOW DIRECTION
- INFERRED SEEPAGE FLOW
- WATER COVERED TAILINGS
- DAM
- SWAMP
- TOMP GROUNDWATER SAMPLING STATION
- SOURCE AREA MONITORING PROGRAM (SAMP) SURFACE WATER SAMPLING STATION

REFERENCE

DRAWING BASED ON 2018 OPERATING CARE & MAINTENANCE ANNUAL REPORT, DENISON MINES INC.; DENISON SAMPLE LOCATION PLAN; BING IMAGERY AS OF DECEMBER 23 - 2019 (IMAGE DATE UNKNOWN); AND CANMAP STREETFILES V2008.4.

NOTES

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ALL LOCATIONS ARE APPROXIMATE.

PROJECT

ELLIOT LAKE SITES GROUNDWATER REPORT
DENISON MINES CORP. AND RIO ALGOM LTD.
ELLIOT LAKE, ONTARIO

TITLE

INFERRED FLOW DIRECTIONS (DENISON TMA)

GOLDER

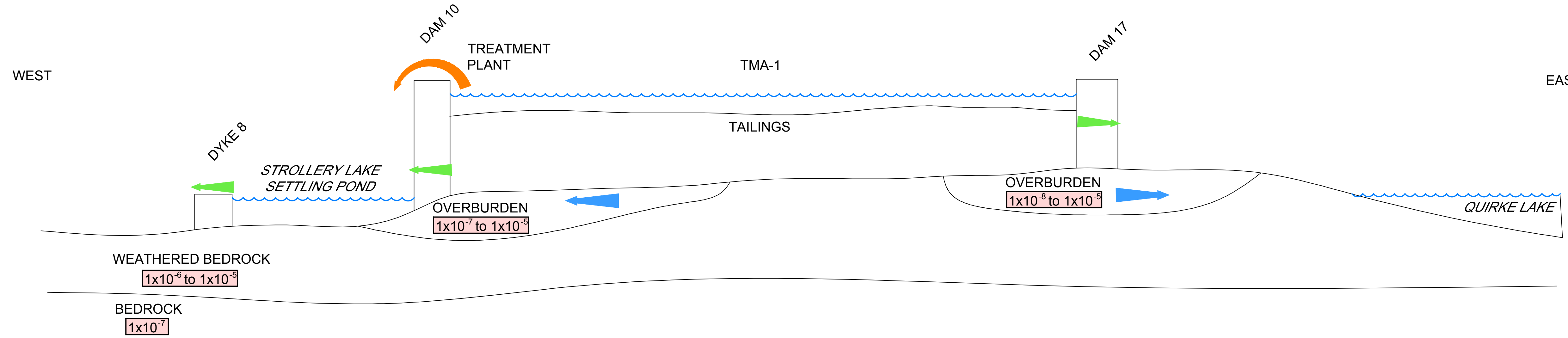
PROJECT No.	19126010	FILE No.	19126010-R01054
		SCALE	AS SHOWN
CADD	ZJB/DCH	Dec 10/20	REV.
CHECK			

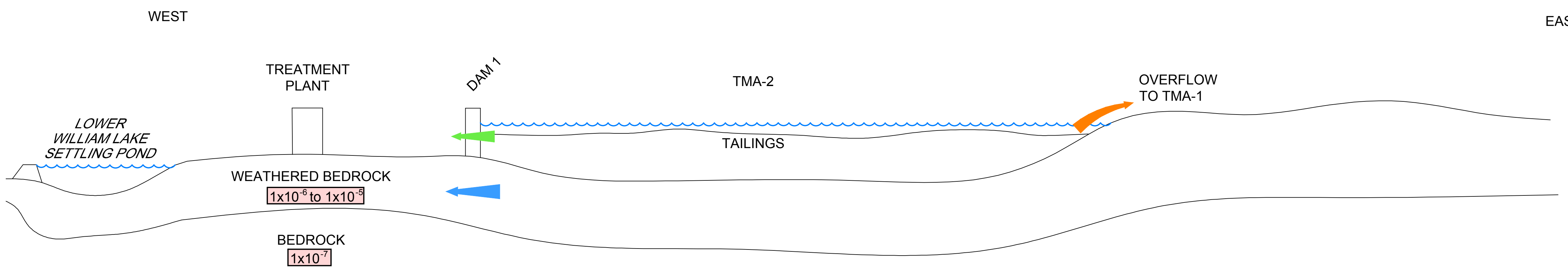
FIGURE 5.4

Client: Denison Environmental Services

Original Format is Tabloid 279mm x 432mm

Drawing file: 19126010-R01054.dwg Dec 10, 2020 - 4:17pm





LEGEND

- INFERRED GROUNDWATER FLOW DIRECTION
- INFERRED SEEPAGE FLOW
- INFERRED SURFACE WATER FLOW DIRECTION

1x10-7 HYDRAULIC CONDUCTIVITY (K) VALUE IN (m/s) FROM HYDRAULIC TESTING

NOTES

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ALL LOCATIONS ARE APPROXIMATE.

PROJECT

ELLIOT LAKE SITES GROUNDWATER REPORT
DENISON MINES CORP. AND RIO ALGOM LTD.
ELLIOT LAKE, ONTARIO

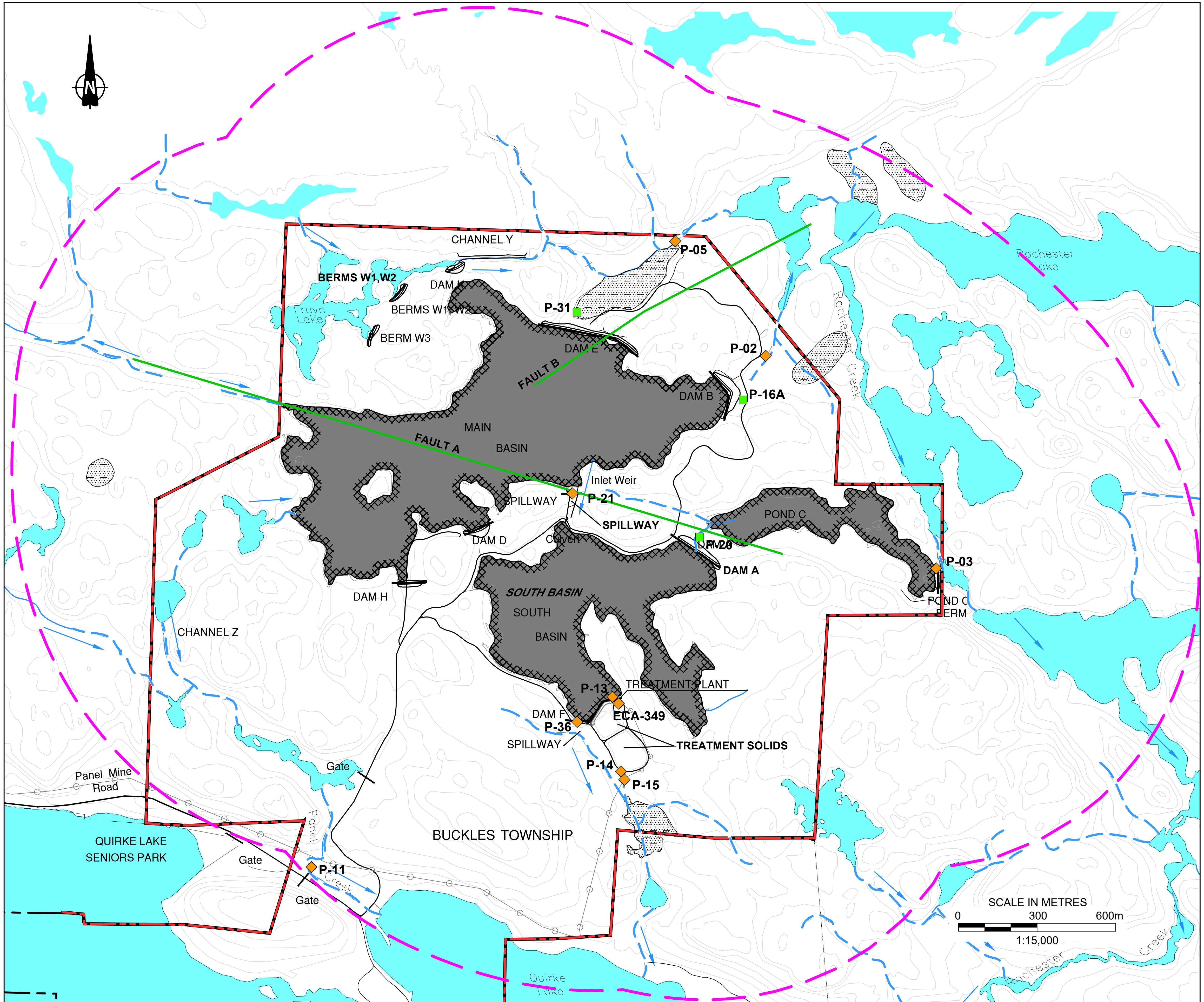
TITLE

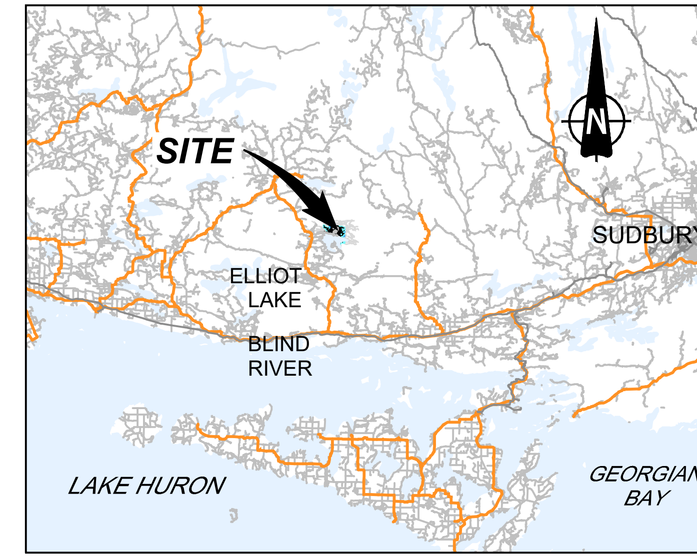
CONCEPTUAL HYDROGEOLOGICAL MODEL (DENISON TMA)

GOLDER

PROJECT No.	19126010	FILE No.	19126010-R01055
		SCALE	N.T.S. REV.
CADD	ZJB/DCH	Dec 15/20	
CHECK			

FIGURE 5.5





KEY PLAN

LEGEND

- APPROXIMATE LIMIT OF LICENSED AREA
- APPROXIMATE CREEK/CHANNEL
- APPROXIMATE FAULT LINE
- 1km BUFFER FROM TMA
- WATER COVERED TAILINGS
- DAM
- SWAMP
- GROUNDWATER SAMPLING STATION
- SOURCE AREA MONITORING PROGRAM (SAMP) SURFACE WATER SAMPLING STATION

REFERENCE

DRAWING BASED ON MINNOW, PANEL SITE SAMP AND TOMP MONTORING STATIONS, FIGURE 3.16, FEBRUARY 2016;
BING IMAGERY AS OF DECEMBER 19 - 2019 (IMAGE DATE UNKNOWN); AND
HYDROGEOLOGICAL ASSESSMENT, PANEL MINE WASTE MANAGEMENT AREA, ELLIOT LAKE, ONTARIO, CONTRACT No. 581-A-05, PROJECT No. 881-1817B, FIGURE 3;
CANMAP STREETFILES V2008.4.

NOTES

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ALL LOCATIONS ARE APPROXIMATE.

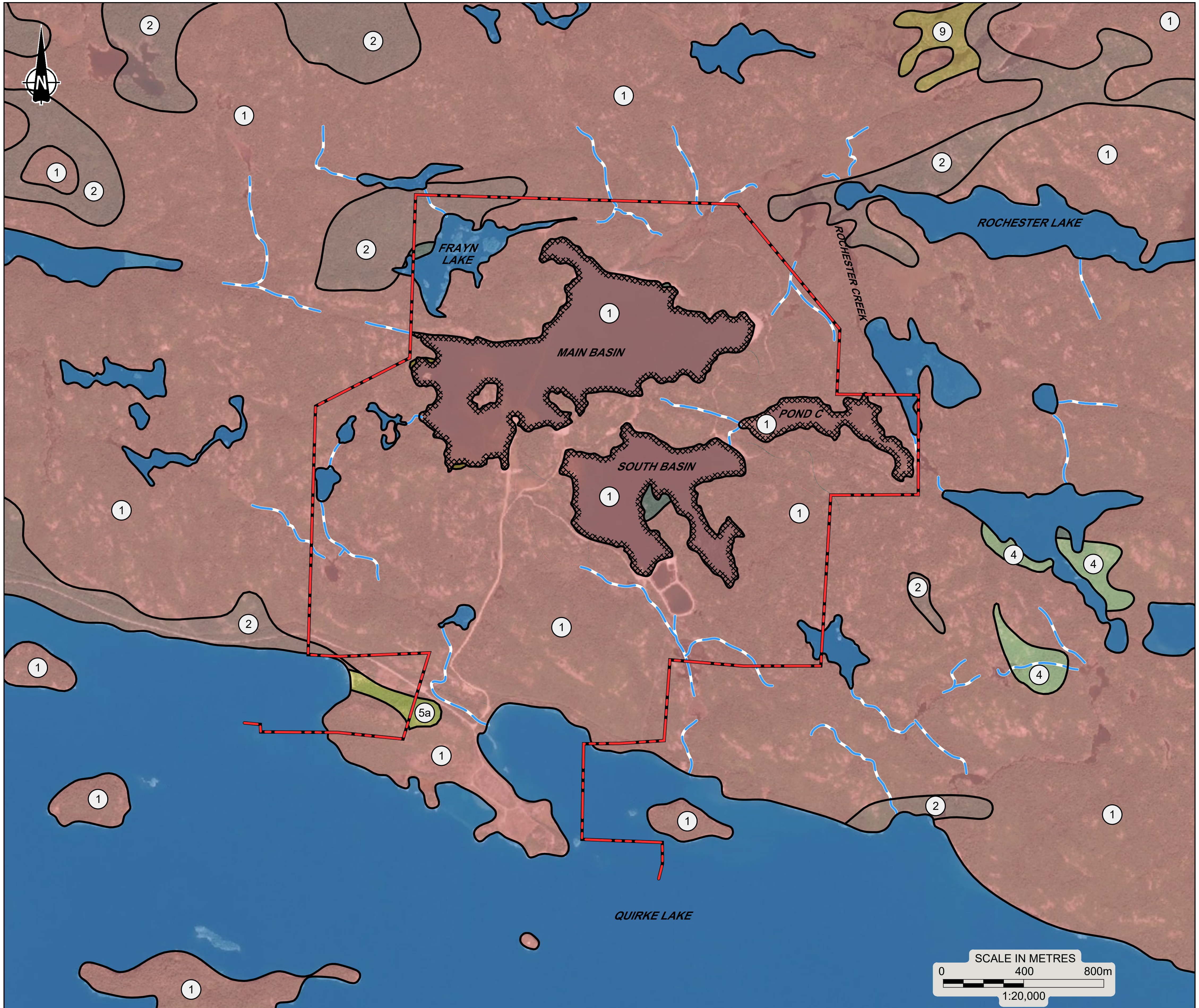
PROJECT
ELLIOT LAKE SITES GROUNDWATER REPORT
DENISON MINES CORP. AND RIO ALGOM LTD.
ELLIOT LAKE, ONTARIO

TITLE
LOCATION PLAN (PANEL TMA)

GOLDER

PROJECT No.	19126010	FILE No.	19126010-R01061
		SCALE	AS SHOWN
CADD	Dec 9/20	REV.	
CHECK			

FIGURE 6.1



LEGEND

- APPROXIMATE LIMIT OF LICENSED AREA
- APPROXIMATE CREEK/CHANNEL
- APPROXIMATE FAULT LINE
- WATER COVERED TAILINGS
- Lake

RECENT

- 9 Organic deposits: peat, much, marshland

PLEISTOCENE

- 5a Glaciofluvial outwash
  - 5a Sand, gravelly sand
- 4 Glaciofluvial Ice-contact stratified drift
- 2 Bedrock-drift complex: thin, variable or discontinuous drift cover over bedrock

PRECAMBRIAN

- 1 Undifferentiated: predominantly bare or very thinly drift covered

REFERENCE

DRAWING BASED ON MINNOW, PANEL SITE SAMP AND TOMP MONTORING STATIONS, FIGURE 3.16, FEBRUARY 2016;
BING IMAGERY AS OF DECEMBER 19 - 2019 (IMAGE DATE UNKNOWN);
MINISTRY OF NORTHERN DEVELOPMENT AND MINES, QUATERNARY GEOLOGY OF RAWHIDE LAKE AREA, OPEN FILE MAP 3231, 1993; AND
HYDROGEOLOGICAL ASSESSMENT, PANEL MINE WASTE MANAGEMENT AREA, ELLIOT LAKE, ONTARIO, CONTACT No. 581-A-05, PROJECT No. 881-1817B, FIGURE 3.

NOTES

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ALL LOCATIONS ARE APPROXIMATE.

PROJECT

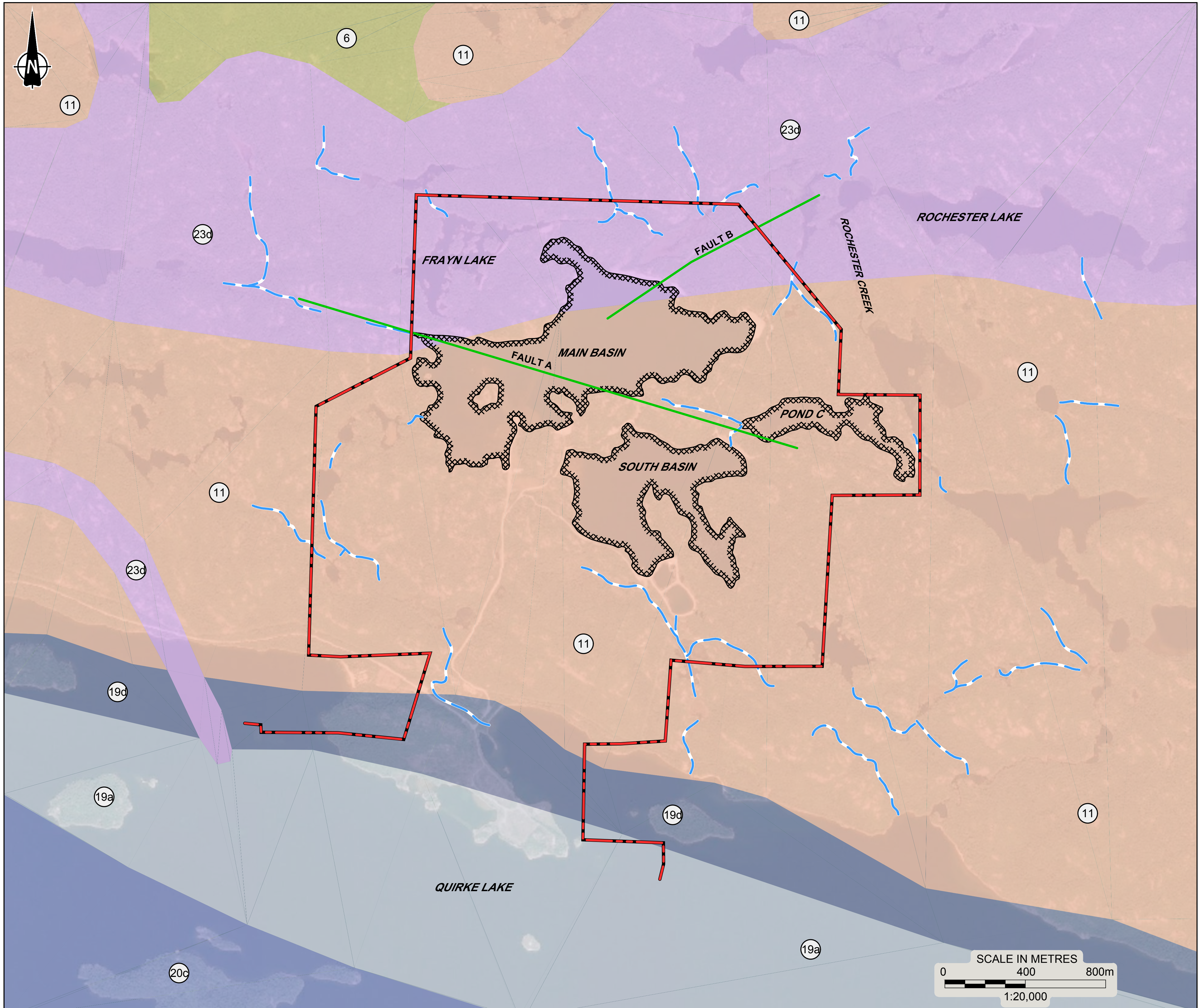
ELLIOT LAKE SITES GROUNDWATER REPORT
DENISON MINES CORP. AND RIO ALGOM LTD.
ELLIOT LAKE, ONTARIO

TITLE

QUATERNARY GEOLOGY (PANEL TMA)

GOLDER

PROJECT No.	19126010	FILE No.	19126010-R01062
CADD	DCH	Dec 7/20	SCALE AS SHOWN REV.
CHECK	STH		FIGURE 6.2



LEGEND

- APPROXIMATE LIMIT OF LICENSED AREA
- APPROXIMATE CREEK/CHANNEL
- APPROXIMATE FAULT LINE
- WATER COVERED TAILINGS
- 6 Felsic to intermediate metavolcanic rocks
- 11 Gneissic tonalite suite
- 19a Hough Lake Group (Mississagi Formation)
- 19d Hough Lake Group (Ramsay Lake Formation)
- 20c Quirke Lake Group (Bruce Formation)
- 23d Mafic and related intrusive rocks

REFERENCE

DRAWING BASED ON ECOMETRIX, GENERAL CONFIGURATION OF NORDIC TMA, FIGURE 2.1, FEBRUARY 2011;
BING IMAGERY AS OF DECEMBER 13 - 2019 (IMAGE DATE UNKNOWN);
MINISTRY OF NORTHERN DEVELOPMENT AND MINES, ONTARIO GEOLOGIC SURVEY, MRD 126-REVISED, 1:250,000 SCALE; AND
HYDROGEOLOGICAL ASSESSMENT, PANEL MINE WASTE MANAGEMENT AREA, ELLIOT LAKE, ONTARIO, CONTACT No. 581-A-05, PROJECT No. 881-1817B, FIGURE 3.

NOTES

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BING IMAGERY USED FOR ILLUSTRATION PURPOSES ONLY AND NOT TO BE USED FOR MEASUREMENTS.
ALL LOCATIONS ARE APPROXIMATE.

PROJECT

ELLIOT LAKE SITES GROUNDWATER REPORT
DENISON MINES CORP. AND RIO ALGOM LTD.
ELLIOT LAKE, ONTARIO

TITLE

BEDROCK GEOLOGY (PANEL TMA)

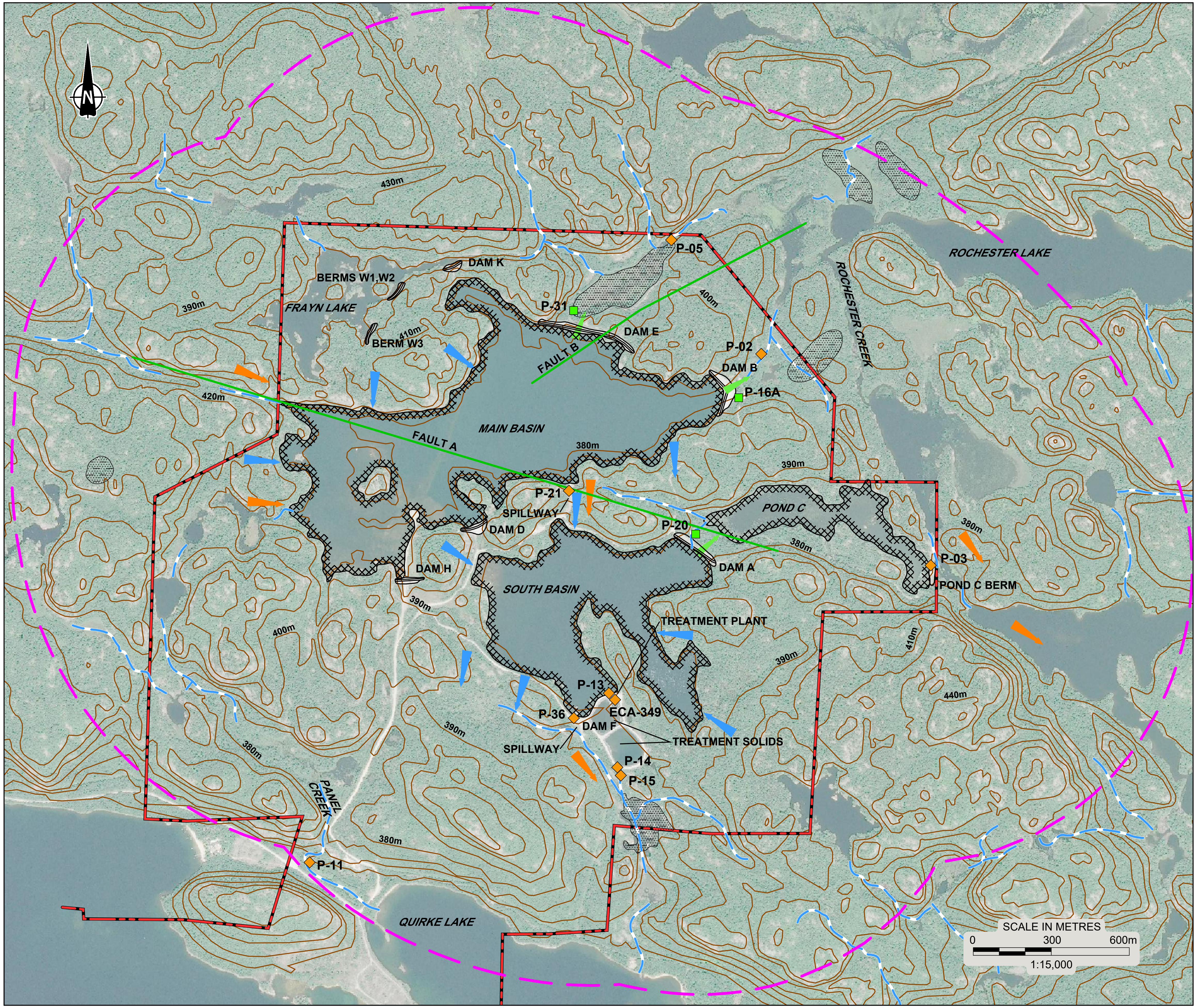
GOLDER

PROJECT No.	19126010		FILE No.	19126010-R01063
			SCALE	AS SHOWN REV.
CADD	DCH	Apr 28/20		
CHECK				

FIGURE 6.3

Client: Denison Environmental Services
Original Format is Tabloid 279mm x 432mm
Apr 28, 2020 - 2:54pm
Drawing file: 19126010-R01063.dwg

Client: Denison Environmental Services
Original Format is Tabloid 279mm x 432mm
Dec 10, 2020 – 11:05am
Drawing file: 19126010–R01064.dwg



LEGEND

APPROXIMATE LIMIT OF LICENSED AREA
APPROXIMATE CREEK/CHANNEL
APPROXIMATE FAULT LINE
1km BUFFER FROM TMA
INFERRED GROUNDWATER FLOW DIRECTION
INFERRED SURFACE WATER FLOW DIRECTION
INFERRED SEEPAGE FLOW
WATER COVERED TAILINGS
DAM
SWAMP
TOMP GROUNDWATER SAMPLING STATION
SOURCE AREA MONITORING PROGRAM (SAMP) SURFACE WATER SAMPLING STATION

REFERENCE

DRAWING BASED ON MINNOW, PANEL SITE SAMP AND TOMP MONTORING STATIONS, FIGURE 3.16, FEBRUARY 2016;
BING IMAGERY AS OF DECEMBER 19 - 2019 (IMAGE DATE UNKNOWN); AND
HYDROGEOLOGICAL ASSESSMENT, PANEL MINE WASTE MANAGEMENT AREA, ELLIOT LAKE, ONTARIO, CONTACT No. 581-A-05, PROJECT No. 881-1817B, FIGURE 3.

NOTES

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ALL LOCATIONS ARE APPROXIMATE.

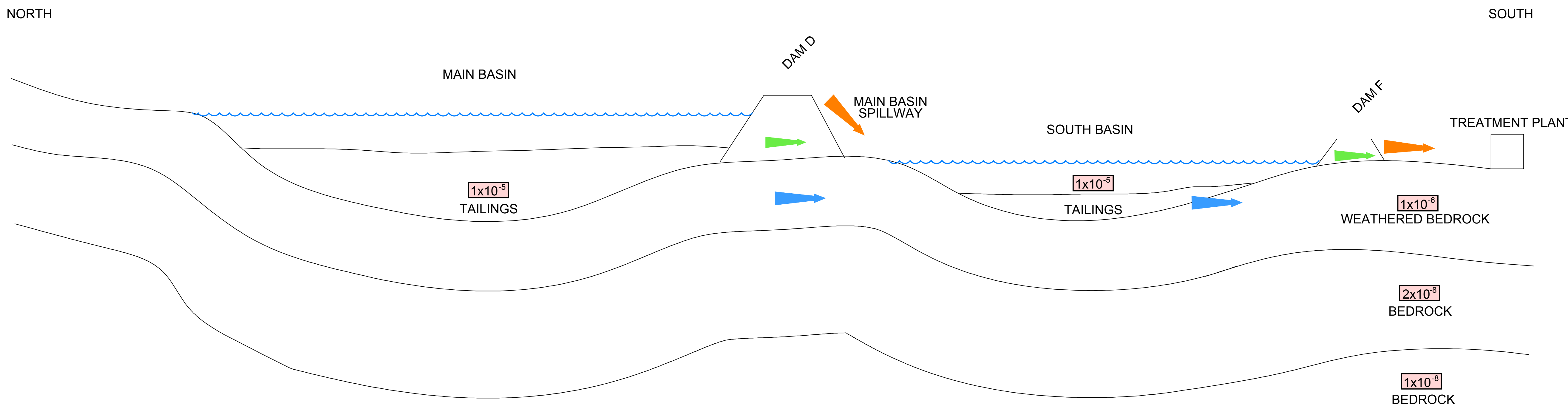
PROJECT
ELLIOT LAKE SITES GROUNDWATER REPORT
DENISON MINES CORP. AND RIO ALGOM LTD.
ELLIOT LAKE, ONTARIO

TITLE
INFERRED FLOW DIRECTIONS (PANEL TMA)

GOLDER

PROJECT No.	19126010	FILE No.	19126010–R01064
		SCALE	AS SHOWN
CADD	ZJB/DCH	Dec 10/20	REV.
CHECK			

FIGURE 6.4



LEGEND

- INFERRED GROUNDWATER FLOW DIRECTION
- INFERRED SEEPAGE FLOW
- INFERRED SURFACE WATER FLOW DIRECTION

$1x10^{-7}$ HYDRAULIC CONDUCTIVITY (K) VALUE IN (m/s) FROM HYDRAULIC TESTING

NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE.

PROJECT

ELLIOT LAKE SITES GROUNDWATER REPORT
DENISON MINES CORP. AND RIO ALGOM LTD.
ELLIOT LAKE, ONTARIO

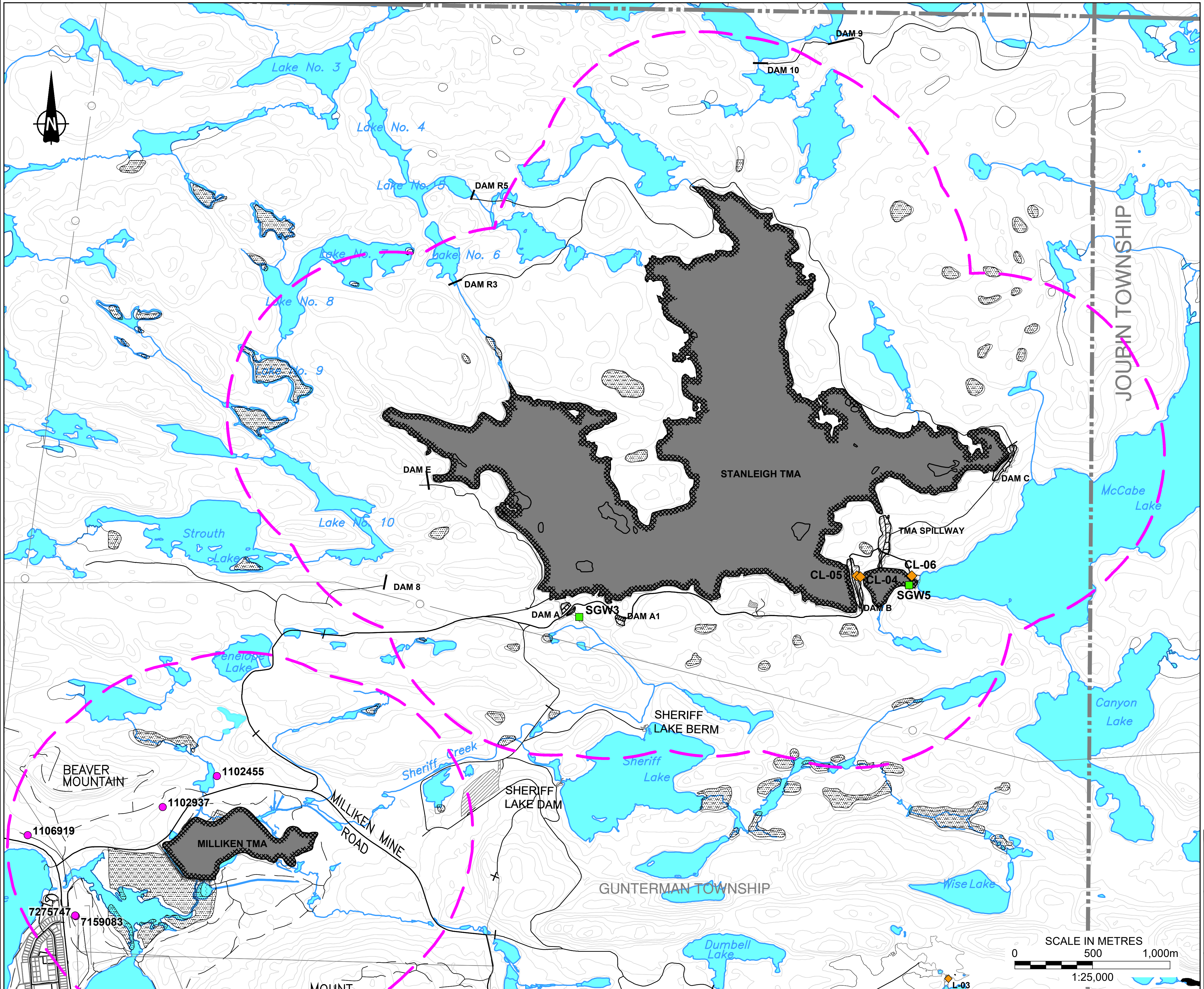
TITLE

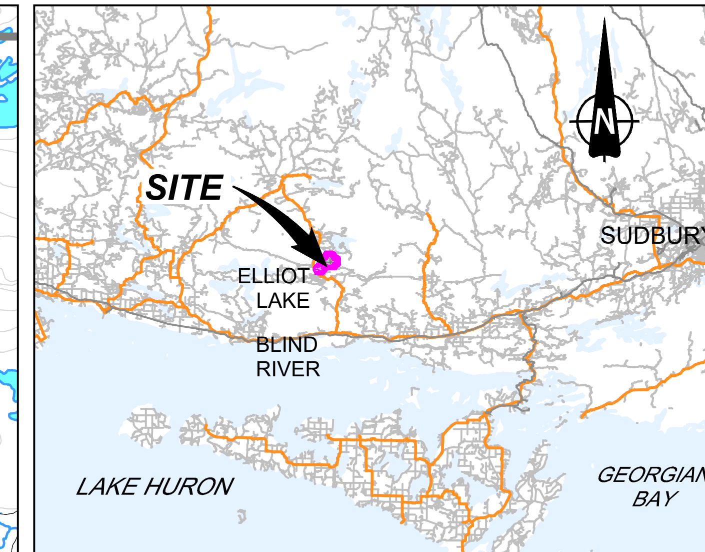
CONCEPTUAL HYDROGEOLOGICAL MODEL (PANEL TMA)

GOLDER

PROJECT No.	19126010	FILE No.	19126010–R01065
		SCALE	N.T.S.
CADD	ZJB/DCH	Oct 2/20	REV.
CHECK			

FIGURE 6.5





KEY PLAN

LEGEND

- WATER COVERED TAILINGS
- DAM
- SWAMP
- 1km BUFFER FROM TMA
- TOMP GROUNDWATER SAMPLING STATION
- SOURCE AREA MONITORING PROGRAM (SAMP) SURFACE WATER SAMPLING STATION
- MOECC IDENTIFIED WATER WELL

REFERENCE

DRAWING BASED ON MINNOW ENVIRONMENTAL INC., SEPTENT RIVER WATERSHED CYCLE 4 (2010 TO 2014) STATE OF THE ENVIRONMENT REPORT, FIGURE 3.25, NOVEMBER 2017;
MOECC WATER WELL DATABASE AS OF DECEMBER 2019
MNR LIO, OBTAINED 2020, PRODUCED BY GOLDER ASSOCIATES LTD UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2020;
BING IMAGERY AS OF DECEMBER 11 - 2019 (IMAGE DATE UNKNOWN); AND
CANMAP STREETFILES V2008.4.

NOTES

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ALL LOCATIONS ARE APPROXIMATE.

PROJECT
ELLIOT LAKE SITES GROUNDWATER REPORT
DENISON MINES CORP. AND RIO ALGOM LTD.
ELLIOT LAKE, ONTARIO

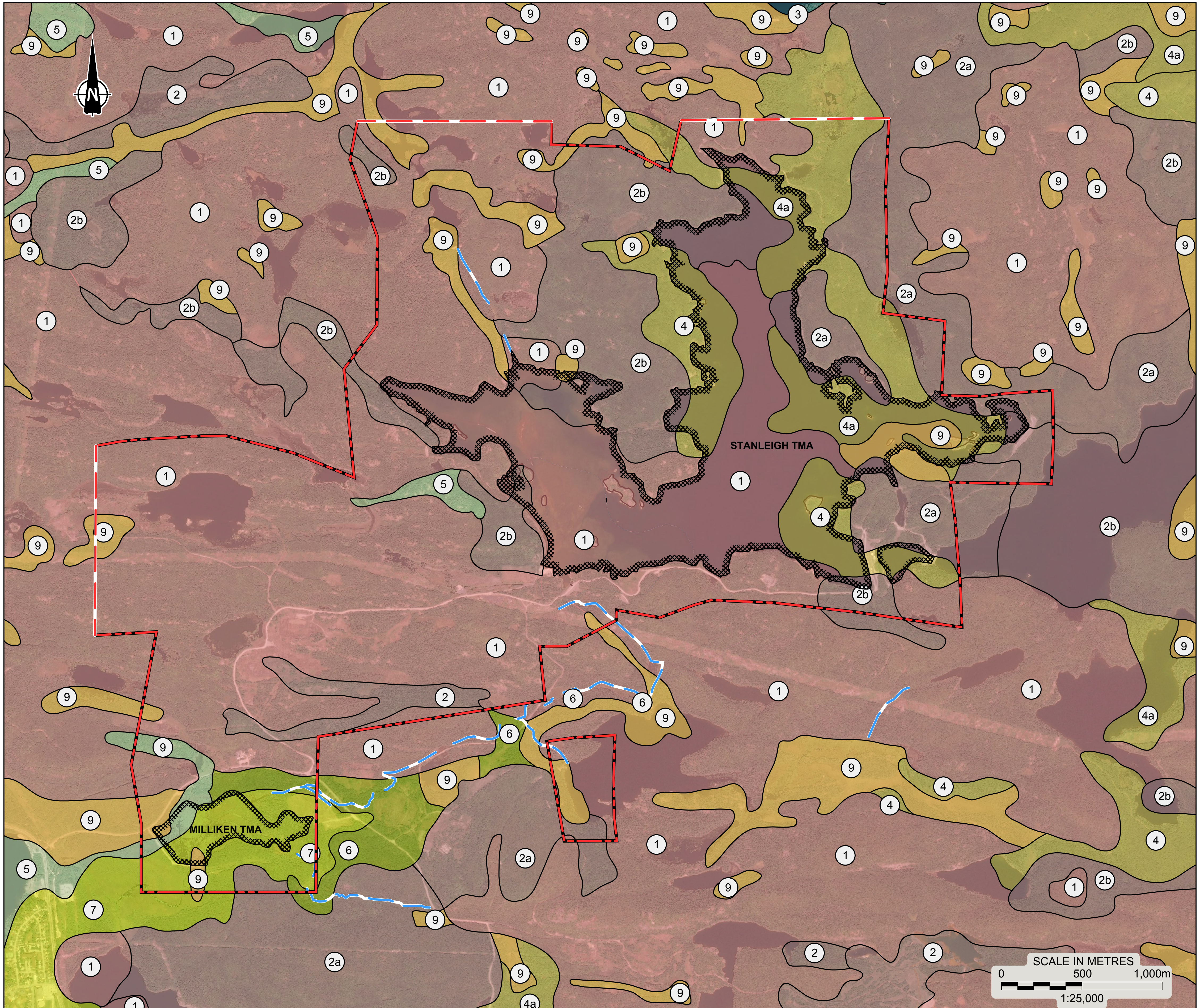
TITLE
LOCATION PLAN (STANLEIGH TMA)

GOLDER

PROJECT No.	19126010	FILE No.	19126010-R01071
		SCALE	AS SHOWN	REV.
CADD		Dec 10/20	
CHECK			

FIGURE 7.1

Client: Denison Environmental Services
Original Format is Tabloid 279mm x 432mm
Drawing file: 19126010-R01071.dwg Dec 10, 2020 - 11:10am



LEGEND

APPROXIMATE LIMIT OF LICENSED AREA

INFERRED LIMIT OF LICENSED AREA

APPROXIMATE CREEK/CHANNEL

WATER COVERED TAILINGS

RECENT

9 Swamp and organic deposits: peat, much, marshland

7 Glaciolacustrine fine-grained deposits: silt and clay; minor sand; massive, lamintated or rhythmically bedded

6 Glaciolacustrine coarse-grained deposits: stratifiec fine to very fine sand and sandy silt; minor gravel, silt and clay

5 Glaciofluvial outwash deposits: stratified sand and gravel; boulders

4 Ice-contact stratified drift: complexly interstratified sand and gravel; minor diamicton, silt and clay
- 4a Kames, kame terraces, eskers and leeside deposits
- 4b Subaqueous fan deposits

3 Till: silty sand to sandy diamicton; generally massive, loose

2 Bedrock-drift complex: thin (less than 1m) discontinuous drift cover over bedrock; thicker drift accumulations may localy subdue bedrock topography
- 2a mainly covered by diamicton (till)
- 2b mainly covered by sand and gravel
- 2c mainly covered by silt and lcay

PRECAMBRIAN

1 Bedrock, undifferentiated: predominantly bare outcrops with drift accumulations locallized in depressions on bedrock surface

REFERENCE

DRAWING BASED ON MINNOW ENVIRONMENTAL INC., SEPTENT RIVER WATERSHED CYCLE 4 (2010 TO 2014) STATE OF THE ENVIRONMENT REPORT, FIGURE 3.25, NOVEMBER 2017;
BING IMAGERY AS OF DECEMBER 11 - 2019 (IMAGE DATE UNKNOWN); AND
MINISTRY OF NORTHERN DEVELOPMENT AND MINES, QUATERNARY GEOLOGY OF ELLIOT LAKE AREA, OPEN FILE MAP 193, 1975.

NOTES

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BING IMAGERY USED FOR ILLUSTRATION PURPOSES ONLY AND NOT TO BE USED FOR MEASUREMENTS.
ALL LOCATIONS ARE APPROXIMATE.

PROJECT

ELLIOT LAKE SITES GROUNDWATER REPORT
DENISON MINES CORP. AND RIO ALGOM LTD.
ELLIOT LAKE, ONTARIO

TITLE

QUATERNARY GEOLOGY (STANLEIGH TMA)

GOLDER

PROJECT No.	19126010	FILE No.	19126010-R01072
		SCALE	AS SHOWN REV.
CADD	ZJB/DCH	Dec 8/20	
CHECK	SH		

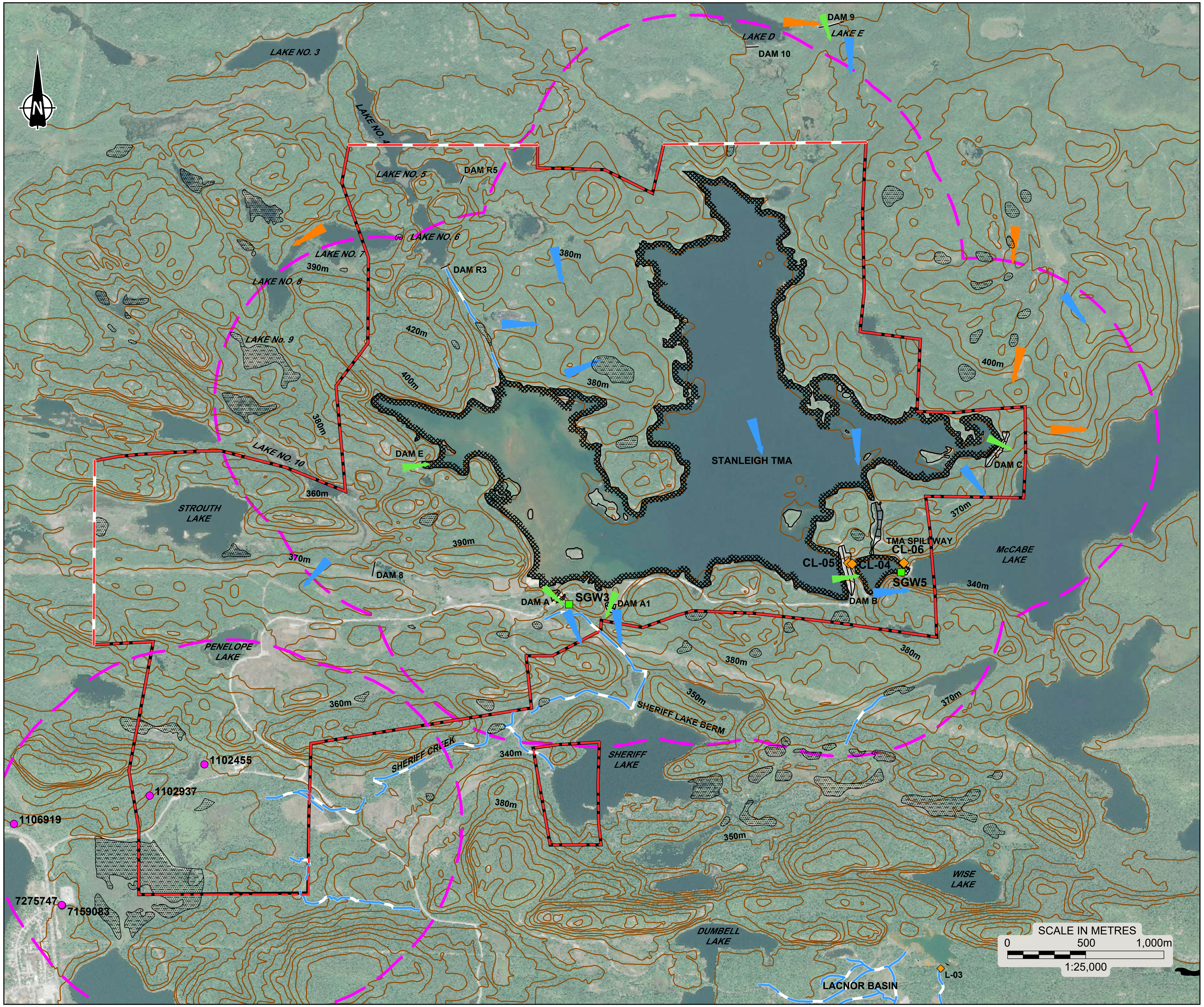
FIGURE 7.2

Client: Denison Environmental Services

Original Format is Tabloid 279mm x 432mm

25mm 0

Drawing file: 19126010-R01072.dwg Dec 08, 2020 - 9:38am



Client: Denison Environmental Services

Original Format is Tabloid 279mm x 432mm

Dec 10, 2020 – 11:17am

Drawing file: 19126010-R01074.dwg

LEGEND

- APPROXIMATE LIMIT OF LICENSED AREA
- INFERRED LIMIT OF LICENSED AREA
- APPROXIMATE CREEK/CHANNEL
- 1km BUFFER FROM TMA
- INFERRED GROUNDWATER FLOW DIRECTION
- INFERRED SURFACE WATER FLOW DIRECTION
- INFERRED SEEPAGE FLOW
- WATER COVERED TAILINGS
- SWAMP
- TOMP GROUNDWATER SAMPLING STATION
- SOURCE AREA MONITORING PROGRAM (SAMP) SURFACE WATER SAMPLING STATION
- MOECC IDENTIFIED WATER WELL

REFERENCE

DRAWING BASED ON MINNOW ENVIRONMENTAL INC., SEPTENT RIVER WATERSHED CYCLE 4 (2010 TO 2014) STATE OF THE ENVIRONMENT REPORT, FIGURE 3.25, NOVEMBER 2017;
MOECC WATER WELL DATABASE AS OF DECEMBER 2019
MNR LIO, OBTAINED 2020, PRODUCED BY GOLDER ASSOCIATES LTD UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2020;
BING IMAGERY AS OF DECEMBER 11 - 2019 (IMAGE DATE UNKNOWN); AND
CANMAP STREETFILES V2008.4.

NOTES

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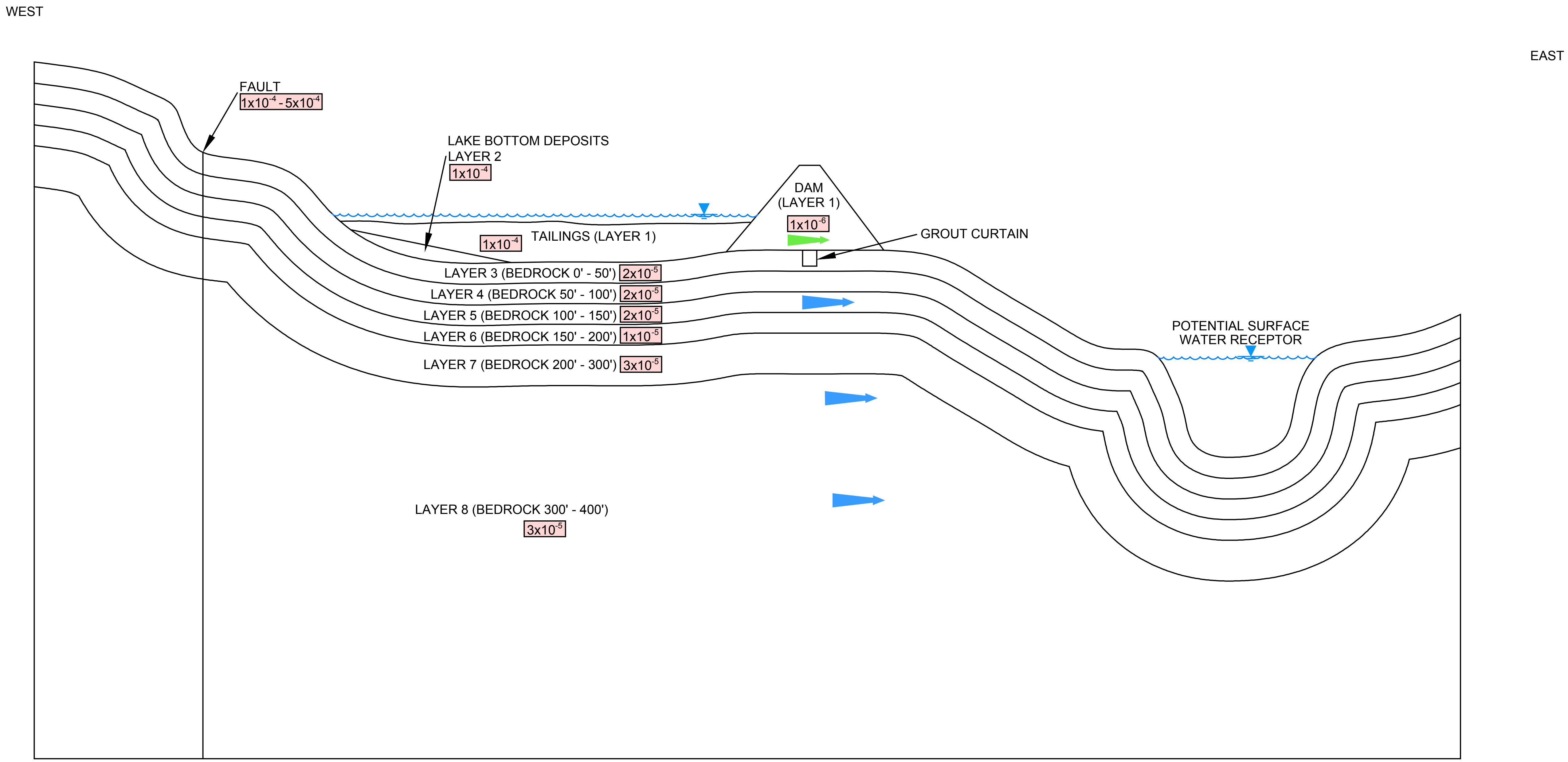
BING IMAGERY USED FOR ILLUSTRATION PURPOSES ONLY AND NOT TO BE USED FOR MEASUREMENTS.
ALL LOCATIONS ARE APPROXIMATE.

PROJECT
ELLIOT LAKE SITES GROUNDWATER REPORT
DENISON MINES CORP. AND RIO ALGOM LTD.
ELLIOT LAKE, ONTARIO

TITLE
INFERRED FLOW DIRECTIONS (STANLEIGH TMA)

GOLDER

PROJECT No.	19126010	FILE No.	19126010-R01074
CADD	ZJB/DCH	Dec 10/20	SCALE AS SHOWN REV.
CHECK			**FIGURE 7.4**



LEGEND

INFERRED GROUNDWATER FLOW DIRECTION

INFERRED SEEPAGE FLOW

$1x10^{-7}$ HYDRAULIC CONDUCTIVITY (K) VALUE IN (m/s) FROM HYDRAULIC TESTING

NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE.

PROJECT

ELLIOT LAKE SITES GROUNDWATER REPORT
DENISON MINES CORP. AND RIO ALGOM LTD.
ELLIOT LAKE, ONTARIO

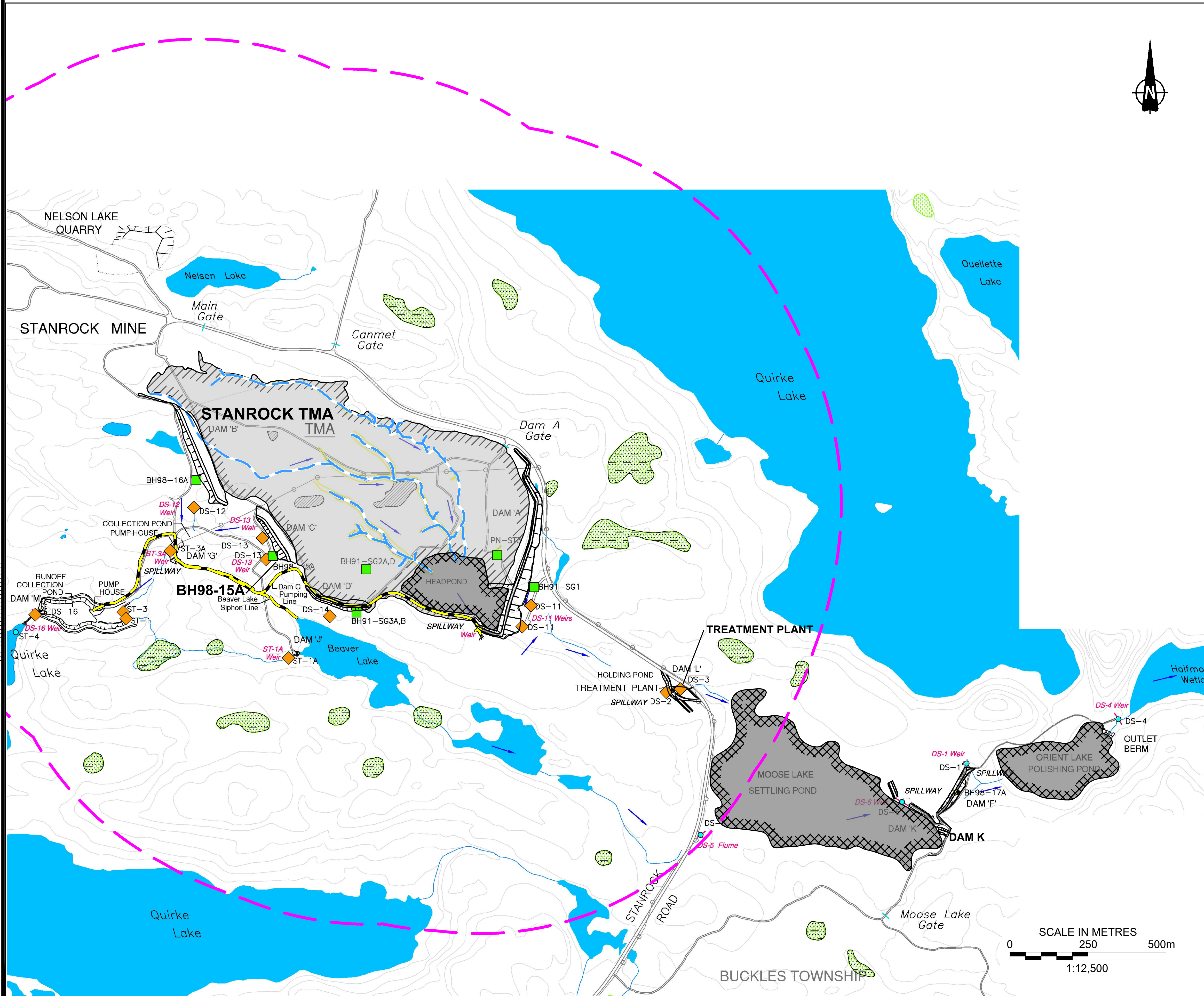
TITLE

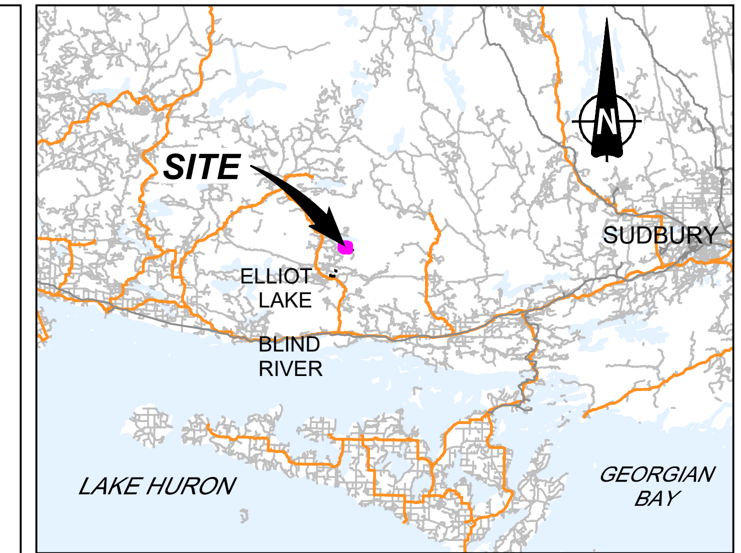
CONCEPTUAL HYDROGEOLOGICAL MODEL (STANLEIGH TMA)

GOLDER

PROJECT No.	19126010	FILE No.	19126010–R01075
		SCALE	N.T.S. REV.
CADD	ZJB/DCH	Oct 2/20	
CHECK	STH		**FIGURE 7.5**

0 25mm





KEY PLAN

LEGEND

- APPROXIMATE LIMIT OF LICENSED AREA
- APPROXIMATE SIPHON LINE/PIPELINE
- APPROXIMATE CREEK/CHANNEL
- 1km BUFFER FROM TMA
- VEGETATED TAILINGS
- WATER COVERED TAILINGS
- DAM
- SWAMP
- TOMP GROUNDWATER SAMPLING STATION
- SOURCE AREA MONITORING PROGRAM (SAMP) SURFACE WATER SAMPLING STATION

REFERENCE

DRAWING BASED ON MINNOW, "STANROCK STIE SAMP AND TOMP MONITORING STATIONS", FIGURE 3.21, PROJECT No. 2555, FEBRUARY 2016;
BING IMAGERY AS OF DECEMBER 13 - 2019 (IMAGE DATE UNKNOWN); AND
CANMAP STREETFILES V2008.4.

NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.
BING IMAGERY USED FOR ILLUSTRATION PURPOSES ONLY AND NOT TO BE USED FOR MEASUREMENTS.
ALL LOCATIONS ARE APPROXIMATE.

PROJECT

ELLIOT LAKE SITES GROUNDWATER REPORT
DENISON MINES CORP. AND RIO ALGOM LTD.
ELLIOT LAKE, ONTARIO

TITLE

LOCATION PLAN (STANROCK TMA)

GOLDER

PROJECT No.	19126010	FILE No.	19126010-R01081
CADD	Dec 10/20	SCALE AS SHOWN	REV.
CHECK	STH		

FIGURE 8.1

Client: Denison Environmental Services
Original Format is Tabloid 279mm x 432mm
Drawing file: 19126010-R01081.dwg Dec 10, 2020 - 11:26am

LEGEND

VEGETATED TAILINGS

WATER COVERED TAILINGS

Lake

RECENT

9 Swamp and organic deposits: peat, much, marshland

4 Ice-contact stratified drift: complexly interstratified sand and gravel; minor diamicton, silt and clay
- 4a Kames, kame terraces, eskers and leeside deposits
- 4b Subaqueous fan deposits

3 Till: silty sand to sandy diamicton; generally massive, loose

2 Bedrock-drift complex: thin (less than 1m) discontinuous drift cover over bedrock; thicker drift accumulations may localy subdue bedrock topography
- 2a mainly covered by diamicton (till)
- 2b mainly covered by sand and gravel

PRECAMBRIAN

1 Bedrock, undifferentiated: predominantly bare outcrops with drift accumulations locallized in depressions on bedrock surface

REFERENCE

DRAWING BASED ON ECOMETRIX, GENERAL CONFIGURATION OF NORDIC TMA, FIGURE 2.1, FEBRUARY 2011;
BING IMAGERY AS OF DECEMBER 13 - 2019 (IMAGE DATE UNKNOWN); AND
MINISTRY OF NORTHERN DEVELOPMENT AND MINES, QUATERNARY GEOLOGY OF ELLIOT LAKE AREA, OPEN FILE MAP 193, 1975.

NOTES

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BING IMAGERY USED FOR ILLUSTRATION PURPOSES ONLY AND NOT TO BE USED FOR MEASUREMENTS.
ALL LOCATIONS ARE APPROXIMATE.

PROJECT

ELLIOT LAKE SITES GROUNDWATER REPORT
DENISON MINES CORP. AND RIO ALGOM LTD.
ELLIOT LAKE, ONTARIO

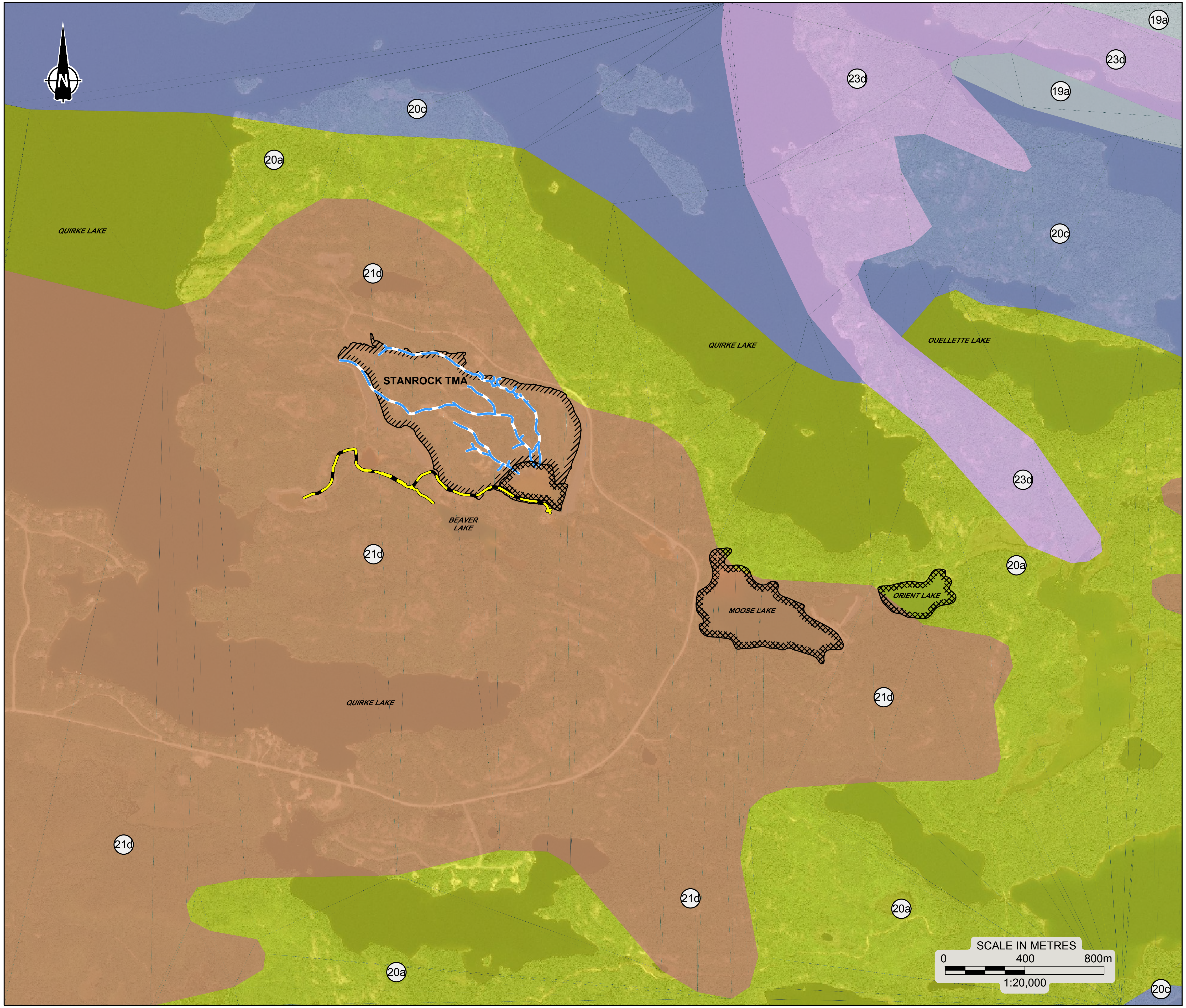
TITLE

QUATERNARY GEOLOGY (STANROCK TMA)

GOLDER

PROJECT No.	19126010	FILE No.	19126010–R01082
		SCALE	AS SHOWN	REV.
CADD	DCH	Oct 2/20	
CHECK			

FIGURE 8.2



LEGEND

- APPROXIMATE LIMIT OF LICENSED AREA
- APPROXIMATE SIPHON LINE/PIPELINE
- APPROXIMATE CREEK/CHANNEL
- VEGETATED TAILINGS
- WATER COVERED TAILINGS
- 19a Hough Lake Group (Mississagi Formation)
- 20a Quirke Lake Group (Serpent Formation)
- 20c Quirke Lake Group (Bruce Formation)
- 21d Cobalt Group (Gowganda Formation)
- 23d Mafic and related intrusive rocks

REFERENCE

DRAWING BASED ON ECOMETRIX, GENERAL CONFIGURATION OF NORDIC TMA, FIGURE 2.1, FEBRUARY 2011;
BING IMAGERY AS OF DECEMBER 13 - 2019 (IMAGE DATE UNKNOWN); AND
MINISTRY OF NORTHERN DEVELOPMENT AND MINES, ONTARIO GEOLOGIC SURVEY, MRD 126-REVISED, 1:250,000 SCALE.

NOTES

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BING IMAGERY USED FOR ILLUSTRATION PURPOSES ONLY AND NOT TO BE USED FOR MEASUREMENTS.
ALL LOCATIONS ARE APPROXIMATE.

PROJECT
ELLIOT LAKE SITES GROUNDWATER REPORT
DENISON MINES CORP. AND RIO ALGOM LTD.
ELLIOT LAKE, ONTARIO

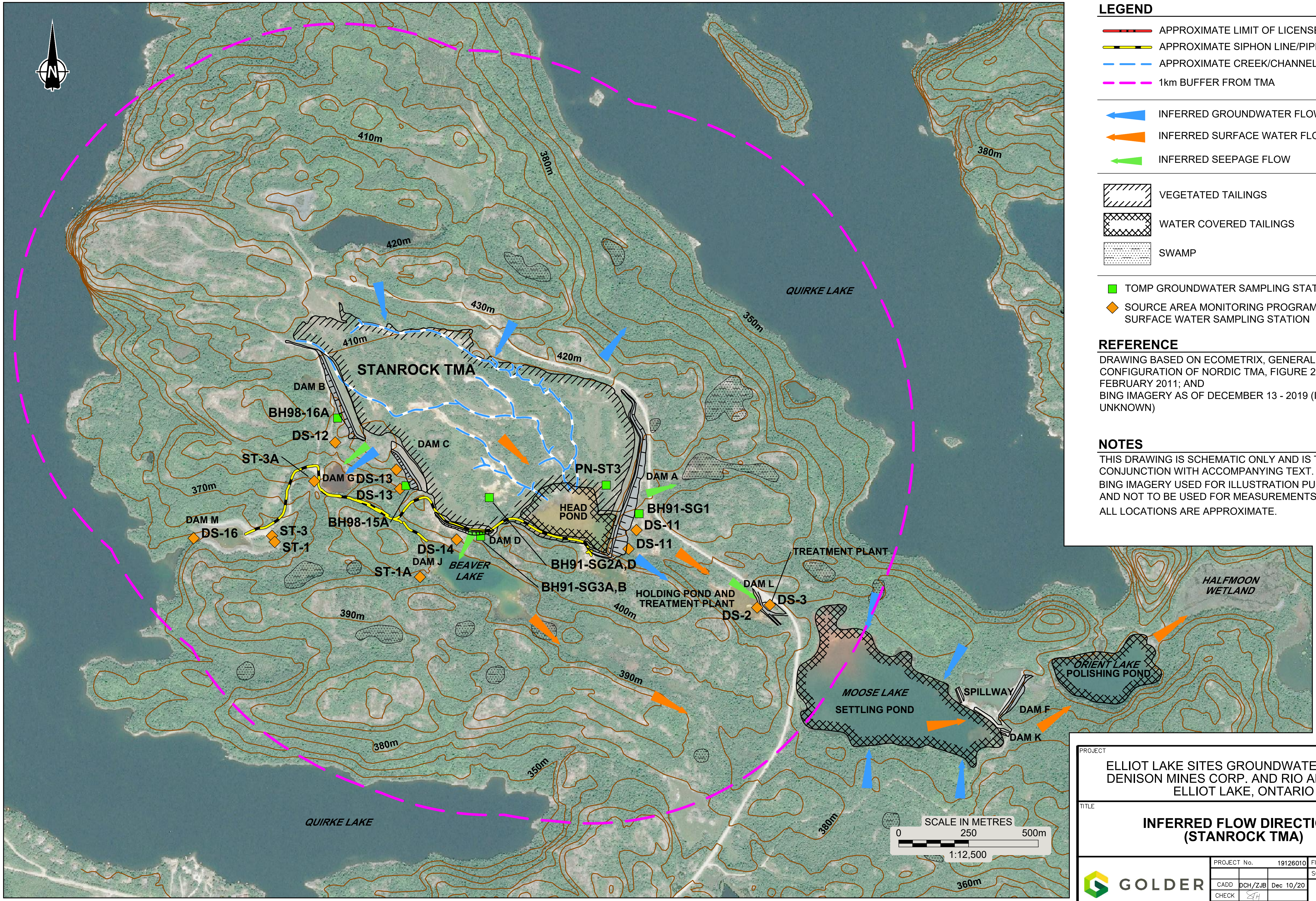
TITLE
BEDROCK GEOLOGY (STANROCK TMA)

GOLDER

PROJECT No.	19126010	FILE No.	19126010-R01083
		SCALE	AS SHOWN
CADD	DCH	Oct 2/20	REV.
CHECK			

FIGURE 8.3

Client: Denison Environmental Services
Original Format is Tabloid 279mm x 432mm
Drawing file: 19126010-R01084.dwg   Dec 10, 2020 – 11:31am



LEGEND

- APPROXIMATE LIMIT OF LICENSED AREA
- APPROXIMATE SIPHON LINE/PIPELINE
- APPROXIMATE CREEK/CHANNEL
- 1km BUFFER FROM TMA
- INFERRED GROUNDWATER FLOW DIRECTION
- INFERRED SURFACE WATER FLOW DIRECTION
- INFERRED SEEPAGE FLOW
- VEGETATED TAILINGS
- WATER COVERED TAILINGS
- SWAMP
- TOMP GROUNDWATER SAMPLING STATION
- SOURCE AREA MONITORING PROGRAM (SAMP) SURFACE WATER SAMPLING STATION

REFERENCE

DRAWING BASED ON ECOMETRIX, GENERAL CONFIGURATION OF NORDIC TMA, FIGURE 2.1, FEBRUARY 2011; AND
BING IMAGERY AS OF DECEMBER 13 - 2019 (IMAGE DATE UNKNOWN)

NOTES

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ALL LOCATIONS ARE APPROXIMATE.

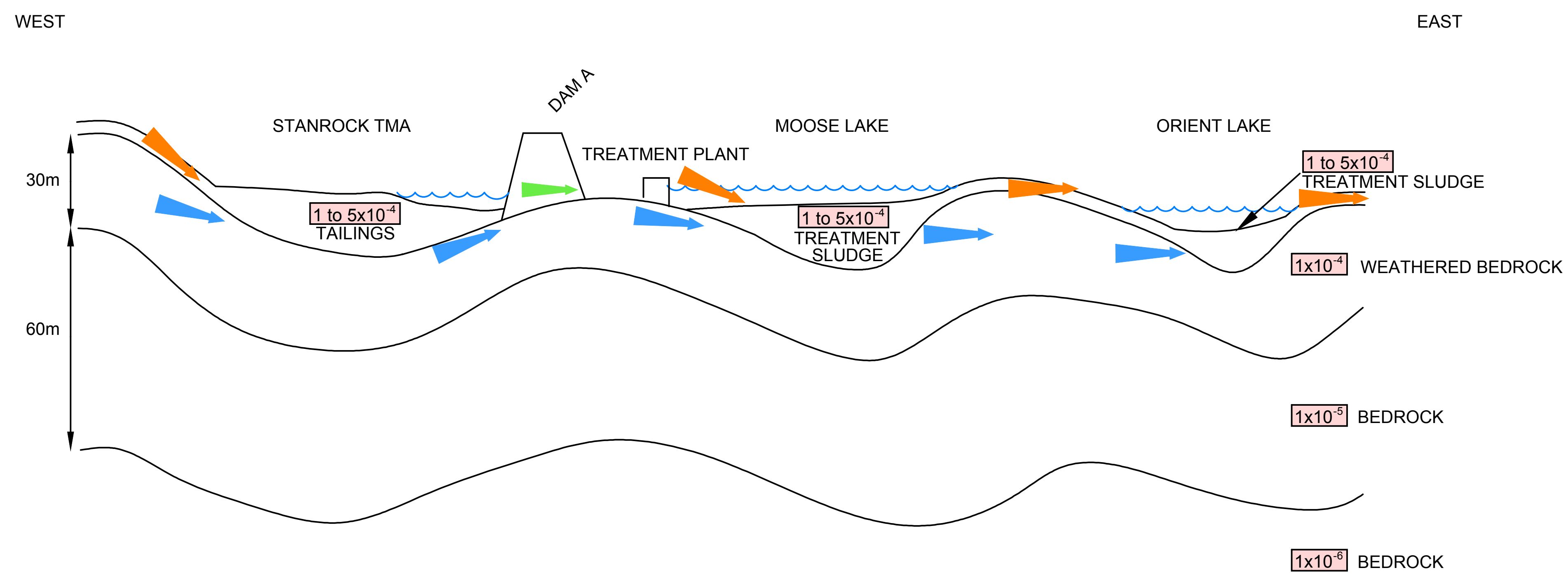
PROJECT
ELLIOT LAKE SITES GROUNDWATER REPORT
DENISON MINES CORP. AND RIO ALGOM LTD.
ELLIOT LAKE, ONTARIO

TITLE
INFERRED FLOW DIRECTIONS (STANROCK TMA)

GOLDER

PROJECT No.	19126010	FILE No.	19126010–R01084
		SCALE	AS SHOWN	REV.
CADD	DCH/ZJB	Dec 10/20	
CHECK			

FIGURE 8.4



LEGEND

- INFERRED GROUNDWATER FLOW DIRECTION (blue arrow)
- INFERRED SEEPAGE FLOW (green arrow)
- INFERRED SURFACE WATER FLOW DIRECTION (orange arrow)

$1x10^{-7}$ HYDRAULIC CONDUCTIVITY (K) VALUE IN (m/s) FROM HYDRAULIC TESTING

NOTES

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ALL LOCATIONS ARE APPROXIMATE.

PROJECT

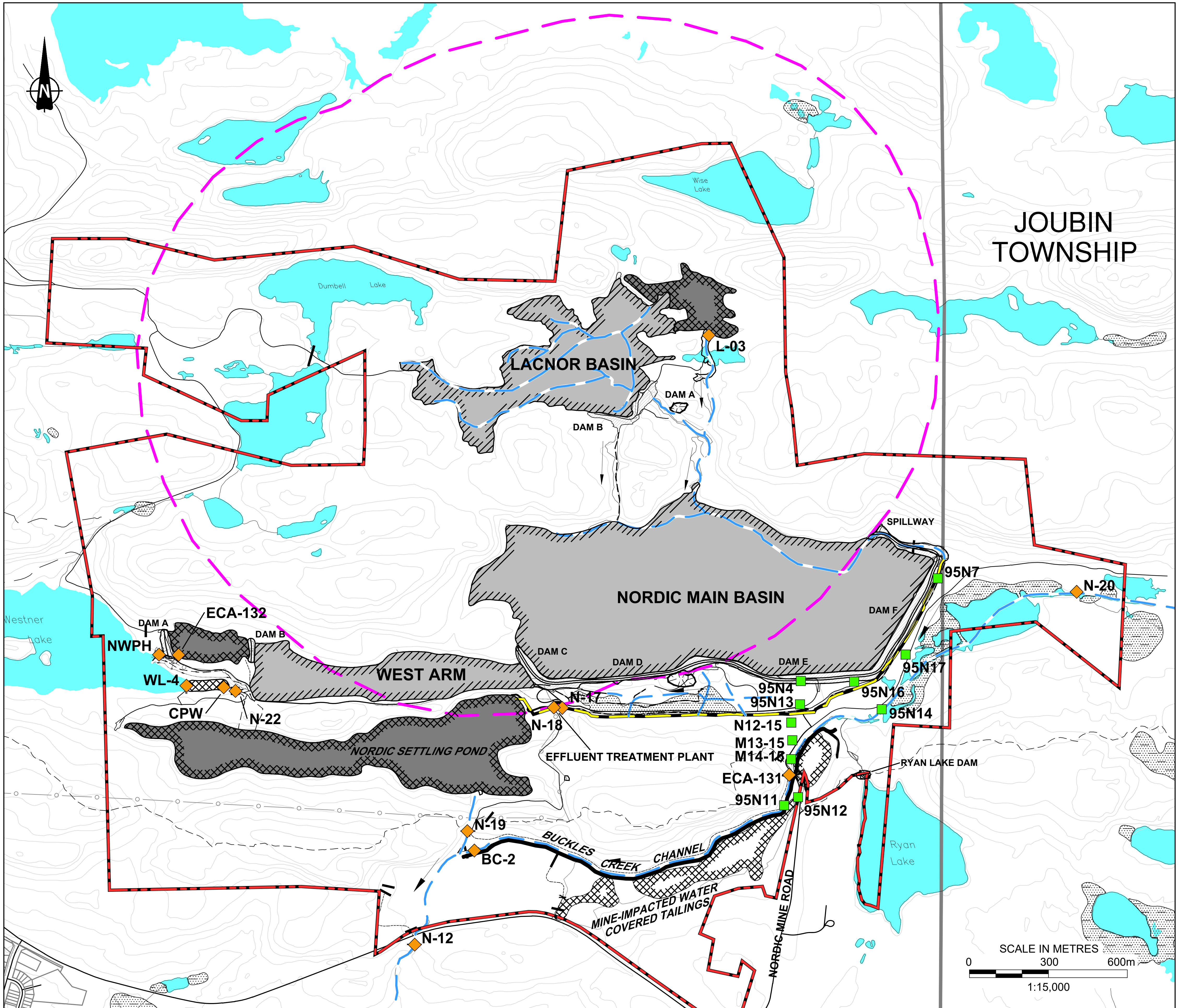
ELLIOT LAKE SITES GROUNDWATER REPORT
DENISON MINES CORP. AND RIO ALGOM LTD.
ELLIOT LAKE, ONTARIO

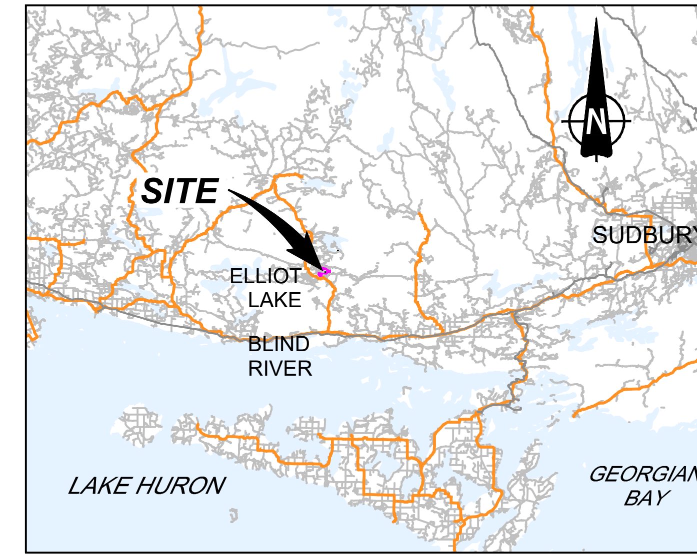
TITLE

CONCEPTUAL HYDROGEOLOGICAL MODEL (STANROCK TMA)

GOLDER

PROJECT No.	19126010	FILE No.	19126010-R01085
		SCALE N.T.S.	REV.
CADD	ZJB/DCH	Oct 2/20	
CHECK	STH		**FIGURE 8.5**





KEY PLAN

LEGEND

- APPROXIMATE LIMIT OF LICENSED AREA
- APPROXIMATE EFFLUENT COLLECTION DITCH
- APPROXIMATE CREEK/CHANNEL
- APPROXIMATE DIVERSION BERM
- 1km BUFFER FROM TMA
- VEGETATED TAILINGS
- TREATMENT SOLIDS
- WATER COVERED TAILINGS
- DAM
- SWAMP
- TOMP GROUNDWATER SAMPLING STATION
- SOURCE AREA MONITORING PROGRAM (SAMP) SURFACE WATER SAMPLING STATION

REFERENCE

DRAWING BASED ON ECOMETRIX, GENERAL CONFIGURATION OF NORDIC TMA, FIGURE 2.1, FEBRUARY 2011;
BING IMAGERY AS OF NOVEMBER 7 - 2019 (IMAGE DATE UNKNOWN); AND
CANMAP STREETFILES V2008.4.

NOTES

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ALL LOCATIONS ARE APPROXIMATE.

PROJECT

ELLIOT LAKE SITES GROUNDWATER REPORT
DENISON MINES CORP. AND RIO ALGOM LTD.
ELLIOT LAKE, ONTARIO

TITLE

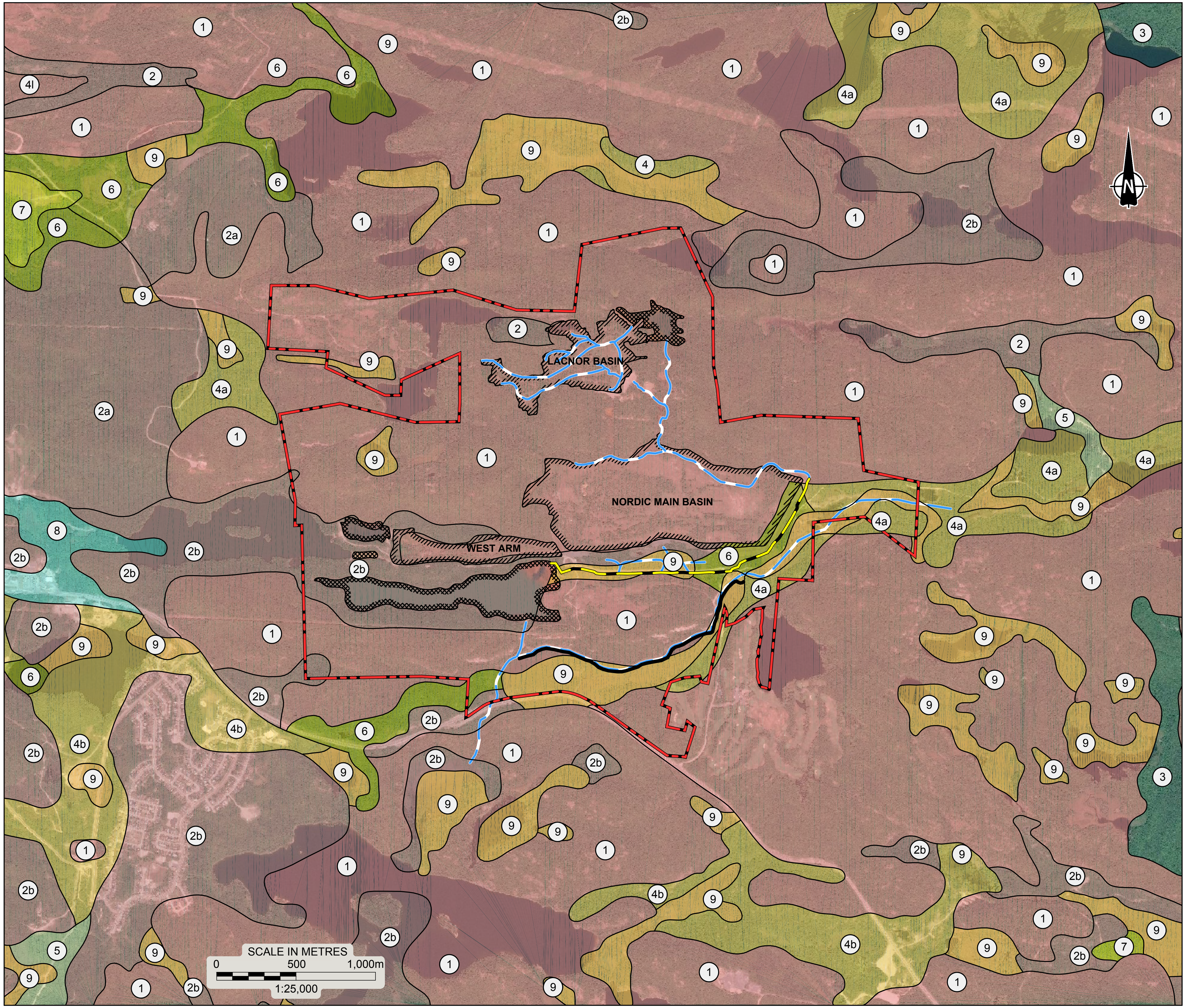
LOCATION PLAN (LACNOR TMA)

GOLDER

PROJECT No.	19126010	FILE No.	19126010-R01091
		SCALE	AS SHOWN	REV.
CADD		Dec 10/20	
CHECK	STH		FIGURE 9.1

Client: Denison Environmental Services

Drawing file: 19126010-R01091.dwg Dec 10, 2020 - 11:50am Original Format is Tabloid 279mm x 432mm



LEGEND

- APPROXIMATE LIMIT OF LICENSED AREA
- APPROXIMATE EFFLUENT COLLECTION DITCH
- APPROXIMATE CREEK/CHANNEL
- APPROXIMATE DIVERSION BERM
- VEGETATED TAILINGS
- WATER COVERED TAILINGS

RECENT

- 9 Swamp and organic deposits: peat, much, marshland
- 8 Alluvium: sand, silt, organics; minor gravel
- 7 Glaciolacustrine fine-grained deposits: silt and clay; minor sand; massive, lamintated or rhythmically bedded
- 6 Glaciolacustrine coarse-grained deposits: stratifiec fine to very fine sand and sandy silt; minor gravel, silt and clay
- 5 Glaciofluvial outwash deposits: stratified sand and gravel; boulders
- 4 Ice-contact stratified drift: complexly interstratified sand and gravel; minor diamicton, silt and clay
  - 4a Kames, kame terraces, eskers and leeside deposits
  - 4b Subaqueous fan deposits
- 3 Till: silty sand to sandy diamicton; generally massive, loose
- 2 Bedrock-drift complex: thin (less than 1m) discontinuous drift cover over bedrock; thicker drift accumulations may localy subdue bedrock topography
  - 2a mainly covered by diamicton (till)
  - 2b mainly covered by sand and gravel
  - 2c mainly covered by silt and lcay

PRECAMBRIAN

- 1 Bedrock, undifferentiated: predominantly bare outcrops with drift accumulations locallized in depressions on bedrock surface

REFERENCE

DRAWING BASED ON ECOMETRIX, GENERAL CONFIGURATION OF NORDIC TMA, FIGURE 2.1, FEBRUARY 2011;
BING IMAGERY AS OF NOVEMBER 7 - 2019 (IMAGE DATE UNKNOWN); AND
MINISTRY OF NORTHERN DEVELOPMENT AND MINES, QUATERNARY GEOLOGY OF ELLIOT LAKE AREA, OPEN FILE MAP 193, 1975.

NOTES

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BING IMAGERY USED FOR ILLUSTRATION PURPOSES ONLY AND NOT TO BE USED FOR MEASUREMENTS.
ALL LOCATIONS ARE APPROXIMATE.

PROJECT

ELLIOT LAKE SITES GROUNDWATER REPORT
DENISON MINES CORP. AND RIO ALGOM LTD.
ELLIOT LAKE, ONTARIO

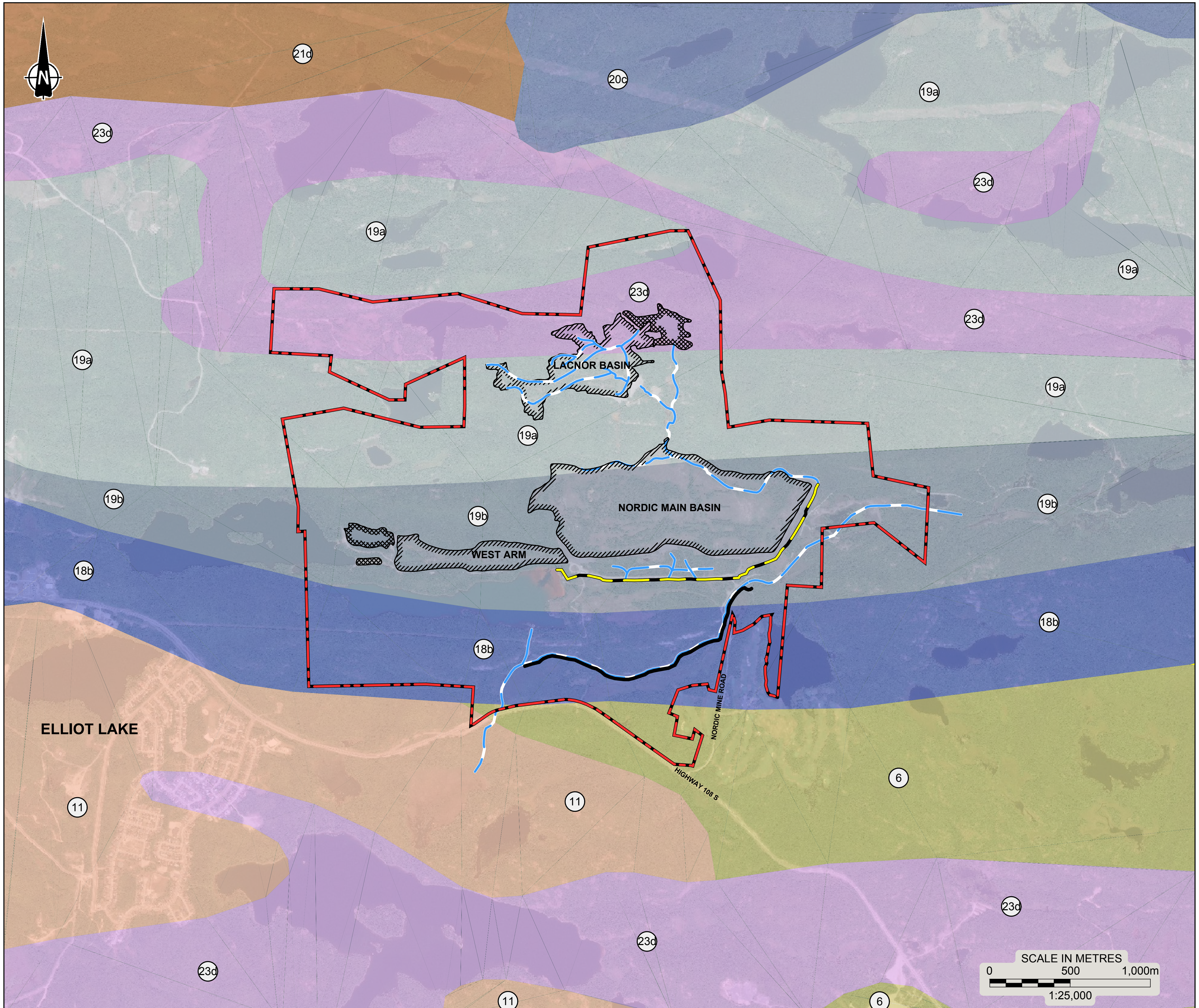
TITLE

QUATERNARY GEOLOGY (LANCOR TMA)

GOLDER

PROJECT No.	19126010	FILE No.	19126010-R01092
CADD	DCH	Oct 2/20	SCALE AS SHOWN REV.
CHECK			**FIGURE 9.2**

Client: Denison Environmental Services
Original Format is Tabloid 279mm x 432mm
25mm 0
Drawing file: 19126010-R01092.dwg Oct 02, 2020 - 4:23pm



LEGEND

- APPROXIMATE LIMIT OF LICENSED AREA
- APPROXIMATE EFFLUENT COLLECTION DITCH
- APPROXIMATE CREEK/CHANNEL
- APPROXIMATE DIVERSION BERM

- VEGETATED TAILINGS
- WATER COVERED TAILINGS

- 6 Felsic to intermediate metavolcanic rocks
- 11 Gneissic tonalite suite
- 18b Elliot Lake Group (Matinenda Formation)
- 19a Hough Lake Group (Mississagi Formation)
- 19b Hough Lake Group (Pecors Formation)
- 20c Quirke Lake Group (Bruce Formation)
- 21d Cobalt Group (Gowganda Formation)
- 23d Mafic and related intrusive rocks

REFERENCE

DRAWING BASED ON ECOMETRIX, GENERAL CONFIGURATION OF NORDIC TMA, FIGURE 2.1, FEBRUARY 2011;
BING IMAGERY AS OF NOVEMBER 7 - 2019 (IMAGE DATE UNKNOWN); AND
MINISTRY OF NORTHERN DEVELOPMENT AND MINES, ONTARIO GEOLOGIC SURVEY, MRD 126-REVISED, 1:250,000 SCALE.

NOTES

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BING IMAGERY USED FOR ILLUSTRATION PURPOSES ONLY AND NOT TO BE USED FOR MEASUREMENTS.
ALL LOCATIONS ARE APPROXIMATE.

PROJECT

ELLIOT LAKE SITES GROUNDWATER REPORT
DENISON MINES CORP. AND RIO ALGOM LTD.
ELLIOT LAKE, ONTARIO

TITLE

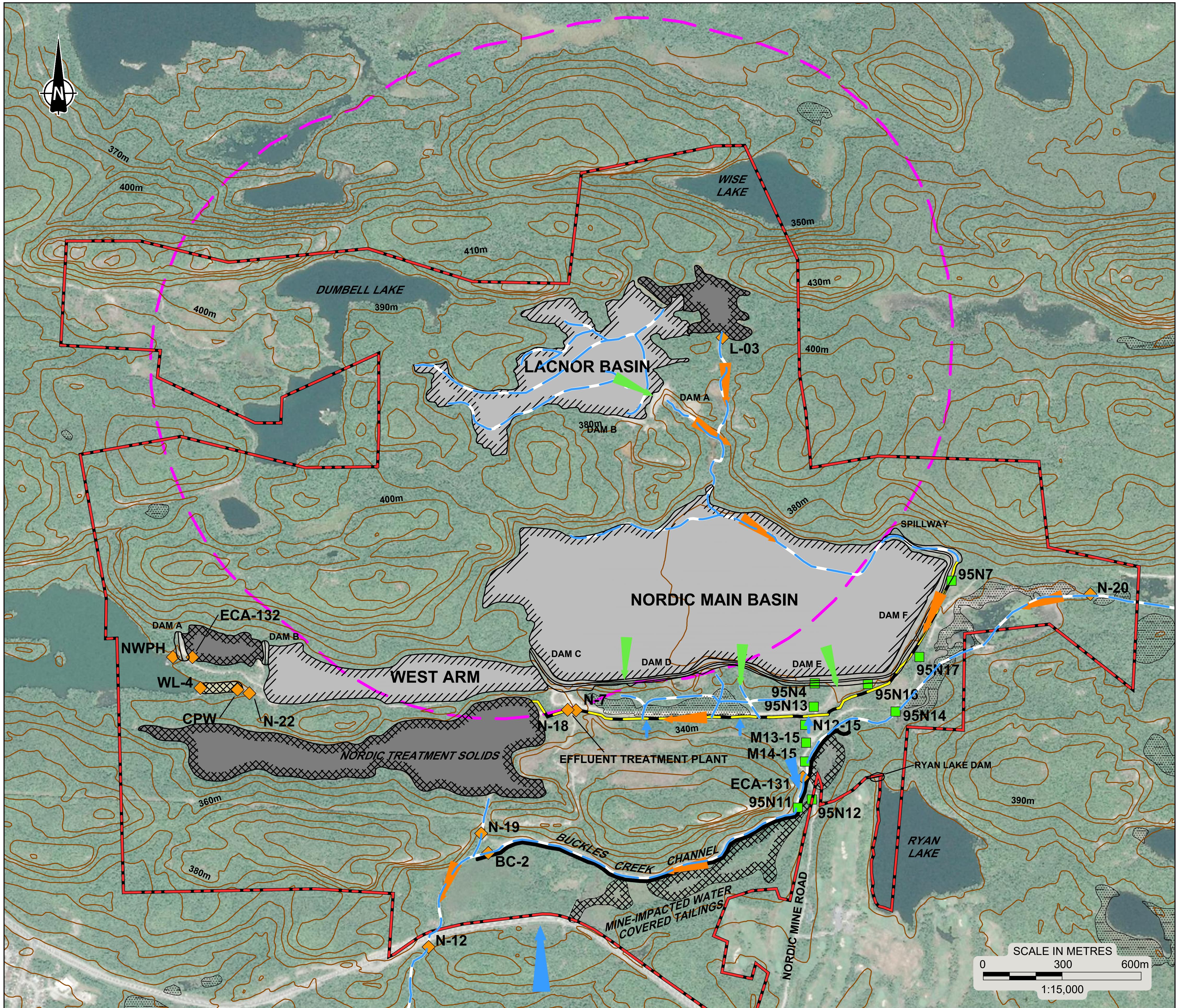
BEDROCK GEOLOGY (LACNOR TMA)

GOLDER

PROJECT No.	19126010	FILE No.	19126010-R01093
		SCALE	AS SHOWN
CADD	DCH	Oct 2/20	REV.
CHECK			

FIGURE 9.3

Client: Denison Environmental Services
Original Format is Tabloid 279mm x 432mm
25mm 0
Drawing file: 19126010-R01093.dwg Oct 02, 2020 - 6:37pm



LEGEND

- APPROXIMATE LIMIT OF LICENSED AREA
- APPROXIMATE EFFLUENT COLLECTION DITCH
- APPROXIMATE CREEK/CHANNEL
- APPROXIMATE DIVERSION BERM
- 1km BUFFER FROM TMA
- INFERRED GROUNDWATER FLOW DIRECTION
- INFERRED SURFACE WATER FLOW DIRECTION
- INFERRED SEEPAGE FLOW
- VEGETATED TAILINGS
- TREATMENT SOLIDS
- WATER COVERED TAILINGS
- DAM
- SWAMP
- TOMP GROUNDWATER SAMPLING STATION
- SOURCE AREA MONITORING PROGRAM (SAMP) SURFACE WATER SAMPLING STATION

REFERENCE

DRAWING BASED ON ECOMETRIX, GENERAL CONFIGURATION OF NORDIC TMA, FIGURE 2.1, FEBRUARY 2011;
BING IMAGERY AS OF NOVEMBER 7 - 2019 (IMAGE DATE UNKNOWN); AND
CANMAP STREETFILES V2008.4.

NOTES

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BING IMAGERY USED FOR ILLUSTRATION PURPOSES ONLY AND NOT TO BE USED FOR MEASUREMENTS.
ALL LOCATIONS ARE APPROXIMATE.

PROJECT

ELLIOT LAKE SITES GROUNDWATER REPORT
DENISON MINES CORP. AND RIO ALGOM LTD.
ELLIOT LAKE, ONTARIO

TITLE

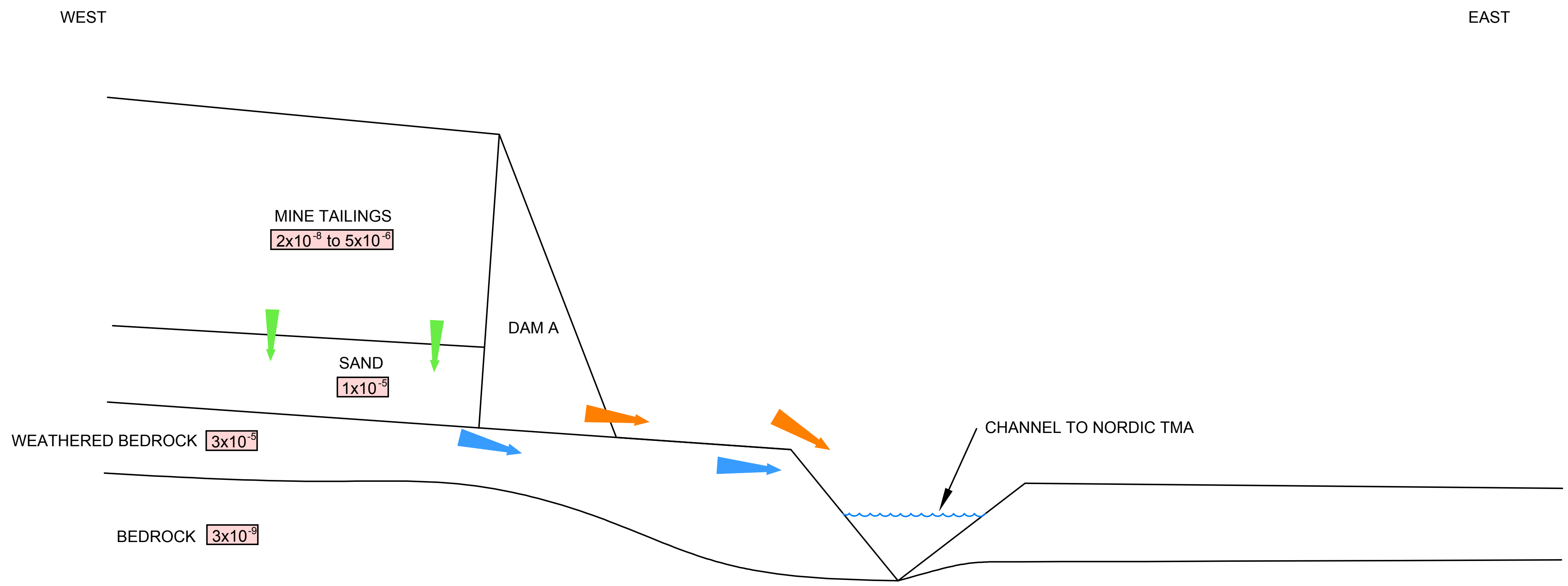
INFERRED FLOW DIRECTIONS (LACNOR TMA)

GOLDER

PROJECT No.	19126010	FILE No.	19126010–R01094
		SCALE	AS SHOWN
CADD	AMS/DCH	Dec 10/20	REV.
CHECK			

FIGURE 9.4

Drawing file: 19126010–R01094.dwg Dec 10, 2020 – 12:04pm Original Format is Tabloid 279mm x 432mm Client: Denison Environmental Services



LEGEND

- INFERRED GROUNDWATER FLOW DIRECTION
- INFERRED SURFACE WATER FLOW DIRECTION
- INFERRED SEEPAGE FLOW

10^{-7} HYDRAULIC CONDUCTIVITY (K) VALUE IN (m/s) FROM HYDRAULIC TESTING

REFERENCE

DRAWING BASED ON ECOMETRIX, CONCEPTUAL HYDROGEOLOGIC MODEL, FIGURE 1, FEBRUARY 2010.

NOTES

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ALL LOCATIONS ARE APPROXIMATE.

PROJECT

ELLIOT LAKE SITES GROUNDWATER REPORT
DENISON MINES CORP. AND RIO ALGOM LTD.
ELLIOT LAKE, ONTARIO

TITLE

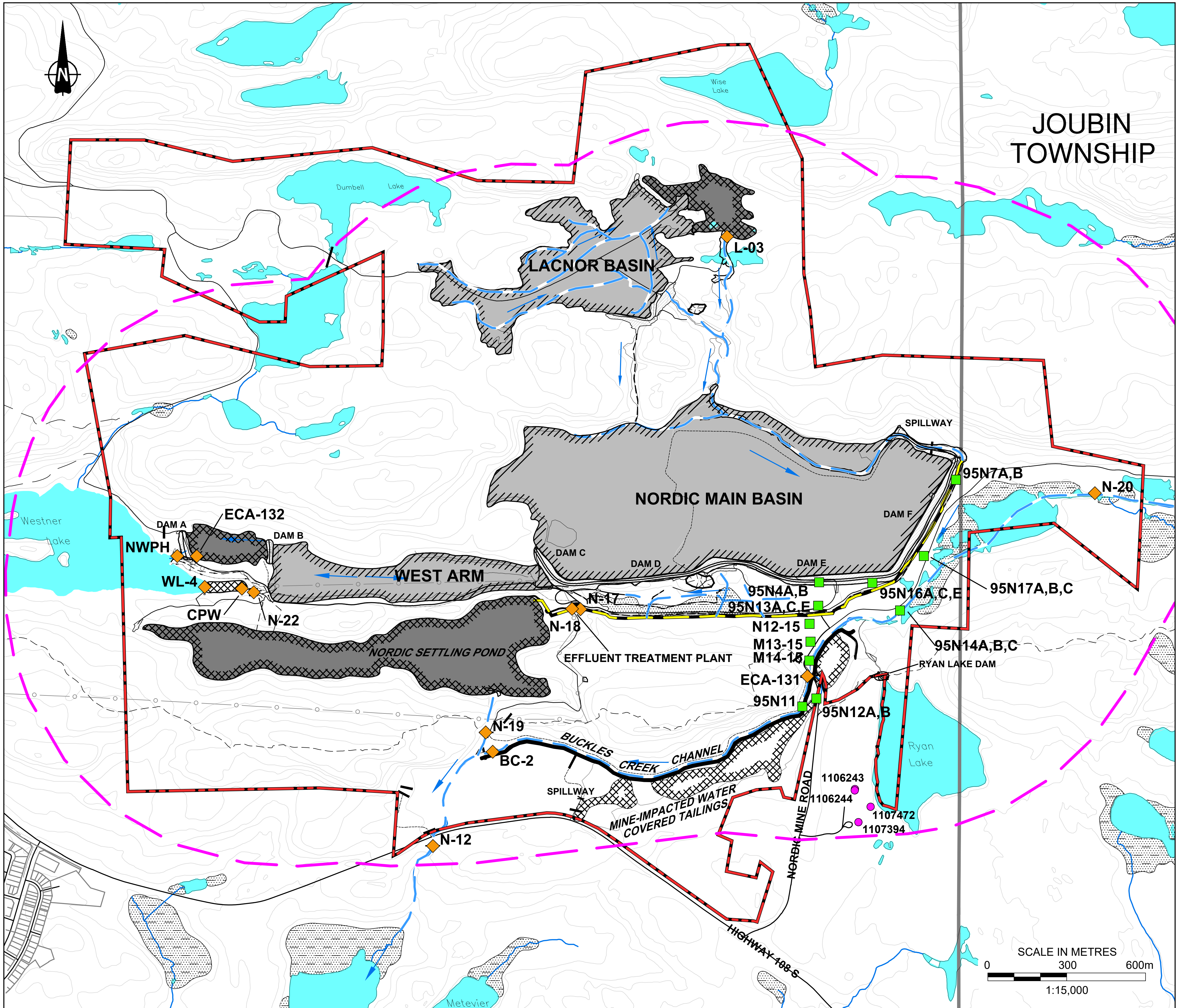
CONCEPTUAL HYDROGEOLOGICAL MODEL (LANCOR TMA)

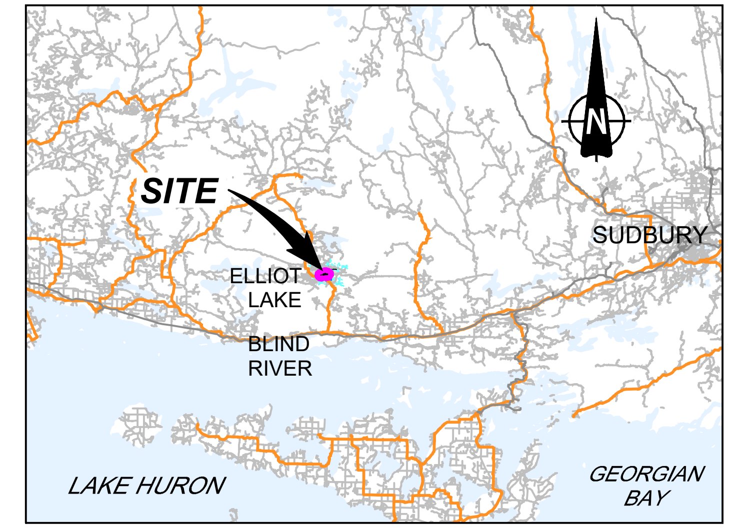
GOLDER

PROJECT No.	19126010	FILE No.	19126010-R01095
		SCALE	N.T.S. REV.
CADD	ZJB/DCH	Oct 2/20	
CHECK			

FIGURE 9.5

Client: Denison Environmental Services   Original Format is Tabloid 279mm x 432mm   Dec 10, 2020 – 12:07pm   Drawing file: 19126010-R010101.dwg





KEY PLAN

LEGEND

- APPROXIMATE LIMIT OF LICENSED AREA
- APPROXIMATE EFFLUENT COLLECTION DITCH
- APPROXIMATE CREEK/CHANNEL
- APPROXIMATE DIVERSION BERM
- 1km BUFFER FROM TMA
- VEGETATED TAILINGS
- TREATMENT SOLIDS
- WATER COVERED TAILINGS
- DAM
- SWAMP
- TOMP GROUNDWATER SAMPLING STATION
- SOURCE AREA MONITORING PROGRAM (SAMP) SURFACE WATER SAMPLING STATION

REFERENCE

DRAWING BASED ON ECOMETRIX, GENERAL CONFIGURATION OF NORDIC TMA, FIGURE 2.1, FEBRUARY 2011; MNR LIO, OBTAINED 2020, PRODUCED BY GOLDER ASSOCIATES LTD UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2020; BING IMAGERY AS OF NOVEMBER 7 - 2019 (IMAGE DATE UNKNOWN); AND CANMAP STREETFILES V2008.4.

NOTES

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ALL LOCATIONS ARE APPROXIMATE.

PROJECT

ELLIOT LAKE SITES GROUNDWATER REPORT
DENISON MINES CORP. AND RIO ALGOM LTD.
ELLIOT LAKE, ONTARIO

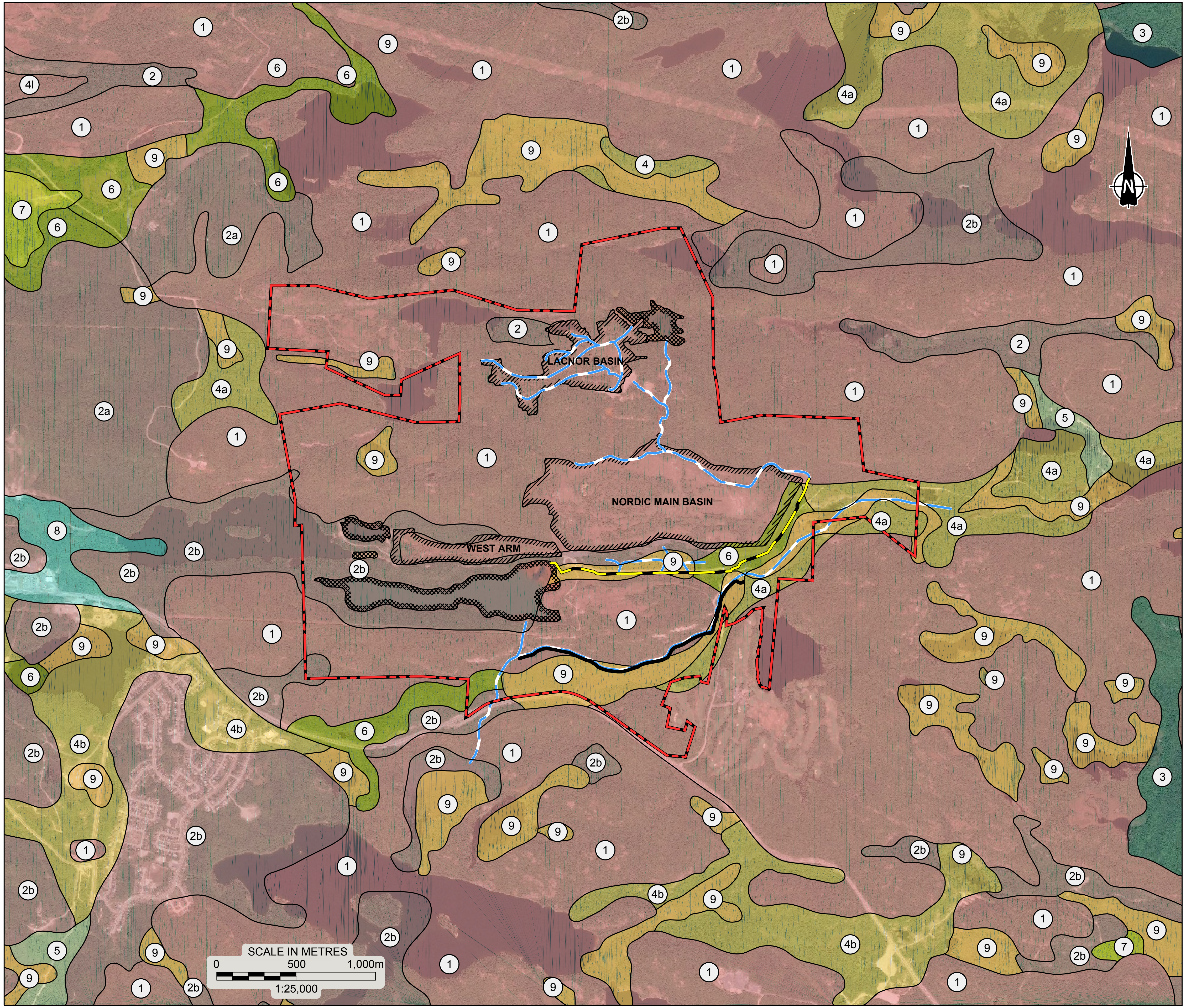
TITLE

LOCATION PLAN (NORDIC TMA)

GOLDER

PROJECT No.	19126010	FILE No.	19126010-R010101
		SCALE	AS SHOWN
CADD	Dec 10/20	REV.	
CHECK			

FIGURE 10.1



LEGEND

- APPROXIMATE LIMIT OF LICENSED AREA
- APPROXIMATE EFFLUENT COLLECTION DITCH
- APPROXIMATE CREEK/CHANNEL
- APPROXIMATE DIVERSION BERM
- VEGETATED TAILINGS
- WATER COVERED TAILINGS

RECENT

9 Swamp and organic deposits: peat, much, marshland

8 Alluvium: sand, silt, organics; minor gravel

7 Glaciolacustrine fine-grained deposits: silt and clay; minor sand; massive, lamintated or rhythmically bedded

6 Glaciolacustrine coarse-grained deposits: stratifiec fine to very fine sand and sandy silt; minor gravel, silt and clay

5 Glaciofluvial outwash deposits: stratified sand and gravel; boulders

4 Ice-contact stratified drift: complexly interstratified sand and gravel; minor diamicton, silt and clay
- 4a Kames, kame terraces, eskers and leeside deposits
- 4b Subaqueous fan deposits

3 Till: silty sand to sandy diamicton; generally massive, loose

2 Bedrock-drift complex: thin (less than 1m) discontinuous drift cover over bedrock; thicker drift accumulations may localy subdue bedrock topography
- 2a mainly covered by diamicton (till)
- 2b mainly covered by sand and gravel
- 2c mainly covered by silt and lcay

PRECAMBRIAN

1 Bedrock, undifferentiated: predominantly bare outcrops with drift accumulations locallized in depressions on bedrock surface

REFERENCE

DRAWING BASED ON ECOMETRIX, GENERAL CONFIGURATION OF NORDIC TMA, FIGURE 2.1, FEBRUARY 2011;
BING IMAGERY AS OF NOVEMBER 7 - 2019 (IMAGE DATE UNKNOWN); AND
MINISTRY OF NORTHERN DEVELOPMENT AND MINES, QUATERNARY GEOLOGY OF ELLIOT LAKE AREA, OPEN FILE MAP 193, 1975.

NOTES

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ALL LOCATIONS ARE APPROXIMATE.

PROJECT

ELLIOT LAKE SITES GROUNDWATER REPORT
DENISON MINES CORP. AND RIO ALGOM LTD.
ELLIOT LAKE, ONTARIO

TITLE

QUATERNARY GEOLOGY (NORDIC TMA)

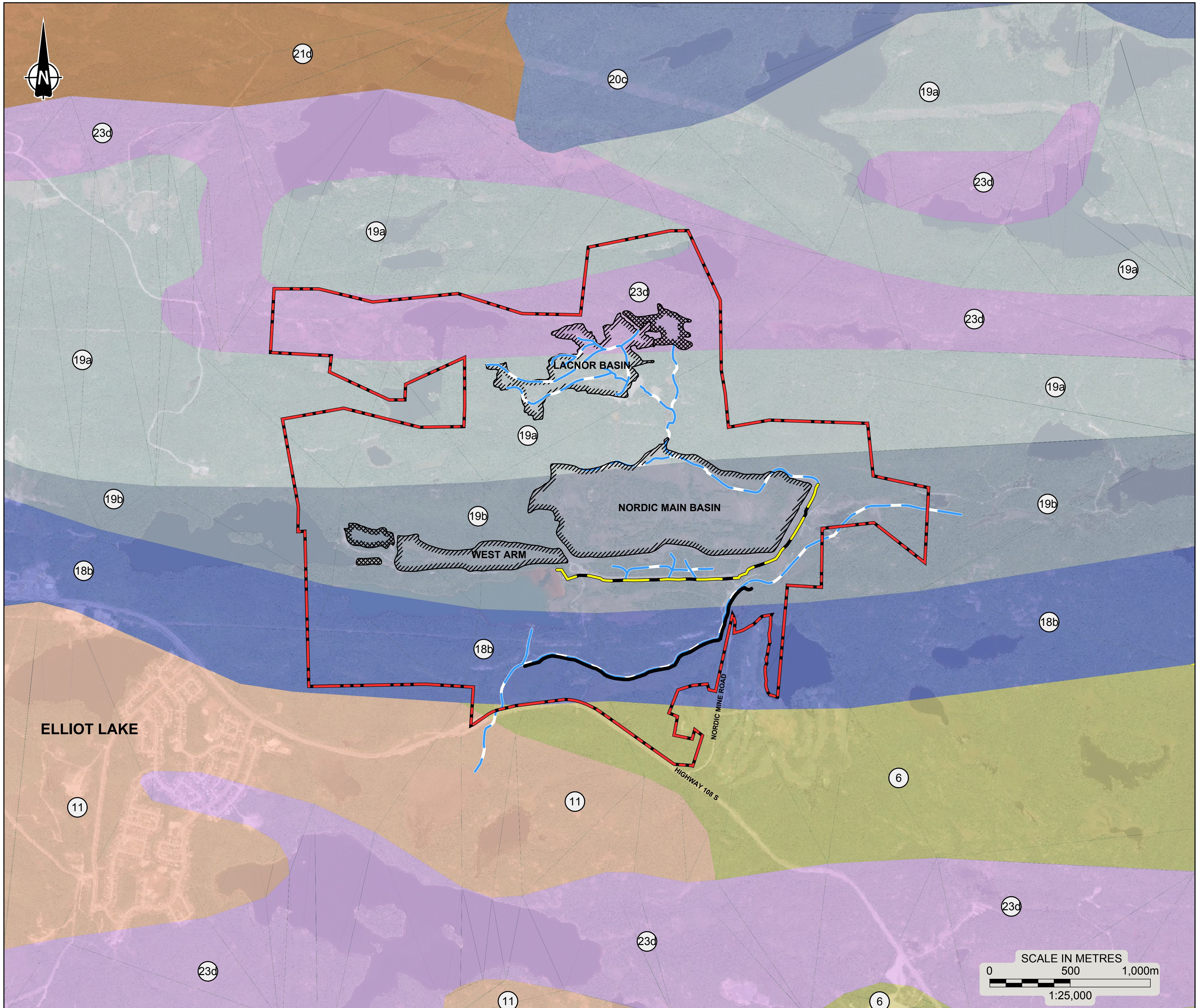
GOLDER

PROJECT No.	19126010	FILE No.	19126010–R010102
		SCALE	AS SHOWN REV.
CADD	DCH	Oct 2/20	
CHECK			FIGURE 10.2

Client: Denison Environmental Services

Original Format is Tabloid 279mm x 432mm

Drawing file: 19126010–R010102.dwg Oct 02, 2020 – 4:21pm



LEGEND

- APPROXIMATE LIMIT OF LICENSED AREA
- APPROXIMATE EFFLUENT COLLECTION DITCH
- APPROXIMATE CREEK/CHANNEL
- APPROXIMATE DIVERSION BERM

- VEGETATED TAILINGS
- WATER COVERED TAILINGS

- 6 Felsic to intermediate metavolcanic rocks
- 11 Gneissic tonalite suite
- 18b Elliot Lake Group (Matinenda Formation)
- 19a Hough Lake Group (Mississagi Formation)
- 19b Hough Lake Group (Pecors Formation)
- 20c Quirke Lake Group (Bruce Formation)
- 21d Cobalt Group (Gowganda Formation)
- 23d Mafic and related intrusive rocks

REFERENCE

DRAWING BASED ON ECOMETRIX, GENERAL CONFIGURATION OF NORDIC TMA, FIGURE 2.1, FEBRUARY 2011;
BING IMAGERY AS OF NOVEMBER 7 - 2019 (IMAGE DATE UNKNOWN); AND
MINISTRY OF NORTHERN DEVELOPMENT AND MINES, ONTARIO GEOLOGIC SURVEY, MRD 126-REVISED, 1:250,000 SCALE.

NOTES

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ALL LOCATIONS ARE APPROXIMATE.

PROJECT
ELLIOT LAKE SITES GROUNDWATER REPORT
DENISON MINES CORP. AND RIO ALGOM LTD.
ELLIOT LAKE, ONTARIO

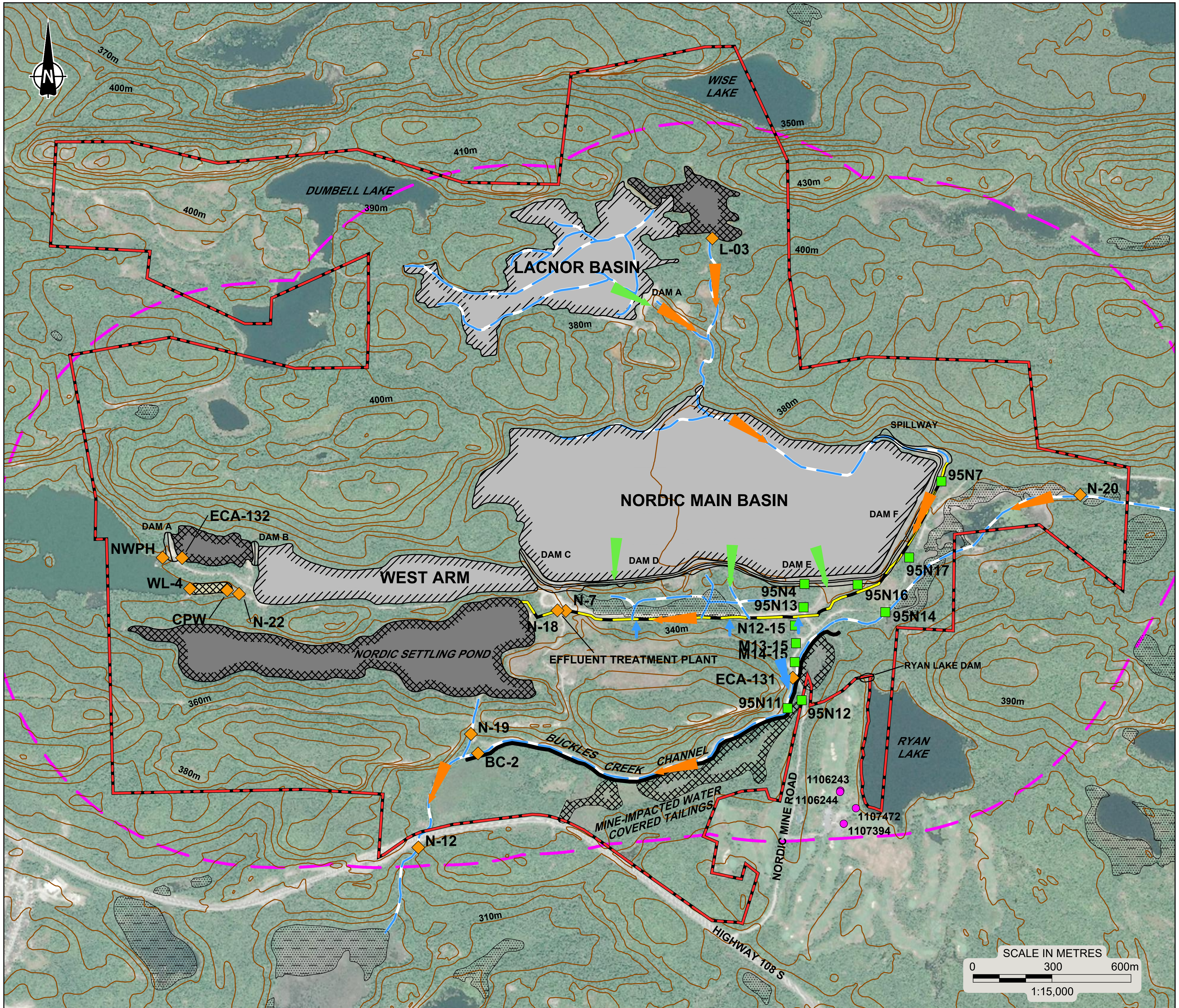
TITLE
BEDROCK GEOLOGY (NORDIC TMA)

GOLDER

PROJECT No.	19126010	FILE No.	19126010-R010103
		SCALE	AS SHOWN	REV.
CADD	DCH	Oct 2/20	
CHECK			

FIGURE 10.3

Client: Denison Environmental Services
Original Format is Tabloid 279mm x 432mm
Drawing file: 19126010-R010103.dwg Oct 02, 2020 - 6:39pm



LEGEND

- APPROXIMATE LIMIT OF LICENSED AREA
- APPROXIMATE EFFLUENT COLLECTION DITCH
- APPROXIMATE CREEK/CHANNEL
- APPROXIMATE DIVERSION BERM
- 1km BUFFER FROM TMA
- INFERRED GROUNDWATER FLOW DIRECTION
- INFERRED SURFACE WATER FLOW DIRECTION
- INFERRED SEEPAGE FLOW
- VEGETATED TAILINGS
- TREATMENT SOLIDS
- WATER COVERED TAILINGS
- DAM
- SWAMP
- TOMP GROUNDWATER SAMPLING STATION
- SOURCE AREA MONITORING PROGRAM (SAMP) SURFACE WATER SAMPLING STATION
- MOECC IDENTIFIED WATER WELL

REFERENCE

DRAWING BASED ON ECOMETRIX, GENERAL CONFIGURATION OF NORDIC TMA, FIGURE 2.1, FEBRUARY 2011;

MOECC WATER WELL DATABASE AS OF DECEMBER 2019

MNR LIO, OBTAINED 2020, PRODUCED BY GOLDER ASSOCIATES LTD UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2020; AND

BING IMAGERY AS OF NOVEMBER 7 - 2019 (IMAGE DATE UNKNOWN).

NOTES

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ALL LOCATIONS ARE APPROXIMATE.

PROJECT

ELLIOT LAKE SITES GROUNDWATER REPORT
DENISON MINES CORP. AND RIO ALGOM LTD.
ELLIOT LAKE, ONTARIO

TITLE

INFERRED FLOW DIRECTIONS (NORDIC TMA)

GOLDER

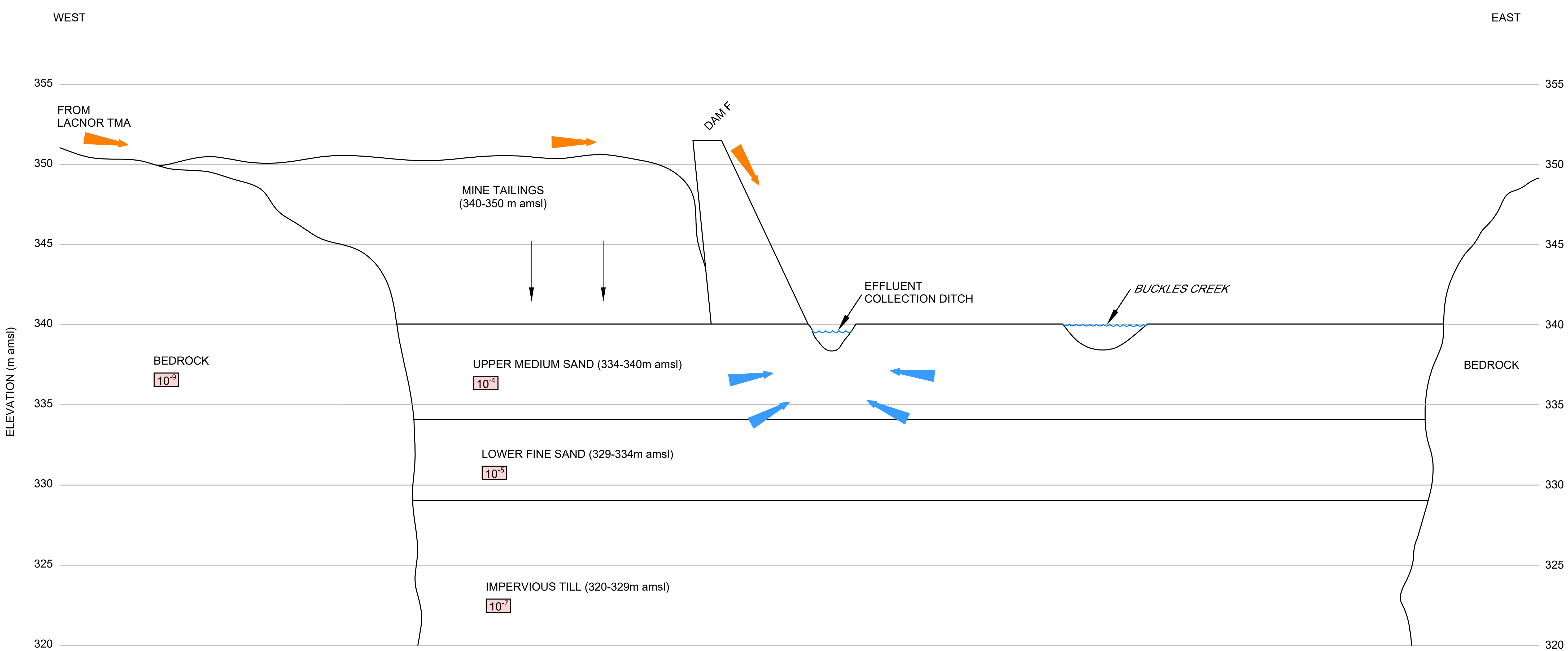
PROJECT No.	19126010	FILE No.	19126010-R010104
CADD	DCH	Dec 10/20	SCALE AS SHOWN REV.
CHECK	STH		**FIGURE 10.4**

Client: Denison Environmental Services

Original Format is Tabloid 279mm x 432mm

Dec 10, 2020 - 12:05pm

Drawing file: 19126010-R010104.dwg



LEGEND

INFILTRATION

INFERRED GROUNDWATER FLOW DIRECTION

INFERRED SURFACE WATER FLOW DIRECTION

10^{-7} HYDRAULIC CONDUCTIVITY (K) VALUE IN (m/s) FROM HYDRAULIC TESTING

REFERENCE

DRAWING BASED ON ECOMETRIX, CONCEPTUAL HYDROGEOLOGIC MODEL, FIGURE 1, FEBRUARY 2010.

NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE.

VERTICAL SCALE IN METRES: 0 – 5 – 10m, 1:250

HORIZONTAL SCALE IN METRES: 0 – 100 – 200m, 1:5,000

PROJECT

ELLIOT LAKE SITES GROUNDWATER REPORT
DENISON MINES CORP. AND RIO ALGOM LTD.
ELLIOT LAKE, ONTARIO

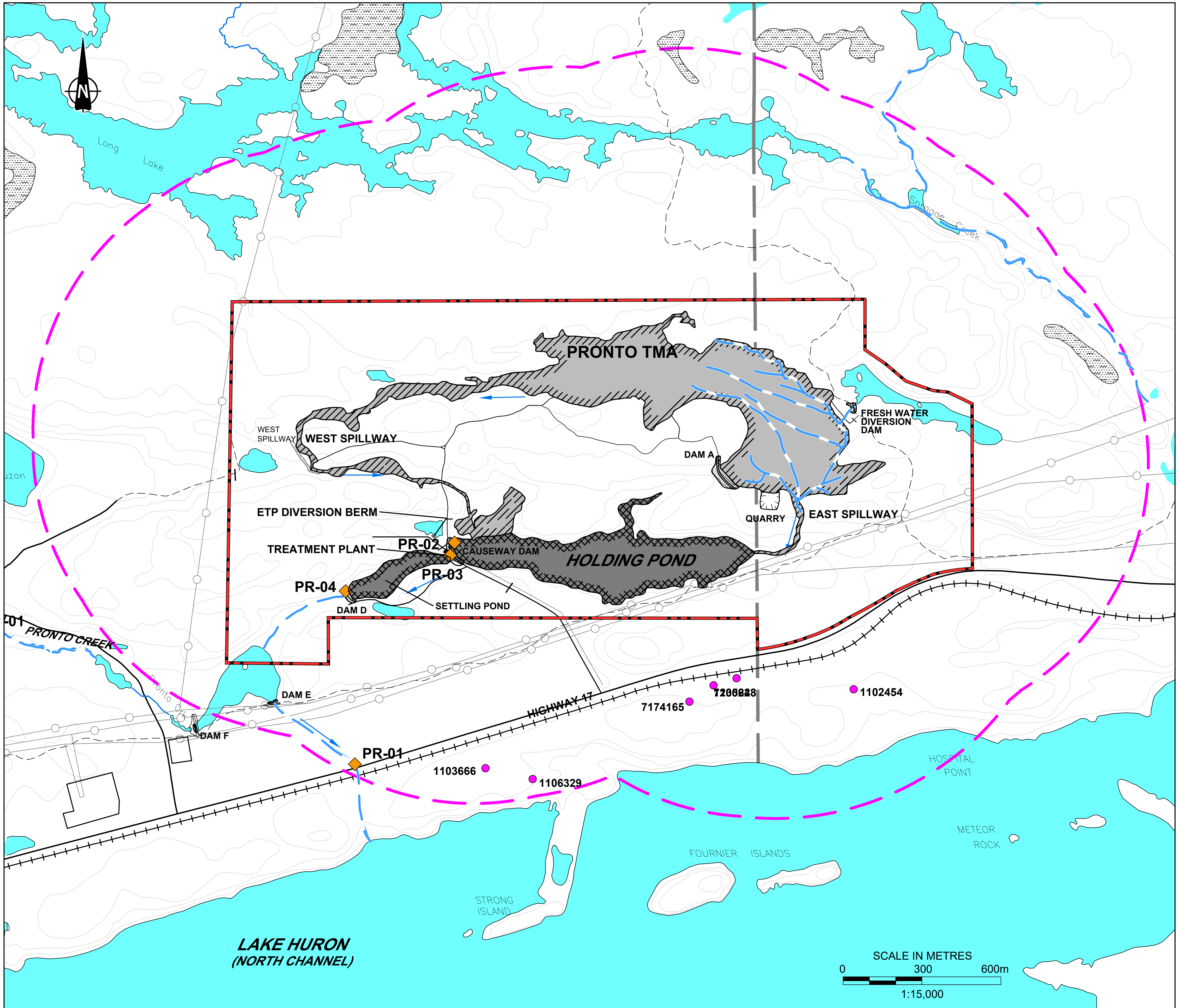
TITLE

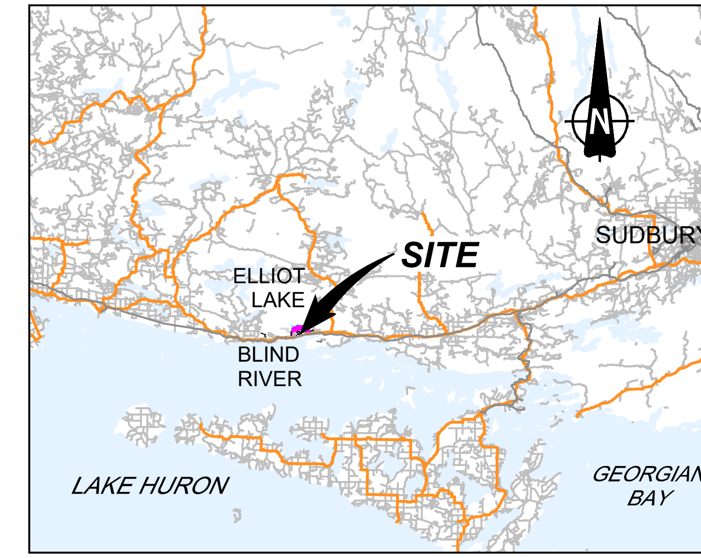
CONCEPTUAL HYDROGEOLOGICAL MODEL (NORDIC TMA)

GOLDER

PROJECT No.	19126010	FILE No.	19126010-R010105
CADD	DCH/ZJB	Dec 10/20	SCALE AS SHOWN
CHECK	STH		REV.

FIGURE 10.5





KEY PLAN

LEGEND

- APPROXIMATE LIMIT OF LICENSED AREA
- APPROXIMATE CREEK/CHANNEL
- 1km BUFFER FROM TMA
- VEGETATED TAILINGS
- WATER COVERED TAILINGS
- SWAMP
- DAM
- SOURCE AREA MONITORING PROGRAM (SAMP) SURFACE WATER SAMPLING STATION
- MOECC IDENTIFIED WATER WELL

REFERENCE

DRAWING BASED ON MINNOW, PRONTO SITE SAMP AND TOMP MONITORING STATIONS, FIGURE 3.35, FEBRUARY 2016;

MOECC WATER WELL DATABASE AS OF DECEMBER 2019

MNR LIO, OBTAINED 2020, PRODUCED BY GOLDER ASSOCIATES LTD UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2020;

BING IMAGERY AS OF DECEMBER 24 - 2019 (IMAGE DATE UNKNOWN); AND

CANMAP STREETFILES V2008.4.

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ALL LOCATIONS ARE APPROXIMATE.

PROJECT

ELLIOT LAKE SITES GROUNDWATER REPORT
DENISON MINES CORP. AND RIO ALGOM LTD.
ELLIOT LAKE, ONTARIO

TITLE

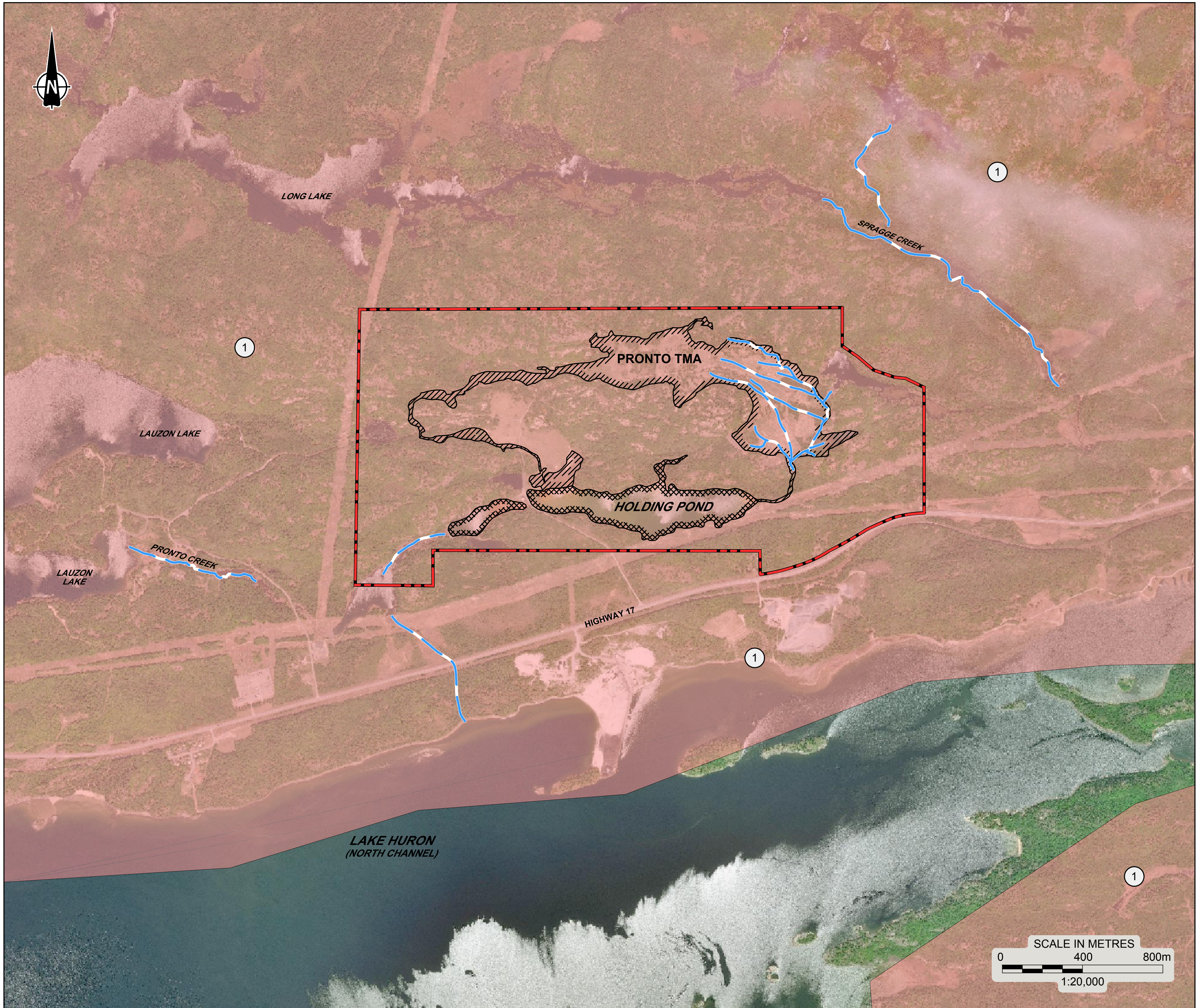
LOCATION PLAN (PRONTO TMA)

GOLDER

PROJECT No.	19126010	FILE No.	19126010–R010111
CADD	Dec 9/20	SCALE	AS SHOWN
CHECK	STH	REV.	

FIGURE 11.1

Client: Denison Environmental Services
Original Format is Tabloid 279mm x 432mm
Dec 09, 2020 – 9:18am
Drawing file: 19126010–R010111.dwg



LEGEND

APPROXIMATE LIMIT OF LICENSED AREA

APPROXIMATE CREEK/CHANNEL

VEGETATED TAILINGS

WATER COVERED TAILINGS

PRECAMBRIAN

1 — Bedrock, undifferentiated igneous and metamorphic rock, exposed at surface or covered by a discontinuous, thin layer of drift

REFERENCE

DRAWING BASED ON MINNOW, PRONTO SITE SAMP AND TOMP MONITORING STATIONS, FIGURE 3.35, FEBRUARY 2016;
BING IMAGERY AS OF DECEMBER 24 - 2019 (IMAGE DATE UNKNOWN); AND
MINISTRY OF NORTHERN DEVELOPMENT AND MINES, QUATERNARY GEOLOGY OF ELLIOT LAKE AREA, OPEN FILE MAP 193, 1975.

NOTES

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ALL LOCATIONS ARE APPROXIMATE.

PROJECT

ELLIOT LAKE SITES GROUNDWATER REPORT
DENISON MINES CORP. AND RIO ALGOM LTD.
ELLIOT LAKE, ONTARIO

TITLE

QUATERNARY GEOLOGY (PRONTO TMA)

GOLDER

PROJECT No.	19126010	FILE No.	19126010-R010112
		SCALE	AS SHOWN
CADD	AMS/DCH	Oct 2/20	
CHECK			

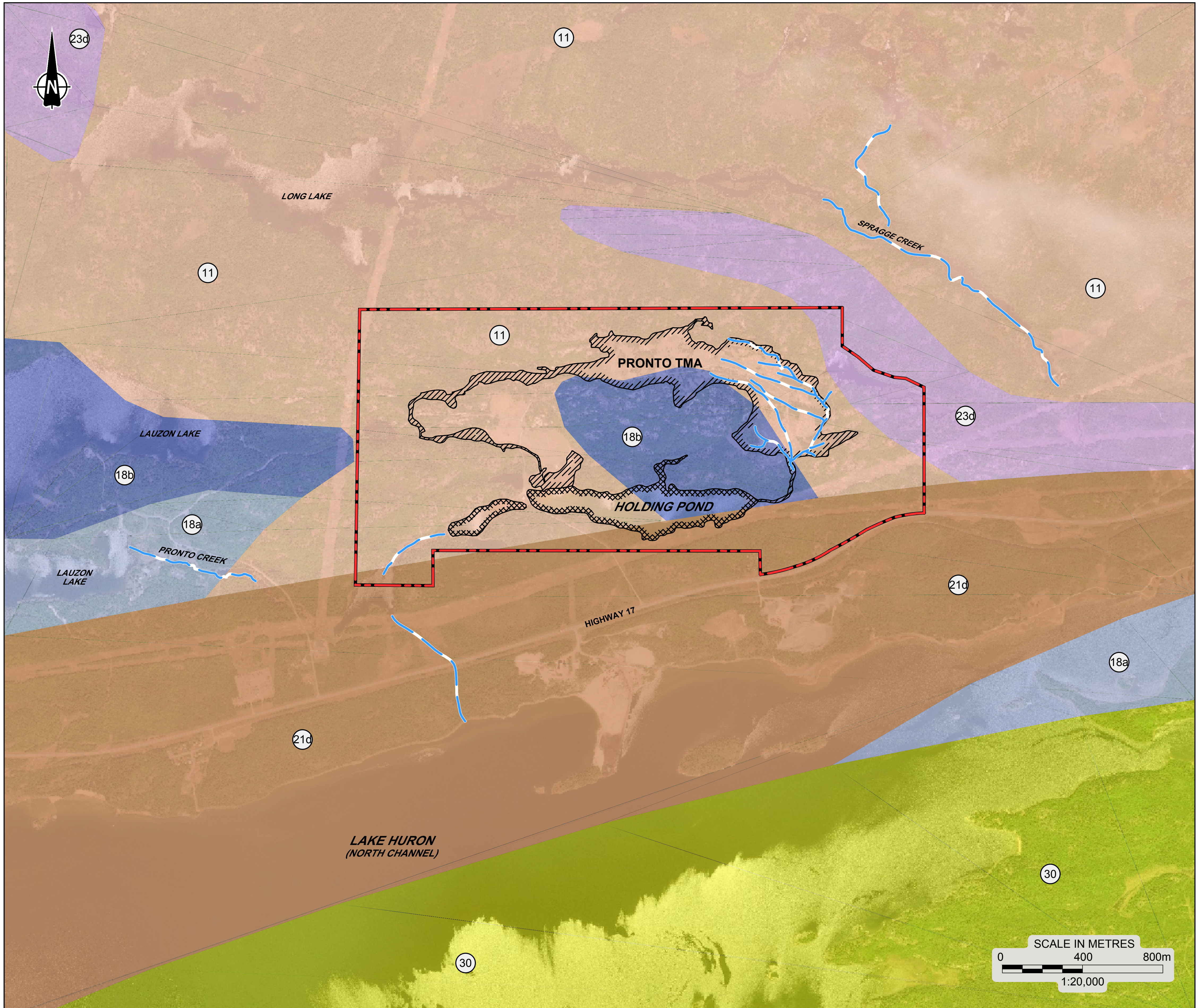
REV.

FIGURE 11.2

Client: Denison Environmental Services

Original Format is Tabloid 279mm x 432mm

Drawing file: 19126010-R010112.dwg Oct 02, 2020 – 6:44pm



LEGEND

- APPROXIMATE LIMIT OF LICENSED AREA
- APPROXIMATE CREEK/CHANNEL
- VEGETATED TAILINGS
- WATER COVERED TAILINGS
- 11 Gneissic tonalite suite
- 18a Elliot Lake Group (McKim Formation)
- 18b Elliot Lake Group (Matinenda Formation)
- 21d Cobalt Group (Gowganda Formation)
- 23d Mafic and related intrusive rocks
- 30 Felsic intrusive rocks

REFERENCE

DRAWING BASED ON MINNOW, PRONTO SITE SAMP AND TOMP MONITORING STATIONS, FIGURE 3.35, FEBRUARY 2016;
BING IMAGERY AS OF DECEMBER 24 - 2019 (IMAGE DATE UNKNOWN); AND
MINISTRY OF NORTHERN DEVELOPMENT AND MINES, ONTARIO GEOLOGIC SURVEY, MRD 126-REVISED, 1:250,000 SCALE.

NOTES

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ALL LOCATIONS ARE APPROXIMATE.

PROJECT

ELLIOT LAKE SITES GROUNDWATER REPORT
DENISON MINES CORP. AND RIO ALGOM LTD.
ELLIOT LAKE, ONTARIO

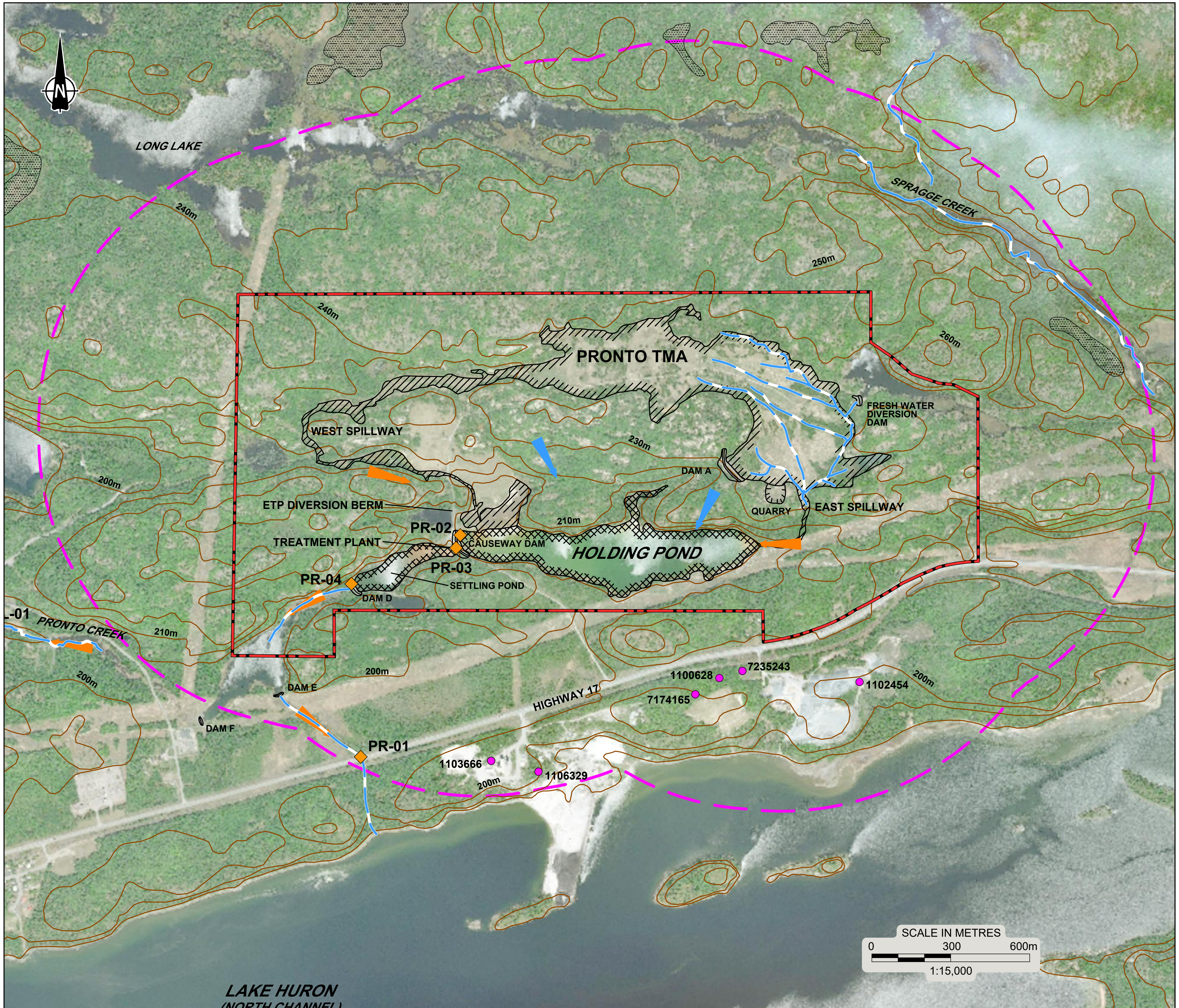
TITLE

BEDROCK GEOLOGY (PRONTO TMA)

GOLDER

PROJECT No.	19126010	FILE No.	19126010-R010113
		SCALE	AS SHOWN
CADD	AMS/DCH	Oct 2/20	REV.
CHECK			FIGURE 11.3

Drawing file: 19126010-R010113.dwg Oct 02, 2020 - 6:46pm Original Format is Tabloid 279mm x 432mm Client: Denison Environmental Services



LEGEND

- APPROXIMATE LIMIT OF LICENSED AREA
- APPROXIMATE CREEK/CHANNEL
- 1km BUFFER FROM TMA
- INFERRED GROUNDWATER FLOW DIRECTION
- INFERRED SURFACE WATER FLOW DIRECTION
- VEGETATED TAILINGS
- WATER COVERED TAILINGS
- SWAMP
- SOURCE AREA MONITORING PROGRAM (SAMP) SURFACE WATER SAMPLING STATION
- MOECC IDENTIFIED WATER WELL

REFERENCE

DRAWING BASED ON MINNOW, PRONTO SITE SAMP AND TOMP MONITORING STATIONS, FIGURE 3.35, FEBRUARY 2016;
MOECC WATER WELL DATABASE AS OF DECEMBER 2019
MNR LIO, OBTAINED 2020, PRODUCED BY GOLDER ASSOCIATES LTD UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2020; AND
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ALL LOCATIONS ARE APPROXIMATE.

PROJECT
ELLIOT LAKE SITES GROUNDWATER REPORT
DENISON MINES CORP. AND RIO ALGOM LTD.
ELLIOT LAKE, ONTARIO

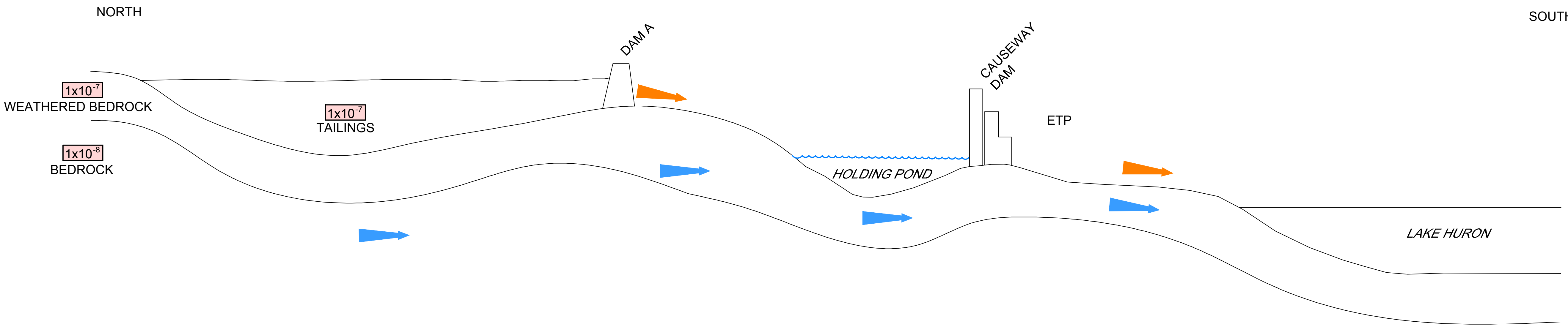
TITLE
INFERRED FLOW DIRECTIONS (PRONTO TMA)

GOLDER

PROJECT No.	19126010	FILE No.	19126010-R010114
		SCALE	AS SHOWN
CADD	AMS/DCH	Dec 7/20	REV.
CHECK			**FIGURE 11.4**

Client: Denison Environmental Services

Drawing file: 19126010-R010114.dwg Dec 07, 2020 - 1:23pm Original Format is Tabloid 279mm x 432mm



LEGEND

- INFERRED GROUNDWATER FLOW DIRECTION
- INFERRED SURFACE WATER FLOW DIRECTION

1×10^{-7} HYDRAULIC CONDUCTIVITY (K) VALUE IN (m/s) FROM HYDRAULIC TESTING

NOTES

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ALL LOCATIONS ARE APPROXIMATE.

PROJECT

ELLIOT LAKE SITES GROUNDWATER REPORT
DENISON MINES CORP. AND RIO ALGOM LTD.
ELLIOT LAKE, ONTARIO

TITLE

CONCEPTUAL HYDROGEOLOGICAL MODEL (PRONTO TMA)

GOLDER

PROJECT No.	19126010		FILE No.	19126010–R010115
			SCALE N.T.S.	REV.
CADD	ZJB/DCH	Oct 2/20		
CHECK				

FIGURE 11.5

APPENDIX A

TMA Monitoring Programs

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

			Parameters and Frequencies[a]											
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]
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.

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APPENDIX M
MAY LAKE SUB-WATERSHED SAMP DATA

Stanrock TMA and Stanleigh TMA

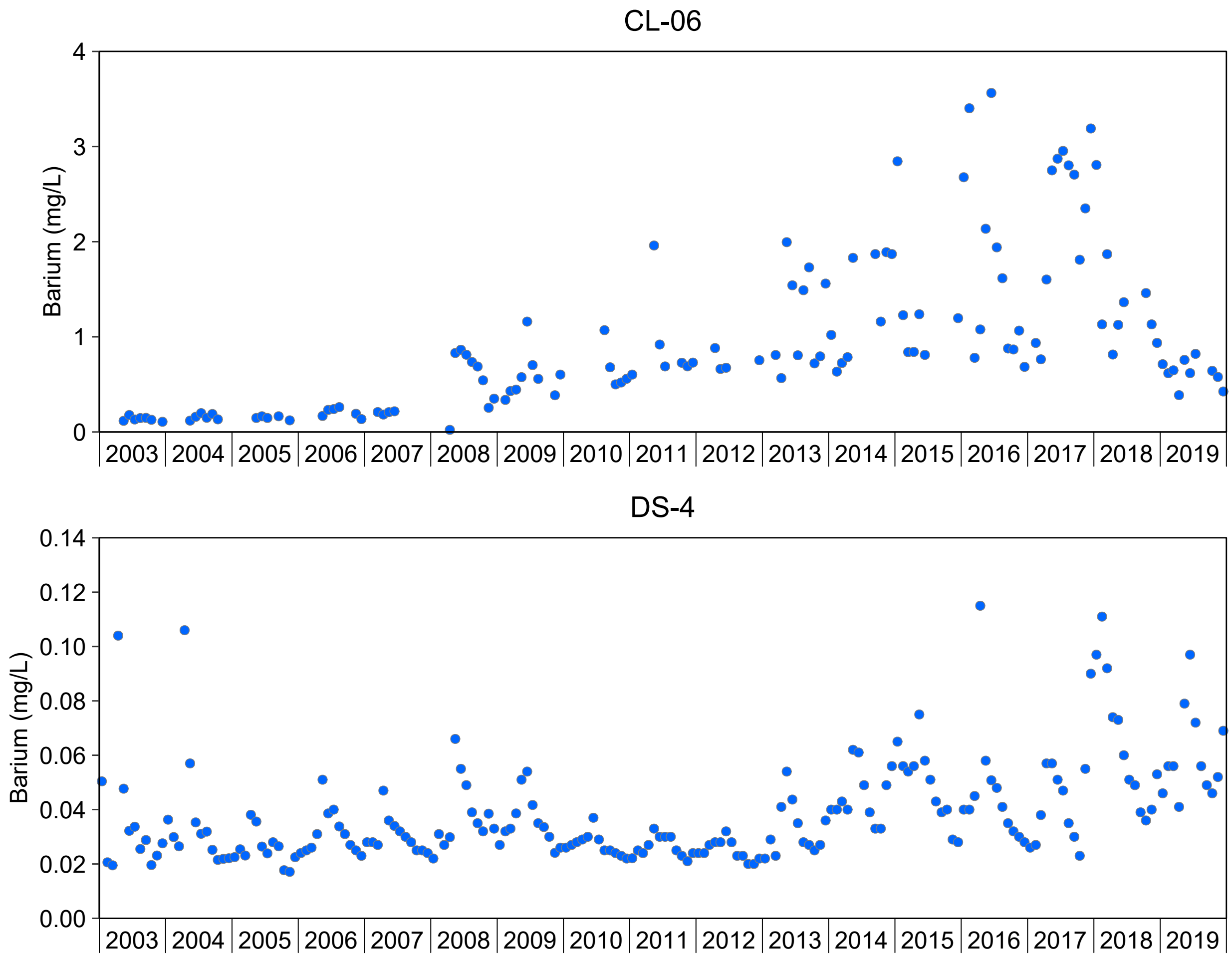


Figure M.1: Concentrations of Barium for SAMP Water Quality Monitoring Stations, Stanleigh and Stanrock TMAs, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Tables M.2 and M.4 for raw data.

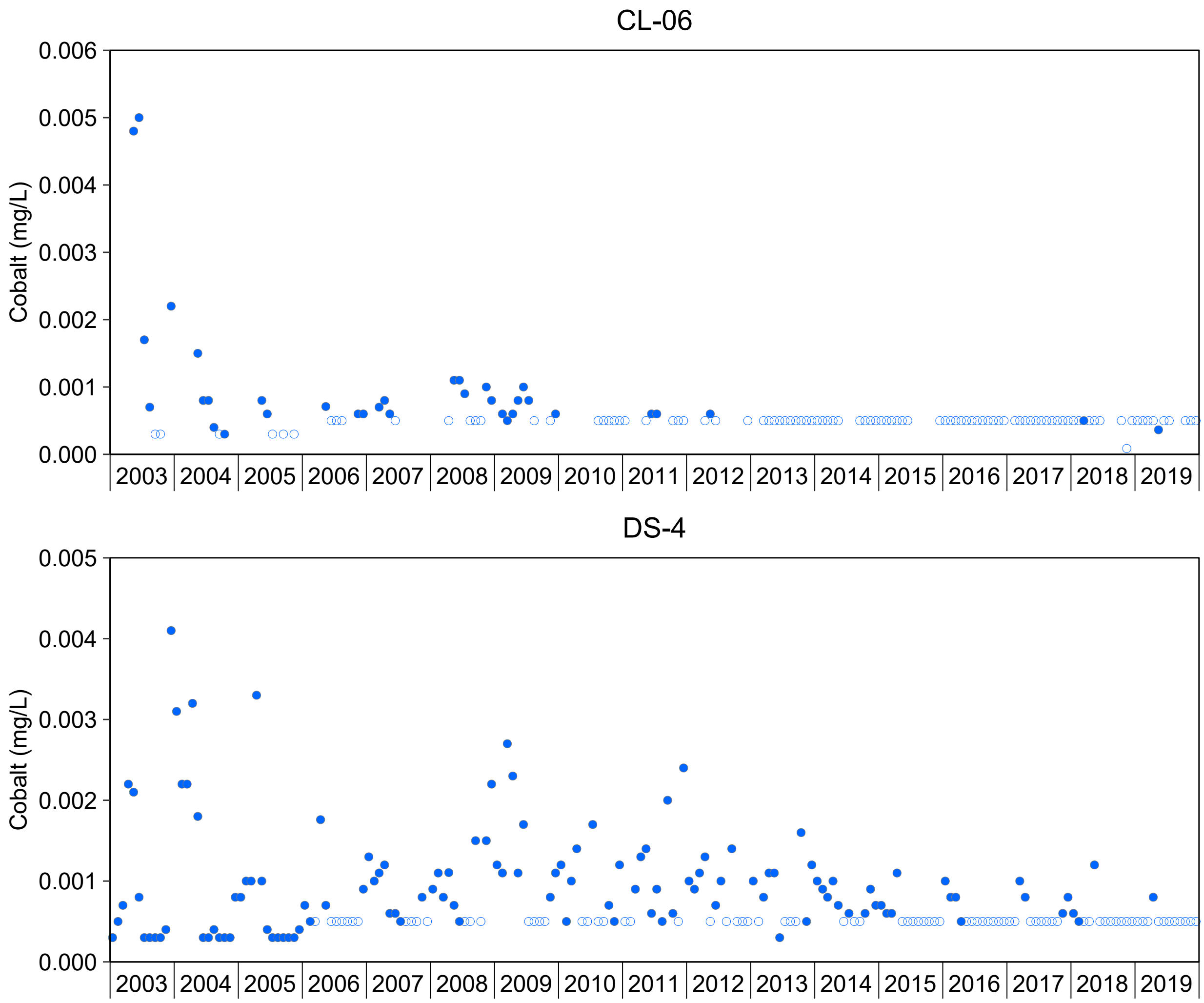


Figure M.2: Concentrations of Cobalt for SAMP Water Quality Monitoring Stations, Stanleigh and Stanrock TMAs, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Cobalt (mg/L) is not included in the trend analysis for SAMP station CL-06 due to >50% non-detectable concentrations in the dataset. See Appendix Tables M.2 and M.4 for raw data.

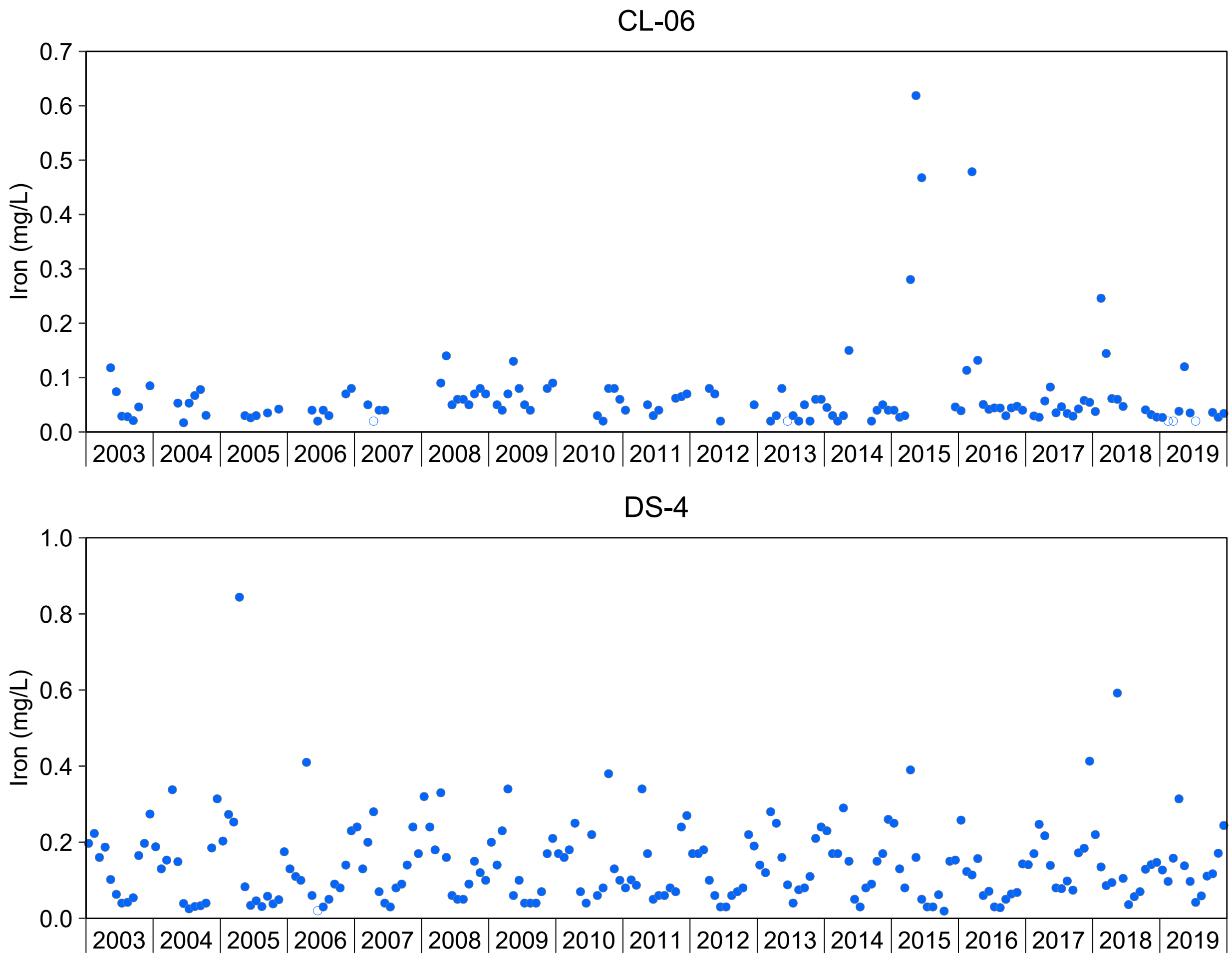


Figure M.3: Concentrations of Iron for SAMP Water Quality Monitoring Stations, Stanleigh and Stanrock TMAs, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Tables M.2 and M.4 for raw data.

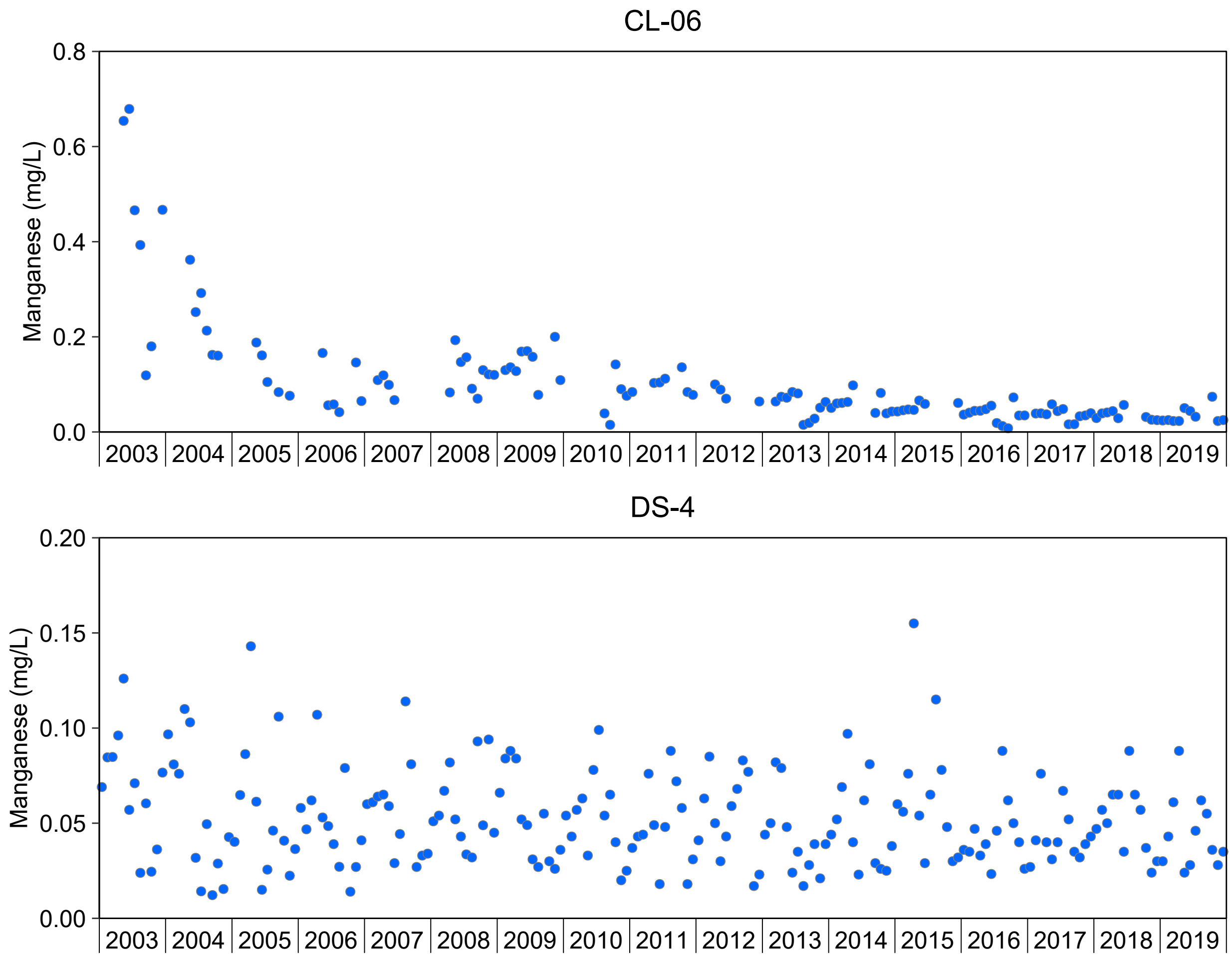


Figure M.4: Concentrations of Manganese for SAMP Water Quality Monitoring Stations, Stanleigh and Stanrock TMAs, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Tables M.2 and M.4 for raw data.

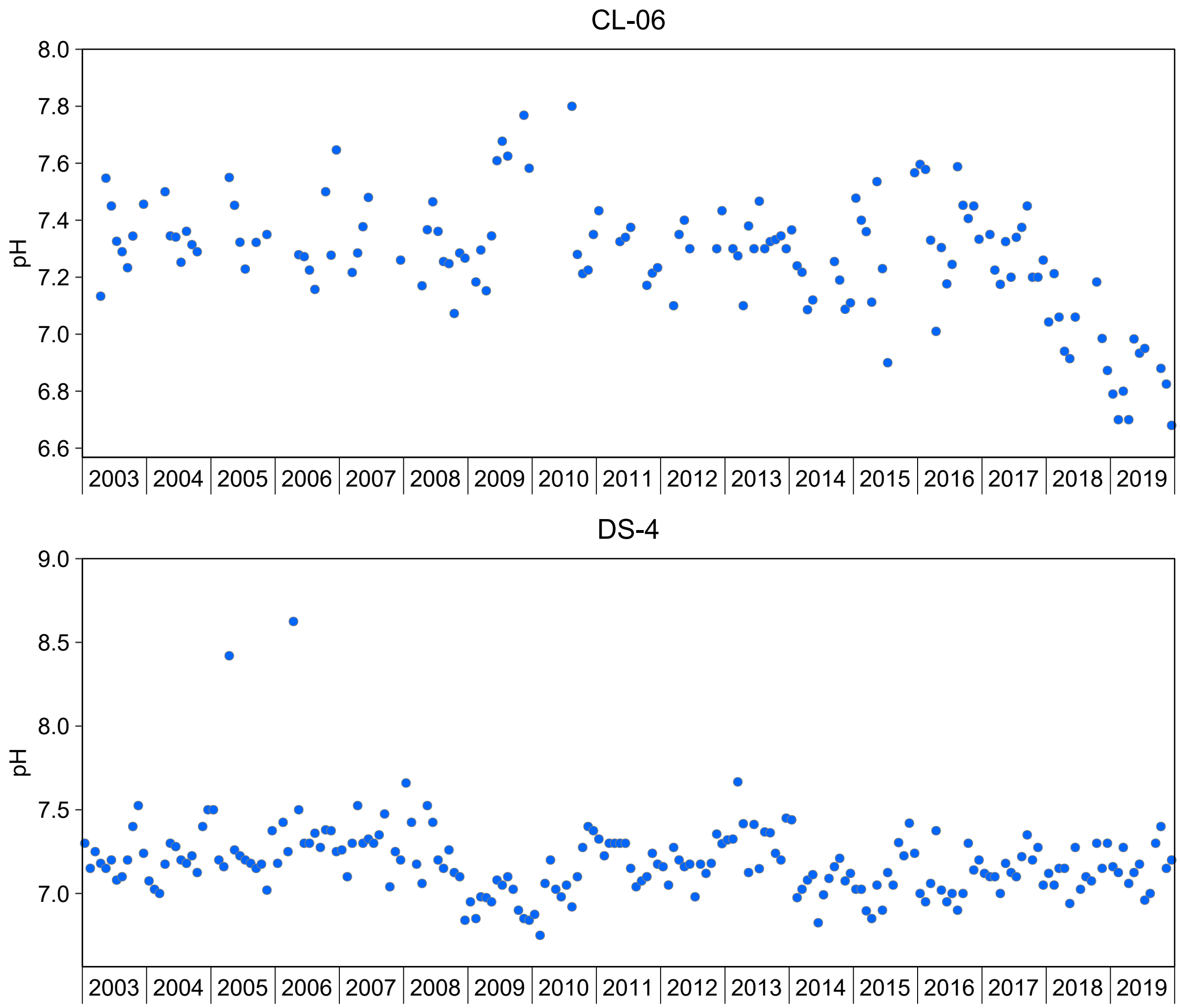


Figure M.5: Field Measurements of pH for SAMP Water Quality Monitoring Stations, Stanleigh and Stanrock TMAs, 2003 to 2019

Note: See Appendix Tables M.2 and M.4 for raw data.

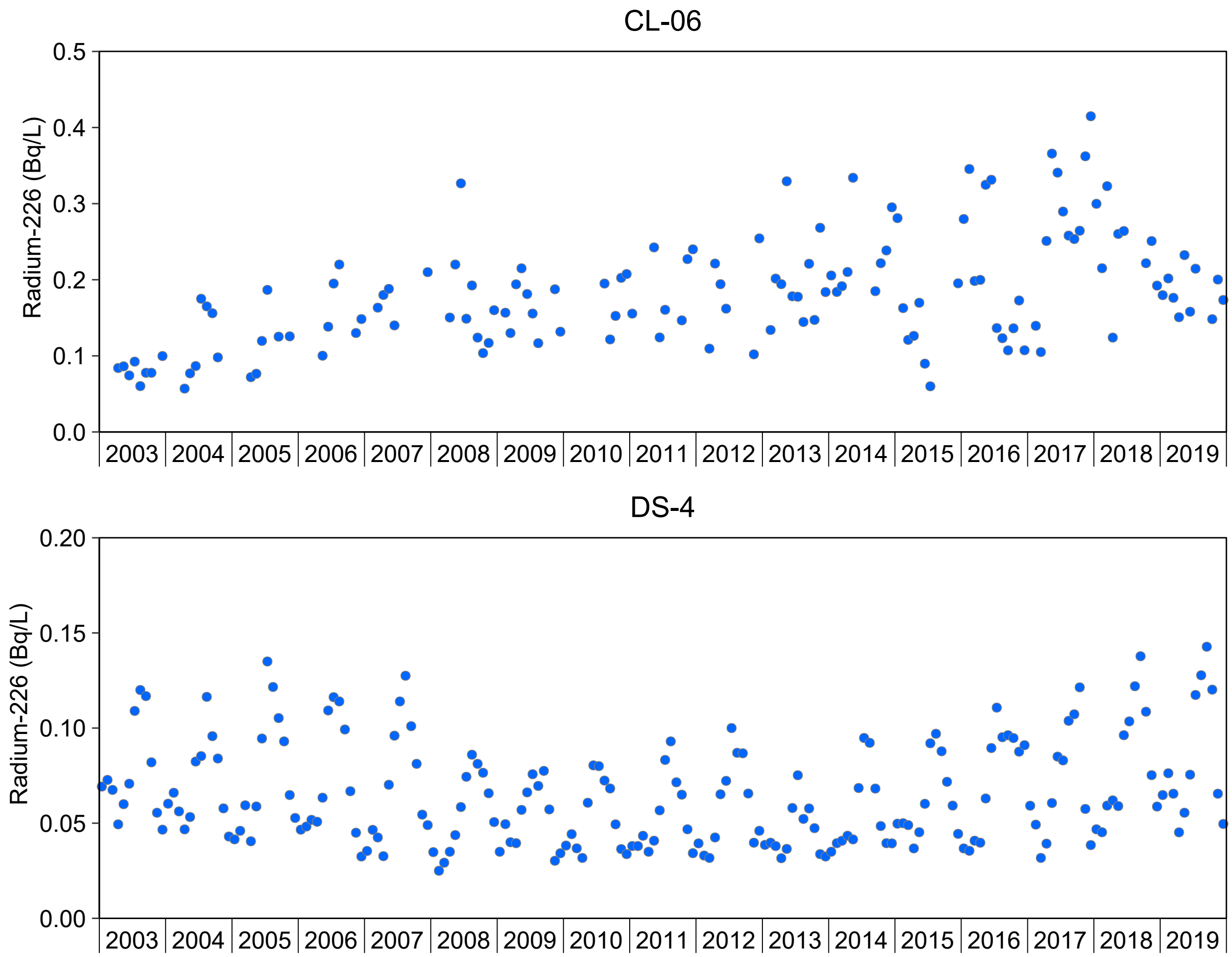


Figure M.6: Concentrations of Radium-226 for SAMP Water Quality Monitoring Stations, Stanleigh and Stanrock TMAs, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Tables M.2 and M.4 for raw data.

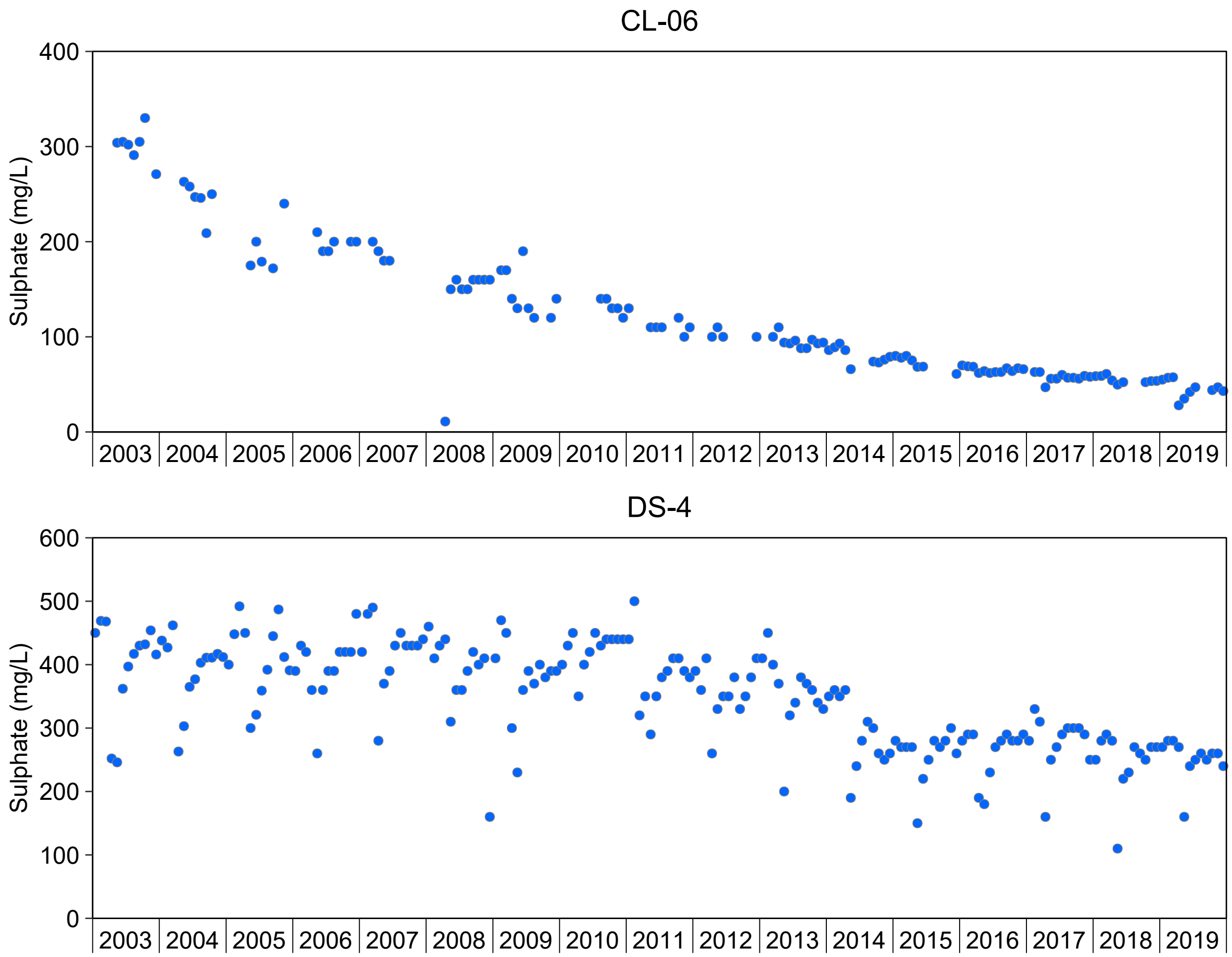


Figure M.7: Concentrations of Sulphate for SAMP Water Quality Monitoring Stations, Stanleigh and Stanrock TMAs, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL.
See Appendix Tables M.2 and M.4 for raw data.

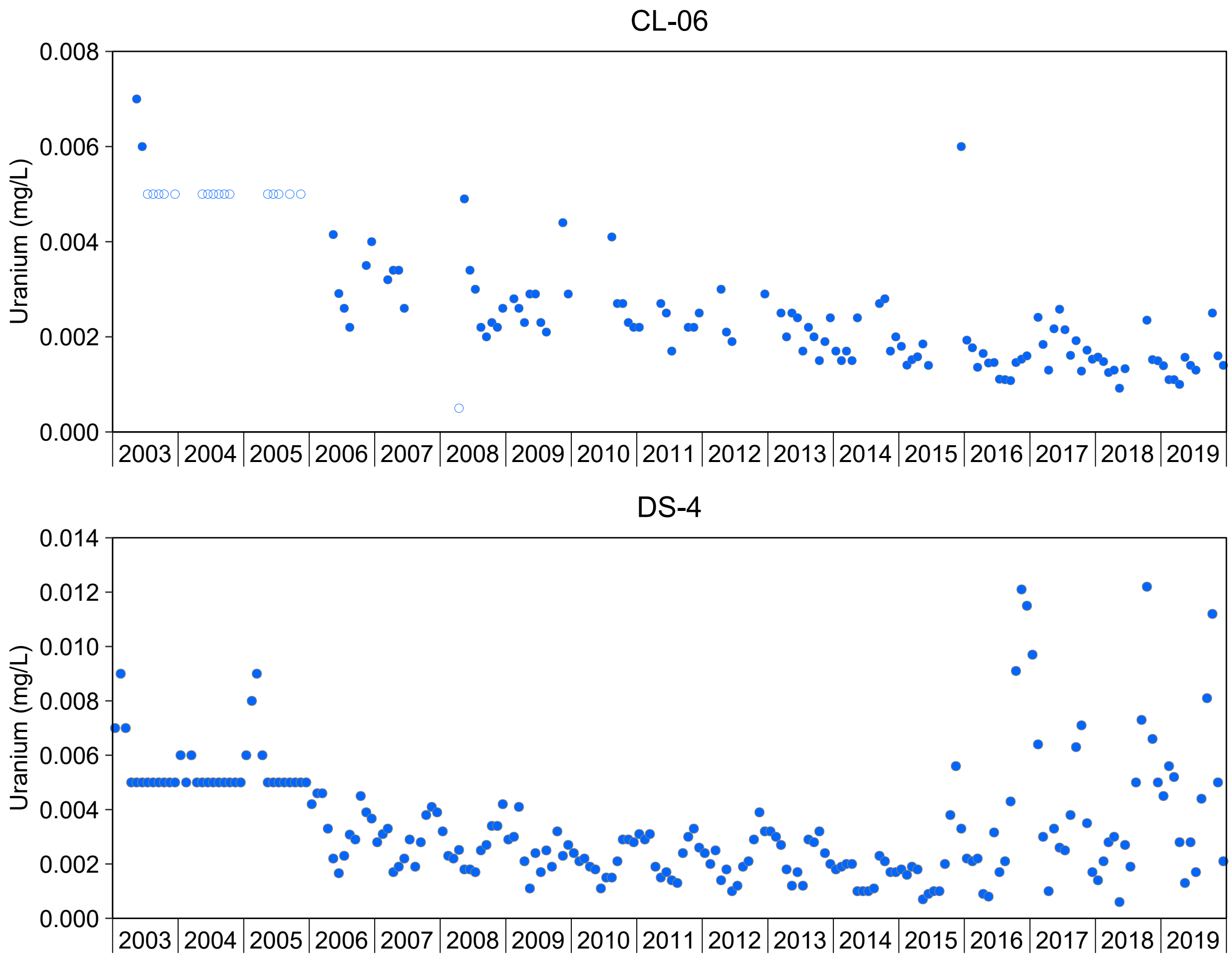
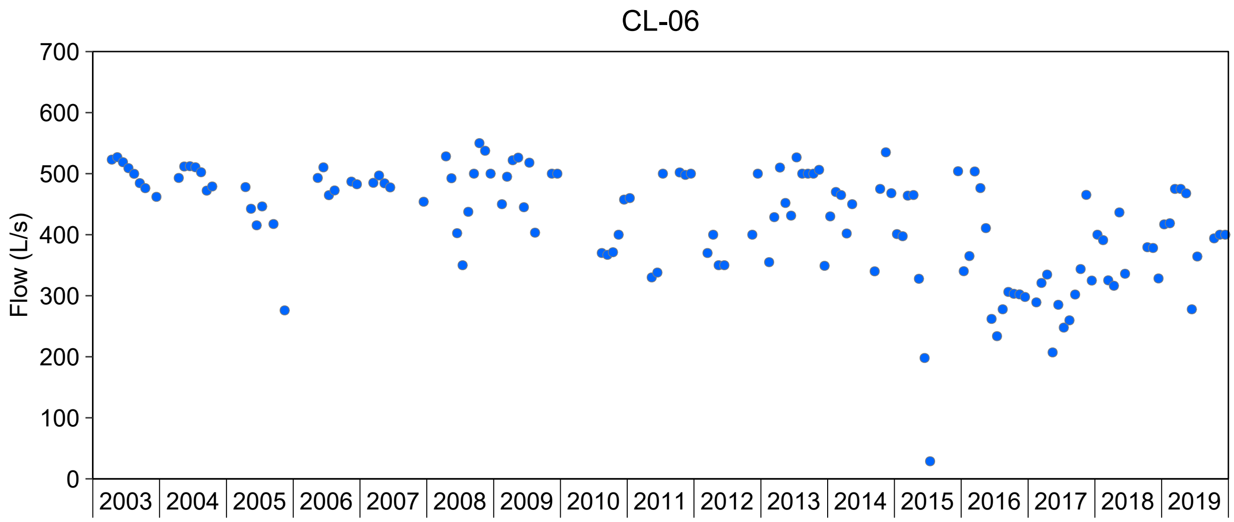


Figure M.8: Concentrations of Uranium for SAMP Water Quality Monitoring Stations, Stanleigh and Stanrock TMAs, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Tables M.2 and M.4 for raw data.



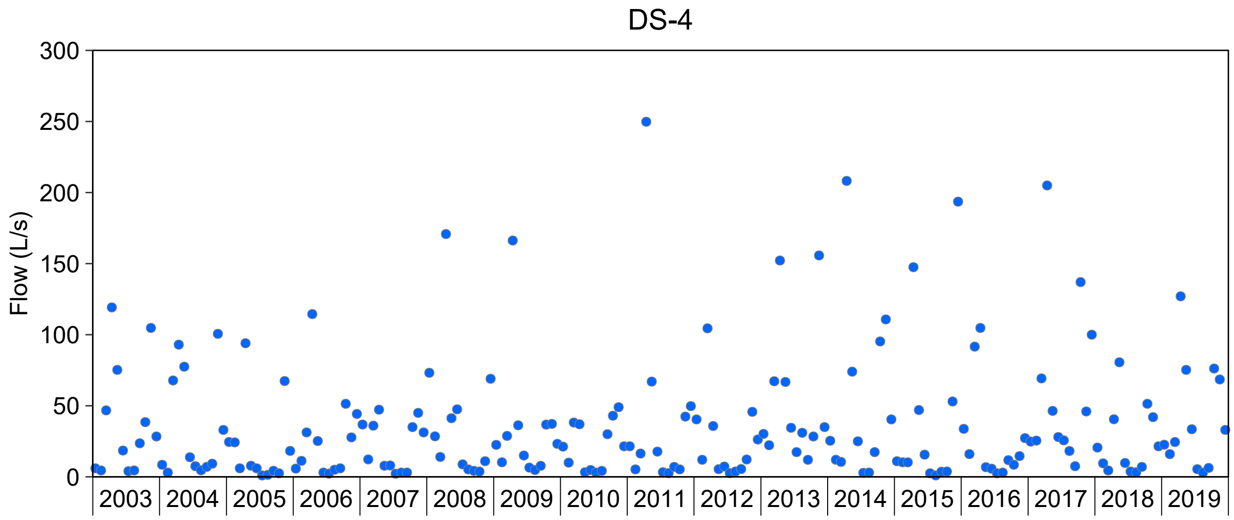


Figure M.9: Flow Monthly Means for SAMP Water Quality Monitoring Stations in Stanleigh and Stanrock TMAs, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Tables M.2 and M.4 for raw data.

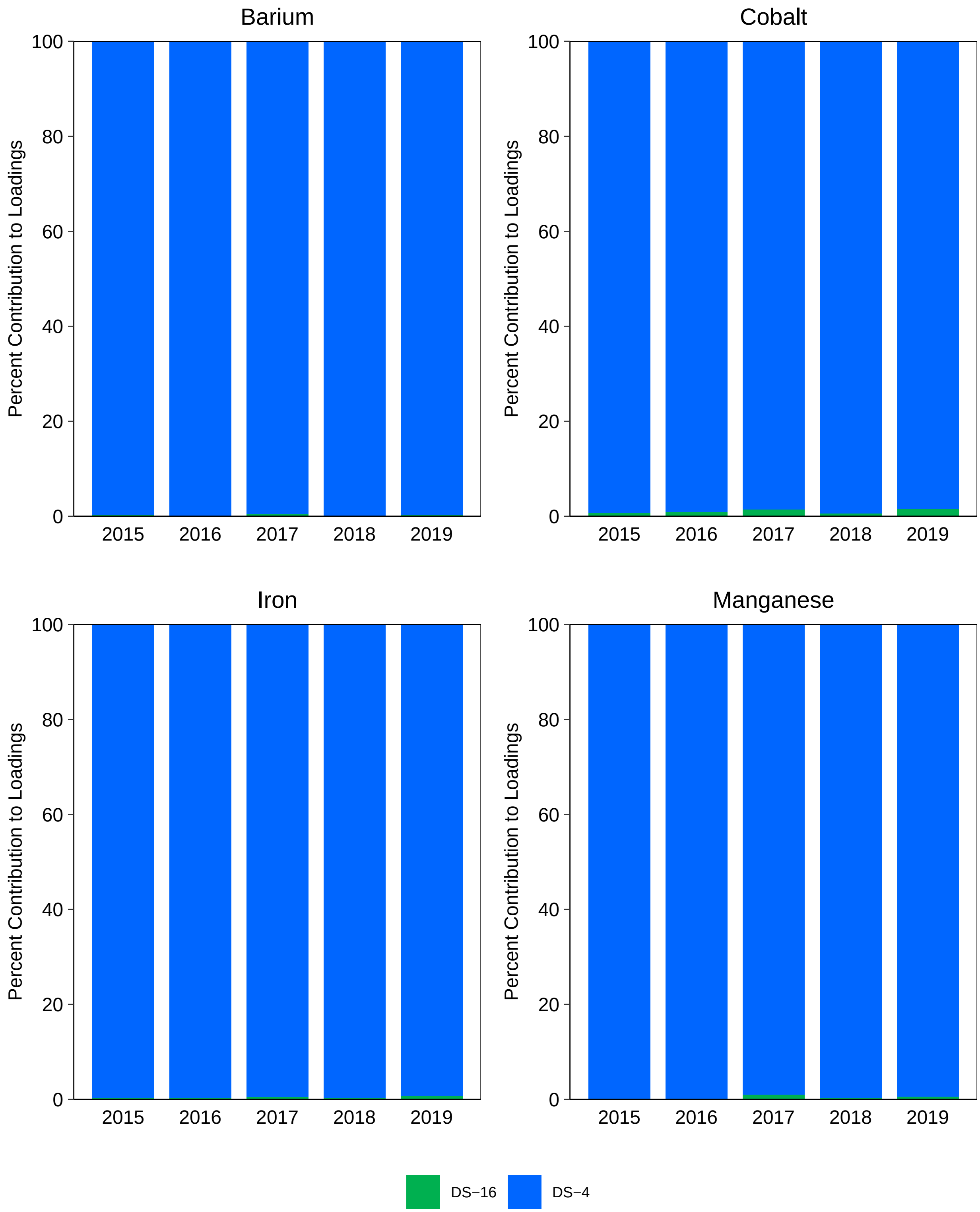


Figure M.10: Percent Contribution of TMA Discharges and Seepages to the Total Loadings from Stanrock TMA, 2015 to 2019

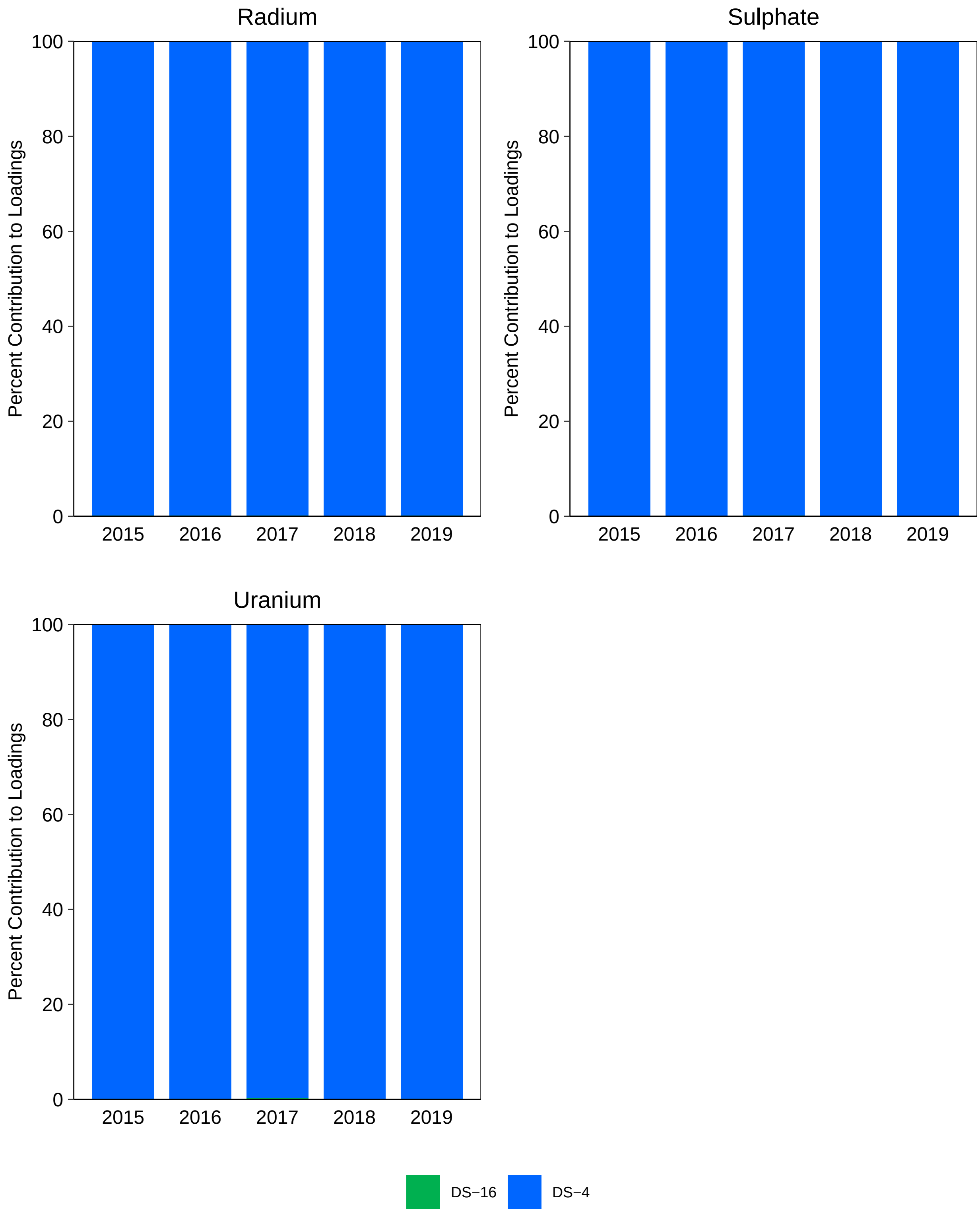


Figure M.10: Percent Contribution of TMA Discharges and Seepages to the Total Loadings from Stanrock TMA, 2015 to 2019

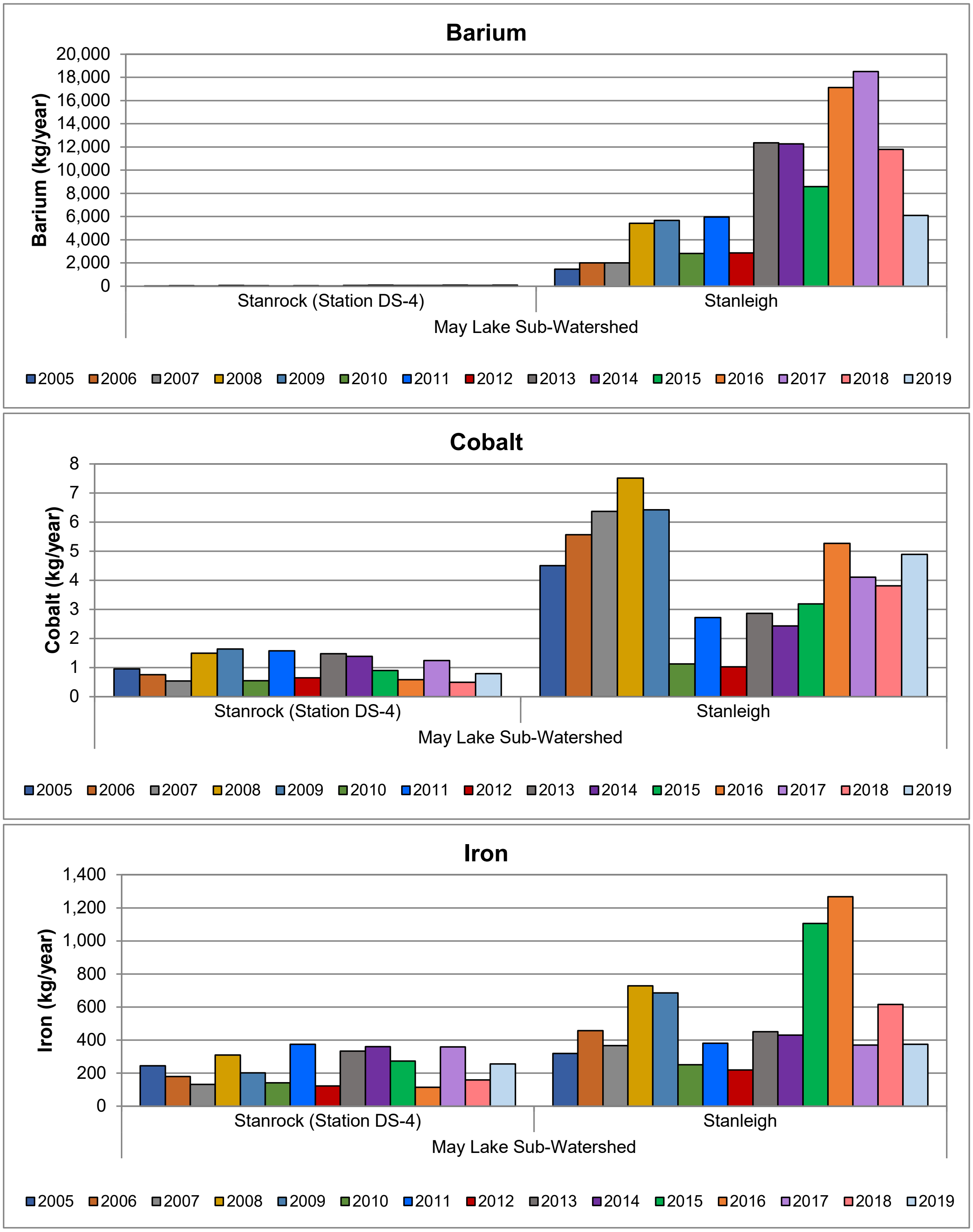


Figure M.11: Annual Loadings from Stanrock TMA and Stanleigh TMA to the May Lake Sub-Watershed, 2005 to 2019

Note: See Appendix Tables M.2 to M.4 for raw data and Appendix Tables M.7 and N.20 for annual discharge and seepage loading rates.

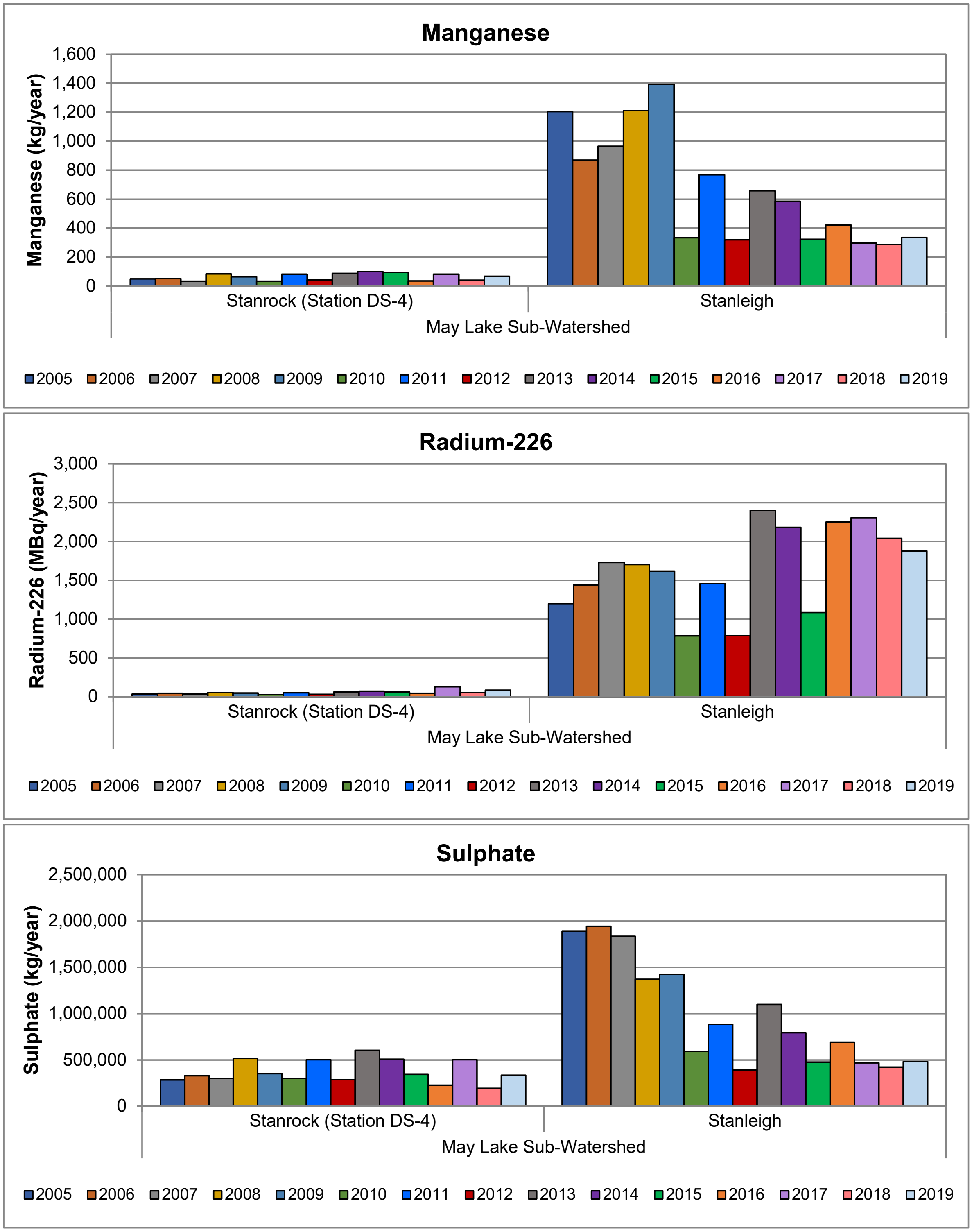


Figure M.11: Annual Loadings from Stanrock TMA and Stanleigh TMA to the May Lake Sub-Watershed, 2005 to 2019

Note: See Appendix Tables M.2 to M.4 for raw data and Appendix Tables M.7 and N.20 for annual discharge and seepage loading rates.

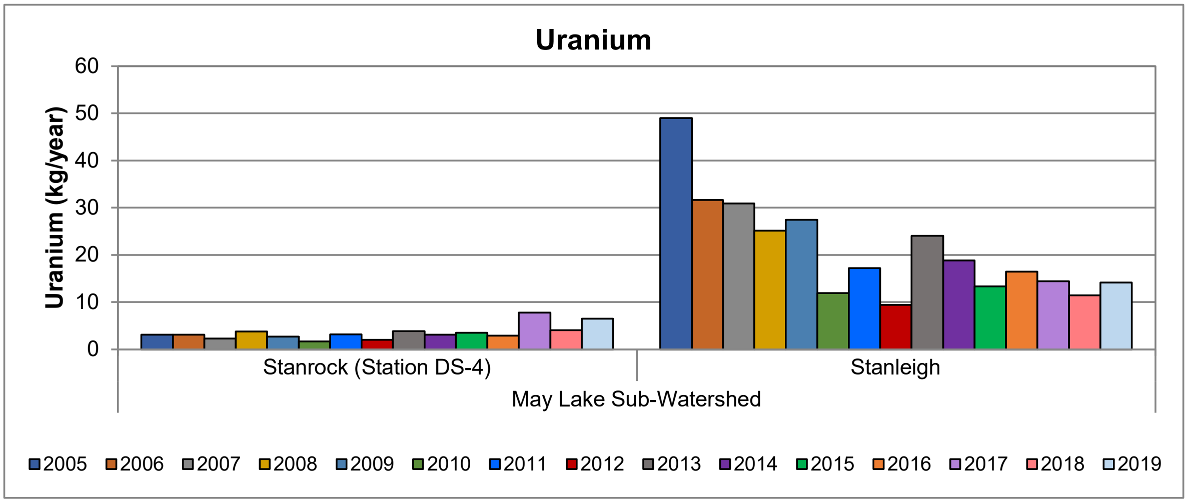


Figure M.11: Annual Loadings from Stanrock TMA and Stanleigh TMA to the May Lake Sub-Watershed, 2005 to 2019

Note: See Appendix Tables M.2 to M.4 for raw data and Appendix Tables M.7 and N.20 for annual discharge and seepage loading rates.

Table M.1: Location of SAMP Data Tables and Figures Within this Cycle 5 SOE Report, May Lake Sub-Watershed

TMA	SAMP Station ID	Type	Description	Also a TOMP or SRWMP Station?	Map Figures	Water Quality Data Tables (barium, cobalt, hardness, iron, manganese, pH, radium-226, sulphate, and/or uranium)	Flow Data Tables	Flow Data Figures	Toxicity Data Tables	Trend Tables	Water Quality / Trend Figures	Loadings Tables	Loadings Figures	Percent Contribution to Loadings Figures	TMA Plant Operations Tables
Stanrock	DS-4	Principal	Orient Lake Outlet (Final Point of Control)	TOMP	3.1, 3.2	M.2	M.2	M.9	3.9	3.11	M.1 to M.8	M.7	M.10, M.11	M.10	M.5
Stanleigh	CL-06	Principal	Final Treated Effluent	TOMP	3.1, 3.3	M.4	M.4	M.9	3.1	3.11	M.1 to M.8	M.7	M.11	na-l	M.6

Notes: na-l = percent contribution to loadings is not assessed for this TMA, as either there is only one station, or loadings are only measured at one station.

Table M.2: Water Quality at SAMP Principal Station DS-4, Located at Orient Lake Outlet (Final Point of Control), Stanrock TMA, 2015 to 2019

Date	Flow (L/s)	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)	Sublethal Toxicity (*Ceriodaphnia dubia*) IC25	Acute Toxicity (*Daphnia magna*) % Mortality	Acute Toxicity (Rainbow Trout) % Mortality
06-Jan-15	13.0	-	7.20	-	0.0510	-	-	-	-	-	-	-	-
13-Jan-15	13.0	322	7.00	280	0.0540	0.0650	0.000700	0.250	0.0600	0.00180	-	-	-
20-Jan-15	9.00	-	7.00	-	0.0470	-	-	-	-	-	-	-	-
27-Jan-15	9.00	-	6.90	-	0.0470	-	-	-	-	-	-	-	-
03-Feb-15	9.00	-	6.90	-	0.0530	-	-	-	-	-	-	-	-
10-Feb-15	13.0	318	7.10	270	0.0460	0.0560	0.000600	0.130	0.0560	0.00160	-	-	-
17-Feb-15	13.0	-	7.10	-	0.0430	-	-	-	-	-	-	-	-
25-Feb-15	6.00	-	7.00	-	0.0580	-	-	-	-	-	-	-	-
03-Mar-15	6.00	-	6.90	-	0.0550	-	-	-	-	-	-	-	-
09-Mar-15	6.00	-	6.90	-	0.0430	-	-	-	-	-	-	-	-
17-Mar-15	17.0	303	6.78	270	0.0490	0.0540	0.000600	0.0800	0.0760	0.00190	-	-	-
24-Mar-15	9.00	-	7.00	-	0.0480	-	-	-	-	-	-	-	-
31-Mar-15	13.0	-	6.90	-	0.0500	-	-	-	-	-	-	-	-
07-Apr-15	35.0	-	6.90	-	0.0340	-	-	-	-	-	-	-	-
14-Apr-15	254	333	6.70	270	0.0490	0.0560	0.00110	0.390	0.155	0.00180	-	-	-
21-Apr-15	254	-	6.90	-	0.0370	-	-	-	-	-	-	-	-
28-Apr-15	47.0	-	6.90	-	0.0270	-	-	-	-	-	-	-	-
05-May-15	41.0	-	7.20	-	0.0410	-	-	-	-	-	-	-	-
12-May-15	91.0	147	7.00	150	0.0360	0.0750	<0.000500	0.160	0.0540	0.000700	100	0	0
19-May-15	9.00	-	6.80	-	0.0570	-	-	-	-	-	-	-	-
26-May-15	47.0	-	7.20	-	0.0470	-	-	-	-	-	-	-	-
02-Jun-15	35.0	-	6.90	-	0.0560	-	-	-	-	-	-	-	-
09-Jun-15	6.00	246	7.10	220	0.0640	0.0580	<0.000500	0.0500	0.0290	0.000900	-	-	-
16-Jun-15	25.0	-	6.80	-	0.0480	-	-	-	-	-	-	-	-
23-Jun-15	9.00	-	6.90	-	0.0620	-	-	-	-	-	-	-	-
29-Jun-15	3.00	-	6.80	-	0.0710	-	-	-	-	-	-	-	-
07-Jul-15	3.00	-	7.00	-	0.0840	-	-	-	-	-	-	-	-
14-Jul-15	3.00	298	7.20	250	0.105	0.0510	<0.000500	0.0300	0.0650	0.00100	-	-	-
21-Jul-15	3.00	-	7.10	-	0.0830	-	-	-	-	-	-	-	-
28-Jul-15	1.00	-	7.20	-	0.0960	-	-	-	-	-	-	-	-
04-Aug-15	1.00	-	7.00	-	0.107	-	-	-	-	-	-	-	-
11-Aug-15	1.00	292	6.90	280	0.106	0.0430	<0.000500	0.0300	0.115	0.00100	-	-	-
18-Aug-15	1.00	-	6.90	-	0.0940	-	-	-	-	-	-	-	-
25-Aug-15	1.00	-	7.40	-	0.0810	-	-	-	-	-	-	-	-
01-Sep-15	1.00	-	7.30	-	0.0930	-	-	-	-	-	-	-	-
08-Sep-15	10.0	-	7.62	-	0.0870	-	-	-	-	-	-	-	-
15-Sep-15	1.00	311	7.10	270	0.0920	0.0390	<0.000500	0.0620	0.0780	0.00200	-	-	-
22-Sep-15	3.00	-	7.40	-	0.0840	-	-	-	-	-	-	-	-
29-Sep-15	3.00	-	7.10	-	0.0830	-	-	-	-	-	-	-	-
07-Oct-15	3.00	-	7.40	-	0.0760	-	-	-	-	-	-	-	-
13-Oct-15	6.00	330	7.30	280	0.0780	0.0400	<0.000500	0.0190	0.0480	0.00380	-	-	-
20-Oct-15	3.00	-	7.10	-	0.0740	-	-	-	-	-	-	-	-
27-Oct-15	3.00	-	7.10	-	0.0590	-	-	-	-	-	-	-	-
03-Nov-15	78.0	-	7.58	-	0.0850	-	-	-	-	-	-	-	-
10-Nov-15	78.0	-	7.40	-	0.0550	-	-	-	-	-	-	-	-
17-Nov-15	21.0	314	7.40	300	0.0550	0.0290	<0.000500	0.150	0.0300	0.00560	100	0	0
24-Nov-15	35.0	-	7.30	-	0.0420	-	-	-	-	-	-	-	-
01-Dec-15	58.0	-	7.40	-	0.0530	-	-	-	-	-	-	-	-
08-Dec-15	21.0	296	7.10	260	0.0430	0.0280	<0.000500	0.153	0.0320	0.00330	-	-	-
15-Dec-15	693	-	7.30	-	0.0440	-	-	-	-	-	-	-	-
22-Dec-15	105	-	7.20	-	0.0480	-	-	-	-	-	-	-	-

Table M.2: Water Quality at SAMP Principal Station DS-4, Located at Orient Lake Outlet (Final Point of Control), Stanrock TMA, 2015 to 2019

Date	Flow (L/s)	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)	Sublethal Toxicity (*Ceriodaphnia dubia*) IC25	Acute Toxicity (*Daphnia magna*) % Mortality	Acute Toxicity (Rainbow Trout) % Mortality
29-Dec-15	91.0	-	7.20	-	0.0340	-	-	-	-	-	-	-	-
n	52	12	52	12	52	12	12	12	12	12	2	2	2
Minimum	1.00	147	6.70	150	0.0270	0.0280	<0.0005	0.0190	0.0290	0.000700	100	0	0
Maximum	693	333	7.62	300	0.107	0.0750	0.00110	0.390	0.155	0.00560	100	0	0
Mean	42.7	292	7.09	258	0.0618	0.0495	0.000583	0.125	0.0665	0.00212	100	0	0
SD	106	51.2	0.215	39.3	0.0212	0.0141	0.000160	0.108	0.0369	0.00144	-	-	-
05-Jan-16	30.0	-	7.20	-	0.0450	-	-	-	-	-	-	-	-
12-Jan-16	47.0	269	6.90	280	0.0340	0.0400	0.00100	0.258	0.0360	0.00220	-	-	-
19-Jan-16	17.0	-	7.00	-	0.0360	-	-	-	-	-	-	-	-
26-Jan-16	41.0	-	6.90	-	0.0320	-	-	-	-	-	-	-	-
02-Feb-16	17.0	-	6.80	-	0.0350	-	-	-	-	-	-	-	-
09-Feb-16	21.0	296	7.10	290	0.0340	0.0400	0.000800	0.123	0.0350	0.00210	-	-	-
16-Feb-16	13.0	-	6.90	-	0.0300	-	-	-	-	-	-	-	-
23-Feb-16	13.0	-	7.00	-	0.0430	-	-	-	-	-	-	-	-
01-Mar-16	47.0	-	6.90	-	0.0260	-	-	-	-	-	-	-	-
08-Mar-16	13.0	352	7.10	290	0.0440	0.0450	0.000800	0.114	0.0470	0.00220	-	-	-
15-Mar-16	136	-	7.00	-	0.0370	-	-	-	-	-	-	-	-
22-Mar-16	191	-	6.80	-	0.0510	-	-	-	-	-	-	-	-
29-Mar-16	71.0	-	7.50	-	0.0460	-	-	-	-	-	-	-	-
05-Apr-16	91.0	-	7.60	-	0.0450	-	-	-	-	-	-	-	-
12-Apr-16	78.0	214	7.50	190	0.0500	0.115	0.000500	0.157	0.0330	0.000900	-	-	-
19-Apr-16	172	-	7.20	-	0.0290	-	-	-	-	-	-	-	-
26-Apr-16	78.0	-	7.20	-	0.0350	-	-	-	-	-	-	-	-
03-May-16	13.0	-	7.10	-	0.0560	-	-	-	-	-	-	-	-
10-May-16	6.00	252	7.10	180	0.0470	0.0580	<0.000500	0.0600	0.0390	0.000800	100	0	0
17-May-16	9.00	-	7.10	-	0.0520	-	-	-	-	-	-	-	-
24-May-16	3.00	-	6.80	-	0.0810	-	-	-	-	-	-	-	-
31-May-16	3.00	-	7.00	-	0.0790	-	-	-	-	-	-	-	-
07-Jun-16	6.00	-	7.00	-	0.0780	-	-	-	-	-	-	-	-
14-Jun-16	13.0	286	7.00	230	0.0840	0.0508	<0.000500	0.0710	0.0233	0.00316	-	-	-
21-Jun-16	3.00	-	7.10	-	0.0940	-	-	-	-	-	-	-	-
28-Jun-16	1.00	-	6.70	-	0.102	-	-	-	-	-	-	-	-
05-Jul-16	3.00	-	6.90	-	0.104	-	-	-	-	-	-	-	-
12-Jul-16	3.00	302	7.00	270	0.121	0.0480	<0.000500	0.0300	0.0460	0.00170	-	-	-
19-Jul-16	1.00	-	7.10	-	0.115	-	-	-	-	-	-	-	-
26-Jul-16	3.00	-	7.00	-	0.103	-	-	-	-	-	-	-	-
02-Aug-16	3.00	-	7.00	-	0.0950	-	-	-	-	-	-	-	-
09-Aug-16	3.00	322	6.80	280	0.0930	0.0410	<0.000500	0.0280	0.0880	0.00210	-	-	-
16-Aug-16	3.00	-	6.90	-	0.0920	-	-	-	-	-	-	-	-
23-Aug-16	3.00	-	6.80	-	0.0930	-	-	-	-	-	-	-	-
30-Aug-16	3.00	-	7.00	-	0.103	-	-	-	-	-	-	-	-
06-Sep-16	3.00	-	6.80	-	0.100	-	-	-	-	-	-	-	-
13-Sep-16	3.00	328	6.90	290	0.0910	0.0350	<0.000500	0.0500	0.0620	0.00430	-	-	-
20-Sep-16	6.00	-	7.10	-	0.0940	-	-	-	-	-	-	-	-
27-Sep-16	35.0	-	7.20	-	0.100	-	-	-	-	-	-	-	-
04-Oct-16	3.00	-	7.40	-	0.0880	-	-	-	-	-	-	-	-
11-Oct-16	3.00	318	7.20	280	0.107	0.0320	<0.000500	0.0640	0.0500	0.00910	100	0	0
18-Oct-16	25.0	-	7.40	-	0.106	-	-	-	-	-	-	-	-
25-Oct-16	3.00	-	7.20	-	0.0780	-	-	-	-	-	-	-	-
01-Nov-16	9.00	-	7.00	-	0.0910	-	-	-	-	-	-	-	-
08-Nov-16	3.00	336	7.20	280	0.0800	0.0300	<0.000500	0.0680	0.0400	0.0121	-	-	-

Table M.2: Water Quality at SAMP Principal Station DS-4, Located at Orient Lake Outlet (Final Point of Control), Stanrock TMA, 2015 to 2019

Date	Flow (L/s)	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)	Sublethal Toxicity (*Ceriodaphnia dubia*) IC25	Acute Toxicity (*Daphnia magna*) % Mortality	Acute Toxicity (Rainbow Trout) % Mortality
15-Nov-16	2.00	-	7.10	-	0.0850	-	-	-	-	-	-	-	-
22-Nov-16	1.00	-	7.10	-	0.0870	-	-	-	-	-	-	-	-
29-Nov-16	58.0	-	7.30	-	0.0950	-	-	-	-	-	-	-	-
06-Dec-16	35.0	-	7.10	-	0.0890	-	-	-	-	-	-	-	-
13-Dec-16	18.0	325	7.20	290	0.0930	0.0280	<0.000500	0.143	0.0260	0.0115	-	-	-
20-Dec-16	21.0	-	7.30	-	0.114	-	-	-	-	-	-	-	-
29-Dec-16	35.0	-	7.20	-	0.0680	-	-	-	-	-	-	-	-
n	52	12	52	12	52	12	12	12	12	12	2	2	2
Minimum	1.00	214	6.70	180	0.0260	0.0280	<0.0005	0.0280	0.0233	0.000800	100	0	0
Maximum	191	352	7.60	290	0.121	0.115	0.00100	0.258	0.0880	0.0121	100	0	0
Mean	27.3	300	7.07	262	0.0733	0.0469	0.000592	0.0972	0.0438	0.00435	100	0	0
SD	41.8	39.4	0.196	39.8	0.0284	0.0232	0.000191	0.0661	0.0175	0.00411	-	-	-
03-Jan-17	9.00	-	7.30	-	0.0670	-	-	-	-	-	-	-	-
10-Jan-17	32.0	326	7.10	280	0.0520	0.0260	<0.000500	0.141	0.0270	0.00970	-	-	-
17-Jan-17	15.0	-	7.10	-	0.0650	-	-	-	-	-	-	-	-
24-Jan-17	21.0	-	7.00	-	0.0600	-	-	-	-	-	-	-	-
31-Jan-17	47.0	-	7.10	-	0.0520	-	-	-	-	-	-	-	-
07-Feb-17	17.0	-	7.10	-	0.0550	-	-	-	-	-	-	-	-
14-Feb-17	17.0	388	7.10	330	0.0420	0.0270	<0.000500	0.170	0.0410	0.00640	-	-	-
21-Feb-17	21.0	-	7.00	-	0.0590	-	-	-	-	-	-	-	-
28-Feb-17	47.0	-	7.20	-	0.0410	-	-	-	-	-	-	-	-
07-Mar-17	58.0	-	7.00	-	0.0320	-	-	-	-	-	-	-	-
14-Mar-17	67.0	-	7.30	-	0.0290	-	-	-	-	-	-	-	-
21-Mar-17	47.0	365	7.10	310	0.0330	0.0380	0.00100	0.247	0.0760	0.00300	-	-	-
28-Mar-17	105	-	7.00	-	0.0330	-	-	-	-	-	-	-	-
04-Apr-17	324	-	7.00	-	0.0360	-	-	-	-	-	-	-	-
12-Apr-17	255	186	7.00	160	0.0350	0.0570	0.000800	0.217	0.0400	0.00100	-	-	-
18-Apr-17	158	-	6.90	-	0.0390	-	-	-	-	-	-	-	-
25-Apr-17	83.0	-	7.10	-	0.0470	-	-	-	-	-	-	-	-
02-May-17	105	-	7.20	-	0.0520	-	-	-	-	-	-	-	-
09-May-17	25.0	-	7.20	-	0.0570	-	-	-	-	-	-	-	-
16-May-17	9.00	-	7.10	-	0.0690	-	-	-	-	-	-	-	-
23-May-17	35.0	319	7.20	250	0.0680	0.0570	<0.000500	0.139	0.0310	0.00330	100	0	0
30-May-17	58.0	-	7.20	-	0.0570	-	-	-	-	-	-	-	-
06-Jun-17	47.0	-	7.20	-	0.0620	-	-	-	-	-	-	-	-
13-Jun-17	13.0	335	7.10	270	0.109	0.0510	<0.000500	0.0800	0.0400	0.00260	-	-	-
20-Jun-17	17.0	-	7.00	-	0.0790	-	-	-	-	-	-	-	-
27-Jun-17	35.0	-	7.20	-	0.0900	-	-	-	-	-	-	-	-
04-Jul-17	67.0	-	7.20	-	0.0760	-	-	-	-	-	-	-	-
11-Jul-17	1.00	373	7.10	290	0.0820	0.0470	<0.000500	0.0780	0.0670	0.00250	-	-	-
25-Jul-17	9.00	-	7.00	-	0.0910	-	-	-	-	-	-	-	-
01-Aug-17	9.00	-	7.20	-	0.108	-	-	-	-	-	-	-	-
08-Aug-17	9.00	346	7.20	300	0.0990	0.0350	<0.000500	0.0980	0.0520	0.00380	-	-	-
15-Aug-17	17.0	-	7.20	-	0.101	-	-	-	-	-	-	-	-
22-Aug-17	47.0	-	7.20	-	0.0920	-	-	-	-	-	-	-	-
29-Aug-17	9.00	-	7.30	-	0.119	-	-	-	-	-	-	-	-
05-Sep-17	9.00	-	7.30	-	0.111	-	-	-	-	-	-	-	-
12-Sep-17	9.00	343	7.50	300	0.114	0.0300	<0.000500	0.0740	0.0350	0.00630	-	-	-
19-Sep-17	6.00	-	7.50	-	0.102	-	-	-	-	-	-	-	-
26-Sep-17	6.00	-	7.10	-	0.102	-	-	-	-	-	-	-	-
03-Oct-17	17.0	-	7.20	-	0.121	-	-	-	-	-	-	-	-

Table M.2: Water Quality at SAMP Principal Station DS-4, Located at Orient Lake Outlet (Final Point of Control), Stanrock TMA, 2015 to 2019

Date	Flow (L/s)	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)	Sublethal Toxicity (*Ceriodaphnia dubia*) IC25	Acute Toxicity (*Daphnia magna*) % Mortality	Acute Toxicity (Rainbow Trout) % Mortality
12-Oct-17	58.0	378	7.40	300	0.105	0.0230	<0.000500	0.172	0.0320	0.00710	54.7	0	0
17-Oct-17	105	-	7.00	-	0.119	-	-	-	-	-	-	-	-
25-Oct-17	400	-	7.20	-	0.193	-	-	-	-	-	-	-	-
31-Oct-17	105	-	7.20	-	0.0690	-	-	-	-	-	-	-	-
07-Nov-17	51.0	-	7.30	-	0.0710	-	-	-	-	-	-	-	-
14-Nov-17	35.0	354	7.30	290	0.0650	0.0550	0.000600	0.184	0.0390	0.00350	-	-	-
21-Nov-17	47.0	-	7.20	-	0.0530	-	-	-	-	-	-	-	-
28-Nov-17	51.0	-	7.30	-	0.0410	-	-	-	-	-	-	-	-
05-Dec-17	299	-	6.90	-	0.0420	-	-	-	-	-	-	-	-
12-Dec-17	51.0	268	7.20	250	0.0310	0.0900	0.000800	0.413	0.0430	0.00170	-	-	-
19-Dec-17	25.0	-	7.10	-	0.0390	-	-	-	-	-	-	-	-
27-Dec-17	25.0	-	7.00	-	0.0420	-	-	-	-	-	-	-	-
n	51	12	51	12	51	12	12	12	12	12	2	2	2
Minimum	1.00	186	6.90	160	0.0290	0.0230	<0.0005	0.0740	0.0270	0.00100	54.7	0	0
Maximum	400	388	7.50	330	0.193	0.0900	0.00100	0.413	0.0760	0.00970	100	0	0
Mean	61.5	332	7.15	278	0.0707	0.0447	0.000600	0.168	0.0436	0.00424	77.4	0	0
SD	84.0	56.0	0.133	43.7	0.0329	0.0191	0.000144	0.0954	0.0147	0.00257	32.0	-	-
02-Jan-18	13.0	-	7.10	-	0.0400	-	-	-	-	-	-	-	-
09-Jan-18	9.00	278	7.10	250	0.0500	0.0970	0.000600	0.220	0.0470	0.00140	-	-	-
16-Jan-18	47.0	-	7.20	-	0.0300	-	-	-	-	-	-	-	-
23-Jan-18	25.0	-	7.00	-	0.0560	-	-	-	-	-	-	-	-
30-Jan-18	9.00	-	7.20	-	0.0580	-	-	-	-	-	-	-	-
06-Feb-18	6.00	-	7.10	-	0.0490	-	-	-	-	-	-	-	-
13-Feb-18	6.00	423	7.10	280	0.0530	0.111	0.000500	0.135	0.0570	0.00210	-	-	-
20-Feb-18	9.00	-	6.90	-	0.0390	-	-	-	-	-	-	-	-
27-Feb-18	17.0	-	7.10	-	0.0400	-	-	-	-	-	-	-	-
06-Mar-18	6.00	-	7.20	-	0.0540	-	-	-	-	-	-	-	-
13-Mar-18	6.00	375	7.20	290	0.0610	0.0920	<0.000500	0.0860	0.0500	0.00280	-	-	-
20-Mar-18	3.00	-	7.10	-	0.0600	-	-	-	-	-	-	-	-
27-Mar-18	3.00	-	7.10	-	0.0620	-	-	-	-	-	-	-	-
03-Apr-18	13.0	-	7.20	-	0.0560	-	-	-	-	-	-	-	-
10-Apr-18	9.00	372	7.20	280	0.0580	0.0740	<0.000500	0.0940	0.0650	0.00300	-	-	-
17-Apr-18	35.0	-	7.20	-	0.0690	-	-	-	-	-	-	-	-
24-Apr-18	105	-	7.00	-	0.0650	-	-	-	-	-	-	-	-
01-May-18	211	-	7.00	-	0.0380	-	-	-	-	-	-	-	-
08-May-18	136	117	7.00	110	0.0360	0.0730	0.00120	0.592	0.0650	0.000600	-	-	-
15-May-18	30.0	-	7.10	-	0.0620	-	-	-	-	-	-	-	-
22-May-18	17.0	-	6.80	-	0.0760	-	-	-	-	-	-	-	-
29-May-18	9.00	-	6.80	-	0.0830	-	-	-	-	-	-	-	-
05-Jun-18	6.00	-	7.30	-	0.0860	-	-	-	-	-	-	-	-
12-Jun-18	6.00	-	7.40	-	0.102	-	-	-	-	-	-	-	-
19-Jun-18	21.0	270	7.30	220	0.101	0.0600	<0.000500	0.105	0.0350	0.00270	100	0	0
26-Jun-18	6.00	-	7.10	-	0.0960	-	-	-	-	-	-	-	-
03-Jul-18	3.00	-	7.00	-	0.115	-	-	-	-	-	-	-	-
10-Jul-18	3.00	292	7.10	230	0.101	0.0510	<0.000500	0.0360	0.0880	0.00190	-	-	-
17-Jul-18	3.00	-	6.90	-	0.101	-	-	-	-	-	-	-	-
24-Jul-18	6.00	-	7.10	-	0.0970	-	-	-	-	-	-	-	-
07-Aug-18	6.00	-	7.30	-	0.130	-	-	-	-	-	-	-	-
14-Aug-18	3.00	317	6.90	270	0.133	0.0490	<0.000500	0.0570	0.0650	0.00500	-	-	-
21-Aug-18	1.00	-	7.00	-	0.113	-	-	-	-	-	-	-	-
28-Aug-18	3.00	-	7.20	-	0.112	-	-	-	-	-	-	-	-

Table M.2: Water Quality at SAMP Principal Station DS-4, Located at Orient Lake Outlet (Final Point of Control), Stanrock TMA, 2015 to 2019

Date	Flow (L/s)	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)	Sublethal Toxicity (*Ceriodaphnia dubia*) IC25	Acute Toxicity (*Daphnia magna*) % Mortality	Acute Toxicity (Rainbow Trout) % Mortality
04-Sep-18	13.0	-	7.20	-	0.157	-	-	-	-	-	-	-	-
11-Sep-18	3.00	312	7.10	260	0.123	0.0390	<0.000500	0.0700	0.0570	0.00730	-	-	-
18-Sep-18	3.00	-	7.00	-	0.136	-	-	-	-	-	-	-	-
25-Sep-18	9.00	-	7.00	-	0.135	-	-	-	-	-	-	-	-
02-Oct-18	6.00	-	7.50	-	0.127	-	-	-	-	-	-	-	-
09-Oct-18	78.0	272	7.30	250	0.142	0.0360	<0.000500	0.129	0.0370	0.0122	-	-	-
16-Oct-18	105	-	7.50	-	0.0950	-	-	-	-	-	-	-	-
23-Oct-18	47.0	-	7.10	-	0.101	-	-	-	-	-	-	-	-
30-Oct-18	21.0	-	7.10	-	0.0780	-	-	-	-	-	-	-	-
06-Nov-18	25.0	-	7.20	-	0.0840	-	-	-	-	-	-	-	-
13-Nov-18	35.0	293	7.10	270	0.0560	0.0400	<0.000500	0.141	0.0240	0.00660	-	-	-
20-Nov-18	17.0	-	7.00	-	0.0810	-	-	-	-	-	-	-	-
27-Nov-18	91.0	-	7.30	-	0.0800	-	-	-	-	-	-	-	-
04-Dec-18	35.0	324	7.40	270	0.0600	0.0530	<0.000500	0.147	0.0300	0.00500	100	0	0
11-Dec-18	13.0	-	7.40	-	0.0570	-	-	-	-	-	-	-	-
18-Dec-18	17.0	-	7.30	-	0.0630	-	-	-	-	-	-	-	-
27-Dec-18	21.0	-	7.10	-	0.0550	-	-	-	-	-	-	-	-
n	51	12	51	12	51	12	12	12	12	12	2	2	2
Minimum	1.00	117	6.80	110	0.0300	0.0360	<0.0005	0.0360	0.0240	0.000600	100	0	0
Maximum	211	423	7.50	290	0.157	0.111	0.00120	0.592	0.0880	0.0122	100	0	0
Mean	26.1	304	7.14	248	0.0806	0.0646	0.000567	0.151	0.0517	0.00422	100	0	0
SD	39.8	75.4	0.159	48.2	0.0324	0.0248	0.000236	0.147	0.0182	0.00326	-	-	-
02-Jan-19	35.0	-	6.90	-	0.0650	-	-	-	-	-	-	-	-
08-Jan-19	35.0	315	7.10	270	0.0770	0.0460	<0.000500	0.127	0.0300	0.00450	-	-	-
15-Jan-19	13.0	-	7.30	-	0.0710	-	-	-	-	-	-	-	-
22-Jan-19	13.0	-	7.40	-	0.0510	-	-	-	-	-	-	-	-
29-Jan-19	17.0	-	7.10	-	0.0600	-	-	-	-	-	-	-	-
05-Feb-19	17.0	-	6.90	-	0.0780	-	-	-	-	-	-	-	-
12-Feb-19	9.00	315	7.20	280	0.0640	0.0560	<0.000500	0.0970	0.0430	0.00560	-	-	-
19-Feb-19	21.0	-	7.30	-	0.0840	-	-	-	-	-	-	-	-
28-Feb-19	17.0	-	7.10	-	0.0790	-	-	-	-	-	-	-	-
04-Mar-19	17.0	-	7.40	-	0.0810	-	-	-	-	-	-	-	-
12-Mar-19	13.0	369	7.20	280	0.0730	0.0560	<0.000500	0.158	0.0610	0.00520	-	-	-
19-Mar-19	47.0	-	7.30	-	0.0540	-	-	-	-	-	-	-	-
26-Mar-19	21.0	-	7.20	-	0.0540	-	-	-	-	-	-	-	-
02-Apr-19	35.0	-	7.20	-	0.0420	-	-	-	-	-	-	-	-
09-Apr-19	105	274	7.10	270	0.0540	0.0410	0.000800	0.314	0.0880	0.00280	-	-	-
16-Apr-19	105	-	7.00	-	0.0460	-	-	-	-	-	-	-	-
22-Apr-19	254	-	7.10	-	0.0390	-	-	-	-	-	-	-	-
30-Apr-19	136	-	6.90	-	0.0450	-	-	-	-	-	-	-	-
07-May-19	51.0	-	6.80	-	0.0420	-	-	-	-	-	-	-	-
14-May-19	78.0	184	7.10	160	0.0570	0.0790	<0.000500	0.138	0.0240	0.00130	100	0	0
21-May-19	105	-	7.20	-	0.0590	-	-	-	-	-	-	-	-
28-May-19	67.0	-	7.40	-	0.0640	-	-	-	-	-	-	-	-
04-Jun-19	9.00	-	7.20	-	0.0710	-	-	-	-	-	-	-	-
11-Jun-19	67.0	260	7.30	240	0.0690	0.0970	<0.000500	0.0970	0.0280	0.00280	-	-	-
18-Jun-19	17.0	-	7.30	-	0.0760	-	-	-	-	-	-	-	-
25-Jun-19	41.0	-	6.90	-	0.0860	-	-	-	-	-	-	-	-
02-Jul-19	11.0	-	7.10	-	0.100	-	-	-	-	-	-	-	-
09-Jul-19	1.00	307	7.10	250	0.120	0.0720	<0.000500	0.0420	0.0460	0.00170	-	-	-
16-Jul-19	6.00	-	6.80	-	0.124	-	-	-	-	-	-	-	-

Table M.2: Water Quality at SAMP Principal Station DS-4, Located at Orient Lake Outlet (Final Point of Control), Stanrock TMA, 2015 to 2019

Date	Flow (L/s)	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)	Sublethal Toxicity (*Ceriodaphnia dubia*) IC25	Acute Toxicity (*Daphnia magna*) % Mortality	Acute Toxicity (Rainbow Trout) % Mortality
23-Jul-19	3.00	-	6.90	-	0.114	-	-	-	-	-	-	-	-
30-Jul-19	6.00	-	6.90	-	0.129	-	-	-	-	-	-	-	-
06-Aug-19	1.00	-	7.00	-	0.150	-	-	-	-	-	-	-	-
13-Aug-19	2.00	300	7.00	260	0.108	0.0560	<0.000500	0.0590	0.0620	0.00440	-	-	-
20-Aug-19	3.00	-	7.10	-	0.131	-	-	-	-	-	-	-	-
27-Aug-19	6.00	-	6.90	-	0.122	-	-	-	-	-	-	-	-
03-Sep-19	1.00	-	7.30	-	0.122	-	-	-	-	-	-	-	-
10-Sep-19	6.00	307	7.10	250	0.143	0.0490	<0.000500	0.111	0.0550	0.00810	-	-	-
17-Sep-19	9.00	-	7.40	-	0.174	-	-	-	-	-	-	-	-
24-Sep-19	9.00	-	7.40	-	0.132	-	-	-	-	-	-	-	-
01-Oct-19	47.0	-	7.50	-	0.170	-	-	-	-	-	-	-	-
08-Oct-19	17.0	314	7.40	260	0.131	0.0460	<0.000500	0.117	0.0360	0.0112	-	-	-
15-Oct-19	35.0	-	7.40	-	0.130	-	-	-	-	-	-	-	-
22-Oct-19	162	-	7.30	-	0.0870	-	-	-	-	-	-	-	-
29-Oct-19	120	-	7.40	-	0.0830	-	-	-	-	-	-	-	-
05-Nov-19	67.0	-	7.20	-	0.0780	-	-	-	-	-	-	-	-
12-Nov-19	35.0	296	7.20	260	0.0660	0.0520	<0.000500	0.171	0.0280	0.00500	100	0	0
19-Nov-19	52.0	-	7.10	-	0.0740	-	-	-	-	-	-	-	-
26-Nov-19	120	-	7.10	-	0.0440	-	-	-	-	-	-	-	-
03-Dec-19	25.0	-	7.30	-	0.0540	-	-	-	-	-	-	-	-
10-Dec-19	67.0	295	7.20	240	0.0480	0.0690	<0.000500	0.244	0.0350	0.00210	-	-	-
16-Dec-19	21.0	-	7.20	-	0.0560	-	-	-	-	-	-	-	-
23-Dec-19	17.0	-	7.20	-	0.0450	-	-	-	-	-	-	-	-
30-Dec-19	35.0	-	7.10	-	0.0450	-	-	-	-	-	-	-	-
n	53	12	53	12	53	12	12	12	12	12	2	2	2
Minimum	1.00	184	6.80	160	0.0390	0.0410	<0.0005	0.0420	0.0240	0.00130	100	0	0
Maximum	254	369	7.50	280	0.174	0.0970	0.000800	0.314	0.0880	0.0112	100	0	0
Mean	42.1	295	7.16	252	0.0834	0.0599	0.000525	0.140	0.0447	0.00456	100	0	0
SD	49.1	43.6	0.176	31.9	0.0356	0.0164	-	0.0761	0.0189	0.00285	-	-	-
Summary Statistics for 2015 to 2019													
n	259	60	259	60	259	60	60	60	60	60	10	10	10
Minimum	1.00	117	6.70	110	0.0260	0.0230	<0.000500	0.0190	0.0233	0.000600	54.7	0	0
Maximum	693	423	7.62	330	0.193	0.115	0.00120	0.592	0.155	0.0122	100	0	0
Mean	39.9	305	7.12	260	0.0740	0.0531	0.000573	0.136	0.0500	0.00390	95.5	0	0
SD	69.9	54.6	0.180	40.8	0.0312	0.0208	0.000166	0.102	0.0236	0.00301	14.3	-	-
Median	17.0	313	7.10	270	0.0680	0.0509	<0.000500	0.120	0.0445	0.00280	100	0	0
10th Percentile	3.00	249	6.90	205	0.0390	0.0295	<0.000500	0.0390	0.0280	0.00100	77.4	0	0
95th Percentile	158	376	7.40	300	0.131	0.0970	0.00100	0.352	0.0880	0.0113	100	0	0

Note: "-" = no data collected. n = number of samples. SD = standard deviation.

Table M.3: Water Quality at SAMP Drainage Station DS-16, Located at Quirke Lake Delta, Stanrock TMA, 2015 to 2019

Date	Flow (L/s)	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
14-Apr-15	6.60	-	6.80	-	-	-	-	-	-	-
21-Apr-15	4.30	-	6.90	-	-	-	-	-	-	-
27-Apr-15	0.700	-	7.20	-	-	-	-	-	-	-
12-May-15	0.200	52.4	6.90	44.0	0.00800	0.0150	<0.000500	0.0900	0.0180	<0.000500
03-Nov-15	0.400	-	6.05	-	-	-	-	-	-	-
10-Nov-15	0.600	39.2	6.80	36.0	<0.00800	0.0120	<0.000500	0.0130	0.0130	<0.000500
17-Nov-15	0.400	-	6.50	-	-	-	-	-	-	-
24-Nov-15	0.600	-	6.50	-	-	-	-	-	-	-
01-Dec-15	1.30	-	6.60	-	-	-	-	-	-	-
08-Dec-15	0.400	-	6.50	-	-	-	-	-	-	-
16-Dec-15	3.60	-	6.60	-	-	-	-	-	-	-
22-Dec-15	1.40	-	6.90	-	-	-	-	-	-	-
29-Dec-15	1.10	-	6.50	-	-	-	-	-	-	-
n										
Minimum										
Maximum										
Mean										
SD										
06-Jan-16	0.200	-	6.50	-	-	-	-	-	-	-
15-Mar-16	11.3	18.3	7.26	13.0	<0.00800	0.00600	<0.000500	0.0330	0.00500	<0.000500
22-Mar-16	1.60	-	6.50	-	-	-	-	-	-	-
29-Mar-16	1.60	-	6.70	-	-	-	-	-	-	-
05-Apr-16	1.10	-	6.50	-	-	-	-	-	-	-
12-Apr-16	0.200	-	6.90	-	-	-	-	-	-	-
19-Apr-16	1.60	-	6.80	-	-	-	-	-	-	-
26-Apr-16	0.200	-	7.00	-	-	-	-	-	-	-
29-Nov-16	0.400	-	6.30	-	-	-	-	-	-	-
n										
Minimum										
Maximum										
Mean										
SD										
28-Feb-17	0.400	-	6.50	-	-	-	-	-	-	-
07-Mar-17	3.00	-	7.10	-	-	-	-	-	-	-
21-Mar-17	0.200	40.9	6.70	29.0	<0.00700	0.0120	<0.000500	0.0360	0.0270	<0.000500
28-Mar-17	1.80	-	6.50	-	-	-	-	-	-	-
04-Apr-17	16.9	-	6.50	-	-	-	-	-	-	-
11-Apr-17	1.30	-	6.60	-	-	-	-	-	-	-
18-Apr-17	0.900	-	6.90	-	-	-	-	-	-	-
25-Apr-17	0.400	-	6.80	-	-	-	-	-	-	-
02-May-17	0.900	-	6.50	-	-	-	-	-	-	-
25-Oct-17	19.4	-	6.60	-	-	-	-	-	-	-
21-Nov-17	0.700	-	6.70	-	-	-	-	-	-	-
05-Dec-17	14.0	15.7	6.40	9.50	<0.00700	0.00700	<0.000500	0.0940	0.0220	<0.000500
n										
Minimum										
Maximum										
Mean										
SD										

Table M.3: Water Quality at SAMP Drainage Station DS-16, Located at Quirke Lake Delta, Stanrock TMA, 2015 to 2019

Date	Flow (L/s)	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
01-May-18	6.60	-	6.60	-	-	-	-	-	-	-
08-May-18	0.800	25.9	6.60	18.0	<0.00700	0.0100	<0.000500	0.0890	0.0190	<0.000500
15-May-18	0.300	-	6.30	-	-	-	-	-	-	-
17-Oct-18	1.30	-	6.70	-	-	-	-	-	-	-
23-Oct-18	0.700	29.9	6.50	24.0	<0.00700	0.0100	<0.000500	0.0600	0.0190	<0.000500
27-Nov-18	0.500	-	6.50	-	-	-	-	-	-	-
n										
Minimum										
Maximum										
Mean										
SD										
02-Apr-19	0.600	-	6.50	-	-	-	-	-	-	-
09-Apr-19	11.3	-	6.50	-	-	-	-	-	-	-
16-Apr-19	6.60	-	6.80	-	-	-	-	-	-	-
22-Apr-19	6.60	-	6.70	-	-	-	-	-	-	-
30-Apr-19	1.30	-	6.80	-	-	-	-	-	-	-
07-May-19	0.700	-	6.50	-	-	-	-	-	-	-
14-May-19	1.30	26.1	6.60	18.0	<0.00700	0.00900	<0.000500	0.0770	0.0140	<0.000500
21-May-19	3.00	-	7.00	-	-	-	-	-	-	-
28-May-19	0.200	-	6.60	-	-	-	-	-	-	-
22-Oct-19	5.80	22.6	6.60	12.0	<0.00700	0.0110	<0.000500	0.0720	0.0120	<0.000500
29-Oct-19	2.00	-	6.90	-	-	-	-	-	-	-
05-Nov-19	0.700	-	6.70	-	-	-	-	-	-	-
26-Nov-19	2.00	-	6.70	-	-	-	-	-	-	-
03-Dec-19	0.200	-	6.70	-	-	-	-	-	-	-
n										
Minimum										
Maximum										
Mean										
SD										
Summary Statistics for 2015 to 2019										
n	54	9	54	9	9	9	9	9	9	9
Minimum	0.200	15.7	6.05	9.50	<0.00700	0.00600	<0.000500	0.0130	0.00500	<0.000500
Maximum	19.4	52.4	7.26	44.0	0.00800	0.0150	<0.000500	0.0940	0.0270	<0.000500
Mean	2.82	30.1	6.66	22.6	0.00711	0.0102	<0.000500	0.0627	0.0166	<0.000500
SD	4.30	11.9	0.225	11.7	-	0.00273	-	0.0291	0.00639	-
Median	1.10	26.1	6.60	18.0	<0.00700	0.0100	<0.000500	0.0720	0.0180	<0.000500
10th Percentile	0.200	15.7	6.50	9.50	<0.00700	0.00600	<0.000500	0.0130	0.00500	<0.000500
95th Percentile	14.0	52.4	7.10	44.0	0.00800	0.0150	<0.000500	0.0940	0.0270	<0.000500

Note: "-" = no data collected. n = number of samples. SD = standard deviation.

Table M.4: Water Quality at SAMP Principal Station CL-06, Final Treated Effluent, Stanleigh TMA, 2015 to 2019

Date	Flow (L/s)	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)	Sublethal Toxicity (*Ceriodaphnia dubia*) IC25	Acute Toxicity (*Daphnia magna*) % Mortality	Acute Toxicity (Rainbow Trout) % Mortality
05-Jan-15	414	86.9	7.56	80.0	0.287	2.89	<0.000500	0.0400	0.0430	0.00180	-	-	-
13-Jan-15	400	-	7.50	-	0.279	3.04	-	-	-	-	-	-	-
20-Jan-15	400	-	7.40	-	0.277	2.78	-	-	-	-	-	-	-
27-Jan-15	390	-	7.45	-	0.270	2.67	-	-	-	-	-	-	-
03-Feb-15	390	90.4	7.40	80.0	0.226	2.23	<0.000500	0.0300	0.0460	0.00150	-	-	-
10-Feb-15	400	-	7.40	-	0.119	1.10	-	-	-	-	-	-	-
18-Feb-15	400	92.9	7.40	76.0	0.167	0.905	<0.000500	0.0240	0.0451	0.00131	-	-	-
24-Feb-15	400	-	7.40	-	0.139	0.676	-	-	-	-	-	-	-
03-Mar-15	400	91.9	7.28	80.0	0.0920	0.824	<0.000500	0.0300	0.0473	0.00152	-	-	-
09-Mar-15	400	-	7.35	-	0.107	0.787	-	-	-	-	-	-	-
17-Mar-15	510	-	7.27	-	0.155	0.764	-	-	-	-	-	-	-
23-Mar-15	500	-	7.50	-	0.167	0.878	-	-	-	-	-	-	-
31-Mar-15	510	-	7.40	-	0.0840	0.943	-	-	-	-	-	-	-
06-Apr-15	500	86.9	7.30	75.0	0.162	0.716	0.000500	0.0230	0.0463	0.00158	100	0	0
09-Apr-15	510	-	7.20	80.0	0.101	0.775	-	0.0700	-	-	-	-	-
13-Apr-15	510	-	7.10	79.0	0.152	0.685	-	0.110	-	-	-	-	-
16-Apr-15	440	-	6.80	72.0	0.119	0.867	-	0.180	-	-	-	-	-
20-Apr-15	440	-	7.20	76.0	0.146	0.921	-	0.290	-	-	-	-	-
23-Apr-15	440	-	7.00	75.0	0.120	0.875	-	0.450	-	-	-	-	-
27-Apr-15	440	-	7.10	72.0	0.0600	1.09	-	0.540	-	-	-	-	-
30-Apr-15	440	-	7.20	73.0	0.150	0.800	-	0.580	-	-	-	-	-
04-May-15	320	82.4	7.11	68.0	0.148	0.927	0.000500	0.600	0.0662	0.00185	-	-	-
07-May-15	330	-	7.47	63.0	0.169	1.11	-	0.760	-	-	-	-	-
11-May-15	330	-	8.23	71.0	0.159	1.44	-	0.510	-	-	-	-	-
14-May-15	320	-	7.60	67.0	0.184	1.60	-	0.770	-	-	-	-	-
19-May-15	330	-	7.40	-	0.219	1.78	-	0.490	-	-	-	-	-
20-May-15	330	-	7.50	-	-	-	-	-	-	-	100	0	0
21-May-15	330	-	7.70	69.0	0.191	1.07	-	0.520	-	-	-	-	-
25-May-15	330	-	7.31	71.0	0.144	0.903	-	0.620	-	-	-	-	-
28-May-15	330	-	7.50	70.0	0.144	1.07	-	0.680	-	-	-	-	-
01-Jun-15	330	80.0	7.50	69.0	0.151	1.17	<0.000500	0.803	0.0619	0.00150	-	-	-
04-Jun-15	330	-	7.41	69.0	0.139	0.897	-	0.520	-	-	-	-	-
26-Jun-15	132	83.0	7.04	68.0	0.0290	0.363	<0.000500	0.0800	0.0560	0.00130	-	-	-
29-Jun-15	132	-	7.18	-	0.0400	-	-	-	-	-	-	-	-
06-Jul-15	4.00	-	6.90	-	0.0600	-	-	-	-	-	-	-	-
16-Dec-15	510	80.1	7.40	61.0	0.0800	0.489	<0.000500	0.0460	0.0610	0.00600	100	0	0
21-Dec-15	492	-	7.80	-	0.198	1.24	-	-	-	-	-	-	-
28-Dec-15	510	-	7.50	-	0.308	1.86	-	-	-	-	-	-	-
n	43	9	39	23	37	35	9	24	9	9	3	3	3
Minimum	4.00	80.0	6.80	61.0	0.0290	0.363	<0.0005	0.0230	0.0430	0.00130	100	0	0
Maximum	510	92.9	8.23	80.0	0.308	3.04	<0.0005	0.803	0.0662	0.00600	100	0	0
Mean	345	86.1	7.35	72.3	0.155	1.23	<0.0005	0.365	0.0525	0.00204	100	0	0
SD	153	4.95	0.257	5.42	0.0687	0.699	-	0.283	0.00876	0.00150	-	-	-
04-Jan-16	492	75.2	7.30	70.0	0.333	2.14	<0.000500	0.0400	0.0381	0.00226	-	-	-
08-Jan-16	300	-	7.30	-	0.334	-	-	-	-	-	-	-	-
12-Jan-16	312	-	7.58	-	0.251	2.60	-	0.0370	-	-	-	-	-
18-Jan-16	300	-	7.55	-	0.318	2.76	-	0.0360	-	-	-	-	-

Table M.4: Water Quality at SAMP Principal Station CL-06, Final Treated Effluent, Stanleigh TMA, 2015 to 2019

Date	Flow (L/s)	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)	Sublethal Toxicity (*Ceriodaphnia dubia*) IC25	Acute Toxicity (*Daphnia magna*) % Mortality	Acute Toxicity (Rainbow Trout) % Mortality
25-Jan-16	297	80.7	8.25	-	0.292	3.21	-	0.0340	-	-	-	-	-
01-Feb-16	300	82.7	7.40	70.0	0.331	3.51	<0.000500	0.0330	0.0405	0.00177	-	-	-
08-Feb-16	300	-	7.70	-	0.296	3.24	-	0.0310	-	-	-	-	-
09-Feb-16	-	-	7.40	-	-	-	-	-	-	-	100	0	0
16-Feb-16	320	-	7.86	-	0.298	3.58	-	0.0340	-	-	-	-	-
22-Feb-16	540	-	7.61	-	0.457	3.28	-	0.188	-	-	-	-	-
01-Mar-16	410	-	7.60	-	0.146	0.885	-	0.382	-	-	100	0	0
07-Mar-16	500	86.8	7.63	71.0	0.191	0.696	<0.000500	0.520	0.0444	0.00136	-	-	-
14-Mar-16	540	-	7.26	-	0.178	0.681	-	0.539	-	-	-	-	-
21-Mar-16	540	-	7.12	-	0.252	0.869	-	0.493	-	-	-	-	-
28-Mar-16	528	-	7.29	-	0.225	0.766	-	0.469	-	-	-	-	-
04-Apr-16	508	76.7	6.96	62.0	0.173	1.17	<0.000500	0.272	0.0445	0.00165	-	-	-
11-Apr-16	285	-	6.95	-	0.0660	0.699	-	0.142	-	-	-	-	-
18-Apr-16	534	-	6.90	-	0.182	0.972	-	0.0640	-	-	-	-	-
25-Apr-16	526	-	7.09	-	0.344	1.47	-	0.0490	-	-	-	-	-
26-Apr-16	529	-	7.15	-	0.234	-	-	-	-	-	-	-	-
02-May-16	427	78.9	7.17	64.0	0.249	1.27	<0.000500	0.0480	0.0478	0.00145	100	0	0
09-May-16	456	-	7.17	-	0.247	1.46	-	0.0460	-	-	-	-	-
16-May-16	423	-	7.35	-	0.330	2.03	-	0.0490	-	-	-	-	-
24-May-16	452	-	7.35	-	0.408	2.58	-	0.0600	-	-	-	-	-
30-May-16	296	-	7.48	-	0.390	3.34	-	0.0500	-	-	-	-	-
06-Jun-16	236	76.5	7.23	62.0	0.326	3.72	<0.000500	0.0460	0.0553	0.00146	-	-	-
13-Jun-16	250	-	7.30	-	0.294	3.40	-	0.0390	-	-	-	-	-
20-Jun-16	300	-	7.00	-	0.374	3.57	-	0.0400	-	-	-	-	-
05-Jul-16	235	-	7.18	-	0.0620	0.782	-	0.0470	-	-	-	-	-
11-Jul-16	220	82.1	7.40	63.0	0.117	2.11	<0.000500	0.0440	0.0188	0.00111	-	-	-
18-Jul-16	240	-	7.20	-	0.201	2.38	-	0.0460	-	-	-	-	-
25-Jul-16	240	-	7.20	-	0.166	2.49	-	0.0400	-	-	-	-	-
02-Aug-16	243	82.3	7.50	63.0	0.0940	1.61	<0.000500	0.0580	0.0125	0.00110	-	-	-
08-Aug-16	280	-	7.45	-	0.168	2.35	-	0.0420	-	-	-	-	-
15-Aug-16	280	-	7.70	-	0.139	2.13	-	0.0530	-	-	-	-	-
22-Aug-16	295	-	7.82	-	0.110	1.07	-	0.0370	-	-	-	-	-
29-Aug-16	291	-	7.47	-	0.105	0.920	-	0.0300	-	-	-	-	-
06-Sep-16	319	76.6	7.51	67.0	0.0980	0.870	<0.000500	0.0300	0.00782	0.00108	-	-	-
12-Sep-16	297	-	7.15	-	0.106	0.950	-	0.0280	-	-	-	-	-
19-Sep-16	306	-	7.23	-	0.104	0.762	-	0.0390	-	-	-	-	-
26-Sep-16	303	-	7.92	-	0.121	0.928	-	0.0220	-	-	-	-	-
03-Oct-16	300	76.1	7.53	64.0	0.116	0.833	<0.000500	0.0240	0.0726	0.00146	-	-	-
11-Oct-16	304	-	7.30	-	0.108	0.762	-	0.0390	-	-	-	-	-
17-Oct-16	308	-	7.40	-	0.161	1.02	-	0.0560	-	-	-	-	-
24-Oct-16	303	-	7.40	-	0.142	0.880	-	0.0570	-	-	-	-	-
31-Oct-16	301	-	7.40	-	0.154	0.841	-	0.0450	-	-	-	-	-
07-Nov-16	303	89.4	7.40	67.0	0.179	0.891	<0.000500	0.0390	0.0346	0.00153	100	0	0
14-Nov-16	300	-	7.40	-	0.160	0.952	-	0.0420	-	-	-	-	-
21-Nov-16	309	-	7.40	-	0.176	0.907	-	0.0550	-	-	-	-	-
28-Nov-16	297	-	7.60	-	0.176	1.51	-	0.0530	-	-	-	-	-
05-Dec-16	291	80.7	7.30	66.0	0.163	0.828	<0.000500	0.0430	0.0348	0.00160	-	-	-

Table M.4: Water Quality at SAMP Principal Station CL-06, Final Treated Effluent, Stanleigh TMA, 2015 to 2019

Date	Flow (L/s)	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)	Sublethal Toxicity (*Ceriodaphnia dubia*) IC25	Acute Toxicity (*Daphnia magna*) % Mortality	Acute Toxicity (Rainbow Trout) % Mortality
12-Dec-16	300	-	7.20	-	0.0870	0.611	-	0.0360	-	-	-	-	-
19-Dec-16	303	-	7.50	-	0.0720	0.614	-	0.0410	-	-	-	-	-
n	52	12	59	17	52	50	12	55	12	12	4	4	4
Minimum	220	75.2	6.90	62.0	0.0620	0.611	<0.0005	0.0220	0.00782	0.00108	100	0	0
Maximum	540	89.4	8.25	71.0	0.457	3.72	<0.0005	0.539	0.0726	0.00226	100	0	0
Mean	347	80.3	7.38	66.4	0.208	1.68	<0.0005	0.127	0.0376	0.00149	100	0	0
SD	99.7	4.52	0.247	3.02	0.100	1.02	-	0.166	0.0182	0.000330	-	-	-
21-Feb-17	290	84.0	7.20	63.0	0.123	1.08	<0.000500	0.0290	0.0388	0.00241	-	-	-
27-Feb-17	281	-	7.50	-	0.156	0.791	-	0.0300	-	-	-	-	-
06-Mar-17	290	94.8	7.30	63.0	0.127	0.799	<0.000500	0.0240	0.0392	0.00184	-	-	-
13-Mar-17	320	-	7.20	-	0.120	0.843	-	0.0320	-	-	-	-	-
20-Mar-17	340	-	7.20	-	0.0830	0.633	-	0.0270	-	-	-	-	-
27-Mar-17	343	-	7.20	-	0.0900	0.780	-	0.0250	-	-	-	-	-
03-Apr-17	332	71.0	7.20	47.0	0.155	0.819	<0.000500	0.0400	0.0371	0.00130	-	-	-
10-Apr-17	362	-	7.00	-	0.144	0.880	-	0.0380	-	-	-	-	-
17-Apr-17	340	-	7.30	-	0.341	2.15	-	0.0670	-	-	-	-	-
24-Apr-17	330	-	7.20	-	0.364	2.56	-	0.0830	-	-	-	-	-
02-May-17	50.0	-	7.40	-	0.412	-	-	-	-	-	-	-	-
04-May-17	235	76.3	7.20	56.0	0.314	2.26	<0.000500	0.0930	0.0583	0.00217	100	20.0	0
08-May-17	230	-	7.50	-	0.356	2.44	-	0.0840	-	-	-	-	-
15-May-17	229	-	7.20	-	0.381	3.55	-	0.0710	-	-	-	-	-
01-Jun-17	300	-	7.30	-	0.328	2.84	-	0.0350	-	-	-	-	-
05-Jun-17	300	70.5	7.20	56.0	0.299	2.85	<0.000500	0.0320	0.0438	0.00258	-	-	-
12-Jun-17	300	-	7.10	-	0.354	2.88	-	0.0320	-	-	-	-	-
19-Jun-17	300	-	7.20	-	0.382	2.92	-	0.0420	-	-	-	-	-
06-Jul-17	260	74.1	7.20	60.0	0.295	2.84	<0.000500	0.0400	0.0482	0.00215	-	-	-
10-Jul-17	250	-	7.30	-	0.302	2.95	-	0.0460	-	-	-	-	-
17-Jul-17	228	-	7.40	-	0.313	3.09	-	0.0490	-	-	-	-	-
24-Jul-17	251	-	7.40	-	0.248	2.92	-	0.0470	-	-	-	-	-
31-Jul-17	260	-	7.40	-	0.290	2.97	-	0.0500	-	-	-	-	-
08-Aug-17	260	69.6	7.30	57.0	0.263	2.30	<0.000500	0.0340	0.0161	0.00161	-	-	-
14-Aug-17	260	-	7.40	-	0.251	3.10	-	0.0330	-	-	-	-	-
21-Aug-17	262	-	7.40	-	0.256	2.98	-	0.0380	-	-	-	-	-
28-Aug-17	260	-	7.40	-	0.262	2.83	-	0.0310	-	-	-	-	-
05-Sep-17	260	77.2	7.30	57.0	0.230	2.61	<0.000500	0.0290	0.0163	0.00192	-	-	-
11-Sep-17	302	-	7.40	-	0.247	2.61	-	0.0300	-	-	-	-	-
18-Sep-17	300	-	7.40	-	0.256	2.53	-	0.0300	-	-	-	-	-
25-Sep-17	300	-	7.70	-	0.281	3.07	-	0.0270	-	-	-	-	-
02-Oct-17	300	70.1	7.20	56.0	0.284	1.94	<0.000500	<0.0200	0.0330	0.00128	-	-	-
10-Oct-17	230	-	7.20	-	0.197	1.81	-	0.0310	-	-	-	-	-
16-Oct-17	350	-	7.20	-	0.233	1.90	-	0.0490	-	-	-	-	-
25-Oct-17	450	-	7.20	-	0.294	1.39	-	0.0580	-	-	-	-	-
26-Oct-17	455	-	-	-	-	-	-	-	-	-	100	0	0
30-Oct-17	495	-	7.20	-	0.314	2.01	-	0.0540	-	-	-	-	-
06-Nov-17	500	58.3	7.20	59.0	0.356	2.23	<0.000500	0.0590	0.0348	0.00172	-	-	-
13-Nov-17	500	-	7.20	-	0.330	2.54	-	0.0460	-	-	-	-	-
20-Nov-17	500	-	7.20	-	0.378	2.43	-	0.0630	-	-	-	-	-

Table M.4: Water Quality at SAMP Principal Station CL-06, Final Treated Effluent, Stanleigh TMA, 2015 to 2019

Date	Flow (L/s)	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)	Sublethal Toxicity (*Ceriodaphnia dubia*) IC25	Acute Toxicity (*Daphnia magna*) % Mortality	Acute Toxicity (Rainbow Trout) % Mortality
27-Nov-17	300	-	7.20	-	0.385	2.20	-	0.0640	-	-	-	-	-
04-Dec-17	260	77.3	7.20	57.0	0.403	2.50	<0.000500	0.0360	0.0396	0.00112	-	-	-
11-Dec-17	350	-	7.10	-	0.455	3.21	-	0.0580	-	-	-	-	-
18-Dec-17	230	-	7.30	-	0.412	3.49	-	0.0580	-	-	-	-	-
22-Dec-17	200	-	7.30	-	0.383	-	-	-	-	-	-	-	-
27-Dec-17	400	80.2	7.40	59.0	0.436	3.56	0.000500	0.0660	0.0394	0.00194	100	0	0
31-Dec-17	400	-	-	-	0.400	-	-	-	-	-	-	-	-
n	306	12	45	12	46	43	12	43	12	12	3	3	3
Minimum	10.0	58.3	7.00	47.0	0.0830	0.633	<0.0005	<0.02	0.0161	0.00112	100	0	0
Maximum	510	94.8	7.70	63.0	0.455	3.56	<0.0005	0.0930	0.0583	0.00258	100	20.0	0
Mean	311	75.3	7.28	57.5	0.289	2.30	<0.0005	0.0449	0.0370	0.00184	100	6.67	0
SD	83.4	8.94	0.126	4.15	0.0965	0.848	-	0.0176	0.0118	0.000456	-	11.5	-
02-Jan-18	400	65.4	7.20	59.0	0.422	2.81	0.000500	0.0550	0.0399	0.00179	-	-	-
08-Jan-18	400	-	7.00	60.0	0.398	2.91	-	0.0460	-	-	-	-	-
10-Jan-18	400	-	6.80	-	-	-	-	-	-	-	100	0	0
15-Jan-18	400	-	7.00	60.0	0.438	2.90	-	0.0550	-	-	-	-	-
22-Jan-18	400	-	7.10	59.0	0.451	2.68	-	0.0350	-	-	100	0	0
25-Jan-18	400	-	7.10	57.0	0.427	2.71	-	0.0520	-	-	-	-	-
29-Jan-18	400	-	7.10	57.0	0.410	2.83	-	0.0530	-	-	-	-	-
01-Feb-18	400	-	7.20	60.0	0.234	1.11	-	0.0820	-	-	-	-	-
05-Feb-18	200	82.1	7.20	58.0	0.168	1.03	<0.000500	0.198	0.0391	0.00148	-	-	-
07-Feb-18	200	-	7.10	56.0	0.194	1.22	-	0.209	-	-	100	0	0
12-Feb-18	450	-	7.20	59.0	0.208	1.08	-	0.241	-	-	-	-	-
15-Feb-18	450	-	7.20	58.0	0.222	1.03	-	0.236	-	-	-	-	-
20-Feb-18	450	-	7.20	58.0	0.186	0.787	-	0.394	-	-	100	0	0
22-Feb-18	500	-	7.30	61.0	0.166	0.961	-	0.408	-	-	-	-	-
26-Feb-18	500	-	7.30	61.0	0.343	1.83	-	0.199	-	-	-	-	-
01-Mar-18	500	-	7.20	60.0	0.344	1.81	-	0.258	-	-	-	-	-
05-Mar-18	500	95.7	7.20	61.0	0.459	2.93	0.000500	0.0900	0.0409	0.00125	-	-	-
26-Mar-18	200	-	6.70	62.0	0.166	0.868	-	0.0850	-	-	100	0	0
02-Apr-18	190	82.2	6.50	56.0	0.0720	0.512	<0.000500	0.0870	0.0439	0.00130	-	-	-
09-Apr-18	200	-	7.40	61.0	0.0780	0.579	-	0.0740	-	-	100	0	0
16-Apr-18	400	-	7.00	59.0	0.0420	0.609	-	0.0510	-	-	-	-	-
23-Apr-18	400	-	6.90	57.0	0.238	1.14	-	0.0420	-	-	100	0	0
30-Apr-18	400	-	6.90	38.0	0.190	1.23	-	0.0530	-	-	-	-	-
07-May-18	500	40.3	6.80	33.0	0.162	0.873	<0.000500	0.0410	0.0289	0.000919	100	0	0
14-May-18	500	-	7.10	56.0	0.404	1.97	-	0.0720	-	-	-	-	-
17-May-18	500	-	6.80	-	0.434	-	-	-	-	-	-	-	-
26-May-18	380	-	6.90	54.0	0.164	0.859	-	0.0700	-	-	-	-	-
28-May-18	380	-	-	-	-	-	-	-	-	-	100	3.30	0
30-May-18	400	-	6.80	56.0	0.137	0.802	-	0.0570	-	-	-	-	-
04-Jun-18	355	63.2	6.60	53.0	0.164	0.882	<0.000500	0.0600	0.0568	0.00133	-	-	-
11-Jun-18	355	-	7.30	52.0	0.264	1.33	-	0.0460	-	-	-	-	-
12-Jun-18	355	-	-	-	-	-	-	-	-	-	100	0	0
18-Jun-18	355	-	7.20	52.0	0.364	1.88	-	0.0350	-	-	-	-	-
04-Oct-18	300	-	7.30	-	0.122	-	-	-	-	-	-	-	-
09-Oct-18	300	-	7.30	52.0	0.186	1.13	-	0.0430	-	-	-	-	-

Table M.4: Water Quality at SAMP Principal Station CL-06, Final Treated Effluent, Stanleigh TMA, 2015 to 2019

Date	Flow (L/s)	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)	Sublethal Toxicity (*Ceriodaphnia dubia*) IC25	Acute Toxicity (*Daphnia magna*) % Mortality	Acute Toxicity (Rainbow Trout) % Mortality
15-Oct-18	300	62.7	7.20	52.0	0.241	1.48	<0.000500	0.0410	0.0315	0.00235	100	0	0
22-Oct-18	450	-	7.10	53.0	0.338	1.77	-	0.0380	-	-	-	-	-
08-Nov-18	400	65.9	7.00	52.0	0.286	1.68	0.0000870	0.0320	0.0271	0.00151	-	-	-
12-Nov-18	400	66.6	7.00	52.0	0.294	1.08	<0.000500	0.0200	0.0255	0.00151	100	0	0
15-Nov-18	400	63.3	7.00	53.0	0.251	0.817	<0.000500	0.0490	0.0273	0.00170	-	-	-
19-Nov-18	400	67.1	6.80	55.0	0.271	1.08	<0.000500	0.0360	0.0276	0.00167	-	-	-
22-Nov-18	400	63.5	7.10	55.0	0.232	1.10	<0.000500	0.0280	0.0224	0.00143	-	-	-
26-Nov-18	400	61.7	6.90	54.0	0.171	1.03	<0.000500	0.0260	0.0243	0.00131	-	-	-
03-Dec-18	400	61.9	6.70	53.0	0.185	0.956	<0.000500	0.0270	0.0254	0.00153	-	-	-
06-Dec-18	400	60.3	7.00	53.0	0.208	1.27	<0.000500	0.0280	0.0244	0.00146	-	-	-
10-Dec-18	400	-	6.80	55.0	0.231	1.36	-	0.0270	-	-	-	-	-
13-Dec-18	400	-	6.80	-	0.241	-	-	-	-	-	-	-	-
27-Dec-18	250	-	6.60	-	0.168	0.158	-	-	-	-	-	-	-
28-Dec-18	250	-	6.70	-	0.121	-	-	-	-	-	-	-	-
n	244	15	74	41	46	42	15	41	15	15	12	12	12
Minimum	89.0	40.3	6.50	33.0	0.0420	0.158	<0.000087	0.0200	0.0224	0.000919	100	0	0
Maximum	500	95.7	7.40	62.0	0.459	2.93	0.000500	0.408	0.0568	0.00235	100	3.30	0
Mean	367	66.8	7.01	55.4	0.250	1.41	0.000115	0.0922	0.0323	0.00150	100	0.275	0
SD	103	12.4	0.194	5.57	0.111	0.744	-	0.0961	0.00971	0.000315	-	0.953	-
02-Jan-19	250	-	6.70	-	0.170	1.09	-	-	-	-	-	-	-
03-Jan-19	250	-	6.90	-	0.144	-	-	-	-	-	-	-	-
07-Jan-19	400	66.5	6.80	55.0	0.150	0.824	<0.000500	0.0190	0.0244	0.00118	-	-	-
10-Jan-19	400	-	6.70	-	0.177	-	-	-	-	-	-	-	-
14-Jan-19	400	57.3	6.80	-	0.142	0.433	-	-	-	-	-	-	-
17-Jan-19	475	-	6.80	-	0.155	-	-	-	-	-	-	-	-
21-Jan-19	475	-	6.80	-	0.203	0.641	-	-	-	-	-	-	-
24-Jan-19	475	-	6.80	-	0.219	-	-	-	-	-	-	-	-
29-Jan-19	475	-	6.80	-	0.227	0.574	-	-	-	-	-	-	-
31-Jan-19	475	-	6.80	-	0.246	-	-	-	-	-	-	-	-
04-Feb-19	475	65.8	6.70	57.0	0.233	0.697	<0.000500	<0.0200	0.0250	0.00110	-	-	-
07-Feb-19	400	-	6.80	-	0.178	-	-	-	-	-	-	-	-
11-Feb-19	400	-	6.70	-	0.190	0.780	-	-	-	-	-	-	-
14-Feb-19	400	-	6.70	-	0.224	-	-	-	-	-	-	-	-
19-Feb-19	400	-	6.80	-	0.146	0.355	-	-	-	-	-	-	-
21-Feb-19	400	-	6.60	-	0.219	-	-	-	-	-	-	-	-
25-Feb-19	400	-	6.70	-	0.178	0.637	-	-	-	-	-	-	-
28-Feb-19	475	-	6.60	-	0.246	-	-	-	-	-	-	-	-
04-Mar-19	475	60.9	6.60	57.0	0.179	0.643	<0.000500	<0.0200	0.0230	0.00110	-	-	-
07-Mar-19	475	-	6.70	-	0.232	-	-	-	-	-	-	-	-
11-Mar-19	475	-	6.80	58.0	0.211	0.850	-	-	-	-	-	-	-
14-Mar-19	475	-	6.90	-	0.204	-	-	-	-	-	-	-	-
18-Mar-19	475	-	6.80	-	0.142	0.623	-	-	-	-	-	-	-
21-Mar-19	475	-	6.70	-	0.156	-	-	-	-	-	-	-	-
25-Mar-19	475	-	7.00	-	0.138	0.476	-	-	-	-	-	-	-
28-Mar-19	475	-	6.90	-	0.148	-	-	-	-	-	-	-	-
01-Apr-19	475	-	6.80	-	0.149	0.422	-	-	-	-	-	-	-
04-Apr-19	475	-	6.80	-	0.143	-	-	-	-	-	-	-	-

Table M.4: Water Quality at SAMP Principal Station CL-06, Final Treated Effluent, Stanleigh TMA, 2015 to 2019

Date	Flow (L/s)	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)	Sublethal Toxicity (*Ceriodaphnia dubia*) IC25	Acute Toxicity (*Daphnia magna*) % Mortality	Acute Toxicity (Rainbow Trout) % Mortality
08-Apr-19	475	-	6.80	-	0.201	0.572	-	-	-	-	-	-	-
11-Apr-19	475	-	6.80	-	0.160	-	-	-	-	-	-	-	-
15-Apr-19	475	-	6.70	-	0.181	0.324	-	-	-	-	-	-	-
17-Apr-19	475	-	6.70	-	0.187	-	-	-	-	-	-	-	-
22-Apr-19	475	37.6	6.60	28.0	0.121	0.225	<0.000500	0.0380	0.0230	0.00100	100	0	0
25-Apr-19	475	-	6.50	-	0.0750	-	-	-	-	-	-	-	-
29-Apr-19	475	-	6.60	-	0.140	0.392	-	-	-	-	-	-	-
02-May-19	475	-	6.80	-	0.186	-	-	-	-	-	-	-	-
06-May-19	475	46.8	7.00	35.0	0.188	0.903	0.000364	0.120	0.0502	0.00157	-	-	-
13-May-19	475	-	7.10	-	0.212	0.569	-	-	-	-	-	-	-
21-May-19	475	-	7.00	-	0.261	0.657	-	-	-	-	-	-	-
27-May-19	475	-	6.90	-	0.315	0.901	-	-	-	-	-	-	-
10-Jun-19	200	56.5	6.90	42.0	0.176	0.507	<0.000500	0.0350	0.0440	0.00140	-	-	-
17-Jun-19	200	-	7.00	-	0.138	0.627	-	-	-	-	-	-	-
24-Jun-19	400	-	6.90	-	0.160	0.722	-	-	-	-	-	-	-
02-Jul-19	400	49.9	7.10	47.0	0.192	0.690	<0.000500	<0.0200	0.0320	0.00130	-	-	-
08-Jul-19	400	-	6.80	-	0.237	0.952	-	-	-	-	-	-	-
03-Oct-19	390	-	7.00	-	0.0860	0.504	-	-	-	-	-	-	-
07-Oct-19	380	60.3	7.00	44.0	0.116	0.688	<0.000500	0.0360	0.0740	0.00250	-	-	-
15-Oct-19	400	-	7.00	-	0.164	0.581	-	-	-	-	-	-	-
21-Oct-19	400	-	6.70	-	0.188	0.706	-	-	-	-	-	-	-
28-Oct-19	400	-	6.70	-	0.187	0.733	-	-	-	-	-	-	-
04-Nov-19	400	57.3	6.80	47.0	0.200	0.614	<0.000500	0.0270	0.0230	0.00160	100	0	0
11-Nov-19	400	-	7.00	-	0.239	0.921	-	-	-	-	-	-	-
18-Nov-19	400	-	6.90	-	0.214	0.620	-	-	-	-	-	-	-
25-Nov-19	400	-	6.60	-	0.148	0.159	-	-	-	-	-	-	-
02-Dec-19	400	59.9	6.60	43.0	0.217	0.713	<0.000500	0.0340	0.0250	0.00140	-	-	-
09-Dec-19	400	-	6.70	-	0.134	0.465	-	-	-	-	-	-	-
16-Dec-19	400	-	6.70	-	0.202	0.417	-	-	-	-	-	-	-
23-Dec-19	400	-	6.70	-	0.143	0.154	-	-	-	-	-	-	-
30-Dec-19	400	-	6.70	-	0.171	0.378	-	-	-	-	-	-	-
n	283	10	60	11	59	41	10	10	10	10	2	2	2
Minimum	100	37.6	6.50	28.0	0.0750	0.154	0.000364	0.0190	0.0230	0.00100	100	0	0
Maximum	475	66.5	7.10	58.0	0.315	1.09	<0.0005	0.120	0.0740	0.00250	100	0	0
Mean	413	56.2	6.80	46.6	0.181	0.603	0.000364	0.0366	0.0344	0.00142	100	0	0
SD	72.6	8.98	0.142	9.69	0.0434	0.212	-	0.0311	0.0169	0.000431	-	-	-
Summary Statistics for 2015 to 2019													
n	928	64	277	104	240	211	58	173	58	58	24	24	24
Minimum	4.00	37.6	6.50	28.0	0.0290	0.154	0.0000870	0.0190	0.00782	0.000919	100	0	0
Maximum	540	95.7	8.25	80.0	0.459	3.72	0.000500	0.803	0.0740	0.00600	100	20.0	0
Mean	361	71.7	7.14	60.3	0.217	1.47	0.000249	0.126	0.0379	0.00164	100	0.971	0
SD	99.8	12.9	0.300	9.98	0.0977	0.946	0.000741	0.179	0.0146	0.000694	-	4.11	-
Median	400	72.6	7.20	59.5	0.190	1.03	0.000364	0.0460	0.0390	0.00150	100	0	0
10th Percentile	234	57.3	6.70	52.0	0.106	0.579	0.0000870	0.0270	0.0224	0.00110	100	0	0
95th Percentile	500	91.9	7.60	76.0	0.409	3.24	0.000500	0.539	0.0662	0.00250	100	3.30	0

Note: "-" = no data collected. n = number of samples. SD = standard deviation.

Table M.5: Summary of Annual Plant Operations and Discharge at Stanrock TMA, 2015 to 2019

ITEM	2015	2016	2017	2018	2019
PLANT OPERATIONS[a]					
Operating Days	125	114	201	126	181
Maximum Daily Plant Flow (L/s @ DS-2)	190	192	230	198	190
Minimum Daily Plant Flow (L/s @ DS-2)	0	0	0	0	0
Monthly Average Daily Plant Flow (L/s @ DS-2)	49.3	45.5	75.7	44.5	64.1
Total Volume Treated (ML)	533	448	1,314	484	1,003
Barium Chloride Consumption					
Total (kg/year)	805	653	1,257	479	938
Monthly Average (mg/L)	1.51	1.46	0.957	0.990	0.935
Lime Consumption					
Total (tonnes/year)	126	117	272	106	166
Monthly Average (g/L)	0.237	0.262	0.207	0.220	0.166
ORIENT CREEK					
Discharge Days	0	0	0	0	0
Maximum Daily Flow (L/s @ DS-5)	4.77	5.00	10.4	10.4	2.57
Minimum Daily Plant Flow (L/s @ DS-5)	0	0	0.220	0	0
Monthly Average Daily Flow (L/s @ DS-5)	1.67	1.96	3.13	5.71	1.54
Total Volume Treated (ML)	0	0	0	0	0
Site Total Including ETP Operations (ML)	533	448	1,314	484	1,003
NEUTRALIZATION					
Lime Consumption					
Site Total Including ETP Operations	126	117	272	106	166
Caustic Soda Consumption					
Orient Creek Total (kg/month)	0	0	0	0	124
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	366	365	365	365
Maximum Daily Discharge Flow (L/s @ DS-4)	693	191	400	211	254
Minimum Daily Discharge Flow (L/s @ DS-4)	1	1	0	0	1
Monthly Average Daily Discharge Flow (L/s @ DS-4)	42.7	27.3	60.3	25.6	42.1
Total Annual Volume Discharged (ML)	1,346	864	1,901	807	1,326

Note: See Appendix Tables M.2 and M.3 (station DS-2) for detailed reagent data.

[a] Influent flows based on daily monitoring requirements as per TOMP.

[b] Effluent flows based on weekly monitoring requirement as per SAMP.

Table M.6: Summary of Annual Plant Operations and Discharge at Stanleigh TMA, 2015 to 2019

ITEM	2015	2016	2017	2018	2019
PLANT OPERATIONS[a]					
Operating Days	173	347	301	236	281
Maximum Daily Plant Flow (L/s @ CL-04)	525	550	510	500	475
Minimum Daily Plant Flow (L/s @ CL-04)	0	0	0	0	0
Monthly Average Daily Plant Flow (L/s @ CL-04)	203	334	262	244	322
Total Volume Treated (ML)	3,036	10,024	6,813	4,976	7,806
Barium Chloride Consumption					
Total (kg/year)	30,800	54,275	41,000	52,175	55,000
Monthly Average (mg/L)	10.1	5.41	6.02	10.5	7.05
Lime Consumption					
Dry (tonne/year)	12.1	16.6	11.8	5.78	1.53
Average (g/L)	0.00399	0.00166	0.00173	0.00116	0.0002
Sodium Sulphate Consumption					
Total (kg/year)	0	0	0	0	39,150
Monthly Average (mg/L)	0	0	0	0	5.02
EFFLUENT[b]					
Discharge Days	183	351	306	244	279
Maximum Daily Discharge Flow (L/s @ CL-06)	510	540	510	500	475
Minimum Daily Discharge Flow (L/s @ CL-06)	0	0	0	0	0
Monthly Average Daily Discharge Flow (L/s @ CL-06)	215	335	261	246	320
Total Annual Volume Discharged (ML)	3,398	10,148	6,889	5,178	7,723

Note: See Appendix Table M.4 (station CL-04) for detailed reagent data.

[a] Influent flows based on daily monitoring requirements as per TOMP.

[b] Effluent flows based on weekly monitoring requirement as per SAMP.

Table M.7: Annual Discharge Loadings from Stanrock TMA and Stanleigh TMA to the May Lake Sub-Watershed, 2015 to 2019

Station		Drainage Type	Year	Annual Discharge (m^3)	Barium (kg/year)	Cobalt (kg/yr)	Iron (kg/yr)	Manganese (kg/yr)	Radium (MBq/yr)	Sulphate (kg/yr)	Uranium (kg/yr)
Stanrock TMA	DS-4	Controlled Discharge (SAMP)	2015	1,316,304	57.9	0.889	269	95.1	61.6	339,088	3.46
			2016	882,403	50.7	0.585	115	35.5	45.1	228,846	2.86
			2017	1,872,720	79.5	1.25	359	82.0	129	504,089	7.77
			2018	805,853	50.5	0.498	160	40.3	55.3	194,379	4.00
			2019	1,339,546	73.0	0.792	256	68.3	87.5	336,196	6.47
			Mean	1,243,365	62.3	0.802	232	64.2	75.7	320,520	4.91
			SD	427,893	13.3	0.294	96.0	25.9	33.8	121,041	2.11
	DS-18	Halfmoon Lake Outlet (SRWMP)	2015	4,833,357	114	-	2,440	169	749	496,075	3.74
			2016	4,249,689	69.8	-	1,797	136	585	271,841	2.37
			2017	7,109,967	125	-	4,855	309	1,340	449,722	6.38
			2018	5,022,410	105	-	1,317	108	724	311,190	3.96
			2019	7,888,925	152	-	2,045	161	963	259,707	6.87
			Mean	5,820,869	113	-	2,491	177	872	357,707	4.66
			SD	1,582,715	29.9	-	1,383	77.8	294	108,113	1.90
Stanleigh TMA	CL-06	Controlled Discharge (SAMP)	2015	6,376,320	8,568	3.19	1,106	322	1,087	477,155	13.3
			2016	10,571,904	17,131	5.27	1,268	420	2,251	691,355	16.5
			2017	8,217,158	18,493	4.11	371	297	2,307	470,019	14.4
			2018	7,745,501	11,792	3.82	616	287	2,041	424,350	11.5
			2019	10,104,048	6,102	4.89	375	336	1,878	481,946	14.2
			Mean	8,602,986	12,417	4.26	747	332	1,913	508,965	14.0
			SD	1,730,030	5,344	0.835	418	52.7	492	104,504	1.81
	SR-06	Outlet of McCabe Lake (SRWMP)	2015	13,666,733	6,474	-	273	219	892	637,694	10.9
			2016	12,016,362	5,048	-	270	189	726	464,644	8.38
			2017	20,104,045	11,858	-	485	230	1,695	783,065	14.1
			2018	14,201,297	9,459	-	768	170	1,366	419,166	8.68
			2019	22,306,615	11,116	-	457	314	1,814	675,501	13.9
			Mean	16,459,010	8,791	-	451	224	1,299	596,014	11.2
			SD	4,475,264	2,943	-	204	55.4	480	151,308	2.74
Stanrock TMA and Stanleigh TMA	SR-15	Outlet of May Lake (SRWMP)	2015	30,083,479	3,700	-	602	181	993	1,083,005	15.0
			2016	26,450,651	3,322	-	528	151	948	952,127	13.2
			2017	44,253,416	6,678	-	885	172	2,971	1,506,096	22.1
			2018	31,260,171	5,838	-	650	140	2,212	992,203	15.6
			2019	49,101,755	8,849	-	1,041	340	2,540	1,410,280	24.6
			Mean	36,229,895	5,678	-	741	197	1,933	1,188,742	18.1
			SD	9,851,039	2,266	-	214	81.6	919	252,778	4.93

Notes: MBq/yr = Million Becquerels per year. Values below LRL were substituted at the LRL for calculations. "-" indicates parameter not measured, as per study design. See Appendix Tables M.2, M.4, S.9 and S.10 for raw data and Appendix Figure M.10 for the percent contribution of loads from Stanrock TMA.

APPENDIX N
QUIRKE LAKE SUB-WATERSHED SAMP DATA

Denison TMA, Spanish-American TMA, Quirke TMA,

and Panel TMA

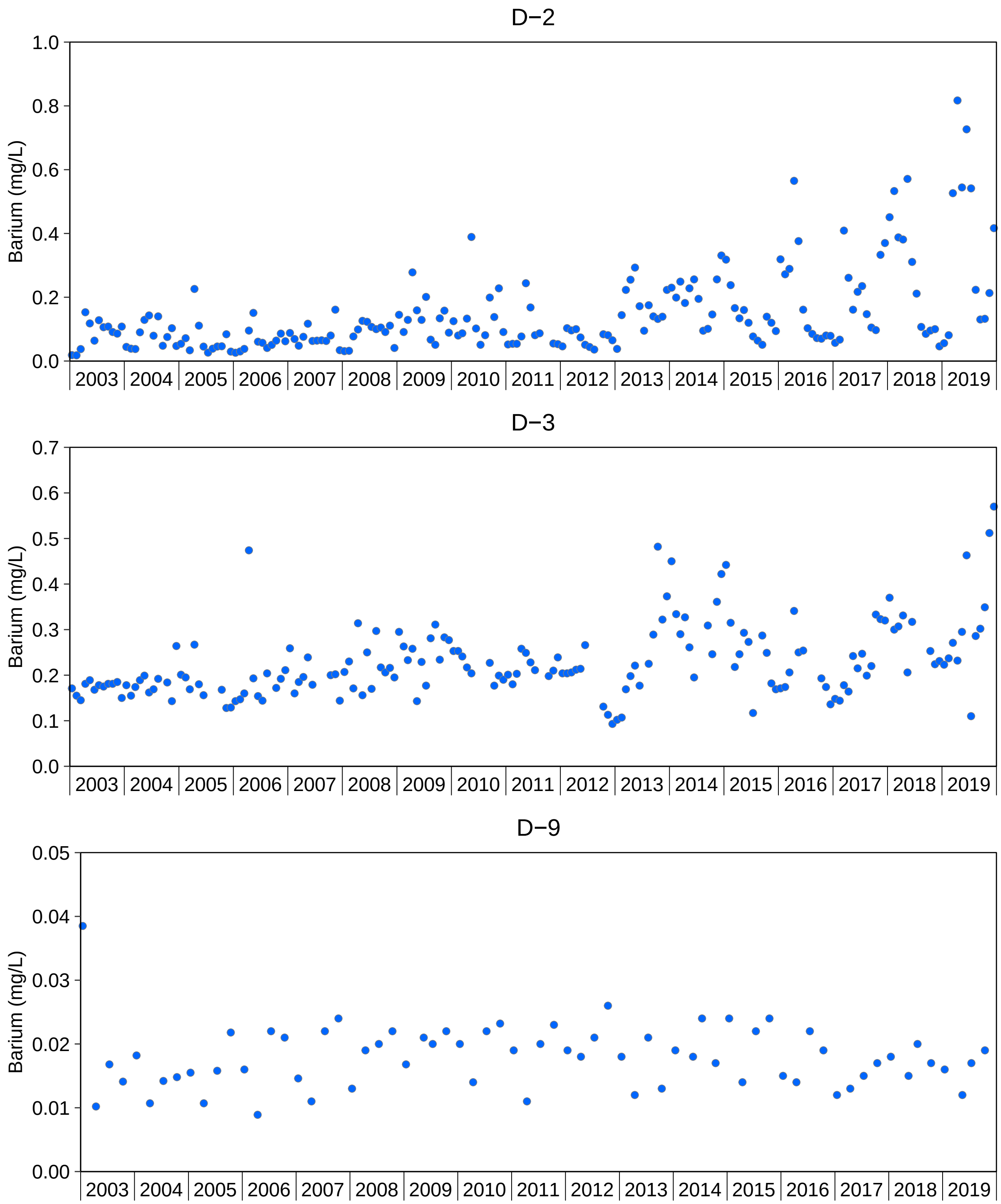


Figure N.1: Concentrations of Barium for SAMP Water Quality Monitoring Stations in Denison, Quirke, Panel, and Stanrock TMAs, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Tables N.2 to N.15 and M.3 for raw data.

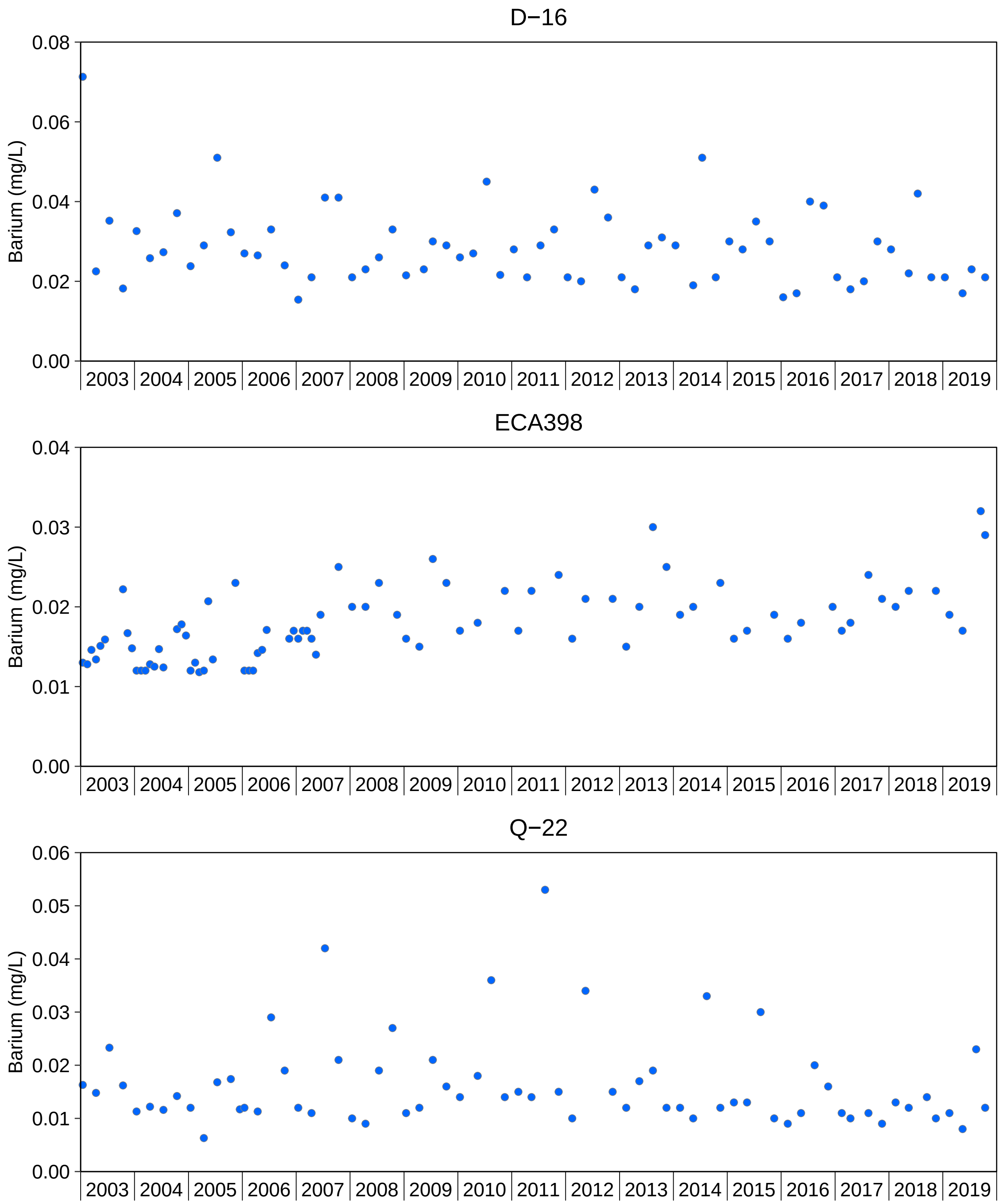


Figure N.1: Concentrations of Barium for SAMP Water Quality Monitoring Stations in Denison, Quirke, Panel, and Stanrock TMAs, 2003 to 2019

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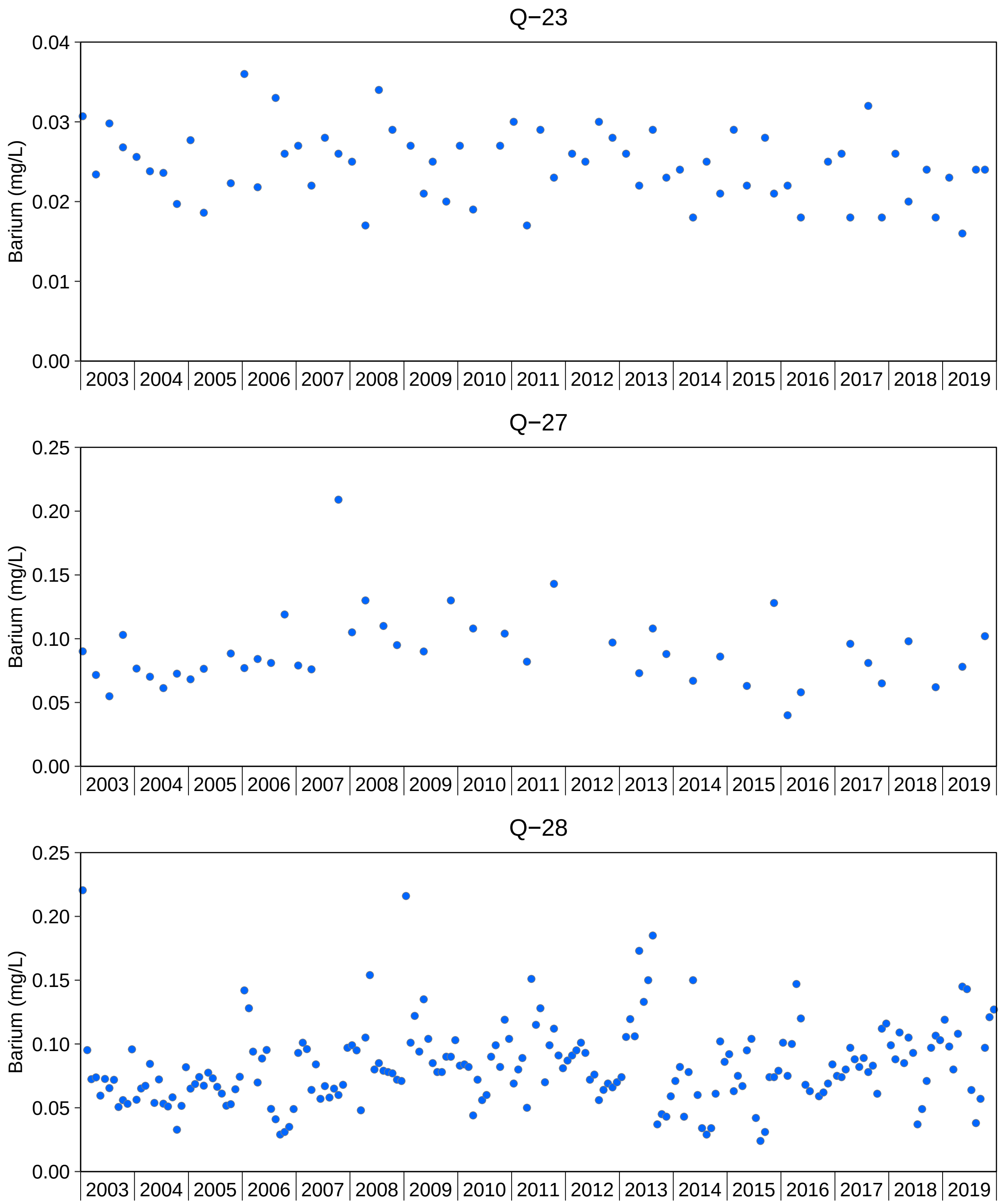

Figure N.1: Concentrations of Barium for SAMP Water Quality Monitoring Stations in Denison, Quirke, Panel, and Stanrock TMAs, 2003 to 2019

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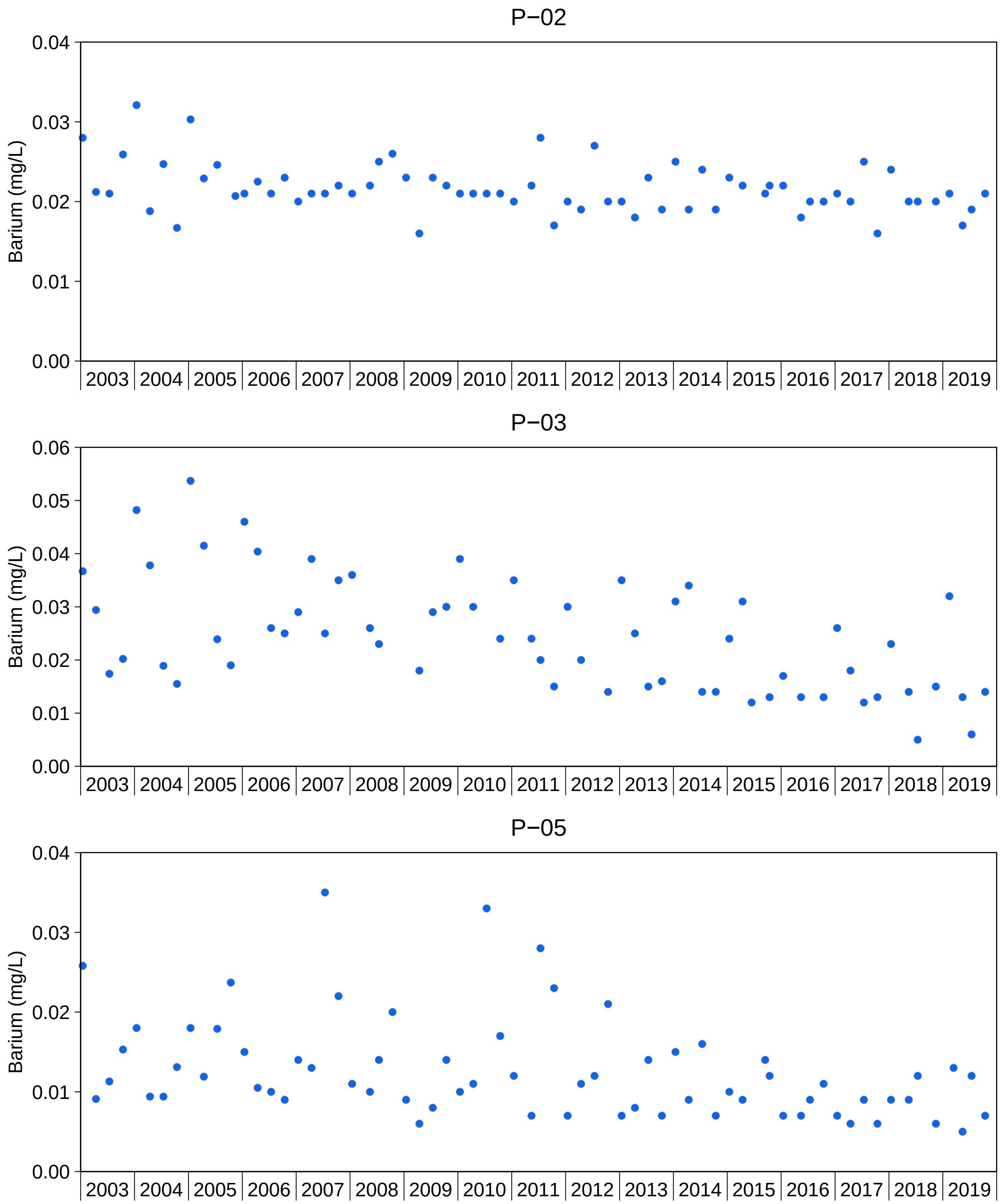


Figure N.1: Concentrations of Barium for SAMP Water Quality Monitoring Stations in Denison, Quirke, Panel, and Stanrock TMAs, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Tables N.2 to N.15 and M.3 for raw data.

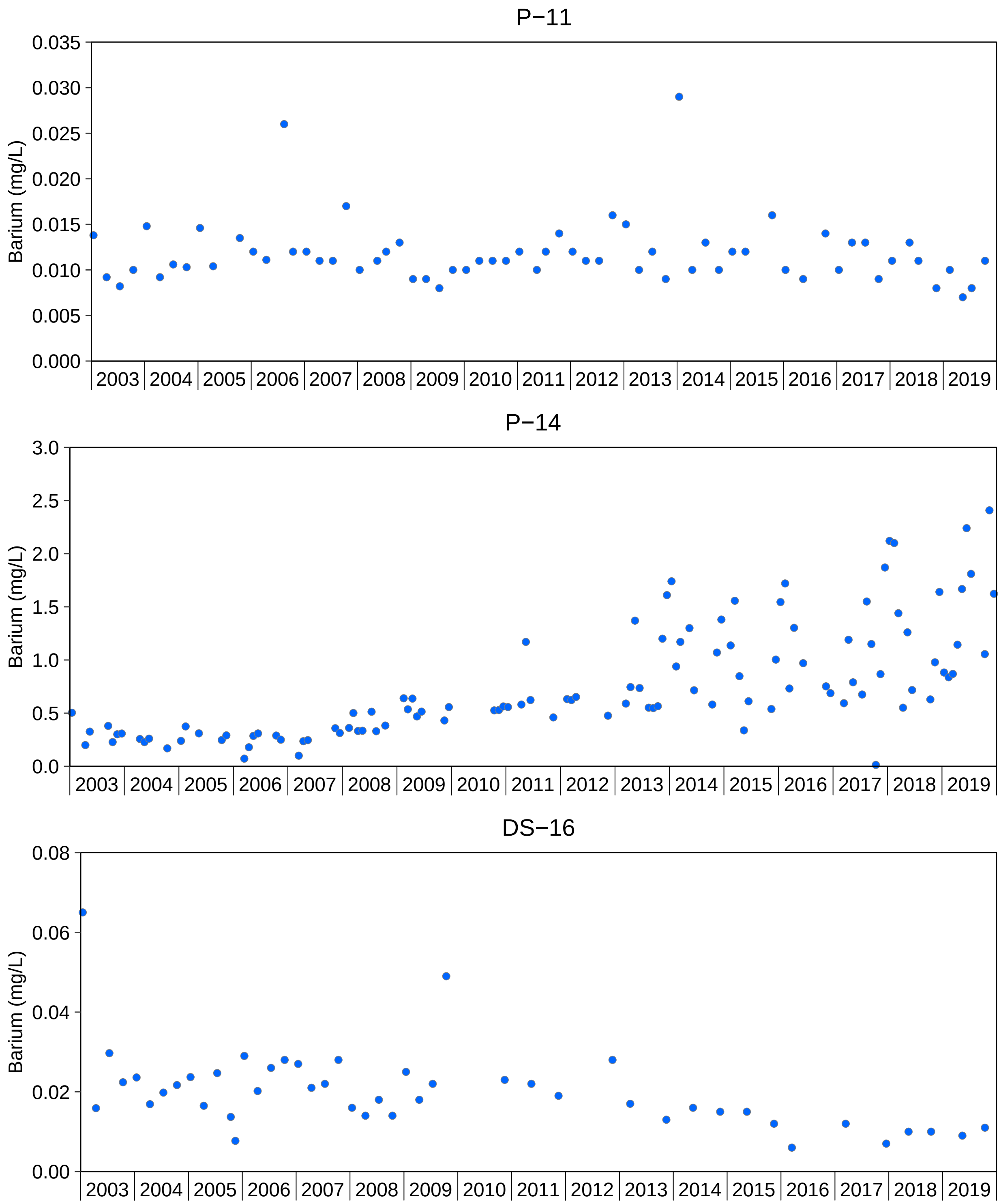


Figure N.1: Concentrations of Barium for SAMP Water Quality Monitoring Stations in Denison, Quirke, Panel, and Stanrock TMAs, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Tables N.2 to N.15 and M.3 for raw data.

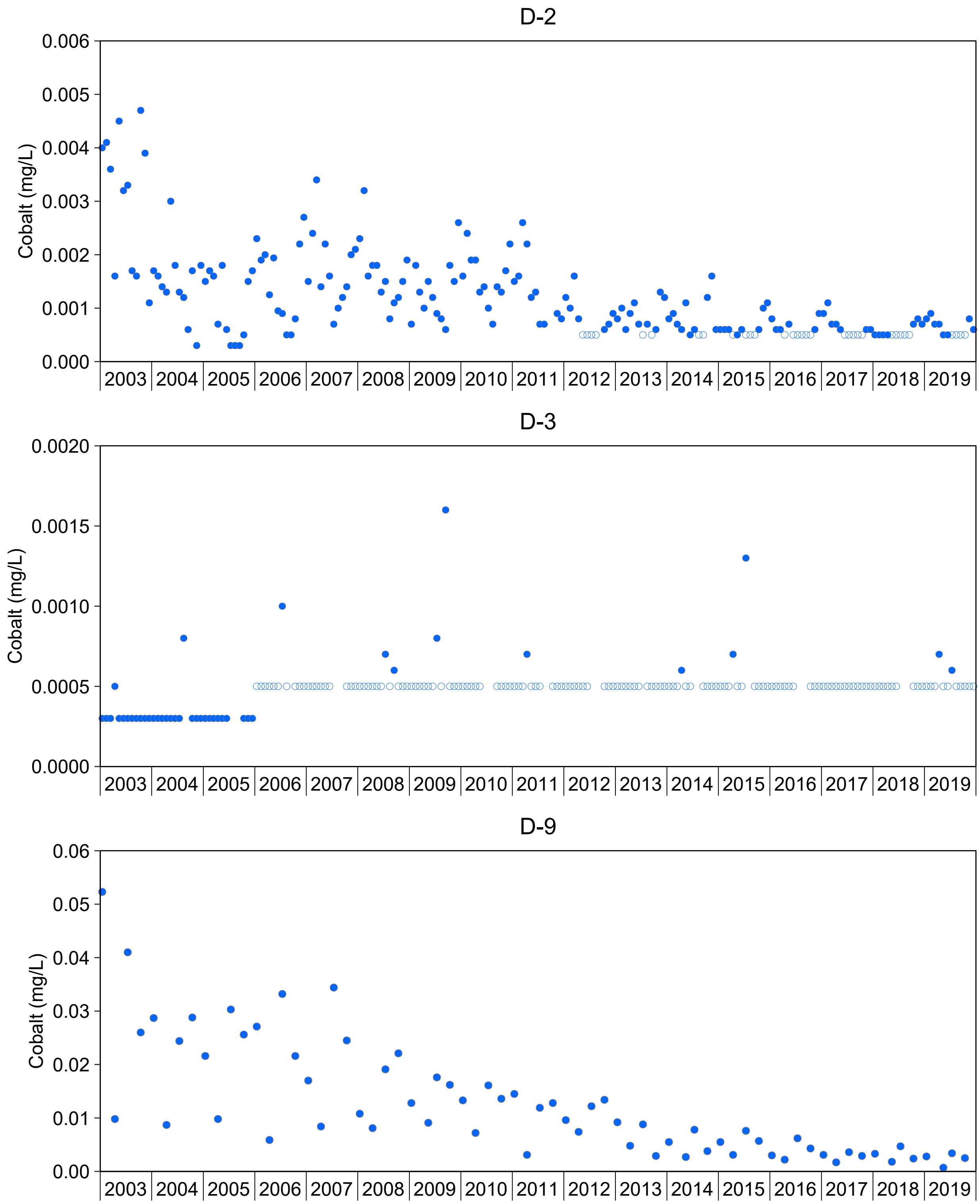


Figure N.2: Concentrations of Cobalt for SAMP Water Quality Monitoring Stations in Denison, Quirke, Panel, and Stanrock TMAs, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Cobalt (mg/L) is not included in the trend analysis for SAMP stations D-3, P-03, P-11, and P-14 due to >50% non-detectable concentrations in the dataset. See Appendix Tables N.2 to N.15 and M.3 for raw data.

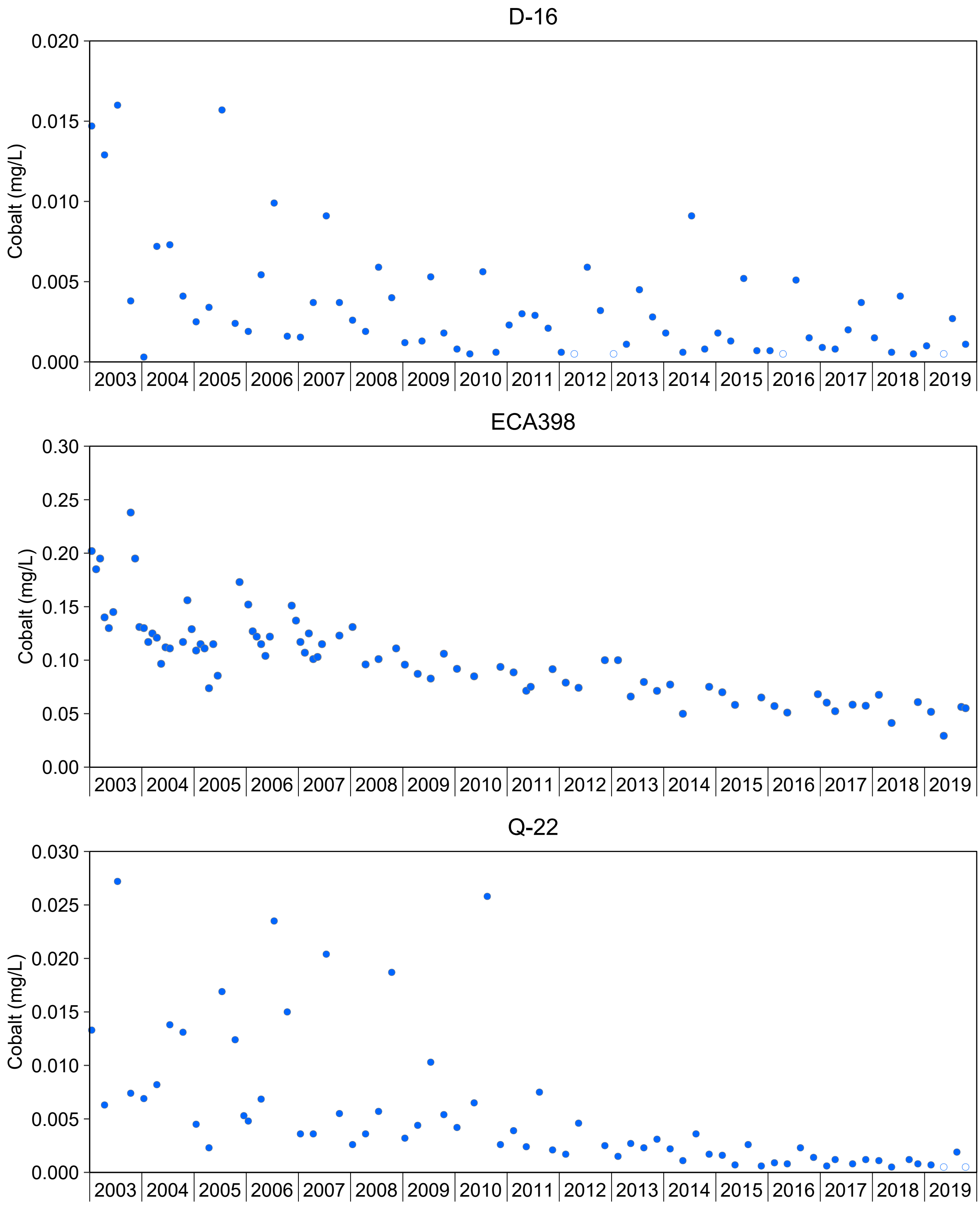


Figure N.2: Concentrations of Cobalt for SAMP Water Quality Monitoring Stations in Denison, Quirke, Panel, and Stanrock TMAs, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Cobalt (mg/L) is not included in the trend analysis for SAMP stations D-3, P-03, P-11, and P-14 due to >50% non-detectable concentrations in the dataset. See Appendix Tables N.2 to N.15 and M.3 for raw data.

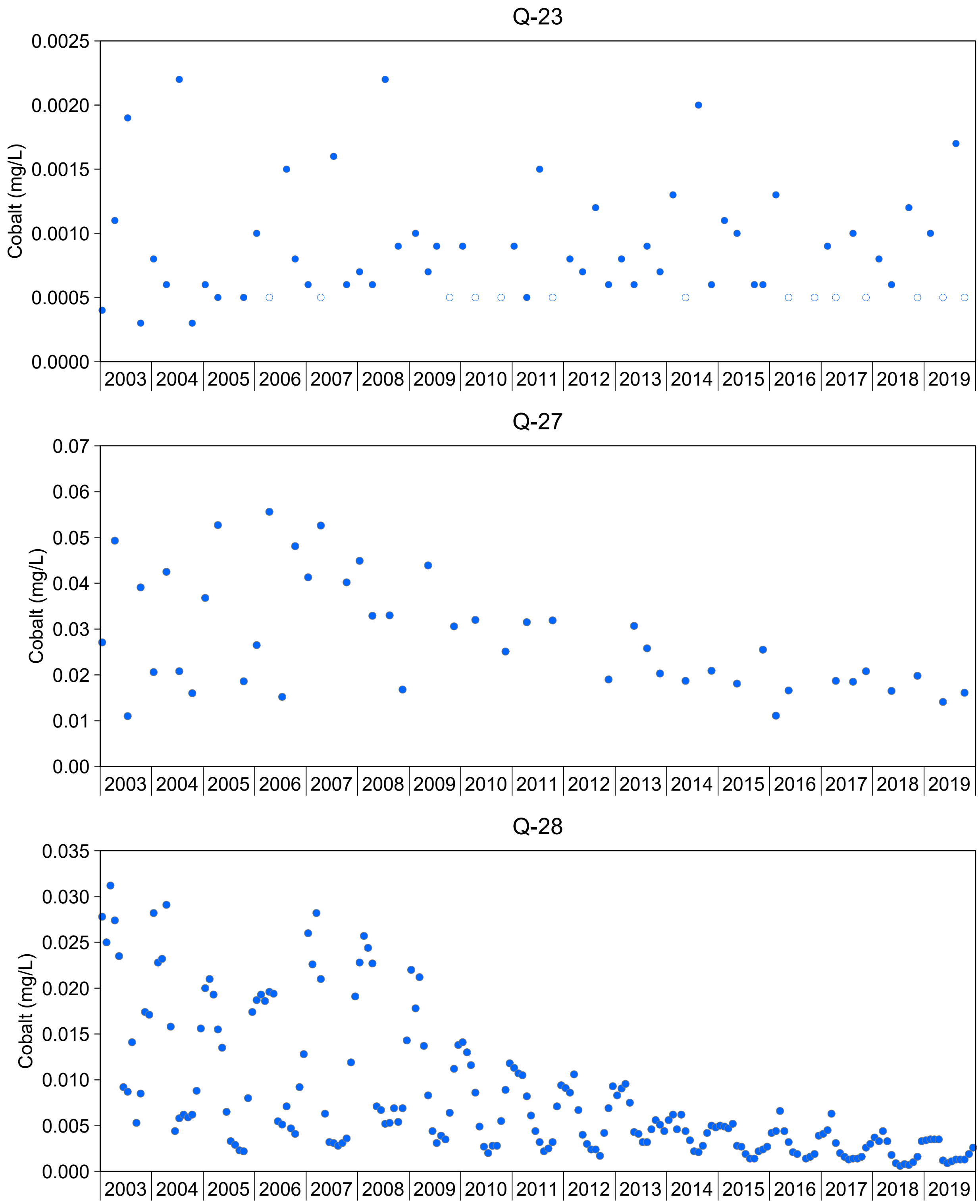


Figure N.2: Concentrations of Cobalt for SAMP Water Quality Monitoring Stations in Denison, Quirke, Panel, and Stanrock TMAs, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Cobalt (mg/L) is not included in the trend analysis for SAMP stations D-3, P-03, P-11, and P-14 due to >50% non-detectable concentrations in the dataset. See Appendix Tables N.2 to N.15 and M.3 for raw data.

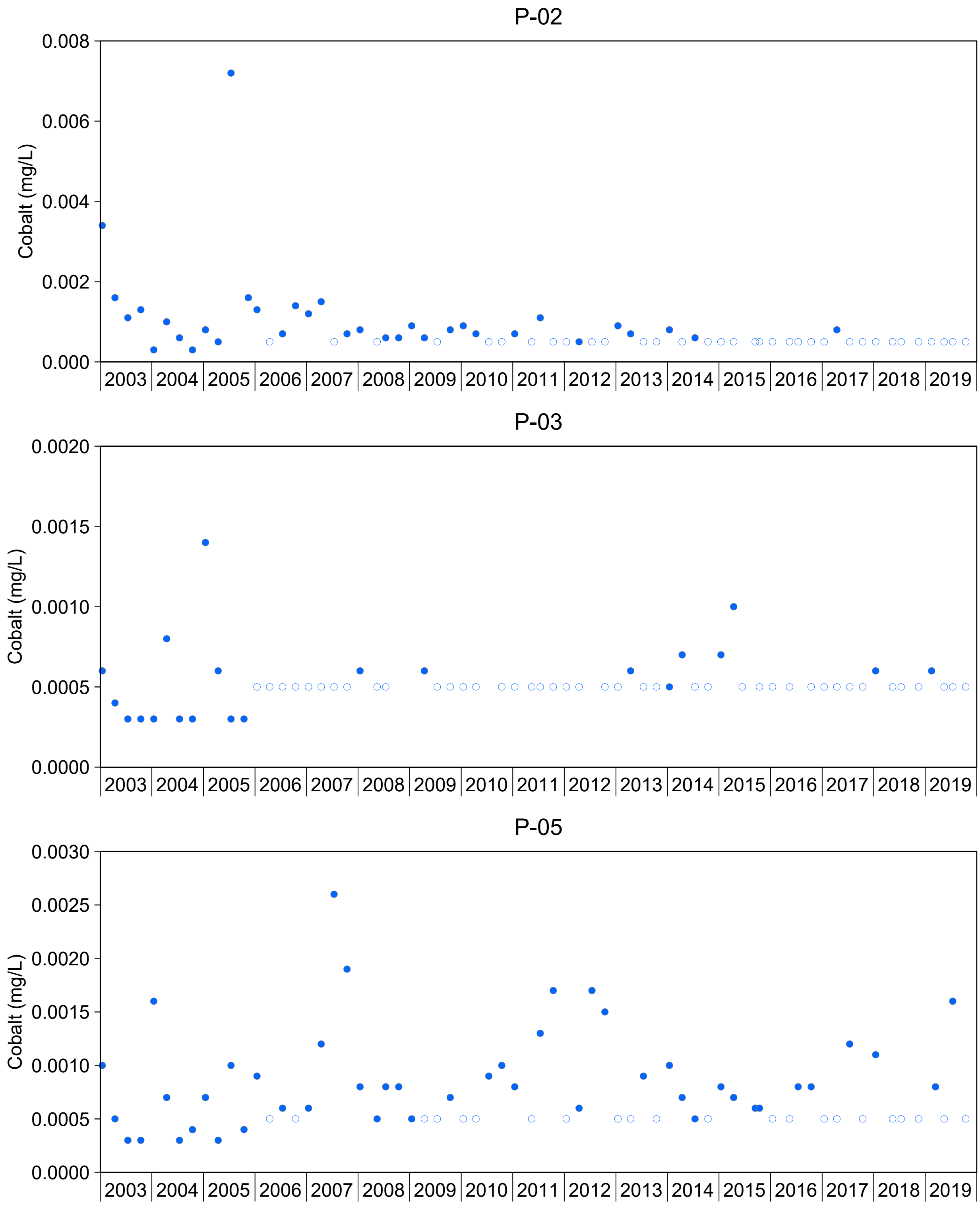


Figure N.2: Concentrations of Cobalt for SAMP Water Quality Monitoring Stations in Denison, Quirke, Panel, and Stanrock TMAs, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Cobalt (mg/L) is not included in the trend analysis for SAMP stations D-3, P-03, P-11, and P-14 due to >50% non-detectable concentrations in the dataset. See Appendix Tables N.2 to N.15 and M.3 for raw data.

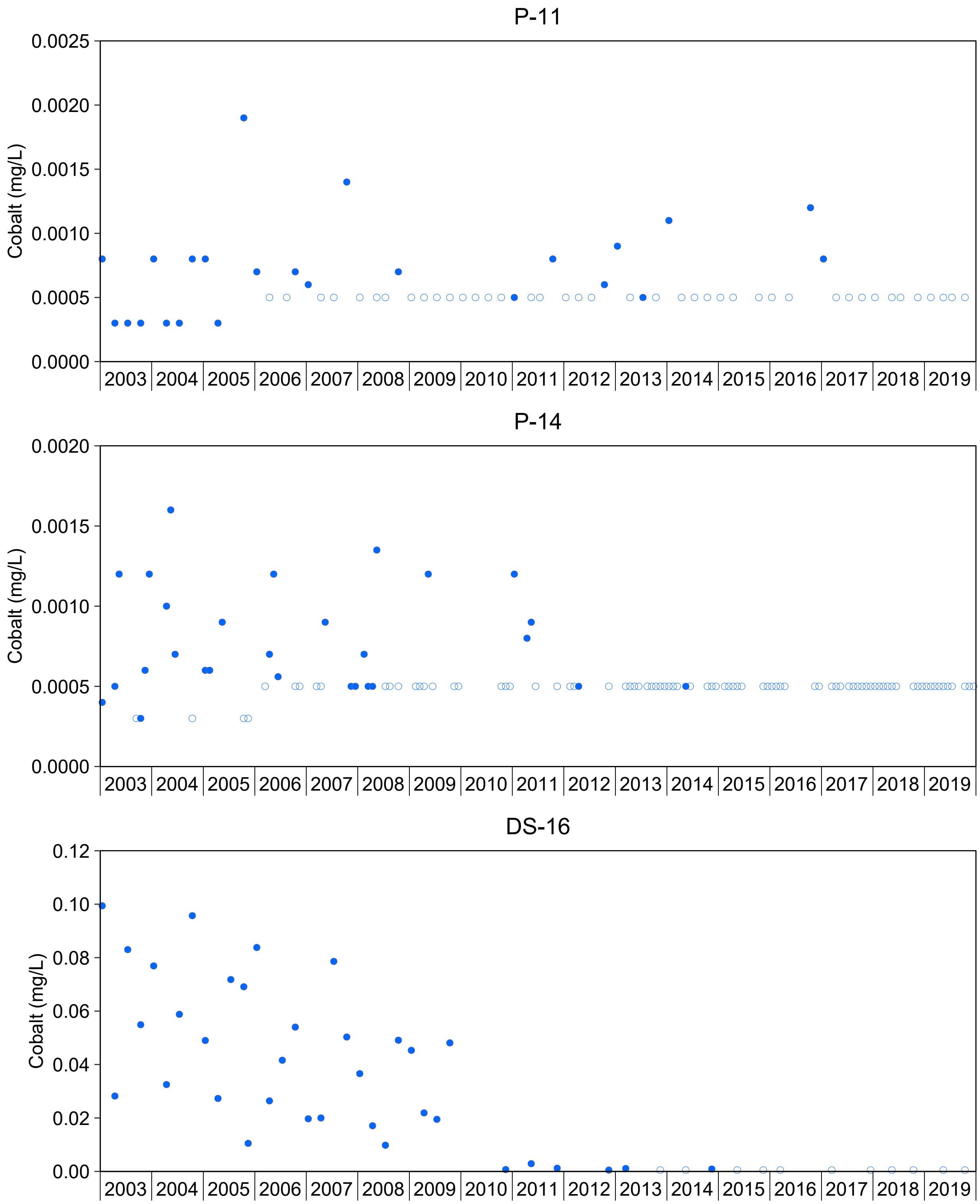


Figure N.2: Concentrations of Cobalt for SAMP Water Quality Monitoring Stations in Denison, Quirke, Panel, and Stanrock TMAs, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Cobalt (mg/L) is not included in the trend analysis for SAMP stations D-3, P-03, P-11, and P-14 due to >50% non-detectable concentrations in the dataset. See Appendix Tables N.2 to N.15 and M.3 for raw data.

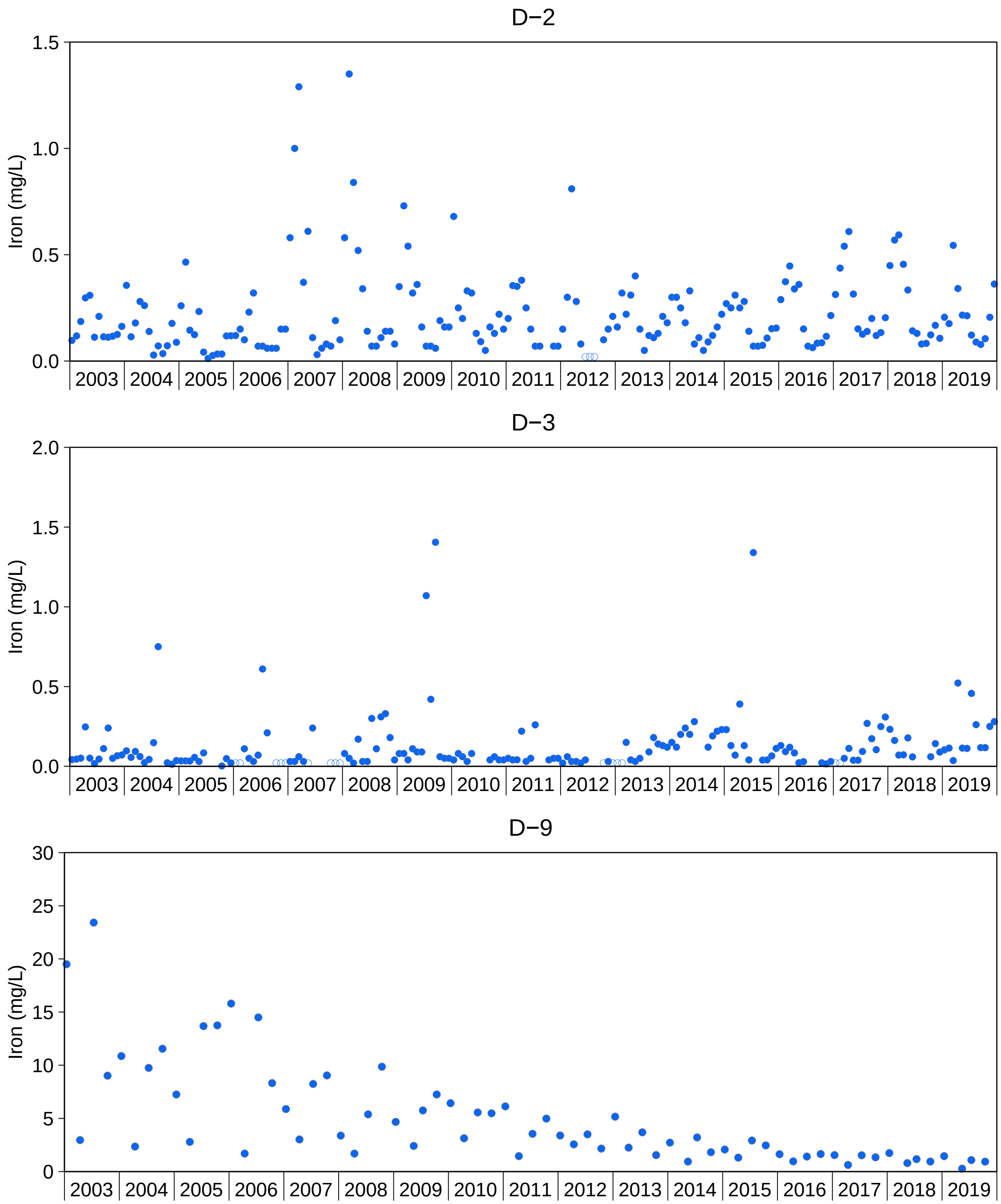


Figure N.3: Concentrations of Iron for SAMP Water Quality Monitoring Stations in Denison, Quirke, Panel, and Stanrock TMAs, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Tables N.2 to N.15 and M.3 for raw data.

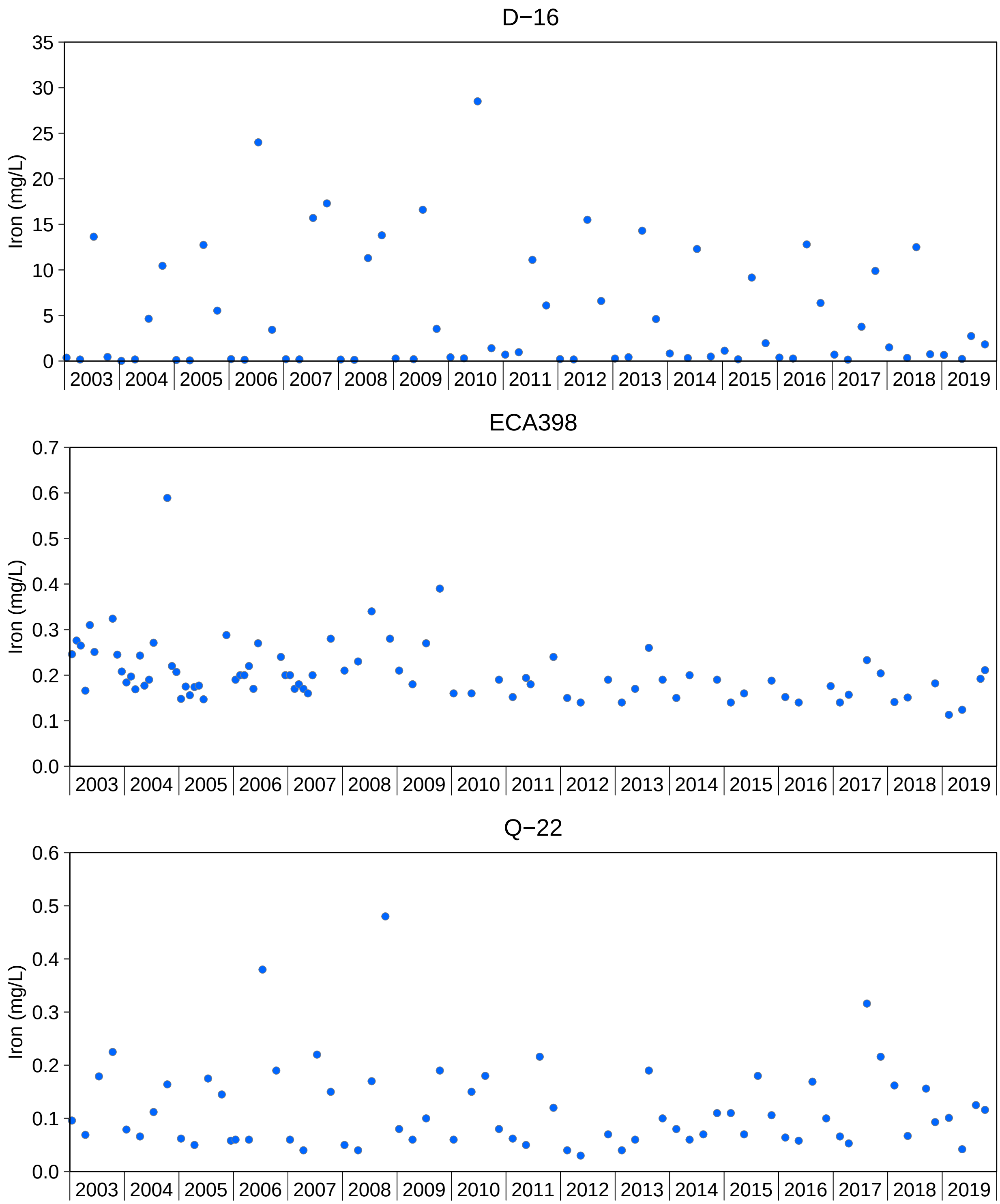


Figure N.3: Concentrations of Iron for SAMP Water Quality Monitoring Stations in Denison, Quirke, Panel, and Stanrock TMAs, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Tables N.2 to N.15 and M.3 for raw data.

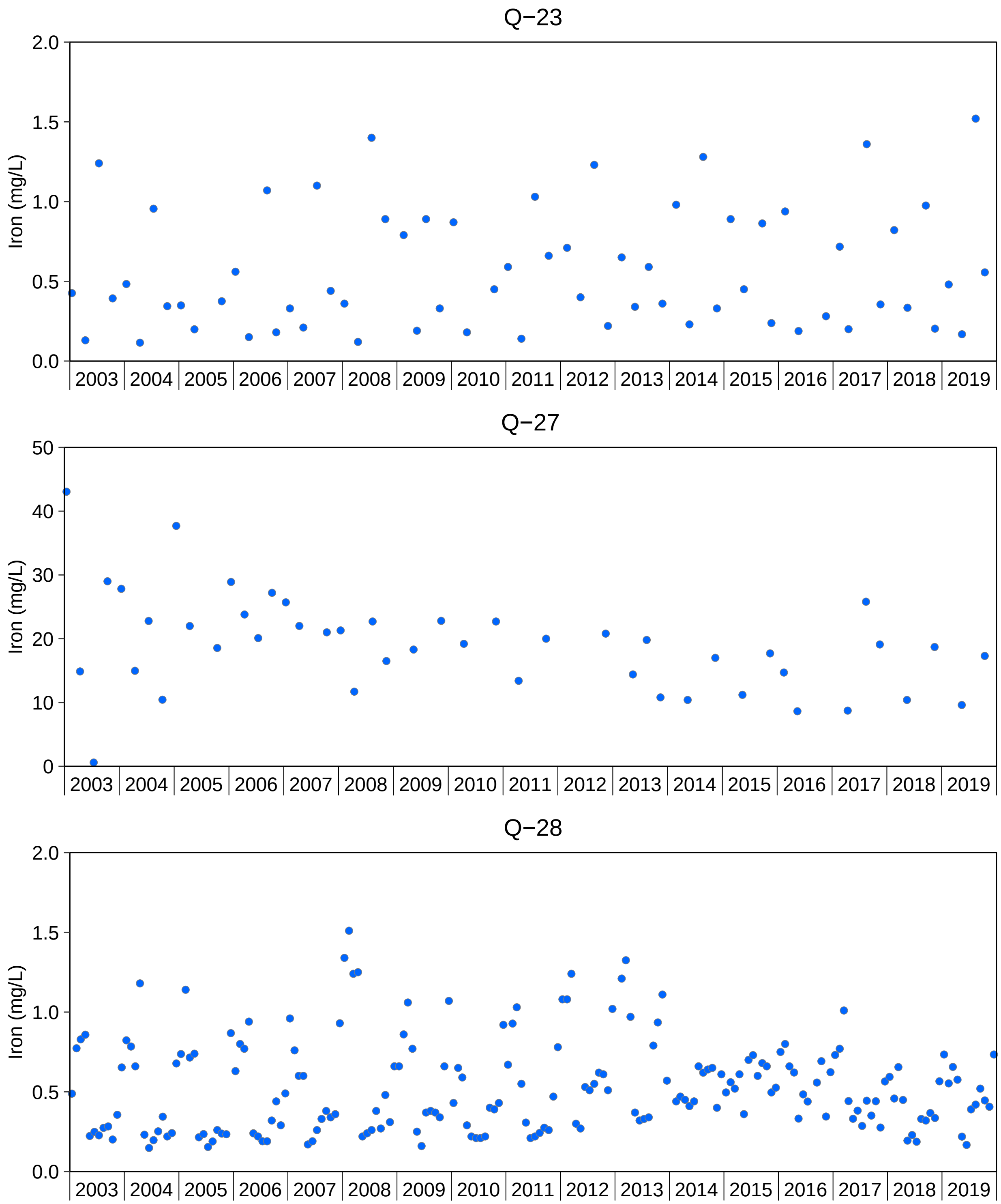


Figure N.3: Concentrations of Iron for SAMP Water Quality Monitoring Stations in Denison, Quirke, Panel, and Stanrock TMAs, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Tables N.2 to N.15 and M.3 for raw data.

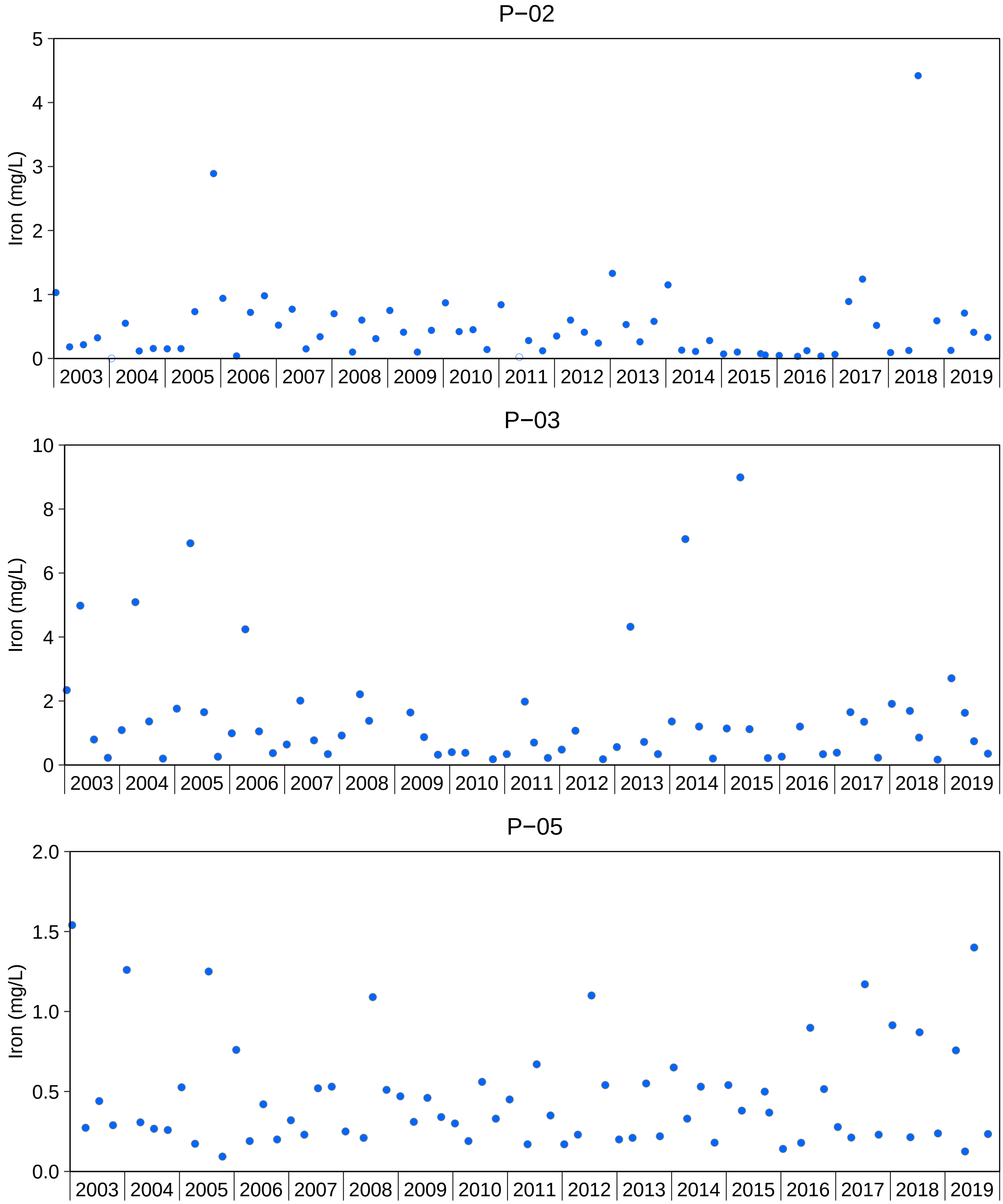


Figure N.3: Concentrations of Iron for SAMP Water Quality Monitoring Stations in Denison, Quirke, Panel, and Stanrock TMAs, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Tables N.2 to N.15 and M.3 for raw data.

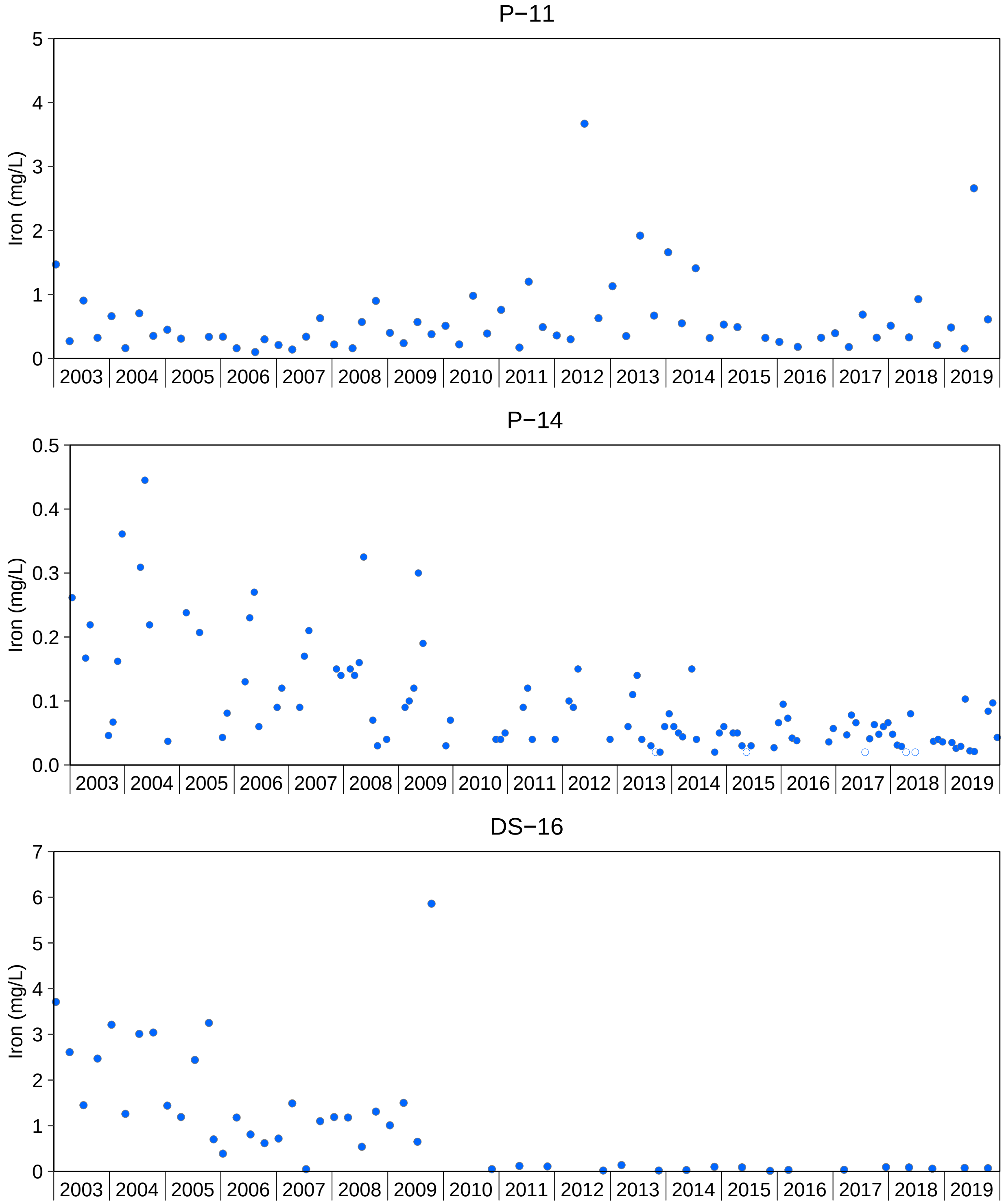


Figure N.3: Concentrations of Iron for SAMP Water Quality Monitoring Stations in Denison, Quirke, Panel, and Stanrock TMAs, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Tables N.2 to N.15 and M.3 for raw data.

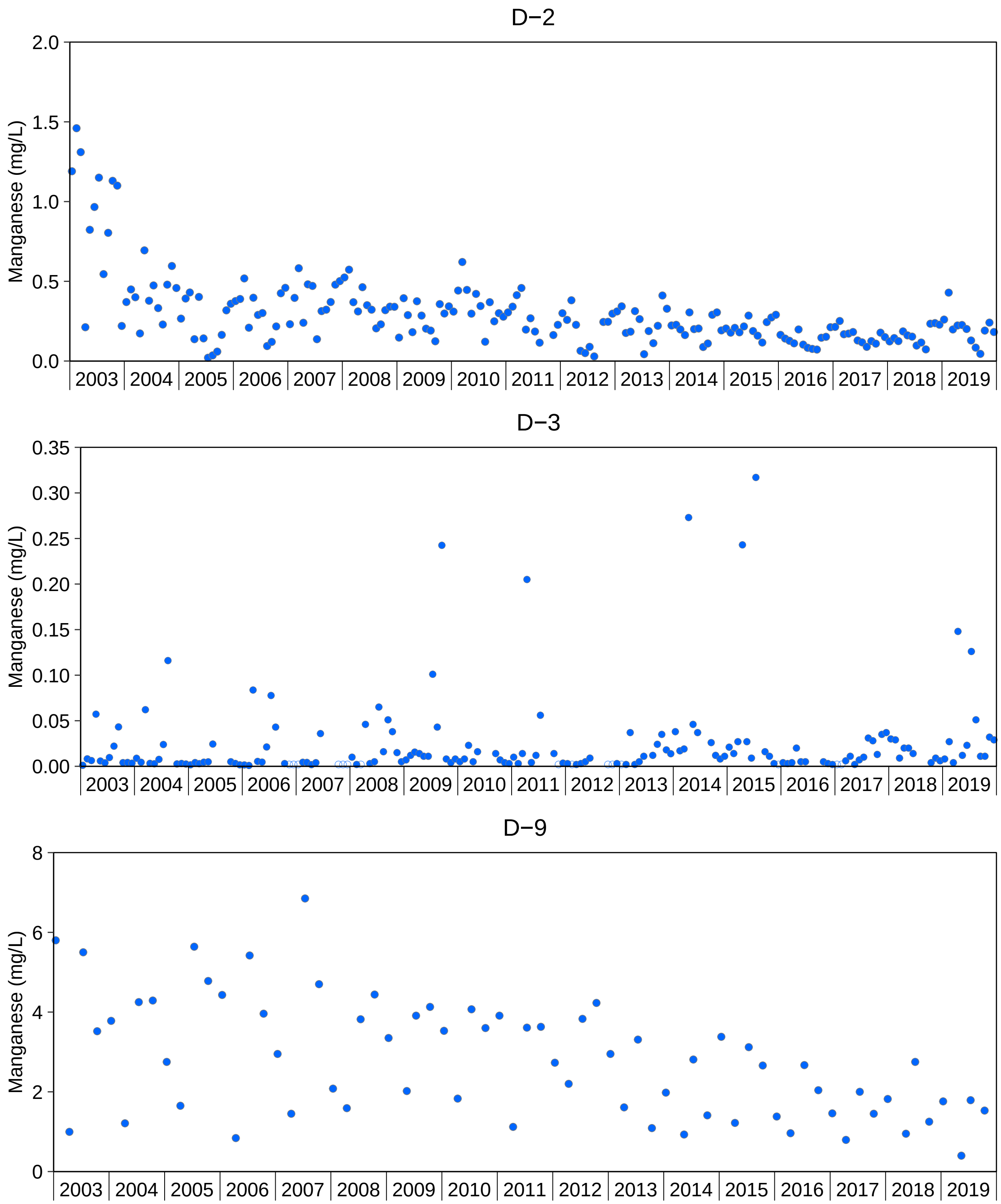


Figure N.4: Concentrations of Manganese for SAMP Water Quality Monitoring Stations in Denison, Quirke, Panel, and Stanrock TMAs, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Tables N.2 to N.15 and M.3 for raw data.

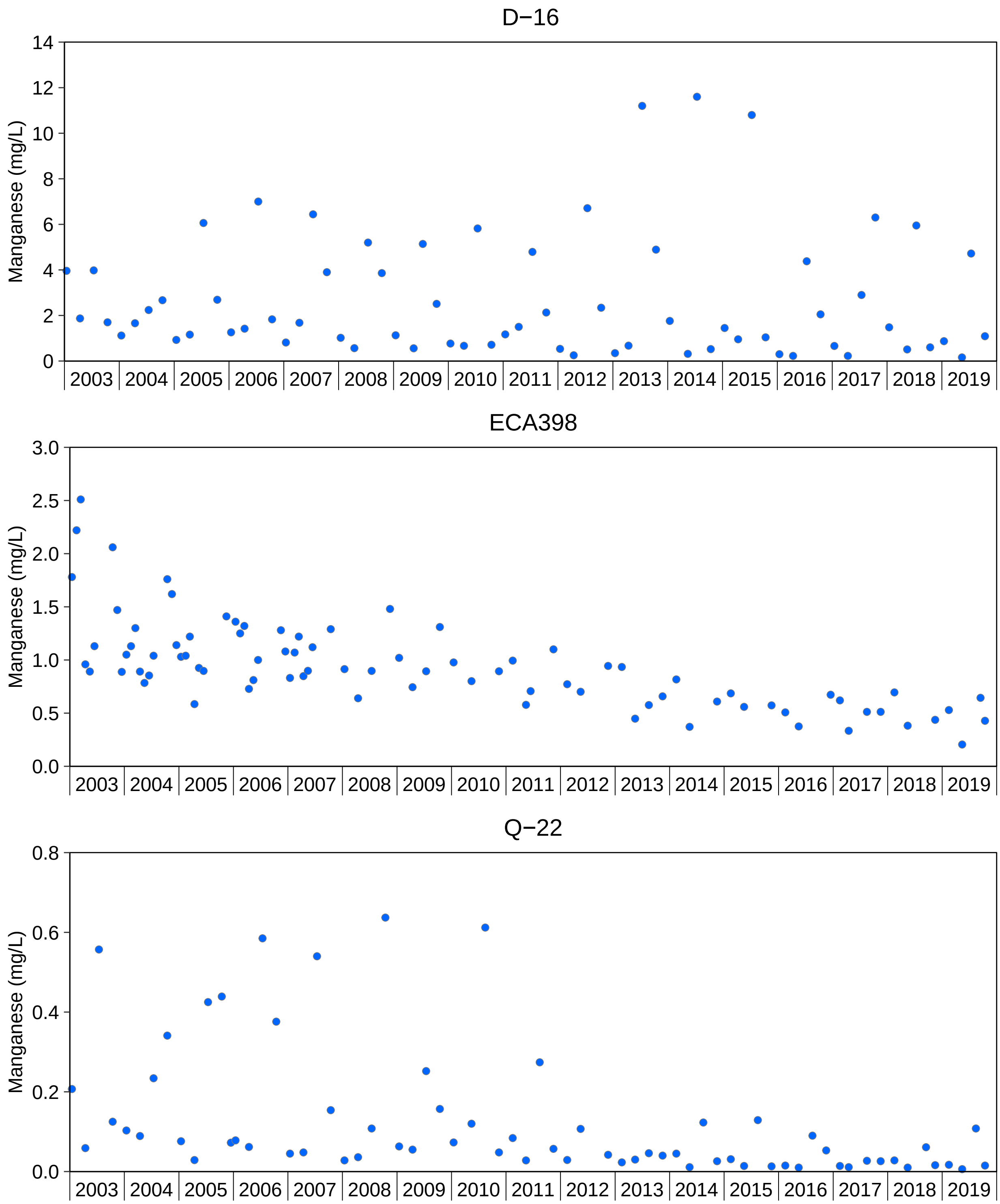


Figure N.4: Concentrations of Manganese for SAMP Water Quality Monitoring Stations in Denison, Quirke, Panel, and Stanrock TMAs, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Tables N.2 to N.15 and M.3 for raw data.

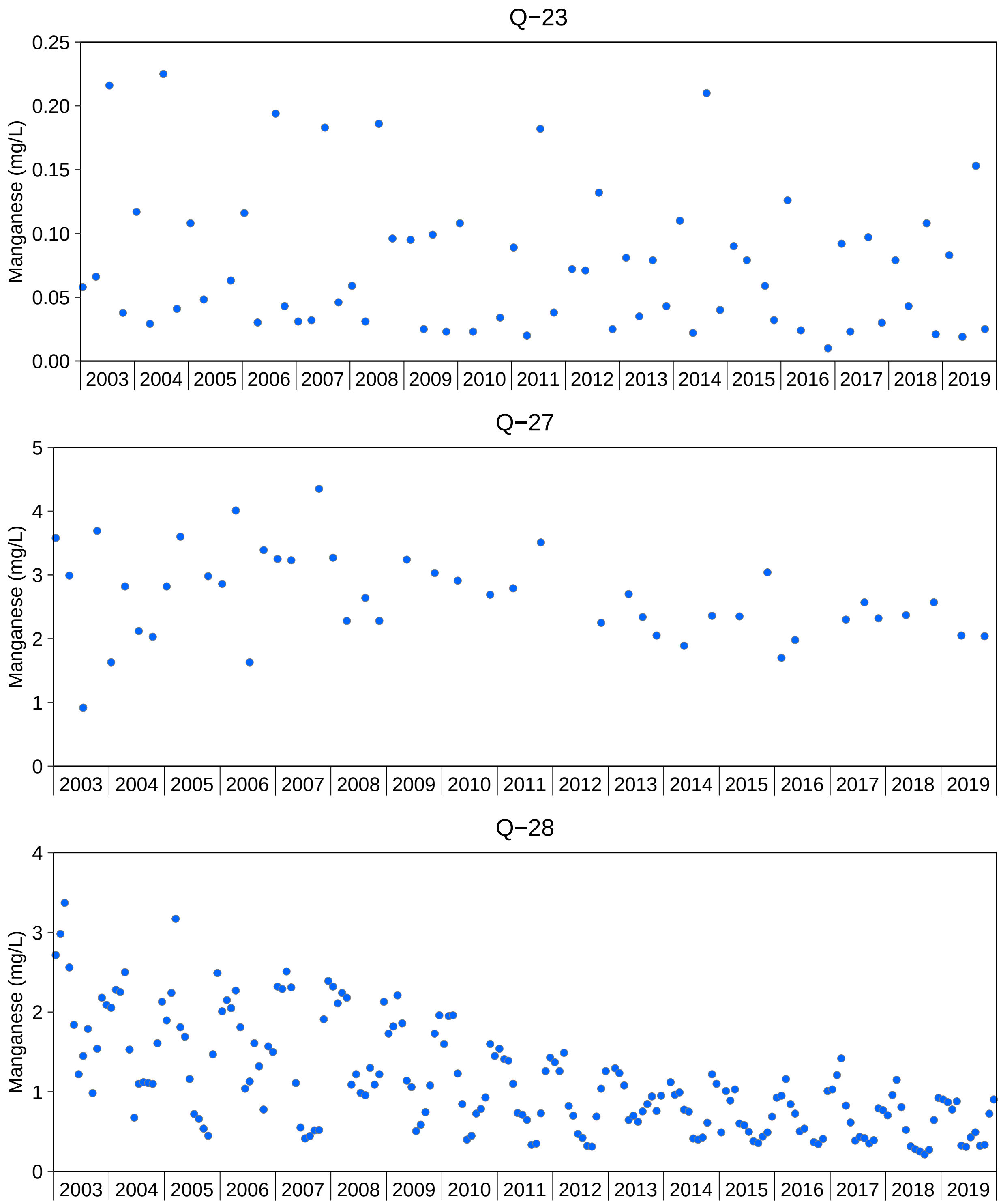


Figure N.4: Concentrations of Manganese for SAMP Water Quality Monitoring Stations in Denison, Quirke, Panel, and Stanrock TMAs, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Tables N.2 to N.15 and M.3 for raw data.

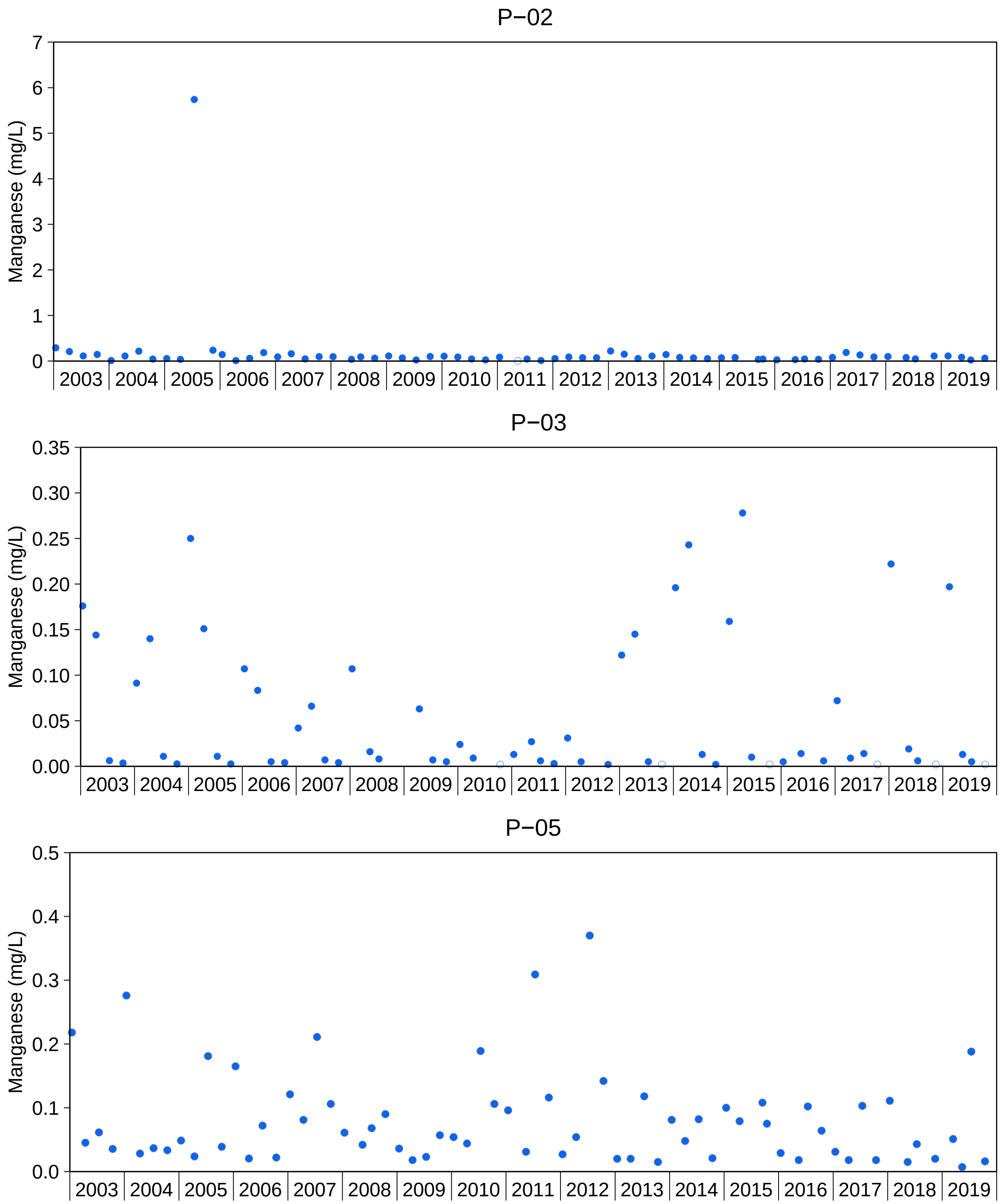


Figure N.4: Concentrations of Manganese for SAMP Water Quality Monitoring Stations in Denison, Quirke, Panel, and Stanrock TMAs, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Tables N.2 to N.15 and M.3 for raw data.

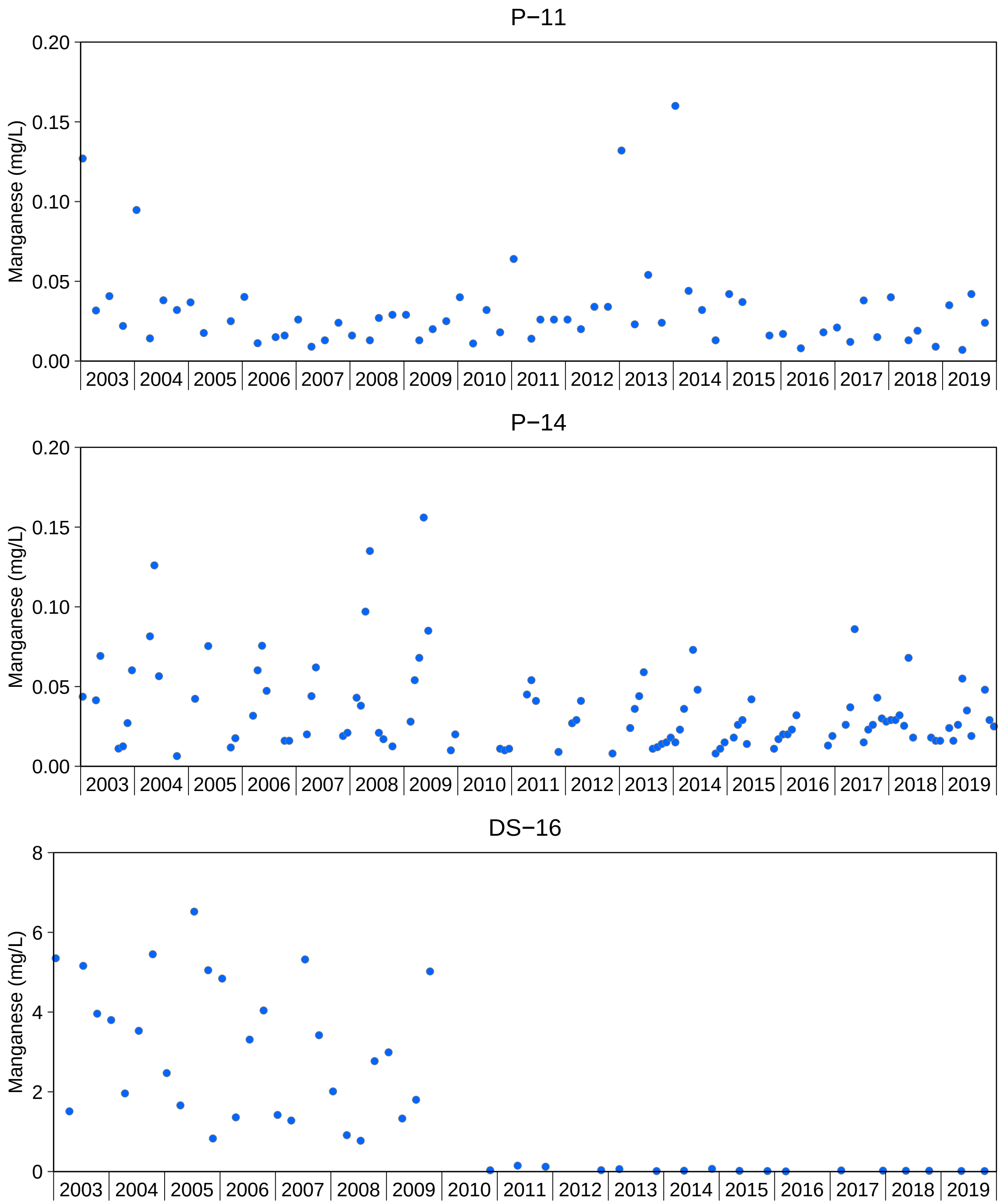


Figure N.4: Concentrations of Manganese for SAMP Water Quality Monitoring Stations in Denison, Quirke, Panel, and Stanrock TMAs, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Tables N.2 to N.15 and M.3 for raw data.

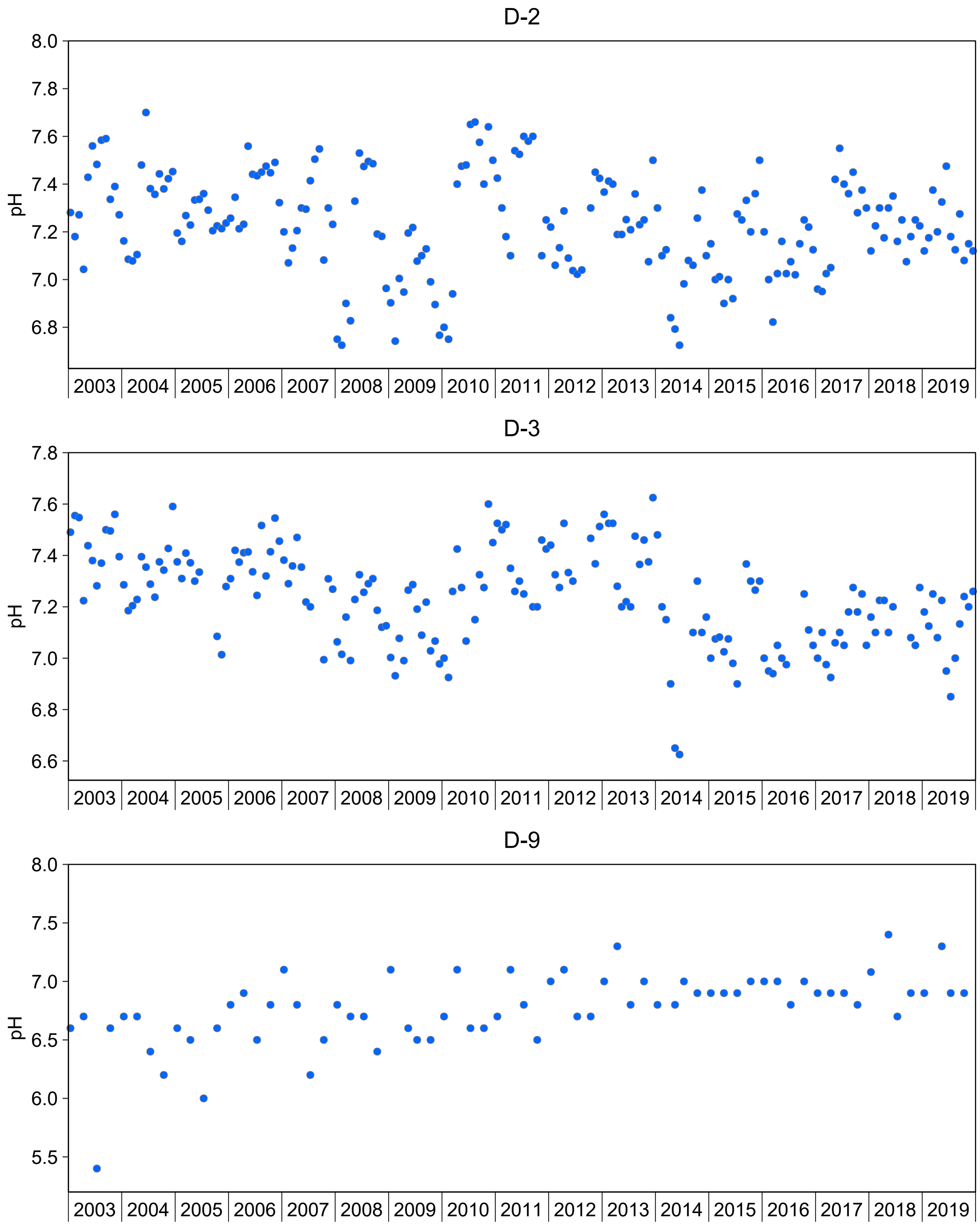


Figure N.5: Field Measurements of pH for SAMP Water Quality Monitoring Stations in Denison, Quirke, Panel, and Stanrock TMAs, 2003 to 2019

Notes: See Appendix Tables N.2 to N.15 and M.3 for raw data.

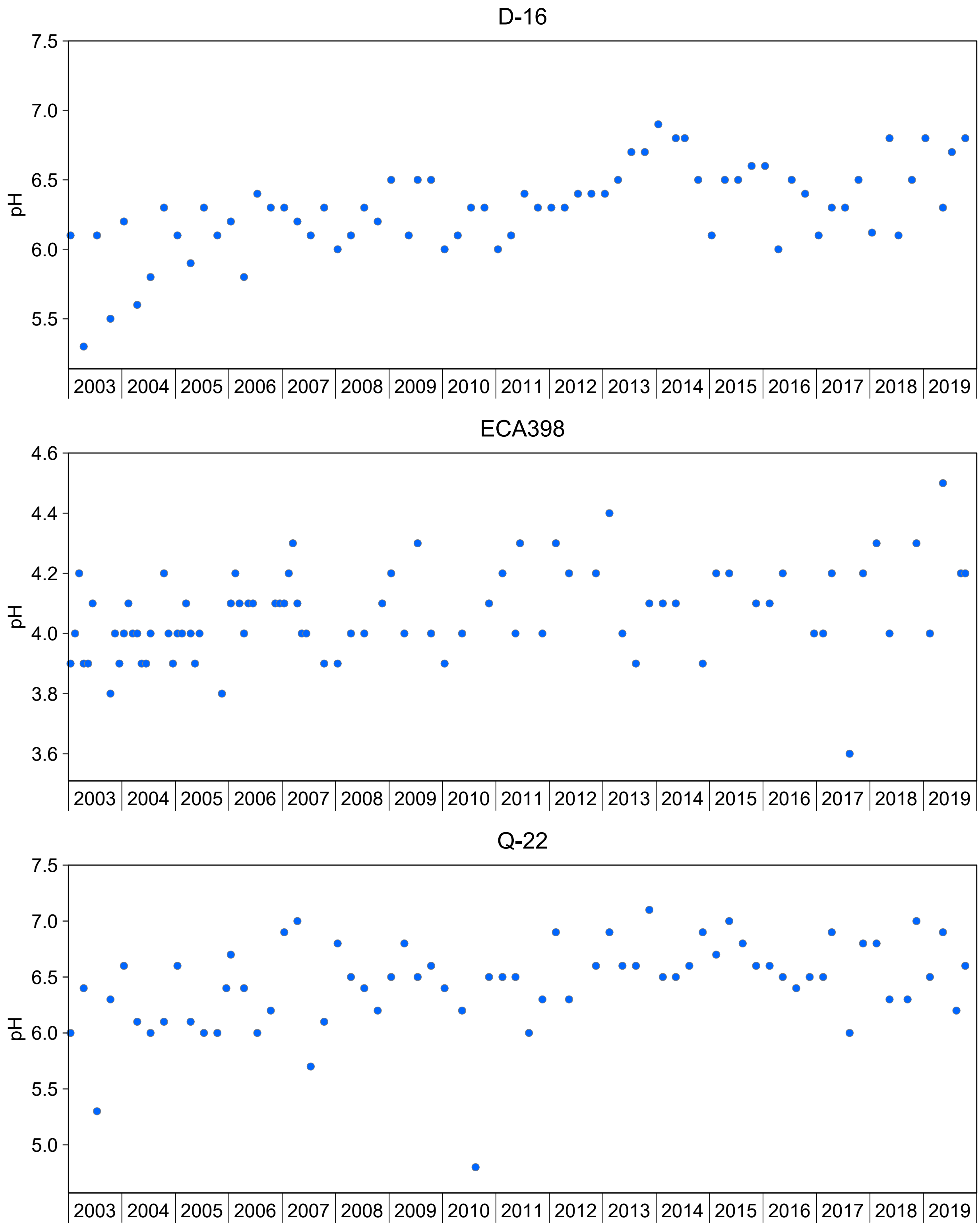


Figure N.5: Field Measurements of pH for SAMP Water Quality Monitoring Stations in Denison, Quirke, Panel, and Stanrock TMAs, 2003 to 2019

Notes: See Appendix Tables N.2 to N.15 and M.3 for raw data.

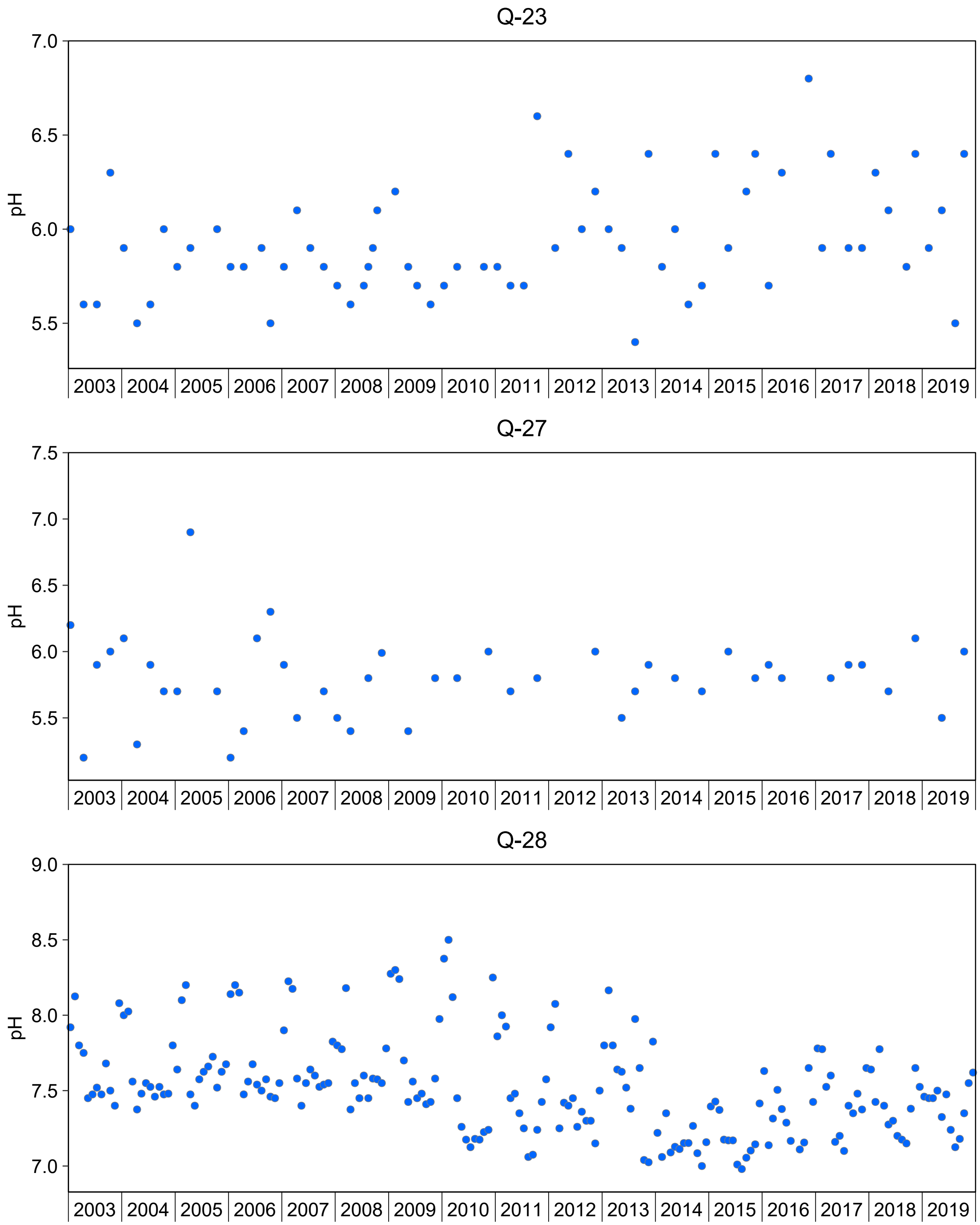


Figure N.5: Field Measurements of pH for SAMP Water Quality Monitoring Stations in Denison, Quirke, Panel, and Stanrock TMAs, 2003 to 2019

Notes: See Appendix Tables N.2 to N.15 and M.3 for raw data.

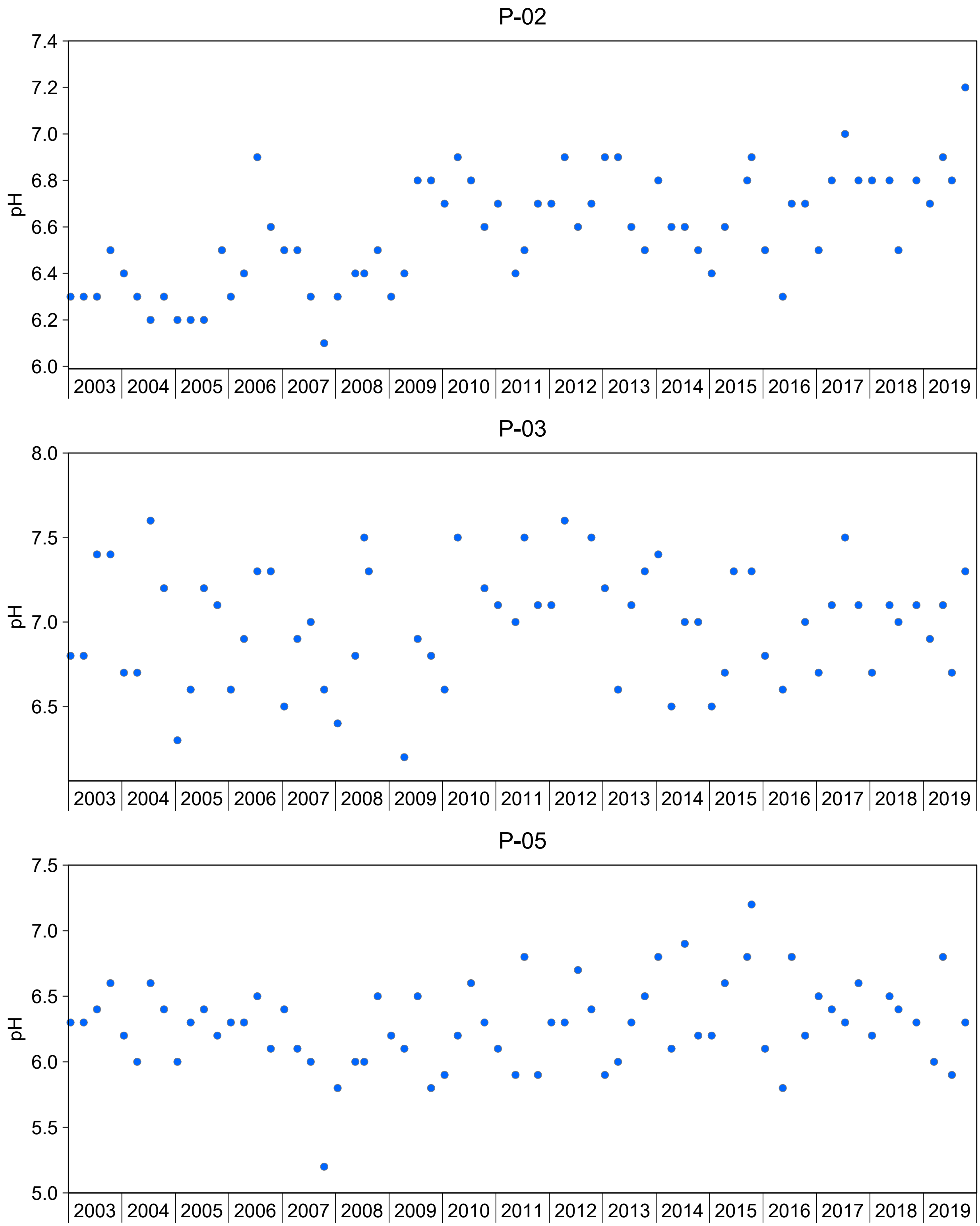


Figure N.5: Field Measurements pH for SAMP Water Quality Monitoring Stations in Denison, Quirke, Panel, and Stanrock TMAs, 2003 to 2019

Notes: See Appendix Tables N.2 to N.15 and M.3 for raw data.

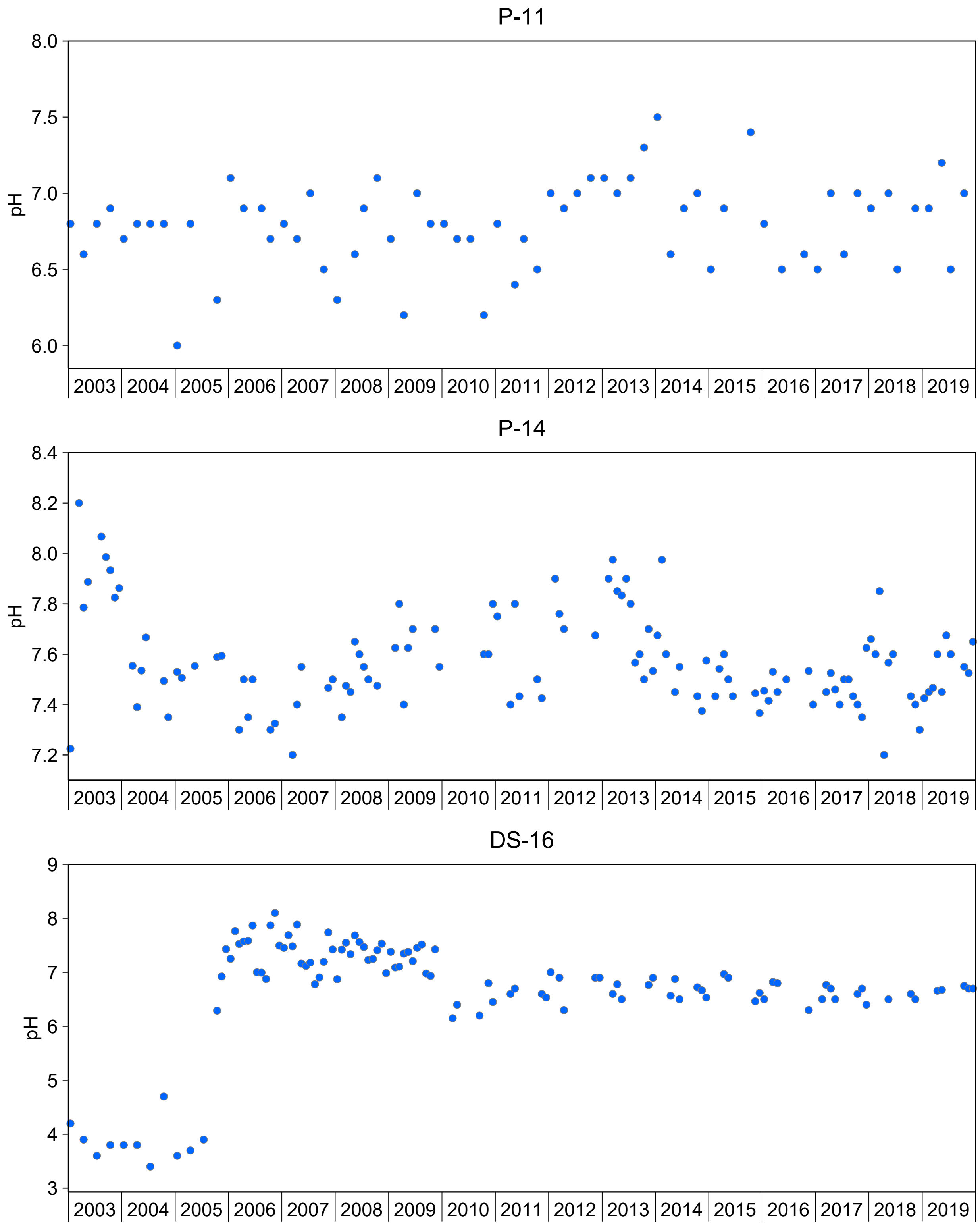


Figure N.5: Field Measurements of pH for SAMP Water Quality Monitoring Stations in Denison, Quirke, Panel, and Stanrock TMAs, 2003 to 2019

Notes: See Appendix Tables N.2 to N.15 and M.3 for raw data.

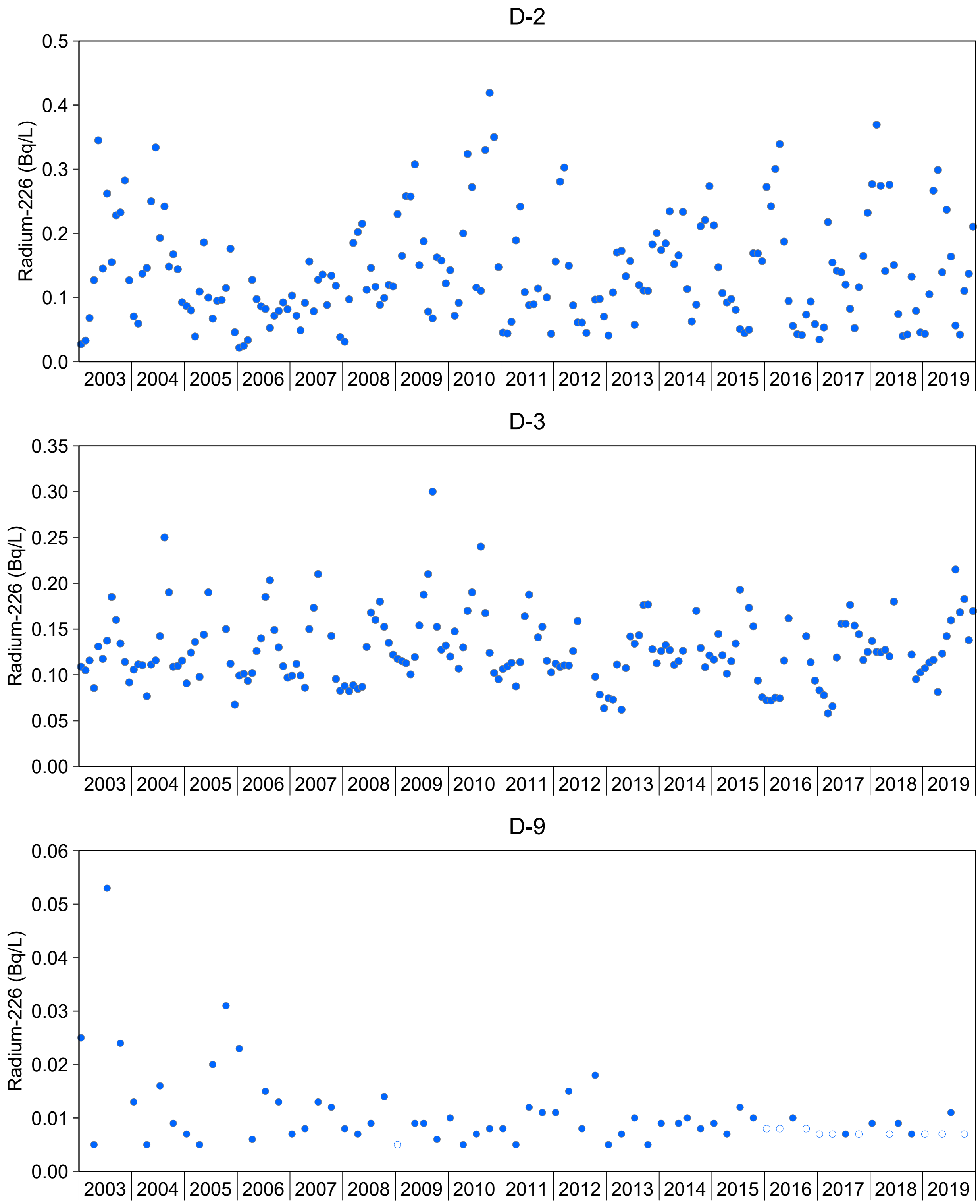


Figure N.6: Concentrations of Radium-226 for SAMP Water Quality Monitoring Stations in Denison, Quirke, Panel, and Stanrock TMAs, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Radium (Bq/L) is not included in the trend analysis for SAMP stations D-16, Q-23, P-03, P-05, and DS-16 due to >50% non-detectable concentrations in the dataset. See Appendix Tables N.2 to N.15 and M.3 for raw data.

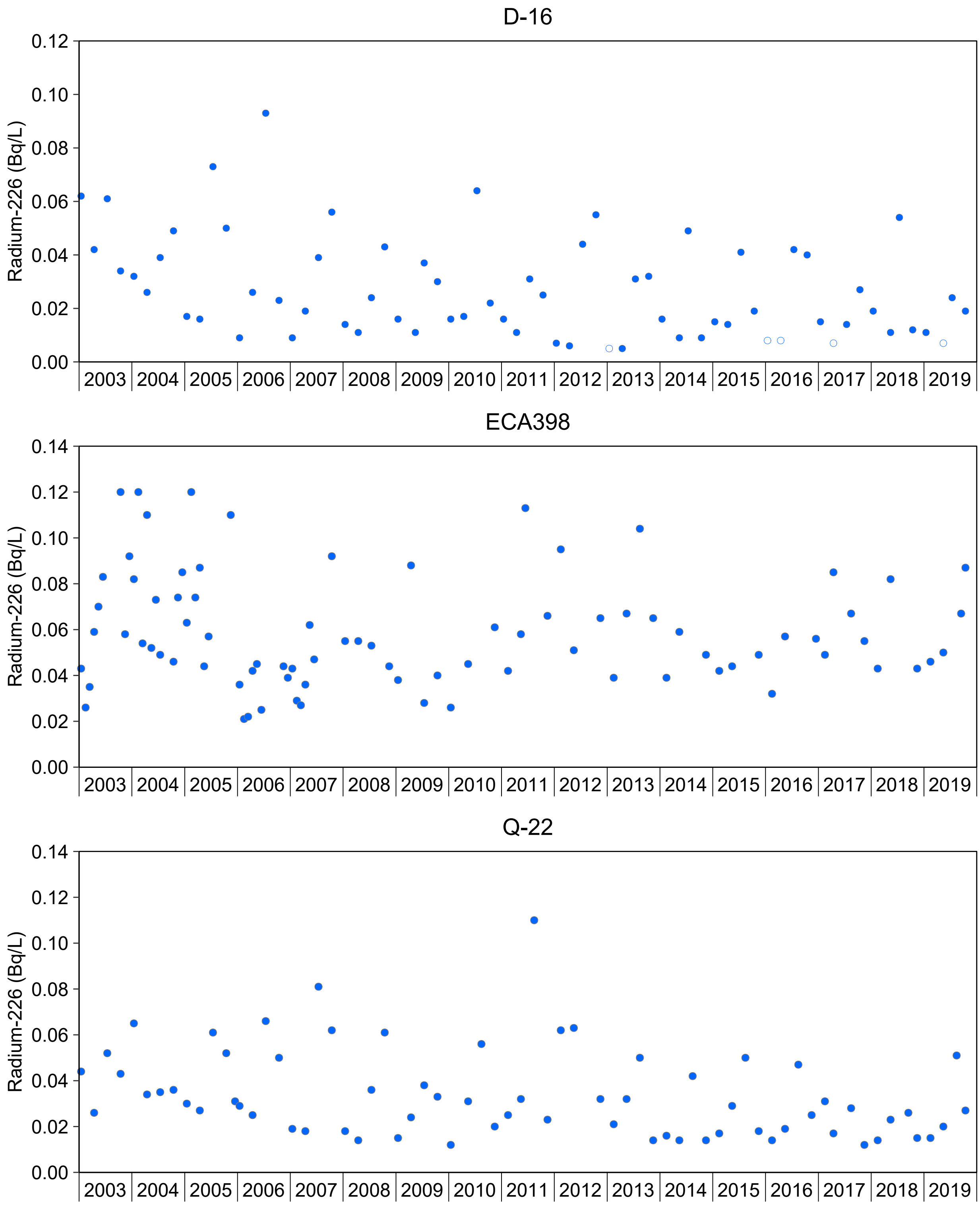
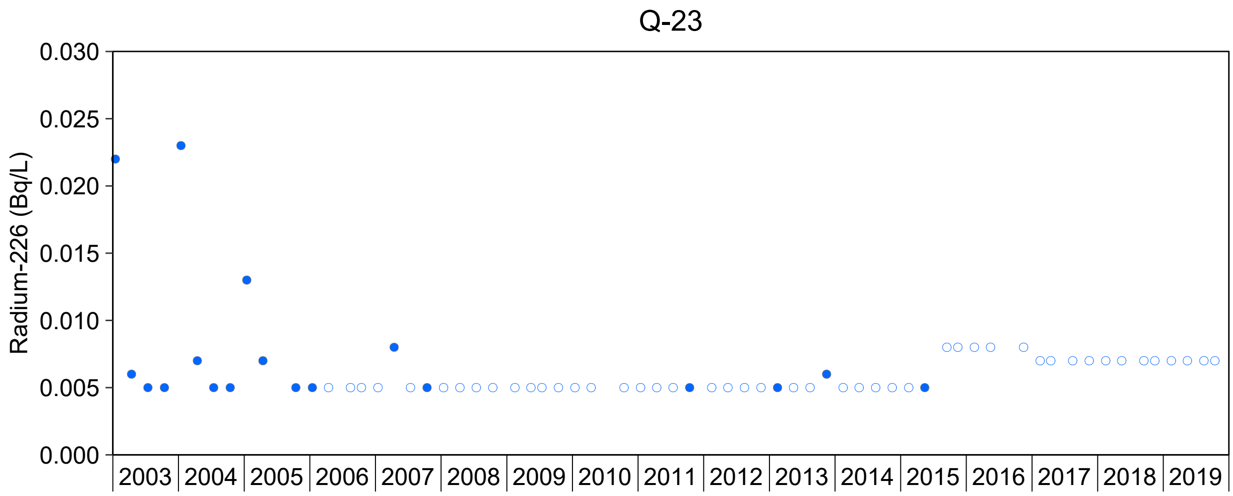
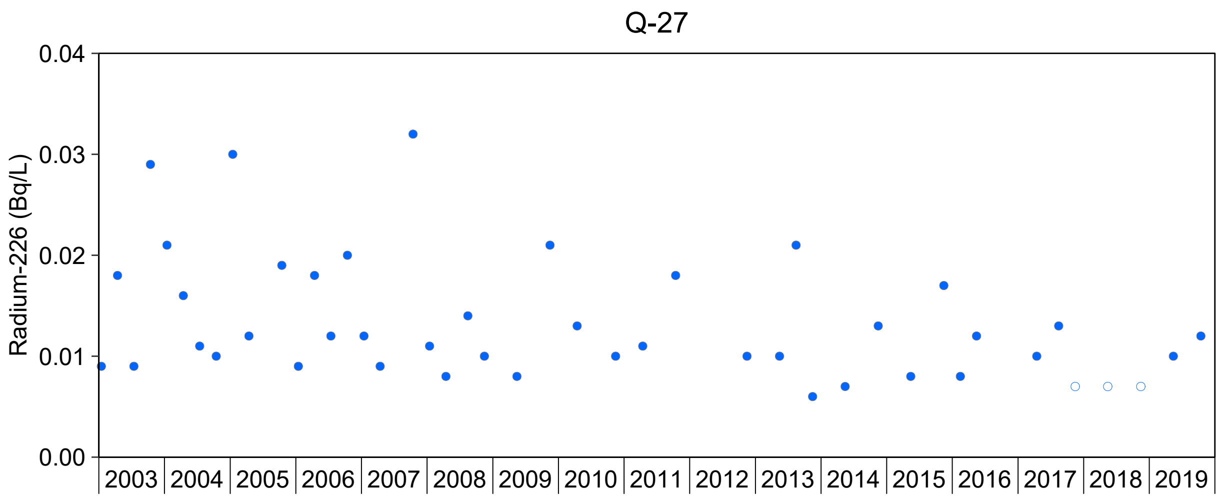


Figure N.6: Concentrations of Radium-226 for SAMP Water Quality Monitoring Stations in Denison, Quirke, Panel, and Stanrock TMAs, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Radium (Bq/L) is not included in the trend analysis for SAMP stations D-16, Q-23, P-03, P-05, and DS-16 due to >50% non-detectable concentrations in the dataset. See Appendix Tables N.2 to N.15 and M.3 for raw data.





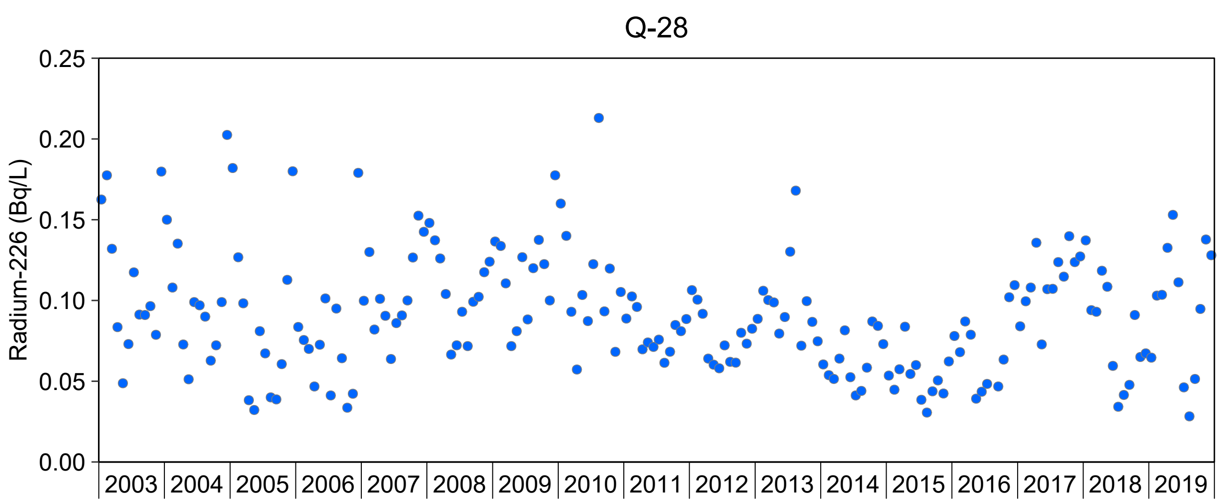


Figure N.6: Concentrations of Radium-226 for SAMP Water Quality Monitoring Stations in Denison, Quirke, Panel, and Stanrock TMAs, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Radium (Bq/L) is not included in the trend analysis for SAMP stations D-16, Q-23, P-03, P-05, and DS-16 due to >50% non-detectable concentrations in the dataset. See Appendix Tables N.2 to N.15 and M.3 for raw data.

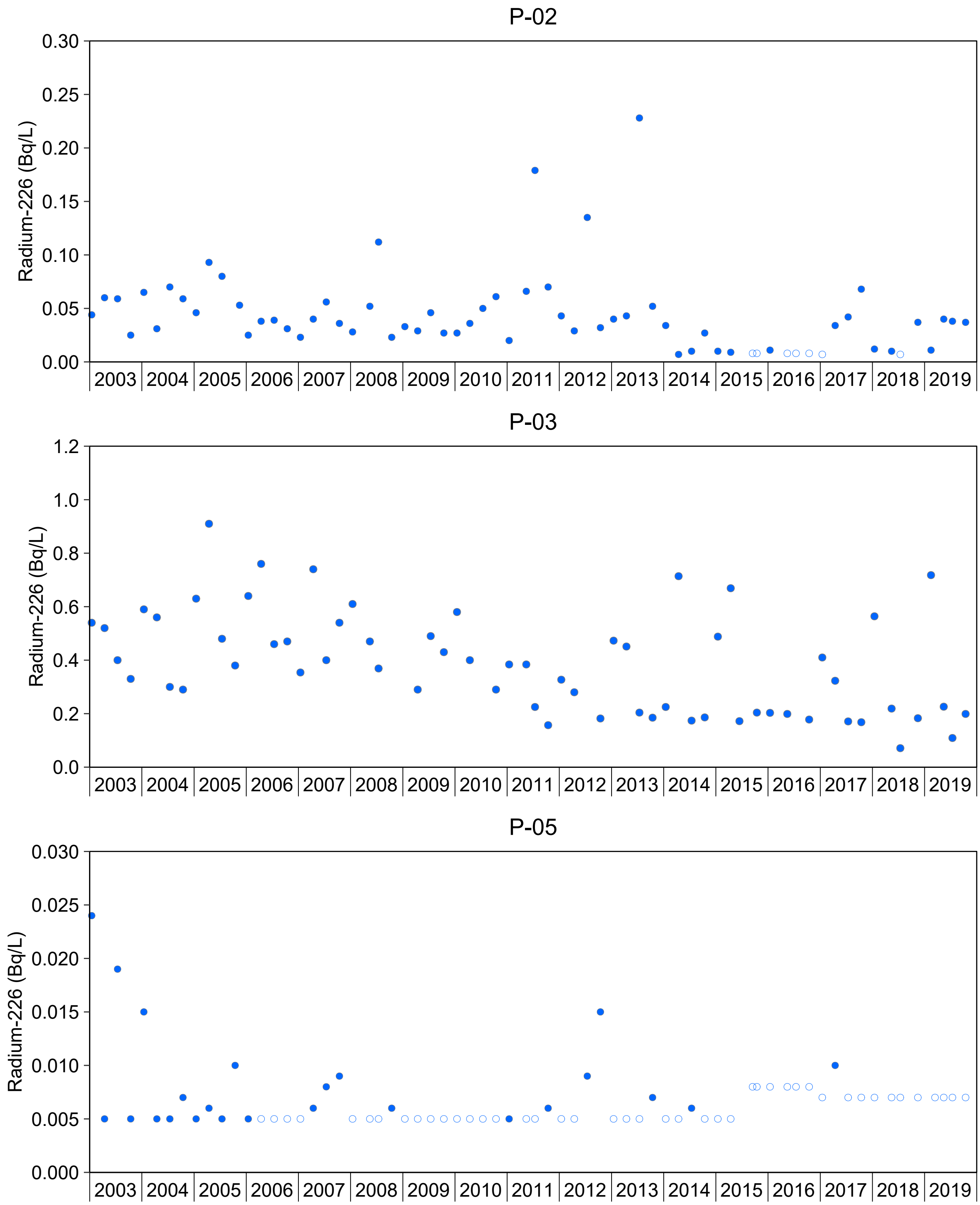


Figure N.6: Concentrations of Radium-226 for SAMP Water Quality Monitoring Stations in Denison, Quirke, Panel, and Stanrock TMAs, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Radium (Bq/L) is not included in the trend analysis for SAMP stations D-16, Q-23, P-03, P-05, and DS-16 due to >50% non-detectable concentrations in the dataset. See Appendix Tables N.2 to N.15 and M.3 for raw data.

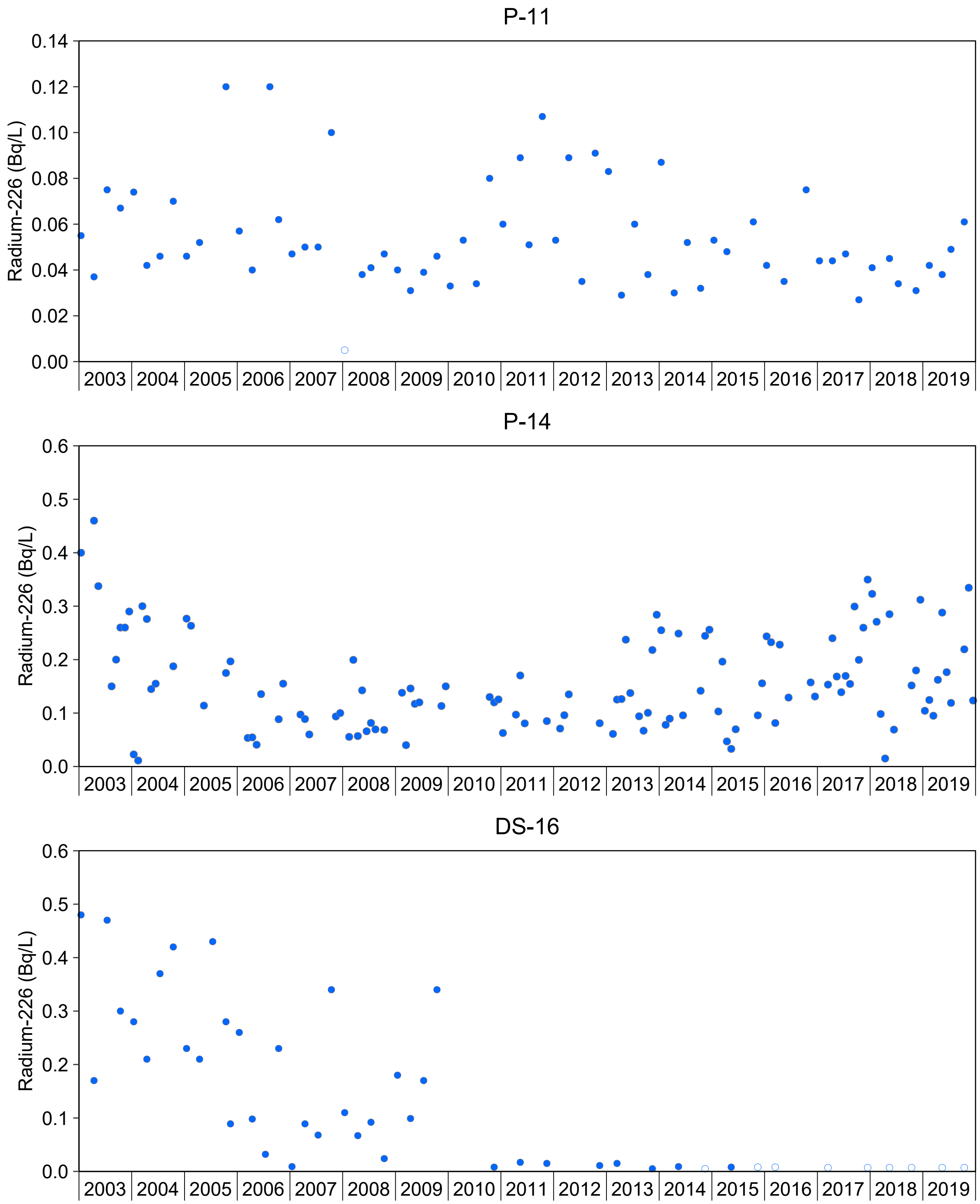


Figure N.6: Concentrations of Radium-226 for SAMP Water Quality Monitoring Stations in Denison, Quirke, Panel, and Stanrock TMAs, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Radium (Bq/L) is not included in the trend analysis for SAMP stations D-16, Q-23, P-03, P-05, and DS-16 due to >50% non-detectable concentrations in the dataset. See Appendix Tables N.2 to N.15 and M.3 for raw data.

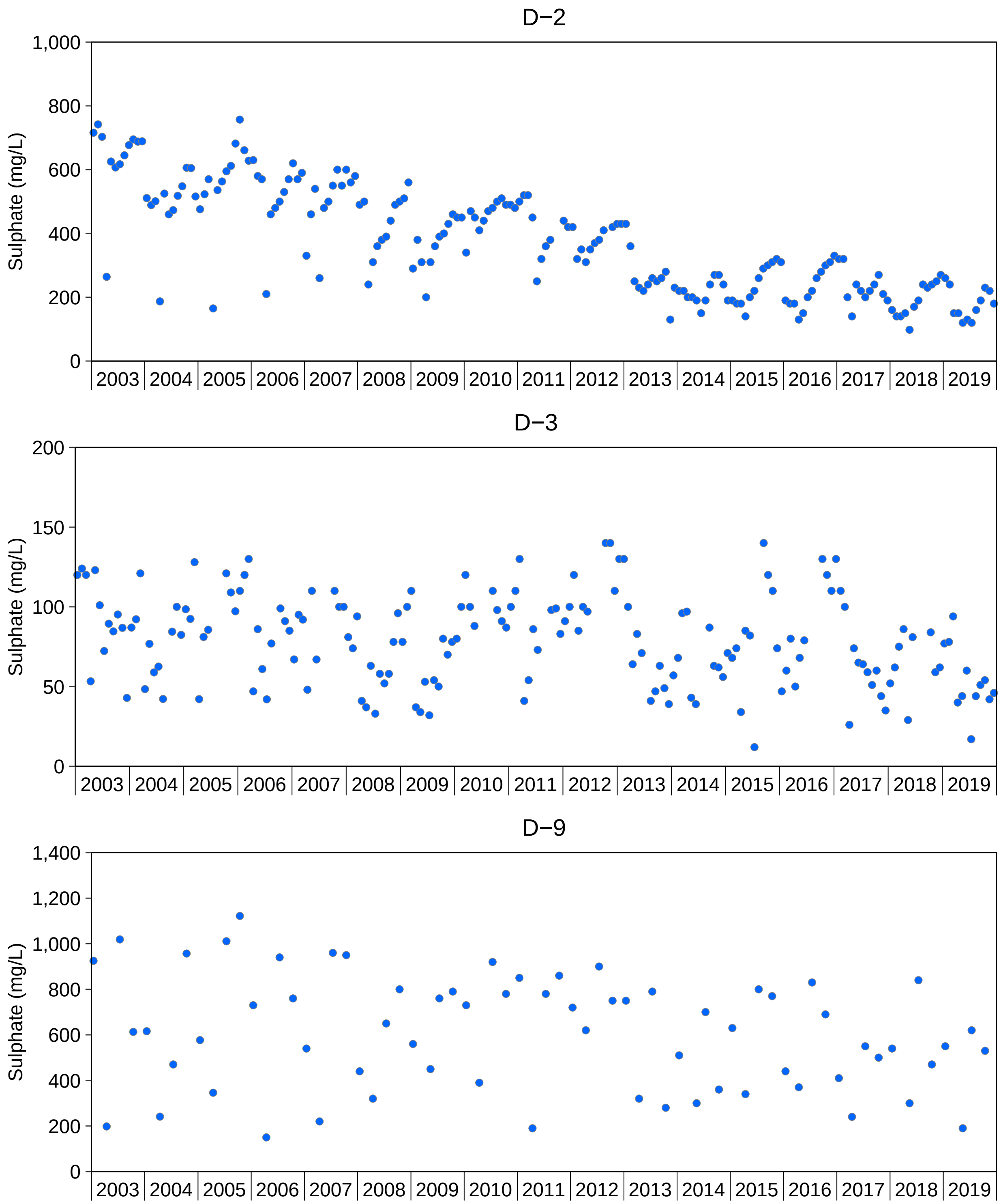


Figure N.7: Concentrations of Sulphate for SAMP Water Quality Monitoring Stations in Denison, Quirke, Panel, and Stanrock TMAs, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Tables N.2 to N.15 and M.3 for raw data.

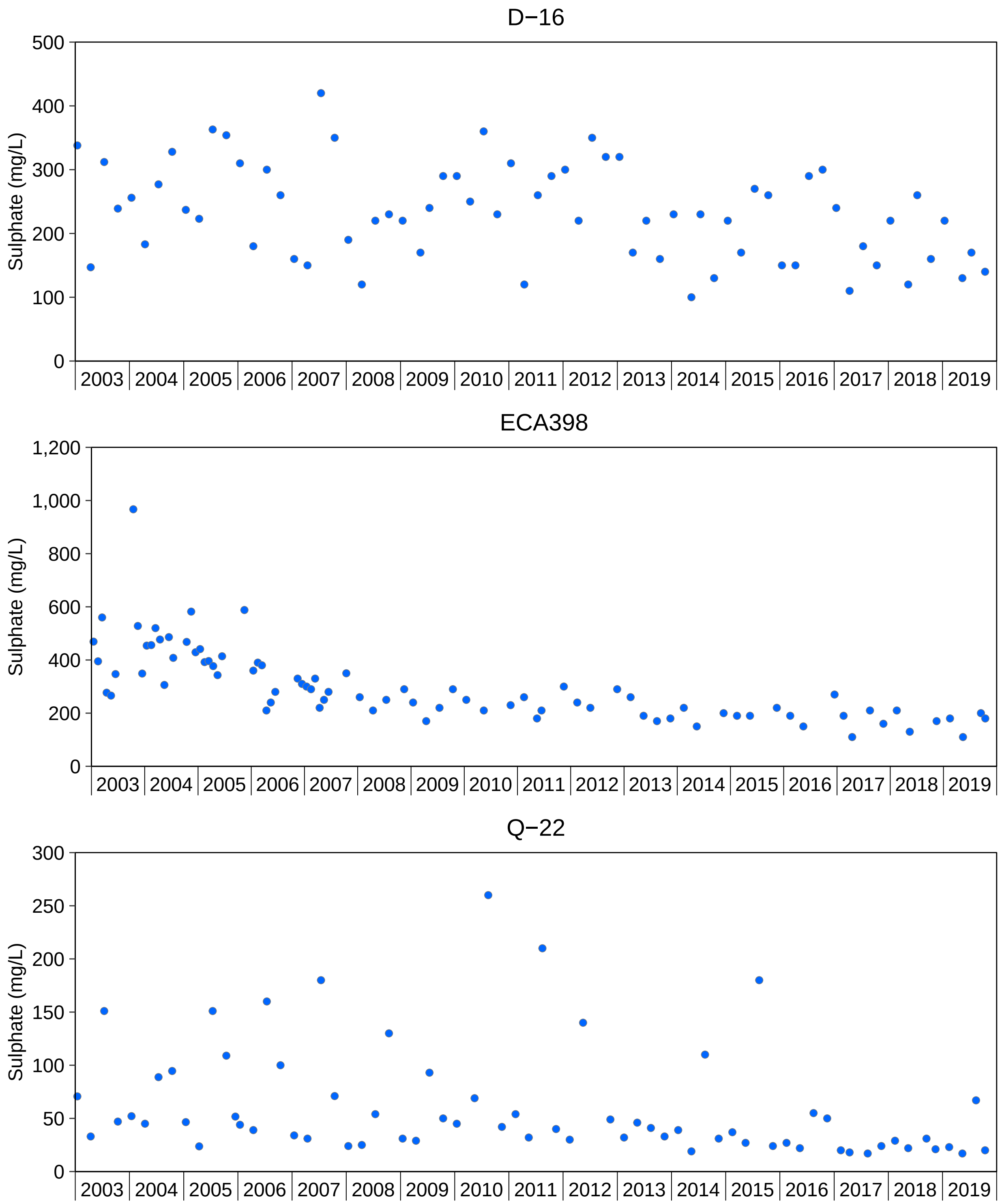


Figure N.7: Concentrations of Sulphate for SAMP Water Quality Monitoring Stations in Denison, Quirke, Panel, and Stanrock TMAs, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Tables N.2 to N.15 and M.3 for raw data.

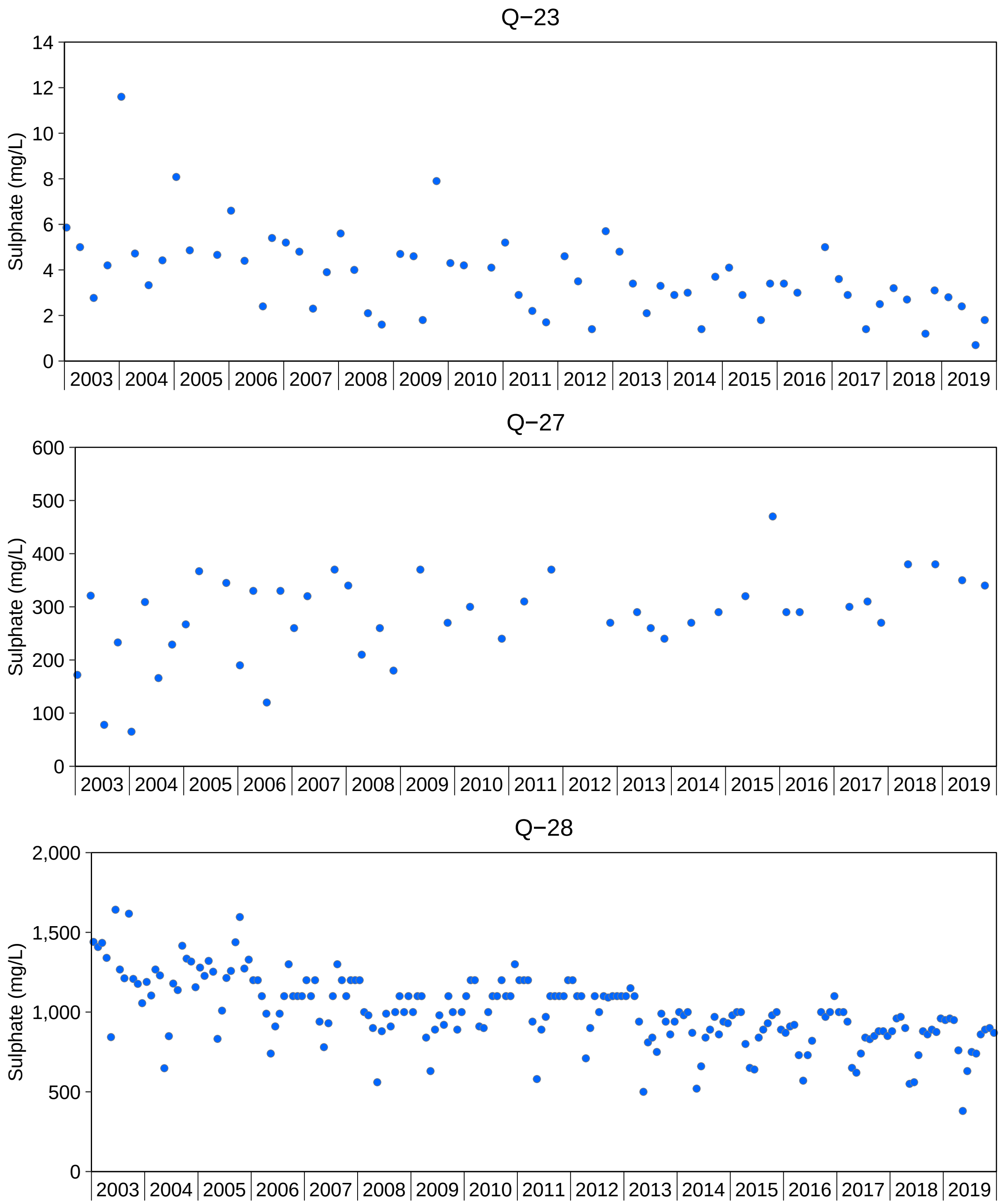


Figure N.7: Concentrations of Sulphate for SAMP Water Quality Monitoring Stations in Denison, Quirke, Panel, and Stanrock TMAs, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Tables N.2 to N.15 and M.3 for raw data.

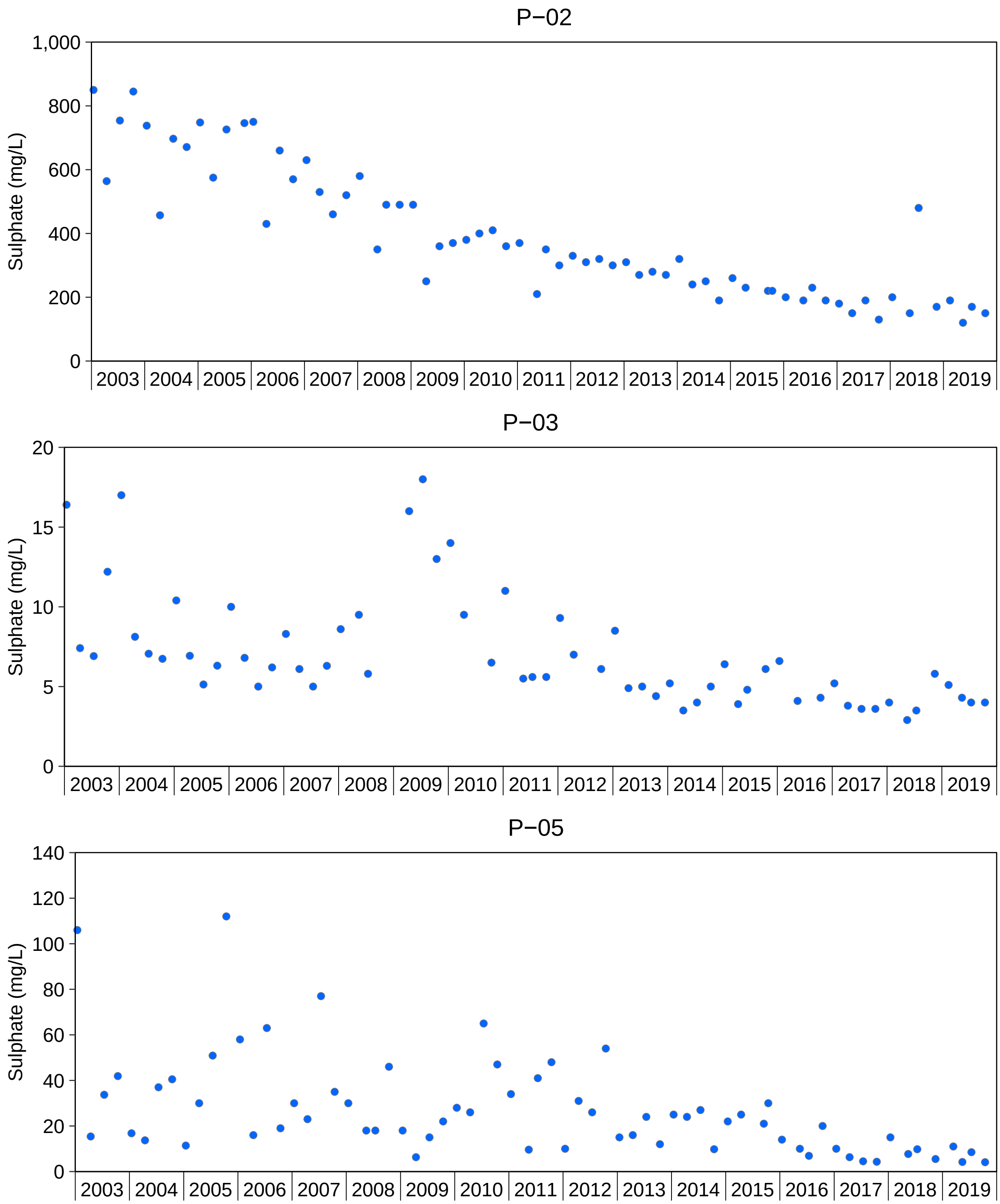


Figure N.7: Concentrations of Sulphate for SAMP Water Quality Monitoring Stations in Denison, Quirke, Panel, and Stanrock TMAs, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Tables N.2 to N.15 and M.3 for raw data.

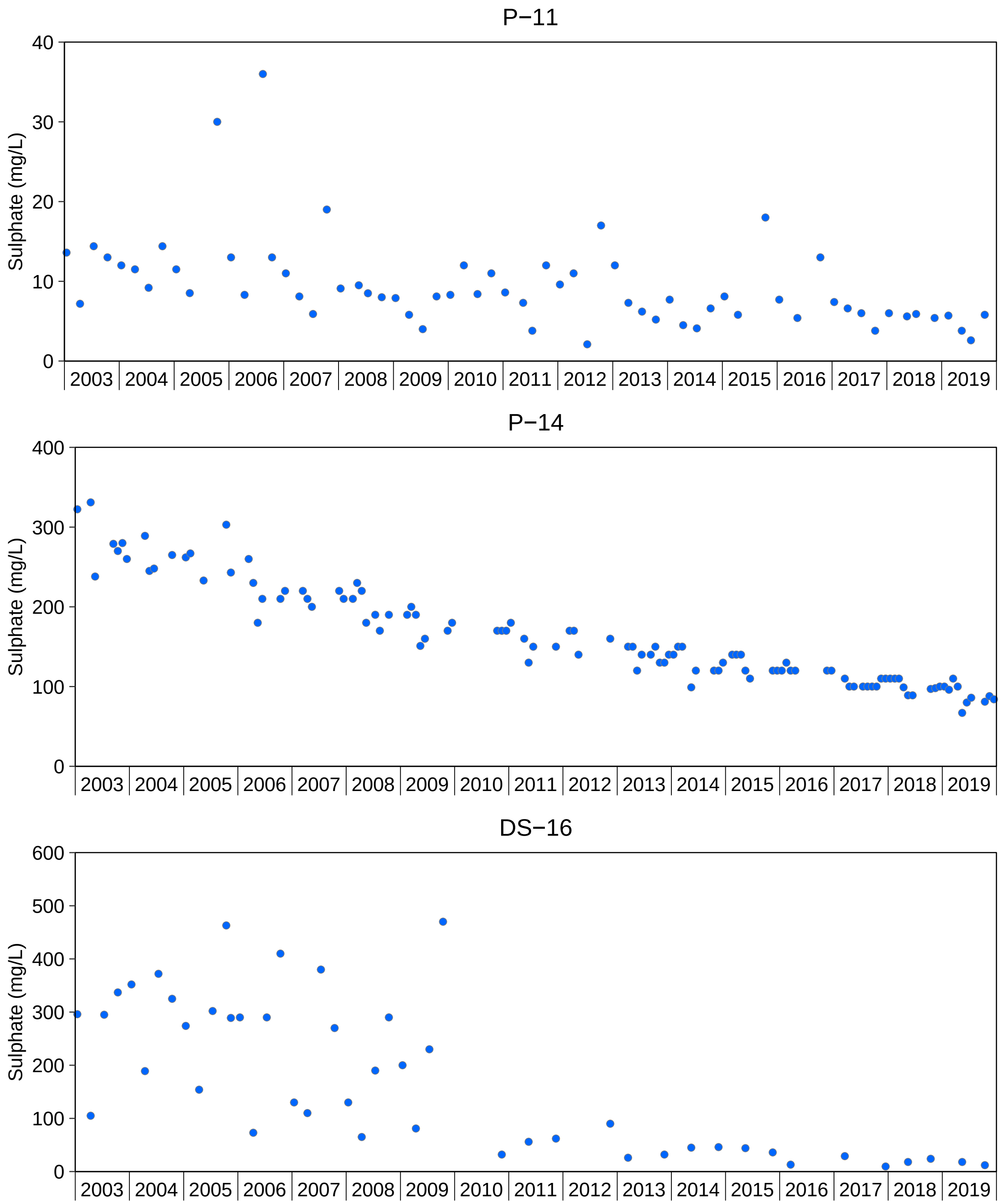


Figure N.7: Concentrations of Sulphate for SAMP Water Quality Monitoring Stations in Denison, Quirke, Panel, and Stanrock TMAs, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL.
See Appendix Tables N.2 to N.15 and M.3 for raw data.

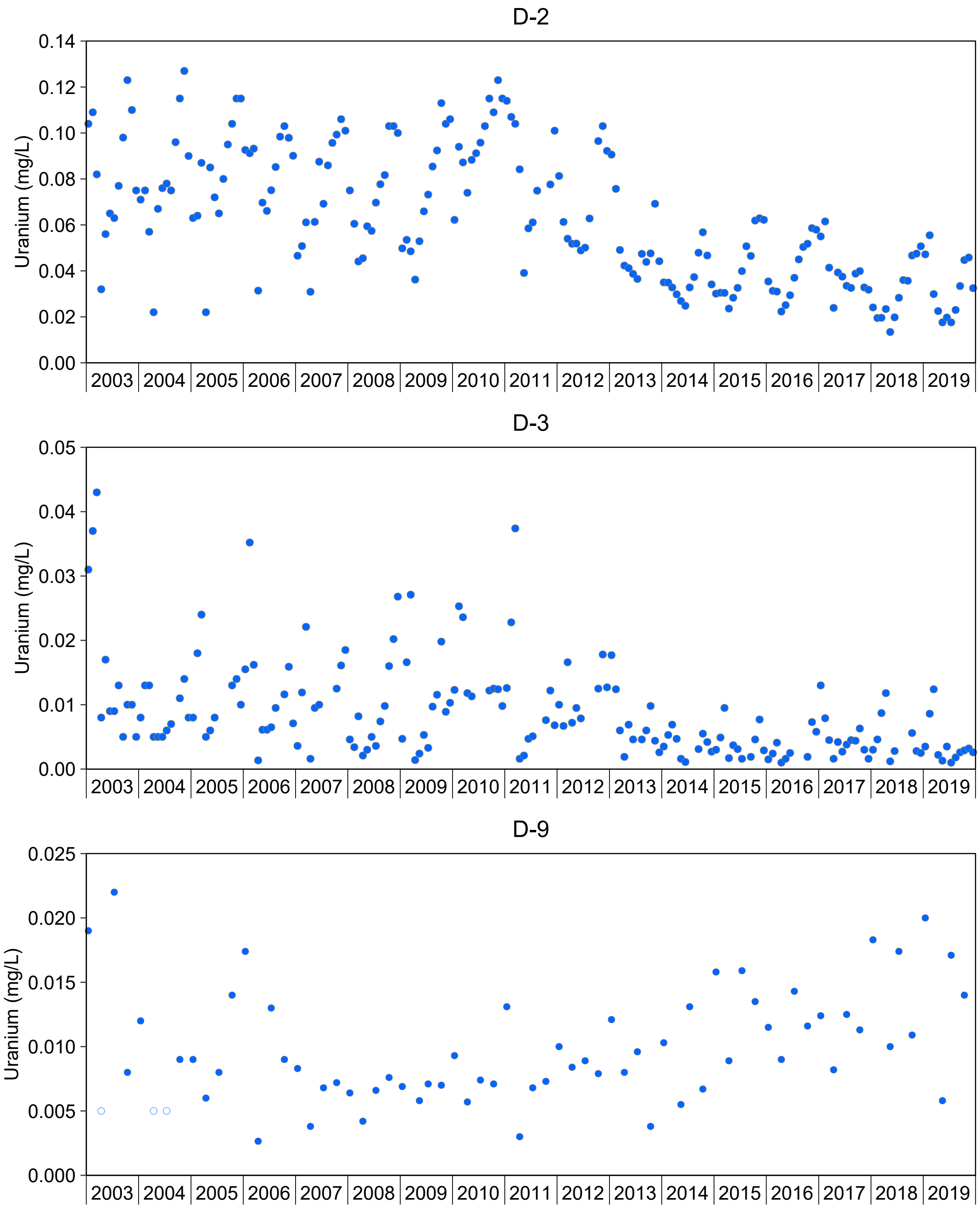


Figure N.8: Concentrations of Uranium for SAMP Water Quality Monitoring Stations in Denison, Quirke, Panel, and Stanrock TMAs, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL.
Uranium (mg/L) is not included in the trend analysis for SAMP station Q-23 due to >50%
non-detectable concentrations in the dataset. See Appendix Tables N.2 to N.15 and M.3 for raw data.

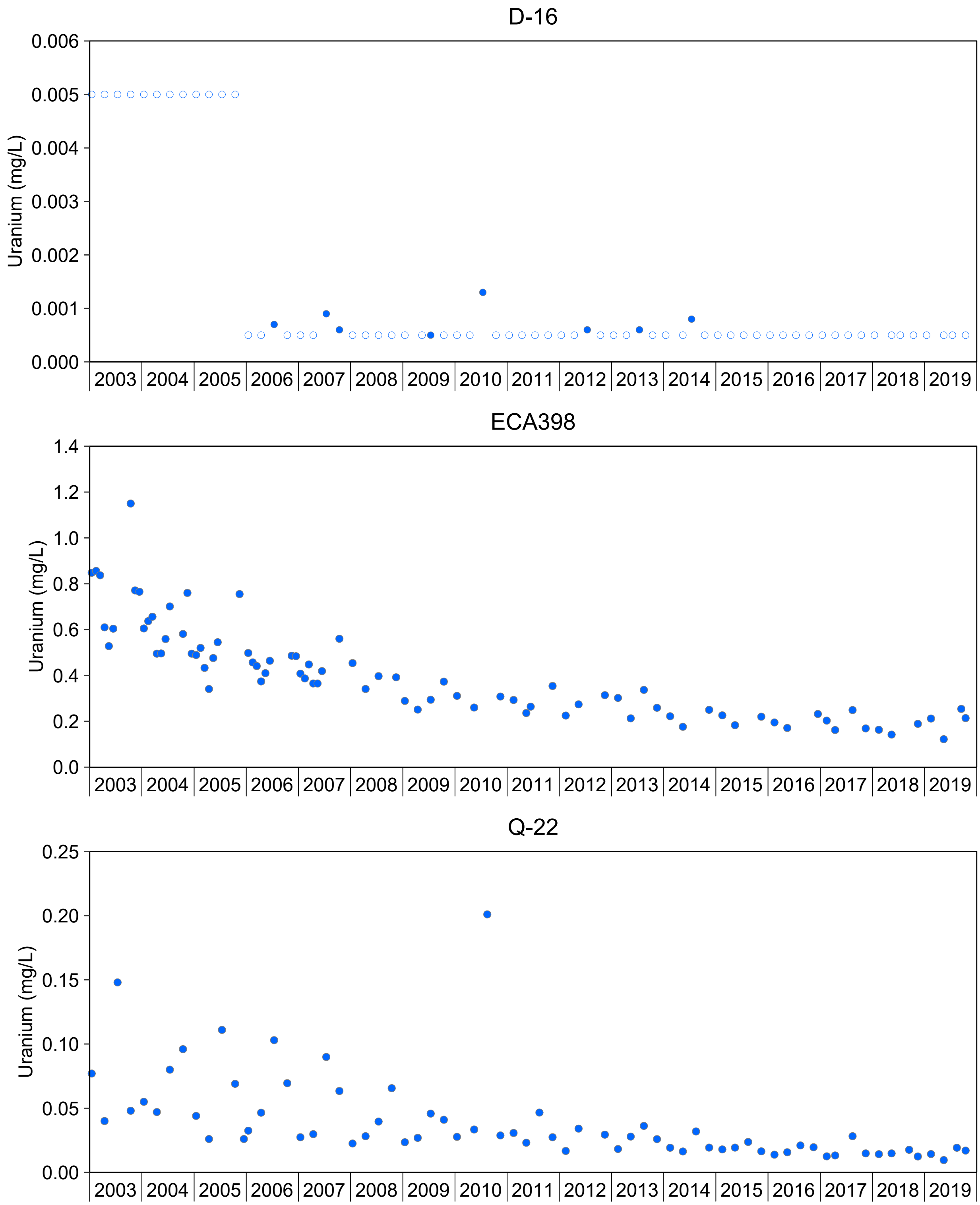


Figure N.8: Concentrations of Uranium for SAMP Water Quality Monitoring Stations in Denison, Quirke, Panel, and Stanrock TMAs, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Uranium (mg/L) is not included in the trend analysis for SAMP station Q-23 due to >50% non-detectable concentrations in the dataset. See Appendix Tables N.2 to N.15 and M.3 for raw data.

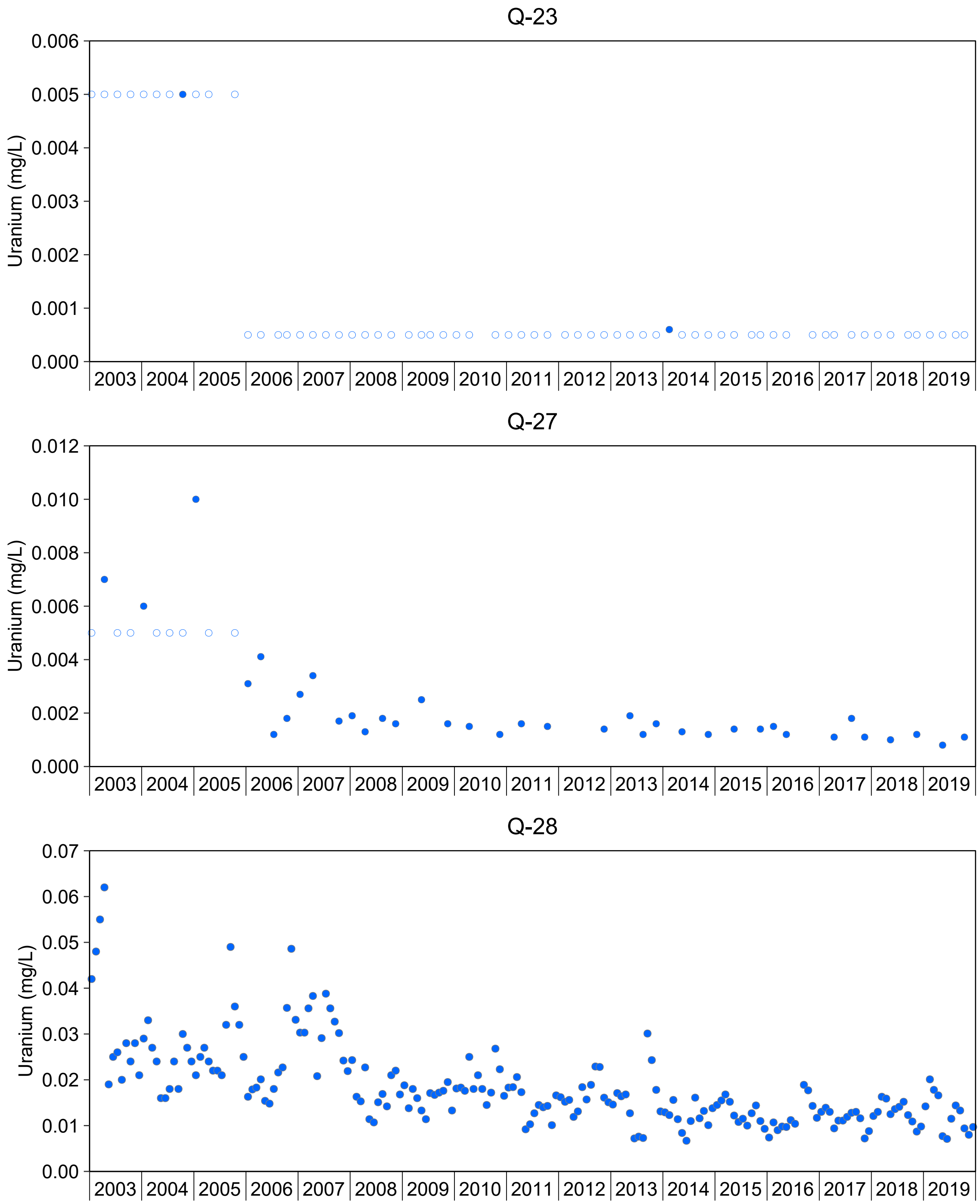


Figure N.8: Concentrations of Uranium for SAMP Water Quality Monitoring Stations in Denison, Quirke, Panel, and Stanrock TMAs, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Uranium (mg/L) is not included in the trend analysis for SAMP station Q-23 due to >50% non-detectable concentrations in the dataset. See Appendix Tables N.2 to N.15 and M.3 for raw data.

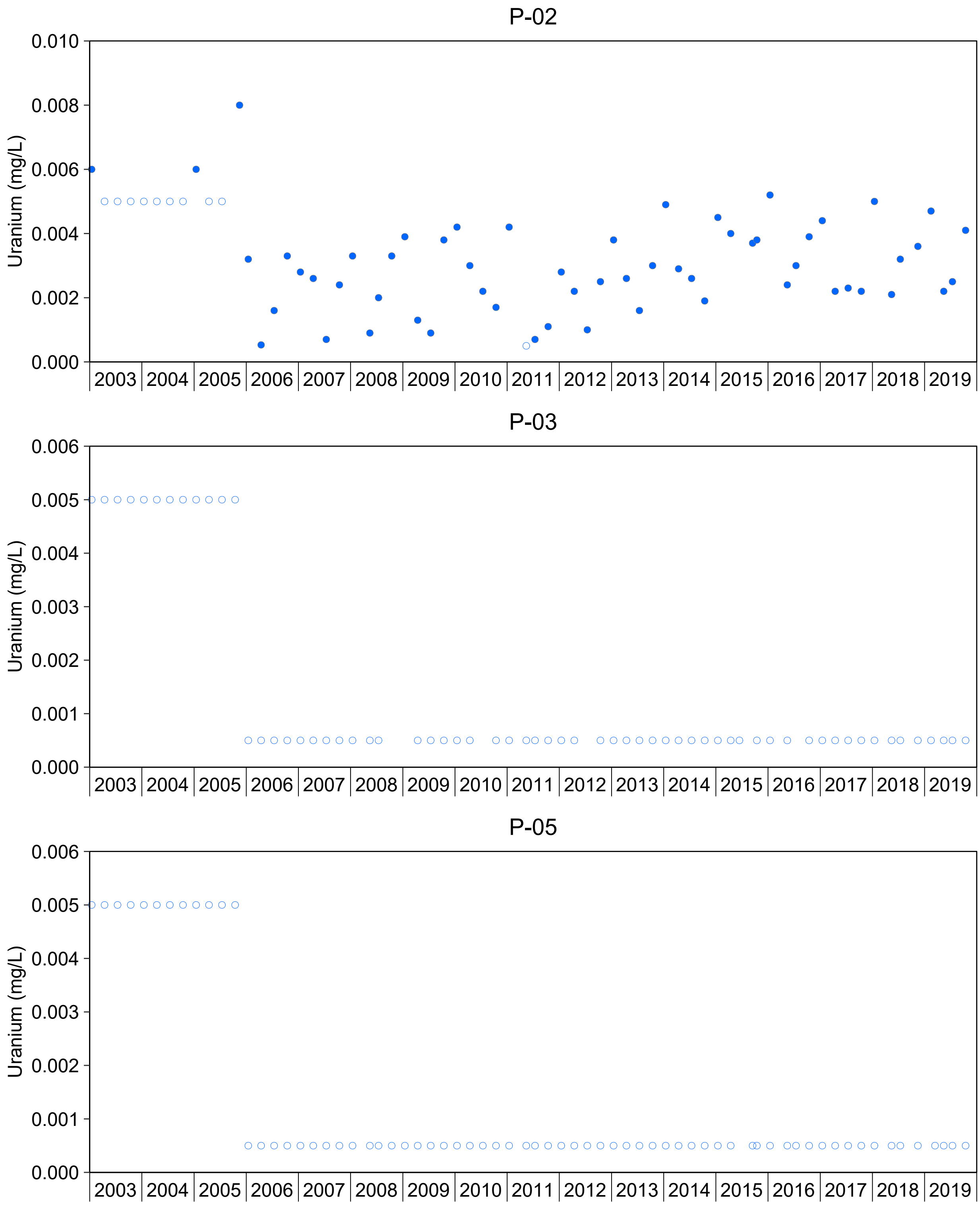


Figure N.8: Concentrations of Uranium for SAMP Water Quality Monitoring Stations in Denison, Quirke, Panel, and Stanrock TMAs, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Uranium (mg/L) is not included in the trend analysis for SAMP station Q-23 due to >50% non-detectable concentrations in the dataset. See Appendix Tables N.2 to N.15 and M.3 for raw data.

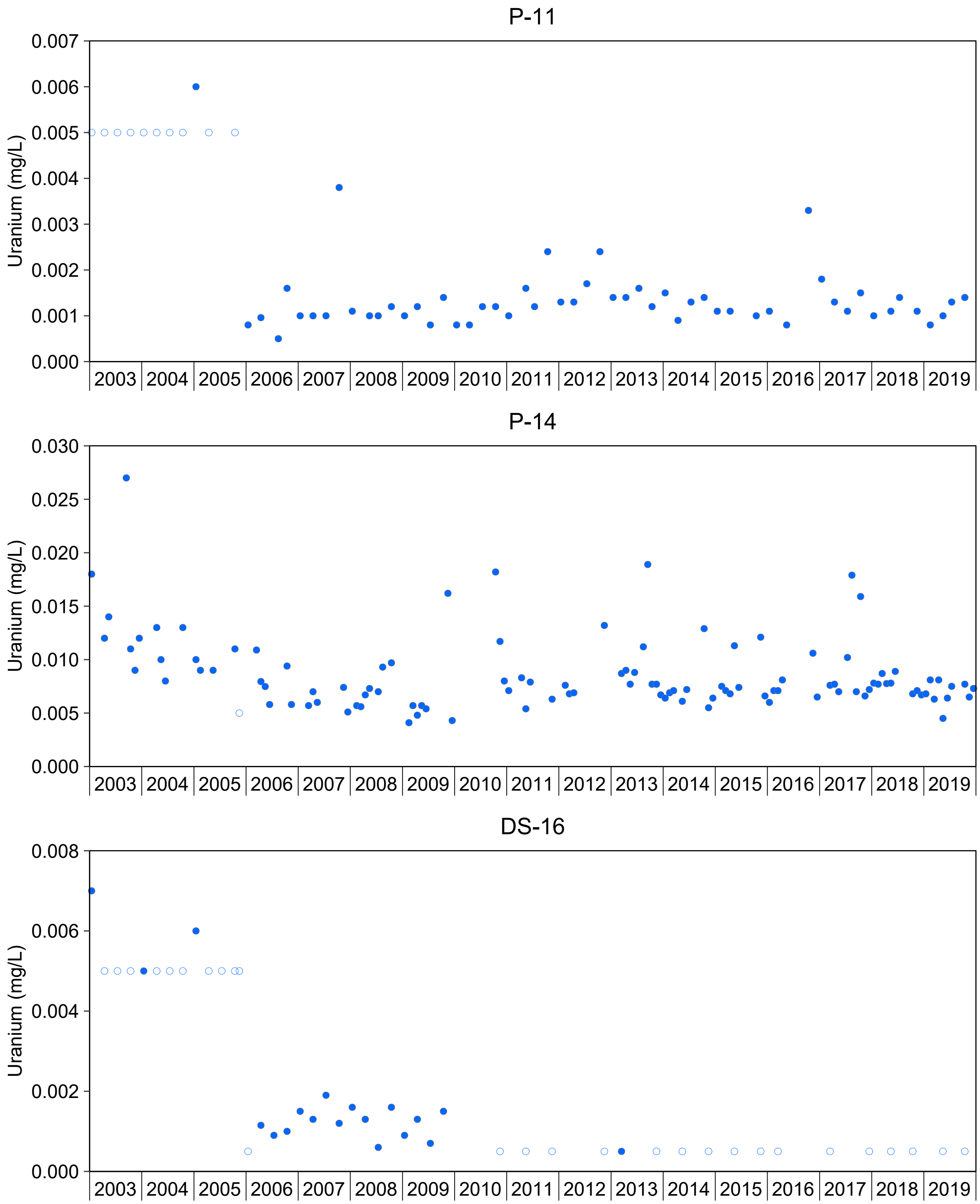


Figure N.8: Concentrations of Uranium for SAMP Water Quality Monitoring Stations in Denison, Quirke, Panel, and Stanrock TMAs, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL.
Uranium (mg/L) is not included in the trend analysis for SAMP station Q-23 due to >50% non-detectable concentrations in the dataset. See Appendix Tables N.2 to N.15 and M.3 for raw data.

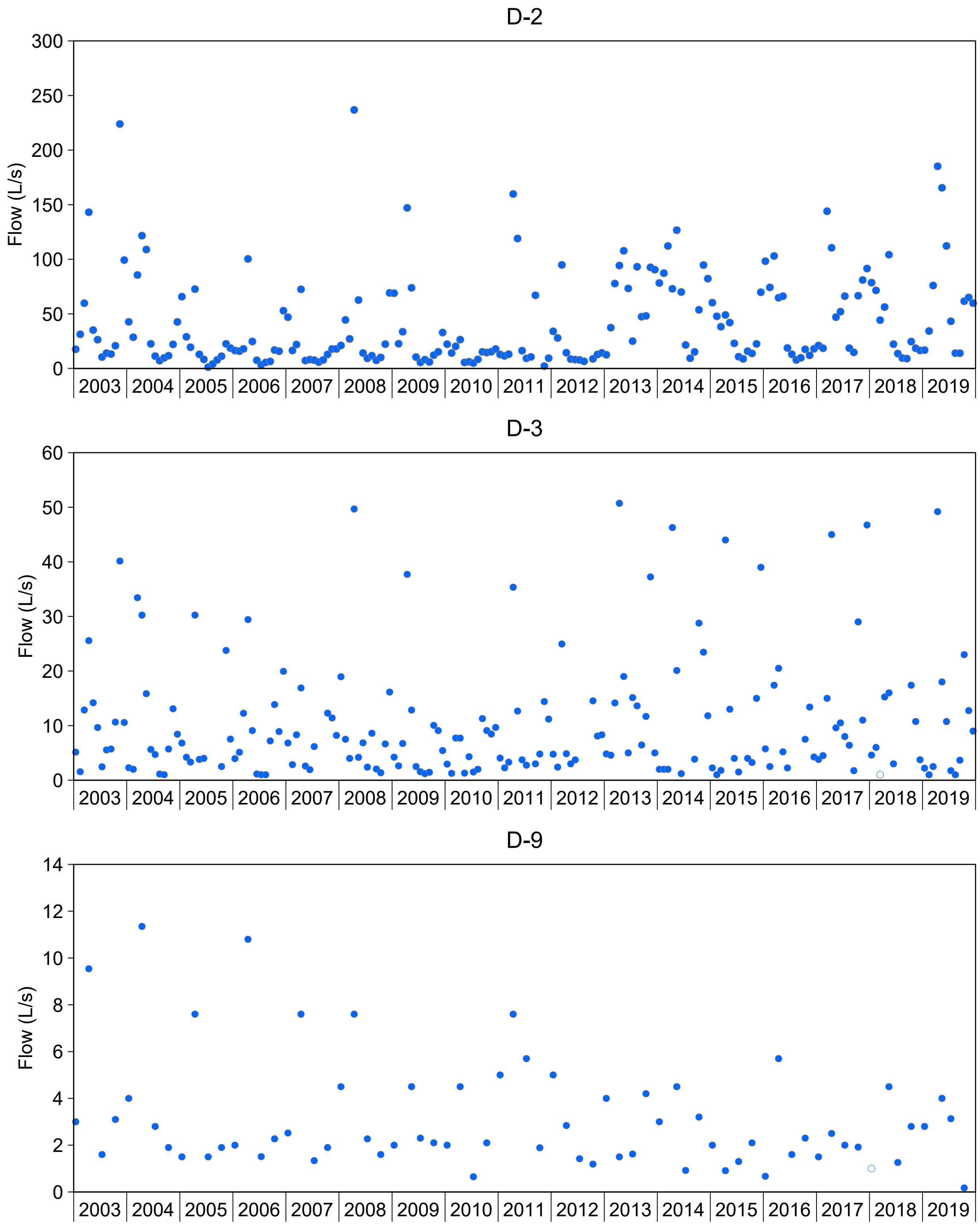


Figure N.9: Flow Measurements for SAMP Water Quality Monitoring Stations in Denison, Quirke, Panel, and Stanrock TMAs, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Tables N.2 to N.15 and M.3 for raw data.

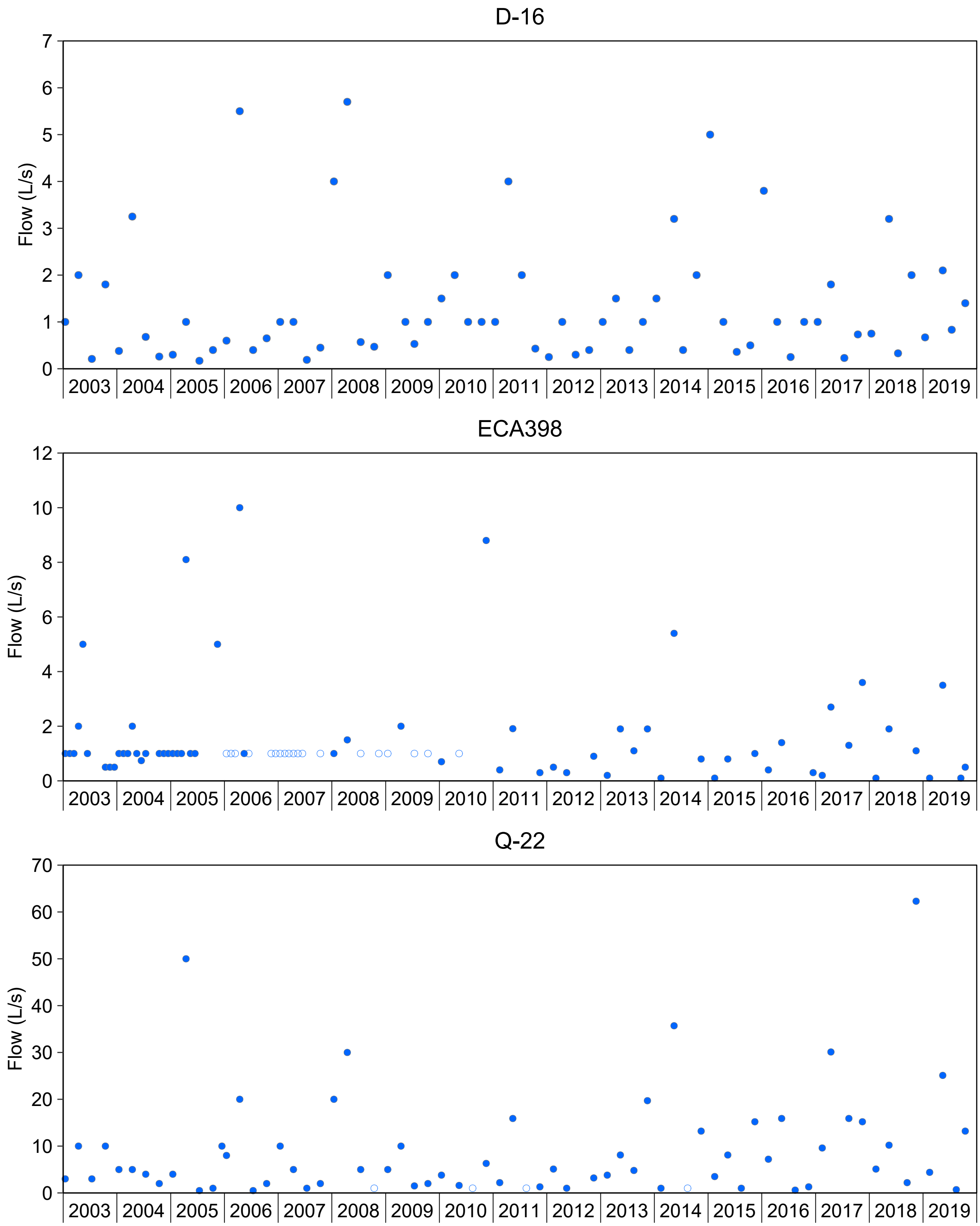


Figure N.9: Flow Measurements for SAMP Water Quality Monitoring Stations in Denison, Quirke, Panel, and Stanrock TMAs, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL.
See Appendix Tables N.2 to N.15 and M.3 for raw data.

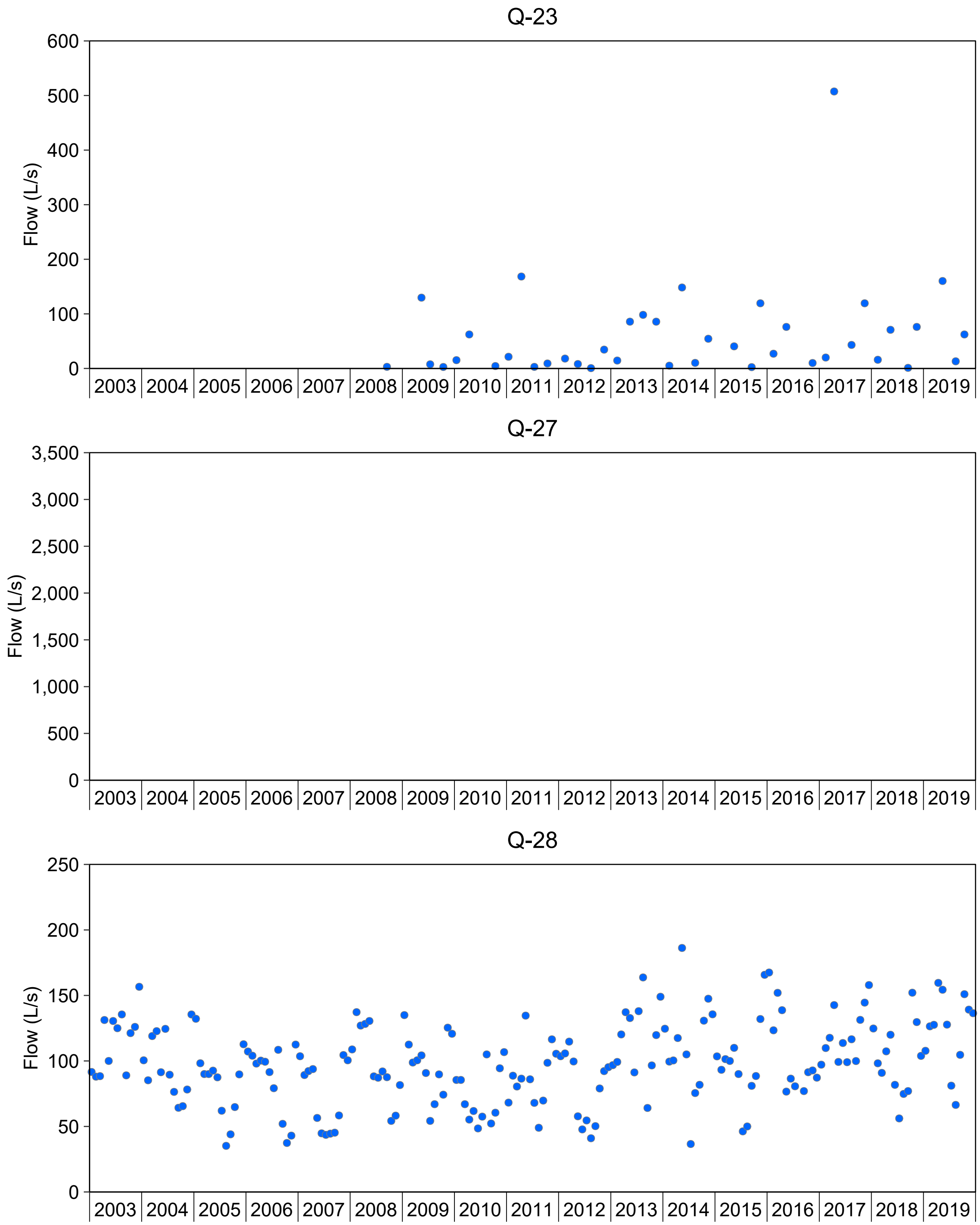


Figure N.9: Flow Measurements for SAMP Water Quality Monitoring Stations in Denison, Quirke, Panel, and Stanrock TMAs, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL.
See Appendix Tables N.2 to N.15 and M.3 for raw data.

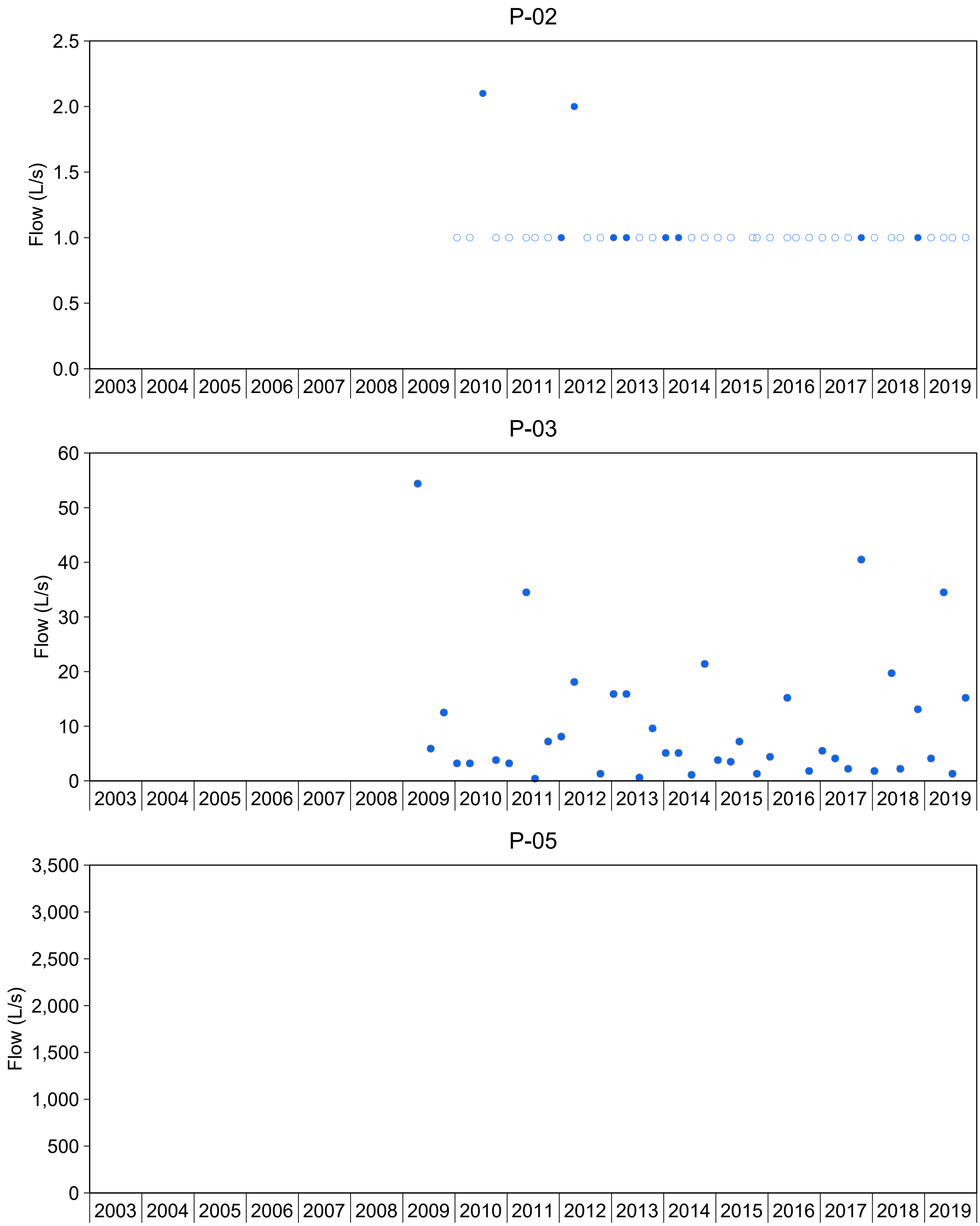


Figure N.9: Flow Measurements for SAMP Water Quality Monitoring Stations in Denison, Quirke, Panel, and Stanrock TMAs, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Tables N.2 to N.15 and M.3 for raw data.

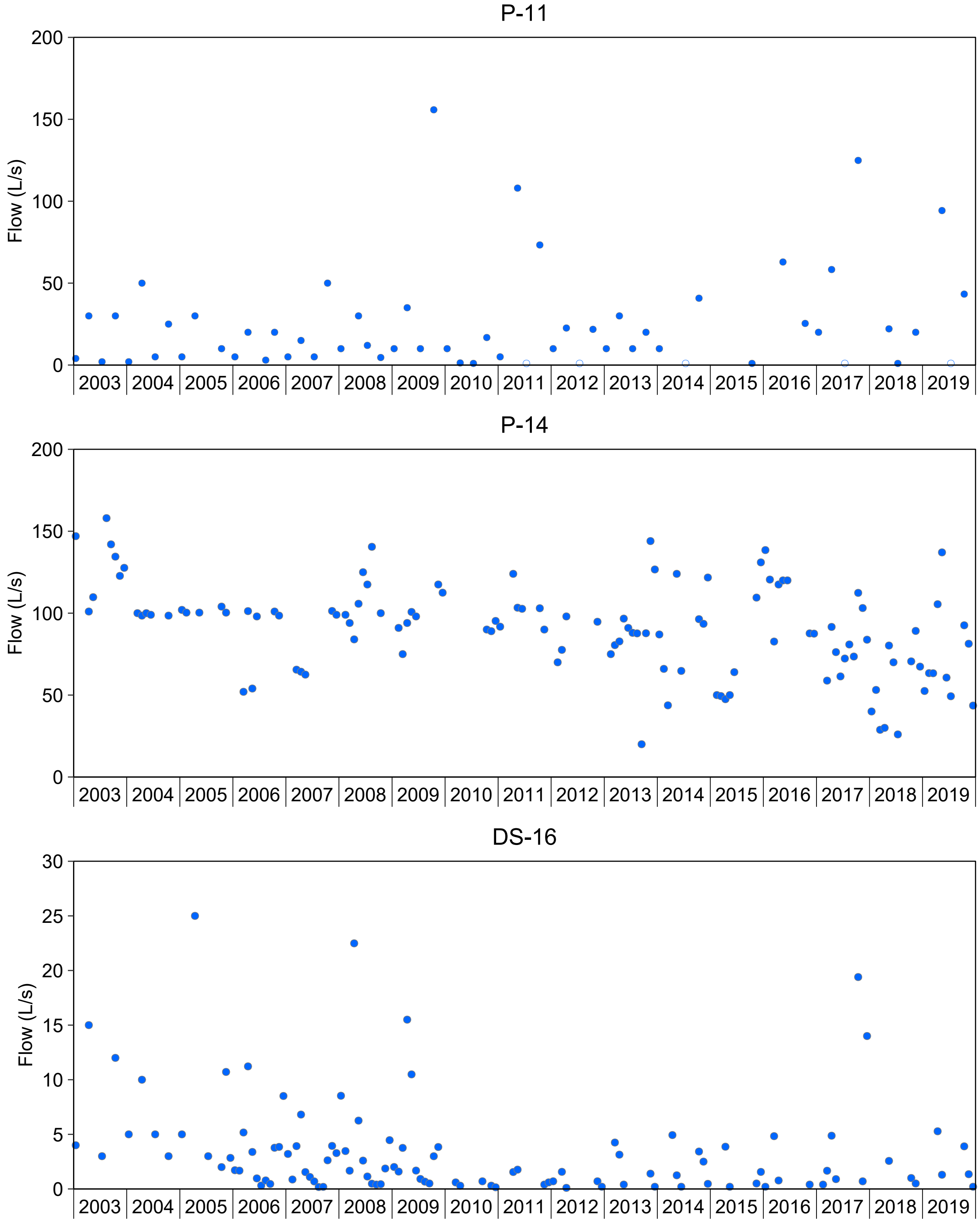


Figure N.9: Flow Measurements for SAMP Water Quality Monitoring Stations in Denison, Quirke, Panel, and Stanrock TMAs, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL.
See Appendix Tables N.2 to N.15 and M.3 for raw data.

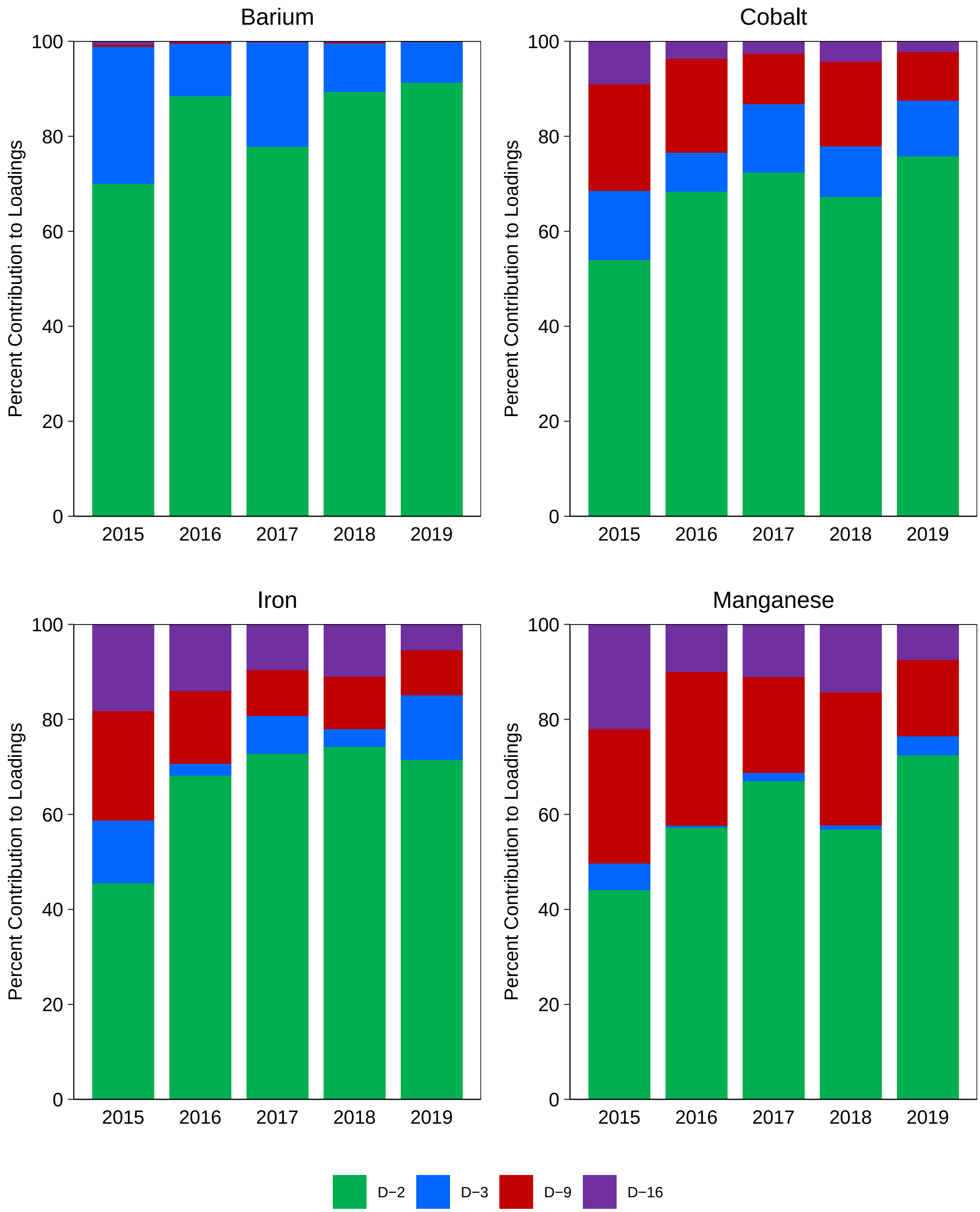


Figure N.10: Percent Contribution of TMA Discharges and Seepages to the Total Loadings from Dension TMA, 2015 to 2019

Notes: See appendix Table N.21 for annual discharge and seepage loadings data.

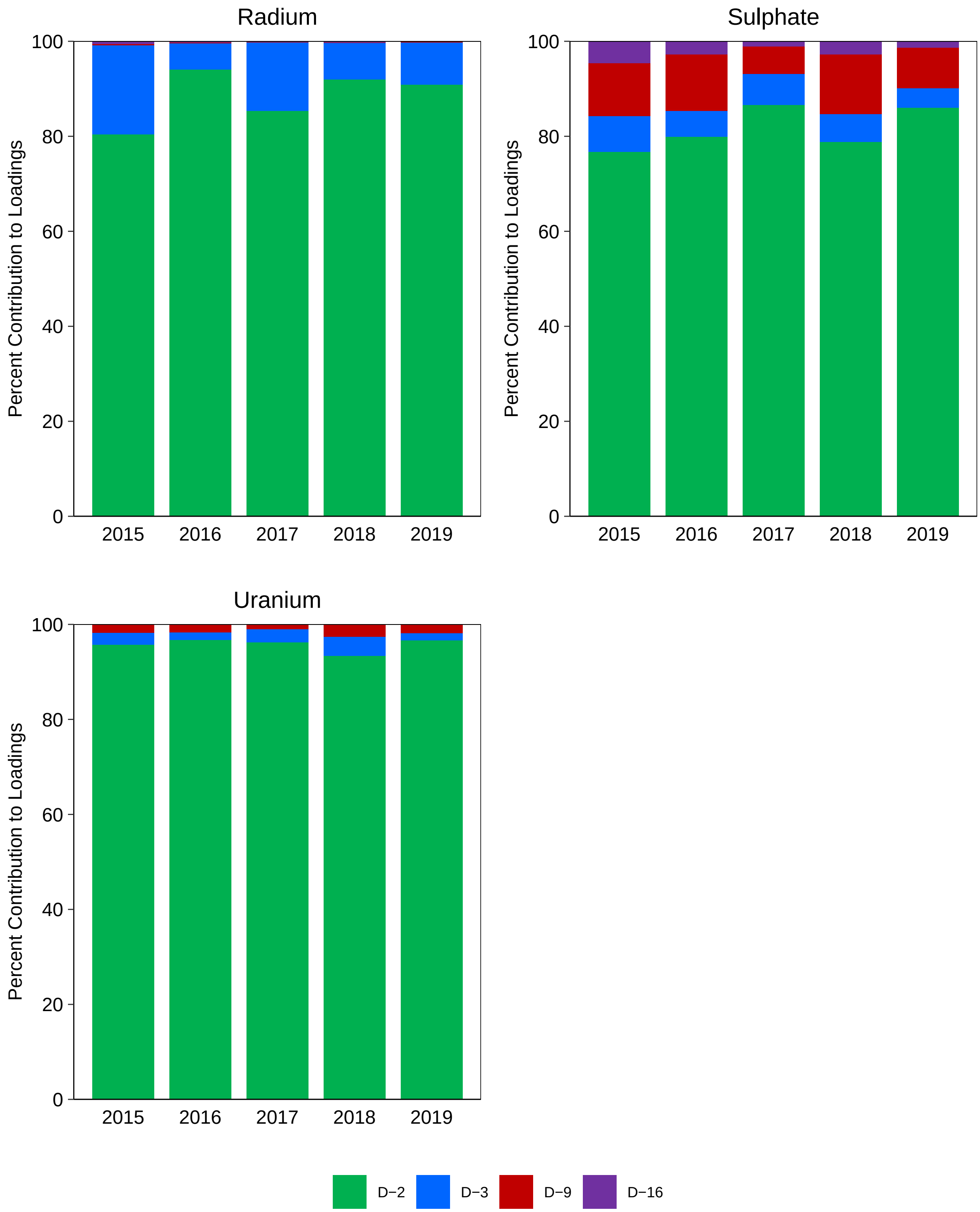


Figure N.10: Percent Contribution of TMA Discharges and Seepages to the Total Loadings from Dension TMA, 2015 to 2019

Notes: See appendix Table N.21 for annual discharge and seepage loadings data.

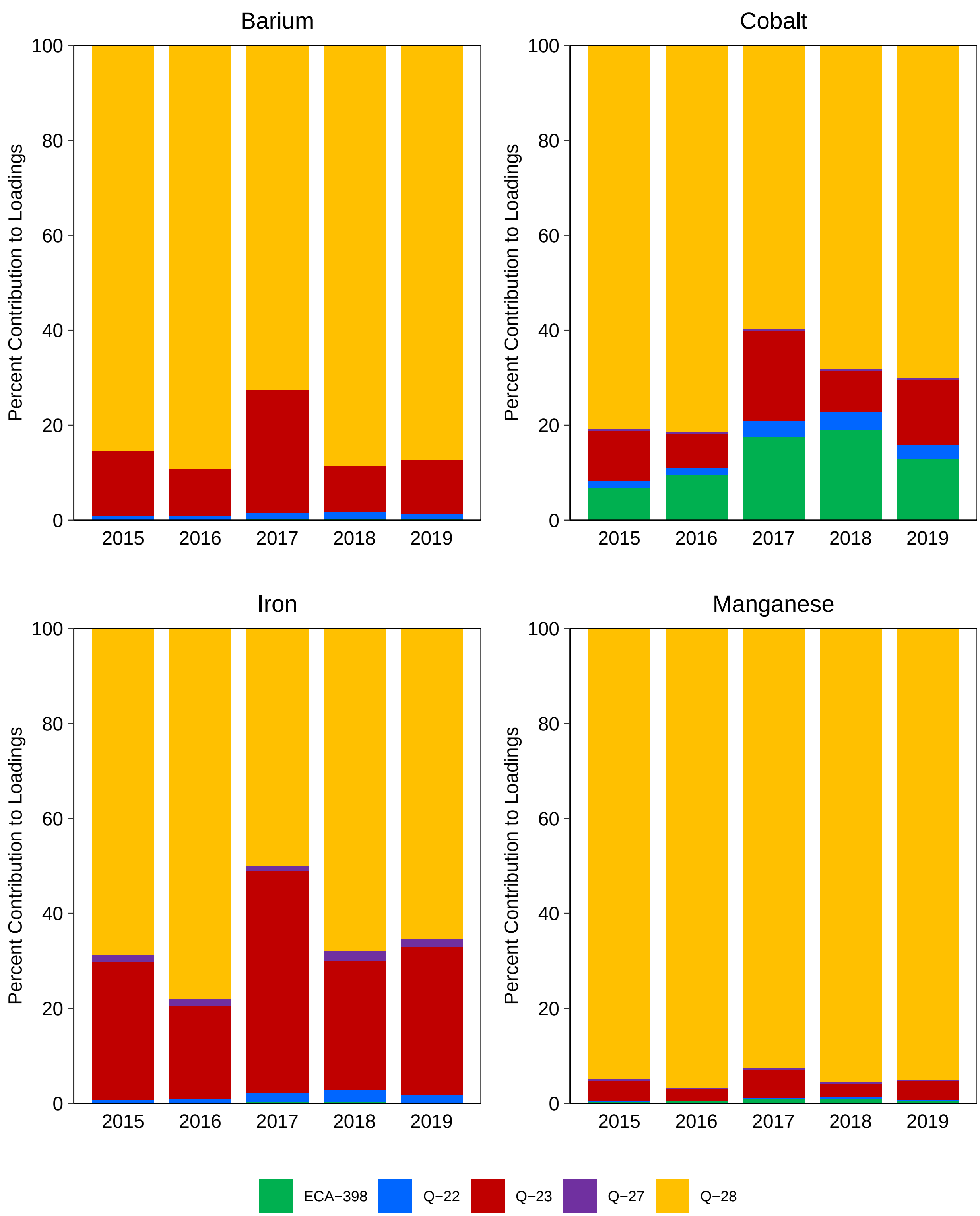


Figure N.11: Percent Contribution of TMA Discharges and Seepages to the Total Loadings from Quirke TMA, 2015 to 2019

Notes: See Appendix Table N.22 for annual discharge and seepage loadings data.

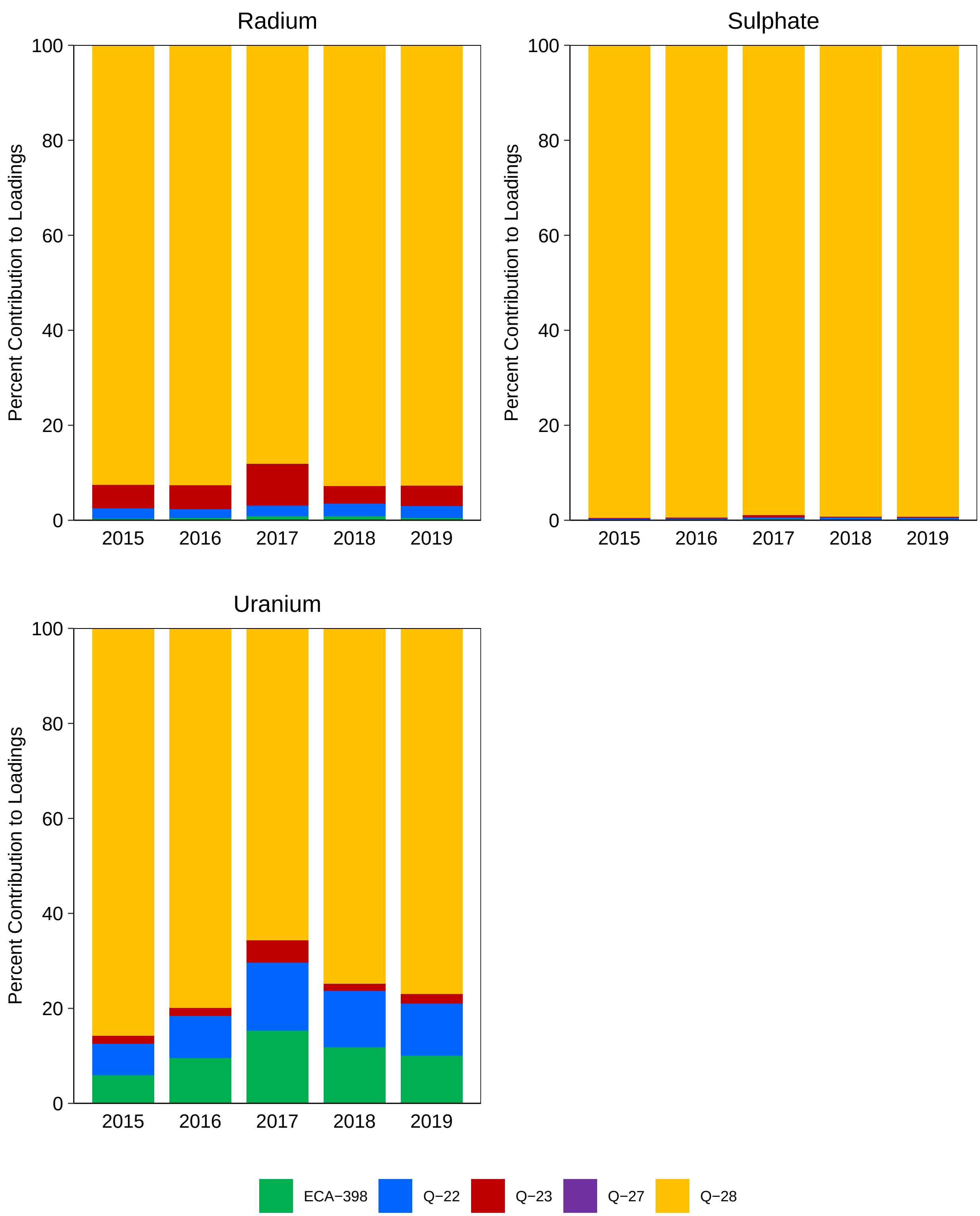


Figure N.11: Percent Contribution of TMA Discharges and Seepages to the Total Loadings from Quirke TMA, 2015 to 2019

Notes: See Appendix Table N.22 for annual discharge and seepage loadings data.

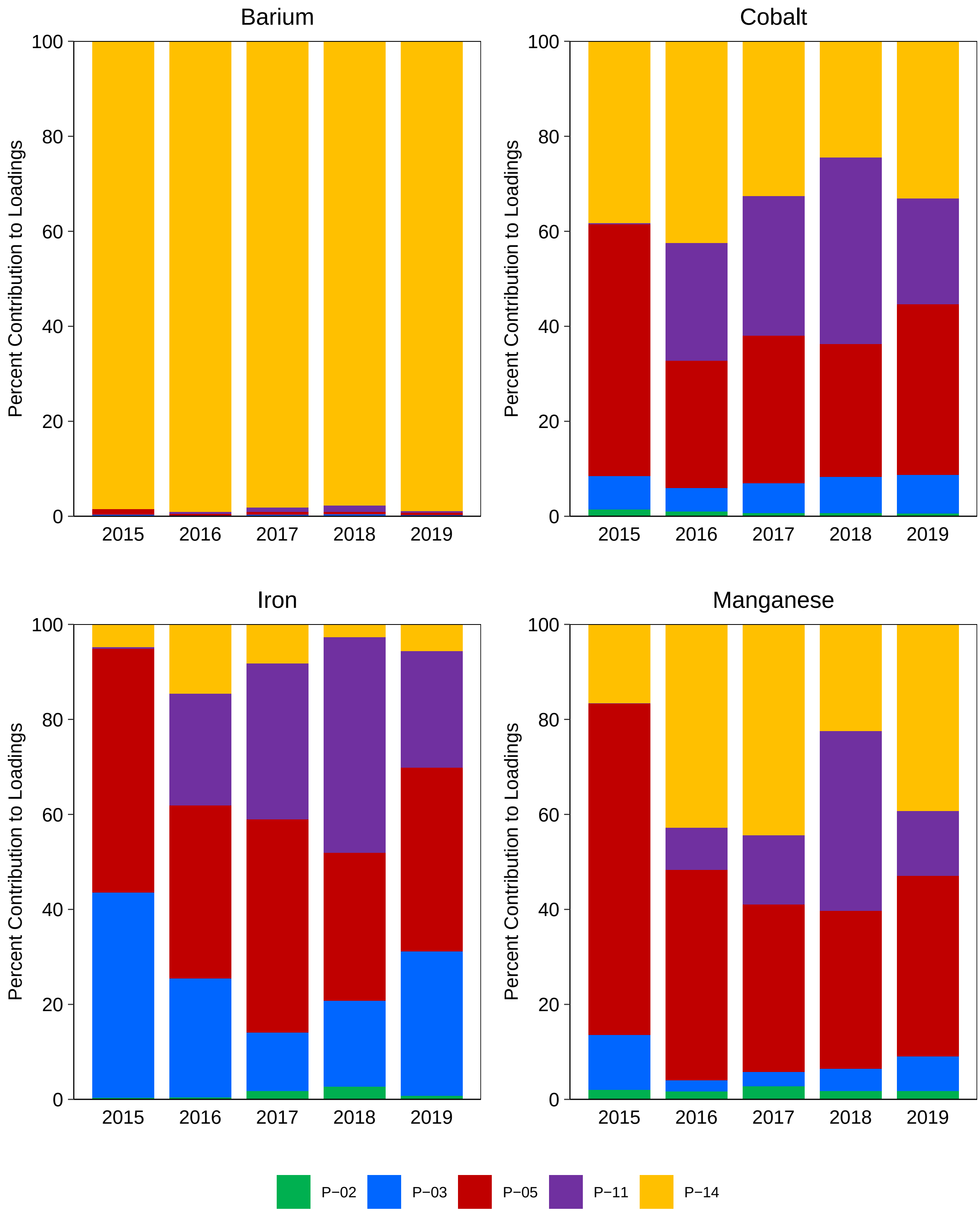


Figure N.12: Percent Contribution of TMA Discharges and Seepages to the Total Loadings from Panel TMA, 2015 to 2019

Notes: See Appendix Table N.23 for annual discharge and seepage loadings data.

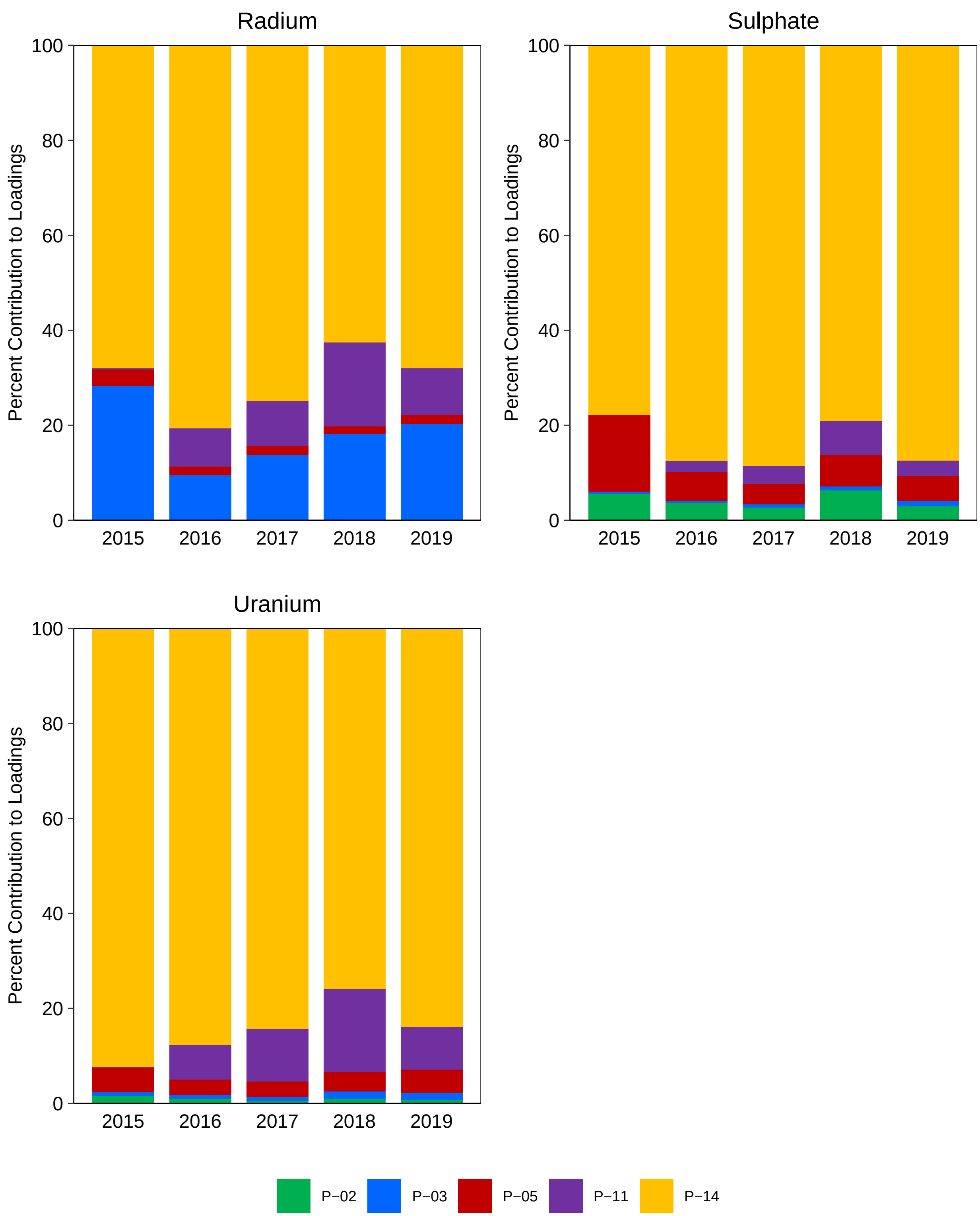
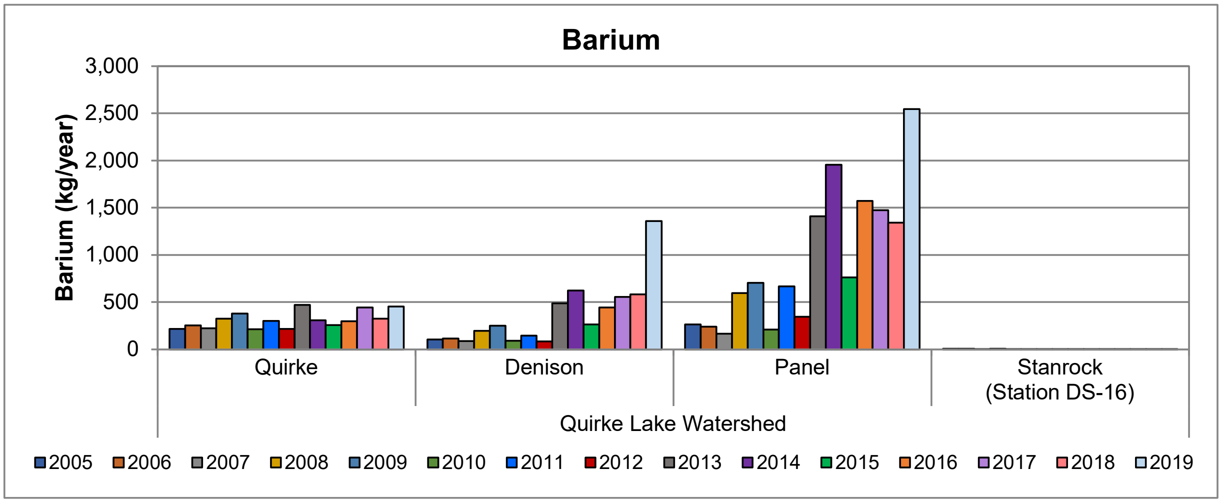
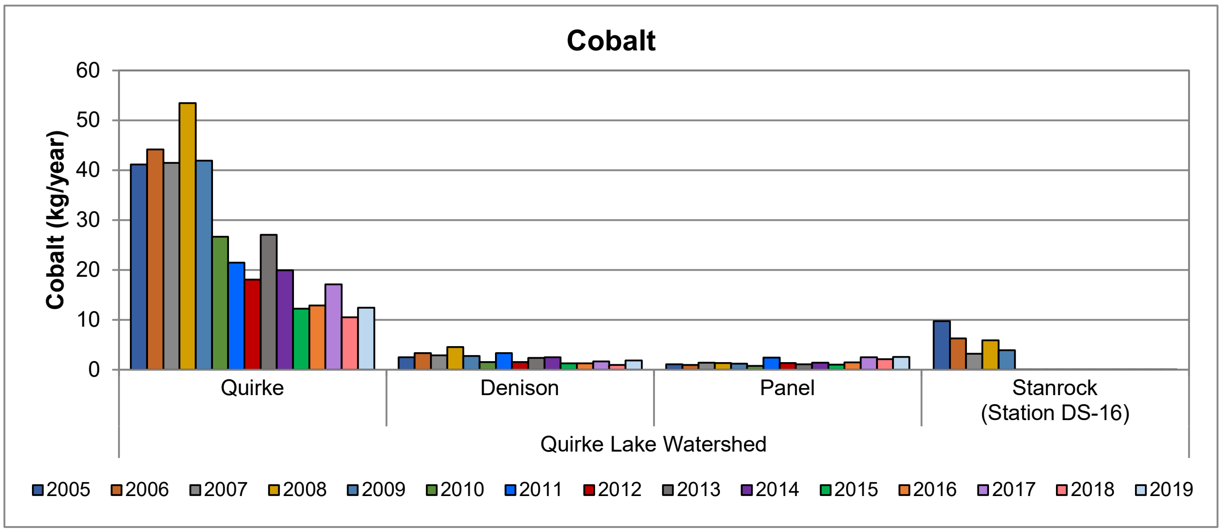


Figure N.12: Percent Contribution of TMA Discharges and Seepages to the Total Loadings from Panel TMA, 2015 to 2019

Notes: See Appendix Table N.23 for annual discharge and seepage loadings data.





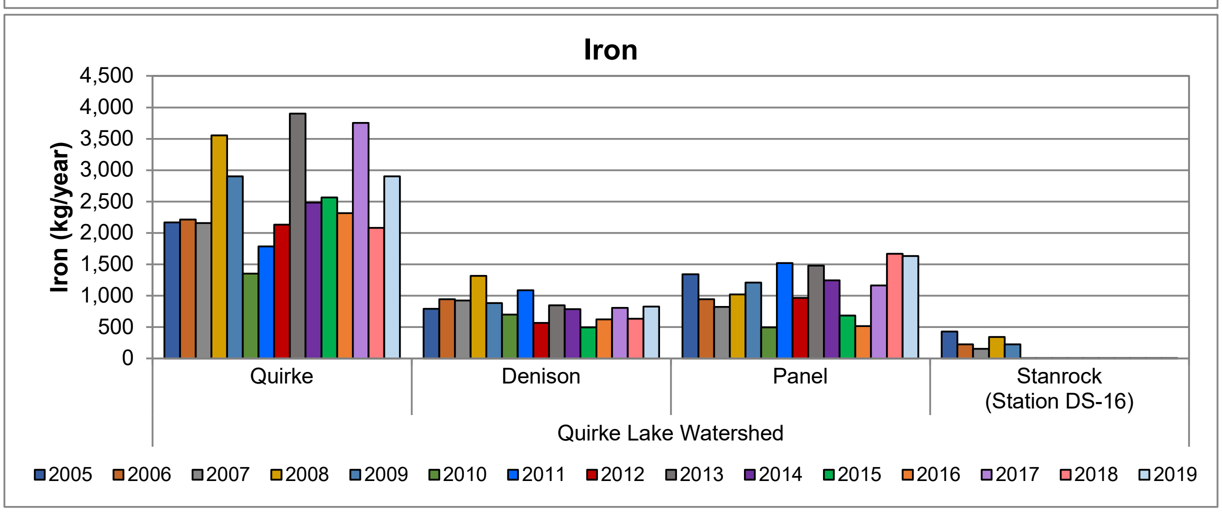
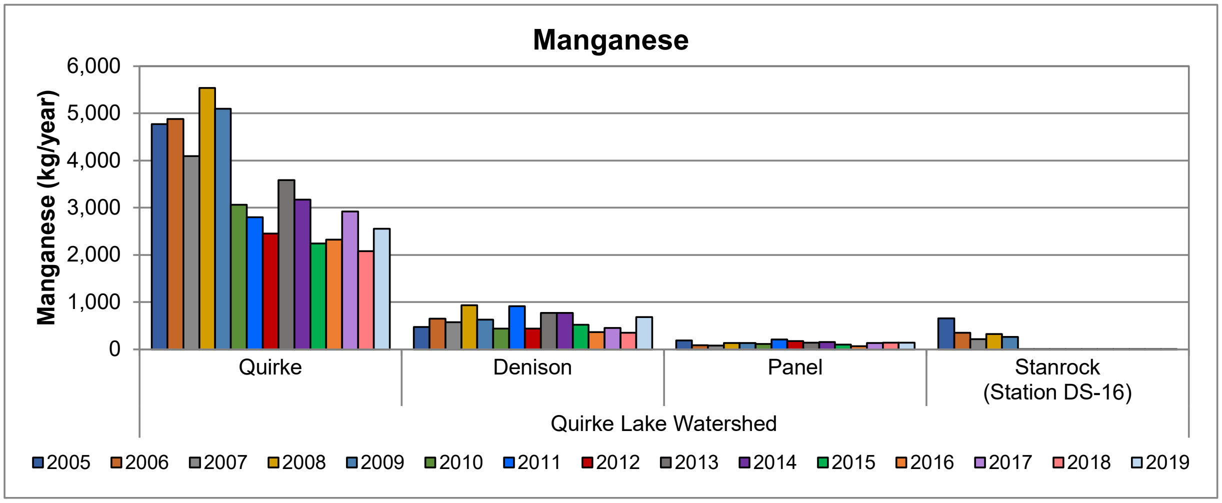
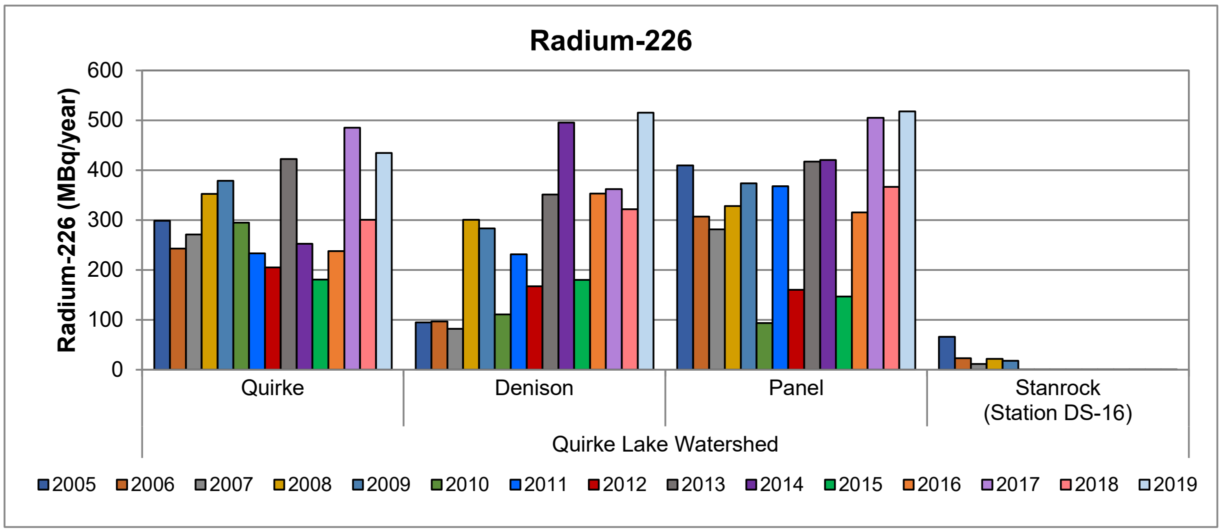


Figure N.13: Annual Loadings from Effluent Discharges from Quirke, Denison, and Panel TMAs, and Seepage from Stanrock TMA to the Quirke Lake Watershed, 2005 to 2019

Note: See Appendix Tables N.2 to N.15 and M.3 for raw data and Appendix Tables N.20 to N.23 for annual discharge and seepage loading rates.





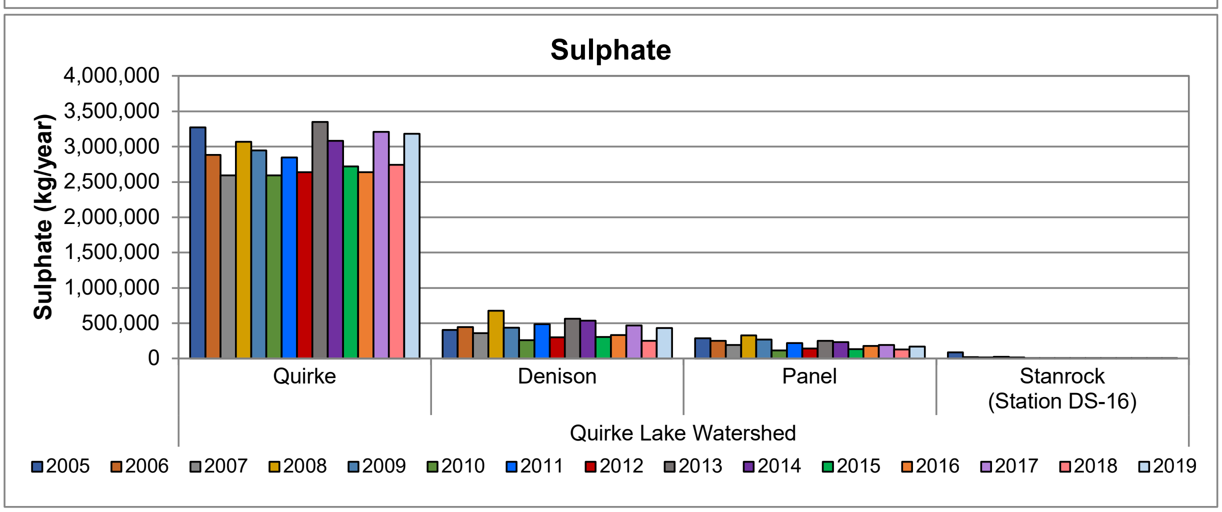


Figure N.13: Annual Loadings from Effluent Discharges from Quirke, Denison, and Panel TMAs, and Seepage from Stanrock TMA to the Quirke Lake Watershed, 2005 to 2019

Note: See Appendix Tables N.2 to N.15 and M.3 for raw data and Appendix Tables N.20 to N.23 for annual discharge and seepage loading rates.

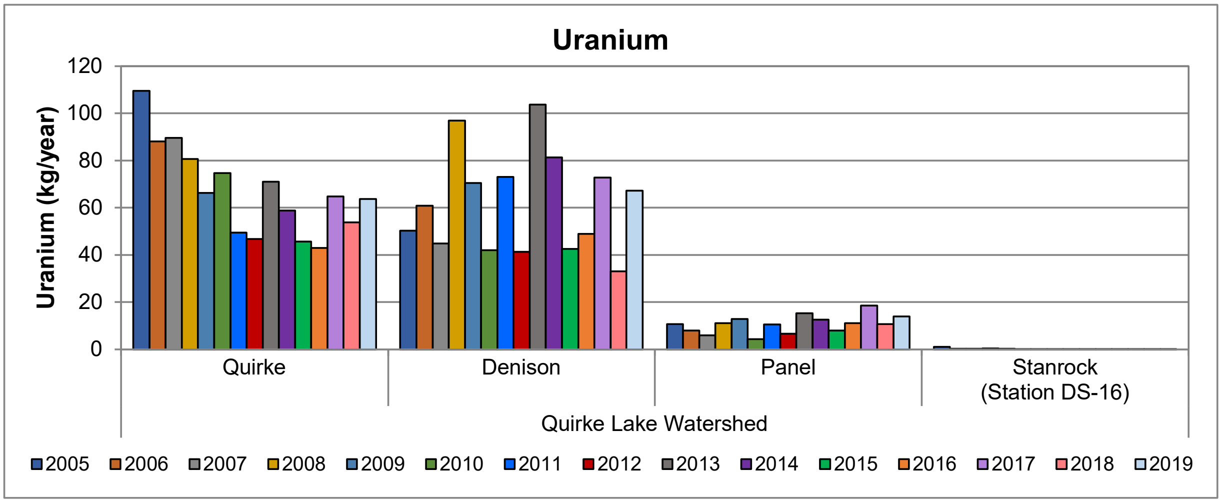


Figure N.13: Annual Loadings from Effluent Discharges from Quirke, Denison, and Panel TMAs, and Seepage from Stanrock TMA to the Quirke Lake Watershed, 2005 to 2019

Note: See Appendix Tables N.2 to N.15 and M.3 for raw data and Appendix Tables N.20 to N.23 for annual discharge and seepage loading rates.

Table N.1: Location of SAMP Data Tables and Figures Within this Cycle 5 SOE Report, Quirke Lake Sub-Watershed

TMA	SAMP Station ID	Type	Description	Also a TOMP or SRWMP Station?	Map Figures	Water Quality Data Tables (barium, cobalt, hardness, iron, manganese, pH, radium-226, sulphate, and/or uranium)	Flow Data Tables	Flow Data Figures	Toxicity Data Tables	Trend Tables	Water Quality / Trend Figures	Loadings Tables	Loadings Figures	Percent Contribution to Loadings Figures	TMA Plant Operations Tables
Denison	D-2	Principal	Stollery Lake Outlet	TOMP	4.1, 4.2	N.2	N.2	N.8	4.14	4.17	N.1 to N.8	N.21	N.10, N.13	N.10	N.16, N.17
	D-3	Principal	TMA-2 Effluent at Denison Mine access road	TOMP	4.1, 4.2	N.3	N.3	N.8	na	4.17	N.1 to N.8	N.21	N.10, N.13		N.16, N.17
	D-9	Seepage	Seepage at Dam 17	no	4.1, 4.2	N.4	N.4	N.8	na	4.17	N.1 to N.8	N.21	N.10, N.13		N.16, N.17
	D-16	Seepage	Seepage at Dam 9	no	4.1, 4.2	N.5	N.5	N.8	na	4.17	N.1 to N.8	N.21	N.10, N.13		N.16, N.17
Quirke	ECA-398	Seepage	Quirke II north of access road	no	4.1, 4.3	N.6	N.6	N.8	na	4.17	N.1 to N.8	N.22	N.11, N.13	N.11	N.18
	Q-22	Drainage	Quirke II Drainage south of access road	no	4.1, 4.3	N.7	N.7	N.8	na	4.17	N.1 to N.8	N.22	N.11, N.13		N.18
	Q-23	Drainage	Swamp Outlet west of Dam K1	no	4.1, 4.3	N.8	N.8	N.8	na	4.17	N.1 to N.8	N.22	N.11, N.13		N.18
	Q-27	Seepage	Dam J Toe Seepage	no	4.1, 4.3	N.9	N.9	N.8	na	4.17	N.1 to N.8	N.22	N.11, N.13		N.18
	Q-28	Principal	Final Treated Effluent	TOMP	4.1, 4.3	N.10	N.10	N.8	4.15	4.17	N.1 to N.8	N.22	N.11, N.13		N.18
Panel	P-02	Seepage	Downstream of Dam B	no	4.1, 4.4	N.11	N.11	N.8	na	4.17	N.1 to N.8	N.23	N.12, N.13	N.12	N.19
	P-03	Drainage	Beaver Pond C Outlet	no	4.1, 4.4	N.12	N.12	N.8	na	4.17	N.1 to N.8	N.23	N.12, N.13		N.19
	P-05	Drainage	Swamp Outlet north of Dam E	no	4.1, 4.4	N.13	N.13	N.8	na	4.17	N.1 to N.8	N.23	N.12, N.13		N.19
	P-11	Drainage	Panel Creek Outlet at Quirke Lake	no	4.1, 4.4	N.14	N.14	N.8	na	4.17	N.1 to N.8	N.23	N.12, N.13		N.19
	P-14	Principal	Final Treated Effluent	TOMP	4.1, 4.4	N.15	N.15	N.8	4.16	4.17	N.1 to N.8	N.23	N.12, N.13		N.19
Stanrock	DS-16	Drainage	Quirke Lake Delta	no	3.1, 3.2	M.3	M.3	N.8	na	4.17	N.1 to N.8	N.20	M.10, N.13	M.10	M.5

Notes: na = parameter not measured at this station (as per study design); therefore, data presentation is not applicable.

Table N.2: Water Quality at SAMP Principal Station D-2, Located at Stollery Lake Outlet, Denison TMA, 2015 to 2019

Date	Flow (L/s)	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)	Sublethal Toxicity (*Ceriodaphnia dubia*) IC25	Acute Toxicity (*Daphnia magna*) % Mortality	Acute Toxicity (Rainbow Trout) % Mortality
06-Jan-15	66.0	-	7.20	-	0.258	-	-	-	-	-	-	-	-
13-Jan-15	66.0	235	7.20	190	0.209	0.318	0.000600	0.270	0.204	0.0301	-	-	-
20-Jan-15	57.0	-	7.10	-	0.199	-	-	-	-	-	-	-	-
27-Jan-15	52.0	-	7.10	-	0.184	-	-	-	-	-	-	-	-
03-Feb-15	52.0	-	6.90	-	0.167	-	-	-	-	-	-	-	-
10-Feb-15	52.0	252	7.00	180	0.151	0.238	0.000600	0.250	0.178	0.0305	-	-	-
17-Feb-15	46.0	-	7.10	-	0.147	-	-	-	-	-	-	-	-
24-Feb-15	41.0	-	7.00	-	0.123	-	-	-	-	-	-	-	-
03-Mar-15	41.0	-	7.20	-	0.116	-	-	-	-	-	-	-	-
09-Mar-15	39.0	-	6.90	-	0.0970	-	-	-	-	-	-	-	-
17-Mar-15	36.0	237	7.06	180	0.107	0.166	0.000600	0.310	0.208	0.0304	-	-	-
24-Mar-15	39.0	-	7.00	-	0.108	-	-	-	-	-	-	-	-
31-Mar-15	36.0	-	6.90	-	0.106	-	-	-	-	-	-	-	-
07-Apr-15	34.0	-	7.10	-	0.108	-	-	-	-	-	-	-	-
14-Apr-15	39.0	202	6.70	140	0.0830	0.134	<0.000500	0.250	0.180	0.0236	-	-	-
21-Apr-15	60.0	-	6.90	-	0.0840	-	-	-	-	-	-	-	-
28-Apr-15	63.0	-	6.90	-	0.0940	-	-	-	-	-	-	-	-
05-May-15	49.0	-	7.00	-	0.0940	-	-	-	-	-	-	-	-
12-May-15	44.0	224	7.00	200	0.100	0.160	0.000500	0.280	0.217	0.0283	100	0	0
19-May-15	23.0	-	6.80	-	0.0940	-	-	-	-	-	-	-	-
26-May-15	52.0	-	7.20	-	0.102	-	-	-	-	-	-	-	-
02-Jun-15	52.0	-	7.00	-	0.102	-	-	-	-	-	-	-	-
09-Jun-15	12.0	269	7.00	220	0.0940	0.120	0.000600	0.140	0.285	0.0326	-	-	-
16-Jun-15	17.0	-	6.90	-	0.0770	-	-	-	-	-	-	-	-
23-Jun-15	17.0	-	6.90	-	0.0770	-	-	-	-	-	-	-	-
29-Jun-15	17.0	-	6.80	-	0.0540	-	-	-	-	-	-	-	-
07-Jul-15	17.0	-	7.30	-	0.0670	-	-	-	-	-	-	-	-
14-Jul-15	11.0	316	7.20	260	0.0480	0.0770	<0.000500	0.0700	0.188	0.0399	-	-	-
21-Jul-15	8.00	-	7.20	-	0.0490	-	-	-	-	-	-	-	-
28-Jul-15	7.00	-	7.40	-	0.0390	-	-	-	-	-	-	-	-
04-Aug-15	4.00	-	7.10	-	0.0210	-	-	-	-	-	-	-	-
11-Aug-15	8.00	329	7.30	290	0.0500	0.0640	<0.000500	0.0700	0.159	0.0507	-	-	-
18-Aug-15	7.00	-	7.20	-	0.0520	-	-	-	-	-	-	-	-
25-Aug-15	16.0	-	7.40	-	0.0550	-	-	-	-	-	-	-	-
01-Sep-15	16.0	-	7.30	-	0.0800	-	-	-	-	-	-	-	-
08-Sep-15	12.0	-	7.36	-	0.0460	-	-	-	-	-	-	-	-
15-Sep-15	17.0	352	7.40	300	0.0390	0.0510	<0.000500	0.0740	0.116	0.0465	-	-	-
22-Sep-15	17.0	-	7.20	-	0.0450	-	-	-	-	-	-	-	-
29-Sep-15	17.0	-	7.40	-	0.0390	-	-	-	-	-	-	-	-
07-Oct-15	17.0	-	7.50	-	0.162	-	-	-	-	-	-	-	-
13-Oct-15	12.0	402	7.20	310	0.157	0.139	0.000600	0.108	0.244	0.0619	-	-	-
20-Oct-15	9.00	-	7.00	-	0.199	-	-	-	-	-	-	-	-
27-Oct-15	17.0	-	7.10	-	0.158	-	-	-	-	-	-	-	-
03-Nov-15	23.0	-	7.24	-	0.186	-	-	-	-	-	-	-	-
10-Nov-15	23.0	-	7.40	-	0.166	-	-	-	-	-	-	-	-
17-Nov-15	17.0	366	7.40	320	0.157	0.120	0.00100	0.152	0.273	0.0629	100	0	0

Table N.2: Water Quality at SAMP Principal Station D-2, Located at Stollery Lake Outlet, Denison TMA, 2015 to 2019

Date	Flow (L/s)	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)	Sublethal Toxicity (*Ceriodaphnia dubia*) IC25	Acute Toxicity (*Daphnia magna*) % Mortality	Acute Toxicity (Rainbow Trout) % Mortality
24-Nov-15	27.0	-	7.40	-	0.166	-	-	-	-	-	-	-	-
01-Dec-15	25.0	-	7.50	-	0.126	-	-	-	-	-	-	-	-
08-Dec-15	19.0	377	7.40	310	0.0900	0.0940	0.00110	0.155	0.290	0.0622	-	-	-
15-Dec-15	75.0	-	7.50	-	0.138	-	-	-	-	-	-	-	-
22-Dec-15	133	-	7.60	-	0.195	-	-	-	-	-	-	-	-
29-Dec-15	97.0	-	7.50	-	0.234	-	-	-	-	-	-	-	-
n	52	12	52	12	52	12	12	12	12	12	2	2	2
Minimum	4.00	202	6.70	140	0.0210	0.0510	<0.0005	0.0700	0.116	0.0236	100	0	0
Maximum	133	402	7.60	320	0.258	0.318	0.00110	0.310	0.290	0.0629	100	0	0
Mean	33.7	297	7.16	242	0.113	0.140	0.000633	0.177	0.212	0.0416	100	0	0
SD	25.2	68.2	0.218	63.5	0.0568	0.0757	0.000206	0.0896	0.0531	0.0147	-	-	-
05-Jan-16	84.0	-	7.40	-	0.356	-	-	-	-	-	-	-	-
12-Jan-16	153	223	7.20	190	0.266	0.319	0.000800	0.289	0.164	0.0354	-	-	-
19-Jan-16	75.0	-	7.10	-	0.223	-	-	-	-	-	-	-	-
26-Jan-16	81.0	-	7.10	-	0.244	-	-	-	-	-	-	-	-
02-Feb-16	81.0	-	7.00	-	0.272	-	-	-	-	-	-	-	-
09-Feb-16	72.0	212	7.00	180	0.223	0.272	0.000600	0.373	0.141	0.0313	-	-	-
16-Feb-16	75.0	-	7.00	-	0.242	-	-	-	-	-	-	-	-
23-Feb-16	69.0	-	7.00	-	0.232	-	-	-	-	-	-	-	-
01-Mar-16	57.0	-	6.90	-	0.217	-	-	-	-	-	-	-	-
08-Mar-16	52.0	247	7.00	180	0.133	0.289	0.000600	0.447	0.127	0.0310	-	-	-
15-Mar-16	173	-	6.91	-	0.319	-	-	-	-	-	-	-	-
22-Mar-16	115	-	6.60	-	0.412	-	-	-	-	-	-	-	-
29-Mar-16	118	-	6.70	-	0.421	-	-	-	-	-	-	-	-
05-Apr-16	84.0	-	7.10	-	0.386	-	-	-	-	-	-	-	-
12-Apr-16	36.0	180	7.10	130	0.402	0.565	<0.000500	0.339	0.111	0.0223	-	-	-
19-Apr-16	87.0	-	6.90	-	0.301	-	-	-	-	-	-	-	-
26-Apr-16	52.0	-	7.00	-	0.268	-	-	-	-	-	-	-	-
03-May-16	72.0	-	7.00	-	0.248	-	-	-	-	-	-	-	-
10-May-16	126	237	7.60	150	0.249	0.376	0.000700	0.360	0.198	0.0251	100	0	0
17-May-16	97.0	-	7.20	-	0.174	-	-	-	-	-	-	-	-
24-May-16	19.0	-	7.10	-	0.157	-	-	-	-	-	-	-	-
31-May-16	17.0	-	6.90	-	0.107	-	-	-	-	-	-	-	-
07-Jun-16	17.0	-	7.00	-	0.103	-	-	-	-	-	-	-	-
14-Jun-16	12.0	263	7.00	200	0.0900	0.161	<0.000500	0.151	0.103	0.0294	-	-	-
21-Jun-16	32.0	-	7.10	-	0.101	-	-	-	-	-	-	-	-
28-Jun-16	14.0	-	7.00	-	0.0840	-	-	-	-	-	-	-	-
05-Jul-16	17.0	-	7.10	-	0.0430	-	-	-	-	-	-	-	-
12-Jul-16	9.00	289	7.10	220	0.0610	0.103	<0.000500	0.0700	0.0830	0.0370	-	-	-
19-Jul-16	17.0	-	7.10	-	0.0600	-	-	-	-	-	-	-	-
26-Jul-16	9.00	-	7.00	-	0.0590	-	-	-	-	-	-	-	-
02-Aug-16	9.00	-	7.00	-	0.0430	-	-	-	-	-	-	-	-
09-Aug-16	5.00	319	7.30	260	0.0330	0.0850	<0.000500	0.0630	0.0760	0.0450	-	-	-
16-Aug-16	7.00	-	7.00	-	0.0440	-	-	-	-	-	-	-	-
23-Aug-16	9.00	-	6.90	-	0.0440	-	-	-	-	-	-	-	-
30-Aug-16	9.00	-	6.90	-	0.0500	-	-	-	-	-	-	-	-

Table N.2: **Water Quality at SAMP Principal Station D-2, Located at Stollery Lake Outlet, Denison TMA, 2015 to 2019**

Date	Flow (L/s)	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)	Sublethal Toxicity (*Ceriodaphnia dubia*) IC25	Acute Toxicity (*Daphnia magna*) % Mortality	Acute Toxicity (Rainbow Trout) % Mortality
06-Sep-16	9.00	-	7.10	-	0.0370	-	-	-	-	-	-	-	-
13-Sep-16	9.00	350	7.00	280	0.0400	0.0720	<0.000500	0.0840	0.0720	0.0504	-	-	-
20-Sep-16	9.00	-	7.20	-	0.0310	-	-	-	-	-	-	-	-
27-Sep-16	12.0	-	7.30	-	0.0580	-	-	-	-	-	-	-	-
04-Oct-16	17.0	-	7.30	-	0.0450	-	-	-	-	-	-	-	-
11-Oct-16	19.0	379	7.30	300	0.0820	0.0700	<0.000500	0.0860	0.146	0.0518	100	0	0
18-Oct-16	17.0	-	7.30	-	0.0770	-	-	-	-	-	-	-	-
25-Oct-16	17.0	-	7.10	-	0.0890	-	-	-	-	-	-	-	-
01-Nov-16	17.0	-	7.20	-	0.122	-	-	-	-	-	-	-	-
08-Nov-16	17.0	378	7.10	310	0.0880	0.0800	0.000600	0.116	0.152	0.0586	-	-	-
15-Nov-16	17.0	-	7.60	-	0.0850	-	-	-	-	-	-	-	-
22-Nov-16	9.00	-	7.20	-	0.0890	-	-	-	-	-	-	-	-
29-Nov-16	0.160	-	7.00	-	0.0840	-	-	-	-	-	-	-	-
06-Dec-16	17.0	-	7.10	-	0.0960	-	-	-	-	-	-	-	-
13-Dec-16	17.0	377	7.20	330	0.0700	0.0790	0.000900	0.214	0.212	0.0579	-	-	-
20-Dec-16	21.0	-	7.10	-	0.0570	-	-	-	-	-	-	-	-
29-Dec-16	17.0	-	7.10	-	0.0110	-	-	-	-	-	-	-	-
n	52	12	52	12	52	12	12	12	12	12	2	2	2
Minimum	0.160	180	6.60	130	0.0110	0.0700	<0.0005	0.0630	0.0720	0.0223	100	0	0
Maximum	173	379	7.60	330	0.421	0.565	0.000900	0.447	0.212	0.0586	100	0	0
Mean	42.3	288	7.09	228	0.151	0.206	0.000600	0.216	0.132	0.0396	100	0	0
SD	42.2	71.1	0.179	66.5	0.116	0.159	0.000105	0.139	0.0456	0.0127	-	-	-
03-Jan-17	27.0	-	7.00	-	0.0250	-	-	-	-	-	-	-	-
10-Jan-17	17.0	376	6.90	320	0.0450	0.0570	0.000900	0.313	0.214	0.0550	-	-	-
17-Jan-17	17.0	-	7.10	-	0.0430	-	-	-	-	-	-	-	-
24-Jan-17	27.0	-	6.80	-	0.0270	-	-	-	-	-	-	-	-
31-Jan-17	17.0	-	7.00	-	0.0320	-	-	-	-	-	-	-	-
07-Feb-17	9.00	-	6.80	-	0.0190	-	-	-	-	-	-	-	-
14-Feb-17	9.00	421	7.10	320	0.0460	0.0670	0.00110	0.437	0.251	0.0615	-	-	-
21-Feb-17	17.0	-	6.80	-	0.0600	-	-	-	-	-	-	-	-
28-Feb-17	39.0	-	7.10	-	0.0880	-	-	-	-	-	-	-	-
07-Mar-17	66.0	-	6.90	-	0.0200	-	-	-	-	-	-	-	-
14-Mar-17	173	-	7.00	-	0.306	-	-	-	-	-	-	-	-
21-Mar-17	240	298	7.00	200	0.292	0.409	0.000700	0.540	0.168	0.0414	-	-	-
28-Mar-17	97.0	-	7.20	-	0.252	-	-	-	-	-	-	-	-
04-Apr-17	81.0	-	7.00	-	0.128	-	-	-	-	-	-	-	-
11-Apr-17	194	209	7.00	140	0.174	0.261	0.000700	0.609	0.172	0.0239	-	-	-
18-Apr-17	115	-	7.00	-	0.148	-	-	-	-	-	-	-	-
25-Apr-17	52.0	-	7.20	-	0.168	-	-	-	-	-	-	-	-
02-May-17	66.0	-	7.30	-	0.165	-	-	-	-	-	-	-	-
09-May-17	39.0	-	7.50	-	0.164	-	-	-	-	-	-	-	-
16-May-17	39.0	-	7.40	-	0.113	-	-	-	-	-	-	-	-
23-May-17	52.0	356	7.50	240	0.121	0.161	0.000600	0.315	0.182	0.0393	100	0	0
30-May-17	39.0	-	7.40	-	0.145	-	-	-	-	-	-	-	-
06-Jun-17	87.0	-	7.60	-	0.124	-	-	-	-	-	-	-	-
13-Jun-17	17.0	297	7.50	220	0.150	0.217	<0.000500	0.151	0.129	0.0375	-	-	-

Table N.2: Water Quality at SAMP Principal Station D-2, Located at Stollery Lake Outlet, Denison TMA, 2015 to 2019

Date	Flow (L/s)	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)	Sublethal Toxicity (*Ceriodaphnia dubia*) IC25	Acute Toxicity (*Daphnia magna*) % Mortality	Acute Toxicity (Rainbow Trout) % Mortality
20-Jun-17	52.0	-	7.50	-	0.133	-	-	-	-	-	-	-	-
27-Jun-17	52.0	-	7.60	-	0.150	-	-	-	-	-	-	-	-
04-Jul-17	115	-	7.40	-	0.116	-	-	-	-	-	-	-	-
11-Jul-17	69.0	290	7.30	200	0.108	0.235	<0.000500	0.126	0.117	0.0335	-	-	-
18-Jul-17	72.0	-	7.50	-	0.143	-	-	-	-	-	-	-	-
25-Jul-17	9.00	-	7.40	-	0.113	-	-	-	-	-	-	-	-
01-Aug-17	17.0	-	7.40	-	0.0690	-	-	-	-	-	-	-	-
08-Aug-17	17.0	281	7.20	220	0.100	0.147	<0.000500	0.139	0.0890	0.0326	-	-	-
15-Aug-17	21.0	-	7.40	-	0.0780	-	-	-	-	-	-	-	-
22-Aug-17	21.0	-	7.40	-	0.0970	-	-	-	-	-	-	-	-
29-Aug-17	17.0	-	7.40	-	0.0680	-	-	-	-	-	-	-	-
05-Sep-17	17.0	-	7.40	-	0.0650	-	-	-	-	-	-	-	-
12-Sep-17	14.0	294	7.50	240	0.0640	0.105	<0.000500	0.200	0.125	0.0388	-	-	-
19-Sep-17	14.0	-	7.40	-	0.0460	-	-	-	-	-	-	-	-
26-Sep-17	14.0	-	7.50	-	0.0340	-	-	-	-	-	-	-	-
03-Oct-17	12.0	-	7.30	-	0.0420	-	-	-	-	-	-	-	-
12-Oct-17	16.0	349	7.40	270	0.0550	0.0970	<0.000500	0.120	0.109	0.0399	100	0	0
17-Oct-17	21.0	-	7.00	-	0.109	-	-	-	-	-	-	-	-
25-Oct-17	203	-	7.50	-	0.180	-	-	-	-	-	-	-	-
31-Oct-17	81.0	-	7.20	-	0.194	-	-	-	-	-	-	-	-
07-Nov-17	81.0	-	7.20	-	0.149	-	-	-	-	-	-	-	-
14-Nov-17	81.0	278	7.50	210	0.205	0.333	0.000600	0.134	0.178	0.0328	-	-	-
21-Nov-17	81.0	-	7.40	-	0.149	-	-	-	-	-	-	-	-
28-Nov-17	81.0	-	7.40	-	0.156	-	-	-	-	-	-	-	-
05-Dec-17	194	-	7.20	-	0.185	-	-	-	-	-	-	-	-
12-Dec-17	81.0	221	7.30	190	0.231	0.370	0.000600	0.204	0.150	0.0318	-	-	-
19-Dec-17	39.0	-	7.30	-	0.239	-	-	-	-	-	-	-	-
27-Dec-17	52.0	-	7.40	-	0.273	-	-	-	-	-	-	-	-
n	52	12	52	12	52	12	12	12	12	12	2	2	2
Minimum	9.00	209	6.80	140	0.0190	0.0570	<0.0005	0.120	0.0890	0.0239	100	0	0
Maximum	240	421	7.60	320	0.306	0.409	0.00110	0.609	0.251	0.0615	100	0	0
Mean	59.2	306	7.26	231	0.123	0.205	0.000642	0.274	0.157	0.0390	100	0	0
SD	55.5	61.1	0.224	52.3	0.0731	0.120	0.000164	0.171	0.0466	0.0103	-	-	-
02-Jan-18	87.0	-	7.00	-	0.233	-	-	-	-	-	-	-	-
09-Jan-18	87.0	213	7.10	160	0.230	0.451	0.000500	0.449	0.123	0.0241	-	-	-
16-Jan-18	66.0	-	7.20	-	0.264	-	-	-	-	-	-	-	-
23-Jan-18	66.0	-	7.20	-	0.299	-	-	-	-	-	-	-	-
30-Jan-18	87.0	-	7.10	-	0.357	-	-	-	-	-	-	-	-
06-Feb-18	73.0	-	7.10	-	0.344	-	-	-	-	-	-	-	-
13-Feb-18	87.0	272	7.20	140	0.338	0.533	0.000500	0.569	0.144	0.0195	-	-	-
20-Feb-18	39.0	-	7.30	-	0.405	-	-	-	-	-	-	-	-
27-Feb-18	87.0	-	7.30	-	0.390	-	-	-	-	-	-	-	-
06-Mar-18	60.0	-	7.40	-	0.422	-	-	-	-	-	-	-	-
13-Mar-18	39.0	223	7.30	140	0.289	0.454	0.000500	0.593	0.125	0.0196	-	-	-
20-Mar-18	39.0	-	7.30	-	0.199	0.395	-	-	-	-	-	-	-
27-Mar-18	39.0	-	7.20	-	0.186	0.314	-	-	-	-	-	-	-

Table N.2: Water Quality at SAMP Principal Station D-2, Located at Stollery Lake Outlet, Denison TMA, 2015 to 2019

Date	Flow (L/s)	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)	Sublethal Toxicity (*Ceriodaphnia dubia*) IC25	Acute Toxicity (*Daphnia magna*) % Mortality	Acute Toxicity (Rainbow Trout) % Mortality
03-Apr-18	39.0	-	7.30	-	0.140	0.340	-	-	-	-	-	-	-
10-Apr-18	39.0	249	7.20	150	0.126	0.343	0.000500	0.455	0.186	0.0234	-	-	-
17-Apr-18	60.0	-	7.00	-	0.115	0.300	-	-	-	-	-	-	-
24-Apr-18	87.0	-	7.20	-	0.184	0.541	-	-	-	-	-	-	-
01-May-18	97.0	-	7.10	-	0.231	0.742	-	-	-	-	-	-	-
08-May-18	115	123	7.00	98.0	0.203	0.450	<0.000500	0.334	0.161	0.0134	-	-	-
15-May-18	115	-	7.30	-	0.283	0.537	-	-	-	-	-	-	-
22-May-18	97.0	-	7.60	-	0.287	0.546	-	-	-	-	-	-	-
29-May-18	97.0	-	7.50	-	0.374	0.580	-	-	-	-	-	-	-
05-Jun-18	29.0	-	7.30	-	0.214	0.381	-	-	-	-	-	-	-
12-Jun-18	27.0	-	7.40	-	0.161	0.319	-	-	-	-	-	-	-
19-Jun-18	17.0	203	7.30	170	0.113	0.293	<0.000500	0.142	0.153	0.0198	100	0	0
26-Jun-18	16.0	-	7.40	-	0.114	0.250	-	-	-	-	-	-	-
03-Jul-18	16.0	-	7.30	-	0.116	0.273	-	-	-	-	-	-	-
10-Jul-18	14.0	237	7.00	190	0.0730	0.228	<0.000500	0.130	0.0970	0.0283	-	-	-
17-Jul-18	16.0	-	7.00	-	0.0530	0.213	-	-	-	-	-	-	-
24-Jul-18	13.0	-	7.30	-	0.0710	0.162	-	-	-	-	-	-	-
31-Jul-18	9.00	-	7.20	-	0.0580	0.181	-	-	-	-	-	-	-
07-Aug-18	12.0	-	7.30	-	0.0440	0.113	-	-	-	-	-	-	-
14-Aug-18	9.00	270	7.30	240	0.0380	0.107	<0.000500	0.0800	0.116	0.0360	-	-	-
21-Aug-18	8.00	-	7.20	-	0.0400	0.108	-	-	-	-	-	-	-
28-Aug-18	9.00	-	7.20	-	0.0380	0.100	-	-	-	-	-	-	-
04-Sep-18	9.00	-	7.10	-	0.0400	0.0980	-	-	-	-	-	-	-
11-Sep-18	9.00	280	7.00	230	0.0470	0.0790	<0.000500	0.0830	0.0730	0.0357	-	-	-
18-Sep-18	9.00	-	7.10	-	0.0290	0.0750	-	-	-	-	-	-	-
25-Sep-18	9.00	-	7.10	-	0.0530	0.0890	-	-	-	-	-	-	-
02-Oct-18	27.0	-	7.20	-	0.0620	0.0840	-	-	-	-	-	-	-
09-Oct-18	19.0	266	7.00	240	0.132	0.107	0.000700	0.123	0.234	0.0467	-	-	-
16-Oct-18	27.0	-	7.30	-	0.199	-	-	-	-	-	-	-	-
23-Oct-18	23.0	-	7.20	-	0.152	-	-	-	-	-	-	-	-
30-Oct-18	27.0	-	7.20	-	0.117	-	-	-	-	-	-	-	-
06-Nov-18	17.0	-	7.20	-	0.118	-	-	-	-	-	-	-	-
13-Nov-18	17.0	303	7.30	250	0.108	0.100	0.000800	0.168	0.238	0.0475	-	-	-
20-Nov-18	23.0	-	7.00	-	0.0590	-	-	-	-	-	-	-	-
27-Nov-18	17.0	-	7.50	-	0.0320	-	-	-	-	-	-	-	-
04-Dec-18	19.0	319	7.40	270	0.0380	0.0460	0.000700	0.107	0.228	0.0507	100	0	0
11-Dec-18	17.0	-	7.30	-	0.0440	-	-	-	-	-	-	-	-
18-Dec-18	16.0	-	7.30	-	0.0490	-	-	-	-	-	-	-	-
27-Dec-18	14.0	-	6.90	-	0.0510	-	-	-	-	-	-	-	-
n	52	12	52	12	52	35	12	12	12	12	2	2	2
Minimum	8.00	123	6.90	98.0	0.0290	0.0460	<0.0005	0.0800	0.0730	0.0134	100	0	0
Maximum	115	319	7.60	270	0.422	0.742	0.000800	0.593	0.238	0.0507	100	0	0
Mean	40.3	246	7.22	190	0.161	0.284	0.000558	0.269	0.156	0.0304	100	0	0
SD	32.9	52.3	0.149	54.7	0.116	0.184	0.000112	0.198	0.0548	0.0126	-	-	-
02-Jan-19	16.0	-	6.90	-	0.0520	-	-	-	-	-	-	-	-
08-Jan-19	17.0	310	7.00	260	0.0460	0.0560	0.000800	0.206	0.260	0.0472	-	-	-

Table N.2: Water Quality at SAMP Principal Station D-2, Located at Stollery Lake Outlet, Denison TMA, 2015 to 2019

Date	Flow (L/s)	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)	Sublethal Toxicity (*Ceriodaphnia dubia*) IC25	Acute Toxicity (*Daphnia magna*) % Mortality	Acute Toxicity (Rainbow Trout) % Mortality
15-Jan-19	17.0	-	7.20	-	0.0410	-	-	-	-	-	-	-	-
22-Jan-19	17.0	-	7.20	-	0.0440	-	-	-	-	-	-	-	-
29-Jan-19	17.0	-	7.30	-	0.0340	-	-	-	-	-	-	-	-
05-Feb-19	9.00	-	7.10	-	0.0340	-	-	-	-	-	-	-	-
12-Feb-19	14.0	290	7.10	240	0.0550	0.0810	0.000900	0.176	0.429	0.0555	-	-	-
19-Feb-19	17.0	-	7.20	-	0.133	-	-	-	-	-	-	-	-
26-Feb-19	97.0	-	7.30	-	0.198	-	-	-	-	-	-	-	-
04-Mar-19	97.0	-	7.30	-	0.300	-	-	-	-	-	-	-	-
12-Mar-19	66.0	227	7.40	150	0.276	0.474	0.000700	0.544	0.198	0.0299	-	-	-
19-Mar-19	52.0	-	7.40	-	0.220	0.517	-	-	-	-	-	-	-
26-Mar-19	89.0	-	7.40	-	0.270	0.588	-	-	-	-	-	-	-
02-Apr-19	104	-	7.30	-	0.226	0.663	-	-	-	-	-	-	-
09-Apr-19	194	205	7.40	150	0.300	0.616	0.000700	0.341	0.223	0.0225	-	-	-
16-Apr-19	115	-	7.30	-	0.401	0.859	-	-	-	-	-	-	-
22-Apr-19	173	-	7.10	-	0.263	-	-	-	-	-	-	-	-
29-Apr-19	340	-	6.90	-	0.304	1.13	-	-	-	-	-	-	-
07-May-19	203	-	6.90	-	0.132	0.724	-	-	-	-	-	-	-
14-May-19	153	154	7.30	120	0.126	0.368	0.000500	0.216	0.226	0.0176	100	0	0
21-May-19	173	-	7.50	-	0.128	0.481	-	-	-	-	-	-	-
28-May-19	133	-	7.60	-	0.171	0.604	-	-	-	-	-	-	-
04-Jun-19	97.0	-	7.60	-	0.204	0.840	-	-	-	-	-	-	-
11-Jun-19	122	185	7.60	130	0.260	0.696	0.000500	0.213	0.201	0.0197	-	-	-
17-Jun-19	97.0	-	7.60	-	0.240	0.663	-	-	-	-	-	-	-
25-Jun-19	133	-	7.10	-	0.243	0.707	-	-	-	-	-	-	-
02-Jul-19	122	-	7.10	-	0.240	0.760	-	-	-	-	-	-	-
09-Jul-19	39.0	180	7.40	120	0.212	0.667	<0.000500	0.122	0.129	0.0176	-	-	-
16-Jul-19	23.0	-	7.00	-	0.150	0.524	-	-	-	-	-	-	-
23-Jul-19	16.0	-	7.40	-	0.122	0.372	-	-	-	-	-	-	-
30-Jul-19	16.0	-	7.00	-	0.0950	0.384	-	-	-	-	-	-	-
06-Aug-19	14.0	-	7.20	-	0.0820	0.289	-	-	-	-	-	-	-
13-Aug-19	14.0	204	7.20	160	0.0680	0.221	<0.000500	0.0890	0.0840	0.0230	-	-	-
20-Aug-19	12.0	-	7.10	-	0.0320	0.185	-	-	-	-	-	-	-
27-Aug-19	16.0	-	7.00	-	0.0430	0.198	-	-	-	-	-	-	-
03-Sep-19	9.00	-	7.30	-	0.0440	0.219	-	-	-	-	-	-	-
10-Sep-19	14.0	264	7.00	190	0.0470	0.118	<0.000500	0.0780	0.0450	0.0334	-	-	-
17-Sep-19	16.0	-	7.40	-	0.0390	0.108	-	-	-	-	-	-	-
24-Sep-19	17.0	-	7.40	-	0.0380	0.0760	-	-	-	-	-	-	-
01-Oct-19	27.0	-	7.10	-	0.0510	0.111	-	-	-	-	-	-	-
08-Oct-19	17.0	286	7.30	230	0.0740	0.102	<0.000500	0.105	0.191	0.0447	-	-	-
15-Oct-19	21.0	-	7.00	-	0.0810	0.0950	-	-	-	-	-	-	-
22-Oct-19	130	-	6.70	-	0.100	0.131	-	-	-	-	-	-	-
29-Oct-19	113	-	7.30	-	0.245	0.223	-	-	-	-	-	-	-
05-Nov-19	106	-	7.00	-	0.111	0.134	-	-	-	-	-	-	-
12-Nov-19	39.0	279	7.20	220	0.140	0.200	0.000800	0.206	0.241	0.0458	100	0	0
19-Nov-19	49.0	-	7.20	-	0.127	0.211	-	-	-	-	-	-	-
26-Nov-19	66.0	-	7.20	-	0.170	0.308	-	-	-	-	-	-	-

Table N.2: Water Quality at SAMP Principal Station D-2, Located at Stollery Lake Outlet, Denison TMA, 2015 to 2019

Date	Flow (L/s)	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)	Sublethal Toxicity (*Ceriodaphnia dubia*) IC25	Acute Toxicity (*Daphnia magna*) % Mortality	Acute Toxicity (Rainbow Trout) % Mortality
03-Dec-19	52.0	-	7.20	-	0.195	0.378	-	-	-	-	-	-	-
10-Dec-19	57.0	249	7.10	180	0.222	0.460	0.000600	0.362	0.182	0.0325	-	-	-
16-Dec-19	52.0	-	7.00	-	0.265	0.446	-	-	-	-	-	-	-
23-Dec-19	66.0	-	7.20	-	0.224	0.433	-	-	-	-	-	-	-
30-Dec-19	72.0	-	7.10	-	0.146	0.366	-	-	-	-	-	-	-
n	53	12	53	12	53	44	12	12	12	12	2	2	2
Minimum	9.00	154	6.70	120	0.0320	0.0560	<0.0005	0.0780	0.0450	0.0176	100	0	0
Maximum	340	310	7.60	260	0.401	1.13	0.000900	0.544	0.429	0.0555	100	0	0
Mean	70.9	236	7.21	179	0.152	0.404	0.000625	0.222	0.201	0.0324	100	0	0
SD	66.2	50.7	0.199	48.7	0.0941	0.260	0.000152	0.136	0.0962	0.0131	-	-	-
Summary Statistics for 2015 to 2019													
n	261	60	261	60	261	115	60	60	60	60	10	10	10
Minimum	0.160	123	6.60	98.0	0.0110	0.0460	<0.000500	0.0630	0.0450	0.0134	100	0	0
Maximum	340	421	7.60	330	0.422	1.13	0.00110	0.609	0.429	0.0629	100	0	0
Mean	49.4	275	7.19	214	0.140	0.299	0.000612	0.232	0.172	0.0366	100	0	0
SD	48.6	65.5	0.203	60.9	0.0954	0.221	0.000158	0.150	0.0672	0.0131	-	-	-
Median	27.0	271	7.20	205	0.116	0.235	0.000500	0.188	0.170	0.0334	100	0	0
10th Percentile	9.00	202	6.90	140	0.0400	0.0790	<0.000500	0.0790	0.0865	0.0197	100	0	0
95th Percentile	133	378	7.50	320	0.319	0.724	0.000950	0.556	0.279	0.0617	100	0	0

Note: "-" = no data collected or SD was incalculable because there was no variability in the data. n = number of samples. SD = standard deviation.

Table N.3: Water Quality at SAMP Principal Station D-3, Located at TMA-2 Effluent at Denison Mine Access Road, Denison TMA, 2015 to 2019

Date	Flow (L/s)	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
06-Jan-15	6.00	-	7.10	-	0.132	-	-	-	-	-
13-Jan-15	1.00	107	7.00	71.0	0.115	0.442	<0.000500	0.230	0.0210	0.00300
20-Jan-15	1.00	-	6.90	-	0.106	-	-	-	-	-
27-Jan-15	1.00	-	7.00	-	0.114	-	-	-	-	-
03-Feb-15	1.00	-	6.90	-	0.110	-	-	-	-	-
10-Feb-15	1.00	118	7.20	68.0	0.104	0.315	<0.000500	0.130	0.0140	0.00490
17-Feb-15	1.00	-	7.20	-	0.117	-	-	-	-	-
24-Feb-15	1.00	-	7.00	-	0.248	-	-	-	-	-
03-Mar-15	1.00	-	6.90	-	0.112	-	-	-	-	-
09-Mar-15	3.00	-	7.10	-	0.132	-	-	-	-	-
17-Mar-15	3.00	125	7.21	74.0	0.121	0.218	<0.000500	0.0700	0.0270	0.00950
24-Mar-15	1.00	-	7.20	-	0.122	-	-	-	-	-
31-Mar-15	1.00	-	7.00	-	0.120	-	-	-	-	-
07-Apr-15	1.00	-	7.20	-	0.125	-	-	-	-	-
14-Apr-15	81.0	62.6	6.90	34.0	0.105	0.246	0.000700	0.390	0.243	0.00170
21-Apr-15	84.0	-	7.10	-	0.0740	-	-	-	-	-
28-Apr-15	10.0	-	6.90	-	0.101	-	-	-	-	-
05-May-15	8.00	-	7.20	-	0.101	-	-	-	-	-
12-May-15	26.0	118	7.10	85.0	0.107	0.293	<0.000500	0.130	0.0270	0.00370
19-May-15	7.00	-	6.80	-	0.132	-	-	-	-	-
26-May-15	11.0	-	7.20	-	0.120	-	-	-	-	-
02-Jun-15	10.0	-	6.90	-	0.134	-	-	-	-	-
09-Jun-15	4.00	123	7.00	82.0	0.122	0.273	<0.000500	0.0400	0.00900	0.00310
16-Jun-15	3.00	-	7.10	-	0.116	-	-	-	-	-
23-Jun-15	2.00	-	6.90	-	0.145	-	-	-	-	-
29-Jun-15	<1.00	-	7.00	-	0.154	-	-	-	-	-
07-Jul-15	2.00	-	7.00	-	0.172	-	-	-	-	-
14-Jul-15	<1.00	30.5	6.80	12.0	0.214	0.117	0.00130	1.34	0.317	0.00160
15-Sep-15	<1.00	181	7.40	140	0.175	0.287	<0.000500	0.0390	0.0160	0.00190
22-Sep-15	6.00	-	7.40	-	0.159	-	-	-	-	-
29-Sep-15	5.00	-	7.30	-	0.186	-	-	-	-	-
07-Oct-15	1.00	-	7.60	-	0.183	-	-	-	-	-
13-Oct-15	1.00	179	7.40	120	0.146	0.249	<0.000500	0.0400	0.0110	0.00460
20-Oct-15	1.00	-	7.00	-	0.165	-	-	-	-	-
27-Oct-15	10.0	-	7.20	-	0.118	-	-	-	-	-
03-Nov-15	22.0	-	7.26	-	0.0960	-	-	-	-	-
10-Nov-15	18.0	154	7.30	110	0.0950	0.182	<0.000500	0.0650	0.00300	0.00770
17-Nov-15	10.0	-	7.20	-	0.0910	-	-	-	-	-
24-Nov-15	10.0	-	7.30	-	0.0930	-	-	-	-	-
01-Dec-15	14.0	-	7.50	-	0.0760	-	-	-	-	-
08-Dec-15	8.00	107	7.30	74.0	0.0720	0.169	<0.000500	0.112	<0.00200	0.00290
15-Dec-15	140	-	7.50	-	0.105	-	-	-	-	-
22-Dec-15	18.0	-	7.10	-	0.0710	-	-	-	-	-
29-Dec-15	15.0	-	7.10	-	0.0540	-	-	-	-	-
n	44	11	44	11	44	11	11	11	11	11
Minimum	<1	30.5	6.80	12.0	0.0540	0.117	<0.0005	0.0390	<0.002	0.00160
Maximum	140	181	7.60	140	0.248	0.442	0.00130	1.34	0.317	0.00950
Mean	12.6	119	7.13	79.1	0.124	0.254	0.000591	0.235	0.0627	0.00405
SD	26.2	44.7	0.194	36.3	0.0383	0.0864	0.000244	0.381	0.109	0.00252
05-Jan-16	7.00	-	7.10	-	0.0710	-	-	-	-	-
12-Jan-16	8.00	62.0	7.00	47.0	0.0710	0.171	<0.000500	0.130	0.00400	0.00150
19-Jan-16	4.00	-	6.90	-	0.0670	-	-	-	-	-
26-Jan-16	4.00	-	7.00	-	0.0800	-	-	-	-	-
02-Feb-16	2.00	-	7.20	-	0.0730	-	-	-	-	-
09-Feb-16	3.00	84.8	6.80	60.0	0.0680	0.174	<0.000500	0.0920	0.00300	0.00240
16-Feb-16	3.00	-	7.00	-	0.0700	-	-	-	-	-
23-Feb-16	2.00	-	6.80	-	0.0770	-	-	-	-	-
01-Mar-16	3.00	-	7.10	-	0.0740	-	-	-	-	-
08-Mar-16	3.00	123	7.10	80.0	0.0840	0.206	<0.000500	0.119	0.00400	0.00410
15-Mar-16	46.0	-	7.10	-	0.0780	-	-	-	-	-
22-Mar-16	15.0	-	6.60	-	0.0520	-	-	-	-	-
29-Mar-16	20.0	-	6.80	-	0.0880	-	-	-	-	-
05-Apr-16	13.0	-	7.00	-	0.0710	-	-	-	-	-
12-Apr-16	7.00	77.2	7.00	50.0	0.0740	0.341	<0.000500	0.0840	0.0200	0.00100
19-Apr-16	46.0	-	7.10	-	0.0780	-	-	-	-	-
26-Apr-16	16.0	-	7.10	-	0.0750	-	-	-	-	-
03-May-16	6.00	-	6.70	-	0.106	-	-	-	-	-
10-May-16	6.00	112	7.20	68.0	0.101	0.250	<0.000500	0.0220	0.00500	0.00160
17-May-16	3.00	-	7.30	-	0.109	-	-	-	-	-
24-May-16	1.00	-	6.70	-	0.129	-	-	-	-	-
31-May-16	10.0	-	7.10	-	0.133	-	-	-	-	-
07-Jun-16	4.00	-	7.00	-	0.158	-	-	-	-	-
14-Jun-16	3.00	139	7.10	79.0	0.193	0.254	<0.000500	0.0290	0.00500	0.00250
21-Jun-16	<1.00	-	7.20	-	0.176	-	-	-	-	-
28-Jun-16	<1.00	-	6.60	-	0.120	-	-	-	-	-
04-Oct-16	1.00	-	7.20	-	0.192	-	-	-	-	-
11-Oct-16	2.00	176	7.20	130	0.139	0.193	<0.000500	0.0220	0.00500	0.00190

Table N.3: Water Quality at SAMP Principal Station D-3, Located at TMA-2 Effluent at Denison Mine Access Road, Denison TMA, 2015 to 2019

Date	Flow (L/s)	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
18-Oct-16	24.0	-	7.40	-	0.119	-	-	-	-	-
25-Oct-16	3.00	-	7.20	-	0.119	-	-	-	-	-
01-Nov-16	4.00	-	7.10	-	0.117	-	-	-	-	-
08-Nov-16	3.00	178	6.90	120	0.124	0.174	<0.000500	0.0150	0.00300	0.00730
15-Nov-16	3.00	-	7.50	-	0.135	-	-	-	-	-
22-Nov-16	39.0	-	7.00	-	0.120	-	-	-	-	-
29-Nov-16	18.0	-	7.05	-	0.0730	-	-	-	-	-
06-Dec-16	9.00	-	7.10	-	0.0690	-	-	-	-	-
13-Dec-16	3.00	148	7.10	110	0.0940	0.136	<0.000500	0.0300	0.00200	0.00580
20-Dec-16	2.00	-	7.00	-	0.107	-	-	-	-	-
29-Dec-16	3.00	-	7.00	-	0.105	-	-	-	-	-
n	39	9	39	9	39	9	9	9	9	9
Minimum	<1	62.0	6.60	47.0	0.0520	0.136	<0.0005	0.0150	0.00200	0.00100
Maximum	46.0	178	7.50	130	0.193	0.341	<0.0005	0.130	0.0200	0.00730
Mean	9.00	122	7.03	82.7	0.102	0.211	<0.0005	0.0603	0.00567	0.00312
SD	11.6	42.0	0.195	30.6	0.0355	0.0618	-	0.0458	0.00548	0.00216
03-Jan-17	2.00	-	7.00	-	0.0990	-	-	-	-	-
10-Jan-17	1.00	181	7.00	130	0.100	0.148	<0.000500	<0.0200	<0.00200	0.0130
17-Jan-17	1.00	-	6.90	-	0.0970	-	-	-	-	-
24-Jan-17	10.0	-	7.00	-	0.0710	-	-	-	-	-
31-Jan-17	5.00	-	7.10	-	0.0490	-	-	-	-	-
07-Feb-17	1.00	-	7.10	-	0.0890	-	-	-	-	-
14-Feb-17	2.00	163	7.10	110	0.0760	0.144	<0.000500	<0.0200	<0.00200	0.00790
21-Feb-17	5.00	-	6.90	-	0.0870	-	-	-	-	-
28-Feb-17	10.0	-	7.30	-	0.0590	-	-	-	-	-
07-Mar-17	10.0	-	7.00	-	0.0430	-	-	-	-	-
14-Mar-17	10.0	-	6.90	-	0.0680	-	-	-	-	-
21-Mar-17	10.0	135	6.80	100	0.0600	0.178	<0.000500	0.0500	0.00600	0.00450
28-Mar-17	30.0	-	7.20	-	0.0610	-	-	-	-	-
04-Apr-17	96.0	-	7.00	-	0.0680	-	-	-	-	-
11-Apr-17	73.0	44.9	6.90	26.0	0.0720	0.164	<0.000500	0.112	0.0110	0.00160
18-Apr-17	6.00	-	6.90	-	0.0490	-	-	-	-	-
25-Apr-17	5.00	-	6.90	-	0.0740	-	-	-	-	-
02-May-17	3.00	-	6.90	-	0.0820	-	-	-	-	-
09-May-17	10.0	-	7.10	-	0.105	-	-	-	-	-
16-May-17	3.00	-	7.00	-	0.126	-	-	-	-	-
23-May-17	14.0	123	7.20	74.0	0.149	0.242	<0.000500	0.0380	0.00200	0.00420
30-May-17	18.0	-	7.10	-	0.133	-	-	-	-	-
06-Jun-17	30.0	-	7.20	-	0.134	-	-	-	-	-
13-Jun-17	3.00	119	7.20	65.0	0.172	0.215	<0.000500	0.0380	0.00700	0.00270
20-Jun-17	3.00	-	7.00	-	0.167	-	-	-	-	-
27-Jun-17	6.00	-	7.00	-	0.150	-	-	-	-	-
04-Jul-17	18.0	-	6.90	-	0.160	-	-	-	-	-
11-Jul-17	3.00	129	7.10	64.0	0.139	0.247	<0.000500	0.0930	0.0100	0.00380
18-Jul-17	1.00	-	7.10	-	0.143	-	-	-	-	-
25-Jul-17	10.0	-	7.10	-	0.181	-	-	-	-	-
01-Aug-17	1.00	-	7.10	-	0.177	-	-	-	-	-
08-Aug-17	<1.00	123	7.10	59.0	0.176	0.199	<0.000500	0.269	0.0310	0.00450
15-Aug-17	6.00	-	7.20	-	0.171	-	-	-	-	-
22-Aug-17	21.0	-	7.30	-	0.187	-	-	-	-	-
29-Aug-17	3.00	-	7.20	-	0.171	-	-	-	-	-
05-Sep-17	3.00	-	7.20	-	0.154	-	-	-	-	-
12-Sep-17	1.00	107	7.30	51.0	0.135	0.220	<0.000500	0.173	0.0280	0.00440
19-Sep-17	2.00	-	7.40	-	0.157	-	-	-	-	-
26-Sep-17	1.00	-	7.20	-	0.169	-	-	-	-	-
03-Oct-17	3.00	-	7.10	-	0.177	-	-	-	-	-
10-Oct-17	14.0	113	7.20	60.0	0.166	0.333	<0.000500	0.104	0.0130	0.00630
17-Oct-17	22.0	-	7.00	-	0.170	-	-	-	-	-
25-Oct-17	92.0	-	7.40	-	0.0860	-	-	-	-	-
31-Oct-17	14.0	-	7.20	-	0.123	-	-	-	-	-
07-Nov-17	10.0	-	7.20	-	0.108	-	-	-	-	-
14-Nov-17	6.00	77.5	7.30	44.0	0.102	0.323	<0.000500	0.249	0.0350	0.00300
21-Nov-17	18.0	-	7.20	-	0.141	-	-	-	-	-
28-Nov-17	10.0	-	7.30	-	0.114	-	-	-	-	-
05-Dec-17	149	-	6.90	-	0.117	-	-	-	-	-
12-Dec-17	10.0	49.6	7.00	35.0	0.112	0.320	<0.000500	0.309	0.0370	0.00160
19-Dec-17	10.0	-	7.20	-	0.111	-	-	-	-	-
26-Dec-17	18.0	-	7.10	-	0.160	-	-	-	-	-
n	52	12	52	12	52	12	12	12	12	12
Minimum	<1	44.9	6.80	26.0	0.0430	0.144	<0.0005	<0.02	<0.002	0.00160
Maximum	149	181	7.40	130	0.187	0.333	<0.0005	0.309	0.0370	0.0130
Mean	15.7	114	7.10	68.2	0.120	0.228	<0.0005	0.123	0.0153	0.00479
SD	27.5	40.5	0.144	31.0	0.0425	0.0676	-	0.101	0.0136	0.00315
02-Jan-18	10.0	-	7.20	-	0.107	-	-	-	-	-
09-Jan-18	10.0	84.3	7.00	52.0	0.115	0.370	<0.000500	0.232	0.0300	0.00300
16-Jan-18	1.00	-	7.30	-	0.187	-	-	-	-	-
23-Jan-18	1.00	-	7.20	-	0.165	-	-	-	-	-

Table N.3: Water Quality at SAMP Principal Station D-3, Located at TMA-2 Effluent at Denison Mine Access Road, Denison TMA, 2015 to 2019

Date	Flow (L/s)	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
30-Jan-18	1.00	-	7.10	-	0.111	-	-	-	-	-
06-Feb-18	5.00	-	7.00	-	0.122	-	-	-	-	-
13-Feb-18	12.0	141	6.90	62.0	0.115	0.300	<0.000500	0.162	0.0290	0.00460
20-Feb-18	2.00	-	7.30	-	0.130	-	-	-	-	-
27-Feb-18	5.00	-	7.20	-	0.133	-	-	-	-	-
06-Mar-18	<1.00	-	7.30	-	0.126	-	-	-	-	-
13-Mar-18	<1.00	142	7.20	75.0	0.117	0.307	<0.000500	0.0700	0.00900	0.00870
20-Mar-18	<1.00	-	7.20	-	0.130	-	-	-	-	-
27-Mar-18	<1.00	-	7.20	-	0.125	-	-	-	-	-
03-Apr-18	2.00	-	7.40	-	0.114	-	-	-	-	-
10-Apr-18	2.00	166	7.30	86.0	0.119	0.331	<0.000500	0.0720	0.0200	0.0118
17-Apr-18	2.00	-	7.10	-	0.134	-	-	-	-	-
24-Apr-18	55.0	-	7.10	-	0.142	-	-	-	-	-
01-May-18	46.0	-	7.10	-	0.0920	-	-	-	-	-
08-May-18	18.0	49.3	7.10	29.0	0.0830	0.206	<0.000500	0.178	0.0200	0.00120
15-May-18	10.0	-	7.00	-	0.114	-	-	-	-	-
22-May-18	3.00	-	7.30	-	0.133	-	-	-	-	-
29-May-18	3.00	-	7.00	-	0.179	-	-	-	-	-
05-Jun-18	7.00	-	7.10	-	0.160	-	-	-	-	-
12-Jun-18	1.00	-	7.20	-	0.201	-	-	-	-	-
19-Jun-18	3.00	115	7.40	81.0	0.177	0.317	<0.000500	0.0590	0.0140	0.00280
26-Jun-18	<1.00	-	7.10	-	0.182	-	-	-	-	-
02-Oct-18	3.00	-	7.00	-	0.150	-	-	-	-	-
09-Oct-18	21.0	113	6.90	84.0	0.115	0.253	<0.000500	0.0600	0.00400	0.00560
16-Oct-18	39.0	-	7.30	-	0.116	-	-	-	-	-
23-Oct-18	14.0	-	7.00	-	0.107	-	-	-	-	-
30-Oct-18	10.0	-	7.20	-	0.123	-	-	-	-	-
06-Nov-18	12.0	-	7.00	-	0.0910	-	-	-	-	-
13-Nov-18	10.0	83.5	6.90	59.0	0.0910	0.224	<0.000500	0.142	0.00900	0.00280
20-Nov-18	7.00	-	7.20	-	0.105	-	-	-	-	-
27-Nov-18	14.0	-	7.10	-	0.0940	-	-	-	-	-
04-Dec-18	6.00	-	7.30	-	0.0980	-	-	-	-	-
11-Dec-18	3.00	93.6	7.40	62.0	0.110	0.231	<0.000500	0.0890	0.00600	0.00250
18-Dec-18	3.00	-	7.20	-	0.0870	-	-	-	-	-
27-Dec-18	3.00	-	7.20	-	0.116	-	-	-	-	-
n	39	9	39	9	39	9	9	9	9	9
Minimum	<1	49.3	6.90	29.0	0.0830	0.206	<0.0005	0.0590	0.00400	0.00120
Maximum	55.0	166	7.40	86.0	0.201	0.370	<0.0005	0.232	0.0300	0.0118
Mean	8.95	110	7.15	65.6	0.126	0.282	<0.0005	0.118	0.0157	0.00478
SD	12.3	36.2	0.139	18.3	0.0295	0.0558	-	0.0625	0.00963	0.00343
02-Jan-19	3.00	-	6.90	-	0.0990	-	-	-	-	-
08-Jan-19	5.00	103	7.10	77.0	0.106	0.223	<0.000500	0.103	0.00800	0.00350
15-Jan-19	1.00	-	7.30	-	0.113	-	-	-	-	-
22-Jan-19	1.00	-	7.30	-	0.110	-	-	-	-	-
29-Jan-19	1.00	-	7.30	-	0.108	-	-	-	-	-
05-Feb-19	1.00	-	7.20	-	0.0940	-	-	-	-	-
12-Feb-19	1.00	122	7.10	78.0	0.120	0.237	<0.000500	0.114	0.0270	0.00860
19-Feb-19	1.00	-	7.20	-	0.126	-	-	-	-	-
28-Feb-19	1.00	-	7.00	-	0.114	-	-	-	-	-
04-Mar-19	1.00	-	7.20	-	0.114	-	-	-	-	-
12-Mar-19	1.00	163	7.30	94.0	0.120	0.271	<0.000500	0.0360	0.00400	0.0124
19-Mar-19	3.00	-	7.20	-	0.143	-	-	-	-	-
26-Mar-19	5.00	-	7.30	-	0.0880	-	-	-	-	-
02-Apr-19	8.00	-	7.10	-	0.0960	-	-	-	-	-
09-Apr-19	113	52.8	7.00	40.0	0.113	0.232	0.000700	0.522	0.148	0.00220
16-Apr-19	34.0	-	7.30	-	0.0580	-	-	-	-	-
22-Apr-19	73.0	-	7.10	-	0.0660	-	-	-	-	-
30-Apr-19	18.0	-	6.90	-	0.0740	-	-	-	-	-
07-May-19	16.0	-	6.80	-	0.123	-	-	-	-	-
14-May-19	14.0	68.5	7.30	44.0	0.124	0.295	<0.000500	0.114	0.0120	0.00130
21-May-19	28.0	-	7.50	-	0.125	-	-	-	-	-
28-May-19	14.0	-	7.30	-	0.121	-	-	-	-	-
04-Jun-19	6.00	-	7.10	-	0.110	-	-	-	-	-
11-Jun-19	25.0	95.4	6.80	60.0	0.173	0.463	<0.000500	0.112	0.0230	0.00350
18-Jun-19	8.00	-	7.00	-	0.139	-	-	-	-	-
25-Jun-19	4.00	-	6.90	-	0.147	-	-	-	-	-
02-Jul-19	3.00	-	7.00	-	0.155	-	-	-	-	-
09-Jul-19	1.00	33.9	6.80	17.0	0.154	0.110	0.000600	0.457	0.126	0.00100
16-Jul-19	2.00	-	6.90	-	0.172	-	-	-	-	-
30-Jul-19	1.00	-	6.70	-	0.157	-	-	-	-	-
13-Aug-19	1.00	90.8	7.00	44.0	0.215	0.286	<0.000500	0.261	0.0510	0.00180
10-Sep-19	6.00	97.0	7.00	51.0	0.139	0.302	<0.000500	0.117	0.0110	0.00260
17-Sep-19	3.00	-	7.30	-	0.183	-	-	-	-	-
24-Sep-19	2.00	-	7.10	-	0.183	-	-	-	-	-
01-Oct-19	3.00	-	7.10	-	0.222	-	-	-	-	-
08-Oct-19	2.00	102	7.30	54.0	0.179	0.349	<0.000500	0.117	0.0110	0.00290
15-Oct-19	6.00	-	7.20	-	0.170	-	-	-	-	-

Table N.3: Water Quality at SAMP Principal Station D-3, Located at TMA-2 Effluent at Denison Mine Access Road, Denison TMA, 2015 to 2019

Date	Flow (L/s)	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
22-Oct-19	70.0	-	7.10	-	0.182	-	-	-	-	-
29-Oct-19	34.0	-	7.50	-	0.161	-	-	-	-	-
05-Nov-19	14.0	-	7.30	-	0.141	-	-	-	-	-
12-Nov-19	6.00	73.1	7.10	42.0	0.170	0.512	<0.000500	0.250	0.0320	0.00320
19-Nov-19	8.00	-	7.20	-	0.137	-	-	-	-	-
26-Nov-19	23.0	-	7.20	-	0.104	-	-	-	-	-
03-Dec-19	14.0	-	7.20	-	0.155	-	-	-	-	-
10-Dec-19	8.00	82.3	7.30	46.0	0.169	0.570	<0.000500	0.280	0.0290	0.00260
16-Dec-19	6.00	-	7.20	-	0.163	-	-	-	-	-
23-Dec-19	7.00	-	7.30	-	0.168	-	-	-	-	-
30-Dec-19	10.0	-	7.30	-	0.194	-	-	-	-	-
n	48	12	48	12	48	12	12	12	12	12
Minimum	1.00	33.9	6.70	17.0	0.0580	0.110	<0.0005	0.0360	0.00400	0.00100
Maximum	113	163	7.50	94.0	0.222	0.570	0.000700	0.522	0.148	0.0124
Mean	12.8	90.3	7.14	53.9	0.137	0.321	0.000525	0.207	0.0402	0.00380
SD	21.4	33.1	0.182	20.7	0.0371	0.133	0.0000391	0.152	0.0473	0.00333
Summary Statistics for 2015 to 2019										
n	222	53	222	53	222	53	53	53	53	53
Minimum	<1.00	30.5	6.60	12.0	0.0430	0.110	<0.000500	0.0150	<0.00200	0.00100
Maximum	149	181	7.60	140	0.248	0.570	0.00130	1.34	0.317	0.0130
Mean	12.1	110	7.11	69.2	0.123	0.261	0.000525	0.154	0.0292	0.00413
SD	21.5	39.6	0.175	29.2	0.0386	0.0937	0.000112	0.200	0.0571	0.00293
Median	5.00	113	7.10	65.0	0.118	0.247	<0.000500	0.112	0.0110	0.00300
10th Percentile	1.00	52.8	6.90	35.0	0.0720	0.164	<0.000500	0.0290	0.00300	0.00160
95th Percentile	46.0	179	7.40	130	0.183	0.463	0.000700	0.457	0.148	0.0118

Note: "-" = no data collected or SD was incalculable because there was no variability in the data. n = number of samples. SD = standard deviation.

Table N.4: Water Quality at SAMP Seepage Station D-9, Located at Seepage at Dam 17, Denison TMA, 2015 to 2019

Date	Flow (L/s)	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
13-Jan-15	2.00	512	6.90	630	0.00900	0.0240	0.00550	2.07	3.38	0.0158
28-Apr-15	0.910	448	6.90	340	0.00700	0.0140	0.00310	1.31	1.22	0.00890
14-Jul-15	1.30	923	6.90	800	0.0120	0.0220	0.00760	2.92	3.12	0.0159
13-Oct-15	2.10	931	7.00	770	0.0100	0.0240	0.00570	2.46	2.66	0.0135
n	4	4	4	4	4	4	4	4	4	4
Minimum	0.910	448	6.90	340	0.00700	0.0140	0.00310	1.31	1.22	0.00890
Maximum	2.10	931	7.00	800	0.0120	0.0240	0.00760	2.92	3.38	0.0159
Mean	1.58	704	6.93	635	0.00950	0.0210	0.00548	2.19	2.60	0.0135
SD	0.570	259	0.0500	210	0.00208	0.00476	0.00184	0.682	0.964	0.00328
12-Jan-16	0.670	495	7.00	440	<0.00800	0.0150	0.00300	1.63	1.38	0.0115
27-Apr-16	5.70	482	7.00	370	<0.00800	0.0140	0.00220	0.960	0.962	0.00900
12-Jul-16	1.60	910	6.80	830	0.0100	0.0220	0.00620	1.41	2.67	0.0143
06-Oct-16	2.30	825	7.00	690	<0.00800	0.0190	0.00430	1.65	2.04	0.0116
n	4	4	4	4	4	4	4	4	4	4
Minimum	0.670	482	6.80	370	<0.008	0.0140	0.00220	0.960	0.962	0.00900
Maximum	5.70	910	7.00	830	0.0100	0.0220	0.00620	1.65	2.67	0.0143
Mean	2.57	678	6.95	582	0.00850	0.0175	0.00392	1.41	1.76	0.0116
SD	2.19	222	0.100	215	-	0.00370	0.00175	0.321	0.750	0.00216
24-Jan-17	1.50	567	6.90	410	<0.00700	0.0120	0.00310	1.55	1.46	0.0124
19-Apr-17	2.50	339	6.90	240	<0.00700	0.0130	0.00170	0.622	0.794	0.00820
12-Jul-17	2.00	682	6.90	550	0.00700	0.0150	0.00360	1.53	2.00	0.0125
11-Oct-17	1.92	593	6.80	500	<0.00700	0.0170	0.00290	1.34	1.45	0.0113
n	4	4	4	4	4	4	4	4	4	4
Minimum	1.50	339	6.80	240	<0.007	0.0120	0.00170	0.622	0.794	0.00820
Maximum	2.50	682	6.90	550	0.00700	0.0170	0.00360	1.55	2.00	0.0125
Mean	1.98	545	6.88	425	0.00700	0.0142	0.00282	1.26	1.43	0.0111
SD	0.410	146	0.0500	136	-	0.00222	0.000806	0.436	0.494	0.00201

Table N.4: Water Quality at SAMP Seepage Station D-9, Located at Seepage at Dam 17, Denison TMA, 2015 to 2019

Date	Flow (L/s)	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
16-Jan-18	<1.00	684	7.08	540	0.00900	0.0180	0.00330	1.74	1.82	0.0183
08-May-18	4.50	440	7.40	300	<0.00700	0.0150	0.00180	0.796	0.949	0.0100
10-Jul-18	1.26	892	6.70	840	0.00900	0.0200	0.00470	1.17	2.75	0.0174
09-Oct-18	2.80	506	6.90	470	0.00700	0.0170	0.00240	0.940	1.25	0.0109
n	4	4	4	4	4	4	4	4	4	4
Minimum	<1	440	6.70	300	<0.007	0.0150	0.00180	0.796	0.949	0.0100
Maximum	4.50	892	7.40	840	0.00900	0.0200	0.00470	1.74	2.75	0.0183
Mean	2.39	630	7.02	538	0.00800	0.0175	0.00305	1.16	1.69	0.0142
SD	1.64	203	0.297	225	0.00122	0.00208	0.00126	0.415	0.792	0.00430
08-Jan-19	2.80	602	6.90	550	<0.00700	0.0160	0.00280	1.45	1.76	0.0200
15-May-19	4.00	253	7.30	190	<0.00700	0.0120	0.000700	0.271	0.398	0.00580
09-Jul-19	3.13	709	6.90	620	0.0110	0.0170	0.00340	1.08	1.79	0.0171
08-Oct-19	0.173	680	6.90	530	<0.00700	0.0190	0.00250	0.930	1.53	0.0140
n	4	4	4	4	4	4	4	4	4	4
Minimum	0.173	253	6.90	190	<0.007	0.0120	0.000700	0.271	0.398	0.00580
Maximum	4.00	709	7.30	620	0.0110	0.0190	0.00340	1.45	1.79	0.0200
Mean	2.53	561	7.00	472	0.00800	0.0160	0.00235	0.933	1.37	0.0142
SD	1.65	210	0.200	192	-	0.00294	0.00116	0.492	0.658	0.00613
Summary Statistics for 2015 to 2019										
n	20	20	20	20	20	20	20	20	20	20
Minimum	0.173	253	6.70	190	<0.00700	0.0120	0.000700	0.271	0.398	0.00580
Maximum	5.70	931	7.40	840	0.0120	0.0240	0.00760	2.92	3.38	0.0200
Mean	2.19	624	6.95	530	0.00805	0.0173	0.00353	1.39	1.77	0.0129
SD	1.38	198	0.160	192	0.00165	0.00371	0.00169	0.615	0.803	0.00371
Median	2.00	598	6.90	535	0.00700	0.0170	0.00310	1.38	1.64	0.0124
10th Percentile	0.670	390	6.80	270	<0.00700	0.0125	0.00175	0.709	0.871	0.00855
95th Percentile	5.10	927	7.35	835	0.0115	0.0240	0.00690	2.69	3.25	0.0192

Note: "-" = SD was incalculable because there was no variability in the data. n = number of samples. SD = standard deviation.

Table N.5: Water Quality at SAMP Seepage Station D-16, Located at Seepage at Dam 9, Denison TMA, 2015 to 2019

Date	Flow (L/s)	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
13-Jan-15	5.00	250	6.10	220	0.0150	0.0300	0.00180	1.13	1.45	<0.000500
28-Apr-15	1.00	187	6.50	170	0.0140	0.0280	0.00130	0.190	0.955	<0.000500
14-Jul-15	0.360	326	6.50	270	0.0410	0.0350	0.00520	9.16	10.8	<0.000500
13-Oct-15	0.500	290	6.60	260	0.0190	0.0300	0.000700	1.96	1.04	<0.000500
n	4	4	4	4	4	4	4	4	4	4
Minimum	0.360	187	6.10	170	0.0140	0.0280	0.000700	0.190	0.955	<0.0005
Maximum	5.00	326	6.60	270	0.0410	0.0350	0.00520	9.16	10.8	<0.0005
Mean	1.72	263	6.42	230	0.0222	0.0308	0.00225	3.11	3.56	<0.0005
SD	2.21	59.6	0.222	45.5	0.0127	0.00299	0.00202	4.10	4.83	-
12-Jan-16	3.80	150	6.60	150	<0.00800	0.0160	0.000700	0.380	0.301	<0.000500
27-Apr-16	1.00	155	6.00	150	<0.00800	0.0170	<0.000500	0.273	0.225	<0.000500
12-Jul-16	0.250	324	6.50	290	0.0420	0.0400	0.00510	12.8	4.38	<0.000500
06-Oct-16	1.00	326	6.40	300	0.0400	0.0390	0.00150	6.37	2.05	<0.000500
n	4	4	4	4	4	4	4	4	4	4
Minimum	0.250	150	6.00	150	<0.008	0.0160	<0.0005	0.273	0.225	<0.0005
Maximum	3.80	326	6.60	300	0.0420	0.0400	0.00510	12.8	4.38	<0.0005
Mean	1.51	239	6.38	222	0.0245	0.0280	0.00195	4.96	1.74	<0.0005
SD	1.57	99.6	0.263	83.8	0.00122	0.0133	0.00223	5.96	1.95	-
24-Jan-17	1.00	279	6.10	240	0.0150	0.0210	0.000900	0.700	0.662	<0.000500
19-Apr-17	1.80	129	6.30	110	<0.00700	0.0180	0.000800	0.149	0.225	<0.000500
12-Jul-17	0.230	220	6.30	180	0.0140	0.0200	0.00200	3.76	2.90	<0.000500
11-Oct-17	0.733	197	6.50	150	0.0270	0.0300	0.00370	9.89	6.30	<0.000500
n	4	4	4	4	4	4	4	4	4	4
Minimum	0.230	129	6.10	110	<0.007	0.0180	0.000800	0.149	0.225	<0.0005
Maximum	1.80	279	6.50	240	0.0270	0.0300	0.00370	9.89	6.30	<0.0005
Mean	0.941	206	6.30	170	0.0158	0.0222	0.00185	3.62	2.52	<0.0005
SD	0.656	62.0	0.163	54.8	0.00674	0.00532	0.00135	4.47	2.78	-

Table N.5: Water Quality at SAMP Seepage Station D-16, Located at Seepage at Dam 9, Denison TMA, 2015 to 2019

Date	Flow (L/s)	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
16-Jan-18	0.750	263	6.12	220	0.0190	0.0280	0.00150	1.50	1.48	<0.000500
08-May-18	3.20	131	6.80	120	0.0110	0.0220	0.000600	0.348	0.510	<0.000500
10-Jul-18	0.330	307	6.10	260	0.0540	0.0420	0.00410	12.5	5.95	<0.000500
09-Oct-18	2.00	159	6.50	160	0.0120	0.0210	0.000500	0.750	0.601	<0.000500
n	4	4	4	4	4	4	4	4	4	4
Minimum	0.330	131	6.10	120	0.0110	0.0210	0.000500	0.348	0.510	<0.0005
Maximum	3.20	307	6.80	260	0.0540	0.0420	0.00410	12.5	5.95	<0.0005
Mean	1.57	215	6.38	190	0.0240	0.0282	0.00168	3.77	2.14	<0.0005
SD	1.30	83.6	0.335	62.2	0.0203	0.00967	0.00168	5.84	2.58	-
08-Jan-19	0.670	227	6.80	220	0.0110	0.0210	0.00100	0.672	0.872	<0.000500
15-May-19	2.10	130	6.30	130	<0.00700	0.0170	<0.000500	0.230	0.159	<0.000500
09-Jul-19	0.833	229	6.70	170	0.0240	0.0230	0.00270	2.74	4.72	<0.000500
08-Oct-19	1.40	173	6.80	140	0.0190	0.0210	0.00110	1.83	1.09	<0.000500
n	4	4	4	4	4	4	4	4	4	4
Minimum	0.670	130	6.30	130	<0.007	0.0170	<0.0005	0.230	0.159	<0.0005
Maximum	2.10	229	6.80	220	0.0240	0.0230	0.00270	2.74	4.72	<0.0005
Mean	1.25	190	6.65	165	0.0152	0.0205	0.00133	1.37	1.71	<0.0005
SD	0.647	47.5	0.238	40.4	0.00678	0.00252	0.000885	1.14	2.05	-
Summary Statistics for 2015 to 2019										
n	20	20	20	20	20	20	20	20	20	20
Minimum	0.230	129	6.00	110	<0.00700	0.0160	<0.000500	0.149	0.159	<0.000500
Maximum	5.00	326	6.80	300	0.0540	0.0420	0.00520	12.8	10.8	<0.000500
Mean	1.40	223	6.43	196	0.0203	0.0260	0.00181	3.37	2.33	<0.000500
SD	1.28	69.9	0.254	59.3	0.0131	0.00809	0.00153	4.29	2.78	-
Median	1.00	224	6.50	175	0.0150	0.0225	0.00120	1.31	1.06	<0.000500
10th Percentile	0.290	130	6.10	125	<0.00800	0.0170	0.000500	0.210	0.225	<0.000500
95th Percentile	4.40	326	6.80	295	0.0480	0.0410	0.00515	12.6	8.55	<0.000500

Note: "-" = SD was incalculable because there was no variability in the data. n = number of samples. SD = standard deviation.

Table N.6: Water Quality at SAMP Seepage Station ECA-398, Located at Quirke II North of Access Road, Quirke TMA, 2015 to 2019

Date	Flow (L/s)	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
09-Feb-15	0.100	201	4.20	190	0.0420	0.0160	0.0700	0.140	0.686	0.226
11-May-15	0.800	160	4.20	190	0.0440	0.0170	0.0582	0.160	0.559	0.183
18-Nov-15	1.00	202	4.10	220	0.0490	0.0190	0.0651	0.188	0.573	0.220
n	3	3	3	3	3	3	3	3	3	3
Minimum	0.100	160	4.10	190	0.0420	0.0160	0.0582	0.140	0.559	0.183
Maximum	1.00	202	4.20	220	0.0490	0.0190	0.0700	0.188	0.686	0.226
Mean	0.633	188	4.17	200	0.0450	0.0173	0.0644	0.163	0.606	0.210
SD	0.473	24.0	0.0577	17.3	0.00361	0.00153	0.00593	0.0241	0.0696	0.0233
08-Feb-16	0.400	170	4.10	190	0.0320	0.0160	0.0571	0.152	0.507	0.195
05-May-16	1.40	167	4.20	150	0.0570	0.0180	0.0510	0.140	0.375	0.171
12-Dec-16	0.300	234	4.00	270	0.0560	0.0200	0.0682	0.176	0.673	0.232
n	3	3	3	3	3	3	3	3	3	3
Minimum	0.300	167	4.00	150	0.0320	0.0160	0.0510	0.140	0.375	0.171
Maximum	1.40	234	4.20	270	0.0570	0.0200	0.0682	0.176	0.673	0.232
Mean	0.700	190	4.10	203	0.0483	0.0180	0.0588	0.156	0.518	0.199
SD	0.608	37.8	0.100	61.1	0.0142	0.00200	0.00872	0.0183	0.149	0.0307
14-Feb-17	0.200	221	4.00	190	0.0490	0.0170	0.0603	0.140	0.620	0.203
20-Apr-17	2.70	140	4.20	110	0.0850	0.0180	0.0523	0.157	0.334	0.162
14-Aug-17	1.30	198	3.60	210	0.0670	0.0240	0.0584	0.233	0.512	0.249
15-Nov-17	3.60	155	4.20	160	0.0550	0.0210	0.0574	0.204	0.512	0.169
n	4	4	4	4	4	4	4	4	4	4
Minimum	0.200	140	3.60	110	0.0490	0.0170	0.0523	0.140	0.334	0.162
Maximum	3.60	221	4.20	210	0.0850	0.0240	0.0603	0.233	0.620	0.249
Mean	1.95	178	4.00	168	0.0640	0.0200	0.0571	0.184	0.495	0.196
SD	1.50	37.5	0.283	43.5	0.0159	0.00316	0.00342	0.0427	0.118	0.0398
13-Feb-18	0.100	228	4.30	210	0.0430	0.0200	0.0676	0.141	0.695	0.163
14-May-18	1.90	134	4.00	130	0.0820	0.0220	0.0413	0.151	0.382	0.142

Table N.6: Water Quality at SAMP Seepage Station ECA-398, Located at Quirke II North of Access Road, Quirke TMA, 2015 to 2019

Date	Flow (L/s)	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
13-Nov-18	1.10	155	4.30	170	0.0430	0.0220	0.0608	0.182	0.437	0.189
n	3	3	3	3	3	3	3	3	3	3
Minimum	0.100	134	4.00	130	0.0430	0.0200	0.0413	0.141	0.382	0.142
Maximum	1.90	228	4.30	210	0.0820	0.0220	0.0676	0.182	0.695	0.189
Mean	1.03	172	4.20	170	0.0560	0.0213	0.0566	0.158	0.505	0.165
SD	0.902	49.3	0.173	40.0	0.0225	0.00115	0.0137	0.0214	0.167	0.0235
12-Feb-19	0.100	168	4.00	180	0.0460	0.0190	0.0517	0.113	0.529	0.212
13-May-19	3.50	99.6	4.50	110	0.0500	0.0170	0.0293	0.124	0.205	0.122
16-Sep-19	0.100	215	4.20	200	0.0670	0.0320	0.0563	0.192	0.644	0.254
07-Oct-19	0.500	180	4.20	180	0.0870	0.0290	0.0551	0.211	0.428	0.214
n	4	4	4	4	4	4	4	4	4	4
Minimum	0.100	99.6	4.00	110	0.0460	0.0170	0.0293	0.113	0.205	0.122
Maximum	3.50	215	4.50	200	0.0870	0.0320	0.0563	0.211	0.644	0.254
Mean	1.05	166	4.22	168	0.0625	0.0242	0.0481	0.160	0.452	0.200
SD	1.64	48.3	0.206	39.5	0.0187	0.00737	0.0127	0.0488	0.187	0.0558
Summary Statistics for 2015 to 2019										
n	17	17	17	17	17	17	17	17	17	17
Minimum	0.100	99.6	3.60	110	0.0320	0.0160	0.0293	0.113	0.205	0.122
Maximum	3.60	234	4.50	270	0.0870	0.0320	0.0700	0.233	0.695	0.254
Mean	1.12	178	4.14	180	0.0561	0.0204	0.0565	0.165	0.510	0.194
SD	1.17	36.7	0.190	40.3	0.0162	0.00444	0.0100	0.0328	0.137	0.0369
Median	0.800	170	4.20	190	0.0500	0.0190	0.0574	0.157	0.512	0.195
10th Percentile	0.100	134	4.00	110	0.0420	0.0160	0.0413	0.124	0.334	0.142
95th Percentile	3.60	234	4.50	270	0.0870	0.0320	0.0700	0.233	0.695	0.254

Note: n = number of samples. SD = standard deviation.

Table N.7: Water Quality at SAMP Drainage Station Q-22, Located at Quirke II Drainage South of Access Road, Quirke TMA, 2015 to 2019

Date	Flow (L/s)	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
09-Feb-15	3.50	47.1	6.70	37.0	0.0170	0.0130	0.00160	0.110	0.0310	0.0179
11-May-15	8.10	31.9	7.00	27.0	0.0290	0.0130	0.000700	0.0700	0.0140	0.0193
06-Aug-15	1.00	101	6.80	180	0.0500	0.0300	0.00260	0.180	0.129	0.0237
n	4	4	4	4	4	4	4	4	4	4
Minimum	1.00	31.6	6.60	24.0	0.0170	0.0100	0.000600	0.0700	0.0130	0.0164
Maximum	15.2	101	7.00	180	0.0500	0.0300	0.00260	0.180	0.129	0.0237
Mean	6.95	52.9	6.78	67.0	0.0285	0.0165	0.00138	0.116	0.0468	0.0193
SD	6.24	32.9	0.171	75.5	0.0153	0.00911	0.000932	0.0460	0.0555	0.00315
18-Nov-15	15.2	31.6	6.60	24.0	0.0180	0.0100	0.000600	0.106	0.0130	0.0164
08-Feb-16	7.20	33.5	6.60	27.0	0.0140	0.00900	0.000900	0.0640	0.0150	0.0138
05-May-16	15.9	32.9	6.50	22.0	0.0190	0.0110	0.000800	0.0580	0.0100	0.0157
n	4	4	4	4	4	4	4	4	4	4
Minimum	0.600	32.9	6.40	22.0	0.0140	0.00900	0.000800	0.0580	0.0100	0.0138
Maximum	15.9	73.9	6.60	55.0	0.0470	0.0200	0.00230	0.169	0.0900	0.0210
Mean	6.25	50.5	6.50	38.5	0.0262	0.0140	0.00135	0.0978	0.0420	0.0175
SD	7.08	20.6	0.0816	16.4	0.0145	0.00497	0.000686	0.0510	0.0373	0.00335
08-Aug-16	0.600	73.9	6.40	55.0	0.0470	0.0200	0.00230	0.169	0.0900	0.0210
21-Nov-16	1.30	61.8	6.50	50.0	0.0250	0.0160	0.00140	0.100	0.0530	0.0196
14-Feb-17	9.60	34.5	6.50	20.0	0.0310	0.0110	0.000600	0.0660	0.0140	0.0125
20-Apr-17	30.1	25.8	6.90	18.0	0.0170	0.0100	0.00120	0.0530	0.0110	0.0132
n	4	4	4	4	4	4	4	4	4	4
Minimum	9.60	25.8	6.00	17.0	0.0120	0.00900	0.000600	0.0530	0.0110	0.0125
Maximum	30.1	34.5	6.90	24.0	0.0310	0.0110	0.00120	0.316	0.0270	0.0282
Mean	17.7	30.5	6.55	19.8	0.0220	0.0102	0.000950	0.163	0.0195	0.0172
SD	8.73	3.72	0.404	3.10	0.00898	0.000957	0.000300	0.126	0.00819	0.00741
14-Aug-17	15.9	29.6	6.00	17.0	0.0280	0.0110	0.000800	0.316	0.0270	0.0282
15-Nov-17	15.2	32.1	6.80	24.0	0.0120	0.00900	0.00120	0.216	0.0260	0.0148
13-Feb-18	5.10	47.2	6.80	29.0	0.0140	0.0130	0.00110	0.162	0.0280	0.0142

Table N.7: Water Quality at SAMP Drainage Station Q-22, Located at Quirke II Drainage South of Access Road, Quirke TMA, 2015 to 2019

Date	Flow (L/s)	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
n	4	4	4	4	4	4	4	4	4	4
Minimum	2.20	29.1	6.30	21.0	0.0140	0.0100	0.000500	0.0670	0.0100	0.0124
Maximum	62.3	51.9	7.00	31.0	0.0260	0.0140	0.00120	0.162	0.0610	0.0176
Mean	20.0	40.0	6.60	25.8	0.0195	0.0122	0.000900	0.120	0.0288	0.0148
SD	28.4	11.2	0.356	4.99	0.00592	0.00171	0.000316	0.0469	0.0228	0.00216
14-May-18	10.2	32.0	6.30	22.0	0.0230	0.0120	0.000500	0.0670	0.0100	0.0148
05-Sep-18	2.20	51.9	6.30	31.0	0.0260	0.0140	0.00120	0.156	0.0610	0.0176
13-Nov-18	62.3	29.1	7.00	21.0	0.0150	0.0100	0.000800	0.0930	0.0160	0.0124
12-Feb-19	4.40	34.2	6.50	23.0	0.0150	0.0110	0.000700	0.101	0.0170	0.0143
13-May-19	25.1	22.1	6.90	17.0	0.0200	0.00800	<0.000500	0.0420	0.00600	0.00960
13-Aug-19	0.700	79.1	6.20	67.0	0.0510	0.0230	0.00190	0.125	0.108	0.0192
07-Oct-19	13.2	30.9	6.60	20.0	0.0270	0.0120	<0.000500	0.116	0.0150	0.0170
n	4	4	4	4	4	4	4	4	4	4
Minimum	0.700	22.1	6.20	17.0	0.0150	0.00800	<0.0005	0.0420	0.00600	0.00960
Maximum	25.1	79.1	6.90	67.0	0.0510	0.0230	0.00190	0.125	0.108	0.0192
Mean	10.9	41.6	6.55	31.8	0.0282	0.0135	0.000900	0.0960	0.0365	0.0150
SD	10.9	25.5	0.289	23.6	0.0159	0.00656	0.000735	0.0373	0.0479	0.00413
Summary Statistics for 2015 to 2019										
n	20	20	20	20	20	20	20	20	20	20
Minimum	0.600	22.1	6.00	17.0	0.0120	0.00800	<0.000500	0.0420	0.00600	0.00960
Maximum	62.3	101	7.00	180	0.0510	0.0300	0.00260	0.316	0.129	0.0282
Mean	12.3	43.1	6.60	36.6	0.0249	0.0133	0.00110	0.119	0.0347	0.0168
SD	14.3	20.7	0.272	36.4	0.0119	0.00537	0.000605	0.0666	0.0355	0.00430
Median	8.85	33.2	6.60	24.0	0.0215	0.0115	0.000850	0.103	0.0165	0.0161
10th Percentile	0.850	27.4	6.25	17.5	0.0140	0.00900	0.000500	0.0555	0.0100	0.0125
95th Percentile	46.2	90.0	7.00	124	0.0505	0.0265	0.00245	0.266	0.118	0.0260

Note: n = number of samples. SD = standard deviation.

Table N.8: Water Quality at SAMP Drainage Station Q-23, Located at Swamp Outlet west of Dam K1, Quirke TMA, 2015 to 2019

Date	Flow (L/s)	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
09-Feb-15	-	10.5	6.40	4.10	<0.00500	0.0290	0.00110	0.890	0.0900	<0.000500
11-May-15	40.5	8.00	5.90	2.90	0.00500	0.0220	0.00100	0.450	0.0790	<0.000500
17-Sep-15	2.40	10.3	6.20	1.80	<0.00800	0.0280	0.000600	0.863	0.0590	<0.000500
09-Nov-15	119	7.35	6.40	3.40	<0.00800	0.0210	0.000600	0.238	0.0320	<0.000500
n	3	4	4	4	4	4	4	4	4	4
Minimum	2.40	7.35	5.90	1.80	<0.005	0.0210	0.000600	0.238	0.0320	<0.0005
Maximum	119	10.5	6.40	4.10	<0.008	0.0290	0.00110	0.890	0.0900	<0.0005
Mean	54.1	9.04	6.22	3.05	0.00500	0.0250	0.000825	0.610	0.0650	<0.0005
SD	59.7	1.60	0.236	0.968	-	0.00408	0.000263	0.320	0.0255	-
08-Feb-16	27.0	9.40	5.70	3.40	<0.00800	0.0220	0.00130	0.938	0.126	<0.000500
05-May-16	76.1	5.80	6.30	3.00	<0.00800	0.0180	<0.000500	0.188	0.0240	<0.000500
n	3	3	3	3	3	3	3	3	3	3
Minimum	10.0	5.80	5.70	3.00	<0.008	0.0180	<0.0005	0.188	0.0100	<0.0005
Maximum	76.1	10.6	6.80	5.00	<0.008	0.0250	0.00130	0.938	0.126	<0.0005
Mean	37.7	8.60	6.27	3.80	<0.008	0.0217	0.000767	0.469	0.0533	<0.0005
SD	34.3	2.50	0.551	1.06	-	0.00351	-	0.409	0.0633	-
21-Nov-16	10.0	10.6	6.80	5.00	<0.00800	0.0250	<0.000500	0.281	0.0100	<0.000500
14-Feb-17	20.0	10.0	5.90	3.60	<0.00700	0.0260	0.000900	0.717	0.0920	<0.000500
20-Apr-17	507	6.10	6.40	2.90	<0.00700	0.0180	<0.000500	0.200	0.0230	<0.000500
n	4	4	4	4	4	4	4	4	4	4
Minimum	20.0	6.10	5.90	1.40	<0.007	0.0180	<0.0005	0.200	0.0230	<0.0005
Maximum	507	10.0	6.40	3.60	<0.007	0.0320	0.00100	1.36	0.0970	<0.0005
Mean	172	8.28	6.02	2.60	<0.007	0.0235	0.000725	0.658	0.0605	<0.0005
SD	227	1.98	0.250	0.920	-	0.00681	0.0000612	0.516	0.0394	-
14-Aug-17	43.1	9.90	5.90	1.40	<0.00700	0.0320	0.00100	1.36	0.0970	<0.000500
15-Nov-17	119	7.10	5.90	2.50	<0.00700	0.0180	<0.000500	0.355	0.0300	<0.000500
13-Feb-18	15.9	10.8	6.30	3.20	<0.00700	0.0260	0.000800	0.821	0.0790	<0.000500
n	4	4	4	4	4	4	4	4	4	4
Minimum	1.10	6.50	5.80	1.20	<0.007	0.0180	<0.0005	0.203	0.0210	<0.0005
Maximum	76.1	11.9	6.40	3.20	<0.007	0.0260	0.00120	0.975	0.108	<0.0005
Mean	41.0	9.02	6.15	2.55	<0.007	0.0220	0.000775	0.583	0.0628	<0.0005
SD	38.0	2.73	0.265	0.926	-	0.00365	0.000300	0.373	0.0385	-

Table N.8: Water Quality at SAMP Drainage Station Q-23, Located at Swamp Outlet west of Dam K1, Quirke TMA, 2015 to 2019

Date	Flow (L/s)	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
14-May-18	70.8	6.90	6.10	2.70	<0.00700	0.0200	0.000600	0.334	0.0430	<0.000500
05-Sep-18	1.10	11.9	5.80	1.20	<0.00700	0.0240	0.00120	0.975	0.108	<0.000500
13-Nov-18	76.1	6.50	6.40	3.10	<0.00700	0.0180	<0.000500	0.203	0.0210	<0.000500
n	4	4	4	4	4	4	4	4	4	4
Minimum	1.10	6.50	5.80	1.20	<0.007	0.0180	<0.0005	0.203	0.0210	<0.0005
Maximum	76.1	11.9	6.40	3.20	<0.007	0.0260	0.00120	0.975	0.108	<0.0005
Mean	41.0	9.02	6.15	2.55	<0.007	0.0220	0.000775	0.583	0.0628	<0.0005
SD	38.0	2.73	0.265	0.926	-	0.00365	0.000300	0.373	0.0385	-
11-Feb-19	-	8.20	5.90	2.80	<0.00700	0.0230	0.00100	0.480	0.0830	<0.000500
14-May-19	160	5.10	6.10	2.40	<0.00700	0.0160	<0.000500	0.168	0.0190	<0.000500
12-Aug-19	13.1	8.50	5.50	0.700	<0.00700	0.0240	0.00170	1.52	0.153	<0.000500
07-Oct-19	62.3	8.70	6.40	1.80	<0.00700	0.0240	<0.000500	0.556	0.0250	<0.000500
n	3	4	4	4	4	4	4	4	4	4
Minimum	13.1	5.10	5.50	0.700	<0.007	0.0160	<0.0005	0.168	0.0190	<0.0005
Maximum	160	8.70	6.40	2.80	<0.007	0.0240	0.00170	1.52	0.153	<0.0005
Mean	78.5	7.62	5.98	1.92	<0.007	0.0217	0.000925	0.681	0.0700	<0.0005
SD	74.9	1.70	0.377	0.914	-	0.00386	0.000429	0.584	0.0624	-
Summary Statistics for 2015 to 2019										
n	17	19	19	19	19	19	19	19	19	19
Minimum	1.10	5.10	5.50	0.700	<0.00500	0.0160	<0.000500	0.168	0.0100	<0.000500
Maximum	507	11.9	6.80	5.00	<0.00800	0.0320	0.00170	1.52	0.153	<0.000500
Mean	80.3	8.51	6.12	2.73	0.00500	0.0228	0.000805	0.607	0.0628	<0.000500
SD	119	1.95	0.319	1.04	-	0.00429	0.000322	0.406	0.0417	-
Median	43.1	8.50	6.10	2.90	0.00500	0.0230	0.000600	0.480	0.0590	<0.000500
10th Percentile	2.40	5.80	5.70	1.20	<0.00500	0.0180	<0.000500	0.188	0.0190	<0.000500
95th Percentile	507	11.9	6.80	5.00	0.00500	0.0320	0.00170	1.52	0.153	<0.000500

Note: "-" = SD was incalculable because there was no variability in the data. n = number of samples. SD = standard deviation.

Table N.9: Water Quality at SAMP Seepage Station Q-27, Located at Dam J Toe Seepage, Quirke TMA, 2015 to 2019

Date	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
11-May-15	303	6.00	320	0.00800	0.0630	0.0181	11.2	2.35	0.00140
09-Nov-15	456	5.80	470	0.0170	0.128	0.0255	17.7	3.04	0.00140
n	2	2	2	2	2	2	2	2	2
Minimum	303	5.80	320	0.00800	0.0630	0.0181	11.2	2.35	0.00140
Maximum	456	6.00	470	0.0170	0.128	0.0255	17.7	3.04	0.00140
Mean	380	5.90	395	0.0125	0.0955	0.0218	14.4	2.70	0.00140
SD	108	0.141	106	0.00636	0.0460	0.00523	4.60	0.488	-
08-Feb-16	297	5.90	290	0.00800	0.0400	0.0111	14.7	1.70	0.00150
05-May-16	340	5.80	290	0.0120	0.0580	0.0166	8.63	1.98	0.00120
n	2	2	2	2	2	2	2	2	2
Minimum	297	5.80	290	0.00800	0.0400	0.0111	8.63	1.70	0.00120
Maximum	340	5.90	290	0.0120	0.0580	0.0166	14.7	1.98	0.00150
Mean	318	5.85	290	0.0100	0.0490	0.0138	11.7	1.84	0.00135
SD	30.4	0.0707	-	0.00283	0.0127	0.00389	4.29	0.198	0.000212
20-Apr-17	364	5.80	300	0.0100	0.0960	0.0187	8.73	2.30	0.00110
14-Aug-17	297	5.90	310	0.0130	0.0810	0.0185	25.8	2.57	0.00180
15-Nov-17	291	5.90	270	<0.00700	0.0650	0.0208	19.1	2.32	0.00110
n	3	3	3	3	3	3	3	3	3
Minimum	291	5.80	270	<0.007	0.0650	0.0185	8.73	2.30	0.00110
Maximum	364	5.90	310	0.0130	0.0960	0.0208	25.8	2.57	0.00180
Mean	317	5.87	293	0.0100	0.0807	0.0193	17.9	2.40	0.00133
SD	40.5	0.0577	20.8	0.00200	0.0155	0.00127	8.60	0.150	0.000404
14-May-18	397	5.70	380	<0.00700	0.0980	0.0165	10.4	2.37	0.00100
13-Nov-18	390	6.10	380	<0.00700	0.0620	0.0198	18.7	2.57	0.00120
n	2	2	2	2	2	2	2	2	2
Minimum	390	5.70	380	<0.007	0.0620	0.0165	10.4	2.37	0.00100
Maximum	397	6.10	380	<0.007	0.0980	0.0198	18.7	2.57	0.00120
Mean	394	5.90	380	<0.007	0.0800	0.0182	14.6	2.47	0.00110
SD	4.95	0.283	-	-	0.0255	0.00233	5.87	0.141	0.000141
14-May-19	329	5.50	350	0.0100	0.0780	0.0141	9.61	2.05	0.000800
07-Oct-19	390	6.00	340	0.0120	0.102	0.0161	17.3	2.04	0.00110
n	2	2	2	2	2	2	2	2	2
Minimum	329	5.50	340	0.0100	0.0780	0.0141	9.61	2.04	0.000800
Maximum	390	6.00	350	0.0120	0.102	0.0161	17.3	2.05	0.00110
Mean	360	5.75	345	0.0110	0.0900	0.0151	13.5	2.04	0.000950
SD	43.1	0.354	7.07	0.00141	0.0170	0.00141	5.44	0.00707	0.000212
Summary Statistics for 2015 to 2019									
n	11	11	11	11	11	11	11	11	11
Minimum	291	5.50	270	<0.00700	0.0400	0.0111	8.63	1.70	0.000800
Maximum	456	6.10	470	0.0170	0.128	0.0255	25.8	3.04	0.00180
Mean	350	5.85	336	0.0101	0.0792	0.0178	14.7	2.30	0.00124
SD	53.6	0.163	57.3	0.00296	0.0251	0.00372	5.51	0.360	0.000273
Median	340	5.90	320	0.0100	0.0780	0.0181	14.7	2.32	0.00120
10th Percentile	297	5.70	290	<0.00700	0.0580	0.0141	8.73	1.98	0.00100
95th Percentile	456	6.10	470	0.0170	0.128	0.0255	25.8	3.04	0.00180

Note: "-" = SD was incalculable because there was no variability in the data. n = number of samples. SD = standard deviation.

Table N.10: Water Quality at SAMP Principal Station Q-28, Located at Final Treated Effluent, Quirke TMA, 2015 to 2019

Date	Flow (L/s)	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)	Sublethal Toxicity (*Ceriodaphnia dubia*) IC25	Acute Toxicity (*Daphnia magna*) % Mortality	Acute Toxicity (Rainbow Trout) % Mortality
05-Jan-15	114	-	7.48	-	0.0730	-	-	-	-	-	-	-	-
12-Jan-15	115	1,000	7.40	980	0.0630	0.0920	0.00500	0.708	1.13	0.0145	-	-	-
19-Jan-15	95.0	957	7.40	-	0.0410	-	-	-	-	-	-	-	-
26-Jan-15	90.0	-	7.30	-	0.0370	-	-	-	-	-	-	-	-
02-Feb-15	95.0	-	7.45	-	0.0430	-	-	-	-	-	-	-	-
09-Feb-15	90.0	983	7.41	1,000	0.0510	0.0630	0.00490	0.560	1.01	0.0155	-	-	-
17-Feb-15	95.0	-	7.48	-	0.0420	-	-	-	-	-	-	-	-
23-Feb-15	93.0	-	7.37	-	0.0430	-	-	-	-	-	-	-	-
02-Mar-15	88.0	-	7.16	-	0.0430	-	-	-	-	-	-	-	-
10-Mar-15	115	1,060	7.50	1,000	0.0630	0.0750	0.00470	0.520	0.891	0.0168	-	-	-
16-Mar-15	111	-	7.20	-	0.0740	-	-	-	-	-	-	-	-
23-Mar-15	99.0	-	7.30	-	0.0460	-	-	-	-	-	-	-	-
30-Mar-15	94.0	-	7.70	-	0.0610	-	-	-	-	-	-	-	-
06-Apr-15	95.0	-	7.50	-	0.0860	-	-	-	-	-	-	-	-
13-Apr-15	95.0	886	7.20	800	0.0600	0.0670	0.00520	0.610	1.03	0.0152	-	-	-
20-Apr-15	70.0	-	7.00	-	0.0390	-	-	-	-	-	-	-	-
27-Apr-15	140	-	7.00	-	0.150	-	-	-	-	-	-	-	-
04-May-15	100	-	7.13	-	0.0510	-	-	-	-	-	-	-	-
11-May-15	115	636	7.10	650	0.0510	0.0950	0.00280	0.360	0.602	0.0122	100	0	0
19-May-15	115	-	7.05	-	0.0570	-	-	-	-	-	-	-	-
25-May-15	110	-	7.40	-	0.0590	-	-	-	-	-	-	-	-
01-Jun-15	110	-	7.37	-	0.0780	-	-	-	-	-	-	-	-
08-Jun-15	110	657	7.00	640	0.0690	0.104	0.00270	0.700	0.581	0.0108	-	-	-
15-Jun-15	75.0	-	7.15	-	0.0620	-	-	-	-	-	-	-	-
22-Jun-15	78.0	-	7.01	-	0.0530	-	-	-	-	-	-	-	-
29-Jun-15	77.0	-	7.32	-	0.0380	-	-	-	-	-	-	-	-
06-Jul-15	50.0	-	7.00	-	0.0380	-	-	-	-	-	-	-	-
13-Jul-15	30.0	862	6.94	840	0.0480	0.0420	0.00190	0.730	0.499	0.0115	-	-	-
20-Jul-15	54.0	-	7.20	-	0.0360	-	-	-	-	-	-	-	-
27-Jul-15	51.0	-	6.90	-	0.0320	-	-	-	-	-	-	-	-
04-Aug-15	54.0	-	7.00	-	0.0130	-	-	-	-	-	-	-	-
10-Aug-15	54.0	915	7.00	890	0.0360	0.0240	0.00140	0.600	0.380	0.0100	-	-	-
17-Aug-15	42.0	-	7.00	-	0.0410	-	-	-	-	-	-	-	-
24-Aug-15	41.0	-	7.00	-	0.0270	-	-	-	-	-	-	-	-
31-Aug-15	59.0	-	6.90	-	0.0360	-	-	-	-	-	-	-	-
08-Sep-15	64.0	-	6.96	-	0.0290	-	-	-	-	-	-	-	-
14-Sep-15	65.0	880	7.20	930	0.0370	0.0310	0.00140	0.680	0.357	0.0127	-	-	-
21-Sep-15	84.0	-	7.00	-	0.0430	-	-	-	-	-	-	-	-
28-Sep-15	111	-	7.06	-	0.0660	-	-	-	-	-	-	-	-
05-Oct-15	111	-	7.00	-	0.0700	-	-	-	-	-	-	-	-
13-Oct-15	82.0	1,140	7.41	980	0.0540	0.0740	0.00220	0.660	0.439	0.0144	-	-	-
19-Oct-15	86.0	-	7.00	-	0.0430	-	-	-	-	-	-	-	-

Table N.10: Water Quality at SAMP Principal Station Q-28, Located at Final Treated Effluent, Quirke TMA, 2015 to 2019

Date	Flow (L/s)	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)	Sublethal Toxicity (*Ceriodaphnia dubia*) IC25	Acute Toxicity (*Daphnia magna*) % Mortality	Acute Toxicity (Rainbow Trout) % Mortality
26-Oct-15	75.0	-	7.00	-	0.0350	-	-	-	-	-	-	-	-
02-Nov-15	107	1,000	7.20	-	0.0290	-	-	-	-	-	-	-	-
09-Nov-15	139	957	7.00	1,000	0.0430	0.0740	0.00240	0.496	0.491	0.0110	100	0	0
16-Nov-15	138	-	7.01	-	0.0440	-	-	-	-	-	-	-	-
23-Nov-15	138	-	7.04	-	0.0370	-	-	-	-	-	-	-	-
30-Nov-15	138	-	7.47	-	0.0590	-	-	-	-	-	-	-	-
07-Dec-15	138	-	7.92	-	0.0580	-	-	-	-	-	-	-	-
14-Dec-15	160	852	7.70	890	0.0590	0.0790	0.00270	0.526	0.689	0.00930	-	-	-
21-Dec-15	185	-	7.04	-	0.0640	-	-	-	-	-	-	-	-
28-Dec-15	180	-	7.00	-	0.0680	-	-	-	-	-	-	-	-
n	52	12	52	12	52	12	12	12	12	12	2	2	2
Minimum	30.0	636	6.90	640	0.0130	0.0240	0.00140	0.360	0.357	0.00930	100	0	0
Maximum	185	1,140	7.92	1,000	0.150	0.104	0.00520	0.730	1.13	0.0168	100	0	0
Mean	96.5	902.3	7.20	883	0.0515	0.0683	0.00311	0.596	0.675	0.0128	100	0	0
SD	34.0	147	0.236	129	0.0203	0.0250	0.00144	0.109	0.272	0.00241	-	-	-
04-Jan-16	180	-	7.10	-	0.0840	-	-	-	-	-	-	-	-
12-Jan-16	180	828	7.82	870	0.0740	0.101	0.00420	0.750	0.927	0.00740	-	-	-
18-Jan-16	155	-	7.52	-	0.0770	-	-	-	-	-	-	-	-
25-Jan-16	155	-	8.08	-	0.0770	-	-	-	-	-	-	-	-
01-Feb-16	111	-	7.21	-	0.0680	-	-	-	-	-	-	-	-
08-Feb-16	109	865	7.26	910	0.0630	0.0750	0.00440	0.800	0.951	0.0107	-	-	-
16-Feb-16	109	-	7.20	-	0.0550	-	-	-	-	-	-	-	-
22-Feb-16	130	-	7.00	-	0.0880	-	-	-	-	-	-	-	-
29-Feb-16	158	-	7.02	-	0.0660	-	-	-	-	-	-	-	-
07-Mar-16	150	-	7.12	-	0.0870	-	-	-	-	-	-	-	-
14-Mar-16	155	997	7.45	920	0.102	0.100	0.00660	0.660	1.16	0.00900	-	-	-
21-Mar-16	150	-	7.18	-	0.0650	-	-	-	-	-	-	-	-
28-Mar-16	153	-	7.51	-	0.0940	-	-	-	-	-	-	-	-
04-Apr-16	155	-	7.52	-	0.0850	-	-	-	-	-	-	-	-
11-Apr-16	148	766	7.72	730	0.0760	0.147	0.00440	0.621	0.845	0.00980	-	-	-
18-Apr-16	143	-	7.41	-	0.0900	-	-	-	-	-	-	-	-
25-Apr-16	109	-	7.37	-	0.0740	-	-	-	-	-	-	-	-
26-Apr-16	-	-	-	-	0.0690	-	-	-	-	-	-	-	-
02-May-16	106	-	7.34	-	0.0510	-	-	-	-	-	-	-	-
09-May-16	104	718	7.34	570	0.0500	0.120	0.00320	0.332	0.727	0.00970	100	0	0
16-May-16	47.0	-	7.30	-	0.0260	-	-	-	-	-	-	-	-
24-May-16	59.0	-	7.56	-	0.0350	-	-	-	-	-	-	-	-
31-May-16	67.0	-	7.35	-	0.0340	-	-	-	-	-	-	-	-
06-Jun-16	84.0	-	7.12	-	0.0380	-	-	-	-	-	-	-	-
13-Jun-16	84.0	812	7.38	730	0.0460	0.0680	0.00210	0.484	0.504	0.0112	-	-	-
20-Jun-16	79.0	-	7.45	-	0.0450	-	-	-	-	-	-	-	-
27-Jun-16	99.0	-	7.20	-	0.0450	-	-	-	-	-	-	-	-

Table N.10: Water Quality at SAMP Principal Station Q-28, Located at Final Treated Effluent, Quirke TMA, 2015 to 2019

Date	Flow (L/s)	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)	Sublethal Toxicity (*Ceriodaphnia dubia*) IC25	Acute Toxicity (*Daphnia magna*) % Mortality	Acute Toxicity (Rainbow Trout) % Mortality
05-Jul-16	40.0	-	7.30	-	0.0260	-	-	-	-	-	-	-	-
11-Jul-16	102	984	7.10	820	0.0540	0.0630	0.00190	0.439	0.538	0.0104	-	-	-
18-Jul-16	100	-	7.10	-	0.0650	-	-	-	-	-	-	-	-
06-Sep-16	107	-	7.06	-	0.0270	-	-	-	-	-	-	-	-
12-Sep-16	80.0	1,060	7.10	1,000	0.0750	0.0590	0.00140	0.558	0.369	0.0189	-	-	-
19-Sep-16	55.0	-	7.10	-	0.0520	-	-	-	-	-	-	-	-
26-Sep-16	66.0	-	7.18	-	0.0330	-	-	-	-	-	-	-	-
03-Oct-16	86.0	-	7.08	-	0.0350	-	-	-	-	-	-	-	-
11-Oct-16	85.0	1,060	7.10	970	0.0620	0.0620	0.00160	0.692	0.345	0.0177	-	-	-
17-Oct-16	86.0	-	7.00	-	0.0860	-	-	-	-	-	-	-	-
24-Oct-16	100	-	7.20	-	0.0610	-	-	-	-	-	-	-	-
31-Oct-16	100	-	7.40	-	0.0730	-	-	-	-	-	-	-	-
07-Nov-16	99.0	-	7.50	-	0.114	-	-	-	-	-	-	-	-
14-Nov-16	98.0	1,050	7.40	1,000	0.121	0.0690	0.00190	0.345	0.411	0.0143	100	0	0
21-Nov-16	101	-	7.50	-	0.0970	-	-	-	-	-	-	-	-
28-Nov-16	73.0	-	8.20	-	0.0760	-	-	-	-	-	-	-	-
05-Dec-16	78.0	-	7.10	-	0.0860	-	-	-	-	-	-	-	-
12-Dec-16	111	1,120	7.00	1,100	0.169	0.0840	0.00390	0.623	1.01	0.0117	-	-	-
19-Dec-16	80.0	-	7.30	-	0.122	-	-	-	-	-	-	-	-
29-Dec-16	80.0	-	8.30	-	0.0610	-	-	-	-	-	-	-	-
n	46	11	46	11	47	11	11	11	11	11	2	2	2
Minimum	40.0	718	7.00	570	0.0260	0.0590	0.00140	0.332	0.345	0.00740	100	0	0
Maximum	180	1,120	8.30	1,100	0.169	0.147	0.00660	0.800	1.16	0.0189	100	0	0
Mean	107	932.7	7.34	875	0.0693	0.0862	0.00324	0.573	0.708	0.0119	100	0	0
SD	35.3	139	0.300	152	0.0284	0.0281	0.00162	0.157	0.288	0.00361	-	-	-
02-Jan-17	80.0	-	8.10	-	0.0440	-	-	-	-	-	-	-	-
09-Jan-17	83.0	1,030	7.70	1,000	0.0670	0.0750	0.00410	0.731	1.03	0.0130	-	-	-
16-Jan-17	95.0	-	7.60	-	0.0980	-	-	-	-	-	-	-	-
23-Jan-17	110	-	7.80	-	0.100	-	-	-	-	-	-	-	-
30-Jan-17	110	-	7.70	-	0.111	-	-	-	-	-	-	-	-
06-Feb-17	110	-	8.00	-	0.104	-	-	-	-	-	-	-	-
13-Feb-17	110	1,120	7.70	1,000	0.100	0.0740	0.00450	0.770	1.21	0.0139	-	-	-
21-Feb-17	110	-	7.80	-	0.102	-	-	-	-	-	-	-	-
27-Feb-17	108	-	7.60	-	0.0920	-	-	-	-	-	-	-	-
06-Mar-17	131	-	7.40	-	0.0860	-	-	-	-	-	-	-	-
16-Mar-17	130	1,000	7.50	940	0.133	0.0800	0.00630	1.01	1.42	0.0130	-	-	-
20-Mar-17	100	-	7.90	-	0.114	-	-	-	-	-	-	-	-
27-Mar-17	100	-	7.30	-	0.0990	-	-	-	-	-	-	-	-
03-Apr-17	127	-	7.30	-	0.117	-	-	-	-	-	-	-	-
10-Apr-17	160	730	7.50	650	0.146	0.0970	0.00310	0.442	0.826	0.00940	-	-	-
17-Apr-17	160	-	8.20	-	0.154	-	-	-	-	-	-	-	-
24-Apr-17	120	-	7.40	-	0.126	-	-	-	-	-	-	-	-

Table N.10: Water Quality at SAMP Principal Station Q-28, Located at Final Treated Effluent, Quirke TMA, 2015 to 2019

Date	Flow (L/s)	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)	Sublethal Toxicity (*Ceriodaphnia dubia*) IC25	Acute Toxicity (*Daphnia magna*) % Mortality	Acute Toxicity (Rainbow Trout) % Mortality
01-May-17	113	-	7.00	-	0.0920	-	-	-	-	-	-	-	-
08-May-17	80.0	727	7.10	620	0.0470	0.0880	0.00200	0.331	0.615	0.0111	85.7	0	0
15-May-17	100	-	7.20	-	0.0640	-	-	-	-	-	-	-	-
23-May-17	100	-	7.20	-	0.0800	-	-	-	-	-	-	-	-
29-May-17	95.0	-	7.30	-	0.0810	-	-	-	-	-	-	-	-
05-Jun-17	140	-	7.40	-	0.114	-	-	-	-	-	-	-	-
13-Jun-17	120	837	7.10	740	0.0680	0.0820	0.00160	0.382	0.388	0.0111	-	-	-
19-Jun-17	120	-	7.00	-	0.0920	-	-	-	-	-	-	-	-
26-Jun-17	124	-	7.30	-	0.154	-	-	-	-	-	-	-	-
04-Jul-17	120	-	7.20	-	0.135	-	-	-	-	-	-	-	-
10-Jul-17	120	882	7.10	840	0.131	0.0890	0.00130	0.286	0.435	0.0119	-	-	-
17-Jul-17	100	-	7.10	-	0.0970	-	-	-	-	-	-	-	-
24-Jul-17	70.0	-	7.00	-	0.0770	-	-	-	-	-	-	-	-
31-Jul-17	95.0	-	7.10	-	0.0960	-	-	-	-	-	-	-	-
08-Aug-17	110	-	7.30	-	0.0870	-	-	-	-	-	-	-	-
14-Aug-17	120	900	7.10	830	0.124	0.0780	0.00140	0.444	0.418	0.0128	-	-	-
21-Aug-17	120	-	7.60	-	0.126	-	-	-	-	-	-	-	-
28-Aug-17	120	-	7.60	-	0.158	-	-	-	-	-	-	-	-
05-Sep-17	120	-	7.40	-	0.137	-	-	-	-	-	-	-	-
11-Sep-17	95.0	916	7.20	850	0.110	0.0830	0.00140	0.351	0.353	0.0130	-	-	-
18-Sep-17	95.0	-	7.10	-	0.114	-	-	-	-	-	-	-	-
25-Sep-17	97.0	-	7.70	-	0.0980	-	-	-	-	-	-	-	-
02-Oct-17	100	-	7.20	-	0.0920	-	-	-	-	-	-	-	-
10-Oct-17	80.0	882	7.20	880	0.197	0.0610	0.00160	0.441	0.392	0.0116	-	-	-
16-Oct-17	107	-	7.10	-	0.0780	-	-	-	-	-	-	-	-
23-Oct-17	160	-	8.40	-	0.135	-	-	-	-	-	-	-	-
30-Oct-17	188	-	7.50	-	0.197	-	-	-	-	-	-	-	-
06-Nov-17	150	-	7.20	-	0.167	-	-	-	-	-	-	-	-
13-Nov-17	146	769	7.70	880	0.120	0.112	0.00260	0.276	0.793	0.00720	100	0	0
20-Nov-17	135	-	7.50	-	0.108	-	-	-	-	-	-	-	-
27-Nov-17	135	-	7.10	-	0.100	-	-	-	-	-	-	-	-
04-Dec-17	135	-	7.40	-	0.0990	-	-	-	-	-	-	-	-
11-Dec-17	180	845	7.40	850	0.132	0.116	0.00300	0.565	0.769	0.00880	-	-	-
18-Dec-17	180	-	7.50	-	0.132	-	-	-	-	-	-	-	-
26-Dec-17	145	-	8.30	-	0.146	-	-	-	-	-	-	-	-
n	365	12	52	12	52	12	12	12	12	12	2	2	2
Minimum	49.0	727	7.00	620	0.0440	0.0610	0.00130	0.276	0.353	0.00720	85.7	0	0
Maximum	190	1,120	8.40	1,000	0.197	0.116	0.00630	1.01	1.42	0.0139	100	0	0
Mean	119	886	7.44	840	0.111	0.0863	0.00274	0.502	0.721	0.0114	92.8	0	0
SD	27.9	119	0.344	120	0.0324	0.0157	0.00156	0.226	0.354	0.00202	10.1	-	-
02-Jan-18	140	-	7.40	-	0.138	-	-	-	-	-	-	-	-
08-Jan-18	110	900	7.50	880	0.110	0.0990	0.00370	0.885	0.823	0.0121	-	-	-

Table N.10: Water Quality at SAMP Principal Station Q-28, Located at Final Treated Effluent, Quirke TMA, 2015 to 2019

Date	Flow (L/s)	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)	Sublethal Toxicity (*Ceriodaphnia dubia*) IC25	Acute Toxicity (*Daphnia magna*) % Mortality	Acute Toxicity (Rainbow Trout) % Mortality
15-Jan-18	130	1,050	7.50	-	0.145	-	-	-	-	-	-	-	-
22-Jan-18	130	-	8.10	-	0.146	-	-	-	-	-	-	-	-
29-Jan-18	130	-	7.70	-	0.147	-	-	-	-	-	-	-	-
05-Feb-18	100	-	7.70	-	0.0990	-	-	-	-	-	-	-	-
12-Feb-18	100	1,290	7.50	960	0.0990	0.0880	0.00330	0.458	0.960	0.0130	-	-	-
20-Feb-18	100	-	7.50	-	0.0790	-	-	-	-	-	-	-	-
26-Feb-18	100	-	7.00	-	0.0990	-	-	-	-	-	-	-	-
05-Mar-18	100	-	7.80	-	0.117	-	-	-	-	-	-	-	-
12-Mar-18	80.0	1,230	7.70	970	0.0850	0.109	0.00440	0.655	1.15	0.0163	-	-	-
19-Mar-18	90.0	-	7.90	-	0.0850	-	-	-	-	-	-	-	-
26-Mar-18	88.0	-	7.70	-	0.0850	-	-	-	-	-	-	-	-
02-Apr-18	90.0	-	7.50	-	0.115	-	-	-	-	-	-	-	-
09-Apr-18	90.0	1,110	7.50	900	0.0980	0.0850	0.00330	0.449	0.808	0.0159	-	-	-
16-Apr-18	110	-	7.90	-	0.151	-	-	-	-	-	-	-	-
23-Apr-18	110	-	7.10	-	0.135	-	-	-	-	-	-	-	-
30-Apr-18	130	-	7.00	-	0.0930	-	-	-	-	-	-	-	-
07-May-18	190	-	7.40	-	0.157	-	-	-	-	-	-	-	-
15-May-18	90.0	666	7.20	550	0.133	0.105	0.00180	0.194	0.523	0.0125	-	-	-
22-May-18	90.0	-	7.30	-	0.0780	-	-	-	-	-	-	-	-
28-May-18	90.0	-	7.20	-	0.0660	-	-	-	-	-	-	-	-
04-Jun-18	90.0	640	7.30	560	0.0660	0.0930	0.000900	0.229	0.317	0.0136	100	0	10.0
11-Jun-18	65.0	-	7.20	-	0.0630	-	-	-	-	-	-	-	-
18-Jun-18	90.0	-	7.20	-	0.0560	-	-	-	-	-	-	-	-
25-Jun-18	90.0	-	7.50	-	0.0530	-	-	-	-	-	-	-	-
03-Jul-18	60.0	-	7.30	-	0.0560	-	-	-	-	-	-	-	-
09-Jul-18	60.0	886	7.10	730	0.0440	0.0370	0.000600	0.187	0.279	0.0141	-	-	-
16-Jul-18	50.0	-	7.30	-	0.0250	-	-	-	-	-	-	-	-
23-Jul-18	50.0	-	7.20	-	0.0190	-	-	-	-	-	-	-	-
30-Jul-18	70.0	-	7.10	-	0.0270	-	-	-	-	-	-	-	-
07-Aug-18	90.0	-	7.20	-	0.0560	-	-	-	-	-	-	-	-
13-Aug-18	90.0	831	7.10	880	0.0360	0.0490	0.000800	0.330	0.252	0.0152	-	-	-
20-Aug-18	83.0	-	7.30	-	0.0410	-	-	-	-	-	-	-	-
27-Aug-18	50.0	-	7.10	-	0.0330	-	-	-	-	-	-	-	-
04-Sep-18	70.0	-	7.10	-	0.0560	-	-	-	-	-	-	-	-
10-Sep-18	100	891	7.20	860	0.0410	0.0710	0.000700	0.320	0.215	0.0123	-	-	-
17-Sep-18	70.0	-	7.20	-	0.0490	-	-	-	-	-	-	-	-
24-Sep-18	70.0	-	7.10	-	0.0450	-	-	-	-	-	-	-	-
01-Oct-18	100	-	7.00	-	0.0400	-	-	-	-	-	-	-	-
09-Oct-18	145	819	7.10	890	0.0930	0.0970	0.00100	0.367	0.273	0.0109	-	-	-
15-Oct-18	170	-	7.70	-	0.135	-	-	-	-	-	-	-	-
22-Oct-18	170	-	7.20	-	0.0890	-	-	-	-	-	-	-	-
29-Oct-18	170	-	7.90	-	0.0980	-	-	-	-	-	-	-	-

Table N.10: Water Quality at SAMP Principal Station Q-28, Located at Final Treated Effluent, Quirke TMA, 2015 to 2019

Date	Flow (L/s)	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)	Sublethal Toxicity (*Ceriodaphnia dubia*) IC25	Acute Toxicity (*Daphnia magna*) % Mortality	Acute Toxicity (Rainbow Trout) % Mortality
05-Nov-18	130	1,050	8.00	870	0.0700	0.109	0.00130	0.302	0.588	0.00920	100	0	0
12-Nov-18	130	994	7.30	880	0.0580	0.104	0.00190	0.370	0.703	0.00820	-	-	-
19-Nov-18	130	-	7.40	-	0.0530	-	-	-	-	-	-	-	-
26-Nov-18	130	-	7.90	-	0.0790	-	-	-	-	-	-	-	-
03-Dec-18	130	-	7.20	-	0.0740	-	-	-	-	-	-	-	-
10-Dec-18	100	932	7.10	960	0.0790	0.103	0.00330	0.566	0.923	0.00980	-	-	-
17-Dec-18	100	-	8.00	-	0.0650	-	-	-	-	-	-	-	-
27-Dec-18	100	-	7.80	-	0.0510	-	-	-	-	-	-	-	-
n	365	13	52	13	52	13	13	13	13	13	2	2	2
Minimum	23.0	640	7.00	550	0.0190	0.0370	0.000600	0.187	0.215	0.00820	100	0	0
Maximum	190	1,290	8.10	970	0.157	0.109	0.00440	0.885	1.15	0.0163	100	0	10.0
Mean	101	941.2	7.41	838	0.0810	0.0884	0.00208	0.409	0.601	0.0125	100	0	5.00
SD	31.1	193	0.307	139	0.0370	0.0229	0.00134	0.198	0.317	0.00253	-	-	7.07
02-Jan-19	100	-	7.50	-	0.0760	-	-	-	-	-	-	-	-
07-Jan-19	100	-	7.30	-	0.0640	-	-	-	-	-	-	-	-
14-Jan-19	100	1,040	7.40	950	0.0660	0.119	0.00340	0.664	0.930	0.0142	-	-	-
21-Jan-19	100	-	7.60	-	0.0670	-	-	-	-	-	-	-	-
28-Jan-19	130	-	7.50	-	0.0500	-	-	-	-	-	-	-	-
04-Feb-19	130	-	7.60	-	0.103	-	-	-	-	-	-	-	-
11-Feb-19	110	976	7.20	960	0.0840	0.0980	0.00350	0.553	0.870	0.0201	-	-	-
19-Feb-19	110	-	7.40	-	0.0980	-	-	-	-	-	-	-	-
25-Feb-19	150	-	7.60	-	0.127	-	-	-	-	-	-	-	-
04-Mar-19	150	-	7.50	-	0.0860	-	-	-	-	-	-	-	-
11-Mar-19	100	966	7.40	950	0.0920	0.0800	0.00350	0.656	0.778	0.0178	-	-	-
18-Mar-19	100	-	7.30	-	0.0940	-	-	-	-	-	-	-	-
25-Mar-19	135	-	7.60	-	0.142	-	-	-	-	-	-	-	-
01-Apr-19	130	-	7.60	-	0.108	-	-	-	-	-	-	-	-
08-Apr-19	100	-	7.30	-	0.0840	-	-	-	-	-	-	-	-
16-Apr-19	170	897	8.10	760	0.155	0.108	0.00350	0.576	0.881	0.0166	100	0	0
22-Apr-19	170	-	7.40	-	0.167	-	-	-	-	-	-	-	-
29-Apr-19	200	-	7.10	-	0.149	-	-	-	-	-	-	-	-
06-May-19	200	-	7.30	-	0.161	-	-	-	-	-	-	-	-
13-May-19	135	411	7.40	380	0.148	0.145	0.00120	0.219	0.326	0.00770	-	-	-
21-May-19	130	-	7.40	-	0.135	-	-	-	-	-	-	-	-
27-May-19	180	-	7.20	-	0.168	-	-	-	-	-	-	-	-
03-Jun-19	115	-	7.20	-	0.123	-	-	-	-	-	-	-	-
10-Jun-19	160	689	7.90	630	0.153	0.143	0.000900	0.167	0.310	0.00710	-	-	-
17-Jun-19	120	-	7.50	-	0.101	-	-	-	-	-	-	-	-
24-Jun-19	120	-	7.30	-	0.0680	-	-	-	-	-	-	-	-
02-Jul-19	120	-	7.30	-	0.0680	-	-	-	-	-	-	-	-
08-Jul-19	85.0	897	7.20	750	0.0450	0.0639	0.00110	0.390	0.429	0.0115	-	-	-
15-Jul-19	85.0	-	7.30	-	0.0400	-	-	-	-	-	-	-	-

Table N.10: Water Quality at SAMP Principal Station Q-28, Located at Final Treated Effluent, Quirke TMA, 2015 to 2019

Date	Flow (L/s)	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)	Sublethal Toxicity (*Ceriodaphnia dubia*) IC25	Acute Toxicity (*Daphnia magna*) % Mortality	Acute Toxicity (Rainbow Trout) % Mortality
22-Jul-19	85.0	-	7.30	-	0.0440	-	-	-	-	-	-	-	-
29-Jul-19	60.0	-	7.10	-	0.0340	-	-	-	-	-	-	-	-
06-Aug-19	60.0	-	7.50	-	0.0220	-	-	-	-	-	-	-	-
12-Aug-19	60.0	856	7.00	740	0.0270	0.0380	0.00130	0.420	0.492	0.0144	-	-	-
19-Aug-19	60.0	-	7.00	-	0.0290	-	-	-	-	-	-	-	-
26-Aug-19	80.0	-	7.00	-	0.0350	-	-	-	-	-	-	-	-
03-Sep-19	80.0	-	7.00	-	0.0340	-	-	-	-	-	-	-	-
09-Sep-19	100	874	7.10	860	0.0410	0.0570	0.00130	0.520	0.323	0.0133	-	-	-
16-Sep-19	120	-	7.20	-	0.0560	-	-	-	-	-	-	-	-
23-Sep-19	100	-	7.30	-	0.0650	-	-	-	-	-	-	-	-
30-Sep-19	100	-	7.30	-	0.0610	-	-	-	-	-	-	-	-
07-Oct-19	140	-	7.30	-	0.0560	-	-	-	-	-	-	-	-
15-Oct-19	140	874	7.10	890	0.0790	0.0970	0.00130	0.446	0.336	0.00940	-	-	-
21-Oct-19	160	-	7.80	-	0.104	-	-	-	-	-	-	-	-
28-Oct-19	175	-	7.20	-	0.140	-	-	-	-	-	-	-	-
04-Nov-19	175	1,040	7.20	-	0.162	-	-	-	-	-	-	-	-
11-Nov-19	100	942	7.30	900	0.137	0.121	0.00190	0.406	0.726	0.00800	100	0	0
18-Nov-19	125	-	8.20	-	0.136	-	-	-	-	-	-	-	-
25-Nov-19	125	-	7.50	-	0.116	-	-	-	-	-	-	-	-
02-Dec-19	150	-	7.70	-	0.130	-	-	-	-	-	-	-	-
09-Dec-19	150	867	7.50	870	0.132	0.127	0.00260	0.734	0.904	0.00970	-	-	-
16-Dec-19	150	-	7.60	-	0.167	-	-	-	-	-	-	-	-
23-Dec-19	120	-	7.60	-	0.104	-	-	-	-	-	-	-	-
30-Dec-19	120	-	7.70	-	0.107	-	-	-	-	-	-	-	-
n	365	12	53	12	53	12	12	12	12	12	2	2	2
Minimum	25.0	411	7.00	380	0.0220	0.0380	0.000900	0.167	0.310	0.00710	100	0	0
Maximum	200	1,040	8.20	960	0.168	0.145	0.00350	0.734	0.930	0.0201	100	0	0
Mean	123	857	7.39	803	0.0951	0.0997	0.00213	0.479	0.609	0.0125	100	0	0
SD	35.9	165	0.258	168	0.0440	0.0342	0.00109	0.173	0.260	0.00427	-	-	-
Summary Statistics for 2015 to 2019													
n	1193	65	255	60	256	60	60	60	60	60	10	10	10
Minimum	23.0	411	6.90	380	0.0130	0.0240	0.000600	0.167	0.215	0.00710	85.7	0	0
Maximum	200	1,290	8.40	1,100	0.197	0.147	0.00660	1.01	1.42	0.0201	100	0	10.0
Mean	114	910	7.36	847	0.0819	0.0858	0.00264	0.509	0.661	0.0122	98.6	0	1.00
SD	33.5	150	0.302	141	0.0392	0.0269	0.00145	0.185	0.295	0.00300	4.52	-	3.16
Median	110	897	7.30	880	0.0755	0.0845	0.00230	0.508	0.608	0.0120	100	0	0
5th Percentile	70.0	718	7.00	635	0.0360	0.0530	0.00105	0.281	0.320	0.00850	92.8	0	0
95th Percentile	175	1,120	8.00	1,000	0.154	0.135	0.00510	0.785	1.15	0.0178	100	0	10.0

Note: "-" = no data collected or SD was incalculable because there was no variability in the data. n = number of samples. SD = standard deviation.

Table N.11: Water Quality at SAMP Seepage Station P-02, Located Downstream of Dam B, Panel TMA, 2015 to 2019

Date	Flow (L/s)	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
26-Jan-15	<1.00	308	6.40	260	0.0100	0.0230	<0.000500	0.0700	0.0700	0.00450
08-Apr-15	<1.00	278	6.60	230	0.00900	0.0220	<0.000500	0.100	0.0770	0.00400
16-Sep-15	<1.00	278	6.80	220	<0.00800	0.0210	<0.000500	0.0750	0.0360	0.00370
20-Oct-15	<1.00	275	6.90	220	<0.00800	0.0220	<0.000500	0.0540	0.0430	0.00380
n	4	4	4	4	4	4	4	4	4	4
Minimum	<1	275	6.40	220	<0.008	0.0210	<0.0005	0.0540	0.0360	0.00370
Maximum	<1	308	6.90	260	0.0100	0.0230	<0.0005	0.100	0.0770	0.00450
Mean	<1	285	6.68	232	0.00875	0.0220	<0.0005	0.0748	0.0565	0.00400
SD	-	15.6	0.222	18.9	0.000612	0.000816	-	0.0191	0.0200	0.000356
21-Jan-16	<1.00	260	6.50	200	0.0110	0.0220	<0.000500	0.0470	0.0270	0.00520
09-May-16	<1.00	243	6.30	190	<0.00800	0.0180	<0.000500	0.0330	0.0310	0.00240
21-Jul-16	<1.00	287	6.70	230	<0.00800	0.0200	<0.000500	0.122	0.0450	0.00300
27-Oct-16	<1.00	230	6.70	190	<0.00800	0.0200	<0.000500	0.0380	0.0380	0.00390
n	4	4	4	4	4	4	4	4	4	4
Minimum	<1	230	6.30	190	<0.008	0.0180	<0.0005	0.0330	0.0270	0.00240
Maximum	<1	287	6.70	230	0.0110	0.0220	<0.0005	0.122	0.0450	0.00520
Mean	<1	255	6.55	202	0.00875	0.0200	<0.0005	0.0600	0.0352	0.00362
SD	-	24.6	0.191	18.9	-	0.00163	-	0.0417	0.00793	0.00122
26-Jan-17	<1.00	260	6.50	180	<0.00700	0.0210	<0.000500	0.0630	0.0790	0.00440
27-Apr-17	<1.00	196	6.80	150	0.0340	0.0200	0.000800	0.890	0.188	0.00220
19-Jul-17	<1.00	259	7.00	190	0.0420	0.0250	<0.000500	1.24	0.133	0.00230
30-Oct-17	1.00	198	6.80	130	0.0680	0.0160	<0.000500	0.517	0.0900	0.00220
n	4	4	4	4	4	4	4	4	4	4
Minimum	<1	196	6.50	130	<0.007	0.0160	<0.0005	0.0630	0.0790	0.00220
Maximum	1.00	260	7.00	190	0.0680	0.0250	0.000800	1.24	0.188	0.00440
Mean	1.00	228	6.78	162	0.0378	0.0205	0.000575	0.678	0.122	0.00278
SD	-	36.1	0.206	27.5	0.0171	0.00370	-	0.505	0.0495	0.00108

Table N.11: Water Quality at SAMP Seepage Station P-02, Located Downstream of Dam B, Panel TMA, 2015 to 2019

Date	Flow (L/s)	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
29-Jan-18	<1.00	281	6.80	200	0.0120	0.0240	<0.000500	0.0920	0.0990	0.00500
15-May-18	<1.00	220	6.80	150	0.0100	0.0200	<0.000500	0.125	0.0760	0.00210
31-Jul-18	<1.00	224	6.50	480	<0.00700	0.0200	<0.000500	4.42	0.0470	0.00320
13-Nov-18	1.00	212	6.80	170	0.0370	0.0200	<0.000500	0.589	0.110	0.00360
n	4	4	4	4	4	4	4	4	4	4
Minimum	<1	212	6.50	150	<0.007	0.0200	<0.0005	0.0920	0.0470	0.00210
Maximum	1.00	281	6.80	480	0.0370	0.0240	<0.0005	4.42	0.110	0.00500
Mean	1.00	234	6.72	250	0.0165	0.0210	<0.0005	1.31	0.0830	0.00348
SD	-	31.6	0.150	155	0.0140	0.00200	-	2.09	0.0279	0.00120
05-Feb-19	<1.00	238	6.70	190	0.0110	0.0210	<0.000500	0.126	0.111	0.00470
14-May-19	<1.00	169	6.90	120	0.0400	0.0170	<0.000500	0.709	0.0830	0.00220
25-Jul-19	<1.00	254	6.80	170	0.0380	0.0190	<0.000500	0.409	0.0230	0.00250
07-Oct-19	<1.00	211	7.20	150	0.0370	0.0210	<0.000500	0.330	0.0620	0.00410
n	4	4	4	4	4	4	4	4	4	4
Minimum	<1	169	6.70	120	0.0110	0.0170	<0.0005	0.126	0.0230	0.00220
Maximum	<1	254	7.20	190	0.0400	0.0210	<0.0005	0.709	0.111	0.00470
Mean	<1	218	6.90	158	0.0315	0.0195	<0.0005	0.394	0.0698	0.00338
SD	-	37.2	0.216	29.9	0.0137	0.00191	-	0.242	0.0371	0.00121
Summary Statistics for 2015 to 2019										
n	20	20	20	20	20	20	20	20	20	20
Minimum	<1.00	169	6.30	120	<0.00700	0.0160	<0.000500	0.0330	0.0230	0.00210
Maximum	1.00	308	7.20	480	0.0680	0.0250	0.000800	4.42	0.188	0.00520
Mean	1.00	244	6.72	201	0.0204	0.0206	0.000515	0.502	0.0734	0.00345
SD	-	36.1	0.212	74.7	0.0175	0.00216	-	0.981	0.0412	0.00103
Median	<1.00	248	6.80	190	0.0105	0.0205	<0.000500	0.123	0.0730	0.00365
10th Percentile	<1.00	197	6.45	140	<0.00800	0.0175	<0.000500	0.0425	0.0290	0.00220
95th Percentile	1.00	298	7.10	370	0.0550	0.0245	0.000650	2.83	0.160	0.00510

Note: "-" = SD was incalculable because there was no variability in the data. n = number of samples. SD = standard deviation.

Table N.12: Water Quality at SAMP Drainage Station P-03, Located at Beaver Pond C Outlet, Panel TMA, 2015 to 2019

Date	Flow (L/s)	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
26-Jan-15	3.80	39.5	6.50	6.40	0.488	0.0240	0.000700	1.14	0.159	<0.000500
08-Apr-15	3.50	45.6	6.70	3.90	0.669	0.0310	0.00100	8.99	0.278	<0.000500
19-Jun-15	7.20	29.2	7.30	4.80	0.172	0.0120	<0.000500	1.12	0.0100	<0.000500
20-Oct-15	1.30	34.3	7.30	6.10	0.204	0.0130	<0.000500	0.216	<0.00200	<0.000500
n	4	4	4	4	4	4	4	4	4	4
Minimum	1.30	29.2	6.50	3.90	0.172	0.0120	<0.0005	0.216	<0.002	<0.0005
Maximum	7.20	45.6	7.30	6.40	0.669	0.0310	0.00100	8.99	0.278	<0.0005
Mean	3.95	37.2	6.95	5.30	0.383	0.0200	0.000675	2.87	0.112	<0.0005
SD	2.44	7.03	0.412	1.16	0.238	0.00913	0.000184	4.11	0.138	-
21-Jan-16	4.40	34.5	6.80	6.60	0.203	0.0170	<0.000500	0.260	0.00500	<0.000500
09-May-16	15.2	25.2	6.60	4.10	0.199	0.0130	<0.000500	1.20	0.0140	<0.000500
27-Oct-16	1.80	33.2	7.00	4.30	0.178	0.0130	<0.000500	0.337	0.00600	<0.000500
n	3	3	3	3	3	3	3	3	3	3
Minimum	1.80	25.2	6.60	4.10	0.178	0.0130	<0.0005	0.260	0.00500	<0.0005
Maximum	15.2	34.5	7.00	6.60	0.203	0.0170	<0.0005	1.20	0.0140	<0.0005
Mean	7.13	31.0	6.80	5.00	0.193	0.0143	<0.0005	0.599	0.00833	<0.0005
SD	7.11	5.04	0.200	1.39	0.0134	0.00231	-	0.522	0.00493	-
26-Jan-17	5.50	56.5	6.70	5.20	0.410	0.0260	<0.000500	0.384	0.0720	<0.000500
27-Apr-17	4.10	30.8	7.10	3.80	0.323	0.0180	<0.000500	1.65	0.00900	<0.000500
19-Jul-17	2.20	31.4	7.50	3.60	0.171	0.0120	<0.000500	1.35	0.0140	<0.000500
30-Oct-17	40.5	23.6	7.10	3.60	0.168	0.0130	<0.000500	0.226	<0.00200	<0.000500
n	4	4	4	4	4	4	4	4	4	4
Minimum	2.20	23.6	6.70	3.60	0.168	0.0120	<0.0005	0.226	<0.002	<0.0005
Maximum	40.5	56.5	7.50	5.20	0.410	0.0260	<0.0005	1.65	0.0720	<0.0005
Mean	13.1	35.6	7.10	4.05	0.268	0.0172	<0.0005	0.902	0.0242	<0.0005
SD	18.3	14.4	0.327	0.772	0.119	0.00640	-	0.704	0.0326	-
29-Jan-18	1.80	42.6	6.70	4.00	0.564	0.0230	0.000600	1.91	0.222	<0.000500
15-May-18	19.7	20.8	7.10	2.90	0.219	0.0140	<0.000500	1.69	0.0190	<0.000500
31-Jul-18	2.20	30.6	7.00	3.50	0.0710	0.00500	<0.000500	0.856	0.00600	<0.000500

Table N.12: Water Quality at SAMP Drainage Station P-03, Located at Beaver Pond C Outlet, Panel TMA, 2015 to 2019

Date	Flow (L/s)	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
13-Nov-18	13.1	32.2	7.10	5.80	0.183	0.0150	<0.000500	0.166	<0.00200	<0.000500
n	4	4	4	4	4	4	4	4	4	4
Minimum	1.80	20.8	6.70	2.90	0.0710	0.00500	<0.0005	0.166	<0.002	<0.0005
Maximum	19.7	42.6	7.10	5.80	0.564	0.0230	0.000600	1.91	0.222	<0.0005
Mean	9.20	31.6	6.98	4.05	0.259	0.0142	0.000525	1.16	0.0622	<0.0005
SD	8.74	8.93	0.189	1.25	0.213	0.00737	-	0.801	0.112	-
05-Feb-19	4.10	48.7	6.90	5.10	0.718	0.0320	0.000600	2.71	0.197	<0.000500
14-May-19	34.5	23.6	7.10	4.30	0.226	0.0130	<0.000500	1.63	0.0130	<0.000500
25-Jul-19	1.30	28.2	6.70	4.00	0.109	0.00600	<0.000500	0.741	0.00500	<0.000500
07-Oct-19	15.2	33.5	7.30	4.00	0.199	0.0140	<0.000500	0.353	<0.00200	<0.000500
n	4	4	4	4	4	4	4	4	4	4
Minimum	1.30	23.6	6.70	4.00	0.109	0.00600	<0.0005	0.353	<0.002	<0.0005
Maximum	34.5	48.7	7.30	5.10	0.718	0.0320	0.000600	2.71	0.197	<0.0005
Mean	13.8	33.5	7.00	4.35	0.313	0.0162	0.000525	1.36	0.0542	<0.0005
SD	15.1	10.9	0.258	0.520	0.275	0.0111	-	1.05	0.100	-
Summary Statistics for 2015 to 2019										
n	19	19	19	19	19	19	19	19	19	19
Minimum	1.30	20.8	6.50	2.90	0.0710	0.00500	<0.000500	0.166	<0.00200	<0.000500
Maximum	40.5	56.5	7.50	6.60	0.718	0.0320	0.00100	8.99	0.278	<0.000500
Mean	9.55	33.9	6.97	4.53	0.288	0.0165	0.000547	1.42	0.0546	<0.000500
SD	11.3	9.19	0.277	1.06	0.189	0.00746	0.000105	1.97	0.0886	-
Median	4.10	32.2	7.00	4.10	0.203	0.0140	<0.000500	1.12	0.0100	<0.000500
10th Percentile	1.30	23.6	6.60	3.50	0.109	0.00600	<0.000500	0.216	<0.00200	<0.000500
95th Percentile	40.5	56.5	7.50	6.60	0.718	0.0320	0.00100	8.99	0.278	<0.000500

Note: "-" = SD was incalculable because there was no variability in the data. n = number of samples. SD = standard deviation.

Table N.13: Water Quality at SAMP Drainage Station P-05, Located at Swamp Outlet North of Dam E, Panel TMA, 2015 to

Date	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
26-Jan-15	32.2	6.20	22.0	<0.00500	0.0100	0.000800	0.540	0.100	<0.000500
08-Apr-15	34.7	6.60	25.0	<0.00500	0.00900	0.000700	0.380	0.0790	<0.000500
16-Sep-15	45.2	6.80	21.0	<0.00800	0.0140	0.000600	0.499	0.108	<0.000500
20-Oct-15	46.0	7.20	30.0	<0.00800	0.0120	0.000600	0.368	0.0750	<0.000500
n	4	4	4	4	4	4	4	4	4
Minimum	32.2	6.20	21.0	<0.005	0.00900	0.000600	0.368	0.0750	<0.0005
Maximum	46.0	7.20	30.0	<0.008	0.0140	0.000800	0.540	0.108	<0.0005
Mean	39.5	6.70	24.5	<0.005	0.0112	0.000675	0.447	0.0905	<0.0005
SD	7.10	0.416	4.04	-	0.00222	0.0000957	0.0858	0.0160	-
21-Jan-16	20.5	6.10	14.0	<0.00800	0.00700	<0.000500	0.141	0.0290	<0.000500
09-May-16	15.2	5.80	10.0	<0.00800	0.00700	<0.000500	0.179	0.0180	<0.000500
21-Jul-16	28.9	6.80	6.90	<0.00800	0.00900	0.000800	0.898	0.102	<0.000500
27-Oct-16	32.3	6.20	20.0	<0.00800	0.0110	0.000800	0.515	0.0640	<0.000500
n	4	4	4	4	4	4	4	4	4
Minimum	15.2	5.80	6.90	<0.008	0.00700	<0.0005	0.141	0.0180	<0.0005
Maximum	32.3	6.80	20.0	<0.008	0.0110	0.000800	0.898	0.102	<0.0005
Mean	24.2	6.22	12.7	<0.008	0.00850	0.000650	0.433	0.0532	<0.0005
SD	7.80	0.419	5.65	-	0.00191	-	0.352	0.0380	-
26-Jan-17	16.5	6.50	10.0	<0.00700	0.00700	<0.000500	0.278	0.0310	<0.000500
27-Apr-17	10.2	6.40	6.30	0.0100	0.00600	<0.000500	0.212	0.0180	<0.000500
19-Jul-17	20.4	6.30	4.50	<0.00700	0.00900	0.00120	1.17	0.103	<0.000500
30-Oct-17	6.70	6.60	4.30	<0.00700	0.00600	<0.000500	0.230	0.0180	<0.000500
n	4	4	4	4	4	4	4	4	4
Minimum	6.70	6.30	4.30	<0.007	0.00600	<0.0005	0.212	0.0180	<0.0005
Maximum	20.4	6.60	10.0	0.0100	0.00900	0.00120	1.17	0.103	<0.0005
Mean	13.4	6.45	6.28	0.00775	0.00700	0.000675	0.472	0.0425	<0.0005
SD	6.16	0.129	2.64	-	0.00141	-	0.466	0.0408	-

Table N.13: Water Quality at SAMP Drainage Station P-05, Located at Swamp Outlet North of Dam E, Panel TMA, 2015 to

Date	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
29-Jan-18	28.6	6.20	15.0	<0.00700	0.00900	0.00110	0.914	0.111	<0.000500
15-May-18	11.3	6.50	7.70	<0.00700	0.00900	<0.000500	0.214	0.0150	<0.000500
31-Jul-18	27.9	6.40	9.80	<0.00700	0.0120	<0.000500	0.870	0.0430	<0.000500
13-Nov-18	9.60	6.30	5.50	<0.00700	0.00600	<0.000500	0.238	0.0200	<0.000500
n	4	4	4	4	4	4	4	4	4
Minimum	9.60	6.20	5.50	<0.007	0.00600	<0.0005	0.214	0.0150	<0.0005
Maximum	28.6	6.50	15.0	<0.007	0.0120	0.00110	0.914	0.111	<0.0005
Mean	19.4	6.35	9.50	<0.007	0.00900	0.000650	0.559	0.0472	<0.0005
SD	10.3	0.129	4.07	-	0.00245	-	0.385	0.0442	-
18-Mar-19	19.0	6.00	11.0	<0.00700	0.0130	0.000800	0.757	0.0510	<0.000500
14-May-19	6.40	6.80	4.20	<0.00700	0.00500	<0.000500	0.125	0.00700	<0.000500
25-Jul-19	27.9	5.90	8.50	<0.00700	0.0120	0.00160	1.40	0.188	<0.000500
07-Oct-19	9.70	6.30	4.10	<0.00700	0.00700	<0.000500	0.234	0.0160	<0.000500
n	4	4	4	4	4	4	4	4	4
Minimum	6.40	5.90	4.10	<0.007	0.00500	<0.0005	0.125	0.00700	<0.0005
Maximum	27.9	6.80	11.0	<0.007	0.0130	0.00160	1.40	0.188	<0.0005
Mean	15.8	6.25	6.95	<0.007	0.00925	0.000850	0.629	0.0655	<0.0005
SD	9.70	0.404	3.39	-	0.00386	0.000490	0.583	0.0838	-
Summary Statistics for 2015 to 2019									
n	20	20	20	20	20	20	20	20	20
Minimum	6.40	5.80	4.10	<0.00500	0.00500	<0.000500	0.125	0.00700	<0.000500
Maximum	46.0	7.20	30.0	0.0100	0.0140	0.00160	1.40	0.188	<0.000500
Mean	22.5	6.40	12.0	0.00525	0.00900	0.000700	0.508	0.0598	<0.000500
SD	12.1	0.343	7.73	-	0.00264	0.000272	0.372	0.0475	-
Median	20.4	6.35	9.90	<0.00700	0.00900	0.000550	0.374	0.0470	<0.000500
10th Percentile	8.15	5.95	4.25	<0.00700	0.00600	<0.000500	0.160	0.0155	<0.000500
95th Percentile	45.6	7.00	27.5	0.00750	0.0135	0.00140	1.28	0.150	<0.000500

Note: "-" = SD was incalculable because there was no variability in the data. n = number of samples. SD = standard deviation.

Table N.14: Water Quality at SAMP Drainage Station P-11, Located at Panel Creek Outlet at Quirke Lake, Panel TMA, 2015 to 2019

Date	Flow (L/s)	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
26-Jan-15	-	16.2	6.50	8.10	0.0530	0.0120	<0.000500	0.530	0.0420	0.00110
08-Apr-15	-	15.8	6.90	5.80	0.0480	0.0120	<0.000500	0.490	0.0370	0.00110
20-Oct-15	1.00	23.8	7.40	18.0	0.0610	0.0160	<0.000500	0.322	0.0160	0.00100
n	1	3	3	3	3	3	3	3	3	3
Minimum	1.00	15.8	6.50	5.80	0.0480	0.0120	<0.0005	0.322	0.0160	0.00100
Maximum	1.00	23.8	7.40	18.0	0.0610	0.0160	<0.0005	0.530	0.0420	0.00110
Mean	1.00	18.6	6.93	10.6	0.0540	0.0133	<0.0005	0.447	0.0317	0.00107
SD	-	4.51	0.451	6.48	0.00656	0.00231	-	0.110	0.0138	0.0000577
21-Jan-16	-	14.2	6.80	7.70	0.0420	0.0100	<0.000500	0.259	0.0170	0.00110
09-May-16	62.9	10.9	6.50	5.40	0.0350	0.00900	<0.000500	0.181	0.00800	0.000800
27-Oct-16	25.4	19.4	6.60	13.0	0.0750	0.0140	0.00120	0.324	0.0180	0.00330
n	2	3	3	3	3	3	3	3	3	3
Minimum	25.4	10.9	6.50	5.40	0.0350	0.00900	<0.0005	0.181	0.00800	0.000800
Maximum	62.9	19.4	6.80	13.0	0.0750	0.0140	0.00120	0.324	0.0180	0.00330
Mean	44.2	14.8	6.63	8.70	0.0507	0.0110	0.000733	0.255	0.0143	0.00173
SD	26.5	4.29	0.153	3.90	0.0214	0.00265	-	0.0716	0.00551	0.00137
26-Jan-17	20.0	13.4	6.50	7.40	0.0440	0.0100	0.000800	0.395	0.0210	0.00180
27-Apr-17	58.3	12.1	7.00	6.60	0.0440	0.0130	<0.000500	0.179	0.0120	0.00130
19-Jul-17	<1.00	17.3	6.60	6.00	0.0470	0.0130	<0.000500	0.686	0.0380	0.00110
30-Oct-17	125	7.30	7.00	3.80	0.0270	0.00900	<0.000500	0.325	0.0150	0.00150
n	4	4	4	4	4	4	4	4	4	4
Minimum	<1	7.30	6.50	3.80	0.0270	0.00900	<0.0005	0.179	0.0120	0.00110
Maximum	125	17.3	7.00	7.40	0.0470	0.0130	0.000800	0.686	0.0380	0.00180
Mean	51.1	12.5	6.78	5.95	0.0405	0.0112	0.000575	0.396	0.0215	0.00142
SD	52.5	4.13	0.263	1.54	0.00911	0.00206	-	0.213	0.0116	0.000299
29-Jan-18	-	14.6	6.90	6.00	0.0410	0.0110	<0.000500	0.512	0.0400	0.00100
15-May-18	22.1	11.9	7.00	5.60	0.0450	0.0130	<0.000500	0.330	0.0130	0.00110
31-Jul-18	1.00	19.8	6.50	5.90	0.0340	0.0110	<0.000500	0.927	0.0190	0.00140
13-Nov-18	20.0	10.6	6.90	5.40	0.0310	0.00800	<0.000500	0.209	0.00900	0.00110
n	3	4	4	4	4	4	4	4	4	4
Minimum	1.00	10.6	6.50	5.40	0.0310	0.00800	<0.0005	0.209	0.00900	0.00100
Maximum	22.1	19.8	7.00	6.00	0.0450	0.0130	<0.0005	0.927	0.0400	0.00140
Mean	14.4	14.2	6.82	5.72	0.0378	0.0107	<0.0005	0.495	0.0202	0.00115
SD	11.6	4.07	0.222	0.275	0.00640	0.00206	-	0.314	0.0138	0.000173
05-Feb-19	-	13.2	6.90	5.70	0.0420	0.0100	<0.000500	0.484	0.0350	0.000800
14-May-19	94.3	8.40	7.20	3.80	0.0380	0.00700	<0.000500	0.156	0.00700	0.00100
25-Jul-19	<1.00	21.7	6.50	2.60	0.0490	0.00800	<0.000500	2.66	0.0420	0.00130
07-Oct-19	43.3	15.5	7.00	5.80	0.0610	0.0110	<0.000500	0.611	0.0240	0.00140
n	3	4	4	4	4	4	4	4	4	4
Minimum	<1	8.40	6.50	2.60	0.0380	0.00700	<0.0005	0.156	0.00700	0.000800
Maximum	94.3	21.7	7.20	5.80	0.0610	0.0110	<0.0005	2.66	0.0420	0.00140
Mean	46.2	14.7	6.90	4.47	0.0475	0.00900	<0.0005	0.978	0.0270	0.00112
SD	34.0	5.53	0.294	1.55	0.0101	0.00183	-	1.14	0.0153	0.000275
Summary Statistics for 2015 to 2019										
n	13	18	18	18	18	18	18	18	18	18
Minimum	<1.00	7.30	6.50	2.60	0.0270	0.00700	<0.000500	0.156	0.00700	0.000800
Maximum	125	23.8	7.40	18.0	0.0750	0.0160	0.00120	2.66	0.0420	0.00330
Mean	36.6	14.8	6.82	6.81	0.0454	0.0109	0.000556	0.532	0.0229	0.00129
SD	39.3	4.44	0.271	3.54	0.0117	0.00234	0.000130	0.568	0.0125	0.000559
Median	22.1	14.4	6.90	5.85	0.0440	0.0110	<0.000500	0.363	0.0185	0.00110
10th Percentile	<1.00	8.40	6.50	3.80	0.0310	0.00800	<0.000500	0.179	0.00800	0.000800
95th Percentile	125	23.8	7.40	18.0	0.0750	0.0160	0.00120	2.66	0.0420	0.00330

Note: "-" = no data collected or SD was incalculable because there was no variability in the data. n = number of samples. SD = standard deviati

Table N.15: **Water Quality at SAMP Principal Station P-14, Final Treated Effluent, Panel TMA, 2015 to 2019**

Date	Flow (L/s)	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)	Sublethal Toxicity (*Ceriodaphnia dubia*) IC25	Acute Toxicity (*Daphnia magna*) % Mortality	Acute Toxicity (Rainbow Trout) % Mortality
12-Feb-15	50.0	179	7.40	140	0.137	1.22	<0.000500	0.0500	0.0180	0.00750	-	-	-
17-Feb-15	50.0	-	7.50	-	0.0270	1.09	-	-	-	-	-	-	-
23-Feb-15	50.0	-	7.40	-	0.145	1.10	-	-	-	-	-	-	-
02-Mar-15	48.0	-	7.60	-	0.226	1.64	-	-	-	-	-	-	-
09-Mar-15	50.0	-	7.80	-	0.218	1.63	-	-	-	-	-	-	-
17-Mar-15	53.0	177	7.51	140	0.245	1.68	<0.000500	0.0500	0.0260	0.00710	-	-	-
23-Mar-15	47.0	-	7.40	-	0.226	1.95	-	-	-	-	-	-	-
30-Mar-15	49.0	-	7.40	-	0.0660	0.885	-	-	-	-	-	-	-
06-Apr-15	48.0	-	7.50	-	0.0540	0.885	-	-	-	-	-	-	-
13-Apr-15	47.0	168	7.70	140	0.0400	0.810	<0.000500	0.0300	0.0290	0.00680	100	0	0
25-May-15	50.0	137	7.50	120	0.0330	0.338	<0.000500	<0.0200	0.0140	0.0113	-	-	-
01-Jun-15	65.0	-	7.60	-	0.0700	0.557	-	-	-	-	-	-	-
08-Jun-15	64.0	135	7.40	110	0.0790	0.652	<0.000500	0.0300	0.0420	0.00740	-	-	-
15-Jun-15	63.0	-	7.30	-	0.0600	0.627	-	-	-	-	-	-	-
05-Nov-15	100	-	7.60	-	0.0870	0.501	-	-	-	-	-	-	-
09-Nov-15	100	157	7.40	120	0.0150	0.533	<0.000500	0.0270	0.0110	0.0121	100	0	0
16-Nov-15	120	-	7.38	-	0.128	0.522	-	-	-	-	-	-	-
23-Nov-15	118	-	7.40	-	0.153	0.598	-	-	-	-	-	-	-
18-Dec-15	123	-	7.50	-	0.0650	0.551	-	-	-	-	-	-	-
21-Dec-15	120	148	7.30	120	0.182	1.26	<0.000500	0.0660	0.0170	0.00660	-	-	-
28-Dec-15	150	-	7.30	-	0.220	1.20	-	-	-	-	-	-	-
n	21	7	21	7	21	21	7	7	7	7	2	2	2
Minimum	47.0	135	7.30	110	0.0150	0.338	<0.0005	<0.02	0.0110	0.00660	100	0	0
Maximum	150	179	7.80	140	0.245	1.95	<0.0005	0.0660	0.0420	0.0121	100	0	0
Mean	74.5	157	7.47	127	0.118	0.963	<0.0005	0.0390	0.0224	0.00840	100	0	0
SD	33.7	18.1	0.132	12.5	0.0763	0.465	-	0.0156	0.0107	0.00229	-	-	-
06-Jan-16	148	-	7.63	-	0.220	1.38	-	-	-	-	-	-	-
12-Jan-16	143	133	7.30	120	0.287	1.68	<0.000500	0.0950	0.0200	0.00600	-	-	-
18-Jan-16	133	-	7.30	-	0.243	1.38	-	-	-	-	-	-	-
27-Jan-16	130	-	7.59	-	0.224	1.74	-	-	-	-	-	-	-
01-Feb-16	122	-	7.53	-	0.209	1.71	-	-	-	-	-	-	-
04-Feb-16	119	145	7.30	130	0.256	1.73	<0.000500	0.0730	0.0200	0.00710	-	-	-
14-Mar-16	48.0	-	7.79	-	0.0610	0.657	-	-	-	-	-	-	-
21-Mar-16	100	166	7.40	120	0.0850	0.812	<0.000500	0.0420	0.0230	0.00710	-	-	-
28-Mar-16	100	-	7.40	-	0.0980	0.726	-	-	-	-	-	-	-
04-Apr-16	100	-	7.40	-	0.192	1.17	-	-	-	-	-	-	-
11-Apr-16	100	159	7.60	120	0.252	1.32	<0.000500	0.0380	0.0320	0.00810	100	0	0
18-Apr-16	150	-	7.30	-	0.263	1.25	-	-	-	-	-	-	-
25-Apr-16	120	-	7.50	-	0.205	1.47	-	-	-	-	-	-	-
02-Jun-16	120	-	7.50	-	0.129	0.970	-	-	-	-	-	-	-
14-Nov-16	78.0	-	7.70	-	0.161	0.684	-	0.0290	-	-	-	-	-
21-Nov-16	95.0	155	7.50	120	0.110	0.776	<0.000500	0.0430	0.0130	0.0106	100	0	0

Table N.15: Water Quality at SAMP Principal Station P-14, Final Treated Effluent, Panel TMA, 2015 to 2019

Date	Flow (L/s)	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)	Sublethal Toxicity (*Ceriodaphnia dubia*) IC25	Acute Toxicity (*Daphnia magna*) % Mortality	Acute Toxicity (Rainbow Trout) % Mortality
28-Nov-16	90.0	-	7.40	-	0.201	0.796	-	-	-	-	-	-	-
05-Dec-16	90.0	-	7.30	-	0.147	0.721	-	-	-	-	-	-	-
12-Dec-16	85.0	157	7.50	120	0.115	0.654	<0.000500	0.0570	0.0190	0.00650	-	-	-
n	20	6	19	6	19	19	6	7	6	6	2	2	2
Minimum	48.0	133	7.30	120	0.0610	0.654	<0.0005	0.0290	0.0130	0.00600	100	0	0
Maximum	150	166	7.79	130	0.287	1.74	<0.0005	0.0950	0.0320	0.0106	100	0	0
Mean	110	152	7.47	122	0.182	1.14	<0.0005	0.0539	0.0212	0.00757	100	0	0
SD	25.7	11.7	0.146	4.08	0.0674	0.409	-	0.0231	0.00624	0.00164	-	-	-
06-Mar-17	58.0	-	7.40	-	0.110	0.582	-	-	-	-	-	-	-
13-Mar-17	60.0	-	7.50	-	0.112	-	-	-	-	-	-	-	-
20-Mar-17	59.0	169	7.30	110	0.292	0.605	<0.000500	0.0470	0.0260	0.00760	-	-	-
27-Mar-17	57.0	-	7.60	-	0.0990	-	-	-	-	-	-	-	-
03-Apr-17	57.0	-	7.80	-	0.197	-	-	-	-	-	-	-	-
10-Apr-17	63.0	151	7.50	100	0.273	1.19	<0.000500	0.0780	0.0370	0.00770	-	-	-
17-Apr-17	100	-	7.40	-	0.237	-	-	-	-	-	-	-	-
24-Apr-17	120	-	7.40	-	0.253	-	-	-	-	-	-	-	-
01-May-17	117	-	7.50	-	0.296	-	-	-	-	-	-	-	-
08-May-17	100	-	7.50	-	0.273	-	-	-	-	-	-	-	-
15-May-17	61.0	131	7.40	100	0.0990	0.790	<0.000500	0.0660	0.0860	0.00700	100	0	0
23-May-17	60.0	-	7.40	-	0.0780	-	-	-	-	-	-	-	-
29-May-17	61.0	-	7.50	-	0.0960	-	-	-	-	-	-	-	-
05-Jun-17	75.0	-	7.40	-	0.139	-	-	-	-	-	-	-	-
10-Jul-17	80.0	142	7.50	100	0.119	0.675	<0.000500	<0.0200	0.0150	0.0102	-	-	-
17-Jul-17	80.0	-	7.50	-	0.220	-	-	-	-	-	-	-	-
24-Aug-17	83.0	-	7.50	-	0.119	-	-	-	-	-	-	-	-
28-Aug-17	80.0	142	7.50	100	0.190	1.55	<0.000500	0.0410	0.0230	0.0179	-	-	-
05-Sep-17	80.0	-	7.50	-	0.320	-	-	-	-	-	-	-	-
11-Sep-17	80.0	142	7.40	100	0.300	1.15	<0.000500	0.0630	0.0260	0.00700	-	-	-
18-Sep-17	84.0	-	7.40	-	0.278	-	-	-	-	-	-	-	-
10-Oct-17	80.0	-	7.70	-	0.132	-	-	-	-	-	-	-	-
16-Oct-17	80.0	136	7.30	100	0.199	0.0130	<0.000500	0.0480	0.0430	0.0159	100	0	0
23-Oct-17	112	-	7.30	-	0.211	-	-	-	-	-	-	-	-
30-Oct-17	163	-	7.30	-	0.256	-	-	-	-	-	-	-	-
06-Nov-17	103	-	7.20	-	0.199	-	-	-	-	-	-	-	-
13-Nov-17	100	128	7.60	110	0.160	0.867	<0.000500	0.0600	0.0300	0.00660	-	-	-
20-Nov-17	100	-	7.40	-	0.339	-	-	-	-	-	-	-	-
27-Nov-17	100	-	7.20	-	0.341	-	-	-	-	-	-	-	-
04-Dec-17	98.0	-	7.50	-	0.368	-	-	-	-	-	-	-	-
11-Dec-17	80.0	134	7.50	110	0.336	1.87	<0.000500	0.0660	0.0280	0.00720	-	-	-
19-Dec-17	80.0	-	7.40	-	0.313	-	-	-	-	-	-	-	-
27-Dec-17	80.0	-	8.10	-	0.382	-	-	-	-	-	-	-	-

Table N.15: Water Quality at SAMP Principal Station P-14, Final Treated Effluent, Panel TMA, 2015 to 2019

Date	Flow (L/s)	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)	Sublethal Toxicity (*Ceriodaphnia dubia*) IC25	Acute Toxicity (*Daphnia magna*) % Mortality	Acute Toxicity (Rainbow Trout) % Mortality
n	229	9	33	9	33	10	9	9	9	9	2	2	2
Minimum	13.0	128	7.20	100	0.0780	0.0130	<0.0005	<0.02	0.0150	0.00660	100	0	0
Maximum	163	169	8.10	110	0.382	1.87	<0.0005	0.0780	0.0860	0.0179	100	0	0
Mean	83.3	142	7.47	103	0.222	0.929	<0.0005	0.0543	0.0349	0.00968	100	0	0
SD	25.4	12.4	0.169	5.00	0.0914	0.531	-	0.0130	0.0208	0.00425	-	-	-
02-Jan-18	80.0	-	7.50	-	0.381	-	-	-	-	-	-	-	-
08-Jan-18	50.0	145	7.50	110	0.354	2.12	<0.000500	0.0480	0.0290	0.00780	-	-	-
15-Jan-18	30.0	-	7.50	-	0.323	-	-	-	-	-	-	-	-
22-Jan-18	30.0	-	8.40	-	0.305	-	-	-	-	-	-	-	-
29-Jan-18	30.0	-	7.40	-	0.252	-	-	-	-	-	-	-	-
05-Feb-18	50.0	-	7.70	-	0.119	-	-	-	-	-	-	-	-
07-Feb-18	50.0	-	7.80	-	0.169	-	-	-	-	-	-	-	-
12-Feb-18	50.0	192	7.30	110	0.281	2.10	<0.000500	0.0310	0.0290	0.00770	-	-	-
20-Feb-18	75.0	-	7.80	-	0.415	-	-	-	-	-	-	-	-
26-Feb-18	30.0	-	7.40	-	0.370	-	-	-	-	-	-	-	-
05-Mar-18	30.0	-	7.80	-	0.229	-	-	-	-	-	-	-	-
12-Mar-18	30.0	220	7.80	110	0.0610	1.44	<0.000500	0.0290	0.0320	0.00870	-	-	-
19-Mar-18	30.0	-	7.80	-	0.0670	-	-	-	-	-	-	-	-
26-Mar-18	30.0	-	8.00	-	0.0360	-	-	-	-	-	-	-	-
30-Apr-18	30.0	153	7.20	99.0	0.0150	0.551	<0.000500	<0.0200	0.0254	0.00776	-	-	-
07-May-18	100	136	7.50	89.0	0.199	1.26	<0.000500	0.0800	0.0680	0.00780	100	0	0
14-May-18	100	-	7.50	-	0.335	-	-	-	-	-	-	-	-
22-May-18	70.0	-	7.70	-	0.321	-	-	-	-	-	-	-	-
25-Jun-18	70.0	135	7.60	89.0	0.0690	0.717	<0.000500	<0.0200	0.0180	0.00890	-	-	-
15-Oct-18	75.0	-	7.50	-	0.140	-	-	-	-	-	-	-	-
22-Oct-18	75.0	-	7.50	-	0.139	-	-	-	-	-	-	-	-
29-Oct-18	75.0	150	7.30	97.0	0.176	0.629	<0.000500	0.0370	0.0180	0.00680	100	0	0
05-Nov-18	75.0	-	7.40	-	0.180	-	-	-	-	-	-	-	-
12-Nov-18	75.0	-	7.50	-	0.159	-	-	-	-	-	-	-	-
19-Nov-18	100	138	7.30	98.0	0.177	0.978	<0.000500	0.0400	0.0160	0.00710	-	-	-
26-Nov-18	100	-	7.40	-	0.203	-	-	-	-	-	-	-	-
03-Dec-18	100	-	7.30	-	0.314	-	-	-	-	-	-	-	-
10-Dec-18	55.0	131	7.30	100	0.310	1.64	<0.000500	0.0360	0.0160	0.00670	-	-	-
n	203	9	28	9	28	9	9	9	9	9	2	2	2
Minimum	8.00	131	7.20	89.0	0.0150	0.551	<0.0005	<0.02	0.0160	0.00670	100	0	0
Maximum	100	220	8.40	110	0.415	2.12	<0.0005	0.0800	0.0680	0.00890	100	0	0
Mean	59.9	156	7.56	100	0.218	1.27	<0.0005	0.0379	0.0279	0.00770	100	0	0
SD	27.2	30.3	0.260	8.33	0.114	0.602	-	0.0166	0.0163	0.000761	-	-	-
10-Jan-19	40.0	-	7.50	-	0.0900	-	-	-	-	-	-	-	-
14-Jan-19	40.0	148	7.40	100	0.0850	0.882	<0.000500	0.0470	0.0180	0.00680	-	-	-
21-Jan-19	60.0	-	7.40	-	0.0960	-	-	-	-	-	-	-	-
28-Jan-19	60.0	-	7.40	-	0.146	-	-	-	-	-	-	-	-

Table N.15: Water Quality at SAMP Principal Station P-14, Final Treated Effluent, Panel TMA, 2015 to 2019

Date	Flow (L/s)	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)	Sublethal Toxicity (*Ceriodaphnia dubia*) IC25	Acute Toxicity (*Daphnia magna*) % Mortality	Acute Toxicity (Rainbow Trout) % Mortality
04-Feb-19	60.0	-	7.50	-	0.114	0.937	-	-	-	-	-	-	-
11-Feb-19	60.0	138	7.60	96.0	0.135	0.972	<0.000500	0.0350	0.0240	0.00810	-	-	-
19-Feb-19	45.0	-	7.30	-	0.0930	0.619	-	-	-	-	-	-	-
25-Feb-19	80.0	-	7.40	-	0.156	0.823	-	-	-	-	-	-	-
04-Mar-19	80.0	-	7.50	-	0.144	0.894	-	-	-	-	-	-	-
08-Mar-19	80.0	143	7.50	110	0.0450	0.959	<0.000500	0.0260	0.0160	0.00630	-	-	-
28-Mar-19	50.0	-	7.40	-	0.0960	0.754	-	-	-	-	-	-	-
01-Apr-19	50.0	-	7.60	-	0.101	0.974	-	-	-	-	-	-	-
08-Apr-19	55.0	-	7.90	-	0.103	0.851	-	-	-	-	-	-	-
15-Apr-19	120	142	7.40	100	0.135	0.982	<0.000500	0.0290	0.0260	0.00810	100	0	0
22-Apr-19	130	-	7.60	-	0.221	1.45	-	-	-	-	-	-	-
29-Apr-19	150	-	7.50	-	0.251	1.46	-	-	-	-	-	-	-
06-May-19	150	-	7.60	-	0.264	1.89	-	-	-	-	-	-	-
13-May-19	150	88.7	7.40	67.0	0.298	1.70	<0.000500	0.103	0.0550	0.00450	-	-	-
21-May-19	150	-	7.40	-	0.269	1.44	-	-	-	-	-	-	-
27-May-19	100	-	7.40	-	0.321	1.64	-	-	-	-	-	-	-
03-Jun-19	60.0	-	7.50	-	0.226	2.56	-	-	-	-	-	-	-
10-Jun-19	60.0	115	7.70	80.0	0.161	2.32	<0.000500	0.0220	0.0350	0.00640	-	-	-
17-Jun-19	60.0	-	7.60	-	0.176	2.11	-	-	-	-	-	-	-
24-Jun-19	60.0	-	7.90	-	0.143	1.97	-	-	-	-	-	-	-
02-Jul-19	60.0	119	7.60	86.0	0.119	1.81	<0.000500	0.0210	0.0190	0.00750	-	-	-
07-Oct-19	60.0	-	7.70	-	0.125	0.872	-	-	-	-	-	-	-
15-Oct-19	80.0	-	7.60	-	0.150	0.819	-	-	-	-	-	-	-
22-Oct-19	120	117	7.30	81.0	0.237	1.11	<0.000500	0.0840	0.0480	0.00770	68.9	3.30	0
28-Oct-19	120	-	7.60	-	0.365	1.42	-	-	-	-	-	-	-
04-Nov-19	80.0	148	7.70	-	0.339	1.94	-	-	-	-	-	-	-
11-Nov-19	80.0	116	7.60	88.0	0.262	2.36	<0.000500	0.0970	0.0290	0.00650	-	-	-
18-Nov-19	80.0	-	7.40	-	0.338	2.92	-	-	-	-	-	-	-
25-Nov-19	80.0	-	7.40	-	0.399	2.41	-	-	-	-	-	-	-
09-Dec-19	40.0	-	7.50	-	0.221	3.11	-	-	-	-	-	-	-
16-Dec-19	40.0	127	7.60	84.0	0.0700	1.13	<0.000500	0.0430	0.0250	0.00730	-	-	-
27-Dec-19	60.0	-	7.60	-	0.0880	1.17	-	-	-	-	-	-	-
30-Dec-19	60.0	-	7.90	-	0.115	1.08	-	-	-	-	-	-	-
n	247	10	37	10	37	34	10	10	10	10	2	2	2
Minimum	10.0	88.7	7.30	67.0	0.0450	0.619	<0.0005	0.0210	0.0160	0.00450	68.9	0	0
Maximum	156	148	7.90	110	0.399	3.11	<0.0005	0.103	0.0550	0.00810	100	3.30	0
Mean	79.3	125	7.54	89.2	0.181	1.48	<0.0005	0.0507	0.0295	0.00692	84.4	1.65	0
SD	35.8	18.0	0.153	12.5	0.0938	0.672	-	0.0318	0.0130	0.00108	22.0	2.33	-

Table N.15: Water Quality at SAMP Principal Station P-14, Final Treated Effluent, Panel TMA, 2015 to 2019

Date	Flow (L/s)	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)	Sublethal Toxicity (*Ceriodaphnia dubia*) IC25	Acute Toxicity (*Daphnia magna*) % Mortality	Acute Toxicity (Rainbow Trout) % Mortality
Summary Statistics for 2015 to 2019													
n	720	42	138	41	138	93	41	42	41	41	10	10	10
Minimum	8.00	88.7	7.20	67.0	0.0150	0.0130	<0.000500	<0.0200	0.0110	0.00450	68.9	0	0
Maximum	163	220	8.40	140	0.415	3.11	<0.000500	0.103	0.0860	0.0179	100	3.30	0
Mean	75.8	145	7.51	106	0.189	1.21	<0.000500	0.0473	0.0279	0.00804	96.9	0.330	0
SD	32.0	22.4	0.182	16.6	0.0975	0.593	-	0.0226	0.0149	0.00247	9.83	1.04	-
Median	75.0	142	7.50	100	0.178	1.10	<0.000500	0.0425	0.0254	0.00740	100	0	0
10th Percentile	30.0	119	7.30	86.0	0.0670	0.598	<0.000500	0.0210	0.0160	0.00650	84.4	0	0
95th Percentile	150	179	7.80	140	0.365	2.36	<0.000500	0.0950	0.0550	0.0121	100	3.30	0

Note: "-" = no data collected or SD was incalculable because there was no variability in the data. n = number of samples. SD = standard deviation.

Table N.16: Summary of Annual Plant Operations and Discharge at Denison TMA-1, 2015 to 2019

ITEM	2015	2016	2017	2018	2019
PLANT OPERATIONS[a]					
Operating Days	131	141	217	163	220
Maximum Daily Plant Flow (L/s @ D-1)	186	173	134	177	197
Minimum Daily Plant Flow (L/s @ D-1)	0	0	0	0	0
Monthly Average Daily Plant Flow (L/s @ D-1)	22	42	53	41	70
Total Volume Treated (ML)	245	508	996	576	1,323
Barium Chloride Consumption					
Total (kg/year)	1,278	3,232	5,027	3,931	11,207
Monthly Average (mg/L)	5.21	6.4	5.0	6.8	8.5
Caustic Soda Consumption					
Total (kg/year)	0	0	783	1,551	0
Monthly Average (mg/L)	0	0	0.787	2.69	0
EFFLUENT[b]					
Discharge Days	365	366	365	365	365
Maximum Daily Discharge Flow (L/s @ D-2)	133	173	240	115	340
Minimum Daily Discharge Flow (L/s @ D-2)	4	0.16	9	8	9
Monthly Average Daily Discharge Flow (L/s @ D-2)	34	42	59	40	71
Total Annual Volume Discharged (ML)	1,063	1,339	1,868	1,271	2,235

Note: See Appendix Tables N.2 to N.5 (station D-1) for detailed reagent data.

[a] Influent flows based on daily monitoring requirements as per TOMP.

[b] Effluent flows based on weekly monitoring requirement as per SAMP.

Table N.17: Summary of Annual Plant Operations and Discharge at Denison TMA-2, 2015 to 2019

ITEM	2015	2016	2017	2018	2019
PLANT OPERATIONS[a]					
Operating Days	340	346	365	358	365
Maximum Daily Plant Flow (L/s @ D-3)	140	46	149	55	113
Minimum Daily Plant Flow (L/s @ D-3)	0	0	1	0	0
Monthly Average Daily Plant Flow (L/s @ D-3)	10.6	6.75	15.7	6.71	11.6
Total Volume Treated (ML)	312	202	494	208	367
Barium Chloride Consumption					
Total (kg/year)	567	590	647	566	526
Monthly Average (mg/L)	1.82	2.92	1.31	2.73	1.44
Caustic Soda Consumption					
Total (kg/year)	0	0	0	0	0
Monthly Average (mg/L)	0	0	0	0	0
EFFLUENT[b]					
Discharge Days	303	274	365	273	326
Maximum Daily Discharge Flow (L/s @ D-3)	140	46	149	55	113
Minimum Daily Discharge Flow (L/s @ D-3)	0	0	1	0	0
Monthly Average Daily Discharge Flow (L/s @ D-3)	10.6	6.75	15.7	6.71	11.6
Total Annual Volume Discharged (ML)	278	160	494	158	327

Note: See Appendix Tables N.2 to N.5 (station D-22) for detailed reagent data.

[a] Influent flows based on daily monitoring requirements as per TOMP.

[b] Effluent flows based on weekly monitoring requirement as per SAMP.

Table N.18: Summary of Annual Plant Operations and Discharge at Quirke TMA, 2015 to 2019

ITEM	2015	2016	2017	2018	2019
PLANT OPERATIONS[a]					
Operating Days	364	324	365	363	363
Maximum Daily Plant Flow (L/s @ Q-05)	190	180	190	190	200
Minimum Daily Plant Flow (L/s @ Q-05)	40	0	49	0	50
Monthly Average Daily Plant Flow (L/s @ Q-05)	96	95.2	120	102	124
Total Volume Treated (ML)	3,019	2,666	3,771	3,189	3,879
Barium Chloride Consumption					
Total (kg/year)	1,891	2,012	2,098	1,825	2,070
Monthly Average (mg/L)	0.626	0.755	0.556	0.572	0.534
Lime Consumption					
Total (ton/year)	37.5	37.0	41.3	37.2	45.2
Monthly Average (g/L)	0.0124	0.0139	0.0110	0.0117	0.0117
BASIN NEUTRALIZATION					
Lime Consumption					
Cell 16 S total dry tonnes/year	31.91	21.07	87.10	43.10	17.70
Cell 16 N total dry tonnes/year	38.56	29.37	67.00	30.60	40.92
Cell 17 total dry tonnes/year	12.76	3.60	13.60	11.40	5.32
EFFLUENT[b]					
Discharge Days	364	324	365	365	365
Maximum Daily Discharge Flow (L/s @ Q-28)	185	180	190	190	200
Minimum Daily Discharge Flow (L/s @ Q-28)	30	0	49	23	25
Monthly Average Daily Discharge Flow (L/s @ Q-28)	96.5	94.3	119	101	123
Total Annual Volume Discharged (ML)	3,036	2,641	3,757	3,199	3,891

Note: See Appendix Table G.7 (station Q-05) for detailed reagent data.

[a] Influent flows based on daily monitoring requirements as per TOMP.

[b] Effluent flows based on weekly monitoring requirement as per SAMP.

Table N.19: Summary of Annual Plant Operations and Discharge at Panel TMA, 2015 to 2019

ITEM	2015	2016	2017	2018	2019
PLANT OPERATIONS[a]					
Operating Days	134	122	226	196	246
Maximum Daily Plant Flow (L/s @ P-13)	154	150	174	100	156
Minimum Daily Plant Flow (L/s @ P-13)	0	0	0	0	0
Monthly Average Daily Plant Flow (L/s @ P-13)	28.2	36.6	52.5	33.1	54.3
Total Volume Treated (ML)	326	386	1,025	560	1,155
Barium Chloride Consumption					
Total (kg/year)	3,725	3,950	6,375	5,125	7,888
Monthly Average (mg/L)	11.4	10.2	6.22	9.15	6.83
Lime Consumption					
Total (tonnes/year)	2.17	2.26	4.10	2.60	5.21
Monthly Average (g/L)	0.00665	0.00585	0.00400	0.00464	0.00451
EFFLUENT[b]					
Discharge Days	134	123	229	202	247
Maximum Daily Discharge Flow (L/s @ P-14)	150	150	163	100	156
Minimum Daily Discharge Flow (L/s @ P-14)	0	0	0	0	0
Monthly Average Daily Discharge Flow (L/s @ P-14)	29.5	41.3	52.2	33.3	53.7
Total Annual Volume Discharged (ML)	342	439	1,034	582	1,146

Note: See Appendix Tables N.11 to N.15 (station P-13) for detailed reagent data.

[a] Influent flows based on daily monitoring requirements as per TOMP.

[b] Effluent flows based on weekly monitoring requirement as per SAMP.

Table N.20: Annual Discharge and Seepage Loadings from Stanrock TMA to the Quirke Lake Sub-Watershed, 2015 to 2019

Station	Drainage Type	Year	Annual Discharge (m^3)	Barium (kg/year)	Cobalt (kg/yr)	Iron (kg/yr)	Manganese (kg/yr)	Radium (MBq/yr)	Sulphate (kg/yr)	Uranium (kg/yr)
Q-09	Inlet to Quirke Lake	2015	65,416,982	4,381	-	4,972	2,224	3,279	3,190,595	168
		2016	57,517,344	3,440	-	5,390	2,498	2,768	2,840,850	130
		2017	96,229,728	5,375	-	17,009	6,477	5,057	5,529,216	226
		2018	67,975,718	8,398	-	26,162	6,862	7,102	3,566,184	153
		2019	106,772,515	5,484	-	14,804	4,569	4,552	4,945,941	159.1
		Mean	78,782,458	5,416	-	13,667	4,526	4,552	4,014,557	167
		SD	21,421,235	1,862	-	8,842	2,161	1,700	1,163,959	35.6
DS-16	Seepage from Dam G and J	2015	12,096	0.166	0.00605	0.701	0.193	0.0968	492	0.00605
		2016	11,483	0.0723	0.00573	0.366	0.0620	0.0916	163	0.00573
		2017	36,366	0.371	0.0182	1.79	0.854	0.258	828	0.0182
		2018	6,480	0.0528	0.00324	0.563	0.135	0.0454	89.6	0.00324
		2019	25,583	0.260	0.0128	1.66	0.427	0.179	520	0.0128
		Mean	18,401	0.184	0.00920	1.02	0.334	0.134	418	0.00920
		SD	12,289	0.133	0.00615	0.659	0.321	0.0845	299	0.00615
SR-01	Outlet of Quirke Lake	2015	132,917,308	5,184	-	2,658	399	2,525	4,785,023	186
		2016	116,866,451	4,512	-	2,331	350	2,292	4,162,495	162
		2017	195,524,097	6,979	-	3,910	587	5,202	6,333,457	242
		2018	138,116,269	4,804	-	2,762	444	3,536	4,221,453	152
		2019	216,945,429	7,590	-	4,339	868	4,287	6,120,416	239
		Mean	160,073,911	5,814	-	3,200	529	3,569	5,124,569	196
		SD	43,524,674	1,381	-	872	209	1,215	1,037,981	42.3

Notes: MBq/yr = Million Becquerels per year. Values below LRL were substituted at the LRL for calculations. "-" indicates parameter not measured, as per study design. See Appendix Tables M.3, S.14, and S.16 for raw data and Appendix Figure M.10 for the percent contribution of loads from each TMA.

Table N.21: Annual Discharge and Seepage Loadings from Denison TMA, 2015 to 2019

Station		Drainage Type	Year	Annual Discharge (m^3)	Barium (kg/year)	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	2015	45,416,886	578	-	1,100	660	265	171,881	22.7
			2016	39,932,424	491	-	1,313	719	319	157,810	19.9
			2017	66,809,174	857	-	2,965	1,242	493	244,329	33.4
			2018	47,193,333	566	-	2,159	965	330	162,745	23.6
			2019	74,128,689	936	-	2,505	1,160	519	245,848	37.1
			Mean	54,696,101	686	-	2,008	949	385	196,523	27.3
			SD	14,872,067	197	-	790	258	113.1	44,624	7.45
	D-6	Outlet of Cinder Lake	2015	1,720,842	26.4	-	575	318	11.3	35,291	0.860
			2016	1,513,036	24.1	-	417	340	13.5	65,215	0.754
			2017	2,531,393	34.1	-	536	279	18.6	58,097	1.27
			2018	1,788,151	31.0	-	1,528	890	27.4	63,978	0.894
			2019	2,808,729	44.4	-	1,646	738	22.8	52,159	1.404
			Mean	2,072,430	32.0	-	940	513	18.7	54,948	1.036
			SD	563,501	7.96	-	595	281	6.61	12,156	0.282
	D-2	Final Discharge from TMA 1	2015	1,055,030	184	0.698	227	228	145	234,737	40.7
			2016	1,363,143	391	0.899	426	206	332	266,644	47.2
			2017	1,843,690	430	1.22	589	302	309	408,353	70.0
			2018	1,272,499	518	0.674	471	197	296	198,850	30.8
			2019	2,253,312	1,239	1.41	594	494	468	371,714	65.0
			Mean	1,557,535	552	0.980	461	285	310	296,059	50.7
			SD	484,132	403	0.325	150	124	115	90,013	16.5
	D-3	Final Discharge from TMA 2	2015	332,294	75.6	0.189	66.2	29.0	33.7	23,109	1.07
			2016	216,778	48.6	0.108	15.5	1.55	19.6	18,069	0.756
			2017	485,222	121	0.243	63.9	8.06	52.1	30,601	2.05
			2018	212,630	59.6	0.106	23.5	3.29	24.5	14,885	1.32
			2019	370,915	117	0.217	113	27.1	46.1	17,610	1.03
			Mean	323,568	84.4	0.173	56.4	13.8	35.2	20,855	1.25
			SD	114,194	33.1	0.0626	39.1	13.2	13.8	6,205	0.494
	D-5	Serpent River d/s of Denison	2015	49,166,904	2,540	-	5,703	3,688	2,071	681,665	70.1
			2016	43,229,596	2,495	-	4,622	3,017	1,692	611,412	63.7
			2017	72,325,528	3,471	-	4,710	1,839	3,144	852,058	92.4
			2018	51,090,030	5,707	-	3,779	2,102	3,854	773,341	82.2
			2019	80,249,406	3,369	-	3,807	1,786	2,525	804,968	79.2
			Mean	59,212,293	3,516	-	4,524	2,486	2,657	744,689	77.5
			SD	16,100,036	1,306	-	791	834	860	97,105	11.1
	Q-09	Quirke Lake Inlet	2015	65,416,982	4,381	-	4,972	2,224	3,279	3,190,595	168
			2016	57,517,344	3,440	-	5,390	2,498	2,768	2,840,850	130
			2017	96,229,728	5,375	-	17,009	6,477	5,057	5,529,216	226
			2018	67,975,718	8,398	-	26,162	6,862	7,102	3,566,184	153
			2019	106,772,515	5,484	-	14,804	4,569	4,552	4,945,941	159.1
			Mean	78,782,458	5,416	-	13,667	4,526	4,552	4,014,557	167
			SD	21,421,235	1,862	-	8,842	2,161	1,700	1,163,959	35.6
Quirke Lake Drainage	D-9	Seepage from Dam 17	2015	51,008	1.14	0.290	115	146	0.492	34,149	0.732
			2016	74,738	1.25	0.259	95.9	116	0.624	39,773	0.803
			2017	63,037	0.922	0.181	78.2	91.0	0.446	27,464	0.688
			2018	66,884	1.13	0.179	70.4	97.1	0.507	31,689	0.844
			2019	77,305	1.19	0.190	79.1	110	0.640	37,237	1.18
			Mean	66,594	1.13	0.220	87.8	112	0.542	34,062	0.850
			SD	10,449	0.124	0.0516	18.0	21.6	0.0854	4,792	0.195
	D-16	Seepage from Dam 9	2015	63,483	1.91	0.117	91.1	114	1.033	13,913	0.0317
			2016	51,218	1.05	0.0486	87.4	35.9	0.717	9,098	0.0255
			2017	29,396	0.659	0.0429	77.9	49.8	0.447	4,900	0.0147
			2018	42,736	1.03	0.0427	69.7	49.8	0.669	6,826	0.0214
			2019	35,372	0.716	0.0419	44.9	50.8	0.518	5,661	0.0177
			Mean	44,441	1.07	0.0586	74.2	60.0	0.677	8,080	0.0222
			SD	13,417	0.499	0.0326	18.4	30.7	0.227	3,626	0.00670
	SR-01	Outlet of Quirke Lake	2015	132,917,308	5,184	-	2,658	399	2,525	4,785,023	186
			2016	116,866,451	4,512	-	2,331	350	2,292	4,162,495	162
			2017	195,524,097	6,979	-	3,910	587	5,202	6,333,457	242
			2018	138,116,269	4,804	-	2,762	444	3,536	4,221,453	152
			2019	216,945,429	7,590	-	4,339	868	4,287	6,120,416	239
			Mean	160,073,911	5,814	-	3,200	529	3,569	5,124,569	196
			SD	43,524,674	1,381	-	872	209	1,215	1,037,981	42.3

Notes: MBq/yr = Million Becquerels per year. Values below LRL were substituted at the LRL for calculations. "-" indicates parameter not measured, as per study design. See Appendix Tables N.2 to N.5, S.14, and S.16 for raw data and Appendix Figure N.10 for the percent contribution of loads from each TMA.

Table N.22: Annual Discharge and Seepage Loadings from Quirke TMA to the Quirke Lake Sub-Watershed, 2015 to 2019

Station	Drainage Type	Year	Annual Discharge (m^3)	Barium (kg/year)	Cobalt (kg/yr)	Iron (kg/yr)	Manganese (kg/yr)	Radium (MBq/yr)	Sulphate (kg/yr)	Uranium (kg/yr)
Q-23	Seepage from Dam J	2015	1,464,039	34.9	1.29	748	94.7	8.99	5,053	0.732
		2016	1,485,147	28.9	0.942	453	58.8	11.8	4,751	0.741
		2017	6,066,878	115	3.25	1,751	176	42.5	17,039	3.03
		2018	1,593,320	31.1	0.908	564	60.5	11.2	4,394	0.797
		2019	2,646,492	51.3	1.70	908	101	18.5	6,397	1.32
		Mean	2,651,175	52.3	1.62	885	98.1	18.6	7,527	1.33
		SD	1,971,993	36.3	0.968	515	47.5	13.8	5,371	0.986
Q-27	Swamp Downstream of Dam K	2015	3,154	0.228	0.0605	38.3	7.73	0.0294	1,078	0.00442
		2016	3,162	0.192	0.0511	34.7	6.38	0.0365	973	0.00407
		2017	3,154	0.242	0.0577	45.4	7.18	0.0346	933	0.00413
		2018	3,154	0.256	0.0584	46.3	7.50	0.0221	1,072	0.00335
		2019	3,154	0.245	0.0525	46.5	7.05	0.0296	1,131	0.00321
		Mean	3,155	0.233	0.0560	42.2	7.17	0.0304	1,037	0.00383
		SD	3.86	0.0247	0.00401	5.39	0.514	0.00561	81.6	0.000526
Q-20	Evans Lake Outlet	2015	450,002	8.10	-	9.00	6.30	3.60	9,450	0.225
		2016	395,661	7.14	-	7.89	5.52	3.16	8,304	0.197
		2017	661,962	13.0	-	15.5	11.1	5.18	14,217	0.331
		2018	467,604	8.46	-	17.8	13.8	3.27	8,884	0.234
		2019	734,486	14.1	-	14.7	17.5	5.24	13,955	0.367
		Mean	541,943	10	-	13	11	4	10,962	0.3
		SD	147,356	3	-	4	5	1.0	2,882	0.07
D-4	Dunlop Lake Outlet	2015	45,416,886	578	-	1,100	660	265	171,881	22.7
		2016	39,932,424	491	-	1,313	719	319	157,810	19.9
		2017	66,809,174	857	-	2,965	1,242	493	244,329	33.4
		2018	47,193,333	566	-	2,159	965	330	162,745	23.6
		2019	74,128,689	936	-	2,505	1,160	519	245,848	37.1
		Mean	54,696,101	686	-	2,008	949	385	196,523	27.3
		SD	14,872,067	197	-	790	258	113.1	44,624	7.45
D-5	Serpent River d/s of Denison	2015	49,166,904	2,540	-	5,703	3,688	2,071	681,665	70.1
		2016	43,229,596	2,495	-	4,622	3,017	1,692	611,412	63.7
		2017	72,325,528	3,471	-	4,710	1,839	3,144	852,058	92.4
		2018	51,090,030	5,707	-	3,779	2,102	3,854	773,341	82.2
		2019	80,249,406	3,369	-	3,807	1,786	2,525	804,968	79.2
		Mean	59,212,293	3,516	-	4,524	2,486	2,657	744,689	77.5
		SD	16,100,036	1,306	-	791	834	860	97,105	11.1
Q-28	Controlled Discharge	2015	3,027,888	219	9.89	1,764	2,126	167	2,706,022	39.1
		2016	3,001,104	263	10.5	1,806	2,244	220	2,621,229	34.3
		2017	3,757,363	322	10.2	1,874	2,704	428	3,175,357	42.6
		2018	3,198,874	287	7.16	1,412	1,983	279	2,718,697	40.2
		2019	3,891,456	395	8.71	1,898	2,423	403	3,160,020	49.0
		Mean	3,375,337	297	9.30	1,751	2,296	299	2,876,265	41.0
		SD	419,593	66.2	1.38	197	279	113	268,713	5.35
ECA-398	Site Drainage	2015	13,841	0.242	0.85	2.30	7.93	0.626	2,744	2.72
		2016	22,533	0.403	1.22	3.36	9.62	1.18	3,782	4.11
		2017	54,389	1.09	3.01	10.0	23.3	3.92	8,031	9.95
		2018	40,643	0.879	2.01	6.98	17.8	2.76	5,933	6.37
		2019	46,768	0.864	1.61	6.36	11.7	2.45	5,715	6.41
		Mean	35,635	0.695	1.74	5.80	14.1	2.19	5,241	5.91
		SD	16,936	0.356	0.832	3.07	6.38	1.31	2,052	2.75
Q-22	Site Drainage	2015	166,968	2.15	0.164	16.3	3.98	3.92	6,103	3.04
		2016	244,581	2.60	0.201	17.7	3.49	4.49	6,043	3.81
		2017	550,014	5.65	0.578	73.7	9.39	11.2	10,409	9.27
		2018	473,463	5.05	0.388	51.9	8.60	7.84	10,661	6.39
		2019	561,211	5.49	0.360	44.7	7.23	10.7	11,111	6.94
		Mean	399,247	4.19	0.338	40.9	6.54	7.64	8,865	5.89
		SD	181,897	1.68	0.165	24.3	2.68	3.40	2,562	2.51
All Quirke Sources			**-**	**355**	**13.1**	**2,724**	**2,422**	**328**	**2,898,935**	**54.2**
Q-09	Serpent River u/s of Quirke Lake	2015	65,416,982	4,381	-	4,972	2,224	3,279	3,190,595	168
		2016	57,517,344	3,440	-	5,390	2,498	2,768	2,840,850	130
		2017	96,229,728	5,375	-	17,009	6,477	5,057	5,529,216	226
		2018	67,975,718	8,398	-	26,162	6,862	7,102	3,566,184	153
		2019	106,772,515	5,484	-	14,804	4,569	4,552	4,945,941	159.1
		Mean	78,782,458	5,416	-	13,667	4,526	4,552	4,014,557	167
		SD	21,421,235	1,862	-	8,842	2,161	1,700	1,163,959	35.6

Notes: MBq/yr = Million Becquerels per year. Values below LRL were substituted at the LRL for calculations. "-" indicates parameter not measured, as per study design. See Appendix Tables N.6 to N.10, S.11, S.14, and S.16 for raw data. See Appendix Figure N.11 for the percent contribution of loads from each TMA.

Table N.23: Annual Discharge and Seepage Loadings from Panel TMA to the Quirke Lake Sub-Watershed, 2015 to 2019

Station	Drainage Type	Year	Annual Discharge (m^3)	Barium (kg/year)	Cobalt (kg/yr)	Iron (kg/yr)	Manganese (kg/yr)	Radium (MBq/yr)	Sulphate (kg/yr)	Uranium (kg/yr)
Q-09	Quirke Lake Inlet	2015	65,416,982	4,381	-	4,972	2,224	3,279	3,190,595	168
		2016	57,517,344	3,440	-	5,390	2,498	2,768	2,840,850	130
		2017	96,229,728	5,375	-	17,009	6,477	5,057	5,529,216	226
		2018	67,975,718	8,398	-	26,162	6,862	7,102	3,566,184	153
		2019	106,772,515	5,484	-	14,804	4,569	4,552	4,945,941	159.1
		Mean	78,782,458	5,416	-	13,667	4,526	4,552	4,014,557	167
		SD	21,421,235	1,862	-	8,842	2,161	1,700	1,163,959	35.6
P-14	Controlled Discharge	2015	825,984	751	0.413	33.0	16.7	99.9	103,691	7.36
		2016	1,291,594	1,558	0.644	75.4	28.7	254	156,088	9.67
		2017	1,647,389	1,444	0.824	95.8	60.1	378	171,356	15.6
		2018	1,051,229	1,309	0.526	45.1	31.4	229	103,851	8.06
		2019	1,692,922	2,514	0.846	92.0	53.3	352	150,640	11.7
		Mean	1,301,823	1,515	0.651	68.3	38.0	263	137,125	10.5
		SD	374,733	639	0.187	28.1	18.1	111	31,381	3.32
P-02	Seepage From Dam B	2015	31,536	0.699	0.0158	2.54	2.03	0.283	7,412	0.128
		2016	31,622	0.640	0.0158	1.99	1.12	0.280	6,475	0.118
		2017	31,536	0.661	0.0179	20.8	3.72	1.06	5,300	0.0912
		2018	31,536	0.658	0.0158	45.5	2.52	0.561	8,218	0.109
		2019	31,536	0.622	0.0158	12.3	2.40	0.972	5,071	0.111
		Mean	31,553	0.656	0.0162	16.6	2.36	0.631	6,495	0.112
		SD	38.6	0.0289	0.000962	17.9	0.940	0.370	1,348	0.0136
P-03	Pond C Discharge	2015	117,184	2.21	0.0758	296	11.7	41.3	605	0.0586
		2016	149,818	2.11	0.0747	129	1.61	29.7	722	0.0747
		2017	316,561	4.80	0.158	143	4.12	68.3	1,217	0.158
		2018	320,941	4.42	0.162	301	6.58	66.0	1,190	0.160
		2019	410,201	6.13	0.209	497	9.98	104	1,815	0.205
		Mean	262,941	3.93	0.136	273	6.79	61.9	1,110	0.131
		SD	124,466	1.74	0.0588	149	4.13	28.7	480	0.0623
P-05	Seepage from Dam E	2015	833,337	8.76	0.573	352	70.2	5.14	21,505	0.417
		2016	732,705	5.86	0.407	189	29.6	5.85	11,026	0.365
		2017	1,225,856	8.54	0.786	522	47.8	9.50	8,286	0.613
		2018	865,933	7.83	0.601	521	46.5	6.06	8,632	0.433
		2019	1,360,159	11.93	0.919	631	51.5	9.52	9,370	0.680
		Mean	1,003,598	8.59	0.657	443	49.1	7.21	11,764	0.502
		SD	272,882	2.19	0.199	174	14.5	2.12	5,547	0.1367
P-11	Site Drainage	2015	6,307	0.1	0.003	2	0.1	0.4	114	0.01
		2016	552,709	5.70	0.377	121	5.95	25.2	4,118	0.805
		2017	1,318,948	14.0	0.745	382	19.8	48.2	7,273	2.04
		2018	1,686,813	18.0	0.843	758	53.1	64.6	9,346	1.86
		2019	1,144,575	9.87	0.572	400	18.6	51.2	5,404	1.25
		Mean	941,871	9.5	0.508	333	19.5	37.9	5,251	1.19
		SD	664,255	6.99	0.334	292	20.6	25.3	3,484	0.825
All Panel Sources			-	**1,538**	**1.97**	**1,134**	**116**	**371**	**161,745**	**12.4**
SR-01	Outlet of Quirke Lake	2015	132,917,308	5,184	-	2,658	399	2,525	4,785,023	186
		2016	116,866,451	4,512	-	2,331	350	2,292	4,162,495	162
		2017	195,524,097	6,979	-	3,910	587	5,202	6,333,457	242
		2018	138,116,269	4,804	-	2,762	444	3,536	4,221,453	152
		2019	216,945,429	7,590	-	4,339	868	4,287	6,120,416	239
		Mean	160,073,911	5,814	-	3,200	529	3,569	5,124,569	196
		SD	43,524,674	1,381	-	872	209	1,215	1,037,981	42.3

Notes: MBq/yr = Million Becquerels per year. Values below LRL were substituted at the LRL for calculations. "-" indicates parameter not measured, as per study design. See Appendix Tables N.11 to N.15, S.14, and S.16 for raw data and Appendix Figure N.12 for the percent contribution of loads from each TMA.

APPENDIX O
ELLIOT LAKE SUB-WATERSHED SAMP DATA

Milliken TMA

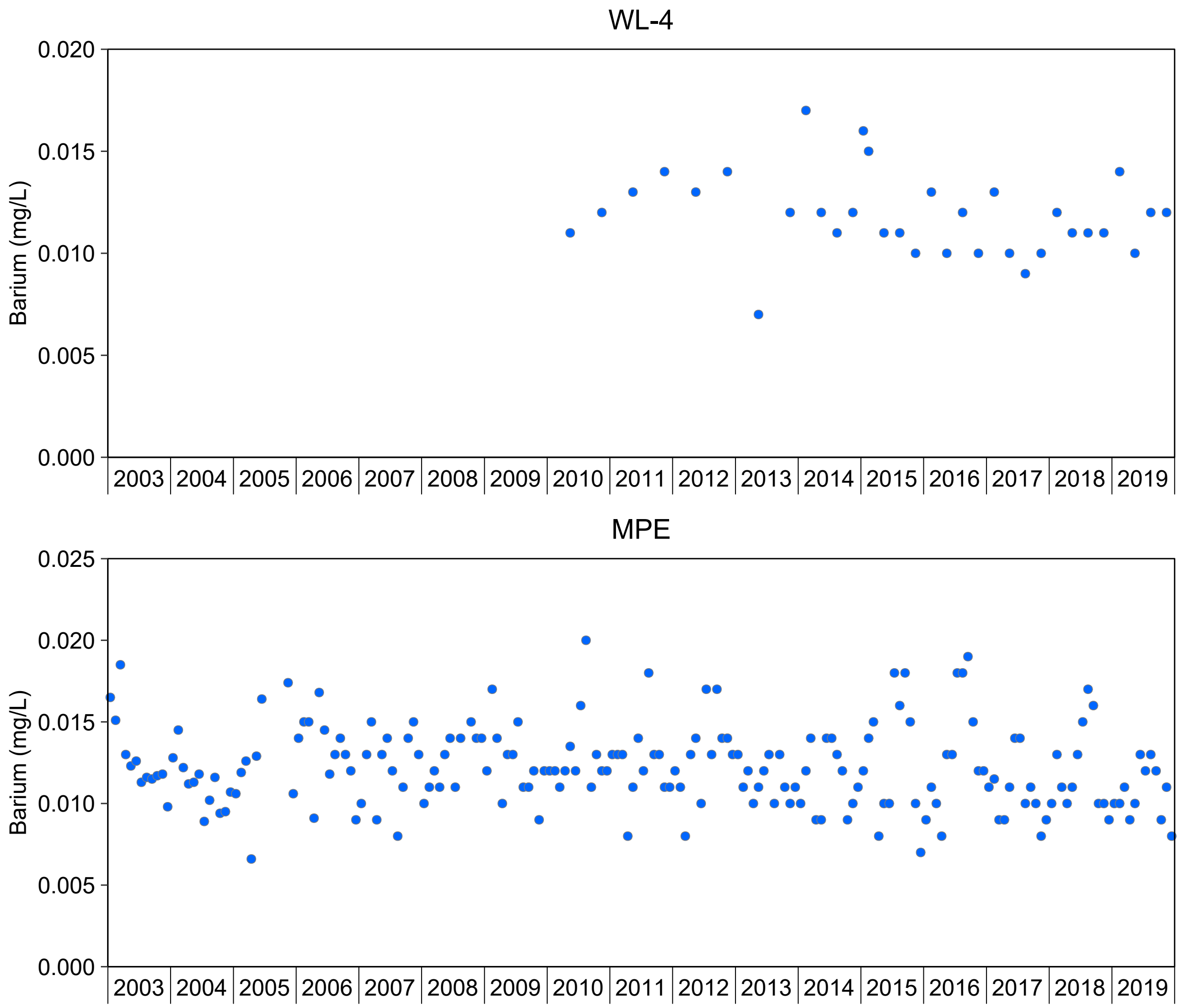


Figure O.1: Concentrations of Barium for SAMP Water Quality Monitoring Stations in Nordic and Milliken TMAs, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Tables P.2 and O.2 for raw data.

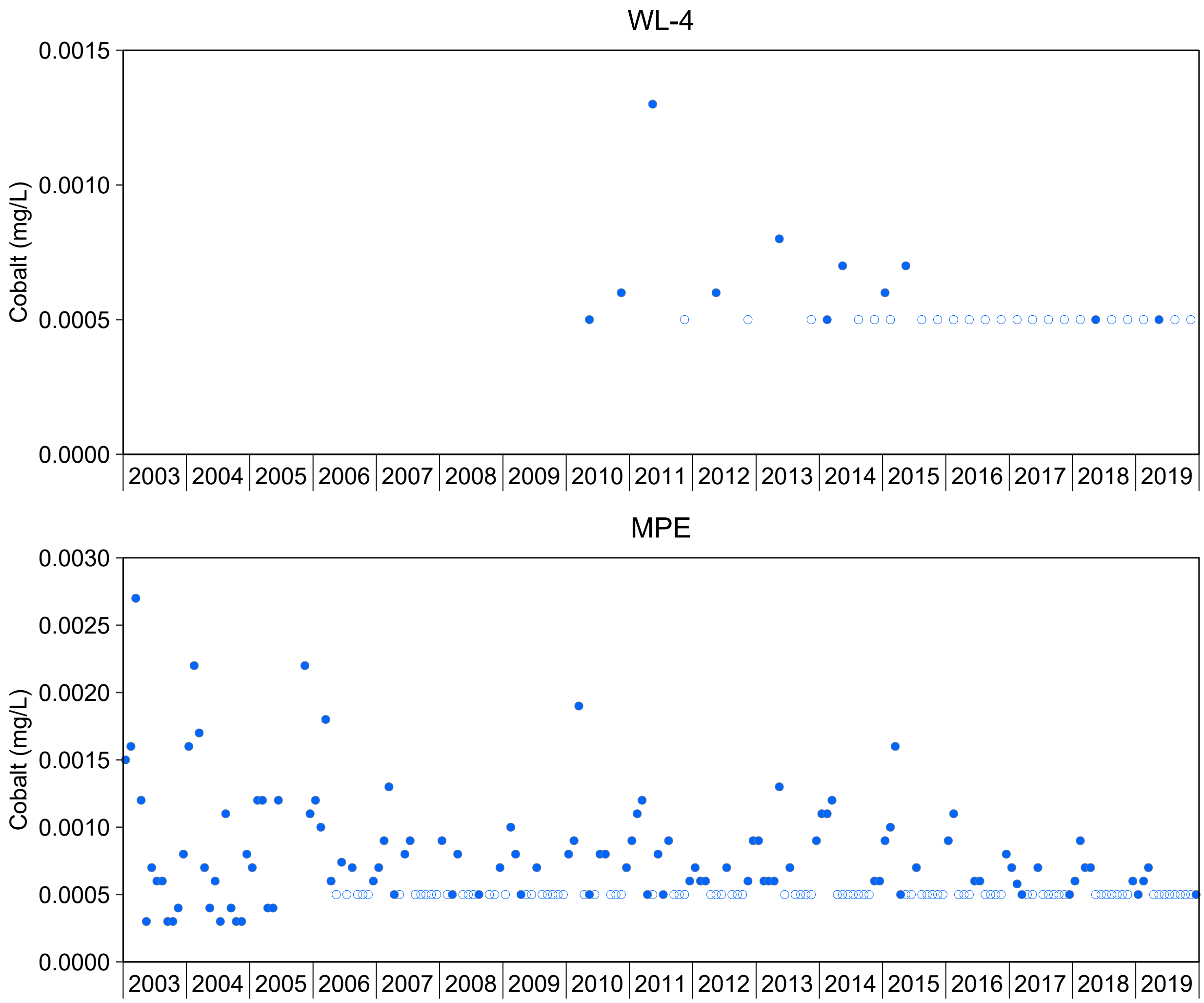


Figure O.2: Concentrations of Cobalt for SAMP Water Quality Monitoring Stations in Nordic and Milliken TMAs, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Cobalt (mg/L) is not included in the trend analysis for SAMP station WL-4 due to >50% non-detectable concentrations in the dataset. See Appendix Tables P.2 and O.2 for raw data.

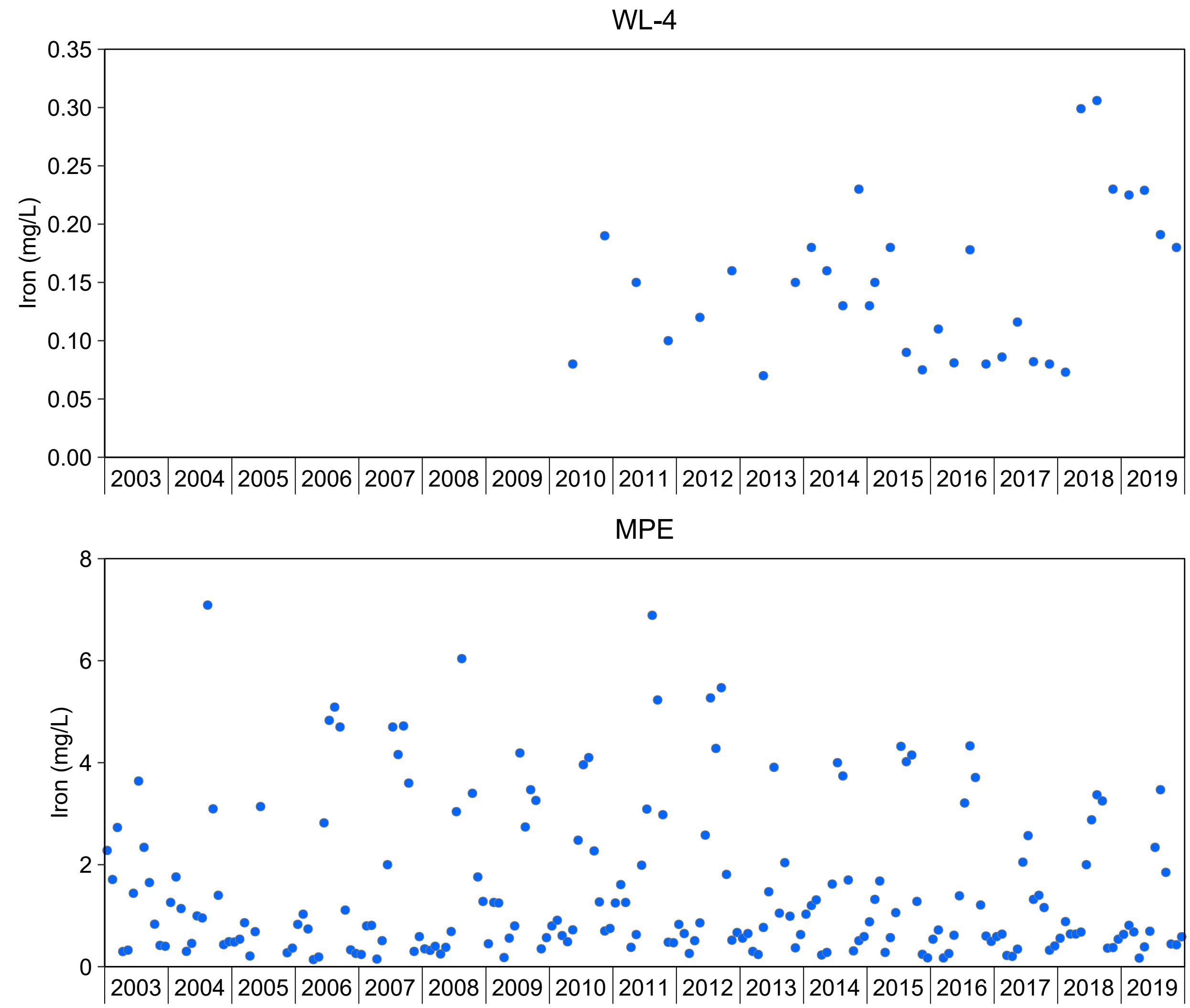


Figure O.3: Concentrations of Iron for SAMP Water Quality Monitoring Stations in Nordic and Milliken TMAs, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL.
See Appendix Tables O.2 and P.2 for raw data.

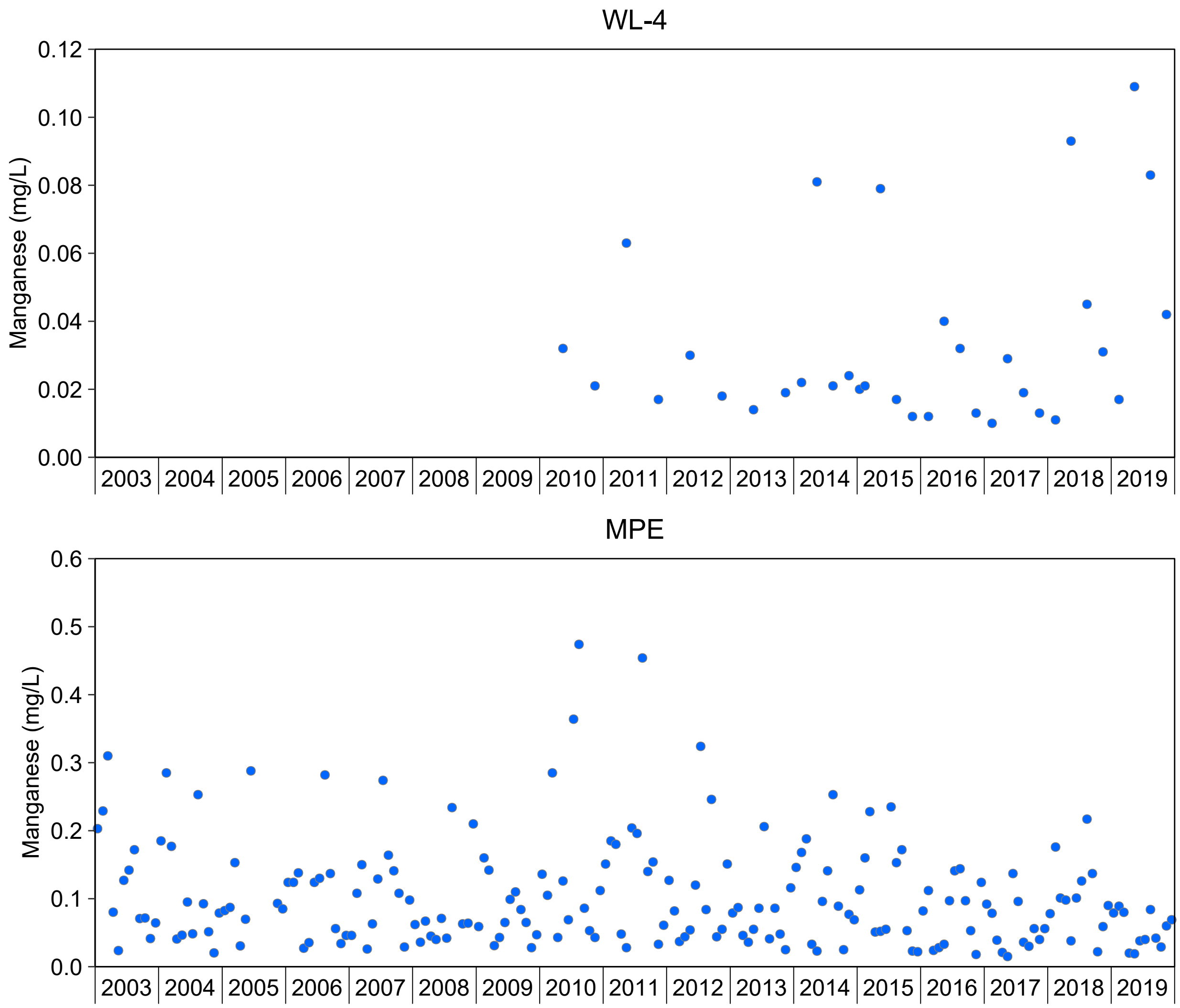


Figure O.4: Concentrations of Manganese for SAMP Water Quality Monitoring Stations in Nordic and Milliken TMAs, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Tables O.2 and P.2 for raw data.

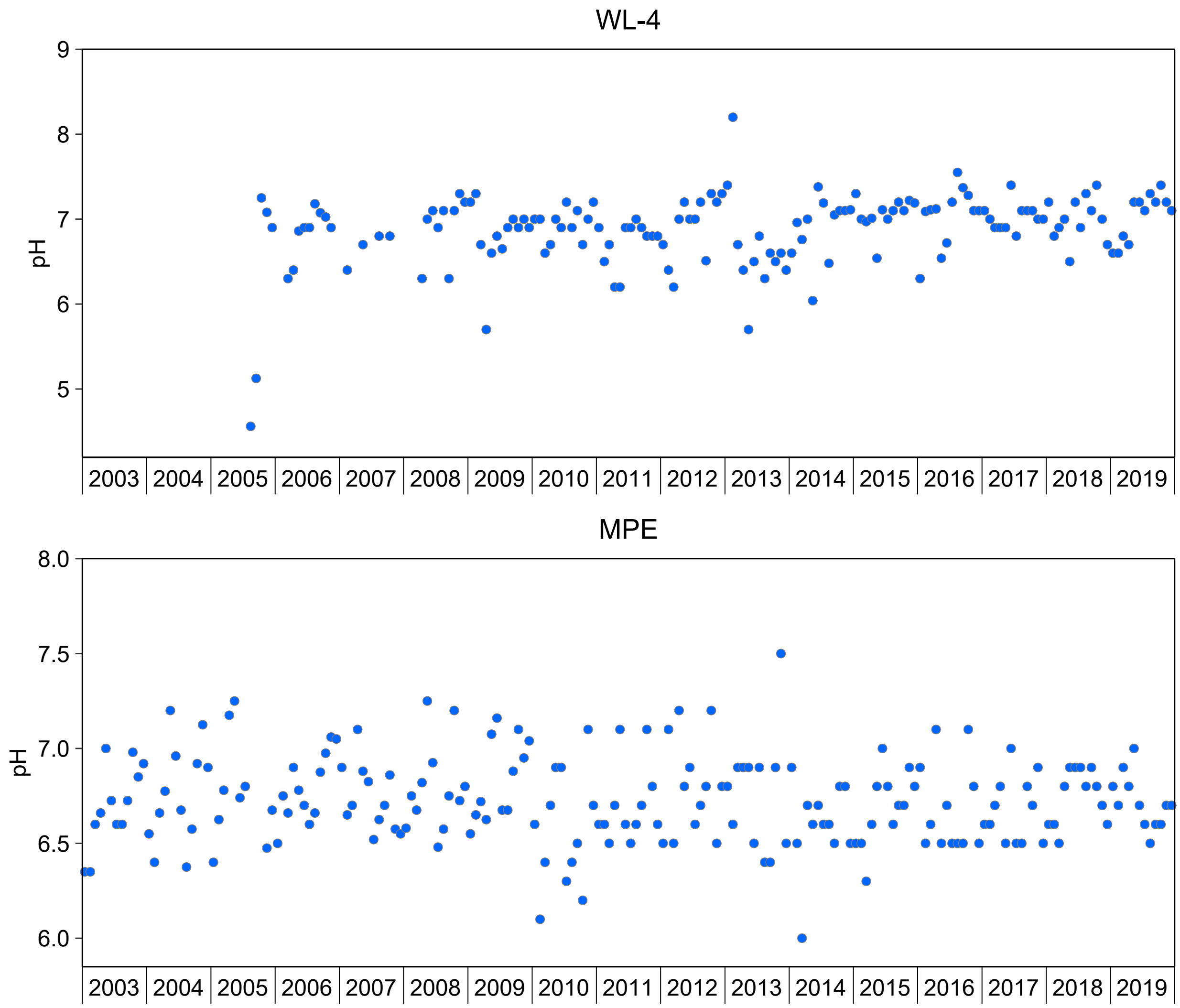


Figure O.5: Field Measurements of pH for SAMP Water Quality Monitoring Stations in Nordic and Milliken TMAs, 2003 to 2019

Notes: See Appendix Tables O.2 and P.2 for raw data.

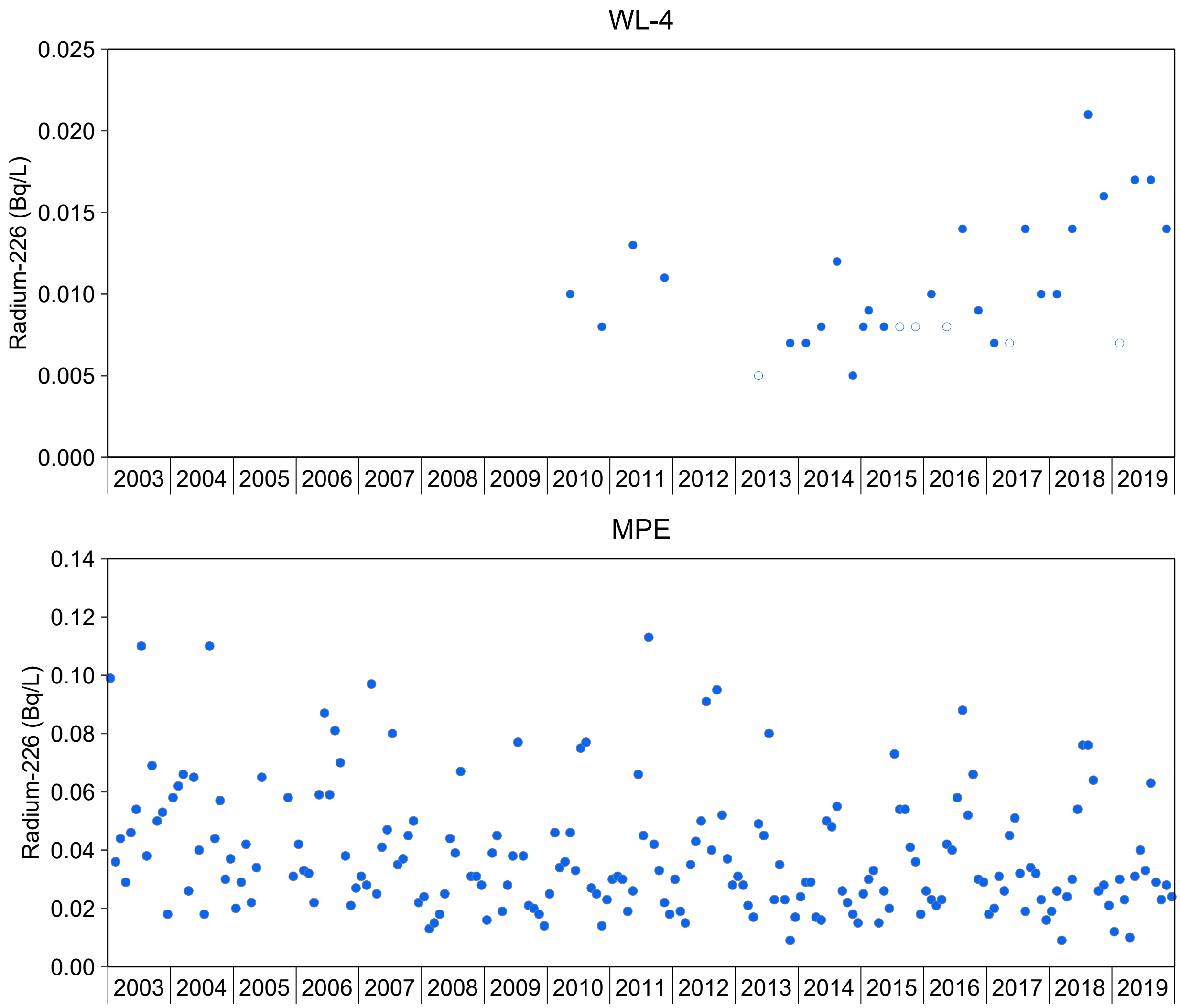


Figure O.6: Concentrations of Radium-226 for SAMP Water Quality Monitoring Stations in Nordic and Milliken TMAs, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL.
See Appendix Tables O.2 and P.2 for raw data.

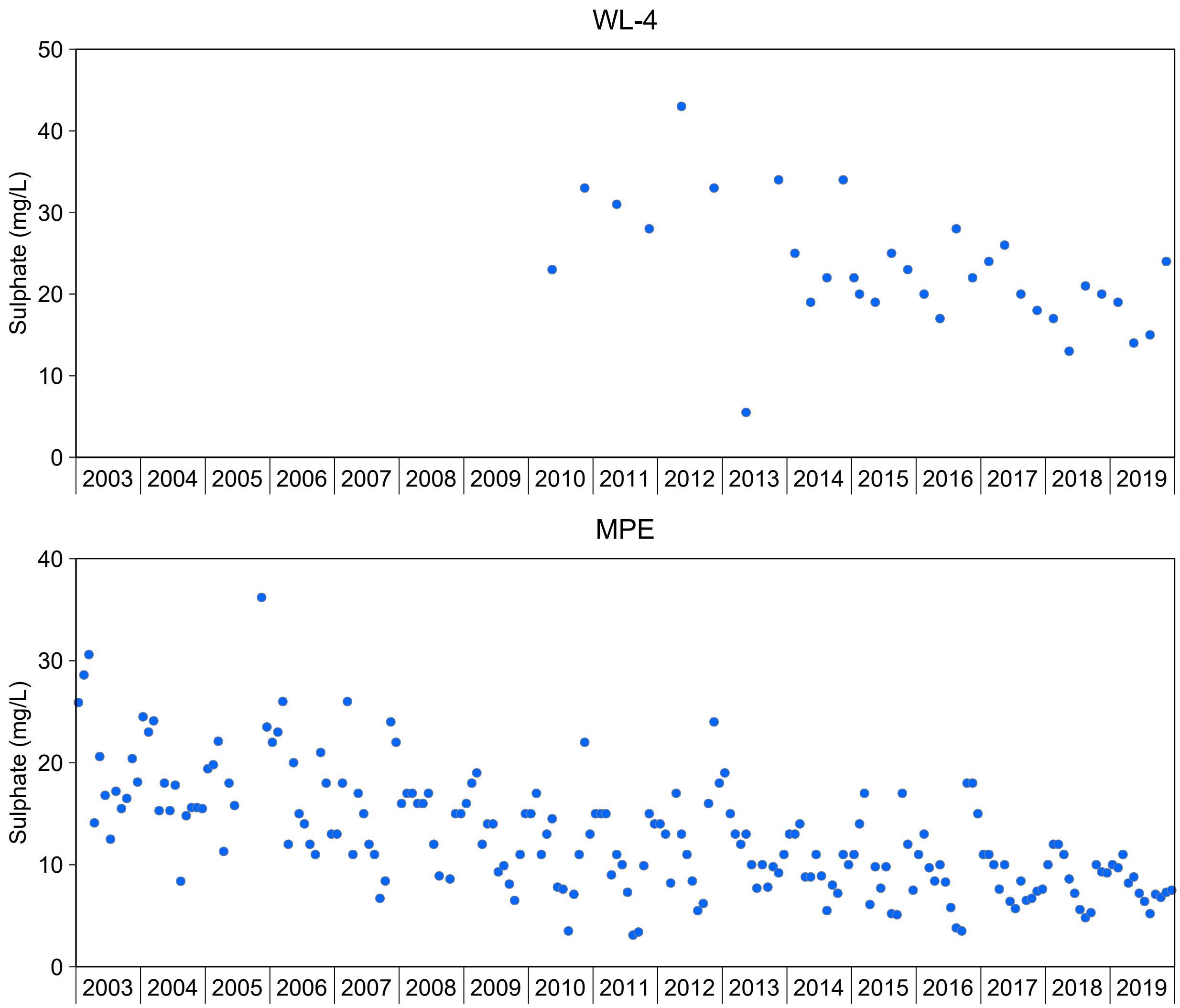


Figure O.7: Concentrations of Sulphate for SAMP Water Quality Monitoring Stations in Nordic and Milliken TMAs, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL.
See Appendix Tables O.2 and P.2 for raw data.

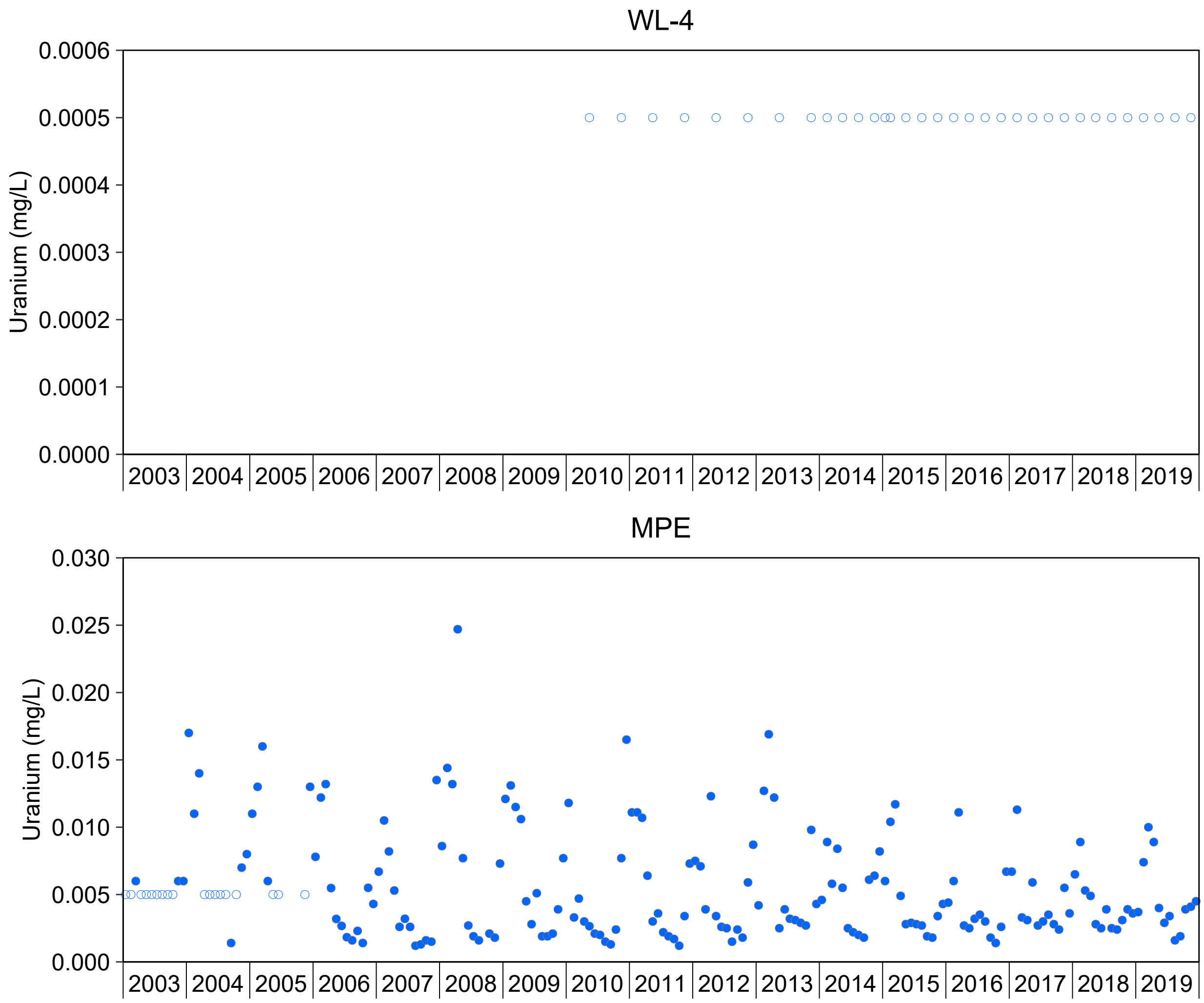


Figure O.8: Concentrations of Uranium for SAMP Water Quality Monitoring Stations in Nordic and Milliken TMAs, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Uranium (mg/L) is not included in the trend analysis for SAMP station WL-4 due to >50% non-detectable concentrations in the dataset. See Appendix Tables O.2 and P.2 for raw data.

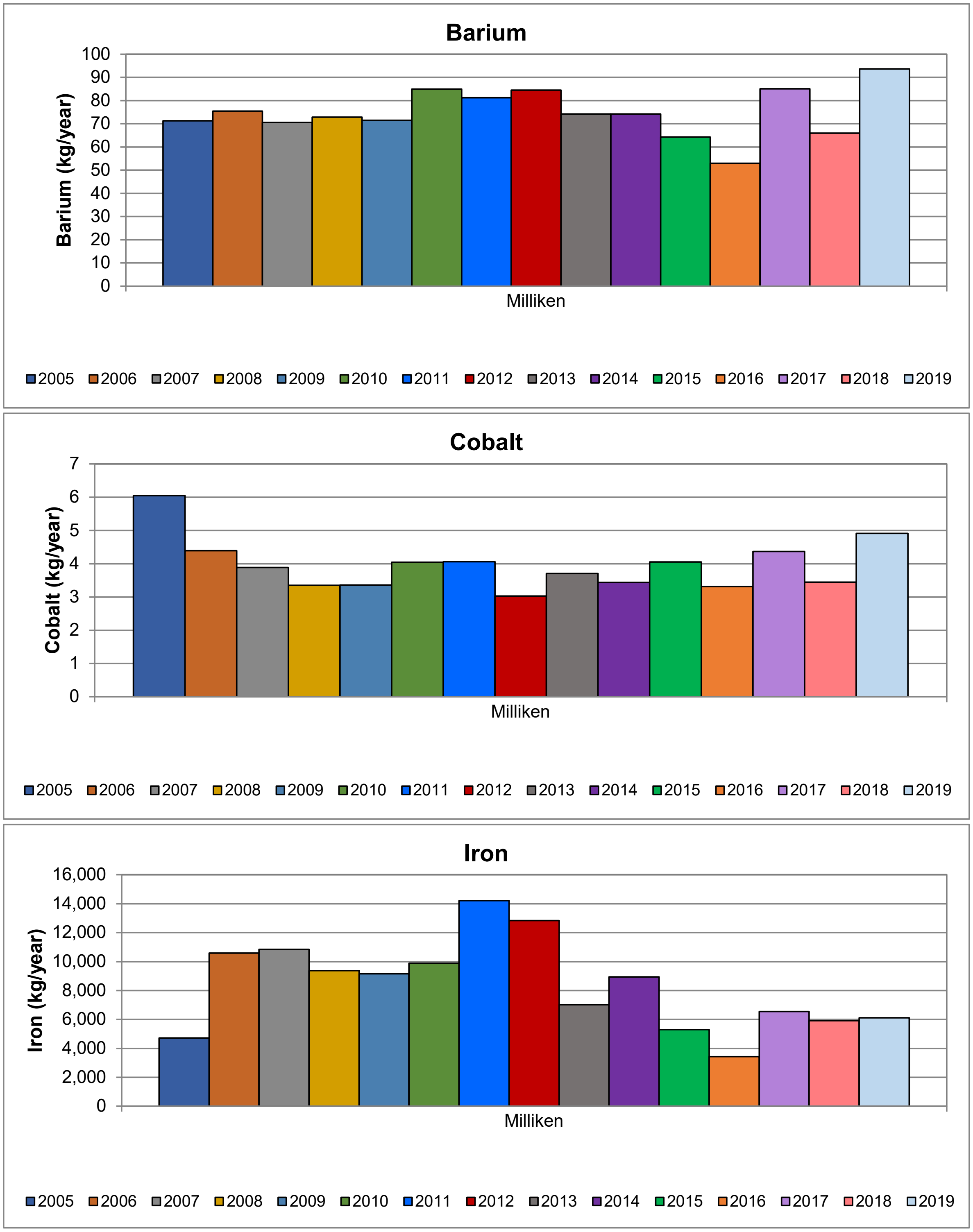
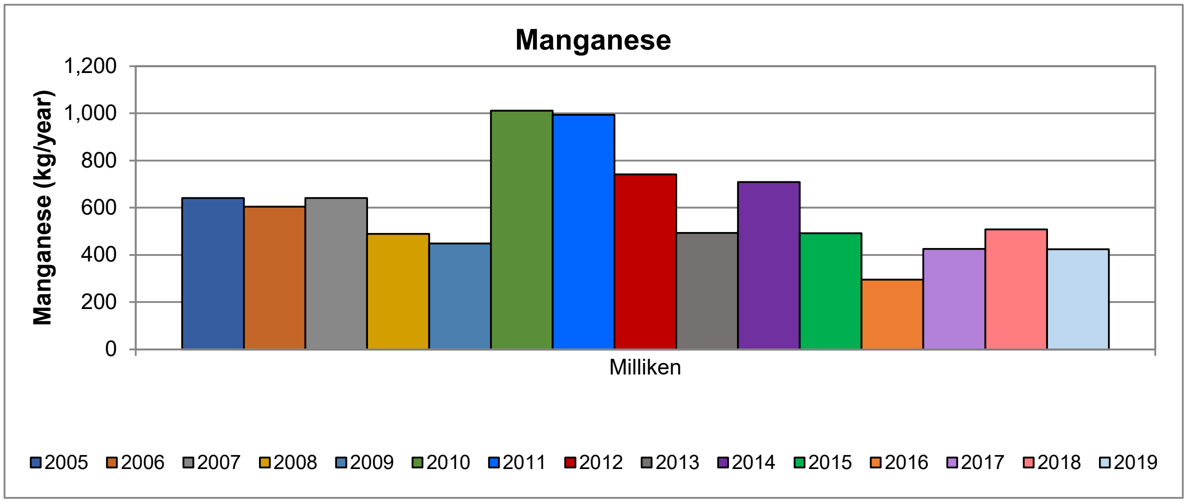
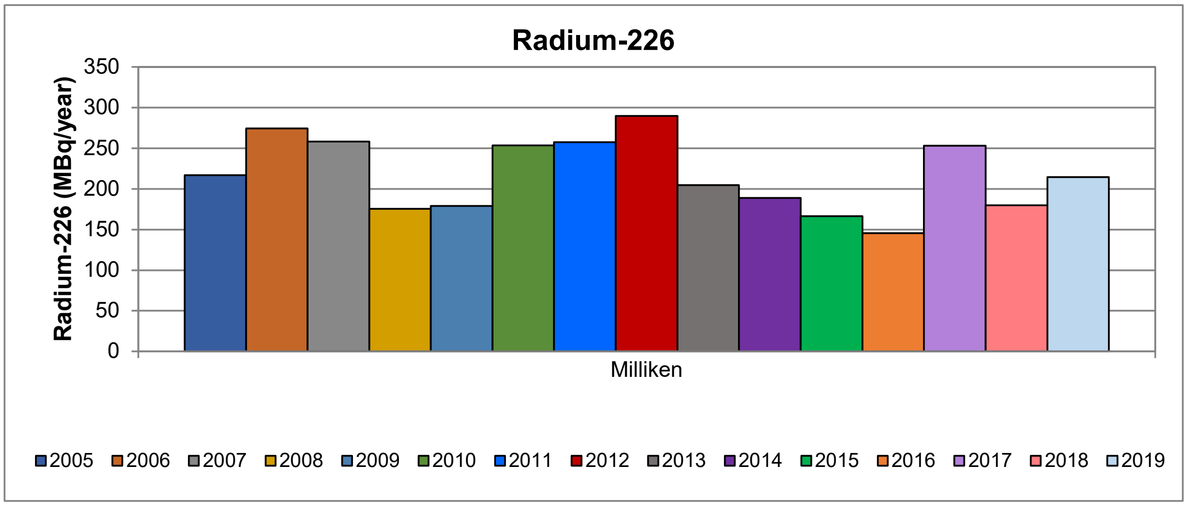


Figure O.9: Annual Loadings from the Milliken TMA to the Elliot Lake Watershed, 2005 to 2019

Note: See Appendix Table O.2 for raw data and Appendix Table O.3 for annual discharge and seepage loading rates.





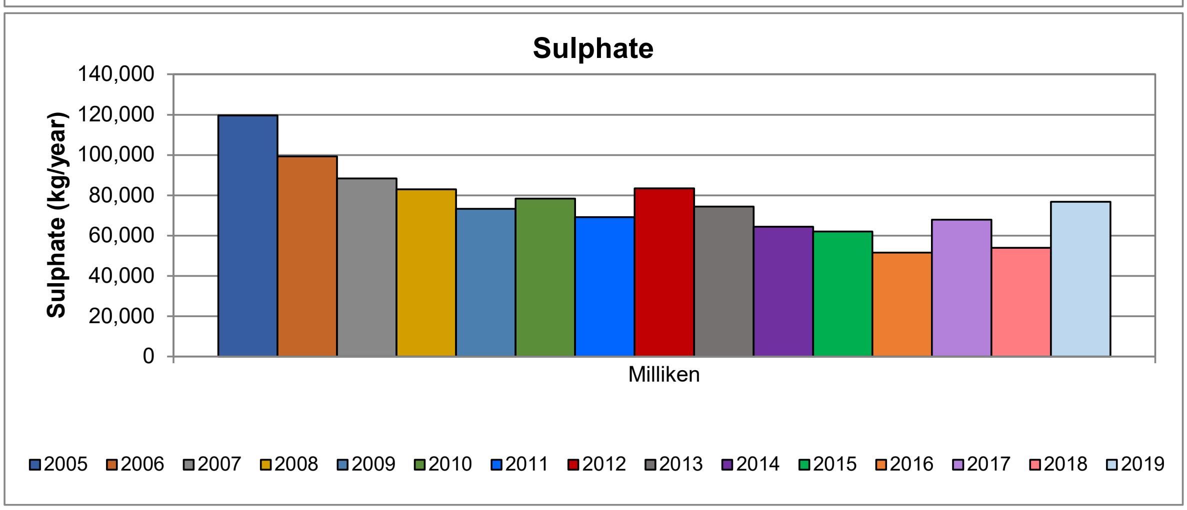


Figure O.9: Annual Loadings from the Milliken TMA to the Elliot Lake Watershed, 2005 to 2019

Note: See Appendix Table O.2 for raw data and Appendix Table O.3 for annual discharge and seepage loading rates.

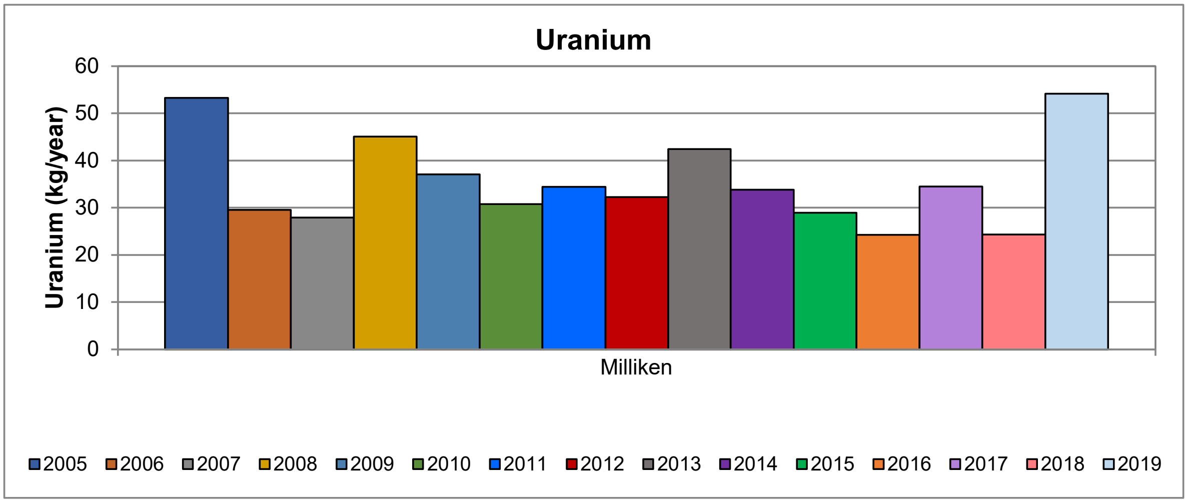
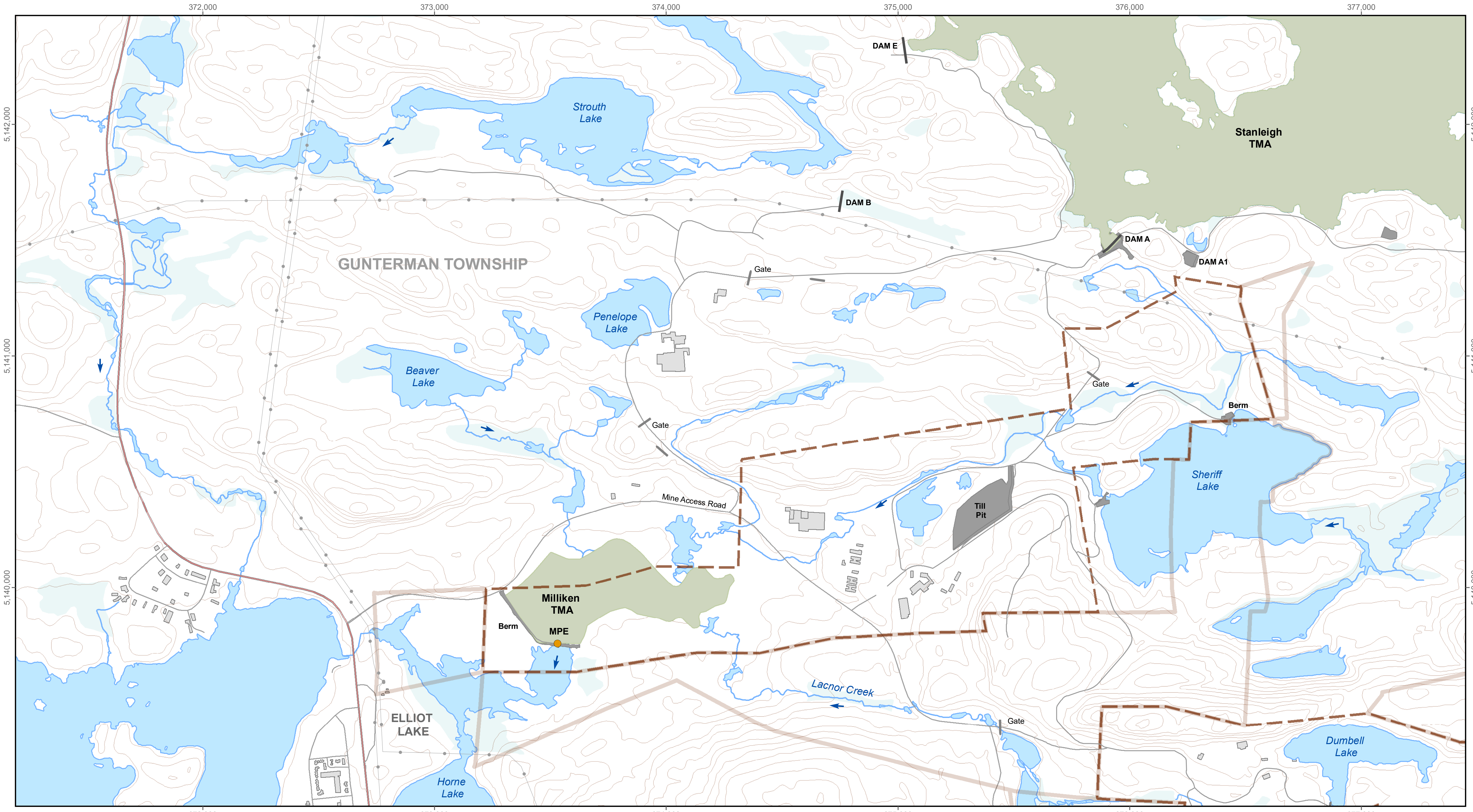


Figure O.9: Annual Loadings from the Milliken TMA to the Elliot Lake Watershed, 2005 to 2019

Note: See Appendix Table O.2 for raw data and Appendix Table O.3 for annual discharge and seepage loading rates.



LEGEND
Monitoring Station
SAMP Surface Water

Water Covered Tailings

Limits of CNSC Licence
Limits of Unlicenced Property
Dam
Contour (10 m)

0 0.25 0.5 1
km

Projection: North American Datum 1983 UTM Zone 17
Reproduced under licence from Her Majesty the Queen in Right of Canada, Department of Natural Resources Canada.

N E S W

Milliken Site SAMP Monitoring Station

Date: March 2021
Project 197202.0041

minnow environmental inc.

Figure O.10

Table O.1: Location of SAMP Data Tables and Figures Within this Cycle 5 SOE Report, Elliot Lake Sub-Watershed

TMA	SAMP Station ID	Type	Description	Also a TOMP or SRWMP Station?	Map Figures	Water Quality Data Tables (barium, cobalt, hardness, iron, manganese, pH, radium-226, sulphate, and/or uranium)	Flow Data Tables	Flow Data Figures	Toxicity Data Tables	Trend Tables	Water Quality / Trend Figures	Loadings Tables	Loadings Figures	Percent Contribution to Loadings Figures	TMA Plant Operations Tables
Milliken	MPE	Principal	Milliken Park Effluent	no	5.1, M.12	O.2	na	na	5.3	5.4	O.1 to O.8	O.3	O.9	na-l	na-m
Nordic	WL-4	Seepage	Seepage to Westner Lake from Coffer Pond	no	6.2, 5.1	P.2	na	na	na	5.4	O.1 to O.8	na	P.10	na-l	P.4

Notes: na = parameter not measured at this station (as per study design); therefore, data presentation is not applicable. na-l = percent contribution to loadings is not assessed for this TMA, as either there is only one station, or loadings are only measured at one station. na-m = not applicable, as Milliken TMA does not have an Effluent Treatment Plant (ETP).

Table O.2: Water Quality at SAMP Principal Station MPE, Milliken Park Effluent, Milliken TMA, 2015 to 2019

Date	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)	Sublethal Toxicity (*Ceriodaphnia dubia*) IC25	Acute Toxicity (*Daphnia magna*) % Mortality	Acute Toxicity (Rainbow Trout) % Mortality
19-Jan-15	30.7	6.50	11.0	0.0250	0.0120	0.000900	0.880	0.113	0.00600	-	-	-
18-Feb-15	39.4	6.50	14.0	0.0300	0.0140	0.00100	1.32	0.160	0.0104	-	-	-
16-Mar-15	42.2	6.30	17.0	0.0330	0.0150	0.00160	1.68	0.228	0.0117	-	-	-
20-Apr-15	17.9	6.60	6.10	0.0150	0.00800	0.000500	0.280	0.0510	0.00490	-	-	-
19-May-15	17.9	6.80	9.80	0.0260	0.0100	<0.000500	0.570	0.0520	0.00280	100	0	0
15-Jun-15	23.1	7.00	7.70	0.0200	0.0100	<0.000500	1.06	0.0550	0.00290	-	-	-
22-Jul-15	36.5	6.80	9.80	0.0730	0.0180	0.000700	4.32	0.235	0.00280	-	-	-
17-Aug-15	41.6	6.60	5.20	0.0540	0.0160	<0.000500	4.02	0.153	0.00270	-	-	-
16-Sep-15	43.3	6.70	5.10	0.0540	0.0180	<0.000500	4.15	0.172	0.00190	-	-	-
19-Oct-15	39.5	6.70	17.0	0.0410	0.0150	<0.000500	1.28	0.0530	0.00180	-	-	-
16-Nov-15	21.8	6.90	12.0	0.0360	0.0100	<0.000500	0.243	0.0230	0.00340	100	0	0
22-Dec-15	15.5	6.80	7.50	0.0180	0.00700	<0.000500	0.174	0.0220	0.00430	-	-	-
n	12	12	12	12	12	12	12	12	12	2	2	2
Minimum	15.5	6.30	5.10	0.0150	0.00700	<0.0005	0.174	0.0220	0.00180	100	0	0
Maximum	43.3	7.00	17.0	0.0730	0.0180	0.00160	4.32	0.235	0.0117	100	0	0
Mean	30.8	6.68	10.2	0.0354	0.0127	0.000683	1.66	0.110	0.00463	100	0	0
SD	10.8	0.195	4.18	0.0174	0.00377	0.000362	1.58	0.0776	0.00324	-	-	-
18-Jan-16	22.1	6.90	11.0	0.0260	0.00900	0.000900	0.539	0.0820	0.00440	-	-	-
16-Feb-16	28.2	6.50	13.0	0.0230	0.0110	0.00110	0.720	0.112	0.00600	-	-	-
28-Mar-16	25.7	6.60	9.70	0.0210	0.0100	<0.000500	0.172	0.0240	0.0111	-	-	-
18-Apr-16	17.4	7.10	8.40	0.0230	0.00800	<0.000500	0.258	0.0280	0.00270	-	-	-
16-May-16	23.3	6.50	10.0	0.0420	0.0130	<0.000500	0.617	0.0330	0.00250	100	0	0
20-Jun-16	32.6	6.70	8.30	0.0400	0.0130	0.000600	1.39	0.0970	0.00320	-	-	-
18-Jul-16	40.7	6.50	5.80	0.0580	0.0180	0.000600	3.21	0.141	0.00350	-	-	-
15-Aug-16	45.0	6.50	3.80	0.0880	0.0180	<0.000500	4.33	0.144	0.00300	-	-	-
19-Sep-16	46.7	6.50	3.50	0.0520	0.0190	<0.000500	3.71	0.0970	0.00180	-	-	-
19-Oct-16	38.9	7.10	18.0	0.0660	0.0150	<0.000500	1.21	0.0530	0.00140	100	0	0
23-Nov-16	33.3	6.80	18.0	0.0300	0.0120	<0.000500	0.601	0.0180	0.00260	-	-	-
19-Dec-16	30.1	6.50	15.0	0.0290	0.0120	0.000800	0.496	0.124	0.00670	-	-	-
n	12	12	12	12	12	12	12	12	12	2	2	2
Minimum	17.4	6.50	3.50	0.0210	0.00800	<0.0005	0.172	0.0180	0.00140	100	0	0
Maximum	46.7	7.10	18.0	0.0880	0.0190	0.00110	4.33	0.144	0.0111	100	0	0
Mean	32.0	6.68	10.4	0.0415	0.0132	0.000625	1.44	0.0794	0.00408	100	0	0
SD	9.32	0.237	4.91	0.0208	0.00364	0.000176	1.46	0.0467	0.00272	-	-	-
17-Jan-17	26.8	6.60	11.0	0.0180	0.0110	0.000700	0.590	0.0920	0.00670	-	-	-
21-Feb-17	31.0	6.60	11.0	0.0200	0.0115	0.000579	0.639	0.0786	0.0113	-	-	-
20-Mar-17	22.7	6.70	10.0	0.0310	0.00900	0.000500	0.221	0.0390	0.00330	-	-	-
17-Apr-17	18.5	6.80	7.60	0.0260	0.00900	<0.000500	0.203	0.0210	0.00310	-	-	-
08-May-17	25.7	6.50	10.0	0.0450	0.0110	<0.000500	0.345	0.0150	0.00590	100	0	0

Table O.2: **Water Quality at SAMP Principal Station MPE, Milliken Park Effluent, Milliken TMA, 2015 to 2019**

Date	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)	Sublethal Toxicity (*Ceriodaphnia dubia*) IC25	Acute Toxicity (*Daphnia magna*) % Mortality	Acute Toxicity (Rainbow Trout) % Mortality
19-Jun-17	31.1	7.00	6.40	0.0510	0.0140	0.000700	2.05	0.137	0.00270	-	-	-
17-Jul-17	29.7	6.50	5.70	0.0320	0.0140	<0.000500	2.57	0.0960	0.00300	-	-	-
21-Aug-17	28.8	6.50	8.40	0.0190	0.0100	<0.000500	1.32	0.0360	0.00350	-	-	-
18-Sep-17	29.5	6.80	6.50	0.0340	0.0110	<0.000500	1.40	0.0300	0.00280	-	-	-
17-Oct-17	22.4	6.70	6.70	0.0320	0.0100	<0.000500	1.16	0.0560	0.00240	-	-	-
20-Nov-17	22.1	6.90	7.40	0.0230	0.00800	<0.000500	0.324	0.0400	0.00550	100	0	0
18-Dec-17	23.2	6.50	7.60	0.0160	0.00900	0.000500	0.407	0.0560	0.00360	-	-	-
n	12	12	12	12	12	12	12	12	12	2	2	2
Minimum	18.5	6.50	5.70	0.0160	0.00800	<0.0005	0.203	0.0150	0.00240	100	0	0
Maximum	31.1	7.00	11.0	0.0510	0.0140	0.000700	2.57	0.137	0.0113	100	0	0
Mean	26.0	6.68	8.19	0.0289	0.0106	0.000540	0.936	0.0580	0.00448	100	0	0
SD	4.14	0.171	1.86	0.0109	0.00190	0.0000836	0.774	0.0362	0.00256	-	-	-
25-Jan-18	28.3	6.60	10.0	0.0190	0.0100	0.000600	0.558	0.0780	0.00650	-	-	-
14-Feb-18	34.9	6.60	12.0	0.0260	0.0130	0.000900	0.884	0.176	0.00890	-	-	-
19-Mar-18	30.7	6.50	12.0	0.00900	0.0110	0.000700	0.641	0.101	0.00530	-	-	-
16-Apr-18	29.3	6.80	11.0	0.0240	0.0100	0.000700	0.640	0.0980	0.00490	-	-	-
22-May-18	24.0	6.90	8.60	0.0300	0.0110	<0.000500	0.679	0.0380	0.00280	100	0	0
27-Jun-18	28.0	6.90	7.20	0.0540	0.0130	<0.000500	2.00	0.101	0.00250	-	-	-
16-Jul-18	36.3	6.90	5.60	0.0760	0.0150	<0.000500	2.88	0.126	0.00390	-	-	-
15-Aug-18	42.0	6.80	4.80	0.0760	0.0170	<0.000500	3.37	0.217	0.00250	-	-	-
17-Sep-18	43.5	6.90	5.30	0.0640	0.0160	<0.000500	3.25	0.137	0.00240	-	-	-
22-Oct-18	22.3	6.80	10.0	0.0260	0.0100	<0.000500	0.364	0.0220	0.00310	100	0	0
20-Nov-18	25.5	6.70	9.30	0.0280	0.0100	<0.000500	0.375	0.0590	0.00390	-	-	-
17-Dec-18	25.2	6.60	9.20	0.0210	0.00900	0.000600	0.539	0.0900	0.00360	-	-	-
n	12	12	12	12	12	12	12	12	12	2	2	2
Minimum	22.3	6.50	4.80	0.00900	0.00900	<0.0005	0.364	0.0220	0.00240	100	0	0
Maximum	43.5	6.90	12.0	0.0760	0.0170	0.000900	3.37	0.217	0.00890	100	0	0
Mean	30.8	6.75	8.75	0.0378	0.0121	0.000583	1.35	0.104	0.00419	100	0	0
SD	6.93	0.145	2.52	0.0233	0.00268	0.0000964	1.18	0.0552	0.00195	-	-	-
21-Jan-19	27.0	6.80	10.0	0.0120	0.0100	0.000500	0.634	0.0790	0.00370	-	-	-
19-Feb-19	24.1	6.70	9.70	0.0300	0.0100	0.000600	0.811	0.0890	0.00740	-	-	-
18-Mar-19	29.4	6.90	11.0	0.0230	0.0110	0.000700	0.682	0.0800	0.0100	-	-	-
17-Apr-19	22.6	6.80	8.20	0.0100	0.00900	<0.000500	0.169	0.0200	0.00890	-	-	-
21-May-19	21.3	7.00	8.80	0.0310	0.0100	<0.000500	0.389	0.0190	0.00400	100	0	0
17-Jun-19	23.5	6.70	7.20	0.0400	0.0130	<0.000500	0.695	0.0380	0.00290	-	-	-
15-Jul-19	29.0	6.60	6.40	0.0330	0.0120	<0.000500	2.34	0.0400	0.00340	-	-	-
21-Aug-19	17.1	6.50	5.20	0.0630	0.0130	<0.000500	3.47	0.0840	0.00160	-	-	-
16-Sep-19	31.9	6.60	7.10	0.0290	0.0120	<0.000500	1.85	0.0420	0.00190	-	-	-
21-Oct-19	20.4	6.60	6.80	0.0230	0.00900	<0.000500	0.445	0.0290	0.00390	71.4	0	0

Table O.2: Water Quality at SAMP Principal Station MPE, Milliken Park Effluent, Milliken TMA, 2015 to 2019

Date	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)	Sublethal Toxicity (*Ceriodaphnia dubia*) IC25	Acute Toxicity (*Daphnia magna*) % Mortality	Acute Toxicity (Rainbow Trout) % Mortality
18-Nov-19	21.6	6.70	7.30	0.0280	0.0110	<0.000500	0.430	0.0600	0.00410	-	-	-
16-Dec-19	22.2	6.70	7.50	0.0240	0.00800	0.000500	0.587	0.0690	0.00450	-	-	-
n	12	12	12	12	12	12	12	12	12	2	2	2
Minimum	17.1	6.50	5.20	0.0100	0.00800	<0.0005	0.169	0.0190	0.00160	71.4	0	0
Maximum	31.9	7.00	11.0	0.0630	0.0130	0.000700	3.47	0.0890	0.0100	100	0	0
Mean	24.2	6.72	7.93	0.0288	0.0107	0.000525	1.04	0.0541	0.00469	85.7	0	0
SD	4.31	0.140	1.67	0.0136	0.00161	0.0000687	0.992	0.0257	0.00266	20.2	-	-
Summary Statistics for 2015 to 2019												
n	60	60	60	60	60	60	60	60	60	10	10	10
Minimum	15.5	6.30	3.50	0.00900	0.00700	<0.000500	0.169	0.0150	0.00140	71.4	0	0
Maximum	46.7	7.10	18.0	0.0880	0.0190	0.00160	4.33	0.235	0.0117	100	0	0
Mean	28.8	6.70	9.09	0.0345	0.0119	0.000591	1.29	0.0810	0.00442	97.1	0	0
SD	7.96	0.177	3.34	0.0179	0.00295	0.000195	1.22	0.0547	0.00258	9.04	-	-
Median	28.1	6.70	8.50	0.0295	0.0110	<0.000500	0.681	0.0735	0.00350	100	0	0
10th Percentile	19.5	6.50	5.25	0.0180	0.00900	<0.000500	0.250	0.0220	0.00215	85.7	0	0
95th Percentile	43.4	7.00	17.0	0.0745	0.0180	0.000950	4.08	0.196	0.0107	100	0	0

Note: "-" = no data collected or SD was incalculable because there was no variability in the data. n = number of samples. SD = standard deviation.

Table O.3: Annual Discharge and Seepage Loadings associated with Milliken TMA, Nordic TMA, and the Elliot Lake Sub-Watershed, 2015 to 2019

Station		Drainage Type	Year	Annual Discharge (m^3)	Barium (kg/year)	Cobalt (kg/yr)	Iron (kg/yr)	Manganese (kg/yr)	Radium (MBq/yr)	Sulphate (kg/yr)	Uranium (kg/yr)
Nordic TMA, SRWMP	SC-01	Westner Lake Outlet	2015	987,505	9.88	-	67	7.90	7.90	20,738	0.494
			2016	868,255	8.66	-	58.7	6.93	6.93	18,145	0.433
			2017	1,452,640	14.3	-	91.3	12.1	11.4	28,040	0.726
			2018	1,026,130	9.42	-	75.2	10.7	7.37	16,606	0.513
			2019	1,611,789	17.7	-	210	29.1	14.06	28,565	0.806
			Mean	1,189,264	12.0	-	100.5	13.4	9.52	22,419	0.594
			SD	323,365	3.88	-	62.4	9.04	3.08	5,573	0.162
Milliken TMA, SAMP	MPE	Discharge	2015	5,625,027	64.3	4.05	5,300	491	166	62,136	28.9
			2016	4,945,759	52.9	3.31	3,442	294	146	51,660	24.2
			2017	8,274,531	85.0	4.37	6,545	426	253	67,942	34.5
			2018	5,845,046	65.9	3.45	5,919	508	180	53,933	24.3
			2019	9,181,076	93.6	4.91	6,108	424	215	76,838	54.1
			Mean	6,774,288	72.4	4.02	5,463	429	192	62,502	33.2
			SD	1,841,953	16.6	0.660	1,215	84	42.4	10,323	12.43
Milliken TMA, SRWMP	M-01	Sheriff Creek Park Dam	2015	7,733,371	124	-	4,550	1,145	108	96,674	21.5
			2016	6,799,503	100	-	3,025	1,037	110	83,669	20.6
			2017	11,375,947	178	-	6,859	863	184	121,274	39.9
			2018	8,035,856	117	-	6,329	609	114	71,073	17.9
			2019	12,622,280	201	-	8,990	1,183	194	116,318	38.2
			Mean	9,313,391	144	-	5,951	967	142	97,801	27.6
			SD	2,532,345	43.1	-	2,276	236	43.1	21,267	10.57

Notes: MBq/yr = Million Becquerels per year. Values below LRL were substituted at the LRL for calculations. "-" indicates parameter not measured, as per study design. See Appendix Tables O.2, S.16, and S.17 for raw data.

APPENDIX P
NORDIC LAKE SUB-WATERSHED SAMP DATA

Lacnor and Nordic TMAS

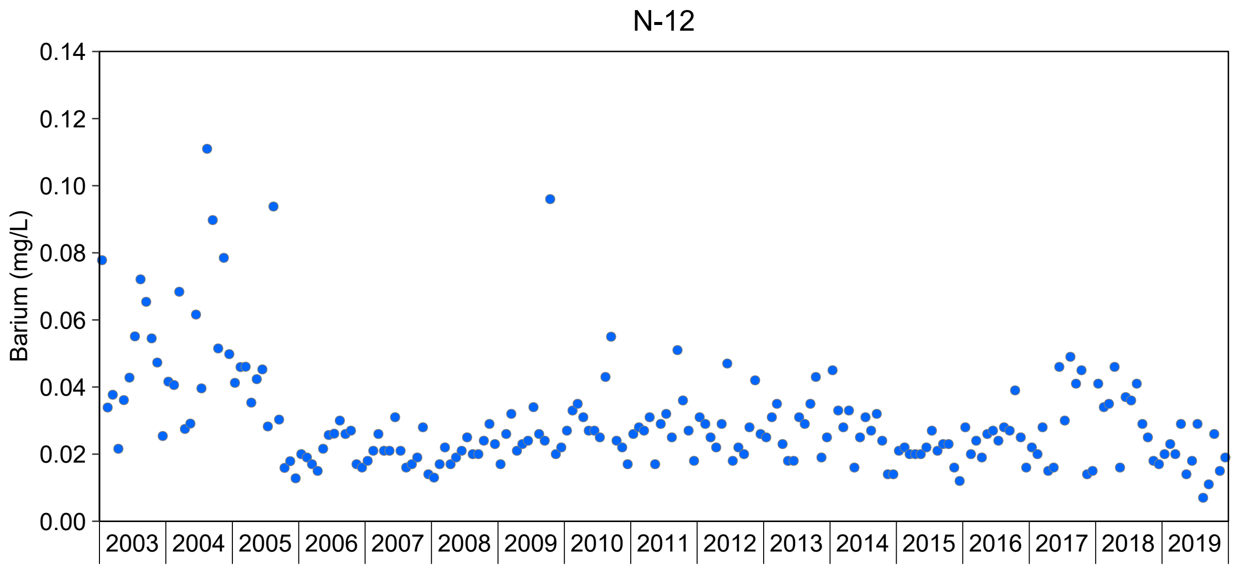


Figure P.1: Concentrations of Barium for SAMP Water Quality Monitoring Stations in Nordic TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Table P.3 for raw data.

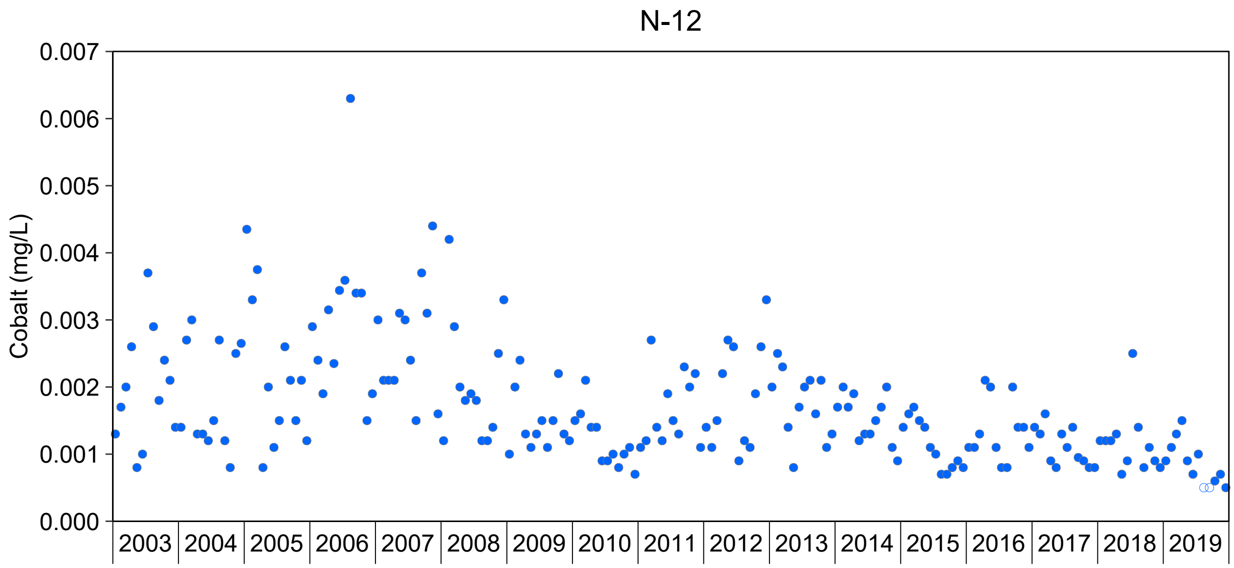


Figure P.2: Concentrations of Cobalt for SAMP Water Quality Monitoring Stations in Nordic TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Table P.3 for raw data.

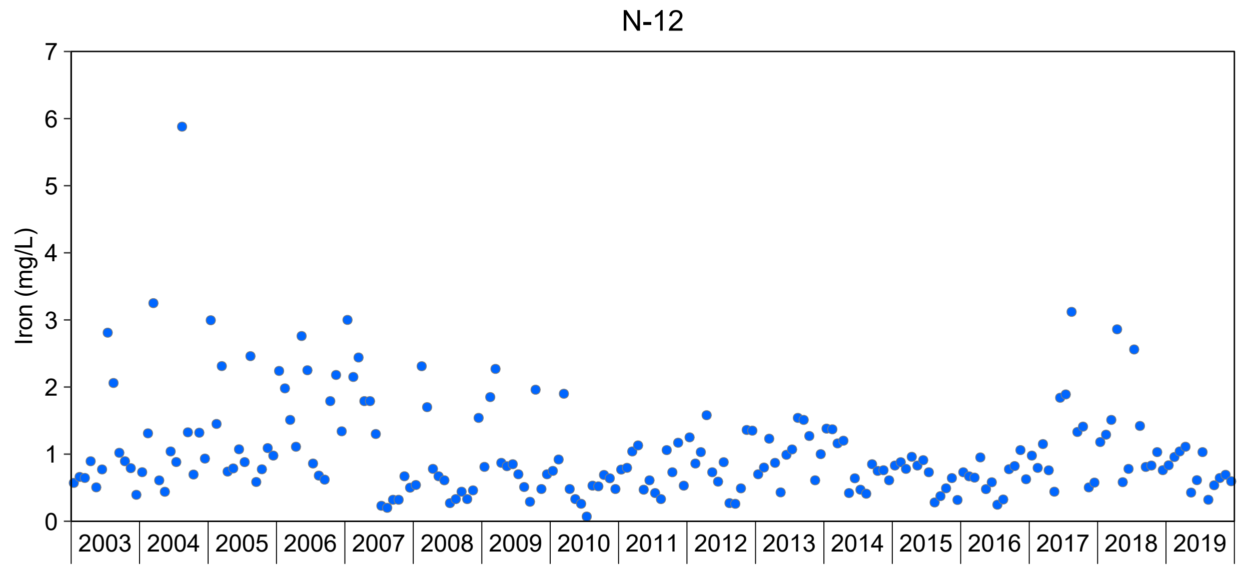


Figure P.3: Concentrations of Iron for SAMP Water Quality Monitoring Stations in Nordic TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Table P.3 for raw data.

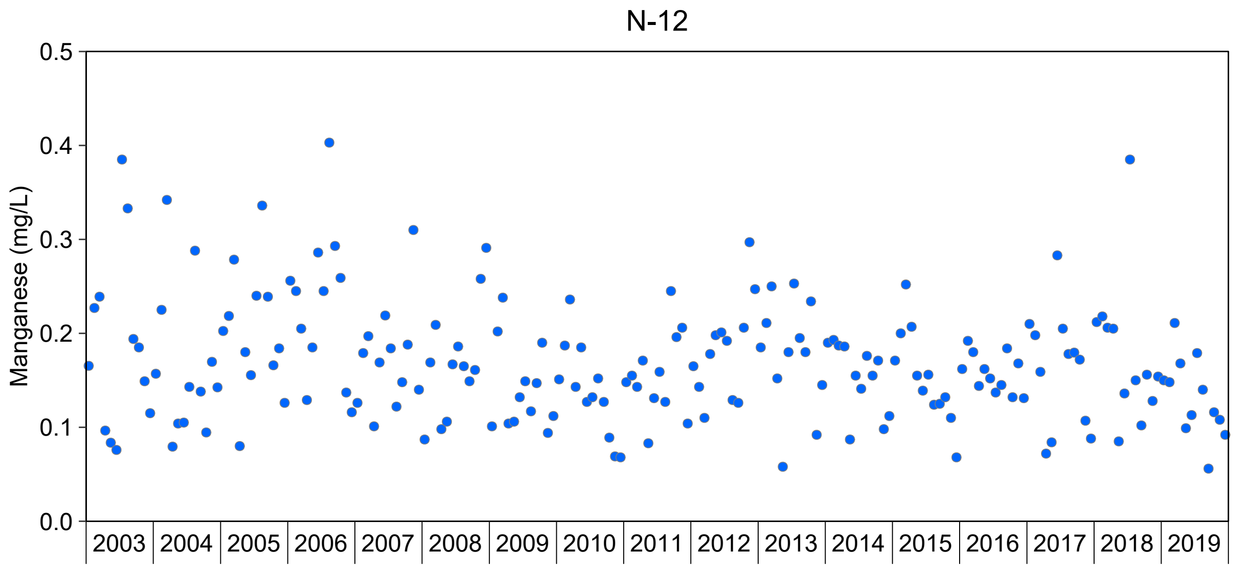


Figure P.4: Concentrations of Manganese for SAMP Water Quality Monitoring Stations in Nordic TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Table P.3 for raw data.

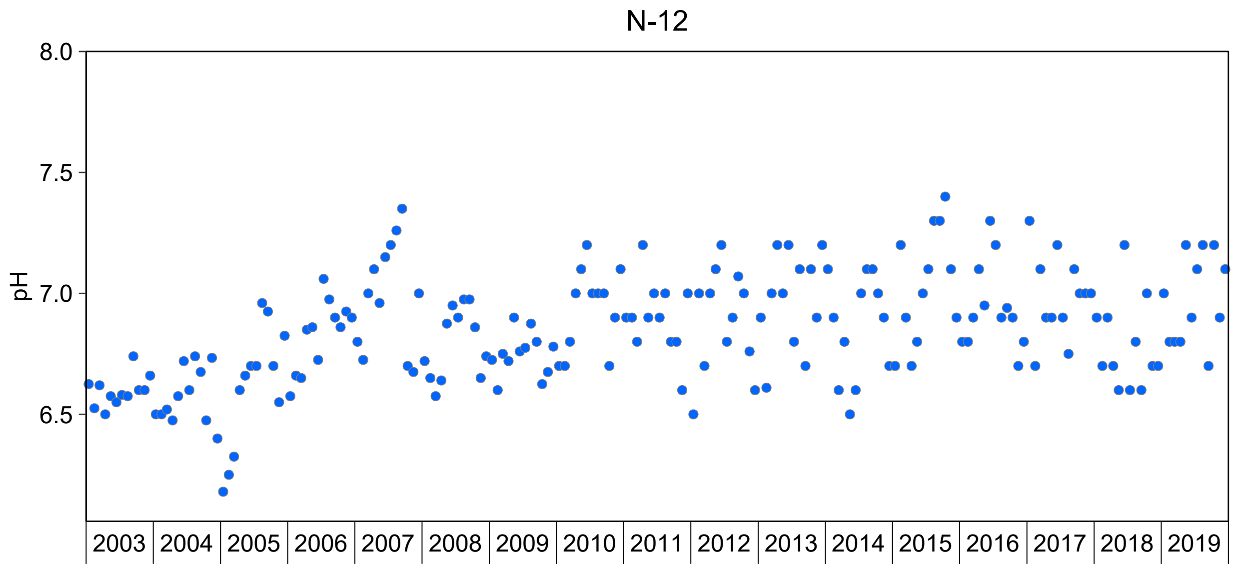


Figure P.5: Field Measurements of pH for SAMP Water Quality Monitoring Stations in Nordic TMA, 2003 to 2019

Notes: See Appendix Table P.3 for raw data.

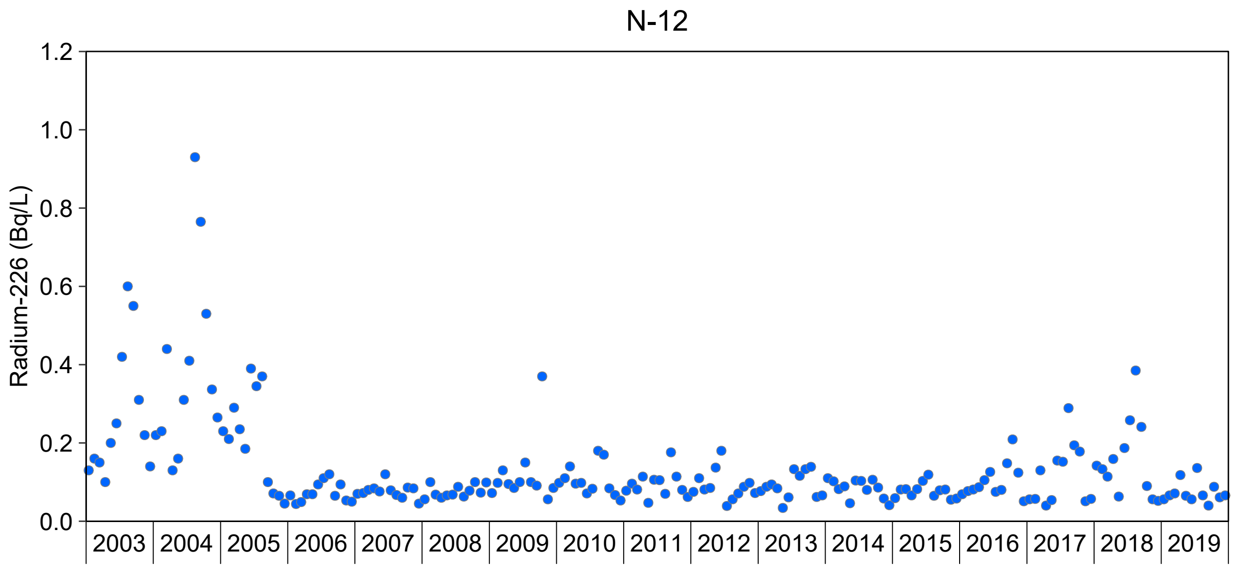


Figure P.6: Concentrations of Radium-226 for SAMP Water Quality Monitoring Stations in Nordic TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL.
See Appendix Table P.3 for raw data.

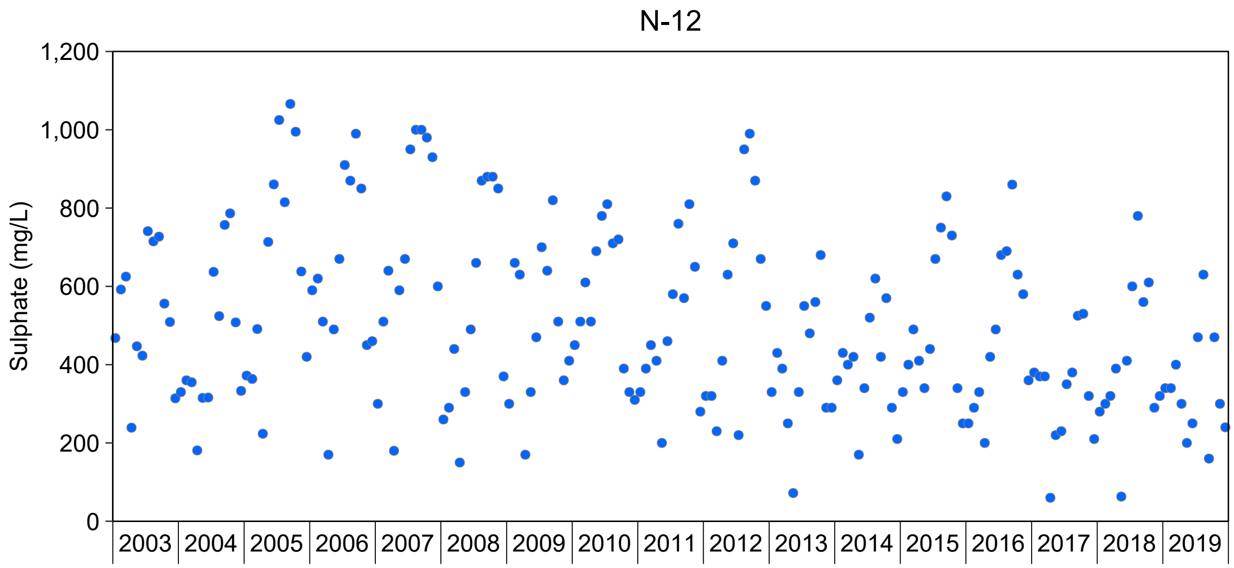


Figure P.7: Concentrations of Sulphate for SAMP Water Quality Monitoring Stations in Nordic TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL.
See Appendix Table P.3 for raw data.

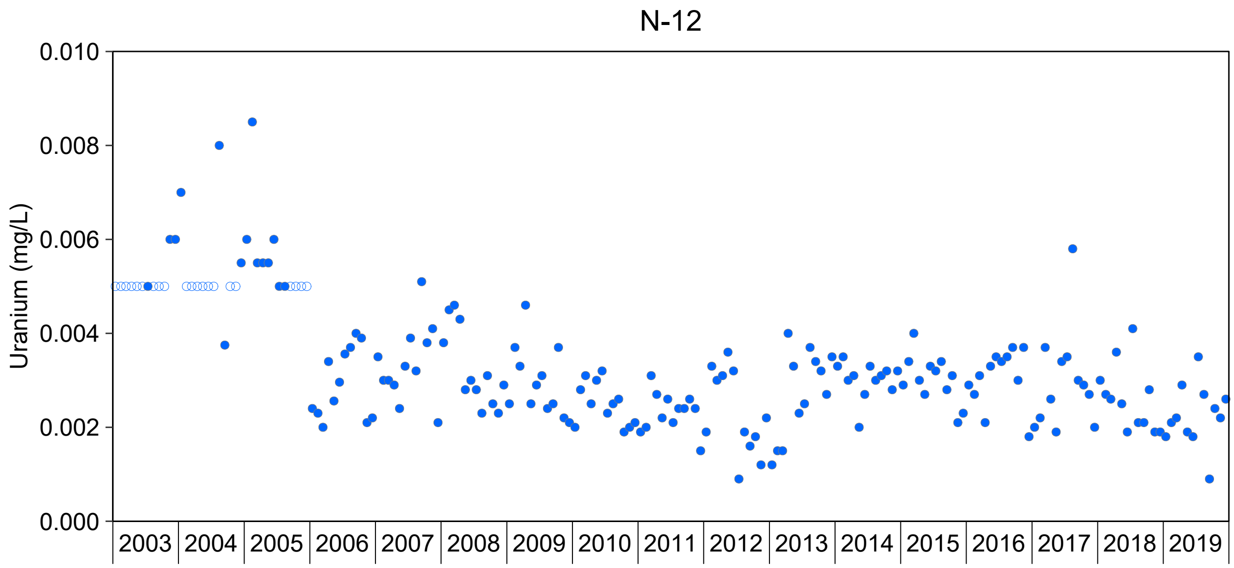


Figure P.8: Concentrations of Uranium for SAMP Water Quality Monitoring Stations in Nordic TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Table P.3 for raw data.

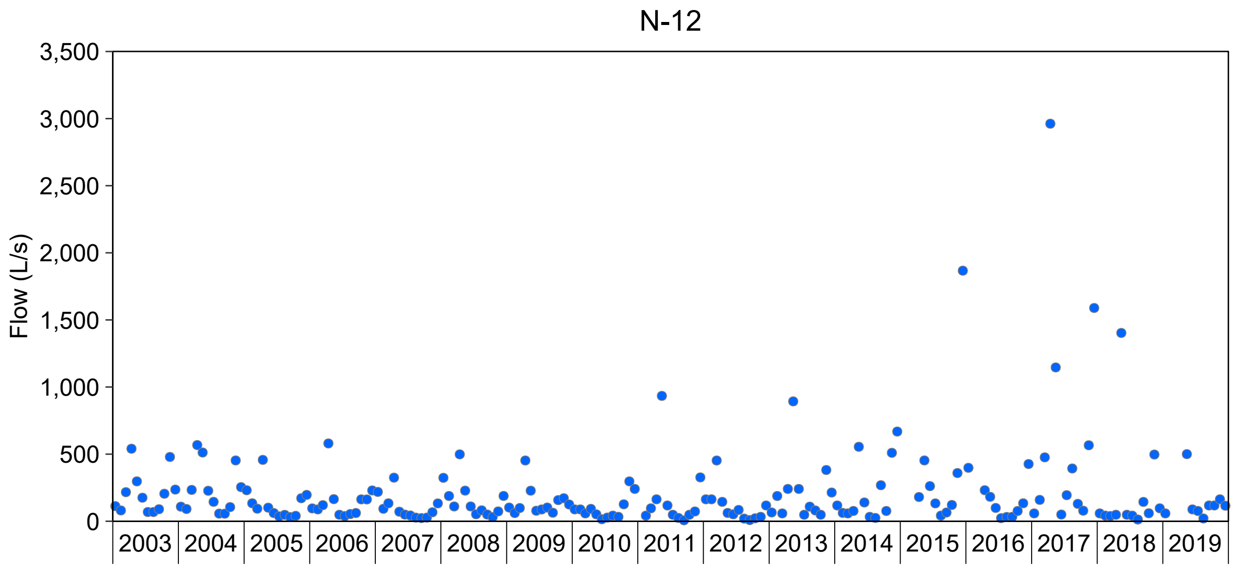
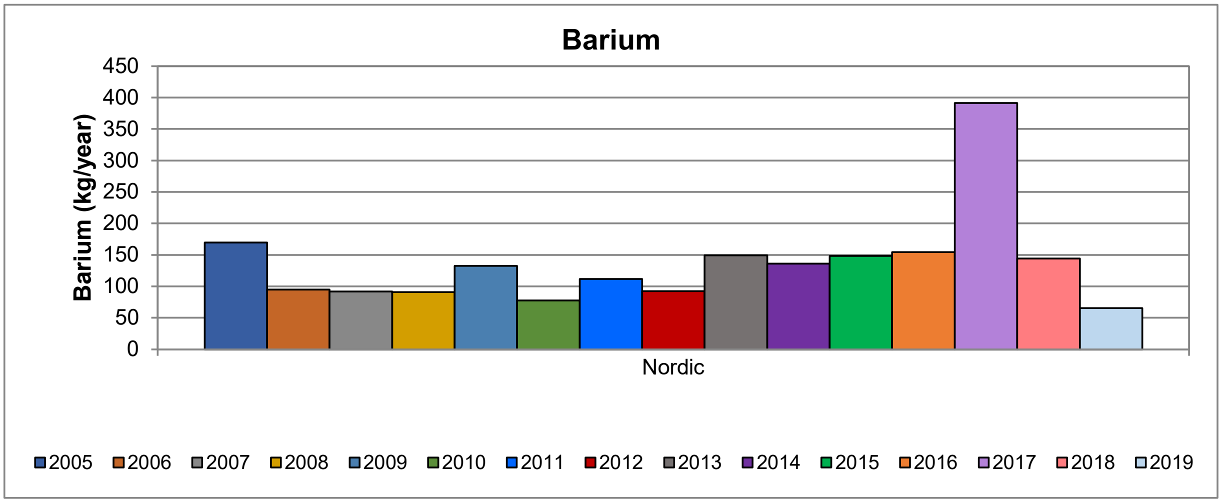
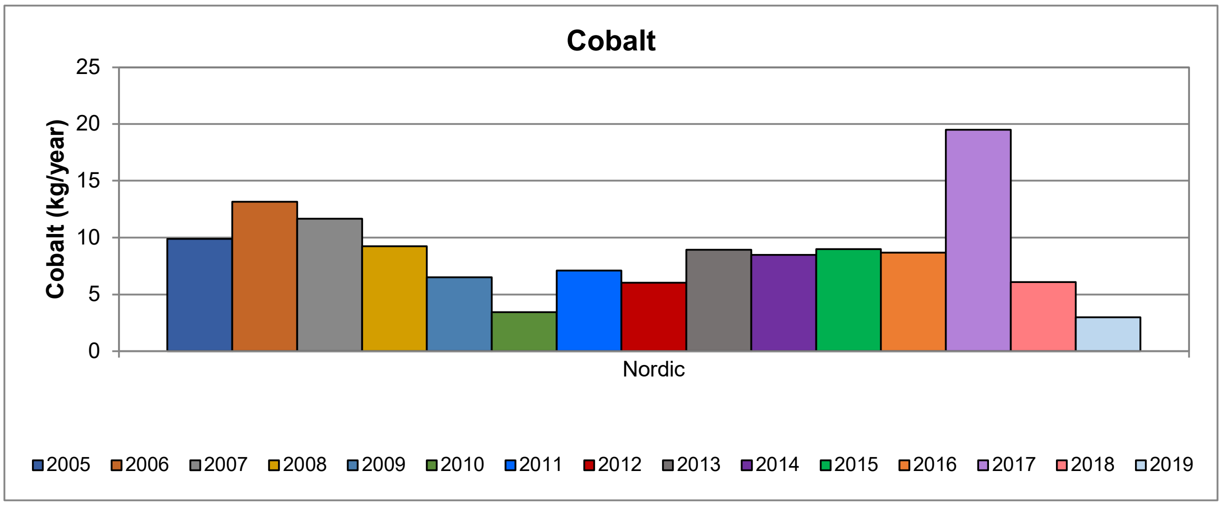


Figure P.9: Flow Monthly Means for SAMP Water Quality Monitoring Stations in Nordic TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Table P.3 for raw data.





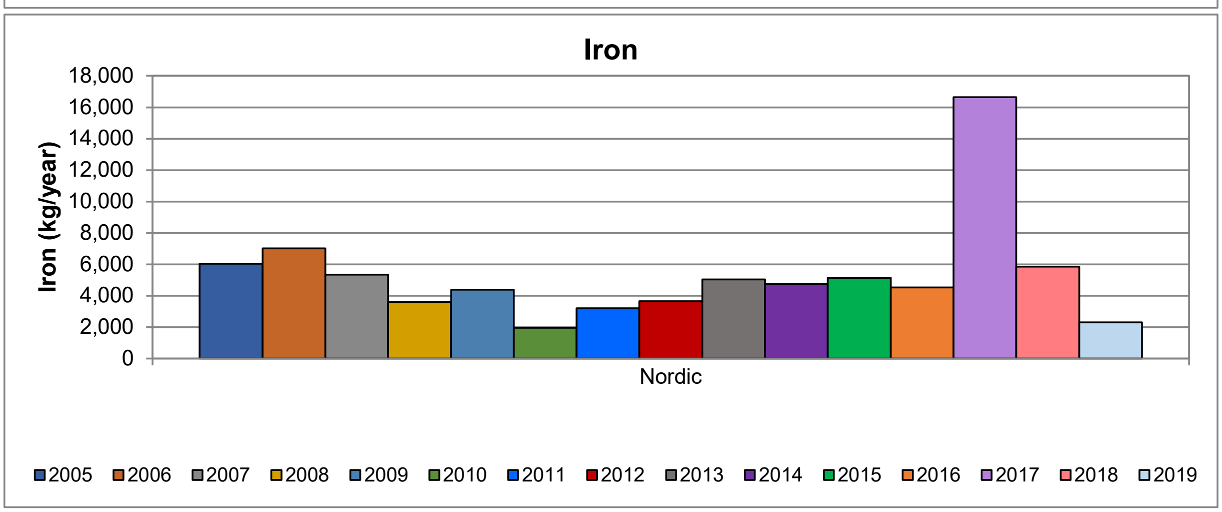
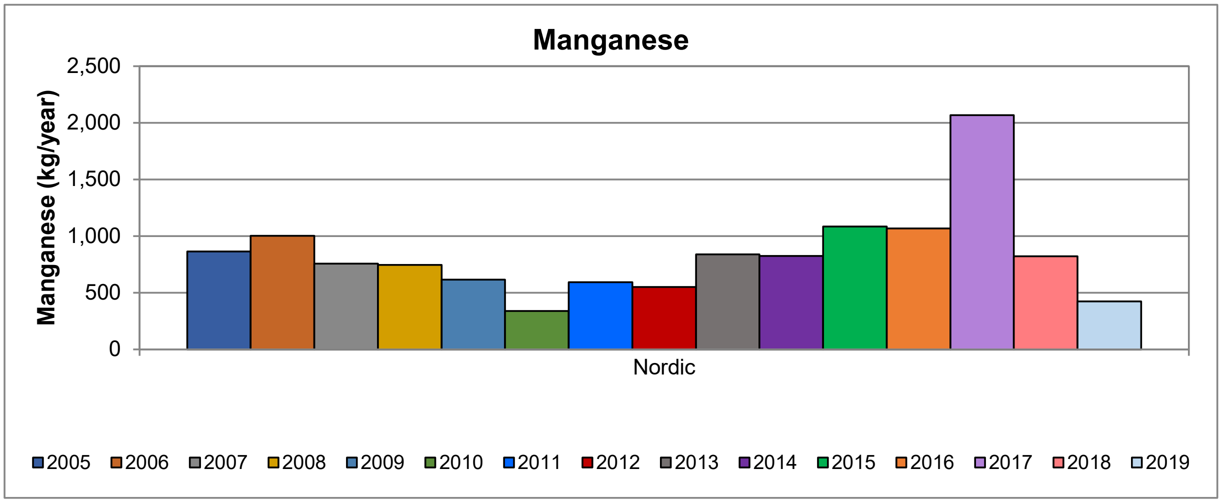
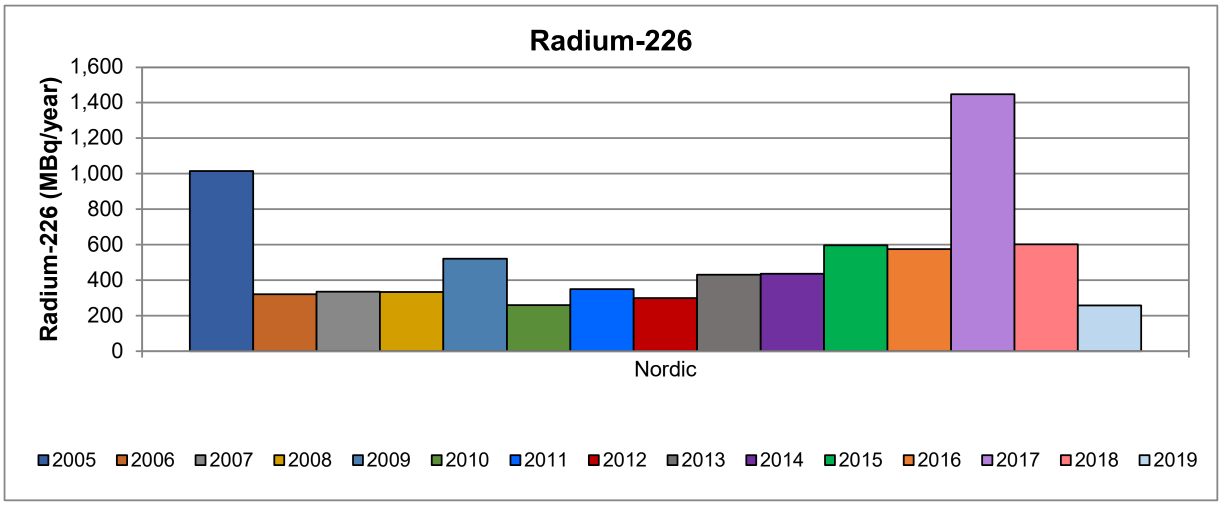


Figure P.10: Annual Loadings from Nordic TMA to the Nordic Lake Watershed, 2005 to 2019

Note: See Appendix Tables P.2 and P.3 for raw data and Appendix Table P.5 for annual discharge and seepage loading rates.





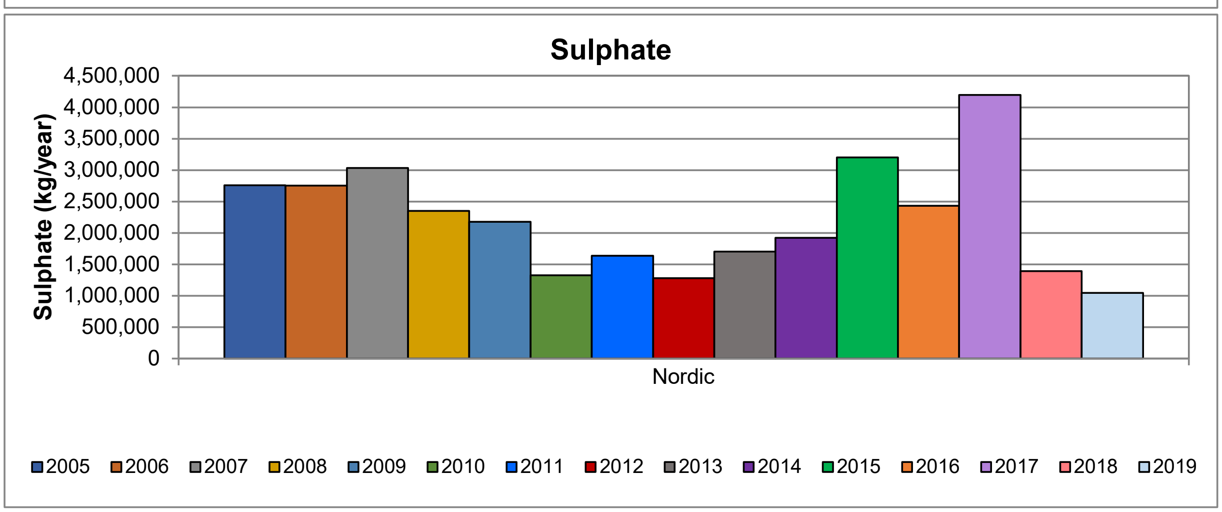


Figure P.10: Annual Loadings from Nordic TMA to the Nordic Lake Watershed, 2005 to 2019

Note: See Appendix Tables P.2 and P.3 for raw data and Appendix Table P.5 for annual discharge and seepage loading rates.

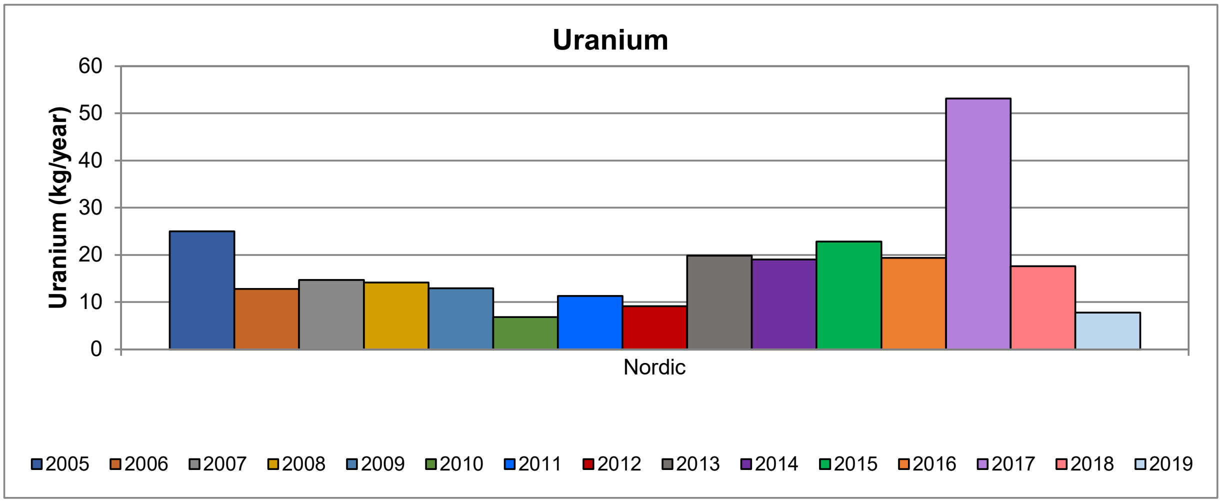


Figure P.10: Annual Loadings from Nordic TMA to the Nordic Lake Watershed, 2005 to 2019

Note: See Appendix Tables P.2 and P.3 for raw data and Appendix Table P.5 for annual discharge and seepage loading rates.

Table P.1: Location of SAMP Data Tables and Figures Within this Cycle 5 SOE Report, Nordic Lake Sub-Watershed

TMA	SAMP Station ID	Type	Description	Also a TOMP or SRWMP Station?	Map Figures	Water Quality Data Tables (barium, cobalt, hardness, iron, manganese, pH, radium-226, sulphate, and/or uranium)	Flow Data Tables	Flow Data Figures	Toxicity Data Tables	Trend Tables	Water Quality / Trend Figures	Loadings Tables	Loadings Figures	Percent Contribution to Loadings Figures	TMA Plant Operations Tables
Nordic	N-12	Principal	Buckles Creek at Highway 108	no	6.1, 7.2	P.3	P.3	P.9	6.7	6.8	P.1 to P.8	P.5	P.10	na-l	P.4

Notes: na-l = percent contribution to loadings is not assessed for this TMA, as either there is only one station, or loadings are only measured at one station.

Table P.2: Water Quality at SAMP Seepage Station WL-4, Located at Seepage to Westner Lake from Coffer Pond, Nordic TMA, 2015 to 2019

Date	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
07-Jan-15	31.7	7.30	22.0	0.00800	0.0160	0.000600	0.130	0.0200	<0.000500
04-Feb-15	31.7	7.00	20.0	0.00900	0.0150	<0.000500	0.150	0.0210	<0.000500
04-Mar-15	-	6.97	-	-	-	-	-	-	-
24-Apr-15	-	7.01	-	-	-	-	-	-	-
06-May-15	26.0	6.54	19.0	0.00800	0.0110	0.000700	0.180	0.0790	<0.000500
03-Jun-15	-	7.11	-	-	-	-	-	-	-
08-Jul-15	-	7.00	-	-	-	-	-	-	-
05-Aug-15	35.2	7.10	25.0	<0.00800	0.0110	<0.000500	0.0900	0.0170	<0.000500
02-Sep-15	-	7.20	-	-	-	-	-	-	-
08-Oct-15	-	7.10	-	-	-	-	-	-	-
04-Nov-15	31.2	7.22	23.0	<0.00800	0.0100	<0.000500	0.0750	0.0120	<0.000500
02-Dec-15	-	7.19	-	-	-	-	-	-	-
n	5	12	5	5	5	5	5	5	5
Minimum	26.0	6.54	19.0	<0.008	0.0100	<0.0005	0.0750	0.0120	<0.0005
Maximum	35.2	7.30	25.0	0.00900	0.0160	0.000700	0.180	0.0790	<0.0005
Mean	31.2	7.06	21.8	0.00820	0.0126	0.000560	0.125	0.0298	<0.0005
SD	3.30	0.194	2.39	0.000490	0.00270	0.0000566	0.0430	0.0277	-
06-Jan-16	-	6.30	-	-	-	-	-	-	-
03-Feb-16	28.6	7.09	20.0	0.0100	0.0130	<0.000500	0.110	0.0120	<0.000500
02-Mar-16	-	7.11	-	-	-	-	-	-	-
06-Apr-16	-	7.12	-	-	-	-	-	-	-
04-May-16	25.1	6.54	17.0	<0.00800	0.0100	<0.000500	0.0810	0.0400	<0.000500
01-Jun-16	-	6.72	-	-	-	-	-	-	-
07-Jul-16	-	7.20	-	-	-	-	-	-	-
03-Aug-16	43.3	7.55	28.0	0.0140	0.0120	<0.000500	0.178	0.0320	<0.000500
07-Sep-16	-	7.37	-	-	-	-	-	-	-
05-Oct-16	-	7.28	-	-	-	-	-	-	-
02-Nov-16	32.7	7.10	22.0	0.00900	0.0100	<0.000500	0.0800	0.0130	<0.000500
07-Dec-16	-	7.10	-	-	-	-	-	-	-
n	4	12	4	4	4	4	4	4	4
Minimum	25.1	6.30	17.0	<0.008	0.0100	<0.0005	0.0800	0.0120	<0.0005
Maximum	43.3	7.55	28.0	0.0140	0.0130	<0.0005	0.178	0.0400	<0.0005
Mean	32.4	7.04	21.8	0.0102	0.0112	<0.0005	0.112	0.0242	<0.0005
SD	7.89	0.353	4.65	0.00252	0.00150	-	0.0460	0.0140	-
04-Jan-17	-	7.10	-	-	-	-	-	-	-
08-Feb-17	37.6	7.00	24.0	0.00700	0.0130	<0.000500	0.0860	0.0100	<0.000500
02-Mar-17	-	6.90	-	-	-	-	-	-	-
05-Apr-17	-	6.90	-	-	-	-	-	-	-
03-May-17	39.0	6.90	26.0	<0.00700	0.0100	<0.000500	0.116	0.0290	<0.000500
07-Jun-17	-	7.40	-	-	-	-	-	-	-
05-Jul-17	-	6.80	-	-	-	-	-	-	-
02-Aug-17	29.0	7.10	20.0	0.0140	0.00900	<0.000500	0.0820	0.0190	<0.000500
06-Sep-17	-	7.10	-	-	-	-	-	-	-
04-Oct-17	-	7.10	-	-	-	-	-	-	-
01-Nov-17	23.2	7.00	18.0	0.0100	0.0100	<0.000500	0.0800	0.0130	<0.000500
06-Dec-17	-	7.00	-	-	-	-	-	-	-
n	4	12	4	4	4	4	4	4	4
Minimum	23.2	6.80	18.0	<0.007	0.00900	<0.0005	0.0800	0.0100	<0.0005
Maximum	39.0	7.40	26.0	0.0140	0.0130	<0.0005	0.116	0.0290	<0.0005
Mean	32.2	7.02	22.0	0.00950	0.0105	<0.0005	0.0910	0.0178	<0.0005
SD	7.45	0.154	3.65	0.00352	0.00173	-	0.0169	0.00838	-
04-Jan-18	-	7.20	-	-	-	-	-	-	-
07-Feb-18	28.9	6.80	17.0	0.0100	0.0120	<0.000500	0.0730	0.0110	<0.000500
07-Mar-18	-	6.90	-	-	-	-	-	-	-
05-Apr-18	-	7.00	-	-	-	-	-	-	-
14-May-18	24.9	6.50	13.0	0.0140	0.0110	0.000500	0.299	0.0930	<0.000500
06-Jun-18	-	7.20	-	-	-	-	-	-	-
05-Jul-18	-	6.90	-	-	-	-	-	-	-
01-Aug-18	31.6	7.30	21.0	0.0210	0.0110	<0.000500	0.306	0.0450	<0.000500
05-Sep-18	-	7.10	-	-	-	-	-	-	-
03-Oct-18	-	7.40	-	-	-	-	-	-	-
07-Nov-18	34.0	7.00	20.0	0.0160	0.0110	<0.000500	0.230	0.0310	<0.000500
05-Dec-18	-	6.70	-	-	-	-	-	-	-
n	4	12	4	4	4	4	4	4	4
Minimum	24.9	6.50	13.0	0.0100	0.0110	<0.0005	0.0730	0.0110	<0.0005
Maximum	34.0	7.40	21.0	0.0210	0.0120	0.000500	0.306	0.0930	<0.0005
Mean	29.8	7.00	17.8	0.0152	0.0112	0.000500	0.227	0.0450	<0.0005
SD	3.90	0.259	3.59	0.00457	0.000500	-	0.108	0.0349	-
02-Jan-19	-	6.60	-	-	-	-	-	-	-
06-Feb-19	31.7	6.60	19.0	<0.00700	0.0140	<0.000500	0.225	0.0170	<0.000500
13-Mar-19	-	6.80	-	-	-	-	-	-	-
03-Apr-19	-	6.70	-	-	-	-	-	-	-

Table P.2: Water Quality at SAMP Seepage Station WL-4, Located at Seepage to Westner Lake from Coffer Pond, Nordic TMA, 2015 to 2019

Date	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
22-May-19	23.8	7.20	14.0	0.0170	0.0100	0.000500	0.229	0.109	<0.000500
05-Jun-19	-	7.20	-	-	-	-	-	-	-
03-Jul-19	-	7.10	-	-	-	-	-	-	-
07-Aug-19	27.6	7.30	15.0	0.0170	0.0120	<0.000500	0.191	0.0830	<0.000500
04-Sep-19	-	7.20	-	-	-	-	-	-	-
02-Oct-19	-	7.40	-	-	-	-	-	-	-
06-Nov-19	37.8	7.20	24.0	0.0140	0.0120	<0.000500	0.180	0.0420	<0.000500
04-Dec-19	-	7.10	-	-	-	-	-	-	-
n	4	12	4	4	4	4	4	4	4
Minimum	23.8	6.60	14.0	<0.007	0.0100	<0.0005	0.180	0.0170	<0.0005
Maximum	37.8	7.40	24.0	0.0170	0.0140	0.000500	0.229	0.109	<0.0005
Mean	30.2	7.03	18.0	0.0138	0.0120	0.000500	0.206	0.0628	<0.0005
SD	5.99	0.281	4.55	0.00184	0.00163	-	0.0244	0.0411	-
Summary Statistics for 2015 to 2019									
n	21	60	21	21	21	21	21	21	21
Minimum	23.2	6.30	13.0	<0.00700	0.00900	<0.000500	0.0730	0.0100	<0.000500
Maximum	43.3	7.55	28.0	0.0210	0.0160	0.000700	0.306	0.109	<0.000500
Mean	31.2	7.03	20.3	0.0111	0.0116	0.000514	0.151	0.0356	<0.000500
SD	5.34	0.250	3.92	0.00426	0.00180	0.0000539	0.0744	0.0299	-
Median	31.6	7.10	20.0	0.0100	0.0110	<0.000500	0.130	0.0210	<0.000500
10th Percentile	24.9	6.65	15.0	<0.00700	0.0100	<0.000500	0.0800	0.0120	<0.000500
95th Percentile	39.0	7.40	26.0	0.0170	0.0150	0.000600	0.299	0.0930	<0.000500

Note: "-" = no data collected or SD was incalculable because there was no variability in the data. n = number of samples. SD = standard deviation.

Table P.3: Water Quality at SAMP Principal Station N-12, Located at Buckles Creek at Hwy. 108, Nordic TMA, 2015 to 2019

Date	Flow (L/s)	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)	Sublethal Toxicity (*Ceriodaphnia dubia*) IC25	Acute Toxicity (*Daphnia magna*) % Mortality	Acute Toxicity (Rainbow Trout) % Mortality
07-Jan-15	-	357	6.70	330	0.0590	0.0210	0.00140	0.830	0.171	0.00290	-	-	-
04-Feb-15	-	451	7.20	400	0.0810	0.0220	0.00160	0.880	0.200	0.00340	-	-	-
04-Mar-15	-	515	6.90	490	0.0820	0.0200	0.00170	0.780	0.252	0.00400	-	-	-
01-Apr-15	180	425	6.70	410	0.0660	0.0200	0.00150	0.960	0.207	0.00300	-	-	-
06-May-15	453	349	6.80	340	0.0820	0.0200	0.00140	0.830	0.155	0.00270	100	0	0
03-Jun-15	262	451	7.00	440	0.103	0.0220	0.00110	0.910	0.139	0.00330	-	-	-
08-Jul-15	133	721	7.10	670	0.119	0.0270	0.00100	0.730	0.156	0.00320	-	-	-
05-Aug-15	41.8	820	7.30	750	0.0650	0.0210	0.000700	0.280	0.124	0.00340	-	-	-
02-Sep-15	65.0	829	7.30	830	0.0790	0.0230	0.000700	0.374	0.125	0.00280	-	-	-
07-Oct-15	121	788	7.40	730	0.0810	0.0230	0.000800	0.491	0.132	0.00310	-	-	-
25-Nov-15	359	383	7.10	340	0.0550	0.0160	0.000900	0.643	0.110	0.00210	100	0	0
16-Dec-15	1,870	268	6.90	250	0.0580	0.0120	0.000800	0.317	0.0680	0.00230	-	-	-
n	9	12	12	12	12	12	12	12	12	12	2	2	2
Minimum	41.8	268	6.70	250	0.0550	0.0120	0.000700	0.280	0.0680	0.00210	100	0	0
Maximum	1,867	829	7.40	830	0.119	0.0270	0.00170	0.960	0.252	0.00400	100	0	0
Mean	387	530	7.03	498	0.0775	0.0206	0.00113	0.669	0.153	0.00302	100	0	0
SD	571	203	0.239	195	0.0190	0.00373	0.000368	0.243	0.0492	0.000513	-	-	-
06-Jan-16	398	331	6.80	250	0.0690	0.0280	0.00110	0.730	0.162	0.00290	-	-	-
03-Feb-16	-	319	6.80	290	0.0770	0.0200	0.00110	0.669	0.192	0.00270	-	-	-
02-Mar-16	-	374	6.90	330	0.0810	0.0240	0.00130	0.650	0.180	0.00310	-	-	-
13-Apr-16	231	228	7.10	200	0.0870	0.0190	0.00210	0.951	0.144	0.00210	-	-	-
04-May-16	241	510	7.10	420	0.105	0.0260	0.00200	0.455	0.162	0.00330	100	0	0
11-May-16	123	-	6.80	-	-	-	-	0.502	-	-	-	-	-
01-Jun-16	99.1	524	7.30	490	0.126	0.0270	0.00110	0.581	0.152	0.00350	-	-	-
06-Jul-16	23.0	768	7.20	680	0.0750	0.0240	0.000800	0.246	0.137	0.00340	-	-	-
03-Aug-16	31.7	868	6.90	690	0.0800	0.0280	0.000800	0.324	0.145	0.00350	-	-	-
07-Sep-16	32.8	842	6.94	860	0.148	0.0270	0.00200	0.775	0.184	0.00370	-	-	-
04-Oct-16	76.3	692	6.90	630	0.209	0.0390	0.00140	0.822	0.132	0.00300	100	0	0
02-Nov-16	134	597	6.70	580	0.124	0.0250	0.00140	1.06	0.168	0.00370	-	-	-
07-Dec-16	426	404	6.80	360	0.0510	0.0160	0.00110	0.626	0.131	0.00180	-	-	-
n	11	12	13	12	12	12	12	13	12	12	2	2	2
Minimum	23.0	228	6.70	200	0.0510	0.0160	0.000800	0.246	0.131	0.00180	100	0	0
Maximum	426	868	7.30	860	0.209	0.0390	0.00210	1.06	0.192	0.00370	100	0	0
Mean	165	538	6.94	482	0.103	0.0252	0.00135	0.645	0.157	0.00306	100	0	0
SD	142	216	0.180	206	0.0435	0.00577	0.000454	0.232	0.0207	0.000607	-	-	-
04-Jan-17	58.3	454	7.30	380	0.0560	0.0220	0.00140	0.978	0.210	0.00200	-	-	-
08-Feb-17	159	442	6.70	370	0.0570	0.0200	0.00130	0.795	0.198	0.00220	-	-	-
01-Mar-17	476	475	7.10	370	0.130	0.0280	0.00160	1.15	0.159	0.00370	-	-	-
05-Apr-17	2,960	80.7	6.90	60.0	0.0400	0.0150	0.000900	0.759	0.0720	0.00260	-	-	-
03-May-17	1,150	276	6.90	220	0.0540	0.0160	0.000800	0.440	0.0840	0.00190	100	0	0
14-Jun-17	49.8	265	7.20	230	0.155	0.0460	0.00130	1.84	0.283	0.00340	-	-	-

Table P.3: **Water Quality at SAMP Principal Station N-12, Located at Buckles Creek at Hwy. 108, Nordic TMA, 2015 to 2019**

Date	Flow (L/s)	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)	Sublethal Toxicity (*Ceriodaphnia dubia*) IC25	Acute Toxicity (*Daphnia magna*) % Mortality	Acute Toxicity (Rainbow Trout) % Mortality
12-Jul-17	194	383	6.90	350	0.152	0.0300	0.00110	1.89	0.205	0.00350	-	-	-
02-Aug-17	153	496	6.90	430	0.409	0.0570	0.00160	4.36	0.213	0.00800	-	-	-
22-Aug-17	633	401	6.60	330	0.169	0.0410	0.00120	1.88	0.143	0.00360	-	-	-
06-Sep-17	162	494	7.10	460	0.219	0.0430	0.000900	1.36	0.140	0.00290	-	-	-
27-Sep-17	97.1	624	7.10	590	0.169	0.0390	0.00100	1.30	0.219	0.00310	-	-	-
04-Oct-17	78.6	350	7.00	530	0.178	0.0450	0.000900	1.41	0.172	0.00290	-	-	-
01-Nov-17	566	295	7.00	320	0.0510	0.0140	0.000800	0.504	0.107	0.00270	100	0	0
06-Dec-17	1,590	240	7.00	210	0.0570	0.0150	0.000800	0.576	0.0880	0.00200	-	-	-
n	14	14	14	14	14	14	14	14	14	14	2	2	2
Minimum	49.8	80.7	6.60	60.0	0.0400	0.0140	0.000800	0.440	0.0720	0.00190	100	0	0
Maximum	2,962	624	7.30	590	0.409	0.0570	0.00160	4.36	0.283	0.00800	100	0	0
Mean	595	377	6.98	346	0.135	0.0308	0.00111	1.37	0.164	0.00318	100	0	0
SD	820	138	0.185	138	0.0992	0.0143	0.000288	0.994	0.0617	0.00152	-	-	-
03-Jan-18	58.3	323	6.90	280	0.142	0.0410	0.00120	1.18	0.212	0.00300	-	-	-
08-Feb-18	41.8	421	6.70	300	0.133	0.0340	0.00120	1.29	0.218	0.00270	-	-	-
07-Mar-18	38.8	494	6.90	320	0.114	0.0350	0.00120	1.51	0.206	0.00260	-	-	-
04-Apr-18	48.2	436	6.70	390	0.159	0.0460	0.00130	2.86	0.205	0.00360	-	-	-
02-May-18	1,400	88.3	6.60	63.0	0.0630	0.0160	0.000700	0.582	0.0850	0.00250	100	0	0
06-Jun-18	48.2	520	7.20	410	0.187	0.0370	0.000900	0.780	0.136	0.00190	-	-	-
05-Jul-18	41.6	717	6.60	600	0.258	0.0360	0.00250	2.56	0.385	0.00410	-	-	-
01-Aug-18	12.7	761	6.80	780	0.385	0.0410	0.00140	1.42	0.150	0.00210	-	-	-
05-Sep-18	144	708	6.60	560	0.241	0.0290	0.000800	0.809	0.102	0.00210	-	-	-
03-Oct-18	59.5	644	7.00	610	0.0900	0.0250	0.00110	0.830	0.156	0.00280	-	-	-
07-Nov-18	497	385	6.70	290	0.0560	0.0180	0.000900	1.03	0.128	0.00190	100	0	0
10-Dec-18	96.3	344	6.70	320	0.0520	0.0170	0.000800	0.761	0.154	0.00190	-	-	-
n	12	12	12	12	12	12	12	12	12	12	2	2	2
Minimum	12.7	88.3	6.60	63.0	0.0520	0.0160	0.000700	0.582	0.0850	0.00190	100	0	0
Maximum	1,403	761	7.20	780	0.385	0.0460	0.00250	2.86	0.385	0.00410	100	0	0
Mean	207	487	6.78	410	0.157	0.0312	0.00117	1.30	0.178	0.00260	100	0	0
SD	398	197	0.185	194	0.0988	0.0102	0.000475	0.720	0.0784	0.000703	-	-	-
02-Jan-19	58.3	374	7.00	340	0.0560	0.0200	0.000900	0.834	0.150	0.00180	-	-	-
07-Feb-19	-	404	6.80	340	0.0660	0.0230	0.00110	0.957	0.148	0.00210	-	-	-
13-Mar-19	-	446	6.80	400	0.0710	0.0200	0.00130	1.04	0.211	0.00220	-	-	-
03-Apr-19	-	366	6.80	300	0.118	0.0290	0.00150	1.11	0.168	0.00290	-	-	-
08-May-19	500	241	7.20	200	0.0650	0.0140	0.000900	0.427	0.0990	0.00190	100	0	0
05-Jun-19	88.2	297	6.90	250	0.0560	0.0180	0.000700	0.612	0.113	0.00180	-	-	-
03-Jul-19	76.5	515	7.10	470	0.136	0.0290	0.00100	1.03	0.179	0.00350	-	-	-
07-Aug-19	20.7	647	7.20	630	0.0660	0.00700	<0.000500	0.320	0.140	0.00270	-	-	-
12-Sep-19	117	191	6.70	160	0.0400	0.0110	<0.000500	0.536	0.0560	0.000900	-	-	-
02-Oct-19	117	601	7.20	470	0.0880	0.0260	0.000600	0.644	0.116	0.00240	-	-	-
06-Nov-19	163	328	6.90	300	0.0610	0.0150	0.000700	0.692	0.108	0.00220	100	0	0

Table P.3: Water Quality at SAMP Principal Station N-12, Located at Buckles Creek at Hwy. 108, Nordic TMA, 2015 to 2019

Date	Flow (L/s)	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)	Sublethal Toxicity (*Ceriodaphnia dubia*) IC25	Acute Toxicity (*Daphnia magna*) % Mortality	Acute Toxicity (Rainbow Trout) % Mortality
04-Dec-19	116	252	7.10	240	0.0660	0.0190	0.000500	0.596	0.0920	0.00260	-	-	-
n	9	12	12	12	12	12	12	12	12	12	2	2	2
Minimum	20.7	191	6.70	160	0.0400	0.00700	<0.0005	0.320	0.0560	0.000900	100	0	0
Maximum	500	647	7.20	630	0.136	0.0290	0.00150	1.11	0.211	0.00350	100	0	0
Mean	140	388	6.98	342	0.0741	0.0192	0.000850	0.733	0.132	0.00225	100	0	0
SD	141	143	0.182	133	0.0274	0.00685	0.000332	0.258	0.0427	0.000654	-	-	-
Summary Statistics for 2015 to 2019													
n	55	62	63	62	62	62	62	63	62	62	10	10	10
Minimum	12.7	80.7	6.60	60.0	0.0400	0.00700	<0.000500	0.246	0.0560	0.000900	100	0	0
Maximum	2,960	868	7.40	860	0.409	0.0570	0.00250	4.36	0.385	0.00800	100	0	0
Mean	316	461	6.94	413	0.110	0.0256	0.00112	0.953	0.157	0.00283	100	0	0
SD	532	188	0.206	182	0.0738	0.0102	0.000406	0.664	0.0547	0.000945	-	-	-
Median	121	430	6.90	370	0.0810	0.0230	0.00110	0.795	0.151	0.00280	100	0	0
10th Percentile	38.8	252	6.70	220	0.0550	0.0150	0.000700	0.427	0.0920	0.00190	100	0	0
95th Percentile	1,590	820	7.30	750	0.241	0.0450	0.00200	1.89	0.219	0.00370	100	0	0

Note: "-" = no data collected or SD was incalculable because there was no variability in the data. n = number of samples. SD = standard deviation.

Table P.4: Summary of Annual Plant Operations and Discharge at Nordic TMA, 2015 to 2019

ITEM	2015	2016	2017	2018	2019
PLANT OPERATIONS[a]					
Operating Days	365	366	365	365	365
Maximum Daily Plant Flow (L/s @ N-17)	725	626	587	221	700
Minimum Daily Plant Flow (L/s @ N-17)	11	18	25	12	28
Monthly Average Daily Plant Flow (L/s @ N-17)	71	54	74	47	79
Total Volume Treated (ML)	2,247	1,695	2,349	1,475	2,477
Barium Chloride Consumption					
Total (kg/year)	0	0	0	0	0
Monthly Average (mg/L)	0.000	0.000	0.000	0.000	0.000
Lime Consumption					
Total (ton/year)	825.9	657.3	788.72	608.4	671.4
Monthly Average (g/L)	0.3676	0.3878	0.3358	0.4126	0.2710
EFFLUENT[b]					
Discharge Days	365	366	365	365	365
Maximum Daily Discharge Flow (L/s @ N-19)	380	333.2	587	221	700
Minimum Daily Discharge Flow (L/s @ N-19)	19	20	25	12	28
Monthly Average Daily Discharge Flow (L/s @ N-19)	67	52	74	47	79
Total Annual Volume Discharged (ML)	2,120	1,641	2,349	1,474	2,477

Note: See Appendix Table I.14 (station N-17) for detailed reagent data.

[a] Influent flows based on daily monitoring requirements as per TOMP.

[b] Effluent flows based on weekly monitoring requirement as per SAMP.

Table P.5: Annual Discharge and Seepage Loadings from Lancor and Nordic TMAs to the Nordic Lake Sub-Watershed, 2015 to 2019

Station	Drainage Type	Year	Annual Discharge (m^3)	Barium (kg/year)	Cobalt (kg/yr)	Iron (kg/yr)	Manganese (kg/yr)	Radium (MBq/yr)	Sulphate (kg/yr)	Uranium (kg/yr)
N-12	Combined Site Discharge to Nordic Lake	2015	8,201,961	148	9.0	5,145	1,083	597	3,204,358	22.8
		2016	7,008,924	154	8.69	4,547	1,068	576	2,433,528	19.4
		2017	20,720,085	392	19.5	16,642	2,067	1,448	4,194,279	53.1
		2018	7,391,477	144	6.09	5,870	820	602	1,392,566	17.6
		2019	3,594,534	65.6	2.99	2,311	421	258	1,047,326	7.74
		Mean	9,383,396	181	9.3	6,903	1,092	696	2,454,411	24.1
		SD	6,577,102	123	6.21	5,604	607	444	1,293,967	17.1
SR-08	Outlet of Nordic Lake	2015	13,458,398	251	-	956	498	398	2,196,516	11.9
		2016	11,833,186	199	-	759	428	356	1,874,103	10.6
		2017	19,797,581	341	-	870	734	536	3,003,622	19.0
		2018	13,984,813	267	-	1,154	934	393	1,946,747	9.58
		2019	21,966,575	409	-	698	1,073	679	3,031,861	14.85
		Mean	16,208,111	293	-	887	734	472	2,410,570	13.2
		SD	4,407,044	82.1	-	179	276	134.5	567,111	3.81

Notes: MBq/yr = Million Bequerels per year. Values below LRL were substituted at the LRL for calculations. "-" indicates parameter not measured, as per study design. See Appendix Tables P.3 and S.19 for raw data.

APPENDIX Q
NEARSHORE LAKE HURON SAMP DATA

Pronto TMA

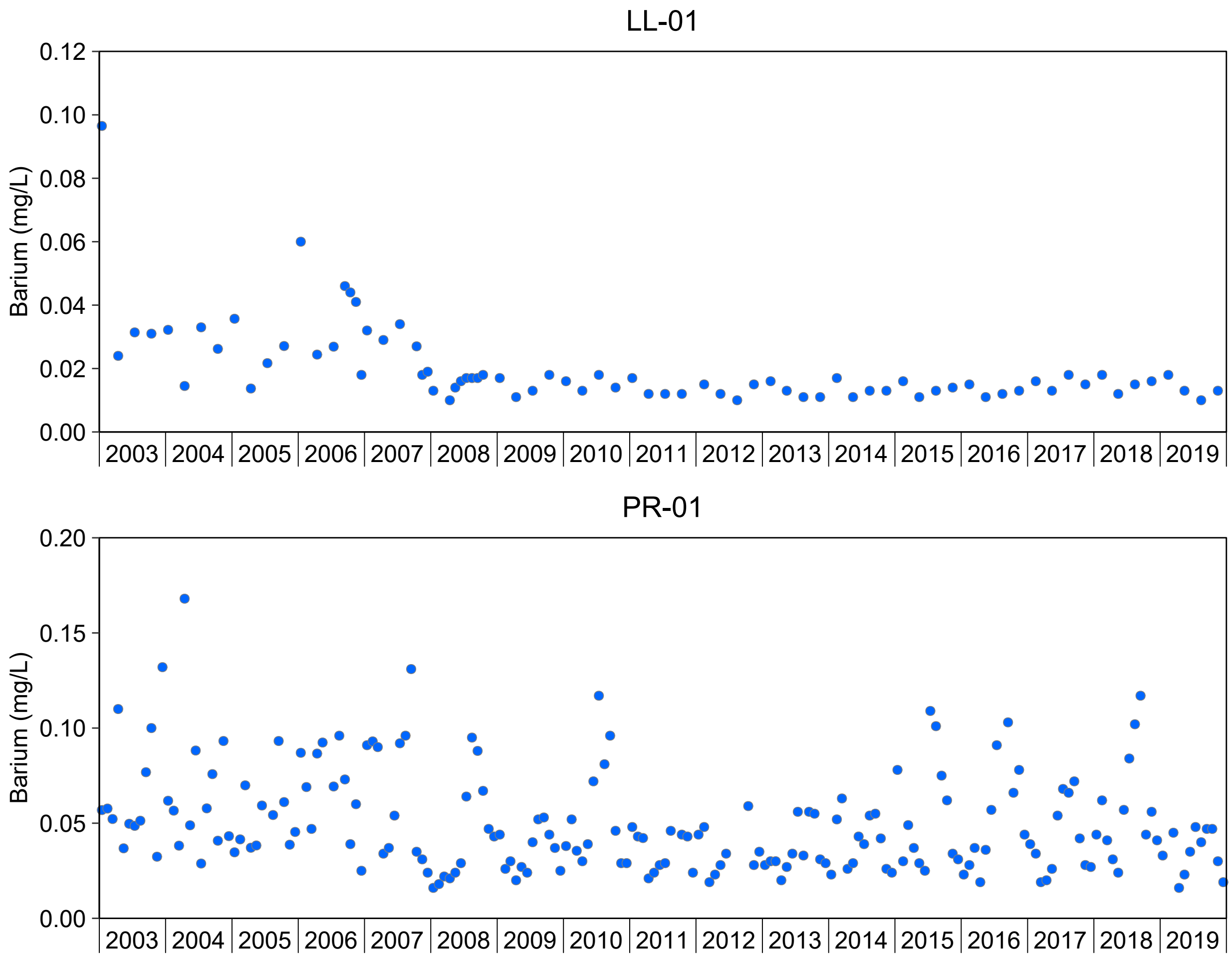


Figure Q.1: Concentrations of Barium for SAMP Water Quality Monitoring Stations in Pronto TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL.
See Appendix Tables Q.2 and Q.3 for raw data.

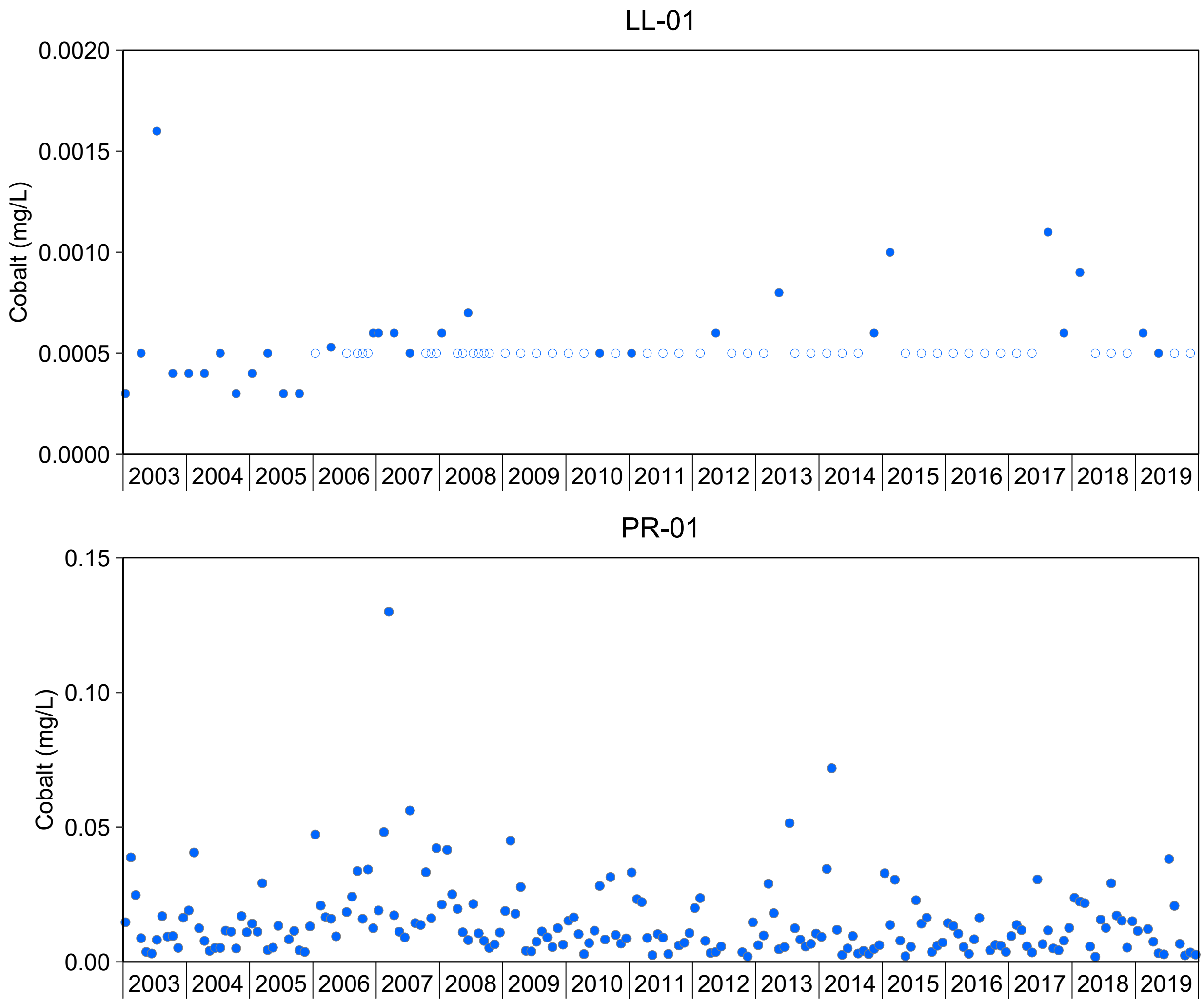


Figure Q.2: Concentrations of Cobalt for SAMP Water Quality Monitoring Stations in Pronto TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Cobalt (mg/L) is not included in the trend analysis for SAMP station LL-01 due to >50% non-detectable concentrations in the dataset. See Appendix Tables Q.2 and Q.3 for raw data.

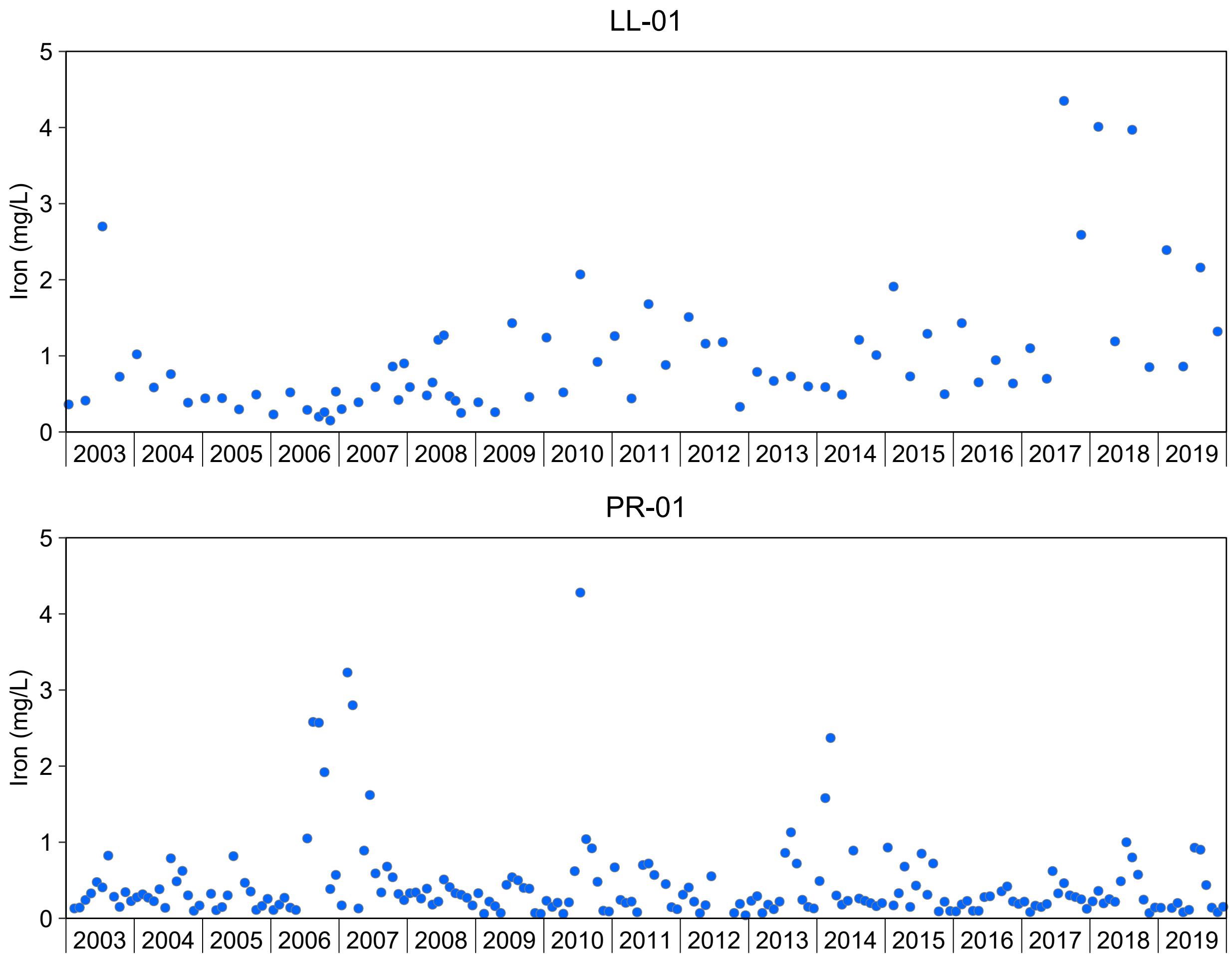


Figure Q.3: Concentrations of Iron for SAMP Water Quality Monitoring Stations in Pronto TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Tables Q.2 and Q.3 for raw data.

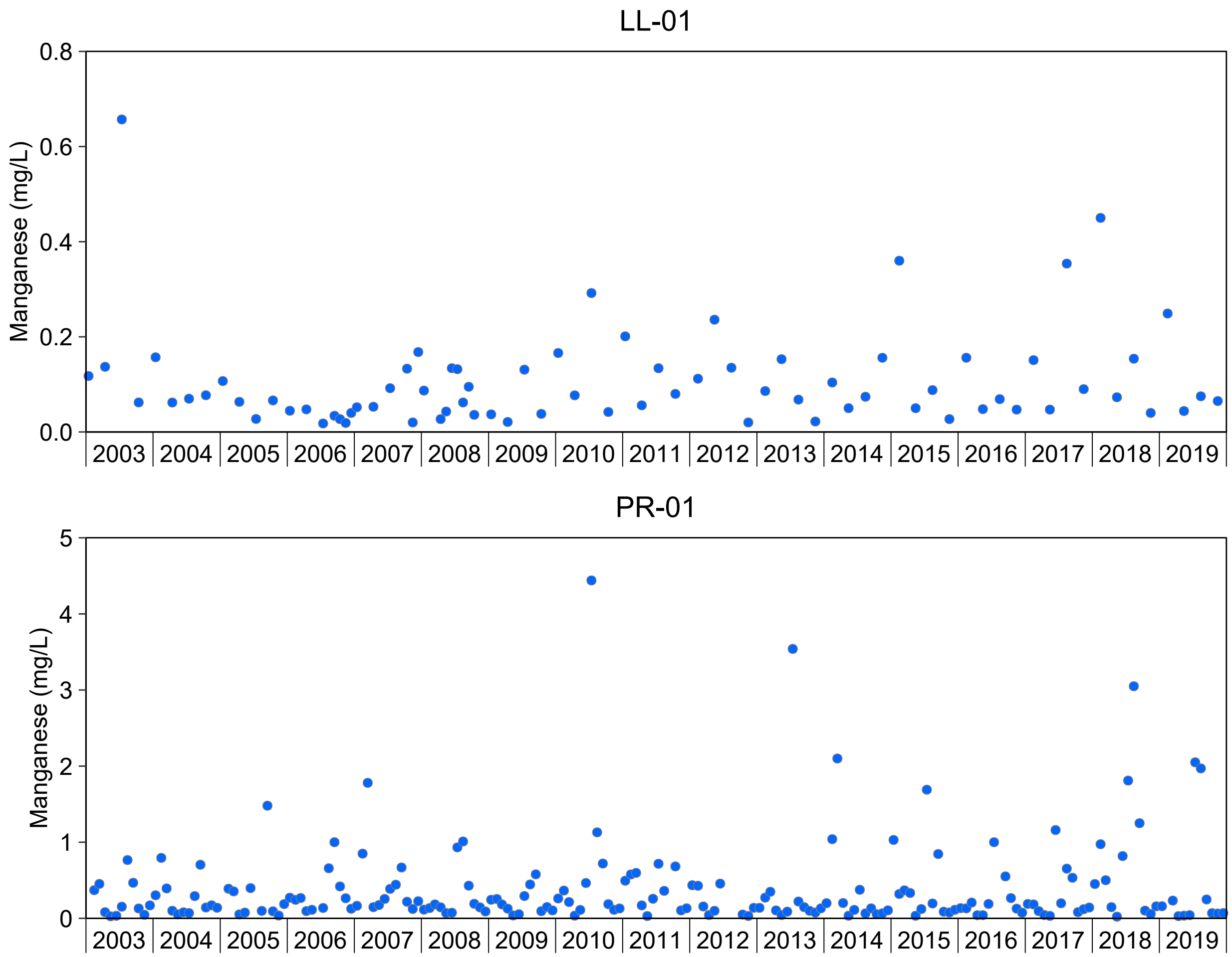


Figure Q.4: Concentrations of Manganese for SAMP Water Quality Monitoring Stations in Pronto TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Tables Q.2 and Q.3 for raw data.

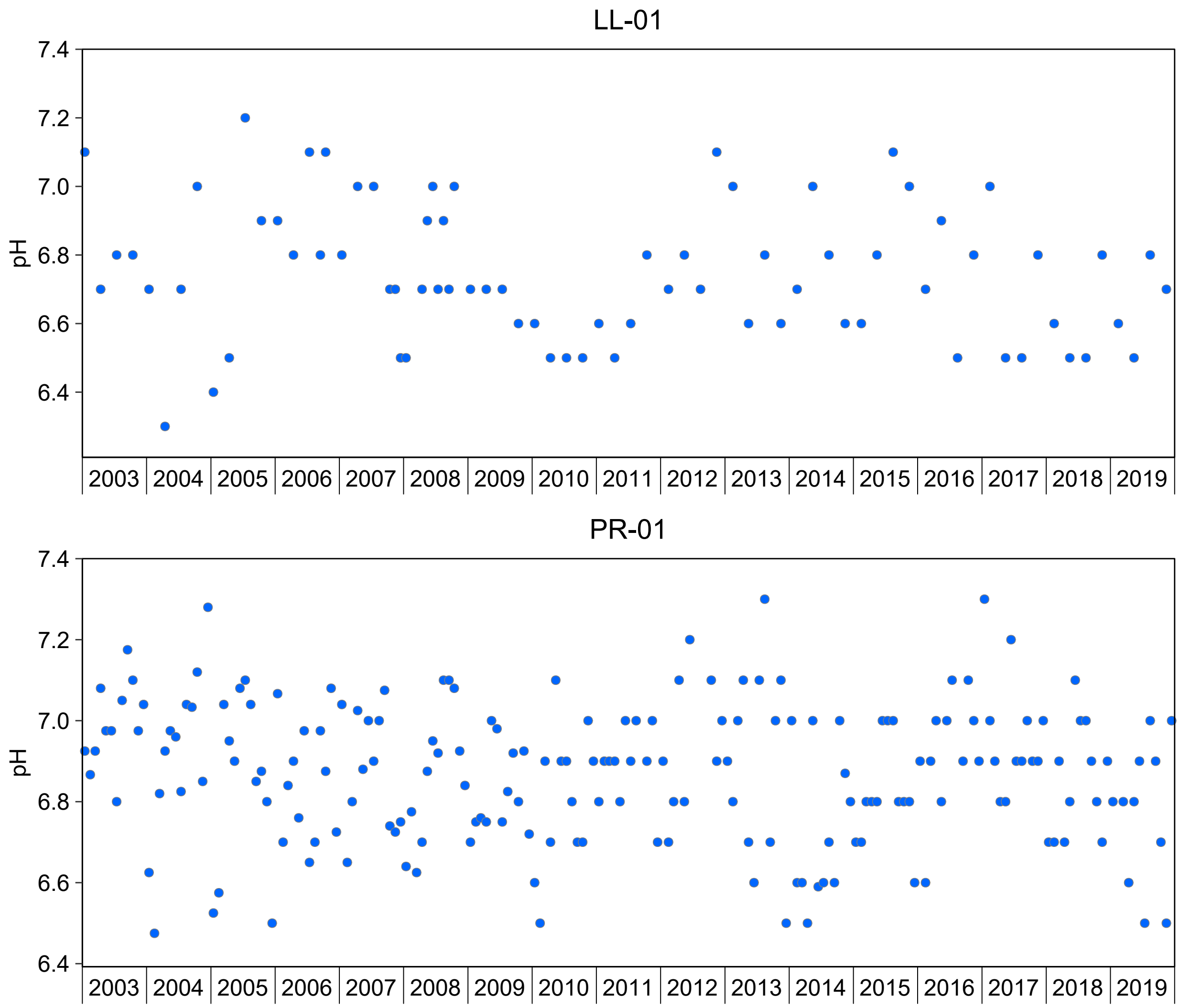


Figure Q.5: Field Measurements of pH for SAMP Water Quality Monitoring Stations in Pronto TMA, 2003 to 2019

Notes: See Appendix Tables Q.2 and Q.3 for raw data.

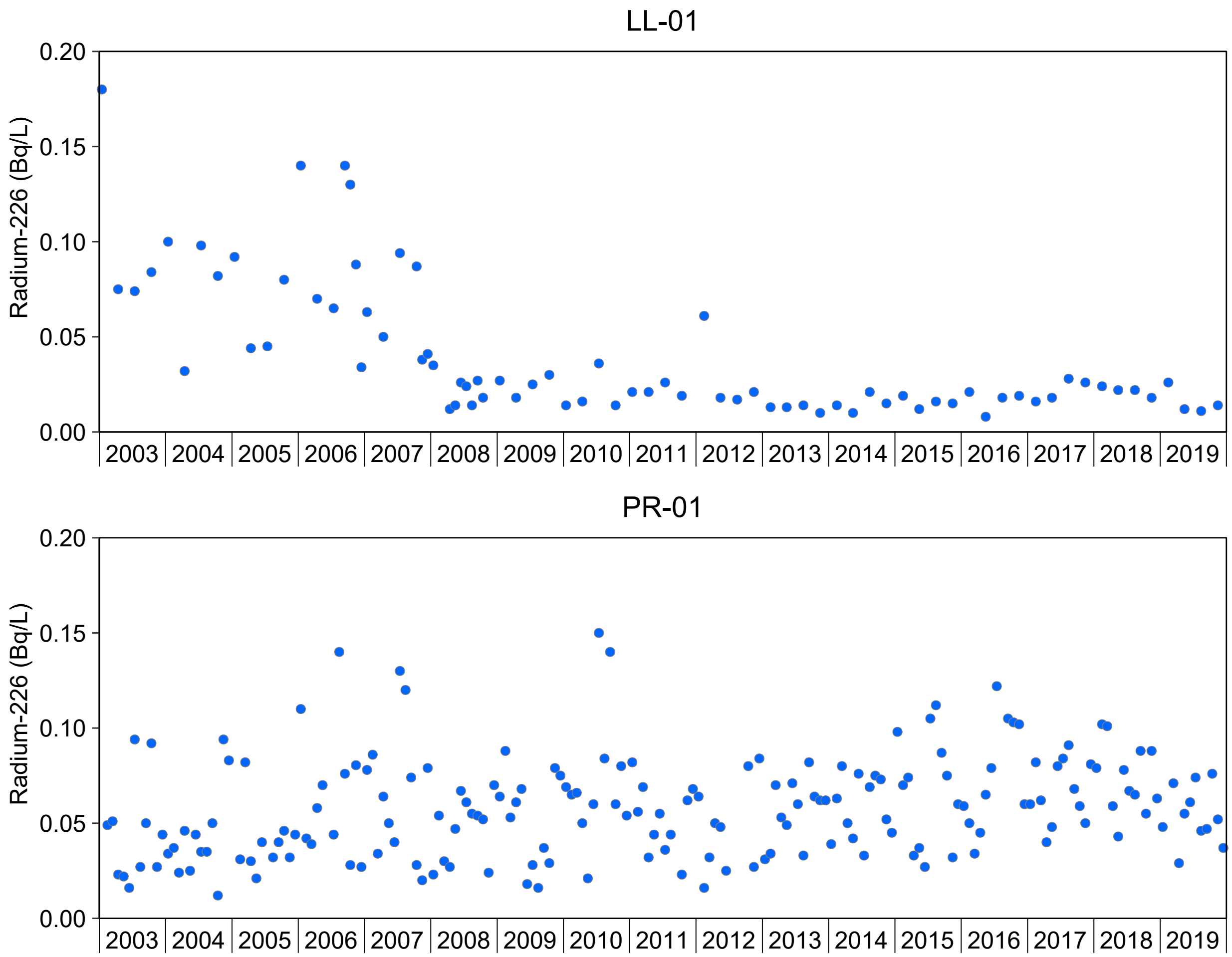


Figure Q.6: Concentrations of Radium-226 for SAMP Water Quality Monitoring Stations in Pronto TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL.
See Appendix Tables Q.2 and Q.3 for raw data.

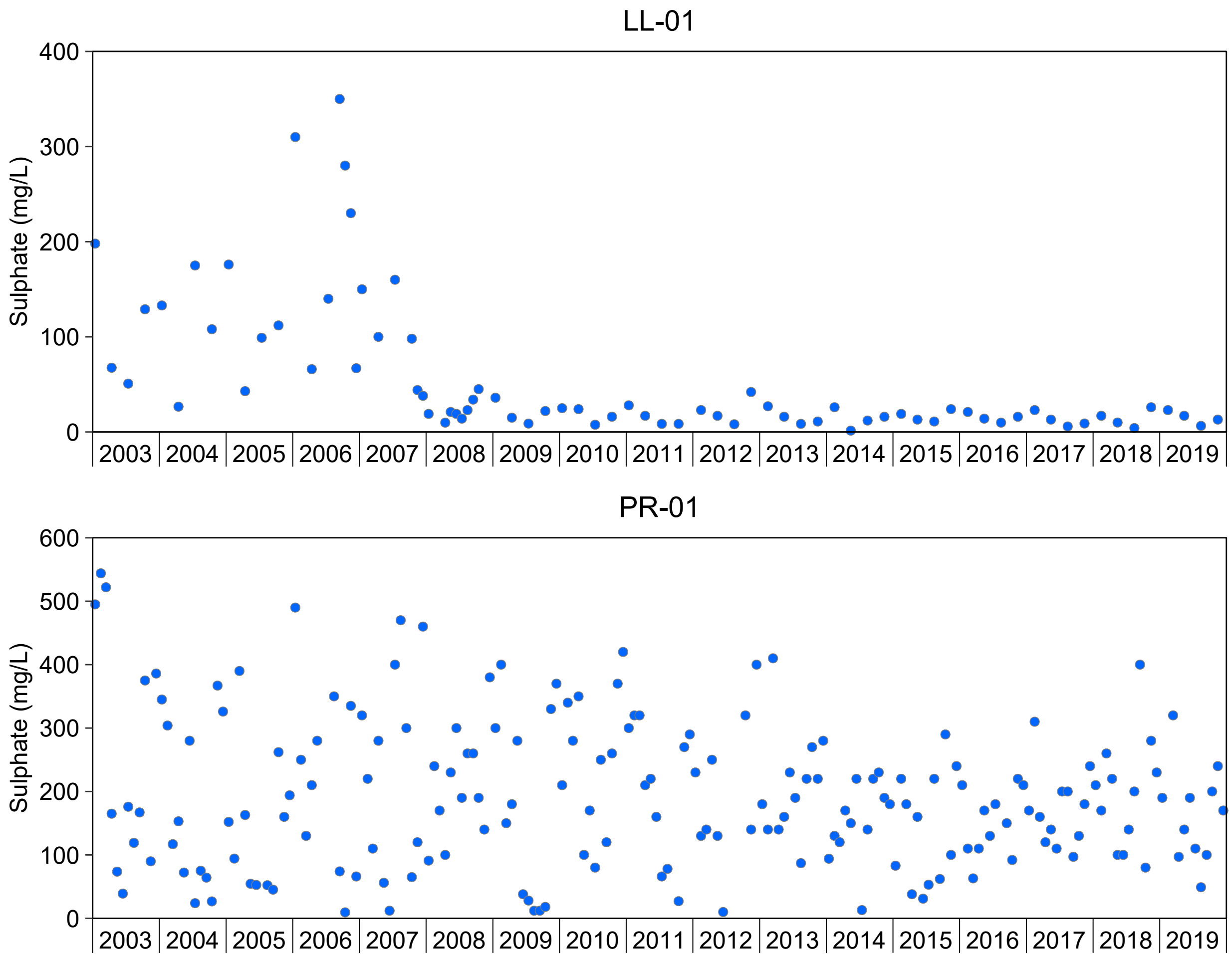


Figure Q.7: Concentrations of Sulphate for SAMP Water Quality Monitoring Stations in Pronto TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL.
See Appendix Tables Q.2 and Q.3 for raw data.

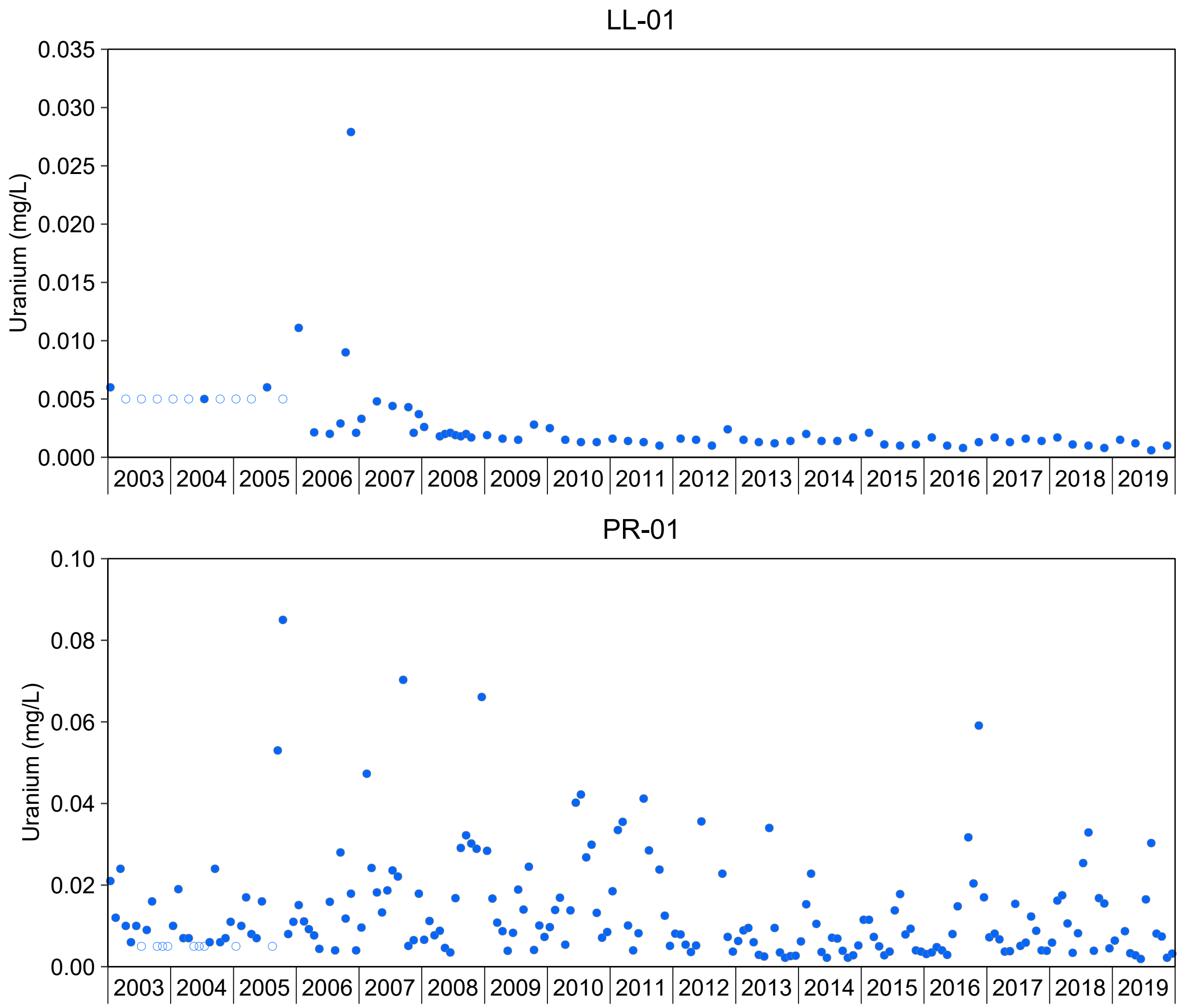


Figure Q.8: Concentrations of Uranium for SAMP Water Quality Monitoring Stations in Pronto TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. See Appendix Tables Q.2 and Q.3 for raw data.

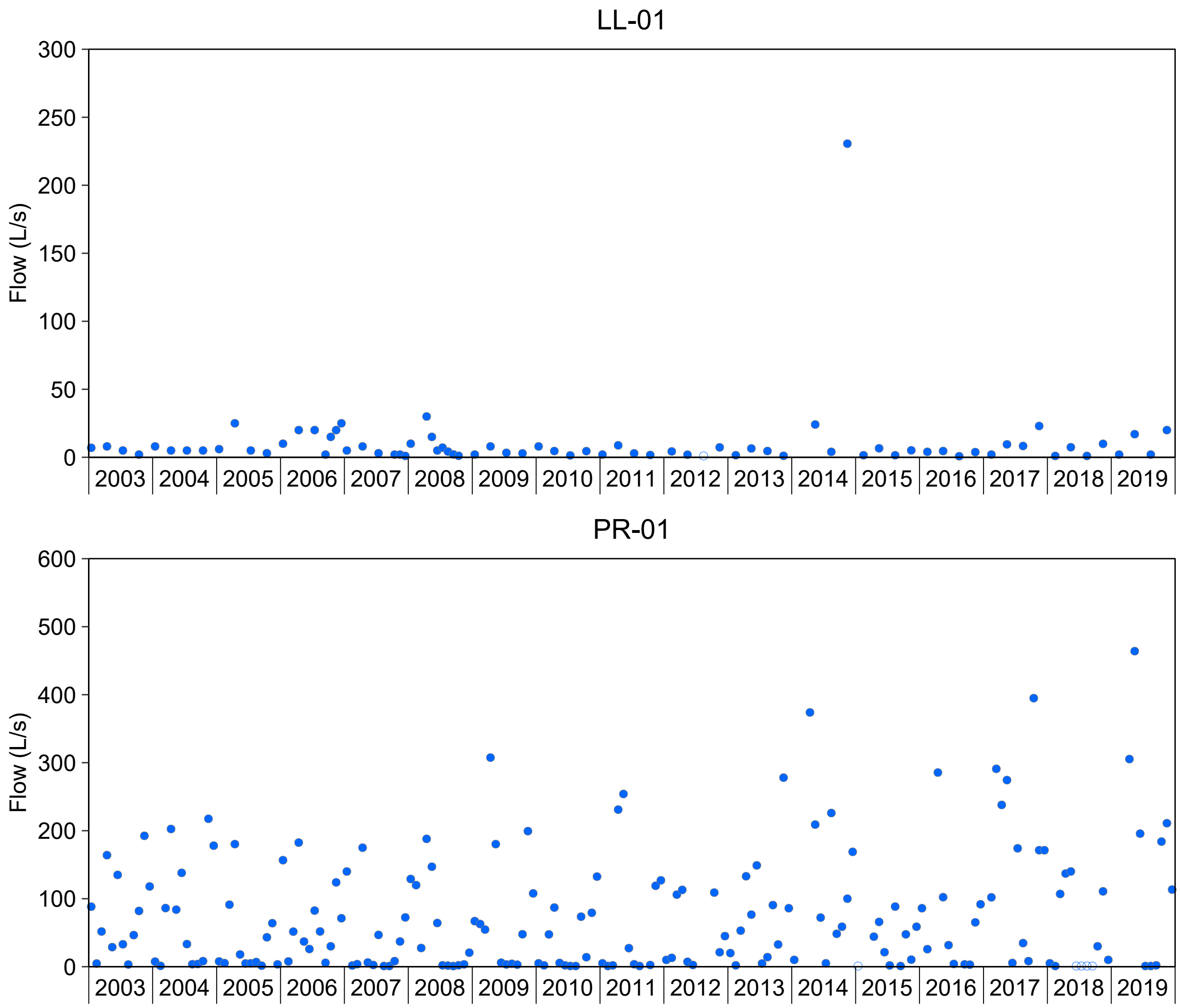


Figure Q.9: Flow Measurements for SAMP Water Quality Monitoring Stations in Pronto TMA, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL.
See Appendix Tables Q.2 and Q.3 for raw data.

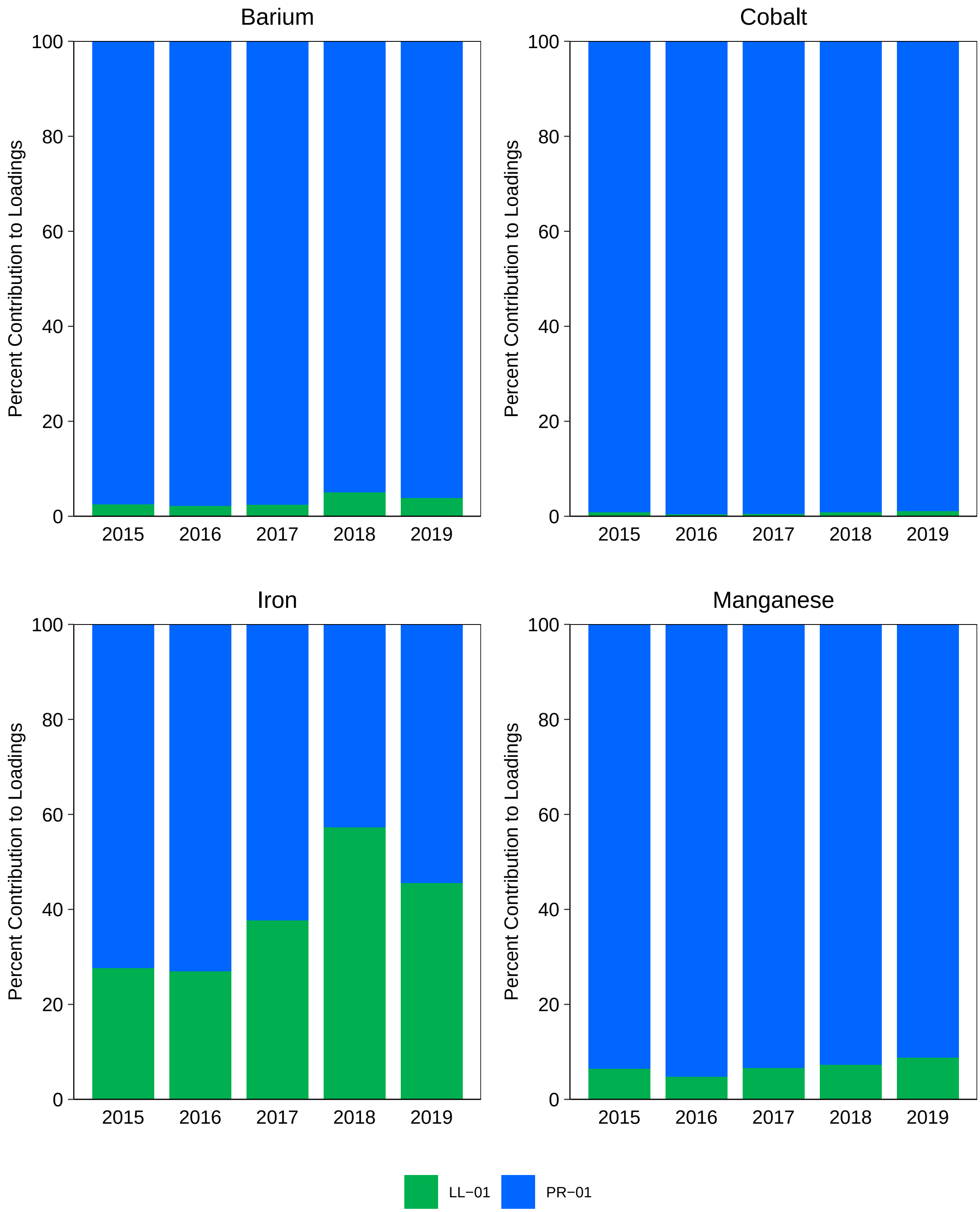


Figure Q.10: Percent Contribution of TMA Discharges and Seepages to the Total Loadings from Pronto TMA, 2015 to 2019

Notes: See Appendix Tables Q.2 and Q.3 for raw data and Appendix Figure Q.5 for the annual discharge and seepage loadings from each TMA.

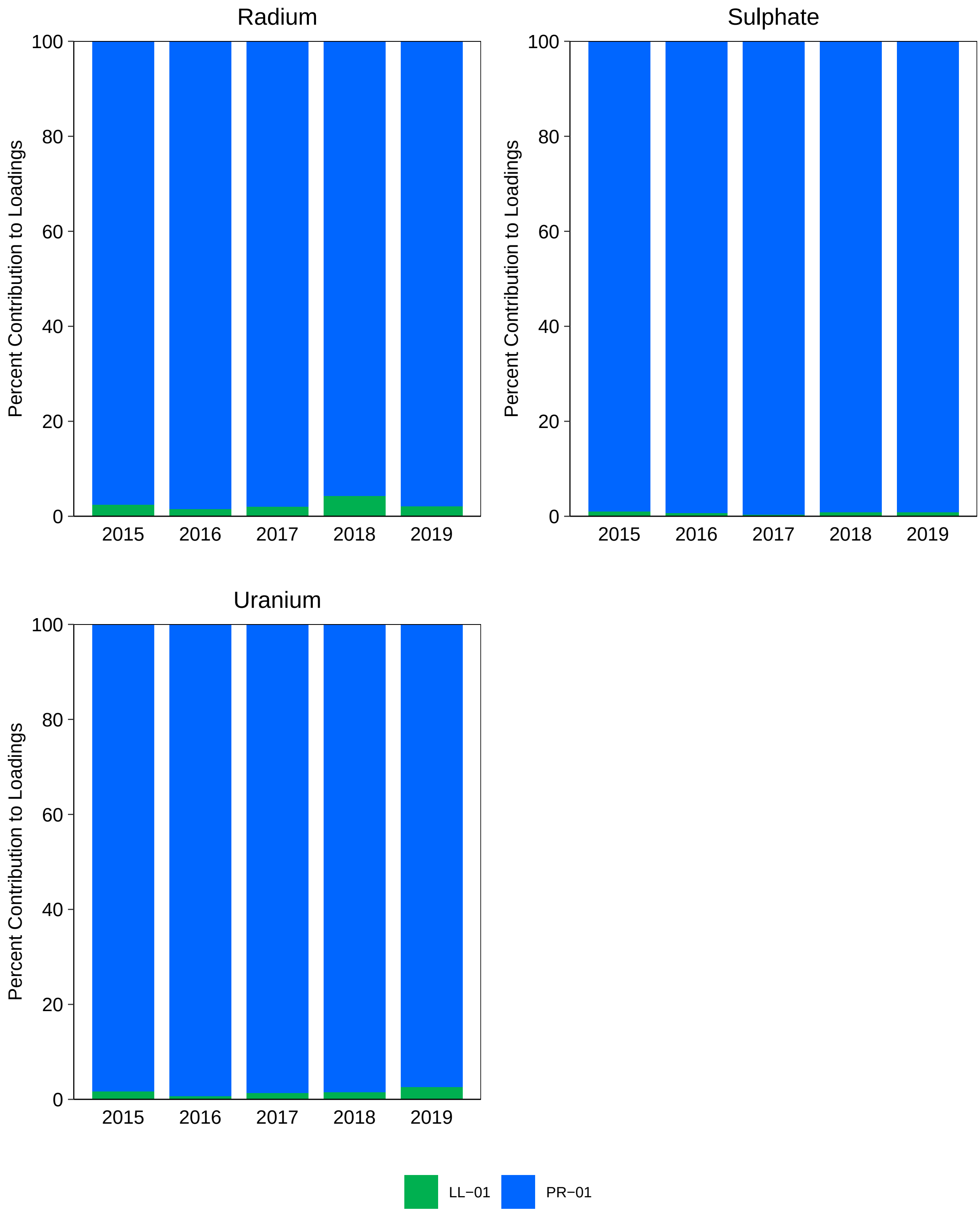
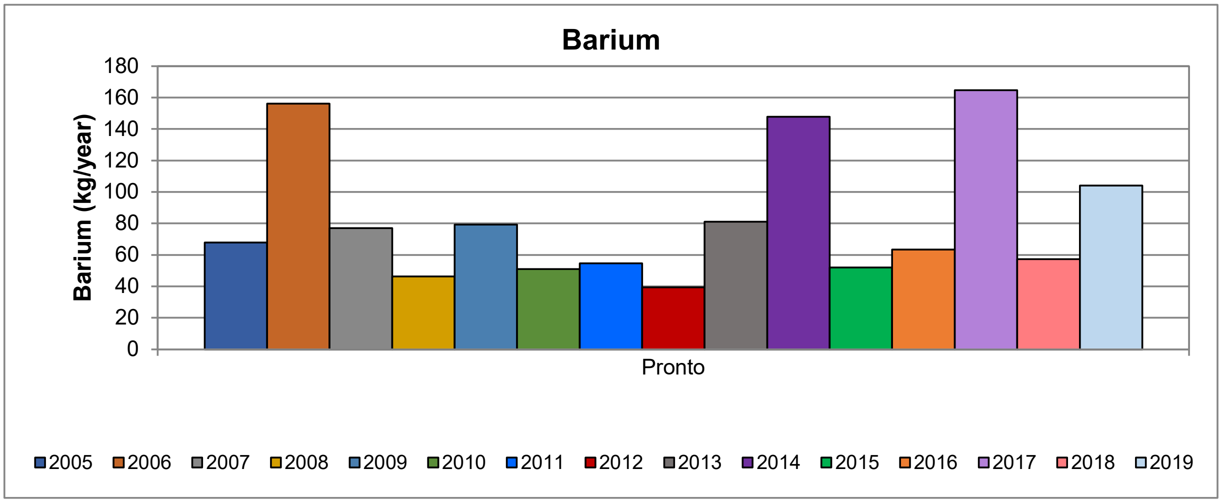
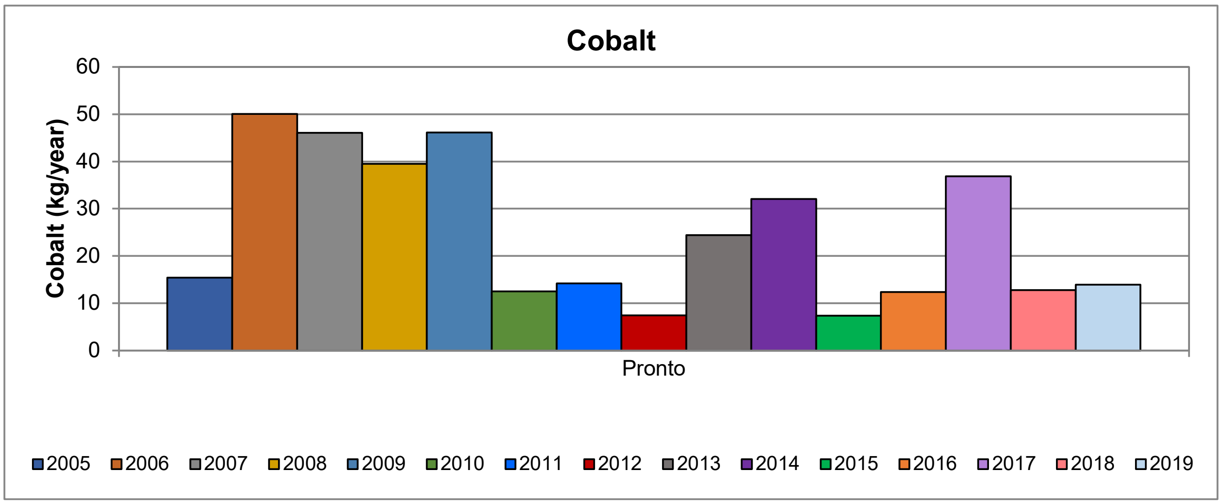


Figure Q.10: Percent Contribution of TMA Discharges and Seepages to the Total Loadings from Pronto TMA, 2015 to 2019

Notes: See Appendix Tables Q.2 and Q.3 for raw data and Appendix Figure Q.5 for the annual discharge and seepage loadings from each TMA.





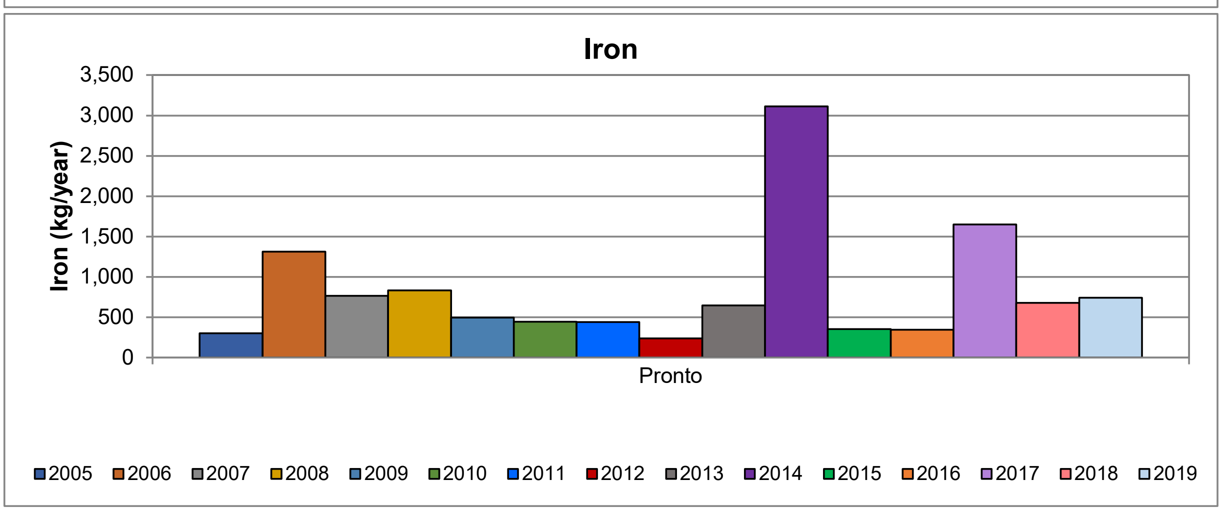
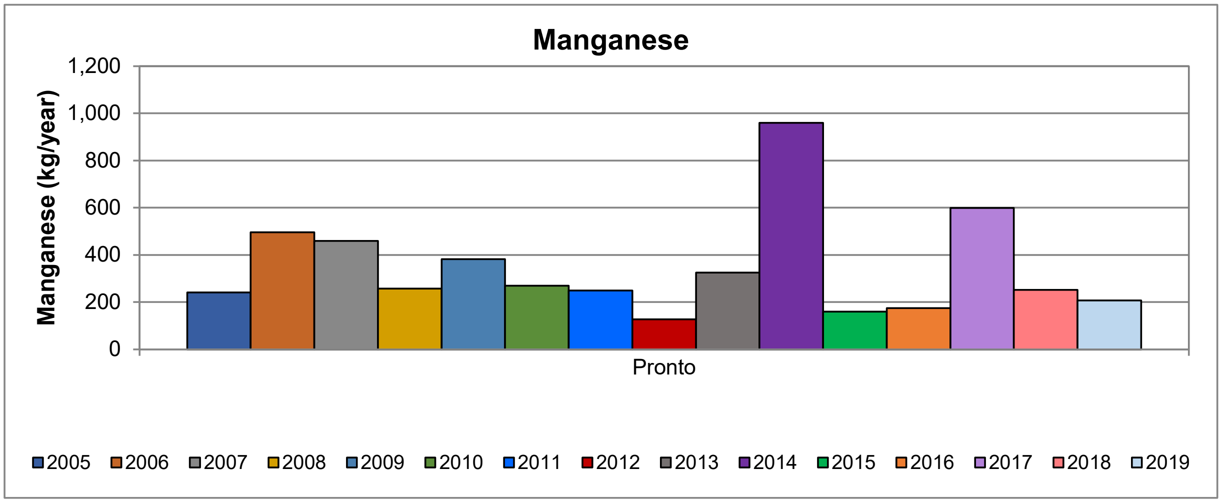
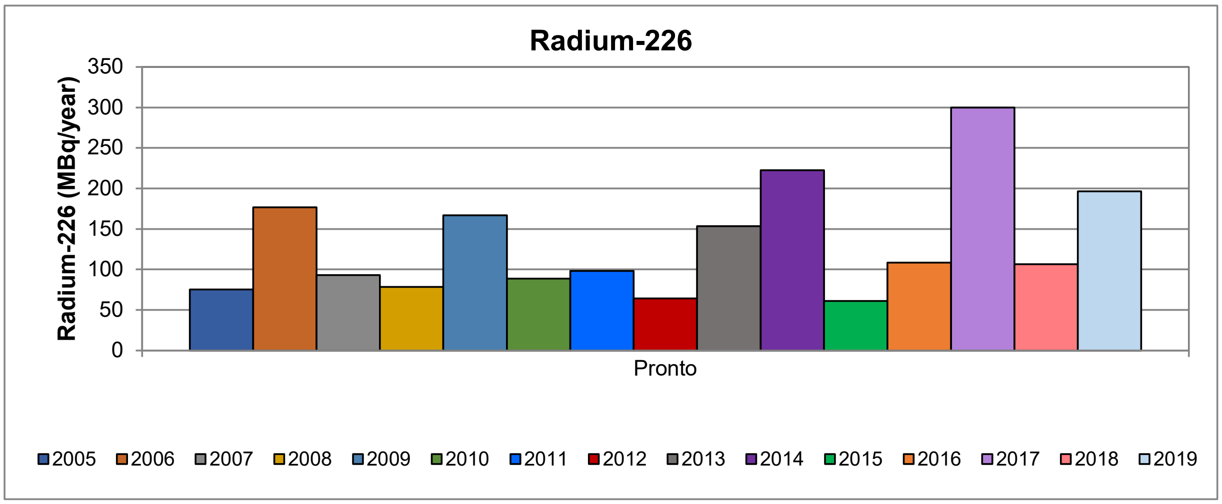


Figure Q.11: Annual Loadings from Pronto TMA to the Near-Shore of Lake Huron, 2005 to 2019

Note: See Appendix Tables Q.2 and Q.3 for raw data and Appendix Table Q.5 for annual discharge and seepage loading rates.





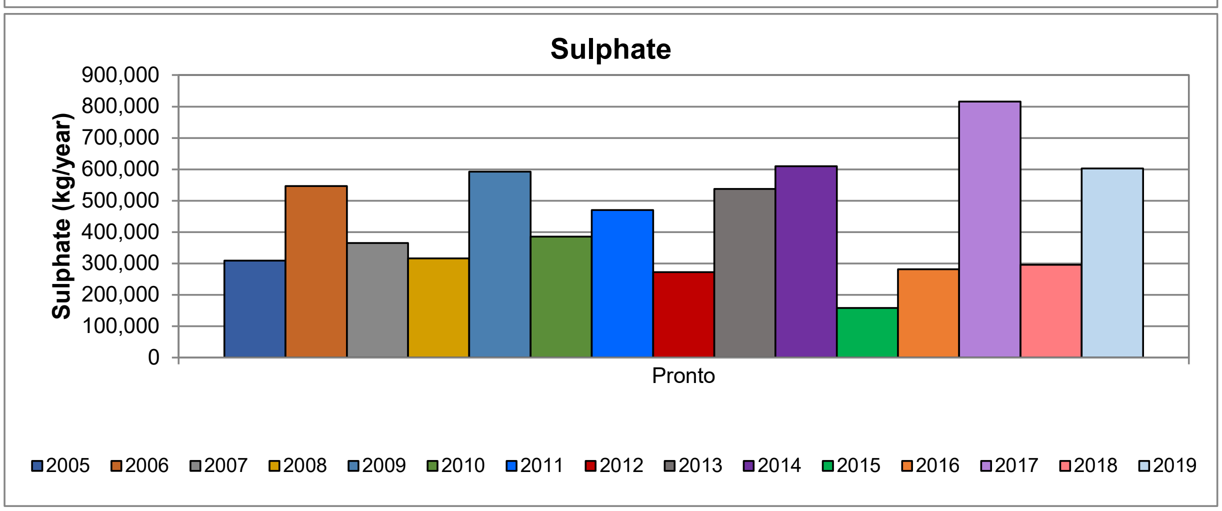


Figure Q.11: Annual Loadings from Pronto TMA to the Near-Shore of Lake Huron, 2005 to 2019

Note: See Appendix Tables Q.2 and Q.3 for raw data and Appendix Table Q.5 for annual discharge and seepage loading rates.

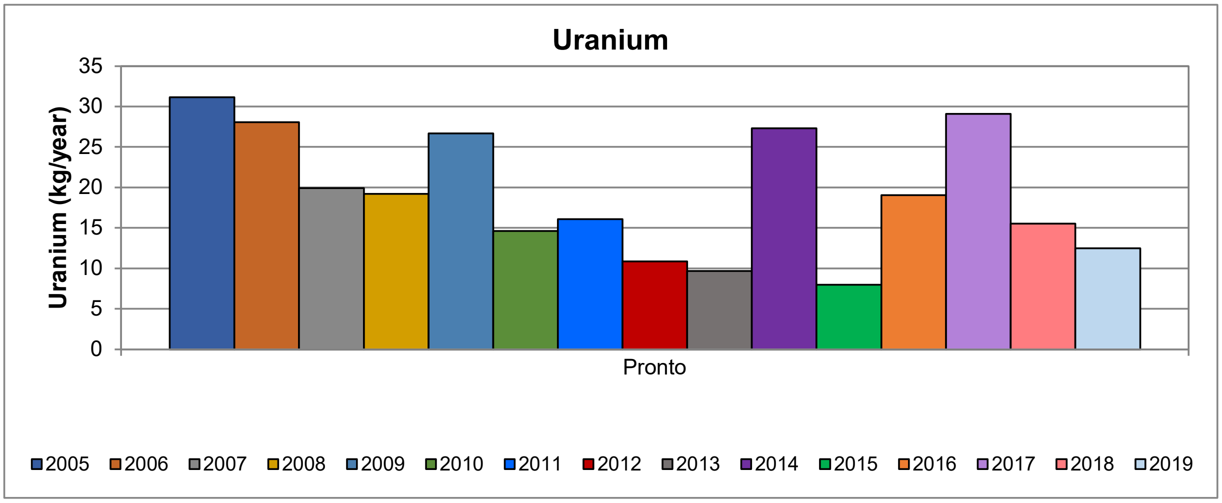


Figure Q.11: Annual Loadings from Pronto TMA to the Near-Shore of Lake Huron, 2005 to 2019

Note: See Appendix Tables Q.2 and Q.3 for raw data and Appendix Table Q.5 for annual discharge and seepage loading rates.

Table Q.1: Location of SAMP Data Tables and Figures Within this Cycle 5 SOE Report, Pronto TMA

TMA	SAMP Station ID	Type	Description	Also a TOMP or SRWMP Station?	Map Figures	Water Quality Data Tables (barium, cobalt, hardness, iron, manganese, pH, radium-226, sulphate, and/or	Flow Data Tables	Flow Data Figures	Toxicity Data Tables	Trend Tables	Water Quality / Trend Figures	Loadings Tables	Loadings Figures	Percent Contribution to Loadings Figures	TMA Plant Operations Tables
Pronto	LL-01	Drainage	Pronto Creek at Inlet to Lake Lauzon	no	7.1	Q.2	Q.2	Q.9	na	7.5	Q.1 to Q.8	Q.5	7.7, Q.10, Q.11	Q.10	Q.4
	PR-01	Principal	Pronto Discharge Channel at Highway 17	no	7.1	Q.3	Q.3	Q.9	7.4	7.5	Q.1 to Q.8	Q.5	7.7, Q.10, Q.11		Q.4

Notes: na = parameter not measured at this station (as per study design); therefore, data presentation is not applicable.

Table Q.2: Water Quality at SAMP Drainage Station LL-01, Located at Pronto Creek at Inlet to Lake Lauzon, Pronto TMA, 2015 to 2019

Date	Flow (L/s)	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
11-Feb-15	1.50	75.2	6.60	19.0	0.0190	0.0160	0.00100	1.91	0.360	0.00210
07-May-15	6.60	40.1	6.80	13.0	0.0120	0.0110	<0.000500	0.730	0.0500	0.00110
12-Aug-15	1.50	52.1	7.10	11.0	0.0160	0.0130	<0.000500	1.29	0.0880	0.00100
11-Nov-15	5.10	59.1	7.00	24.0	0.0150	0.0140	<0.000500	0.496	0.0270	0.00110
n	4	4	4	4	4	4	4	4	4	4
Minimum	1.50	40.1	6.60	11.0	0.0120	0.0110	<0.0005	0.496	0.0270	0.00100
Maximum	6.60	75.2	7.10	24.0	0.0190	0.0160	0.00100	1.91	0.360	0.00210
Mean	3.68	56.6	6.88	16.8	0.0155	0.0135	0.000625	1.11	0.131	0.00132
SD	2.59	14.7	0.222	5.91	0.00289	0.00208	-	0.631	0.155	0.000519
10-Feb-16	4.00	66.5	6.70	21.0	0.0210	0.0150	<0.000500	1.43	0.156	0.00170
11-May-16	4.60	48.7	6.90	14.0	0.00800	0.0110	<0.000500	0.652	0.0480	0.00100
10-Aug-16	0.770	50.8	6.50	9.80	0.0180	0.0120	<0.000500	0.943	0.0690	0.000800
09-Nov-16	3.80	65.8	6.80	16.0	0.0190	0.0130	<0.000500	0.637	0.0470	0.00130
n	4	4	4	4	4	4	4	4	4	4
Minimum	0.770	48.7	6.50	9.80	0.00800	0.0110	<0.0005	0.637	0.0470	0.000800
Maximum	4.60	66.5	6.90	21.0	0.0210	0.0150	<0.0005	1.43	0.156	0.00170
Mean	3.29	58.0	6.72	15.2	0.0165	0.0127	<0.0005	0.916	0.0800	0.00120
SD	1.72	9.51	0.171	4.65	0.00580	0.00171	-	0.371	0.0517	0.000392
07-Feb-17	2.00	64.6	7.00	23.0	0.0160	0.0160	<0.000500	1.10	0.151	0.00170
10-May-17	9.50	48.2	6.50	13.0	0.0180	0.0130	<0.000500	0.700	0.0470	0.00130
10-Aug-17	8.30	65.3	6.50	5.80	0.0280	0.0180	0.00110	4.35	0.354	0.00160
15-Nov-17	23.0	44.0	6.80	8.90	0.0260	0.0150	0.000600	2.59	0.0900	0.00140
n	4	4	4	4	4	4	4	4	4	4
Minimum	2.00	44.0	6.50	5.80	0.0160	0.0130	<0.0005	0.700	0.0470	0.00130
Maximum	23.0	65.3	7.00	23.0	0.0280	0.0180	0.00110	4.35	0.354	0.00170
Mean	10.7	55.5	6.70	12.7	0.0220	0.0155	0.000675	2.18	0.160	0.00150
SD	8.84	11.0	0.245	7.49	0.00589	0.00208	0.000306	1.66	0.136	0.000183
14-Feb-18	1.00	76.7	6.60	17.0	0.0240	0.0180	0.000900	4.01	0.450	0.00170
16-May-18	7.39	40.5	6.50	9.90	0.0220	0.0120	<0.000500	1.19	0.0730	0.00110
08-Aug-18	1.00	60.4	6.50	4.10	0.0220	0.0150	<0.000500	3.97	0.154	0.00100
14-Nov-18	9.90	71.9	6.80	26.0	0.0180	0.0160	<0.000500	0.852	0.0400	0.000800
n	4	4	4	4	4	4	4	4	4	4
Minimum	1.00	40.5	6.50	4.10	0.0180	0.0120	<0.0005	0.852	0.0400	0.000800
Maximum	9.90	76.7	6.80	26.0	0.0240	0.0180	0.000900	4.01	0.450	0.00170
Mean	4.82	62.4	6.60	14.2	0.0215	0.0152	0.000600	2.51	0.179	0.00115
SD	4.53	16.1	0.141	9.44	0.00252	0.00250	-	1.72	0.187	0.000387
20-Feb-19	2.00	76.9	6.60	23.0	0.0260	0.0180	0.000600	2.39	0.249	0.00150
08-May-19	17.0	40.6	6.50	17.0	0.0120	0.0130	0.000500	0.860	0.0440	0.00120
15-Aug-19	2.00	55.7	6.80	6.40	0.0110	0.0100	<0.000500	2.16	0.0750	0.000600
13-Nov-19	20.0	51.1	6.70	13.0	0.0140	0.0130	<0.000500	1.32	0.0650	0.00100
n	4	4	4	4	4	4	4	4	4	4
Minimum	2.00	40.6	6.50	6.40	0.0110	0.0100	<0.0005	0.860	0.0440	0.000600
Maximum	20.0	76.9	6.80	23.0	0.0260	0.0180	0.000600	2.39	0.249	0.00150
Mean	10.2	56.1	6.65	14.8	0.0158	0.0135	0.000525	1.68	0.108	0.00108
SD	9.60	15.3	0.129	6.97	0.00695	0.00332	0.0000612	0.716	0.0947	0.000377
Summary Statistics for 2015 to 2019										
n	20	20	20	20	20	20	20	20	20	20
Minimum	0.770	40.1	6.50	4.10	0.00800	0.0100	<0.000500	0.496	0.0270	0.000600
Maximum	23.0	76.9	7.10	26.0	0.0280	0.0180	0.00110	4.35	0.450	0.00210
Mean	6.55	57.7	6.71	14.7	0.0182	0.0141	0.000585	1.68	0.132	0.00125
SD	6.54	12.3	0.192	6.43	0.00543	0.00240	0.000197	1.21	0.124	0.000376
Median	4.30	57.4	6.70	13.5	0.0180	0.0135	<0.000500	1.24	0.0740	0.00115
10th Percentile	1.00	40.6	6.50	6.10	0.0115	0.0110	<0.000500	0.645	0.0420	0.000800
95th Percentile	21.5	76.8	7.05	25.0	0.0270	0.0180	0.00105	4.18	0.405	0.00190

Note: "-" = SD was incalculable because there was no variability in the data. n = number of samples. SD = standard deviation.

Table Q.3: Water Quality at SAMP Principal Station PR-01, Located at Pronto Discharge Channel at Highway 17, Pronto TMA, 2015 to 2019

Date	Flow (L/s)	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)	Sublethal Toxicity (*Ceriodaphnia dubia*) IC25	Acute Toxicity (*Daphnia magna*) % Mortality	Acute Toxicity (Rainbow Trout) % Mortality
20-Jan-15	<1.00	153	6.70	83.0	0.0980	0.0780	0.0329	0.930	1.03	0.0115	-	-	-
11-Feb-15	-	248	6.70	220	0.0700	0.0300	0.0137	0.170	0.320	0.0115	-	-	-
12-Mar-15	-	221	6.80	180	0.0740	0.0490	0.0305	0.330	0.368	0.00730	-	-	-
09-Apr-15	44.2	116	6.80	38.0	0.0330	0.0370	0.00790	0.680	0.333	0.00500	-	-	-
13-May-15	65.9	182	6.80	160	0.0370	0.0290	0.00210	0.150	0.0340	0.00280	100	0	0
10-Jun-15	21.3	97.0	7.00	31.0	0.0270	0.0250	0.00560	0.430	0.122	0.00370	-	-	-
09-Jul-15	1.90	155	7.00	53.0	0.105	0.109	0.0229	0.850	1.69	0.0138	-	-	-
12-Aug-15	88.4	270	7.00	220	0.112	0.101	0.0142	0.310	0.195	0.0178	-	-	-
16-Sep-15	1.00	165	6.80	62.0	0.0870	0.0750	0.0164	0.721	0.845	0.00790	-	-	-
14-Oct-15	47.6	275	6.80	290	0.0750	0.0620	0.00370	0.0910	0.0870	0.00930	100	0	0
11-Nov-15	10.4	145	6.80	100	0.0320	0.0340	0.00600	0.218	0.0770	0.00400	-	-	-
09-Dec-15	58.8	269	6.60	240	0.0600	0.0310	0.00720	0.0960	0.112	0.00370	-	-	-
n	10	12	12	12	12	12	12	12	12	12	2	2	2
Minimum	<1	97.0	6.60	31.0	0.0270	0.0250	0.00210	0.0910	0.0340	0.00280	100	0	0
Maximum	88.4	275	7.00	290	0.112	0.109	0.0329	0.930	1.69	0.0178	100	0	0
Mean	34.1	191	6.82	140	0.0675	0.0550	0.0136	0.415	0.434	0.00819	100	0	0
SD	31.5	63.0	0.127	89.5	0.0300	0.0295	0.0103	0.303	0.504	0.00472	-	-	-
13-Jan-16	86.0	226	6.90	210	0.0590	0.0230	0.0144	0.0910	0.134	0.00310	-	-	-
10-Feb-16	25.8	154	6.60	110	0.0500	0.0280	0.0133	0.183	0.131	0.00350	-	-	-
09-Mar-16	-	124	6.90	63.0	0.0340	0.0370	0.0105	0.228	0.207	0.00480	-	-	-
13-Apr-16	286	152	7.00	110	0.0450	0.0190	0.00550	0.0980	0.0410	0.00400	100	0	0
11-May-16	102	189	6.80	170	0.0650	0.0360	0.00300	0.0980	0.0420	0.00290	-	-	-
08-Jun-16	31.7	186	7.00	130	0.0790	0.0570	0.00840	0.279	0.189	0.00800	-	-	-
13-Jul-16	4.10	258	7.10	180	0.122	0.0910	0.0163	0.290	1.00	0.0148	-	-	-
14-Sep-16	3.50	263	6.90	150	0.105	0.103	0.00430	0.355	0.551	0.0317	-	-	-
12-Oct-16	3.00	189	7.10	92.0	0.103	0.0660	0.00630	0.419	0.266	0.0204	-	-	-
09-Nov-16	65.2	286	7.00	220	0.102	0.0780	0.00600	0.222	0.127	0.0591	100	0	0
07-Dec-16	91.8	274	6.90	210	0.0600	0.0440	0.00370	0.189	0.0740	0.0170	-	-	-
n	10	11	11	11	11	11	11	11	11	11	2	2	2
Minimum	3.00	124	6.60	63.0	0.0340	0.0190	0.00300	0.0910	0.0410	0.00290	100	0	0
Maximum	286	286	7.10	220	0.122	0.103	0.0163	0.419	1.00	0.0591	100	0	0
Mean	69.9	209	6.93	150	0.0749	0.0529	0.00834	0.223	0.251	0.0154	100	0	0
SD	84.9	55.3	0.142	52.8	0.0290	0.0284	0.00462	0.107	0.286	0.0172	-	-	-
11-Jan-17	-	214	7.30	170	0.0600	0.0390	0.00960	0.219	0.189	0.00720	-	-	-
07-Feb-17	102	365	7.00	310	0.0820	0.0340	0.0137	0.0820	0.183	0.00810	-	-	-
08-Mar-17	291	212	6.90	160	0.0620	0.0190	0.0118	0.166	0.0950	0.00670	-	-	-
12-Apr-17	238	155	6.80	120	0.0400	0.0200	0.00580	0.149	0.0430	0.00370	-	-	-
01-May-17	274	186	6.80	140	0.0480	0.0260	0.00350	0.188	0.0320	0.00380	100	0	0
14-Jun-17	5.50	206	7.20	110	0.0800	0.0540	0.0306	0.621	1.16	0.0154	-	-	-

Table Q.3: Water Quality at SAMP Principal Station PR-01, Located at Pronto Discharge Channel at Highway 17, Pronto TMA, 2015 to 2019

Date	Flow (L/s)	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)	Sublethal Toxicity (*Ceriodaphnia dubia*) IC25	Acute Toxicity (*Daphnia magna*) % Mortality	Acute Toxicity (Rainbow Trout) % Mortality
12-Jul-17	174	253	6.90	200	0.0840	0.0680	0.00660	0.328	0.198	0.00510	-	-	-
10-Aug-17	34.7	255	6.90	200	0.0910	0.0660	0.0117	0.462	0.653	0.00590	-	-	-
13-Sep-17	8.20	185	7.00	97.0	0.0680	0.0720	0.00500	0.302	0.533	0.0123	-	-	-
25-Oct-17	395	159	6.90	130	0.0590	0.0420	0.00430	0.280	0.0810	0.00880	100	0	0
15-Nov-17	171	230	6.90	180	0.0500	0.0280	0.00790	0.250	0.120	0.00400	-	-	-
13-Dec-17	171	239	7.00	240	0.0810	0.0270	0.0126	0.125	0.142	0.00390	-	-	-
n	11	12	12	12	12	12	12	12	12	12	2	2	2
Minimum	5.50	155	6.80	97.0	0.0400	0.0190	0.00350	0.0820	0.0320	0.00370	100	0	0
Maximum	395	365	7.30	310	0.0910	0.0720	0.0306	0.621	1.16	0.0154	100	0	0
Mean	170	222	6.97	171	0.0671	0.0412	0.0103	0.264	0.286	0.00708	100	0	0
SD	125	55.9	0.150	60.6	0.0164	0.0192	0.00728	0.152	0.335	0.00366	-	-	-
11-Jan-18	5.00	230	6.70	210	0.0790	0.0440	0.0238	0.223	0.451	0.00590	-	-	-
14-Feb-18	1.00	306	6.70	170	0.102	0.0620	0.0224	0.360	0.974	0.0162	-	-	-
21-Mar-18	107	290	6.90	260	0.101	0.0410	0.0218	0.197	0.501	0.0175	-	-	-
11-Apr-18	137	284	6.70	220	0.0590	0.0310	0.00570	0.252	0.147	0.0106	-	-	-
09-May-18	140	133	6.80	100	0.0430	0.0240	0.00190	0.217	0.0220	0.00340	100	0	0
13-Jun-18	<1.00	177	7.10	100	0.0780	0.0570	0.0157	0.487	0.818	0.00820	-	-	-
11-Jul-18	<1.00	238	7.00	140	0.0670	0.0840	0.0126	1.00	1.81	0.0254	-	-	-
08-Aug-18	<1.00	334	7.00	200	0.0650	0.102	0.0292	0.800	3.05	0.0329	-	-	-
12-Sep-18	<1.00	434	6.90	400	0.0880	0.117	0.0172	0.574	1.25	0.00390	-	-	-
10-Oct-18	30.0	159	6.80	80.0	0.0550	0.0440	0.0153	0.245	0.101	0.0168	-	-	-
21-Nov-18	111	329	6.70	280	0.0880	0.0560	0.00530	0.0700	0.0580	0.0155	100	0	0
19-Dec-18	10.0	290	6.90	230	0.0630	0.0410	0.0151	0.142	0.158	0.00450	-	-	-
n	12	12	12	12	12	12	12	12	12	12	2	2	2
Minimum	<1	133	6.70	80.0	0.0430	0.0240	0.00190	0.0700	0.0220	0.00340	100	0	0
Maximum	140	434	7.10	400	0.102	0.117	0.0292	1.00	3.05	0.0329	100	0	0
Mean	45.4	267	6.85	199	0.0740	0.0586	0.0155	0.381	0.778	0.0134	100	0	0
SD	60.5	84.8	0.138	90.6	0.0184	0.0285	0.00820	0.283	0.905	0.00917	-	-	-
09-Jan-19	-	222	6.80	190	0.0480	0.0330	0.0115	0.139	0.159	0.00640	-	-	-
13-Mar-19	-	359	6.80	320	0.0710	0.0450	0.0122	0.136	0.233	0.00870	-	-	-
22-Apr-19	305	103	6.60	97.0	0.0290	0.0160	0.00750	0.201	0.0290	0.00330	100	0	0
08-May-19	464	160	6.80	140	0.0550	0.0230	0.00320	0.0800	0.0350	0.00280	-	-	-
12-Jun-19	196	251	6.90	190	0.0610	0.0350	0.00280	0.111	0.0420	0.00190	-	-	-
10-Jul-19	1.00	216	6.50	110	0.0740	0.0480	0.0382	0.928	2.05	0.0165	-	-	-
15-Aug-19	1.00	169	7.00	49.0	0.0460	0.0400	0.0208	0.902	1.97	0.0303	-	-	-
11-Sep-19	2.00	170	6.90	100	0.0470	0.0470	0.00670	0.437	0.248	0.00810	-	-	-
16-Oct-19	184	250	6.70	200	0.0760	0.0470	0.00240	0.140	0.0680	0.00740	100	0	0
13-Nov-19	211	280	6.50	240	0.0520	0.0300	0.00350	0.0800	0.0630	0.00220	-	-	-

Table Q.3: Water Quality at SAMP Principal Station PR-01, Located at Pronto Discharge Channel at Highway 17, Pronto TMA, 2015 to 2019

Date	Flow (L/s)	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Cobalt (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)	Sublethal Toxicity (*Ceriodaphnia dubia*) IC25	Acute Toxicity (*Daphnia magna*) % Mortality	Acute Toxicity (Rainbow Trout) % Mortality
11-Dec-19	113	169	7.00	170	0.0370	0.0190	0.00270	0.151	0.0690	0.00320	-	-	-
n	9	11	11	11	11	11	11	11	11	11	2	2	2
Minimum	1.00	103	6.50	49.0	0.0290	0.0160	0.00240	0.0800	0.0290	0.00190	100	0	0
Maximum	464	359	7.00	320	0.0760	0.0480	0.0382	0.928	2.05	0.0303	100	0	0
Mean	164	214	6.77	164	0.0542	0.0348	0.0101	0.300	0.451	0.00825	100	0	0
SD	156	70.2	0.179	76.2	0.0151	0.0117	0.0109	0.319	0.775	0.00846	-	-	-
Summary Statistics for 2015 to 2019													
n	52	58	58	58	58	58	58	58	58	58	10	10	10
Minimum	<1.00	97.0	6.50	31.0	0.0270	0.0160	0.00190	0.0700	0.0220	0.00190	100	0	0
Maximum	464	434	7.30	400	0.122	0.117	0.0382	1.00	3.05	0.0591	100	0	0
Mean	94.7	221	6.87	165	0.0676	0.0487	0.0116	0.318	0.443	0.0104	100	0	0
SD	112	69.5	0.159	76.0	0.0231	0.0254	0.00868	0.251	0.620	0.00992	-	-	-
Median	53.2	218	6.90	170	0.0650	0.0415	0.00900	0.222	0.171	0.00735	100	0	0
10th Percentile	1.00	145	6.70	63.0	0.0370	0.0230	0.00300	0.0910	0.0410	0.00310	100	0	0
95th Percentile	305	359	7.10	310	0.105	0.103	0.0306	0.928	1.97	0.0317	100	0	0

Note: "-" = no data collected or SD was incalculable because there was no variability in the data. n = number of samples. SD = standard deviation.

Table Q.4: Summary of Annual Plant Operations and Discharge at Pronto TMA, 2015 to 2019

ITEM	2015	2016	2017	2018	2019
PLANT OPERATIONS[a]					
Operating Days	134	122	226	196	246
Maximum Daily Plant Flow (L/s @ PR-02)	179	181	171	173	215
Minimum Daily Plant Flow (L/s @ PR-02)	0	0	0	0	0
Monthly Average Daily Plant Flow (L/s @ PR-02)	50	45	66	34	72
Total Volume Treated (ML)	579	473	1,292	573	1,527
Barium Chloride Consumption					
Total (kg/year)	3,725	3,950	6,375	5,125	7,888
Monthly Average (mg/L)	6.437	8.343	4.934	8.942	5.165
Lime Consumption					
Total (ton/year)	2.2	2.3	4.1	2.6	5.21
Monthly Average (g/L)	0.0037	0.0048	0.0032	0.0045	0.0034
EFFLUENT[b]					
Discharge Days	134	123	229	202	247
Maximum Daily Discharge Flow (L/s @ PR-04)	178	181	171	173	215
Minimum Daily Discharge Flow (L/s @ PR-04)	0	0	0	0	0
Monthly Average Daily Discharge Flow (L/s @ PR-04)	51	45	66	33	66
Total Annual Volume Discharged (ML)	588	477	1,310	576	1,401

Note: See Appendix Tables Q.2 and Q.3 (station PR-02) for detailed reagent data.

[a] Influent flows based on daily monitoring requirements as per TOMP.

[b] Effluent flows based on weekly monitoring requirement as per SAMP.

Table Q.5: Annual Discharge and Seepage Loadings from Pronto TMA to Nearshore Lake Huron, 2015 to 2019

Station	Drainage Type	Year	Annual Discharge (m^3)	Barium (kg/year)	Cobalt (kg/yr)	Iron (kg/yr)	Manganese (kg/yr)	Radium (MBq/yr)	Sulphate (kg/yr)	Uranium (kg/yr)
PR-01	Controlled Discharge	2015	883,587	50.6	7.27	256	149	59.5	156,588	7.84
		2016	1,824,898	61.9	12.3	253	167	107	279,869	18.9
		2017	4,856,027	161	36.7	1,030	559	294	813,196	28.7
		2018	1,513,090	54.4	12.7	291	233	102	293,344	15.3
		2019	3,567,334	99.9	13.8	405	188	192	597,893	12.1
		Mean	2,528,987	85.5	16.5	447	259	151	428,178	16.6
		SD	1,637,713	46.4	11.5	332	170	93.2	269,712	7.92
LL-01	Upstream Source to Lake Lauzon	2015	105,909	1.3	0.061	98	10	1.5	1,698	0.13
		2016	108,697	1.41	0.0542	93.8	8.33	1.65	1,922	0.136
		2017	266,518	4.05	0.184	623	39.6	6.22	2,776	0.383
		2018	198,457	2.88	0.111	390	18.3	4.57	2,545	0.236
		2019	301,709	4.07	0.152	339	18.1	4.22	5,090	0.323
		Mean	196,258	2.75	0.113	309	18.9	3.63	2,806	0.242
		SD	89,290	1.34	0.057	222	12.4	2.02	1,350	0.112
All Pronto Sources			-	**88.3**	**16.6**	**756**	**278**	**155**	**430,984**	**16.8**

Notes: MBq/yr = Million Becquerels per year. Values below LRL were substituted at the LRL for calculations. See Appendix Tables Q.2 and Q.3 for raw data and Appendix Figure Q.10 for the percent contribution of loads from each TMA.

APPENDIX R
RESOLVING MIXED LEVELS OF TAXONOMIC RESOLUTIONS FOR BENTHIC INVERTEBRATES

APPENDIX R RESOLVING MIXED-LEVELS OF TAXONOMIC RESOLUTION FOR BENTHIC INVERTEBRATES

R.1 INTRODUCTION

Processing of benthic invertebrate data for ecological assessment generally involves determining taxonomic richness (number of taxa present) as well as community composition, which is typically assessed using abundances (and/or density) of all taxa present and their relative proportion of the total community. Taxonomic richness and community composition can be informative metrics on their own, however they are also utilized in the calculation of diversity indices (e.g. Simpson's Evenness and Simpson's Diversity). Determination of taxonomic richness and community composition from taxonomic data can be complicated by inconsistencies in taxonomic data, relating to the taxonomic level to which organisms can practicably be identified by the laboratory ("resolution"). Taxonomists endeavour to classify organisms within the most specific taxon (a defined taxonomic identity of any rank) possible, generally Genus or Species, however specimens that are damaged or are in an early developmental stage may lack the morphological features necessary to confirm an identification to the same level that can be achieved for some adult specimens. Furthermore, the information needed to confirm the identification of specimens may not be available in taxonomic keys or other resources. When individuals of a single taxon are identified to different levels of resolution within a single sample they are considered redundant or "ambiguous" taxa. The presence of these ambiguous taxa may result in inflated estimates of richness or distorted patterns of diversity across sites. For example, some specimens may be identified to the genus level (e.g., *Baetis*) while others are identified to the species level (e.g., *Baetis tricaudatus*). If ambiguous taxa are not resolved, then the coarser-resolution taxon (i.e., the Genus-level, *Baetis*) is counted as a unique taxon when it may actually be the same species as the finer-level taxon (i.e., species-level, *B. tricaudatus*). Therefore, one consequence of the common practice of identifying organisms to the lowest practicable taxonomic level (LPL) is that the "species list" (complete list of taxa identified) from any site contains a mixture of taxa (or "mixed-level") wherein an individual taxon may have multiple specimens identified to several different levels of taxonomic resolution. As a result, benthic invertebrate data typically comprise a mixture of identification levels due to difficulties in achieving a uniform Species, Genus, or even Family-level identification for aquatic macroinvertebrates (Cranston 1990) and must undergo additional consolidation steps prior to data analysis.

At least four options are available for dealing with taxa identified to mixed-levels of taxonomic resolution:

1. remove data for any organisms identified to a level less-specific than the target resolution (i.e. anything not at the Genus or Species level);

2. group all data for any organisms identified to a level less-specific than the target resolution into an "Other" group, a standalone but undefined taxon;

3. proportionally distribute data for any organisms identified to a level less-specific than the target resolution into values for organisms positively identified to target resolution according to the ratios of those positively identified taxa (i.e. “rolling down” unidentified taxa to more specific taxonomic levels); or

4. combine all related taxa least-specific taxon to which consistent identification is possible (i.e. “rolling up” unidentified taxa to less-specific taxonomic levels – often family-level).

Option 1 (though sometimes used) is unsatisfactory because a bias is introduced into the sample (because difficult to identify taxa are not randomly distributed, but rather occur more frequently in particular Classes, Orders, and Families). The second option (also sometimes used) is unsatisfactory because organisms grouped as “Other” contribute no useful information (beyond increasing the total density estimate), and complicate further analyses. The third option assumes that the ratio of taxa among ambiguous taxa is the same as in specimens of identified decisively, which may or may not be accurate. The fourth option is most conservative but may lead to a significant loss of data. For example, specimens of the Genera *Baetis* and *Pseudocloeon* might be lumped together and analyzed as Baetidae. The preferred option for analysis depends on the distribution of the organisms among taxa. If identified specimens in the two genera above constitute only 10% of the total abundance, it may be most appropriate to lump them together with the other 90% in the less-specific taxon (Family: Baetidae). Conversely, if 90% of the identified organisms fall into the two Genera, it is more defensible to apportion the ambiguous taxa identified only to Baetidae (Family) into the values for specimens identified to Genus, and any resulting error may not seriously bias the analysis. In order to standardize the decision-making process, reduce subjectivity, and improve the efficiency of benthic community data processing, Minnow has developed and applied a decision key which is used in the processing of all benthic invertebrate community data.

R.2 DECISION KEY

Resolution of redundant or ambiguous taxa was achieved through implementation of a decision key that dictated criteria for data processing (Appendix Figure U.1). The first two options for dealing with taxa identified to mixed-levels of taxonomic resolution outlined in Section U.1 were considered unsatisfactory, therefore the decision key makes use of abundance and richness criteria to apply options 3 (roll-down) and 4 (roll-up) for each level of the taxonomic hierarchy. This method preserves as much detailed taxonomic information as possible, while addressing issues of taxonomic ambiguities. The decision key was modified from the Puget Sound Long-Term Marine Sediment Benthic Invertebrate Summary and is outlined below (Weakland et al. 2018).

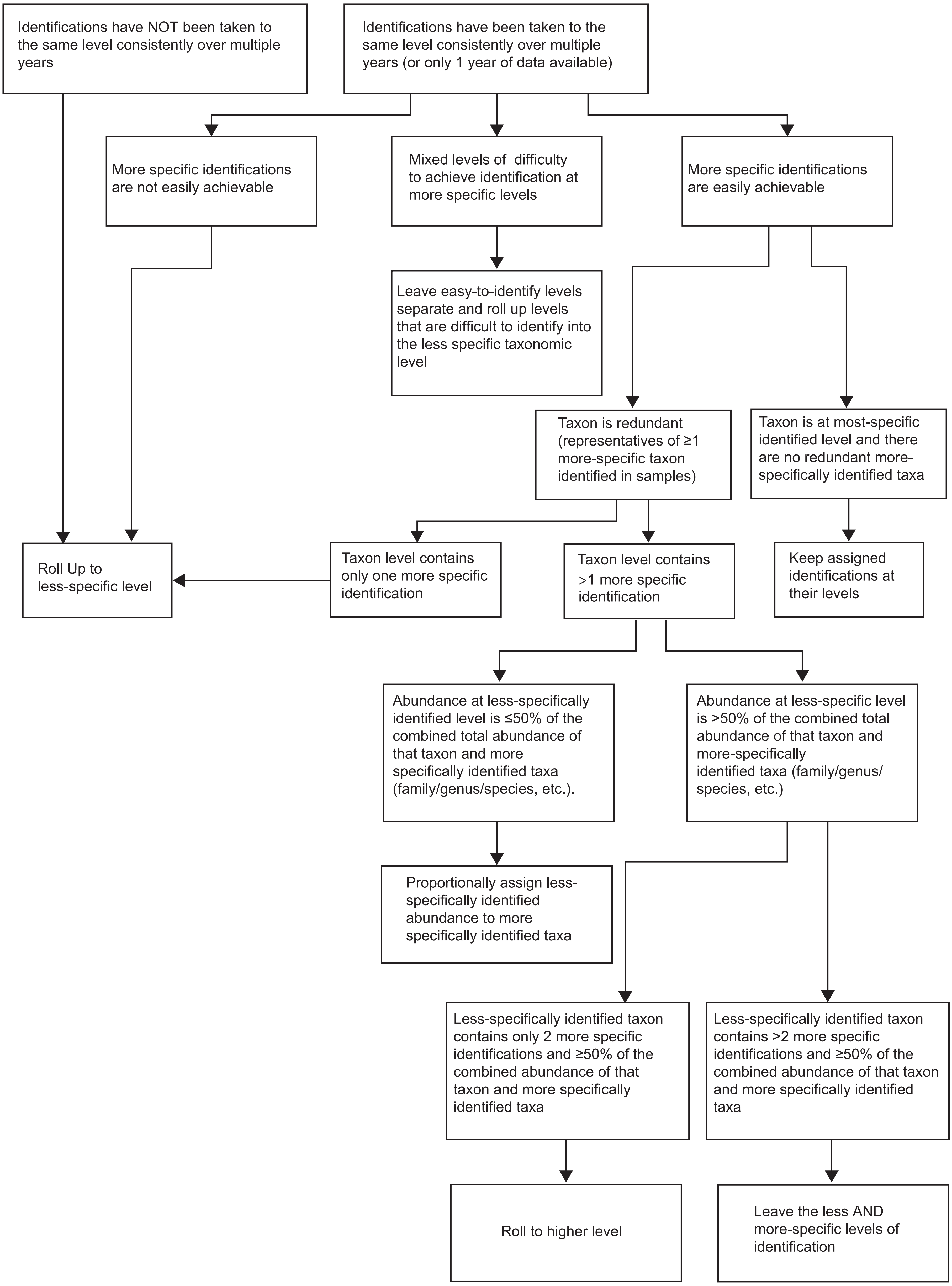
The decision key rules are summarised as follows (see Appendix Figure U.1 for details).

- If identifications have not been taken to the same level consistently over multiple years of monitoring, data are rolled up to a less-specific taxonomic level. If identifications have been taken to the same level consistently over multiple years or only one year of data is available, they are kept at their respective taxonomic levels.
- If for a taxa identified to mixed-levels of resolution it is known that differentiating among specimens at more-specific levels of identification is notably challenging (e.g. due to inconsistencies in taxonomic keys or fragility of defining features) then all taxa are rolled up to a less-specific taxonomic level. If the difficulty of identifications are of mixed levels of difficulty, then easy-to-identify taxa are left at their respective level of identification, whereas difficult-to-identify taxa are rolled up to a less-specific level. If the identifications are easy, then they are kept at their respective taxonomic levels.
- For examples that have satisfied the above criteria, if there are no more-specific levels of identification or there are no organisms identified to a more-specific taxon, they are left at that level of identification.

R.3 REFERENCES

Cranston, P.S. 1990. Biomonitoring and invertebrate taxonomy. Environmental Monitoring and Assessment 14: 265-273

Weakland, S., V. Partridge, and M. Dutch. 2018. Sediment Quality in Puget Sound: Changes in chemistry, toxicity, and benthic invertebrates at multiple geographic scales, 1989–2015. Publication Number: 18-03-004.https://fortress.wa.gov/ecy/publications/SummaryPages/1803004.html



Decision Key for Resolving Mixed Levels of Taxonomic Resolution

Date: February 2021
Project 197202.0041

minnow environmental inc.

Figure R.1

APPENDIX S

SRWMP WATER QUALITY DATA

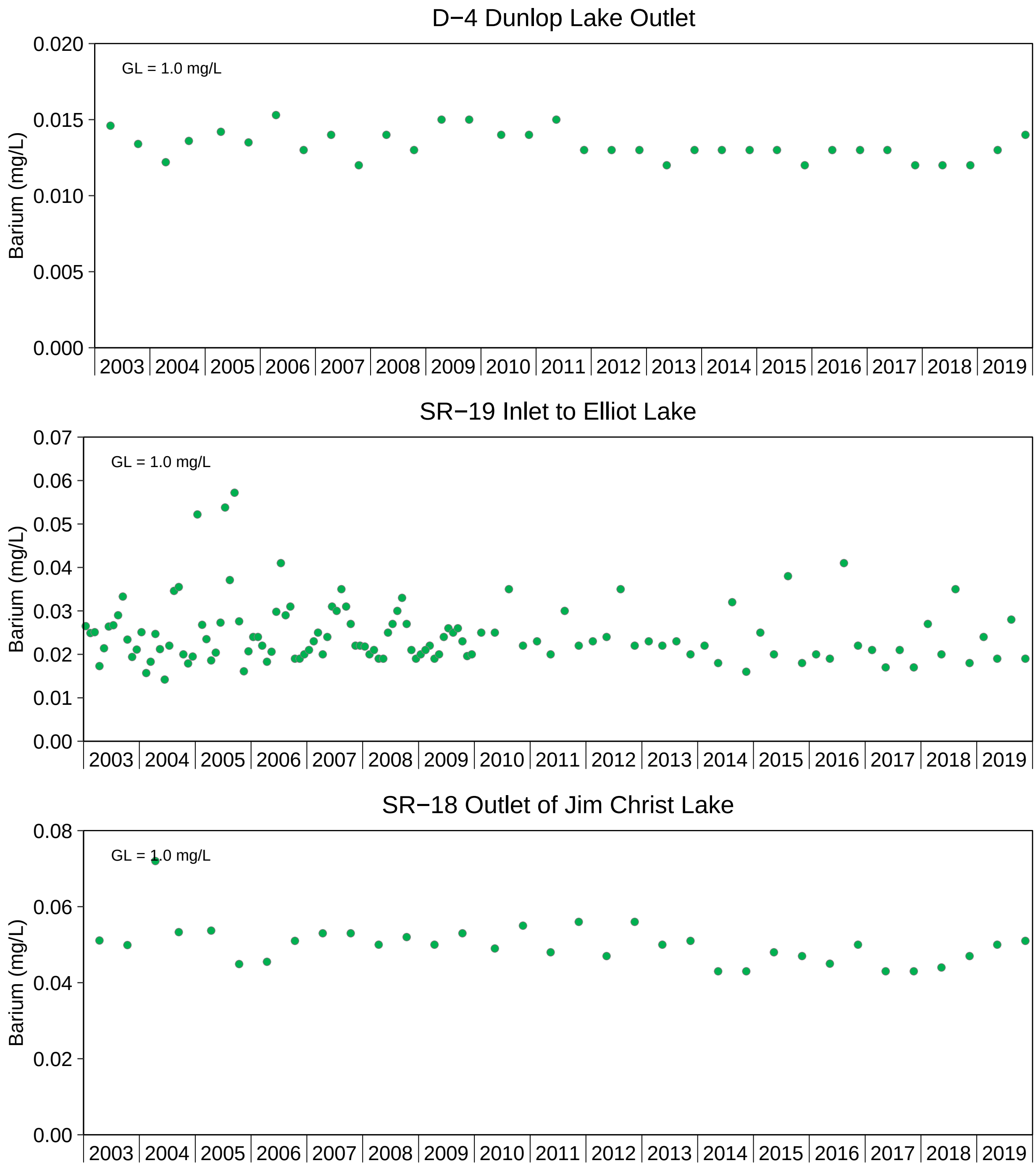


Figure S.1: Barium Concentrations for SRWMP Water Quality Monitoring Stations in the May Lake Sub−Watershed, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guideline = BC Guideline. Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium−226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014. See Appendix Tables S.3 to S.7 for raw data.

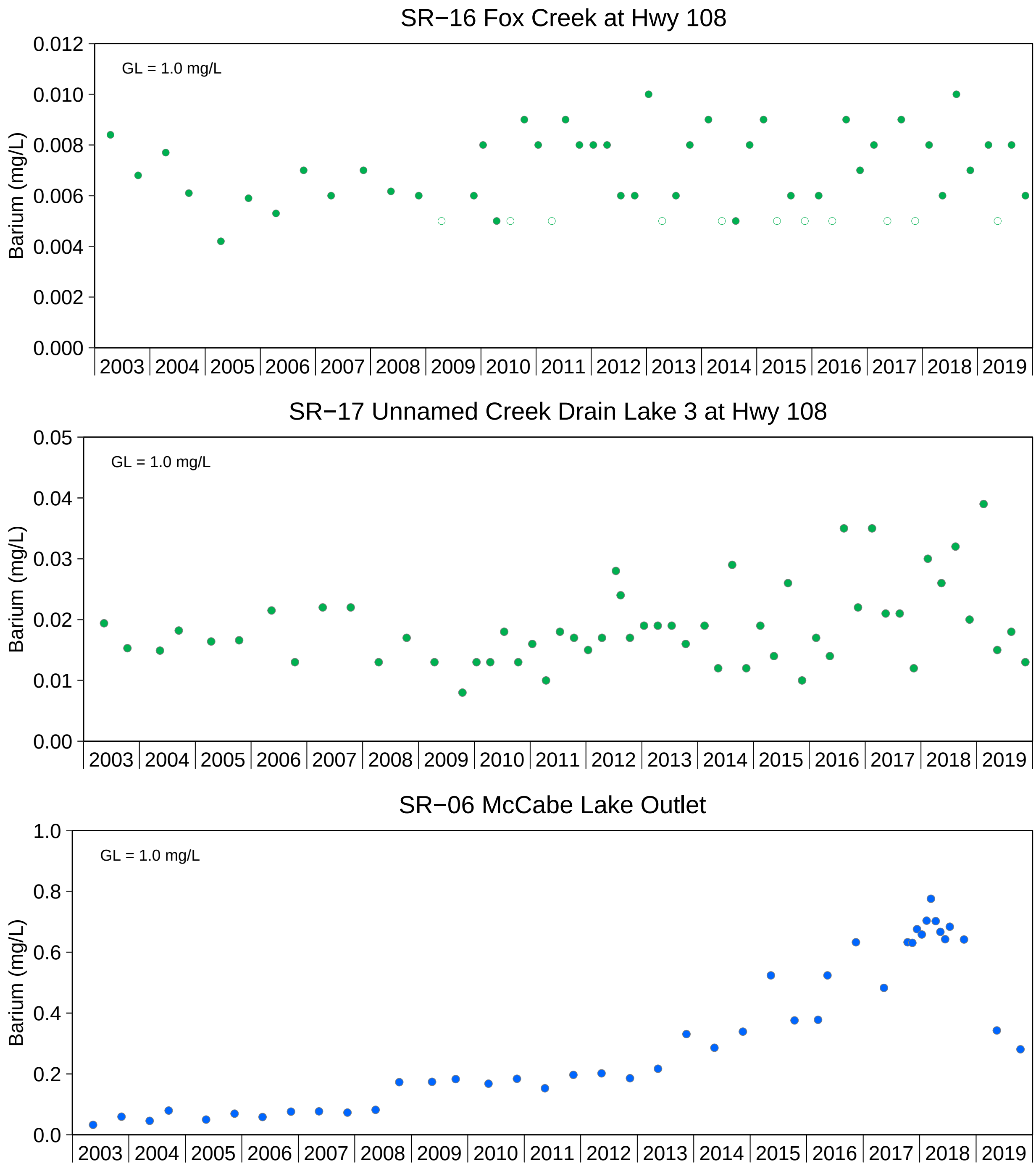


Figure S.1: Barium Concentrations for SRWMP Water Quality Monitoring Stations in the May Lake Sub−Watershed, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guideline = BC Guideline. Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium−226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014. See Appendix Tables S.3 to S.7 for raw data.

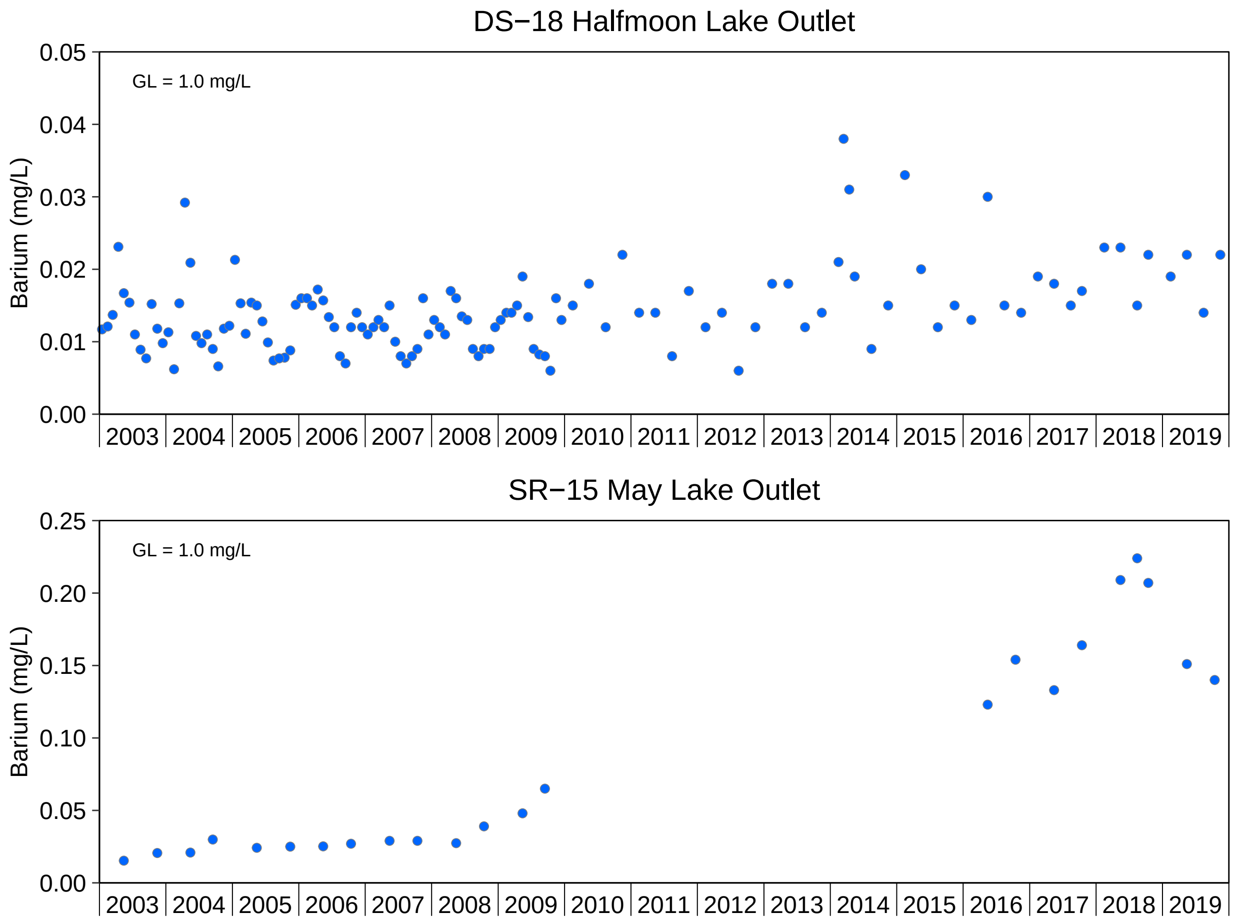


Figure S.1: Barium Concentrations for SRWMP Water Quality Monitoring Stations in the May Lake Sub−Watershed, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guideline = BC Guideline. Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium−226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014. See Appendix Tables S.3 to S.7 for raw data.

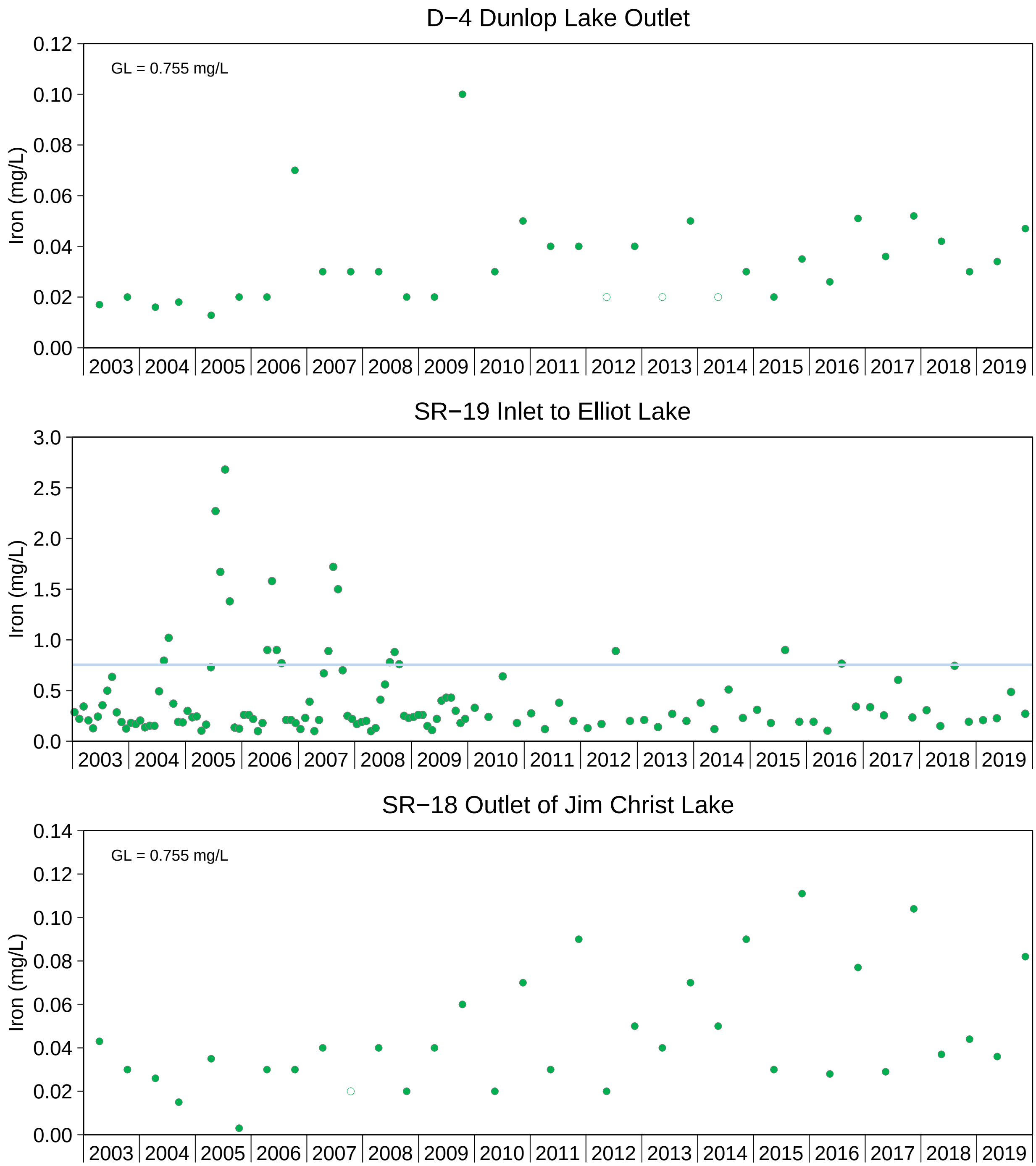


Figure S.2: Iron Concentrations for SRWMP Water Quality Monitoring Stations in the May Lake Sub−Watershed, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guideline = Upper limit of background concentrations (95th percentile) based on data collected from lake reference stations (blue; D−4, SR−18, SR−19) and wetland reference stations (green; SR−16, SR−17) from 2015 to 2019. Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium−226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014. See Appendix Tables S.3 to S.5 and S.7 for raw data.

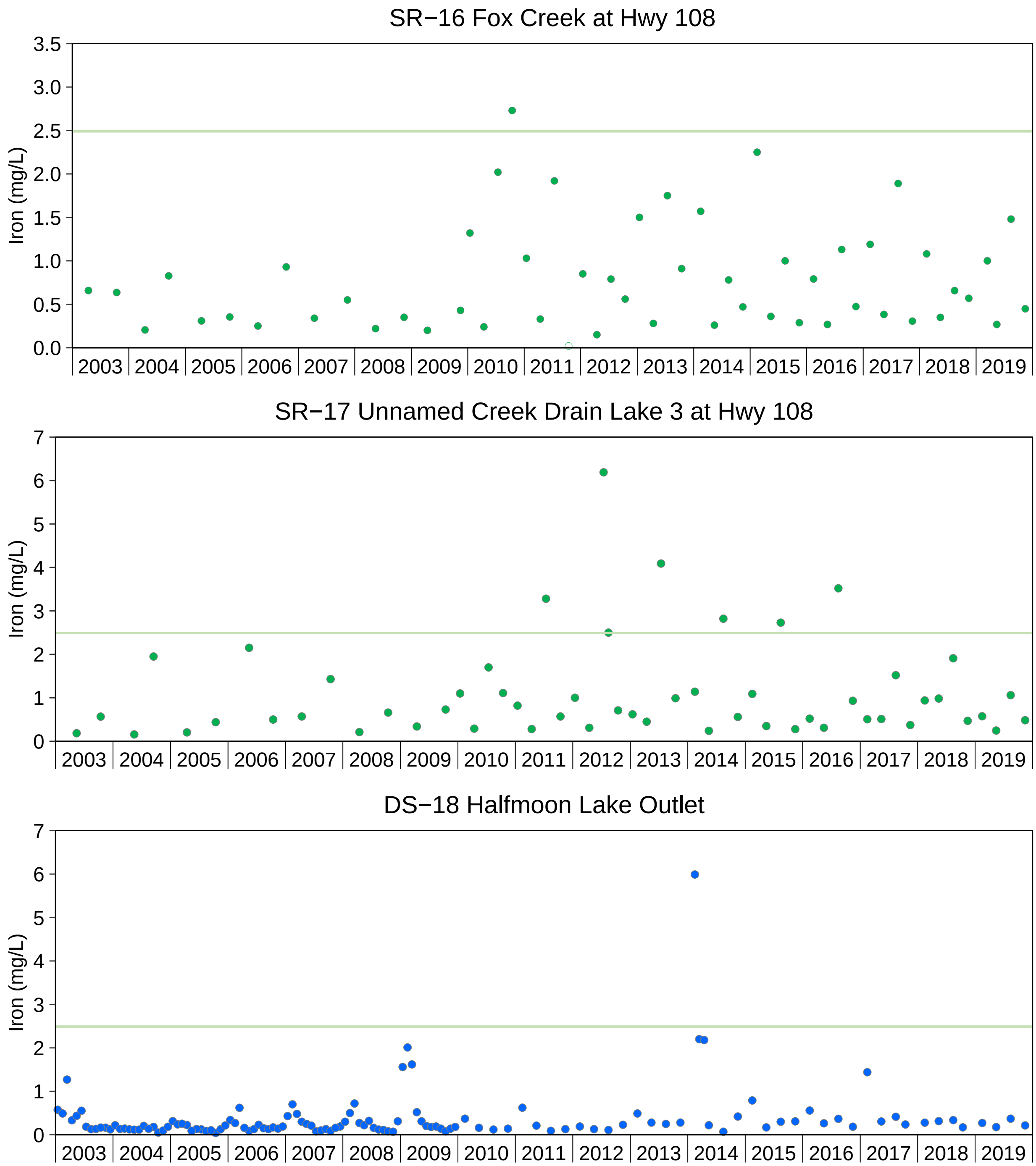


Figure S.2: Iron Concentrations for SRWMP Water Quality Monitoring Stations in the May Lake Sub−Watershed, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guideline = Upper limit of background concentrations (95th percentile) based on data collected from lake reference stations (blue; D−4, SR−18, SR−19) and wetland reference stations (green; SR−16, SR−17) from 2015 to 2019. Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium−226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014. See Appendix Tables S.3 to S.5 and S.7 for raw data.

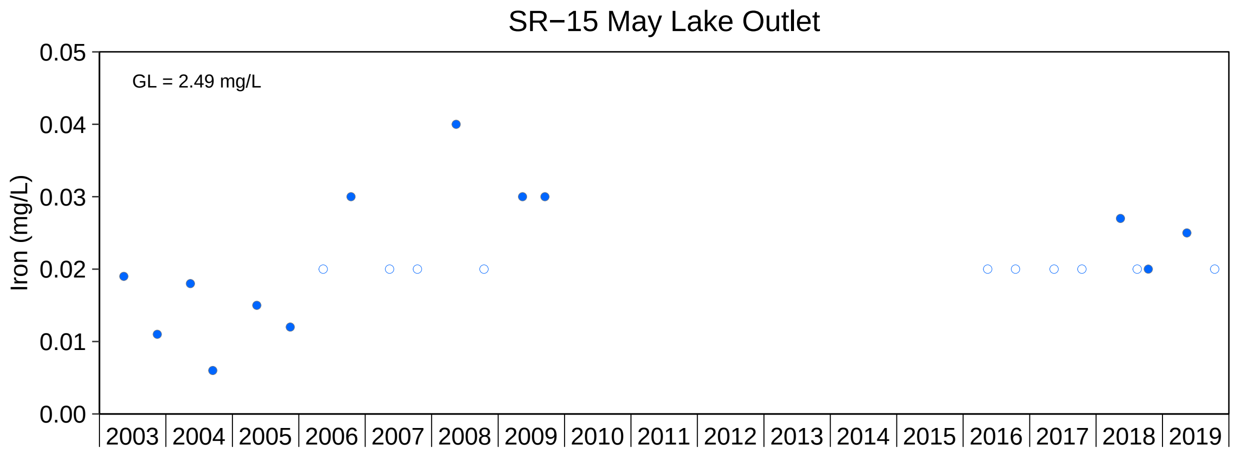


Figure S.2: Iron Concentrations for SRWMP Water Quality Monitoring Stations in the May Lake Sub−Watershed, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guideline = Upper limit of background concentrations (95th percentile) based on data collected from lake reference stations (blue; D−4, SR−18, SR−19) and wetland reference stations (green; SR−16, SR−17) from 2015 to 2019. Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium−226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014. See Appendix Tables S.3 to S.5 and S.7 for raw data.

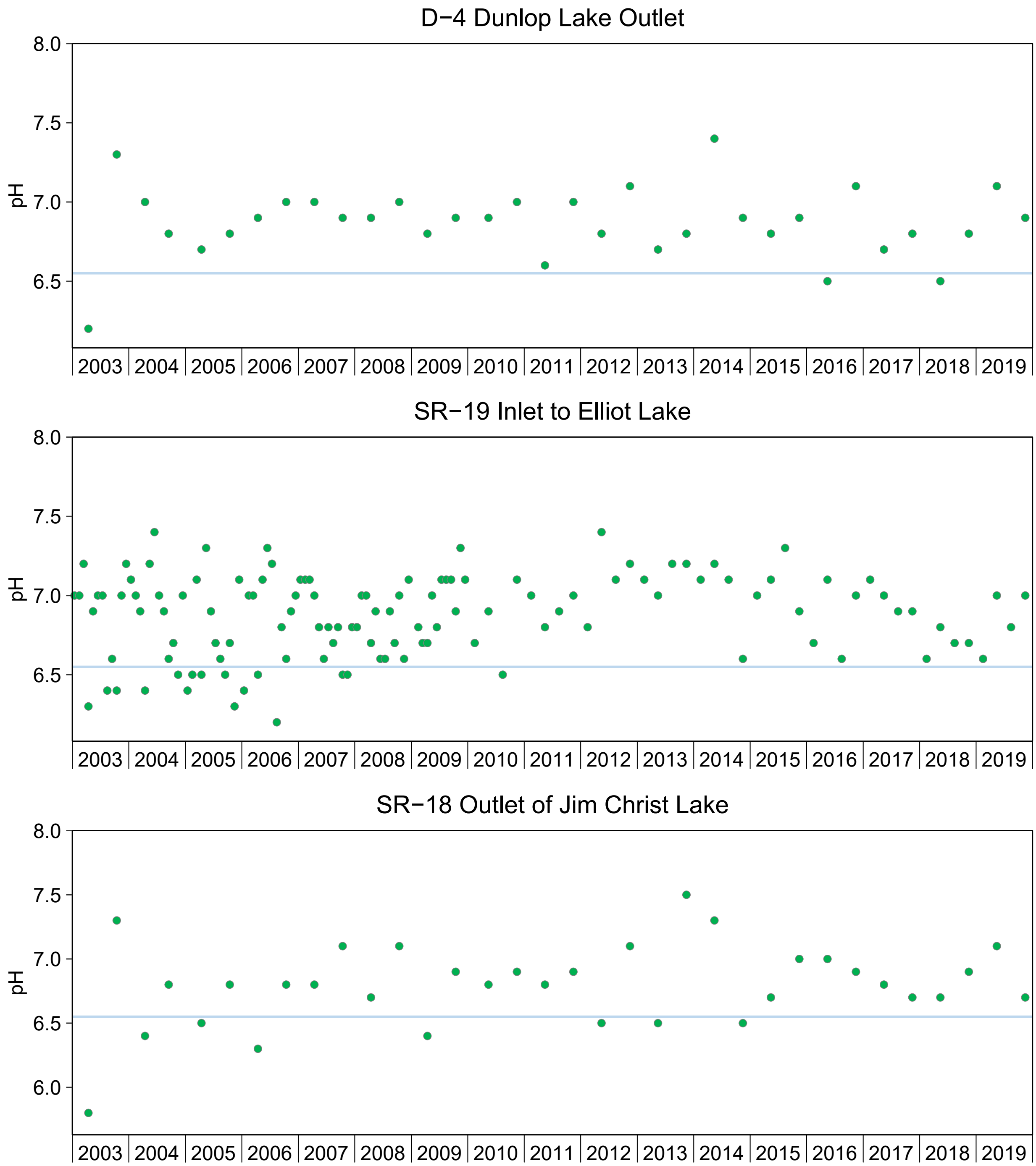


Figure S.3: Field Measurements of pH for SRWMP Water Quality Monitoring Stations in the May Lake Sub−Watershed, 2003 to 2019

Notes: Guideline = Upper limit of background concentrations (95th percentile) based on data collected from lake reference stations (blue; D−4, SR−18, SR−19) and wetland reference stations (green; SR−16, SR−17) from 2015 to 2019. Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium−226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014. See Appendix Tables S.3 to S.7 for raw data.

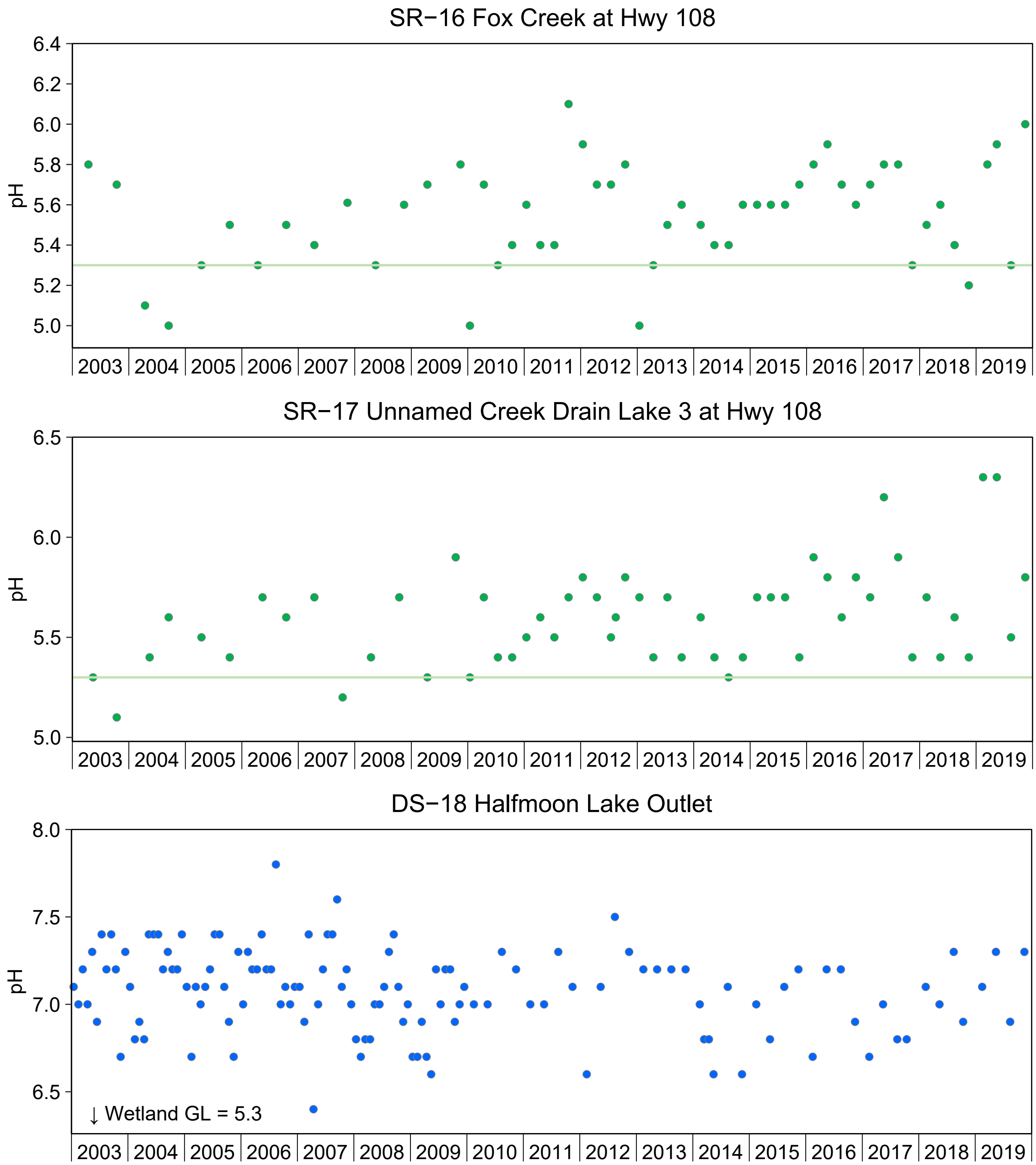


Figure S.3: Field Measurements of pH for SRWMP Water Quality Monitoring Stations in the May Lake Sub−Watershed, 2003 to 2019

Notes: Guideline = Upper limit of background concentrations (95th percentile) based on data collected from lake reference stations (blue; D−4, SR−18, SR−19) and wetland reference stations (green; SR−16, SR−17) from 2015 to 2019. Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium−226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014. See Appendix Tables S.3 to S.7 for raw data.

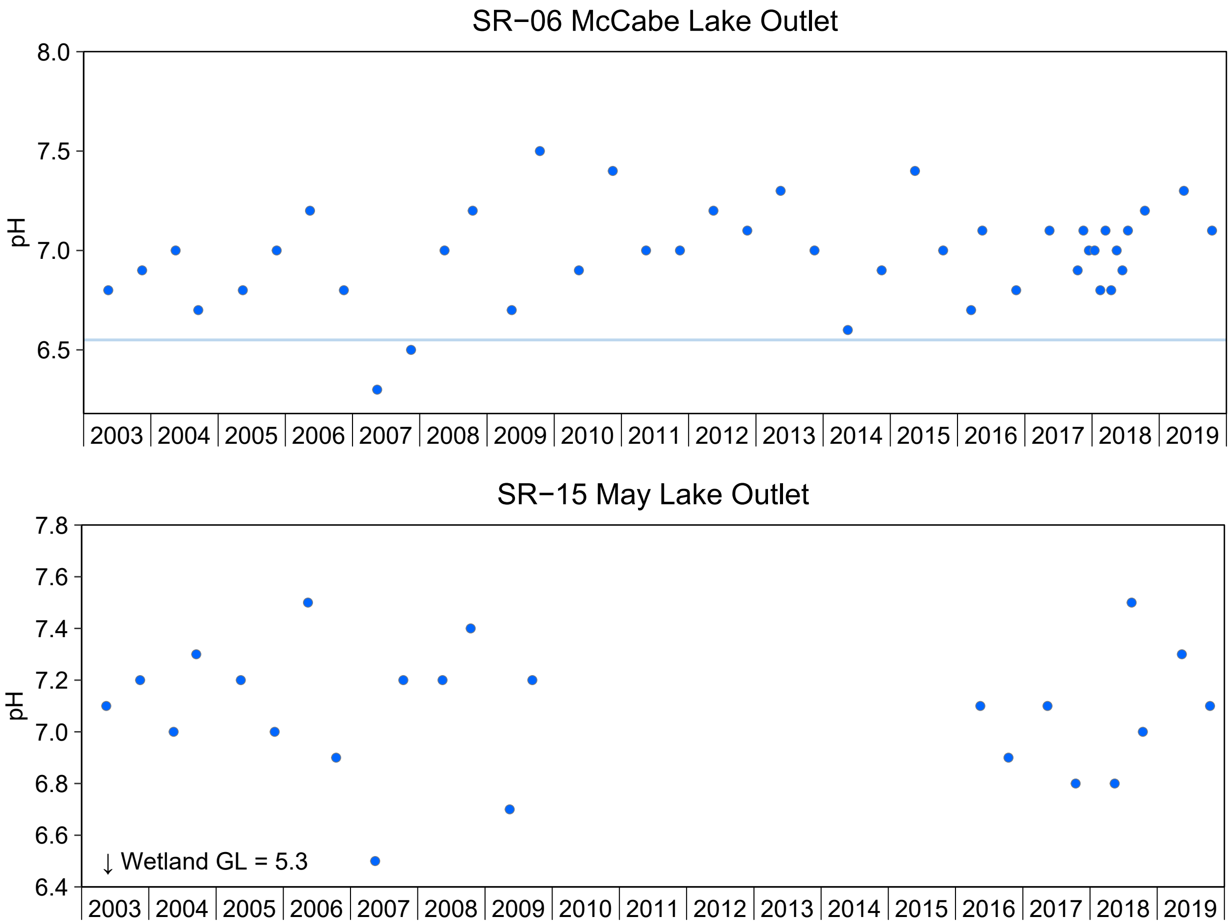


Figure S.3: Field Measurements of pH for SRWMP Water Quality Monitoring Stations in the May Lake Sub−Watershed, 2003 to 2019

Notes: Guideline = Upper limit of background concentrations (95th percentile) based on data collected from lake reference stations (blue; D−4, SR−18, SR−19) and wetland reference stations (green; SR−16, SR−17) from 2015 to 2019. Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium−226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014. See Appendix Tables S.3 to S.7 for raw data.

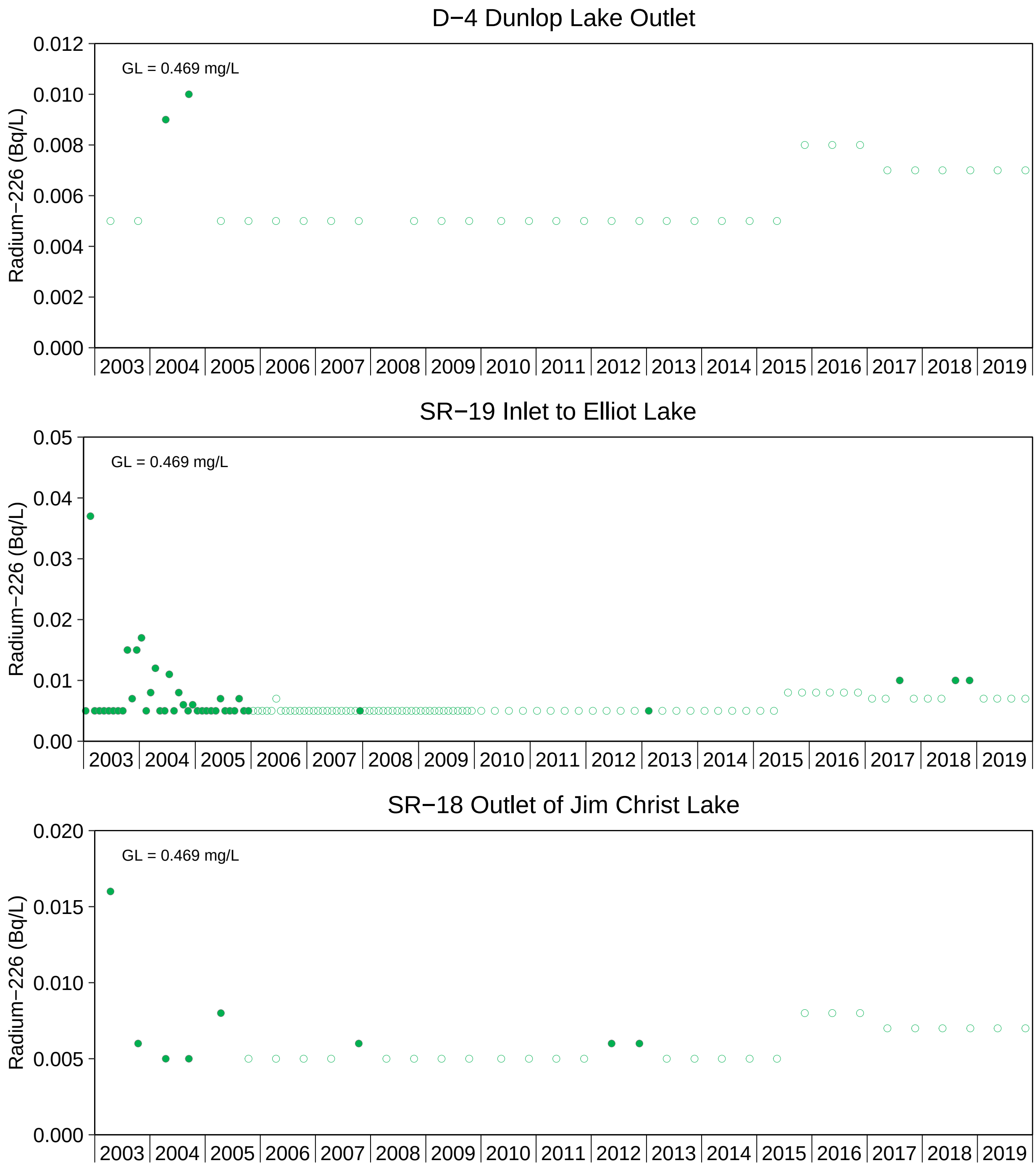


Figure S.4: Radium−226 Concentrations for SRWMP Water Quality Monitoring Stations in the May Lake Sub−Watershed, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guideline = site−specific benchmark. Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium-226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014. Radium (Bq/L) is not included in the trend analysis for SWRMP stations D−4, SR−16, SR−17, SR−18, and SR−19 due to >50% non−detectable concentrations in the dataset. See Appendix Tables S.3 to S.7 for raw data.

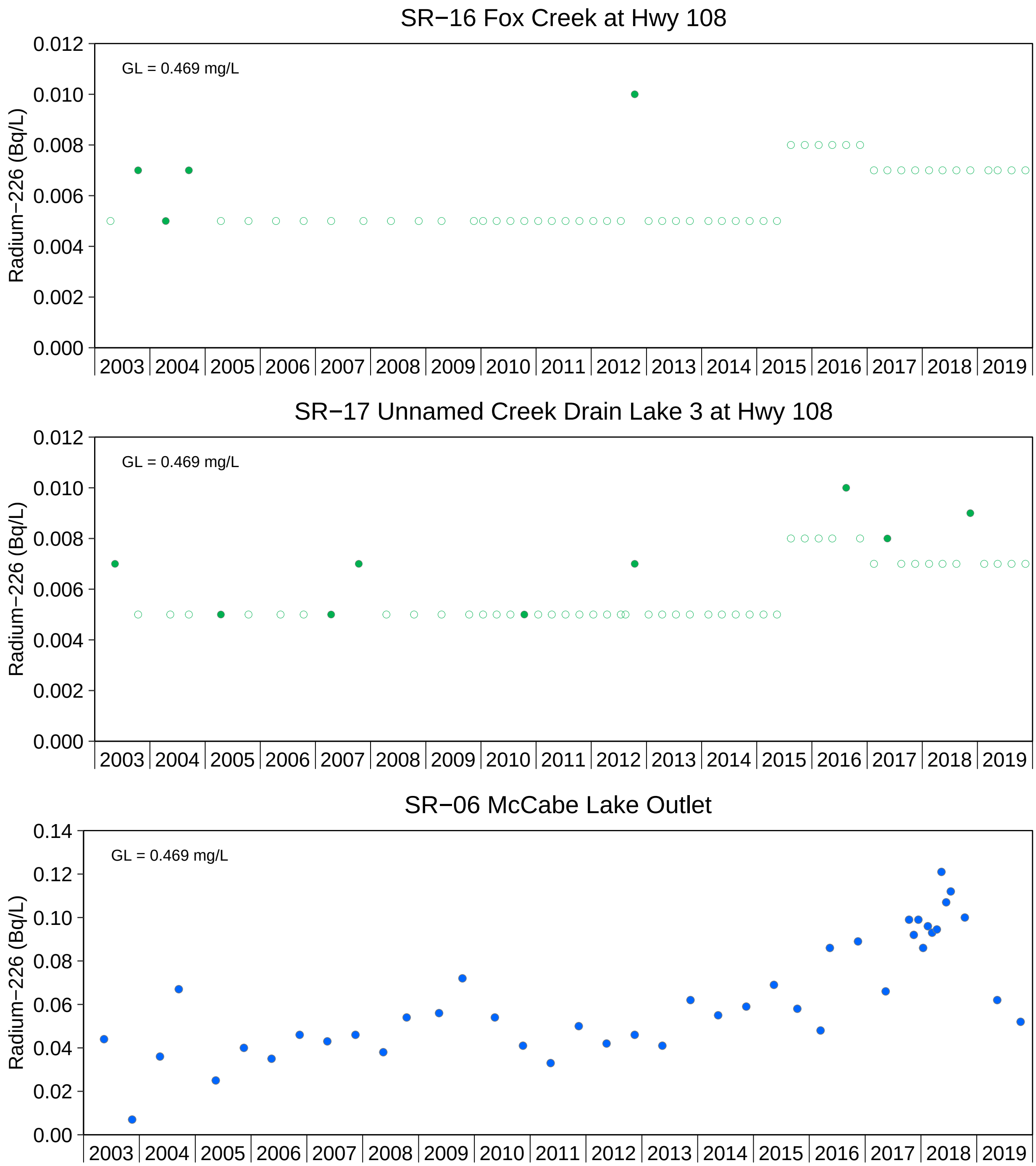


Figure S.4: Radium−226 Concentrations for SRWMP Water Quality Monitoring Stations in the May Lake Sub−Watershed, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guideline = site−specific benchmark. Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium-226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014. Radium (Bq/L) is not included in the trend analysis for SWRMP stations D−4, SR−16, SR−17, SR−18, and SR−19 due to >50% non−detectable concentrations in the dataset. See Appendix Tables S.3 to S.7 for raw data.

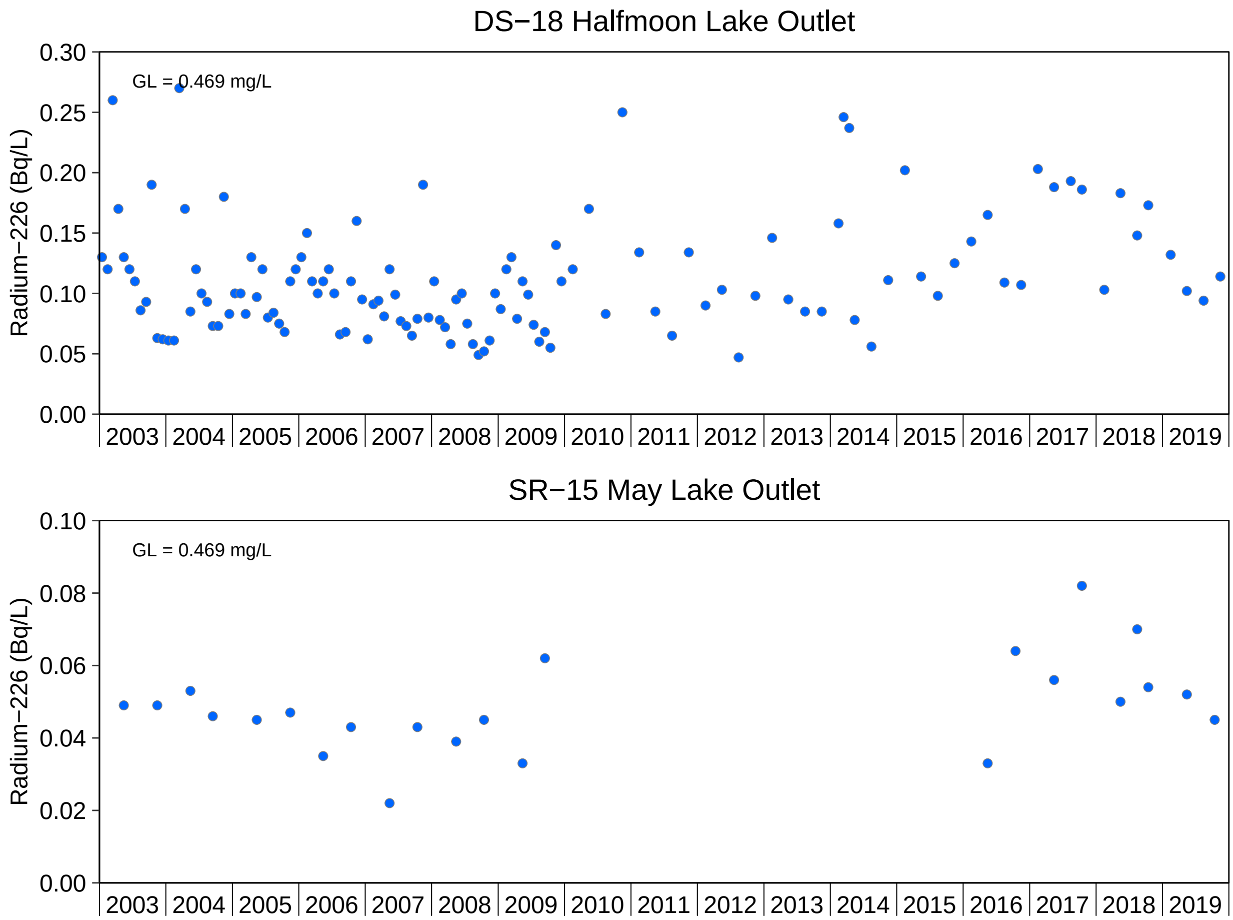


Figure S.4: Radium−226 Concentrations for SRWMP Water Quality Monitoring Stations in the May Lake Sub−Watershed, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guideline = site−specific benchmark. Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium-226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014. Radium (Bq/L) is not included in the trend analysis for SWRMP stations D−4, SR−16, SR−17, SR−18, and SR−19 due to >50% non−detectable concentrations in the dataset. See Appendix Tables S.3 to S.7 for raw data.

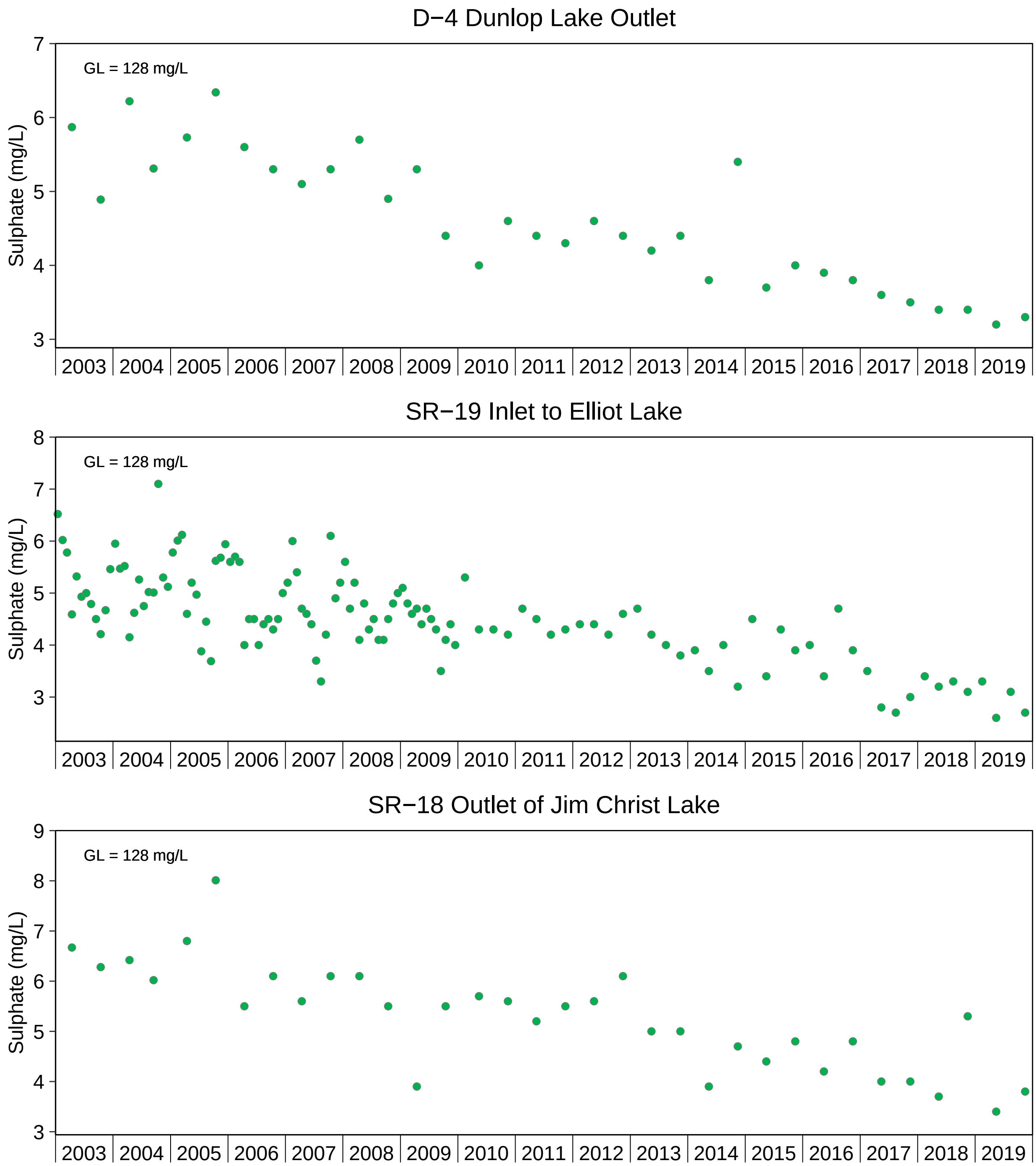


Figure S.5: Sulphate Concentrations for SWRMP Water Quality Monitoring Stations in the May Lake Sub−Watershed, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guideline = BC Guideline (hardness dependent, see Appendix S.1 and S.2). Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium−226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014. See Appendix Tables S.3 to S.7 for raw data.

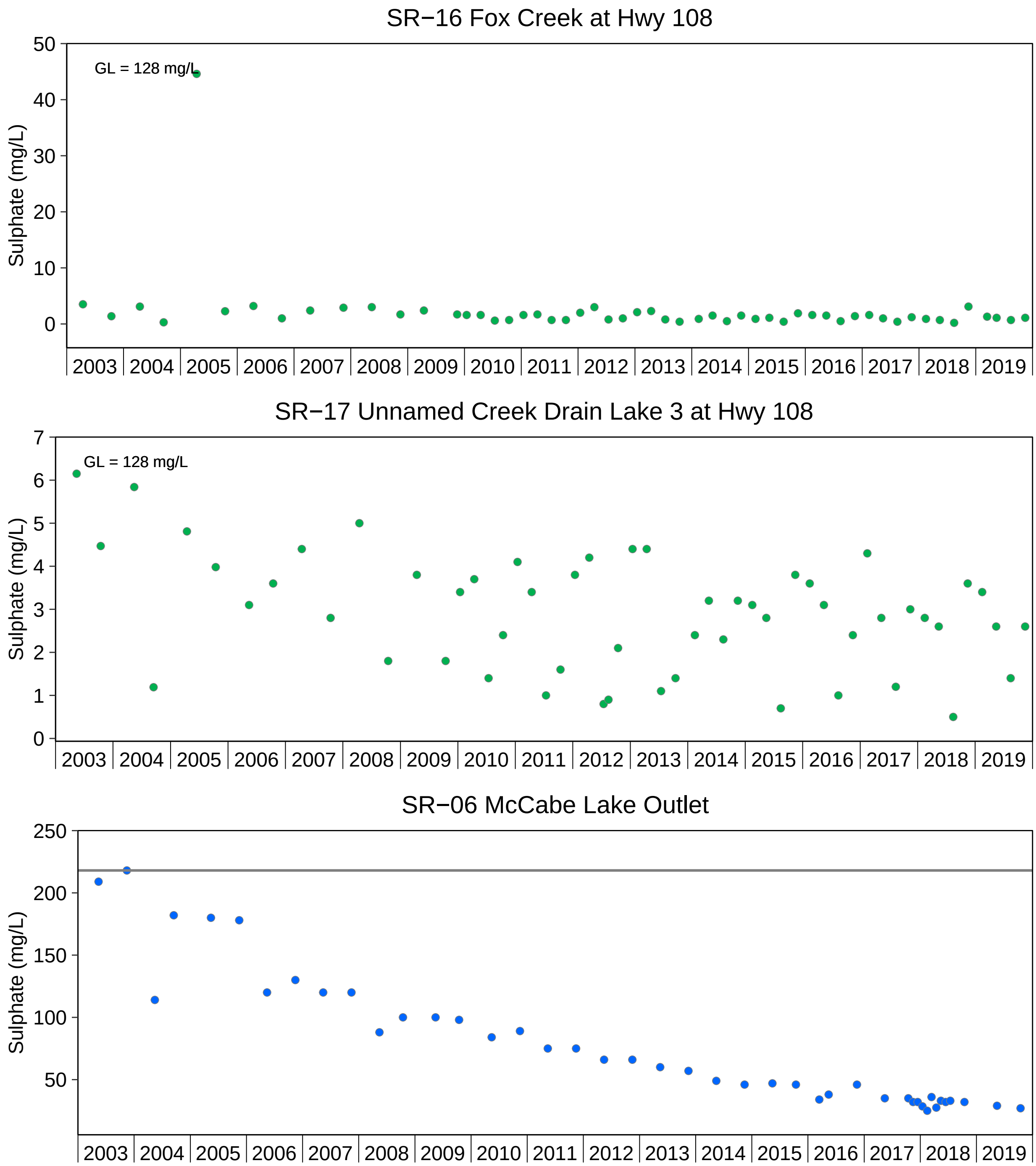


Figure S.5: Sulphate Concentrations for SWRMP Water Quality Monitoring Stations in the May Lake Sub−Watershed, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guideline = BC Guideline (hardness dependent, see Appendix S.1 and S.2). Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium−226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014. See Appendix Tables S.3 to S.7 for raw data.

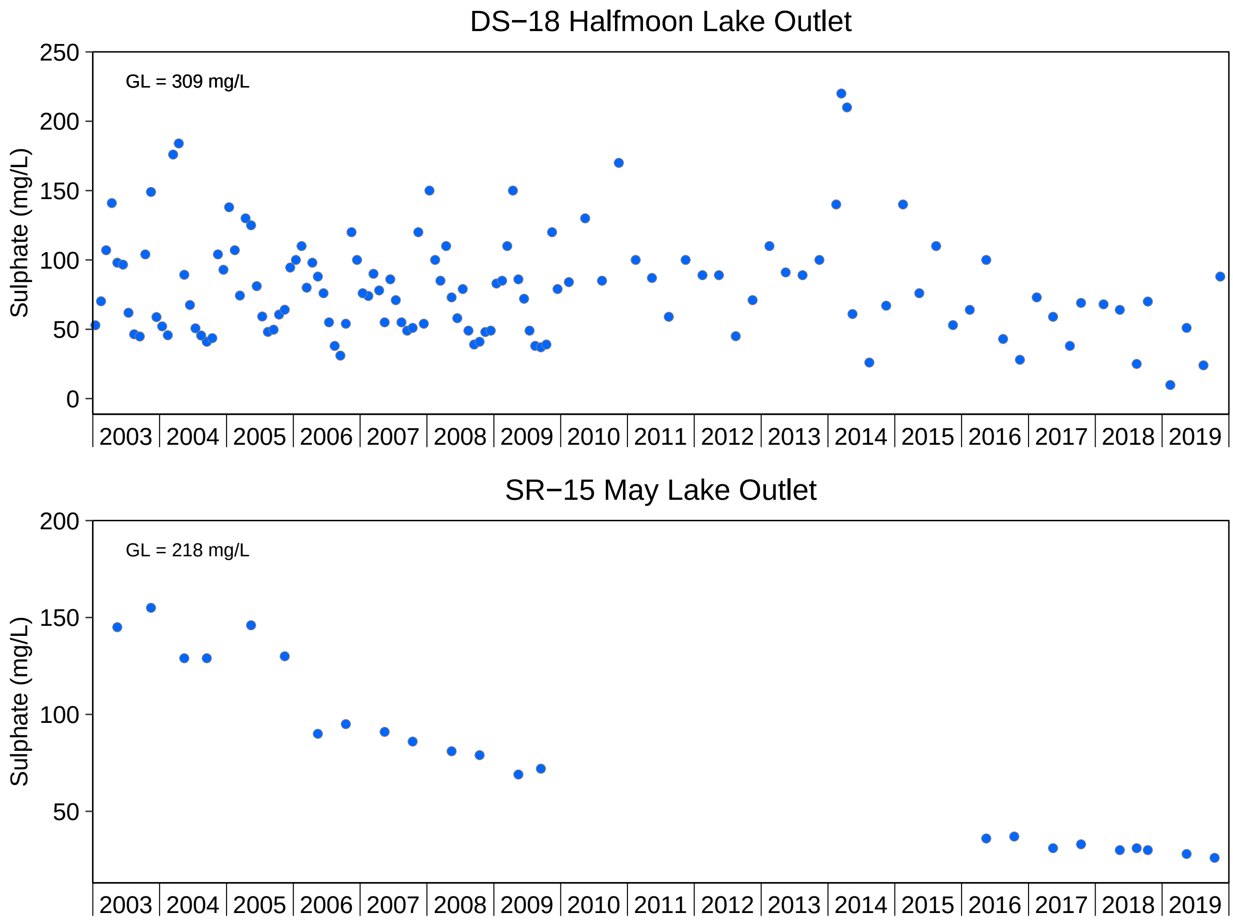


Figure S.5: Sulphate Concentrations for SWRMP Water Quality Monitoring Stations in the May Lake Sub−Watershed, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guideline = BC Guideline (hardness dependent, see Appendix S.1 and S.2). Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium−226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014. See Appendix Tables S.3 to S.7 for raw data.

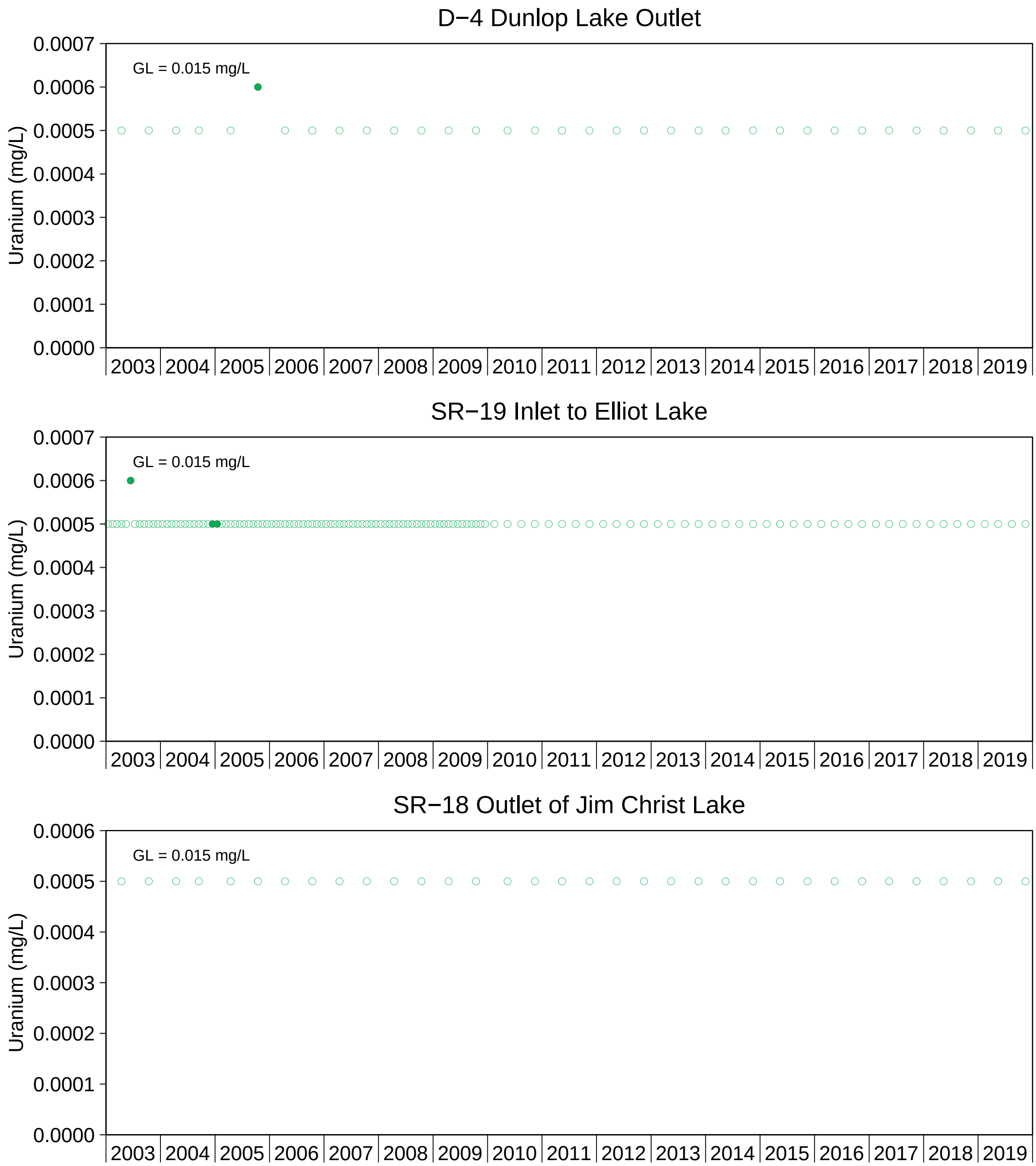
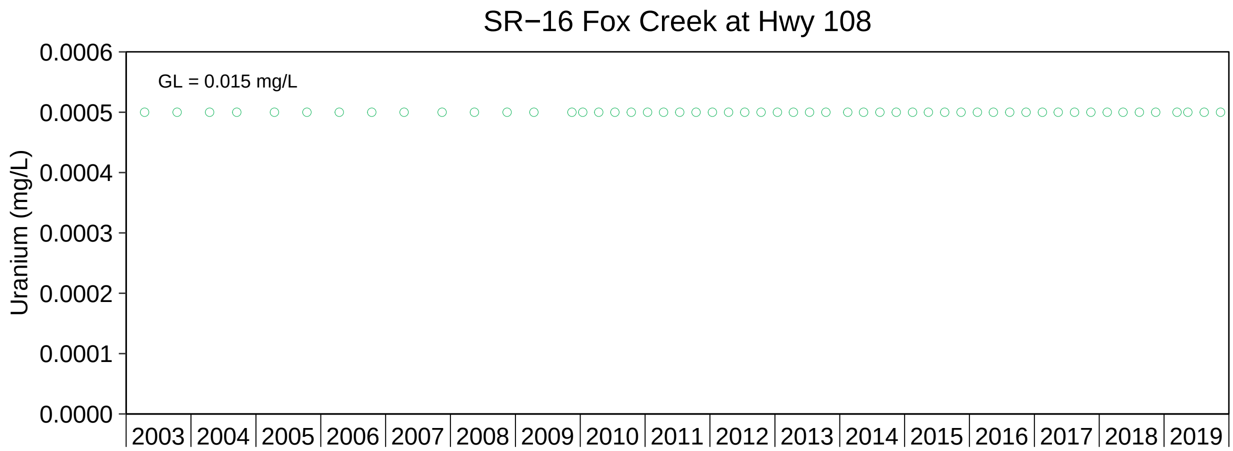
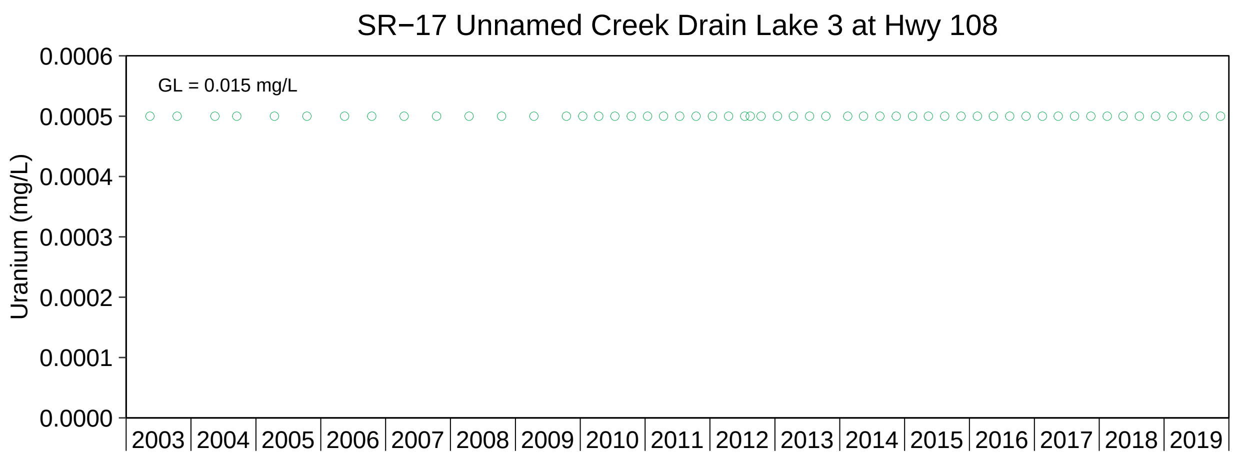


Figure S.6: Uranium Concentrations for SRWMP Water Quality Monitoring Stations in the May Lake Sub−Watershed, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guideline = Federal Guideline. Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium −226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014. Uranium (mg/L) is not included in the trend analysis for SWRMP stations D−4, SR−16, SR−17, SR−18, and SR−19 due to >50%non −detectable concentrations in the dataset. See Appendix Tables S.3 to S.7 for raw data.





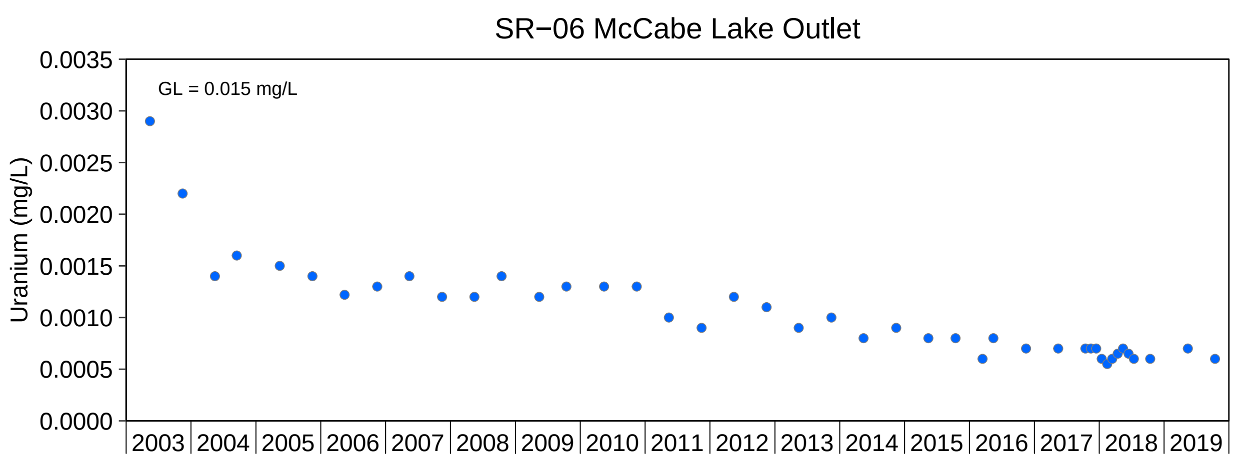


Figure S.6: Uranium Concentrations for SRWMP Water Quality Monitoring Stations in the May Lake Sub−Watershed, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guideline = Federal Guideline. Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium −226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014. Uranium (mg/L) is not included in the trend analysis for SWRMP stations D−4, SR−16, SR−17, SR−18, and SR−19 due to >50%non −detectable concentrations in the dataset. See Appendix Tables S.3 to S.7 for raw data.

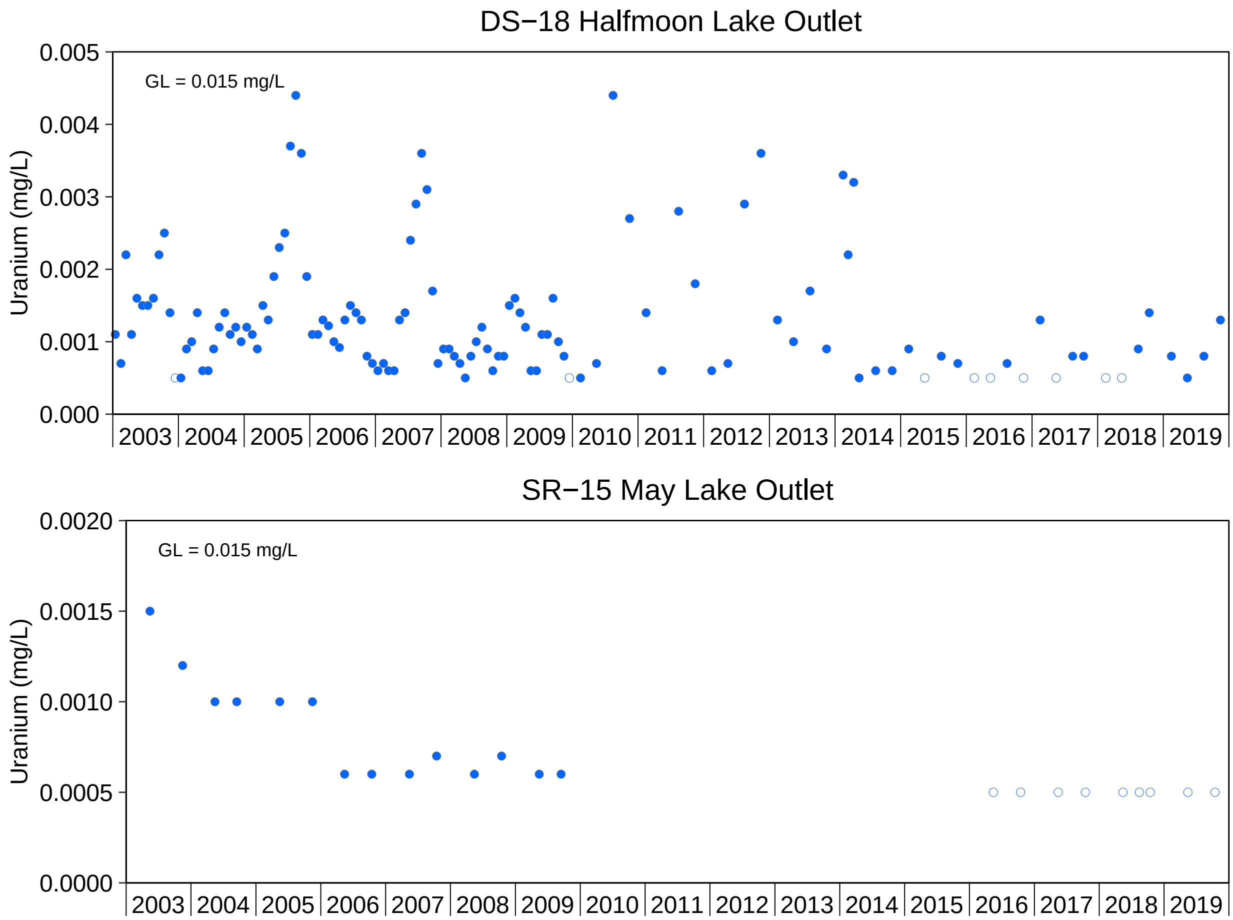


Figure S.6: Uranium Concentrations for SRWMP Water Quality Monitoring Stations in the May Lake Sub−Watershed, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guideline = Federal Guideline. Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium −226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014. Uranium (mg/L) is not included in the trend analysis for SWRMP stations D−4, SR−16, SR−17, SR−18, and SR−19 due to >50%non −detectable concentrations in the dataset. See Appendix Tables S.3 to S.7 for raw data.

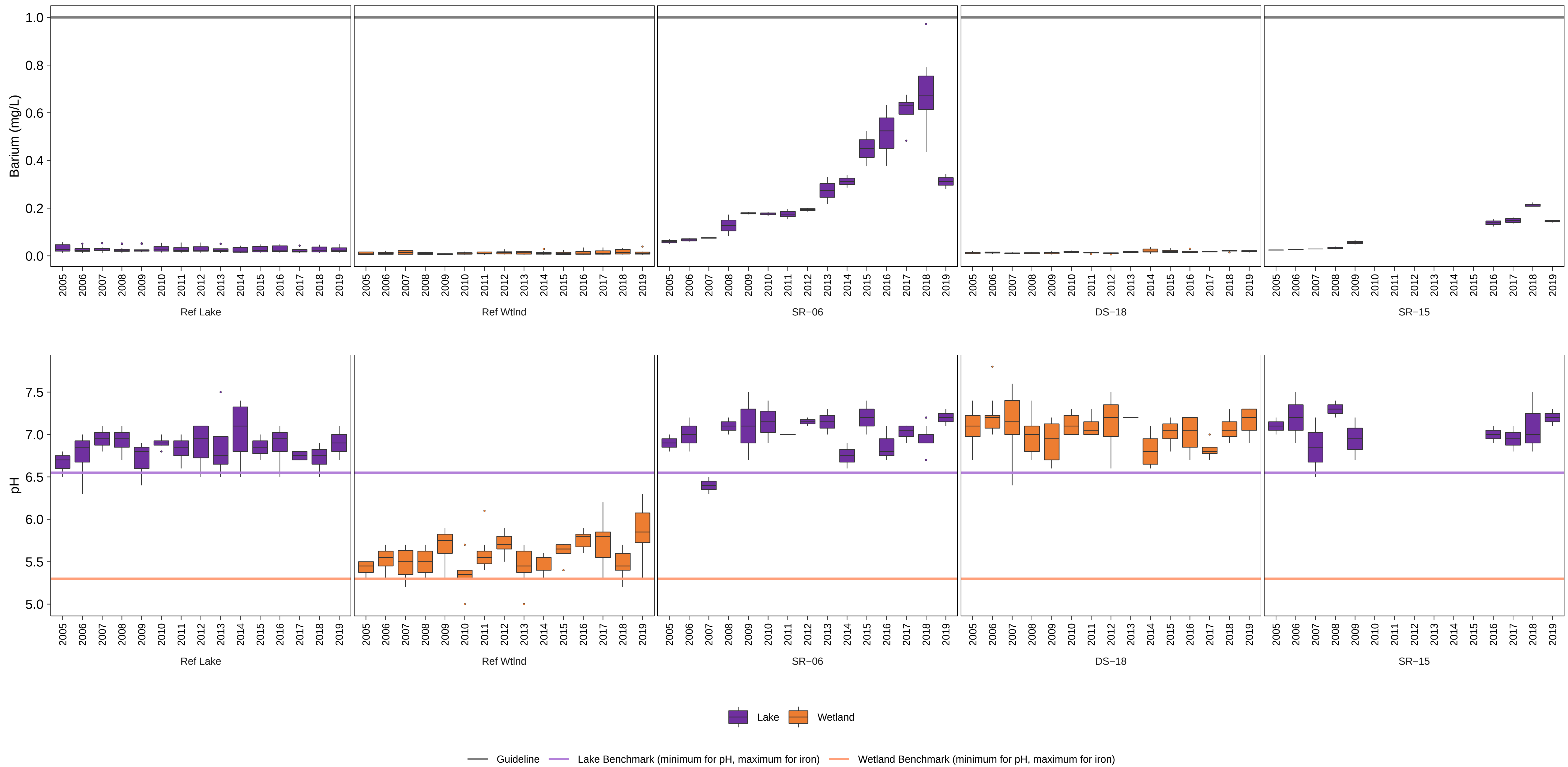


Figure S.7: Concentration of Metals in Water from the May Lake Sub−watershed Compared to Reference Areas and Benchmarks, SRWMP, 2005 to 2019

Notes: Boxes represent the interquartile range (IQR; 25th to 75th percentile) with the median designated as a solid horizontal line within the IQR. Vertical lines extend 1.5 x IQR above and below each respective percentile with values beyond this range designated with a *. Parameters with no variation for a given year will result in a single horizontal line (i.e., 25th, median, and 75th percentile are all the same value). ND denotes parameter not assessed for this station, as per study design. For pH and iron, Station DS−18 is compared to the wetland benchmark, while stations SR−06 and SR−15 are compared to the lake benchmark. See Appendix Tables S.3 to S.7 for raw data. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium−226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014.

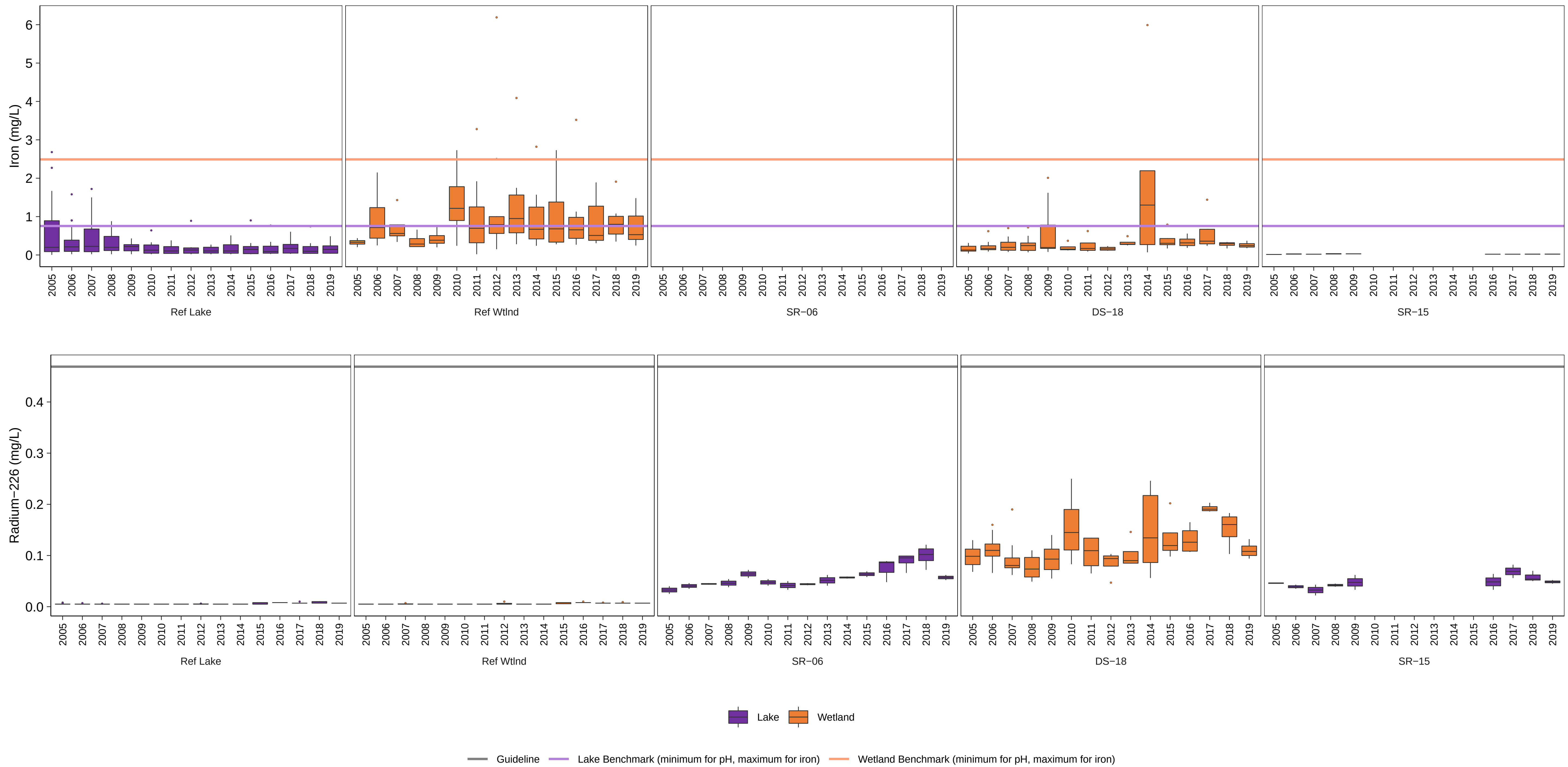


Figure S.7: Concentration of Metals in Water from the May Lake Sub−watershed Compared to Reference Areas and Benchmarks, SRWMP, 2005 to 2019

Notes: Boxes represent the interquartile range (IQR; 25th to 75th percentile) with the median designated as a solid horizontal line within the IQR. Vertical lines extend 1.5 x IQR above and below each respective percentile with values beyond this range designated with a *. Parameters with no variation for a given year will result in a single horizontal line (i.e., 25th, median, and 75th percentile are all the same value). ND denotes parameter not assessed for this station, as per study design. For pH and iron, Station DS−18 is compared to the wetland benchmark, while stations SR−06 and SR−15 are compared to the lake benchmark. See Appendix Tables S.3 to S.7 for raw data. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium−226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014.

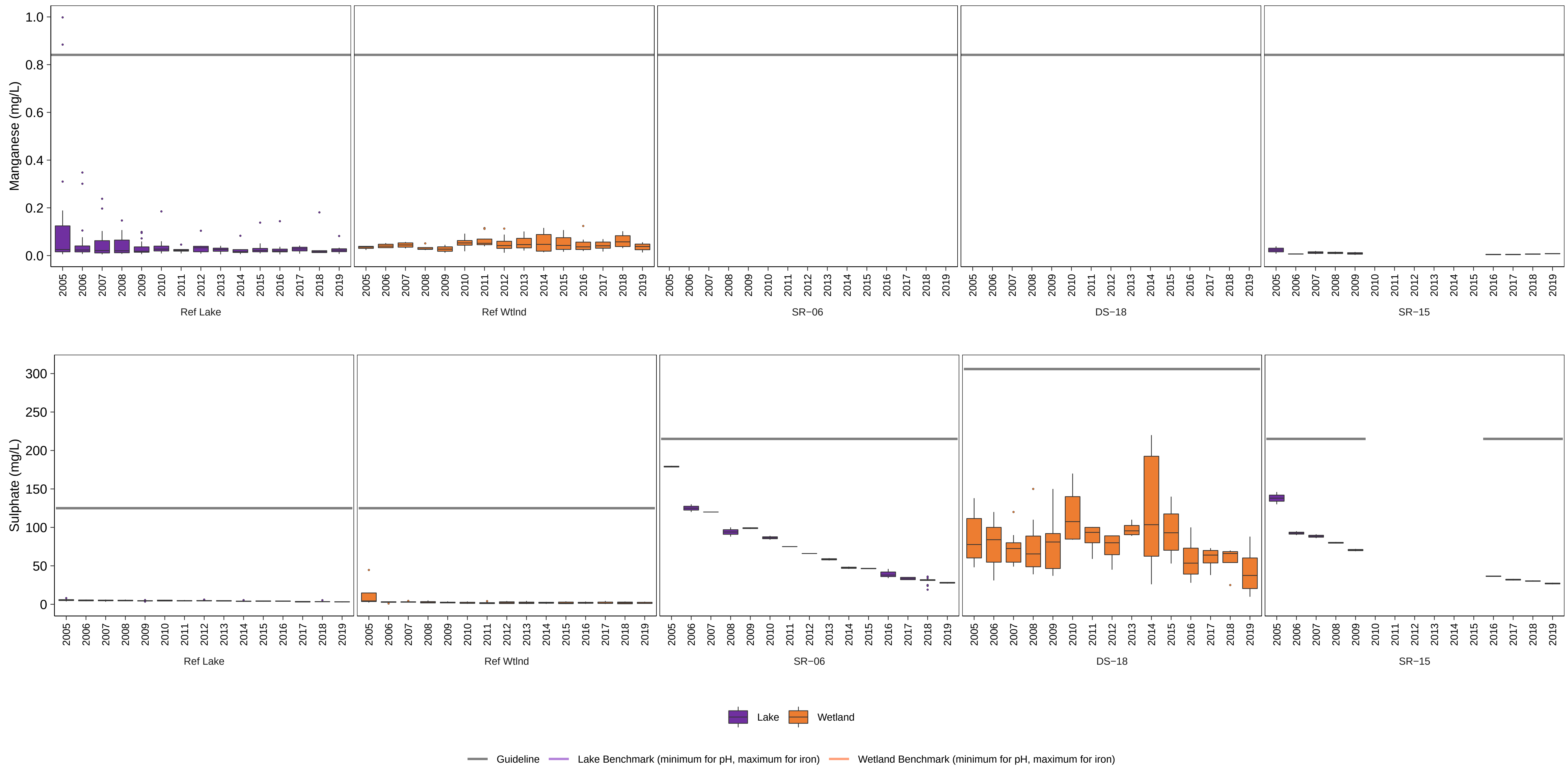


Figure S.7: Concentration of Metals in Water from the May Lake Sub−watershed Compared to Reference Areas and Benchmarks, SRWMP, 2005 to 2019

Notes: Boxes represent the interquartile range (IQR; 25th to 75th percentile) with the median designated as a solid horizontal line within the IQR. Vertical lines extend 1.5 x IQR above and below each respective percentile with values beyond this range designated with a *. Parameters with no variation for a given year will result in a single horizontal line (i.e., 25th, median, and 75th percentile are all the same value). ND denotes parameter not assessed for this station, as per study design. For pH and iron, Station DS−18 is compared to the wetland benchmark, while stations SR−06 and SR−15 are compared to the lake benchmark. See Appendix Tables S.3 to S.7 for raw data. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium−226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014.

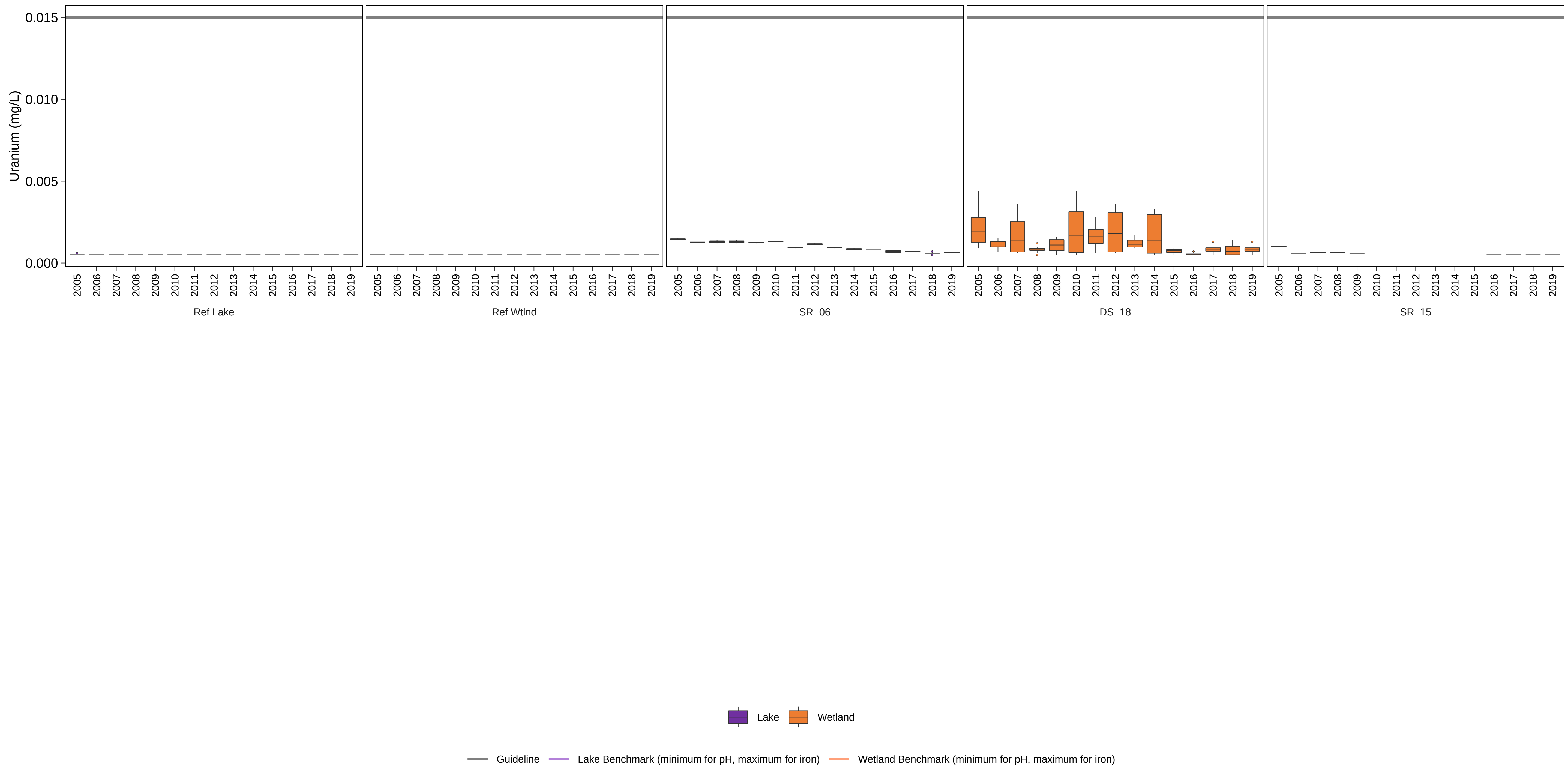


Figure S.7: Concentration of Metals in Water from the May Lake Sub−watershed Compared to Reference Areas and Benchmarks, SRWMP, 2005 to 2019

Notes: Boxes represent the interquartile range (IQR; 25th to 75th percentile) with the median designated as a solid horizontal line within the IQR. Vertical lines extend 1.5 x IQR above and below each respective percentile with values beyond this range designated with a *. Parameters with no variation for a given year will result in a single horizontal line (i.e., 25th, median, and 75th percentile are all the same value). ND denotes parameter not assessed for this station, as per study design. For pH and iron, Station DS−18 is compared to the wetland benchmark, while stations SR−06 and SR−15 are compared to the lake benchmark. See Appendix Tables S.3 to S.7 for raw data. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium−226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014.

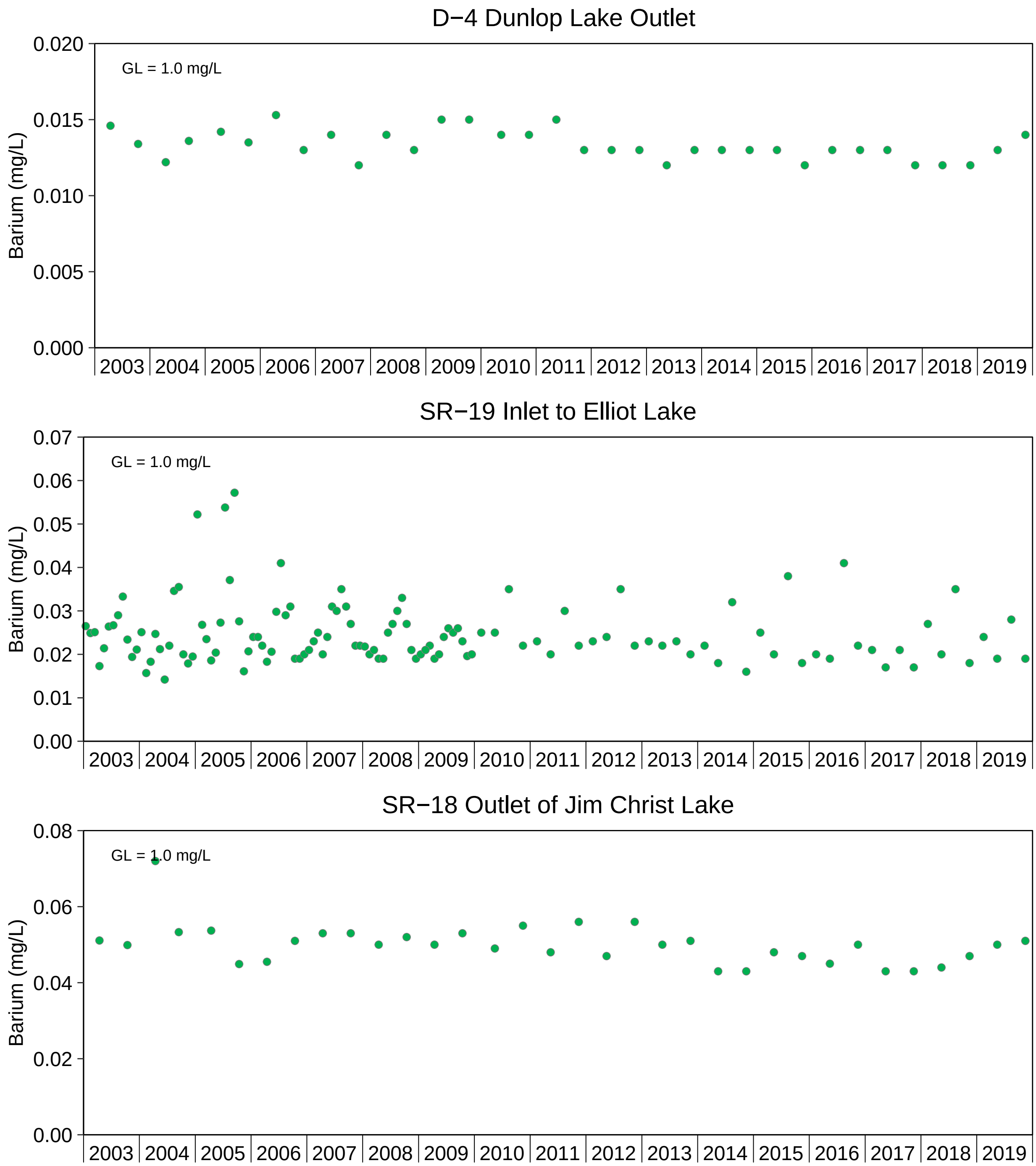
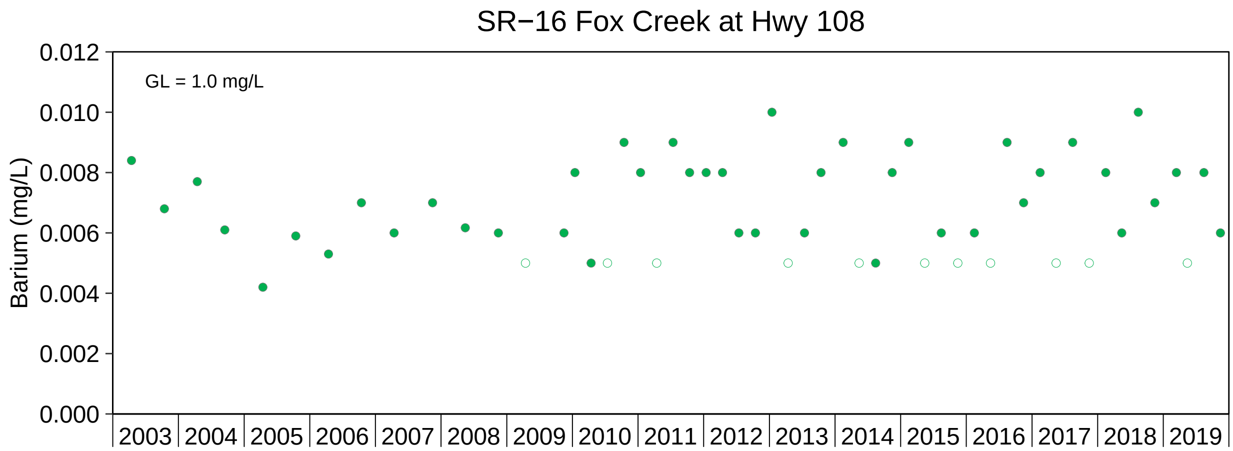
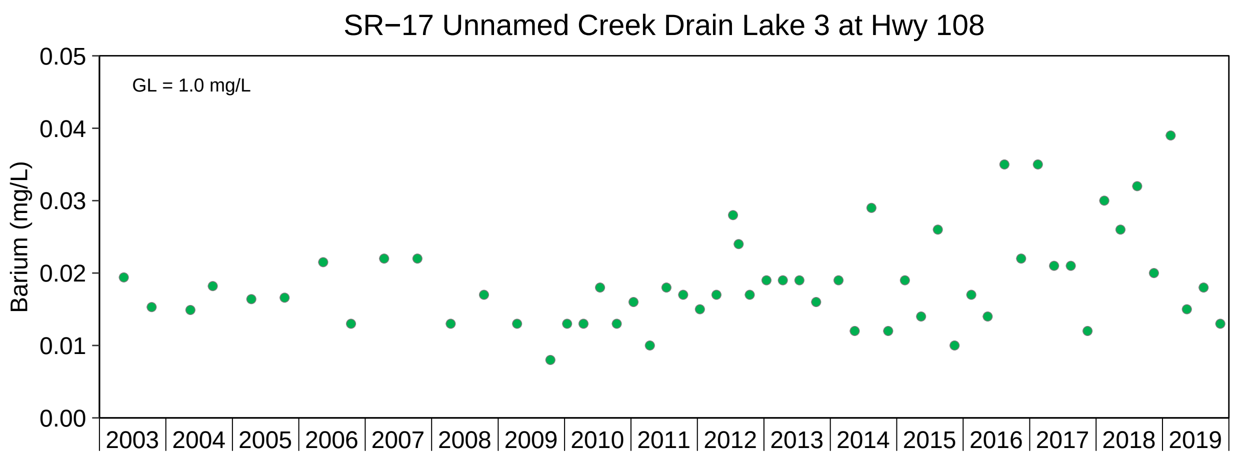


Figure S.8: Barium Concentrations for SRWMP Water Quality Monitoring Stations for the Quirke Lake Sub−Watershed, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guideline = BC Guideline. Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium-226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014.
See Appendix Tables S.3 to S.4, S.8 to S.12 for raw data.





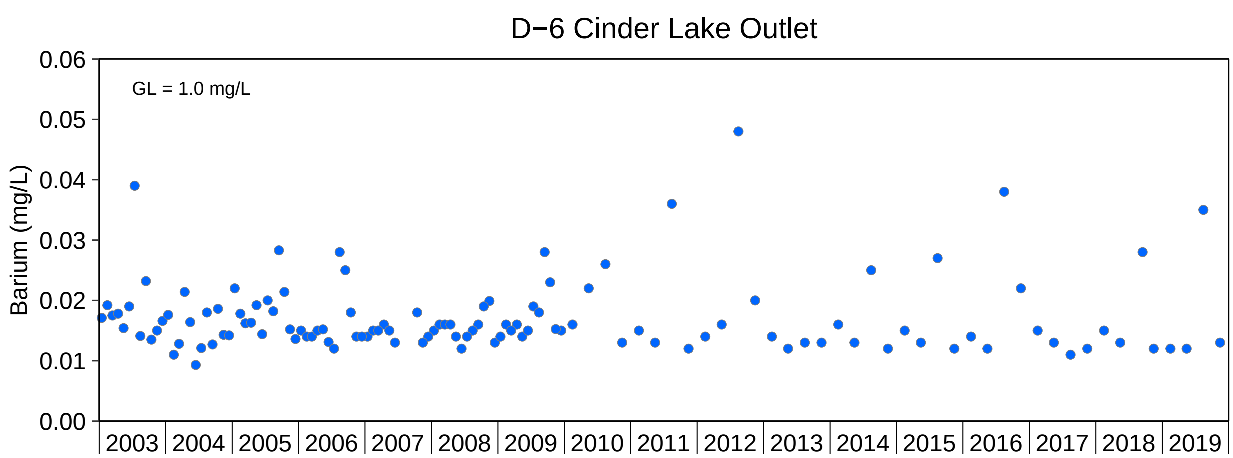


Figure S.8: Barium Concentrations for SRWMP Water Quality Monitoring Stations for the Quirke Lake Sub−Watershed, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guideline = BC Guideline. Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium-226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014.
See Appendix Tables S.3 to S.4, S.8 to S.12 for raw data.

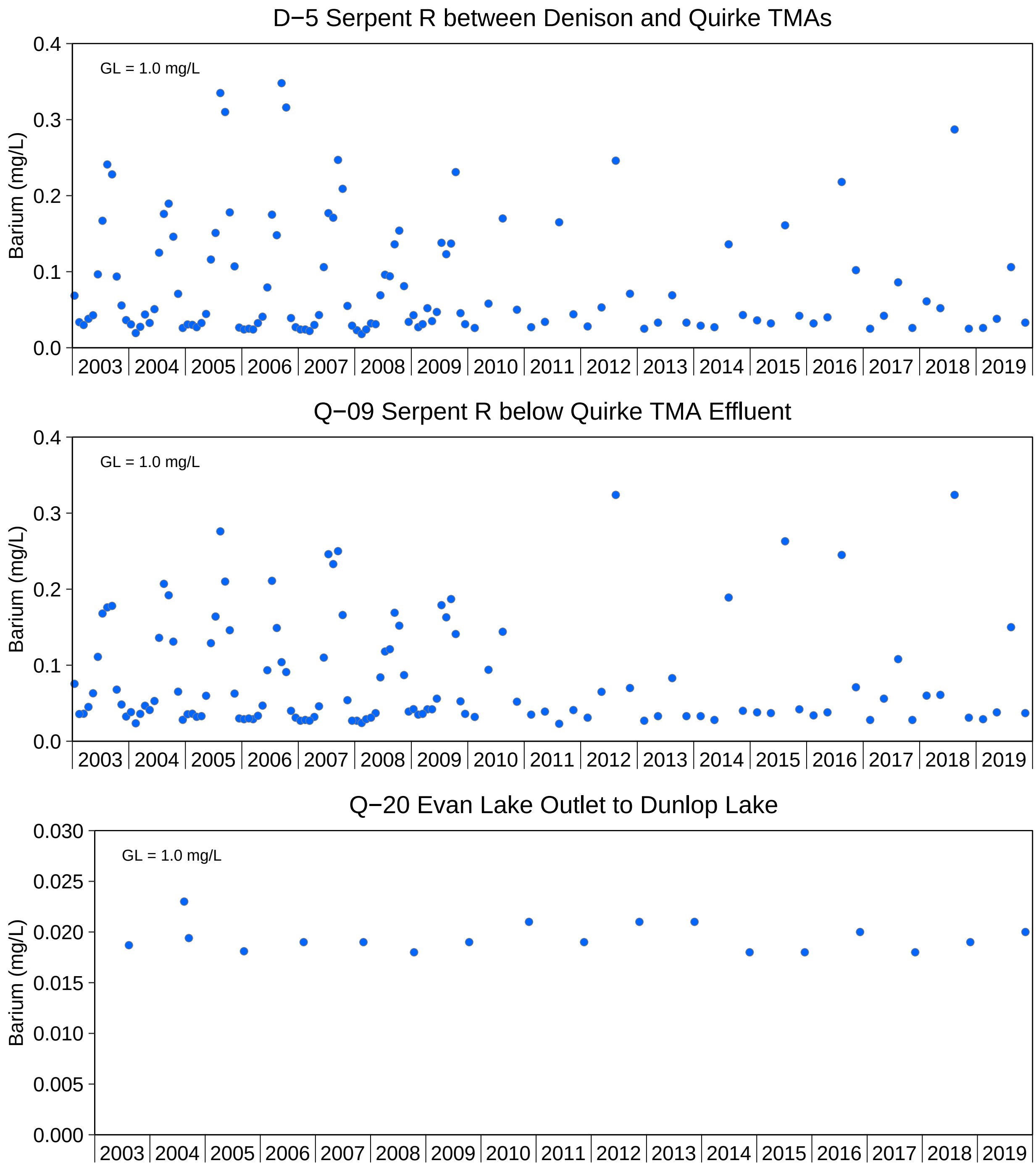


Figure S.8: Barium Concentrations for SRWMP Water Quality Monitoring Stations for the Quirke Lake Sub−Watershed, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guideline = BC Guideline. Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium-226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014.
See Appendix Tables S.3 to S.4, S.8 to S.12 for raw data.

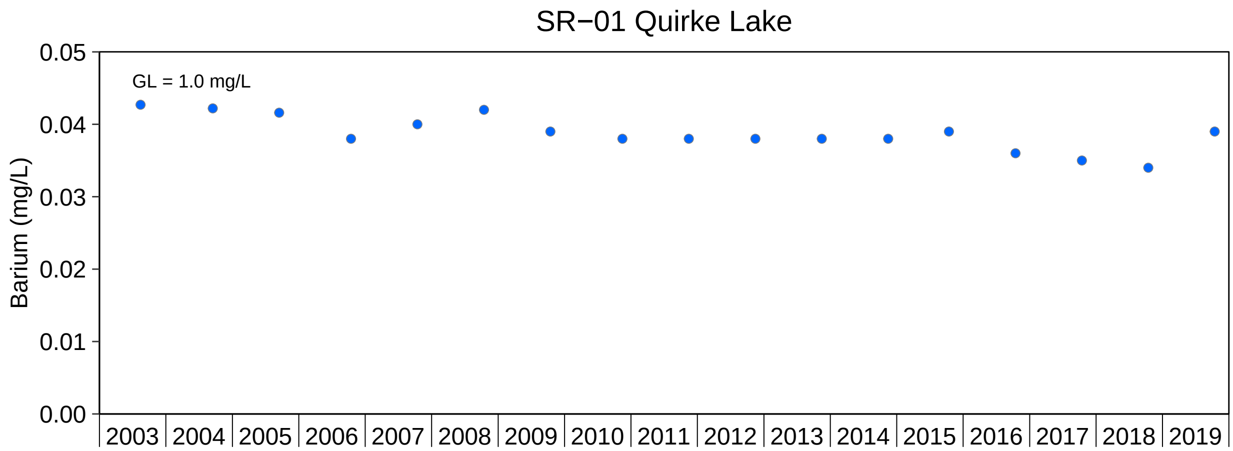


Figure S.8: Barium Concentrations for SRWMP Water Quality Monitoring Stations for the Quirke Lake Sub−Watershed, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guideline = BC Guideline. Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium-226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014.
See Appendix Tables S.3 to S.4, S.8 to S.12 for raw data.

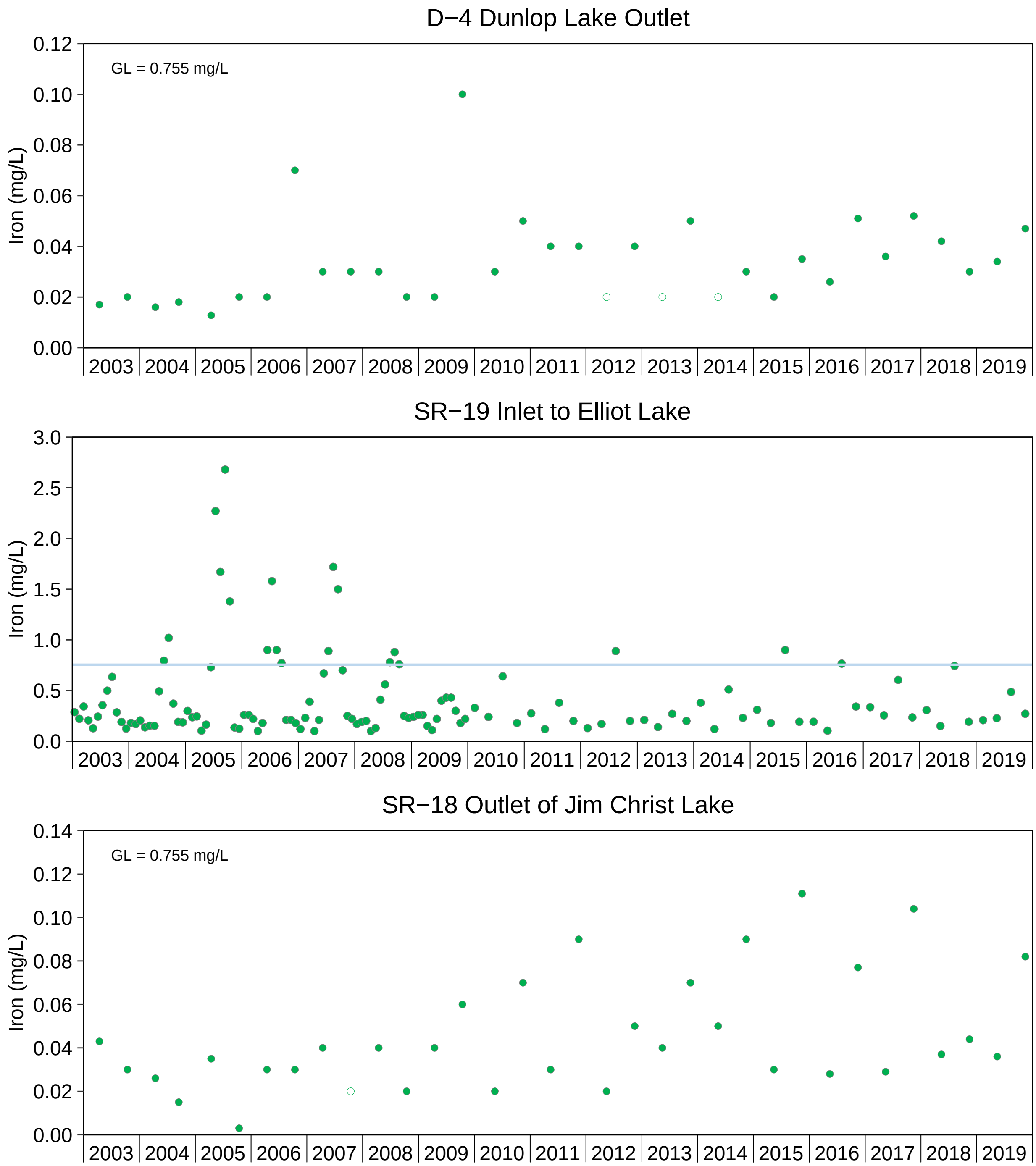


Figure S.9: Iron Concentrations for SRWMP Water Quality Monitoring Stations for the Quirke Lake Sub−Watershed, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guideline = Upper limit of background concentrations (95th percentile) based on data collected from lake reference stations (blue; D−4, SR−18, SR−19) and wetland reference stations (green; SR−16, SR−17) from 2015 to 2019. See SRW benchmark (Table 2.11) for receiving environment standard based on background or approved guidelines. Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium−226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014. See Appendix Tables S.3 to S.4 and S.8 for raw data.

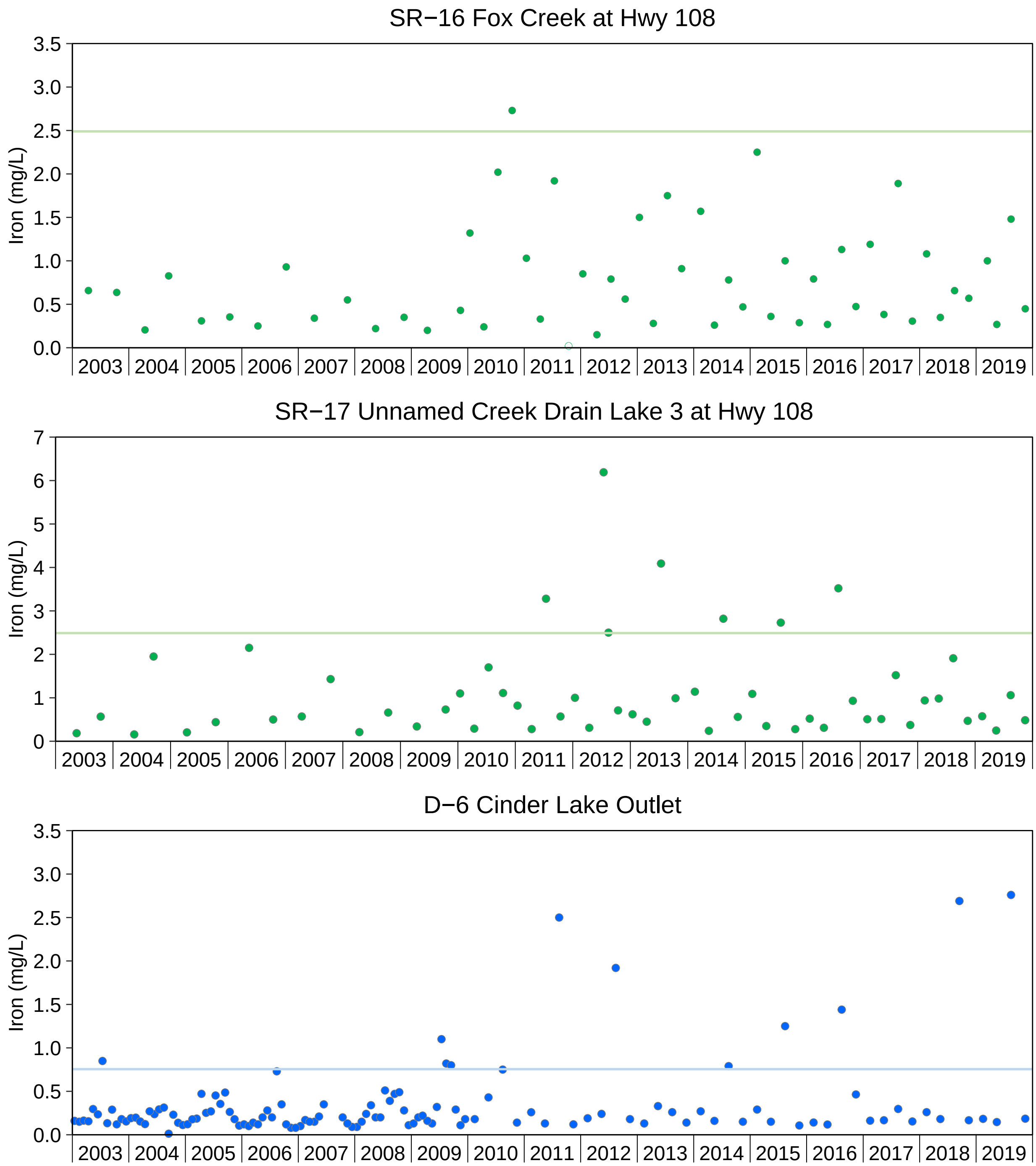


Figure S.9: Iron Concentrations for SRWMP Water Quality Monitoring Stations for the Quirke Lake Sub−Watershed, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guideline = Upper limit of background concentrations (95th percentile) based on data collected from lake reference stations (blue; D−4, SR−18, SR−19) and wetland reference stations (green; SR−16, SR−17) from 2015 to 2019. See SRW benchmark (Table 2.11) for receiving environment standard based on background or approved guidelines. Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium−226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014. See Appendix Tables S.3 to S.4 and S.8 for raw data.

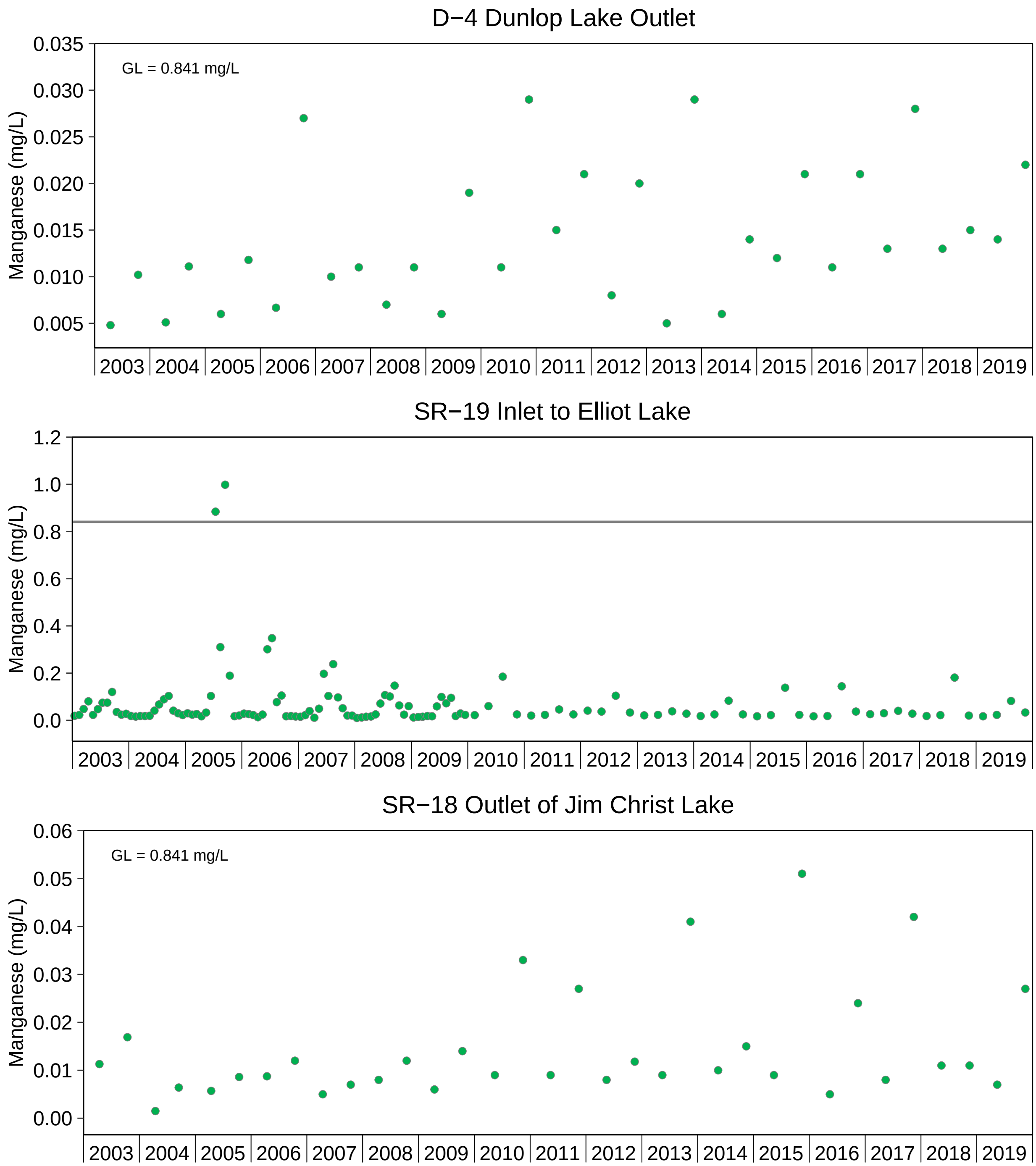


Figure S.10: Manganese Concentrations for SWRMP Water Quality Monitoring Stations for the Quirke Lake Sub−Watershed, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. GL = BC ENV (hardness dependent, calculated based on mean hardness at D−6, see Appendix Table S.2), see SRW benchmark (Table 2.8) for receiving environment standard based approved guideline. Reference areas are plotted in green and mine −exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium−226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014. See Appendix Tables S.3 to S.4 and S.8 for raw data.

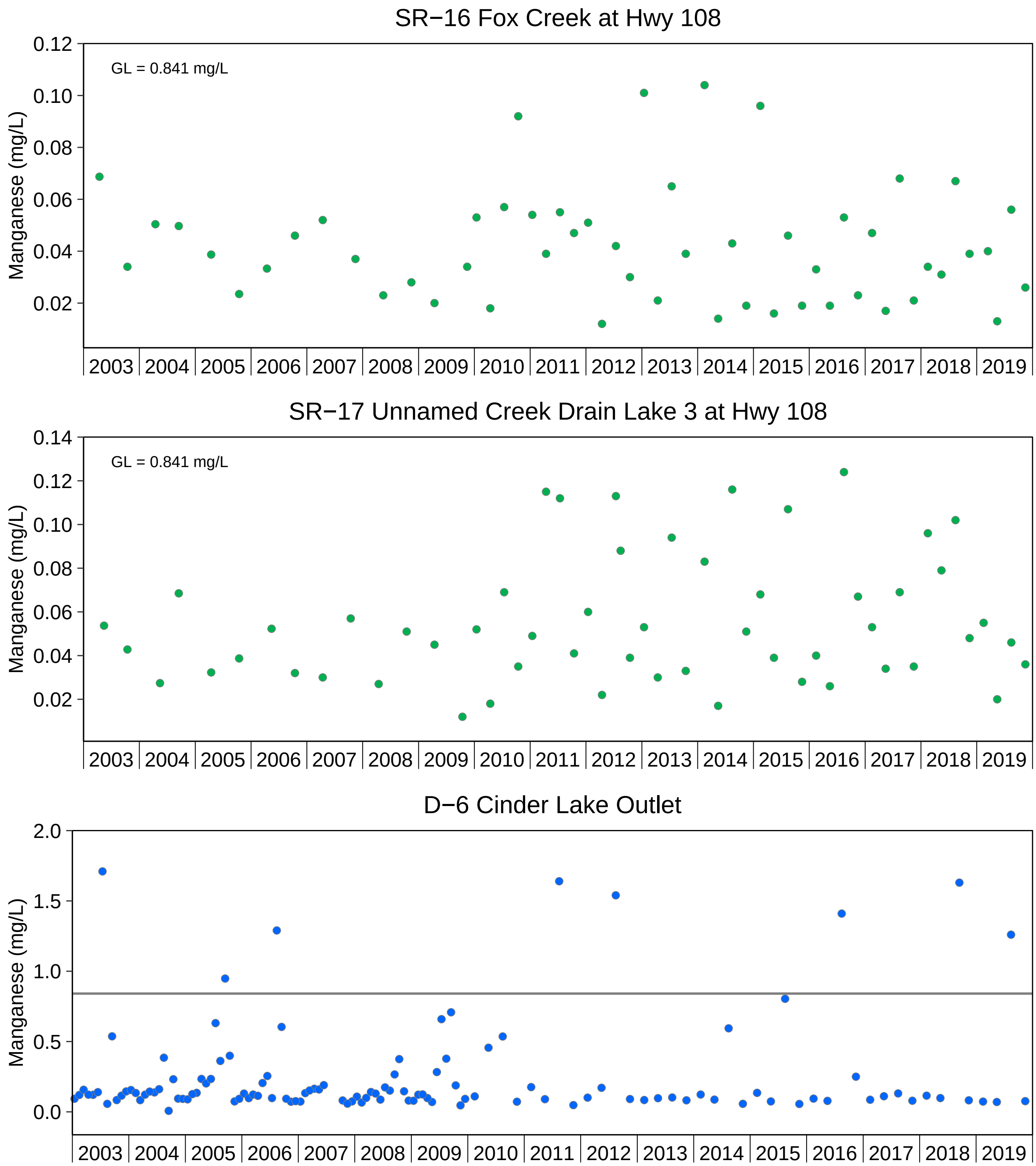


Figure S.10: Manganese Concentrations for SWRMP Water Quality Monitoring Stations for the Quirke Lake Sub−Watershed, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. GL = BC ENV (hardness dependent, calculated based on mean hardness at D−6, see Appendix Table S.2), see SRW benchmark (Table 2.8) for receiving environment standard based approved guideline. Reference areas are plotted in green and mine −exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium−226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014. See Appendix Tables S.3 to S.4 and S.8 for raw data.

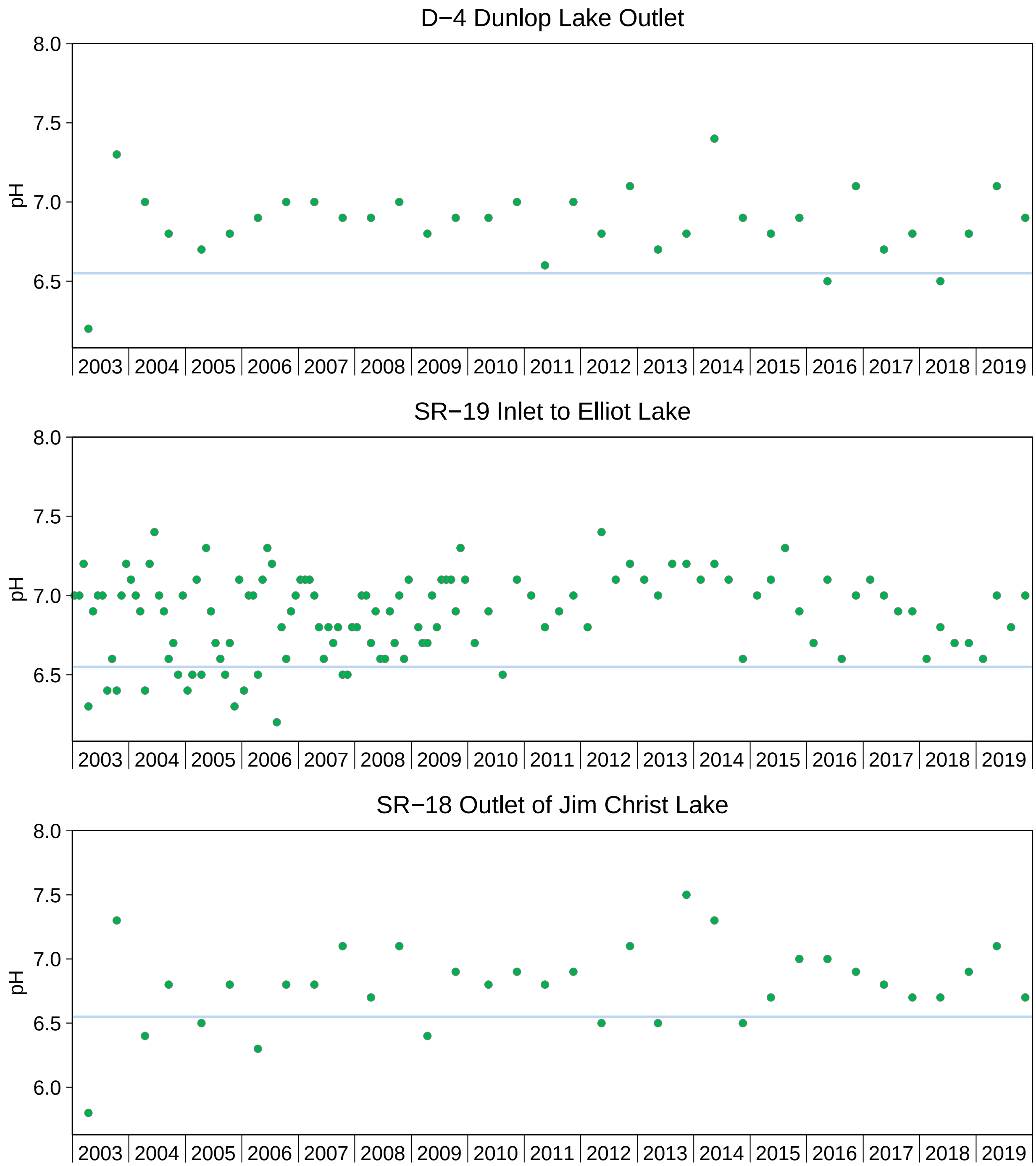


Figure S.11: Field Measurements of pH for SRWMP Water Quality Monitoring Stations for the Quirke Lake Sub−Watershed, 2003 to 2019

Notes: Guideline = Upper limit of background concentrations (95th percentile) based on data collected from lake reference stations (blue; D−4, SR−18, SR−19) and wetland reference stations (green; SR−16, SR−17) from 2015 to 2019. See SRW benchmark (Table 2.11) for receiving environment standard based on background or approved guidelines. Reference areas are plotted in green and mine−exposed areas are plotted in blue.
See Appendix Tables S.3 to S.4, S.8 to S.12 for raw data.

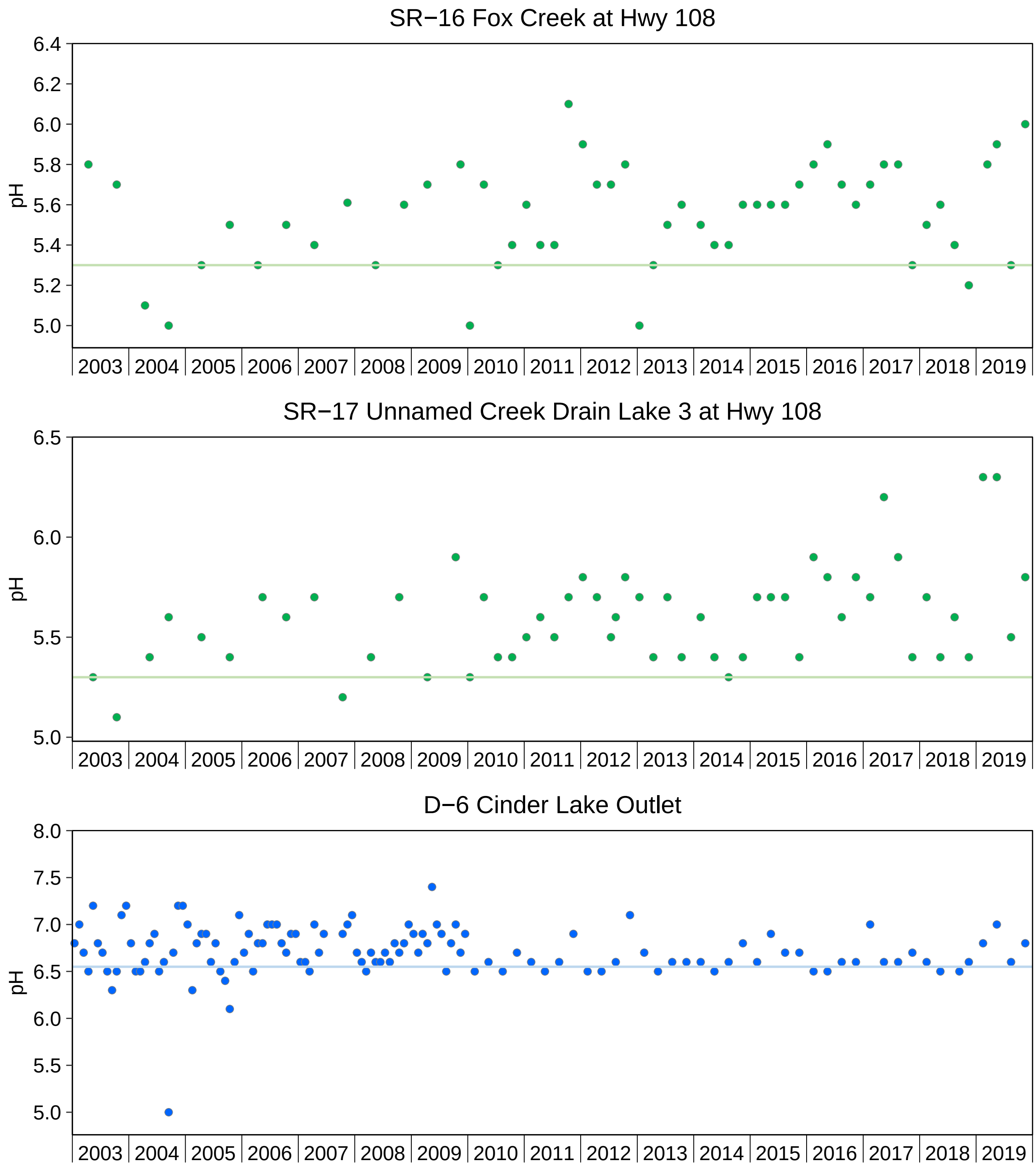


Figure S.11: Field Measurements of pH for SRWMP Water Quality Monitoring Stations for the Quirke Lake Sub−Watershed, 2003 to 2019

Notes: Guideline = Upper limit of background concentrations (95th percentile) based on data collected from lake reference stations (blue; D−4, SR−18, SR−19) and wetland reference stations (green; SR−16, SR−17) from 2015 to 2019. See SRW benchmark (Table 2.11) for receiving environment standard based on background or approved guidelines. Reference areas are plotted in green and mine−exposed areas are plotted in blue.
See Appendix Tables S.3 to S.4, S.8 to S.12 for raw data.

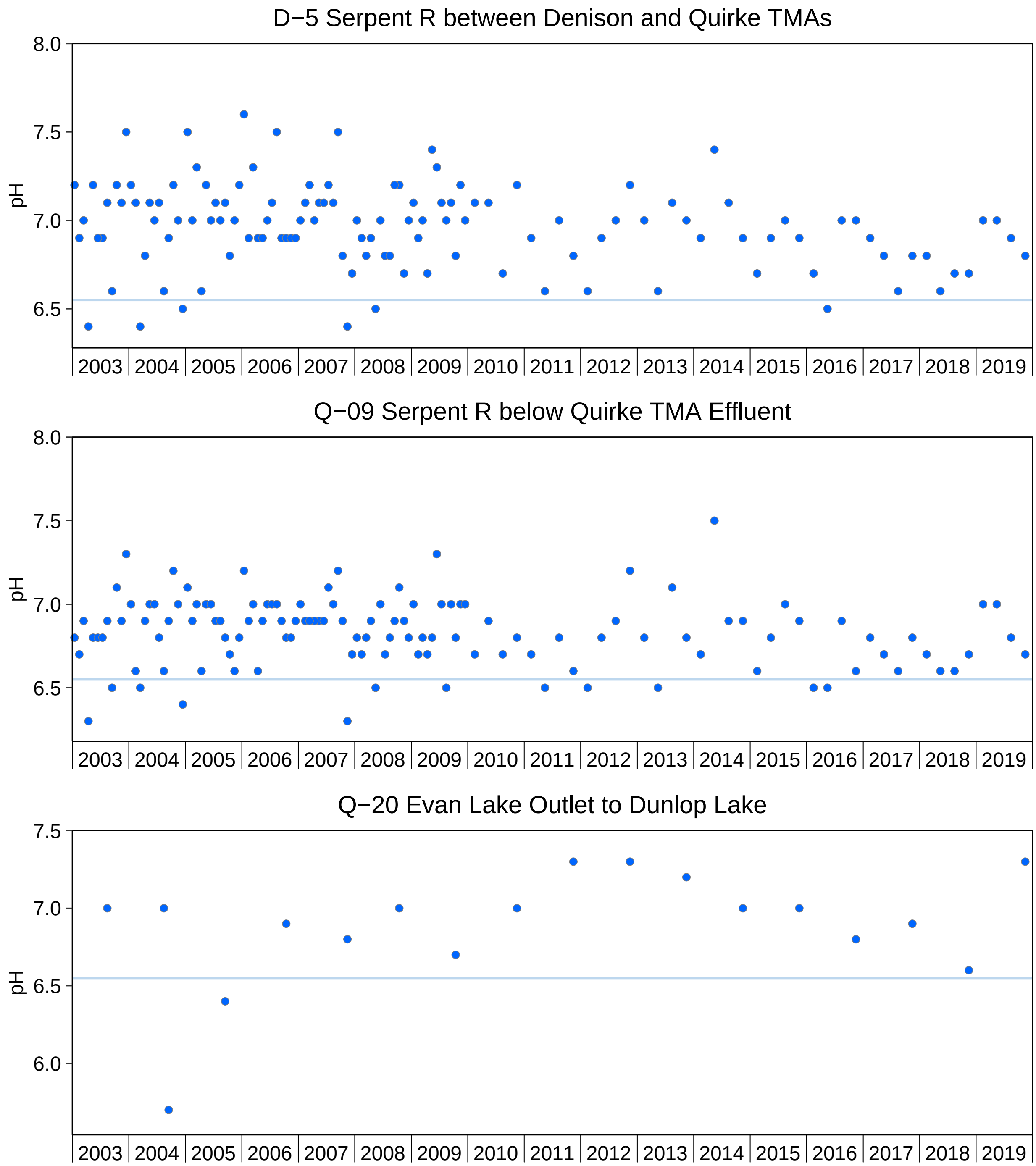


Figure S.11: Field Measurements of pH for SRWMP Water Quality Monitoring Stations for the Quirke Sub−Watershed, 2003 to 2019

Notes: Guideline = Upper limit of background concentrations (95th percentile) based on data collected from lake reference stations (blue; D−4, SR−18, SR−19) and wetland reference stations (green; SR−16, SR−17) from 2015 to 2019. See SRW benchmark (Table 2.11) for receiving environment standard based on background or approved guidelines. Reference areas are plotted in green and mine−exposed areas are plotted in blue. See Appendix Tables S.3 to S.4, S.8 to S.12 for raw data.

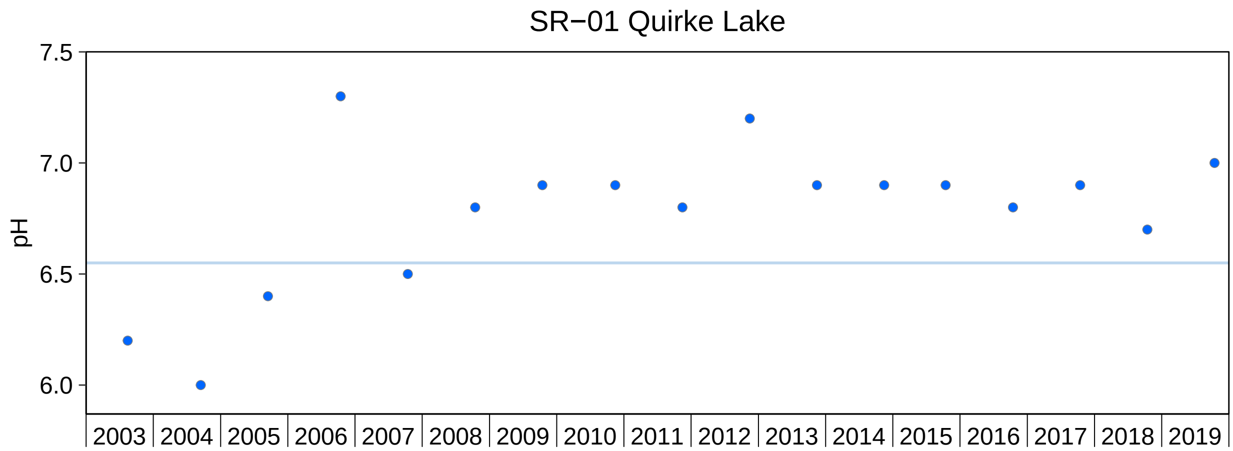


Figure S.11: Field Measurements of pH for SRWMP Water Quality Monitoring Stations for the Quirke Lake Sub−Watershed, 2003 to 2019

Notes: Guideline = Upper limit of background concentrations (95th percentile) based on data collected from lake reference stations (blue; D−4, SR−18, SR−19) and wetland reference stations (green; SR−16, SR−17) from 2015 to 2019. See SRW benchmark (Table 2.11) for receiving environment standard based on background or approved guidelines. Reference areas are plotted in green and mine−exposed areas are plotted in blue.
See Appendix Tables S.3 to S.4, S.8 to S.12 for raw data.

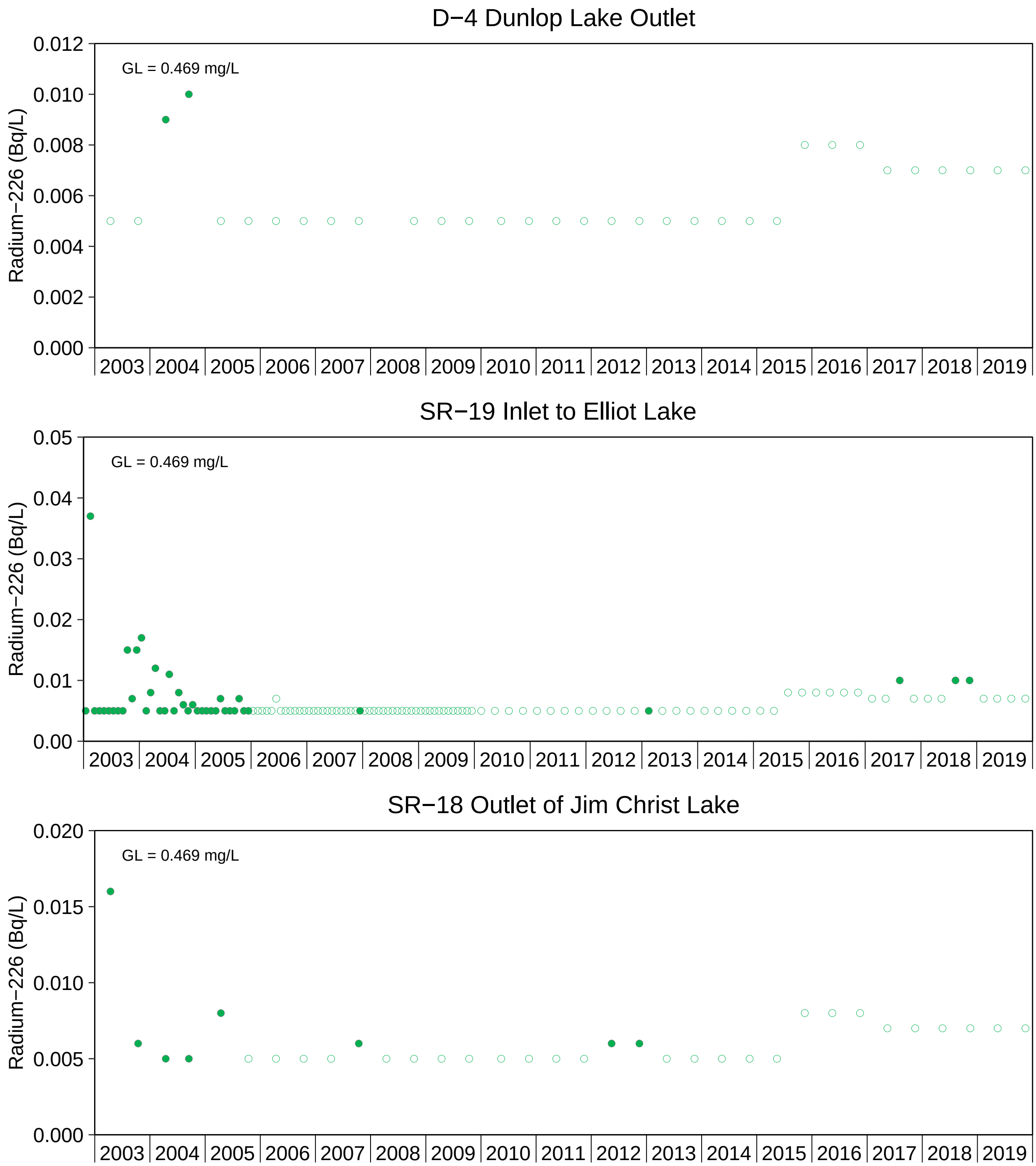
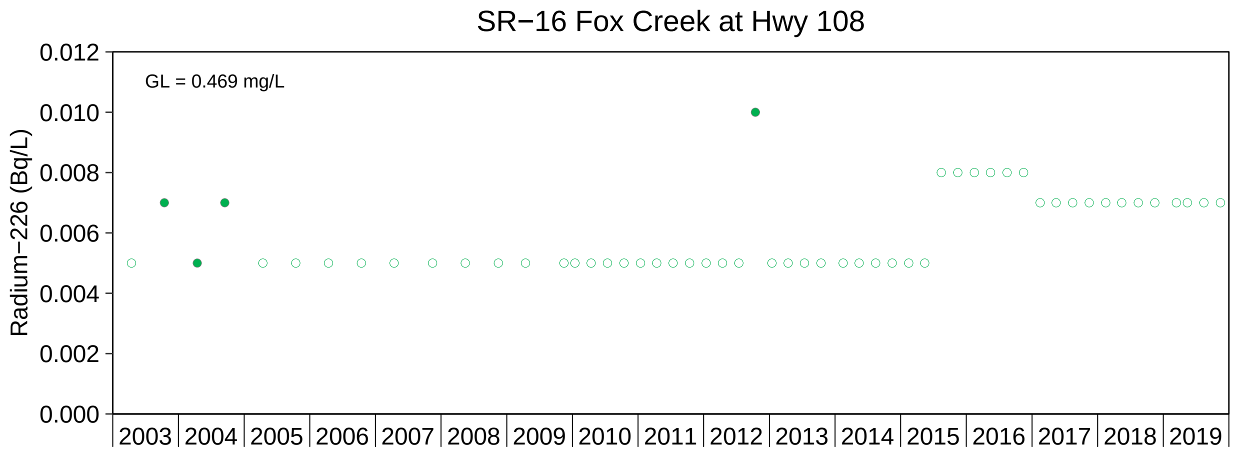
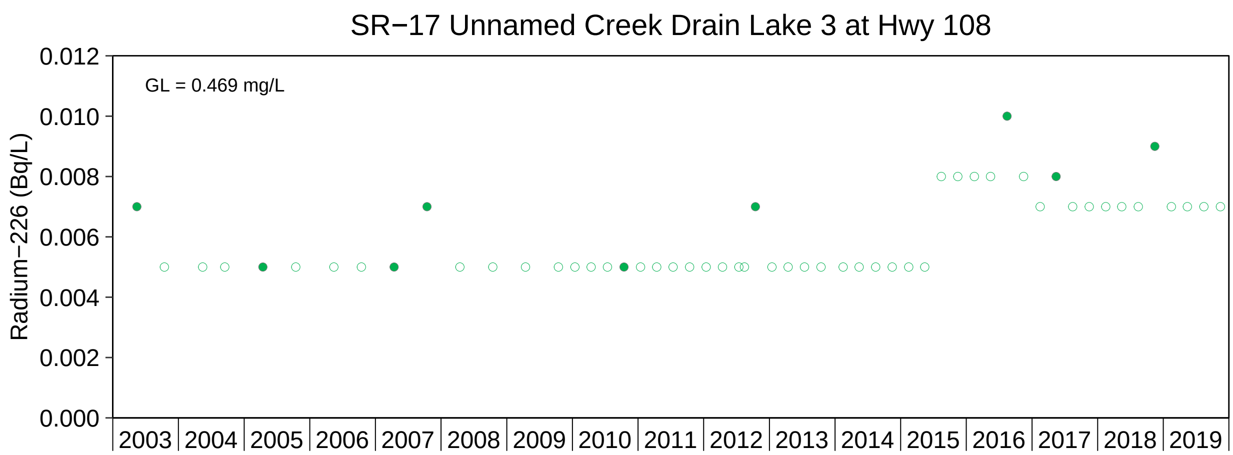


Figure S.12: Radium−226 Concentrations for SRWMP Water Quality Monitoring Stations for the Quirke Lake Sub−Watershed, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guideline = site−specific benchmark. Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium−226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014. Radium (Bq/L) is not included in the trend analysis for SWRMP stations D−4, D−6, Q−20, SR−16, SR−17, SR−18, and SR−19 due to >50% non−detectable concentrations in the dataset. See Appendix Tables S.3 to S.4, S.8 to S.12 for raw data.





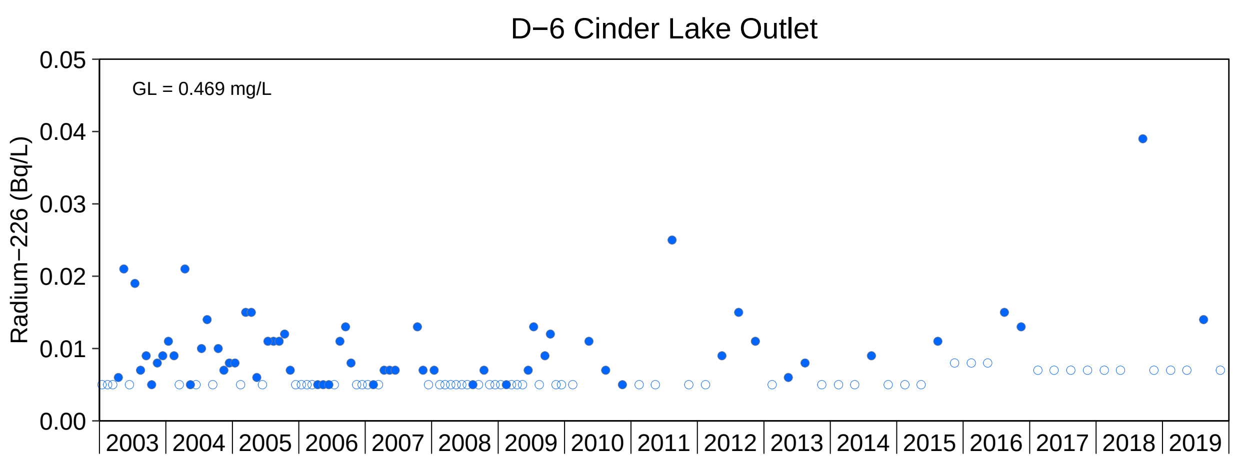


Figure S.12: Radium−226 Concentrations for SRWMP Water Quality Monitoring Stations for the Quirke Lake Sub−Watershed, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guideline = site−specific benchmark. Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium−226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014. Radium (Bq/L) is not included in the trend analysis for SWRMP stations D−4, D−6, Q−20, SR−16, SR−17, SR−18, and SR −19 due to >50% non−detectable concentrations in the dataset. See Appendix Tables S.3 to S.4, S.8 to S.12 for raw data.

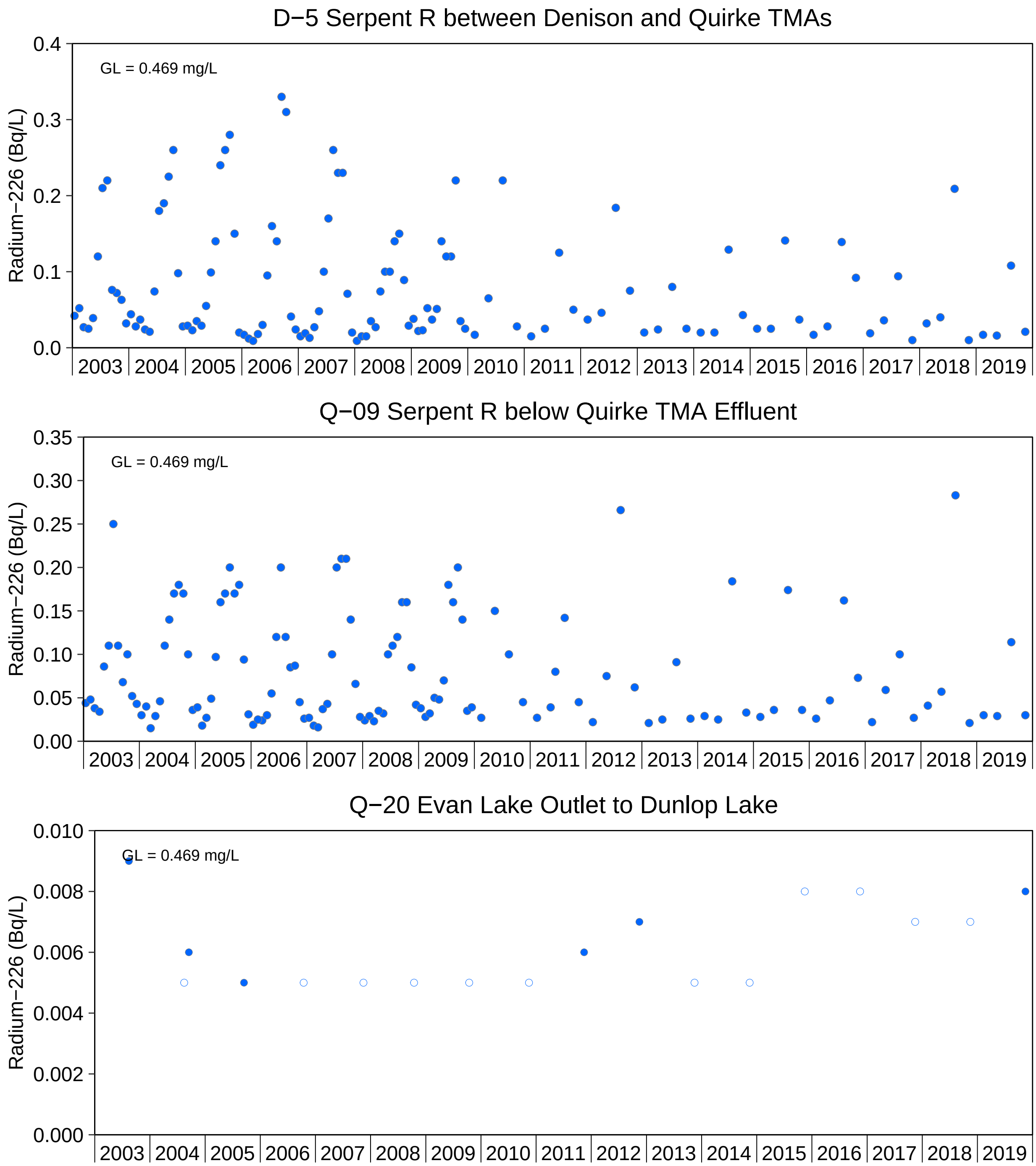


Figure S.12: Radium−226 Concentrations for SRWMP Water Quality Monitoring Stations for the Quirke Lake Sub−Watershed, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guideline = site−specific benchmark. Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium−226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014. Radium (Bq/L) is not included in the trend analysis for SWRMP stations D−4, D−6, Q−20, SR−16, SR−17, SR−18, and SR −19 due to >50% non−detectable concentrations in the dataset. See Appendix Tables S.3 to S.4, S.8 to S.12 for raw data.

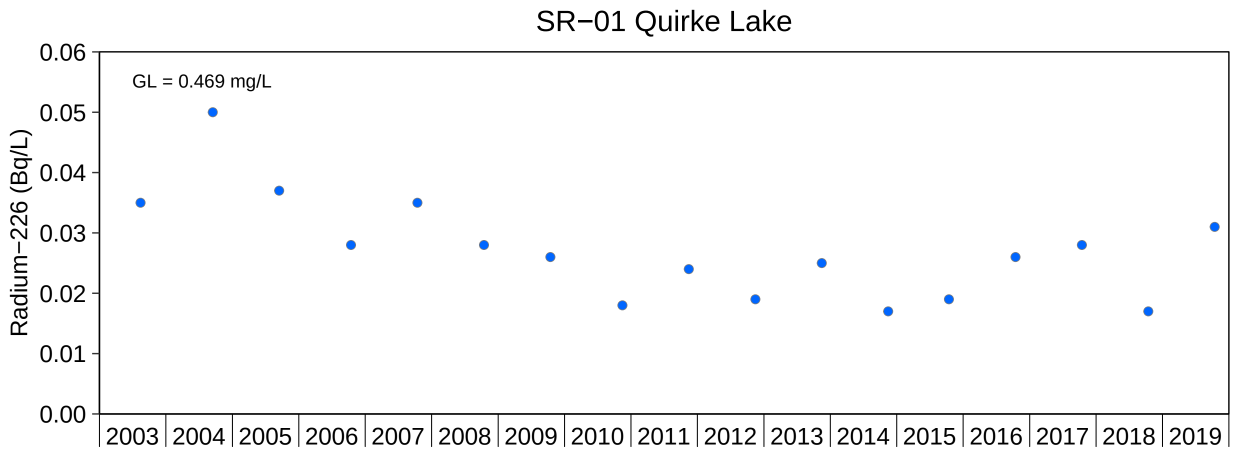


Figure S.12: Radium−226 Concentrations for SRWMP Water Quality Monitoring Stations for the Quirke Lake Sub−Watershed, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guideline = site−specific benchmark. Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium−226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014. Radium (Bq/L) is not included in the trend analysis for SWRMP stations D−4, D−6, Q−20, SR−16, SR−17, SR−18, and SR −19 due to >50% non−detectable concentrations in the dataset. See Appendix Tables S.3 to S.4, S.8 to S.12 for raw data.

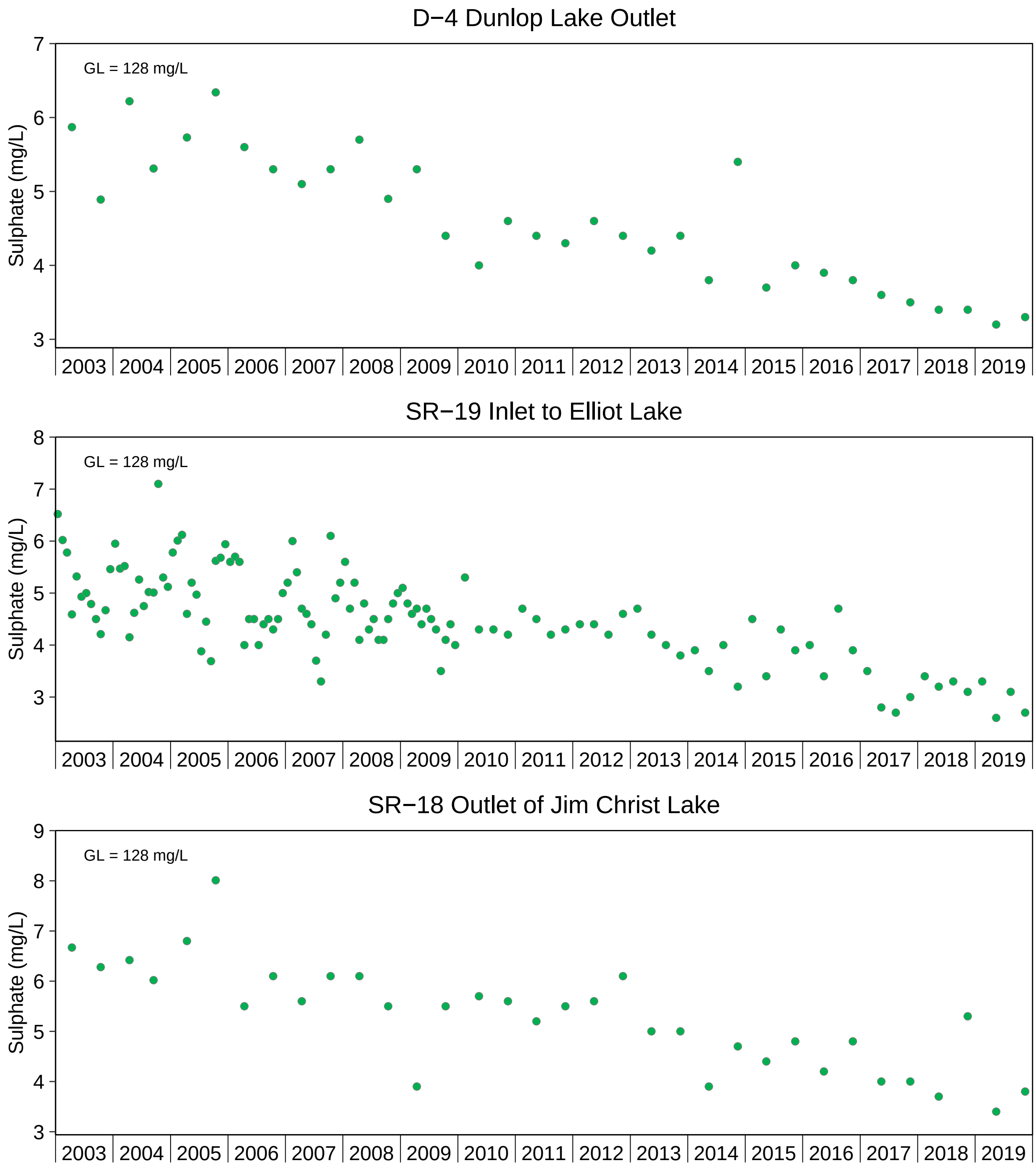


Figure S.13: Sulphate Concentrations for SWRMP Water Quality Monitoring Stations for the Quirke Lake Sub−Watershed, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guideline = BC Guideline (hardness dependent, see Appendix S.1 and S.2). Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium−226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014. See Appendix Tables S.3 to S.4, S.8 to S.12 for raw data.

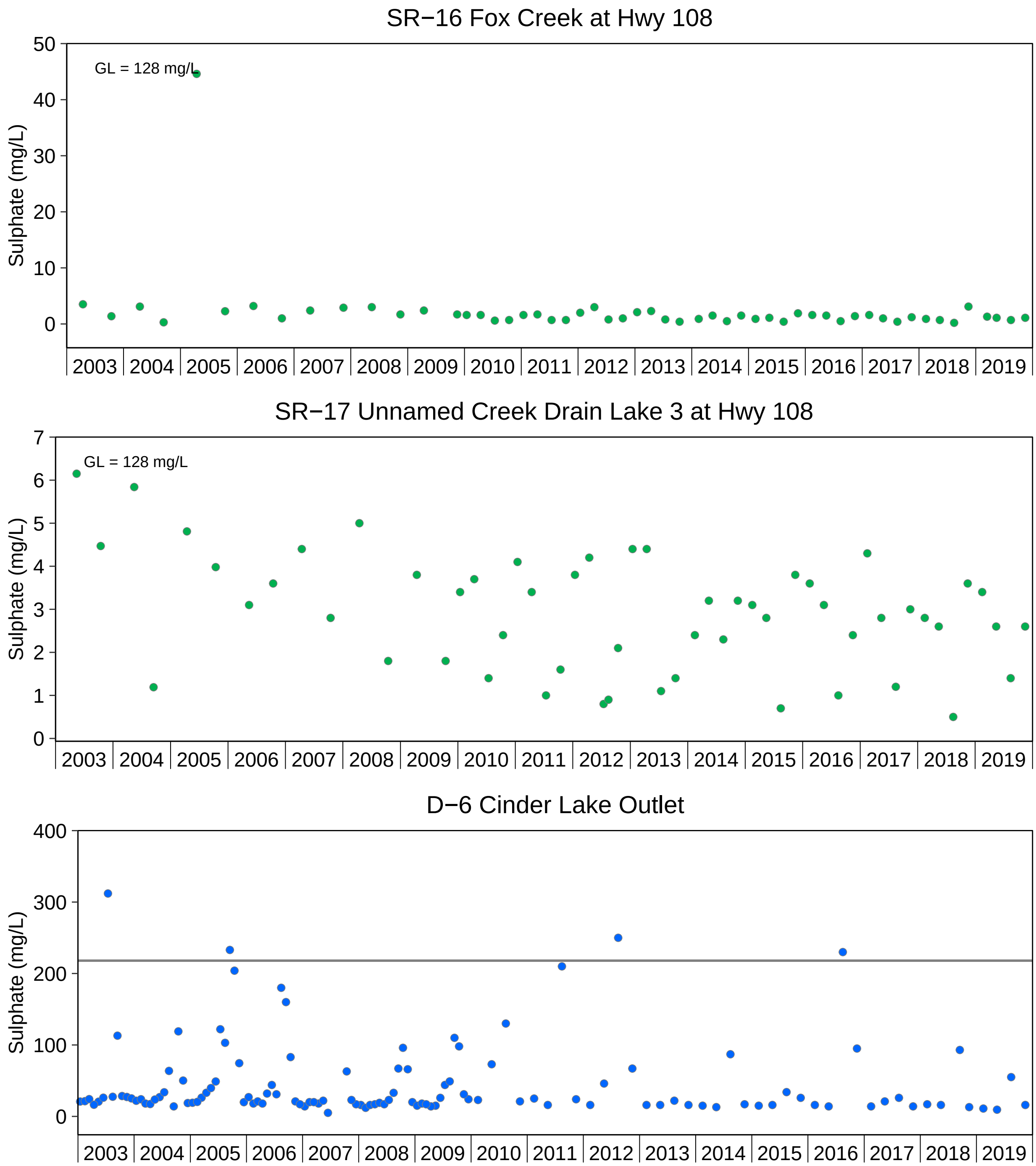


Figure S.13: Sulphate Concentrations for SWRMP Water Quality Monitoring Stations for the Quirke Lake Sub−Watershed, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guideline = BC Guideline (hardness dependent, see Appendix S.1 and S.2). Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium−226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014. See Appendix Tables S.3 to S.4, S.8 to S.12 for raw data.

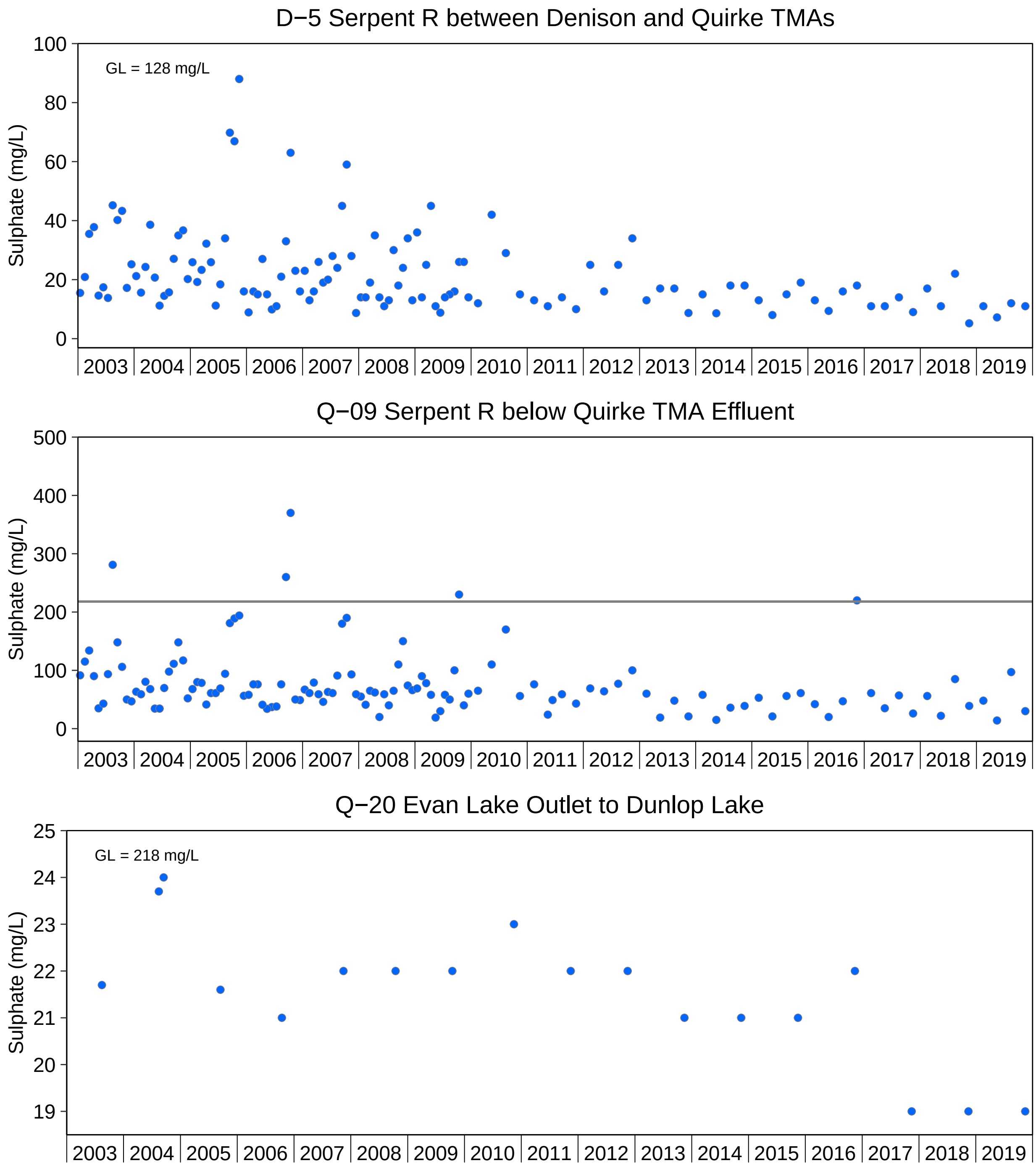


Figure S.13: Sulphate Concentrations for SWRMP Water Quality Monitoring Stations for the Quirke Lake Sub−Watershed, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guideline = BC Guideline (hardness dependent, see Appendix S.1 and S.2). Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium−226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014. See Appendix Tables S.3 to S.4, S.8 to S.12 for raw data.

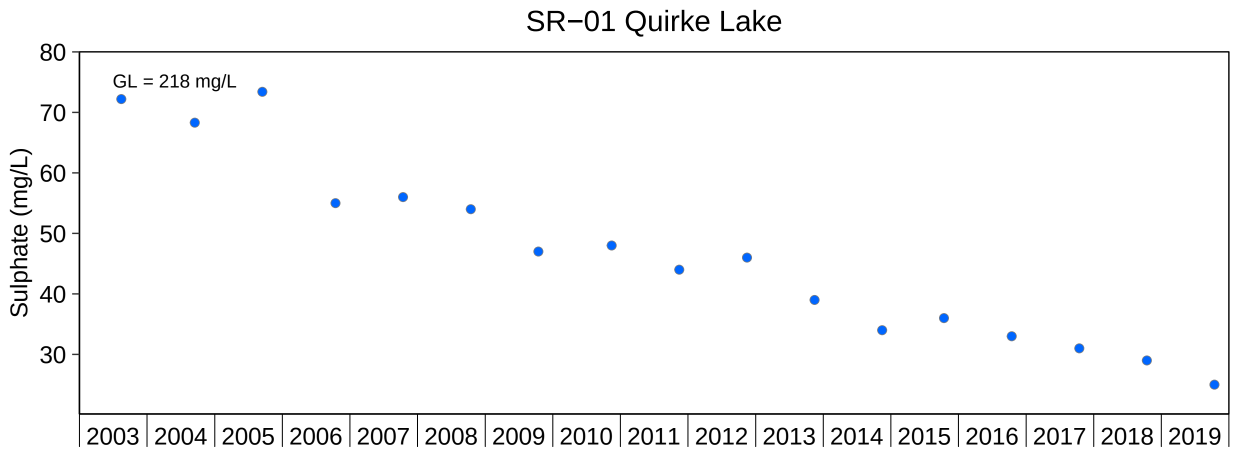


Figure S.13: Sulphate Concentrations for SWRMP Water Quality Monitoring Stations for the Quirke Lake Sub−Watershed, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guideline = BC Guideline (hardness dependent, see Appendix S.1 and S.2). Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium−226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014. See Appendix Tables S.3 to S.4, S.8 to S.12 for raw data.

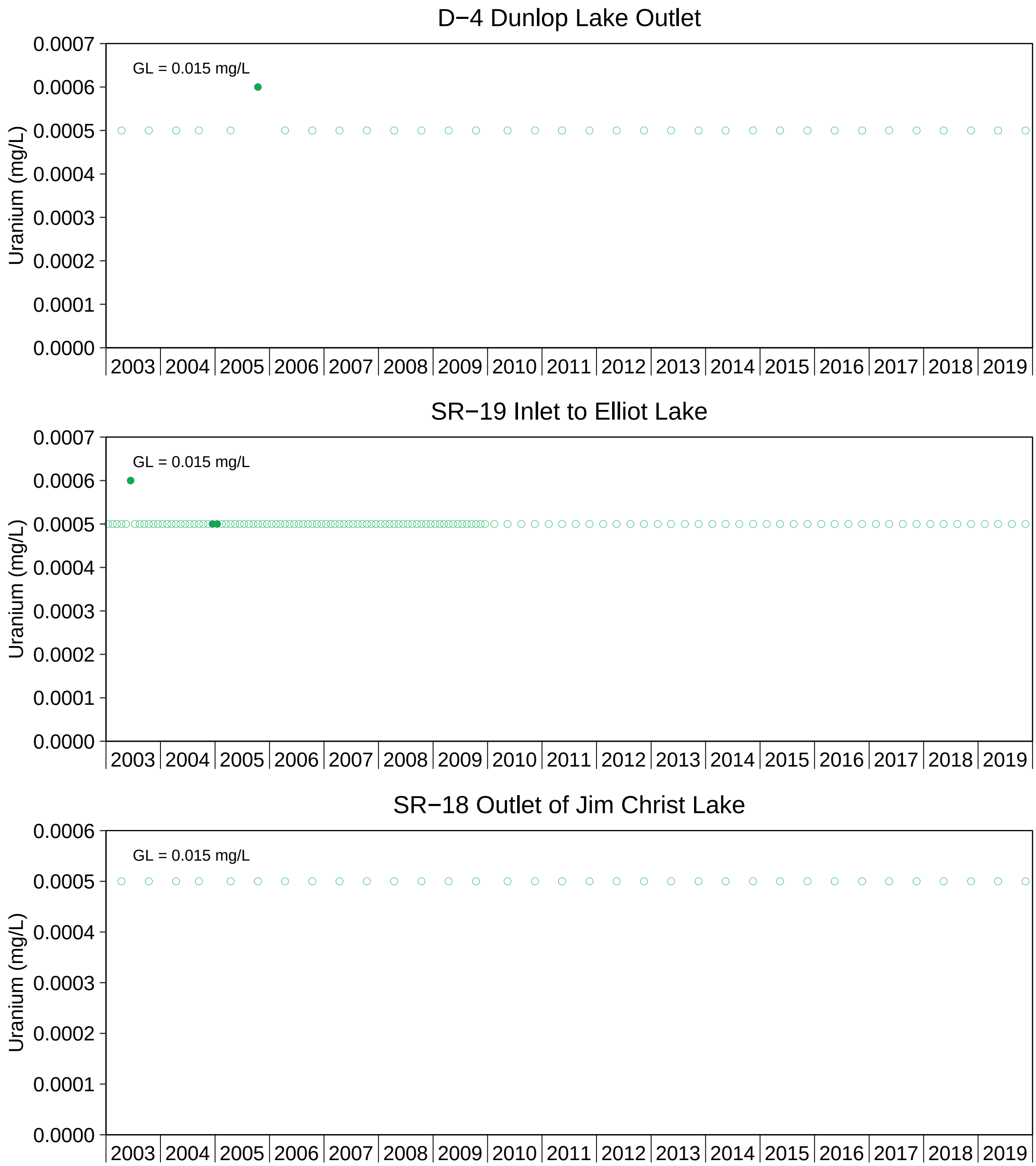


Figure S.14: Uranium Concentrations for SRWMP Water Quality Monitoring Stations for the Quirke Lake Sub−Watershed, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guideline = Federal Guideline. Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium−226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014. Uranium (mg/L) is not included in the trend analysis for SWRMP stations D−4, D−6, Q−20, SR−16, SR−17, SR−18, and SR−19 due to >50% non−detectable concentrations in the dataset. See Appendix Tables S.3 to S.4, S.8 to S.12 for raw data.

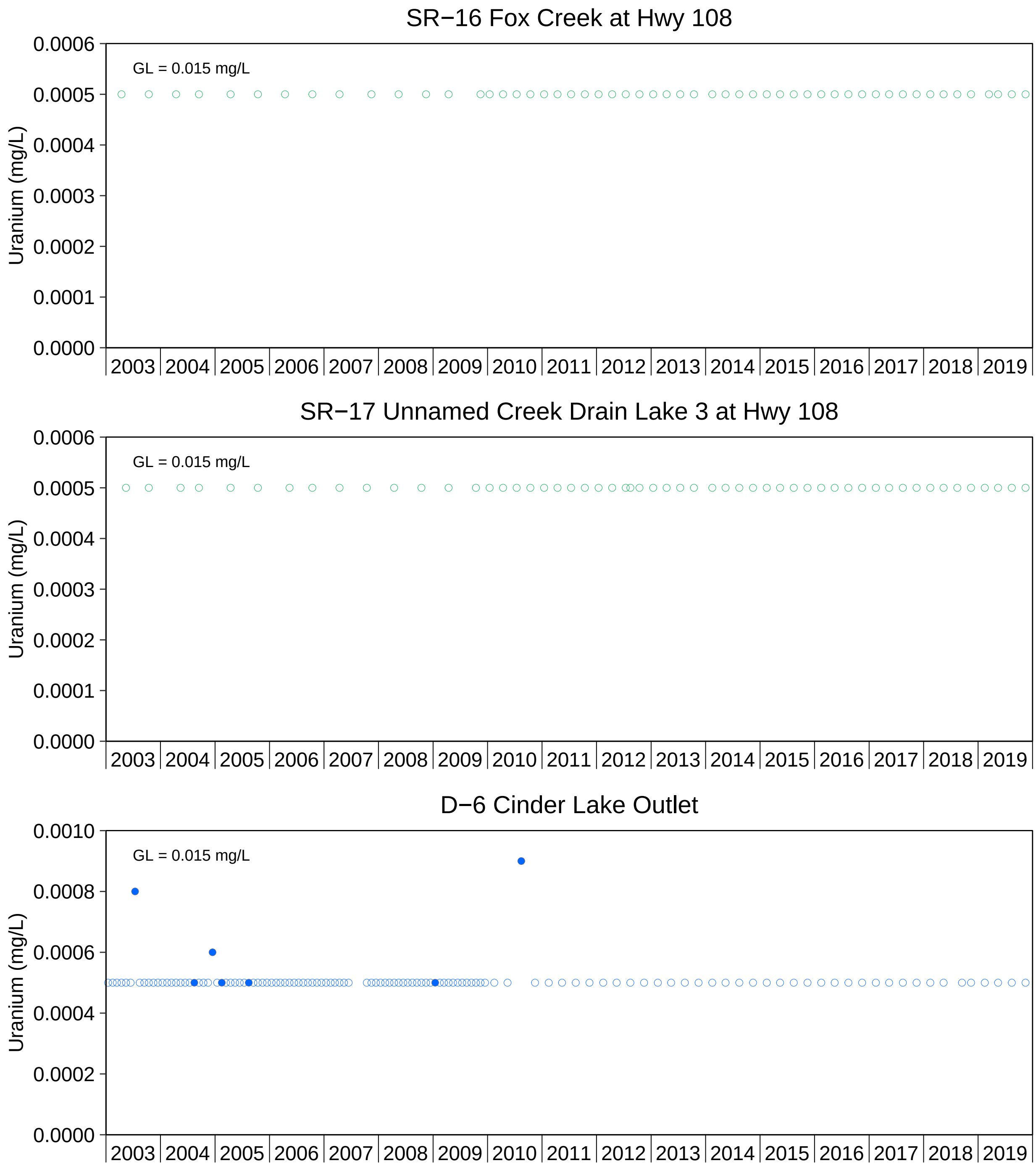


Figure S.14: Uranium Concentrations for SRWMP Water Quality Monitoring Stations for the Quirke Lake Sub−Watershed, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guideline = Federal Guideline. Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium−226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014. Uranium (mg/L) is not included in the trend analysis for SWRMP stations D−4, D−6, Q−20, SR−16, SR−17, SR−18, and SR−19 due to >50% non−detectable concentrations in the dataset. See Appendix Tables S.3 to S.4, S.8 to S.12 for raw data.

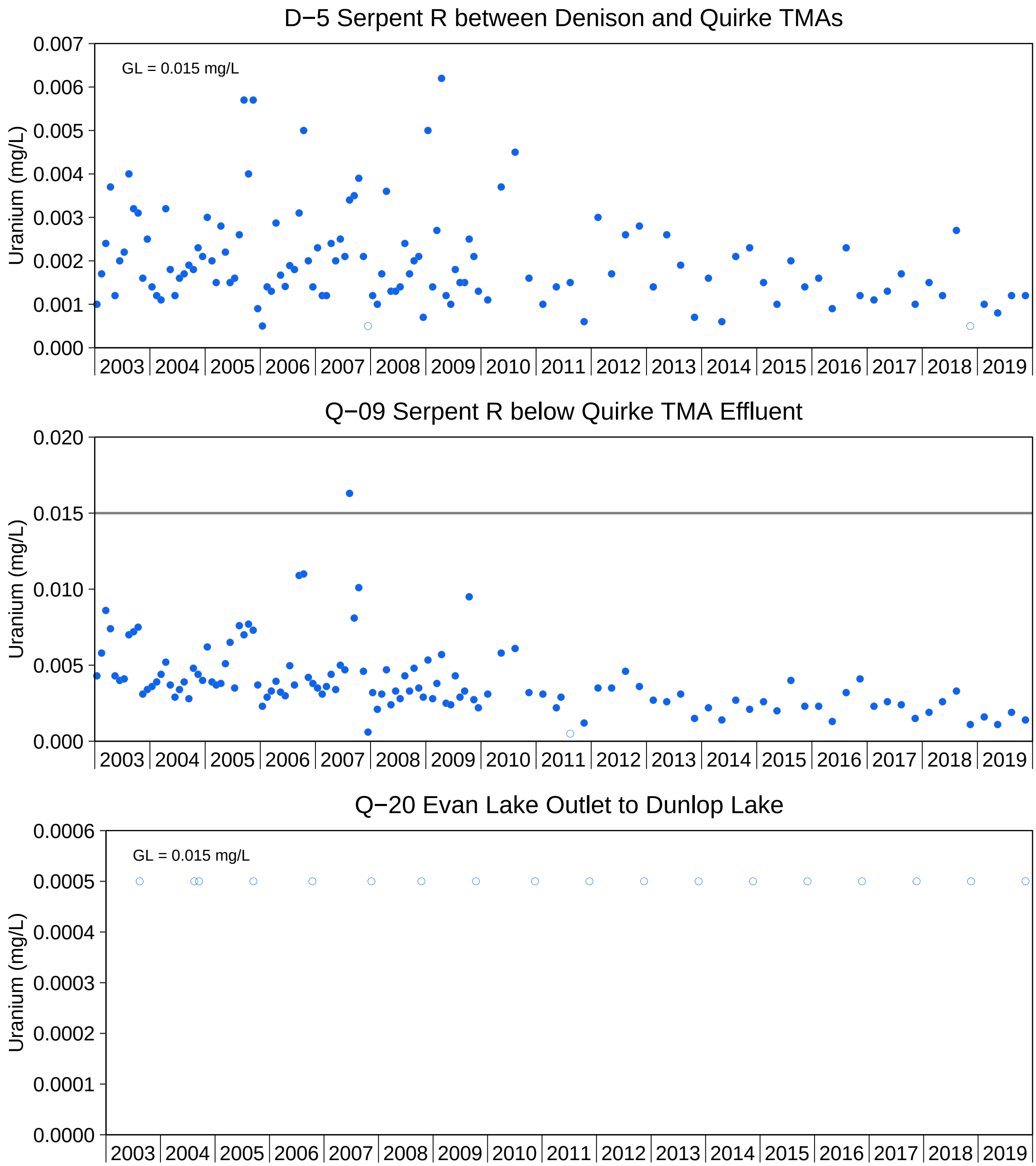


Figure S.14: Uranium Concentrations for SRWMP Water Quality Monitoring Stations for the Quirke Lake Sub−Watershed, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guideline = Federal Guideline. Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium−226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014. Uranium (mg/L) is not included in the trend analysis for SWRMP stations D−4, D−6, Q−20, SR−16, SR−17, SR−18, and SR−19 due to >50% non−detectable concentrations in the dataset. See Appendix Tables S.3 to S.4, S.8 to S.12 for raw data.

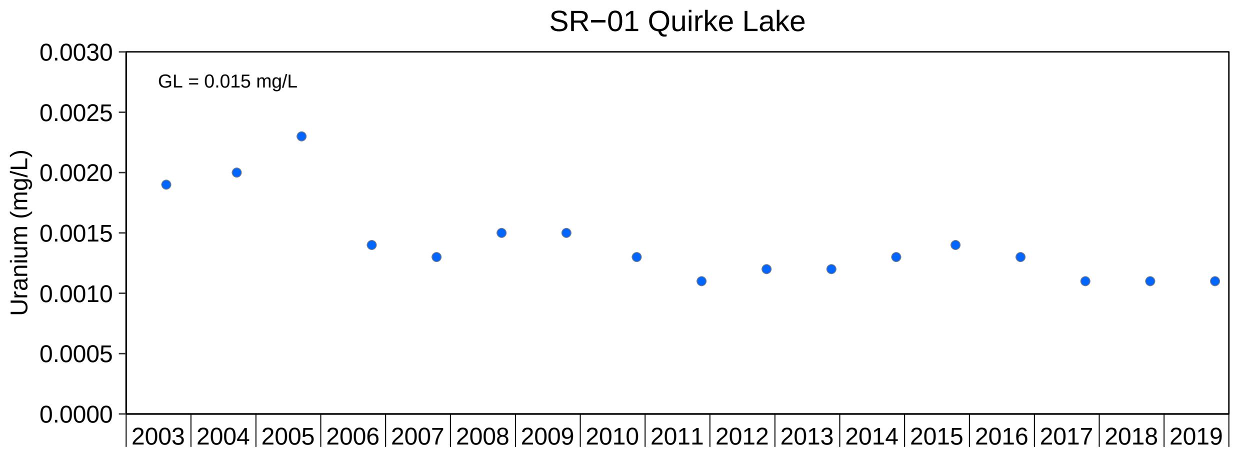


Figure S.14: Uranium Concentrations for SRWMP Water Quality Monitoring Stations for the Quirke Lake Sub−Watershed, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guideline = Federal Guideline. Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium−226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014. Uranium (mg/L) is not included in the trend analysis for SWRMP stations D−4, D−6, Q−20, SR−16, SR−17, SR−18, and SR−19 due to >50% non−detectable concentrations in the dataset. See Appendix Tables S.3 to S.4, S.8 to S.12 for raw data.

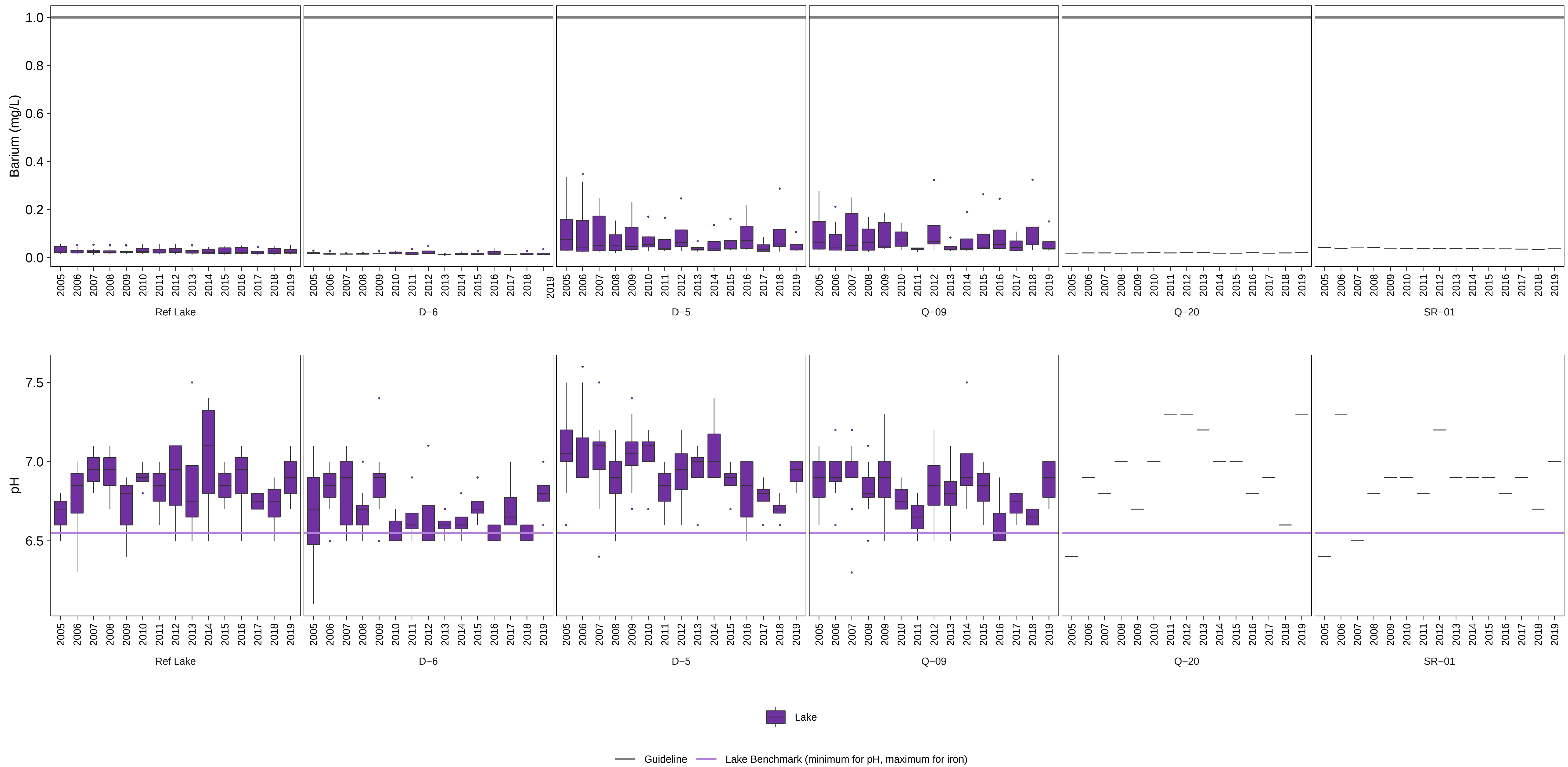


Figure S.15: Concentration of Metals in Water from the Quirke Lake Sub−watershed Compared to Reference Areas and Benchmarks, SRWMP, 2005 to 2019

Notes: Boxes represent the interquartile range (IQR; 25th to 75th percentile) with the median designated as a solid horizontal line within the IQR. Vertical lines extend 1.5 x IQR above and below each respective percentile with values beyond this range designated with a *. Parameters with no variation for a given year will result in a single horizontal line (i.e., 25th, median, and 75th percentile are all the same value). ND denotes parameter not assessed for this station, as per study design. Tables S.3, and S.8 to S.12 for raw data.

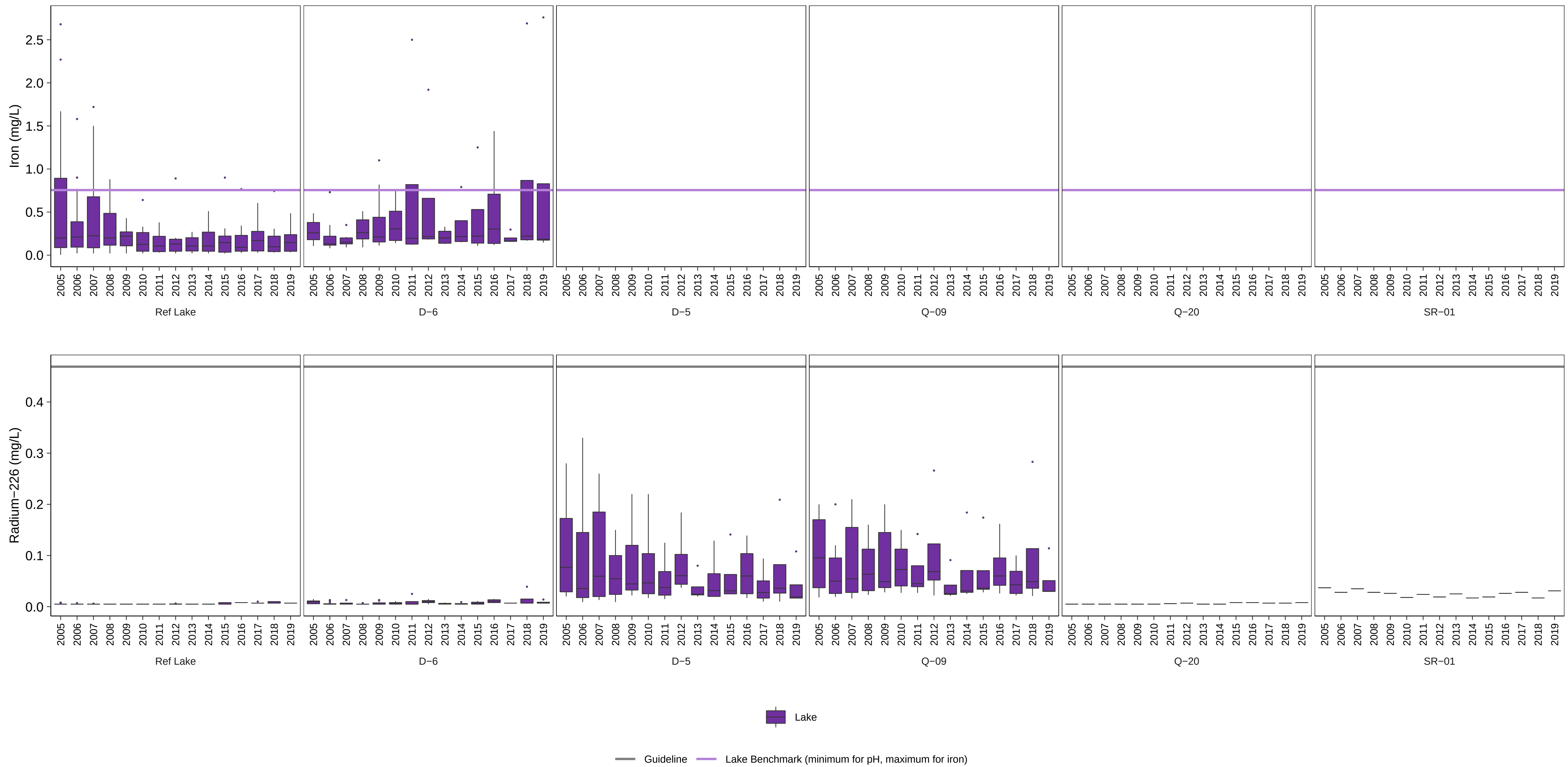


Figure S.15: Concentration of Metals in Water from the Quirke Lake Sub−watershed Compared to Reference Areas and Benchmarks, SRWMP, 2005 to 2019

Notes: Boxes represent the interquartile range (IQR; 25th to 75th percentile) with the median designated as a solid horizontal line within the IQR. Vertical lines extend 1.5 x IQR above and below each respective percentile with values beyond this range designated with a *. Parameters with no variation for a given year will result in a single horizontal line (i.e., 25th, median, and 75th percentile are all the same value). ND denotes parameter not assessed for this station, as per study design. Tables S.3, and S.8 to S.12 for raw data.

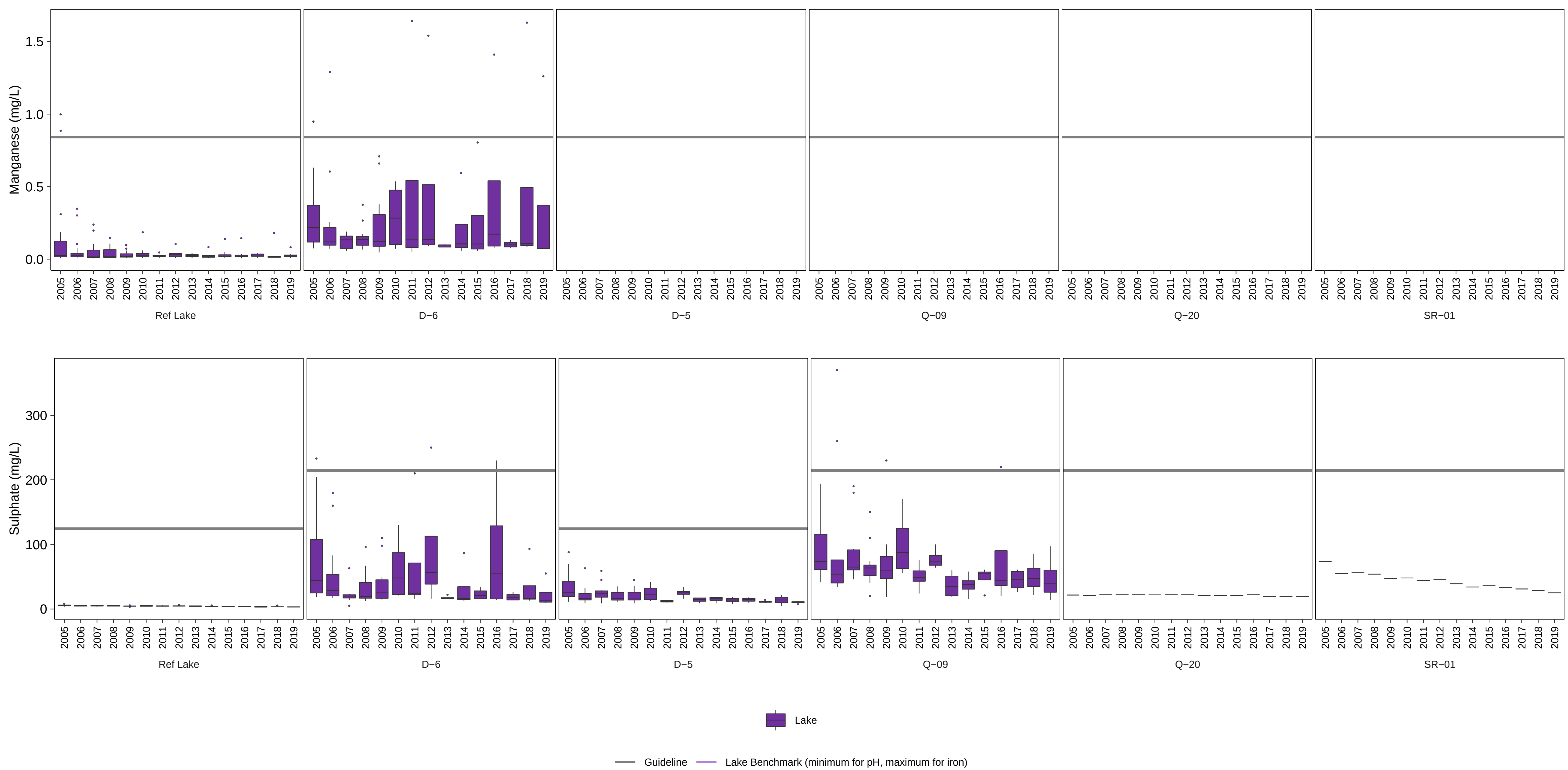


Figure S.15: Concentration of Metals in Water from the Quirke Lake Sub−watershed Compared to Reference Areas and Benchmarks, SRWMP, 2005 to 2019

Notes: Boxes represent the interquartile range (IQR; 25th to 75th percentile) with the median designated as a solid horizontal line within the IQR. Vertical lines extend 1.5 x IQR above and below each respective percentile with values beyond this range designated with a *. Parameters with no variation for a given year will result in a single horizontal line (i.e., 25th, median, and 75th percentile are all the same value). ND denotes parameter not assessed for this station, as per study design. Tables S.3, and S.8 to S.12 for raw data.

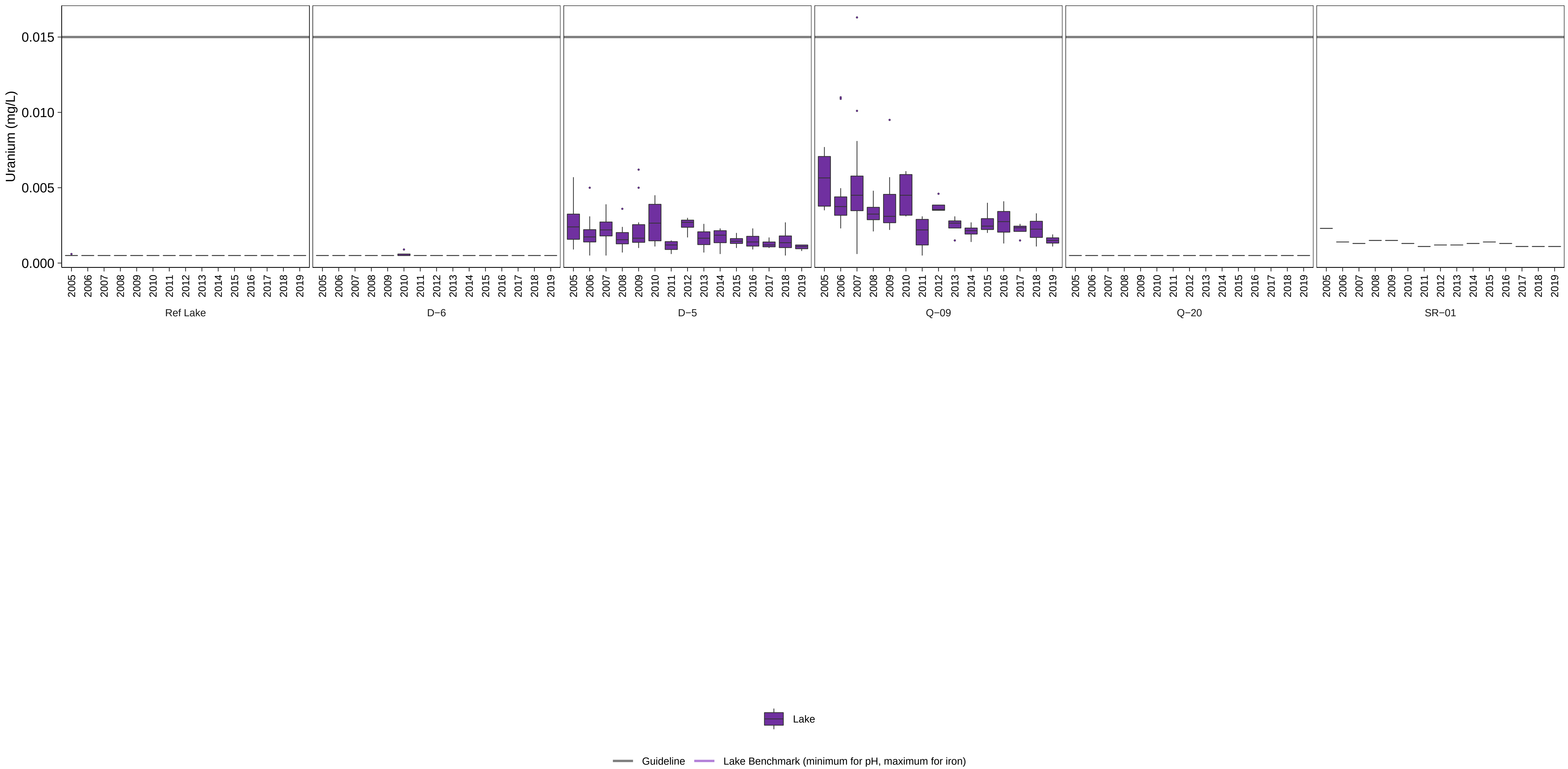


Figure S.15: Concentration of Metals in Water from the Quirke Lake Sub−watershed Compared to Reference Areas and Benchmarks, SRWMP, 2005 to 2019

Notes: Boxes represent the interquartile range (IQR; 25th to 75th percentile) with the median designated as a solid horizontal line within the IQR. Vertical lines extend 1.5 x IQR above and below each respective percentile with values beyond this range designated with a *. Parameters with no variation for a given year will result in a single horizontal line (i.e., 25th, median, and 75th percentile are all the same value). ND denotes parameter not assessed for this station, as per study design. Tables S.3, and S.8 to S.12 for raw data.

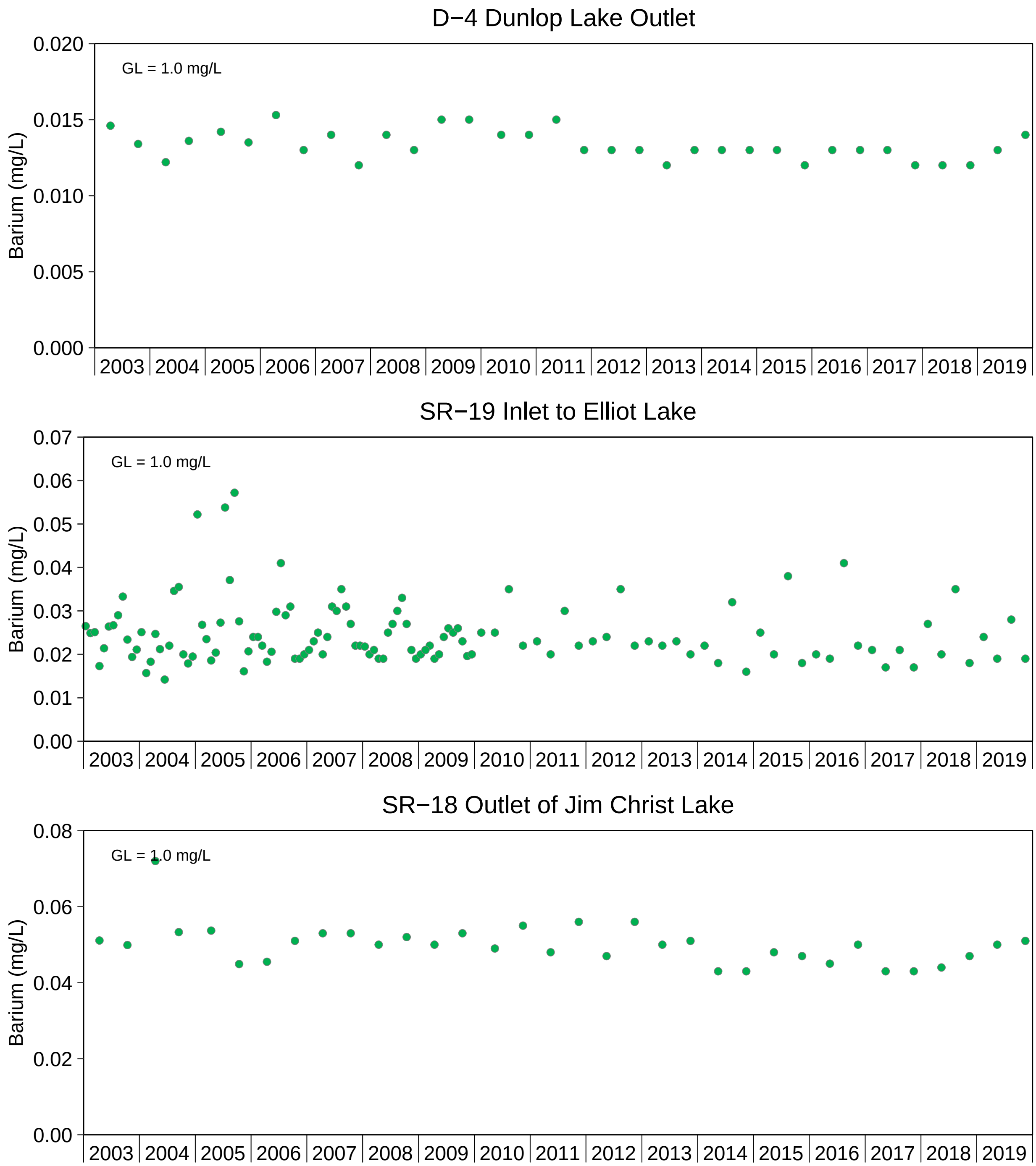


Figure S.16: Barium Concentrations for SRWMP Water Quality Monitoring Stations in the Elliot Lake Sub−Watershed, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guideline = BC Guideline. Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium −226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014. See Appendix Tables S.3 to S.4 and S.13 to S.14 for raw data.

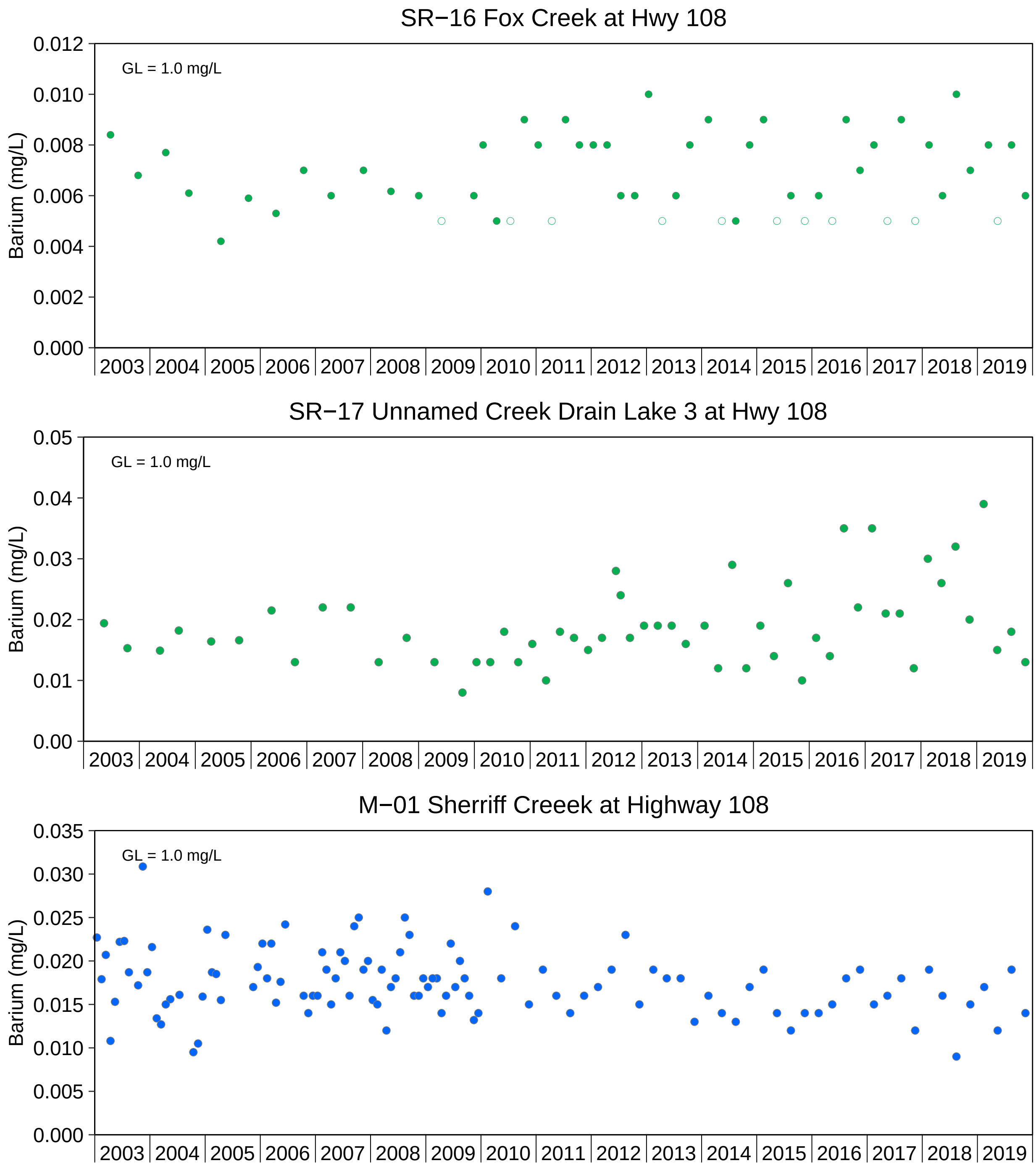


Figure S.16: Barium Concentrations for SRWMP Water Quality Monitoring Stations in the Elliot Lake Sub−Watershed, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guideline = BC Guideline. Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium −226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014. See Appendix Tables S.3 to S.4 and S.13 to S.14 for raw data.

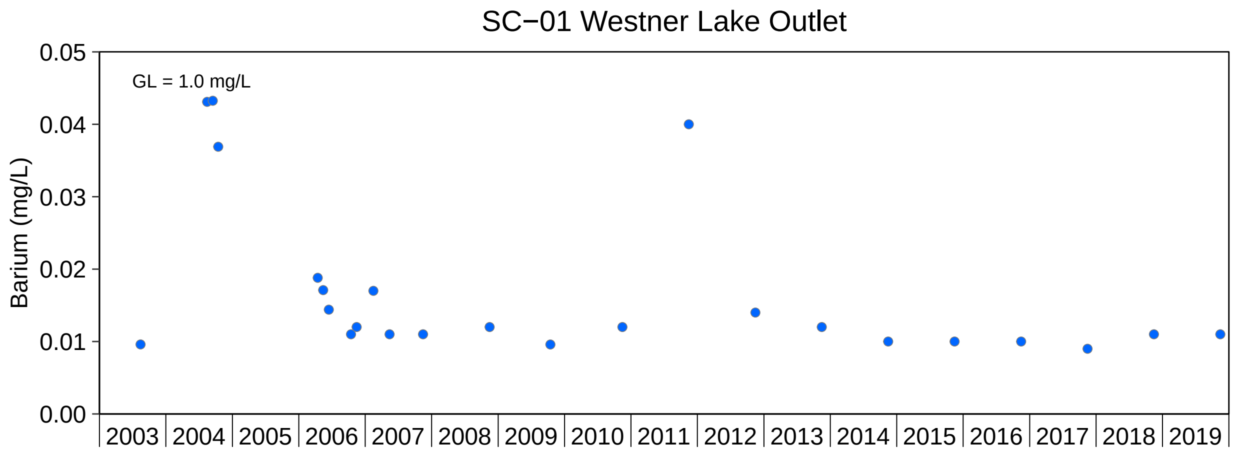


Figure S.16: Barium Concentrations for SRWMP Water Quality Monitoring Stations in the Elliot Lake Sub−Watershed, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guideline = BC Guideline. Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium −226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014. See Appendix Tables S.3 to S.4 and S.13 to S.14 for raw data.

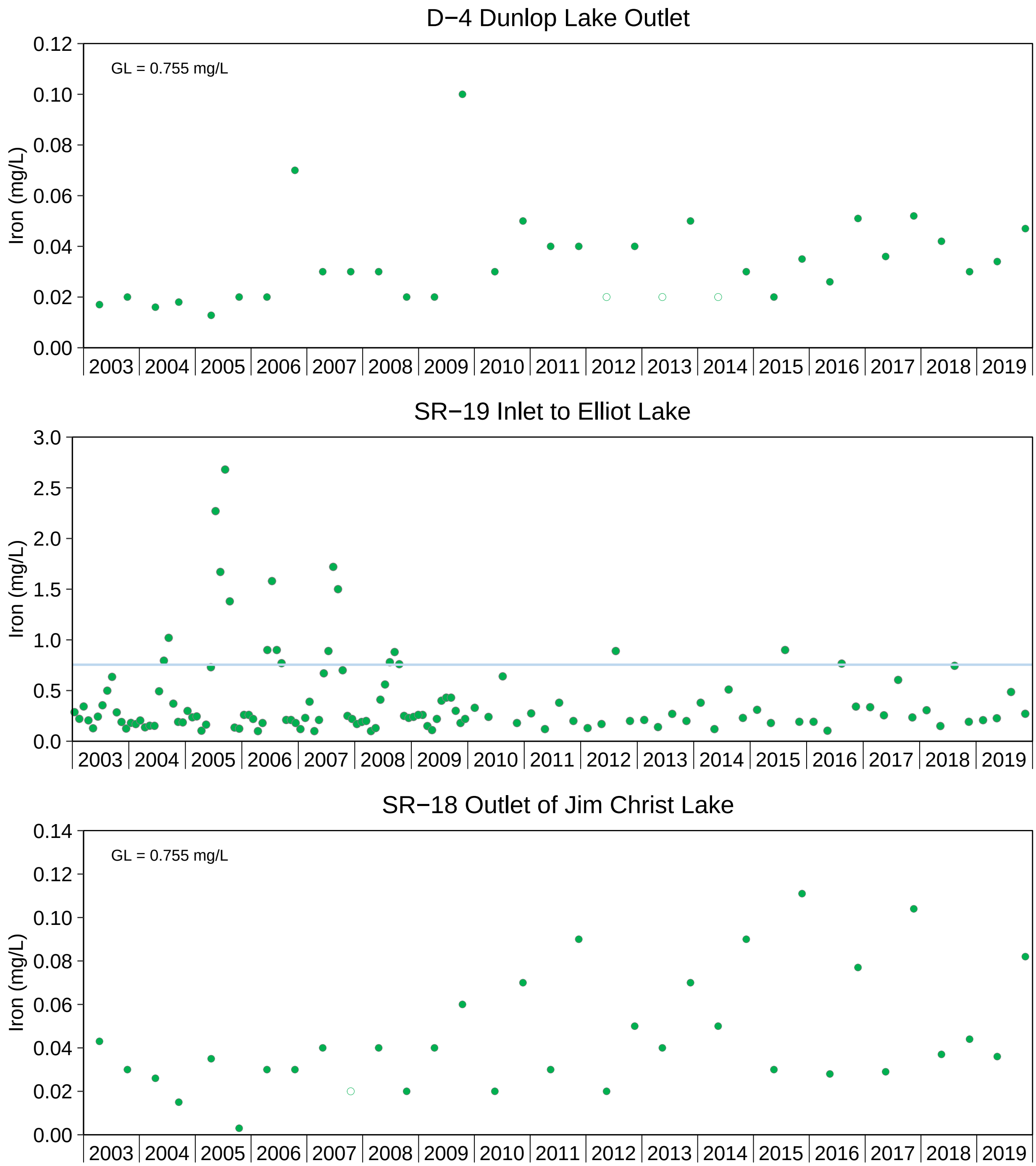


Figure S.17: Iron Concentrations for SRWMP Water Quality Monitoring Stations in the Elliot Lake Sub−Watershed, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guideline = Upper limit of background concentrations (95th percentile) based on data collected from lake reference stations (blue; D−4, SR−18, SR−19) and wetland reference stations (green; SR−16, SR−17) from 2015 to 2019. Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium−226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014. See Appendix Tables S.3 to S.4 and S.13 to S.14 for raw data.

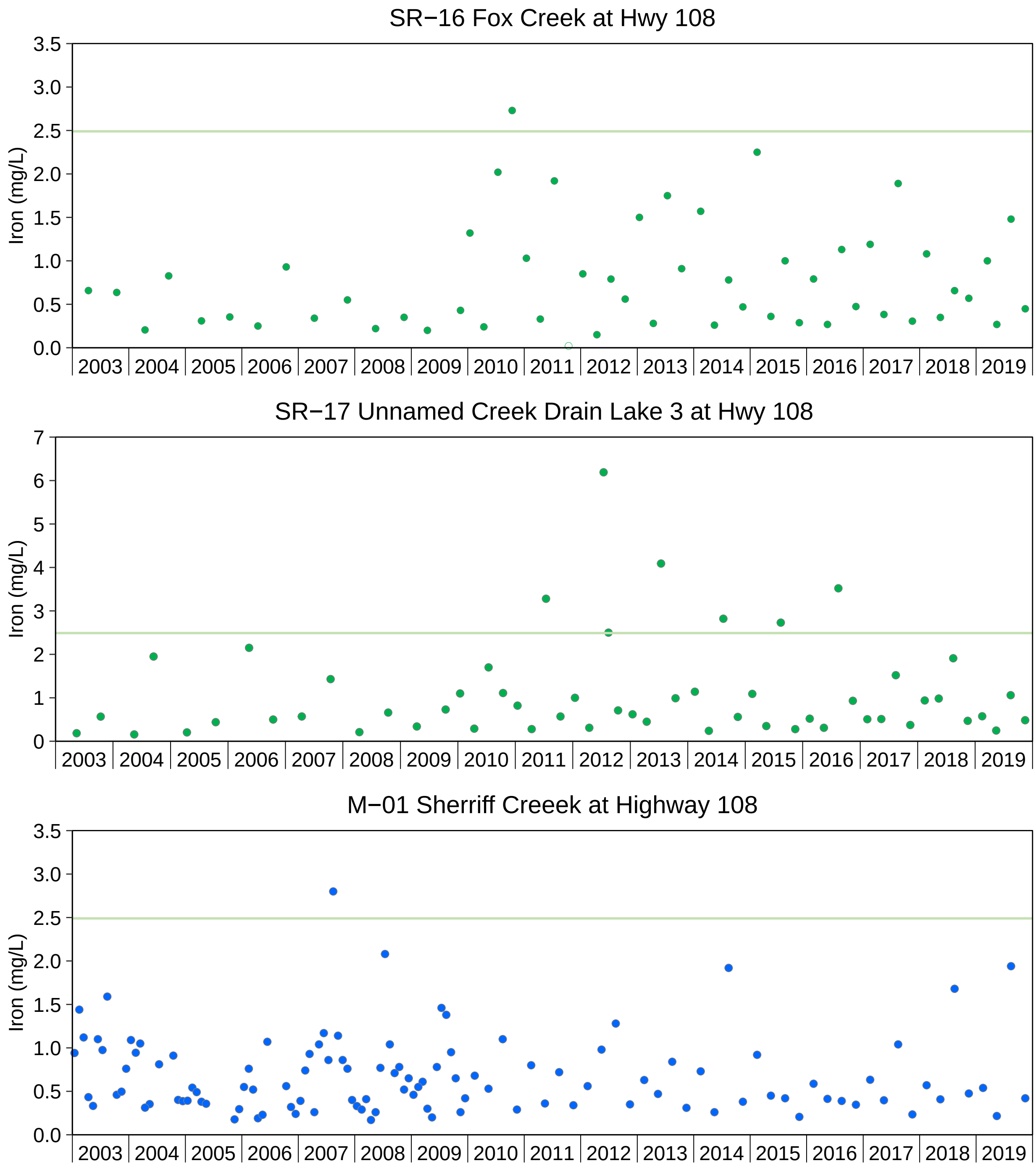


Figure S.17: Iron Concentrations for SRWMP Water Quality Monitoring Stations in the Elliot Lake Sub−Watershed, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guideline = Upper limit of background concentrations (95th percentile) based on data collected from lake reference stations (blue; D−4, SR−18, SR−19) and wetland reference stations (green; SR−16, SR−17) from 2015 to 2019. Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium−226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014. See Appendix Tables S.3 to S.4 and S.13 to S.14 for raw data.

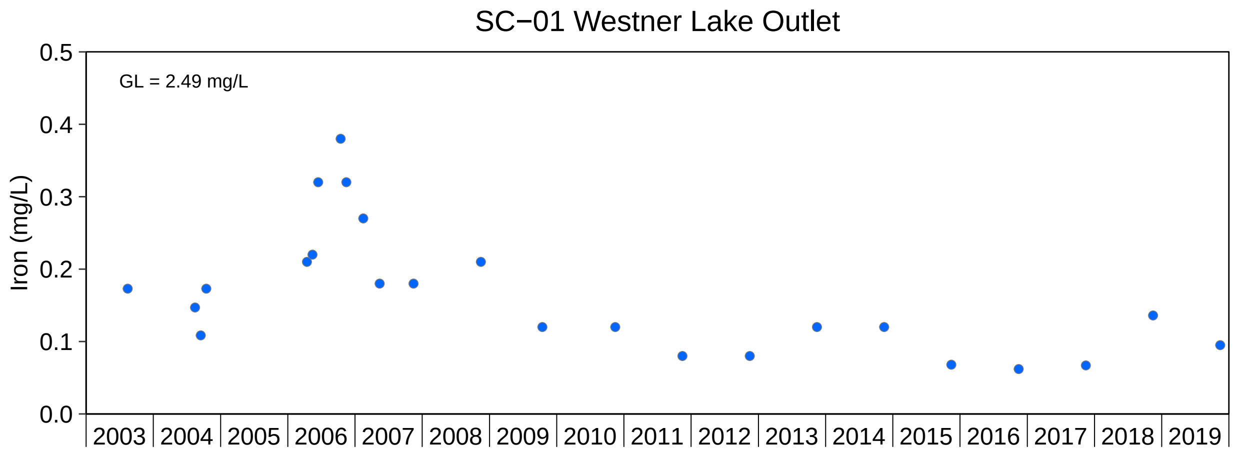


Figure S.17: Iron Concentrations for SRWMP Water Quality Monitoring Stations in the Elliot Lake Sub−Watershed, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guideline = Upper limit of background concentrations (95th percentile) based on data collected from lake reference stations (blue; D−4, SR−18, SR−19) and wetland reference stations (green; SR−16, SR−17) from 2015 to 2019. Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium−226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014. See Appendix Tables S.3 to S.4 and S.13 to S.14 for raw data.

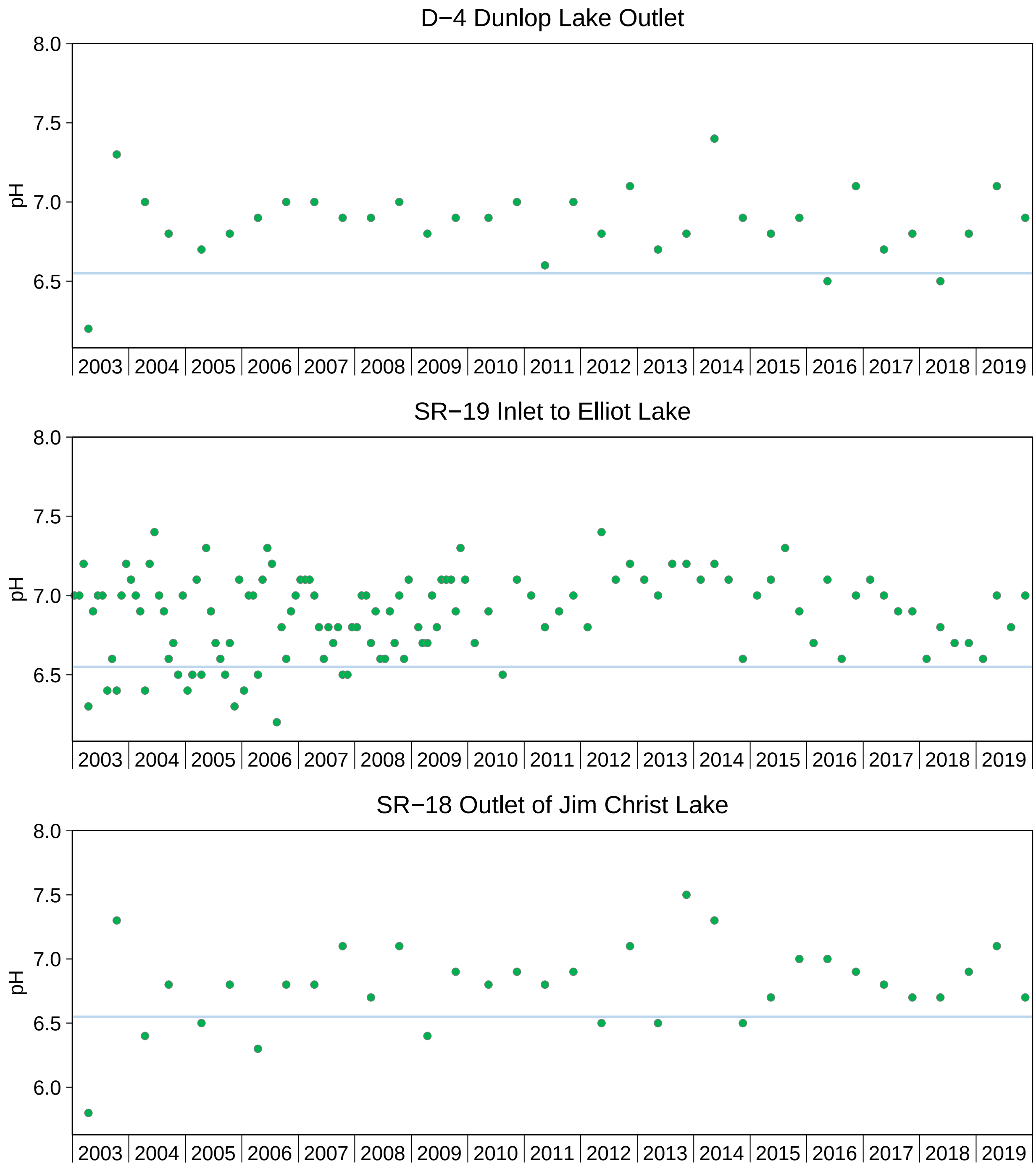


Figure S.18: Field Measurements of pH for SRWMP Water Quality Monitoring Stations in the Elliot Lake Sub−Watershed, 2003 to 2019

Notes: Guideline = Upper limit of background concentrations (95th percentile) based on data collected from lake reference stations (blue; D−4, SR−18, SR−19) and wetland reference stations (green; SR−16, SR−17) from 2015 to 2019. Reference areas are plotted in green and mine−exposed areas are plotted in blue. See Appendix Tables S.3 to S.4 and S.13 to S.14 for raw data.

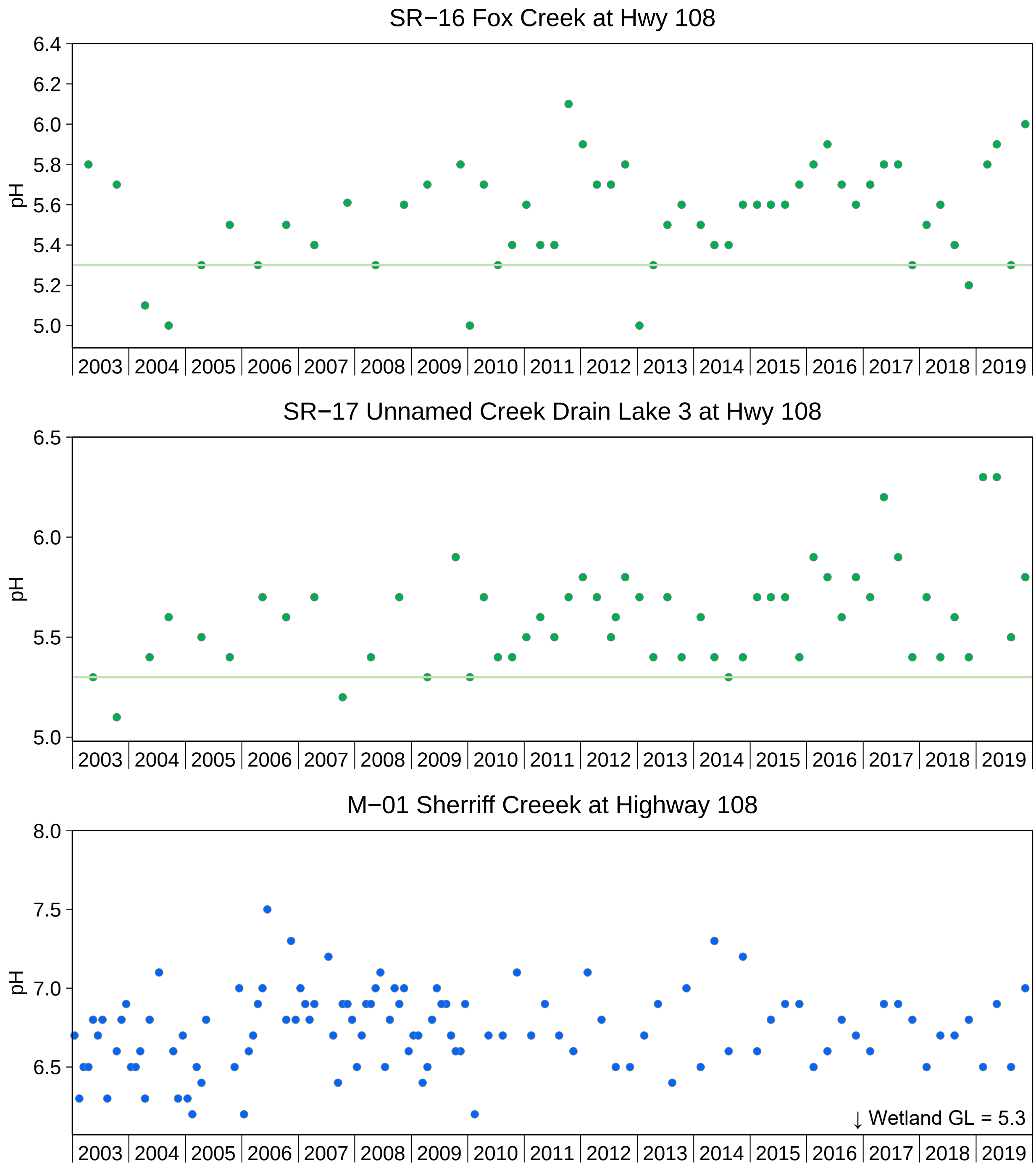


Figure S.18: Field Measurements of pH for SRWMP Water Quality Monitoring Stations in the Elliot Lake Sub−Watershed, 2003 to 2019

Notes: Guideline = Upper limit of background concentrations (95th percentile) based on data collected from lake reference stations (blue; D−4, SR−18, SR−19) and wetland reference stations (green; SR−16, SR−17) from 2015 to 2019. Reference areas are plotted in green and mine−exposed areas are plotted in blue. See Appendix Tables S.3 to S.4 and S.13 to S.14 for raw data.

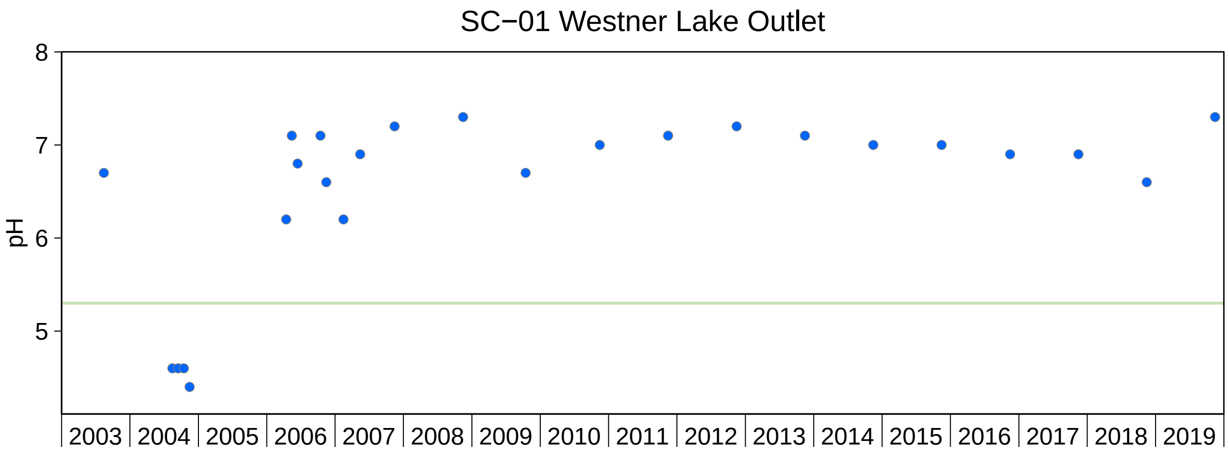
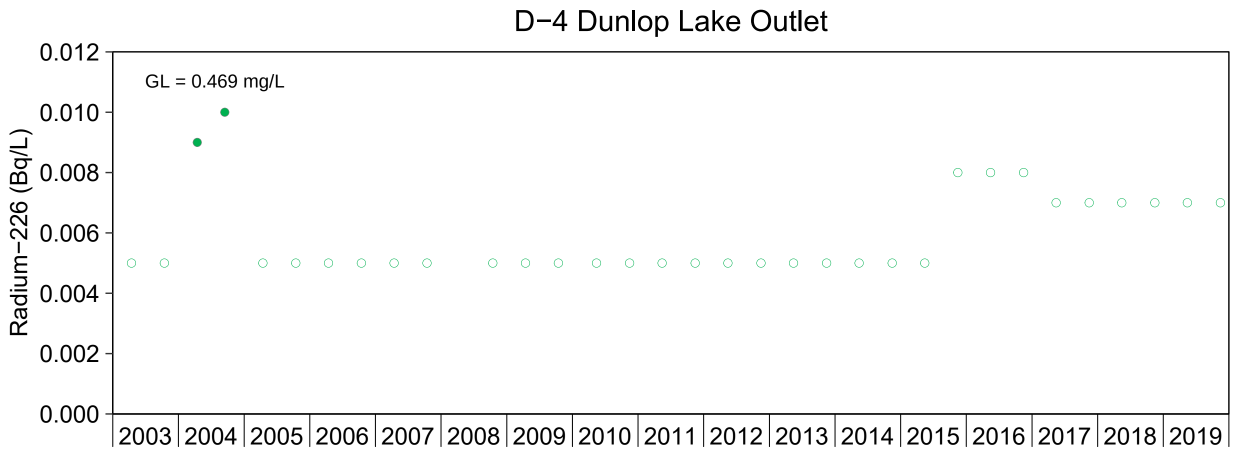
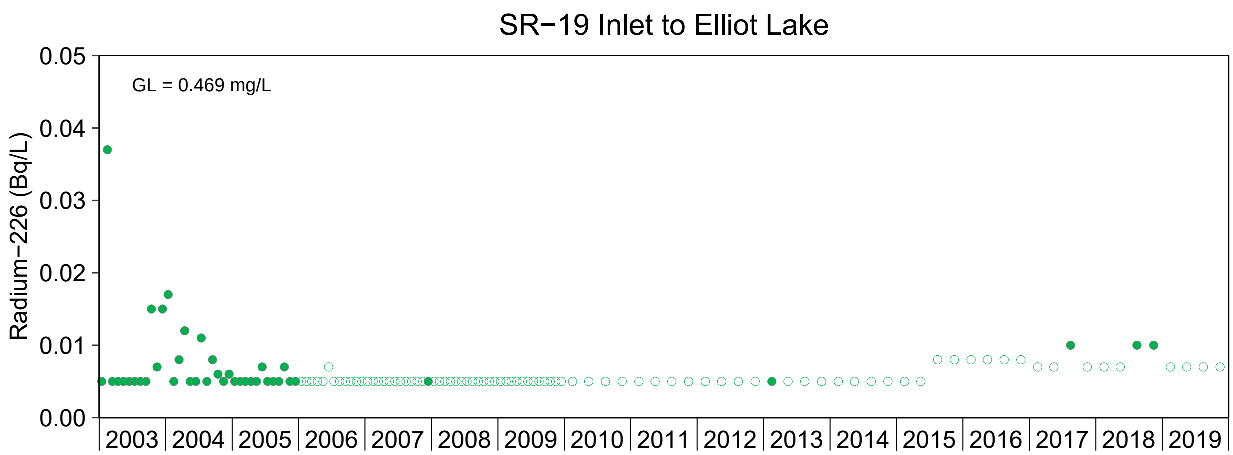


Figure S.18: Field Measurements of pH for SRWMP Water Quality Monitoring Stations in the Elliot Lake Sub−Watershed, 2003 to 2019

Notes: Guideline = Upper limit of background concentrations (95th percentile) based on data collected from lake reference stations (blue; D−4, SR−18, SR−19) and wetland reference stations (green; SR−16, SR−17) from 2015 to 2019. Reference areas are plotted in green and mine−exposed areas are plotted in blue. See Appendix Tables S.3 to S.4 and S.13 to S.14 for raw data.





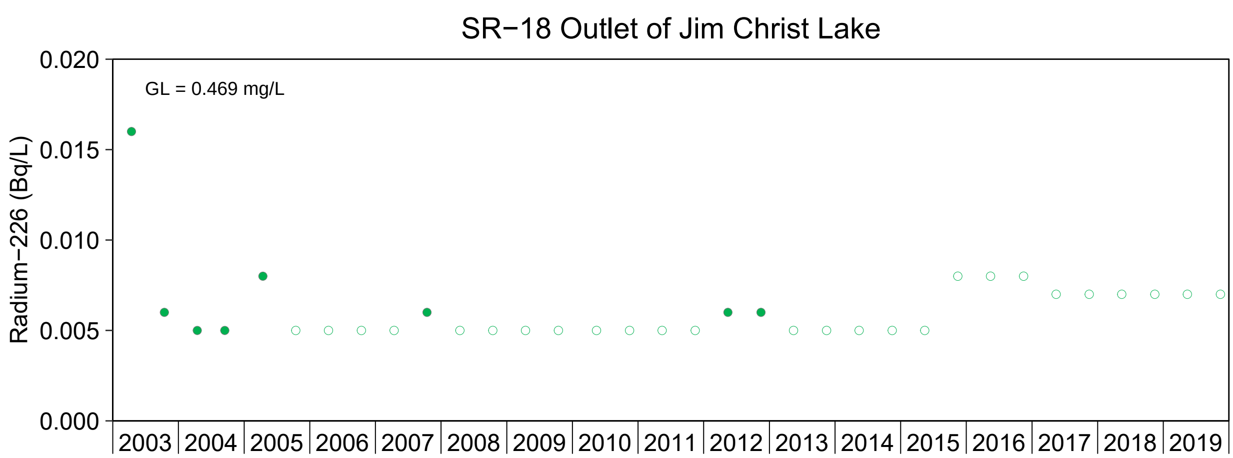


Figure S.19: Radium−226 Concentrations for SRWMP Water Quality Monitoring Stations in the Elliot Lake Sub−Watershed, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guideline = site−specific benchmark. Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium− 226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014. Radium (Bq/L) is not included in the trend analysis for SWRMP stations D−4, SR−16, SR−17, SR−18, and SR−19 due to >50% non−detectable concentrations in the dataset. See Appendix Tables S.3 to S.4 and S.13 to S.14 for raw data.

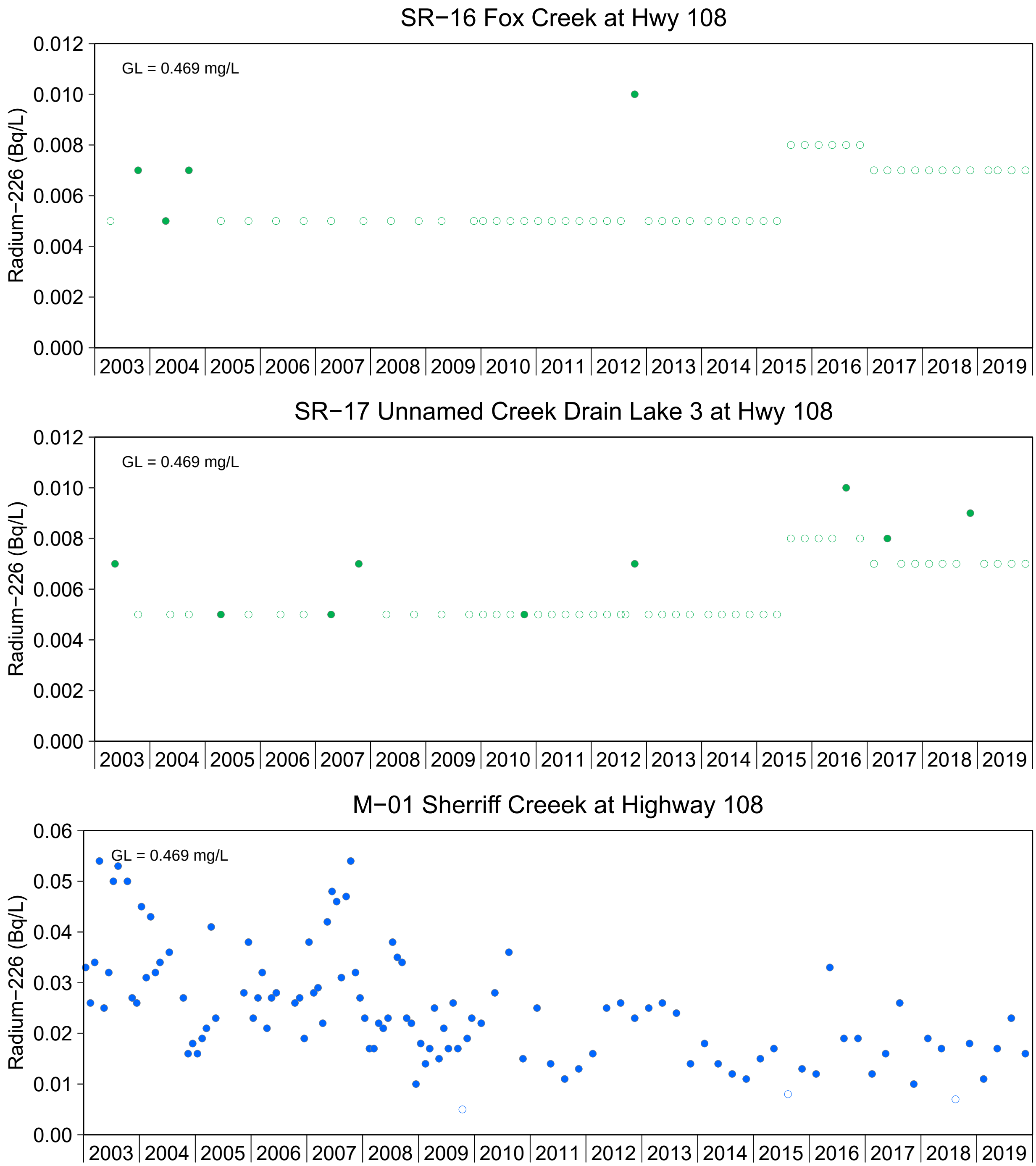


Figure S.19: Radium−226 Concentrations for SRWMP Water Quality Monitoring Stations in the Elliot Lake Sub−Watershed, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guideline = site−specific benchmark. Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium− 226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014. Radium (Bq/L) is not included in the trend analysis for SWRMP stations D−4, SR−16, SR−17, SR−18, and SR−19 due to >50% non−detectable concentrations in the dataset. See Appendix Tables S.3 to S.4 and S.13 to S.14 for raw data.

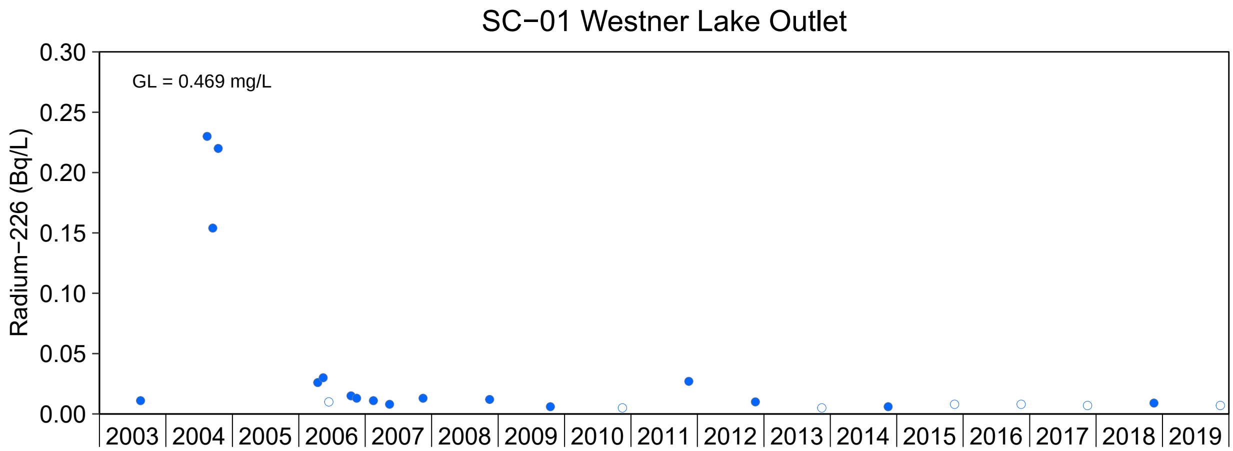


Figure S.19: Radium−226 Concentrations for SRWMP Water Quality Monitoring Stations in the Elliot Lake Sub−Watershed, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guideline = site−specific benchmark. Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium− 226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014. Radium (Bq/L) is not included in the trend analysis for SWRMP stations D−4, SR−16, SR−17, SR−18, and SR−19 due to >50% non−detectable concentrations in the dataset. See Appendix Tables S.3 to S.4 and S.13 to S.14for raw data.

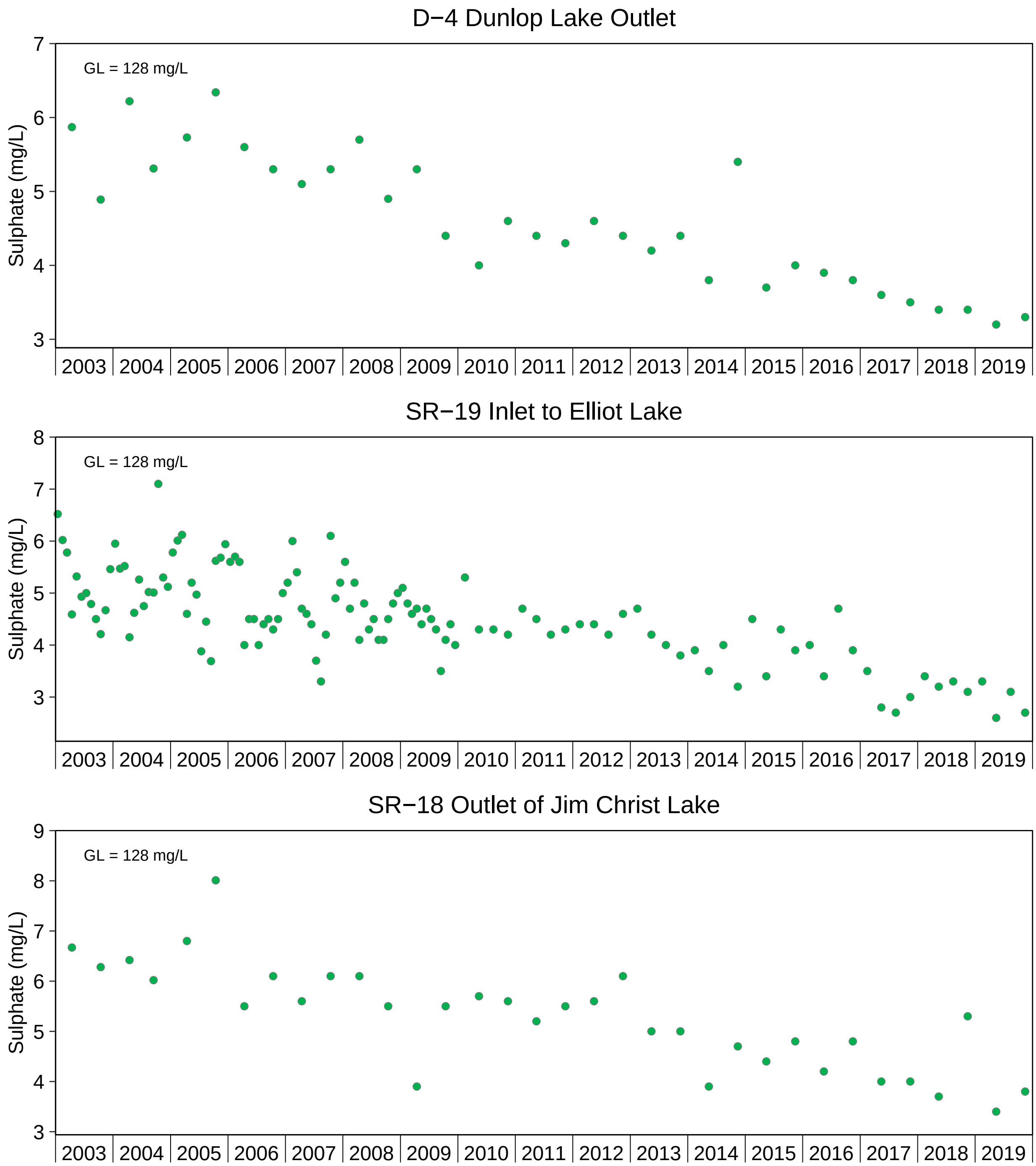


Figure S.20: Sulphate Concentrations for SWRMP Water Quality Monitoring Stations in the Elliot Lake Sub−Watershed, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guideline = BC Guideline (hardness dependent, see Appendix S.1 and S.2). Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium−226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014. See Appendix Tables S.3 to S.4 and S.13 to S.14 for raw data.

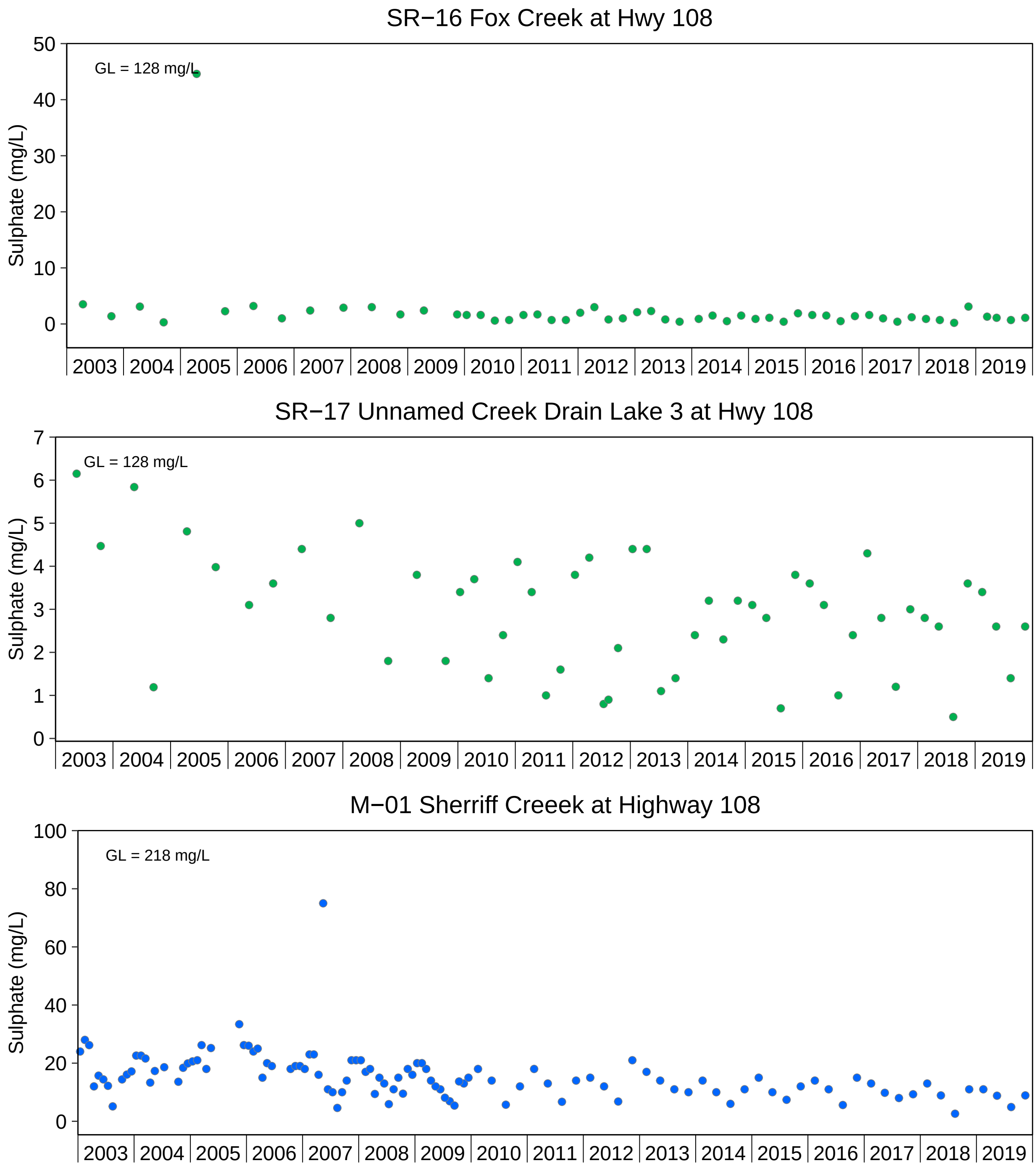


Figure S.20: Sulphate Concentrations for SWRMP Water Quality Monitoring Stations in the Elliot Lake Sub−Watershed, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guideline = BC Guideline (hardness dependent, see Appendix S.1 and S.2). Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium−226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014. See Appendix Tables S.3 to S.4 and S.13 to S.14 for raw data.

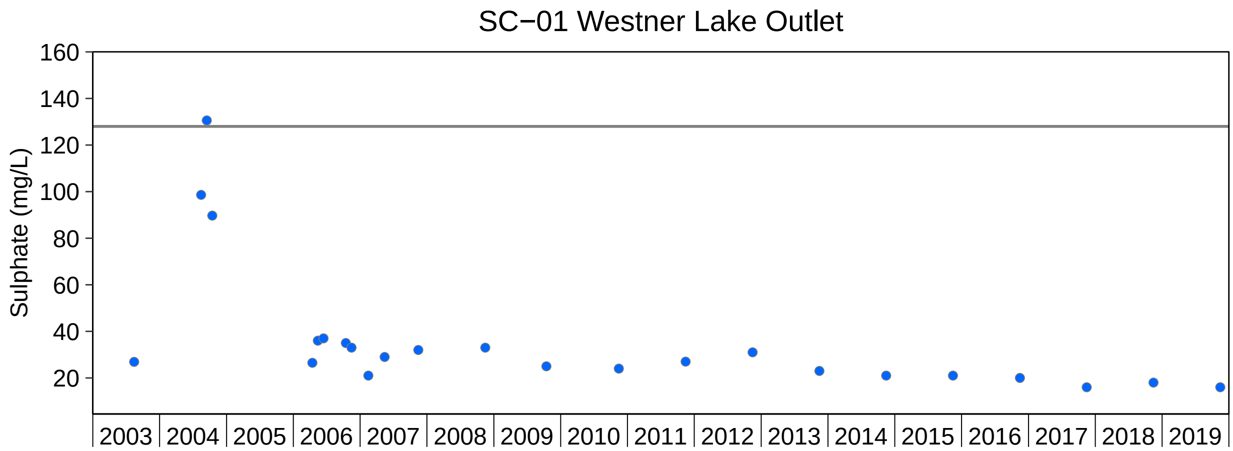


Figure S.20: Sulphate Concentrations for SWRMP Water Quality Monitoring Stations in the Elliot Lake Sub−Watershed, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guideline = BC Guideline (hardness dependent, see Appendix S.1 and S.2). Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium−226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014. See Appendix Tables S.3 to S.4 and S.13 to S.14 for raw data.

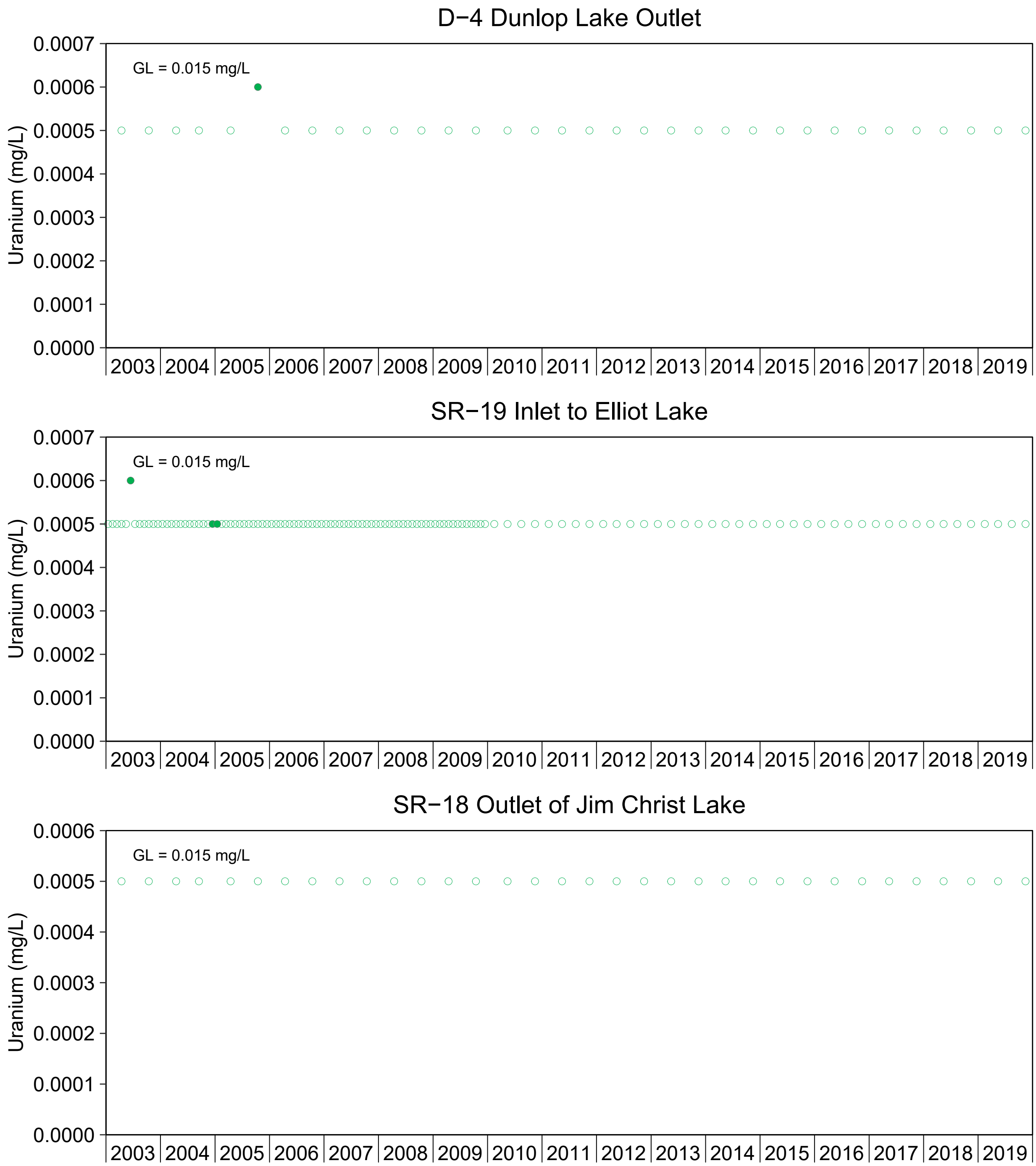
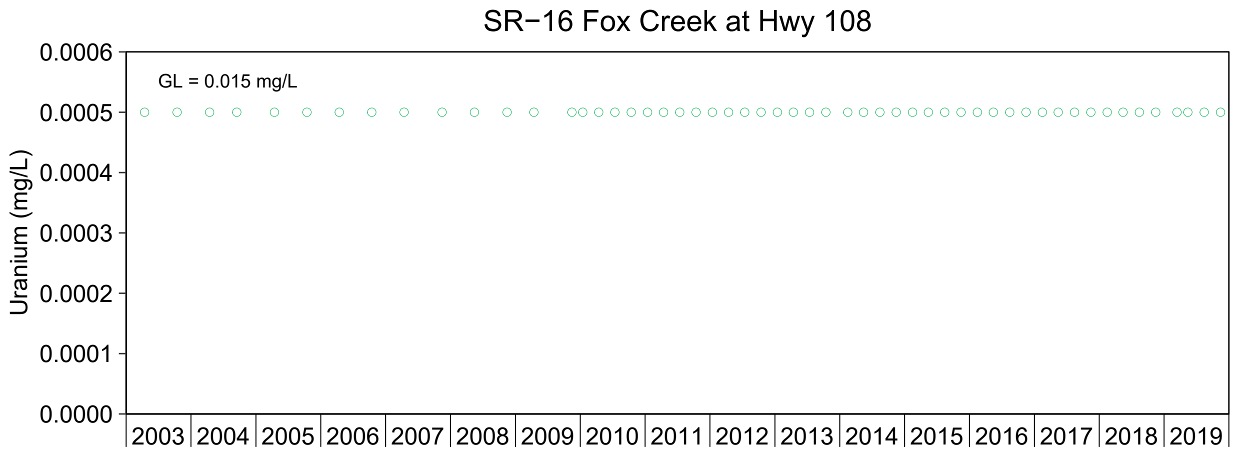
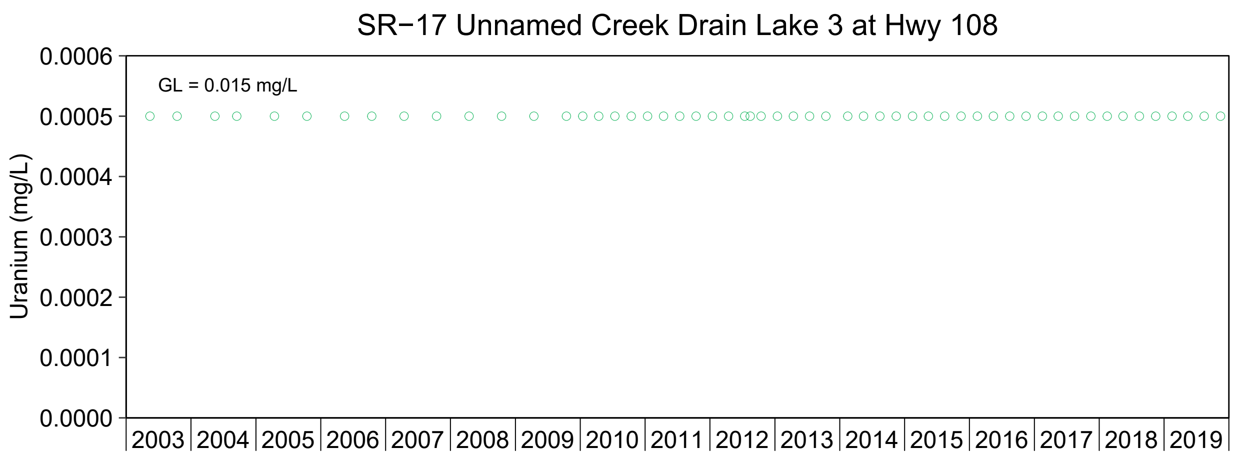


Figure S.21: Uranium Concentrations for SRWMP Water Quality Monitoring Stations in the Elliot Lake Sub−Watershed, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guideline = Federal Guideline. Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium−226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014. Uranium (mg/L) is not included in the trend analysis for SWRMP stations D−4, SC−01, SR−16, SR−17, SR−18, and SR−19 due to >50% non−detectable concentrations in the dataset. See Appendix Tables S.3 to S.4 and S.13 to S.14 for raw data.





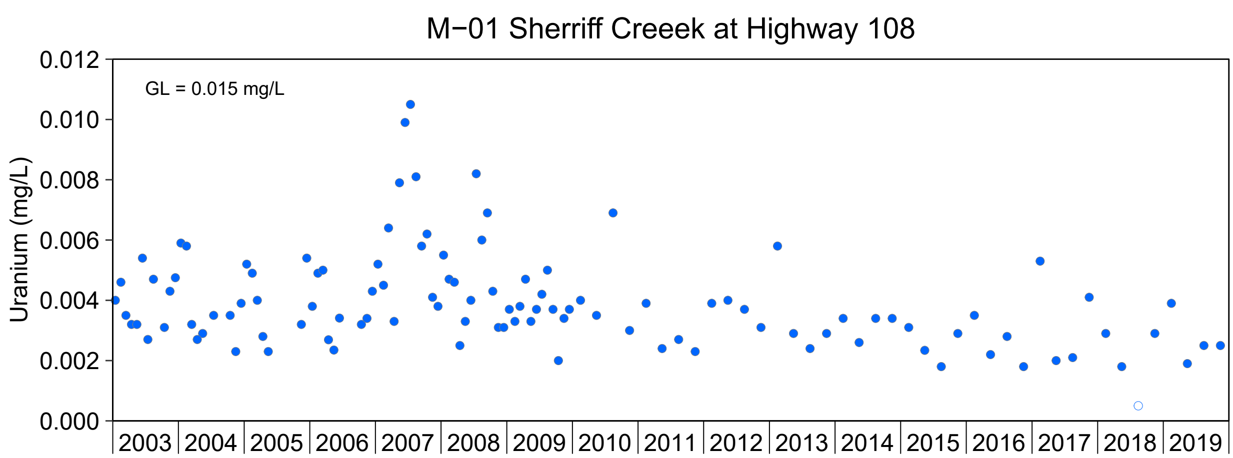


Figure S.21: Uranium Concentrations for SRWMP Water Quality Monitoring Stations in the Elliot Lake Sub−Watershed, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guideline = Federal Guideline. Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium−226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014. Uranium (mg/L) is not included in the trend analysis for SWRMP stations D−4, SC−01, SR−16, SR−17, SR−18, and SR−19 due to >50% non−detectable concentrations in the dataset. See Appendix Tables S.3 to S.4 and S.13 to S.14 for raw data.

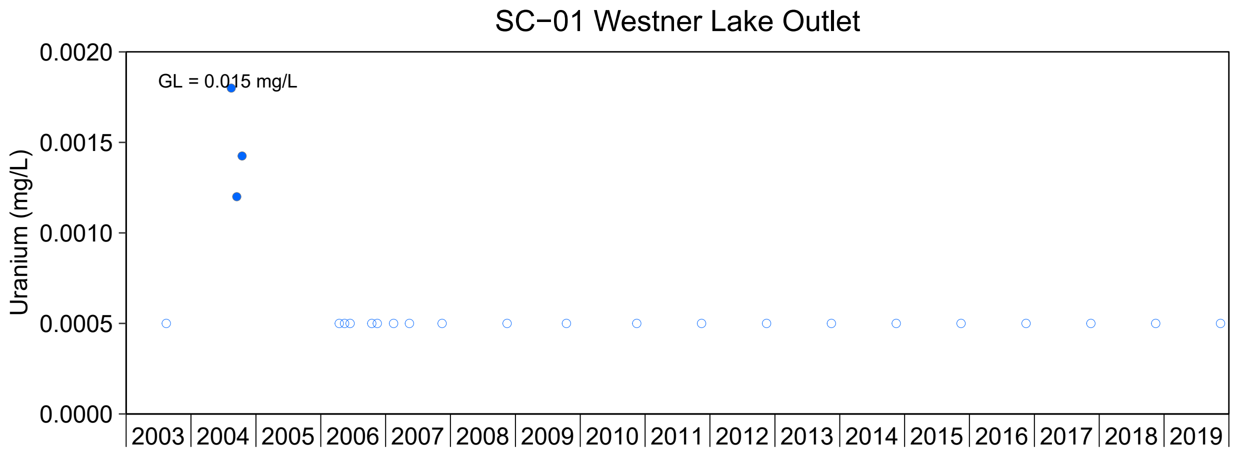


Figure S.21: Uranium Concentrations for SRWMP Water Quality Monitoring Stations in the Elliot Lake Sub−Watershed, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guideline = Federal Guideline. Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium−226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014. Uranium (mg/L) is not included in the trend analysis for SWRMP stations D−4, SC−01, SR−16, SR−17, SR−18, and SR−19 due to >50% non−detectable concentrations in the dataset. See Appendix Tables S.3 to S.4 and S.13 to S.14 for raw data.

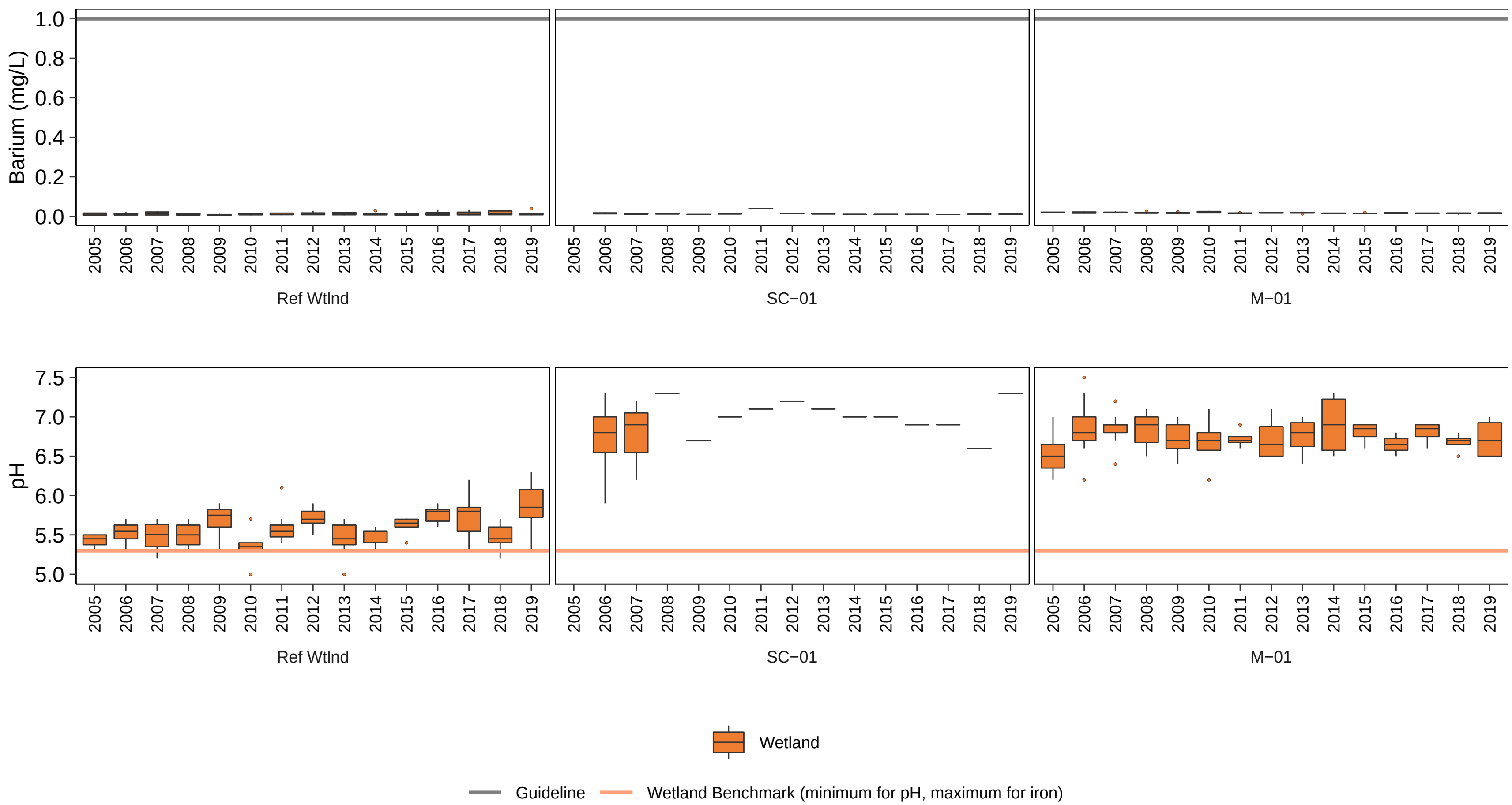


Figure S.22: **Concentration of Metals in Water from the Elliot Lake Sub−watershed Compared to Reference Areas and Benchmarks, SRWMP, 2005 to 2019**

Notes: Boxes represent the interquartile range (IQR; 25th to 75th percentile) with the median designated as a solid horizontal line within the IQR. Vertical lines extend 1.5 x IQR above and below each respective percentile with values beyond this range designated with a *. Parameters with no variation for a given year will result in a single horizontal line (i.e., 25th, median, and 75th percentile are all the same value). See Appendix Tables S.4, S.13 and S.14 for raw data.

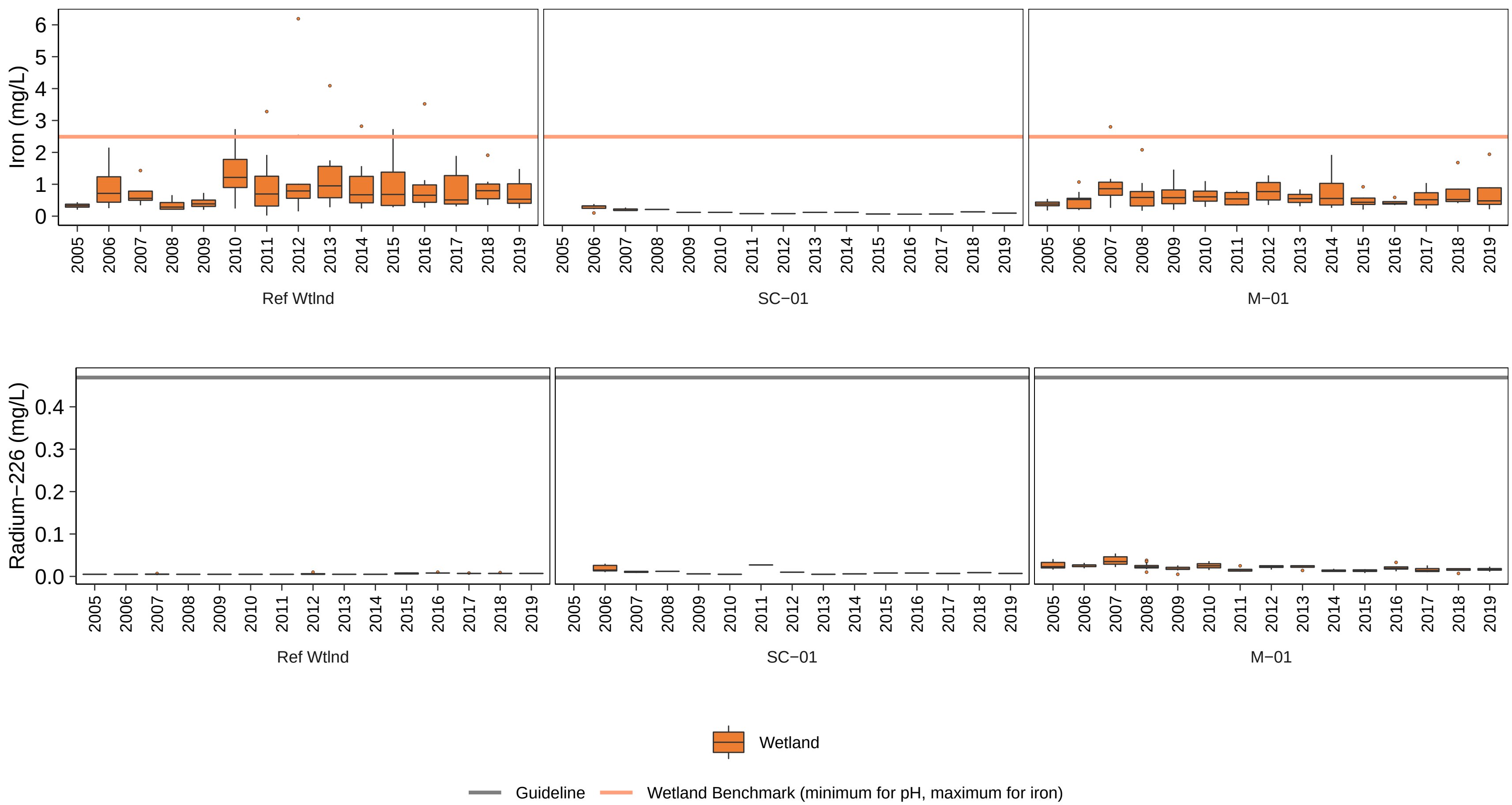


Figure S.22: Concentration of Metals in Water from the Elliot Lake Sub−watershed Compared to Reference Areas and Benchmarks, SRWMP, 2005 to 2019

Notes: Boxes represent the interquartile range (IQR; 25th to 75th percentile) with the median designated as a solid horizontal line within the IQR. Vertical lines extend 1.5 x IQR above and below each respective percentile with values beyond this range designated with a *. Parameters with no variation for a given year will result in a single horizontal line (i.e., 25th, median, and 75th percentile are all the same value). See Appendix Tables S.4, S.13 and S.14 for raw data.

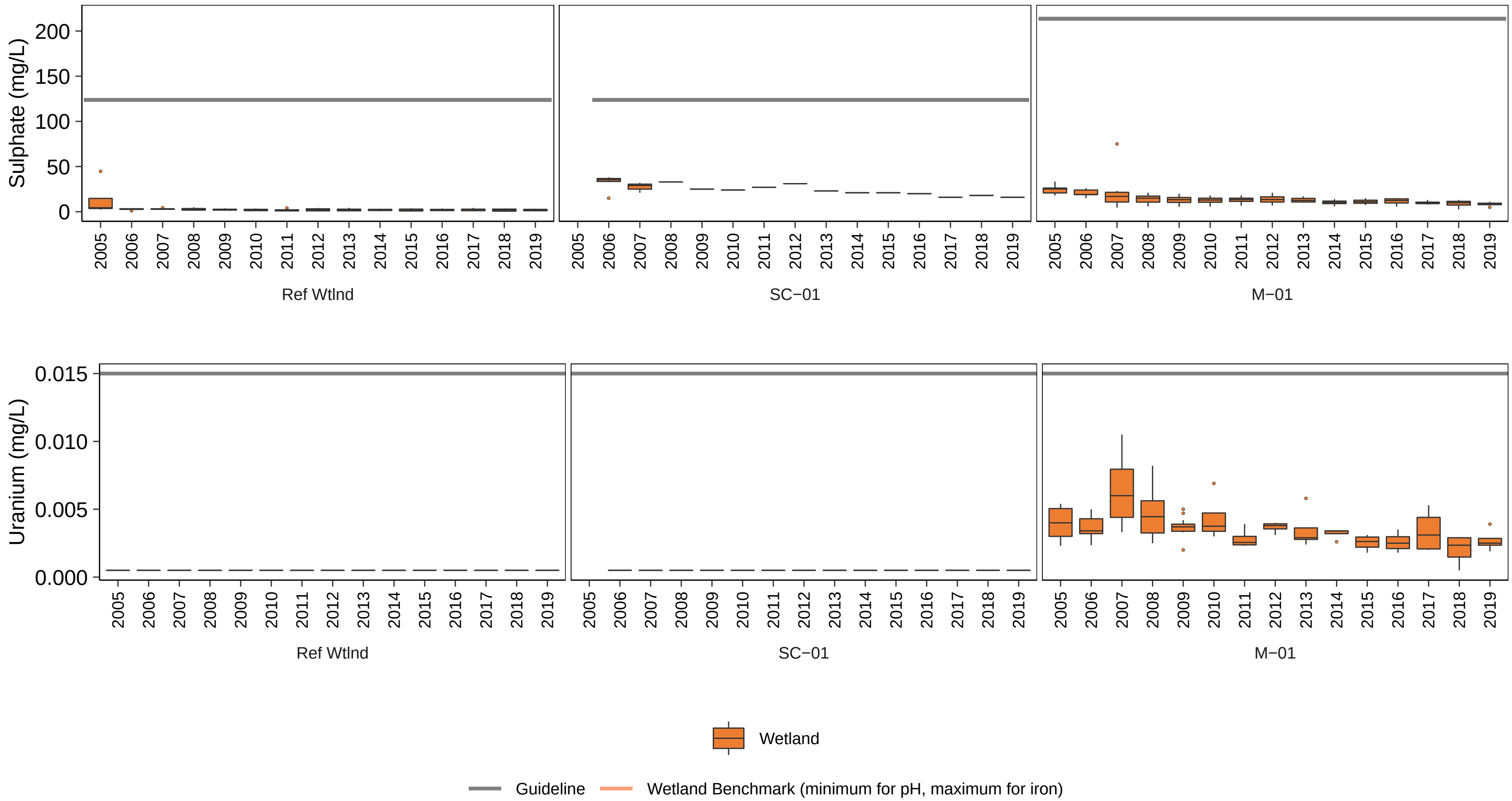


Figure S.22: Concentration of Metals in Water from the Elliot Lake Sub−watershed Compared to Reference Areas and Benchmarks, SRWMP, 2005 to 2019

Notes: Boxes represent the interquartile range (IQR; 25th to 75th percentile) with the median designated as a solid horizontal line within the IQR. Vertical lines extend 1.5 x IQR above and below each respective percentile with values beyond this range designated with a *. Parameters with no variation for a given year will result in a single horizontal line (i.e., 25th, median, and 75th percentile are all the same value). See Appendix Tables S.4, S.13 and S.14 for raw data.

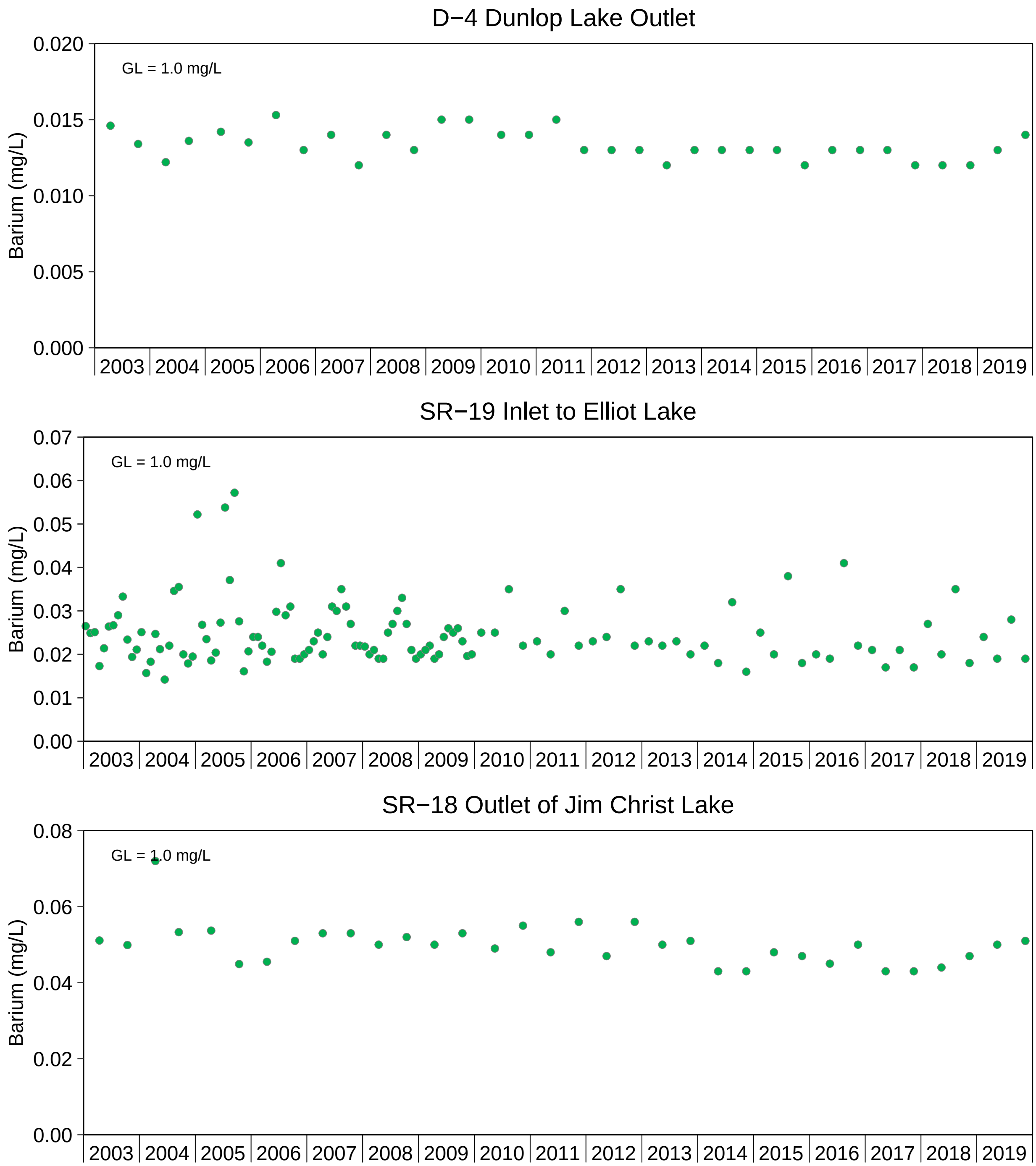


Figure S.23: Barium Concentrations for SRWMP Water Quality Monitoring Stations in the Nordic Lake Sub−Watershed, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guideline = BC Guideline. Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium-226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014.
See Appendix Tables S.3, S.4 and S.15 for raw data.

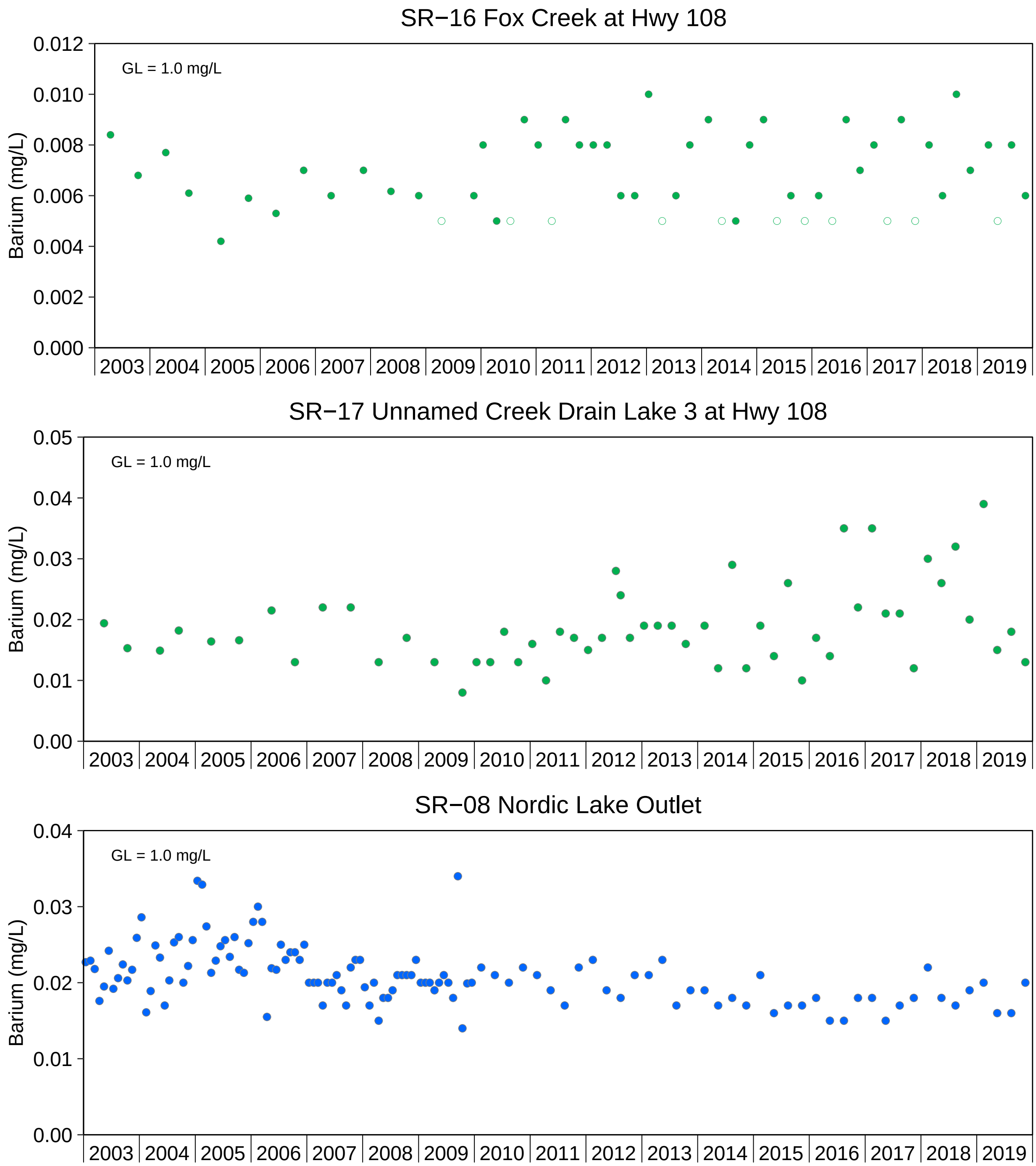


Figure S.23: Barium Concentrations for SRWMP Water Quality Monitoring Stations in the Nordic Lake Sub−Watershed, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL.
Guideline = BC Guideline. Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium-226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014.
See Appendix Tables S.3, S.4 and S.15 for raw data.

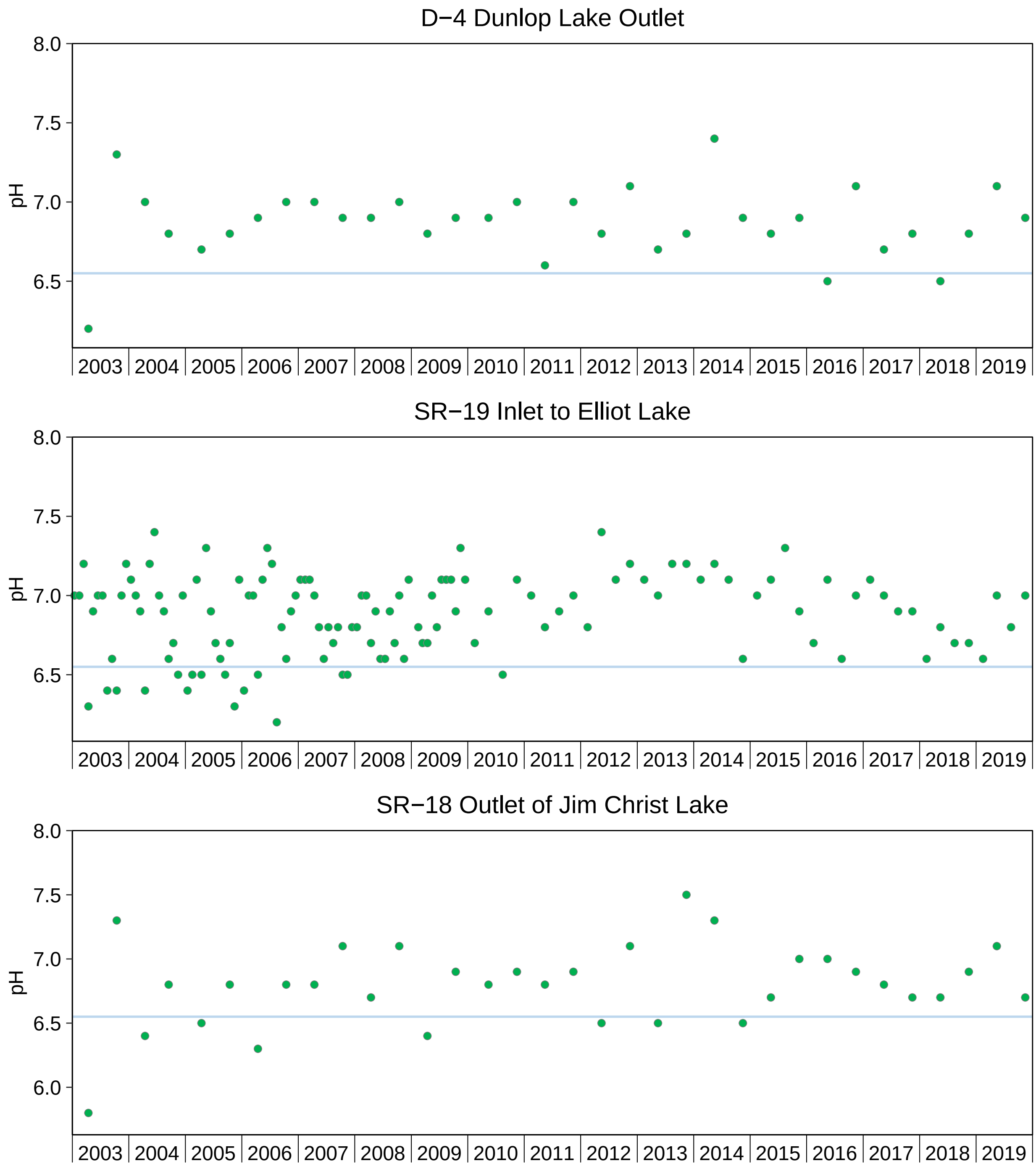


Figure S.24: Field Measurements of pH for SRWMP Water Quality Monitoring Stations in the Nordic Lake Sub−Watershed, 2003 to 2019

Notes: Guideline = Upper limit of background concentrations (95th percentile) based on data collected from lake reference stations (blue; D−4, SR−18, SR−19) and wetland reference stations (green; SR−16, SR−17) from 2015 to 2019. Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium−226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014. See Appendix Tables S.3, S.4 and S.15 for raw data.

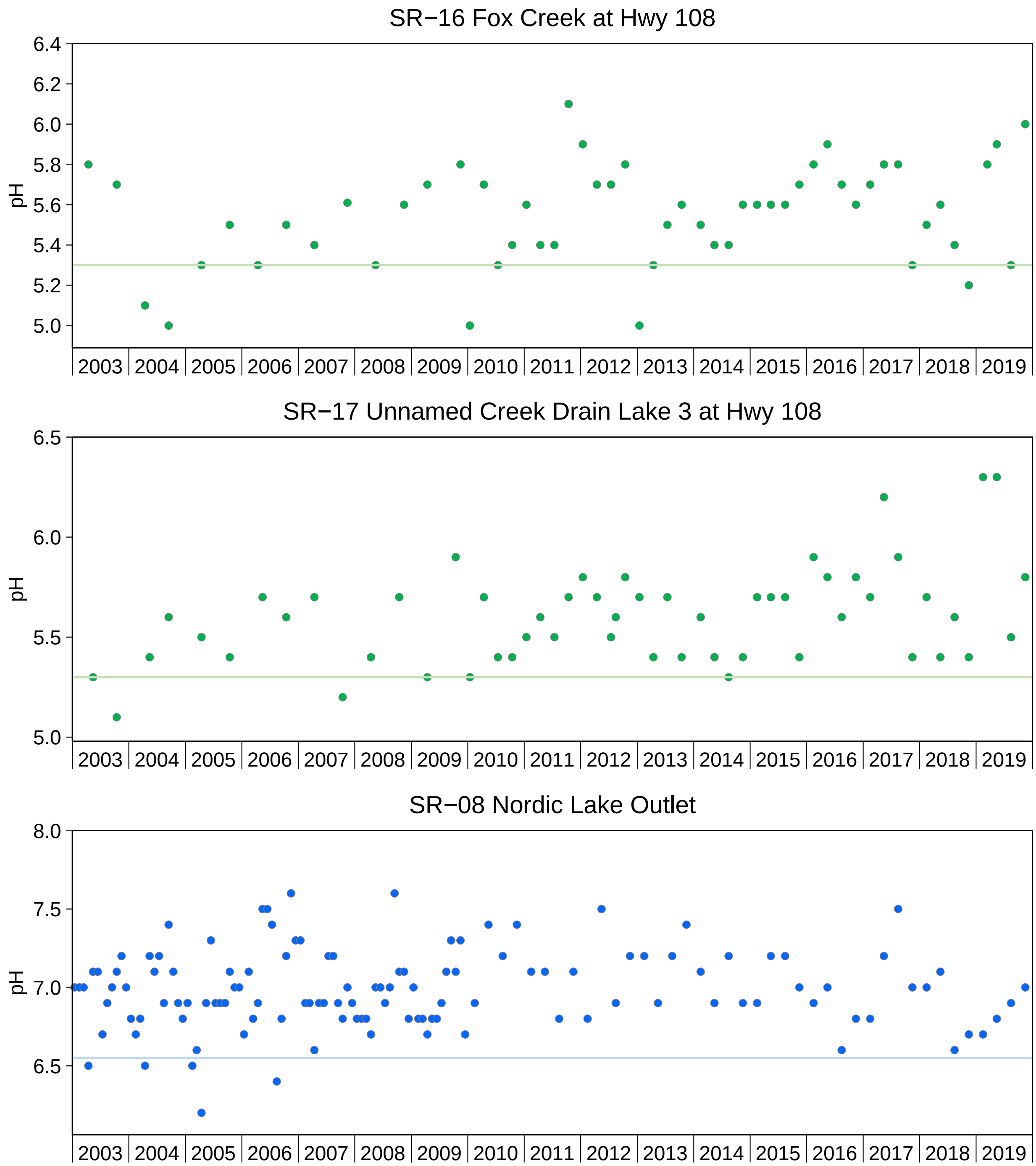


Figure S.24: Field Measurements of pH for SRWMP Water Quality Monitoring Stations in the Nordic Lake Sub−Watershed, 2003 to 2019

Notes: Guideline = Upper limit of background concentrations (95th percentile) based on data collected from lake reference stations (blue; D−4, SR−18, SR−19) and wetland reference stations (green; SR−16, SR−17) from 2015 to 2019. Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium−226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014. See Appendix Tables S.3, S.4 and S.15 for raw data.

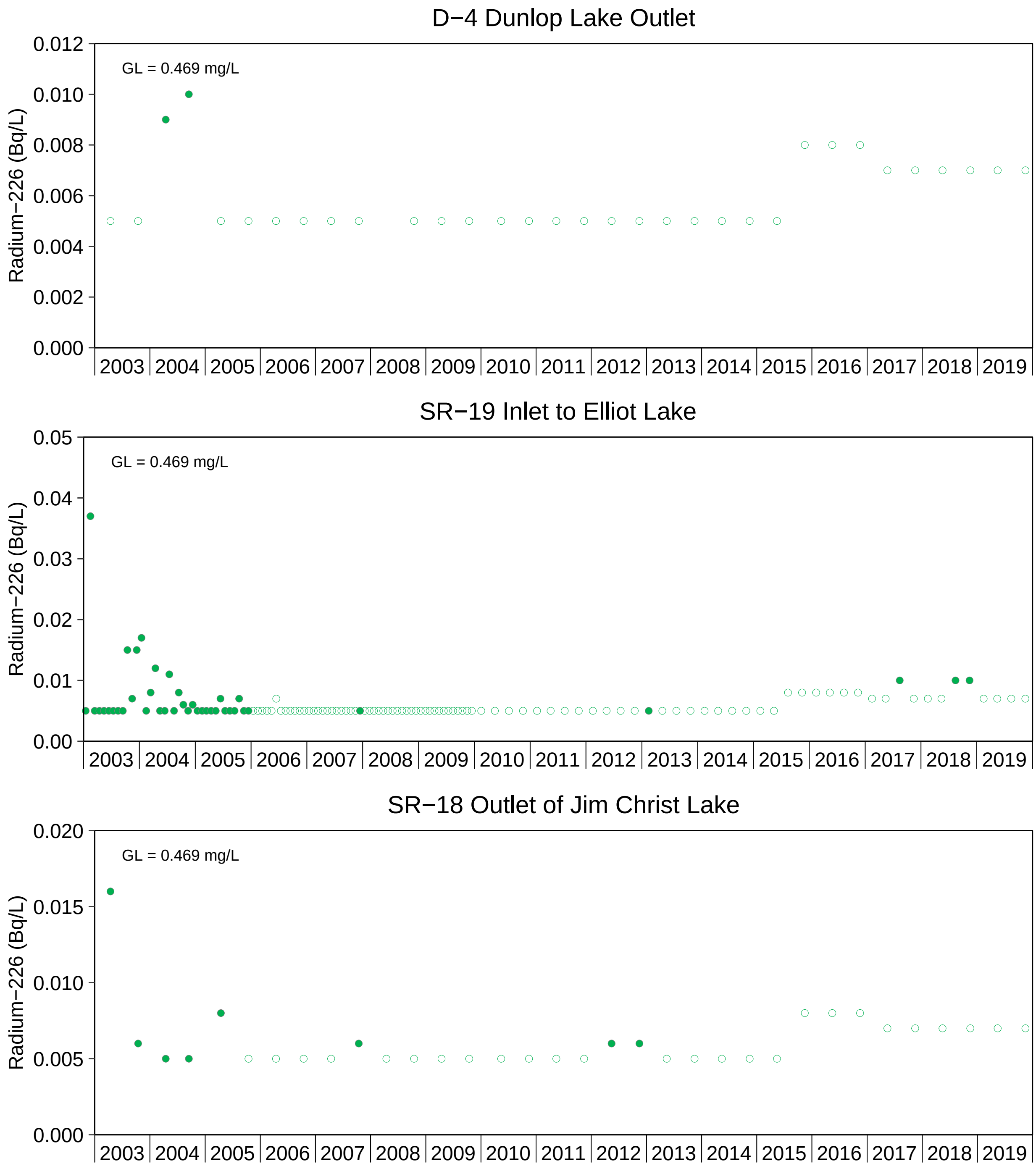


Figure S.25: Radium−226 Concentrations for SRWMP Water Quality Monitoring Stations in the Nordic Lake Sub−Watershed, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guideline = site−specific benchmark. Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium-226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014. Radium-226 is not included in the trend analysis for SWRMP stations D−4, SR−16, SR−17, SR−18, and SR−19 due to >50% non−detectable concentrations in the dataset. See Appendix Tables S.3, S.4 and S.15 for raw data.

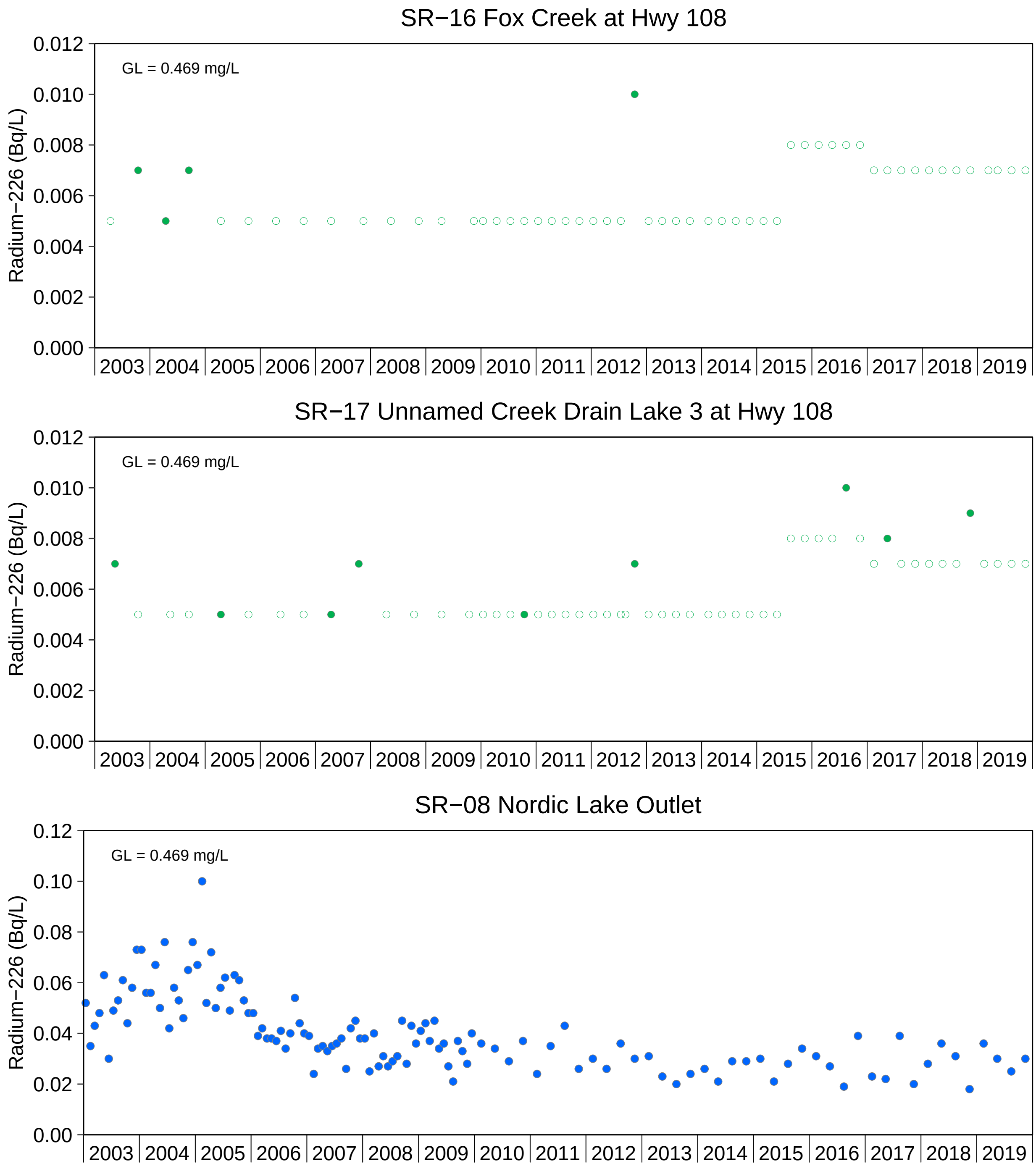


Figure S.25: Radium−226 Concentrations for SRWMP Water Quality Monitoring Stations in the Nordic Lake Sub−Watershed, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guideline = site−specific benchmark. Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium-226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014. Radium-226 is not included in the trend analysis for SWRMP stations D−4, SR−16, SR−17, SR−18, and SR−19 due to >50% non−detectable concentrations in the dataset. See Appendix Tables S.3, S.4 and S.15 for raw data.

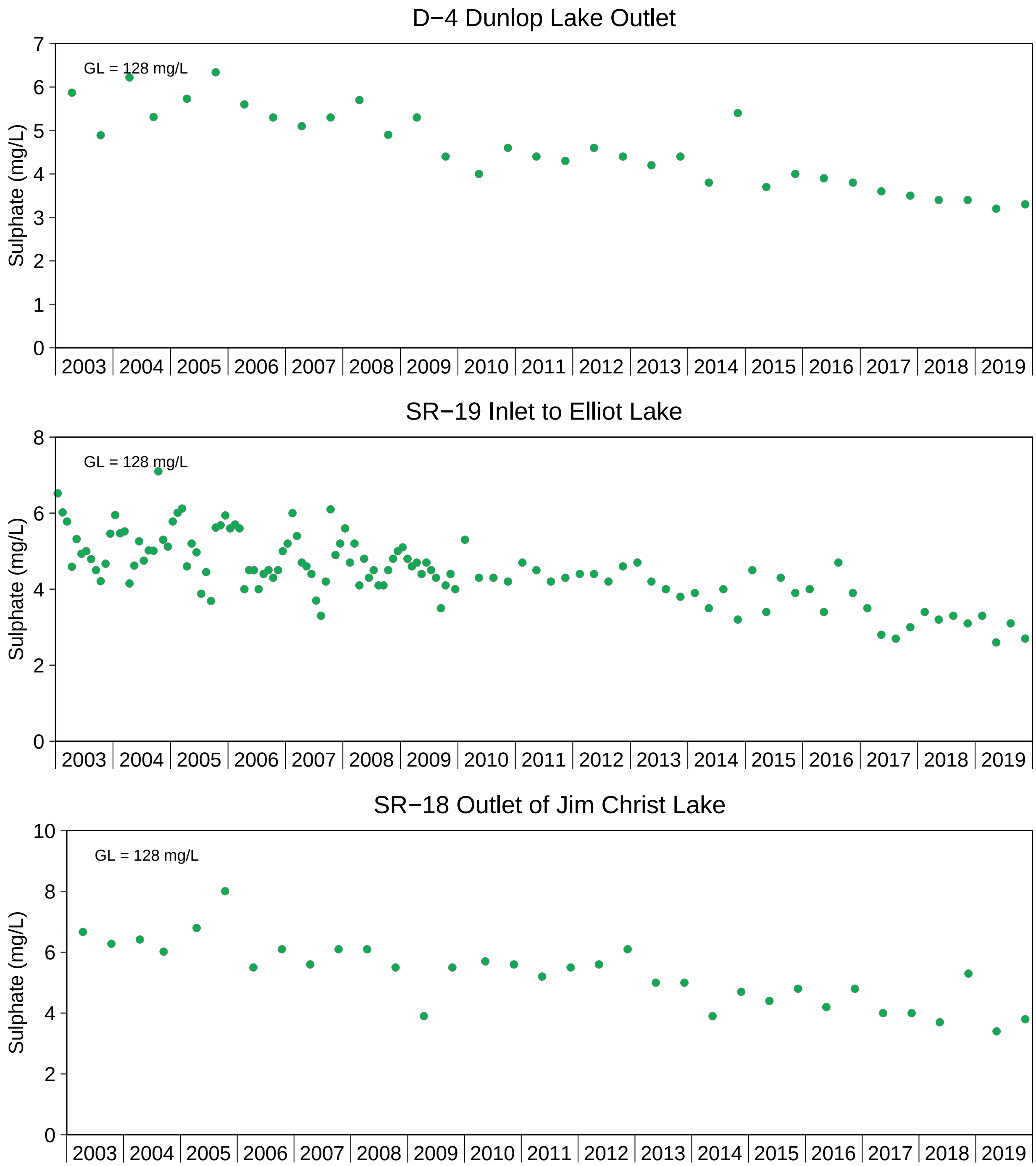


Figure S.26: Sulphate Concentrations for SWRMP Water Quality Monitoring Stations in the Nordic Lake Sub−Watershed, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guideline = BC Guideline (hardness dependent, see Appendix S.1 and S.2). Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium−226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014. See Appendix Tables S.3, S.4 and S.15 for raw data.

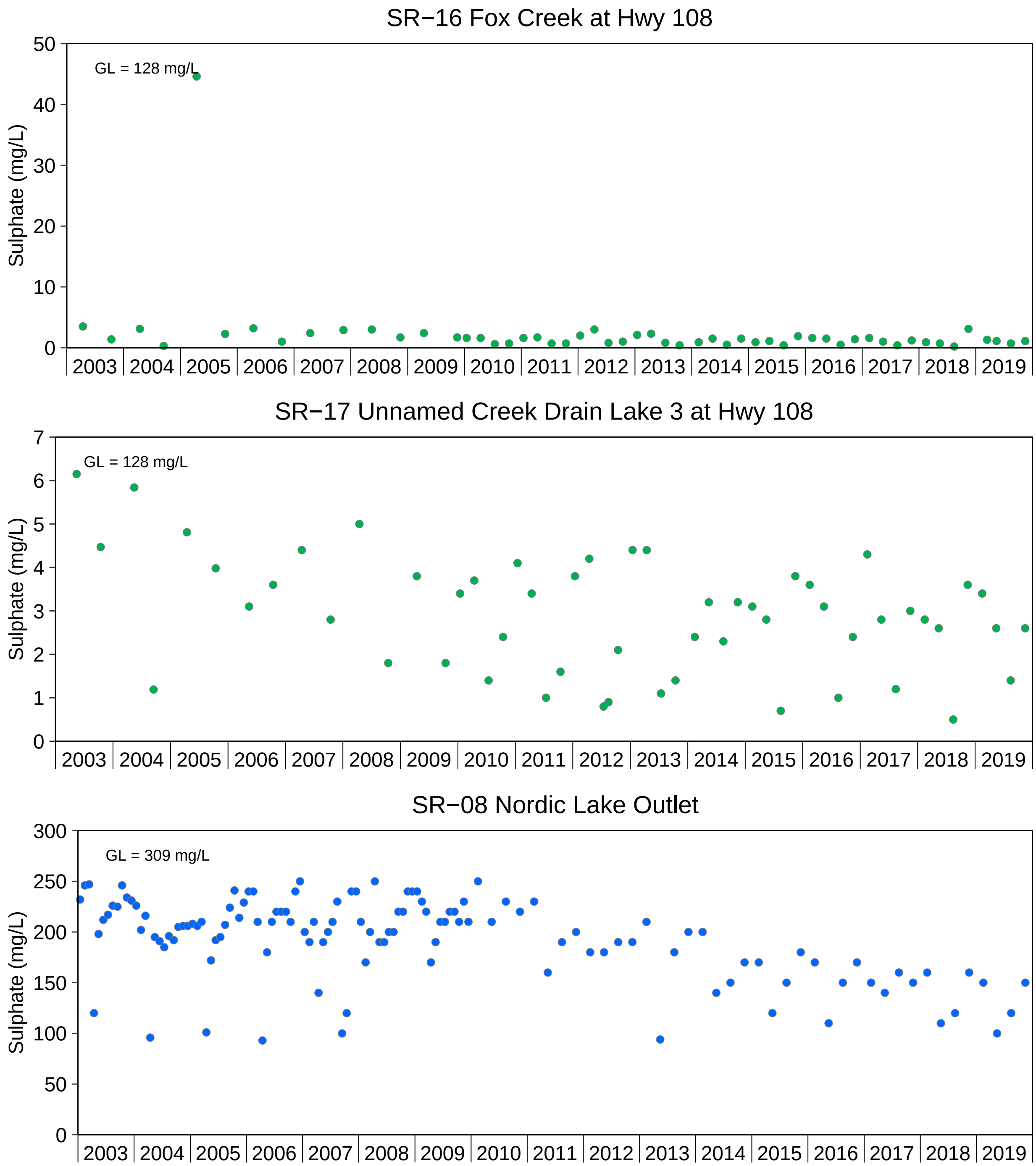


Figure S.26: Sulphate Concentrations for SWRMP Water Quality Monitoring Stations in the Nordic Lake Sub−Watershed, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guideline = BC Guideline (hardness dependent, see Appendix S.1 and S.2). Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium−226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014. See Appendix Tables S.3, S.4 and S.15 for raw data.

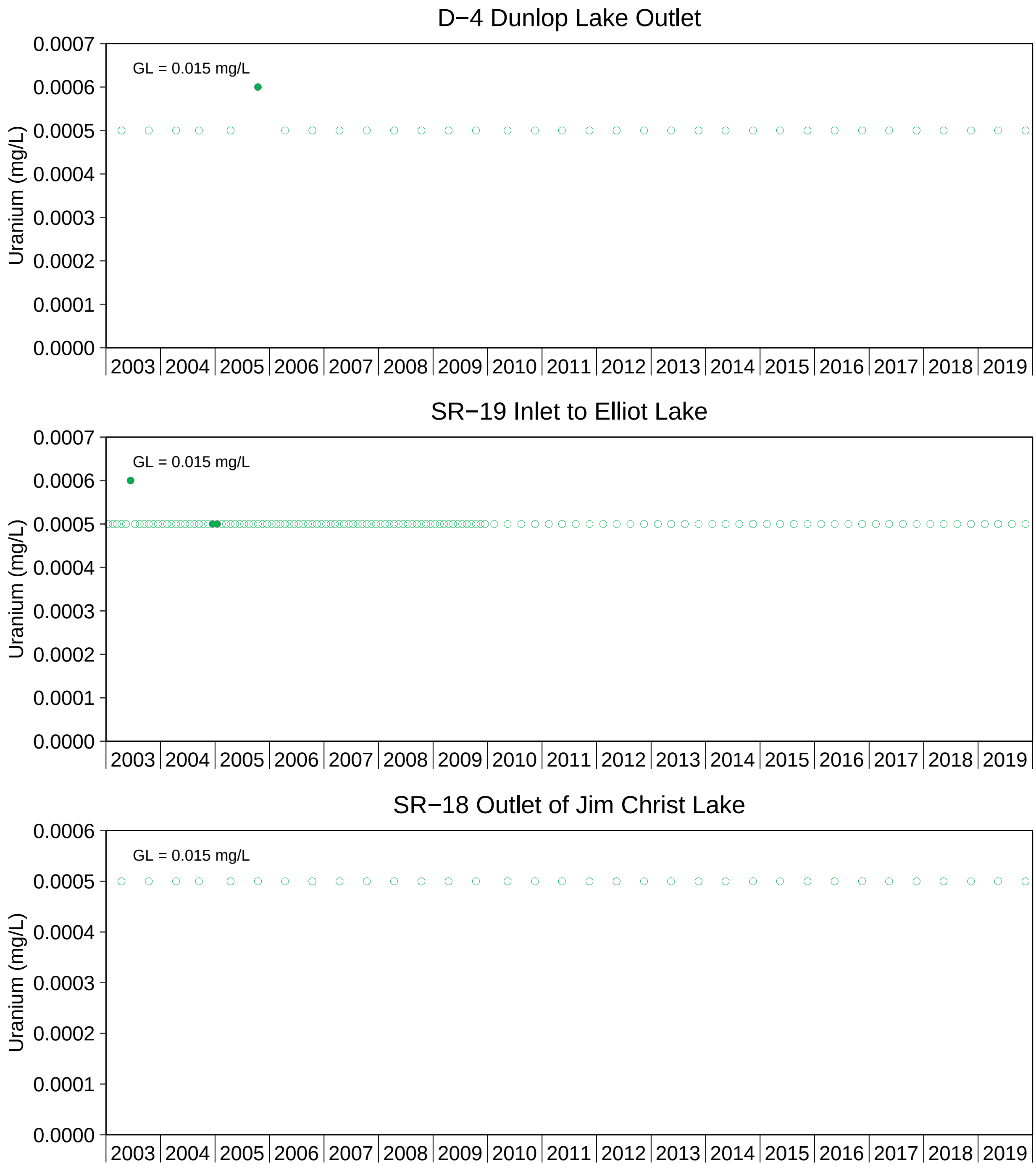


Figure S.27: Uranium Concentrations for SRWMP Water Quality Monitoring Stations in the Nordic Lake Sub−Watershed, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guideline = Federal Guideline. Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium−226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014. Uranium is not included in the trend analysis for SWRMP stations D−4, SR−16, SR−17, SR−18, and SR−19 due to >50% non−detectable concentrations in the dataset. See Appendix Tables S.3, S.4 and S.15 for raw data.

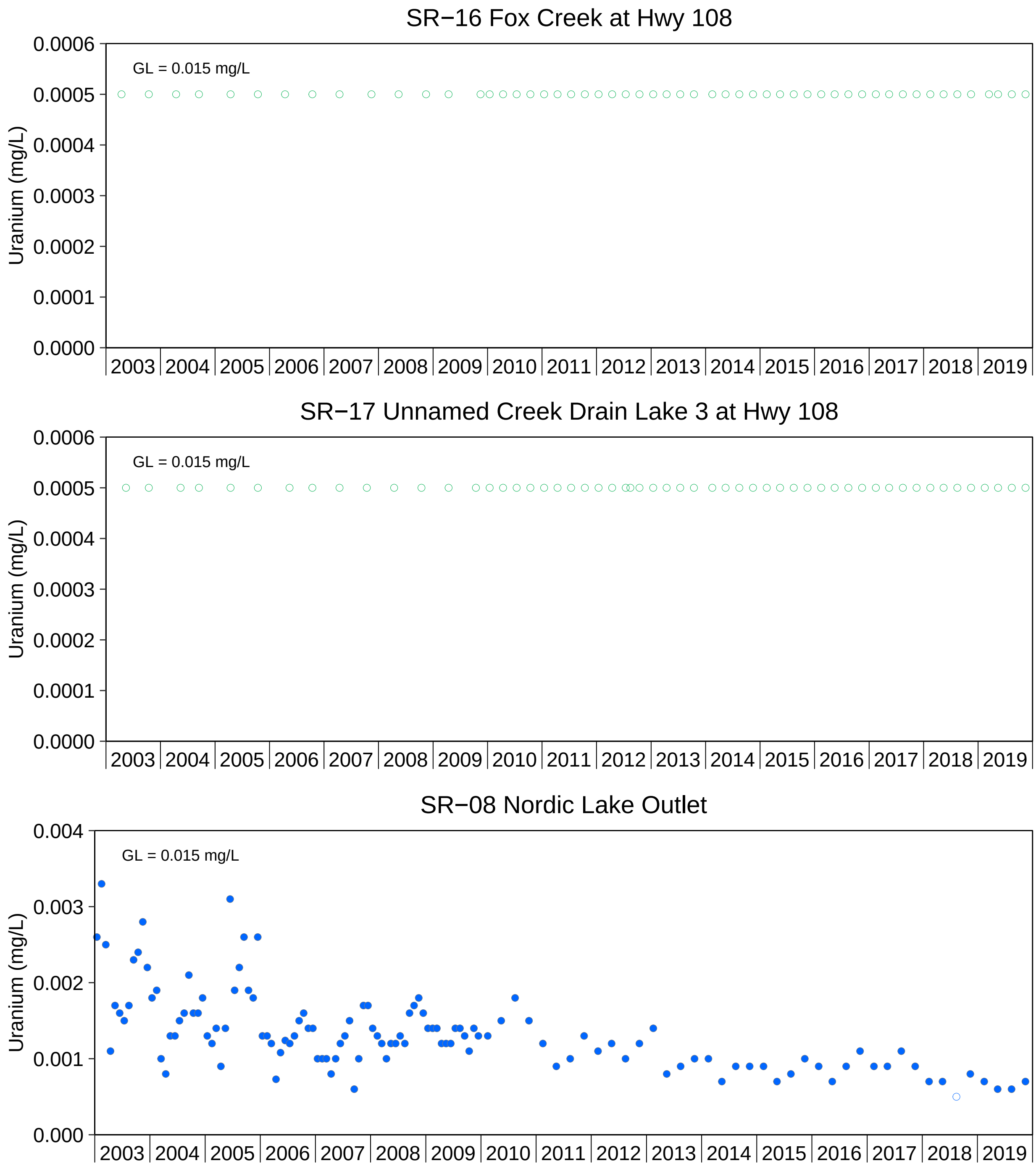


Figure S.27: Uranium Concentrations for SRWMP Water Quality Monitoring Stations in the Nordic Lake Sub−Watershed, 2003 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guideline = Federal Guideline. Reference areas are plotted in green and mine−exposed areas are plotted in blue. May Lake outlet station SR−15 was removed from SRWMP in 2009 but reinstated in 2014 following increasing radium−226 at the Stanleigh TMA and McCabe Lake, therefore no data are available from 2010 to 2014. Uranium is not included in the trend analysis for SWRMP stations D−4, SR−16, SR−17, SR−18, and SR−19 due to >50% non−detectable concentrations in the dataset. See Appendix Tables S.3, S.4 and S.15 for raw data.

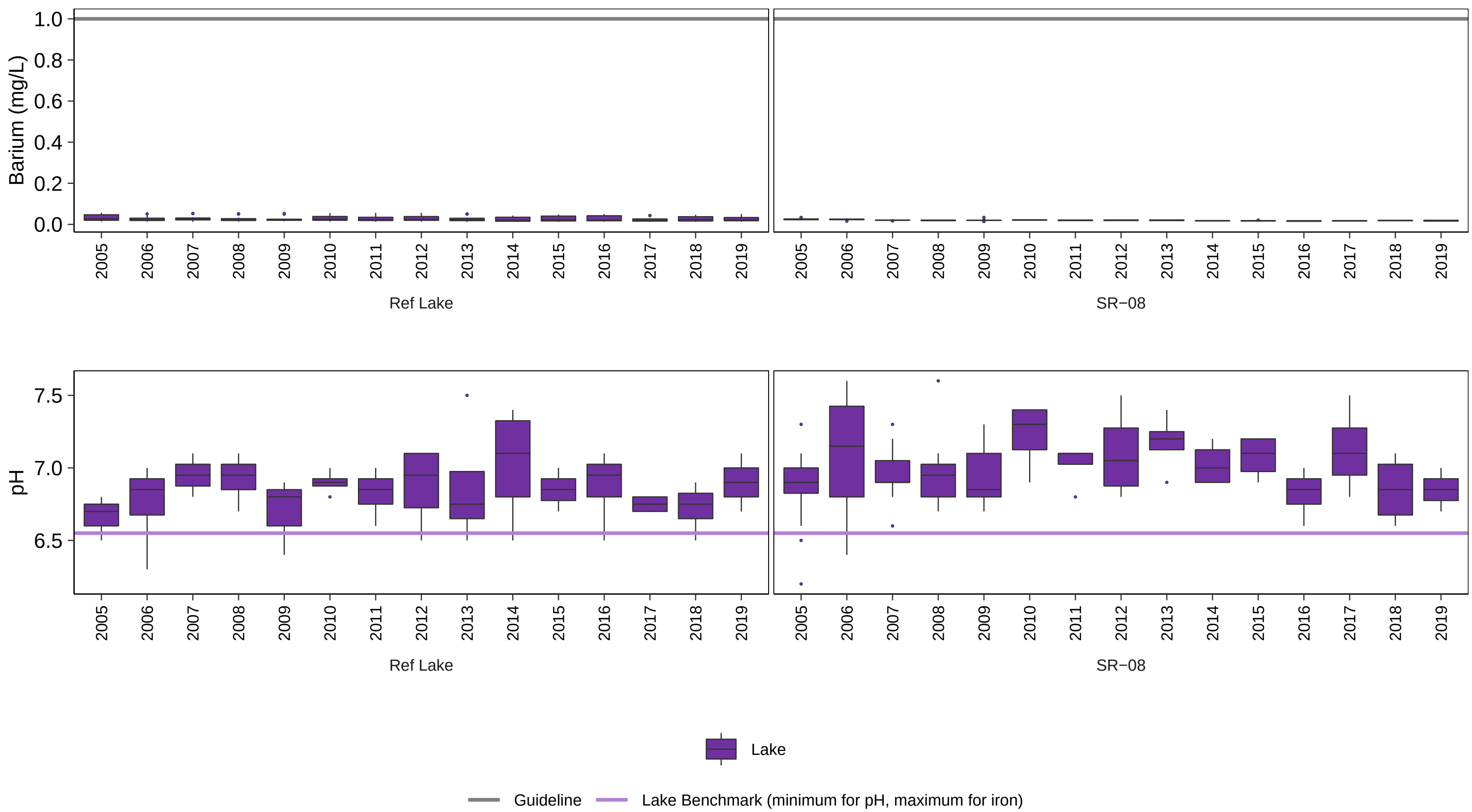


Figure S.28: Concentration of Metals in Water from the Nordic Lake Sub−watershed Compared to Reference Areas and Benchmarks, SRWMP, 2005 to 2019

Notes: Boxes represent the interquartile range (IQR; 25th to 75th percentile) with the median designated as a solid horizontal line within the IQR. Vertical lines extend 1.5 x IQR above and below each respective percentile with values beyond this range designated with a *. Parameters with no variation for a given year will result in a single horizontal line (i.e., 25th, median, and 75th percentile are all the same value). See Appendix Tables S.3 and S.15 for raw data.

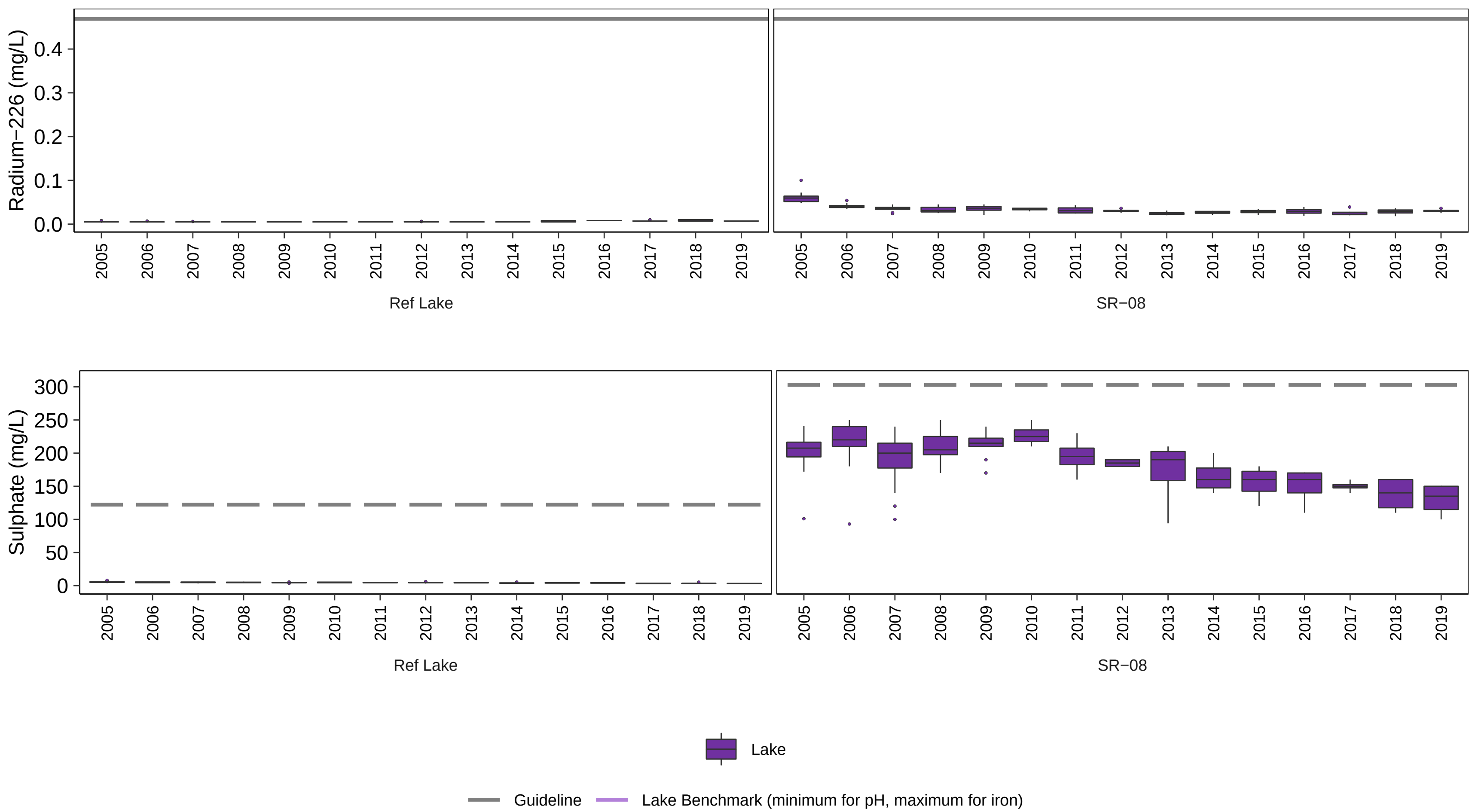


Figure S.28: Concentration of Metals in Water from the Nordic Lake Sub−watershed Compared to Reference Areas and Benchmarks, SRWMP, 2005 to 2019

Notes: Boxes represent the interquartile range (IQR; 25th to 75th percentile) with the median designated as a solid horizontal line within the IQR. Vertical lines extend 1.5 x IQR above and below each respective percentile with values beyond this range designated with a *. Parameters with no variation for a given year will result in a single horizontal line (i.e., 25th, median, and 75th percentile are all the same value). See Appendix Tables S.3 and S.15 for raw data.

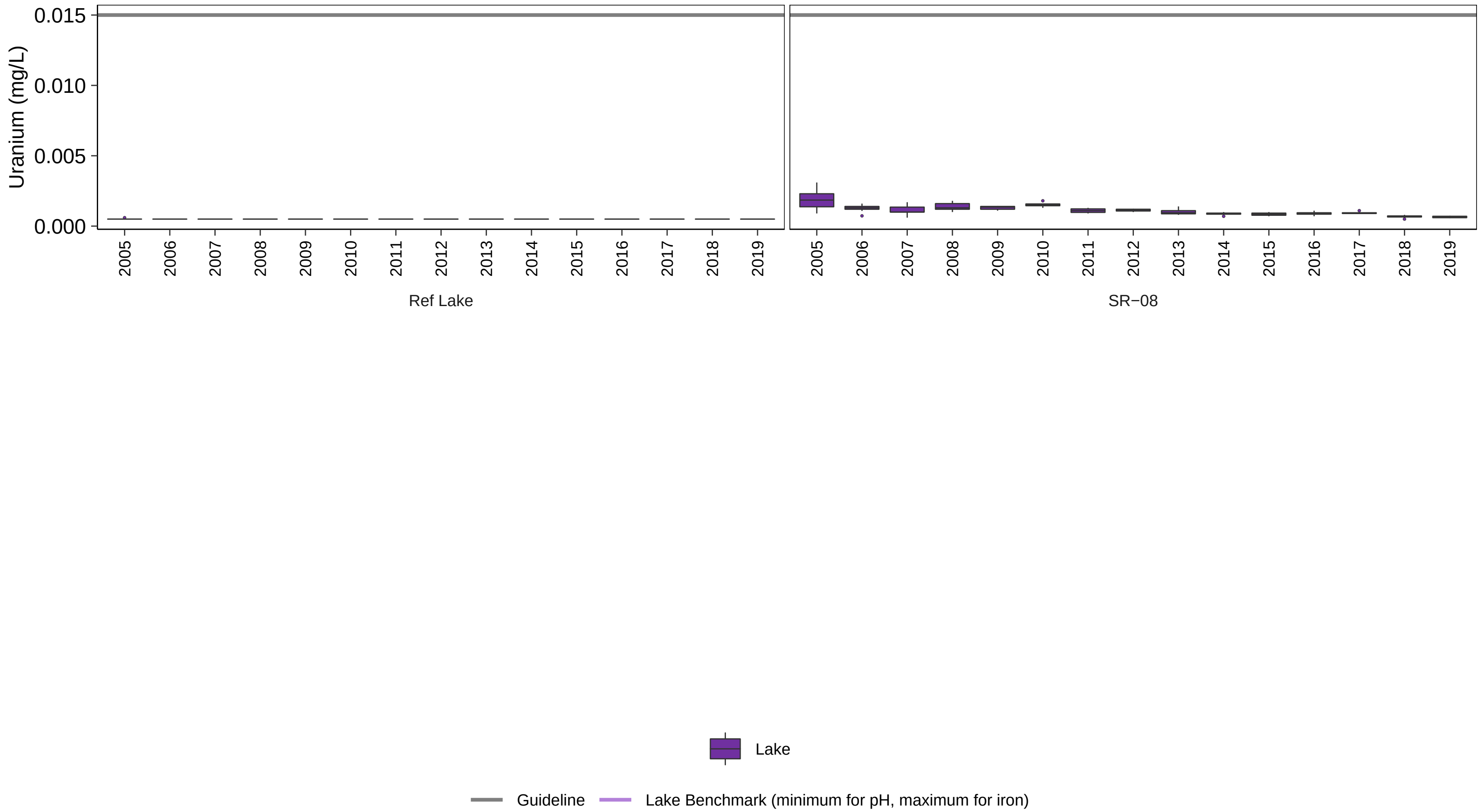


Figure S.28: Concentration of Metals in Water from the Nordic Lake Sub−watershed Compared to Reference Areas and Benchmarks, SRWMP, 2005 to 2019

Notes: Boxes represent the interquartile range (IQR; 25th to 75th percentile) with the median designated as a solid horizontal line within the IQR. Vertical lines extend 1.5 x IQR above and below each respective percentile with values beyond this range designated with a *. Parameters with no variation for a given year will result in a single horizontal line (i.e., 25th, median, and 75th percentile are all the same value). See Appendix Tables S.3 and S.15 for raw data.

Table S.1: Water Quality Benchmarks Selected[a] for Comparison in the SRWMP, Cycle 5

Parameter	Units	Water Quality Guideline			Upper Limit of Background (2015 to 2019)		Dose-based Site-specific Benchmark[g]	Rationale
		PWQO[b]	Federal[c]	Other Jurisdiction[d]	Lakes[e]	Wetlands[f]		
Barium	mg/L	-	-	1	0.050	0.0350	-	The BC working WQG is selected, as no federal or PWQO guidelines are available, and the BCWQG is greater than the upper limit of background.
Iron	mg/L	0.3	0.3	-	0.755	2.49	-	The upper limit of background is selected, as these values are greater than PWQO and federal guidelines.
Manganese	mg/L	-	-	0.841[h]	0.141	0.104	-	The BCWQG is selected, as no federal or Ontario guidelines are available, and the BCWQG is greater than the upper limit of background.
pH[i]	pH units	6.5 to 8.5	6.5 to 9.0	-	6.5	5.3	-	The upper limit of background is selected, as the wetland value is less than the minimum PWQO and federal guideline.
Radium-226	Bq/L	1	-	-	0.0100	0.00850	0.469	The dose-base site-specific benchmark is selected, as per CNSC request.
Sulphate	mg/L	-	-	128 to 429[j]	4.80	3.70	-	The BCWQG is selected, as no federal or Ontario guidelines are available, and the BCWQG is greater than the upper limit of background.
Uranium	mg/L	0.005	0.015	-	<0.00050	<0.00050	-	The federal guideline is selected, as it is more recent than the PWQO, and it is higher than the upper limit of background.

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

(green) Benchmark applied to the wetland stations (i.e., stations located downstream of shallow basins with wetland habitats; M-01, DS-18, SC-01).

(grey) Benchmark applied to both the lake and wetland stations.

Note: dash "-" indicates no applicable guideline or benchmark.

[a] The benchmarks selected for comparison in the SOE interpretive report are the higher of: (1) the most recent PWQO or federal guideline, or if those are unavailable then a guideline from another jurisdiction; or (2) the upper limit of background (i.e., reference area) concentration.

[b] PWQO - Provincial Water Quality Objectives (OMOE 1994).

[c] Federal - Canadian Council of Ministers of the Environment (CCME 2020).

[d] In instances where neither jurisdiction (federal or Ontario) has developed a guideline (i.e., barium, manganese, and sulphate) the British Columbia Water Quality Guideline (BCWQG; BC ENV 2019) water quality guideline is applied.

[e] Upper limit of background concentrations (95th percentile) based on data collected from lake reference stations (D-4, SR-18, and SR-19) from 2015 to 2019 (Appendix Table S.3).

[f] Upper limit of background concentrations (95th percentile) based on data collected from reference stations located downstream of shallow basins that have wetland habitats (SR-16 and SR-17) from 2015 to 2019 (Appendix Table S.4).

[g] From EcoMetrix 2020 (Appendix I).

[h] Manganese guideline (BC ENV 2020) is hardness dependent and the value calculated for the SRWMP using the average hardness for D-6, which is the only station manganese is monitored.

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

[j] Sulphate guidelines are taken from the Ambient Water Quality Guidelines (BC ENV 2020). The guideline is hardness dependent and the value calculated for the SRWMP for each station using the average hardness for that station from 2015 to 2019.

Table S.2: Mean Hardness Concentrations (mg/L) at SRWMP Stations from 2015 to 2019, and Resulting BCMOE Sulphate and BCMOE Manganese Guidelines

Station Type		Location	Mean Hardness (mg/L)	BCMOE Sulphate[a] Guideline	BCMOE Manganese[b] Guideline
Reference	Lake	D-4	9.45	128	0.841
		SR-19	16.8		
		SR-18	10.2		
	Wetland	SR-16	7.84		
		SR-17	11.7		
Mine-exposed		D-6	53.6	218	0.841
		DS-18	83	309	NA
		SR-15	46.6	218	NA
		M-01	35.4	218	NA
		SC-01	29.4	128	NA
		D-5	23.2	128	NA
		Q-09	63.5	218	NA
		Q-20	38.7	218	NA
		SR-01	37.6	218	NA
		SR-06	46.6	218	NA
		SR-08	177	309	NA

Note: "NA" indicates parameter not sampled at this station.

[a] 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.

[b] Benchmark - guideline is hardness dependent, and was calculated based on average hardness at D-6.

Table S.3: Water Quality at Reference SRWMP Stations D-4, SR-18, SR-19 (Lake Characteristic), 2015 to 2019

Station	Date	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
D-4 (Dunlop Lake Outlet)	4-May-15	8.60	6.80	3.70	0.00500	0.0130	0.0200	0.0120	<0.000500
	16-Nov-15	9.90	6.90	4.00	<0.00800	0.0120	0.0350	0.0210	<0.000500
	3-May-16	9.40	6.50	3.90	<0.00800	0.0130	0.0260	0.0110	<0.000500
	29-Nov-16	10.7	7.10	3.80	<0.00800	0.0130	0.0510	0.0210	<0.000500
	16-May-17	10.1	6.70	3.60	<0.00700	0.0130	0.0360	0.0130	<0.000500
	21-Nov-17	9.20	6.80	3.50	<0.00700	0.0120	0.0520	0.0280	<0.000500
	24-May-18	9.50	6.50	3.40	<0.00700	0.0120	0.0420	0.0130	<0.000500
	26-Nov-18	9.20	6.80	3.40	<0.00700	0.0120	0.0300	0.0150	<0.000500
	23-May-19	8.80	7.10	3.20	<0.00700	0.0130	0.0340	0.0140	<0.000500
	12-Nov-19	9.10	6.90	3.30	<0.00700	0.0140	0.0470	0.0220	<0.000500
SR-18 (Outlet of Jim Christ Lake)	4-May-15	9.70	6.70	4.40	<0.00500	0.0480	0.0300	0.00900	<0.000500
	16-Nov-15	11.1	7.00	4.80	<0.00800	0.0470	0.111	0.0510	<0.000500
	2-May-16	9.60	7.00	4.20	<0.00800	0.0450	0.0280	0.00500	<0.000500
	24-Nov-16	11.5	6.90	4.80	<0.00800	0.0500	0.0770	0.0240	<0.000500
	24-May-17	10.5	6.80	4.00	<0.00700	0.0430	0.0290	0.00800	<0.000500
	21-Nov-17	10.2	6.70	4.00	<0.00700	0.0430	0.104	0.0420	<0.000500
	24-May-18	9.20	6.70	3.70	<0.00700	0.0440	0.0370	0.0110	<0.000500
	26-Nov-18	10.6	6.90	5.30	<0.00700	0.0470	0.0440	0.0110	<0.000500
	23-May-19	8.40	7.10	3.40	<0.00700	0.0500	0.0360	0.00700	<0.000500
	20-Nov-19	11.7	6.70	3.80	<0.00700	0.0510	0.0820	0.0270	<0.000500
SR-19 (Inlet to Elliot Lake)	23-Feb-15	19.1	7.0	4.50	<0.00500	0.0250	0.310	0.0170	<0.000500
	21-May-15	14.3	7.1	3.40	<0.00500	0.0200	0.180	0.0220	<0.000500
	18-Aug-15	27.5	7.3	4.30	<0.00800	0.0380	0.900	0.138	<0.000500
	16-Nov-15	12.0	6.9	3.90	<0.00800	0.0180	0.192	0.0230	<0.000500
	11-Feb-16	15.8	6.7	4.00	<0.00800	0.0200	0.192	0.0170	<0.000500
	2-May-16	12.7	7.1	3.40	<0.00800	0.0190	0.104	0.0180	<0.000500
	23-Aug-16	29.7	6.6	4.70	<0.00800	0.0410	0.766	0.144	<0.000500
	24-Nov-16	16.0	7.0	3.90	<0.00800	0.0220	0.342	0.0370	<0.000500
	23-Feb-17	14.5	7.1	3.50	<0.00700	0.0210	0.336	0.0260	<0.000500
	24-May-17	13.3	7.0	2.80	0.00700	0.0170	0.256	0.0300	<0.000500
	10-Aug-17	16.7	6.9	2.70	0.0100	0.0210	0.605	0.0400	<0.000500
	21-Nov-17	13.3	6.9	3.00	<0.00700	0.0170	0.235	0.0280	<0.000500
	22-Feb-18	18.3	6.6	3.40	<0.00700	0.0270	0.306	0.0180	<0.000500
	24-May-18	15.6	6.8	3.20	<0.00700	0.0200	0.150	0.0220	<0.000500
	22-Aug-18	25.0	6.7	3.30	0.0100	0.0350	0.744	0.181	<0.000500
	26-Nov-18	12.8	6.7	3.10	0.0100	0.0180	0.192	0.0200	<0.000500
	12-Feb-19	15.6	6.6	3.30	<0.00700	0.0240	0.208	0.0170	<0.000500
	23-May-19	11.8	7.0	2.60	<0.00700	0.0190	0.227	0.0230	<0.000500
	27-Aug-19	17.4	6.8	3.10	<0.00700	0.0280	0.486	0.0820	<0.000500
	20-Nov-19	14.0	7.0	2.70	<0.00700	0.0190	0.271	0.0330	<0.000500
Number of Samples (n)		40	40	40	40	40	40	40	40
Minimum		8.40	6.50	2.60	<0.005	0.0120	0.0200	0.00500	<0.0005
Maximum		29.7	7.30	5.30	0.0100	0.0510	0.900	0.181	<0.0005
Mean		13.3	6.86	3.68	0.00545	0.0266	0.199	0.0325	<0.0005
Standard Deviation (SD)		5.01	0.188	0.621	0.00154	0.0136	0.222	0.0381	-
Median		11.8	6.90	3.55	<0.005	0.0205	0.108	0.0215	<0.0005
10th Percentile		9.15	6.60	2.90	<0.005	0.0125	0.0295	0.0100	<0.0005
95th Percentile		26.2	7.10	4.80	0.0100	0.0500	0.755	0.141	<0.0005

Note: "-" indicates standard deviation unable to be calculated.

Table S.4: Water Quality at Reference SRWMP Station SR-16 and SR-17 (Wetland Characteristic), 2015 to 2019

Date	Date	Hardness (mg/L)	pH	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)
SR-16 Fox Creek at Highway 108	11-Feb-15	10.2	5.60	0.900	<0.00500	0.00900	2.25	0.0960	<0.000500
	14-May-15	5.00	5.60	1.10	<0.00500	<0.00500	0.360	0.0160	<0.000500
	12-Aug-15	7.70	5.60	0.400	<0.00800	0.00600	1.00	0.0460	<0.000500
	16-Nov-15	5.90	5.70	1.90	<0.00800	<0.00500	0.288	0.0190	<0.000500
	10-Feb-16	7.40	5.80	1.60	<0.00800	0.00600	0.791	0.0330	<0.000500
	11-May-16	5.80	5.90	1.50	<0.00800	<0.00500	0.268	0.0190	<0.000500
	24-Aug-16	9.30	5.70	0.500	<0.00800	0.00900	1.13	0.0530	<0.000500
	23-Nov-16	9.30	5.60	1.40	<0.00800	0.00700	0.474	0.0230	<0.000500
	23-Feb-17	9.90	5.70	1.60	<0.00700	0.00800	1.19	0.0470	<0.000500
	25-May-17	6.10	5.80	1.00	<0.00700	<0.00500	0.383	0.0170	<0.000500
	10-Aug-17	8.70	5.80	0.400	<0.00700	0.00900	1.89	0.0680	<0.000500
	21-Nov-17	4.90	5.30	1.20	<0.00700	<0.00500	0.306	0.0210	<0.000500
	14-Feb-18	9.00	5.50	0.900	<0.00700	0.00800	1.08	0.0340	<0.000500
	24-May-18	6.40	5.60	0.700	<0.00700	0.00600	0.349	0.0310	<0.000500
	22-Aug-18	12.4	5.40	0.200	<0.00700	0.0100	0.657	0.0670	<0.000500
	26-Nov-18	8.20	5.20	3.10	<0.00700	0.00700	0.569	0.0390	<0.000500
	13-Mar-19	8.80	5.80	1.30	<0.00700	0.00800	1.00	0.0400	<0.000500
	27-May-19	4.70	5.90	1.10	<0.00700	<0.00500	0.268	0.0130	<0.000500
	28-Aug-19	10.2	5.30	0.700	<0.00700	0.00800	1.48	0.0560	<0.000500
	20-Nov-19	6.90	6.00	1.10	<0.00700	0.00600	0.448	0.0260	<0.000500
SR-17 Unnamed Creek Drain Lake 3 at Hwy 108	11-Feb-15	11.7	5.70	3.10	<0.00500	0.0190	1.09	0.0680	<0.000500
	14-May-15	7.40	5.70	2.80	0.00500	0.0140	0.350	0.0390	<0.000500
	6-Aug-15	15.1	5.70	0.700	<0.00800	0.0260	2.73	0.107	<0.000500
	17-Nov-15	6.70	5.40	3.80	<0.00800	0.0100	0.279	0.0280	<0.000500
	11-Feb-16	10.9	5.90	3.60	<0.00800	0.0170	0.520	0.0400	<0.000500
	11-May-16	7.30	5.80	3.10	<0.00800	0.0140	0.310	0.0260	<0.000500
	24-Aug-16	19.7	5.60	1.00	0.0100	0.0350	3.52	0.124	<0.000500
	23-Nov-16	13.3	5.80	2.40	<0.00800	0.0220	0.931	0.0670	<0.000500
	23-Feb-17	17.2	5.70	4.30	<0.00700	0.0350	0.507	0.0530	<0.000500
	24-May-17	11.2	6.20	2.80	0.00800	0.0210	0.511	0.0340	<0.000500
	10-Aug-17	11.9	5.90	1.20	<0.00700	0.0210	1.52	0.0690	<0.000500
	21-Nov-17	7.00	5.40	3.00	<0.00700	0.0120	0.374	0.0350	<0.000500
	22-Feb-18	17.7	5.70	2.80	<0.00700	0.0300	0.939	0.0960	<0.000500
	24-May-18	11.1	5.40	2.60	<0.00700	0.0260	0.983	0.0790	<0.000500
	22-Aug-18	16.7	5.60	0.500	<0.00700	0.0320	1.91	0.102	<0.000500
	26-Nov-18	11.3	5.40	3.60	0.00900	0.0200	0.470	0.0480	<0.000500
	26-Feb-19	13.6	6.30	3.40	<0.00700	0.0390	0.575	0.0550	<0.000500
	23-May-19	6.20	6.30	2.60	<0.00700	0.0150	0.247	0.0200	<0.000500
	28-Aug-19	10.9	5.50	1.40	<0.00700	0.0180	1.06	0.0460	<0.000500
	19-Nov-19	7.90	5.80	2.60	<0.00700	0.0130	0.484	0.0360	<0.000500
Number of Samples (n)		40	40	40	40	40	40	40	40
Minimum		4.70	5.20	0.200	<0.005	<0.005	0.247	0.0130	<0.0005
Maximum		19.7	6.30	4.30	0.0100	0.0390	3.52	0.124	<0.0005
Mean		9.79	5.69	1.85	0.00530	0.0144	0.887	0.0484	<0.0005
Standard Deviation (SD)		3.72	0.251	1.14	0.00124	0.00964	0.727	0.0276	-
Median		9.15	5.70	1.45	<0.005	0.0100	0.572	0.0400	<0.0005
10th Percentile		5.85	5.40	0.500	<0.005	<0.005	0.283	0.0190	<0.0005
95th Percentile		17.4	6.25	3.70	0.00850	0.0350	2.49	0.104	<0.0005

Note: "-" indicates standard deviation unable to be calculated.

Table S.5: Water Quality at Mine-Exposed SRWMP Station DS-18, Halfmoon Lake Outlet, 2015 to 2019

Date	Hardness (mg/L)	pH	Sulphate (mg/L)[a]	Radium-226 (Bq/L)	Barium (mg/L)	Iron (mg/L)	Uranium (mg/L)
Benchmark	-	5.3	309	0.469	1.0	2.49	0.015
23-Feb-15	162	7.00	140	0.202	0.0330	0.790	0.000900
20-May-15	87.0	6.80	76.0	0.114	0.0200	0.170	<0.000500
11-Aug-15	57.0	7.10	110	0.0980	0.0120	0.300	0.000800
17-Nov-15	66.0	7.20	53.0	0.125	0.0150	0.309	0.000700
n	4	4	4	4	4	4	4
Minimum	57.0	6.80	53.0	0.0980	0.0120	0.170	<0.0005
Maximum	162	7.20	140	0.202	0.0330	0.790	0.000900
Mean	93.0	7.02	94.8	0.135	0.0200	0.392	0.000725
SD	47.7	0.171	38.2	0.0462	0.00927	0.273	0.000102
9-Feb-16	72.5	6.70	64.0	0.143	0.0130	0.558	<0.000500
10-May-16	135	7.20	100	0.165	0.0300	0.264	<0.000500
16-Aug-16	69.6	7.20	43.0	0.109	0.0150	0.367	0.000700
24-Nov-16	45.1	6.90	28.0	0.107	0.0140	0.185	<0.000500
n	4	4	4	4	4	4	4
Minimum	45.1	6.70	28.0	0.107	0.0130	0.185	<0.0005
Maximum	135	7.20	100	0.165	0.0300	0.558	0.000700
Mean	80.6	7.00	58.8	0.131	0.0180	0.344	0.000550
SD	38.3	0.245	31.2	0.0280	0.00804	0.161	-
23-Feb-17	101	6.70	73.0	0.203	0.0190	1.44	0.00130
26-May-17	82.3	7.00	59.0	0.188	0.0180	0.306	<0.000500
22-Aug-17	61.8	6.80	38.0	0.193	0.0150	0.414	0.000800
18-Oct-17	88.8	6.80	69.0	0.186	0.0170	0.237	0.000800
n	4	4	4	4	4	4	4
Minimum	61.8	6.70	38.0	0.186	0.0150	0.237	<0.0005
Maximum	101	7.00	73.0	0.203	0.0190	1.44	0.00130
Mean	83.5	6.82	59.8	0.192	0.0173	0.599	0.000850
SD	16.4	0.126	15.6	0.00759	0.00171	0.565	0.000265
15-Feb-18	108	7.10	68.0	0.103	0.0230	0.278	<0.000500
30-May-18	76.3	7.00	64.0	0.183	0.0230	0.314	<0.000500
30-Aug-18	45.8	7.30	25.0	0.148	0.0150	0.337	0.000900
24-Oct-18	90.8	6.90	70.0	0.173	0.0220	0.171	0.00140
n	4	4	4	4	4	4	4
Minimum	45.8	6.90	25.0	0.103	0.0150	0.171	<0.0005
Maximum	108	7.30	70.0	0.183	0.0230	0.337	0.00140
Mean	80.2	7.08	56.8	0.152	0.0207	0.275	0.000825
SD	26.4	0.171	21.3	0.0357	0.00386	0.0735	0.000306
19-Feb-19	90.4	7.10	9.80	0.132	0.0190	0.271	0.000800
30-May-19	58.7	7.30	51.0	0.102	0.0220	0.177	0.000500
28-Aug-19	47.7	6.90	24.0	0.0940	0.0140	0.370	0.000800
13-Nov-19	115	7.30	88.0	0.114	0.0220	0.215	0.00130
n	4	4	4	4	4	4	4
Minimum	47.7	6.90	9.80	0.0940	0.0140	0.177	0.000500
Maximum	115.0	7.30	88.0	0.132	0.0220	0.370	0.00130
Mean	78.0	7.15	43.2	0.110	0.0192	0.258	0.000850
SD	30.6	0.191	34.4	0.0165	0.00377	0.0839	0.000332
Summary Statistics for 2015 to 2019							
n	20	20	20	20	20	20	20
Minimum	45.1	6.70	9.80	0.0940	0.0120	0.170	<0.000500
Maximum	162	7.30	140	0.203	0.0330	1.44	0.00140
Mean	83.0	7.02	62.6	0.144	0.0190	0.374	0.000760
SD	30.3	0.198	31.5	0.0389	0.00553	0.290	0.000293
Median	79.3	7.00	64.0	0.138	0.0185	0.303	0.000750
10th Percentile	46.8	6.75	24.5	0.100	0.0135	0.174	<0.000500
95th Percentile	148	7.30	125	0.202	0.0315	1.12	0.00135

[grey box] Value exceeded benchmark or guideline.

Note: "-" indicates no benchmark available or SD was incalculable because there was no variability in the data.

[a] SRW Benchmark dependent on water hardness. See Table S.1 for details.

Table S.6: Water Quality at Mine-Exposed SRWMP Station SR-06, McCabe Lake Outlet,

Date	Hardness (mg/L)	pH	Sulphate (mg/L)[a]	Radium-226 (Bq/L)	Barium (mg/L)	Uranium (mg/L)
Benchmark	-	6.5	218	0.469	1.0	0.015
22-May-15	-	7.40	47.0	0.0690	0.524	0.000800
26-Oct-15	-	7.00	46.0	0.0580	0.376	0.000800
n	0	2	2	2	2	2
Minimum	-	7.00	46.0	0.0580	0.376	0.000800
Maximum	-	7.40	47.0	0.0690	0.524	0.000800
Mean	-	7.20	46.5	0.0635	0.450	0.000800
SD	-	0.283	0.707	0.00778	0.105	-
1-Mar-16	47.6	6.70	34.0	0.0480	0.378	0.000600
26-May-16	50.0	7.10	38.0	0.0860	0.524	0.000800
7-Nov-16	62.1	6.80	46.0	0.0890	0.633	0.000700
n	3	3	3	3	3	3
Minimum	47.6	6.70	34.0	0.0480	0.378	0.000600
Maximum	62.1	7.10	46.0	0.0890	0.633	0.000800
Mean	53.2	6.87	39.3	0.0743	0.512	0.000700
SD	7.77	0.208	6.11	0.0229	0.128	0.000100
26-May-17	60.4	7.10	35.0	0.0660	0.483	0.000700
18-Oct-17	48.0	6.90	35.0	0.0990	0.633	0.000700
23-Nov-17	52.0	7.10	32.0	0.0920	0.631	0.000700
27-Dec-17	49.4	7.00	32.0	0.0990	0.676	0.000700
n	4	4	4	4	4	4
Minimum	48.0	6.90	32.0	0.0660	0.483	0.000700
Maximum	60.4	7.10	35.0	0.0990	0.676	0.000700
Mean	52.5	7.02	33.5	0.0890	0.606	0.000700
SD	5.55	0.0957	1.73	0.0157	0.0844	-
10-Jan-18	49.1	7.00	32.0	0.0820	0.754	0.000600
24-Jan-18	46.0	7.00	25.0	0.0900	0.563	0.000600
7-Feb-18	34.2	6.90	19.0	0.0720	0.436	<0.000500
21-Feb-18	48.9	6.70	31.0	0.120	0.972	0.000600
26-Mar-18	44.6	7.10	36.0	0.0930	0.776	0.000600
11-Apr-18	46.9	6.70	31.0	0.113	0.791	0.000700
23-Apr-18	39.7	6.90	24.0	0.0760	0.614	0.000600
28-May-18	44.1	7.00	33.0	0.121	0.667	0.000700
12-Jun-18	45.2	6.90	32.0	0.102	0.591	0.000700
25-Jun-18	47.3	6.90	32.0	0.112	0.695	0.000600
9-Jul-18	44.9	7.20	34.0	0.114	0.697	0.000600
23-Jul-18	45.9	7.00	32.0	0.110	0.671	0.000600
15-Oct-18	44.9	7.20	32.0	0.100	0.642	0.000600
n	13.0	13	13	13	13	13
Minimum	34.2	6.70	19.0	0.0720	0.436	<0.0005
Maximum	49.1	7.20	36.0	0.121	0.972	0.000700
Mean	44.7	6.96	30.2	0.100	0.682	0.000615
SD	3.95	0.156	4.69	0.0165	0.129	0.0000440
30-May-19	37.3	7.30	29.0	0.0620	0.343	0.000700
24-Oct-19	36.1	7.10	27.0	0.0520	0.281	0.000600
n	2	2	2	2	2	2
Minimum	36.1	7.10	27.0	0.0520	0.281	0.000600
Maximum	37.3	7.30	29.0	0.0620	0.343	0.000700
Mean	36.7	7.20	28.0	0.0570	0.312	0.000650
SD	0.849	0.141	1.41	0.00707	0.0438	0.0000707
Summary Statistics for 2015 to 2019						
n	22	24	24	24	24	24
Minimum	34.2	6.70	19.0	0.0480	0.281	<0.000500
Maximum	62.1	7.40	47.0	0.121	0.972	0.000800
Mean	46.6	7.00	33.1	0.0885	0.598	0.000658
SD	6.59	0.179	6.55	0.0217	0.160	0.0000712
Median	46.4	7.00	32.0	0.0910	0.632	0.000650
10th Percentile	37.3	6.70	25.0	0.0580	0.376	0.000600
95th Percentile	60.4	7.30	46.0	0.120	0.791	0.000800

Value exceeded benchmark or guideline.

Note: "-" indicates no data or benchmark available or SD was incalculable because there was no variability in the data.

[a] SRW Benchmark dependent on water hardness. See Table S.1 for details.

Table S.7: Water Quality at Mine-Exposed SRWMP Station SR-15, May Lake Outlet, 2015 to 2

Date	Hardness (mg/L)	pH	Sulphate (mg/L)[a]	Radium-226 (Bq/L)	Barium (mg/L)	Iron (mg/L)	Uranium (mg/L)
Benchmark	-	5.3	218	0.469	1.0	2.49	0.015
26-May-16	52.4	7.10	36.0	0.0330	0.123	<0.0200	<0.000500
20-Oct-16	51.3	6.90	37.0	0.0640	0.154	<0.0200	<0.000500
n	2	2	2	2	2	2	2
Minimum	51.3	6.90	36.0	0.0330	0.123	<0.02	<0.0005
Maximum	52.4	7.10	37.0	0.0640	0.154	<0.02	<0.0005
Mean	51.9	7.00	36.5	0.0485	0.138	<0.02	<0.0005
SD	0.778	0.141	0.707	0.0219	0.0219	-	-
26-May-17	57.3	7.10	31.0	0.0560	0.133	<0.0200	<0.000500
18-Oct-17	47.3	6.80	33.0	0.0820	0.164	<0.0200	<0.000500
n	2	2	2	2	2	2	2
Minimum	47.3	6.80	31.0	0.0560	0.133	<0.02	<0.0005
Maximum	57.3	7.10	33.0	0.0820	0.164	<0.02	<0.0005
Mean	52.3	6.95	32.0	0.0690	0.149	<0.02	<0.0005
SD	7.07	0.212	1.41	0.0184	0.0219	-	-
30-May-18	44.2	6.80	30.0	0.0500	0.209	0.0270	<0.000500
30-Aug-18	42.3	7.50	31.0	0.0700	0.224	<0.0200	<0.000500
24-Oct-18	46.9	7.00	30.0	0.0540	0.207	0.0200	<0.000500
n	3	3	3	3	3	3	3
Minimum	42.3	6.80	30.0	0.0500	0.207	<0.02	<0.0005
Maximum	46.9	7.50	31.0	0.0700	0.224	0.0270	<0.0005
Mean	44.5	7.10	30.3	0.0580	0.213	0.0223	<0.0005
SD	2.31	0.361	0.577	0.0106	0.00929	0.00467	-
30-May-19	40.2	7.30	28.0	0.0520	0.151	0.0250	<0.000500
24-Oct-19	37.9	7.10	26.0	0.0450	0.140	<0.0200	<0.000500
n	2	2	2	2	2	2	2
Minimum	37.9	7.10	26.0	0.0450	0.140	<0.02	<0.0005
Maximum	40.2	7.30	28.0	0.0520	0.151	0.0250	<0.0005
Mean	39.1	7.20	27.0	0.0485	0.146	0.0225	<0.0005
SD	1.63	0.141	1.41	0.00495	0.00778	-	-
Summary Statistics for 2015 to 2019							
n	9	9	9	9	9	9	9
Minimum	37.9	6.80	26.0	0.0330	0.123	<0.0200	<0.000500
Maximum	57.3	7.50	37.0	0.0820	0.224	0.0270	<0.000500
Mean	46.6	7.07	31.3	0.0562	0.167	0.0213	<0.000500
SD	6.24	0.229	3.54	0.0143	0.0369	0.00311	-
Median	46.9	7.10	31.0	0.0540	0.154	<0.0200	<0.000500
10th Percentile	37.9	6.80	26.0	0.0330	0.123	<0.0200	<0.000500
95th Percentile	57.3	7.50	37.0	0.0820	0.224	0.0270	<0.000500

Value exceeded benchmark or guideline.

Notes: "-" indicates no benchmark available or SD was incalculable because there was no variability in the data.

[a] SRW Benchmark dependent on water hardness. See Table S.1 for details.

Table S.8: Water Quality at Mine-Exposed SRWMP Station D-6, Cinder Lake Outlet, 2015 to 20

Date	Hardness (mg/L)	pH	Sulphate (mg/L)[a]	Radium-226 (Bq/L)	Barium (mg/L)	Iron (mg/L)	Manganese (mg/L)[a]	Uranium (mg/L)
Benchmark	-	6.5	218	0.469	1	0.755	0.841	0.015
11-Feb-15	25.1	6.60	15.0	<0.00500	0.0150	0.290	0.135	<0.000500
20-May-15	21.4	6.90	16.0	<0.00500	0.0130	0.150	0.074	<0.000500
11-Aug-15	136	6.70	34.0	0.0110	0.0270	1.25	0.804	<0.000500
17-Nov-15	30.6	6.70	26.0	<0.00800	0.0120	0.107	0.0560	<0.000500
n	4	4	4	4	4	4	4	4
Minimum	21.4	6.60	15.0	<0.005	0.0120	0.107	0.0560	<0.0005
Maximum	136	6.90	34.0	0.0110	0.0270	1.25	0.804	<0.0005
Mean	53.3	6.72	22.8	0.00650	0.0167	0.449	0.267	<0.0005
SD	55.3	0.126	9.00	-	0.00695	0.540	0.359	-
17-Feb-16	22.4	6.50	16.0	<0.00800	0.0140	0.141	0.0940	<0.000500
3-May-16	20.3	6.50	14.0	<0.00800	0.0120	0.118	0.0780	<0.000500
16-Aug-16	254	6.60	230	0.0150	0.0380	1.44	1.41	<0.000500
29-Nov-16	107	6.60	95.0	0.0130	0.0220	0.464	0.250	<0.000500
n	4	4	4	4	4	4	4	4
Minimum	20.3	6.50	14.0	<0.008	0.0120	0.118	0.0780	<0.0005
Maximum	254	6.60	230	0.0150	0.0380	1.44	1.41	<0.0005
Mean	101	6.55	88.8	0.0110	0.0215	0.541	0.458	<0.0005
SD	110	0.0577	101	0.00122	0.0118	0.620	0.639	-
23-Feb-17	24.0	7.00	14.0	<0.00700	0.0150	0.162	0.0860	<0.000500
16-May-17	33.2	6.60	21.0	<0.00700	0.0130	0.167	0.111	<0.000500
9-Aug-17	35.2	6.60	26.0	<0.00700	0.0110	0.297	0.131	<0.000500
21-Nov-17	22.5	6.70	14.0	0.00700	0.0120	0.153	0.0790	<0.000500
n	4	4	4	4	4	4	4	4
Minimum	22.5	6.60	14.0	<0.007	0.0110	0.153	0.0790	<0.0005
Maximum	35.2	7.00	26.0	<0.007	0.0150	0.297	0.131	<0.0005
Mean	28.7	6.72	18.8	<0.007	0.0127	0.195	0.102	<0.0005
SD	6.40	0.189	5.85	-	0.00171	0.0684	0.0239	-
22-Feb-18	26.2	6.60	17.0	<0.00700	0.0150	0.260	0.115	<0.000500
24-May-18	22.9	6.50	16.0	<0.00700	0.0130	0.181	0.0980	<0.000500
5-Sep-18	124	6.50	93.0	0.0390	0.0280	2.69	1.63	<0.000500
26-Nov-18	22.7	6.60	13.0	<0.00700	0.0120	0.167	0.0820	<0.000500
n	4	4	4	4	4	4	4	4
Minimum	22.7	6.50	13.0	<0.007	0.0120	0.167	0.0820	<0.0005
Maximum	124	6.60	93.0	0.0390	0.0280	2.69	1.63	<0.0005
Mean	49.0	6.55	34.8	0.0150	0.0170	0.824	0.481	<0.0005
SD	50.1	0.0577	38.9	-	0.00744	1.24	0.766	-
20-Feb-19	19.6	6.80	11.0	<0.00700	0.0120	0.183	0.0730	<0.000500
23-May-19	15.4	7.00	9.40	<0.00700	0.0120	0.146	0.0700	<0.000500
28-Aug-19	85.1	6.60	55.0	0.0140	0.0350	2.76	1.26	<0.000500
12-Nov-19	23.6	6.80	16.0	<0.00700	0.0130	0.185	0.0760	<0.000500
n	4	4	4	4	4	4	4	4
Minimum	15.4	6.60	9.40	<0.007	0.0120	0.146	0.0700	<0.0005
Maximum	85.1	7.00	55.0	0.0140	0.0350	2.76	1.26	<0.0005
Mean	35.9	6.80	22.8	0.00875	0.0180	0.818	0.370	<0.0005
SD	33.0	0.163	21.6	-	0.0113	1.29	0.594	-
Summary Statistics for 2015 to 2019								
n	20	20	20	20	20	20	20	20
Minimum	15.4	6.50	9.40	<0.00500	0.0110	0.107	0.0560	<0.000500
Maximum	254	7.00	230	0.0390	0.0380	2.76	1.63	<0.000500
Mean	53.6	6.67	37.6	0.00847	0.0172	0.566	0.336	<0.000500
SD	60.3	0.156	51.7	0.00785	0.00821	0.822	0.504	-
Median	24.6	6.60	16.0	<0.00700	0.0130	0.182	0.0960	<0.000500
10th Percentile	19.9	6.50	12.0	<0.00700	0.0120	0.130	0.0715	<0.000500
95th Percentile	195	7.00	162	0.0270	0.0365	2.72	1.52	<0.000500

[shaded box] Value exceeded benchmark or guideline.

Note: "-" = SD was incalculable because there was no variability in the data.

[a] Benchmark dependent on water hardness. See Table S.1 for details.

Table S.9: Water Quality at Mine-Exposed SRWMP Station D-5, Serpent R Between Denison and Quirke TMAs, 2015 to 2019

Date	Hardness (mg/L)	pH	Sulphate (mg/L)[a]	Radium-226 (Bq/L)	Barium (mg/L)	Uranium (mg/L)
Benchmark	-	6.5	128	0.469	1.0	0.015
11-Feb-15	-	6.70	13.0	0.0250	0.0360	0.00150
4-May-15	-	6.90	8.00	0.0250	0.0320	0.00100
6-Aug-15	-	7.00	15.0	0.141	0.161	0.00200
16-Nov-15	-	6.90	19.0	0.0370	0.0420	0.00140
n	0	4	4	4	4	4
Minimum	-	6.70	8.00	0.0250	0.0320	0.00100
Maximum	-	7.00	19.0	0.141	0.161	0.00200
Mean	-	6.88	13.8	0.0570	0.0678	0.00148
SD	-	0.126	4.57	0.0563	0.0623	0.000411
17-Feb-16	21.1	6.70	13.0	0.0170	0.0320	0.00160
3-May-16	17.1	6.50	9.40	0.0280	0.0400	0.000900
16-Aug-16	34.4	7.00	16.0	0.139	0.218	0.00230
29-Nov-16	33.7	7.00	18.0	0.0920	0.102	0.00120
n	4	4	4	4	4	4
Minimum	17.1	6.50	9.40	0.0170	0.0320	0.000900
Maximum	34.4	7.00	18.0	0.139	0.218	0.00230
Mean	26.6	6.80	14.1	0.0690	0.0980	0.00150
SD	8.79	0.245	3.75	0.0572	0.0859	0.000606
23-Feb-17	21.6	6.90	11.0	0.0190	0.0250	0.00110
16-May-17	20.5	6.80	11.0	0.0360	0.0420	0.00130
9-Aug-17	22.7	6.60	14.0	0.0940	0.0860	0.00170
21-Nov-17	17.2	6.80	9.00	0.0100	0.0260	0.00100
n	4	4	4	4	4	4
Minimum	17.2	6.60	9.00	0.0100	0.0250	0.00100
Maximum	22.7	6.90	14.0	0.0940	0.0860	0.00170
Mean	20.5	6.78	11.2	0.0397	0.0448	0.00128
SD	2.38	0.126	2.06	0.0377	0.0286	0.000310
22-Feb-18	30.2	6.80	17.0	0.0320	0.0610	0.00150
24-May-18	18.8	6.60	11.0	0.0400	0.0520	0.00120
22-Aug-18	44.0	6.70	22.0	0.209	0.287	0.00270
26-Nov-18	13.2	6.70	5.20	0.0100	0.0250	<0.000500
n	4	4	4	4	4	4
Minimum	13.2	6.60	5.20	0.0100	0.0250	<0.0005
Maximum	44.0	6.80	22.0	0.209	0.287	0.00270
Mean	26.6	6.70	13.8	0.0728	0.106	0.00148
SD	13.6	0.0816	7.29	0.0917	0.121	0.000757
20-Feb-19	21.5	7.00	11.0	0.0170	0.0260	0.00100
23-May-19	14.8	7.00	7.20	0.0160	0.0380	0.000800
26-Aug-19	21.9	6.90	12.0	0.108	0.106	0.00120
12-Nov-19	19.2	6.80	11.0	0.0210	0.0330	0.00120
n	4	4	4	4	4	4
Minimum	14.8	6.80	7.20	0.0160	0.0260	0.000800
Maximum	21.9	7.00	12.0	0.108	0.106	0.00120
Mean	19.4	6.92	10.3	0.0405	0.0508	0.00105
SD	3.26	0.0957	2.12	0.0451	0.0372	0.000191
Summary Statistics for 2015 to 2019						
n	16	20	20	20	20	20
Minimum	13.2	6.50	5.20	0.0100	0.0250	<0.000500
Maximum	44.0	7.00	22.0	0.209	0.287	0.00270
Mean	23.2	6.82	12.6	0.0558	0.0735	0.00136
SD	8.23	0.153	4.22	0.0556	0.0714	0.000498
Median	21.3	6.80	11.5	0.0300	0.0410	0.00120
10th Percentile	14.8	6.60	7.60	0.0130	0.0255	0.000850
95th Percentile	44.0	7.00	20.5	0.175	0.252	0.00250

Value exceeded benchmark or guideline.

Note: "-" indicates no data or benchmark available or SD was incalculable because there was no variability in the data.

[a] SRW Benchmark dependent on water hardness. See Table S.1 for details.

Table S.10: Water Quality at Mine-Exposed SRWMP Station Q-09, Serpent R Below Quirke TMA Effluent, 2015 to 2019

Date	Hardness (mg/L)	pH	Sulphate (mg/L)[a]	Radium-226 (Bq/L)	Barium (mg/L)	Uranium (mg/L)
Benchmark	-	6.5	218	0.469	1.0	0.015
11-Feb-15	65.8	6.60	53.0	0.0280	0.0380	0.00260
4-May-15	26.4	6.80	21.0	0.0360	0.0370	0.00200
6-Aug-15	74.1	7.00	56.0	0.174	0.263	0.00400
18-Nov-15	69.8	6.90	61.0	0.0360	0.0420	0.00230
n	4	4	4	4	4	4
Minimum	26.4	6.60	21.0	0.0280	0.0370	0.00200
Maximum	74.1	7.00	61.0	0.174	0.263	0.00400
Mean	59.0	6.82	47.8	0.0685	0.0950	0.00272
SD	22.0	0.171	18.1	0.0704	0.112	0.000885
17-Feb-16	48.7	6.50	42.0	0.0260	0.0340	0.00230
3-May-16	27.4	6.50	20.0	0.0470	0.0380	0.00130
16-Aug-16	68.1	6.90	47.0	0.162	0.245	0.00320
29-Nov-16	227	6.60	220	0.0730	0.0710	0.00410
n	4	4	4	4	4	4
Minimum	27.4	6.50	20.0	0.0260	0.0340	0.00130
Maximum	227	6.90	220	0.162	0.245	0.00410
Mean	92.8	6.62	82.2	0.0770	0.0970	0.00272
SD	91.0	0.189	92.6	0.0598	0.100	0.00120
23-Feb-17	74.3	6.80	61.0	0.0220	0.0280	0.00230
16-May-17	46.3	6.70	35.0	0.0590	0.0560	0.00260
9-Aug-17	66.7	6.60	57.0	0.100	0.108	0.00240
21-Nov-17	35.1	6.80	26.0	0.0270	0.0280	0.00150
n	4	4	4	4	4	4
Minimum	35.1	6.60	26.0	0.0220	0.0280	0.00150
Maximum	74.3	6.80	61.0	0.100	0.108	0.00260
Mean	55.6	6.72	44.8	0.0520	0.0550	0.00220
SD	18.1	0.0957	16.9	0.0360	0.0377	0.000483
22-Feb-18	72.4	6.70	56.0	0.0410	0.0600	0.00190
24-May-18	31.6	6.60	22.0	0.0570	0.0610	0.00260
22-Aug-18	113	6.60	85.0	0.283	0.324	0.00330
26-Nov-18	49.3	6.70	39.0	0.0210	0.0310	0.00110
n	4	4	4	4	4	4
Minimum	31.6	6.60	22.0	0.0210	0.0310	0.00110
Maximum	113	6.70	85.0	0.283	0.324	0.00330
Mean	66.6	6.65	50.5	0.100	0.119	0.00222
SD	35.2	0.0577	26.9	0.123	0.137	0.000943
20-Feb-19	58.7	7.00	48.0	0.0300	0.0290	0.00160
23-May-19	22.1	7.00	14.0	0.0290	0.0380	0.00110
26-Aug-19	53.4	6.80	97.0	0.114	0.150	0.00190
12-Nov-19	39.6	6.70	30.0	0.0300	0.0370	0.00140
n	4	4	4	4	4	4
Minimum	22.1	6.70	14.0	0.0290	0.0290	0.00110
Maximum	58.7	7.00	97.0	0.114	0.150	0.00190
Mean	43.5	6.88	47.2	0.0508	0.0635	0.00150
SD	16.4	0.150	36.0	0.0422	0.0578	0.000337
Summary Statistics for 2015 to 2019						
n	20	20	20	20	20	20
Minimum	22.1	6.50	14.0	0.0210	0.0280	0.00110
Maximum	227	7.00	220	0.283	0.324	0.00410
Mean	63.5	6.74	54.5	0.0698	0.0859	0.00228
SD	44.2	0.160	44.4	0.0675	0.0887	0.000872
Median	56.1	6.70	47.5	0.0385	0.0400	0.00230
10th Percentile	26.9	6.55	20.5	0.0240	0.0285	0.00120
95th Percentile	170	7.00	158	0.228	0.294	0.00405

(Shaded) Value exceeded benchmark or guideline.

Note: "-" indicates no benchmark available or SD was incalculable because there was no variability in the data.

[a] SRW Benchmark dependent on water hardness. See Table S.1 for details.

Table S.11: Water Quality at Mine-Exposed SRWMP Station Q-20, Evan Lake Outlet to Dunlop Lake, 2015 to 2019

Date	Hardness (mg/L)	pH	Sulphate (mg/L)[a]	Radium-226 (Bq/L)	Barium (mg/L)	Uranium (mg/L)
Benchmark	-	6.5	218	0.469	1.0	0.015
16-Nov-15	-	7.00	21.0	<0.00800	0.0180	<0.000500
24-Nov-16	40.0	6.80	22.0	<0.00800	0.0200	<0.000500
21-Nov-17	37.1	6.90	19.0	<0.00700	0.0180	<0.000500
26-Nov-18	38.2	6.60	19.0	<0.00700	0.0190	<0.000500
13-Nov-19	39.4	7.30	19.0	0.00800	0.0200	<0.000500
Summary Statistics for 2015 to 2019						
n	4	5	5	5	5	5
Minimum	37.1	6.60	19.0	<0.00700	0.0180	<0.000500
Maximum	40.0	7.30	22.0	0.00800	0.0200	<0.000500
Mean	38.7	6.92	20.0	0.00720	0.0190	<0.000500
SD	1.29	0.259	1.41	-	0.00100	-
Median	38.8	6.90	19.0	<0.00800	0.0190	<0.000500
10th Percentile	37.1	6.60	19.0	<0.00700	0.0180	<0.000500
95th Percentile	40.0	7.30	22.0	0.00800	0.0200	<0.000500

Value exceeded benchmark or guideline.

Note: "-" indicates no data/benchmark available or standard deviation unable to be calculated.

[a] SRW Benchmark dependent on water hardness. See Table S.1 for details.

Table S.12: Water Quality at Mine-Exposed SRWMP Station SR-01, Quirke Lake, 2015 to 2019

Date	Hardness (mg/L)	pH	Sulphate (mg/L)[a]	Radium-226 (Bq/L)	Barium (mg/L)	Uranium (mg/L)
Benchmark	-	6.5	218	0.469	1.0	0.015
26-Oct-15	-	6.90	36.0	0.0190	0.0390	0.00140
20-Oct-16	40.0	6.80	33.0	0.0260	0.0360	0.00130
18-Oct-17	38.3	6.90	31.0	0.0280	0.0350	0.00110
23-Oct-18	35.4	6.70	29.0	0.0170	0.0340	0.00110
25-Oct-19	36.6	7.00	25.0	0.0310	0.0390	0.00110
Summary Statistics for 2015 to 2019						
n	4	5	5	5	5	5
Minimum	35.4	6.70	25.0	0.0170	0.0340	0.00110
Maximum	40.0	7.00	36.0	0.0310	0.0390	0.00140
Mean	37.6	6.86	30.8	0.0242	0.0366	0.00120
SD	2.01	0.114	4.15	0.00597	0.00230	0.000141
Median	37.4	6.90	31.0	0.0260	0.0360	0.00110
10th Percentile	35.4	6.70	25.0	0.0170	0.0340	0.00110
95th Percentile	40.0	7.00	36.0	0.0310	0.0390	0.00140

Value exceeded benchmark or guideline.

Note: "-" indicates no data or benchmark available.

[a] SRW Benchmark dependent on water hardness. See Table S.1 for details.

Table S.13: Water Quality at Mine-Exposed SRWMP Station M-01, Sherriff Creek at Highway 108, 2015 to 2019

Date	Hardness (mg/L)	pH	Sulphate (mg/L)[a]	Radium-226 (Bq/L)	Barium (mg/L)	Iron (mg/L)	Uranium (mg/L)
Benchmark	-	5.3	218	0.469	1.0	2.49	0.015
18-Feb-15	-	6.60	15.0	0.0150	0.0190	0.920	0.00310
19-May-15	-	6.80	10.0	0.0170	0.0140	0.450	0.00234
17-Aug-15	-	6.90	7.40	<0.00800	0.0120	0.420	0.00180
16-Nov-15	-	6.90	12.0	0.0130	0.0140	0.206	0.00290
n	0	4	4	4	4	4	4
Minimum	-	6.60	7.40	<0.008	0.0120	0.206	0.00180
Maximum	-	6.90	15.0	0.0170	0.0190	0.920	0.00310
Mean	-	6.80	11.1	0.0132	0.0148	0.499	0.00254
SD	-	0.141	3.21	0.00203	0.00299	0.301	0.000586
16-Feb-16	32.1	6.50	14.0	0.0120	0.0140	0.587	0.00350
16-May-16	31.8	6.60	11.0	0.0330	0.0150	0.413	0.00220
16-Aug-16	68.6	6.80	5.60	0.0190	0.0180	0.389	0.00280
23-Nov-16	45.0	6.70	15.0	0.0190	0.0190	0.346	0.00180
n	4	4	4	4	4	4	4
Minimum	31.8	6.50	5.60	0.0120	0.0140	0.346	0.00180
Maximum	68.6	6.80	15.0	0.0330	0.0190	0.587	0.00350
Mean	44.4	6.65	11.4	0.0207	0.0165	0.434	0.00258
SD	17.3	0.129	4.22	0.00881	0.00238	0.106	0.000741
23-Feb-17	34.7	6.60	13.0	0.0120	0.0150	0.633	0.00530
24-May-17	36.6	6.90	9.80	0.0160	0.0160	0.397	0.00200
10-Aug-17	43.1	6.90	8.00	0.0260	0.0180	1.04	0.00210
21-Nov-17	30.6	6.80	9.30	0.0100	0.0120	0.234	0.00410
n	4	4	4	4	4	4	4
Minimum	30.6	6.60	8.00	0.0100	0.0120	0.234	0.00200
Maximum	43.1	6.90	13.0	0.0260	0.0180	1.04	0.00530
Mean	36.3	6.80	10.0	0.0160	0.0152	0.576	0.00338
SD	5.21	0.141	2.12	0.00712	0.00250	0.350	0.00161
14-Feb-18	41.7	6.50	13.0	0.0190	0.0190	0.570	0.00290
22-May-18	32.6	6.70	8.90	0.0170	0.0160	0.408	0.00180
22-Aug-18	13.0	6.70	2.60	<0.00700	0.00900	1.68	<0.000500
26-Nov-18	32.5	6.80	11.0	0.0180	0.0150	0.475	0.00290
n	4	4	4	4	4	4	4
Minimum	13.0	6.50	2.60	<0.007	0.00900	0.408	<0.0005
Maximum	41.7	6.80	13.0	0.0190	0.0190	1.68	0.00290
Mean	30.0	6.68	8.88	0.0152	0.0148	0.783	0.00202
SD	12.1	0.126	4.51	0.00102	0.00419	0.602	0.000674
12-Feb-19	33.7	6.50	11.0	0.0110	0.0170	0.539	0.00390
22-May-19	25.2	6.90	8.80	0.0170	0.0120	0.216	0.00190
27-Aug-19	31.7	6.50	4.90	0.0230	0.0190	1.94	0.00250
19-Nov-19	34.0	7.00	8.90	0.0160	0.0140	0.420	0.00250
n	4	4	4	4	4	4	4
Minimum	25.2	6.50	4.90	0.0110	0.0120	0.216	0.00190
Maximum	34.0	7.00	11.0	0.0230	0.0190	1.94	0.00390
Mean	31.2	6.72	8.40	0.0168	0.0155	0.779	0.00270
SD	4.10	0.263	2.54	0.00492	0.00311	0.786	0.000849
Summary Statistics for 2015 to 2019							
n	16	20	20	20	20	20	20
Minimum	13.0	6.50	2.60	<0.00700	0.00900	0.206	<0.000500
Maximum	68.6	7.00	15.0	0.0330	0.0190	1.94	0.00530
Mean	35.4	6.73	9.96	0.0164	0.0154	0.614	0.00264
SD	11.5	0.163	3.29	0.00581	0.00283	0.460	0.000927
Median	33.2	6.75	9.90	0.0165	0.0150	0.435	0.00250
10th Percentile	25.2	6.50	5.25	0.00850	0.0120	0.225	0.00180
95th Percentile	68.6	6.95	15.0	0.0295	0.0190	1.81	0.00470

Value exceeded benchmark or guideline.

Note: "-" indicates no data or benchmark available.

[a] SRW Benchmark dependent on water hardness. See Table S.1 for details.

Table S.14: Water Quality at Mine-Exposed SRWMP Station SC-01, Westner Lake Outlet, 2015 to 2019

Date	Hardness (mg/L)	pH	Sulphate (mg/L)[a]	Radium-226 (Bq/L)	Barium (mg/L)	Iron (mg/L)	Uranium (mg/L)
Benchmark	-	5.3	128	0.469	1.0	2.49	0.015
16-Nov-15	-	7.00	21.0	<0.00800	0.0100	0.0680	<0.000500
24-Nov-16	31.0	6.90	20.0	<0.00800	0.0100	0.0620	<0.000500
21-Nov-17	26.1	6.90	16.0	<0.00700	0.00900	0.0670	<0.000500
26-Nov-18	31.5	6.60	18.0	0.00900	0.0110	0.136	<0.000500
13-Nov-19	29.1	7.30	16.0	<0.00700	0.0110	0.0950	<0.000500
Summary Statistics for 2015 to 2019							
n	4	5	5	5	5	5	5
Minimum	26.1	6.60	16.0	<0.00700	0.00900	0.0620	<0.000500
Maximum	31.5	7.30	21.0	0.00900	0.0110	0.136	<0.000500
Mean	29.4	6.94	18.2	0.00740	0.0102	0.0856	<0.000500
SD	2.45	0.251	2.28	-	0.000837	0.0310	-
Median	30.0	6.90	18.0	<0.00800	0.0100	0.0680	<0.000500
10th Percentile	26.1	6.60	16.0	<0.00700	0.00900	0.0620	<0.000500
95th Percentile	31.5	7.30	21.0	0.00900	0.0110	0.136	<0.000500

Value exceeded benchmark or guideline.

Note: "-" indicates no data/benchmark available or standard deviation unable to be calculated.

[a] SRW Benchmark dependent on water hardness. See Table S.1 for details.

Table S.15: Water Quality at Mine-Exposed SRWMP Station SR-08, Nordic Lake Outlet, 2015 to 2019

Date	Hardness (mg/L)	pH	Sulphate (mg/L)[a]	Radium-226 (Bq/L)	Barium (mg/L)	Uranium (mg/L)
Benchmark	-	6.5	309	0.469	1.0	0.015
23-Feb-15	185	6.90	170	0.0300	0.0210	0.000900
21-May-15	132	7.20	120	0.0210	0.0160	0.000700
18-Aug-15	172	7.20	150	0.0280	0.0170	0.000800
16-Nov-15	191	7.00	180	0.0340	0.0170	0.00100
n	4	4	4	4	4	4
Minimum	132	6.90	120	0.0210	0.0160	0.000700
Maximum	191	7.20	180	0.0340	0.0210	0.00100
Mean	170	7.08	155	0.0282	0.0178	0.000850
SD	26.5	0.150	26.5	0.00544	0.00222	0.000129
23-Feb-16	208	6.90	170	0.0310	0.0180	0.000900
2-May-16	133	7.00	110	0.0270	0.0150	0.000700
23-Aug-16	185	6.60	150	0.0190	0.0150	0.000900
24-Nov-16	188	6.80	170	0.0390	0.0180	0.00110
n	4	4	4	4	4	4
Minimum	133	6.60	110	0.0190	0.0150	0.000700
Maximum	208	7.00	170	0.0390	0.0180	0.00110
Mean	179	6.82	150	0.0290	0.0165	0.000900
SD	32.0	0.171	28.3	0.00833	0.00173	0.000163
23-Feb-17	180	6.80	150	0.0230	0.0180	0.000900
24-May-17	179	7.20	140	0.0220	0.0150	0.000900
10-Aug-17	195	7.50	160	0.0390	0.0170	0.00110
21-Nov-17	191	7.00	150	0.0200	0.0180	0.000900
n	4	4	4	4	4	4
Minimum	179	6.80	140	0.0200	0.0150	0.000900
Maximum	195	7.50	160	0.0390	0.0180	0.00110
Mean	186	7.12	150	0.0260	0.0170	0.000950
SD	7.97	0.299	8.16	0.00876	0.00141	0.000100
22-Feb-18	250	7.00	160	0.0280	0.0220	0.000700
22-May-18	136	7.10	110	0.0360	0.0180	0.000700
22-Aug-18	160	6.60	120	0.0310	0.0170	<0.000500
26-Nov-18	190	6.70	160	0.0180	0.0190	0.000800
n	4	4	4	4	4	4
Minimum	136	6.60	110	0.0180	0.0170	<0.0005
Maximum	250	7.10	160	0.0360	0.0220	0.000800
Mean	184	6.85	138	0.0282	0.0190	0.000675
SD	49.2	0.238	26.3	0.00759	0.00216	0.0000530
27-Feb-19	198	6.70	150	0.0360	0.0200	0.000700
27-May-19	111	6.80	100	0.0300	0.0160	0.000600
27-Aug-19	157	6.90	120	0.0250	0.0160	0.000600
13-Nov-19	190	7.00	150	0.0300	0.0200	0.000700
n	4	4	4	4	4	4
Minimum	111	6.70	100	0.0250	0.0160	0.000600
Maximum	198	7.00	150	0.0360	0.0200	0.000700
Mean	164	6.85	130	0.0302	0.0180	0.000650
SD	39.5	0.129	24.5	0.00450	0.00231	0.0000577
Summary Statistics for 2015 to 2019						
n	20	20	20	20	20	20
Minimum	111	6.60	100	0.0180	0.0150	<0.000500
Maximum	250	7.50	180	0.0390	0.0220	0.00110
Mean	177	6.94	144	0.0284	0.0176	0.000805
SD	31.4	0.226	23.3	0.00648	0.00198	0.000155
Median	185	6.95	150	0.0290	0.0175	0.000800
10th Percentile	132	6.65	110	0.0195	0.0150	0.000600
95th Percentile	229	7.35	175	0.0390	0.0215	0.00110

Value exceeded benchmark or guideline.

Note: "-" indicates no benchmark available.

[a] SRW Benchmark dependent on water hardness. See Table S.1 for details.

Table S.16: Number of Samples Exceeding Selected Benchmarks (shaded values) at SRWMP Stations, 2015 to 2019

Station	# of Samples	Barium	Iron	Manganese[a]	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)		-	0.755	-	6.5	-	-	-
Upper Limit of Background (Wetland)		-	2.49	-	5.3	-	-	-
Guideline		1.0	-	0.841	-	0.469	128 to 429	0.015
D-6	20	0	**4**	**3**	0	0	**1**	0
DS-18	20	0	0	NA	0	0	0	0
SR-15	9	0	0	NA	0	0	0	0
M-01	20	0	0	NA	0	0	0	0
SC-01	5	0	0	NA	0	0	0	0
D-5	20	0	NA	NA	0	0	0	0
Q-09	20	0	NA	NA	0	0	**1**	0
Q-20	5	0	NA	NA	0	0	0	0
SR-01	5	0	NA	NA	0	0	0	0
SR-06	24	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.

Benchmark applied to wetland stations: M-01, DS-18, SC-01, SR-15.

Benchmark applied to lake and wetland stations.

Note: "NA" indicates parameter not sampled at this station.

[a] Benchmark - Guideline is hardness dependent. Average hardness at station D-6 was used as the basis for the guideline selection, see Appendix Table S.1.

[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 S.2 for site hardness values used.

Table S.17: *In Situ* Water Quality Measurements at Reference and Mine-exposed Benthic Invertebrate Community and Sediment Sampling Stations, SRWMP, September 2019

Area Type		Waterbody	Station ID	Measurement Depth (m)	Temperature (°C)	pH	Specific Conductance (µS/cm)	Dissolved Oxygen (% saturation)	Dissolved Oxygen (mg/L)
Reference	Surface	Dunlop Lake	DUL_2019-1	0.3	17.8	6.35	26.7	97.6	8.86
			DUL_2019-2	0.3	17.5	6.44	27.1	96.9	8.83
			DUL_2019-3	0.3	17.9	5.88	27.1	96.6	8.74
			DUL_2019-4	0.3	18.2	6.38	27.3	98.5	8.84
			DUL_2019-5	0.3	17.9	6.32	27.7	97.0	8.81
		Semiwite Lake	SL_2019-01	0.3	17.8	6.42	29.5	99.8	8.94
			SL_2019-02	0.3	17.4	6.20	29.3	97.4	8.76
			SL_2019-03	0.3	17.7	5.70	29.4	99.6	8.93
			SL_2019-04	0.3	17.6	5.81	29.4	98.0	8.84
			SL_2019-05	0.3	17.7	5.75	29.4	98.2	8.87
		Summers Lake	SUL_2019-01	0.3	17.0	7.00	17.0	96.6	9.31
			SUL_2019-02	0.3	16.9	6.47	18.0	99.9	9.66
			SUL_2019-03	0.3	17.4	6.32	18.0	99.3	9.51
			SUL_2019-04	0.3	17.0	7.08	17.0	96.6	9.33
			SUL_2019-05	0.3	17.3	6.34	17.0	99.7	9.54
		Ten Mile Lake	TML_2019-01	0.3	17.6	6.46	23.4	105.5	9.68
			TML_2019-02	0.3	16.9	6.05	24.4	97.2	9.09
			TML_2019-03	0.3	18.2	6.56	23.3	106.7	9.69
			TML_2019-04	0.3	18.6	6.25	23.4	107.9	9.79
			TML_2019-05	0.3	17.1	6.42	23.3	101.8	9.45
	Bottom	Dunlop Lake	DUL_2019-1	14.5	8.7	5.69	27.6	78.2	8.75
			DUL_2019-2	16.0	8.5	5.11	36.3	74.6	8.42
			DUL_2019-3	14.9	8.6	5.58	27.7	80.6	9.04
			DUL_2019-4	15.5	8.4	5.45	27.5	77.5	8.71
			DUL_2019-5	15.5	7.8	5.66	28.7	73.4	8.35
		Semiwite Lake	SL_2019-01	14.5	6.9	5.19	30.0	65.1	7.47
			SL_2019-02	14.5	6.8	5.05	30.3	62.3	7.26
			SL_2019-03	14.3	7.3	5.14	30.1	62.8	7.15
			SL_2019-04	15.0	6.6	5.06	30.0	64.5	7.47
			SL_2019-05	14.5	7.5	5.40	29.8	67.7	7.67
		Summers Lake	SUL_2019-01	15.5	5.7	5.00	22.0	62.3	7.88
			SUL_2019-02	13.0	5.6	5.13	20.0	112.2	14.11
			SUL_2019-03	15.5	4.6	4.86	20.0	85.2	10.97
			SUL_2019-04	15.0	5.7	5.01	22.0	62.3	7.81
			SUL_2019-05	17.5	4.8	4.77	22.0	76.5	9.81
		Ten Mile Lake	TML_2019-01	17.2	7.6	6.09	23.5	115.6	13.40
			TML_2019-02	18.0	6.0	5.52	24.6	92.7	11.12
			TML_2019-03	17.1	7.4	6.01	31.3	9.1	1.05
			TML_2019-04	17.7	5.9	5.71	23.6	98.5	11.86
			TML_2019-05	18.3	5.9	5.67	23.6	98.7	11.87
Mine-exposed	Surface	May Lake	MAL_2019-01	0.3	17.8	6.89	139.0	112.8	10.34
			MAL_2019-02	0.3	17.8	6.71	109.0	110.5	10.17
			MAL_2019-03	0.3	18.4	6.61	112.1	101.2	9.10
			MAL_2019-04	0.3	19.0	6.72	112.7	100.6	8.96
			MAL_2019-05	0.3	17.1	6.96	108.4	109.5	10.23
		McCabe Lake	ML_2019-01	0.3	16.9	7.35	108.0	105.4	10.17
			ML_2019-02	0.3	17.1	7.27	109.0	99.8	9.62
			ML_2019-03	0.3	17.3	6.77	108.0	101.7	9.76
			ML_2019-04	0.3	17.0	7.23	109.0	95.6	9.21
			ML_2019-05	0.3	17.1	7.12	108.0	97.4	9.38
		Nordic Lake	NL_2019-01	0.3	17.9	7.67	494.0	95.4	9.03
			NL_2019-02	0.3	18.2	7.53	483.0	104.1	9.85
			NL_2019-03	0.3	18.0	7.52	482.0	96.4	9.06
			NL_2019-04	0.3	18.3	7.56	481.0	93.0	8.73
			NL_2019-05	0.3	18.2	7.54	481.0	94.2	8.86
		Quirke Lake	QL_2019-01	0.3	17.5	6.58	110.9	102.3	9.25
			QL_2019-02	0.3	17.5	6.55	103.5	100.1	9.17
			QL_2019-03	0.3	18.2	6.49	103.5	102.5	9.22
			QL_2019-04	0.3	17.3	6.33	105.9	101.7	9.32
			QL_2019-05	0.3	17.9	6.31	105.8	102.2	9.24
	Bottom	May Lake	MAL_2019-01	14.2	6.0	5.92	154.5	74.6	8.99
			MAL_2019-02	15.6	5.6	5.80	109.6	77.1	9.32
			MAL_2019-03	15.6	6.0	5.99	113.7	80.1	9.52
			MAL_2019-04	16.5	5.8	5.76	113.3	65.2	7.81
			MAL_2019-05	15.3	6.0	6.50	110.5	82.9	9.99
		McCabe Lake	ML_2019-01	15.2	9.0	6.51	115.0	86.7	10.00
			ML_2019-02	14.0	7.8	6.08	115.0	77.6	7.22
			ML_2019-03	14.8	9.3	6.04	122.0	72.8	8.30
			ML_2019-04	14.0	8.6	6.20	121.0	72.4	9.02
			ML_2019-05	14.4	7.9	6.22	118.0	84.3	10.02
		Nordic Lake	NL_2019-01	13.5	4.2	6.99	565.0	68.0	8.82
			NL_2019-02	16.5	3.0	6.56	570.0	73.0	9.84
			NL_2019-03	16.1	3.7	6.70	569.0	74.9	9.83
			NL_2019-04	17.0	4.2	6.79	561.0	82.9	10.71
			NL_2019-05	16.2	3.2	6.61	567.0	71.2	10.55
		Quirke Lake	QL_2019-01	19.5	5.8	6.03	105.3	95.4	11.33
			QL_2019-02	19.0	6.0	5.81	105.3	87.5	10.41
			QL_2019-03	19.5	5.9	6.42	106.1	93.0	11.03
			QL_2019-04	19.0	5.8	5.77	105.2	92.4	11.02
			QL_2019-05	22.5	5.9	6.20	105.1	93.7	11.17

Table S.18: *In Situ* Water Quality Depth Profiles for SRWMP Lakes, September 2019

Lake Type	Lake	Station ID	UTM (11U, NAD83)		Depth	Temperature	pH	Dissolved Oxygen		Specific Conductivity
			Easting	Northing	(m)	(°C)		(mg/L)	(%)	(µS/cm)
Reference	Dunlop Lake	DUL_2019-02	365441	5150867	0.3	17.50	6.44	8.83	96.9	27.1
					1.0	17.60	6.01	9.03	98.6	26.8
					2.0	17.60	6.08	8.60	93.7	26.9
					3.0	17.60	6.18	8.87	96.0	26.8
					4.0	17.50	6.20	8.69	95.3	27.0
					5.0	17.00	6.15	9.31	100.6	26.9
					6.0	17.00	6.19	9.31	100.8	27.0
					7.0	16.50	6.24	9.00	95.8	27.0
					8.0	16.20	6.21	9.20	97.0	27.1
					9.0	16.20	6.04	9.30	96.3	27.2
					10.0	13.50	5.96	9.29	92.3	27.5
					11.0	11.20	5.77	9.58	90.4	27.5
					12.0	9.90	5.62	9.47	87.2	27.5
					13.0	9.30	5.47	9.08	82.5	27.5
					14.0	9.00	5.35	9.05	81.4	27.5
					15.0	8.80	5.21	8.82	78.9	27.5
					16.0	8.50	5.11	8.42	74.6	36.3
		DUL_2019-04	368751	5149613	0.3	18.20	6.38	8.84	98.5	27.3
					1.0	18.10	6.42	8.92	98.7	27.3
					2.0	18.00	6.45	8.90	98.2	27.3
					3.0	18.00	6.48	8.85	97.3	27.3
					4.0	18.00	6.38	9.00	99.1	27.3
					5.0	18.00	6.39	8.96	98.6	27.3
					6.0	17.90	6.43	9.10	99.9	27.4
					7.0	16.60	6.54	9.00	97.3	27.3
					8.0	16.20	6.54	9.06	95.4	27.4
					9.0	15.70	6.44	8.96	94.0	27.4
					10.0	12.20	6.18	9.24	89.2	27.6
					11.0	10.30	5.94	9.50	88.6	27.5
					12.0	9.70	5.85	9.61	87.6	27.5
					13.0	9.60	5.81	9.33	85.3	27.4
					14.0	9.60	5.66	9.39	84.3	27.5
					15.0	8.60	5.56	8.91	79.1	27.5
					15.5	8.40	5.45	8.71	77.5	27.5
Reference	Semiwite Lake	SL_2019-02	371659	5158814	0.3	17.40	6.20	8.76	97.4	29.3
					1.0	17.40	6.07	8.66	95.8	29.1
					2.0	17.40	6.09	8.82	97.8	29.4
					3.0	17.40	6.07	8.97	99.2	29.3
					4.0	17.30	5.95	9.04	99.3	29.5
					5.0	16.70	5.95	9.17	100.0	29.6
					6.0	16.60	6.05	9.18	99.9	29.5
					7.0	15.80	6.11	8.94	96.2	29.5
					8.0	15.60	6.02	8.98	94.7	29.6
					9.0	13.80	5.77	8.53	87.3	29.7
					10.0	9.50	5.64	7.67	71.3	29.3
					11.0	8.20	5.37	7.65	69.2	29.7
					12.0	7.90	5.22	7.38	65.8	29.7
					13.0	7.20	5.12	7.43	64.7	29.9
					14.0	6.80	5.05	7.43	64.4	30.2
					14.5	6.80	5.05	7.26	62.3	30.3
		SL_2019-04	372503	5159406	0.3	17.60	5.81	8.84	98.0	29.4
					1.0	17.50	6.06	8.61	95.6	29.4
					2.0	17.50	6.06	8.73	96.4	29.4
					3.0	17.10	6.12	9.08	98.8	29.5
					4.0	16.40	6.18	9.20	99.2	29.5
					5.0	16.30	6.10	9.05	98.3	29.5
					6.0	16.00	6.11	8.88	94.4	29.5
					7.0	15.80	6.15	8.85	94.4	29.5
					8.0	15.80	6.09	8.54	89.9	29.6
					9.0	14.00	5.91	8.15	84.5	29.6
					10.0	11.10	5.67	7.79	74.8	29.8
					11.0	8.00	5.40	7.41	66.1	30.0
					12.0	7.40	5.26	7.61	66.8	29.7
					13.0	7.00	5.15	7.45	64.8	29.8
					14.0	6.90	5.09	7.44	64.1	29.9
					15.0	6.60	5.06	7.47	64.5	30.0
Reference	Summers Lake	SUL_2019-02	365068	5146614	0.3	16.88	6.47	9.66	99.9	18.0
					1.0	16.69	6.42	9.44	97.1	18.0
					2.0	16.61	6.40	9.41	96.5	18.0
					3.0	16.57	6.40	9.30	95.4	18.0
					4.0	16.52	6.34	9.24	94.8	17.0
					5.0	16.01	6.25	9.44	95.7	18.0
					6.0	15.59	6.30	9.60	96.5	17.0
					7.0	15.21	6.09	9.57	95.5	18.0
					8.0	13.52	5.97	10.53	101.1	18.0
					9.0	9.66	5.77	13.52	118.7	18.0
					10.0	8.01	5.62	14.50	122.6	18.0
					11.0	6.68	5.25	14.21	116.2	20.0
					12.0	6.02	5.24	14.28	114.8	20.0
					13.0	5.62	5.13	14.11	112.2	20.0
		SUL_2019-04	364872	5147338	0.3	16.96	7.08	9.33	96.6	17.0
					1.0	16.93	7.02	9.21	95.2	18.0
					2.0	16.81	6.90	9.22	95.1	19.0
					3.0	16.76	6.85	9.11	93.8	18.0
					4.0	16.70	6.75	8.99	92.7	17.0
					5.0	16.05	6.75	9.33	94.7	18.0
					6.0	15.53	6.58	9.40	94.3	18.0
					7.0	15.15	6.39	9.45	94.0	17.0
					8.0	13.09	6.05	10.63	101.1	18.0
					9.0	8.70	6.00	13.36	115.0	18.0
					10.0	7.61	5.28	13.14	110.0	20.0
					11.0	6.75	4.95	11.37	93.2	20.0
					12.0	6.37	4.92	10.48	85.0	20.0
					13.0	6.17	4.90	9.61	77.7	20.0
					14.0	5.96	4.95	9.08	73.0	20.0
					15.0	5.67	5.01	7.81	62.3	22.0

Table S.18: *In Situ* Water Quality Depth Profiles for SRWMP Lakes, September 2019

Lake Type	Lake	Station ID	UTM (11U, NAD83)		Depth	Temperature	pH	Dissolved Oxygen		Specific Conductivity
			Easting	Northing	(m)	(°C)		(mg/L)	(%)	(µS/cm)
Reference	Ten Mile Lake	TML_2019-02	363615	5151602	0.3	16.90	6.05	9.09	97.2	24.4
					1.0	16.90	6.28	9.01	96.5	24.4
					2.0	16.90	6.36	8.57	91.9	24.4
					3.0	16.90	6.39	8.65	92.8	24.4
					4.0	16.90	6.46	8.31	89.0	24.4
					5.0	16.90	6.47	8.73	93.5	24.3
					6.0	16.80	6.48	8.58	91.8	24.4
					7.0	16.70	6.41	8.78	94.0	24.4
					8.0	16.50	6.51	8.52	90.6	24.4
					9.0	16.50	6.56	8.23	87.4	24.4
					10.0	16.30	6.53	8.62	91.3	24.4
					11.0	14.20	6.55	10.40	104.7	24.6
					12.0	11.30	6.54	12.41	117.8	24.4
					13.0	10.00	6.45	11.36	108.4	26.6
					14.0	8.40	6.07	12.06	106.8	24.5
					15.0	7.60	5.99	12.67	110.3	24.4
					16.0	6.70	5.83	11.91	101.1	24.6
					17.0	6.30	5.63	11.47	96.4	24.6
					18.0	6.00	5.52	11.12	92.7	24.6
		TML_2019-04	360651	5153825	0.3	18.60	6.25	9.79	107.9	23.4
					1.0	18.10	6.25	9.32	102.2	23.3
					2.0	17.30	6.25	9.20	99.3	23.3
					3.0	17.10	6.24	9.25	99.7	23.3
					4.0	17.00	6.21	8.88	95.5	23.2
					5.0	16.90	6.17	9.02	96.8	23.2
					6.0	16.90	6.15	8.99	96.4	23.3
					7.0	16.70	6.16	9.09	97.1	23.2
					8.0	16.60	6.18	8.58	91.2	23.2
					9.0	16.40	6.20	9.58	100.9	23.2
					10.0	16.20	6.18	9.56	101.0	23.2
					11.0	15.40	6.17	9.79	101.8	23.3
					12.0	9.90	6.26	12.82	117.8	23.6
					13.0	9.10	6.27	13.77	123.7	23.3
					14.0	7.80	6.27	13.30	115.8	23.4
					15.0	7.00	6.12	13.14	112.4	23.5
					16.0	6.50	5.98	12.57	106.4	23.5
					17.0	6.20	5.88	11.81	99.1	23.5
					17.7	5.90	5.71	11.86	98.5	23.6
Mine-exposed	May Lake	MAL_2019-02	384357	5143310	0.3	17.80	6.71	10.17	110.5	109.0
					1.0	17.80	6.85	10.15	110.1	109.0
					2.0	17.60	6.89	10.03	108.9	109.1
					3.0	16.90	6.93	9.96	106.2	108.9
					4.0	16.80	6.93	10.20	108.5	109.0
					5.0	16.60	6.92	9.68	102.6	108.8
					6.0	16.50	6.88	9.65	102.0	108.8
					7.0	16.10	6.84	9.76	102.3	108.9
					8.0	15.00	6.68	9.72	99.6	108.8
					9.0	11.20	6.22	10.64	100.6	108.3
					10.0	8.20	6.09	10.44	91.7	108.8
					11.0	7.00	6.01	10.36	88.9	109.2
					12.0	6.70	5.97	9.86	83.2	109.4
					13.0	6.40	5.93	10.29	86.1	109.3
					14.0	6.20	5.90	9.72	81.0	109.5
					15.0	5.70	5.81	9.60	79.3	109.5
					15.6	5.60	5.80	9.32	77.1	109.6
		MAL_2019-04	385829	5143354	0.3	19.00	6.72	8.96	100.6	112.7
					1.0	19.00	6.83	8.91	99.6	112.7
					2.0	19.00	6.86	8.69	96.4	112.7
					3.0	18.70	6.90	8.68	97.2	112.5
					4.0	18.50	6.93	8.80	97.7	112.4
					5.0	18.00	6.96	9.15	100.4	112.6
					6.0	17.70	6.99	9.11	99.9	122.5
					7.0	16.50	6.96	9.02	96.2	112.4
					8.0	10.90	6.11	10.05	94.9	112.0
					9.0	9.60	6.03	10.04	91.8	112.2
					10.0	8.40	5.98	9.82	87.7	112.7
					11.0	7.40	5.94	9.62	83.4	112.8
					12.0	6.90	5.90	9.45	81.0	112.9
					13.0	6.70	5.86	9.09	77.6	113.1
					14.0	6.30	5.83	9.01	76.3	113.1
					15.0	6.10	5.80	8.99	75.5	113.1
					16.0	5.90	5.79	8.87	74.2	113.3
					16.5	5.80	5.76	7.81	65.2	113.3

Table S.18: *In Situ* Water Quality Depth Profiles for SRWMP Lakes, September 2019

Lake Type	Lake	Station ID	UTM (11U, NAD83)		Depth	Temperature	pH	Dissolved Oxygen		Specific Conductivity
			Easting	Northing	(m)	(°C)		(mg/L)	(%)	(µS/cm)
Mine-exposed	McCabe Lake	ML_2019-02	379486	5142144	0.3	17.11	7.27	9.62	99.8	109.0
					1.0	17.10	7.29	9.29	96.3	109.0
					2.0	17.10	7.29	9.15	94.9	110.0
					3.0	17.10	7.32	9.08	94.2	108.0
					4.0	17.10	7.30	9.03	93.6	108.0
					5.0	17.10	7.30	9.01	93.4	111.0
					6.0	16.68	7.35	9.20	94.5	111.0
					7.0	16.20	7.28	9.35	95.1	109.0
					8.0	15.95	7.22	9.35	94.7	107.0
					9.0	15.57	7.12	9.32	93.7	108.0
					10.0	14.86	6.96	9.36	92.8	111.0
					11.0	10.48	6.31	9.16	82.2	114.0
					12.0	9.80	6.29	9.10	80.2	118.0
					13.0	8.02	6.09	9.60	81.1	117.0
					14.0	7.82	6.08	7.22	77.6	115.0
		ML_2019-04	379158	5142083	0.3	17.04	7.23	9.21	95.6	109.0
					1.0	17.04	7.25	8.90	92.3	109.0
					2.0	17.04	7.30	8.82	91.4	109.0
					3.0	17.04	7.30	8.79	91.0	109.0
					4.0	17.03	7.32	8.80	91.2	108.0
					5.0	17.02	7.35	8.78	91.0	108.0
					6.0	16.97	7.30	8.80	91.1	108.0
					7.0	16.22	7.35	9.13	92.9	108.0
					8.0	15.88	7.25	9.19	93.0	109.0
					9.0	15.21	7.14	9.18	92.0	111.0
					10.0	14.17	6.92	9.22	90.0	112.0
					11.0	10.71	6.42	9.06	81.8	117.0
					12.0	9.69	6.26	8.72	76.9	116.0
					13.0	8.67	6.20	9.10	78.2	117.0
					14.0	8.56	6.20	9.02	77.4	121.0
Mine-exposed	Nordic Lake	NL_2019-02	376832	5135678	0.3	18.16	7.53	9.85	104.1	483.0
					1.0	18.16	7.54	9.25	98.4	483.0
					2.0	18.16	7.54	9.10	96.8	483.0
					3.0	18.14	7.54	9.02	95.7	483.0
					4.0	16.87	7.62	9.52	98.3	488.0
					5.0	16.36	7.55	9.61	98.3	491.0
					6.0	16.08	7.54	9.64	98.1	490.0
					7.0	15.70	7.49	9.62	97.2	491.0
					8.0	12.63	7.15	11.43	107.7	517.0
					9.0	6.92	7.06	15.30	125.6	544.0
					10.0	5.86	6.87	13.55	108.7	549.0
					11.0	5.35	6.83	13.04	103.4	552.0
					12.0	4.81	6.77	12.24	95.6	555.0
					13.0	4.30	6.66	12.11	93.9	557.0
					14.0	3.96	6.65	11.31	86.7	559.0
					15.0	3.55	6.63	10.83	81.7	561.0
					16.0	3.02	6.60	10.75	80.0	570.0
					16.5	2.98	6.56	9.64	73.0	570.0
		NL_2019-04	377379	5135339	0.3	18.26	7.56	8.73	93.0	481.0
					1.0	18.27	7.61	8.56	91.1	482.0
					2.0	18.09	7.59	8.61	91.0	480.0
					3.0	16.70	7.58	9.11	93.7	490.0
					4.0	16.25	7.57	9.14	93.3	488.0
					5.0	16.00	7.55	9.07	91.9	492.0
					6.0	15.54	7.52	9.16	92.1	493.0
					7.0	11.98	7.32	11.75	108.9	522.0
					8.0	7.69	7.25	14.26	119.7	542.0
					9.0	6.18	7.14	14.82	120.7	549.0
					10.0	5.09	7.08	14.07	115.0	553.0
					11.0	4.60	6.88	13.06	101.4	555.0
					12.0	4.25	6.83	12.64	97.5	557.0
					13.0	4.19	6.79	12.11	93.4	558.0
					14.0	4.16	6.75	11.78	90.4	559.0
					15.0	4.16	6.75	11.50	88.4	560.0
					16.0	4.16	6.75	11.12	85.3	560.0
					17.0	4.15	6.79	10.71	82.9	561.0

Table S.18: *In Situ* Water Quality Depth Profiles for SRWMP Lakes, September 2019

Lake Type	Lake	Station ID	UTM (11U, NAD83)		Depth	Temperature	pH	Dissolved Oxygen		Specific Conductivity
			Easting	Northing	(m)	(°C)		(mg/L)	(%)	(µS/cm)
Mine-exposed	Quirke Lake	QL_2019-02	381098	5150983	0.3	17.50	6.55	9.17	100.1	103.5
					1.0	17.50	6.62	9.22	101.2	103.6
					2.0	17.50	6.67	9.48	103.4	104.1
					3.0	17.20	6.77	9.48	102.5	104.3
					4.0	17.10	6.83	9.30	101.8	104.3
					5.0	17.10	6.92	9.65	103.8	104.2
					6.0	16.50	6.95	9.71	103.6	104.2
					7.0	16.40	6.96	9.70	103.3	104.2
					8.0	16.00	6.95	9.47	101.1	104.2
					9.0	16.00	6.93	9.64	101.2	104.2
					10.0	15.40	6.87	9.61	99.7	104.3
					11.0	10.40	6.72	11.74	108.2	104.5
					12.0	8.30	6.51	12.03	104.6	104.7
					13.0	7.50	6.28	11.42	98.3	104.9
					14.0	7.20	6.14	11.38	97.0	104.9
					15.0	6.50	6.02	11.03	94.4	105.2
					16.0	6.50	5.97	10.77	91.1	105.2
					17.0	6.20	5.89	10.67	89.7	105.2
					18.0	6.10	5.89	10.33	87.5	105.2
					19.0	6.00	5.81	10.41	87.5	105.3
		QL_2019-04	378194	5148792	0.3	17.30	6.33	9.32	101.7	105.9
					1.0	17.30	6.38	9.01	98.1	105.9
					2.0	17.30	6.41	9.11	99.4	105.9
					3.0	17.20	6.44	9.12	99.5	105.5
					4.0	17.20	6.47	9.48	103.3	105.3
					5.0	16.70	6.52	9.27	99.7	105.6
					6.0	16.20	6.54	9.45	100.4	105.2
					7.0	16.10	6.54	9.32	98.8	105.1
					8.0	15.60	6.52	9.36	98.7	105.1
					9.0	15.30	6.49	9.51	99.4	105.1
					10.0	14.30	6.45	9.56	98.0	106.3
					11.0	12.20	6.32	10.81	105.6	105.6
					12.0	8.30	6.11	11.84	105.3	105.0
					13.0	7.40	6.05	11.91	103.7	105.0
					14.0	7.20	6.01	11.53	104.9	104.9
					15.0	6.90	5.95	11.38	98.1	104.8
					16.0	6.50	5.87	11.26	95.4	105.0
					17.0	6.30	5.83	11.22	95.3	105.0
					18.0	6.00	5.80	11.09	105.1	105.1
					19.0	5.80	5.77	11.02	92.4	105.2

Cider Stream beaver dams, upstream of station D-6.

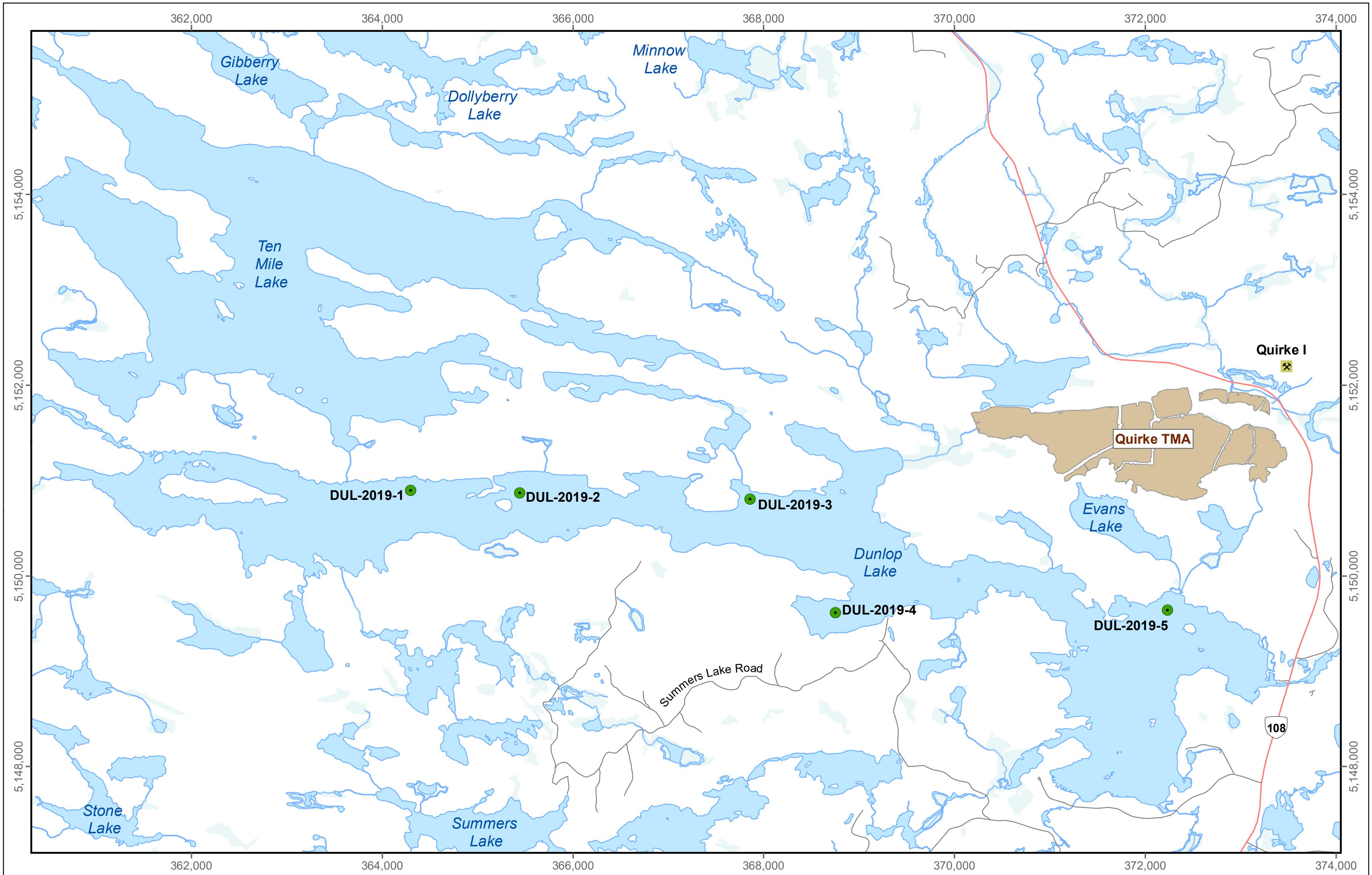
Cider Stream, upstream of station D-6.

Cider Stream, upstream of station D-6.

Cider Stream, station D-6 is sampled downstream of the culverts. The confluence of the Cinder Stream and Serpent River is behind the trees.

Photo Set S.1: Wetland Habitat at SRWMP Station D-6

APPENDIX T
SRWMP SEDIMENT QUALITY AND BENTHIC INVERTEBRATE COMMUNITY DATA



LEGEND

Reference Sediment Quality and Benthic Invertebrate Community Sampling Location

0 0.75 1.5 3
Kilometers

N W E S

Map Projection: UTM Zone 17 U NAD 1983
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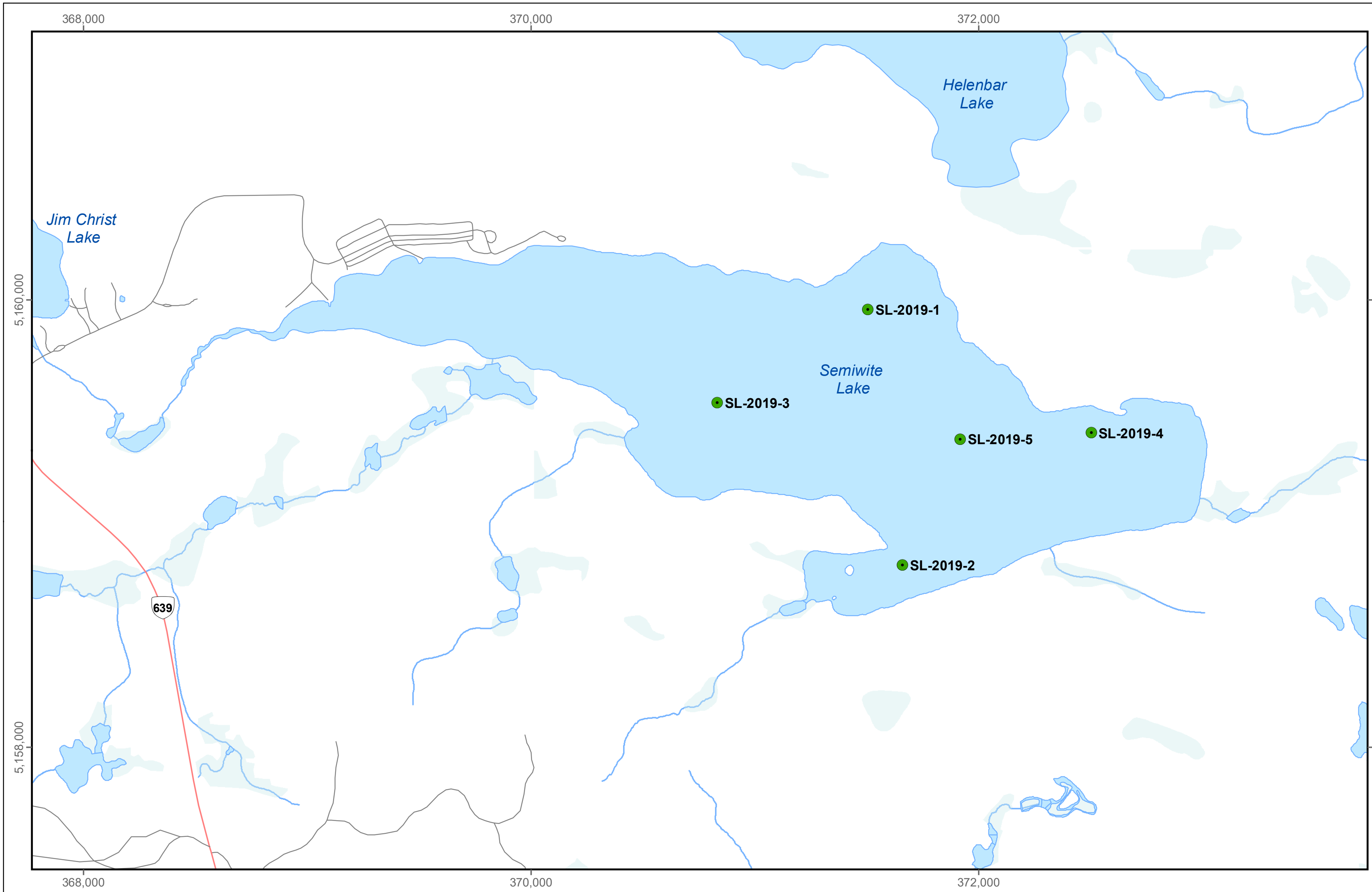
SRWMP Sediment Quality and Benthic Invertebrate Community Sampling Locations in Dunlop Lake

Date: February 2021
Project 197202.0041

minnow environmental inc.

Figure T.1

Document Path: C:\Users\MLaPalme\Trinity Consultants, Inc\BHP - 197202.0041 - Cycle 5 SOE\4 - GIS\Cycle 5 Report\19-41 Figure T.1 SRWMP Sediment Quality and BI Sampling Locations, in Dunlop Lake.mxd



LEGEND

Reference Sediment Quality and Benthic Invertebrate Community Sampling Location

0 0.25 0.5 1
Kilometers

N W E S

Map Projection: UTM Zone 17 U NAD 1983
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SRWMP Sediment Quality and Benthic Invertebrate Community Sampling Locations in Semiwite Lake

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Project 197202.0041

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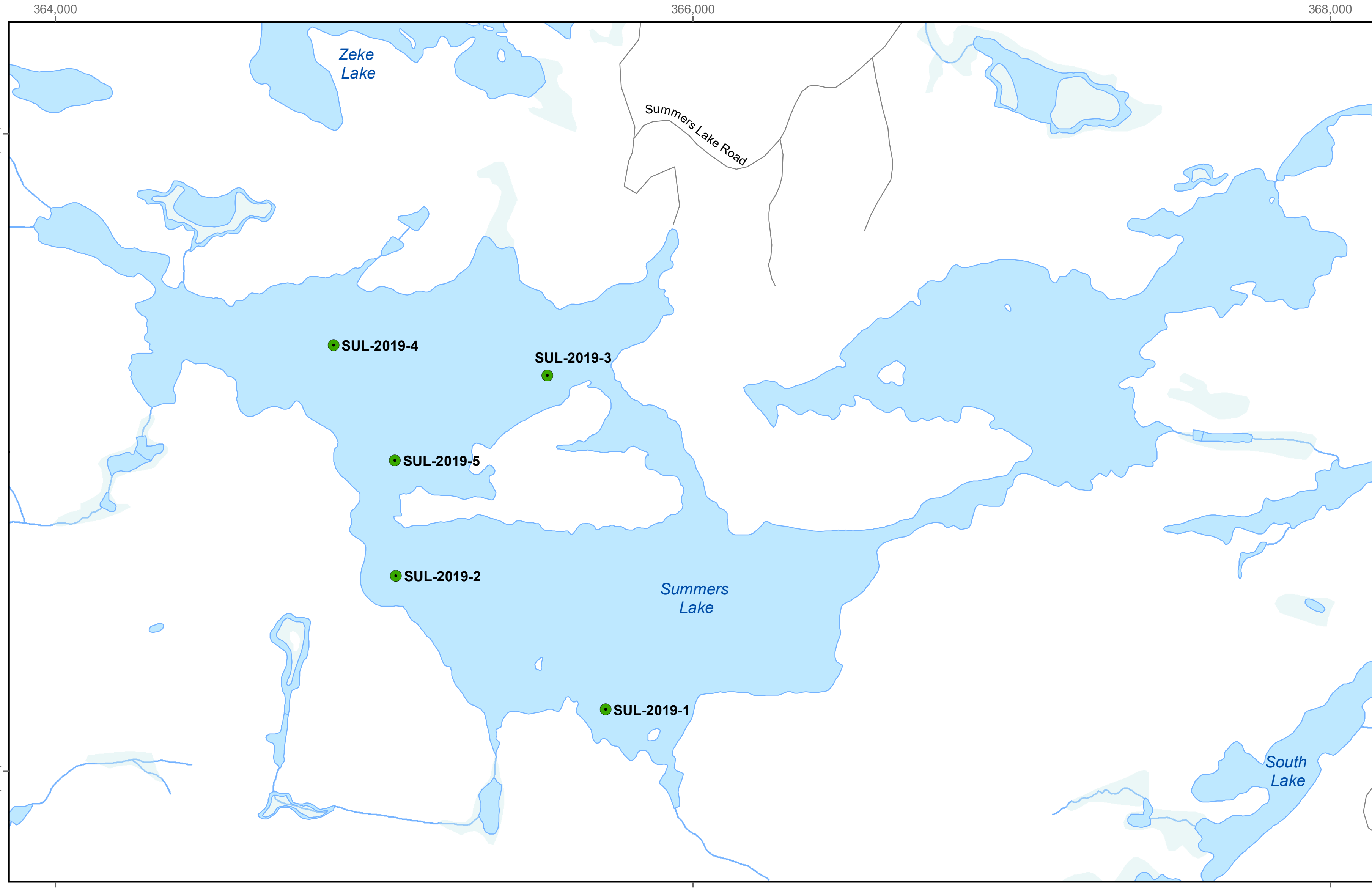
Figure T.2

Document Path: C:\Users\MLaPalme\Trinity Consultants, Inc\BHP - 197202.0041 - Cycle 5 SOE\4 - GIS\Cycle 5 Report\19-41 Figure T.2 SRWMP Sediment Quality and BI Sampling Locations, in Semiwite Lake.mxd



LEGEND

● Reference Sediment Quality and Benthic Invertebrate Community Sampling Location

0 200 400 800
Meters

N W E S

Map Projection: UTM Zone 17 U NAD 1983
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SRWMP Sediment Quality and Benthic Invertebrate Community Sampling Locations in Summers Lake

Date: February 2021
Project 197202.0041

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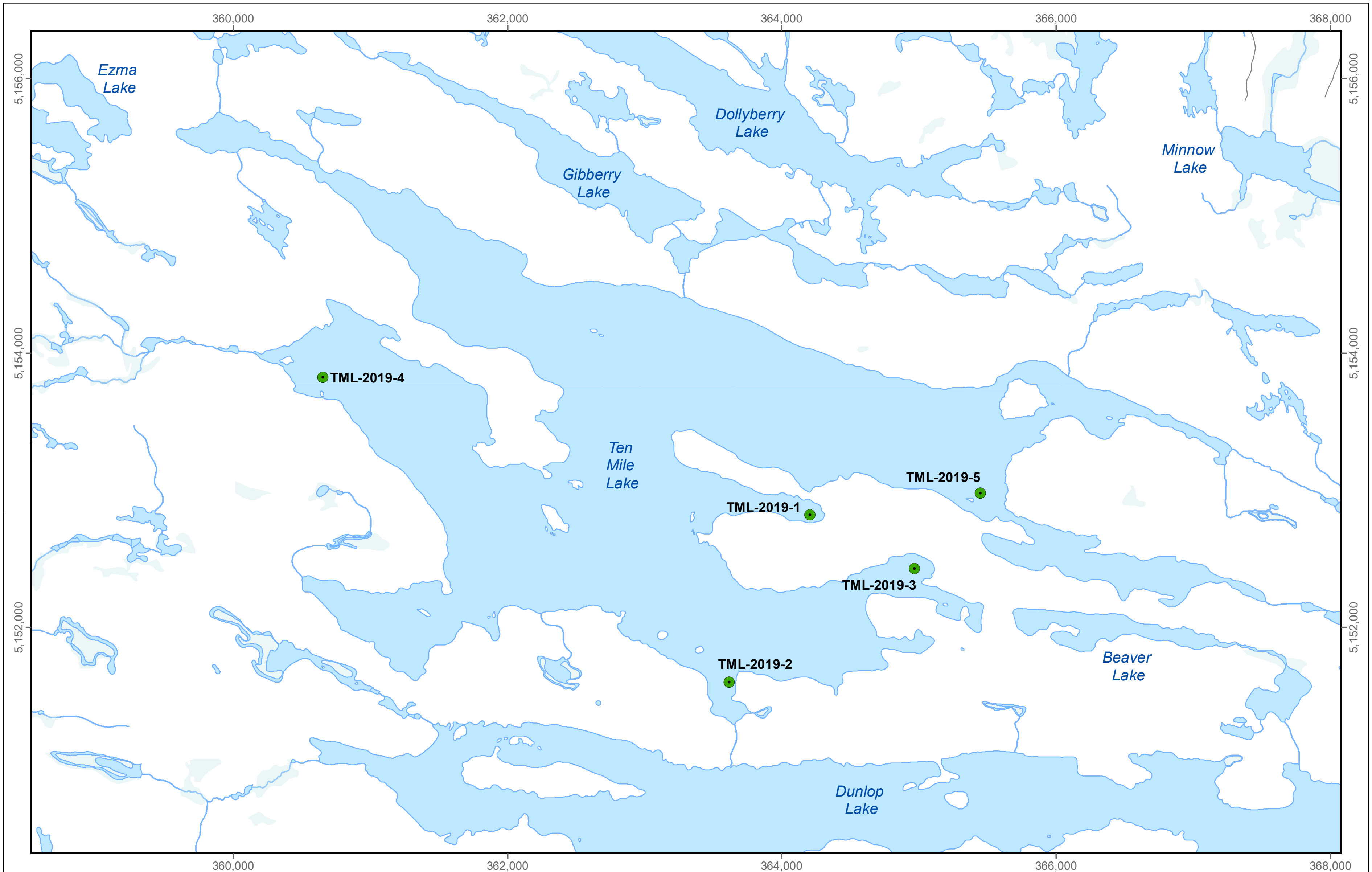
Figure T.3

Document Path: C:\Users\MLaPalme\Trinity Consultants, Inc\BHP - 197202.0041 - Cycle 5 SOE\4 - GIS\Cycle 5 Report\19-41 Figure T.3 SRWMP Sediment Quality and BI Sampling Locations, in Summers Lake.mxd



LEGEND

● Reference Sediment Quality and Benthic Invertebrate Community Sampling Location

0 0.5 1 2
Kilometers

N W E S

Map Projection: UTM Zone 17 U NAD 1983
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SRWMP Sediment Quality and Benthic Invertebrate Community Sampling Locations in Ten Mile Lake

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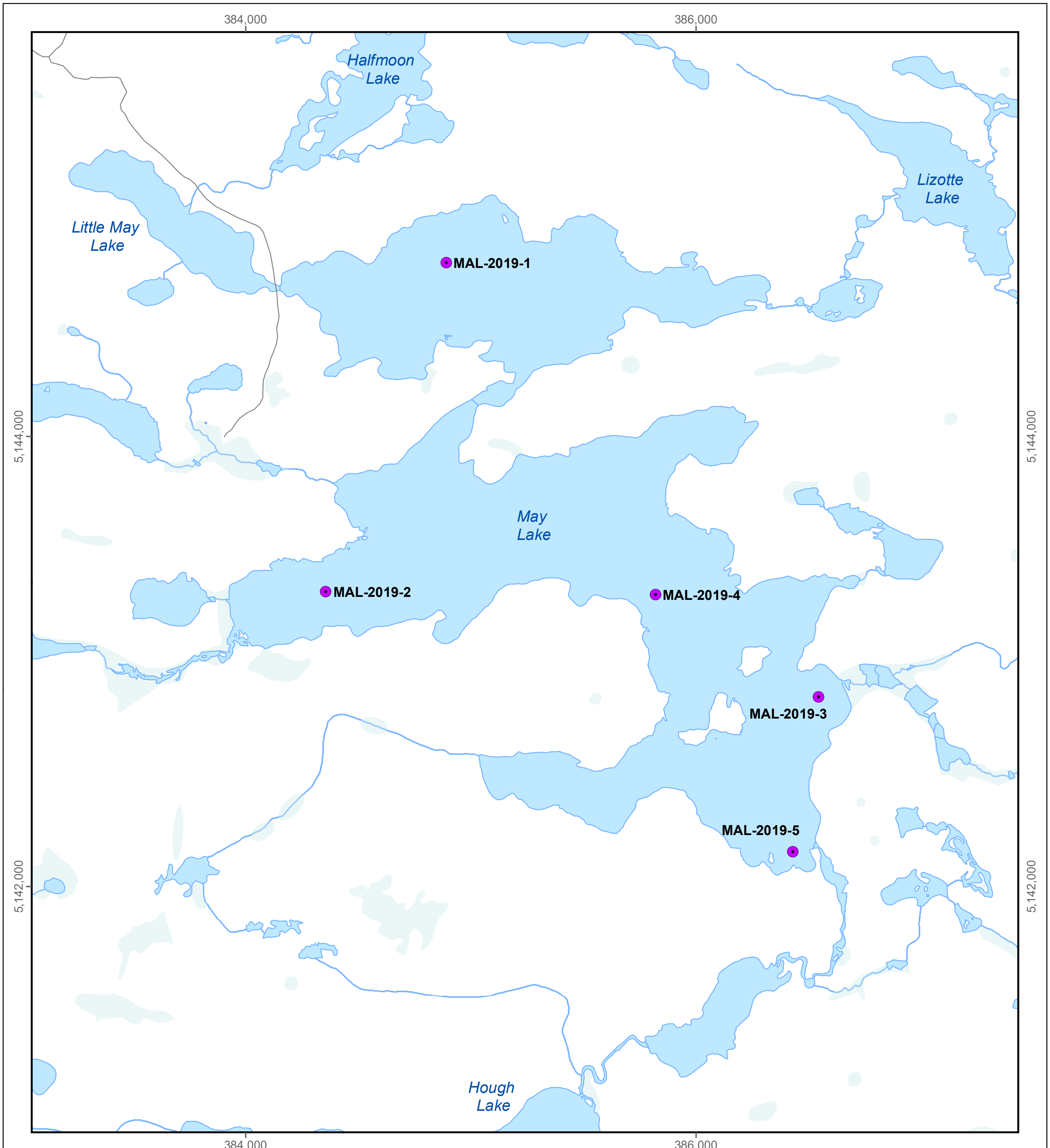
Figure T.4

Document Path: C:\Users\MLaPalme\Trinity Consultants, Inc\BHP - 197202.0041 - Cycle 5 SOE\4 - GIS\Cycle 5 Report\19-41 Figure T.4 SRWMP Sediment Quality and BI Sampling Locations, in Ten Mile Lake.mxd



LEGEND

Mine-exposed Sediment Quality and Benthic Invertebrate Community Sampling Location

SRWMP Sediment Quality and Benthic Invertebrate Community Sampling Locations in May Lake

0 0.5 1 2
Kilometers

Map Projection: UTM Zone 17 U NAD 1983
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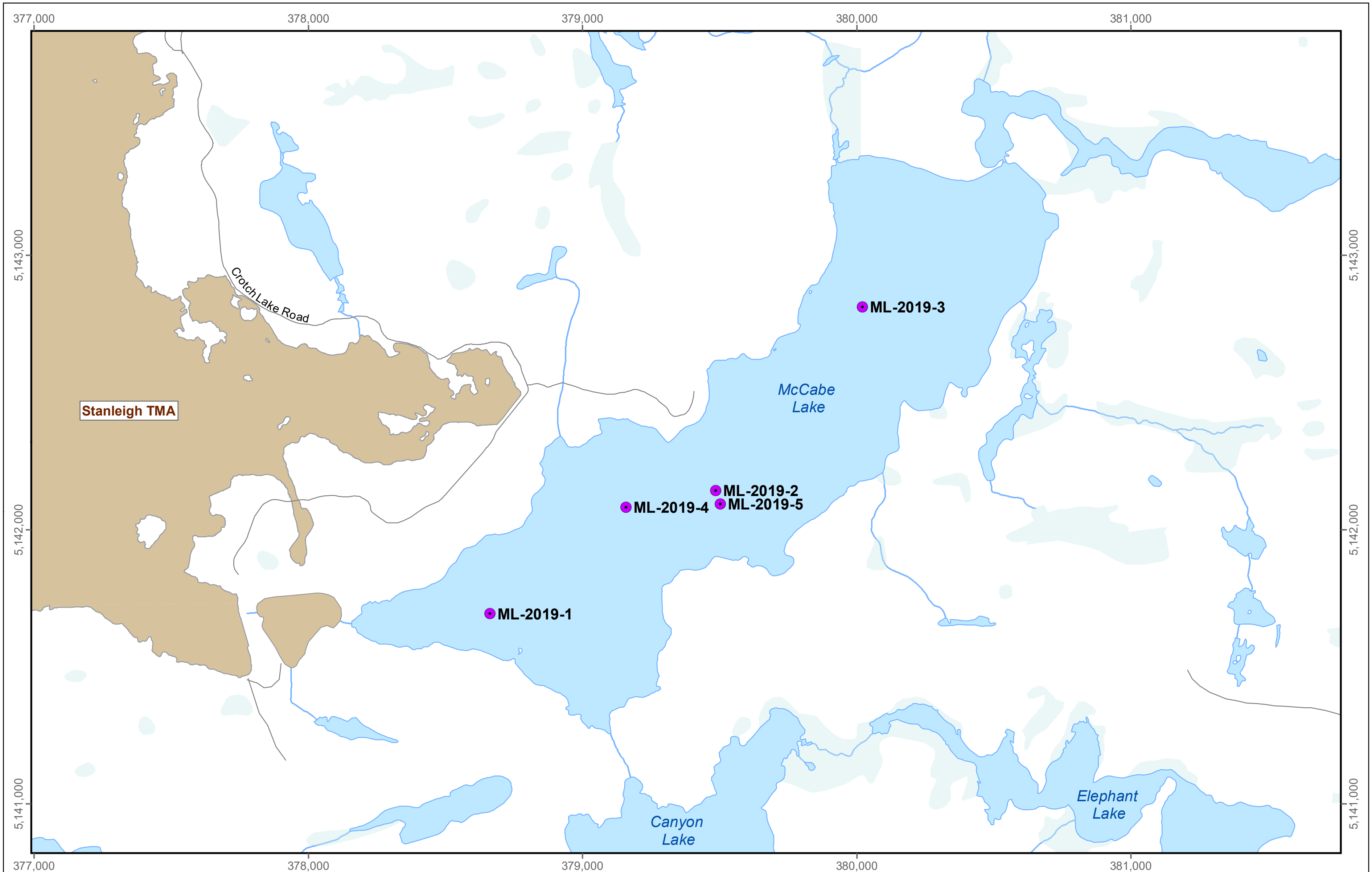
Figure T.5

Document Path: C:\Users\MLaPalme\Trinity Consultants, Inc\BHP - 197202.0041 - Cycle 5 SOE\4 - GIS\Cycle 5 Report\19-41 Figure T.5 SRWMP Sediment Quality and BI in May Lake.mxd



LEGEND

● Mine-exposed Sediment Quality and Benthic Invertebrate Community Sampling Location

0 0.25 0.5 1
Kilometers

N W E S

Map Projection: UTM Zone 17 U NAD 1983
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SRWMP Sediment Quality and Benthic Invertebrate Community Sampling Locations in McCabe Lake

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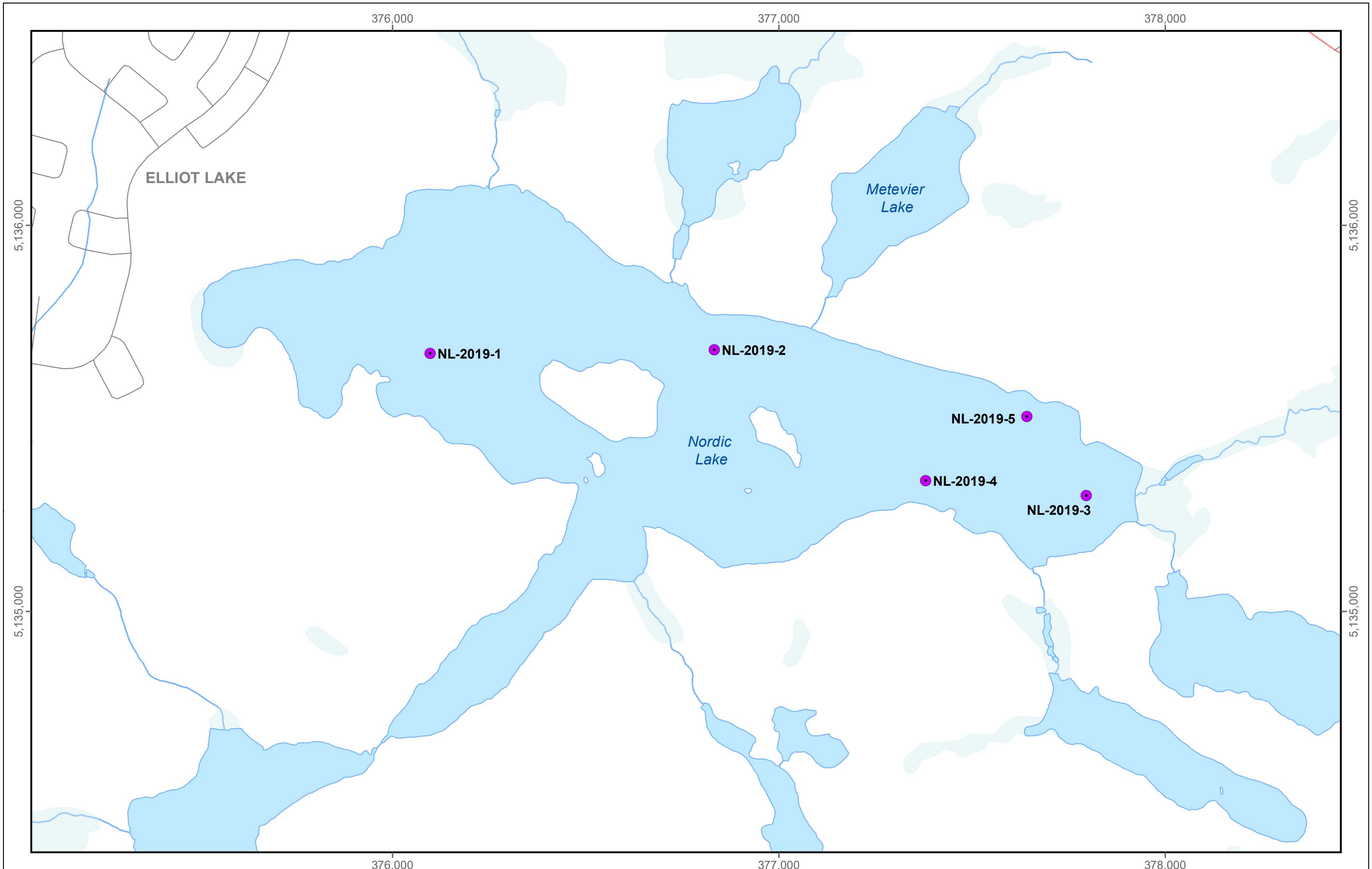
Figure T.6

Document Path: C:\Users\MLaPalme\Trinity Consultants, Inc\BHP - 197202.0041 - Cycle 5 SOE\4 - GIS\Cycle 5 Report\19-41 Figure T.6 SRWMP Sediment Quality and BI Sampling Locations, in McCabe Lake.mxd



LEGEND

Mine-exposed Sediment Quality and Benthic Invertebrate Community Sampling Location

0 150 300 600
Meters

N S W E

Map Projection: UTM Zone 17 U NAD 1983
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SRWMP Sediment Quality and Benthic Invertebrate Community Sampling Locations in Nordic Lake

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Figure T.7

Document Path: C:\Users\MLaPalme\Trinity Consultants, Inc\BHP - 197202.0041 - Cycle 5 SOE\4 - GIS\Cycle 5 Report\19-41 Figure T.7 SRWMP Sediment Quality and BI Sampling Locations, Nordic Lake.mxd

LEGEND

Mine-exposed Sediment Quality and Benthic Invertebrate Community Sampling Location

SRWMP Sediment Quality and Benthic Invertebrate Community Sampling Locations in Quirke Lake

0 1 2 4
Kilometers

Map Projection: UTM Zone 17 U NAD 1983

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Date: February 2021
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Figure T.8

Document Path: C:\Users\MLaPalme\Trinity Consultants, Inc\BHP - 197202.0041 - Cycle 5 SOE\4 - GIS\Cycle 5 Report\19-41 Figure T.8 SRWMP Sediment Quality and BI in Quirke Lake.mxd

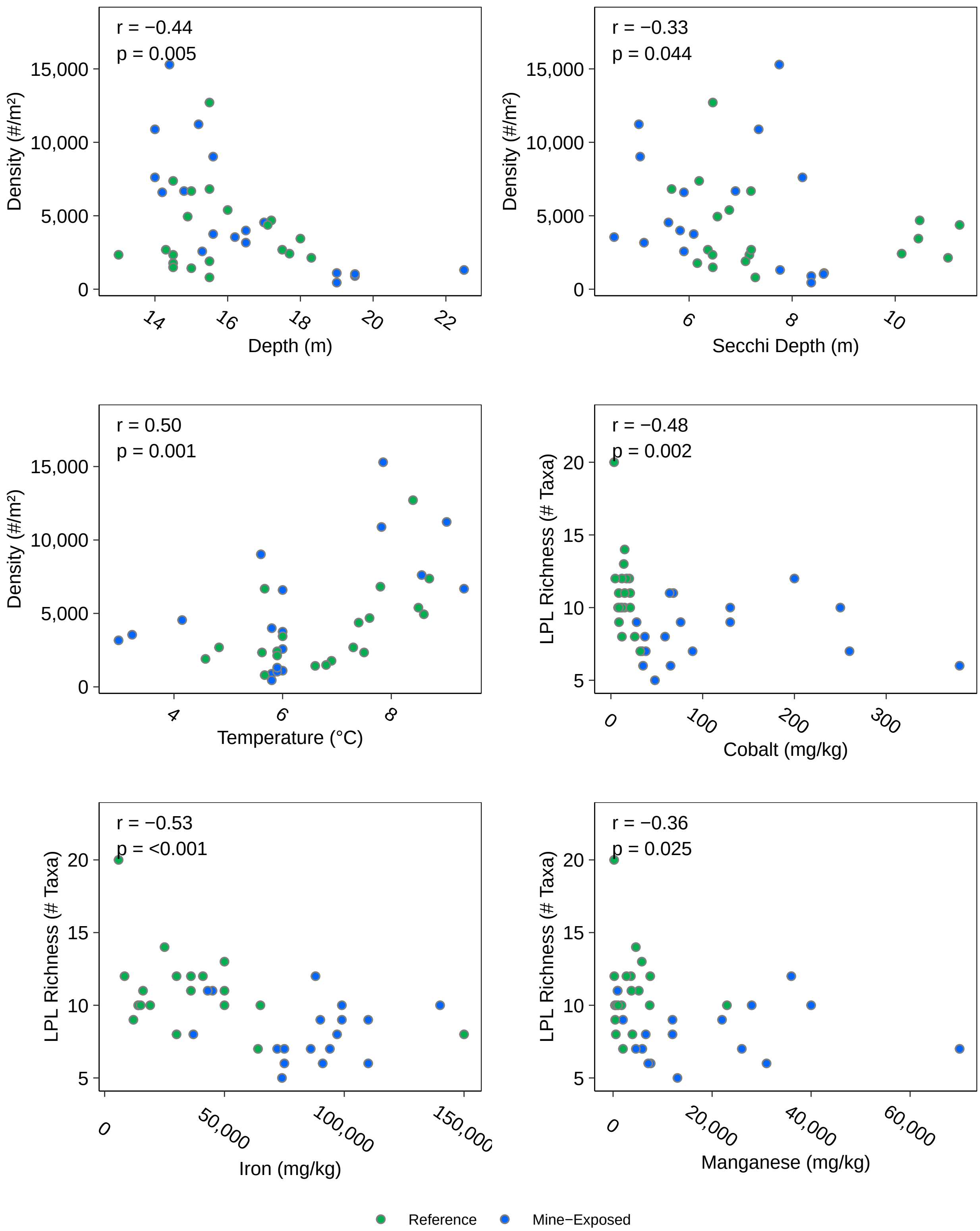

Figure T.9: Correlation between Benthic Invertebrate Community Endpoints and Habitat Parameters

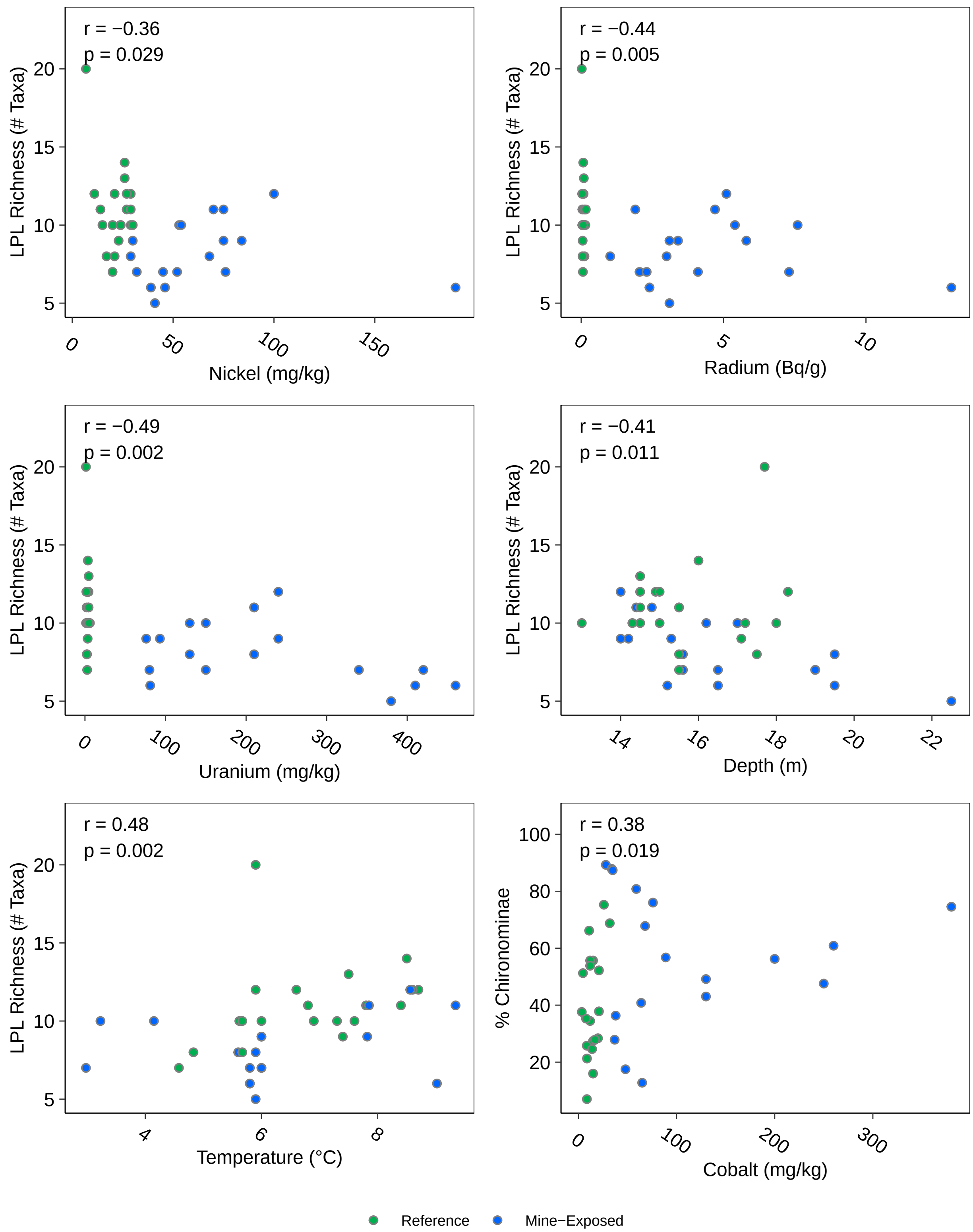

Figure T.9: Correlation between Benthic Invertebrate Community Endpoints and Habitat Parameters

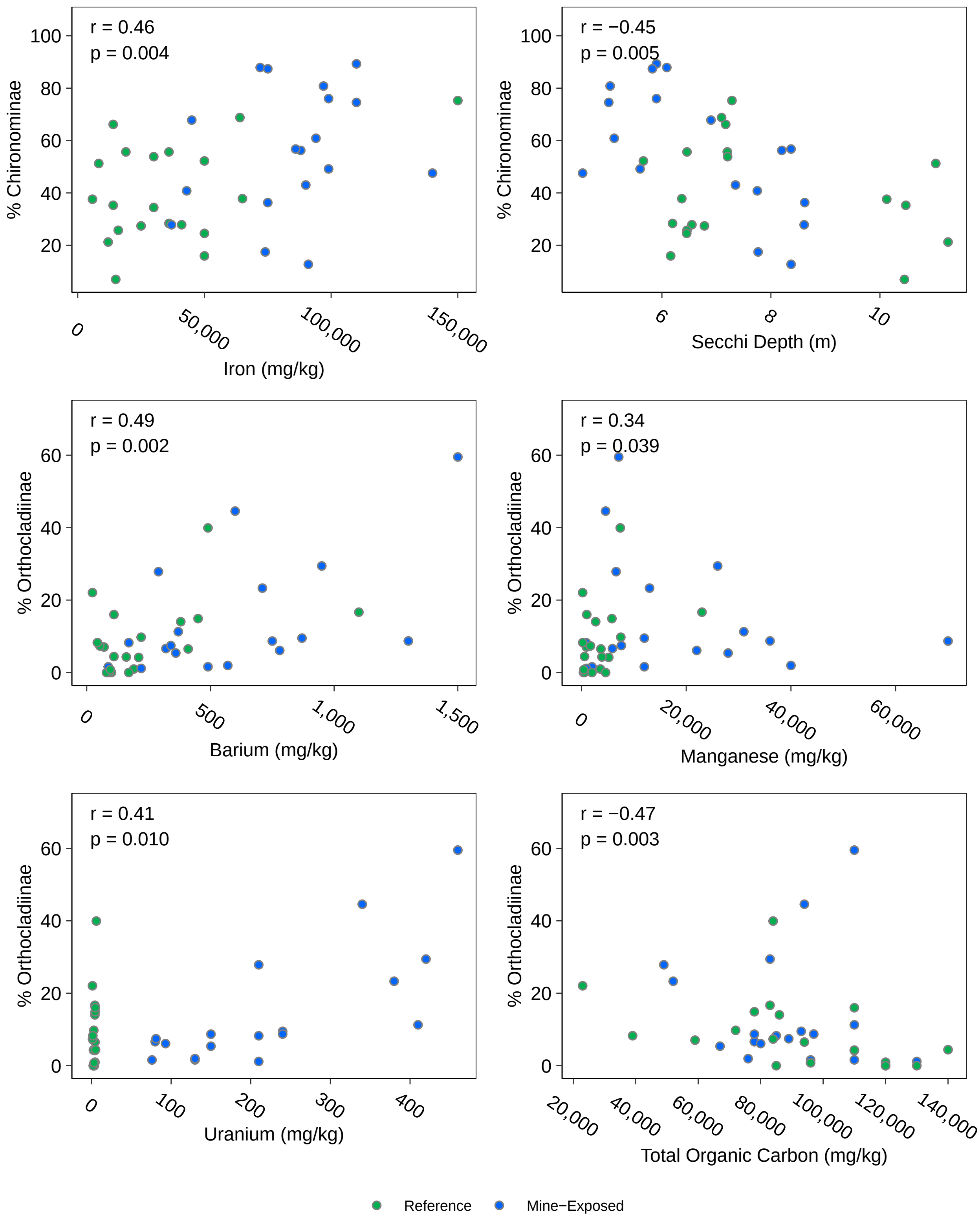

Figure T.9: Correlation between Benthic Invertebrate Community Endpoints and Habitat Parameters

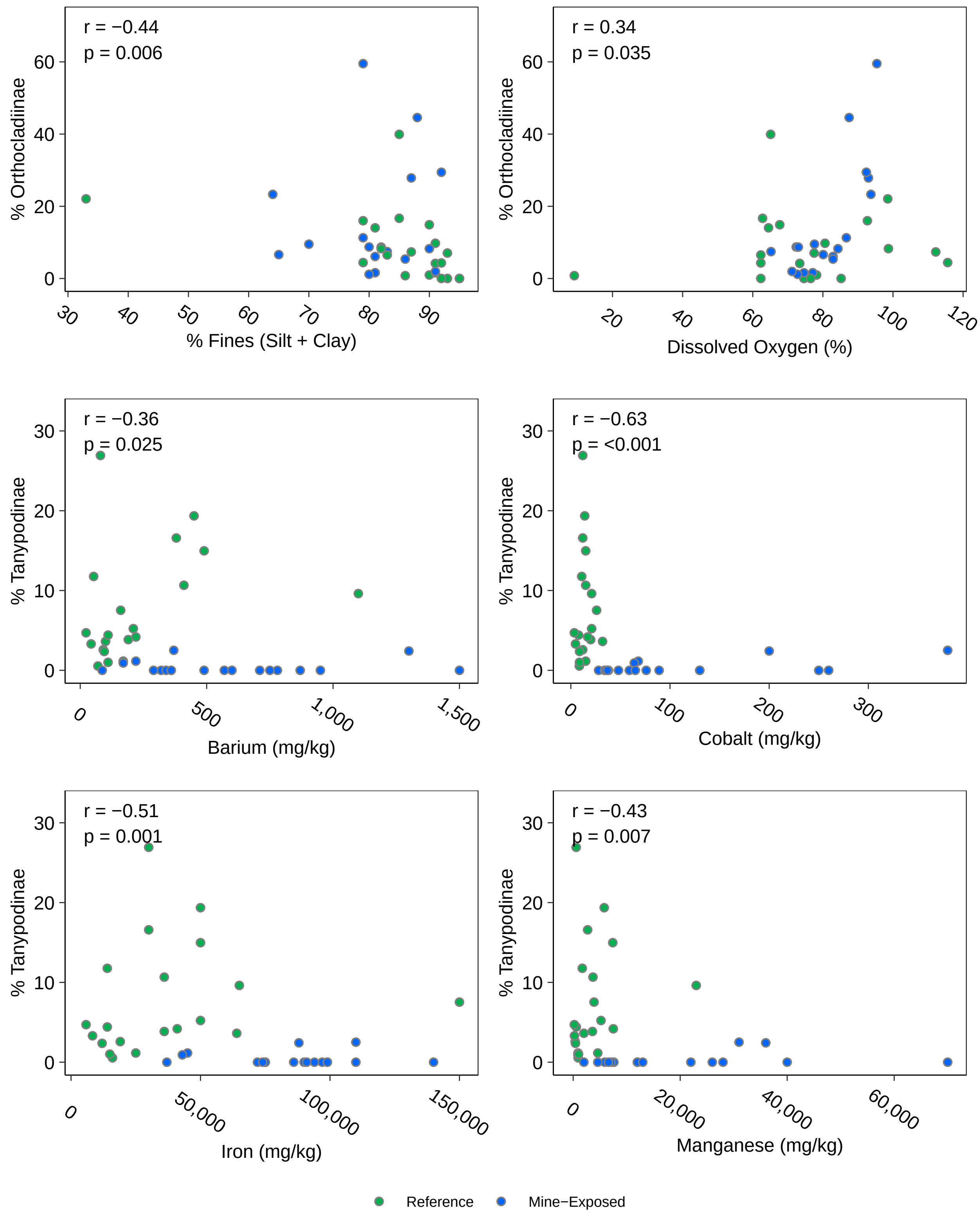

Figure T.9: Correlation between Benthic Invertebrate Community Endpoints and Habitat Parameters

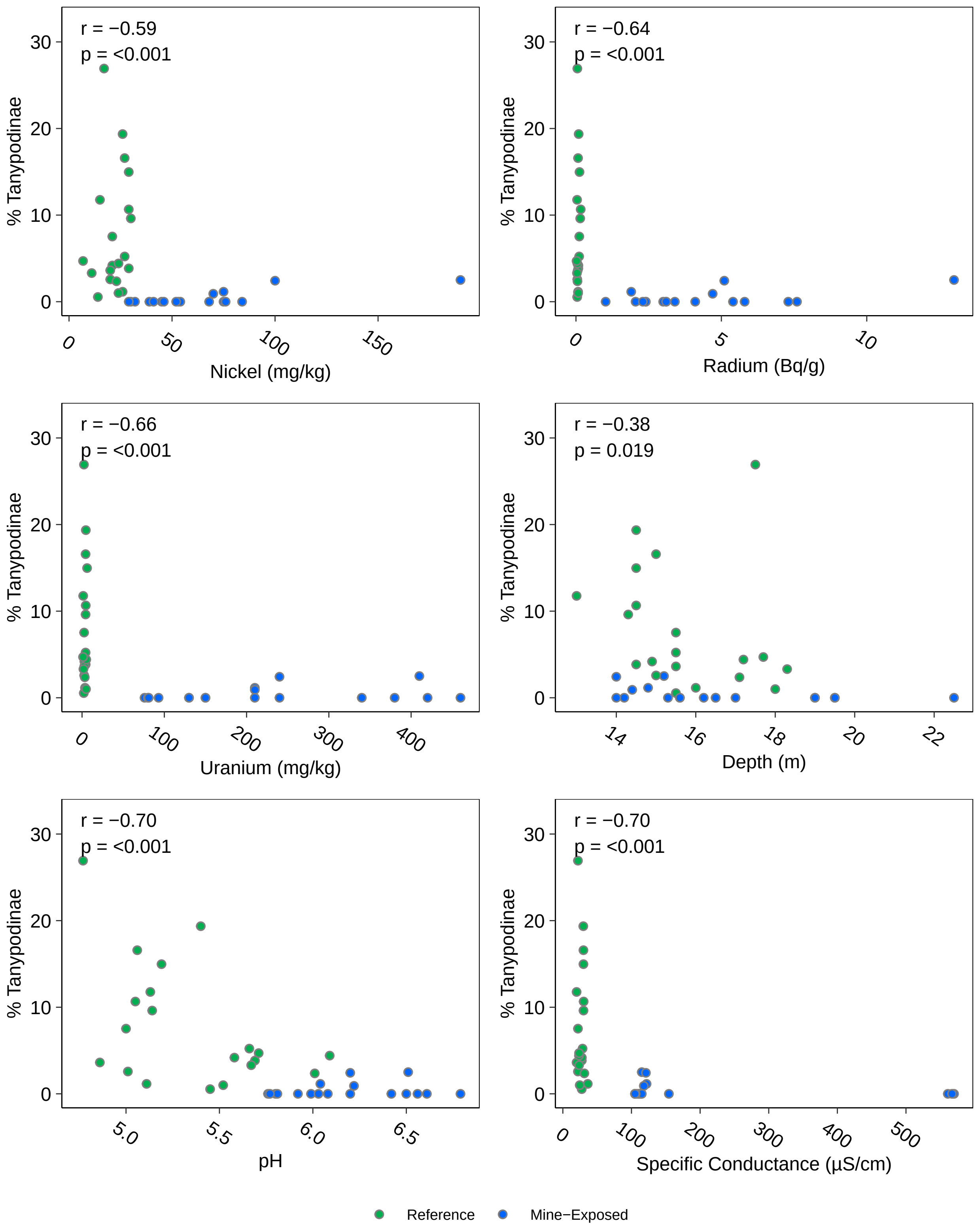

Figure T.9: Correlation between Benthic Invertebrate Community Endpoints and Habitat Parameters

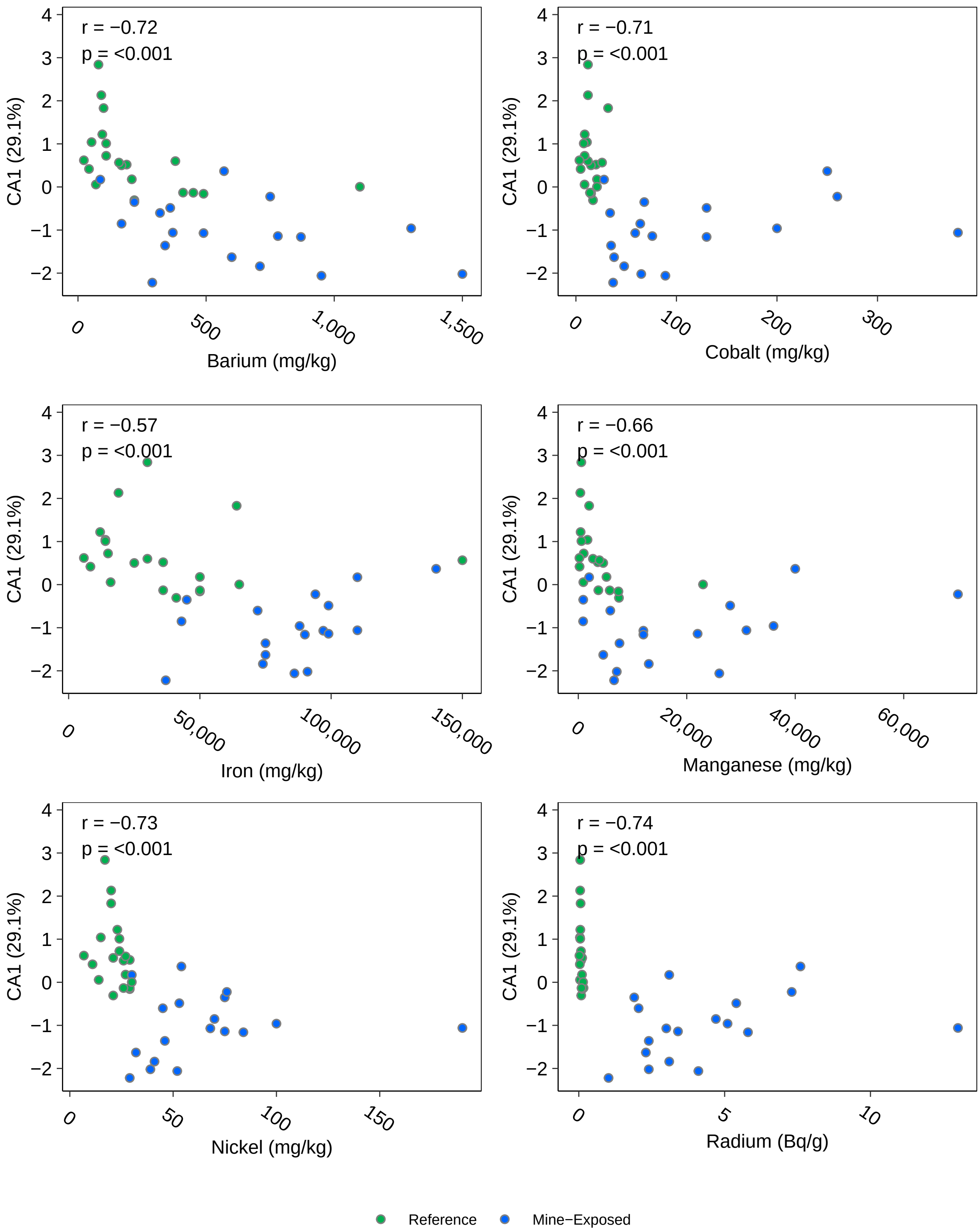

Figure T.9: Correlation between Benthic Invertebrate Community Endpoints and Habitat Parameters

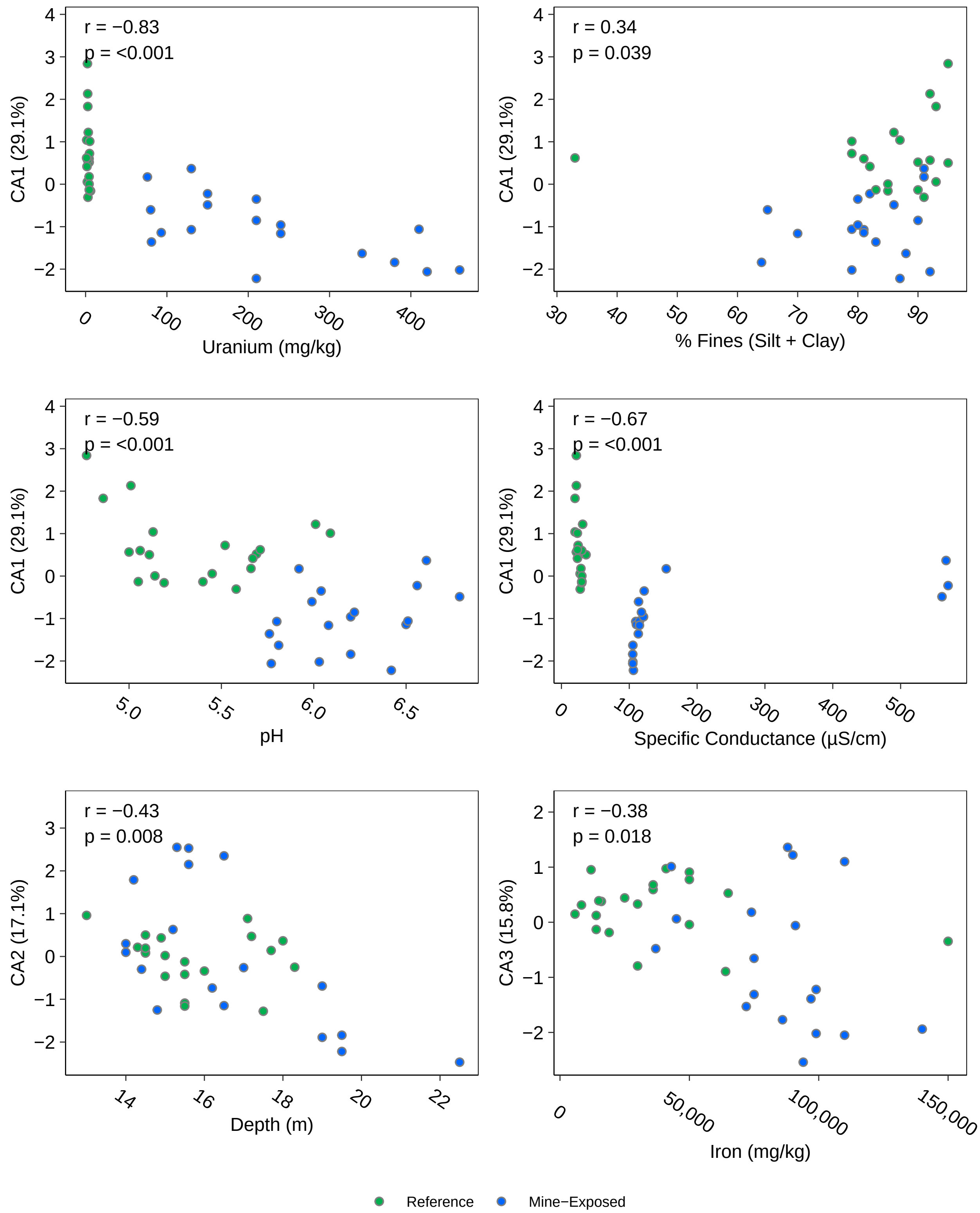

Figure T.9: Correlation between Benthic Invertebrate Community Endpoints and Habitat Parameters

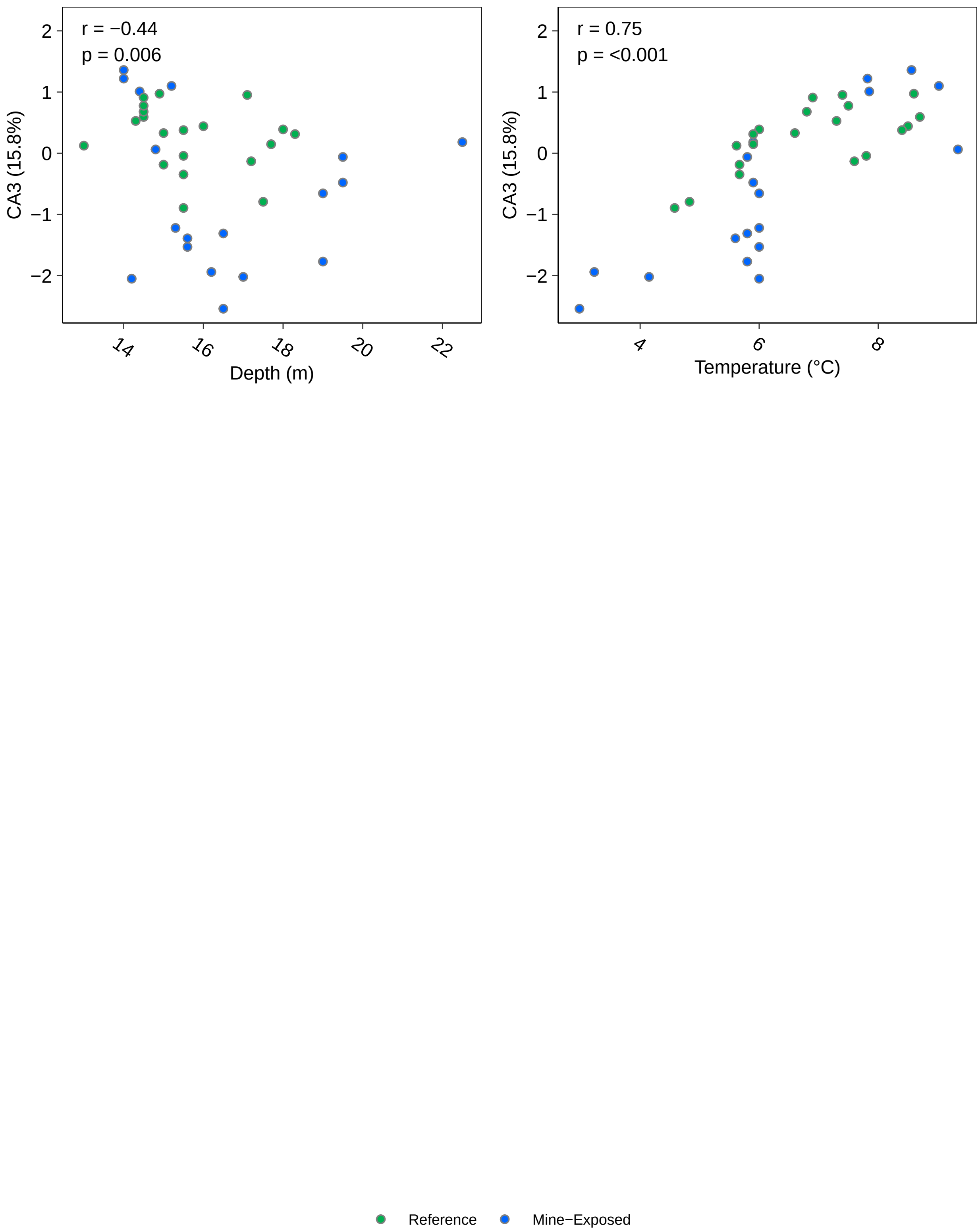

Figure T.9: Correlation between Benthic Invertebrate Community Endpoints and Habitat Parameters

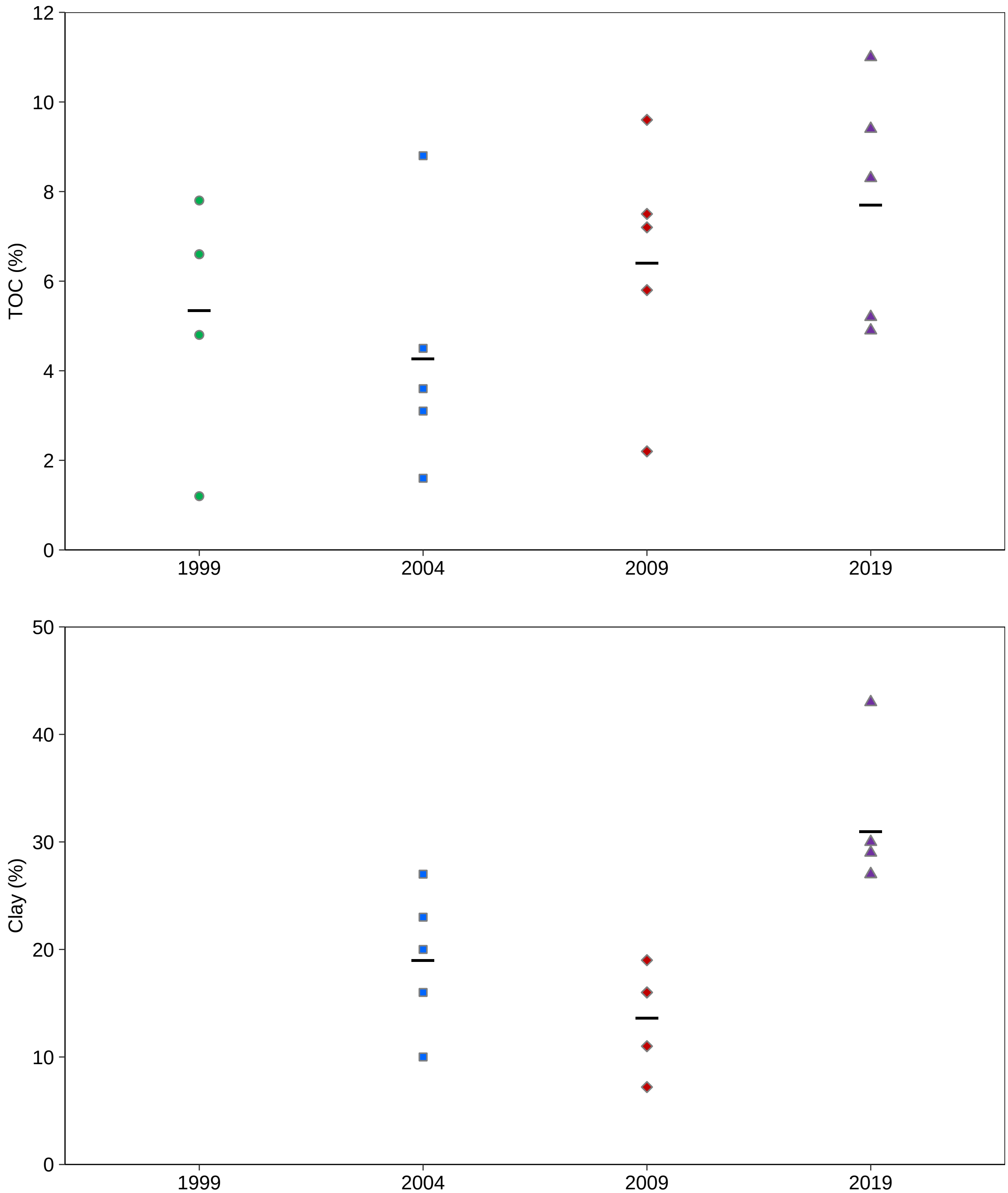

Figure T.10: Total Organic Carbon (%) and Clay (%) in Quirke Lake Sediment Samples, for 1999 (Cycle 1), 2004 (Cycle 2), 2009 (Cycle 3) and 2019 (Cycle 5), SRWMP

Note: The black dash represents the yearly mean. Clay data were not collected in 1999.

Table T.1: Sediment Quality and Benthic Invertebrate Community Sampling Locations, SRWMP, September 2019

Lake Type	Lake	Station ID	UTM Zone 17	
			Easting	Northing
Reference	Dunlop Lake (DL)	DUL-2019-1	364300	5150897
		DUL-2019-2	365441	5150867
		DUL-2019-3	367859	5150805
		DUL-2019-4	368751	5149613
		DUL-2019-5	372231	5149642
	Semiwite Lake (SL)	SL-2019-1	371505	5159958
		SL-2019-2	371659	5158814
		SL-2019-3	370832	5159540
		SL-2019-4	372503	5159406
		SL-2019-5	371917	5159377
	Summers Lake (SUL)	SUL-2019-1	365726	5146194
		SUL-2019-2	365068	5146614
		SUL-2019-3	365543	5147241
		SUL-2019-4	364872	5147338
		SUL-2019-5	365065	5146975
	Ten Mile Lake (TML)	TML-2019-1	364205	5152822
		TML-2019-2	363615	5151602
		TML-2019-3	364966	5152432
		TML-2019-4	360651	5153825
		TML-2019-5	365447	5152979
Mine-exposed	May Lake (MAL)	MAL-2019-1	384891	5144773
		MAL-2019-2	384357	5143310
		MAL-2019-3	386545	5142843
		MAL-2019-4	385820	5143297
		MAL-2019-5	386430	5142155
	McCabe Lake (ML)	ML-2019-1	378663	5141695
		ML-2019-2	379486	5142144
		ML-2019-3	380020	5142813
		ML-2019-4	379158	5142083
		ML-2019-5	379502	5142095
	Quirke Lake (QL)	QL-2019-1	378184	5151261
		QL-2019-2	381098	5150983
		QL-2019-3	383882	5149515
		QL-2019-4	378194	5148792
		QL-2019-5	380595	5148765
	Nordic Lake (NL)	NL-2019-1	376097	5135668
		NL-2019-2	376832	5135678
		NL-2019-3	377795	5135301
		NL-2019-4	377379	5135339
		NL-2019-5	377641	5135505

Table T.2: Sediment Quality Benchmarks, SRWMP Cycle 5

Parameter	Units	Upper Limit of Background[a] (Reference Lakes 2019)	PSQG[b] (1993)		Thompson et al. (2005)		Lake-specific Dose-based Radium-226 Benchmark (EcoMetrix 2019)			
			LEL[c]	SEL[d]	LEL[c]	SEL[d]	McCabe	May	Quirke	Nordic
Barium	mg/kg	795	-	-	-	-	-	-	-	-
Cobalt	mg/kg	29.0	-	-	-	-	-	-	-	-
Iron	mg/kg	108,000	20,000	40,000	-	-	-	-	-	-
Manganese	mg/kg	15,200	460	1,100	-	-	-	-	-	-
Nickel	mg/kg	29.5	-	-	23.4	484.0	-	-	-	-
Uranium	mg/kg	5.60	-	-	104.4	5,874.1	-	-	-	-
Radium-226	Bq/g	0.154	-	-	0.60	14.40	46.4	9.56	20.6	39.8

Highlighting indicates benchmarks used for screening, see Table 2.11. The Provincial Sediment Quality Guidelines (PSQGs; OMOE 1993) are not used, as they are lower than the upper limit of background. For nickel, the Thompson et al. (2005) LEL is less than the upper limit of background, therefore not used for assessment. For uranium and radium-226, the upper limit of background is less than Thompson et al. (2005) LEL, and therefore are not used for assessment.

[a] The upper limit of background is estimated as upper 95th percentile of values collected across all reference area replicates (see Section 2.2.3).

[b] Ontario Provincial Sediment Quality Guidelines (OMOE 1993).

[c] Lowest effect level.

[d] Severe effect level.

Table T.3: Sediment Particle Size, Moisture Content, and Total Organic Carbon, Radium-226, and Metal Concentrations of Sediment from Reference Lakes, SRWMP, September 2019

Analyte	Units	Upper Limit of Background[a] (Reference Lakes 2019)	Thompson et al. (2005)[a]		Lake-specific Dose-based Radium-226 Benchmark[a] EcoMetrix (2019)				Reference																	
									Dunlop Lake									Semiwite Lake								
			LEL	SEL	May	McCabe	Nordic	Quirke	DUL-1	DUL-2	DUL-3	DUL-4	DUL-5	Mean	Std Dev	Min	Max	SL-1	SL-2	SL-3	SL-4	SL-5	Mean	Std Dev	Min	Max
									24-Sep-19	24-Sep-19	24-Sep-19	24-Sep-19	19-Sep-19					25-Sep-19	25-Sep-19	25-Sep-19	25-Sep-19	25-Sep-19				
Physical Tests																										
Moisture	%	-	-	-	-	-	-	-	90	85	84	81	89	86	3.7	81	90	87	88	88	88	85	87	1.3	85	88
Particle Size																										
% Gravel (>2mm)	%	-	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% Sand (2.0mm - 0.063mm)	%	-	-	-	-	-	-	-	10	5.5	8.9	6.5	8.9	8.0	1.9	5.5	10	16	17	15	19	9.5	15	3.6	9.5	19
% Silt (0.063mm - 4µm)	%	-	-	-	-	-	-	-	69	75	73	79	62	72	6.5	62	79	57	49	59	56	57	56	3.8	49	59
% Clay (<4µm)	%	-	-	-	-	-	-	-	21	20	18	14	29	20	5.5	14	29	28	34	26	25	33	29	4.1	25	34
Anions and Nutrients																										
Total Organic Carbon	mg/kg	-	-	-	-	-	-	-	120,000	85,000	72,000	59,000	110,000	89,200	25,528	59,000	120,000	84,000	94,000	83,000	86,000	78,000	85,000	5,831	78,000	94,000
Radionuclide																										
Radium-226	Bq/g	-	0.60	14.4	9.56	46.4	39.8	20.6	0.081	0.073	0.083	0.042	0.11	0.078	0.024	0.042	0.11	0.122	0.163	0.146	0.072	0.093	0.119	0.037	0.072	0.163
Metals																										
Barium	µg/g	795	-	-	-	-	-	-	190	170	220	70	210	172	60	70	220	490	410	1,100	380	450	566	301	380	1,100
Cobalt	µg/g	29	-	-	-	-	-	-	20	15	17	8.6	21	16	4.9	8.6	21	15	15	21	12	14	15	3.4	12	21
Iron	µg/g	108,000	-	-	-	-	-	-	36,000	25,000	41,000	16,000	50,000	33,600	13,353	16,000	50,000	50,000	36,000	65,000	30,000	50,000	46,200	13,682	30,000	65,000
Manganese	µg/g	15,200	-	-	-	-	-	-	3,600	4,600	7,500	930	5,200	4,366	2,396	930	7,500	7,400	3,700	23,000	2,700	5,800	8,520	8,298	2,700	23,000
Nickel	µg/g	29.5	-	484.0	-	-	-	-	29	26	21	14	27	23.4	6.0	14	29	29	29	30	27	26	28	1.6	26	30
Uranium	µg/g	-	104.4	5,874	-	-	-	-	4.4	3.6	2.9	2.1	4.3	3.46	0.97	2.1	4.4	6.1	4.5	4.3	4.3	4.6	4.8	0.76	4.3	6.1

Indicates value greater than the upper limit of background (for reference lakes, September 2019).
Indicates value greater than the Thompson et al. (2005) SEL.
Indicates value greater than the lake-specific dose-based benchmark (EcoMetrix 2019).
Notes: "-" indicates no data available or benchmark not applicable. Data plotted in Figure 8.2.
[a] See Table 2.11 and Appendix Table T.2.

Table T.3: Sediment Particle Size, Moisture Content, and Total Organic Carbon, Radium-226, and Metal Concentrations of Sediment from Reference Lakes, SRWMP, September 2019

Analyte	Units	Upper Limit of Background[a] (Reference Lakes 2019)	Thompson et al. (2005)[a]		Lake-specific Dose-based Radium-226 Benchmark[a] EcoMetrix (2019)				Reference																	
									Summers Lake									Ten Mile Lake								
			LEL	SEL	May	McCabe	Nordic	Quirke	SUL-1	SUL-2	SUL-3	SUL-4	SUL-5	Mean	Std Dev	Min	Max	TML-1	TML-2	TML-3	TML-4	TML-5	Mean	Std Dev	Min	Max
									22-Sep-19	24-Sep-19	24-Sep-19	24-Sep-19	24-Sep-19					20-Sep-19	21-Sep-19	20-Sep-19	21-Sep-19	20-Sep-19				
Physical Tests																										
Moisture	%	-	-	-	-	-	-	-	87	82	86	88	88	86	2.5	82	88	88	89	86	64	74	80	10.9	64	89
Particle Size																										
% Gravel (>2mm)	%	-	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0	0	0.64	0	0.31	0	0.19	0.29	0	0.64
% Sand (2.0mm - 0.063mm)	%	-	-	-	-	-	-	-	8.7	13	7.2	8.1	4.6	8.3	3.0	4.6	13	21	20	14	67	18	28.0	22	14.0	67
% Silt (0.063mm - 4µm)	%	-	-	-	-	-	-	-	66	66	60	66	69	65	3.3	60	69	51	49	58	26	66	50	15	26	66
% Clay (<4µm)	%	-	-	-	-	-	-	-	26	21	33	26	26	26	4.3	21	33	28	30	28	7	16	22	10	7	30
Anions and Nutrients																										
Total Organic Carbon	%	-	-	-	-	-	-	-	110,000	84,000	120,000	130,000	120,000	112,800	17,584	84,000	130,000	140,000	110,000	96,000	23,000	39,000	81,600	49,176	23,000	140,000
Radionuclide																										
Radium-226	Bq/g	-	0.60	14.4	9.56	46.4	39.8	20.6	0.115	0.039	0.061	0.046	0.048	0.062	0.031	0.039	0.115	0.048	0.074	0.052	0.021	0.035	0.046	0.020	0.021	0.074
Metals																										
Barium	µg/g	795	-	-	-	-	-	-	160	53	100	91	80	96.8	39	53	160	110	110	95	23	43	76	41	23	110
Cobalt	µg/g	29	-	-	-	-	-	-	26	11	32	12	12	19	9.7	11	32	7.8	8.7	8.8	3.5	4.7	6.7	2.4	3.5	8.8
Iron	µg/g	108,000	-	-	-	-	-	-	150,000	14,000	64,000	19,000	30,000	55,400	56,363	14,000	150,000	14,000	15,000	12,000	5,800	8,300	11,020	3,884	5,800	15,000
Manganese	µg/g	15,200	-	-	-	-	-	-	3,900	1,700	2,000	380	560	1,708	1,412	380	3,900	580	1,000	430	210	240	492	321	210	1,000
Nickel	µg/g	29.5	-	484.0	-	-	-	-	21	15	20	20	17	19	2.5	15	21	24	24	23	6.8	11	18	8.2	6.8	24
Uranium	µg/g	-	104.4	5,874	-	-	-	-	2.5	1.4	2.7	2.6	2.3	2.3	0.52	1.4	2.7	5.1	4.8	3.3	1.2	1.7	3.2	1.8	1.2	5.1

Indicates value greater than the upper limit of background (for reference lakes, September 2019).
Indicates value greater than the Thompson et al. (2005) SEL.
Indicates value greater than the lake-specific dose-based benchmark (EcoMetrix 2019).

Notes: "-" indicates no data available or benchmark not applicable. Data plotted in Figure 8.2.

[a] See Table 2.11 and Appendix Table T.2.

Table T.4: Sediment Particle Size, Moisture Content, and Total Organic Carbon, Radium-226, and Metal Concentrations of Sediment from Mine-exposed Lakes, SRWMP, September 2019

Analyte	Units	Upper Limit of Background[a] (Reference Lakes 2019)	Thompson et al. (2005)[a]		Lake-specific Dose-based Radium-226 Benchmark[a] EcoMetrix (2019)				Mine-Exposed																	
									May Lake									McCabe Lake								
			LEL	SEL	May	McCabe	Nordic	Quirke	MAL-01	MAL-02	MAL-03	MAL-04	MAL-05	Mean	Std Dev	Min	Max	ML-01	ML-02	ML-03	ML-04	ML-05	Mean	Std Dev	Min	Max
									22-Sep-19	22-Sep-19	22-Sep-19	22-Sep-19	22-Sep-19					25-Sep-19	18-Sep-19	18-Sep-19	25-Sep-19	25-Sep-19				
Physical Tests																										
Moisture	%	-	-	-	-	-	-	-	85	87	80	85	83	84	2.6	80	87	90	87	90	87	85	88	2.2	85	90
Particle Size																										
% Gravel (>2mm)	%	-	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% Sand (2.0mm - 0.063mm)	%	-	-	-	-	-	-	-	8.7	18	35	17	19	20	9.6	8.7	35	21	31	20	20	11	21	7.1	11	31
% Silt (0.063mm - 4µm)	%	-	-	-	-	-	-	-	66	53	46	56	60	56	7.5	46	66	51	53	44	62	67	55	9.1	44	67
% Clay (<4µm)	%	-	-	-	-	-	-	-	25	28	19	27	21	24	3.9	19	28	28	17	36	18	23	24	7.8	17	36
Anions and Nutrients																										
Total Organic Carbon	mg/kg	-	-	-	-	-	-	-	96,000	110,000	78,000	89,000	80,000	90,600	13,031	78,000	110,000	96,000	110,000	78,000	89,000	80,000	90,600	13,031	78,000	110,000
Radionuclide																										
Radium-226	Bq/g	-	0.60	14.4	9.56	46.4	39.8	20.6	3.10	3.00	2.05	2.40	3.40	2.79	0.55	2.05	3.40	13.0	5.80	1.90	5.10	4.70	6.10	4.13	1.90	13.0
Metals																										
Barium	µg/g	795	-	-	-	-	-	-	87	490	320	340	780	403	255	87	780	370	870	220	1,300	170	586	486	170	1300
Cobalt	µg/g	29	-	-	-	-	-	-	28	59	34	35	76	46	20	28	76	380	130	68	200	64	168	131	64	380
Iron	µg/g	108,000	-	-	-	-	-	-	110,000	97,000	72,000	75,000	99,000	90,600	16,410	72,000	110,000	110,000	90,000	45,000	88,000	43,000	75,200	29,761	43,000	110,000
Manganese	µg/g	15,200	-	-	-	-	-	-	2,000	12,000	5,900	7,600	22,000	9,900	7,657	2,000	22,000	31,000	12,000	910	36,000	890	16,160	16,560	890	36,000
Nickel	µg/g	29.5	-	484.0	-	-	-	-	30	68	45	46	75	53	18	30	75	190	84	75	100	70	104	50	70	190
Uranium	µg/g	-	104.4	5,874	-	-	-	-	76	130	80	81	93	92	22	76	130	410	240	210	240	210	262	84	210	410

Indicates value greater than the upper limit of background (for reference lakes, September 2019).
Indicates value greater than the Thompson et al. (2005) SEL.
Indicates value greater than the lake-specific dose-based benchmark (EcoMetrix 2019).

Notes: "-" indicates no data available or benchmark not applicable. Data plotted in Figure 8.2.

[a] See Table 2.11 and Appendix Table T.2.

Table T.4: **Sediment Particle Size, Moisture Content, and Total Organic Carbon, Radium-226, and Metal Concentrations of Sediment from Mine-exposed Lakes, SRWMP, September 2019**

Analyte	Units	Upper Limit of Background[a] (Reference Lakes 2019)	Thompson et al. (2005)[a]		Lake-specific Dose-based Radium-226 Benchmark[a] EcoMetrix (2019)				Mine-Exposed																	
									Nordic Lake									Quirke Lake								
			LEL	SEL	May	McCabe	Nordic	Quirke	NL-01	NL-02	NL-03	NL-04	NL-05	Mean	Std Dev	Min	Max	QL-01	QL-02	QL-03	QL-04	QL-05	Mean	Std Dev	Min	Max
									23-Sep-19	23-Sep-19	23-Sep-19	23-Sep-19	23-Sep-19					19-Sep-19	23-Sep-19	23-Sep-19	19-Sep-19	23-Sep-19				
Physical Tests																										
Moisture	%	-	-	-	-	-	-	-	85	84	80	83	83	83	1.9	80	85	87	84	81	85	82	84	2.4	81	87
Particle Size																										
% Gravel (>2mm)	%	-	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% Sand (2.0mm - 0.063mm)	%	-	-	-	-	-	-	-	6.2	17	14	14	8.4	12	4.5	6.2	17	20	11	13	8.6	36	18	11	8.6	36
% Silt (0.063mm - 4µm)	%	-	-	-	-	-	-	-	76	52	57	55	60	60	9.4	52	76	52	59	60	49	34	51	10	34	60
% Clay (<4µm)	%	-	-	-	-	-	-	-	17	30	29	31	31	28	6.0	17	31	27	29	27	43	30	31	6.7	27	43
Anions and Nutrients																										
Total Organic Carbon	mg/kg	-	-	-	-	-	-	-	87,000	78,000	72,000	67,000	76,000	76,000	7,450	67,000	87,000	110,000	94,000	49,000	83,000	52,000	77,600	26,557	49,000	110,000
Radionuclide																										
Radium-226	Bq/g	-	0.60	14.4	9.56	46.4	39.8	20.6	2.04	7.30	4.50	5.40	7.60	5.37	2.27	2.04	7.60	2.40	2.30	1.02	4.10	3.10	2.58	1.13	1.02	4.10
Metals																										
Barium	µg/g	795	-	-	-	-	-	-	140	750	390	360	570	442	230	140	750	1,500	600	290	950	710	810	453	290	1,500
Cobalt	µg/g	29	-	-	-	-	-	-	26	260	120	130	250	157	98	26	260	65	38	37	89	48	55.4	21.9	37	89
Iron	µg/g	108,000	-	-	-	-	-	-	52,000	94,000	83,000	99,000	140,000	93,600	31,722	52,000	140,000	91,000	75,000	37,000	86,000	74,000	72,600	21,173	37,000	91,000
Manganese	µg/g	15,200	-	-	-	-	-	-	580	70,000	18,000	28,000	40,000	31,316	26,004	580	70,000	7,100	4,600	6,600	26,000	13,000	11,460	8,710	4,600	26,000
Nickel	µg/g	29.5	-	484.0	-	-	-	-	38	76	36	53	54	51	16	36	76	39	32	29	52	41	39	9.0	29	52
Uranium	µg/g	-	104.4	5,874	-	-	-	-	82	150	88	150	130	120	33	82	150	460	340	210	420	380	362.0	96.0	210	460

Indicates value greater than the upper limit of background (for reference lakes, September 2019).
Indicates value greater than the Thompson et al. (2005) SEL.
Indicates value greater than the lake-specific dose-based benchmark (EcoMetrix 2019).

Notes: "-" indicates no data available or benchmark not applicable. Data plotted in Figure 8.2.

[a] See Table 2.11 and Appendix Table T.2.

Table T.5: Benthic Invertebrate Community Density (organisms per m^2), SRWMP, September 2019

Order	Family	Subfamily	Taxa	Reference									
				Dunlop Lake (DUL)					Ten Mile Lake (TML)				
				1	2	3	4	5	1	2	3	4	5
Amphipoda	Crangonyx	-	*Crangonyx*	0	0	0	0	0	0	0	0	0	0
	Hyalella	-	*Hyalella*	0	0	0	0	0	0	0	0	0	0
	Diporeia	-	*Diporeia*	0	0	0	0	0	0	0	0	0	0
Coleoptera	Optioservus	Elminae	*Optioservus*	0	0	0	0	0	0	0	0	0	0
Diptera	Bezzia	Ceratopogoninae	*Bezzia*	0	0	0	0	0	0	0	0	0	0
			Mallochohelea	0	0	0	0	0	0	0	0	0	0
			Probezzia	0	0	0	0	0	0	0	0	0	0
			Sphaeromias	0	0	0	0	0	0	0	0	0	0
	Chaoborus flavicans	Chaoborinae	*Chaoborus flavicans*	0	0	0	0	0	0	0	0	0	0
			Chaoborus punctipennis	0	0	0	0	0	0	0	0	0	0
	Chironomus	Chironominae	*Chironomus*	0	35.4	0	34.4	0	68.9	68.9	0	96.3	565
			Cladopelma	0	0	0	0	0	0	0	0	0	0
			Cladotanytarsus	0	0	0	0	0	0	0	0	0	0
			Dicrotendipes	0	0	0	0	0	0	0	0	0	0
			Endochironomus	0	0	0	0	0	0	0	0	0	0
			Micropsectra	70.9	212	586	1,240	2,778	689	103	344	385	353
			Microtendipes	0	0	0	0	0	0	0	0	0	0
			Nilothauma	0	0	0	0	0	0	0	0	0	0
			Pagastiella	0	0	0	0	0	0	0	0	8.75	0
			Paracladopelma	0	0	0	0	0	0	0	0	0	0
			Paratanytarsus	0	0	0	0	0	0	0	0	0	0
			Polypedilum halterale	0	0	0	0	0	0	0	0	8.75	0
			Polypedilum scalaenum	0	0	0	0	0	0	0	0	0	0
			Sergentia	780	168	0	620	356	207	0	68.9	123	35.3
			Stempellina	0	0	0	0	0	0	0	0	0	0
			Stempellinella	0	0	0	0	0	0	0	0	0	0
			Stictochironomus	1,134	868	689	448	71.2	689	68.9	517	298	141
			Tanytarsus	106	195	103	930	356	0	0	0	0	0
			Tribelos	0	0	0	0	0	0	0	0	0	0
		Diamesinae	*Potthastia*	0	0	0	0	0	0	0	0	0	0
			Protanypus	0	35.4	34.4	0	0	0	0	0	43.8	70.6
		Orthocladiinae	*Cricotopus*	0	0	0	0	0	0	0	0	0	0
			Zalutschia	0	0	0	0	0	0	0	0	0	0
			Heterotanytarsus	0	0	0	0	0	0	0	0	0	0
			Heterotrissocladius	70.9	0	482	896	285	138	344	0	499	141
			Paracladius	0	0	0	0	0	68.9	207	34.4	35.0	35.3
			Parakiefferiella	0	0	0	0	0	0	0	0	0	0
			Psectrocladius	0	0	0	0	0	0	0	0	0	0
		Tanypodinae	*Ablabesmyia*	0	0	0	0	71.2	0	0	0	8.75	0
			Zavrelimyia	0	0	0	0	0	0	0	0	0	0
			Procladius	284	62.0	207	68.9	285	207	34.4	103	105	70.6
	Hemerodromia	Hemerodromiinae	*Hemerodromia*	0	0	0	0	0	0	0	0	0	0
Ephemeroptera	Caenis	Caeninae	*Caenis*	0	0	0	0	0	0	0	0	0	0
	Hexagenia	-	*Hexagenia*	0	0	34.4	0	0	0	0	0	0	0
	Stenonema femoratum	-	*Stenonema femoratum*	0	0	0	0	0	0	0	0	0	0
	Leptophlebiidae	-	*Leptophlebiidae*	0	0	0	0	0	0	0	0	0	0
Harpacticoida	-	-	*Harpacticoida*	413	258	34.4	310	482	1,584	1,412	1,722	267	68.9
Megaloptera	Sialis	-	*Sialis*	0	0	0	0	0	0	0	0	0	0
Mysida	Mysis	-	*Mysis*	0	0	0	0	0	0	0	0	0	0
Odonata	Argia moesta	-	*Argia moesta*	0	0	0	0	0	0	0	0	0	0
Trichoptera	Cheumatopsyche	Hydropsychinae	*Cheumatopsyche*	0	0	0	0	0	0	0	0	0	0
			Ceratopsyche morosa	0	0	0	0	0	0	0	0	0	0
			Ceratopsyche walkeri	0	0	0	0	0	0	0	0	0	0
	Ceraclea	Leptocerinae	*Ceraclea*	0	0	0	0	0	0	0	0	0	0
			Mystacides	0	0	0	0	0	0	0	0	0	0
			Oecetis	0	0	0	0	0	0	0	0	0	0
			Triaenodes	0	0	0	0	0	0	0	0	0	0
	Agrypnia	Phryganeinae	*Agrypnia*	0	8.61	17.2	0	68.9	0	0	0	0	0
			Fabria	0	0	0	0	0	0	0	0	0	0
Trombidiformes	Lebertia	-	*Lebertia*	0	8.61	0	0	0	0	0	0	0	0
	Oxus	-	*Oxus*	0	0	0	0	0	0	0	0	8.61	0
	Pionidae	-	Pionidae	34.4	8.61	0	0	0	0	34.4	0	8.61	0
	-	-	*Trombidiformes*	0	0	0	0	0	0	0	0	0	0
Tubificida	Ilyodrilus templetoni	Tubificinae	*Ilyodrilus templetoni*	0	0	0	0	0	0	0	0	0	0
			Limnodrilus hoffmeisteri	0	0	0	0	0	0	0	0	0	0
			Limnodrilus udekemianus	34.4	0	0	0	0	0	0	0	0	0
		Naidinae	*Nais variabilis*	0	0	0	0	0	0	0	0	0	0
		Rhyacodrilinae	*Rhyacodrilus montana*	0	0	0	0	0	0	0	0	8.61	0
		Naidinae	*Slavina appendiculata*	0	0	0	0	0	0	0	0	0	0
		Tubificinae	*Tubifex tubifex*	0	0	0	0	0	0	0	0	0	0
Veneroida	Pisidium	-	*Pisidium*	1,137	663	207	2,721	620	0	0	34.4	8.61	34.4
		-	*Sphaerium nitidum*	0	0	0	0	0	0	0	0	0	0
-	-	-	*Arachnida*	0	0	0	0	0	0	0	0	8.61	0
-	-	-	Nematoda	68.9	94.7	138	758	0	68.9	172	276	146	276
-	-	-	Ostracoda	3,238	2,773	2,411	4,684	1,447	964	999	1,274	336	344
-	-	-	Tubificinae	0	0	0	0	0	0	0	0	17.2	0

Table T.5: Benthic Invertebrate Community Density (organisms per m^2), SRWMP, September 2019

Order	Family	Subfamily	Taxa	Reference									
				Semiwite Lake (SL)					Summer Lake (SUL)				
				1	2	3	4	5	1	2	3	4	5
Amphipoda	Crangonyx	-	*Crangonyx*	0	0	0	0	0	0	0	0	0	0
	Hyalella	-	*Hyalella*	0	0	0	0	0	0	0	0	0	0
	Diporeia	-	*Diporeia*	0	0	0	0	0	0	0	0	0	0
Coleoptera	Optioservus	Elminae	*Optioservus*	0	0	0	0	0	0	0	0	0	0
Diptera	Bezzia	Ceratopogoninae	*Bezzia*	0	0	0	0	0	0	0	0	0	34.4
			Mallochohelea	17.2	0	0	34.4	0	0	0	0	0	0
			Probezzia	0	0	0	0	0	0	0	0	0	0
			Sphaeromias	0	0	0	0	0	0	0	0	0	0
	Chaoborus flavicans	Chaoborinae	*Chaoborus flavicans*	0	17.2	0	0	0	0	0	0	0	0
			Chaoborus punctipennis	0	0	0	0	0	34.4	172	34.4	68.9	103
	Chironomus	Chironominae	*Chironomus*	0	35.3	17.2	36.5	17.4	198	0	172	896	103
			Cladopelma	0	0	0	0	0	0	0	0	0	0
			Cladotanytarsus	0	0	0	0	0	0	0	0	0	0
			Dicrotendipes	0	0	0	0	0	0	0	0	0	0
			Endochironomus	0	0	0	0	0	0	0	0	0	0
			Micropsectra	142	300	155	128	436	0	0	0	0	0
			Microtendipes	0	0	0	0	0	0	0	0	0	0
			Nilothauma	0	0	0	0	0	0	0	0	0	0
			Pagastiella	0	0	0	0	0	0	0	0	0	0
			Paracladopelma	0	0	0	0	0	0	0	0	0	0
			Paratanytarsus	0	0	0	0	0	0	0	0	0	0
			Polypedilum halterale	0	0	0	0	17.4	0	0	0	0	0
			Polypedilum scalaenum	0	0	0	0	0	0	0	0	0	0
			Sergentia	53.1	35.3	172	164	17.4	207	1,274	1,137	2,687	1,343
			Stempellina	0	0	0	0	0	0	0	0	0	0
			Stempellinella	0	0	0	0	0	0	0	0	0	0
			Stictochironomus	88.5	459	672	164	105	198	276	0	138	0
			Tanytarsus	0	0	0	0	0	0	0	0	0	0
			Tribelos	0	0	0	0	0	0	0	0	0	0
		Diamesinae	*Potthastia*	0	0	0	0	0	0	0	0	0	0
			Protanypus	0	0	0	0	0	0	34.4	0	0	0
		Orthocladiinae	*Cricotopus*	0	0	0	0	0	0	0	0	0	0
			Zalutschia	0	0	0	0	0	0	0	0	0	0
			Heterotanytarsus	0	0	0	0	0	0	0	0	0	0
			Heterotrissocladius	708	97.0	448	201	349	34.4	172	0	0	0
			Paracladius	0	0	0	0	0	0	0	0	0	0
			Parakiefferiella	0	0	0	0	0	0	0	0	0	0
			Psectrocladius	0	0	0	0	0	0	0	0	0	0
		Tanypodinae	*Ablabesmyia*	0	0	0	0	0	0	0	0	0	0
			Zavrelimyia	0	0	0	0	0	0	0	0	0	0
			Procladius	266	159	258	237	453	60.3	276	68.9	172	723
	Hemerodromia	Hemerodromiinae	*Hemerodromia*	0	0	0	0	0	0	0	0	0	0
Ephemeroptera	Caenis	Caeninae	*Caenis*	0	0	0	0	0	0	0	0	0	0
	Hexagenia	-	*Hexagenia*	0	0	0	0	17.2	0	0	0	0	0
	Stenonema femoratum	-	*Stenonema femoratum*	0	0	0	0	0	0	0	0	0	0
	Leptophlebiidae	-	*Leptophlebiidae*	0	0	0	0	0	0	0	0	0	0
Harpacticoida	-	-	*Harpacticoida*	0	0	0	68.9	0	0	0	0	1,274	276
Megaloptera	Sialis	-	*Sialis*	0	0	0	0	0	0	0	0	0	0
Mysida	Mysis	-	*Mysis*	0	0	0	0	0	0	0	0	0	0
Odonata	Argia moesta	-	*Argia moesta*	0	0	0	0	0	0	0	0	0	0
Trichoptera	Cheumatopsyche	Hydropsychinae	*Cheumatopsyche*	0	0	0	0	0	0	0	0	0	0
			Ceratopsyche morosa	0	0	0	0	0	0	0	0	0	0
			Ceratopsyche walkeri	0	0	0	0	0	0	0	0	0	0
	Ceraclea	Leptocerinae	*Ceraclea*	0	0	0	0	0	0	0	0	0	0
			Mystacides	0	0	0	0	0	0	0	0	0	0
			Oecetis	0	0	0	0	0	0	0	0	0	0
			Triaenodes	0	0	0	0	0	0	0	0	0	0
	Agrypnia	Phryganeinae	*Agrypnia*	0	0	0	0	17.2	0	0	8.61	0	0
			Fabria	0	0	0	0	0	0	0	0	0	0
Trombidiformes	Lebertia	-	*Lebertia*	0	8.61	0	17.2	0	51.7	34.4	0	0	0
	Oxus	-	*Oxus*	0	0	0	0	0	0	0	0	0	0
	Pionidae	-	Pionidae	0	0	0	0	0	0	34.4	0	0	34.4
	-	-	*Trombidiformes*	0	0	0	0	0	0	0	0	0	0
Tubificida	Ilyodrilus templetoni	Tubificinae	*Ilyodrilus templetoni*	0	0	0	0	0	0	0	0	0	0
			Limnodrilus hoffmeisteri	0	0	0	0	0	0	0	0	34.4	0
			Limnodrilus udekemianus	0	0	0	0	0	0	0	0	0	0
		Naidinae	*Nais variabilis*	0	0	0	0	0	0	0	0	0	0
		Rhyacodrilinae	*Rhyacodrilus montana*	17.2	0	0	0	0	0	0	0	0	0
		Naidinae	*Slavina appendiculata*	0	0	0	0	0	0	0	0	0	0
		Tubificinae	*Tubifex tubifex*	0	0	0	0	0	0	0	0	0	0
Veneroida	Pisidium	-	*Pisidium*	241	215	327	51.7	138	17.2	0	0	0	0
		-	*Sphaerium nitidum*	0	0	0	0	0	0	0	0	0	0
-	-	-	*Arachnida*	0	0	17.2	0	0	0	0	0	0	0
-	-	-	Nematoda	86.1	94.7	138	51.7	276	0	34.4	34.4	103	0
-	-	-	Ostracoda	155	68.9	482	276	482	0	34.4	448	723	68.9
-	-	-	Tubificinae	0	0	0	0	17.2	0	0	0	586	0

Table T.5: Benthic Invertebrate Community Density (organisms per m²), SRWMP, September 2019

Order	Family	Subfamily	Taxa	Mine-Exposed									
				May Lake (MAL)					McCabe Lake (ML)				
				1	2	3	4	5	1	2	3	4	5
Amphipoda	Crangonyx	-	*Crangonyx*	0	0	0	0	0	0	0	0	0	0
	Hyalella	-	*Hyalella*	0	0	0	0	0	0	0	0	0	0
	Diporeia	-	*Diporeia*	0	0	0	0	0	0	0	0	0	0
Coleoptera	Optioservus	Elminae	*Optioservus*	0	0	0	0	0	0	0	0	0	0
Diptera	Bezzia	Ceratopogoninae	*Bezzia*	0	0	0	0	0	0	0	0	0	0
			Mallochohelea	0	0	0	0	43.1	0	0	0	0	0
			Probezzia	0	0	0	0	0	0	0	0	0	0
			Sphaeromias	0	0	0	0	0	0	0	0	0	0
	Chaoborus flavicans	Chaoborinae	*Chaoborus flavicans*	0	0	0	0	0	0	0	0	0	0
			Chaoborus punctipennis	17.2	0	0	0	0	0	0	0	0	0
	Chironomus	Chironominae	*Chironomus*	0	0	0	0	0	0	138	768	0	140
			Cladopelma	0	0	0	0	0	0	0	0	0	0
			Cladotanytarsus	0	0	0	0	0	0	0	0	0	0
			Dicrotendipes	0	72.2	0	0	0	0	207	0	0	0
			Endochironomus	0	0	0	0	0	0	0	0	0	0
			Micropsectra	1,963	6,859	1,597	3,343	1,320	5,839	2,893	3,149	2,214	3,225
			Microtendipes	0	0	0	0	0	0	0	0	0	0
			Nilothauma	0	0	0	0	0	0	0	0	36.9	0
			Pagastiella	0	0	0	0	0	0	0	0	0	0
			Paracladopelma	0	0	0	0	0	0	0	0	0	0
			Paratanytarsus	0	0	0	0	0	0	0	0	0	0
			Polypedilum halterale	0	0	0	0	0	0	0	0	0	0
			Polypedilum scalaenum	0	0	0	0	0	0	0	0	0	0
			Sergentia	3,005	0	35.5	0	0	0	0	154	0	0
			Stempellina	0	0	0	0	0	0	0	0	0	0
			Stempellinella	0	0	0	0	0	0	0	0	0	0
			Stictochironomus	921	361	1,667	149	637	1,689	1,447	0	1,402	2,314
			Tanytarsus	0	0	0	0	0	844	0	461	627	561
			Tribelos	0	0	0	0	0	0	0	0	0	0
		Diamesinae	*Potthastia*	0	0	0	0	0	0	0	0	0	0
			Protanypus	0	72.2	0	0	64.6	0	0	0	36.9	210
		Orthocladiinae	*Cricotopus*	0	0	0	0	0	0	0	0	0	0
			Zalutschia	0	0	0	0	0	0	0	0	0	0
			Heterotanytarsus	0	0	0	0	0	0	0	0	0	0
			Heterotrissocladius	34.7	72.2	248	223	157	1,266	964	76.8	664	1,262
			Paracladius	0	0	0	0	0	0	0	0	0	0
			Parakiefferiella	69.5	72.2	0	74.3	0	0	68.9	0	0	0
			Psectrocladius	0	0	0	0	0	0	0	0	0	0
		Tanypodinae	*Ablabesmyia*	0	0	0	0	0	0	0	0	0	0
			Zavrelimyia	0	0	0	0	0	0	0	0	0	0
			Procladius	0	0	0	0	0	281	0	76.8	185	140
	Hemerodromia	Hemerodromiinae	*Hemerodromia*	0	0	0	0	0	0	0	0	0	0
Ephemeroptera	Caenis	Caeninae	*Caenis*	0	0	0	0	0	0	0	68.9	0	0
	Hexagenia	-	*Hexagenia*	0	0	0	0	8.61	0	0	0	0	0
	Stenonema femoratum	-	*Stenonema femoratum*	0	0	0	0	0	0	0	0	0	0
	Leptophlebiidae	-	*Leptophlebiidae*	0	0	0	0	0	0	0	0	0	0
Harpacticoida	-	-	*Harpacticoida*	0	0	0	0	0	0	0	0	0	0
Megaloptera	Sialis	-	*Sialis*	0	0	0	0	0	0	0	0	0	0
Mysida	Mysis	-	*Mysis*	0	0	0	0	0	0	0	0	0	0
Odonata	Argia moesta	-	*Argia moesta*	0	0	0	0	0	0	0	0	0	0
Trichoptera	Cheumatopsyche	Hydropsychinae	*Cheumatopsyche*	0	0	0	0	0	0	0	0	0	0
			Ceratopsyche morosa	0	0	0	0	0	0	0	0	0	0
			Ceratopsyche walkeri	0	0	0	0	0	0	0	0	0	0
	Ceraclea	Leptocerinae	*Ceraclea*	0	0	0	0	0	0	0	0	0	0
			Mystacides	0	0	0	0	0	0	0	0	0	0
			Oecetis	0	0	0	0	0	0	0	0	0	0
			Triaenodes	0	0	0	0	0	0	0	0	0	0
	Agrypnia	Phryganeinae	*Agrypnia*	0	0	0	0	0	0	0	0	0	0
			Fabria	0	0	0	0	0	0	0	0	0	0
Trombidiformes	Lebertia	-	*Lebertia*	0	0	34.4	0	43.1	0	0	0	0	68.9
	Oxus	-	*Oxus*	0	0	0	0	0	0	0	0	34.4	0
	Pionidae	-	Pionidae	0	68.9	0	0	8.61	0	0	68.9	0	0
	-	-	*Trombidiformes*	0	0	0	0	0	0	0	0	0	0
Tubificida	Ilyodrilus templetoni	Tubificinae	*Ilyodrilus templetoni*	0	0	0	0	0	0	0	0	0	0
			Limnodrilus hoffmeisteri	34.4	0	0	0	0	0	0	0	0	0
			Limnodrilus udekemianus	0	0	0	0	0	0	0	0	0	0
		Naidinae	*Nais variabilis*	0	0	0	0	0	0	0	0	0	0
		Rhyacodrilinae	*Rhyacodrilus montana*	0	0	0	0	0	0	0	0	0	0
		Naidinae	*Slavina appendiculata*	0	0	0	0	0	0	0	0	0	0
		Tubificinae	*Tubifex tubifex*	0	0	0	0	0	0	0	0	0	0
Veneroida	Pisidium	-	*Pisidium*	0	0	0	0	0	0	138	138	138	276
		-	*Sphaerium nitidum*	0	0	0	0	0	0	0	0	0	0
-	-	-	*Arachnida*	0	0	0	0	0	0	0	0	0	0
-	-	-	Nematoda	0	0	0	0	0	1,309	4,960	1,033	2,170	7,027
-	-	-	Ostracoda	517	1,447	138	138	293	0	0	689	34.4	68.9
-	-	-	Tubificinae	34.4	0	34.4	68.9	0	0	68.9	0	68.9	0

Table T.5: Benthic Invertebrate Community Density (organisms per m^2), SRWMP, September 2019

Order	Family	Subfamily	Taxa	Mine-Exposed							
				Nordic Lake (NL)			Quirke Lake (QL)				
				2	4	5	1	2	3	4	5
Amphipoda	Crangonyx	-	*Crangonyx*	0	0	0	0	0	0	0	0
	Hyalella	-	*Hyalella*	0	0	0	0	0	0	0	0
	Diporeia	-	*Diporeia*	0	0	0	0	34.4	301	0	17.2
Coleoptera	Optioservus	Elminae	*Optioservus*	0	0	0	0	0	0	0	0
Diptera	Bezzia	Ceratopogoninae	*Bezzia*	0	0	0	0	0	0	0	0
			Mallochohelea	0	34.4	0	34.4	0	0	0	0
			Probezzia	0	0	0	0	0	0	0	0
			Sphaeromias	0	0	0	0	0	0	0	0
	Chaoborus flavicans	Chaoborinae	*Chaoborus flavicans*	0	0	0	0	0	0	0	0
			Chaoborus punctipennis	0	0	0	0	0	0	0	0
	Chironomus	Chironominae	*Chironomus*	413	105	534	38.1	18.2	27.9	56.5	172
			Cladopelma	0	0	0	0	0	0	0	0
			Cladotanytarsus	0	0	0	0	0	0	0	0
			Dicrotendipes	0	0	0	0	0	0	0	0
			Endochironomus	0	0	34.4	0	0	0	0	0
			Micropsectra	344	1,153	103	76.1	382	130	169	57.2
			Microtendipes	0	0	0	0	0	0	0	0
			Nilothauma	0	0	0	0	0	0	0	0
			Pagastiella	0	0	0	0	0	0	0	0
			Paracladopelma	0	0	0	0	0	0	0	0
			Paratanytarsus	0	0	0	0	0	0	0	0
			Polypedilum halterale	0	0	0	0	0	0	0	0
			Polypedilum scalaenum	0	0	0	0	0	0	0	0
			Sergentia	1,102	419	844	0	0	0	0	0
			Stempellina	0	0	0	0	0	0	0	0
			Stempellinella	0	0	0	0	0	0	0	0
			Stictochironomus	0	105	34.4	0	0	0	0	0
			Tanytarsus	68.9	454	138	0	0	130	28.2	0
			Tribelos	0	0	0	0	0	0	0	0
		Diamesinae	*Potthastia*	0	0	0	0	0	0	0	0
			Protanypus	0	0	0	76.1	72.8	18.6	18.8	0
		Orthocladiinae	*Cricotopus*	0	0	0	0	0	0	0	0
			Zalutschia	0	0	0	0	0	0	0	0
			Heterotanytarsus	0	0	0	0	0	0	0	0
			Heterotrissocladius	276	245	68.9	533	491	288	132	305
			Paracladius	0	0	0	0	0	0	0	0
			Parakiefferiella	0	0	0	0	0	0	0	0
			Psectrocladius	0	0	0	0	0	0	0	0
		Tanypodinae	*Ablabesmyia*	0	0	0	0	0	0	0	0
			Zavrelimyia	0	0	0	0	0	0	0	0
			Procladius	0	0	0	0	0	0	0	0
	Hemerodromia	Hemerodromiinae	*Hemerodromia*	0	0	0	0	0	0	0	0
Ephemeroptera	Caenis	Caeninae	*Caenis*	0	0	0	0	0	0	0	0
	Hexagenia	-	*Hexagenia*	0	0	0	0	0	0	0	0
	Stenonema femoratum	-	*Stenonema femoratum*	0	0	0	0	0	0	0	0
	Leptophlebiidae	-	*Leptophlebiidae*	0	0	0	0	0	0	0	0
Harpacticoida	-	-	*Harpacticoida*	0	0	34.4	0	0	0	0	0
Megaloptera	Sialis	-	*Sialis*	0	34.4	0	0	0	0	0	0
Mysida	Mysis	-	*Mysis*	0	0	0	0	0	0	8.61	0
Odonata	Argia moesta	-	*Argia moesta*	0	0	0	0	0	0	0	0
Trichoptera	Cheumatopsyche	Hydropsychinae	*Cheumatopsyche*	0	0	0	0	0	0	0	0
			Ceratopsyche morosa	0	0	0	0	0	0	0	0
			Ceratopsyche walkeri	0	0	0	0	0	0	0	0
	Ceraclea	Leptocerinae	*Ceraclea*	0	0	0	0	0	0	0	0
			Mystacides	0	0	0	0	0	0	0	0
			Oecetis	0	0	0	0	0	0	0	0
			Triaenodes	0	0	0	0	0	0	0	0
	Agrypnia	Phryganeinae	*Agrypnia*	0	0	0	0	0	0	0	0
			Fabria	0	0	0	0	0	0	0	0
Trombidiformes	Lebertia	-	*Lebertia*	0	0	0	0	0	0	0	0
	Oxus	-	*Oxus*	0	0	0	0	0	0	0	0
	Pionidae	-	Pionidae	0	0	0	0	0	0	0	0
	-	-	*Trombidiformes*	0	0	0	0	0	0	0	0
Tubificida	Ilyodrilus templetoni	Tubificinae	*Ilyodrilus templetoni*	0	0	0	0	0	0	0	0
			Limnodrilus hoffmeisteri	0	0	0	0	0	0	0	0
			Limnodrilus udekemianus	0	0	0	0	0	0	0	0
		Naidinae	*Nais variabilis*	0	0	0	0	0	0	0	0
		Rhyacodrilinae	*Rhyacodrilus montana*	68.9	138	86.1	0	0	94.7	34.4	0
		Naidinae	*Slavina appendiculata*	0	0	0	0	0	0	0	0
		Tubificinae	*Tubifex tubifex*	0	0	0	0	0	0	0	0
Veneroida	Pisidium	-	*Pisidium*	0	0	0	138	68.9	43.1	0	758
		-	*Sphaerium nitidum*	0	0	0	0	0	0	0	0
-	-	-	*Arachnida*	0	0	0	0	0	0	0	0
-	-	-	Nematoda	0	0	0	0	0	0	0	0
-	-	-	Ostracoda	896	1,860	1,671	0	34.4	0	0	0
-	-	-	Tubificinae	0	0	0	0	0	0	0	0

Table T.6: Benthic Invertebrate Community Endpoints, SRWMP, September 2019

Lake Type	Lake	Replicate	Density (# individuals/m²)	LPL Richness (# taxa)	% Chironominae	% Orthocladiinae	% Tanypodinae
Reference	DUL	1	7,371	12.0	28.4	0.962	3.85
		2	5,391	14.0	27.4	0	1.15
		3	4,943	12.0	27.9	9.76	4.18
		4	12,710	11.0	25.7	7.05	0.542
		5	6,820	11.0	52.2	4.18	5.22
		Pooled	7,447	12.0	32.3	4.39	2.99
	TML	1	4,684	10.0	35.3	4.41	4.41
		2	3,444	10.0	7.00	16.0	1.00
		3	4,374	9.00	21.3	0.787	2.36
		4	2,420	20.0	37.6	22.1	4.70
		5	2,136	12.0	51.3	8.27	3.31
		Pooled	3,412	12.2	30.5	10.3	3.16
	SL	1	1,774	10.0	16.0	39.9	15.0
		2	1,490	11.0	55.7	6.51	10.7
		3	2,687	10.0	37.8	16.7	9.62
		4	1,429	12.0	34.4	14.0	16.6
		5	2,342	13.0	24.6	14.9	19.4
		Pooled	1,944	11.2	33.7	18.4	14.2
	SUL	1	801	8.00	75.3	4.30	7.53
		2	2,342	10.0	66.2	7.35	11.8
		3	1,903	7.00	68.8	0	3.62
		4	6,682	10.0	55.7	0	2.58
		5	2,687	8.00	53.8	0	26.9
		Pooled	2,883	8.60	63.9	2.33	10.5
Mine-Exposed	QL	1	896	6.00	12.8	59.5	0
		2	1,102	7.00	36.3	44.6	0
		3	1,033	8.00	27.9	27.9	0
		4	448	7.00	56.8	29.4	0
		5	1,309	5.00	17.5	23.3	0
	ML	1	11,229	6.00	74.6	11.3	2.51
		2	10,884	9.00	43.0	9.49	0
		3	6,682	11.0	67.8	1.15	1.15
		4	7,612	12.0	56.2	8.73	2.42
		5	15,293	11.0	40.8	8.25	0.917
	MAL	1	6,596	9.00	89.3	1.58	0
		2	9,024	8.00	80.8	1.60	0
		3	3,754	7.00	87.9	6.61	0
		4	3,996	6.00	87.4	7.44	0
		5	2,575	9.00	76.0	6.10	0
	NL	2	3,169	7.00	60.9	8.70	0
		4	4,547	10.0	49.2	5.38	0
		5	3,548	10.0	47.6	1.94	0

Notes: LPL = lowest practical level. Mine-exposed areas: Quirke Lake (QL), McCabe Lake (ML), May Lake (MAL), Nordic Lake (NL). Reference areas: Dunlop Lake (DUL), Ten Mile Lake (TML), Semiwite Lake (SL), Summers Lake (SUL).

Table T.7: Summary Statistics for Benthic Invertebrate Community Endpoints, SRWMP, September 2019

Endpoint	Exposure	Station	N	Mean	SD	SE	Minimum	Median	Maximum
Density (#/m²)	Reference	DUL	5	7,447	3,106	1,389	4,943	6,820	12,710
		TML	5	3,412	1,136	508	2,136	3,444	4,684
		SL	5	1,944	550	246	1,429	1,774	2,687
		SUL	5	2,883	2,239	1,002	801	2,342	6,682
		Pooled	4	3,922	1,140	570	801	2,893	12,710
	Mine-Exposed	QL	5	958	322	144	448	1,033	1,309
		ML	5	10,340	3,407	1,524	6,682	10,884	15,293
		MAL	5	5,189	2,598	1,162	2,575	3,996	9,024
		NL	3	3,754	712	411	3169	3,548	4,547
LPL Richness (# taxa)	Reference	DUL	5	12.0	1.22	0.548	11	12	14
		TML	5	12.2	4.49	2.01	9	10	20
		SL	5	11.2	1.30	0.583	10	11	13
		SUL	5	8.60	1.34	0.600	7	8	10
		Pooled	4	11.0	1.60	0.801	7.00	10.5	20.0
	Mine-Exposed	QL	5	6.60	1.14	0.510	5	7	8
		ML	5	9.80	2.39	1.07	6	11	12
		MAL	5	7.80	1.30	0.583	6	8	9
		NL	3	9.00	1.73	1.00	7.00	10.0	10.0
% Chironominae	Reference	DUL	5	32.3	11.2	4.99	25.7	27.9	52.2
		TML	5	30.5	16.9	7.56	7.00	35.3	51.3
		SL	5	33.7	15.0	6.70	16.0	34.4	55.7
		SUL	5	63.9	9.04	4.04	53.8	66.2	75.3
		Pooled	4	40.1	3.57	1.78	7.00	34.9	75.3
	Mine-Exposed	QL	5	30.2	17.4	7.79	12.8	27.9	56.8
		ML	5	56.5	14.8	6.64	40.8	56.2	74.6
		MAL	5	84.3	5.66	2.53	76.0	87.4	89.3
		NL	3	52.5	7.3	4.2	47.6	49.2	60.9
% Orthocladiinae	Reference	DUL	5	4.39	4.09	1.83	0	4.18	9.76
		TML	5	10.3	8.66	3.87	0.787	8.27	22.1
		SL	5	18.4	12.6	5.65	6.51	14.9	39.9
		SUL	5	2.33	3.37	1.51	0	0	7.35
		Pooled	4	8.86	4.32	2.16	0	6.22	39.9
	Mine-Exposed	QL	5	36.9	14.9	6.68	23.3	29.4	59.5
		ML	5	7.78	3.88	1.74	1.15	8.73	11.3
		MAL	5	4.67	2.85	1.27	1.58	6.10	7.44
		NL	3	5.34	3.38	1.95	1.94	5.38	8.7
% Tanypodinae	Reference	DUL	5	2.99	2.03	0.909	0.542	3.85	5.22
		TML	5	3.16	1.52	0.681	1.00	3.31	4.70
		SL	5	14.2	4.08	1.82	9.62	15.0	19.4
		SUL	5	10.5	9.88	4.42	2.58	7.53	26.9
		Pooled	4	7.72	3.83	1.91	0.5	5.69	26.9
	Mine-Exposed	QL	5	0	0	0	0	0	0
		ML	5	1.40	1.06	0.476	0	1.15	2.51
		MAL	5	0	0	0	0	0	0
		NL	3	0	0	0	0	0	0
CA1 (29.1%)	Reference	DUL	5	0.190	0.343	0.153	-0.307	0.178	0.519
		TML	5	0.798	0.318	0.142	0.417	0.723	1.22
		SL	5	0.0364	0.322	0.144	-0.158	-0.131	0.600
		SUL	5	1.68	0.899	0.402	0.566	1.83	2.84
		Pooled	4	0.676	0.286	0.143	-0.307	0.451	2.840
	Mine-Exposed	QL	5	-1.95	0.227	0.102	-2.22	-2.02	-1.63
		ML	5	-0.877	0.315	0.141	-1.16	-0.960	-0.351
		MAL	5	-0.800	0.609	0.272	-1.36	-1.07	0.171
		NL	3	-0.114	0.437	0.252	-0.486	-0.224	0.367
CA2 (17.1%)	Reference	DUL	5	-0.0718	0.345	0.154	-0.419	-0.124	0.434
		TML	5	0.322	0.419	0.187	-0.251	0.365	0.886
		SL	5	0.202	0.185	0.0827	0.0210	0.193	0.500
		SUL	5	-0.606	0.931	0.416	-1.28	-1.09	0.960
		Pooled	4	-0.0385	0.322	0.161	-1.28	0.0345	0.960
	Mine-Exposed	QL	5	-1.82	0.682	0.305	-2.47	-1.89	-0.691
		ML	5	-0.104	0.723	0.323	-1.25	0.0969	0.630
		MAL	5	2.27	0.314	0.140	1.79	2.35	2.55
		NL	3	-0.717	0.447	0.258	-1.15	-0.737	-0.261
CA3 (15.8%)	Reference	DUL	5	0.469	0.367	0.164	-0.0423	0.442	0.973
		TML	5	0.335	0.399	0.179	-0.131	0.313	0.953
		SL	5	0.645	0.224	0.100	0.330	0.679	0.910
		SUL	5	-0.419	0.424	0.190	-0.894	-0.346	0.124
		Pooled	4	0.258	0.0894	0.0447	-0.894	0.378	0.973
	Mine-Exposed	QL	5	-0.557	0.756	0.338	-1.77	-0.479	0.182
		ML	5	0.953	0.515	0.230	0.0623	1.10	1.36
		MAL	5	-1.50	0.326	0.146	-2.05	-1.39	-1.22
		NL	3	-2.17	0.324	0.187	-2.54	-2.02	-1.94

Notes: n = number of samples. SD = standard deviation. SE = standard error. LPL = lowest practical level. CA = correspondence analysis.
Mine-exposed areas: Quirke Lake (QL), McCabe Lake (ML), May Lake (MAL), Nordic Lake (NL). Reference areas: Dunlop Lake (DUL), Ten Mile Lake (TML), Semiwite Lake (SL), Summers Lake (SUL).

Table T.8: Taxa Correspondence Analysis (CA) Scores, SRWMP, September 2019

Order	Family	Subfamily	Taxa	CA1 (29.1%)	CA2 (17.1%)	CA3 (15.8%)
Diptera	Chironomidae	Chironominae	Chironomus	0.0459	-0.684	-0.287
			Sergentia	0.598	-0.0992	-0.394
			Stictochironomus	-0.0309	0.486	0.0600
			Tanytarsus	-0.467	-0.440	-0.0799
			Micropsectra	-0.428	0.204	-0.158
		Orthocladiinae	Heterotrissocladius	-0.457	0.0126	-0.0978
		Tanypodinae	Procladius	0.435	-0.0369	0.370
Harpacticoida	-	-	Harpacticoida	0.859	-0.0448	0.141
Veneroida	Pisidiidae	-	Pisidium	-0.347	-0.371	0.456
-	-	-	Nematoda	0.0772	0.0384	0.591
-	-	-	Ostracoda	0.191	0.222	-0.242

Table T.9: Correspondence Analysis (CA) Scores, SRWMP, September 2019

Exposure	Lake	Replicate	CA1 (29.1%)	CA2 (17.1%)	CA3 (15.8%)
Reference	DUL	1	0.519	0.0904	0.593
		2	0.502	-0.340	0.442
		3	-0.307	0.434	0.973
		4	0.0563	-0.419	0.378
		5	0.178	-0.124	-0.0423
		Pooled	0.190	-0.072	0.469
	TML	1	1.01	0.469	-0.131
		2	0.723	0.365	0.390
		3	1.22	0.886	0.953
		4	0.619	0.140	0.148
		5	0.417	-0.251	0.313
		Pooled	0.798	0.322	0.335
	SL	1	-0.158	0.500	0.910
		2	-0.131	0.0802	0.679
		3	0.00432	0.214	0.528
		4	0.600	0.0210	0.330
		5	-0.134	0.193	0.776
		Pooled	0.036	0.202	0.645
	SUL	1	0.566	-1.09	-0.346
		2	1.04	0.960	0.124
		3	1.83	-1.16	-0.894
		4	2.13	-0.463	-0.186
		5	2.84	-1.28	-0.793
		Pooled	1.681	-0.607	-0.419
Mine-Exposed	QL	1	-2.02	-1.84	-0.0606
		2	-1.63	-0.691	-0.655
		3	-2.22	-2.22	-0.479
		4	-2.06	-1.89	-1.77
		5	-1.84	-2.47	0.182
	ML	1	-1.06	0.630	1.10
		2	-1.16	0.0969	1.22
		3	-0.351	-1.25	0.0623
		4	-0.960	0.299	1.36
		5	-0.852	-0.299	1.01
	MAL	1	0.171	1.79	-2.05
		2	-1.07	2.53	-1.39
		3	-0.603	2.15	-1.53
		4	-1.36	2.35	-1.31
		5	-1.14	2.55	-1.22
	NL	2	-0.224	-1.15	-2.54
		4	-0.486	-0.261	-2.02
		5	0.367	-0.737	-1.94

Notes: Mine-exposed areas: Quirke Lake (QL), McCabe Lake (ML), May Lake (MAL), Nordic Lake (NL).
Reference areas: Dunlop Lake (DUL), Ten Mile Lake (TML), Semiwite Lake (SL), Summers Lake (SUL).

Table T.10: Benthic Invertebrate Community ANOVA Results for 2019 Correspondence Analysis

Endpoint	Transformation	Lake	MCT[a]	Reference MCT[b]	P-Value	MOD[c]
CA1 (29.1%)	Rank	MAL	-1.066	0.542	0.004	-3.91
		ML	-0.960		0.002	-3.65
		NL	-0.224		0.184	-1.86
		QL	-2.016		<0.001	-6.22
CA2 (18.9%)	Untransformed	MAL	2.273	0.235	<0.001	3.82
		ML	-0.104		0.829	-0.11
		NL	-0.717		0.079	-1.12
		QL	-1.822		<0.001	-2.95
CA3 (16.0%)	Rank	MAL	-1.394	0.3540	0.002	-5.03
		ML	1.104		0.082	2.16
		NL	-2.023		0.003	-6.84
		QL	-0.479		0.086	-2.40

(grey) P-value < 0.1.

(blue) 2 < MOD < -2.

Notes: ANOVA = analysis of variance. CA = correspondence analysis.

[a] Measures of Central Tendency (MCT) calculated as back-transformed estimated marginal means from a one-way ANOVA with reference lakes nested within a pooled reference status, and individual mine-exposed lakes over time.

[b] Calculated as the back-transformed estimated marginal mean of the pooled reference areas from one-way ANOVA.

[c] Magnitude of Difference (MOD) calculated as $(MCT_{exposed}-MCT_{ReferencePool})/SD_{model}$, where SDmodel is the standard deviation of the one-way ANOVA model residuals.

Table T.11: Benthic Invertebrate Community ANOVA Results for Within-Lake Correspondence Analysis, 1999 to 2019

Lake	Endpoint	Transformation	Year	MCT[a]	Temporal Differences	
					Pairwise Contrasts[b]	MOD[c] vs base year
MAL	CA1 (48.6%)	untransformed	2004	-0.638	B	b
			2009	-0.452	B	0.245
			2019	1.01	A	2.16
	CA2 (19.7%)	untransformed	2004	0.500	A	b
			2009	-0.454	A	-0.869
			2019	0.198	A	-0.275
	CA3 (17.7%)	untransformed	2004	0.974	A	b
			2009	0.0220	A	-0.911
			2019	-0.326	A	-1.24
ML	CA1 (35.7%)	untransformed	1999	-1.73	C	b
			2004	-0.404	B	2.23
			2009	-0.196	B	2.58
			2019	0.944	A	4.49
	CA2 (20.8%)	untransformed	1999	2.18	A	b
			2004	-0.721	C	-3.42
			2009	-0.898	C	-3.63
			2019	0.631	B	-1.82
	CA3 (17.0%)	untransformed	1999	-1.28	A	b
			2004	-0.0770	A	0.783
			2009	-0.307	A	0.633
			2019	0.269	A	1.01
NL	CA1 (27.9%)	untransformed	1999	-1.4700	C	b
			2004	-0.448	B	1.67
			2009	0.8720	A	3.82
			2019	0.07	AB	2.51
	CA2 (23.0%)	untransformed	1999	-0.02	A	b
			2004	-0.245	A	-0.23
			2009	-0.26	A	-0.24
			2019	0.953	A	0.95
	CA3 (17.1%)	untransformed	1999	-0.202	A	b
			2004	0.5010	A	0.717
			2009	0.568	A	0.786
			2019	-1.040	A	-0.85
QL	CA1 (44.9%)	rank	1999	0.657	A	b
			2004	0.481	AB	-1.01
			2009	0.401	BC	-1.47
			2019	-1.33	C	-11.4
	CA2 (23.6%)	untransformed	1999	1.42	A	b
			2004	-0.496	BC	-2.17
			2009	-0.835	C	-2.55
			2019	0.379	B	-1.18
	CA3 (16.5%)	untransformed	1999	0.752	A	b
			2004	-0.412	A	-1.14
			2009	0.0707	A	-0.668
			2019	-0.0866	A	-0.822

[shaded] 2 < MOD < -2.

Notes: ANOVA = analysis of variance. CA = correspondence analysis. Mine-exposed areas: Quirke Lake (QL), McCabe Lake (ML), May Lake (MAL), Nordic Lake (NL).

[a] Measures of Central Tendency (MCT) calculated as back-transformed estimated marginal means from a one-way ANOVA with reference lakes nested within a pooled reference status, and individual mine-exposed lakes over time.

[b] Years that share a letter are not significantly different based on Tukey's Honestly Significant Difference (α=0.1).

[c] Magnitude of Difference (MOD) calculated as $(MCT_{year}-MCT_{baseline})/SD_{model}$, where SDmodel is the standard deviation of the one-way ANOVA model residuals.

Table T.12: CA Scores for May Lake (MAL), 2004, 2009, and 2019

Year	Replicate	CA1 (48.6%)	CA2 (19.7%)	CA3 (17.7%)
2004	R1	-1.59	-0.735	-0.618
	R2	-0.522	1.48	1.42
	R3	0.198	0.750	2.12
2009	R1	-1.76	-0.582	-0.310
	R2	-0.835	0.892	0.621
	R3	-0.227	-0.412	-0.557
	R4	-0.292	-0.377	-0.661
	R5	0.849	-1.79	1.02
2019	R1	0.557	1.53	-1.58
	R2	1.28	-0.780	-0.718
	R3	0.719	0.877	0.594
	R4	1.48	0.721	-0.902
	R5	1.03	-1.35	0.979

Table T.13: Taxa CA Scores for May Lake (MAL), 1999, 2004, 2009, and 2019

Order	Family	Subfamily	Taxa	CA1 (48.6%)	CA2 (19.7%)	CA3 (17.7%)
Diptera	Chironomidae	Chironominae	Chironomus	-1.06	-0.332	-0.345
			Micropsectra	0.218	0.0774	0.0841
			Sergentia	-0.583	0.326	-0.289
			Stictochironomus	0.502	0.0847	0.0416
		Diamesinae	Protanypus	0.0238	-0.910	-0.0568
		Orthocladiinae	Heterotrissocladius	0.0991	-0.0619	0.136
			Parakiefferiella	0.674	0.207	-0.921
-	-	-	Arachnida	-0.728	0.286	0.429
-	-	-	Ostracoda	0.0499	-0.00675	0.116

Table T.14: CA Scores for McCabe Lake (ML), 1999, 2004, 2009, and 2019

Year	Replicate	CA1 (35.7%)	CA2 (20.8%)	CA3 (17.0%)
1999	R1	-2.14	1.09	0.907
	R2	-1.73	1.16	-0.569
	R3	-1.33	4.27	-4.16
2004	R1	-0.508	-0.610	0.749
	R2	0.434	-1.37	-2.65
	R3	-1.14	-0.180	1.67
2009	R1	0.112	-0.559	0.833
	R2	-0.118	-1.36	-0.865
	R3	-0.427	-0.977	-0.0411
	R4	-0.193	-0.495	-1.26
	R5	-0.355	-1.09	-0.200
2019	R1	1.61	0.789	0.930
	R2	1.38	0.503	-0.742
	R3	-0.399	0.906	0.445
	R4	1.17	-0.0629	0.323
	R5	0.953	1.02	0.385

Table T.15: Taxa CA Scores for McCabe Lake (ML), 1999, 2004, 2009, and 2019

Order	Family	Subfamily	Taxa	CA1 (35.7%)	CA2 (20.8%)	CA3 (17.0%)
Diptera	Chironomidae	Chironominae	Chironomus	-0.468	1.21	-0.677
			Dicrotendipes	-0.200	-0.352	-0.466
			Micropsectra	0.431	0.0859	0.267
			Sergentia	-1.03	0.107	0.563
			Stictochironomus	1.28	0.572	0.230
			Tanytarsus	-0.204	0.0390	0.291
		Orthocladiinae	Heterotrissocladius	0.384	-0.159	0.0233
		Tanypodinae	Procladius	-0.192	0.0340	-0.314
Veneroida	Pisidiidae	-	Pisidium	-0.00573	-0.353	0.0938
Tubificida	Naididae	Tubificinae	Tubificinae	0.222	-0.740	-0.810
-	-	-	Nematoda	0.512	0.0828	0.0493
-	-	-	Ostracoda	-0.545	-0.125	0.152

Table T.16: CA Scores for Nordic Lake (NL), 1999, 2004, 2009, and 2019

Year	Replicate	CA1 (27.9%)	CA2 (23.0%)	CA3 (17.1%)
1999	R1	-2.15	-1.10	-0.212
	R2	-1.40	-0.159	-1.72
	R3	-0.875	1.21	1.32
2004	R1	-1.05	1.57	1.41
	R2	0.190	-0.937	-0.390
	R3	-0.486	-1.36	0.486
2009	R1	0.377	0.345	1.74
	R2	1.94	-0.0797	-0.508
	R3	0.399	-1.57	0.0154
	R4	0.902	-0.428	0.965
	R5	0.738	0.445	0.630
2019	R2	-0.536	1.00	-0.837
	R4	0.365	1.05	-1.54
	R5	0.369	0.812	-0.733

Table T.17: Taxa CA Scores for Nordic Lake (NL), 1999, 2004, 2009, and 2019

Order	Family	Subfamily	Taxa	CA1 (43.5%)	CA2 (18.8%)	CA3 (14.4%)
Diptera	Chironomidae	Chironominae	Chironomus	0.217	0.178	0.110
			Micropsectra	-0.123	0.0106	-0.0294
			Sergentia	-0.441	0.170	-0.0251
			Stictochironomus	0.818	0.00541	-0.498
			Tanytarsus	0.256	0.681	0.193
		Orthocladiinae	Heterotrissocladius	0.189	-0.162	-0.207
Harpacticoida	-	-	Harpacticoida	0.279	-0.251	0.383
-	-	-	Arachnida	0.640	-0.527	0.378
-	-	-	Nematoda	-0.448	-0.647	0.476
-	-	-	Ostracoda	-0.173	0.0624	0.0334
-	-	Rhyacodrilinae	*Rhyacodrilus montana*	-0.166	-0.302	-0.551

Table T.18: CA Scores for Quirke Lake (QL), 1999, 2004, 2009, and 2019

Year	Replicate	CA1 (44.9%)	CA2 (23.6%)	CA3 (16.5%)
1999	R1	0.707	0.463	1.43
	R2	0.657	-0.0905	1.33
	R3	0.629	1.53	1.18
	R4	0.408	1.69	-1.25
	R5	1.18	3.51	1.07
2004	R1	0.481	-1.37	0.703
	R2	0.343	-1.03	-1.04
	R3	0.629	0.190	-1.51
	R4	0.458	0.111	-0.830
	R5	0.654	-0.378	0.612
2009	R1	0.401	-1.23	-0.265
	R2	0.305	-1.63	1.06
	R3	0.469	-0.445	0.935
	R4	-0.254	-0.780	-0.669
	R5	0.465	-0.0942	-0.707
2019	R1	-2.12	0.172	-0.720
	R2	-1.33	-0.316	-0.821
	R3	-1.12	1.17	-0.162
	R4	0.234	0.806	-0.487
	R5	-2.83	0.0576	1.76

Table T.19: Taxa CA Scores for Quirke Lake (QL), 1999, 2004, 2009, and 2019

Order	Family	Subfamily	Taxa	CA1 (44.9%)	CA2 (23.6%)	CA3 (16.5%)
Diptera	Chironomidae	Chironominae	Chironomus	-0.0400	-0.272	0.333
			Micropsectra	0.146	0.244	0.122
		Diamesinae	Protanypus	-0.243	0.0720	-0.808
		Orthocladiinae	Heterotrissocladius	-0.0715	-0.160	-0.0956
Veneroida	Pisidiidae	-	Pisidium	-1.99	0.221	0.204
-	-	-	Ostracoda	0.384	-0.528	-0.0817
-	-	Rhyacodrilinae	*Rhyacodrilus montana*	0.431	0.648	0.0285

Table T.20: Spearman Rank Correlations Between Benthic Invertebrate Community Endpoints and Habitat Characteristics, SRWMP, September 2019

Parameter	Statistic	Sediment Quality									*In Situ* Water Quality					
		Barium (mg/kg)	Cobalt (mg/kg)	Iron (mg/kg)	Manganese (mg/kg)	Nickel (mg/kg)	Radium (Bq/g)	Uranium (mg/kg)	Total Organic Carbon (mg/kg)	% Fines (Silt + Clay)	Depth (m)	Secchi Depth (m)	Temperature (°C)	pH	Specific Conductance (µS/cm)	Dissolved Oxygen (%)
Density (#/m²)	rho	-0.19	0.12	-0.01	-0.04	0.25	0.14	0.02	0.26	0.01	-0.44	-0.33	0.50	0.25	0.27	-0.14
	p-value	0.260	0.480	0.959	0.828	0.123	0.405	0.929	0.115	0.957	0.005	0.044	0.001	0.137	0.100	0.390
LPL Richness (# Taxa)	rho	-0.31	-0.48	-0.53	-0.36	-0.36	-0.44	-0.49	-0.14	0.14	-0.41	0.08	0.48	-0.28	-0.25	-0.17
	p-value	0.054	0.002	<0.001	0.025	0.029	0.005	0.002	0.387	0.395	0.011	0.632	0.002	0.092	0.128	0.310
% Chironominae	rho	-0.03	0.38	0.46	0.16	0.31	0.30	0.05	0.21	0.03	-0.26	-0.45	-0.29	0.07	0.25	-0.13
	p-value	0.868	0.019	0.004	0.340	0.055	0.064	0.783	0.200	0.840	0.116	0.005	0.081	0.681	0.129	0.438
% Orthocladiinae	rho	0.49	0.13	0.09	0.34	0.18	0.22	0.41	-0.47	-0.44	0.21	0.27	0.06	0.20	0.12	0.34
	p-value	0.002	0.446	0.612	0.039	0.291	0.176	0.010	0.003	0.006	0.202	0.112	0.730	0.227	0.474	0.035
% Tanypodinae	rho	-0.36	-0.63	-0.51	-0.43	-0.59	-0.64	-0.66	0.22	0.21	-0.38	0.11	0.23	-0.70	-0.70	-0.26
	p-value	0.025	<0.001	0.001	0.007	<0.001	<0.001	<0.001	0.185	0.212	0.019	0.503	0.158	<0.001	<0.001	0.111
CA1 (29.1%)	rho	-0.72	-0.71	-0.57	-0.66	-0.73	-0.74	-0.83	0.31	0.34	-0.15	0.13	-0.09	-0.59	-0.67	-0.21
	p-value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.056	0.039	0.382	0.458	0.586	<0.001	<0.001	0.217
CA2 (17.1%)	rho	-0.07	-0.18	-0.01	0.03	0.07	-0.02	-0.15	0.04	-0.32	-0.43	-0.30	0.26	0.03	0.05	-0.11
	p-value	0.681	0.283	0.929	0.839	0.668	0.884	0.354	0.820	0.054	0.008	0.076	0.111	0.853	0.764	0.512
CA3 (15.8%)	rho	0.00	-0.25	-0.38	-0.15	-0.09	-0.18	-0.11	0.04	-0.17	-0.44	0.29	0.75	-0.17	-0.19	-0.11
	p-value	0.986	0.133	0.018	0.378	0.585	0.268	0.529	0.798	0.320	0.006	0.078	<0.001	0.317	0.248	0.496

(blue) rho > 0.6 or rho < -0.6.

(grey) P-Value < 0.05.

(yellow) P-Value < 0.05/15 = 0.00333 (corrected for multiple comparisons).

APPENDIX U
PUBLIC DOSE ESTIMATION FOR THE CLOSED MINES OF THE SERPENT RIVER WATERSHED (ECOMETRIX 2020)

PUBLIC DOSE ESTIMATION FOR THE CLOSED MINES OF THE SERPENT RIVER WATERSHED

Report prepared for:

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October 10, 2020

EcoMetrix INCORPORATED

PUBLIC DOSE ESTIMATION FOR THE CLOSED MINES OF THE SERPENT RIVER WATERSHED

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EXECUTIVE SUMMARY

The Canadian Nuclear Safety Commission (CNSC) has asked Rio Algom Limited (Rio Algom) and Denison Mines Inc. to undertake annual reporting of radiation dose to the public associated with their closed uranium mine sites in the Serpent River Watershed. The annual dose reporting will be based on periodic updates undertaken as part of the five-year State of the Environment (SOE) reports.

This public dose estimation is intended to provide updated dose values in consideration of 2019 data on radionuclides in sport fish. The intention is to estimate realistic doses for a representative person residing in the City of Elliot Lake to be included in annual Serpent River Watershed Monitoring reports. Elliot Lake is the only lake in the watershed with an urban community. The residents of the City are potentially exposed to radioactive substances via both Elliot Lake water and recreational use of mine properties, and are considered to be the population with the greatest potential for exposure to radiation and radioactive materials from the closed mine sites.

Ingestion of drinking water from Elliot Lake, and ingestion of fish caught in this and other lakes downstream of the Tailings Management Areas (TMAs) were identified as key ingestion pathways based on upper bound public dose estimates prepared for SOE reports for the Serpent River Watershed. Radon and direct gamma pathways were identified as key pathways based on upper bound dose estimates for people walking near TMAs prepared by the CNSC.

Site-specific surveys of residents were undertaken by Rio Algom in 2016 to characterize resident exposure pathways and habits relevant to exposure, and monitoring was undertaken to characterize mine site gamma and radon fields, as well as drinking water radionuclide concentrations, to update the characterization of the levels of public exposure. This report includes the results of the 2016 site-specific surveys and monitoring programs, as well as the 2019 data on sport fish, and provides a public dose estimation, based on current understanding of human receptors and key exposure pathways.

The 2016 monitoring program to support public dose estimation for a representative Elliot Lake resident included:

- Surveys of City of Elliot Lake residents to refine estimates of time spent on roads and trails near the TMAs and estimates of fish consumption from different lakes in the Serpent River watershed;
- Monitoring of radon and gamma on roads and trails near TMAs often used by walkers and hikers; and
- Monitoring of appropriate U-238 series radionuclides in drinking water from the City of Elliot Lake Water Treatment Plant, after treatment.

The 2016 data from these surveys and monitoring programs were used in the public dose estimation, along with the 2019 sport fish data. The sport fish data pertain to the lakes most used for fishing.

Based on the public dose calculations, it may be concluded that:

- Public dose to the representative person is approximately 0.01 mSv/a, after correction for background exposure.
- This value is based on available measurements of radon and direct gamma near TMAs, and U-238 series radionuclides in treated drinking water and sport fish, as well as survey information and several assumptions for exposure factors.

The public dose estimation will next be reviewed, and if required, updated as part of the 2025 State of the Environment report.

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1.0 INTRODUCTION

1.1 Background

The Canadian Nuclear Safety Commission (CNSC) has asked Rio Algom Limited and Denison Mines Inc. to undertake annual reporting of radiation dose to the public associated with their closed uranium mine sites in the Serpent River Watershed.

State of the Environment (SOE) reports for the watershed have previously focused on demonstrating upper bounds of public dose, using rather conservative assumptions for hypothetical human residents on lakes downstream of the Tailings Management Areas (TMAs). The CNSC (2002) also estimated upper bound doses from recreational use of TMAs in and around Elliot Lake, based on conservative use assumptions. Neither of these dose estimates are considered to be realistic estimates of public dose.

The intention of this report is to present a more realistic public dose for a representative person exposed to radioactivity from the closed mine properties. The value reported here is based on the radon and gamma survey data, along with two rounds of drinking water quality data collected in 2016, as well as 2019 sport fish data. The public dose estimation will be reviewed, and if required, updated as part of the next State of the Environment report whose field program is scheduled for the fall of 2024.

Elliot Lake is the only lake in the watershed with an urban community. The residents of the city are potentially exposed to radioactive substances via consumption of Elliot Lake water and recreational use of mine properties, and are considered to be the population with the greatest potential for exposure to radiation and radioactive materials from the closed mine sites.

A preliminary design for a monitoring program to support public dose estimation was prepared in early 2016 (Ecometrix, 2016). Based on this plan, site-specific surveys of residents were completed in 2016 to characterize their exposure pathways and habits relevant to exposure. Additional radiological monitoring in 2016 included radon and gamma monitoring on roads and trails near TMAs often used by walkers and hikers and radionuclide monitoring of drinking water. This information was used in conjunction with historic fish tissue data to estimate an interim public dose for a representative resident of the City of Elliot Lake (Ecometrix, 2018). The present report provides an update to the public dose, in consideration of recent fish tissue data.

1.2 Objectives

The objective of this report is to document site-specific survey and monitoring data relevant to public exposure, and use it to derive a realistic public dose estimate for a representative person in the population group living near the closed mine properties in the Serpent River watershed. It is recognized that some revisions to the estimated public dose may be appropriate as environmental monitoring data are updated in future. Any data changes up to 2024 will be addressed as part of the updates to the representative public dose in the 2025 State of the Environment Report.

2.0 THE REPRESENTATIVE PERSON AND MAIN EXPOSURE PATHWAYS

2.1 The Representative Person

In estimating public dose for comparison to a dose constraint, the dose is estimated for a "representative person" with characteristics that reflect those of the group that receives the highest dose (ICRP, 2007). The representative person is equivalent to, and replaces, the "average member of the critical group" which was previously used for determining compliance with a public dose constraint (ICRP, 1986).

The critical group within which the representative person is defined must be large enough to support reliable characterization of typical habits relevant to exposure, and should be relatively homogeneous. The ICRP has defined homogeneity to mean that the individual doses within the group lie substantially within a range of a factor of ten, provided that the mean is less than one-tenth of the dose limit (ICRP, 1986). The preliminary survey of 300 Elliot Lake residents indicates that, of those using TMAs for walking and hiking, the use rates vary within a factor of ten. Since this is the dominant exposure pathway of dose, the Elliot Lake group was considered to be homogeneous.

The group size and homogeneity conditions imply that the representative person should not be characterized based on single individuals or households with extreme behaviors. Rather, the representative person can reflect an average across distinct practices within the group. Site-specific surveys on habits relevant to exposure should be conducted to characterize the representative person. Surveys should address the use of local food and water resources, as appropriate. The Elliot Lake survey addressed local fish consumption, as well as TMA use for walking and hiking.

In characterizing the representative person, averaging should not occur across age classes. The ICRP considers three age classes, for which intake rates and dose coefficients have been defined (ICRP, 2007). Nominal ages are 1 year (age 0 to 5), 10 years (age 6 to 15) and adult (age 16 to 70). These age classes may be designated infant, child and adult (CSA, 2014). Since Elliot Lake is a retirement community, the adult age class is dominant, with only 10% of the population in the 0-14 age group according to the 2011 census. The preliminary survey of 300 residents indicated that only 6 out of 300 respondents had children under the age of 16 who walk or hike around the closed mine properties, and only 7 had children who eat locally caught fish. The small sample sizes make it difficult to reliably characterize TMA or local fish use rates for child or infant age groups. Therefore, only adult doses were estimated.

2.2 Main Exposure Pathways

Upper bound ingestion doses to hypothetical human residents on lakes downstream of the TMAs were estimated by Ecometrix (Ecometrix, 2011) and included in Appendix F of the

2011 SOE report (Minnow, 2011). While these estimates are conservative, and are not considered suitable as public dose estimates, they provide a preliminary indication of key ingestion pathways. The dose estimate for a hypothetical resident on Elliot Lake, after correction for background, was 0.0244 mSv/a. The ingestion dose estimates were based on 1.5 L/day of lake water intake, 2.92 kg/year of local fish consumption, 1 kg/year of local waterfowl (mallard) consumption and 1 kg/year of local moose meat consumption. Of the pathways considered, intake of drinking water and fish accounted for almost 99% of the incremental dose (73% from drinking water, 26% from fish). These two main exposure pathways have been included in the public dose calculations.

Upper bound doses arising from exposure to radon and gamma radiation while walking near TMAs were estimated by the CNSC as 0.04 and 0.06 mSv/a (incremental), respectively, based on an assumed 200 hours each year at the location of highest measured radon and gamma radiation (Lacnor and Nordic TMAs) (CNSC, 2002). The gamma dose estimate makes no allowance for the cover that was placed on the tailings after the gamma survey. The incremental dose from radon was estimated as 0.016 mSv/a for a person at Nordic Lake. The radon dose estimates assume full progeny ingrowth. While these estimates are overly conservative, and not suitable as public dose estimates, they suggest that radon and direct gamma pathways should be included in the public dose calculations.

The assumed water ingestion rate of 1.5 L/day (Health Canada, 1995) is an average value for adults in the general population. The water supply for Elliot Lake residents comes from Elliot Lake. Water consumption rates are physiologically driven, thus it is reasonable to apply this rate to the Elliot Lake water supply for Elliot Lake residents.

The assumed fish ingestion rate of 2.92 kg/year (8 g/day, U.S. EPA, 1997) is a value for freshwater anglers. The U.S. EPA also cites a value of 5 g/day for anglers around Lake Ontario (U.S. EPA, 2011). The assumption that all fish are taken from Elliot Lake is probably overly conservative. While Elliot Lake and other local lakes may be used, it is likely that much of the fish consumption is not of local origin. The 2016 site-specific survey has been used in the present assessment to clarify local amounts of fish consumption.

The concentrations of radionuclides in water that have been used in historical dose calculations are either measured values in Elliot Lake water, or values estimated from sediments and partition coefficients. The water quality monitoring data are often reported as “non-detects”, which are values below the reporting limit. The use of water quality monitoring data for Elliot Lake means that there has been no accounting in the past for water treatment. 2016 treated water monitoring results have been used in the present assessment for the calculation of dose from municipal drinking water.

The concentrations of radionuclides in sport fish that have been used in the dose calculations are either measured values in sport fish from Elliot Lake, or values estimated from water and bioaccumulation factors. The fish chemistry data are often reported as non-detects. Only Unat and Ra-226 have previously been measured in sport fish. Some of the bioaccumulation factors used previously for sport fish were estimated from forage fish values. 2019 measured activities in sport fish have been used in the present assessment for the calculation of dose from fish ingestion.

3.0 SURVEYS AND MONITORING TO CHARACTERIZE EXPOSURE

The site-specific surveys and monitoring programs support the estimation of realistic public dose to a representative person residing in the City of Elliot Lake. Based on the main exposure pathways identified in Section 2.2, the surveys and monitoring program included the following components: surveys to refine estimates of time spent hiking at TMAs, surveys to refine estimates of fish consumed from lakes downstream of TMAs, monitoring of radon and gamma where people walk, hike or otherwise use trails and roads at TMAs, monitoring of radionuclides in drinking water, and monitoring of radionuclides in fish. The design of surveys and monitoring programs is discussed in the following sections.

3.1 Survey of Habits Relevant to Exposure

The intent of the site-specific surveys of residents is to characterize exposure pathways and habits relevant to exposure. The survey form for trail users and fishers was designed to address the following questions:

- How many hours do residents use trails and roads at the TMAs?
- How do people divide their trail use time among the TMAs?
- Where do people fish and how much fish do they consume from each lake?
- Which fish species are consumed?

The answers provided in the survey informed the estimation of public dose and the design of the monitoring programs for radon, gamma and sport fish. The survey was administered to residents of the Elliot Lake area as part of a larger community survey conducted on behalf of Rio Algom Limited by Globescan. A screening question was included at the beginning of the survey to determine whether the respondent is a resident of Elliot Lake. Data were collected from one respondent per household who responded on behalf of the entire household.

The survey questions and results are provided in Appendix A.

It is expected that most people in Elliot Lake will be on municipal water, which is drawn from Elliot Lake and treated prior to distribution. There are some homeowners and cottage owners on the lakefront, who take water directly from the lake, and Quirke Lake is the main area for development. There may also be some people who drink bottled water. In characterizing the representative Elliot Lake resident, it would be reasonable to assume that this person drinks water from the municipal system. Surveys to investigate the frequency of use of drinking water sources other than the municipal water supply could be considered at a later date, based on information about these sources.

3.2 Measurements of Radon and Direct Gamma

The intent of the radon and direct gamma monitoring program is to characterize levels of exposure to radon and direct gamma for trail users at the TMAs.

Denison Environmental Services (DES, 2016a,b) conducted an initial monitoring program in December 2015 to measure radon and direct gamma radiation during walking surveys at the Lacnor, Milliken, Stanleigh, Quirke, Panel, Nordic, Pronto, Denison and Stanrock TMAs. In 2016, the surveys were repeated quarterly and extended to include the Buckles tailings and the Spanish American TMA. DES provided the data. The surveys were conducted quarterly to assess seasonal variability. Figures showing the location of the walking surveys are provided in Appendix B. The Esten Lake boat launch trail was surveyed to estimate background radiation in areas uninfluenced by TMAs. Radon decay products were collected on filter paper with an air sampling pump and then alpha radiation was measured using a scintillometer. Gamma radiation was measured using an SEI Inspector USB multi-radiation detector.

Radon was typically highest in October or December and lowest in April or July, with a maximum/minimum ratio ranging between 8 and 28. The gamma field was typically highest in July or October, but was much less variable, and was the dominant component of exposure for a walker near any TMA. The maximum/minimum ratio for the total exposure ranged between 1.1 and 1.9, and averaged 1.4. Since there was little seasonality in total exposure, it was considered acceptable to characterize TMA use on an annual basis.

3.3 Monitoring of Concentrations in Drinking Water and Fish

The intent of the monitoring program for drinking water and sport fish is to characterize levels of exposure to radionuclides through the ingestion pathway.

The water treatment plant for the City of Elliot Lake provides annual reporting on concentrations of uranium in treated water. Recent annual reports indicate that uranium concentrations in municipal drinking water were 0.172 µg/L on 31 January 2014 and 0.149 µg/L on 22 July 2015 (City of Elliot Lake, 2014, 2015). Uranium concentrations in treated municipal drinking water are approximately one tenth of uranium concentrations in untreated water from Elliot Lake, based on 2010 lake water quality used in the previous dose assessment for Elliot Lake (Ecometrix, 2011).

Monitoring of radionuclides in treated municipal drinking water was completed in August 2016 and November 2016 to provide additional data to support the estimation of annual public dose. Data for treated water were used in the present assessment.

Detection limits for radionuclides in drinking water were 0.1 µg/L for U, 0.01 Bq/L for Th-230, 0.005 Bq/L for Ra-226, 0.02 Bq/L for Pb-210, and 0.005 Bq/L for Po-210. Certificates of Analysis for drinking water are provided in Appendix C.

Radionuclides in the Th-232 series were not detected in lake waters during the special investigation study (Ecometrix, 2011). They were elevated in sediments relative to background only in Quirke and May lakes. Using partitioning estimates of concentrations in water, the drinking water dose from the Th-232 series contributed less than 5% of the total ingestion dose for the representative human at Elliot Lake. The analysis of Th-232 radionuclides in drinking water was not considered to be warranted because of its small contribution to total dose.

Sport fish were collected in 2019 by gill net and hoop net, in three exposed lakes (Elliot, Quirke and McCarthy lakes) and a reference lake (Dunlop Lake) (Minnow, 2020). The three exposed lakes were the lakes in the Serpent River watershed most used by sport fishers (Ecometrix, 2018). While lake trout and walleye were targeted, as the species most consumed by Elliot Lake residents, only two lake trout and no walleye were caught. Smallmouth bass and northern pike are next in order of preference, based on site-specific survey results, and sufficient numbers were collected. Five fish of these species in each lake were analyzed for U-238 series radionuclides (Minnow, 2020).

Detection limits for radionuclides in sport fish were 0.001 ug/g for Unat, 0.1-0.5 Bq/kg for Th-230, 0.2 Bq/kg for Ra-226, 1 Bq/kg for Pb-210, and 0.2 Bq/kg for Po-210 (all values on a fresh weight basis). Measured values in fish flesh were at or below detection limits for Unat and Pb-210, consistently below for Th-230, above or below for Ra-226, and consistently above for Po-210. The report by Minnow (2020) and Certificates of Analysis for sport fish, are provided in Appendix D.

Radionuclides in the Th-232 series were not measured in sport fish during the special investigation study (Ecometrix, 2011). They were elevated in sediments relative to background only in Quirke and May lakes. Using bioaccumulation estimates of concentrations in sport fish, the sport fish dose from the Th-232 series contributed less than 1% of the total ingestion dose for the representative human at Quirke Lake and 3% of the total ingestion dose for the representative human at May Lake. The analysis of Th-232 radionuclides in sport fish is not considered to be warranted because of its small contribution to total dose.

4.0 ESTIMATION OF PUBLIC DOSE

4.1 Overview of Approach

The approach to public dose estimation is intended to capture the main exposure pathways for Elliot Lake residents, as discussed in Section 2.2. Those pathways are exposure to radon and direct gamma radiation while walking near TMAs, ingestion of drinking water from Elliot Lake, and ingestion of fish caught in lakes downstream of the TMAs. The approach is intended to produce a realistic dose estimate, and uses 2016 survey and monitoring data to improve the estimate. A dose estimation for adult residents is presented here to illustrate the approach. The adult age class is dominant in Elliot Lake, as noted in Section 2.1; therefore, only adult dose was calculated. The use of survey and monitoring data and the assumptions made in this initial dose estimation are discussed by pathway in the following sections.

4.2 Radon and Direct Gamma Measurements

Measurements of dose from radon progeny in air and from direct gamma radiation while walking on roads and trails near the TMAs were obtained by Denison Environmental Services during four surveys in 2016 (April, July, October, December) (data provided by DES). Radon decay products were collected on filter paper with an air sampling pump and then alpha radiation was measured using a scintillometer. Gamma radiation was measured using an SEI Inspector USB multi-radiation detector. Table 4.1 summarizes the monitoring results assuming that the time spent close to TMAs would be 200 hours per year.

Measurements at the Esten Lake boat launch trail provide an estimate of background dose while walking in areas uninfluenced by TMAs. The Esten Lake area was chosen because it has similar environmental characteristics to the TMAs, but has no tailings nearby.

A survey of Elliot Lake residents conducted by Rio Algom Limited in 2016 (Appendix A) provides an estimate of the actual number of hours per year spent walking near TMAs for the representative person, and the proportion of that time spent at each TMA. The measured doses recorded for a nominal 200 hours per year at each TMA were adjusted for actual hours, and a weighted average dose across TMAs was calculated using the proportion of time at each TMA based on the resident survey. The average number of hours per year walking at TMAs was 110.76 hours (2.13 hours per week) for a typical Elliot Lake resident.

The survey of Elliot Lake residents indicated that Milliken/Sheriff Creek Park was most used for walking and hiking, followed by the Quirke TMA. The use proportions for the TMAs, as reported in the survey, were adjusted up to account for the people who did not know the TMA used. The resulting proportions (45.3% Milliken, 12.6% Quirke, 9.5% Stanleigh, 9.5% Nordic, 8.4% Panel, 7.4% Denison, and 7.4% Stanrock) were used to allot the time spent walking among TMAs, making a weighted average dose from casual access at TMAs for the typical Elliot Lake resident.

Table 4.1: Radon and Direct Gamma Doses from Walking Near TMAs for a Nominal 200 Hours per Year (2016)

Site	Route	Radon Dose (mSv/a*)	Gamma Mean Dose (mSv/a*)	Total Annual Dose (mSv/a*)	Annual Dose for TMA (mSv/a*)
Denison	William's Lake ETP to Settling Pond Berm	0.003818	0.058728	0.062545	0.04687
	TMA 1 Treatment Plant to Dam 10	0.001430	0.029773	0.031203	
Stanrock	Main Gate to Rooster Rock	0.004158	0.043343	0.047501	0.04657
	Main Gate to Dam A Gate	0.003121	0.042525	0.045646	
Lacnor	Dumbell Lake gate to Dam A	0.001476	0.060696	0.062172	0.062172
Milliken	Tailing Management Area (Sheriff Creek Sanctuary)	0.001902	0.028084	0.029986	0.029986
Stanleigh	Gate 1 to Gate 2	0.002274	0.032206	0.034480	0.053916
	Tailing Management Area	0.001935	0.071417	0.073353	
Quirke	Gate to gate	0.006848	0.041048	0.047896	0.047896
Panel	Gate 1 to peninsula	0.004803	0.066627	0.071430	0.063754
	Tailing Management Area	0.003384	0.052695	0.056079	
Nordic	Gate to past Treatment Plant	0.001451	0.063308	0.064759	0.064759
Buckles		0.001883	0.046327	0.048210	0.048210
Pronto	Gate to Treatment Plant	0.002134	0.040689	0.042822	0.04005
	Tailing Management Area	0.003638	0.03363	0.037268	
Spanish American	Tailing Management Area	0.00169	0.036063	0.037753	0.037753
Esten Lake	Esten Boat Launch trail	0.001866	0.024304	0.026170	0.026170

*Based on a radiation exposure period of 200 hours.

The casual access dose from measured radon and direct gamma radiation includes a background component. In order to calculate an incremental dose from walking near the TMAs, the dose as measured at Esten Lake must be subtracted from the dose measured at each TMA.

4.3 Radionuclides in Drinking Water and Fish

Measurements are available for some radionuclides in Elliot Lake drinking water (City of Elliot Lake, 2014, 2015), and in flesh samples from sport fish collected in lakes downstream of the TMAs (Elliot Lake, Quirke Lake and McCarthy Lake) and in a reference lake (Minnow, 2005). Additional samples of treated drinking water were obtained by DES in August and November of 2016 and analyzed by SRC Environmental Analytical Laboratories for U-238 series radionuclides.

Based on the City of Elliot Lake measurements of uranium in treated drinking water (0.149 and 0.172 µg/L), and the two DES measurements (both <0.1 µg/L), the average uranium concentration in the treated water was 0.13 µg/L, or approximately one thirteenth of the lake water concentrations used in previous dose assessments for Elliot Lake (Ecometrix, 2011), where uranium was 1.7 µg/L. Those concentrations included measured values for uranium and Pb-210, and detection limit values (<0.01 Bq/L) for Th-230, Ra-226 and Po-210. For the public dose assessment, the treated water concentration of uranium was 0.13 µg/L and the concentrations of Th-234 and Th-230 were assumed to have the same ratios to U as reported for lake water by Ecometrix (Ecometrix, 2011). Ra-226 in treated drinking water was estimated from the uranium concentration, based on the Ra/U ratio reported by Health Canada (2009) for the Elliot Lake water supply (0.015 Bq/L Ra per µg/L U). Pb-210 and Po-210 were estimated from the Ra-226, based on the ratios for Elliot Lake water reported by Ecometrix (2011). All the estimated radionuclide concentrations were below their limits of detection.

Health Canada has reported historical data for the Elliot Lake water supply (before treatment) (Health Canada, 2009). The data show that concentrations of uranium and Ra-226 were relatively constant in 1995-96 when the record ends, at about 0.6 µg/L and 0.007 Bq/L respectively. The concentrations for treated water, at present, are about one third of this level.

The treated drinking water concentrations include a background component. It is unclear what the background levels are in treated water. However, Health Canada (2009) reports that concentrations in Canadian water supplies range from <0.1 to 1 µg/L for uranium, and from <0.005 to 0.02 Bq/L for Ra-226. In order to calculate an incremental dose from treated drinking water at Elliot Lake, a background uranium concentration of 0.1 µg/L was assumed, and background concentrations of other radionuclides were estimated using ratios as described above. This implies a background concentration of 0.0015 Bq/L for Ra-226, which is unlikely to be detectable. Incremental dose can be calculated by subtracting the dose based on background concentrations from the dose based on Elliot Lake concentrations.

Using this low level of background is conservative, resulting in calculation of a small incremental exposure. Health Canada has suggested that the measured levels of radionuclides in the Elliot Lake water supply likely represent natural background rather than effects from uranium mining operations (Health Canada, 2019).

Average measured concentrations of Unat, Ra-226 and Po-210 in 2019 sport fish, by lake, were used in the public dose assessment. Concentrations of Th-230 were estimated from uranium, and concentrations of Pb-210 were estimated from Ra-226, except for one detected value, using the isotope ratios that were previously found in forage fish (Ecometrix, 2011).

The survey of Elliot Lake residents by Rio Algom Limited in 2016 indicates that Elliot Lake, Quirke Lake and McCarthy Lake are the lakes most used for local fish consumption. The use proportions for these lakes from the survey were adjusted to account for the people who did not know the lake fished, and to include the small fraction of people who used May Lake or Nordic Lake (collectively only 4% of users who knew the lake fished). The resulting proportions (50.4% Elliot, 28.3% Quirke, and 21.2% McCarthy) were used to weight the fish flesh concentrations across lakes, making a set of average concentrations for fish taken from exposed lakes, i.e. those downstream of TMAs.

The survey information also provided an estimate of the number of meals per year of fish from lakes downstream of TMAs (Elliot, Quirke, Nordic, McCabe, May and McCarthy), and this was converted to an intake rate for the representative person. The survey indicated an average of 7 meals per year for the typical Elliot Lake resident. For the interim dose estimate, using a meal size of 0.227 kg (fresh weight) (OMOECC, 2015), the intake rate of local fish was estimated at 1.59 kg/year.

The sport fish concentrations include a background component. Background levels were taken from sport fish collected in Dunlop Lake in 2019 (Minnow, 2020). Incremental dose from fish was estimated by subtracting the dose based on background concentrations from the dose based on exposed lake concentrations in fish flesh. It should be noted that Po-210 in fish was slightly higher in Dunlop Lake than the average value for exposed lakes, and Po-210 is a major part of dose from fish, so the incremental dose from fish is effectively zero.

4.4 Public Dose Estimate

The public dose estimate for a representative person (adult) at Elliot Lake was calculated using radon and direct gamma measurements near TMAs, and radionuclide concentrations in treated drinking water and in sport fish flesh, as described above in Sections 4.2 and 4.3.

The casual access dose was calculated assuming 110.76 hours per year spent walking near the TMAs. The adult water intake of 1.5 L/d (Health Canada, 1995) was assumed to occur 365 days per year. This intake rate was applied to treated Elliot Lake drinking water. The adult intake of sport fish flesh from affected lakes was assumed to be 1.59 kg/year on a fresh weight basis.

Using these access and ingestion rates, the dose to human receptors was calculated as follows:

$$D_h = D_{r+g} + (C_w \bullet I_w + C_f \bullet I_f) \bullet DCF_i$$

where:

where:	D_h	=	human radiation dose (Sv/a)
	D_{r+g}	=	dose from radon and gamma, with TMA-specific values weighted by proportion of local walking time spent at each TMA (Sv/a)
	C_w	=	activity concentration in drinking water (Bq/L)
	I_w	=	drinking water intake rate (L/a)
	C_f	=	concentration in sport fish flesh, with lake-specific values weighted by proportion of local intake arising from each lake (Bq/kg fw)
	I_f	=	intake of sport fish flesh from affected lakes (kg fw / a)
	DCF_i	=	ingestion dose coefficient (Sv/Bq)

Ingestion dose coefficients were taken from ICRP Publication 72 (ICRP, 1996). The values provided by ICRP include dose contributions from progeny that may grow in over a lifetime following radionuclide ingestion. In addition, the values listed for parents and short-lived progeny have been combined to account for environmental ingrowth of progeny.

The dose limit for people (members of the public) is 1 mSv/a, as recommended in ICRP Publication 60 (ICRP, 1991). This is an incremental dose. Background radiation exposure, including natural and anthropogenic sources, is typically about 2 mSv/a (Health Canada, 2014). In addition, Health Canada has defined a dose constraint of 0.3 mSv/a as an incremental value above which dose management may be needed for naturally occurring radioactive materials (Health Canada, 2014). This is a conservative value which allows for exposure from other sources while still ensuring that incremental dose to a member of the public does not exceed the public dose limit.

The human doses calculated from measured radon, direct gamma, and radionuclide concentrations in affected areas include a natural background component. Therefore, the background component must be removed before comparison to the public dose limit, or to a dose constraint. The background component was estimated as described above, but using background values for radon, direct gamma and radionuclide concentrations, as described in Sections 4.2 and 4.3.

The total dose estimate, including background, as outlined in Table 4.2, is 0.035 mSv/a. The background dose estimate, as outlined in Table 4.3, is 0.026 mSv/a, and the incremental dose is 0.01 mSv/a. This is well below the public dose limit of 1 mSv/a, and also well below the dose constraint of 0.3 mSv/a.

Table 4.2: Estimation of Background-Inclusive Dose for a Representative Adult in Elliot Lake

Parameter	Units	U238/234	TH234+	TH230	RA226	RN222+	PB210+	PO210	TOTAL
Water conc.	Bq/L	0.0032	0.0026	0.0008	0.0020	0.0020	0.0059	0.0020	
Sport fish tissue conc.	Bq/kg (fw)	0.025	0.012	0.007	0.257	0.026	0.483	3.260	
Ingestion rate water	L/a	547.5	547.5	547.5	547.5	547.5	547.5	547.5	
Ingestion rate fish	kg/a	1.59	1.59	1.59	1.59	1.59	1.59	1.59	
Exposure via water	Bq/a	1.75	1.41	0.42	1.07	1.07	3.20	1.07	
Exposure via fish	Bq/a	0.04	0.02	0.01	0.41	0.04	0.77	5.18	
Ingestion DCF adult	Sv/Bq	4.70E-08	3.40E-09	2.10E-07	2.80E-07	2.50E-10	6.91E-07	1.20E-06	
Dose via water	mSv/a	8.23E-05	4.80E-06	8.79E-05	2.99E-04	2.67E-07	2.21E-03	1.28E-03	3.97E-03
Dose via fish	mSv/a	1.84E-06	6.56E-08	2.38E-06	1.15E-04	1.02E-08	5.31E-04	6.22E-03	6.87E-03
Total ingestion dose	mSv/a	8.41E-05	4.87E-06	9.03E-05	4.14E-04	2.77E-07	2.75E-03	7.50E-03	1.08E-02
Casual access dose	mSv/a								2.39E-02
Total dose	mSv/a								3.47E-02

* mg/L U x 24.6 Bq/mg   # mg/kg x 24.6 Bq/mg

+ indicates that progeny contributions are included in the DCF

Table 4.3: Estimation of Background Dose for a Representative Adult

Parameter	Units	U238/234	TH234+	TH230	RA226	RN222+	PB210+	PO210	TOTAL
Water conc.	Bq/L	0.0025*	0.0020	0.0006	0.0015	0.0015	0.0045	0.0015	
Sport fish tissue conc.	Bq/kg (fw)	0.025#	0.012	0.007	0.240	0.024	0.436	3.940	
Ingestion rate water	L/a	547.5	547.5	547.5	547.5	547.5	547.5	547.5	
Ingestion rate fish	kg/a	1.59	1.59	1.59	1.59	1.59	1.59	1.59	
Exposure via water	Bq/a	1.35	1.09	0.32	0.82	0.82	2.46	0.82	
Exposure via fish	Bq/a	0.04	0.02	0.01	0.38	0.04	0.69	6.26	
Ingestion DCF adult	Sv/Bq	4.70E-08	3.40E-09	2.10E-07	2.80E-07	2.50E-10	6.91E-07	1.20E-06	
Dose via water	mSv/a	6.33E-05	3.70E-06	6.76E-05	2.30E-04	2.05E-07	1.70E-03	9.86E-04	3.05E-03
Dose via fish	mSv/a	1.84E-06	6.56E-08	2.38E-06	1.07E-04	9.54E-09	4.80E-04	7.52E-03	8.11E-03
Total ingestion dose	mSv/a	6.51E-05	3.76E-06	7.00E-05	3.37E-04	2.15E-07	2.18E-03	8.50E-03	1.12E-02
Casual access dose	mSv/a								1.45E-02
Total dose	mSv/a								2.57E-02

* mg/L U x 24.6 Bq/mg   # mg/kg x 24.6 Bq/mg

+ indicates that progeny contributions are included in the DCF

5.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the public dose calculations, it may be concluded that:

- Public dose to the representative person is approximately 0.01 mSv/a, after correction for background exposure.
- This value is based on available measurements of radon and direct gamma near TMAs, and U-238 series radionuclides in treated drinking water and sport fish, as well as critical group survey information and several assumptions for exposure factors.

The public dose estimation may be refined in the future based on information from critical group surveys and from the monitoring program.

Recommendations for the monitoring program to support future public dose estimates include:

- In subsequent cycles, consider whether the resident survey or components of the monitoring program may need to be updated, based on possible demographic changes in the community, changes in waste management operations, or trends observed in the watershed monitoring program.

The information from the resident survey and monitoring programs is expected to be used in public dose estimation as described in Section 4.4. Public dose estimates may be revised in the future as the relevant information is updated.

6.0 REFERENCES

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Appendix A Questionnaire and Results for Survey of Elliot Lake Residents

q5.1t recode. How many years have you lived in the area around Elliot Lake?

Sample Size	300
Less than 1	
Column %	1
1 - 5	
Column %	8
6 - 10	
Column %	9
11 - 15	
Column %	9
16 - 20	
Column %	14
21 - 25	
Column %	8
26 - 30	
Column %	6
31 - 35	
Column %	6
36+	
Column %	37
DK/NA	
Column %	1

q5.1t_mean. How many years have you lived in the area around Elliot Lake?

Sample Size	296
Mean	29
Std. Dev.	18

Q5.2. Do you ever eat fish that was caught in local lakes - in other words, from either Elliot Lake, McCarthy Lake, May Lake, Nordic Lake or Quirke Lake?

Sample Size	300	Meals/Year		Weighted Average Meals per Year
Yes - at least three times a week or more				
Column %	1	156		7
Yes - around once a week on average over the year				
Column %	8	52		
Yes - about once a month on average over the year				
Column %	14	12		
Yes - a few times a year				
Column %	41	3		
No, never				
Column %	31	0		
DK/NA				
Column %	5	0		

Q5.3. Of the lakes I just mentioned, where would you say most of the local fish that you eat comes from?

Sample Size	192	% of those that know	
Elliot Lake			
Column %	30	48.3	50.4
McCarthy Lake			
Column %	13	20.3	21.2
McCabe Lake			
Column %	0	0.0	
May Lake			
Column %	2	3.4	omit
Nordic Lake			
Column %	1	0.8	omit
Quirke Lake			
Column %	17	27.1	28.3
DK/NA			
Column %	39		

Q5.4. What species of fish caught from local lakes would you say you eat most often?	
Sample Size	192
Lake trout	
Column %	43
Brook/Speckle trout	
Column %	2
Rainbow trout	
Column %	4
Northern pike	
Column %	6
Smallmouth bass	
Column %	7
Walleye/Pickerel	
Column %	21
Splake	
Column %	1
Perch	
Column %	3
Whitefish	
Column %	1
Sturgeon	
Column %	1
Other	
Column %	13
Q5.5. Do you have any children under the age of 16 in your household that eat fish that was caught in local lakes - in other words, from either Elliot Lake, McCarthy Lake, McCabe Lake, May Lake, Nordic Lake or Quirke Lake?	
Sample Size	300
Yes	
Column %	7
No	
Column %	92
DK/NA	
Column %	2

q5.7 recode. How many hours per week would you say you spend walking or hiking around the closed mine properties in the area? (this would include Quirke, Panel, Spanish American, Stanleigh, Milliken and Sheriff Creek Park, Lacnor, Nordic, Buckles, Pronto, Denison and Stanrock)

Sample Size	300
Zero	
Column %	59
1 - 5	
Column %	18
6 - 10	
Column %	7
11 - 15	
Column %	3
16 - 20	
Column %	1
21+	
Column %	1
DK/NA	
Column %	12

q5.7_mean. How many hours per week would you say you spend walking or hiking around the closed mine properties in the area...?

Sample Size	264	Hours per Year
Mean	2.13	110.76
Std. Dev.	5.39	

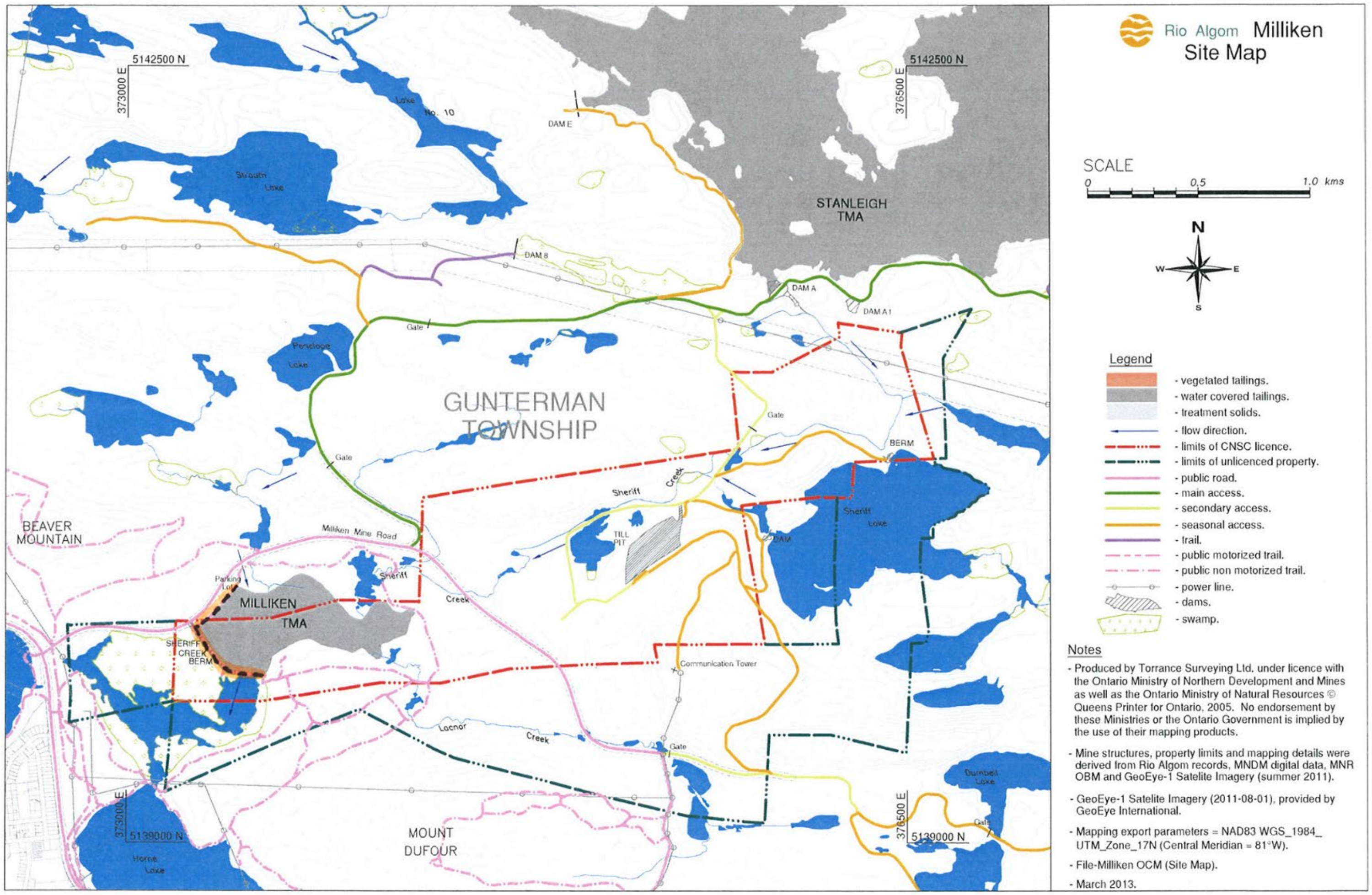
Q5.8. Considering the mine properties I just mentioned, on which one would you say you walk or hike the most?

Sample Size	124	% of those that know
Quirke		
Column %	10	12.6
Panel		
Column %	6	8.4
Spanish American		
Column %	0	0.0
Stanleigh		
Column %	7	9.5
Milliken / Sheriff Creek Park		
Column %	35	45.3
Lacnor		
Column %	0	0.0
Nordic		
Column %	7	9.5
Buckles		
Column %	0	0.0
Pronto		
Column %	0	0.0
Denison		
Column %	6	7.4
Stanrock		
Column %	6	7.4
DK/NA		
Column %	23	

Q5.9. Do you have any children under age 16 who spend time walking or hiking around the closed mine properties in the area...?

Sample Size	300
Yes	
Column %	6
No	
Column %	92
DK/NA	
Column %	2

Appendix B Site Maps with Walking Surveys for Radon and Gamma


Rio Algom Milliken Site Map
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.
- power line.
- dams.
- swamp.
Notes
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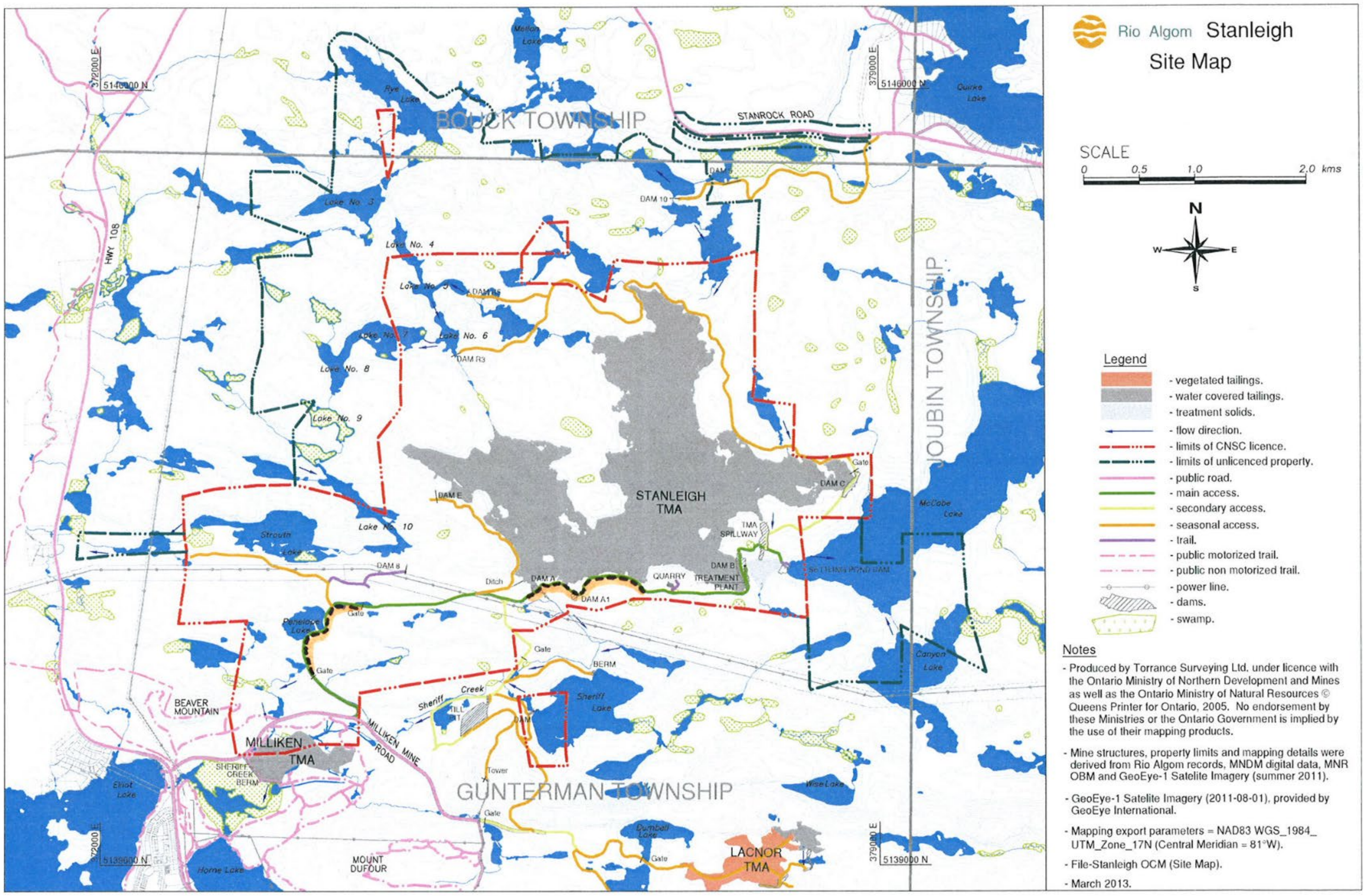
- Mine structures, property limits and mapping details were derived from Rio Algom records, MNDM digital data, MNR OBM and GeoEye-1 Satelite Imagery (summer 2011).
- GeoEye-1 Satelite Imagery (2011-08-01), provided by GeoEye International.
- Mapping export parameters = NAD83 WGS_1984_ UTM_Zone_17N (Central Meridian = 81°W).
- File-Milliken OCM (Site Map).
- March 2013.
5142500 N
373000 E
376500 E
5139000 N
STANLEIGH TMA
GUNTERMAN TOWNSHIP
MILLIKEN TMA
BEAVER MOUNTAIN
MOUNT DUFOUR
SHERIFF CREEK BERM
DAM A
DAM A1
DAM B
DAM E
BERM
Sheriff Creek
Sheriff Lake
TILL PIT
Milliken Mine Road
Communication Tower
Gate
Lacnor Creek
Horne Lake
Dunlop Lake
Parking Lot


Rio Algom Stanleigh
Site Map
SCALE
0 0.5 1.0 2.0 kms
N
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.
- power line.
- dams.
- swamp.
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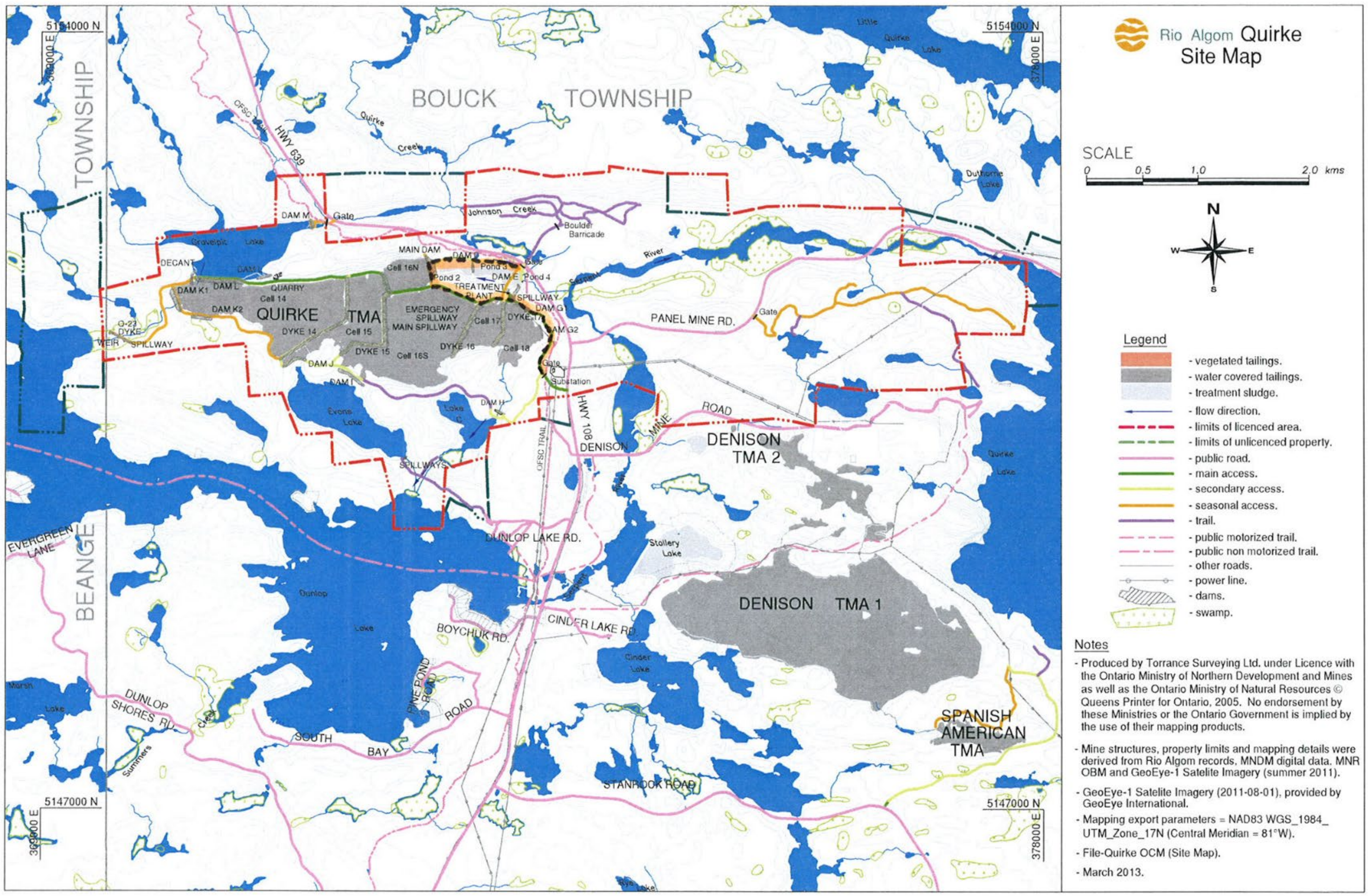
- GeoEye-1 Satelite Imagery (2011-08-01), provided by GeoEye International.
- Mapping export parameters = NAD83 WGS_1984_UTM_Zone_17N (Central Meridian = 81°W).
- File-Stanleigh OCM (Site Map).
- March 2013.
BOUCK TOWNSHIP
JOUBIN TOWNSHIP
GUNTERMAN TOWNSHIP
STANROCK ROAD
STANLEIGH TMA
MILLIKEN TMA
LACNOR TMA
MILLIKEN MINE ROAD
HWY 108
BEAVER MOUNTAIN
MOUNT DUFOUR
TMA SPILLWAY
TREATMENT PLANT
QUARRY
DAM A
DAM A1
DAM B
DAM C
DAM E
DAM 8
DAM 10
DAM R3
Lake No. 3
Lake No. 4
Lake No. 6
Lake No. 8
Lake No. 9
Lake No. 10
Sheriff Creek
Sheriff Lake
McCabe Lake
Canyon Lake
Elliot Lake
Home Lake
Penelope Lake
Strouth Lake
Rye Lake
Quirke Lake
372000 E
379000 E
5146000 N
5139000 N



Rio Algom Quirke
Site Map
SCALE
0 0.5 1.0 2.0 kms
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.
- other roads.
- power line.
- dams.
- swamp.
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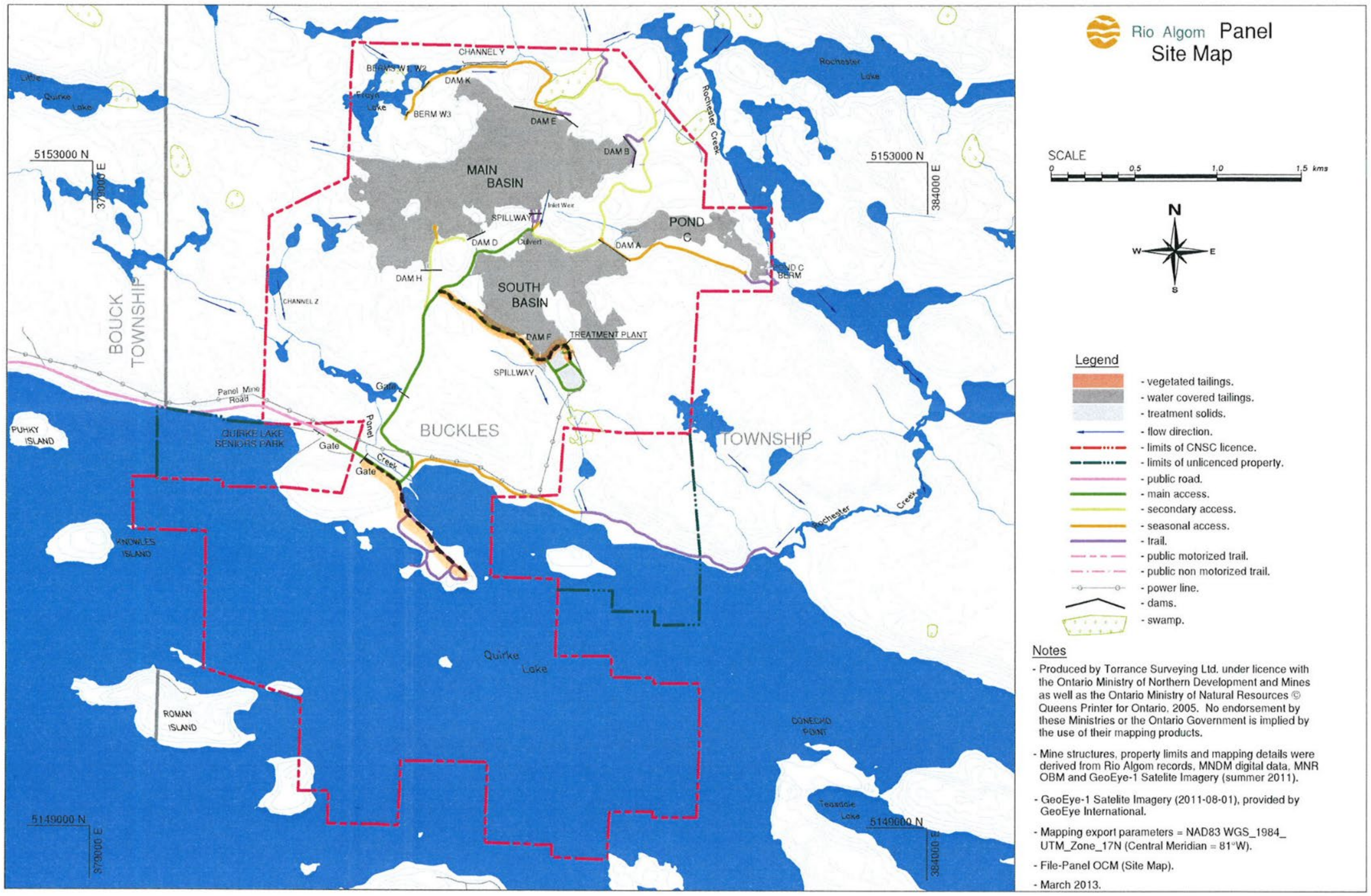
- GeoEye-1 Satellite Imagery (2011-08-01), provided by GeoEye International.
- Mapping export parameters = NAD83 WGS_1984_ UTM_Zone_17N (Central Meridian = 81°W).
- File-Quirke OCM (Site Map).
- March 2013.
BOUCK TOWNSHIP
BEANGE TOWNSHIP
QUIRKE TMA
DENISON TMA 2
DENISON TMA 1
SPANISH AMERICAN TMA
PANEL MINE RD.
DUNLOP LAKE RD.
CINDER LAKE RD.
BOYCHUK RD.
DUNLOP SHORES RD.
SOUTH BAY ROAD
STANROCK ROAD
DENISON MINE ROAD
HWY 639
HWY 108
5154000 N
5147000 N
378000 E


Rio Algom Panel
Site Map
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.
- power line.
- dams.
- swamp.
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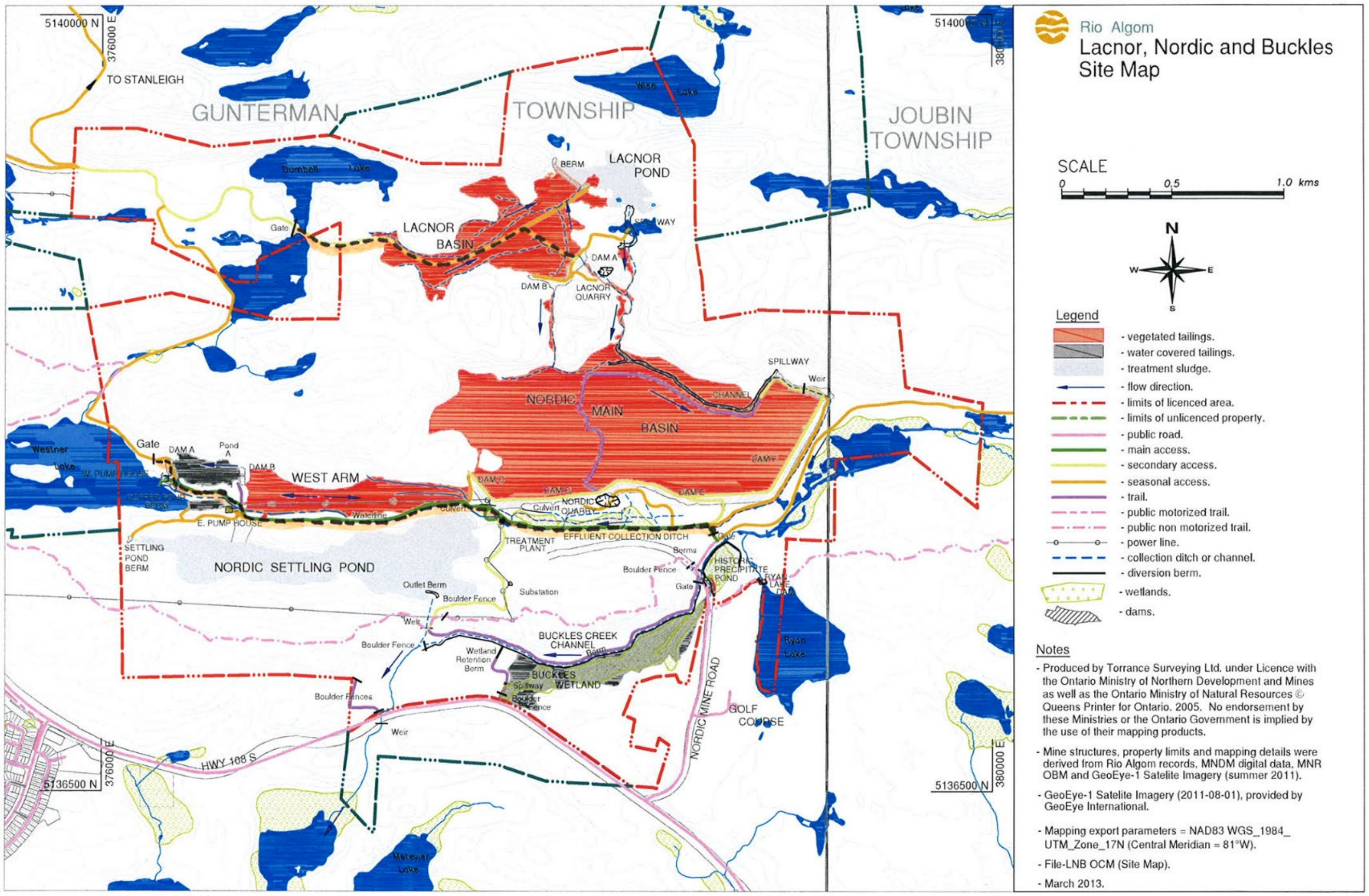
- GeoEye-1 Satelite Imagery (2011-08-01), provided by GeoEye International.
- Mapping export parameters = NAD83 WGS_1984_UTM_Zone_17N (Central Meridian = 81°W).
- File-Panel OCM (Site Map).
- March 2013.
MAIN
BASIN
SOUTH
BASIN
POND
C
BUCKLES
TOWNSHIP
BOUCK
TOWNSHIP
CHANNEL Y
DAM K
DAM E
DAM B
DAM D
DAM H
DAM A
SPILLWAY
TREATMENT PLANT
CHANNEL Z
Panel Mine
Road
Gate
QUIRKE LAKE
SENIORS PARK
PUHKY
ISLAND
ROMAN
ISLAND
Quirke
Lake
Rochester
Lake
Rochester Creek
5153000 N
370000 E
384000 E
5149000 N


Rio Algom
Lacnor, Nordic and Buckles Site Map
SCALE
0
0.5
1.0 kms
N
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.
- power line.
- collection ditch or channel.
- diversion berm.
- wetlands.
- dams.
Notes
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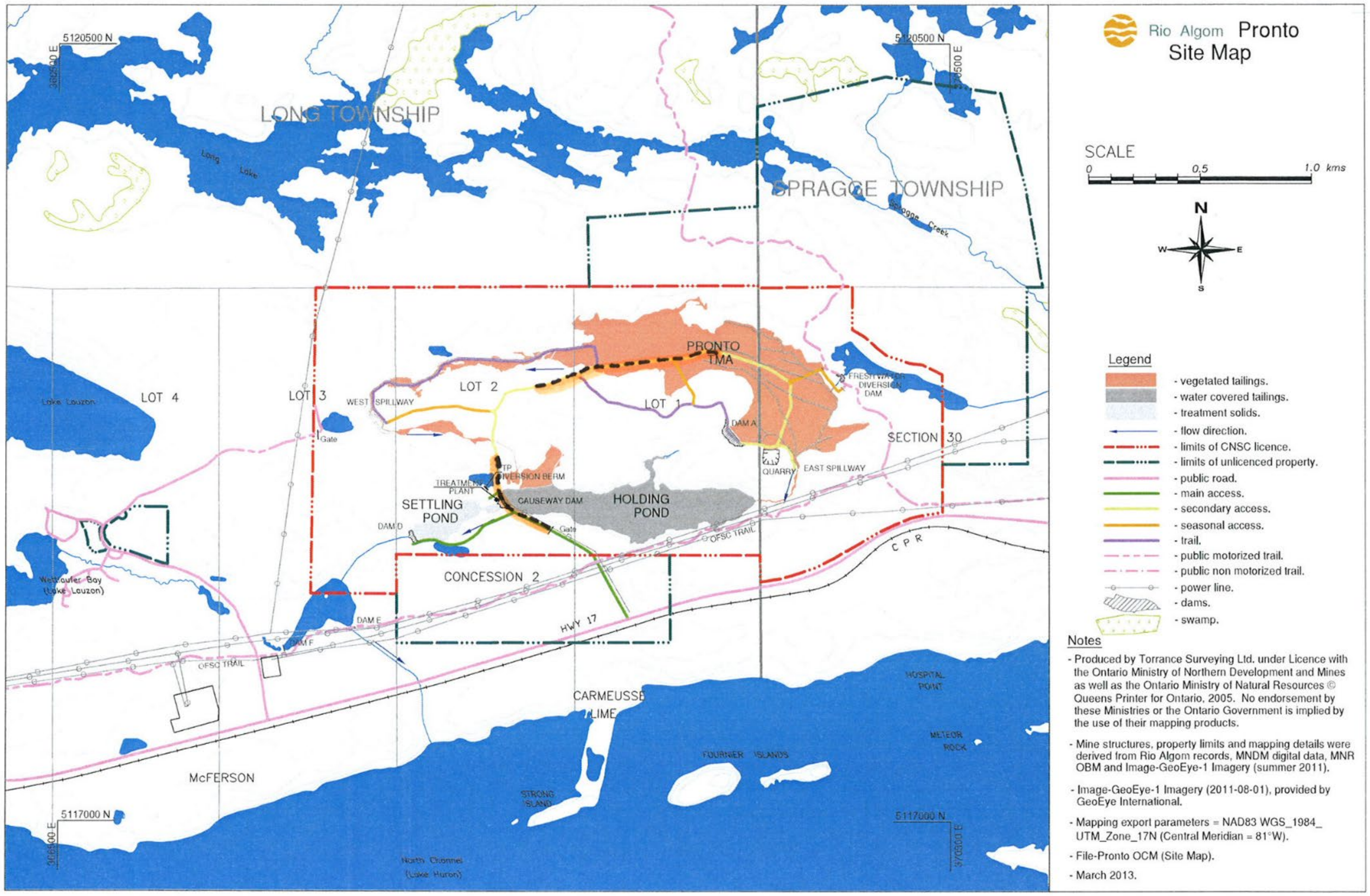
- GeoEye-1 Satelite Imagery (2011-08-01), provided by GeoEye International.
- Mapping export parameters = NAD83 WGS_1984_ UTM_Zone_17N (Central Meridian = 81°W).
- File-LNB OCM (Site Map).
- March 2013.
5140000 N
376000 E
TO STANLEIGH
GUNTERMAN
TOWNSHIP
JOUBIN TOWNSHIP
LACNOR POND
BERM
LACNOR BASIN
Gate
DAM A
DAM B
LACNOR QUARRY
SPILLWAY
Weir
NORDIC MAIN BASIN
CHANNEL
WEST ARM
Pond A
Waterline
Culvert
NORDIC QUARRY
TREATMENT PLANT
EFFLUENT COLLECTION DITCH
SETTLING POND BERM
E. PUMP HOUSE
NORDIC SETTLING POND
Outlet Berm
Boulder Fence
Substation
Berms
HISTORIC PRECIPITATE POND
BUCKLES CREEK CHANNEL
Wetland Retention Berm
BUCKLES WETLAND
Spillway
Boulder Fences
NORDIC MINE ROAD
GOLF COURSE
HWY 108 S
5136500 N
376000 E
5136500 N
380000 E



Ref. 20-2706
October 10, 2020

Appendix C Certificates of Analysis for Drinking Water

SRC SASKATCHEWAN RESEARCH COUNCIL

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SRC Group # 2016-14713

Dec 14, 2016

Denison Environmental Services
1 Horne Walk, Suite 200
Elliot Lake, ON P5A 2A5
Attn: Valerie Kilp

Date Samples Received: Dec-01-2016 Client P.O.: 107732

This is a final report.

Lab Section 1 results have been authorized by Keith Gipman QP, Supervisor
Lab Section 2 results have been authorized by Melissa Tackaberry-Syed QP, Supervisor
Lab Section 3 results have been authorized by Pat Moser QP, Supervisor
Lab Sections 4 and 5 results have been authorized by Vicky Snook QP, Supervisor
Lab Section 6 results have been authorized by Marion McConnell QP, Supervisor

QP: Qualified Person in accordance with the Saskatchewan Environmental Code, Corrective Action Plan Chapter, for the purposes of certifying a laboratory analysis

* Test methods and data are validated by the laboratory's Quality Assurance Program.

* Routine methods follow recognized procedures from sources such as
    * Standard Methods for the Examination of Water and Wastewater APHA AWWA WEF
    * Environment Canada
    * US EPA
    * CANMET

* The results reported relate only to the test samples as provided by the client.

* Samples will be kept for 30 days after the final report is sent. Please contact the lab if you have any special requirements.

* Additional information is available upon request.

SASKATCHEWAN RESEARCH COUNCIL
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SRC Group # 2016-14713

Dec 14, 2016

Denison Environmental Services
1 Horne Walk, Suite 200
Elliot Lake, ON P5A 2A5
Attn: Valerie Kilp

Date Samples Received: Dec-01-2016 Client P.O.: 107732

40387 11/29/2016 DWW *WATER*

Analyte	Units	40387
Lab Section 2 (ICP)		
Uranium	ug/L	<0.1
Lab Section 4 (Radiochemistry)		
Lead-210	Bq/L	<0.02
Polonium-210	Bq/L	<0.005
Radium-226	Bq/L	<0.005
Thorium-230	Bq/L	<0.01

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

Page 1 of 1

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SRC Group # 2016-10582

Sep 21, 2016

Denison Environmental Services
1 Horne Walk, Suite 200
Elliot Lake, ON P5A 2A5
Attn: Valerie Kilp

Date Samples Received: Sep-06-2016 Client P.O.: 107732

This is a final report.

Lab Section 1 results have been authorized by Keith Gipman, Supervisor

Lab Section 2 results have been authorized by Melissa Tackaberry-Syed, Supervisor

Lab Section 3 results have been authorized by Pat Moser, Supervisor

Lab Sections 4 and 5 results have been authorized by Vicky Snook, Supervisor

Lab Section 6 results have been authorized by Marion McConnell, Supervisor

---

* Test methods and data are validated by the laboratory's Quality Assurance Program.

* Routine methods follow recognized procedures from sources such as

  * Standard Methods for the Examination of Water and Wastewater APHA AWWA WEF
  * Environment Canada
  * US EPA
  * CANMET

* The results reported relate only to the test samples as provided by the client.

* Samples will be kept for 30 days after the final report is sent. Please contact the lab if you have any special requirements.

* Additional information is available upon request.

SRC SASKATCHEWAN RESEARCH COUNCIL
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SRC Group # 2016-10582

Sep 21, 2016

Denison Environmental Services
1 Horne Walk, Suite 200
Elliot Lake, ON P5A 2A5
Attn: Valerie Kilp

Date Samples Received: Sep-06-2016 Client P.O.: 107732

27799 08/31/2016 DWW *WATER*

Analyte	Units	27799
Lab Section 2 (ICP)		
Uranium	ug/L	<0.1
Lab Section 4 (Radiochemistry)		
Lead-210	Bq/L	<0.02
Polonium-210	Bq/L	<0.005
Radium-226	Bq/L	<0.005
Thorium-230	Bq/L	<0.01

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

Page 1 of 1

Appendix D Report and Certificates of Analysis for Sport Fish

minnow environmental inc.
A Trinity Consultants Company

Technical Memo

Date: January 20, 2020

To: Don Hart, EcoMetrix Incorporated

From: Jess Tester, Minnow Environmental Inc.

Cc: Cynthia Russel, Minnow Environmental Inc.

RE: Radionuclides in Sport Fish Tissue for the Update to the Public Dose Estimation

Background

There are eleven decommissioned mining operations located in the Serpent River Watershed (SRW; Quirke I and Quirke II, Panel, Denison, Spanish-American, Can-met, Stanrock, Stanleigh, Milliken, Lacnor, Nordic, Buckles), and one located near the north shore of Lake Huron (Pronto). The long-term care and maintenance of these sites is the responsibility of Rio Algom Limited (RAL) and Denison Mines Inc. (DMI). Risk assessments were previously conducted in the SRW as part of the Environmental Assessments conducted in support of mine decommissioning (Rio Algom 1995, Denison 1995, AECB 1997, CNSC 2002) and the 1999 Serpent River Watershed Monitoring Report (SRWMP; Minnow and Beak 2001). A comprehensive study of dose and risk was conducted in 2009 as part of the Cycle 3 State of the Environment (SOE) interpretive report and then updated in 2011 (EcoMetrix 2011, Minnow 2012). The Canadian Nuclear Safety Commission (CNSC) has asked RAL and DMI to undertake annual reporting of radiation dose to the public associated with their closed uranium mine sites in the SRW. The annual dose reporting will be based on periodic updates undertaken as part of the SOE reports. 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. 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. An interim public dose estimation for a representative member of the Elliot Lake public was calculated and reported (EcoMetrix 2018), then included the Cycle 5 SOE study design (Minnow 2019). This interim report used 2005 data for concentration of radionuclides in sport fish, but recommended an update to the public dose estimation to include updated data for the concentrations of U-238 series radionuclides (i.e., uranium-nat, thorium-230, radium-226, lead-210, and polonium-210) in sport fish collected from the SRW lakes most used by sport fishers (i.e., Elliot, McCarthy, and Quirke lakes; EcoMetrix 2018).

Methods

In support of the update to the public dose estimation, sampling was conducted in September 2019, concurrent with SRWMP sediment quality and benthic invertebrate community sampling. Mine-exposed Elliot, McCarthy, and Quirke lakes were fished, as was Dunlop Lake to provide reference radionuclide concentrations (Figures 1 to 4). As prescribed by EcoMetrix (2018), fishing targeted the most commonly consumed species: primarily lake trout and walleye, or, if unavailable, smallmouth bass and northern pike. Fishing was conducted using a combination of hoop nets and gill nets. A total of five individual fish were targeted per lake for muscle tissue collection, with 130 grams wet weight (g w.w.) of tissue collected from each individual to provide sufficient volume for analysis. All methods were consistent with available technical guidance (e.g., Environment Canada 2012) and included the collection of meristic data (fish weight and length). Quality control samples (field split samples) were collected at a 10% frequency. Following the collection of tissue samples using clean implements, the samples were placed in labelled Whirl-Pak™ bags and frozen, and then were shipped on ice to the analytical laboratory. Tissue samples will be sent to SRC Environmental Analytical Laboratories (Saskatoon, Saskatchewan) for analysis of radionuclides (i.e., uranium-nat, thorium-230, radium-226, lead-210, and polonium-210). Target maximum laboratory reporting limits (LRL) for fish tissue were provided to the laboratory as prescribed by EcoMetrix (2018).

Results

Fish for tissue samples were primarily caught by gill netting (Table 1), with supplementary fishing conducted using hoop nets (Table 2). Although preferentially targeting lake trout and walleye, few lake trout and no walleye were caught (Tables 1 and 2). In the three mine exposed lakes, the smallmouth bass sacrificed for tissue samples ranged from 31.2 to 47.7 cm in total length (Tables 3 to 5), while reference lake fish ranged from 30.2 cm to 36.1 cm in total length (Table 6). Northern pike in mine-exposed lakes ranged from 50.5 to 91.4 cm in total length (Tables 3 to 5), whereas no northern pike were caught in the reference lake (Table 6).

The achieved LRLs met the target values, except for thorium-230 (Table 7). The target LRL for thorium-230 was not met in all samples due to lab failing to follow the instructions. This was identified during Minnow's data quality review process, and samples with sufficient remaining tissue were reanalyzed, resulting in improved detection limits for some samples.

Measured concentrations of lead-210, thorium-230, and uranium were at or below the LRL. Concentrations of radium-226 in mine-exposed fish tissue were comparable to fish from the reference lake, ranging from <0.0002 to 0.0004 Bq/g (Table 8). Concentrations of polonium-210 in fish tissue from mine-exposed McCarthy and Quirke Lakes were similar to or lower than fish from the reference lake, where as fish tissue from Elliot Lake had slightly higher concentrations compared to reference (Table 8).

Conclusion

The 2019 fish tissue radionuclide data will be used by EcoMetrix Inc. to provide an update to the public dose estimation by August 2020, allowing the new public dose estimation to be included in the Cycle 5 SOE interpretive report.

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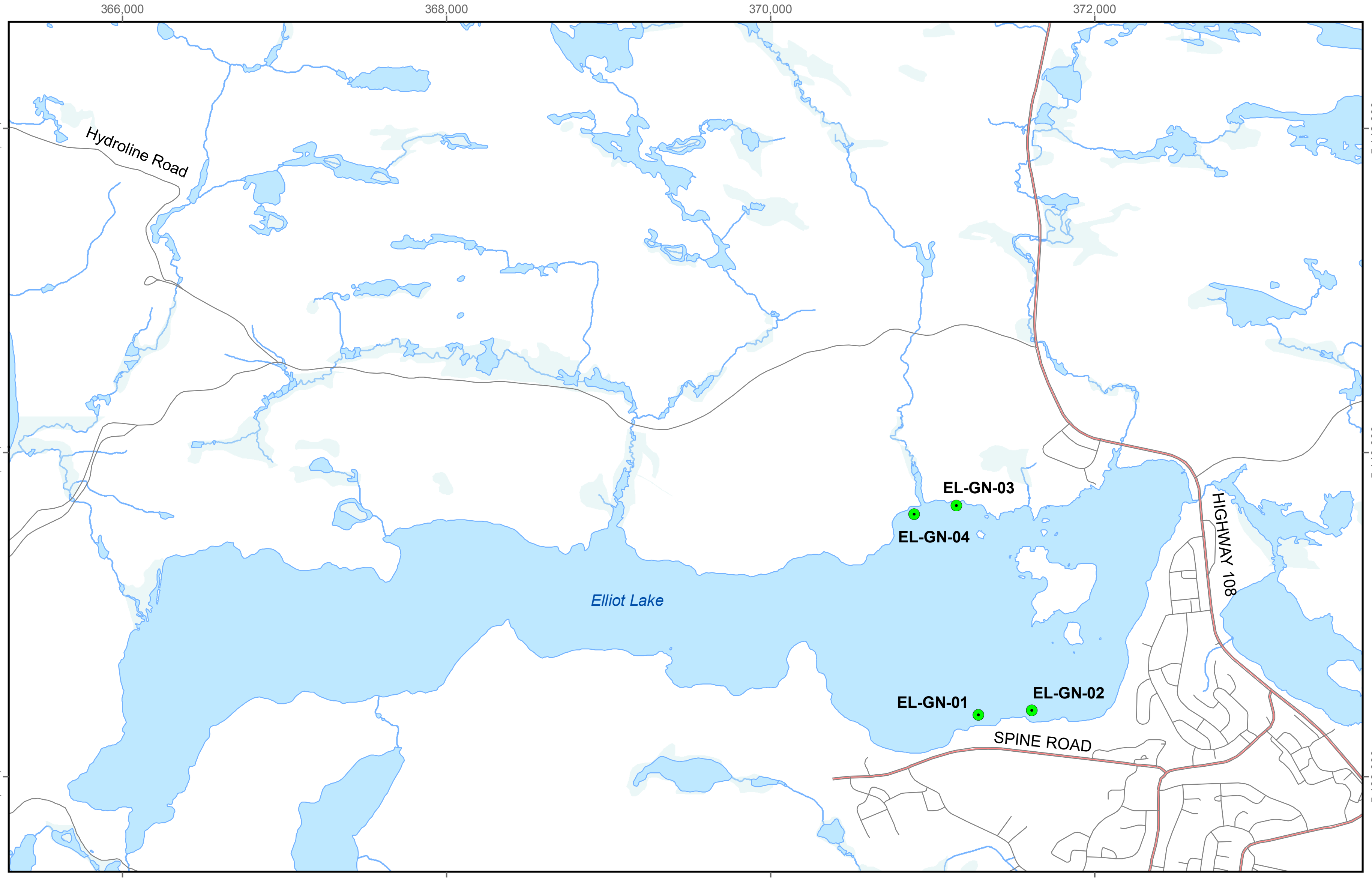
Rio Algom. 1995. EIS Decommissioning of the Quirke and Panel WMAs. February.

FIGURES



LEGEND

Gill Net Sample Location

0 0.375 0.75 1.5 km

N W E S

Map Projection: UTM Zone 17 U NAD 1983
Data Source: Reproduced under licence from Her Majesty the Queen in Right of Canada, Department of Natural Resources Canada. All rights reserved.

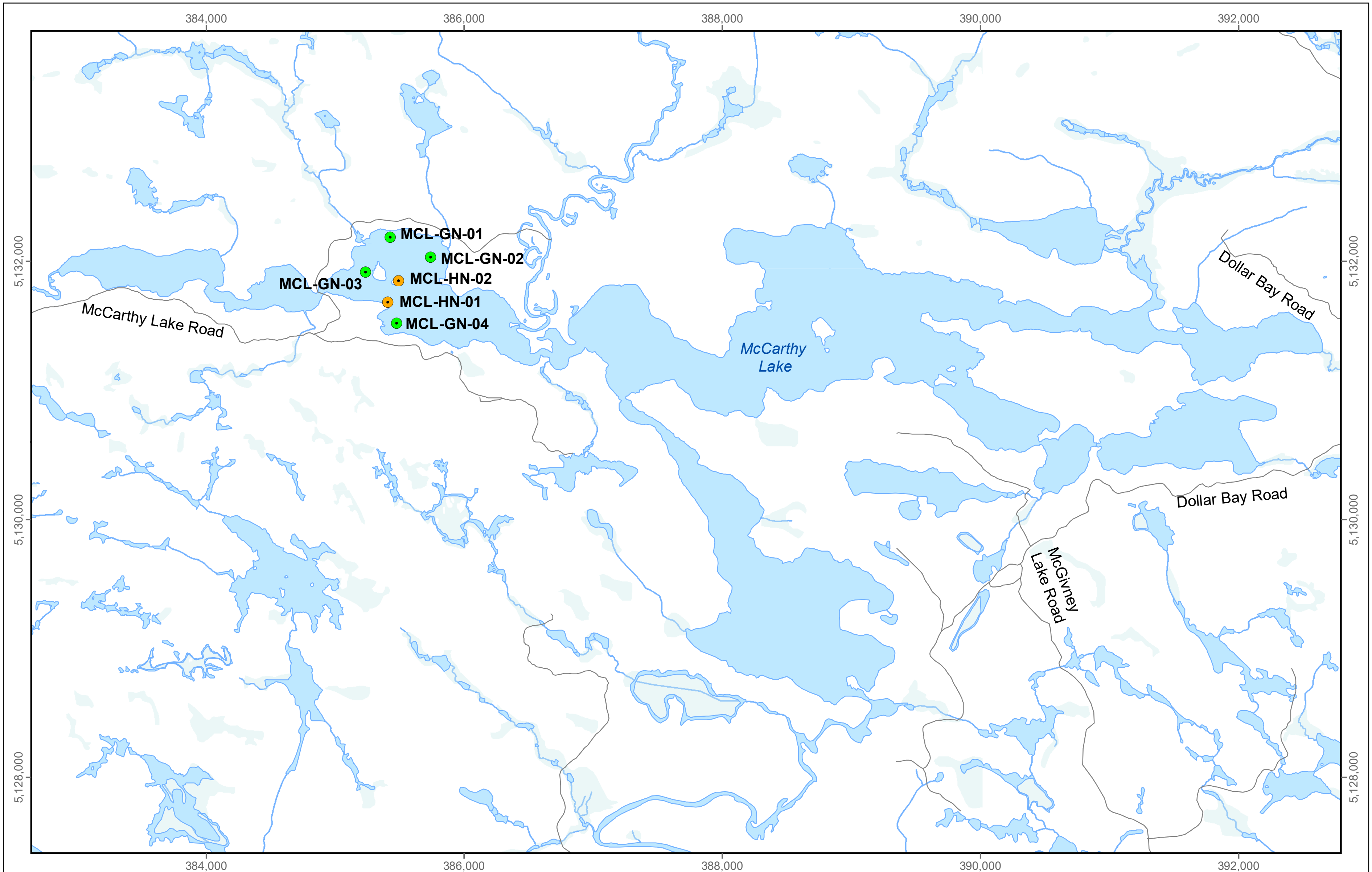
Elliot Lake Fishing Locations, September 2019

Date: October 2019
Project 197202.0041

minnow environmental inc.

Figure 1

Document Path: S:\Projects\197202\197202.0041 - Denison BHP Cycle 5 SOE Implementation and Report\4 - GIS\Fish Permit Response\19-41 Figure 2 Elliot Lake Fishing Locations, September 2019.mxd



LEGEND

- Gill Net Sample Location
- Hoop Net Sample Location

0 0.5 1 2
km

N W E S

Map Projection: UTM Zone 17 U NAD 1983
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McCarthy Lake Fishing Locations, September 2019

Date: October 2019
Project 197202.0041

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Figure 2

Document Path: S:\Projects\197202\197202.0041 - Denison BHP Cycle 5 SOE Implementation and Report\4 - GIS\Fish Permit Response\19-41 Figure 3 McCarthy Lake Fishing Locations, September 2019.mxd

Quirke Lake Fishing Locations, September 2019

0 0.75 1.5 3 km

Map Projection: UTM Zone 17 U NAD 1983
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Date: October 2019
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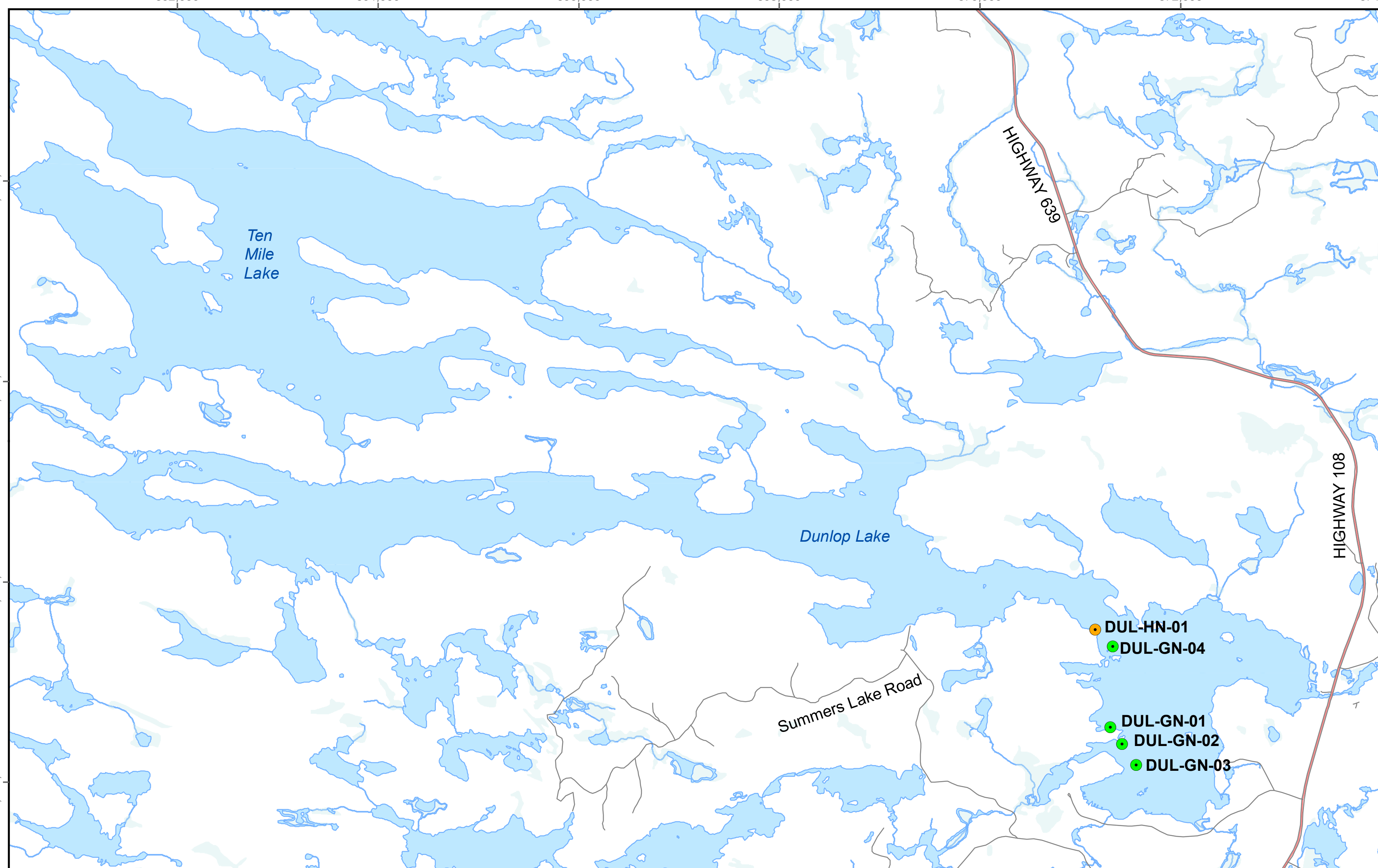
Figure 3

Document Path: S:\Projects\197202\197202.0041 - Denison BHP Cycle 5 SOE Implementation and Report\4 - GIS\Fish Permit Response\19-41 Figure 4 Quirke Lake Fishing Locations, September 2019.mxd



LEGEND

- Gill Net Sample Location
- Hoop Net Sample Location

0 0.5 1 2 km

N E S W

Map Projection: UTM Zone 17 U NAD 1983
Data Source: Reproduced under licence from Her Majesty the Queen in Right of Canada, Department of Natural Resources Canada. All rights reserved.

Dunlop Lake Fishing Locations, September 2019

Date: October 2019
Project 197202.0041

minnow environmental inc.

Figure 4

Document Path: S:\Projects\197202\197202.0041 - Denison BHP Cycle 5 SOE Implementation and Report\4 - GIS\Fish Permit Response\19-41 Figure 1 Dunlop Lake Fishing Locations, September 2019.mxd

TABLES

Table 1: Summary of Gill Net Catch Records for Dunlop Lake, Elliot Lake, McCarthy Lake, and Quirke Lake, September 2019

Waterbody	Exposure Type	Net Set ID	Mesh Size (in)	Length (m)	UTM (NAD 83, 15U)		Set Date	Lift Date	Set Time	Lift Time	Time (hrs)	Effort (m*hrs/ 100 m)	Target Species								
													Lake Trout			Northern Pike			Smallmouth Bass		
					Easting	Northing							Catch	Mortality	CPUE	Catch	Mortality	CPUE	Catch	Mortality	CPUE
Dunlop Lake	Reference	DUL-GN-01	3	30.48	371299	5148550	19-Sep-19	20-Sep-19	12:00	13:00	25.00	7.62	1	1	0.13	0	0	0	5	5	0.66
		DUL-GN-02	3	30.48	371415	5148379	19-Sep-19	20-Sep-19	12:10	13:40	25.50	7.77	0	0	0	0	0	0	1	1	0.13
		DUL-GN-03	4	30.48	371557	5148173	19-Sep-19	20-Sep-19	12:15	14:10	25.92	7.90	0	0	0	0	0	0	0	0	0
		DUL-GN-04	4	30.48	371322	5149357	19-Sep-19	20-Sep-19	12:25	14:20	25.92	7.90	0	0	0	0	0	0	0	0	0
										Total	**248.83**	**75.84**	**1**	**1**	**0.01**	**0**	**0**	**0**	**6**	**6**	**0.08**
Elliot Lake	Mine-exposed	EL-GN-01	4	30.48	371282	5138384	17-Sep-19	18-Sep-19	18:30	15:50	21.33	6.50	0	0	0	1	1	0.15	0	0	0
		EL-GN-02	3	30.48	371612	5138411	17-Sep-19	18-Sep-19	18:40	16:15	21.58	6.58	0	0	0	1	0	0.15	9	6	1.37
		EL-GN-03	4	30.48	371148	5139675	17-Sep-19	18-Sep-19	18:50	17:10	22.33	6.81	1	1	0.15	1	0	0.15	0	0	0
		EL-GN-04	3	30.48	370886	5139622	17-Sep-19	18-Sep-19	19:00	16:50	21.83	6.65	0	0	0	0	0	0	0	0	0
										Total	**87.08**	**26.54**	**1**	**1**	**0.04**	**3**	**1**	**0.11**	**9**	**6**	**0.34**
McCarthy Lake	Mine-exposed	MCL-GN-01	3	30.48	385426	5132185	17-Sep-19	18-Sep-19	16:45	9:50	17.08	5.21	0	0	0	6	6	1.15	1	1	0.19
		MCL-GN-02	4	30.48	385739	5132030	17-Sep-19	18-Sep-19	16:00	10:10	18.17	5.54	0	0	0	0	0	0	0	0	0
		MCL-GN-03	3	30.48	385236	5131918	17-Sep-19	18-Sep-19	16:05	10:30	18.42	5.61	0	0	0	3	3	0.53	0	0	0
		MCL-GN-04	4	30.48	385476	5131520	17-Sep-19	18-Sep-19	16:25	10:40	18.25	5.56	0	0	0	0	0	0	1	1	0.18
										Total	**71.92**	**21.92**	**0**	**0**	**0**	**9**	**9**	**0.41**	**2**	**2**	**0.09**
Quirke Lake	Mine-exposed	QL-GN-01	4	30.48	380719	5150705	19-Sep-19	20-Sep-19	9:30	8:50	23.33	7.11	0	0	0	0	0	0	0	0	0
		QL-GN-02	3	30.48	380530	5150692	19-Sep-19	20-Sep-19	9:40	9:00	23.33	7.11	0	0	0	1	1	0.14	4	4	0.56
		QL-GN-03	3	30.48	382190	5150471	19-Sep-19	20-Sep-19	9:50	9:30	23.67	7.21	0	0	0	0	0	0	0	0	0
		QL-GN-04	4	30.48	382095	5150627	19-Sep-19	20-Sep-19	10:00	9:40	23.67	7.21	0	0	0	0	0	0	0	0	0
		QL-GN-05	3	30.48	380520	5150715	20-Sep-19	21-Sep-19	10:35	8:35	22.00	6.71	0	0	0	2	2	0.30	2	2	0.30
		QL-GN-06	4	30.48	380344	5150811	20-Sep-19	21-Sep-19	10:45	8:50	22.08	6.73	0	0	0	0	0	0	0	0	0
		QL-GN-07	3	30.48	379713	5149940	20-Sep-19	21-Sep-19	11:00	9:00	22.00	6.71	0	0	0	0	0	0	2	2	0.30
		QL-GN-08	4	30.48	379916	5149866	20-Sep-19	21-Sep-19	11:10	9:30	22.33	6.81	0	0	0	0	0	0	0	0	0
										Total	**182.42**	**55.60**	**0**	**0**	**0**	**3**	**3**	**0.05**	**8**	**8**	**0.14**

Catch-per-unit-effort (CPUE) = number of fish / effort, expressed as number of fish per 100m hour.

Table 1: Summary of Gill Net Catch Records for Dunlop Lake, Elliot Lake, McCarthy Lake, and Quirke Lake, September 2019

Waterbody	Exposure Type	Net Set ID	Bycatch Species											
			Brown Bullhead			Burbot			Rock Bass			White Sucker		
			Catch	Mortality	CPUE	Catch	Mortality	CPUE	Catch	Mortality	CPUE	Catch	Mortality	CPUE
Dunlop Lake	Reference	DUL-GN-01	0	0	0	0	0	0	1	0	0.13	3	0	0.39
		DUL-GN-02	0	0	0	1	1	0.13	0	0	0	2	1	0.26
		DUL-GN-03	0	0	0	0	0	0	0	0	0	0	0	0
		DUL-GN-04	0	0	0	0	0	0	0	0	0	2	1	0.25
			0	**0**	**0**	**1**	**1**	**0.01**	**1**	**0**	**0.01**	**7**	**2**	**0.09**
Elliot Lake	Mine-exposed	EL-GN-01	0	0	0	0	0	0	0	0	0	0	0	0
		EL-GN-02	9	0	1.37	0	0	0	3	0	0.46	1	1	0.15
		EL-GN-03	0	0	0	0	0	0	0	0	0	1	1	0.15
		EL-GN-04	0	0	0	0	0	0	2	0	0.30	0	0	0
			9	**0**	**0.34**	**0**	**0**	**0**	**5**	**0**	**0.19**	**2**	**2**	**0.08**
McCarthy Lake	Mine-exposed	MCL-GN-01	0	0	0	0	0	0	0	0	0	1	0	0.19
		MCL-GN-02	0	0	0	0	0	0	0	0	0	1	0	0.18
		MCL-GN-03	1	0	0.18	0	0	0	0	0	0	0	0	0
		MCL-GN-04	0	0	0	0	0	0	0	0	0	0	0	0
			1	**0**	**0.05**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**0.09**
Quirke Lake	Mine-exposed	QL-GN-01	0	0	0	0	0	0	0	0	0	0	0	0
		QL-GN-02	2	0	0.28	0	0	0	0	0	0	1	0	0.14
		QL-GN-03	2	0	0.28	0	0	0	0	0	0	0	0	0
		QL-GN-04	0	0	0	0	0	0	0	0	0	1	1	0.14
		QL-GN-05	0	0	0	0	0	0	0	0	0	0	0	0
		QL-GN-06	0	0	0	0	0	0	0	0	0	0	0	0
		QL-GN-07	0	0	0	0	0	0	0	0	0	0	0	0
		QL-GN-08	0	0	0	0	0	0	0	0	0	0	0	0
			4	**0**	**0.07**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**1**	**0.04**

Catch-per-unit-effort (CPUE) = number of fish / effort, expressed as number of fish per 100m hour.

Table 2: Summary of Hoop Net Catch Records for McCarthy Lake, Quirke Lake and Dunlop Lake, September 2019

Waterbody	Net Set ID	Hoop Size (in)	Length (m)	UTM (NAD 83, 15U)		Set Date	Lift Date	Set Time	Lift Time	Time (hrs)	Effort (m*hrs/ 100 m)	Target Species					
												Northern Pike			Smallmouth Bass		
				Easting	Northing							Catch	Mortality	CPUE	Catch	Mortality	CPUE
McCarthy Lake	MCL-HN-01	2.5	15.24	385408	5131683	17-Sep-19	18-Sep-19	13:50	11:05	21.25	3.24	1	0	0.31	0	0	0
	MCL-HN-02	3.0	15.24	385493	5131850	17-Sep-19	18-Sep-19	14:15	12:15	22.00	3.35	0	0	0	0	0	0
Quirke Lake	QL-HN-01	2.5	15.24	381002	5150902	19-Sep-19	20-Sep-19	8:50	9:50	25.00	3.81	0	0	0	8	0	2.10
Dunlop Lake	DUL-HN-01	2.5	15.24	371150	5149524	19-Sep-19	20-Sep-19	13:10	9:00	19.83	3.02	0	0	0	1	0	0.33
										Total	**13.4**	**1**	**0**	**0.07**	**9**	**0**	**0.67**

Catch-per-unit-effort (CPUE) = # of fish / effort, expressed as # of fish per 100m hour.

Table 2: Summary of Hoop Net Catch Records for McCarthy Lake, Quirke Lake and Dunlop Lake, September 2019

Waterbody	Net Set ID	Bycatch Species											
		Brown Bullhead			Pumpkinseed			Rock Bass			Yellow Perch		
		Catch	Mortality	CPUE	Catch	Mortality	CPUE	Catch	Mortality	CPUE	Catch	Mortality	CPUE
McCarthy Lake	MCL-HN-01	249	0	76.89	4	1	1.24	19	0	5.87	2	1	0.62
	MCL-HN-02	0	0	0	0	0	0	1	0	0.30	0	0	0
Quirke Lake	QL-HN-01	0	0	0	0	0	0	101	0	26.51	0	0	0
Dunlop Lake	DUL-HN-01	0	0	0	0	0	0	7	0	2.32	0	0	0
		249	**0**	**18.55**	**4**	**1**	**0.30**	**128**	**0**	**9.54**	**2**	**1**	**0.15**

Catch-per-unit-effort (CPUE) = # of fish / effort, expressed as # of fish per 100m hour.

Table 3: Measurements of Fish used for Fish Tissue Sampling from Elliot Lake (Mine-exposed), September 2019

Area	Processing Date	Catch Method ID	Fish ID	Fish Species	Total Length (cm)	Fork Length (cm)	Body Weight (g)
Elliot Lake	18-Sep-19	EL-GN-02	EL-SMB-01	smallmouth bass	39.5	37.0	890
	18-Sep-19	EL-GN-02	EL-SMB-02	smallmouth bass	34.5	33.0	550
	18-Sep-19	EL-GN-02	EL-SMB-03	smallmouth bass	34.2	32.1	510
	18-Sep-19	EL-GN-02	EL-SMB-05	smallmouth bass	31.2	29.4	450
	18-Sep-19	EL-GN-01	EL-NP-06	northern pike	91.4	86.2	5,510
				total sample size	**6**	**6**	**6**
				average	**43.8**	**41**	**1,388**
				median	**34.4**	**33**	**530**
				standard deviation	**23.5**	**22.2**	**2,027**
				standard error	**9.6**	**9.05**	**827**
				minimum	**31.2**	**29**	**415**
				maximum	**91.4**	**86**	**5,510**

Table 4: Measurements of Fish used for Fish Tissue Sampling from McCarthy Lake (Mine-exposed), September 2019

Area	Processing Date	Catch Method ID	Fish ID	Fish Species	Total Length (cm)	Fork Length (cm)	Body Weight (g)
McCarthy Lake	18-Sep-19	MCL-GN-01	MCL-NP-01	northern pike	50.5	47.1	790
	18-Sep-19	MCL-GN-01	MCL-NP-02	northern pike	75.3	71.9	2,760
	18-Sep-19	MCL-GN-03	MCL-NP-03	northern pike	60.6	57.0	1,580
	18-Sep-19	MCL-GN-04	MCL-SMB-05	smallmouth bass	47.7	45.0	1,690
	18-Sep-19	MCL-GN-01	MCL-NP-06	northern pike	57.3	53.4	1,115
				total sample size	**6**	**6**	**6**
				average	**53.2**	**50.2**	**1,371**
				median	**53.9**	**50.3**	**1,348**
				standard deviation	**15.8**	**15.0**	**854**
				standard error	**6.44**	**6.13**	**349**
				minimum	**27.8**	**26.5**	**290**
				maximum	**75.3**	**71.9**	**2,760**

Table 5: Measurements of Fish used for Fish Tissue Sampling from Quirke Lake (Mine-exposed), September 2019

Area	Processing Date	Catch Method ID	Fish ID	Fish Species	Total Length (cm)	Fork Length (cm)	Body Weight (g)
Quirke Lake	20-Sep-19	QL-GN-02	QL-SMB-01	smallmouth bass	44.4	41.8	1,110
	20-Sep-19	QL-GN-02	QL-SMB-02	smallmouth bass	32.7	30.9	375
	20-Sep-19	QL-GN-02	QL-SMB-03	smallmouth bass	34.8	32.9	580
	21-Sep-19	QL-GN-05	QL-SMB-04	smallmouth bass	32.7	30.1	400
	21-Sep-19	QL-GN-05	QL-SMB-05	smallmouth bass	33.1	31.1	420
				total sample size	**5**	**5**	**5**
				average	**35.5**	**33.4**	**577**
				median	**33.1**	**31.1**	**420**
				standard deviation	**5.03**	**4.83**	**309**
				standard error	**2.25**	**2.16**	**138**
				minimum	**32.7**	**30.1**	**375**
				maximum	**44.4**	**41.8**	**1,110**

Table 6: Measurements of Fish used for Fish Tissue Sampling from Dunlop Lake (Reference), September 2019

Area	Processing Date	Catch Method ID	Fish ID	Fish Species	Total Length (cm)	Fork Length (cm)	Body Weight (g)
Dunlop Lake	20-Sep-19	DUL-GN-01	DUL-SMB-01	smallmouth bass	30.2	28.7	330
	20-Sep-19	DUL-GN-01	DUL-SMB-02	smallmouth bass	32.2	30.5	420
	20-Sep-19	DUL-GN-01	DUL-SMB-03	smallmouth bass	30.1	28.2	325
	20-Sep-19	DUL-GN-02	DUL-SMB-04	smallmouth bass	36.1	34.2	590
	20-Sep-19	DUL-GN-01	DUL-SMB-05	smallmouth bass	31.6	30.0	410
				total sample size	**5**	**5**	**5**
				average	**32.0**	**30.3**	**415**
				median	**31.6**	**30.0**	**410**
				standard deviation	**2.44**	**2.36**	**107**
				standard error	**1.09**	**1.06**	**48**
				minimum	**30.1**	**28.2**	**325**
				maximum	**36.1**	**34.2**	**590**

Table 7: Achieved Laboratory Reporting Limits (LRLs) Compared to Target LRLs

Parameter	Units	Target LRL	Achieved LRL
Uranium-nat	µg/g	0.001	0.001
Thorium-230	Bq/g	0.0001	0.0001 / 0.0002 / 0.0005
Radium-226	Bq/g	0.0006	0.0002
Lead-210	Bq/g	0.001	0.001
Polonium-210	Bq/g	0.0002	0.0002

Highlighted values indicate LRLs that did not meet the target LRL.

Table 8: Radionuclide concentrations in Fish Tissue Samples collected from Dunlop, Elliot, McCarthy, and Quirke Lakes

Exposure Type	Lake	Sample ID	Species	Lead-210	Polonium-210	Radium-226	Thorium-230	Uranium
				Bq/g	Bq/g	Bq/g	Bq/g	ug/g
Reference	Dunlop Lake	DUL-SMB-01	smallmouth bass	<0.001	0.0031	<0.0002	<0.0002	<0.001
		DUL-SMB-02	smallmouth bass	<0.001	0.0047	<0.0002	<0.0005	<0.001
		DUL-SMB-03	smallmouth bass	<0.001	0.0042	<0.0002	<0.0002	<0.001
		DUL-SMB-04	smallmouth bass	<0.001	0.0037	<0.0002	<0.0001	<0.001
		DUL-SMB-05	smallmouth bass	<0.001	0.0040	0.0004	<0.0002	<0.001
Mine-exposed	Elliot Lake	EL-SMB-01	smallmouth bass	<0.001	0.0049	0.0003	<0.0001	<0.001
		EL-SMB-02	smallmouth bass	<0.001	0.0051	<0.0002	<0.0002	0.001
		EL-SMB-03	smallmouth bass	<0.001	0.0037	0.0004	<0.0002	<0.001
		EL-SMB-05	smallmouth bass	<0.001	0.0054	<0.0002	<0.0002	<0.001
		EL-NP-06	northern pike	<0.001	0.0006	0.0003	<0.0001	<0.001
	McCarthy Lake	MCL-NP-01	northern pike	<0.001	0.0026	<0.0002	<0.0005	<0.001
		MCL-NP-02	northern pike	<0.001	0.0011	<0.0002	<0.0002	<0.001
		MCL-NP-03	northern pike	<0.001	0.0030	<0.0002	<0.0002	<0.001
		MCL-NP-06	northern pike	<0.001	0.0010	<0.0002	<0.0002	<0.001
		MCL-SMB-05	smallmouth bass	<0.001	0.0036	<0.0002	<0.0002	<0.001
		MCL-SMB-05X [a]	smallmouth bass	<0.001	0.0042	<0.0002	<0.0002	<0.001
	Quirke Lake	QL-SMB-01	smallmouth bass	<0.001	0.0029	0.0003	<0.0002	<0.001
		QL-SMB-01X [b]	smallmouth bass	<0.001	0.0032	<0.0002	<0.0001	<0.001
		QL-SMB-02	smallmouth bass	<0.001	0.0033	<0.0002	<0.0002	<0.001
		QL-SMB-03	smallmouth bass	0.001	0.0017	0.0004	<0.0002	<0.001
		QL-SMB-04	smallmouth bass	<0.001	0.0019	0.0002	<0.0002	<0.001
		QL-SMB-05	smallmouth bass	<0.001	0.0042	<0.0002	<0.0002	<0.001

[a] Field split of sample MCL-SMB-05, analyzed for QA/QC.

[b] Field split of sample QL-SMB-01, analyzed for QA/QC.

ATTACHMENT A

SASKATCHEWAN RESEARCH COUNCIL
Environmental Analytical Laboratories
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Revised

SRC Group # 2019-14432

Jan 08, 2020

Minnow Environmental Inc.
2 Lamb Street
Georgetown, ON L7G 3M9
Attn: Jess Tester

Date Samples Received: Oct-08-2019

Client P.O.: 19-41 Cycle 5 SRWMP and SOE

All results have been reviewed and approved by a Qualified Person in accordance with the Saskatchewan Environmental Code, Corrective Action Plan Chapter, for the purposes of certifying a laboratory analysis

Results from Lab Section 2 authorized by Keith Gipman, Supervisor
Results from Lab Section 4 authorized by Vicky Snook, Supervisor

---

* Test methods and data are validated by the laboratory's Quality Assurance Program.

* Routine methods follow recognized procedures from sources such as
    * Standard Methods for the Examination of Water and Wastewater APHA AWWA WEF
    * Environment Canada
    * US EPA
    * CANMET

* The results reported relate only to the test samples as provided by the client.

* Samples will be kept for 30 days after the final report is sent. Please contact the lab if you have any special requirements.

* Additional information is available upon request.

* Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

This is a final report.

SRC SASKATCHEWAN RESEARCH COUNCIL

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SRC Group # 2019-14432

Jan 08, 2020

Minnow Environmental Inc.

2 Lamb Street
Georgetown, ON L7G 3M9
Attn: Jess Tester

Sample #:	**2019066730**	Client PO #:	**19-41 Cycle 5 SRWMP and SOE**
Date Sampled:	**Sep 18, 2019**	Date Received:	**Oct 08, 2019**
Sample Matrix:	**TISSUE**		
Description:	**09/18/2019 EL-SMB-01**		

Analyte	Units	Result	+/-	DL	Weight (g)
Lab Section 2					
Uranium	ug/g	<0.001		0.001	20.13
Lab Section 4					
Lead-210	Bq/g	<0.001		0.001	20.13
Polonium-210	Bq/g	0.0049	0.0007	0.0002	20.13
Radium-226	Bq/g	0.0003	0.0003	0.0002	20.13
Thorium-230	Bq/g	<0.0001		0.0001	20.13

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

The temperature of the cooler was 4.6 °C upon receipt.

Results are reported on an as received basis.
Note revised results for Thorium 230 analysis. Jan 7, 2020 VS

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SRC Group # 2019-14432

Jan 08, 2020

Minnow Environmental Inc.

Sample #:	**2019066731**	Client PO #:	**19-41 Cycle 5 SRWMP and SOE**
Date Sampled:	**Sep 18, 2019**	Date Received:	**Oct 08, 2019**
Sample Matrix:	**TISSUE**		
Description:	**09/18/2019 EL-SMB-02**		

Analyte	Units	Result	+/-	DL	Weight (g)
Lab Section 2					
Uranium	ug/g	0.001	0.001	0.001	20.13
Lab Section 4					
Lead-210	Bq/g	<0.001		0.001	20.13
Polonium-210	Bq/g	0.0051	0.0008	0.0002	20.13
Radium-226	Bq/g	<0.0002		0.0002	20.13
Thorium-230	Bq/g	<0.0002		0.0002	20.13

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

The temperature of the cooler was 4.6 °C upon receipt.

Results are reported on an as received basis.
Note revised results for Thorium 230 analysis. Jan 7, 2020 VS

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Jan 08, 2020

Minnow Environmental Inc.

Sample #: **2019066732**
Date Sampled: **Sep 18, 2019**
Sample Matrix: **TISSUE**
Description: **09/18/2019 EL-SMB-03**

Client PO #: **19-41 Cycle 5 SRWMP and SOE**
Date Received: **Oct 08, 2019**

Analyte	Units	Result	+/-	DL	Weight (g)
Lab Section 2					
Uranium	ug/g	<0.001		0.001	20.09
Lab Section 4					
Lead-210	Bq/g	<0.001		0.001	20.09
Polonium-210	Bq/g	0.0037	0.0009	0.0002	20.09
Radium-226	Bq/g	0.0004	0.0003	0.0002	20.09
Thorium-230	Bq/g	<0.0002		0.0002	20.09

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

The temperature of the cooler was 4.6 °C upon receipt.

Results are reported on an as received basis.
Note revised results for Thorium 230 analysis. Jan 7, 2020 VS

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Jan 08, 2020

Minnow Environmental Inc.

Sample #: **2019066733**
Date Sampled: **Sep 18, 2019**
Sample Matrix: **TISSUE**
Description: **09/18/2019 EL-SMB-05**

Client PO #: **19-41 Cycle 5 SRWMP and SOE**
Date Received: **Oct 08, 2019**

Analyte	Units	Result	+/-	DL	Weight (g)
Lab Section 2					
Uranium	ug/g	<0.001		0.001	20.65
Lab Section 4					
Lead-210	Bq/g	<0.001		0.001	20.65
Polonium-210	Bq/g	0.0054	0.0008	0.0002	20.65
Radium-226	Bq/g	<0.0002		0.0002	20.65
Thorium-230	Bq/g	<0.0002		0.0002	20.65

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

The temperature of the cooler was 4.6 °C upon receipt.

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Note revised results for Thorium 230 analysis. Jan 7, 2020 VS

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Jan 08, 2020

Minnow Environmental Inc.

Sample #: **2019066734**
Date Sampled: **Sep 18, 2019**
Sample Matrix: **TISSUE**
Description: **09/18/2019 EL-NP-06**

Client PO #: **19-41 Cycle 5 SRWMP and SOE**
Date Received: **Oct 08, 2019**

Analyte	Units	Result	+/-	DL	Weight (g)
Lab Section 2					
Uranium	ug/g	<0.001		0.001	20.02
Lab Section 4					
Lead-210	Bq/g	<0.001		0.001	20.02
Polonium-210	Bq/g	0.0006	0.0003	0.0002	20.02
Radium-226	Bq/g	0.0003	0.0003	0.0002	20.02
Thorium-230	Bq/g	<0.0001		0.0001	20.02

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

The temperature of the cooler was 4.6 °C upon receipt.

Results are reported on an as received basis.
Note revised results for Thorium 230 analysis. Jan 7, 2020 VS

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Minnow Environmental Inc.

Sample #: **2019066735**
Date Sampled: **Sep 18, 2019**
Sample Matrix: **TISSUE**
Description: **09/18/2019 MCL-NP-01**

Client PO #: **19-41 Cycle 5 SRWMP and SOE**
Date Received: **Oct 08, 2019**

Analyte	Units	Result	+/-	DL	Weight (g)
Lab Section 2					
Uranium	ug/g	<0.001		0.001	20.38
Lab Section 4					
Lead-210	Bq/g	<0.001		0.001	20.38
Polonium-210	Bq/g	0.0026	0.0006	0.0002	20.38
Radium-226	Bq/g	<0.0002		0.0002	20.38
Thorium-230	Bq/g	<0.0005		0.0005	20.38

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

This sample was reanalyzed for Polonium 210. Reanalysis confirms original results are within the expected measurement uncertainty.

The temperature of the cooler was 4.6 °C upon receipt.

Results are reported on an as received basis.
Note revised results for Thorium 230 analysis. Jan 7, 2020 VS

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Jan 08, 2020

Minnow Environmental Inc.

Sample #: **2019066736**
Date Sampled: **Sep 18, 2019**
Sample Matrix: **TISSUE**
Description: **09/18/2019 MCL-NP-02**

Client PO #: **19-41 Cycle 5 SRWMP and SOE**
Date Received: **Oct 08, 2019**

Analyte	Units	Result	+/-	DL	Weight (g)
Lab Section 2					
Uranium	ug/g	<0.001		0.001	20.73
Lab Section 4					
Lead-210	Bq/g	<0.001		0.001	20.73
Polonium-210	Bq/g	0.0011	0.0005	0.0002	20.73
Radium-226	Bq/g	<0.0002		0.0002	20.73
Thorium-230	Bq/g	<0.0002		0.0002	20.73

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

The temperature of the cooler was 4.6 °C upon receipt.

Results are reported on an as received basis.
Note revised results for Thorium 230 analysis. Jan 7, 2020 VS

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Jan 08, 2020

Minnow Environmental Inc.

Sample #: **2019066737**
Date Sampled: **Sep 18, 2019**
Sample Matrix: **TISSUE**
Description: **09/18/2019 MCL-NP-03**

Client PO #: **19-41 Cycle 5 SRWMP and SOE**
Date Received: **Oct 08, 2019**

Analyte	Units	Result	+/-	DL	Weight (g)
Lab Section 2					
Uranium	ug/g	<0.001		0.001	20.26
Lab Section 4					
Lead-210	Bq/g	<0.001		0.001	20.26
Polonium-210	Bq/g	0.0030	0.0008	0.0002	20.26
Radium-226	Bq/g	<0.0002		0.0002	20.26
Thorium-230	Bq/g	<0.0002		0.0002	20.26

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

This sample was reanalyzed for Polonium 210. Reanalysis confirms original results are within the expected measurement uncertainty.

The temperature of the cooler was 4.6 °C upon receipt.

Results are reported on an as received basis.
Note revised results for Thorium 230 analysis. Jan 7, 2020 VS

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Minnow Environmental Inc.

Sample #: **2019066738**
Date Sampled: **Sep 18, 2019**
Sample Matrix: **TISSUE**
Description: **09/18/2019 MCL-NP-06**

Client PO #: **19-41 Cycle 5 SRWMP and SOE**
Date Received: **Oct 08, 2019**

Analyte	Units	Result	+/-	DL	Weight (g)
Lab Section 2					
Uranium	ug/g	<0.001		0.001	20.25
Lab Section 4					
Lead-210	Bq/g	<0.001		0.001	20.25
Polonium-210	Bq/g	0.0010	0.0004	0.0002	20.25
Radium-226	Bq/g	<0.0002		0.0002	20.25
Thorium-230	Bq/g	<0.0002		0.0002	20.25

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

The temperature of the cooler was 4.6 °C upon receipt.

Results are reported on an as received basis.
Note revised results for Thorium 230 analysis. Jan 7, 2020 VS

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Jan 08, 2020

Minnow Environmental Inc.

Sample #: **2019066739**
Date Sampled: **Sep 18, 2019**
Sample Matrix: **TISSUE**
Description: **09/18/2019 MCL-SMB-05**

Client PO #: **19-41 Cycle 5 SRWMP and SOE**
Date Received: **Oct 08, 2019**

Analyte	Units	Result	+/-	DL	Weight (g)
Lab Section 2					
Uranium	ug/g	<0.001		0.001	20.39
Lab Section 4					
Lead-210	Bq/g	<0.001		0.001	20.39
Polonium-210	Bq/g	0.0036	0.0009	0.0002	20.39
Radium-226	Bq/g	<0.0002		0.0002	20.39
Thorium-230	Bq/g	<0.0002		0.0002	20.39

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

The temperature of the cooler was 4.6 °C upon receipt.

Results are reported on an as received basis.
Note revised results for Thorium 230 analysis. Jan 7, 2020 VS

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SRC Group # 2019-14432

Jan 08, 2020

Minnow Environmental Inc.

Sample #: **2019066740**
Date Sampled: **Sep 20, 2019**
Sample Matrix: **TISSUE**
Description: **09/20/2019 DUL-SMB-01**

Client PO #: **19-41 Cycle 5 SRWMP and SOE**
Date Received: **Oct 08, 2019**

Analyte	Units	Result	+/-	DL	Weight (g)
Lab Section 2					
Uranium	ug/g	<0.001		0.001	20.17
Lab Section 4					
Lead-210	Bq/g	<0.001		0.001	20.17
Polonium-210	Bq/g	0.0031	0.0008	0.0002	20.17
Radium-226	Bq/g	<0.0002		0.0002	20.17
Thorium-230	Bq/g	<0.0002		0.0002	20.17

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

The temperature of the cooler was 4.6 °C upon receipt.

Results are reported on an as received basis.
Note revised results for Thorium 230 analysis. Jan 7, 2020 VS

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SRC Group # 2019-14432

Jan 08, 2020

Minnow Environmental Inc.

Sample #: **2019066741**
Date Sampled: **Sep 20, 2019**
Sample Matrix: **TISSUE**
Description: **09/20/2019 DUL-SMB-02**

Client PO #: **19-41 Cycle 5 SRWMP and SOE**
Date Received: **Oct 08, 2019**

Analyte	Units	Result	+/-	DL	Weight (g)
Lab Section 2					
Uranium	ug/g	<0.001		0.001	20.01
Lab Section 4					
Lead-210	Bq/g	<0.001		0.001	20.01
Polonium-210	Bq/g	0.0047	0.0007	0.0002	20.01
Radium-226	Bq/g	<0.0002		0.0002	20.01
Thorium-230	Bq/g	<0.0005		0.0005	20.01

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

The temperature of the cooler was 4.6 °C upon receipt.

Results are reported on an as received basis.
Note revised results for Thorium 230 analysis. Jan 7, 2020 VS

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Jan 08, 2020

Minnow Environmental Inc.

Sample #: **2019066742**
Date Sampled: **Sep 20, 2019**
Sample Matrix: **TISSUE**
Description: **09/20/2019 DUL-SMB-03**

Client PO #: **19-41 Cycle 5 SRWMP and SOE**
Date Received: **Oct 08, 2019**

Analyte	Units	Result	+/-	DL	Weight (g)
Lab Section 2					
Uranium	ug/g	<0.001		0.001	20.12
Lab Section 4					
Lead-210	Bq/g	<0.001		0.001	20.12
Polonium-210	Bq/g	0.0042	0.0006	0.0002	20.12
Radium-226	Bq/g	<0.0002		0.0002	20.12
Thorium-230	Bq/g	<0.0002		0.0002	20.12

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Jan 08, 2020

Minnow Environmental Inc.

Sample #: **2019066743**
Date Sampled: **Sep 20, 2019**
Sample Matrix: **TISSUE**
Description: **09/20/2019 DUL-SMB-04**

Client PO #: **19-41 Cycle 5 SRWMP and SOE**
Date Received: **Oct 08, 2019**

Analyte	Units	Result	+/-	DL	Weight (g)
Lab Section 2					
Uranium	ug/g	<0.001		0.001	20.03
Lab Section 4					
Lead-210	Bq/g	<0.001		0.001	20.03
Polonium-210	Bq/g	0.0037	0.0009	0.0002	20.03
Radium-226	Bq/g	<0.0002		0.0002	20.03
Thorium-230	Bq/g	<0.0001		0.0001	20.03

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Note revised results for Thorium 230 analysis. Jan 7, 2020 VS

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SRC Group # 2019-14432

Jan 08, 2020

Minnow Environmental Inc.

Sample #:	**2019066744**	Client PO #:	**19-41 Cycle 5 SRWMP and SOE**
Date Sampled:	**Sep 20, 2019**	Date Received:	**Oct 08, 2019**
Sample Matrix:	**TISSUE**		
Description:	**09/20/2019 DUL-SMB-05**		

Analyte	Units	Result	+/-	DL	Weight (g)
Lab Section 2					
Uranium	ug/g	<0.001		0.001	20.43
Lab Section 4					
Lead-210	Bq/g	<0.001		0.001	20.43
Polonium-210	Bq/g	0.0040	0.0006	0.0002	20.43
Radium-226	Bq/g	0.0004	0.0003	0.0002	20.43
Thorium-230	Bq/g	<0.0002		0.0002	20.43

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The temperature of the cooler was 4.6 °C upon receipt.

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Note revised results for Thorium 230 analysis. Jan 7, 2020 VS

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Jan 08, 2020

Minnow Environmental Inc.

Sample #: **2019066745**
Date Sampled: **Sep 20, 2019**
Sample Matrix: **TISSUE**
Description: **09/20/2019 QL-SMB-01**

Client PO #: **19-41 Cycle 5 SRWMP and SOE**
Date Received: **Oct 08, 2019**

Analyte	Units	Result	+/-	DL	Weight (g)
Lab Section 2					
Uranium	ug/g	<0.001		0.001	20.12
Lab Section 4					
Lead-210	Bq/g	<0.001		0.001	20.12
Polonium-210	Bq/g	0.0029	0.0007	0.0002	20.12
Radium-226	Bq/g	0.0003	0.0003	0.0002	20.12
Thorium-230	Bq/g	<0.0002		0.0002	20.12

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Note revised results for Thorium 230 analysis. Jan 7, 2020 VS

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SRC Group # 2019-14432

Jan 08, 2020

Minnow Environmental Inc.

Sample #: **2019066746**
Date Sampled: **Sep 20, 2019**
Sample Matrix: **TISSUE**
Description: **09/20/2019 QL-SMB-02**

Client PO #: **19-41 Cycle 5 SRWMP and SOE**
Date Received: **Oct 08, 2019**

Analyte	Units	Result	+/-	DL	Weight (g)
Lab Section 2					
Uranium	ug/g	<0.001		0.001	20.33
Lab Section 4					
Lead-210	Bq/g	<0.001		0.001	20.33
Polonium-210	Bq/g	0.0033	0.0008	0.0002	20.33
Radium-226	Bq/g	<0.0002		0.0002	20.33
Thorium-230	Bq/g	<0.0002		0.0002	20.33

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The temperature of the cooler was 4.6 °C upon receipt.

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Note revised results for Thorium 230 analysis. Jan 7, 2020 VS

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SRC Group # 2019-14432

Jan 08, 2020

Minnow Environmental Inc.

Sample #: **2019066747**
Date Sampled: **Sep 20, 2019**
Sample Matrix: **TISSUE**
Description: **09/20/2019 QL-SMB-03**

Client PO #: **19-41 Cycle 5 SRWMP and SOE**
Date Received: **Oct 08, 2019**

Analyte	Units	Result	+/-	DL	Weight (g)
Lab Section 2					
Uranium	ug/g	<0.001		0.001	20.26
Lab Section 4					
Lead-210	Bq/g	0.001	0.001	0.001	20.26
Polonium-210	Bq/g	0.0017	0.0006	0.0002	20.26
Radium-226	Bq/g	0.0004	0.0003	0.0002	20.26
Thorium-230	Bq/g	<0.0002		0.0002	20.26

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Note revised results for Thorium 230 analysis. Jan 7, 2020 VS

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Jan 08, 2020

Minnow Environmental Inc.

Sample #: **2019066748**
Date Sampled: **Sep 21, 2019**
Sample Matrix: **TISSUE**
Description: **09/21/2019 QL-SMB-04**

Client PO #: **19-41 Cycle 5 SRWMP and SOE**
Date Received: **Oct 08, 2019**

Analyte	Units	Result	+/-	DL	Weight (g)
Lab Section 2					
Uranium	ug/g	<0.001		0.001	20.34
Lab Section 4					
Lead-210	Bq/g	<0.001		0.001	20.34
Polonium-210	Bq/g	0.0019	0.0007	0.0002	20.34
Radium-226	Bq/g	0.0002	0.0002	0.0002	20.34
Thorium-230	Bq/g	<0.0002		0.0002	20.34

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Jan 08, 2020

Minnow Environmental Inc.

Sample #: **2019066749**
Date Sampled: **Sep 21, 2019**
Sample Matrix: **TISSUE**
Description: **09/21/2019 QL-SMB-05**

Client PO #: **19-41 Cycle 5 SRWMP and SOE**
Date Received: **Oct 08, 2019**

Analyte	Units	Result	+/-	DL	Weight (g)
Lab Section 2					
Uranium	ug/g	<0.001		0.001	20.14
Lab Section 4					
Lead-210	Bq/g	<0.001		0.001	20.14
Polonium-210	Bq/g	0.0042	0.0006	0.0002	20.14
Radium-226	Bq/g	<0.0002		0.0002	20.14
Thorium-230	Bq/g	<0.0002		0.0002	20.14

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

The temperature of the cooler was 4.6 °C upon receipt.

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Note revised results for Thorium 230 analysis. Jan 7, 2020 VS

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Jan 08, 2020

Minnow Environmental Inc.

Sample #: **2019066750**
Date Sampled: **Sep 20, 2019**
Sample Matrix: **TISSUE**
Description: **09/20/2019 QL-SMB-01X**

Client PO #: **19-41 Cycle 5 SRWMP and SOE**
Date Received: **Oct 08, 2019**

Analyte	Units	Result	+/-	DL	Weight (g)
Lab Section 2					
Uranium	ug/g	<0.001		0.001	20.34
Lab Section 4					
Lead-210	Bq/g	<0.001		0.001	20.34
Polonium-210	Bq/g	0.0032	0.0008	0.0002	20.34
Radium-226	Bq/g	<0.0002		0.0002	20.34
Thorium-230	Bq/g	<0.0001		0.0001	20.34

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

The temperature of the cooler was 4.6 °C upon receipt.

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Note revised results for Thorium 230 analysis. Jan 7, 2020 VS

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SRC Group # 2019-14432

Jan 08, 2020

Minnow Environmental Inc.

Sample #: **2019066751**
Date Sampled: **Sep 18, 2019**
Sample Matrix: **TISSUE**
Description: **09/18/2019 MCL-SMB-05X**

Client PO #: **19-41 Cycle 5 SRWMP and SOE**
Date Received: **Oct 08, 2019**

Analyte	Units	Result	+/-	DL	Weight (g)
Lab Section 2					
Uranium	ug/g	<0.001		0.001	20.19
Lab Section 4					
Lead-210	Bq/g	<0.001		0.001	20.19
Polonium-210	Bq/g	0.0042	0.0006	0.0002	20.19
Radium-226	Bq/g	<0.0002		0.0002	20.19
Thorium-230	Bq/g	<0.0002		0.0002	20.19

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The temperature of the cooler was 4.6 °C upon receipt.

Results are reported on an as received basis.
Note revised results for Thorium 230 analysis. Jan 7, 2020 VS

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Dec 06, 2019

This report was generated for samples included in SRC Group # 2019-14432

Quality Control Report

Jess Tester
Minnow Environmental Inc.
2 Lamb Street
Georgetown, ON L7G 3M9

Reference Materials and Standards:

A reference material of known concentration is used whenever possible as either a control sample or control standard and analyzed with each batch of samples. These "QC" results are used to assess the performance of the method and must be within clearly defined limits; otherwise corrective action is required.

QC Analysis	Units	Target Value	Obtained Value
Lead-210	Bq/L	19.7	21.0
Lead-210	Bq	7.47	7.72
Lead-210	Bq/L	19.7	20.3
Lead-210	Bq	0.370	0.398
Polonium-210	Bq/L	18.8	19.0
Polonium-210	Bq	0.370	0.353
Polonium-210	Bq/L	18.8	20.3
Polonium-210	Bq	0.075	0.082
Polonium-210	Bq/L	18.8	18.4
Polonium-210	Bq	0.370	0.334
Radium-226	Bq/L	16.8	15.4
Radium-226	Bq	0.043	0.040
Thorium-230	Bq/L	19.9	23.6
Thorium-232	Bq	0.195	0.218

Duplicates:

Duplicates are used to assess problems with precision and help ensure that samples within a given batch were processed appropriately. The difference between duplicates must be within strict limits, otherwise corrective action is required. Please note, the duplicate(s) in this report are duplicates analyzed within a given batch of test samples and may not be from this specific group of samples.

Duplicate Analysis	Units	Sample ID	First Result	Second Result
Lead-210	Bq/g	66730	<0.001	<0.001
Lead-210	Bq/g	66734	<0.001	<0.001
Lead-210	Bq/g	68033	<0.08	<0.08
Lead-210	Bq/g	68078	0.22	0.26
Polonium-210	Bq/g	66730	0.0046	0.0052
Polonium-210	Bq/g	66734	0.0004	0.0007
Polonium-210	Bq/g	67926	<0.005	<0.005
Radium-226	Bq/g	66744	0.0007	<0.0002
Radium-226	Bq/g	66749	0.0003	<0.0002
Radium-226	Bq/g	67603	0.01	<0.005

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Dec 06, 2019

This report was generated for samples included in SRC Group # 2019-14432

Duplicate Analysis	Units	Sample ID	First Result	Second Result
Thorium-230	Bq/g	66738	<0.0005	<0.0005
Thorium-230	Bq/g	66743	<0.0005	<0.0005
Uranium	ug/g	66733	<0.001	<0.001
Uranium	ug/g	66751	<0.001	<0.001

All quality control results were within the specified limits and considered acceptable.

Roxane Ortmann - Quality Assurance Supervisor

APPENDIX V
CORRESPONDENCE

APPENDIX V
CORRESPONDENCE

Serpent River Watershed Cycle 5 State of the Environment Report Submission Extension (October 2020)

30 October 2020
Ron Stenson
Senior Project Officer, Regulatory Operations Branch
Uranium Mines and Mills Division, Canadian Nuclear Safety Commission
280 Slater Street, Station B
P.O. Box 1046
Ottawa ON K1P 5S9

Dear Mr. Stenson

Serpent River Watershed Cycle 5 State of the Environment Report Submission Extension

In the Cycle 5 Study Design for the Serpent River Water Monitoring Program (SRWMP), Source Area Monitoring Program (SAMP), and Tailings Management Area Operational Monitoring Program (TOMP), submitted to the Elliot Lake Joint Review Group (JRG) via email in April 2019, Rio Algom Limited (RAL) and Denison Mines Incorporated (DMI) committed to submitting the Cycle 5 State of the Environment (SOE) interpretive report on or before 1 December 2020. Due to the COVID-19 pandemic, there were shifts in consultant timelines impacting the timeline to produce the final report. As such RAL and DMI would like to request an extension for the report delivery to 31 March 2021.

Please let me know if you have any questions or concerns with the updated report delivery timeline.

Kind Regards

Holly Heffner
BHP, Principal Licensing and Permitting
Holly.heffner@bhp.com

Click or tap here to enter text.

APPENDIX V
CORRESPONDENCE

RAL and DMI Responses to the Second Round of Regulator Comments on the Cycle 5 Study Design for the SRWMP, SAMP, and TOMP (April 2020)

Confidential Technical Memo

Date: April 24, 2020

To: Tony Lambert and Holly Heffner (Rio Algom Limited [RAL]), and Angie Corson (Denison Mines Inc. [DMI])

From: Jess Tester and Cynthia Russel (Minnow Environmental Inc.), and Don Hart (EcoMetrix Inc.)

RE: RAL and DMI Responses to the Second Round of Regulator Comments on the Cycle 5 Study Design for the SRWMP, SAMP, and TOMP

The Cycle 5 Study Design for the Serpent River Watershed Monitoring Program (SRWMP), the Source Area Watershed Monitoring Program (SAMP), and Tailings Management Area (TMA) Operational Monitoring Program (TOMP)(Minnow 2019) was submitted to the Joint Review Group (JRG) in April 2019. Comments on the study design were received from the Ministry of the Environment, Conservation, and Parks (MECP) on June 28, 2019, as well as from the Canadian Nuclear Safety Commission (CNSC) on October 2, 2019. Licensee responses to comments were provided in a Technical Memo dated December 12, 2019 (Attachment #1). Following review of these responses, on March 3, 2020 the JRG indicated that all the licensee responses were acceptable; however, they did request additional clarification on two comments (Attachment #2 provides comments from JRG). The Licensees have provided clarification below, following the preceding correspondences.

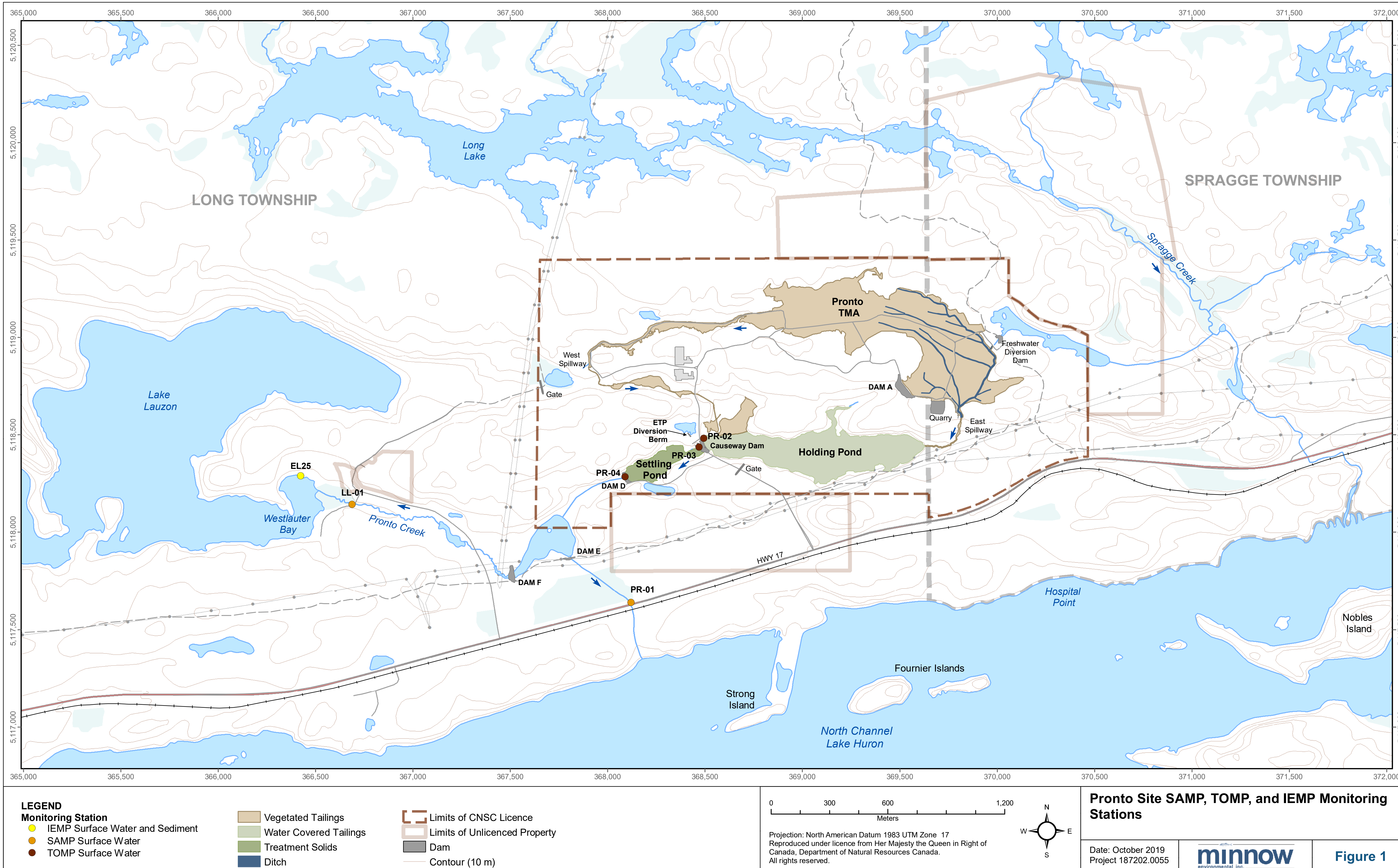
Pronto TMA and the IEMP Monitoring Location EL25

CNSC, October 2, 2019

Explore and report on the relationship between the Pronto TMA and the IEMP monitoring location EL25. If the location has been affected by historic or current operations, provide a plan for actions to protect the public and the environment.

Licensees Response, December 12, 2019

The Pronto TMA effluent discharges primarily to a drainage ditch that flows south and discharges into Lake Huron, although some site drainage to Pronto Creek reports to Lake Lauzon (Figure 1). Historically, the Pronto TMA only discharged to Lauzon Lake via Pronto Creek; however, in the



Document Path: S:\Projects\187202\187202.0055 - Denison Environmental Cycle 5 SOE Study Design\4 - GIS\Response\18-55 Figure 1 Pronto Site SAMP, TOMP, and IEMP Monitoring Stations.mxd late 1970s, Dam F was constructed to direct flow away from Lake Lauzon towards Lake Huron via the Pronto Discharge Channel. The Independent Environmental Monitoring Program (IEMP) monitoring location EL25, located in Lauzon Lake, therefore has been affected by historic operations (Figure 1). The IEMP station EL25 is downstream of SAMP station LL-01.

As part of the IEMP, radium-226 was measured at EL25 in surface water in 2015 and 2018, resulting in concentrations of <0.030 Bq/L for both years (CNSC 2019). Radium-226 concentrations were also measured at EL25 in the top 5 cm of sediment in 2015 and 2018, resulting in concentrations of 656 Bq/kg dry weight (d.w.) and 1,120 Bq/kg d.w., respectively (CNSC 2019). Based on water and sediment quality, the IEMP concluded that there are no expected health impacts at the concentrations measured (CNSC 2019).

In the Cycle 3 SRWMP (2009), the highest mean concentration of radium in sediment at a reference lake was 158 Bq/kg. This confirms that station EL25, with measured concentrations of 656 Bq/kg d.w. and 1,120 Bq/kg d.w, has been impacted by historic operations. Although the sediment concentrations are higher than background as well as the Thompson et al. (2016) Lowest Effect Level (LEL) of 600 Bq/kg, they are lower than the Severe Effect Level (SEL) of 14,400 Bq/kg (Thompson et al. 2016) and lower than the lowest proposed dose-based benchmark of 9,560 Bq/kg (EcoMetrix 2019) (Figure 2). Furthermore, lakes in the region have been shown to have slow deposition rates (Minnow 2013), with estimates of 22, 33, and 10 to 18 years to accumulate 1 cm of sediment in McCabe, Quirke, and Nordic Lakes, respectively. Therefore, it is likely that the IEMP's 5-cm deep sediment sample includes sediments that are very old, and unsurprisingly the sample reflects historical influence of the former flow pathway.

Surface water concentrations of radium-226 at station LL-01 (located downstream of the TMA and upstream of station EL25) have been well below the discharge criterion and showed a decreasing trend from 2003 to 2018 (Figure 3; Minnow 2017). Water quality at SAMP station LL-01 will continue to be monitored. Based on water quality, sediment quality, and the IEMP conclusions, no other actions are necessary to protect the public and the environment.

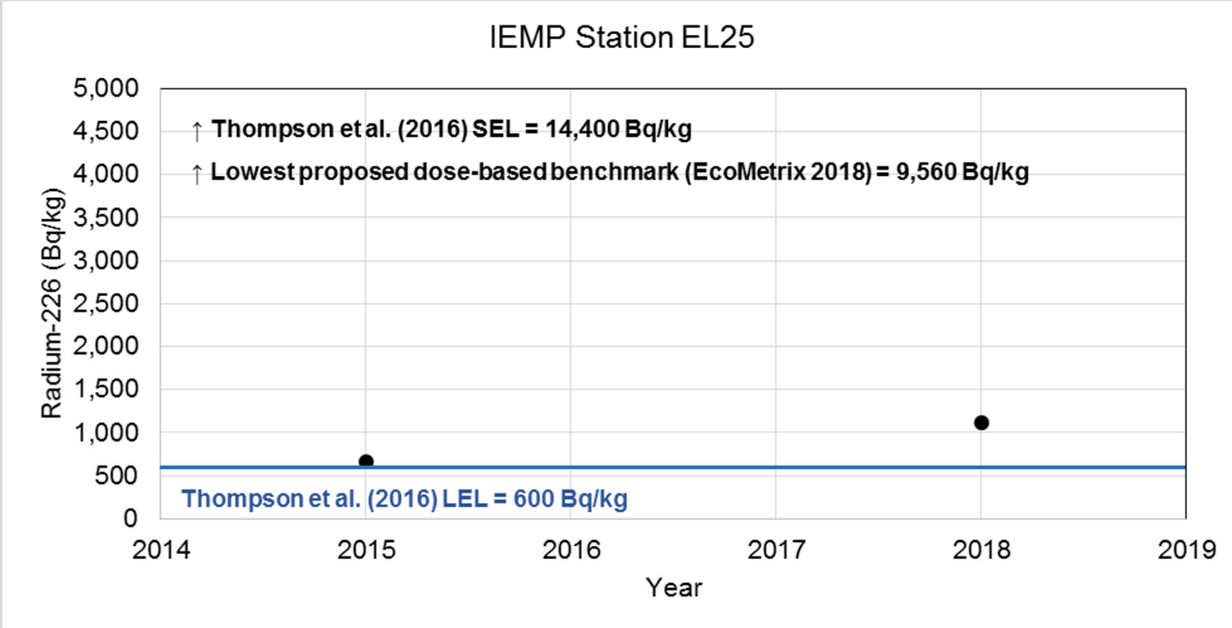


Figure 2: Radium-226 concentrations in sediment at IEMP station EL25 compared to sediment quality guidelines and benchmarks, 2015 and 2018

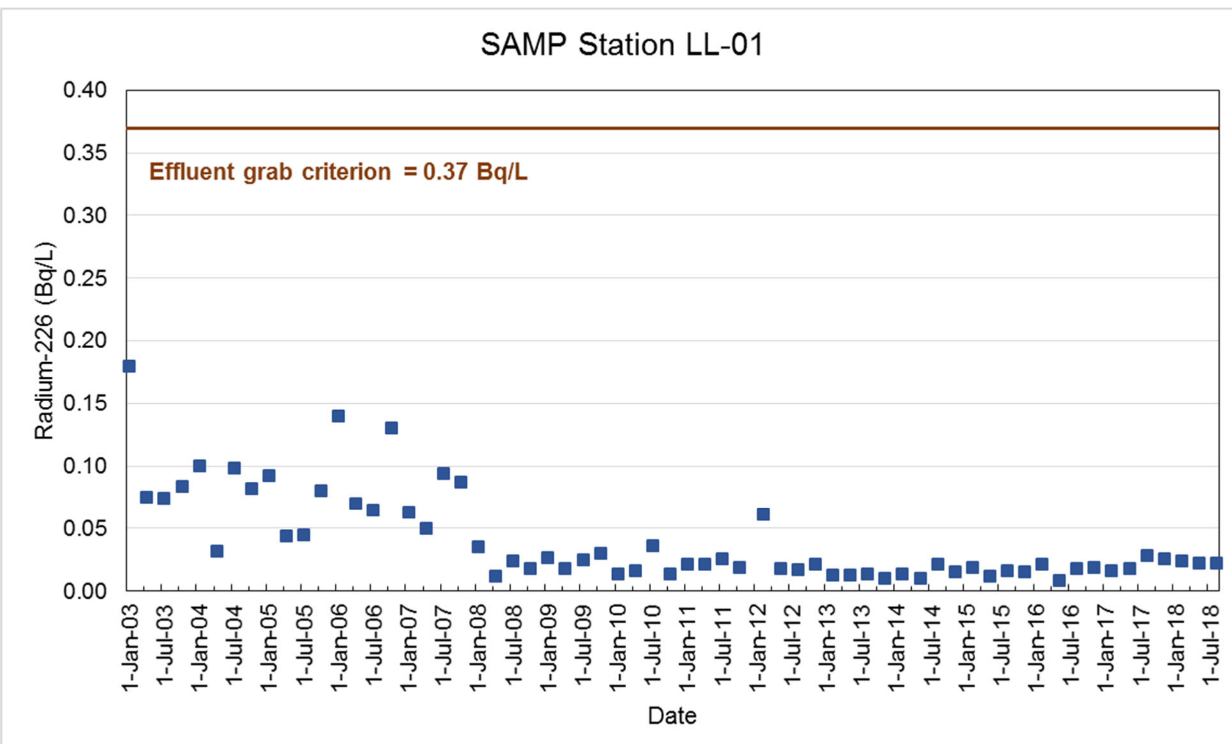


Figure 3: Radium-226 concentrations in water at SAMP station LL-01 compared to effluent grab criterion, 2003 to 2018

CNSC Disposition of Comment 3 Response, March 11, 2020

CNSC staff requests the licensee provide the historical data the response is based on, including the sediment and water quality monitoring results, to the CNSC for review.

Licensees Response, April 24, 2020

Water quality monitoring results for SAMP station LL-01 are provided in Attachment #3. The CNSC collected the two EL25 sediment samples that were referenced in the licensee response (CNSC 2019). Sediment quality results for reference lakes from the Cycle 3 SRWMP (2009) are provided in Attachment #4. The sediment deposition rate study (Minnow 2013) is provided in Attachment #5.

Site-Specific Water and Sediment Quality Criteria

CNSC, October 2, 2019

Revise Ra-226 site-specific water and sediment quality criteria to use the 95th percentile dose rates for sessile organisms and the upper confidence level for mobile organisms for consistency with Clauses 7.3.3.1 and 7.3.3.2 of CSA N288.6. Site-specific concentration factors for benthos, fish and riparian wildlife should be used to support the derivation of the Ra-226 benchmarks.

Licensees Response, December 12, 2019

Clauses 7.3.3.1 and 7.3.3.2 in CSA N288.6 do not pertain to development of media screening criteria. They pertain to the calculation of organism exposure concentrations in an ecological risk assessment. The screening criteria for radium-226 that were used in the Cycle 5 Study Design for the for the SRWMP, SAMP, and TOMP were appropriately derived to reflect site-specific concentration factors and partition coefficients, which are embedded in the "Calculated Dose" of the criterion equation (EcoMetrix 2019, Attachment C herein). These factors and coefficients define the relationship between water concentration and dose, or sediment concentration and dose, on a lake-specific basis. They can be seen in the dose calculation sheets from Appendix D of EcoMetrix (2011), which were attached to the EcoMetrix memo (Attachment C herein). The concentrations that were compared to the screening criteria in the Cycle 5 Study Design were the maximum measured concentrations. Thus, the screening process was appropriately conservative.

CNSC Disposition of Comment 4 Response, March 11, 2020

While clauses 7.3.3.1 and 7.3.3.2 pertain to organism exposure concentrations, the spirit of these clauses is to ensure adequate conservatism is incorporated within the assumptions used to assess the likelihood of effects to an ecosystem. CNSC staff accepts the screening criteria are adequately conservative to assess the radiological risks to biota for individual water and sediment results.

It is stated in the dose calculation sheets in attachment C that PC or BAF values in red were derived from lake measurements, presumably from the in-lake measurements (boxes highlighted in blue). However, despite differing values in water concentrations and organism concentrations across lakes, BAF's for fish and plants remain unchanged for all lakes. It is expected these values would change from lake to lake, depending on the measured water concentrations and concentrations in fish and plants.

CNSC staff request an explanation be provided as to why the BAF's from water to fish and water to plants are identical across lakes as it is expected that the values would differ from lake to lake based on the different measurements of water, fish, and plant concentrations in each lake.

Licensees Response, April 24, 2020

The screening criteria derived for radium-226 in water and sediment were based on the dose to biota, and the water or sediment concentration that drives the dose. The criteria derivation assumed that the media ratios, including water:fish ratios and water:plant ratios, were lake-specific. The lake-specific media concentrations (water, sediment, fish, plant) were in fact used in the dose calculations for each lake.

The CNSC has requested clarification on the generic watershed bioaccumulation factors (BAFs) for forage fish and aquatic plants. The generic watershed BAFs for forage fish and aquatic plants were used in the Special Investigation study (EcoMetrix 2011) only when a measured fish or plant value was unavailable. For example, the generic water to fish BAF for thorium-230 was used to estimate thorium-232 and thorium-228 in fish, and the radium-226 BAF was used to estimate radium-228 in fish. Within the Cycle 5 Study Design for the SRWMP, SAMP, and TOMP (Minnow 2019), the generic watershed BAFs for radium-226 in sport fish were used in the calculation of radium-226 dose for the generic human on each lake. The generic values were used because sport fish data were available for only three lakes (Quirke, Elliot, and McCarthy lakes), and because the sport fish BAFs were less variable among lakes (i.e., factor of 2 above and below the geometric mean). Although the generic radium-226 BAF for sport fish was used in the calculation of the radium-226 criteria based on human dose, these generic BAFs in the dose tables do not affect the radium-226 screening criteria selected to be used in Cycle 5. This is because the screening criteria were based on muskrat dose (not human dose), as the muskrat dose resulted in the the lowest (i.e., most conservative) calculated criteria across the entire Serpent River Watershed (SRW).

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Attachment #1

December 12, 2019:
RAL and DMI Responses to Regulator Comments on the Cycle 5 Study Design for the SRWMP, SAMP, and TOMP

Confidential Technical Memo

Date: December 12, 2019

To: Tony Lambert and Holly Heffner (Rio Algom Limited [RAL]), Janet Lowe and Angie Corson (Denison Environmental Services [DES])

From: Jess Tester and Cynthia Russel (Minnow Environmental Inc.)

RE: RAL and DMI Responses to Regulator Comments on the Cycle 5 Study Design for the SRWMP, SAMP, and TOMP

The Cycle 5 Study Design for the Serpent River Watershed Monitoring Program (SRWMP), the Source Area Watershed Monitoring Program (SAMP), and Tailings Management Area (TMA) Operational Monitoring Program (TOMP) was submitted to the Joint Review Group (JRG) in April 2019. Comments on the study design were received from the Ministry of the Environment, Conservation, and Parks (MECP) on June 28, 2019 (Attachment A), as well as from the Canadian Nuclear Safety Commission (CNSC) on October 2, 2019 (Attachment B). Licensee responses to comments are provided below.

[MECP] Include dissolved organic carbon (DOC) as a monitoring parameter in anticipation of a new Federal Environmental Quality Guideline for iron, currently posted for public review, that includes DOC and pH as toxicity modifiers.

Due to the new Federal Water Quality Guideline (FWQG) for iron, DOC will be added as a monitoring parameter at all SRWMP water quality monitoring stations where iron is currently measured (i.e., D-4, SR-19, SR-18, SR-16, SR-17, D-6, DS-18, SR-15, M-01, and SC-01). Conversely, DOC will not be collected for SAMP and TOMP water quality data. Although the SAMP and TOMP water quality data (i.e., mine sources of effluent and seepage) may be compared to environmental criteria (e.g., the FWQG) to identify potential variables or sources of concern relative to the downstream receiving environment, it is recognized that SAMP and TOMP water quality data are not required to achieve criteria for receiving environment quality. The TOMP water quality data will be compared to the 50-year post-decommissioning Environmental Impact Statement (EIS) predictions. The SAMP water quality will be screened against effluent grab criteria and monthly average discharge criteria.

[MECP] Data presented in the Cycle 4 study report ("Serpent River Watershed Cycle 4 [2010 to 2014] State of the Environment Report" dated March 2016) show three mine seepages with chemistry potentially toxic to aquatic biota. Denison Mine monitoring stations D-9 and D-16, part of the Source Area Monitoring Program (SAMP), have high iron concentrations (2010-2014 mean 5.28mg/L at D-16 and 3.48 mg/L at D-9). At Quirke Mine, SAMP monitoring station ECA-398 has low pH (2010-2014 mean pH 4.1). the potential near-field effects on aquatic biota should be examined. As part of the Cycle 5 include standard acute (rainbow trout, *daphnia magna)* and sub-lethal (*Ceriodaphnia dubia*) toxicity testing of the seepage water at those three locations twice per year. If toxicity is confirmed, the area of aquatic habitat not meeting water quality objectives should be described for each seepage discharge.

In order to understand the potential toxicity of the three mine seepages (D-9, D-16, and ECA-398), samples will be collected twice in 2020 for analysis of standard acute toxicity testing (rainbow trout and *Daphnia magna*) and sub-lethal (*Ceriodaphnia dubia*) toxicity testing. Results will be included within the Cycle 5 SOE interpretive report as a Special Investigation, although the Cycle 5 SOE will otherwise cover data collected from 2015 to 2019 (and earlier, where applicable).

[CNSC] Provide a justification for the absence of pore water monitoring stations or monitoring of Ra-226 in the groundwater in order to demonstrate/support the assumptions/predictions regarding the increasing Ra-226 levels in the final effluent at Stanleigh TMA.

Pore water and groundwater quality for the Elliot Lake Mines, including the Stanleigh TMA are monitored under the TOMP. Pore water was collected from the Stanleigh TMA during Cycle 1 and Cycle 2 of the TOMP in order to monitor basin performance. Following Cycle 2, the JRG approved the removal pore water monitoring at Stanleigh TMA stations based on the recommendations of the Cycle 3 Study Design (Minnow 2009b and EcoMetrix 2008). Pore water monitoring was discontinued at the Stanleigh TMA because expected changes in pore water conditions had already been realized and the pore water data were no longer required for management or understanding of conditions within the TMAs. Pore water sampling was considered to be redundant with ongoing monitoring of influent basin water at station CL-04. The TOMP groundwater monitoring parameters have been acidity, pH, conductivity, and iron since the program was developed in 2002 (Minnow 2002), and sulphate replaced conductivity in Cycle 3 (Minnow 2009b). These parameters have been used to detect potential migration of substances away from the basins over time.

Notably, this lack of pore water monitoring and radium-226 in groundwater monitoring is not expected to hinder understanding the increasing radium-226 levels in the final effluent of the Stanleigh TMA (discharged from the settling pond at station CL-06), as the levels of radium-226 are not increasing within the Stanleigh TMA basin influent water (station CL-04) or within the ETP treated water (station CL-05). The increase in radium-226 levels is a treatment method efficiency issue, not a TMA basin performance issue.

Outside of the TOMP, several separate investigations have been conducted as part of the monitoring and response studies to further the understanding of source term characterization which have included pore water as well as basin conditions and performance. These studies have provided evidence that the increasing radium-226 levels at Stanleigh result from a treatment method efficiency issue, as outlined below:

1. A pore water investigation was undertaken at Stanleigh TMA in 2015, investigating radium-226 pore water concentrations and the potential for winter anoxia to cause increasing levels of radium-226. The investigation showed that there was no winter anoxia at the three stations where pore water samples were collected. Flux of radium-226 from the surface sediments was highest at the station which had mineral content with little capacity for retention of radium-226 (i.e., 95% silicate and phyllosilicates). Therefore, although the flux was highest at this station, there is little potential for changes in flux due to the inert nature of the sediment mineral composition.
2. After the 2015 study, the bathymetry of the Stanleigh TMA was determined, which indicated a deep basin (deeper than the stations investigated in 2015) where winter anoxia may still be possible. A pore water investigation of this deep basin took place in 2017, and although the water overlying the sediment was anoxic, the pore water radium-226 concentration (0.5 Bq/L) was lower than the other stations that were oxic (concentrations ranged from 1.7 to 6.1 Bq/L in the top 2 cm of sediment). Therefore, the 2015 and 2017 pore water studies indicate that there is no basis for expecting an anoxia- or redox-related seasonal change in radium-226 from the TMA, and there was no observation of a seasonal source of radium-226 from the TMA basin sediments.
3. The second pore water investigation at Stanleigh was part of a larger comprehensive study of the Stanleigh TMA sediment. This study concluded that radium-226 fluxes from sediment are not expected to change based on the sediment mineralogical composition that was assessed at four stations. At two of the stations, sediment consisted of mainly inert minerals (aluminosilicates and quartz). At a third station, total organic carbon (TOC) likely controlled radium-226. At a fourth station, radium-226 was stable, predominantly associated with the residual phase of a sequential extraction analysis (SEA), which was likely due to an association with barite. Based on SEA, the station with the most labile radium-226 was the station with radium-226 associated with TOC, where radium-226 may

be released as TOC degrades. Currently, radium-226 in pore water at this station is low (1.7 Bq/L).

4. Several bench test experiments have been undertaken, starting in 2017 and currently ongoing, which have shown that the seasonally increasing radium-226 concentration in effluent results from a seasonally decreased barite particle size. A modified treatment process that addresses the barite particle size has been implemented, and provides additional evidence that the increasing radium-226 levels in effluent are not associated with TMA basin performance.

The objective of the TOMP is to track the performance of the TMAs and to generate data used to make decisions about the management and discharge compliance of the TMAs. Since increasing radium concentrations are a function of treatment performance and not basin performance, treatment efficacy will continue to be investigated outside of the TOMP. Pore water monitoring and monitoring of radium-226 in groundwater at the Stanleigh TMA are not needed within the TOMP to further this investigation.

[CNSC] Identify and quantify potential sources of seepage/drainage from the Stanleigh TMA to the settling pond, which receives the treated effluent discharging from the water treatment plant prior to being released into the McCabe Lake.

The Stanleigh settling pond watershed is confined by Dam B to the west and topographic ridges to the north and south of the settling pond. It is retained by the settling pond dam at the inlet to McCabe Lake. Sources of drainage and seepage to the Stanleigh settling pond were identified during the original design phase for the settling pond (Golder 2006). The total drainage catchment area for the Stanleigh TMA is approximately 35 hectares (ha), with a surface area of 4.5 ha, and an estimated 8.7 Mm^3 TMA annual runoff. The settling pond catchment area is small, and the estimated volume of surface runoff that reports to the settling pond is small relative to the volume of effluent treated, (Table 1).

Table 1: Estimated Annual Runoff Volumes for the Stanleigh Settling Pond Catchment Area

Volume Type	Return Period	Rainfall (mm)	Runoff Volume (m^3)
Annual High	100-year wet	1,169	265,880
Annual Average	N/A	884	201,170
Annual Low	Unknown	575	130,810

In addition to surface runoff to the settling pond, seepage from Dam B to the settling pond was estimated (Golder 2006). Total mean seepage was determined to be less than 0.2 L/s based on actual field seepage monitoring points in the valley downstream of Dam B (stations CL-12 and CL-13). This seepage rate equates to approximately 6,307 m^3/yr. of seepage reporting to the settling pond. This is 7×10^{-14}% of the estimated 8.7 Mm^3 TMA annual runoff treated and released to the settling pond by the effluent treatment plant.

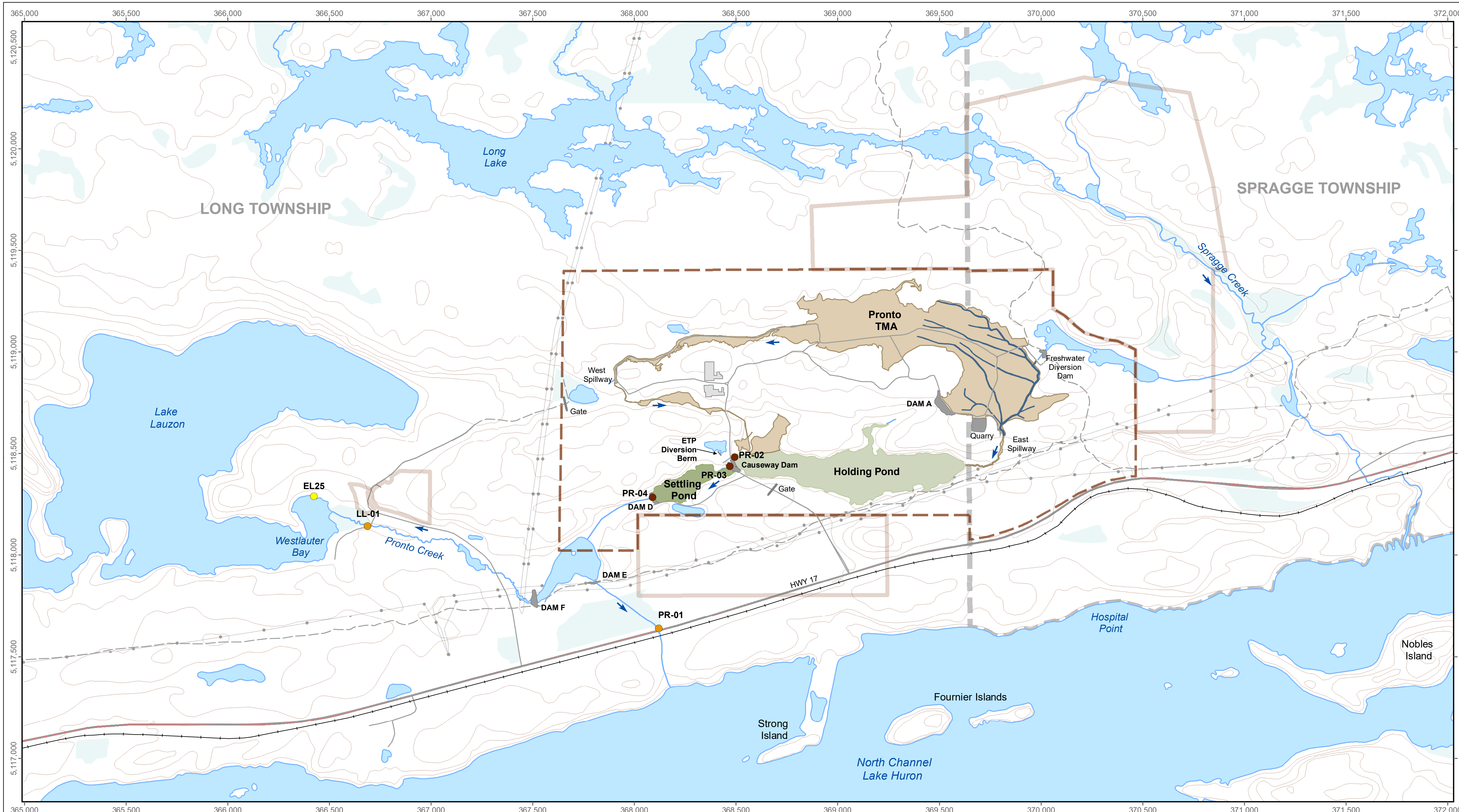
The estimated quantity of seepage from the Stanleigh TMA (through Dam B) to the settling pond is insignificant compared to the estimated TMA annual runoff volume, and treatment criteria are currently being achieved at the point of discharge into the receiving environment at SAMP and TOMP surface water station CL-06.

[CNSC] Explore and report on the relationship between the Pronto TMA and the IEMP monitoring location EL25. If the location has been affected by historic or current operations, provide a plan for actions to protect the public and the environment.

The Pronto TMA effluent discharges primarily to a drainage ditch that flows south and discharges into Lake Huron, although some site drainage to Pronto Creek reports to Lake Lauzon (Figure 1). Historically, the Pronto TMA only discharged to Lauzon Lake via Pronto Creek; however, in the late 1970s, Dam F was constructed to direct flow away from Lake Lauzon towards Lake Huron via the Pronto Discharge Channel. The Independent Environmental Monitoring Program (IEMP) monitoring location EL25, located in Lauzon Lake, therefore has been affected by historic operations (Figure 1). The IEMP station EL25 is downstream of SAMP station LL-01.

As part of the IEMP, radium-226 was measured at EL25 in surface water in 2015 and 2018, resulting in concentrations of <0.030 Bq/L for both years (CNSC 2019). Radium-226 concentrations were also measured at EL25 in the top 5 cm of sediment in 2015 and 2018, resulting in concentrations of 656 Bq/kg dry weight (d.w.) and 1,120 Bq/kg d.w., respectively (CNSC 2019). Based on water and sediment quality, the IEMP concluded that there are no expected health impacts at the concentrations measured (CNSC 2019).

In the Cycle 3 SRWMP (2009), the highest mean concentration of radium in sediment at a reference lake was 158 Bq/kg. This confirms that station EL25, with measured concentrations of 656 Bq/kg d.w. and 1,120 Bq/kg d.w, has been impacted by historic operations. Although the sediment concentrations are higher than background as well as the Thompson et al. (2016) Lowest Effect Level (LEL) of 600 Bq/kg, they are lower than the Severe Effect Level (SEL) of 14,400 Bq/kg (Thompson et al. 2016) and lower than the lowest proposed dose-based benchmark of 9,560 Bq/kg (EcoMetrix 2019) (Figure 2). Furthermore, lakes in the region have been shown to have slow deposition rates (Minnow 2013), with estimates of 22, 33, and 10 to 18 years to accumulate 1 cm of sediment in McCabe, Quirke, and Nordic Lakes, respectively. Therefore, it is likely that the IEMP's 5-cm deep sediment sample includes sediments that are very old, and unsurprisingly the sample reflects historical influence of the former flow pathway.



LEGEND

Monitoring Station

- IEMP Surface Water and Sediment
- SAMP Surface Water
- TOMP Surface Water

Vegetated Tailings
Water Covered Tailings
Treatment Solids
Ditch
Limits of CNSC Licence
Limits of Unlicenced Property
Dam
Contour (10 m)

0 300 600 1,200
Meters

N E S W

Projection: North American Datum 1983 UTM Zone 17
Reproduced under licence from Her Majesty the Queen in Right of Canada, Department of Natural Resources Canada.

Pronto Site SAMP, TOMP, and IEMP Monitoring Stations

Date: October 2019
Project 187202.0055

minnow environmental inc.

Figure 1

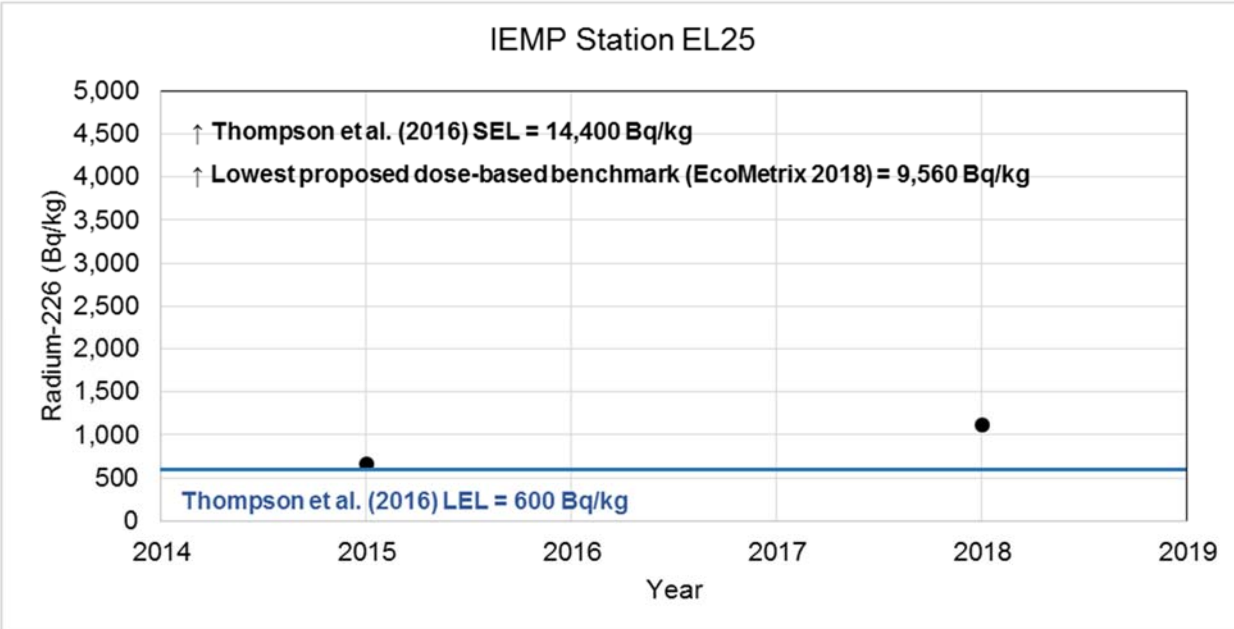


Figure 1: **Radium-226 concentrations in sediment at IEMP station EL25 compared to sediment quality guidelines and benchmarks, 2015 and 2018**

Surface water concentrations of radium-226 at station LL-01 (located downstream of the TMA and upstream of station EL25) have been well below the discharge criterion and showed a decreasing trend from 2003 to 2018 (Figure 3; Minnow 2017). Water quality at SAMP station LL-01 will continue to be monitored. Based on water quality, sediment quality, and the IEMP conclusions, no other actions are necessary to protect the public and the environment.

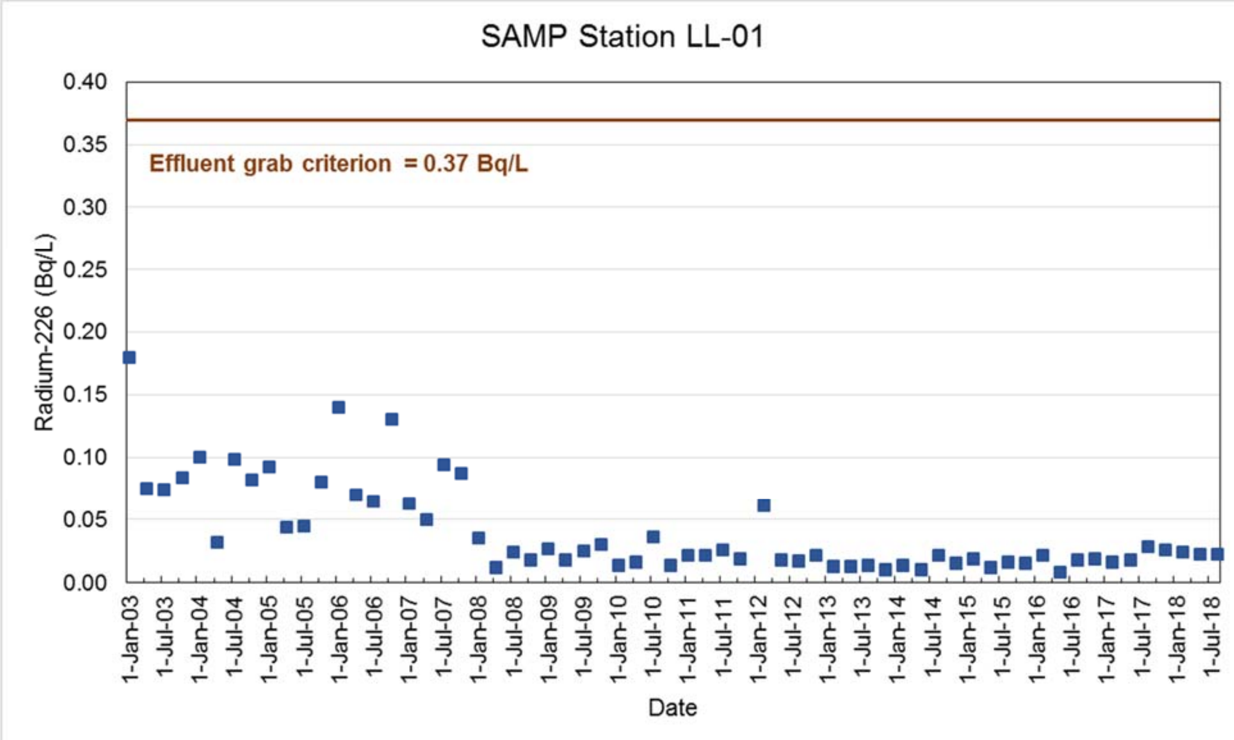


Figure 3: Radium-226 concentrations in water at SAMP station LL-05 compared to effluent grab criterion, 2003 to 2018

[CNSC] Revise Ra-226 site-specific water and sediment quality criteria to use the 95th percentile dose rates for sessile organisms and the upper confidence level for mobile organisms for consistency with Clauses 7.3.3.1 and 7.3.3.2 of CSA N288.6. Site-specific concentration factors for benthos, fish and riparian wildlife should be used to support the derivation of the Ra-226 benchmarks.

Clauses 7.3.3.1 and 7.3.3.2 in CSA N288.6 do not pertain to development of media screening criteria. They pertain to the calculation of organism exposure concentrations in an ecological risk assessment. The screening criteria for radium-226 that were used in the Cycle 5 Study Design for the for the SRWMP, SAMP, and TOMP were appropriately derived to reflect site-specific concentration factors and partition coefficients, which are embedded in the "Calculated Dose" of the criterion equation (EcoMetrix 2019, Attachment C herein). These factors and coefficients define the relationship between water concentration and dose, or sediment concentration and dose, on a lake-specific basis. They can be seen in the dose calculation sheets from Appendix D of EcoMetrix (2011b), which were attached to the EcoMetrix memo (Attachment C herein). The concentrations that were compared to the screening criteria in the

Cycle 5 Study Design were the maximum measured concentrations. Thus, the screening process was appropriately conservative.

[CNSC] Explain why radium-226 is not proposed to be measured in groundwater or pore waters at any of the TMAs. CNSC staff are of the opinion that the groundwater and pore water quality TOMP subprogram is limited and requires further justification – the conceptual groundwater model relies on TMA groundwater reporting to the surface.

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 TMAs (Golder and CCL 1992a)
- Geological and Hydrogeological Assessment; Supporting Documents, Volume 2 Decommissioning Study; Stanrock Mine TMAs (Golder and CCL 1992b)
- Hydrogeological Assessments of the Effects of Quirke/Panel Mine Flooding on Regional and Local Groundwater Flow Systems, Elliot Lake Ontario (Golder 1991a)
- Hydrogeological Assessment, Panel Mine Waste Management Area, Elliot Lake Ontario (Golder 1991b)
- Hydrogeological Modelling of the Stanleigh Waste Management Area, Post Closure Conditions (Golder 1996)
- 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 these assessments was that groundwater from the TMAs reports to local surface water bodies. These downstream water bodies are monitored and assessed as part of the SRWMP. The current groundwater monitoring program is conducted under the TOMP as perimeter monitoring to assess the movement of TMA-influenced water downgradient of the TMAs. The substances monitored under TOMP 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 have been and will be assessed using non-parametric statistics.

To address the concerns of the JRG, the Cycle 5 SOE interpretive report will include basic hydrogeologic conceptual models, a summary explaining the history of groundwater monitoring, and the results of previous hydrogeological studies.

Radium-226 has not been a TOMP pore water monitoring parameter, as radium-226 concentrations in effluent are meeting discharge criterion. In the future, if elevated concentrations of radium-226 occur in effluent, the addition of radium-226 as a tailings pore water monitoring parameter may be considered, if deemed beneficial for understanding elevated concentrations.

[CNSC] Update the hydrogeological predictions and long-term radium (or other actinide) evolution and how this information is used to inform the cycle 5 study design (TOMP).

There were no hydrogeological predictions made in the Environmental Assessments, as it was understood that groundwater would report to surface water. Within each SOE report, comparisons are made between surface water predictions from the Environmental Assessments and concentrations measured in surface water (Minnow 2017). Results have shown surface water quality improving, as predicted (Minnow 2017). Although there are no hydrogeological predictions for comparison, the Cycle 5 SOE interpretive report will include basic hydrogeologic conceptual models, a summary explaining the history of groundwater monitoring, and the results of previous hydrogeological studies.

[CNSC] Discontinue, as discussed, benthic invertebrate community monitoring at Elliot Lake under the SRWMP. CNSC staff notes that water quality monitoring at M-01 (the inlet to Elliot Lake) will continue to be conducted and concur that downstream monitoring in Elliot Lake will be reinstated should increase concentrations of mine-related substances be detected.

Acknowledged. Thank you.

[CNSC] Consider, to demonstrate lake recovery, taking sediment cores in all lakes including Elliot Lake, and focus on the top 10 cm and slice at 0.5 cm in the first centimeter and then every centimeter to a depth of 10 centimeters to provide evidence of recovery.

Sediment quality in the SRWMP lakes has been measured in 1-cm thick core slices that were collected in 1999, 2004, and 2009 (Minnow and Beak 2001, Minnow 2005, 2011), as well as recent samples collected in 2019 as part of the Cycle 5 SRWMP. These data will be presented in the Cycle 5 SOE interpretive report to assess lake recovery over time.

In addition to this, sediment deposition rates and sediment quality were assessed in McCabe, Quirke, and Nordic lakes in a detailed study conducted in 2011 and 2012 (Minnow 2013). McCabe, Quirke, and Nordic lakes were selected for this study because they are near-field receiving lakes that were historically the most influenced by mining activities, and they represented a range of lake productivity (and therefore likely a range of deposition rates). The sediment deposition rates were determined using two approaches: (1) sediment traps to assess the sedimentation rate and sediment quality at that time at SRWMP sediment and benthic invertebrate monitoring stations, and (2) sediment core profiling at deep-basin locations to investigate historical sediment quality and to determine, using sediment chemistry, how deposition rates changed over time relative to the historical mining influence within the lake. The results indicated that SRWMP sediment and benthic invertebrate monitoring stations would take roughly 22, > 33, and 10 to 18 years at McCabe, Quirke, and Nordic lakes, respectively, to accumulate 1 cm of sediment, or half those durations for 0.5 cm of sediment (Table 2; Minnow 2013).

Table 2: Estimated Sediment Deposition Rates in McCabe, Quirke, and Nordic Lakes (Minnow 2013)

Lake	Deposition rate (mm/yr.)		Estimated number of years to accumulate 1 cm of sediment	
	Deep-basin station	SRWMP sediment and benthic invertebrate monitoring station	Deep-basin station	SRWMP sediment and benthic invertebrate monitoring station
McCabe Lake	0.6	0.40 to 0.44	16.5	22
Quirke Lake	0.3	> 0.3	33	> 33
Nordic Lake	0.74	0.55 to 1.06	13.5	10 to 18

For the 2011/2012 study, sediment was collected in 0.5-cm thick slices from cores and was analyzed to determine metals concentrations, including the SRWMP monitoring parameters barium, cobalt, iron, manganese, nickel, and uranium (Figures 4 to 6; Minnow 2013).

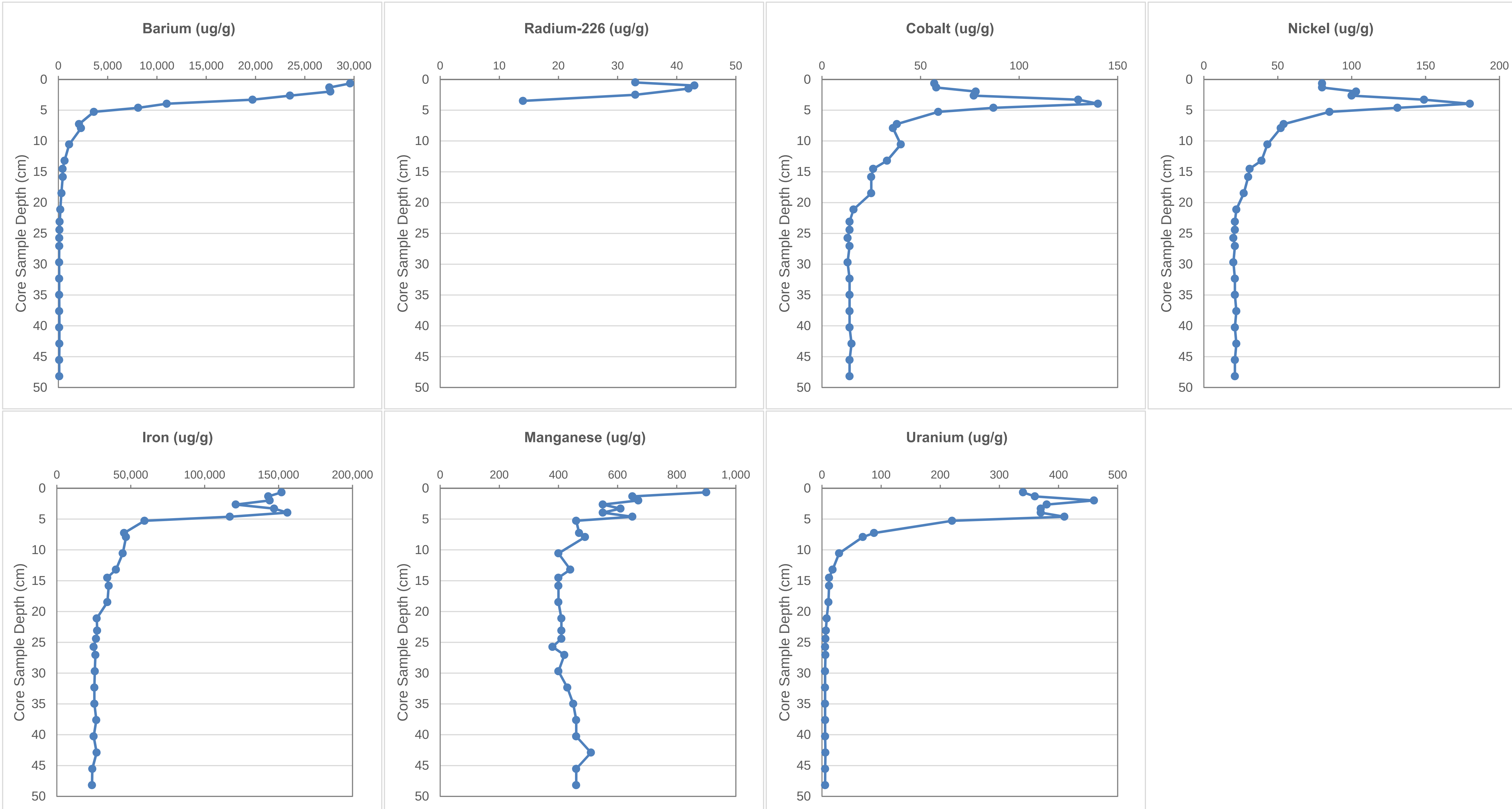


Figure 4: McCabe Lake Sediment Quality from Sediment Core Sections (Minnow 2013)

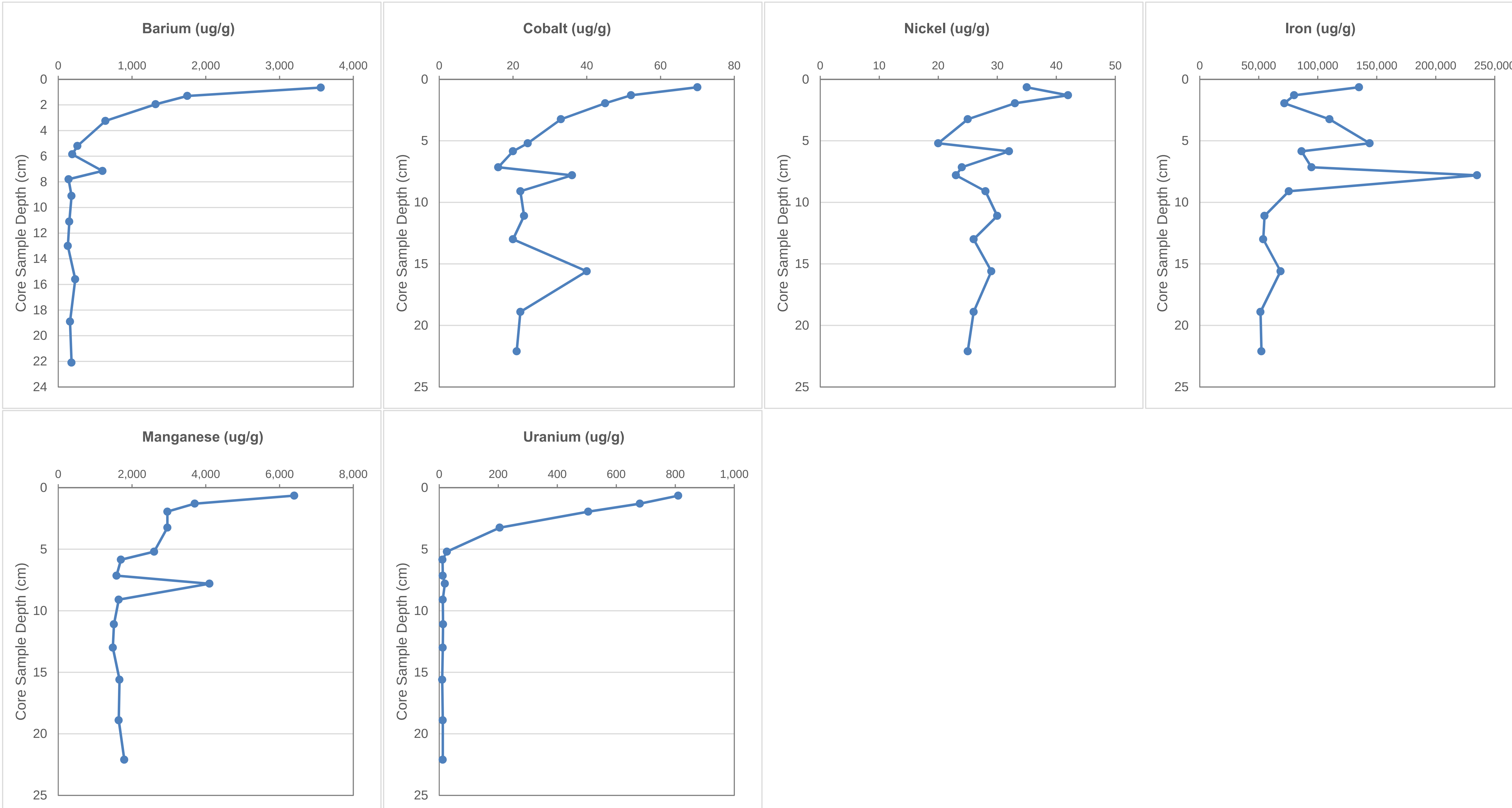


Figure 5: Quirke Lake Sediment Quality from Sediment Core Sections (Minnow 2013)

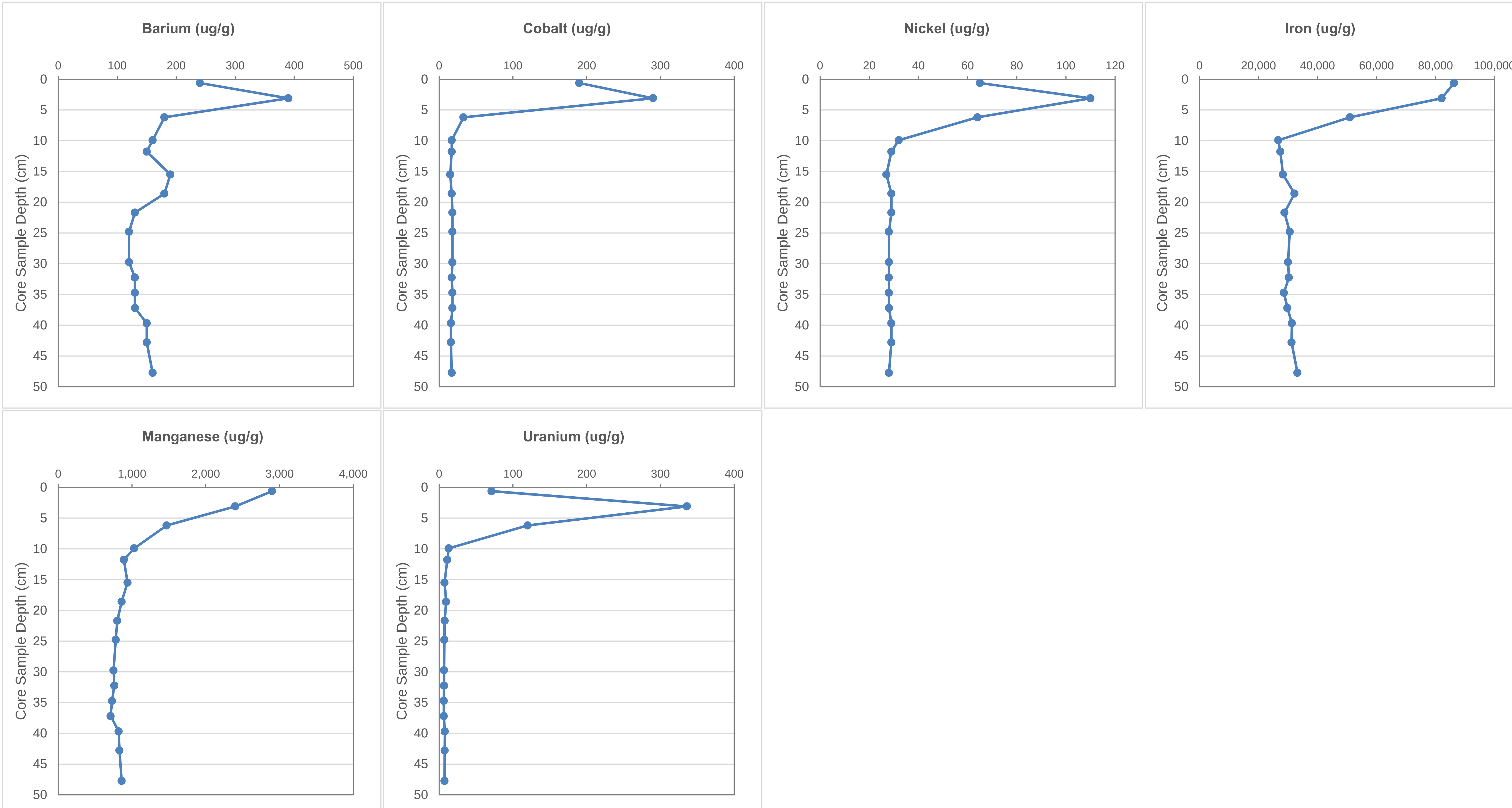


Figure 6: Nordic Lake Sediment Quality from Sediment Core Sections (Minnow 2013)

McCabe Lake slices were also analyzed for radium-226[1] (Figure 4; Minnow 2013). In McCabe and Nordic lakes (Figures 4 and 6), concentrations of cobalt, nickel, and uranium were lower in the top sediments compared to deeper sediments, as were radium-226 and iron in McCabe Lake, suggesting lake recovery. Quirke Lake metal concentrations generally did not indicate lake recovery (Figure 5); however, Quirke Lake had the slowest estimated deposition rates of the three lakes, and the 0.65-cm thick surficial sediment may have represented over 21.7 years' worth of deposition (Minnow 2013) and therefore could have included sediments that had accumulated prior to mine closure, which occurred in the early 1990s.

The sediment data collected for the SRWMP as well as for the 2011/2012 sediment deposition study are sufficient to assess concentrations of mine-related parameters over time and to evaluate lake recovery. The additional work that is proposed by the CNSC would be redundant to the existing data.

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[1] The main objective of the 2011/2012 study was to estimate deposition rates, and sediment chemistry data were collected to support this objective. Radium-226 was measured in core samples from McCabe Lake, but not Quirke or Nordic lakes because this parameter was not needed to determine time markers in the metal profiles of the core.

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ATTACHMENT A

Ministry of the Environment, Conservation and Parks

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Ministère de l'Environnement, de la Protection de la nature et des Parcs

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Ontario

June 28, 2019

MEMORANDUM

TO: Kirk Crosson
Senior Environmental Officer
Sault Ste. Marie District Office

FROM: Ed Snucins
Surface Water Specialist
Technical Support, Northern Region

RE: Cycle 5 Study Design Elliot Lake Closed Mines

As requested, I have reviewed the report entitled "Cycle 5 Study Design For the SRWMP, SAMP, and TOMP" dated April 2019 that was prepared by Minnow Environmental Inc. for Rio Algom Limited and Denison Mines Inc. Following are my recommendations for improvements to the surface water study design.

(1) Include dissolved organic carbon (DOC) as a monitoring parameter in anticipation of a new Federal Environmental Quality Guideline for iron, currently posted for public review, that includes DOC and pH as toxicity modifiers.

(2) Data presented in the Cycle 4 study report ("Serpent River Watershed Cycle 4 (2010 to 2014) State of the Environment Report" dated March 2016) show three mine seepages with chemistry potentially toxic to aquatic biota. Denison Mine monitoring stations D-9 and D-16, part of the Source Area Monitoring Program (SAMP), have high iron concentrations (2010-2014 mean 5.28 mg/L at D-16 and 3.48 mg/L at D-9). At Quirke Mine, SAMP monitoring station ECA-398 has low pH (2010-2014 mean pH 4.1). The potential near-field effects on aquatic biota should be examined. As part of Cycle 5 include standard acute (rainbow trout, *Daphnia magna*) and sub-lethal (*Ceriodaphnia dubia*) toxicity testing of the seepage water at those three locations twice per year. If toxicity is confirmed, the area of aquatic habitat not meeting water quality objectives should be described for each seepage discharge.

Ed Snucins, M.Sc.
Surface Water Specialist

cc. Regional file – SW 03 10 (Elliot Lake, Serpent River)

ATTACHMENT B

From: Stenson, Ron (CNSC/CCSN)
To: Heffner, Holly
Cc: Lambert, Tony; UMMD / DMUCU (CNSC/CCSN); Janet Lowe
Subject: RE: Proposed changes to the Serpent River Watershed Monitoring Field Program
Date: Wednesday, October 02, 2019 12:02:45 PM
Attachments: image002.png

Good morning Holly.

I have the official version of CNSC specialist staff's comments on the Cycle 5 Study Design for the SRWMP, SAMP and TOMP. There are a number of comments listed below which I would be happy to speak with you about.

CNSC staff recommend that the licensees:

- Provide a justification for the absence of pore water monitoring stations or monitoring of Ra-226 in the groundwater in order to demonstrate/support the assumptions/predictions regarding the increasing Ra-226 levels in the final effluent at Stanleigh TMA.
- Identify and quantify potential sources of seepage/drainage from the Stanleigh TMA to the settling pond, which receives the treated effluent discharging from the water treatment plant prior to being released into the McCabe Lake.
- Explore and report on the relationship between the Pronto TMA and the IEMP monitoring location EL25. If the location has been affected by historic or current operations, provide a plan for actions to protect the public and the environment.
- Revise Ra-226 site-specific water and sediment quality criteria to use the 95th percentile dose rates for sessile organisms and the upper confidence level for mobile organisms for consistency with Clauses 7.3.3.1 and 7.3.3.2 of CSA N288.6. Site-specific concentration factors for benthos, fish and riparian wildlife should be used to support the derivation of the Ra-226 benchmarks.
- Explain why radium-226 is not proposed to be measured in groundwater or pore waters at any of the TMAs. CNSC staff are of the opinion that the groundwater and pore water quality TOMP subprogram is limited and requires further justification – the conceptual groundwater model relies on TMA groundwater reporting to the surface.
- Update the hydrogeological predictions and long-term radium (or other actinide) evolution and how this information is used to inform the cycle 5 study design (TOMP).
- Discontinue, as discussed, benthic invertebrate community monitoring at Elliot Lake under the SRWMP. CNSC staff notes that water quality monitoring at M-01 (the inlet to Elliot Lake) will continue to be conducted and concur that downstream monitoring in Elliot Lake will be reinstated should increased concentrations of mine-related substances be detected.
- Consider, to demonstrate lake recovery, taking sediment cores in all lakes including Elliot Lake, and focus on the top 10 cm and slice at 0.5 cm in the first centimeter and then every centimeter to a depth of 10 centimeters to provide evidence of recovery.

If you have immediate concerns or wish to discuss next steps, please contact me.

Ron

Ron Stenson
Uranium mines and Mills Division
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ron.stenson@canada.ca

From: Stenson, Ron (CNSC/CCSN)
Sent: September 12, 2019 10:29 AM
To: 'Heffner, Holly' <holly.heffner@bhp.com>
Subject: RE: Proposed changes to the Serpent River Watershed Monitoring Field Program

Good morning Holly.

I am finally back in the office this week and have checked in with my subject matter experts. I have a draft of their comments and will be discussing some small issues with you all when it is signed off by their management.

With regards to both Rabbit Lake and Half Moon Lake sediment and invertebrate sampling, my SMEs agree with your arguments and support removing the requirement from the program.

I will send our formal review findings shortly and we can discuss any concerns that you may have following that.

Thank you for welcoming me to your offices. I enjoyed meeting your team and gained a better understanding of the current and future work on the Rio sites.

Ron

Ron Stenson

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Canada's Nuclear Regulator
L'organisme de réglementation nucléaire du Canada

From: Heffner, Holly <holly.heffner@bhp.com>
Sent: September 11, 2019 12:46 PM
To: Stenson, Ron (CNSC/CCSN) <ron.stenson@canada.ca>
Subject: RE: Proposed changes to the Serpent River Watershed Monitoring Field Program

Hi Ron,

I just thought I would check in on the below and if there has been any progress in reviewing the changes to the field program?

Thanks

Holly

From: Heffner, Holly
Sent: Tuesday, August 27, 2019 9:11 AM
To: Stenson, Ron (CNSC/CCSN) <ron.stenson@canada.ca>
Subject: Proposed changes to the Serpent River Watershed Monitoring Field Program

Hi Ron,

I appreciate you being able to meet with myself and my Rio Algom Limited (RAL) colleagues today. As discussed there are two proposed changes to the Serpent River Watershed Monitoring Program (SRWMP) detailed in the Cycle 5 Design that we would like to confirm are acceptable with the JRG, prior to execution of the field work starting on September 16th 2019, if possible.

The proposed changes include:

1. Elliot Lake: discontinue sediment and benthic invertebrate monitoring in Elliot Lake
    a. This change was first proposed in the Cycle 3 State of the Environment Report and in the Cycle 4 study design, however the decision was left unresolved as sediment and benthic sampling was not completed in Cycle 4.
    b. Based on improvements in water quality (mine related substances less than benchmarks and no or decreasing trends in concentrations), no observed

sediment toxicity, and gradual improvement in benthic invertebrate communities, it is proposed that sediment quality and benthic invertebrate community sampling be discontinued for Elliot Lake. Water quality monitoring will continue at M-01 (the inlet to the lake); if concentrations of mine-related substances increase, downstream monitoring in Elliot Lake could be reinstated. For detailed justification of this change please refer to the Cycle 5 Study Design for the SRWMP, SAMP and TOMP Section 5.3.2.1 Elliot Lake

2. Halfmoon Lake: not sampling sediment and benthic invertebrates in Halfmoon Lake
    a. As part of the response to the Cycle 4 SOE Interpretive Report, CNSC stated that, "For the next SOE report, the licensee is expected to consider the trends for Ra-226 at Halfmoon Lake in evaluating whether benthic sampling is required in Halfmoon Lake". After review, we proposed that sediment and benthic invertebrate sampling in Halfmoon Lake is not required.
    b. Halfmoon Lake is not comparable to the other lakes in the system (very shallow and small) and May Lake which is comparable and located immediately downstream has been used as the assessment lake. Review of concentrations and trends show that concentrations have decreased since the benthic community was last sampled in 1999. In 1999 Halfmoon Lake did not demonstrate mine-related impacts , therefore it is expected that 2019 would not show mine-related impacts as water concentrations are equivalent to 1999 or lower. Detailed justification for not sampling sediment and benthic invertebrates in Halfmoon Lake are detailed in the Cycle 5 Study Design for the SRWMP, SAMP and TOMP Section 5.3.2.2 Halfmoon Lake.

If you wouldn't mind checking with the subject matter experts and seeing if there were any concerns with those two changes prior to September 16th that would be fantastic.

Thanks,

Holly Heffner

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ATTACHMENT C

MEMO

To:	Janet Lowe, Denison Mines Inc.; Tony Lambert, Rio Algom Limited	From:	Don Hart, Rina Parker
Ref:	**Site-specific Criteria for Ra-226**	Date:	29 March 2019

As an input to the Cycle 5 Design of the Serpent River Watershed Monitoring Program, Denison Mines Inc. (Denison) and Rio Algom Limited (Rio Algom) have asked EcoMetrix Incorporated (EcoMetrix) to develop site-specific criteria for Ra-226 in water and sediment. We understand that these criteria will be used in screening of water and sediment quality data to identify samples/areas of potential concern based on Ra-226 measurements.

This memo describes our approach to development of the site-specific criteria, proposes the criteria, and compares the proposed site-specific criteria to existing generic criteria for Ra-226 in water and sediment.

Approach to Site-specific Criteria Development

Previous studies of the Serpent River Watershed have documented water and sediment quality with respect to U-238 series radionuclides in water, sediment, aquatic plants, fish and benthic invertebrates in the watershed lakes (Minnow, 2011) and associated radiation doses to aquatic biota, riparian wildlife and generic humans assumed to be using the lake resources (EcoMetrix, 2011). The radiochemistry and associated doses were described for six watershed lakes: McCabe, May, Elliot, Nordic, Quirke and McCarthy Lake. McCarthy Lake has since been dropped from the monitoring program.

The detailed dose calculations for each lake remaining in the program are included in Appendix D of the EcoMetrix (2011) report. The dose calculation methodology is described in detail in Section 2 of that report. The dose calculations are reproduced as an Attachment to this memo. They are briefly described below.

For Ra-226, quantitative measurements were available for all media (water, sediment, aquatic plants, fish, benthic invertebrates) in all lakes, except for water values in Elliot and McCarthy Lake, where Ra-226 was non-detect. In these cases, the detection limit value of 0.01 Bq/L was used. In all other cases, average values for each medium were used.

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The dose calculations assumed that short-lived progeny of Ra-226 (Rn-222 and its short-lived progeny) were at secular equilibrium with Ra-226 in water and sediment. It was also assumed that the short-lived progeny were present in fish, benthic invertebrates and aquatic plants at 10% of the Ra-226 concentration. This percentage was determined for fish bone (Lucas et al., 1979). It is considered to be conservative for soft tissues, which lose ingrown radon more rapidly, and for plants and invertebrates since they have no bone. It was assumed that the short-lived progeny were present in mammals and birds at 30% of the Ra-226 concentration. This percentage was determined for mammalian bone. It is considered conservative for soft tissues of mammals and birds.

The concentrations of Ra-226 in riparian wildlife (muskrat, mink, mallard, scaup, merganser) were calculated using allometric food intake rates (U.S. EPA, 1993), allometric food to tissue transfer factors for mammals (EcoMetrix, 2011), and site-specific transfer factors for waterfowl (EcoMetrix, 2011). Sediment ingestion rates were estimated as a percentage of dry-weight food intake (U.S. EPA 1993, CCME, 1996).

Internal and external dose conversion factors (DCFs) for wildlife were taken from Amiro (1997), but internal DCFs were increased 10-fold for Ra-226 and short-lived progeny to account for the greater biological effectiveness of alpha radiation. The occupancy factor for sediment was 0.5 for fish, plants, and ducks, and 1.0 for benthic invertebrates, mink and muskrat, as described in EcoMetrix (2011).

For the generic human receptor, on each lake, an adult water intake of 1.5 L/d (Health Canada, 1995), a sport fish intake of 8 g/d (U.S. EPA, 1997) (2.92 kg/a), a duck (mallard) meat intake of 2 kg/a, and a moose meat intake of 2 kg/a were assumed. The duck and moose intake rates were based on information from a local sportsman. It was assumed that 50% of the duck and moose consumed is from the lake under assessment. This is a conservative assumption, since moose have large home ranges, and since watershed lakes contain very little marsh habitat suitable for mallards.

Internal and external DCFs for humans were taken from ICRP Publication 72 (ICRP, 1996). They include dose contributions from short-lived daughters that may grow in over a lifetime following radionuclide ingestion.

Site-specific criteria for Ra-226 were calculated at each of the six watershed lakes, based on:

- the highest dose among aquatic biota (which was the dose to aquatic plants),
- the highest dose among riparian wildlife (which was the dose to muskrats), and
- the dose to the generic human.

In each case, the criteria were calculated as:

$$Water\ Criterion\ \left(\frac{Bq}{L}\right) = \frac{Dose\ Benchmark}{Calculated\ Dose} \times C_{Ra-226\ water}$$

$$Sediment\ Criterion\ \left(\frac{Bq}{kg\ dw}\right) = \frac{Dose\ Benchmark}{Calculated\ Dose} \times C_{Ra-226\ sediment}$$

where,

$C_{Ra\text{-}226\ water}$ = Concentration of Ra-226 in water in Bq/L

$C_{Ra\text{-}226\ sediment}$ = Concentration of Ra-226 in sediment in Bq/kg dw

The dose benchmark was 10 mGy/d for aquatic plants (UNSCEAR, 2008), 2.4 mGy/d for the muskrat (UNSCEAR, 2008), and 1 mSv/a for the generic human (ICRP, 2007). The calculated dose is the dose from Ra-226 plus short-lived progeny. The concentration on the right side of the equation is the concentration of Ra-226 in water or sediment that was driving the calculated dose. Thus, the criterion is the concentration of Ra-226 in water or sediment that would correspond to the dose benchmark. This assumes that, if Ra-226 increases in one medium, it will increase proportionally in other media.

Finally, for both water and sediment, the lowest of the criteria for aquatic plant, muskrat or generic human was selected as the site-specific criterion. The lowest criterion was the one based on the muskrat dose, for all lakes, since the muskrat always had the highest dose (Table 1).

Proposed Site-specific Criteria for Ra-226

Table 1 shows the average Ra-226 concentrations in water and sediment for six lakes in the Serpent River Watershed, the resulting doses to aquatic plants, muskrats and generic humans using aquatic resources in each lake, and the corresponding criteria for Ra-226 in water and sediment that would bring the dose up to the dose benchmark. The criteria were calculated as outlined above.

We recommend that the criteria can be applied on a lake by lake basis, using the lowest of the three criteria for water, and the lowest of the three criteria for sediment, for screening in each lake. This approach would be adequately protective in each lake. As shown in Table 1, the lowest criterion is always that derived for the muskrat.

Alternatively, for simplicity, the lowest water criterion across all lakes could be applied in each lake, and the lowest sediment criterion across all lakes could be applied in each lake, making the screening process simple and conservative. These criteria would be 0.469 Bq/L in water, and 9,560 Bq/kg (dry weight) for sediment.

Table 1: Ra-226 Concentrations, Highest Doses, and Ra-226 Criteria for Six Lakes in the Serpent River Watershed

Lake (Ra-226 Bq/L) (Ra-226 Bq/kg)	**Receptor**	**Dose [1]**	**Units**	**Ra-226 Criterion Water (Bq/L)**	**Ra-226 Criterion Sediment (Bq/kg)**
McCabe	Plant	1.62E-01	mGy/d	3.71E+00	1.24E+05
(0.06 Bq/L)	Muskrat	1.04E-01	mGy/d	1.39E+00	4.64E+04
(2000 Bq/kg)	Human	1.09E-02	mSv/a	5.52E+00	1.84E+05
May	Plant	1.09E-01	mGy/d	4.58E+00	2.01E+04
(0.05 Bq/L)	Muskrat	5.52E-02	mGy/d	2.17E+00	***9.56E+03***
(220 Bq/kg)	Human	8.91E-03	mSv/a	5.61E+00	2.47E+04
Quirke	Plant	4.74E-01	mGy/d	1.06E+00	4.64E+04
(0.05 Bq/L)	Muskrat	2.56E-01	mGy/d	***4.69E-01***	2.06E+04
(2200 Bq/kg)	Human	1.05E-02	mSv/a	4.78E+00	2.10E+05
Nordic	Plant	3.65E-02	mGy/d	8.23E+00	1.01E+05
(0.03 Bq/L)	Muskrat	2.23E-02	mGy/d	3.23E+00	3.98E+04
(370 Bq/kg)	Human	5.23E-03	mSv/a	5.73E+00	7.07E+04
Elliot	Plant	3.23E-02	mGy/d	3.10E+00	1.95E+05
(0.01 Bq/L)	Muskrat	2.37E-02	mGy/d	1.01E+00	6.39E+04
(630 Bq/kg)	Human	1.84E-03	mSv/a	5.44E+00	3.42E+05

[1] Dose includes contributions from Ra-226, Rn-222 and short-lived progeny
[2] Bolded and italics values indicate lowest water and sediment criteria across all lakes.

Comparison to Existing Generic Criteria for Ra-226

The U.S. DOE (2002) has developed a water criterion of 0.2 Bq/L for Ra-226, which is considered to be protective of aquatic biota and riparian wildlife in all situations. The DOE has also developed a sediment criterion of 4,000 Bq/kg (dry weight) for Ra-226, which is considered to be protective of aquatic biota and riparian wildlife in all situations. These criteria were based on the UNSCEAR (1996) dose benchmarks of 10 mGy/d and 1 mGy/d for aquatic biota and terrestrial biota, respectively. For the current assessment a dose benchmark of 10 mGy/d was used for aquatic biota and 2.4 mG/d was used for terrestrial biota, based on UNSCEAR (2008). Terrestrial biota includes all birds and mammals, and therefore includes riparian wildlife. The site-specific criteria proposed above (0.469 Bq/L and 9,560 Bq/kg dw) are approximately two times higher than the DOE criteria consistent with the higher terrestrial dose benchmark used for the muskrat.

Health Canada (2009) developed a drinking water criterion of 0.5 Bq/L for Ra-226, which is considered to be protective of human drinking water use. This criterion was based on a dose benchmark of 0.1 mSv/a, which was conservatively set at one tenth of the public dose limit, and a drinking water intake of 2 L/d. The site-specific criterion proposed above for water (0.469 Bq/L) rounds to the Health Canada value, although it is based on protecting the most sensitive wildlife species (i.e., the muskrat). Our lowest site-specific value for human protection is 4.78 Bq/L, based on a dose benchmark of 1 mSv/a. If we had used the same conservative benchmark as Health Canada (0.1 mSv/a) our criterion would be slightly lower than the Health Canada value, consistent with our consideration of additional food pathways.

The Ontario drinking water guideline for Ra-226 is 0.6 Bq/L (Government of Ontario, 2006) which is based on a dose benchmark of 0.1 mSv/a, and an unspecified drinking water intake rate. The guideline is consistent with an intake rate on the order of 1.5 L/d.

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Ecological Dose Calculations - Aquatic Biota - McCabe Lake

Parameter	Units	U238/234	TH234+	TH230	RA226	RN222+	PB210+	PO210	TH232	RA228+	Th-228+	TOTAL
Water conc.	Bq/L	0.02952	0.0075	0.00874	0.06	0.06	0.03	0.01	0.0008	0.0012	0.0016	
Sed to water PC	L/kg (dw)	25000	49200	49200	33333	33333	83333	166666	49200	33333	49200	
Sediment conc.	Bq/kg (dw)	738	369	430	2000	2000	2500	2400	40	40	80	
Sediment conc.	Bq/kg (ww)	74	37	43	200	200	250	240	4	4	8	
Wat to fish BAF	L/kg (fw)	478	218	218	540	-	861	-	218	540	218	
Fish tissue conc.	Bq/kg (fw)	11.39792	1.635	1.9053	21.667	2.1667	36.667	503.333	0.18	223.333	0.35	
Wat to aquatic plant BAF	L/kg (fw)	5090	6215	6215	3748	-	2499	-	6215	3748	6215	
Aquatic plant conc.	Bq/kg (fw)	40.221	46.61	109.4	146	14.60	84.85	79.65	7.04	34.6	13.7	
Wat to benthos BAF	L/kg (fw)	276	276	276	486	-	3643	20000	276	486	276	
Benthos conc.	Bq/kg (fw)	8.15	2.07	2.41	29.16	2.92	109.29	200.00	0.22	0.58	0.45	
Int. DCF tissue	Gy/a per Bq/kg (fw)	2.31E-05	4.56E-06	2.41E-05	2.46E-05	1.12E-04	2.19E-06	2.73E-05	2.06E-05	7.12E-06	1.77E-04	
Ext. DCF sediment	Gy/a per Bq/kg (ww)	5.40E-08	1.53E-05	5.35E-08	2.4E-07	6.70E-05	4.56E-06	2.58E-10	4.67E-08	3.55E-05	5.81E-05	
Ext. dose sediment (OF_s .5)	mGy/d	5.45E-06	7.73E-04	3.15E-06	6.58E-05	1.84E-02	1.56E-03	8.48E-08	2.56E-07	1.95E-04	6.37E-04	2.08E-02
Int. abs. dose fish	mGy/d	7.21E-04	2.04E-05	1.26E-04	1.46E-03	6.65E-04	2.20E-04	3.76E-02	1.00E-05	4.36E-03	1.72E-04	4.09E-02
Int. abs dose plant	mGy/d	2.55E-03	5.82E-04	7.22E-03	9.84E-03	4.48E-03	5.08E-04	5.96E-03	3.97E-04	6.75E-04	6.64E-03	3.11E-02
Int. abs dose benthos	mGy/d	5.16E-04	2.59E-05	1.59E-04	1.97E-03	8.95E-04	6.55E-04	1.50E-02	1.27E-05	1.14E-05	2.18E-04	1.92E-02
RBE alpha	-	10	1	10	10	10	1	10	10	1	10	
γ eq. . dose fish	mGy/d	7.22E-03	7.94E-04	1.26E-03	1.47E-02	2.50E-02	1.78E-03	3.76E-01	1.00E-04	4.55E-03	2.35E-03	4.27E-01
γ eq. dose plant	mGy/d	2.55E-02	1.36E-03	7.22E-02	9.85E-02	6.32E-02	2.07E-03	5.96E-02	3.97E-04	8.69E-04	6.70E-02	3.22E-01
γ eq. . dose benthos	mGy/d	5.17E-03	1.57E-03	1.60E-03	1.98E-02	4.57E-02	3.78E-03	1.50E-01	1.27E-04	4.00E-04	3.45E-03	2.27E-01

value from lake measurement(s) (green font= LT; blue font= average contains a LT used at face value)
red font PC or BAF based on Lake measurements
blue font BAF based on in-basin measurements
green font BAF from literature

dose values used in criteria derivation

Ecological Dose Calculations - Riparian Wildlife - McCabe Lake

Parameter	Units	U238/234	TH234+	TH230	RA226	RN222+	PB210+	PO210	TH232	RA228+	Th-228+	TOTAL
Water conc.	Bq/L	0.02952	0.0075	0.0087	0.06	0.0600	0.03	0.01	0.0008	0.0012	0.0016	
Sed to water PC	L/kg (dw)	25000	49200	49200	33333	33333	83333	166666	49200	33333	49200	
Sediment conc.	Bq/kg (dw)	738	369	430	2000	2000	2500	2400	40	40	80	
Sediment conc.	Bq/kg (ww)	74	37	43	200	200	250	240	4	4	8	
Wat to fish BAF	L/kg (fw)	478	218	218	540	-	861	-	218	540	218	
Fish tissue conc.	Bq/kg (fw)	11.40	1.635	1.905	21.667	2.1667	36.667	503.333	0.18	223.333	0.35	
Wat to aquatic plant BAF	L/kg (fw)	5090	6215	6215	3748	-	2499	-	6215	3748	6215	
Aquatic plant conc.	Bq/kg (fw)	40.221	46.61	109.4	146	14.60	84.85	79.65	7.04	34.6	13.7	
Wat to benthos BAF	L/kg (fw)	276	276	276	486	-	3643	20000	276	486	276	
Benthos conc.	Bq/kg (fw)	8.15	2.07	2.41	29.16	2.92	109.29	200.00	0.22	0.58	0.45	
Ing. TF mallard	d/kg	0.008	0.050	0.050	0.046	-	0.162	4.62	0.050	0.046	0.050	
Ing. TF scaup	d/kg	0.008	0.496	0.496	0.423	-	0.162	4.62	0.496	0.423	0.496	
Ing. TF merganser	d/kg	0.163	4.89	4.89	3.91	-	1.99	5.45	4.894	3.910	4.894	
Ing. TF muskrat	d/kg	0.077	0.031	0.031	0.694	-	0.462	0.540	0.031	0.694	0.031	
Ing. TF mink	d/kg	0.080	0.032	0.032	0.717	-	0.478	0.558	0.032	0.717	0.032	
Int. DCF tissue	Gy/a per Bq/kg (fw)	2.31E-05	4.56E-06	2.41E-05	2.46E-05	1.12E-04	2.19E-06	2.73E-05	2.06E-05	7.12E-06	1.77E-04	
Ext. DCF sediment	Gy/a per Bq/kg (ww)	5.40E-08	1.53E-05	5.35E-08	2.4E-07	6.70E-05	4.56E-06	2.58E-10	4.67E-08	3.55E-05	5.81E-05	
Ext. dose sediment (OF$_s$ .5)	mGy/d	2.73E-06	3.87E-04	1.58E-06	3.29E-05	9.18E-03	7.81E-04	4.24E-08	1.28E-07	9.73E-05	3.18E-04	1.08E-02
Int. abs. dose mallard	mGy/d	2.64E-06	3.83E-06	4.66E-05	6.07E-05	8.29E-05	1.19E-05	3.99E-03	2.58E-06	3.92E-06	4.32E-05	4.25E-03
Int. abs. dose scaup	mGy/d	5.77E-07	2.47E-06	1.52E-05	1.14E-04	1.56E-04	1.20E-05	7.47E-03	1.21E-06	6.60E-07	2.08E-05	7.80E-03
Int. abs. dose merganser	mGy/d	2.02E-05	1.85E-05	1.14E-04	9.91E-04	1.35E-03	7.49E-05	3.41E-02	9.04E-06	2.82E-03	1.55E-04	3.96E-02
Int. abs. dose muskrat	mGy/d	1.10E-04	8.69E-06	1.01E-04	3.60E-03	4.91E-03	1.51E-04	2.09E-03	5.72E-06	2.03E-04	9.59E-05	1.13E-02
Int. abs. dose mink	mGy/d	1.27E-05	1.94E-07	1.19E-06	2.45E-04	3.35E-04	2.34E-05	4.04E-03	9.49E-08	5.94E-04	1.63E-06	5.25E-03
RBE alpha	-	10	1	10	10	10	1	10	10	1	10	
γ eq. dose mallard	mGy/d	2.91E-05	3.91E-04	4.67E-04	6.40E-04	1.00E-02	7.93E-04	3.99E-02	2.60E-05	1.01E-04	7.51E-04	5.31E-02
γ eq. dose scaup	mGy/d	8.49E-06	3.89E-04	1.54E-04	1.17E-03	1.07E-02	7.93E-04	7.47E-02	1.22E-05	9.79E-05	5.26E-04	8.86E-02
γ eq. dose merganser	mGy/d	2.05E-04	4.05E-04	1.14E-03	9.94E-03	2.27E-02	8.56E-04	3.41E-01	9.05E-05	2.92E-03	1.87E-03	3.81E-01
γ eq. dose muskrat	mGy/d	1.11E-03	7.82E-04	1.01E-03	3.60E-02	6.75E-02	1.71E-03	2.09E-02	5.75E-05	3.98E-04	1.60E-03	1.31E-01
γ eq. dose mink	mGy/d	1.33E-04	7.74E-04	1.51E-05	2.52E-03	2.17E-02	1.59E-03	4.04E-02	1.21E-06	7.88E-04	6.53E-04	6.85E-02

		Mallard	Scaup	Merganser	Muskrat	Mink		Moose
Body weight	kg	1.134	0.815	1.723	1.415	1.354		400
Ing. water	L/d	0.065	0.051	0.085	0.135	0.142		21.8
Ing. sediment	kg/d (dw)	0.00126	0.00102	0.00017	0.00744	0.000475		0.057
Ing. plant	kg/d (fw)	0.252			0.425			3.3
Ing. benthos	kg/d (fw)		0.204					
Ing. fish	kg/d (fw)			0.331		0.19		
Occupancy factor	-	0.5	0.5	0.5	1.0	1.0		1.0

Human Dose Calculations - Generic Adult - McCabe Lake

Parameter	Units	U238/234	TH234+	TH230	RA226	RN222+	PB210+	PO210	TH232	RA228+	TH228+	TOTAL
Water conc.	Bq/L	0.02952	0.0075	0.0087	0.06	0.0600	0.03	0.01	0.0008	0.0012	0.0016	
Wat to fish BAF	L/kg (fw)	11.4	5.2	5.2	19.1	-	30.5	171.9	5.2	19.1	5.2	
Sport fish tissue conc.	Bq/kg (fw)	0.337	0.039	0.045	1.146	0.115	0.914	1.719	0.004	0.023	0.008	
Moose wb conc.	Bq/kg (fw)	0.19	0.07	0.15	6.03	1.81	2.84	3.12	0.01	1.18	0.02	
Moose meat conc.	Bq/kg (fw)	0.10	0.04	0.10	2.23	0.67	1.08	1.84	0.01	0.44	0.01	
Mallard duck wb conc.	Bq/kg (fw)	0.04	0.31	0.71	0.90	0.27	1.98	53.37	0.05	0.20	0.09	
Mallard duck meat conc.	Bq/kg (fw)	0.02	0.19	0.44	0.33	0.10	0.75	31.49	0.03	0.07	0.06	
Ingestion rate water	L/a	547.5	547.5	547.5	547.5	547.5	547.5	547.5	547.5	547.5	547.5	
Ingestion rate fish	kg/a	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	
Ingestion rate moose	kg/a	1	1	1	1	1	1	1	1	1	1	
Ingestion rate mallard	kg/a	1	1	1	1	1	1	1	1	1	1	
Exposure via water	Bq/a	16.16	4.11	4.79	32.85	32.85	16.43	5.48	0.45	0.66	0.89	
Exposure via fish	Bq/a	0.98	0.11	0.13	3.35	0.33	2.67	5.02	0.01	0.07	0.02	
Exposure via moose	Bq/a	0.10	0.04	0.10	2.23	0.67	1.08	1.84	0.01	0.44	0.01	
Exposure via mallard	Bq/a	0.02	0.19	0.44	0.33	0.10	0.75	31.49	0.03	0.07	0.06	
Ingestion DCF adult	Sv/Bq	4.70E-08	3.40E-09	2.10E-07	2.80E-07	2.50E-10	6.91E-07	1.20E-06	2.30E-07	6.90E-07	7.20E-08	
Dose via water	mSv/a	7.60E-04	1.40E-05	1.00E-03	9.20E-03	8.21E-06	1.14E-02	6.57E-03	1.02E-04	4.53E-04	6.41E-05	2.95E-02
Dose via fish	mSv/a	4.62E-05	3.87E-07	2.79E-05	9.37E-04	8.37E-08	1.84E-03	6.02E-03	2.84E-06	4.62E-05	1.78E-06	8.93E-03
Dose via moose	mSv/a	4.54E-06	1.50E-07	2.04E-05	6.25E-04	1.67E-07	7.45E-04	2.21E-03	1.48E-06	3.00E-04	9.04E-07	3.91E-03
Dose via mallard	mSv/a	9.81E-07	6.57E-07	9.34E-05	9.33E-05	2.50E-08	5.21E-04	3.78E-02	6.64E-06	5.13E-05	4.05E-06	3.86E-02
Total ingestion dose	mSv/a	8.11E-04	1.52E-05	1.15E-03	1.09E-02	8.49E-06	1.45E-02	5.26E-02	1.13E-04	8.51E-04	7.08E-05	8.09E-02

Ecological Dose Calculations - Aquatic Biota - May Lake

Parameter	Units	U238/234	TH234+	TH230	RA226	RN222+	PB210+	PO210	TH232	RA228+	Th-228+	TOTAL
Water conc.	Bq/L	0.0369	0.004	0.01	0.05	0.05	0.019	0.01	0.01	0.10	0.01	
Sed to water PC	L/kg (dw)	10667	49200	49200	4400	4400	34733	69466	49200	4400	49200	
Sediment conc.	Bq/kg (dw)	393.6	196.8	5100	220	220	660	780	780	500	660	
Sediment conc.	Bq/kg (ww)	39	20	510	22	22	66	78	78	50	66	
Wat to fish BAF	L/kg (fw)	478	218	218	540	-	861	-	218	540	218	
Fish tissue conc.	Bq/kg (fw)	5.412	0.872	5	13	1.3	23.333	453.333	2.18	143.33	5.667	
Wat to aquatic plant BAF	L/kg (fw)	5090	6215	6215	3748	-	2499	-	6215	3748	6215	
Aquatic plant conc.	Bq/kg (fw)	61.9551	24.86	31.5	109.35	10.94	83.85	85.05	6.05	53	13.875	
Wat to benthos BAF	L/kg (fw)	276	276	276	486	-	3643	20000	276	486	276	
Benthos conc.	Bq/kg (fw)	10.18	1.10	2.76	24.30	2.43	69.22	200.00	2.76	48.60	2.76	
Int. DCF tissue	Gy/a per Bq/kg (fw)	2.31E-05	4.56E-06	2.41E-05	2.46E-05	1.12E-04	2.19E-06	2.73E-05	2.06E-05	7.12E-06	1.77E-04	
Ext. DCF sediment	Gy/a per Bq/kg (ww)	5.40E-08	1.53E-05	5.35E-08	2.4E-07	6.70E-05	4.56E-06	2.58E-10	4.67E-08	3.55E-05	5.81E-05	
Ext. dose sediment (OF_s .5)	mGy/d	2.91E-06	4.12E-04	3.74E-05	7.23E-06	2.02E-03	4.12E-04	2.76E-08	4.98E-06	2.43E-03	5.25E-03	1.06E-02
Int. abs. dose fish	mGy/d	3.43E-04	1.09E-05	3.30E-04	8.76E-04	3.99E-04	1.40E-04	3.39E-02	1.23E-04	2.80E-03	2.75E-03	4.17E-02
Int. abs dose plant	mGy/d	3.92E-03	3.11E-04	2.08E-03	7.37E-03	3.36E-03	5.02E-04	6.36E-03	3.41E-04	1.03E-03	6.72E-03	3.20E-02
Int. abs dose benthos	mGy/d	6.45E-04	1.38E-05	1.82E-04	1.64E-03	7.46E-04	4.15E-04	1.50E-02	1.56E-04	9.48E-04	1.34E-03	2.10E-02
RBE alpha	-	10	1	10	10	10	1	10	10	1	10	
γ eq. . dose fish	mGy/d	3.43E-03	4.23E-04	3.34E-03	8.77E-03	6.01E-03	5.52E-04	3.39E-01	1.24E-03	5.23E-03	3.27E-02	4.01E-01
γ eq. dose plant	mGy/d	3.92E-02	7.23E-04	2.08E-02	7.37E-02	3.56E-02	9.15E-04	6.36E-02	3.42E-03	3.47E-03	7.25E-02	3.14E-01
γ eq. . dose benthos	mGy/d	6.45E-03	8.39E-04	1.90E-03	1.64E-02	1.15E-02	1.24E-03	1.50E-01	1.57E-03	5.81E-03	2.39E-02	2.19E-01

Ecological Dose Calculations - Riparian Wildlife - May Lake

Parameter	Units	U238/234	TH234+	TH230	RA226	RN222+	PB210+	PO210	TH232	RA228+	Th-228+	TOTAL
Water conc.	Bq/L	0.0369	0.004	0.01	0.05	0.05	0.019	0.01	0.01	0.10	0.01	
Sed to water PC	L/kg (dw)	10667	49200	49200	4400	4400	34733	69466	49200	4400	49200	
Sediment conc.	Bq/kg (dw)	393.6	196.8	5100	220	220	660	780	780	500	660	
Sediment conc.	Bq/kg (ww)	39	20	510	22	22	66	78	78	50	66	
Wat to fish BAF	L/kg (fw)	478	218	218	540	-	861	-	218	540	218	
Fish tissue conc.	Bq/kg (fw)	5.412	0.872	5	13	1.3	23.333	453.333	2.18	143.33	5.667	
Wat to aquatic plant BAF	L/kg (fw)	5090	6215	6215	3748	-	2499	-	6215	3748	6215	
Aquatic plant conc.	Bq/kg (fw)	61.9551	24.86	31.5	109.35	10.94	83.85	85.05	6.05	53	13.875	
Wat to benthos BAF	L/kg (fw)	276	276	276	486	-	3643	20000	276	486	276	
Benthos conc.	Bq/kg (fw)	10.18	1.10	2.76	24.30	2.43	69.22	200.00	2.76	48.60	2.76	
Ing. TF mallard	d/kg	0.008	0.050	0.050	0.046	-	0.162	4.62	0.050	0.046	0.050	
Ing. TF scaup	d/kg	0.008	0.496	0.496	0.423	-	0.162	4.62	0.496	0.423	0.496	
Ing. TF merganser	d/kg	0.163	4.89	4.89	3.91	-	1.99	5.45	4.894	3.910	4.894	
Ing. TF muskrat	d/kg	0.077	0.031	0.031	0.694	-	0.462	0.540	0.031	0.694	0.031	
Ing. TF mink	d/kg	0.080	0.032	0.032	0.717	-	0.478	0.558	0.032	0.717	0.032	
Int. DCF tissue	Gy/a per Bq/kg (fw)	2.31E-05	4.56E-06	2.41E-05	2.46E-05	1.12E-04	2.19E-06	2.73E-05	2.06E-05	7.12E-06	1.77E-04	
Ext. DCF sediment	Gy/a per Bq/kg (ww)	5.40E-08	1.53E-05	5.35E-08	2.4E-07	6.70E-05	4.56E-06	2.58E-10	4.67E-08	3.55E-05	5.81E-05	
Ext. dose sediment (OF_s .5)	mGy/d	1.45E-06	2.06E-04	1.87E-05	3.62E-06	1.01E-03	2.06E-04	1.38E-08	2.49E-06	1.22E-03	2.63E-03	5.29E-03
Int. abs. dose mallard	mGy/d	3.84E-06	2.04E-06	2.38E-05	4.30E-05	5.87E-05	1.06E-05	3.87E-03	3.55E-06	6.25E-06	5.27E-05	4.08E-03
Int. abs. dose scaup	mGy/d	5.92E-07	1.32E-06	9.43E-05	7.40E-05	1.01E-04	7.16E-06	7.19E-03	1.90E-05	4.31E-05	1.49E-04	7.68E-03
Int. abs. dose merganser	mGy/d	9.63E-06	9.84E-06	4.04E-04	5.73E-04	7.83E-04	4.67E-05	3.06E-02	1.18E-04	1.82E-03	2.36E-03	3.68E-02
Int. abs. dose muskrat	mGy/d	1.43E-04	4.63E-06	1.04E-04	2.25E-03	3.07E-03	1.12E-04	1.69E-03	1.46E-05	3.55E-04	1.61E-04	7.91E-03
Int. abs. dose mink	mGy/d	6.15E-06	1.03E-07	7.10E-06	1.25E-04	1.70E-04	1.36E-05	3.61E-03	1.41E-06	3.84E-04	2.15E-05	4.34E-03
RBE alpha	-	10	1	10	10	10	1	10	10	1	10	
γ eq. dose mallard	mGy/d	3.99E-05	2.08E-04	2.57E-04	4.34E-04	1.60E-03	2.17E-04	3.87E-02	3.80E-05	1.22E-03	3.15E-03	4.59E-02
γ eq. dose scaup	mGy/d	7.37E-06	2.08E-04	9.62E-04	7.43E-04	2.02E-03	2.13E-04	7.19E-02	1.93E-04	1.26E-03	4.11E-03	8.16E-02
γ eq. dose merganser	mGy/d	9.78E-05	2.16E-04	4.06E-03	5.74E-03	8.84E-03	2.53E-04	3.06E-01	1.18E-03	3.03E-03	2.62E-02	3.56E-01
γ eq. dose muskrat	mGy/d	1.43E-03	4.17E-04	1.08E-03	2.25E-02	3.27E-02	5.25E-04	1.69E-02	1.51E-04	2.79E-03	6.87E-03	8.54E-02
γ eq. dose mink	mGy/d	6.44E-05	4.13E-04	1.08E-04	1.25E-03	3.72E-03	4.26E-04	3.61E-02	1.91E-05	2.82E-03	5.47E-03	5.04E-02

		Mallard	Scaup	Merganser	Muskrat	Mink		Moose
Body weight	kg	1.134	0.815	1.723	1.415	1.354		400
Ing. water	L/d	0.065	0.051	0.085	0.135	0.142		21.8
Ing. sediment	kg/d (dw)	0.00126	0.00102	0.00017	0.00744	0.000475		0.057
Ing. plant	kg/d (fw)	0.252			0.425			3.3
Ing. benthos	kg/d (fw)		0.204					
Ing. fish	kg/d (fw)			0.331		0.19		
Occupancy factor	-	0.5	0.5	0.5	1.0	1.0		1.0

Human Dose Calculations - Generic Adult - May Lake

Parameter	Units	U238/234	TH234+	TH230	RA226	RN222+	PB210+	PO210	TH232	RA228+	TH228+	TOTAL
Water conc.	Bq/L	0.0369	0.004	0.01	0.05	0.05	0.0190	0.01	0.01	0.10	0.01	
Water to fish BCF	L/kg (fw)	11.4	5.2	5.2	19.1	-	30.5	171.9	5.2	19.1	5.2	
Sport fish tissue conc.	Bq/kg (fw)	0.421	0.021	0.052	0.955	0.096	0.579	1.719	0.052	1.910	0.052	
Moose wb conc.	Bq/kg (fw)	0.25	0.04	0.16	3.78	1.13	2.11	2.54	0.03	2.08	0.03	
Moose meat conc.	Bq/kg (fw)	0.13	0.02	0.10	1.40	0.42	0.80	1.50	0.02	0.77	0.02	
Mallard duck wb conc.	Bq/kg (fw)	0.06	0.16	0.36	0.64	0.19	1.77	51.80	0.06	0.32	0.11	
Mallard duck meat conc.	Bq/kg (fw)	0.03	0.10	0.23	0.24	0.07	0.67	30.56	0.04	0.12	0.07	
Ingestion rate water	L/a	547.5	547.5	547.5	547.5	547.5	547.5	547.5	547.5	547.5	547.5	
Ingestion rate fish	kg/a	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	
Ingestion rate moose	kg/a	1	1	1	1	1	1	1	1	1	1	
Ingestion rate mallard	kg/a	1	1	1	1	1	1	1	1	1	1	
Exposure via water	Bq/a	20.20	2.19	5.48	27.38	27.38	10.40	5.48	5.48	54.75	5.48	
Exposure via fish	Bq/a	1.23	0.06	0.15	2.79	0.28	1.69	5.02	0.15	5.58	0.15	
Exposure via moose	Bq/a	0.13	0.02	0.10	1.40	0.42	0.80	1.50	0.02	0.77	0.02	
Exposure via mallard	Bq/a	0.03	0.10	0.23	0.24	0.07	0.67	30.56	0.04	0.12	0.07	
Ingestion DCF adult	Sv/Bq	4.70E-08	3.40E-09	2.10E-07	2.80E-07	2.50E-10	6.91E-07	1.20E-06	2.30E-07	6.90E-07	7.20E-08	
Dose via water	mSv/a	9.50E-04	7.45E-06	1.15E-03	7.67E-03	6.84E-06	7.19E-03	6.57E-03	1.26E-03	3.78E-02	3.94E-04	6.30E-02
Dose via fish	mSv/a	5.77E-05	2.06E-07	3.19E-05	7.81E-04	6.97E-08	1.17E-03	6.02E-03	3.49E-05	3.85E-03	1.09E-05	1.20E-02
Dose via moose	mSv/a	5.89E-06	8.00E-08	2.09E-05	3.92E-04	1.05E-07	5.54E-04	1.80E-03	3.75E-06	5.30E-04	1.52E-06	3.30E-03
Dose via mallard	mSv/a	1.43E-06	3.50E-07	4.77E-05	6.61E-05	1.77E-08	4.66E-04	3.67E-02	9.12E-06	8.19E-05	4.93E-06	3.74E-02
Total ingestion dose	mSv/a	1.01E-03	8.08E-06	1.25E-03	8.90E-03	7.04E-06	9.38E-03	5.11E-02	1.31E-03	4.22E-02	4.12E-04	1.16E-01

Ecological Dose Calculations - Aquatic Biota - Quirke Lake

Parameter	Units	U238/234	TH234+	TH230	RA226	RN222+	PB210+	PO210	TH232	RA228+	Th-228+	TOTAL
Water conc.	Bq/L	0.0640	0.02225	0.01	0.05	0.05	0.06	0.01	0.0053	0.0080	0.0075	
Sed to water PC	L/kg (dw)	34231	49200	49200	44000	44000	38333	76666	49200	44000	49200	
Sediment conc.	Bq/kg (dw)	2189.4	1094.7	2700	2200	2200	2300	2600	260	350	370	
Sediment conc.	Bq/kg (ww)	219	109	270	220	220	230	260	26	35	37	
Wat to fish BAF	L/kg (fw)	478	218	218	540	-	861	-	218	540	218	
Fish tissue conc.	Bq/kg (fw)	63.55	4.8505	22	59.67	5.9667	30	1006.67	1.15	106.67	4.67	
Wat to aquatic plant BAF	L/kg (fw)	5090	6215	6215	3748	-	2499	-	6215	3748	6215	
Aquatic plant conc.	Bq/kg (fw)	1466.01	138.28	608.81	462.5	46.25	481.875	534.375	77.56	128.75	70.69	
Wat to benthos BAF	L/kg (fw)	276	276	276	486	-	3643	20000	276	486	276	
Benthos conc.	Bq/kg (fw)	17.65	6.14	2.76	24.30	2.43	218.58	200.00	1.46	3.87	2.08	
Int. DCF tissue	Gy/a per Bq/kg (fw)	2.31E-05	4.56E-06	2.41E-05	2.46E-05	1.12E-04	2.19E-06	2.73E-05	2.06E-05	7.12E-06	1.77E-04	
Ext. DCF sediment	Gy/a per Bq/kg (ww)	5.40E-08	1.53E-05	5.35E-08	2.4E-07	6.70E-05	4.56E-06	2.58E-10	4.67E-08	3.55E-05	5.81E-05	
Ext. dose sediment (OF_s .5)	mGy/d	1.62E-05	2.29E-03	1.98E-05	7.23E-05	2.02E-02	1.44E-03	9.19E-08	1.66E-06	1.70E-03	2.95E-03	2.87E-02
Int. abs. dose fish	mGy/d	4.02E-03	6.06E-05	1.45E-03	4.02E-03	1.83E-03	1.80E-04	7.53E-02	6.50E-05	2.08E-03	2.26E-03	9.13E-02
Int. abs dose plant	mGy/d	9.28E-02	1.73E-03	4.02E-02	3.12E-02	1.42E-02	2.89E-03	4.00E-02	4.38E-03	2.51E-03	3.43E-02	2.64E-01
Int. abs dose benthos	mGy/d	1.12E-03	7.67E-05	1.82E-04	1.64E-03	7.46E-04	1.31E-03	1.50E-02	8.23E-05	7.54E-05	1.01E-03	2.12E-02
RBE alpha	-	10	1	10	10	10	1	10	10	1	10	
γ eq. . dose fish	mGy/d	4.02E-02	2.35E-03	1.45E-02	4.03E-02	3.85E-02	1.62E-03	7.53E-01	6.52E-04	3.78E-03	2.56E-02	9.20E-01
γ eq. dose plant	mGy/d	9.28E-01	4.02E-03	4.02E-01	3.12E-01	1.62E-01	4.32E-03	4.00E-01	4.38E-02	4.21E-03	3.46E-01	2.61E+00
γ eq. . dose benthos	mGy/d	1.12E-02	4.67E-03	1.86E-03	1.65E-02	4.78E-02	4.18E-03	1.50E-01	8.26E-04	3.48E-03	1.60E-02	2.56E-01

Ecological Dose Calculations - Riparian Wildlife - Quirke Lake

Parameter	Units	U238/234	TH234+	TH230	RA226	RN222+	PB210+	PO210	TH232	RA228+	Th-228+	TOTAL
Water conc.	Bq/L	0.06396	0.02225	0.01	0.05	0.05	0.06	0.01	0.0053	0.0080	0.0075	
Sed to water PC	L/kg (dw)	34231	49200	49200	44000	44000	38333	76666	49200	44000	49200	
Sediment conc.	Bq/kg (dw)	2189.4	1094.7	2700	2200	2200	2300	2600	260	350	370	
Sediment conc.	Bq/kg (ww)	219	109	270	220	220	230	260	26	35	37	
Wat to fish BAF	L/kg (fw)	478	218	218	540	-	861	-	218	540	218	
Fish tissue conc.	Bq/kg (fw)	63.55	4.8505	22	59.67	5.9667	30	1006.67	1.15	106.67	4.67	
Wat to aquatic plant BAF	L/kg (fw)	5090	6215	6215	3748	-	2499	-	6215	3748		
Aquatic plant conc.	Bq/kg (fw)	1466.01	138.28	608.81	462.5	46.25	481.875	534.375	77.5625	128.75	70.69	
Wat to benthos BAF	L/kg (fw)	276	276	276	486	-	3643	20000	276	486	276	
Benthos conc.	Bq/kg (fw)	17.65	6.14	2.76	24.30	2.43	218.58	200.00	1.46	3.87	2.08	
Ing. TF mallard	d/kg	0.008	0.050	0.050	0.046	-	0.162	4.62	0.050	0.046	0.050	
Ing. TF scaup	d/kg	0.008	0.496	0.496	0.423	-	0.162	4.62	0.496	0.423	0.496	
Ing. TF merganser	d/kg	0.163	4.89	4.89	3.91	-	1.99	5.45	4.894	3.910	4.894	
Ing. TF muskrat	d/kg	0.077	0.031	0.031	0.694	-	0.462	0.540	0.031	0.694	0.031	
Ing. TF mink	d/kg	0.080	0.032	0.032	0.717	-	0.478	0.558	0.032	0.717	0.032	
Int. DCF tissue	Gy/a per Bq/kg (fw)	2.31E-05	4.56E-06	2.41E-05	2.46E-05	1.12E-04	2.19E-06	2.73E-05	2.06E-05	7.12E-06	1.77E-04	
Ext. DCF sediment	Gy/a per Bq/kg (ww)	5.40E-08	1.53E-05	5.35E-08	2.4E-07	6.70E-05	4.56E-06	2.58E-10	4.67E-08	3.55E-05	5.81E-05	
Ext. dose sediment (OF_s .5)	mGy/d	8.09E-06	1.15E-03	9.89E-06	3.62E-05	1.01E-02	7.19E-04	4.59E-08	8.31E-07	8.51E-04	1.47E-03	1.43E-02
Int. abs. dose mallard	mGy/d	8.88E-05	1.14E-05	2.60E-04	1.84E-04	2.52E-04	6.02E-05	2.38E-02	2.82E-05	1.47E-05	2.22E-04	2.50E-02
Int. abs. dose scaup	mGy/d	1.39E-06	7.34E-06	5.43E-05	1.03E-04	1.40E-04	2.27E-05	7.51E-03	7.87E-06	4.73E-06	9.62E-05	7.95E-03
Int. abs. dose merganser	mGy/d	1.11E-04	5.48E-05	1.25E-03	2.65E-03	3.63E-03	6.16E-05	6.81E-02	5.88E-05	1.35E-03	1.91E-03	7.92E-02
Int. abs. dose muskrat	mGy/d	3.12E-03	2.58E-05	5.68E-04	9.96E-03	1.36E-02	6.15E-04	9.95E-03	6.07E-05	7.76E-04	4.90E-04	3.92E-02
Int. abs. dose mink	mGy/d	6.62E-05	5.75E-07	1.15E-05	5.99E-04	8.18E-04	1.95E-05	8.03E-03	6.17E-07	2.86E-04	1.64E-05	9.85E-03
RBE alpha	-	10	1	10	10	10	1	10	10	1	10	
γ eq. dose mallard	mGy/d	8.96E-04	1.16E-03	2.61E-03	1.88E-03	1.26E-02	7.79E-04	2.38E-01	2.82E-04	8.66E-04	3.70E-03	2.63E-01
γ eq. dose scaup	mGy/d	2.20E-05	1.15E-03	5.53E-04	1.06E-03	1.15E-02	7.41E-04	7.51E-02	7.96E-05	8.56E-04	2.44E-03	9.35E-02
γ eq. dose merganser	mGy/d	1.12E-03	1.20E-03	1.25E-02	2.66E-02	4.64E-02	7.80E-04	6.81E-01	5.88E-04	2.20E-03	2.06E-02	7.93E-01
γ eq. dose muskrat	mGy/d	3.12E-02	2.32E-03	5.70E-03	9.96E-02	1.56E-01	2.05E-03	9.95E-02	6.09E-04	2.48E-03	7.85E-03	4.07E-01
γ eq. dose mink	mGy/d	6.78E-04	2.29E-03	1.35E-04	6.06E-03	2.84E-02	1.46E-03	8.03E-02	7.83E-06	1.99E-03	3.11E-03	1.24E-01

		Mallard	Scaup	Merganser	Muskrat	Mink		Moose
Body weight	kg	1.134	0.815	1.723	1.415	1.354		400
Ing. water	L/d	0.065	0.051	0.085	0.135	0.142		21.8
Ing. sediment	kg/d (dw)	0.00126	0.00102	0.00017	0.00744	0.000475		0.057
Ing. plant	kg/d (fw)	0.252			0.425			3.3
Ing. benthos	kg/d (fw)		0.204					
Ing. fish	kg/d (fw)			0.331		0.19		
Occupancy factor	-	0.5	0.5	0.5	1.0	1.0		1.0

Human Dose Calculations - Generic Adult - Quirke Lake

Parameter	Units	U238/234	TH234+	TH230	RA226	RN222+	PB210+	PO210	TH232	RA228+	TH228+	TOTAL
Water conc.	Bq/L	0.06396	0.02225	0.01	0.05	0.05	0.06	0.01	0.0053	0.0080	0.0075	
Wat to fish BAF	L/kg (fw)	11.4	5.2	5.2	19.1	-	30.5	171.9	5.2	19.1	5.2	
Sport fish tissue conc.	Bq/kg (fw)	0.729	0.116	0.052	0.955	0.096	1.827	1.719	0.027	0.152	0.039	
Moose wb conc.	Bq/kg (fw)	5.46	0.21	2.38	16.69	5.01	11.54	14.91	0.30	4.49	0.28	
Moose meat conc.	Bq/kg (fw)	2.73	0.13	1.50	6.18	1.85	4.39	8.80	0.19	1.66	0.18	
Mallard duck wb conc.	Bq/kg (fw)	1.40	0.91	3.94	2.73	0.82	10.05	318.74	0.50	0.75	0.46	
Mallard duck meat conc.	Bq/kg (fw)	0.70	0.57	2.48	1.01	0.30	3.82	188.06	0.31	0.28	0.29	
Ingestion rate water	L/a	547.5	547.5	547.5	547.5	547.5	547.5	547.5	547.5	547.5	547.5	
Ingestion rate fish	kg/a	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	
Ingestion rate moose	kg/a	1	1	1	1	1	1	1	1	1	1	
Ingestion rate mallard	kg/a	1	1	1	1	1	1	1	1	1	1	
Exposure via water	Bq/a	35.02	12.18	5.48	27.38	27.38	32.85	5.48	2.89	4.36	4.12	
Exposure via fish	Bq/a	2.13	0.34	0.15	2.79	0.28	5.34	5.02	0.08	0.44	0.11	
Exposure via moose	Bq/a	2.73	0.13	1.50	6.18	1.85	4.39	8.80	0.19	1.66	0.18	
Exposure via mallard	Bq/a	0.70	0.57	2.48	1.01	0.30	3.82	188.06	0.31	0.28	0.29	
Ingestion DCF adult	Sv/Bq	4.70E-08	3.40E-09	2.10E-07	2.80E-07	2.50E-10	6.91E-07	1.20E-06	2.30E-07	6.90E-07	7.20E-08	
Dose via water	mSv/a	1.65E-03	4.14E-05	1.15E-03	7.67E-03	6.84E-06	2.27E-02	6.57E-03	6.65E-04	3.01E-03	2.96E-04	4.38E-02
Dose via fish	mSv/a	1.00E-04	1.15E-06	3.19E-05	7.81E-04	6.97E-08	3.69E-03	6.02E-03	1.85E-05	3.06E-04	8.22E-06	1.10E-02
Dose via moose	mSv/a	1.28E-04	4.45E-07	3.15E-04	1.73E-03	4.63E-07	3.03E-03	1.06E-02	4.32E-05	1.15E-03	1.27E-05	1.70E-02
Dose via mallard	mSv/a	3.30E-05	1.95E-06	5.21E-04	2.83E-04	7.59E-08	2.64E-03	2.26E-01	7.23E-05	1.92E-04	2.08E-05	2.29E-01
Total ingestion dose	mSv/a	1.91E-03	4.50E-05	2.02E-03	1.05E-02	7.45E-06	3.21E-02	2.49E-01	7.99E-04	4.65E-03	3.38E-04	3.01E-01

Ecological Dose Calculations - Aquatic Biota - Nordic Lake

Parameter	Units	U238/234	TH234+	TH230	RA226	RN222+	PB210+	PO210	TH232	RA228+	Th-228+	TOTAL
Water conc.	Bq/L	0.0394	0.004	0.0010	0.03	0.0300	0.03	0.01	0.0004	0.0016	0.0012	
Sed to water PC	L/kg (dw)	10000	49200	49200	12333	12333	10333	20666	49200	12333	49200	
Sediment conc.	Bq/kg (dw)	393.6	196.8	50	370	370	310	270	20	20	60	
Sediment conc.	Bq/kg (ww)	39	20	5	37	37	31	27	2	2	6	
Wat to fish BAF	L/kg (fw)	478	218	218	540	-	861	-	218	540	218	
Fish tissue conc.	Bq/kg (fw)	4.5099	0.872	0.2215	10.333	1.0333	20	396.667	0.09	0.88	0.27	
Wat to aquatic plant BAF	L/kg (fw)	5090	6215	6215	3748	-	2499	-	6215	3748	6215	
Aquatic plant conc.	Bq/kg (fw)	15.3381	24.86	6.32	33.7	3.37	14.8	8.95	2.53	6.08	1.55	
Wat to benthos BAF	L/kg (fw)	276	276	276	486	-	3643	20000	276	486	276	
Benthos conc.	Bq/kg (fw)	10.86	1.10	0.28	14.58	1.46	109.29	200.00	0.11	0.79	0.34	
Int. DCF tissue	Gy/a per Bq/kg (fw)	2.31E-05	4.56E-06	2.41E-05	2.46E-05	1.12E-04	2.19E-06	2.73E-05	2.06E-05	7.12E-06	1.77E-04	
Ext. DCF sediment	Gy/a per Bq/kg (ww)	5.40E-08	1.53E-05	5.35E-08	2.4E-07	6.70E-05	4.56E-06	2.58E-10	4.67E-08	3.55E-05	5.81E-05	
Ext. dose sediment (OF_s .5)	mGy/d	2.91E-06	4.12E-04	3.66E-07	1.22E-05	3.40E-03	1.94E-04	9.54E-09	1.28E-07	9.73E-05	4.78E-04	4.59E-03
Int. abs. dose fish	mGy/d	2.85E-04	1.09E-05	1.46E-05	6.96E-04	3.17E-04	1.20E-04	2.97E-02	5.00E-06	1.71E-05	1.29E-04	3.13E-02
Int. abs dose plant	mGy/d	9.71E-04	3.11E-04	4.17E-04	2.27E-03	1.03E-03	8.87E-05	6.69E-04	1.43E-04	1.19E-04	7.51E-04	6.77E-03
Int. abs dose benthos	mGy/d	6.88E-04	1.38E-05	1.85E-05	9.83E-04	4.47E-04	6.55E-04	1.50E-02	6.33E-06	1.54E-05	1.63E-04	1.79E-02
RBE alpha	-	10	1	10	10	10	1	10	10	1	10	
γ eq. . dose fish	mGy/d	2.86E-03	4.23E-04	1.47E-04	6.98E-03	6.57E-03	3.14E-04	2.97E-01	5.01E-05	1.14E-04	1.77E-03	3.16E-01
γ eq. dose plant	mGy/d	9.71E-03	7.23E-04	4.17E-03	2.27E-02	1.37E-02	2.82E-04	6.69E-03	1.43E-03	2.16E-04	7.99E-03	6.77E-02
γ eq. . dose benthos	mGy/d	6.88E-03	8.39E-04	1.86E-04	9.85E-03	1.13E-02	1.04E-03	1.50E-01	6.36E-05	2.10E-04	2.59E-03	1.83E-01

Ecological Dose Calculations - Riparian Wildlife - Nordic Lake

Parameter	Units	U238/234	TH234+	TH230	RA226	RN222+	PB210+	PO210	TH232	RA228+	Th-228+	TOTAL
Water conc.	Bq/L	0.03936	0.004	0.0010	0.03	0.0300	0.03	0.01	0.0004	0.0016	0.0012	
Sed to water PC	L/kg (dw)	10000	49200	49200	12333	12333	10333	20666	49200	12333	49200	
Sediment conc.	Bq/kg (dw)	393.6	196.8	50	370	370	310	270	20	20	60	
Sediment conc.	Bq/kg (ww)	39	20	5	37	37	31	27	2	2	6	
Wat to fish BAF	L/kg (fw)	478	218	218	540	-	861	-	218	540	218	
Fish tissue conc.	Bq/kg (fw)	4.5099	0.872	0.2215447	10.333	1.0333	20	396.667	0.09	0.88	0.27	
Wat to aquatic plant BAF	L/kg (fw)	5090	6215	6215	3748	-	2499	-	6215	3748	6215	
Aquatic plant conc.	Bq/kg (fw)	15.3381	24.86	6.32	33.7	3.37	14.8	8.95	2.53	6.08	1.55	
Wat to benthos BAF	L/kg (fw)	276	276	276	486	-	3643	20000	276	486	276	
Benthos conc.	Bq/kg (fw)	10.86	1.10	0.28	14.58	1.46	109.29	200.00	0.11	0.79	0.34	
Ing. TF mallard	d/kg	0.008	0.050	0.050	0.046	-	0.162	4.62	0.050	0.046	0.050	
Ing. TF scaup	d/kg	0.008	0.496	0.496	0.423	-	0.162	4.62	0.496	0.423	0.496	
Ing. TF merganser	d/kg	0.163	4.89	4.89	3.91	-	1.99	5.45	4.894	3.910	4.894	
Ing. TF muskrat	d/kg	0.077	0.031	0.031	0.694	-	0.462	0.540	0.031	0.694	0.031	
Ing. TF mink	d/kg	0.080	0.032	0.032	0.717	-	0.478	0.558	0.032	0.717	0.032	
Int. DCF tissue	Gy/a per Bq/kg (fw)	2.31E-05	4.56E-06	2.41E-05	2.46E-05	1.12E-04	2.19E-06	2.73E-05	2.06E-05	7.12E-06	1.77E-04	
Ext. DCF sediment	Gy/a per Bq/kg (ww)	5.40E-08	1.53E-05	5.35E-08	2.4E-07	6.70E-05	4.56E-06	2.58E-10	4.67E-08	3.55E-05	5.81E-05	
Ext. dose sediment (OF_s .5)	mGy/d	1.45E-06	2.06E-04	1.83E-07	6.08E-06	1.70E-03	9.68E-05	4.77E-09	6.39E-08	4.86E-05	2.39E-04	2.01E-03
Int. abs. dose mallard	mGy/d	1.04E-06	2.04E-06	2.74E-06	1.38E-05	1.89E-05	2.00E-06	4.49E-04	9.38E-07	6.96E-07	5.67E-06	4.89E-04
Int. abs. dose scaup	mGy/d	6.25E-07	1.32E-06	1.77E-06	4.78E-05	6.53E-05	1.09E-05	7.10E-03	6.06E-07	7.48E-07	1.56E-05	7.23E-03
Int. abs. dose merganser	mGy/d	8.09E-06	9.84E-06	1.32E-05	4.60E-04	6.28E-04	3.98E-05	2.68E-02	4.52E-06	1.12E-05	1.16E-04	2.80E-02
Int. abs. dose muskrat	mGy/d	4.61E-05	4.63E-06	6.22E-06	7.98E-04	1.09E-03	2.38E-05	2.35E-04	2.13E-06	3.70E-05	1.65E-05	2.20E-03
Int. abs. dose mink	mGy/d	5.29E-06	1.03E-07	1.39E-07	1.04E-04	1.41E-04	1.13E-05	3.15E-03	4.75E-08	2.46E-06	1.22E-06	3.41E-03
RBE alpha	-	10	1	10	10	10	1	10	10	1	10	
γ eq. dose mallard	mGy/d	1.19E-05	2.08E-04	2.76E-05	1.44E-04	1.89E-03	9.88E-05	4.49E-03	9.44E-06	4.93E-05	2.96E-04	6.87E-03
γ eq. dose scaup	mGy/d	7.71E-06	2.08E-04	1.79E-05	4.84E-04	2.35E-03	1.08E-04	7.10E-02	6.12E-06	4.94E-05	3.95E-04	7.42E-02
γ eq. dose merganser	mGy/d	8.23E-05	2.16E-04	1.32E-04	4.60E-03	7.98E-03	1.37E-04	2.68E-01	4.53E-05	5.98E-05	1.40E-03	2.81E-01
γ eq. dose muskrat	mGy/d	4.64E-04	4.17E-04	6.26E-05	8.00E-03	1.43E-02	2.18E-04	2.35E-03	2.14E-05	1.34E-04	6.43E-04	2.58E-02
γ eq. dose mink	mGy/d	5.58E-05	4.13E-04	1.75E-06	1.05E-03	4.81E-03	2.05E-04	3.15E-02	6.03E-07	9.97E-05	4.90E-04	3.80E-02

		Mallard	Scaup	Merganser	Muskrat	Mink		Moose
Body weight	kg	1.134	0.815	1.723	1.415	1.354		400
Ing. water	L/d	0.065	0.051	0.085	0.135	0.142		21.8
Ing. sediment	kg/d (dw)	0.00126	0.00102	0.00017	0.00744	0.000475		0.057
Ing. plant	kg/d (fw)	0.252			0.425			3.3
Ing. benthos	kg/d (fw)		0.204					
Ing. fish	kg/d (fw)			0.331		0.19		
Occupancy factor	-	0.5	0.5	0.5	1.0	1.0		1.0

Human Dose Calculations - Generic Adult - Nordic Lake

Parameter	Units	U238/234	TH234+	TH230	RA226	RN222+	PB210+	PO210	TH232	RA228+	TH228+	TOTAL
Water conc.	Bq/L	0.03936	0.004	0.0010	0.03	0.0300	0.03	0.01	0.0004	0.0016	0.0012	
Wat to fish BAF	L/kg (fw)	11.4	5.2	5.2	19.1	-	30.5	171.9	5.2	19.1	5.2	
Sport fish tissue conc.	Bq/kg (fw)	0.449	0.021	0.005	0.573	0.057	0.914	1.719	0.002	0.031	0.006	
Moose wb conc.	Bq/kg (fw)	0.08	0.04	0.01	1.34	0.40	0.45	0.35	0.00	0.21	0.00	
Moose meat conc.	Bq/kg (fw)	0.04	0.02	0.01	0.50	0.15	0.17	0.21	0.00	0.08	0.00	
Mallard duck wb conc.	Bq/kg (fw)	0.02	0.16	0.04	0.21	0.06	0.33	6.00	0.02	0.04	0.01	
Mallard duck meat conc.	Bq/kg (fw)	0.01	0.10	0.03	0.08	0.02	0.13	3.54	0.01	0.01	0.01	
Ingestion rate water	L/a	547.5	547.5	547.5	547.5	547.5	547.5	547.5	547.5	547.5	547.5	
Ingestion rate fish	kg/a	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	
Ingestion rate moose	kg/a	1	1	1	1	1	1	1	1	1	1	
Ingestion rate mallard	kg/a	1	1	1	1	1	1	1	1	1	1	
Exposure via water	Bq/a	21.55	2.19	0.56	16.43	16.43	16.43	5.48	0.22	0.89	0.67	
Exposure via fish	Bq/a	1.31	0.06	0.02	1.67	0.17	2.67	5.02	0.01	0.09	0.02	
Exposure via moose	Bq/a	0.04	0.02	0.01	0.50	0.15	0.17	0.21	0.00	0.08	0.00	
Exposure via mallard	Bq/a	0.01	0.10	0.03	0.08	0.02	0.13	3.54	0.01	0.01	0.01	
Ingestion DCF adult	Sv/Bq	4.70E-08	3.40E-09	2.10E-07	2.80E-07	2.50E-10	6.91E-07	1.20E-06	2.30E-07	6.90E-07	7.20E-08	
Dose via water	mSv/a	1.01E-03	7.45E-06	1.17E-04	4.60E-03	4.11E-06	1.14E-02	6.57E-03	5.12E-05	6.13E-04	4.81E-05	2.44E-02
Dose via fish	mSv/a	6.16E-05	2.06E-07	3.24E-06	4.68E-04	4.18E-08	1.84E-03	6.02E-03	1.42E-06	6.24E-05	1.33E-06	8.47E-03
Dose via moose	mSv/a	1.91E-06	8.00E-08	1.26E-06	1.39E-04	3.73E-08	1.18E-04	2.49E-04	5.50E-07	5.47E-05	1.55E-07	5.65E-04
Dose via mallard	mSv/a	3.87E-07	3.50E-07	5.49E-06	2.13E-05	5.70E-09	8.75E-05	4.25E-03	2.41E-06	9.11E-06	5.31E-07	4.37E-03
Total ingestion dose	mSv/a	1.08E-03	8.08E-06	1.27E-04	5.23E-03	4.19E-06	1.34E-02	1.71E-02	5.56E-05	7.39E-04	5.01E-05	3.78E-02

Ecological Dose Calculations - Aquatic Biota - Elliot Lake

Parameter	Units	U238/234	TH234+	TH230	RA226	RN222+	PB210+	PO210	TH232	RA228+	Th-228+	TOTAL
Water conc.	Bq/L	0.04182	0.0338	0.01	0.01	0.01	0.03	0.01	0.0016	0.0034	0.0035	
Sed to water PC	L/kg (dw)	79412	49200	49200	23517	23517	25333	50666	49200	23517	49200	
Sediment conc.	Bq/kg (dw)	3321	1660.5	1040	630	630	760	740	80	80	170	
Sediment conc.	Bq/kg (ww)	332	166	104	63	63	76	74	8	8	17	
Wat to fish BAF	L/kg (fw)	478	218	218	540	-	861	-	218	540	218	
Fish tissue conc.	Bq/kg (fw)	14.9241	7.3575	4.33	11	1.1	20	29	0.35	116.7	0.75	
Wat to aquatic plant BAF	L/kg (fw)	5090	6215	6215	3748	-	2499	-	6215	3748	6215	
Aquatic plant conc.	Bq/kg (fw)	21.279	209.76	4.0	27	2.70	11.5	4.75	1.25	12.75	1.75	
Wat to benthos BAF	L/kg (fw)	276	276	276	486	-	3643	20000	276	486	276	
Benthos conc.	Bq/kg (fw)	11.54	9.32	2.76	4.86	0.49	109.29	200.00	0.45	1.65	0.95	
Int. DCF tissue	Gy/a per Bq/kg (fw)	2.31E-05	4.56E-06	2.41E-05	2.46E-05	1.12E-04	2.19E-06	2.73E-05	2.06E-05	7.12E-06	1.77E-04	
Ext. DCF sediment	Gy/a per Bq/kg (ww)	5.40E-08	1.53E-05	5.35E-08	2.4E-07	6.70E-05	4.56E-06	2.58E-10	4.67E-08	3.55E-05	5.81E-05	
Ext. dose sediment (OFs .5)	mGy/d	2.45E-05	3.48E-03	7.62E-06	2.07E-05	5.78E-03	4.75E-04	2.62E-08	5.11E-07	3.89E-04	1.35E-03	1.15E-02
Int. abs. dose fish	mGy/d	9.45E-04	9.19E-05	2.86E-04	7.41E-04	3.38E-04	1.20E-04	2.17E-03	2.00E-05	2.28E-03	3.65E-04	7.35E-03
Int. abs dose plant	mGy/d	1.35E-03	2.62E-03	2.64E-04	1.82E-03	8.28E-04	6.89E-05	3.55E-04	7.05E-05	2.49E-04	8.48E-04	8.47E-03
Int. abs dose benthos	mGy/d	7.30E-04	1.16E-04	1.82E-04	3.28E-04	1.49E-04	6.55E-04	1.50E-02	2.53E-05	3.23E-05	4.62E-04	1.76E-02
RBE alpha	-	10	1	10	10	10	1	10	10	1	10	
γ eq. . dose fish	mGy/d	9.47E-03	3.57E-03	2.87E-03	7.43E-03	9.16E-03	5.95E-04	2.17E-02	2.01E-04	2.67E-03	5.00E-03	6.27E-02
γ eq. dose plant	mGy/d	1.35E-02	6.10E-03	2.65E-03	1.82E-02	1.41E-02	5.44E-04	3.55E-03	7.06E-04	6.38E-04	9.83E-03	6.98E-02
γ eq. . dose benthos	mGy/d	7.35E-03	7.08E-03	1.84E-03	3.32E-03	1.31E-02	1.60E-03	1.50E-01	2.54E-04	8.10E-04	7.33E-03	1.92E-01

Ecological Dose Calculations - Riparian Wildlife - Elliot Lake

Parameter	Units	U238/234	TH234+	TH230	RA226	RN222+	PB210+	PO210	TH232	RA228+	Th-228+	TOTAL
Water conc.	Bq/L	0.04182	0.0338	0.01	0.01	0.01	0.03	0.01	0.0016	0.0034	0.0035	
Sed to water PC	L/kg (dw)	79412	49200	49200	23517	23517	25333	50666	49200	23517	49200	
Sediment conc.	Bq/kg (dw)	3321	1660.5	1040	630	630	760	740	80	80	170	
Sediment conc.	Bq/kg (ww)	332	166	104	63	63	76	74	8	8	17	
Wat to fish BAF	L/kg (fw)	478	218	218	540	-	861	-	218	540	218	
Fish tissue conc.	Bq/kg (fw)	14.924082	7.3575	4.33	11	1.1	20.00	29	0.35	116.7	0.75	
Wat to aquatic plant BAF	L/kg (fw)	5090	6215	6215	3748	-	2499	-	6215	3748	6215	
Aquatic plant conc.	Bq/kg (fw)	21.279	209.76	4	27	2.70	11.5	4.75	1.25	12.75	1.75	
Wat to benthos BAF	L/kg (fw)	276	276	276	486	-	3643	20000	276	486	276	
Benthos conc.	Bq/kg (fw)	11.54	9.32	2.76	4.86	0.49	109.29	200.00	0.45	1.65	0.95	
Ing. TF mallard	d/kg	0.008	0.050	0.050	0.046	-	0.162	4.62	0.050	0.046	0.050	
Ing. TF scaup	d/kg	0.008	0.496	0.496	0.423	-	0.162	4.62	0.496	0.423	0.496	
Ing. TF merganser	d/kg	0.163	4.89	4.89	3.91	-	1.99	5.45	4.894	3.910	4.894	
Ing. TF muskrat	d/kg	0.077	0.031	0.031	0.694	-	0.462	0.540	0.031	0.694	0.031	
Ing. TF mink	d/kg	0.080	0.032	0.032	0.717	-	0.478	0.558	0.032	0.717	0.032	
Int. DCF tissue	Gy/a per Bq/kg (fw)	2.31E-05	4.56E-06	2.41E-05	2.46E-05	1.12E-04	2.19E-06	2.73E-05	2.06E-05	7.12E-06	1.77E-04	
Ext. DCF sediment	Gy/a per Bq/kg (ww)	5.40E-08	1.53E-05	5.35E-08	2.4E-07	6.70E-05	4.56E-06	2.58E-10	4.67E-08	3.55E-05	5.81E-05	
Ext. dose sediment (OF_s .5)	mGy/d	1.23E-05	1.74E-03	3.81E-06	1.04E-05	2.89E-03	2.37E-04	1.31E-08	2.56E-07	1.95E-04	6.77E-04	5.77E-03
Int. abs. dose mallard	mGy/d	2.28E-06	1.72E-05	3.84E-06	1.17E-05	1.60E-05	1.87E-06	3.68E-04	5.89E-07	1.48E-06	7.97E-06	4.31E-04
Int. abs. dose scaup	mGy/d	1.37E-06	1.11E-05	2.66E-05	2.33E-05	3.18E-05	1.12E-05	7.18E-03	2.42E-06	1.73E-06	4.42E-05	7.34E-03
Int. abs. dose merganser	mGy/d	2.84E-05	8.31E-05	2.60E-04	4.94E-04	6.75E-04	4.03E-05	1.98E-03	1.81E-05	1.48E-03	3.30E-04	5.39E-03
Int. abs. dose muskrat	mGy/d	1.65E-04	3.91E-05	1.92E-05	7.56E-04	1.03E-03	2.92E-05	3.04E-04	1.96E-06	8.14E-05	3.00E-05	2.46E-03
Int. abs. dose mink	mGy/d	2.23E-05	8.72E-07	2.77E-06	1.16E-04	1.58E-04	1.19E-05	2.45E-04	1.90E-07	3.11E-04	3.47E-06	8.70E-04
RBE alpha	-	10	1	10	10	10	1	10	10	1	10	
γ eq. dose mallard	mGy/d	3.51E-05	1.76E-03	4.22E-05	1.28E-04	3.05E-03	2.39E-04	3.68E-03	6.15E-06	1.96E-04	7.56E-04	9.89E-03
γ eq. dose scaup	mGy/d	2.60E-05	1.75E-03	2.70E-04	2.44E-04	3.21E-03	2.49E-04	7.18E-02	2.45E-05	1.96E-04	1.12E-03	7.89E-02
γ eq. dose merganser	mGy/d	2.97E-04	1.82E-03	2.60E-03	4.95E-03	9.64E-03	2.78E-04	1.98E-02	1.81E-04	1.67E-03	3.98E-03	4.53E-02
γ eq. dose muskrat	mGy/d	1.67E-03	3.52E-03	2.00E-04	7.58E-03	1.61E-02	5.04E-04	3.04E-03	2.01E-05	4.70E-04	1.65E-03	3.48E-02
γ eq. dose mink	mGy/d	2.47E-04	3.48E-03	3.54E-05	1.18E-03	7.36E-03	4.87E-04	2.45E-03	2.41E-06	7.00E-04	1.39E-03	1.73E-02

		Mallard	Scaup	Merganser	Muskrat	Mink		Moose
Body weight	kg	1.134	0.815	1.723	1.415	1.354		400
Ing. water	L/d	0.065	0.051	0.085	0.135	0.142		21.8
Ing. sediment	kg/d (dw)	0.00126	0.00102	0.00017	0.00744	0.000475		0.057
Ing. plant	kg/d (fw)	0.252			0.425			3.3
Ing. benthos	kg/d (fw)		0.204					
Ing. fish	kg/d (fw)			0.331		0.19		
Occupancy factor	-	0.5	0.5	0.5	1.0	1.0		1.0

Human Dose Calculations - Generic Adult - Elliot Lake

Parameter	Units	U238/234	TH234+	TH230	RA226	RN222+	PB210+	PO210	TH232	RA228+	TH228+	TOTAL
Water conc.	Bq/L	0.04182	0.0338	0.01	0.01	0.01	0.03	0.01	0.0016	0.0034	0.0035	
Wat to fish BAF	L/kg (fw)	11.4	5.2	5.2	19.1	-	30.5	171.9	5.2	19.1	5.2	
Sport fish tissue conc.	Bq/kg (fw)	0.477	0.175	0.052	0.191	0.019	0.914	1.719	0.008	0.065	0.018	
Moose wb conc.	Bq/kg (fw)	0.29	0.32	0.03	1.26	0.38	0.55	0.45	0.00	0.47	0.01	
Moose meat conc.	Bq/kg (fw)	0.14	0.20	0.02	0.47	0.14	0.21	0.27	0.002	0.17	0.004	
Mallard duck wb conc.	Bq/kg (fw)	0.04	1.38	0.06	0.17	0.05	0.31	4.92	0.01	0.08	0.02	
Mallard duck meat conc.	Bq/kg (fw)	0.02	0.87	0.04	0.06	0.02	0.12	2.90	0.01	0.028	0.01	
Ingestion rate water	L/a	547.5	547.5	547.5	547.5	547.5	547.5	547.5	547.5	547.5	547.5	
Ingestion rate fish	kg/a	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	
Ingestion rate moose	kg/a	1	1	1	1	1	1	1	1	1	1	
Ingestion rate mallard	kg/a	1	1	1	1	1	1	1	1	1	1	
Exposure via water	Bq/a	22.90	18.48	5.48	5.48	5.48	16.43	5.48	0.89	1.86	1.89	
Exposure via fish	Bq/a	1.39	0.51	0.15	0.56	0.06	2.67	5.02	0.02	0.19	0.05	
Exposure via moose	Bq/a	0.14	0.20	0.02	0.47	0.14	0.21	0.27	0.00	0.17	0.00	
Exposure via mallard	Bq/a	0.02	0.87	0.04	0.06	0.02	0.12	2.90	0.01	0.03	0.01	
Ingestion DCF adult	Sv/Bq	4.70E-08	3.40E-09	2.10E-07	2.80E-07	2.50E-10	6.91E-07	1.20E-06	2.30E-07	6.90E-07	7.20E-08	
Dose via water	mSv/a	1.08E-03	6.28E-05	1.15E-03	1.53E-03	1.37E-06	1.14E-02	6.57E-03	2.05E-04	1.29E-03	1.36E-04	2.34E-02
Dose via fish	mSv/a	6.54E-05	1.74E-06	3.19E-05	1.56E-04	1.39E-08	1.84E-03	6.02E-03	5.68E-06	1.31E-04	3.78E-06	8.26E-03
Dose via moose	mSv/a	6.73E-06	6.75E-07	3.85E-06	1.31E-04	3.51E-08	1.44E-04	3.21E-04	5.05E-07	1.20E-04	2.82E-07	7.28E-04
Dose via mallard	mSv/a	8.46E-07	2.95E-06	7.70E-06	1.80E-05	4.83E-09	8.19E-05	3.48E-03	1.51E-06	1.94E-05	7.46E-07	3.62E-03
Total ingestion dose	mSv/a	1.15E-03	6.82E-05	1.19E-03	1.84E-03	1.42E-06	1.34E-02	1.64E-02	2.12E-04	1.56E-03	1.41E-04	3.60E-02

Attachment #2

March 3, 2020:
Further Regulator Comments
on the
Cycle 5 Study Design
for the
SRWMP, SAMP, and TOMP

Jess Tester

From: Stenson, Ron (CNSC/CCSN) <ron.stenson@canada.ca>
Sent: Wednesday, March 11, 2020 11:48 AM
To: Heffner, Holly
Cc: Lambert, Tony; Angie Corson Msc; Jess Tester; Cynthia Russel; Paton, Ann; Hewitt, David; Pandolfi, Dana (CNSC/CCSN); Zhang, Henry (CNSC/CCSN); Brown, Julie (CNSC/CCSN); Alwarda, Ramina (EC); Kim, Duck (EC); jerry.wedzicha@ontario.ca; pierre.lefebvre@ontario.ca; Becker, Megan (MNRF); jim.trottier@ontario.ca; ed.snucins@ontario.ca; Crosson, Kirk (MECP); Fagan, Kelly-Anne (EC); Purdon, Rob H. (ENDM); UMMD / DMUCU (CNSC/CCSN)
Subject: RE: Response to JRG Comments on the Cycle 5 Study Design for the SRWMP, SAMP and TOMP

Good morning Holly.

I apologise for the delay in providing our review of your response to our comments. As you are aware we had some logistical issues with staff availability. Our team has now completed their review. All of your responses are acceptable, with the following two comments requesting some additional clarification. Please consider the proposed Cycle 5 monitoring plan (Minnow, 2019) as acceptable, considering the comments you have received from the JRG. Depending on the review of the information requested below, we may ask for some tweaking of the plan in future years, but please proceed with the plan as submitted for the 2020 field season.

CNSC staff are requesting clarification on the following two points:

Comment 3 Response: CNSC staff requests the licensee provide the historical data the response is based on, including the sediment and water quality monitoring results.

And,

Comment 4 Response: CNSC staff request an explanation be provided as to why the BAF's from water to fish and water to plants are identical across lakes as it is expected that the values would differ from lake to lake based on the different measurements of water, fish, and plant concentrations in each lake.

Please provide the requested clarifications by June 30, 2020. If you have any comments or questions please don't hesitate to contact me.

I am appending my specialist's complete review to help you address their two requests.

Ron Stenson

Ron Stenson

Senior Project Officer, Regulatory Operations Branch
Uranium Mines and Mills Division
Directorate of Nuclear Cycle and Facilities Regulation
Canadian Nuclear Safety Commission / Government of Canada
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CNSC SME Comments :

Review Purpose and Summary of Findings:

Denison Mines Inc. (DMI) and Rio Algom Ltd. (RAL) submitted the Cycle 5 Study Design for the Serpent River Water Monitoring Program (SRWMP), Source Area Monitoring Program (SAMP), and Tailings Management Area Operational Monitoring Program (TOMP) (e-Doc# 5889088). DERPA staff reviewed the Cycle 5 Study Design, and provided comments and recommendations (e-Doc# 5919986) to the CNSC Project Officer in July 2019. A subset of the comments were provided to DMI and RAL on October 2, 2019 (e-Doc# 6018691) CNSC staff received a request to review DMI and RAL responses to CNSC staff comments (e-Doc# 6120950) in December 2019.

The purpose of the review is to disposition RAL and DMI responses to CNSC staff comments on the Cycle 5 Study Design for the SRWMP, SAMP, and TOMP document.

Technical Recommendation and Conclusion:

CNSC staff have reviewed and dispositioned the responses provided by the licensees to CNSC staff comments:

CNSC Comment 1. *Provide a justification for the absence of pore water monitoring stations or monitoring of Ra-226 in the groundwater in order to demonstrate/support the assumptions/predictions regarding the increasing Ra-226 levels in the final effluent at Stanleigh TMA and*
CNSC Comment 2. *Identify and quantify potential sources of seepage/drainage from the Stanleigh TMA to the settling pond, which receives the treated effluent discharging from the water treatment plant prior to being released into the McCabe Lake.*

CNSC Disposition of Comment 1 and 2 Responses: CNSC staff found the licensees' response to be acceptable. However, CNSC staff note that the effluent discharged at Stanleigh exceeded the regulatory licence limit for radium-226 in 2017. From a compliance perspective, the comment responses are satisfactory, so long as future exceedances do not occur.

CNSC Comment 3. *Explore and report on the relationship between the Pronto TMA and the IEMP monitoring location EL25. If the location has been affected by historic or current operations, provide a plan for actions to protect the public and the environment.*

CNSC Disposition of Comment 3 Response: CNSC staff requests the licensee provide the historical data the response is based on, including the sediment and water quality monitoring results, to the CNSC for review.

CNSC Comment 4. *Revise Ra-226 site-specific water and sediment quality criteria to use the 95th percentile dose rates for sessile organisms and the upper confidence level for mobile organisms for consistency with Clauses 7.3.3.1 and 7.3.3.2 of CSA N288.6. Site-specific concentration factors for benthos, fish and riparian wildlife should be used to support the derivation of the Ra-226 benchmarks.*

CNSC Disposition of Comment 4 Response: While clauses 7.3.3.1 and 7.3.3.2 pertain to organism exposure concentrations, the spirit of these clauses is to ensure adequate conservatism is incorporated within the assumptions used to assess the likelihood of effects to an ecosystem. CNSC staff accepts the screening criteria are adequately conservative to assess the radiological risks to biota for individual water and sediment results.

It is stated in the dose calculation sheets in attachment C that PC or BAF values in red were derived from lake measurements, presumably from the in lake measurements (boxes highlighted in blue). However, despite differing values in water concentrations and organism concentrations across lakes, BAF's for fish and plants remain unchanged for all lakes. It is expected these values would change from lake to lake, depending on the measured water concentrations and concentrations in fish and plants.

CNSC staff request an explanation be provided as to why the BAF's from water to fish and water to plants are identical across lakes as it is expected that the values would differ from lake to lake based on the different measurements of water, fish, and plant concentrations in each lake.

CNSC Comment 5. *Explain why radium-226 is not proposed to be measured in groundwater or pore waters at any of the TMAs. CNSC staff are of the opinion that the groundwater and pore water quality TOMP subprogram is limited and requires further justification – the conceptual groundwater model relies on TMA groundwater reporting to the surface and*

Comment 6. *Update the hydrogeological predictions and long-term radium (or other actinide) evolution and how this information is used to inform the cycle 5 study design (TOMP)*

CNSC Disposition of Comments 5 and 6 Responses: CNSC staff found the licensees' responses acceptable; CNSC staff have no further comments.

CNSC Comment 7. *Discontinue, as discussed, benthic invertebrate community monitoring at Elliot Lake under the SRWMP. CNSC staff notes that water quality monitoring at M-01 (the inlet to Elliot Lake) will continue to be conducted and concur that downstream monitoring in Elliot Lake will be reinstated should increase concentrations of mine-related substances be detected*

CNSC Comment 8. *Consider, to demonstrate lake recovery, taking sediment cores in all lakes including Elliot Lake, and focus on the top 10 cm and slice at 0.5 cm in the first centimeter and then every centimeter to a depth of 10 centimeters to provide evidence of recovery*

CNSC Disposition of Comments 7 and 8 Responses: CNSC staff found the licensees' response to be acceptable; CNSC staff have no further comments.

From: Heffner, Holly <holly.heffner@bhp.com>
Sent: December 16, 2019 9:27 AM
To: Stenson, Ron (CNSC/CCSN) <ron.stenson@canada.ca>; Purdon, Rob H. (ENDM) <Rob.H.Purdon@ontario.ca>; Fagan, Kelly-Anne (EC) <kelly-anne.fagan@canada.ca>; Crosson, Kirk (MECP) <Kirk.Crosson@ontario.ca>; ed.snucins@ontario.ca; jim.trottier@ontario.ca; Becker, Megan (MNRF) <Megan.Becker@ontario.ca>; pierre.lefebvre@ontario.ca; jerry.wedzicha@ontario.ca; Kim, Duck (EC) <duck.kim@canada.ca>; Alwarda, Ramina (EC) <ramina.alwarda@canada.ca>; Zhang, Henry (CNSC/CCSN) <henry.zhang@canada.ca>; Brown, Julie (CNSC/CCSN) <julie.brown@canada.ca>
Cc: Lambert, Tony <anthony.g.lambert@bhp.com>; Janet Lowe (JLowe@denisonenvironmental.com) <JLowe@denisonenvironmental.com>; Angie Corson Msc <acorson@denisonenvironmental.com>; Jess Tester <Jtester@minnow.ca>; Cynthia Russel <crussel@minnow.ca>; Paton, Ann <ann.paton@bhp.com>; Hewitt, David

<David.Hewitt@bhp.com>
Subject: Response to JRG Comments on the Cycle 5 Study Design for the SRWMP, SAMP and TOMP

Hello members of the Elliot Lake Joint Review Group (JRG),

On behalf of Denison Mines Incorporated and Rio Algom Limited, please see attached our responses to the comments received from the JRG on the Cycle 5 Study Design for the Serpent River Watershed Monitoring Program (SRWMP), Source Area Monitoring Program (SAMP) and Tailings Management Area Operational Monitoring Program (TOMP).

Please let us know if the responses to your comments are acceptable, or if you have any additional questions or concerns by the 31st of January 2020.

In addition, should you wish to discuss the responses as a group, please let me know and I would be happy to set up a conference call.

Kind Regards,

Holly Heffner

BHP
Holly Heffner
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Saskatoon, SK S7K 1L3 Canada
We work flexibly at BHP. I'm sending this message now because it suits me, but I don't expect that you will read, respond to or action it outside your regular hours.

Attachment #3

Water Quality Data

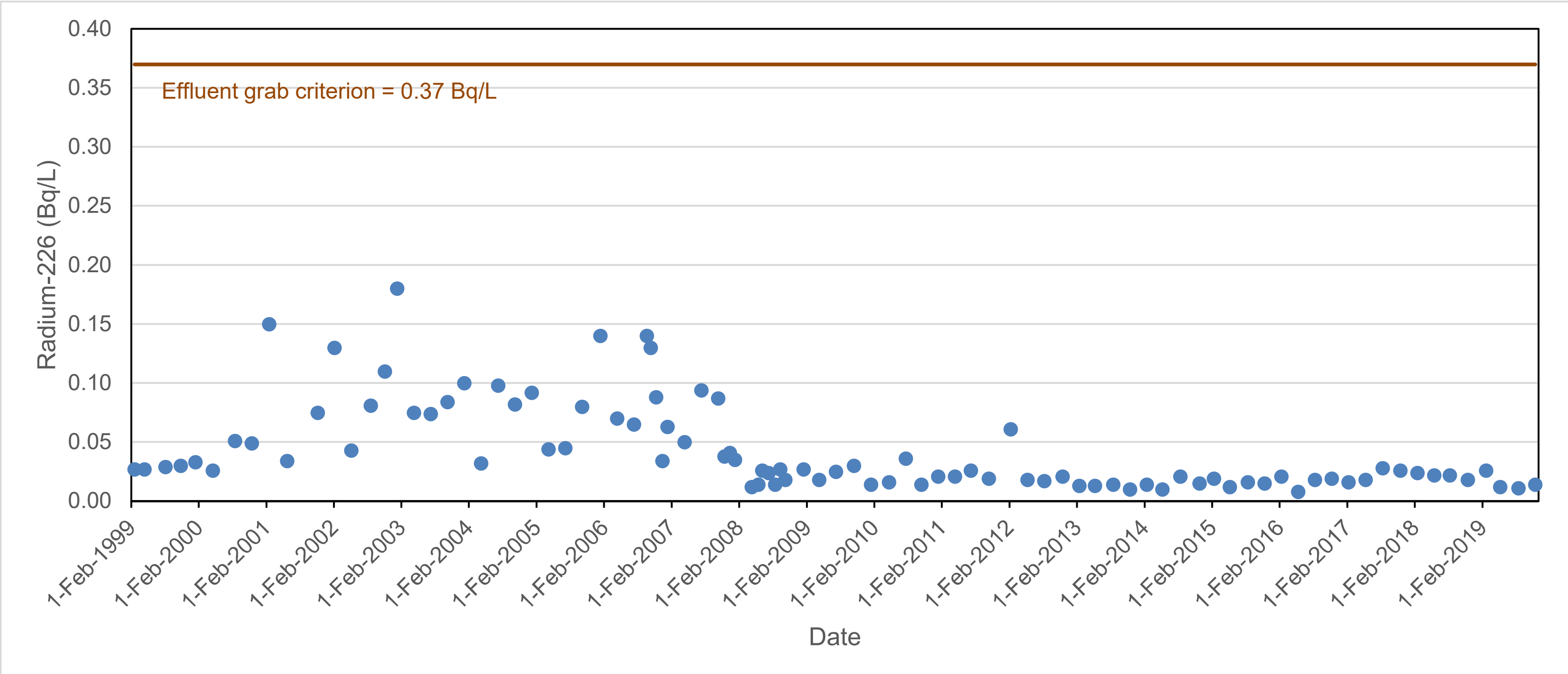

Figure C.1: Radium-226 concentrations in water at SAMP station LL-01 compared to effluent grab criterion, 1999 to 2019

Table C.1: Radium-226 concentrations in water at SAMP station LL-01, 1999 to 2019

Date Sampled	Radium-226 (Bq/L)
19-Feb-1999	0.027
14-Apr-1999	0.027
5-Aug-1999	0.029
26-Oct-1999	0.030
14-Jan-2000	0.033
17-Apr-2000	0.026
15-Aug-2000	0.051
14-Nov-2000	0.049
15-Feb-2001	0.150
24-May-2001	0.034
5-Nov-2001	0.075
4-Feb-2002	0.130
6-May-2002	0.043
19-Aug-2002	0.081
4-Nov-2002	0.110
8-Jan-2003	0.180
9-Apr-2003	0.075
9-Jul-2003	0.074
8-Oct-2003	0.084
7-Jan-2004	0.100
7-Apr-2004	0.032
7-Jul-2004	0.098
6-Oct-2004	0.082
5-Jan-2005	0.092
6-Apr-2005	0.044
6-Jul-2005	0.045
4-Oct-2005	0.080
12-Jan-2006	0.140
12-Apr-2006	0.070
12-Jul-2006	0.065
20-Sep-2006	0.140
11-Oct-2006	0.130
8-Nov-2006	0.088
13-Dec-2006	0.034
10-Jan-2007	0.063
11-Apr-2007	0.050
11-Jul-2007	0.094
10-Oct-2007	0.087
14-Nov-2007	0.038
12-Dec-2007	0.041
9-Jan-2008	0.035
9-Apr-2008	0.012
14-May-2008	0.014
4-Jun-2008	0.026
9-Jul-2008	0.024
13-Aug-2008	0.014
10-Sep-2008	0.027
8-Oct-2008	0.018
14-Jan-2009	0.027
8-Apr-2009	0.018
8-Jul-2009	0.025
14-Oct-2009	0.030
13-Jan-2010	0.014
21-Apr-2010	0.016
21-Jul-2010	0.036
13-Oct-2010	0.014
12-Jan-2011	0.021
13-Apr-2011	0.021
7-Jul-2011	0.026
12-Oct-2011	0.019
8-Feb-2012	0.061
9-May-2012	0.018
8-Aug-2012	0.017
14-Nov-2012	0.021
13-Feb-2013	0.013
8-May-2013	0.013
15-Aug-2013	0.014
14-Nov-2013	0.010
12-Feb-2014	0.014
7-May-2014	0.010
13-Aug-2014	0.021
24-Nov-2014	0.015
11-Feb-2015	0.019
7-May-2015	0.012
12-Aug-2015	0.016
11-Nov-2015	0.015
10-Feb-2016	0.021
11-May-2016	<0.008
10-Aug-2016	0.018
9-Nov-2016	0.019
7-Feb-2017	0.016
10-May-2017	0.018
10-Aug-2017	0.028
15-Nov-2017	0.026
14-Feb-2018	0.024
16-May-2018	0.022
8-Aug-2018	0.022
14-Nov-2018	0.018
20-Feb-2019	0.026
8-May-2019	0.012
15-Aug-2019	0.011
13-Nov-2019	0.014

Attachment #4

Reference Lake Sediment Quality Data

Table D.1: Lake Sediment Quality, SRWMP 2009 (Appendix Table E.30 of Minnow 2009)

	Parameter	Radium-226
	Units	Bq/kg
CNSC[a] Screening Value	LEL	600
	SEL	14,400
Rochester (RL)	1	100
	2	170
	3	140
	4	240
	5	120
	Mean	154
Semiwhite (SL)	1	160
	2	90
	3	270
	4	70
	5	180
	Mean	154
Dunlop (DL)	1	70
	2	70
	3	140
	4	50
	5	110
	Mean	88
Ten Mile (TML)	1	100
	2	60
	3	70
	4	50
	5	40
	Mean	64
Summers (SUL)	1	170
	2	110
	3	280
	4	140
	5	90
	Mean	158
	Reference Mean	124
	Standard Deviation	67

[a] Thompson *et al*., 2005.

Attachment #5

Minnow 2013:
Sediment Deposition Investigation

Determination of Deposition Rates Using Sediment Core Profiling and Sediment Traps in McCabe, Quirke, and Nordic Lakes, Elliot Lake, Ontario

Report Prepared For:
Denison Mines Inc. and
Rio Algom Limited
Elliot Lake, ON

Prepared By:
Minnow Environmental Inc.
Georgetown, ON

October 2013

Determination of Deposition Rates Using Sediment Core Profiling and Sediment Traps in McCabe, Quirke and Nordic Lakes, Elliot Lake, Ontario

Final Report

Prepared for:

Denison Mines Inc.,
Elliot Lake, Ontario
and
Rio Algom Limited
Elliot Lake, Ontario

Prepared by:

Minnow Environmental Inc.

for

Cheryl Wiramanaden, Ph.D.
Project Manager

Cynthia Russel, B.Sc.
Project Principal

October 2013

EXECUTIVE SUMMARY

Uranium mining was undertaken in the Elliot Lake area of northeastern Ontario for approximately forty years. The mines generally operated from the late 1950's to the mid 1960's and again from the early 1970's until the early 1990's when most of the mines closed. At the time of closure, Rio Algom Limited and Denison Mines Inc. evaluated their individual existing monitoring programs in terms of their relevance to current and closure conditions. One outcome from this evaluation was the development of the Serpent River Watershed Monitoring Program (SRWMP) which provided a monitoring program for receiving environments for all of the mine operations in one comprehensive, harmonized study design. The SRWMP was specifically designed to assess the recovery of the receiving environment following the implementation of the decommissioning plans. One premise for the design of the SRWMP was that monitoring should occur at a frequency relative to the ability of the receiving environment to change or improve. In the case of sediment quality and the health of the benthic invertebrate communities, the expected rate of change in sediment quality should be used as the basis for monitoring frequency.

In order to detect a change in sediment quality a reasonable monitoring frequency must be determined. Sediment deposition rate can be used to indicate the time necessary for sufficient fresh sediment (with improved sediment quality) to accumulate, such that a change in sediment quality and benthic invertebrate communities would be observable. The sediment deposition rate in the deepest basins of Quirke Lake, the largest lake in the SRWMP, was investigated in 1984 (McKee et al. 1987) and found a mining-based deposition rate for Quirke Lake of 1.4 to 2.6 mm/yr (McKee et al. 1987). An average 2 mm/yr deposition rate would therefore result in a deposition of 1 cm every five years. Thus, the frequency of monitoring for the initial SRWMP was established at once every five years to capture the expected rate of change in sediment and benthic invertebrate communities (i.e., the top 1 cm of sediment sampled every five years).

The SRWMP was implemented on a five year interval starting in 1999, with two subsequent cycles of monitoring in 2004 and 2009. Since 1999, results from the SRWMP have indicated a substantial improvement in water quality (Minnow 2011), but there has generally been a lack of measurable improvement in sediment quality. Therefore this study was designed to investigate if the original basis for the monitoring frequency (*i.e.,* sediment deposition rate) was sufficiently accurate for the current closed mine conditions. The present study was designed to determine current deposition rates under decommissioned conditions in order to re-evaluate the SRWMP frequency moving forward. Three near-field receiving lakes that were historically the most influenced by

mining activities (McCabe Lake, Quirke Lake, and Nordic Lake) were selected for the study, as they represent a range of lake productivity and likely deposition rates.

The sediment deposition rates were determined using two approaches: sediment traps to assess the current sedimentation rate and sediment quality, and sediment core profiling to investigate historical sediment quality and to determine, using sediment chemistry, how deposition rates changed over time relative to the historical mining influence within the lake.

Sediment traps were located at lake stations 15 m in depth in order to reflect previous SRWMP sediment and benthic invertebrate community sampling stations. The quality of currently depositing sediment was then compared to sediment quality from SRWMP sediment stations, and the amount of material in the sediment traps was used to calculate a sediment deposition rate at the 15 m stations. In contrast, sediment cores were collected in the deepest basin of each lake as these areas represented the most profundal areas of the lake and thus would provide the most conservative deposition rates. In addition, the operational history of each of the mines was investigated to assist in the interpretation of the sediment core profiles.

The McCabe Lake study sediment traps showed that currently depositing sediment has generally improved in quality compared to the 2009 sediment quality data in the same locations from the SRWMP. The deposition rate determined by the sediment traps ranged 0.40 to 0.44 mm/yr. These sediment deposition rates were consistent throughout the lake, indicating low variability and good agreement between benthic invertebrate community sampling stations.

The deep-basin sediment core was investigated in terms of establishing a timeline for the history of mining activity for the lake, and also to establish sediment recovery. The timeline for the McCabe Lake core was based on non-migratory analytes that included ^{137}Cs, and titanium, as well as the use of analytes associated with mining such as barium, and sulphur. Analytes associated with mining were combined with knowledge of the historical mine activities (including the use of water quality and effluent loadings to the lake) to help establish time markers along the core profile. The deposition rate for the current (non-mining) period was approximately 0.6 mm/yr. This slightly higher rate compared to the sediment traps is consistent with the core being taken from the more depositional location in the lake. Therefore these results show that it would take 16.5 years for 1 cm of sediment to accumulate in the deepest part of McCabe Lake, while at the SRWMP benthic invertebrate stations it would take 22 years.

The Quirke Lake study investigated sediment deposition in the deepest part of the lake at 99.5 m. The lake has significant public access and boating on it, and therefore sediment traps were not deployed (in case of disturbance during the deployment period). The deep-basin core used the non-migratory analytes lead and aluminum to help establish a timeline, along with iron, a strong marker for the mining signature. In addition, archived data from a survey in 1984 allowed for the comparison of metals profiles (Beak 1985), as well as pre- and during mining deposition rates (0.31 mm/yr and 1.6 mm/yr respectively) established for the lake from the same survey (McKee et al. 1987). In 1984 the pre-mining deposition rate was determined using non-migratory pollen and diatomaceous shells to establish a timeline. The post-mining deposition rate derived for the present study core was 0.3 mm/yr, which is in agreement with the pre-mining deposition rate derived in the previous study of 0.31 mm/yr (McKee et al. 1987). The deepest part of the lake would provide a conservative estimate for deposition rates at the much shallower 15-m SRWMP benthic invertebrate stations. Based on the deep-basin deposition rate it would take 33 years to accumulate 1 cm of sediment.

Nordic Lake was considered to be the most productive of the three study lakes. Sediment traps were deployed at three of the SRWMP 15-m benthic invertebrate monitoring stations over the summer period of 2012, and hidden from sight to prevent any disturbance due to public access to the lake. Currently depositing sediment trap material was also generally improved compared to the top 1 cm of sediment collected during the 2009 SRWMP.

Sediment trap deposition rates were somewhat varied, two sediment trap stations showed lower deposition rates of 0.55 and 0.67 mm/yr, than the most northerly sediment trap station deposition rate of 1.06 mm/yr. The higher deposition rate at this station was attributed to the closer proximity of the station to the predominant inflow to the lake (which also contains treated effluent discharge from the Nordic and Lacnor TMAs). Although varied, these deposition rates were comparable to McCabe and Quirke Lake deposition rates, consistent with Nordic Lake being a more productive lake.

The Nordic Lake deep-basin core approximate timeline was based on the non-migratory analytes ^{137}Cs, ^{214}Pb, stable lead and barium that provided a current deposition rate estimate of 0.74 mm/yr. This is consistent with the other lakes and with the sediment trap deposition rates collected at the Nordic Lake SRWMP benthic invertebrate monitoring stations. A deposition rate of 0.74 mm/yr would mean that it would take 13.5 years to accumulate 1 cm of sediment in the deep-basin. The deposition rates at the benthic invertebrate monitoring stations also indicated that it would take between 10 and 18 years to accumulate 1 cm of sediment at the actual monitoring locations.

The sediment deposition rates at the benthic invertebrate monitoring stations for the SRWMP indicated that even at the most rapidly depositing lake (Nordic Lake) it would take over ten years to accumulate 1 cm of sediment. This means that the frequency of monitoring in the SRWMP (i.e., five years) is too great to allow for significant improvement in benthic invertebrate communities and in sediment quality to be detected/measured.

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1.0 INTRODUCTION

1.1 Project Background

Uranium mining was undertaken in the Elliot Lake area of northeastern Ontario for approximately forty years. The mines generally operated from the late 1950's to the mid 1960's and again from the early 1970's until the early 1990's when most of the mines ceased to operate. At the time of closure, Rio Algom Limited (Rio Algom) and Denison Mines Inc. (Denison) evaluated their individual existing monitoring programs in terms of their relevance to current and closure conditions. One outcome from this evaluation was the development of the Serpent River Watershed Monitoring Program (SRWMP) which provided a monitoring program for receiving environments for all of the mine operations in one comprehensive, harmonized study design. The SRWMP was specifically designed to assess the recovery of the receiving environment following the implementation of the decommissioning plans. One premise for the design of the SRWMP was that monitoring should occur at a frequency relative to the ability of the receiving environment to change or improve. In the case of sediment quality and the health of the benthic invertebrate communities, the expected rate change in sediment quality should be used as the basis for monitoring frequency.

In order to detect a change in sediment quality a reasonable monitoring frequency must be determined. Sediment deposition rate can be used to indicate the time necessary for sufficient fresh sediment (with improved sediment quality) to accumulate, such that a change in sediment quality and the benthic invertebrate community would be observable. The sediment deposition rate in the deepest basins of Quirke Lake, the largest lake in the SRWMP, was investigated in 1984 (McKee *et al.* 1987). Sediment deposition rates were determined based on sediment core profiles of pollen and diatom shells (indicative of pH changes in the lake). In 1984, mines were still operating, and therefore the deposition rates determined were likely higher than natural rates for the lake. The mining-based deposition rate for Quirke Lake was 1.4 to 2.6 mm/yr (McKee *et al.* 1987). The average 2 mm/yr deposition rate would therefore result in a deposition of 1 cm every five years. Thus, the frequency of monitoring for the initial SRWMP was established at once every five years to capture the expected rate of change in sediment and benthic invertebrate communities (*i.e.,* the top 1 cm of sediment sampled every five years).

The SRWMP was implemented on a five year interval starting in 1999, with two subsequent cycles of monitoring in 2004 and 2009. Since 1999, results from the SRWMP have indicated a substantial improvement in water quality (Minnow 2011), and that fish tissue concentrations were well below the conservative benchmarks for human consumption (Minnow 2005, 2011). While water quality has improved dramatically there has been a general lack of measurable improvement in sediment quality. Some improvement in the health of the benthic invertebrate communities has been observed since 1999 but consistent with the lack of change in sediment, the changes have been modest relative to water quality improvement. Therefore this study was designed to investigate if the original basis for the monitoring frequency (*i.e.,* sediment deposition rate) was sufficiently accurate for the current closed mine conditions. The present study was designed to determine current deposition rates under decommissioned conditions in order to re-evaluate the SRWMP frequency moving forward. Three near-field receiving lakes that were historically the most influenced by mining activities (McCabe Lake, Quirke Lake, and Nordic Lake) were selected for the study, as they represent a range of lake productivity and likely deposition rates.

1.2 Approach

The sediment deposition rates were determined using two approaches: sediment traps to assess the current sedimentation rate and sediment quality, and sediment core profiling to investigate historical sediment quality and to determine, using sediment chemistry, how deposition rates have changed over time relative to the historical mining influence within the lake.

Sediment traps were located at lake station 15 m in depth in order to reflect previous SRWMP sediment and benthic invertebrate community sampling stations. The quality of currently depositing sediment was then compared to sediment quality previously measured at SRWMP sediment stations, and the amount of material in the sediment traps was used to calculate a sediment deposition rate at the 15 m stations. In contrast, sediment cores were collected in the deepest basin of each lake as these areas represented the most profundal areas of the lake and thus would provide the most conservative deposition rates.

1.3 Objectives

The study investigated three primary objectives:

(1) to determine the current (decommissioned) deposition rates, using sediment traps,

(2) to determine the quality of currently depositing sediment using sediment trap material, and

(3) to determine historical to current deposition rates using sediment core chemical profiles.

1.4 Report Organization

Methods used for sample collection, laboratory analyses and data analyses are presented in Section 2.0. Historical background of the three receiving lakes is summarized in Section 3.0. Results and discussion of the sediment trap and sediment core depth profiles are presented for each lake in Section 4.0. Section 5.0 provides a summary of results, with conclusions in Section 6.0. References cited throughout the document are provided in Section 7.0.

2.0 METHODS

The field program for this study took place over two field seasons (2011 and 2012). Two field excursions were conducted each year to allow for sediment trap deployment and retrieval as well as coring. Water collection and other supporting information were collected opportunistically during either the deployment or retrieval excursion. Deployment and retrieval of sediment traps occurred in May and October respectively. Samples from McCabe Lake were collected in 2011 (Figure 2.1), and samples from Quirke Lake (Figure 2.2) and Nordic Lake (Figure 2.3) were collected in 2012. Sediment traps were deployed in McCabe Lake and Nordic Lake only, while deep-basin cores were collected from all three lakes.

2.1 Water

In each sampling year, water, temperature, specific conductivity, dissolved oxygen, and pH were measured *in situ* along a depth profile in 1 m intervals using a YSI multiprobe, to identify the location of the thermocline in each study lake (*i.e.*, McCabe Lake in 2011, and Nordic Lake and Quirke Lake in 2012). In addition, the same *in situ* variables were measured at each sediment trap station at the time of deployment and retrieval, at 30 cm above the sediment-water interface. This was done to determine the redox status of the water at the location of the sediment traps.

Water samples were taken from each lake from 30 cm above the sediment-water interface, except in Quirke Lake where water was collected at 30 m, for analysis of total metals and total ^{226}Ra. The water was collected using a van Dorn sampler during the deployment period. Water was poured directly into pre-cleaned high density polyethylene bottles and preserved to a final concentration of 0.25 % nitric acid. The bottles were filled with no air space and stored in coolers on ice packs until the samples could be refrigerated later the same day. Water samples were sent by overnight courier in coolers (with ice packs) to the Saskatchewan Research Council Analytical Laboratories (SRC) for analysis.

2.2 Deep-basin Core Collection

Sediment cores were collected from McCabe Lake in 2011 and from Quirke Lake and Nordic Lake in 2012. The cores were taken at the deepest basin of each lake, representative of the most profundal area. The deepest part of the lake was located using bathymetry maps and a depth sounder. Once at the station, the location was recorded using a GPS. The core was collected using a 4” diameter Tech Ops corer to which

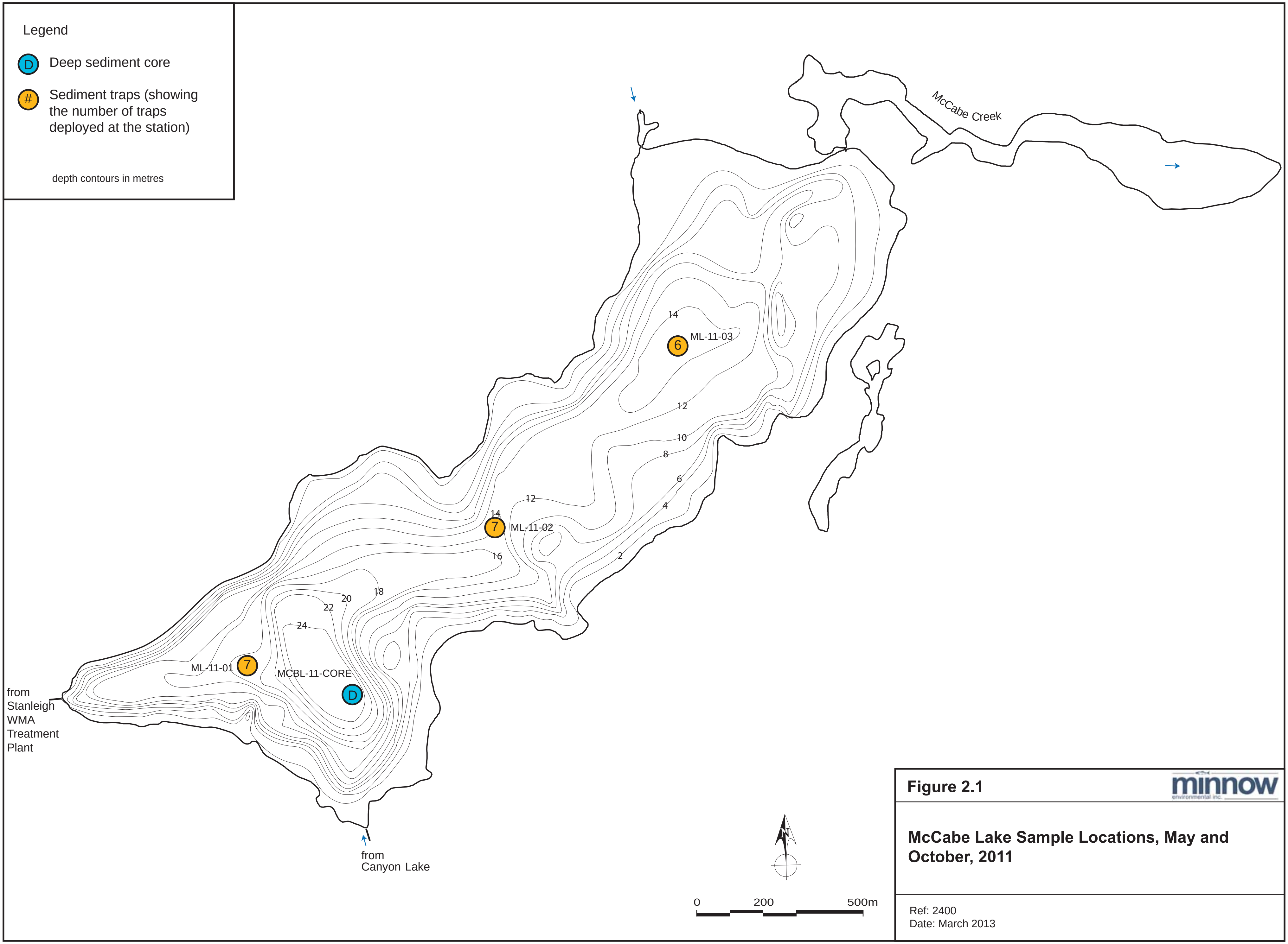
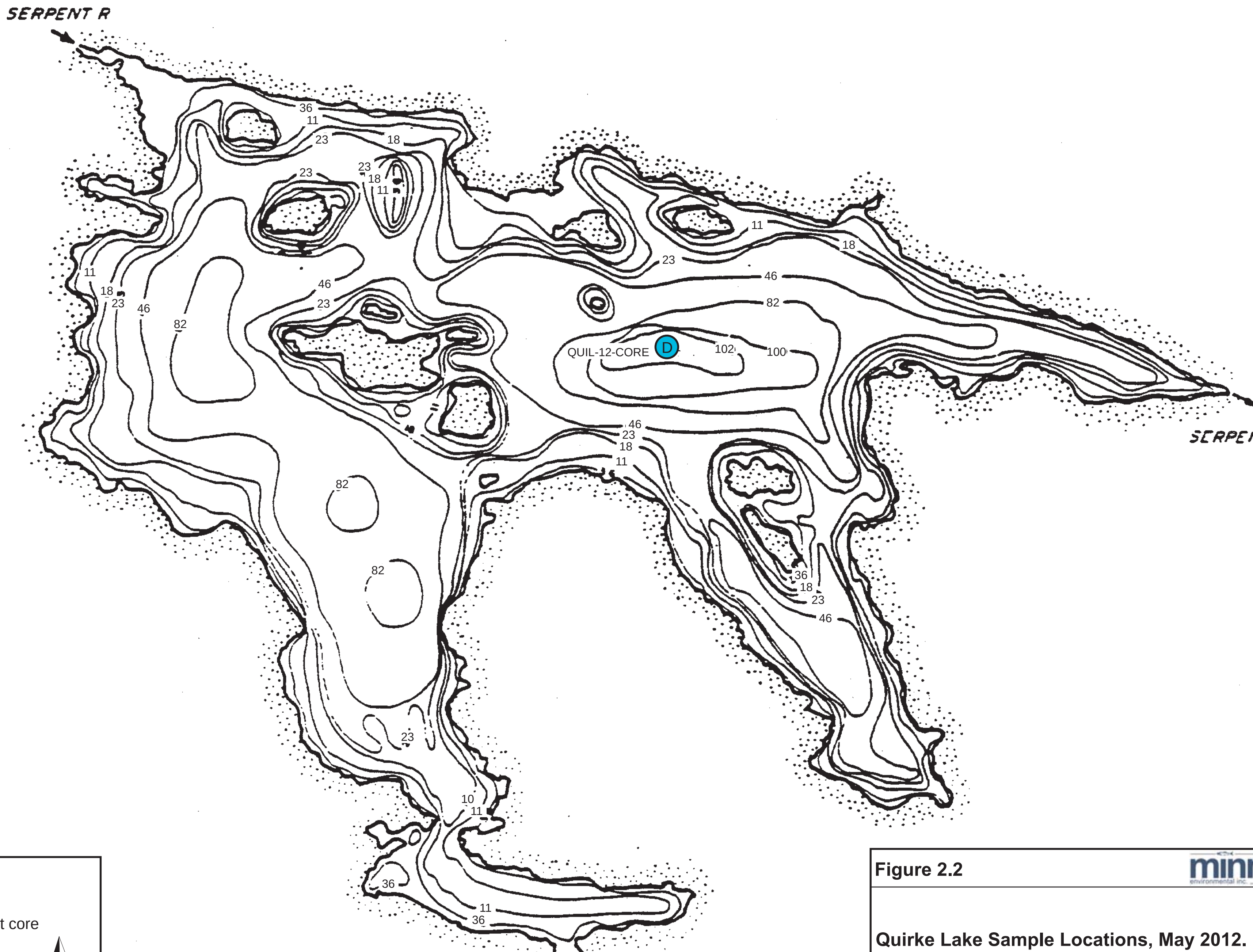


Figure 2.1

minnow environmental inc.

McCabe Lake Sample Locations, May and October, 2011

Ref: 2400
Date: March 2013



Legend

Deep sediment core

0 400 m 1 km

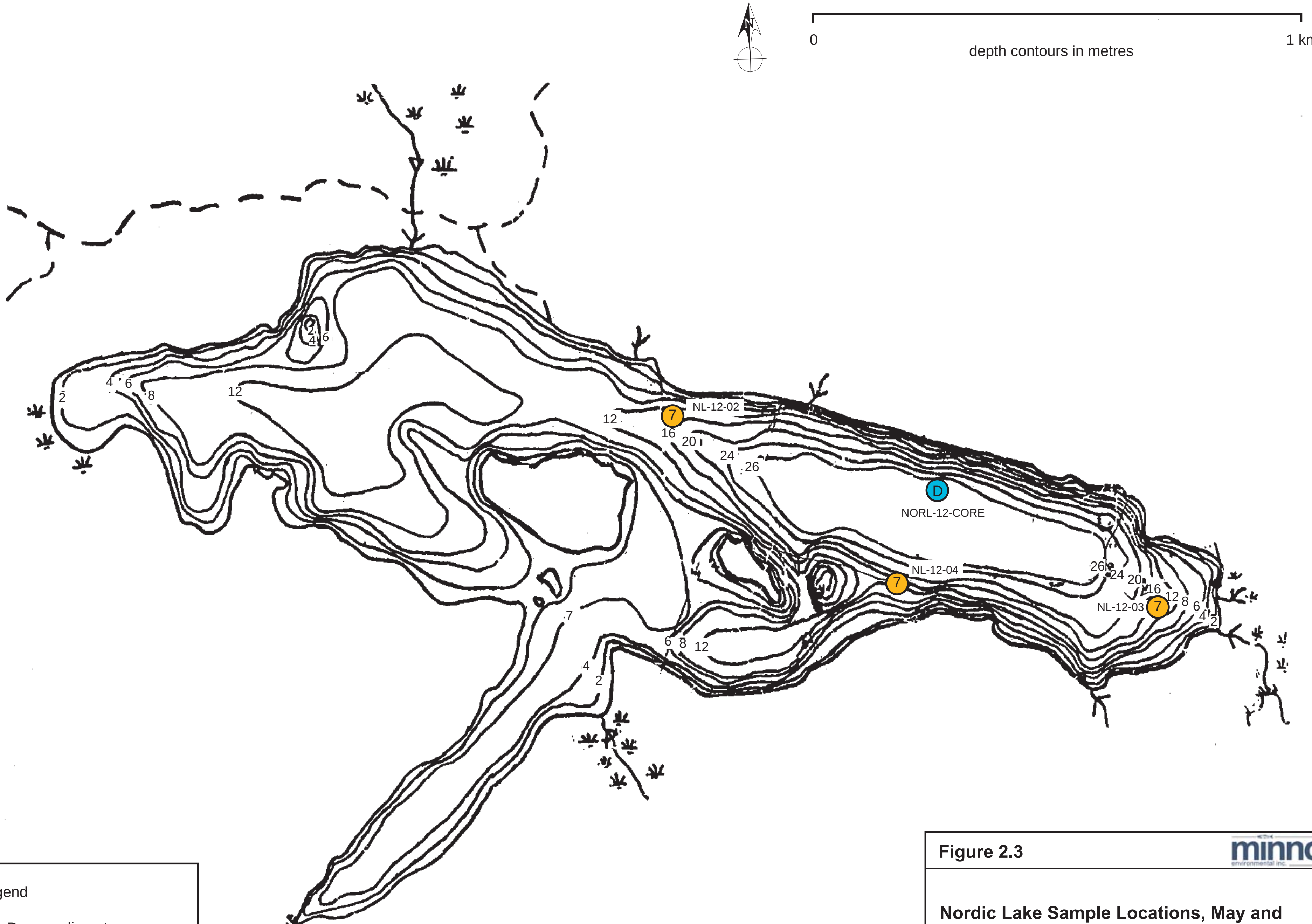
depth contours in metres

Figure 2.2

minnow environmental inc.

Quirke Lake Sample Locations, May 2012.

Ref: 2400
Date: March 2013



Legend

D Deep sediment core

Sediment traps (showing the number of traps deployed at the station)

Figure 2.3

minnow environmental inc.

Nordic Lake Sample Locations, May and October, 2012.

Ref: 2400
Date: March 2013

additional weights had been added (5, 10, or 15 kg) to ensure sufficiently deep penetration into the sediment. The core was lifted gently from the sediment to the water surface and was consistently held upright in order to prevent shifting of material in the surface layers of the core. Provided the core was of sufficient length (based on the predicted depth necessary to reach background concentrations), and the sediment-water interface appeared flat and undisturbed, the core was accepted and taken back to shore (slowly) for inspection and extruding. At the shoreline, the core was measured, and photos and notes were taken, identifying any observable horizons. The core was then mounted on the extruding apparatus (constructed by Machine All Inc.), and using a pressure of no greater than 40 psi, water was used to slowly move the sediment up the core tube in 6 mm increments. Each sediment section was collected using a collar (marked at 6 mm) and a box slicer. The section was placed into a re-sealable plastic bag, and all material from the collar and box slicer was also placed into the bag using a scraper. The scraper, collar and box slicer were cleaned between sections using site water. Each section was then placed in a cooler with ice packs until the samples could be frozen later the same day.

Several variables were analyzed, and samples were sent for analysis in a step-wise decision making process. Firstly, frozen sediment sections were sent overnight in a cooler with ice packs to Flett Research Ltd, Winnipeg. The selected sections were analyzed for ^{137}Cs activity, (a non-destructive technique) and bulk density. Bulk density was analyzed here as the dry weight divided by the wet volume of the sediment section. ^{137}Cs is an artificial radionuclide that is globally present in environmental samples due to atmospheric nuclear testing which occurred primarily during 1954-1968 (Matisoff and Whiting 2011). Subsequently the highest fallout activity of ^{137}Cs occurred in 1963 with a smaller peak in 1958 (Klaminder *et al.* 2012). As a result of these time markers, ^{137}Cs has been used extensively in sedimentation based studies since the late 1950's when ^{137}Cs was first detected in atmospheric fallout (Appleby 2002, Matisoff and Whiting 2011).

In a water body ^{137}Cs may come from atmospheric fallout or from the watershed; the additional watershed source would lead to a broadening of a peak associated with 1958 or 1963 through time. ^{137}Cs is also known to diffuse down the core, and this can also complicate ^{137}Cs data interpretation. Therefore, ^{137}Cs data may not necessarily result in a clear peak, but on the basis of several considerations (discussed for each lake), dates can be assigned to the data. With these factors in mind, ^{137}Cs data is still a widely used technique that can add information to the dating of a sediment core.

Once a date had been identified using ^{137}Cs (*i.e.,* between 1954 and 1968), additional sections of the core that span a range in time from before mining operations to current were sent to the Saskatchewan Research Council Analytical Laboratories for metal concentration determination, additional bulk density analyses, sulphur analysis, and ^{226}Ra analysis for a few top sections for McCabe Lake only.

A sediment core has several parameters that should inter-relate, such that concentration profiles of different analytes should be consistent with each other if they have the same source, and provided they do not react differently within the sediment environment.

Changes in relative metal concentrations along a depth profile were used to indicate changes in mining influence on the lake, and therefore provide additional markers in time. With the use of historical reports and knowledge from Rio Algom and Denison Mines, changes in mining practices over time helped to pinpoint additional time markers in the metal profiles of the core. In this way, each core was further separated into eras and deposition rates were calculated for each era; results indicated the change in deposition rate from historical to current. Sediment core-based deposition rates were calculated using the distance along the core (mm) between time markers divided by the estimated time passed (years).

One technique that was used to help differentiate natural variation in inorganic deposition from inorganic deposition associated with mining activity was the normalization of metal concentration data to titanium. This technique can be used provided titanium is not associated with mining activity. In contrast to other metals, titanium is biologically inert and does not undergo diagenetic reactions, and so is typically indicative of lithogenic deposition, (*i.e.,* natural inorganic, not biological, deposition; Boes *et al.* 2011). Titanium concentrations can therefore be used to normalize other metal concentrations so that variation due to natural inorganic deposition can be "flattened out" (Boes *et al.* 2011). When normalized to titanium, metals that are associated with natural inorganic deposition only should appear to flatten because there is no relative difference to titanium (*i.e.,* titanium and that element have the same source; Audry *et al.* 2004). Whereas those metals that are associated with mining, when normalized to titanium, will still show profiles that relate to mining activity, without variation due to natural inorganic deposition (Audry *et al.* 2004).

2.3 Sediment Traps

Sediment traps were deployed in McCabe Lake and Nordic Lake in May 2011 and 2012 respectively. Each lake had three stations with 6 to 7 traps deployed at each station.

Station locations were at 15 m depth to reflect benthic invertebrate community stations from previous SRWMP cycles. Sediment traps were constructed in-house and consisted of a 23 cm diameter plastic funnel that had been plugged using plastic stoppers. The plastic funnel was secured to a small pail that contained a 2 kg weight in a re-sealable plastic bag. The whole device was placed on a tray so that the traps would remain upright for the duration of the deployment period (Photo 1, Appendix B). In McCabe Lake, traps were attached to a 15 m line with a float and slowly lowered to the sediment surface. In Nordic Lake, traps were deployed and linked to an anchor such that the location of the traps was not visible from the water surface as this lake has greater public access. When installed, the opening of each trap was approximately 26 cm above the sediment-water interface.

Sediment traps were retrieved in October 2011 and 2012 in McCabe Lake and Nordic Lake, respectively. Each trap was retrieved by firstly releasing a lightly weighted lid down the line of the trap, this ensured that during retrieval sediment was not re-suspended or lost from the trap. The trap was then slowly retrieved and carefully brought into the boat minimizing the loss of water from the trap (Photo 2, Appendix B). A photo was taken to document if the sediment trap had undergone any disturbance during retrieval (e.g., Photos 3 and 4, Appendix B). The depth of sediment material collected in the funnel was then measured. The funnel (still containing sediment and water) was then transferred to and steadied in a large clean pail before it was brought back to the shoreline. All water in the funnel was considered part of the sample as it likely contained some fine material that may have re-suspended during retrieval. Water was separated from the sediment by slow and careful decant using plastic containers and plastic transfer pipettes. All sediment in each funnel was transferred to a clean wide mouthed plastic container (high density polyethylene), and kept in coolers with ice packs until it could be frozen later each day. All sediment traps from one station were combined as one sample such that there were three sediment trap samples per lake.

Water from the sediment traps was transferred back to Minnow Environmental in sealed clean pails where it was filtered using 0.45 μm cellulose acetate filters. Water from Nordic Lake was pre-filtered using 3.0 μm cellulose acetate filters, but ultimately all sediment trap water was filtered using the 0.45 μm filters. The used filters were transferred to clean plastic petri dishes (polystyrene) and frozen.

Filters from each station were combined and sent along with the combined sediment for each station to Saskatchewan Research Council Analytical Laboratories by overnight courier in coolers with ice packs for the determination of dry weight amount, metals concentration including ^{226}Ra, and bulk density where there was sufficient material.

In order to determine a deposition rate, the dry weight of the material from the combined sediment traps was combined with the dry weight of material on the filters. The number and type of filters was recorded so that the average weight of a blank filter (based on 20 filters) could be used to correct for the filter weight contribution.

The sedimentation rate was calculated according to (Kemp *et al.* 1974):

$$\textit{Sedimentation rate}\ \left(gm^{-2}yr^{-1}\right) = \frac{\textit{dry weight (g)}}{\textit{total area}\ (m^{2})} \div \textit{deployment time period (yr)} \quad (1)$$

The uncompacted thickness of sediment accumulation per year was the calculated (Kemp *et al.* 1974):

$$\textit{Annual accumulation thickness}\ \left(myr^{-1}\right) = \frac{\textit{Sedimentation rate}\ (gm^{-2}yr^{-1})}{\textit{Dry bulk density}\ (gm^{-3})} \quad (2)$$

The calculation of annual accumulation thickness assumes no seasonal changes in accumulation rate.

The quality of material from the sediment traps was determined in a similar way; the chemistry data for material from the traps was combined with the chemistry data of material from the filters. However, the filters were digested and analyzed with the filter material; this was corrected for by subtracting the contribution of metals from blank filters (blank filters were pre-analyzed). The metal concentration in a blank 0.45 and 3.0 µm filter was determined separately so that any contamination associated with the filters could be subtracted from the final metal concentrations. Dry weight amounts of each metal from the sediment trap material and the filter material was then combined to determine the sediment quality of the bulk sample for each station.

3.0 HISTORICAL BACKGROUND OF LAKES

3.1 McCabe Lake

McCabe Lake is a two-basin lake located directly downstream of the Stanleigh tailing management area (TMA). The Stanleigh TMA received tailings from the Milliken and Stanleigh mines which both started operation in 1958. Operation of the Stanleigh mill ceased in 1960 and the Milliken mill ceased in 1964 (Table 3.1; Rio Algom 2000). However, in 1983 the Stanleigh mine was re-opened and continued operation until 1996. Effluent from the Stanleigh TMA was first treated with barium and lime additions in 1973. However, the effluent was not treated consistently (with barium) until 1983, following the restart of operations and construction of an effluent treatment plant built at the TMA outlet in 1981 (Minnow 2011). The effluent treatment plant consisted of a reagent addition building and a complex sand filtration plant for treatment solids removal.

As part of the Stanleigh Mine decommissioning, dams around the perimeter of the TMA were raised to allow flooding of the TMA from 1998 to 2002. Therefore, no effluent was released into McCabe Lake during this time. In 2007, the effluent treatment plant was replaced with a simpler system where effluent is treated with barium chloride for radium removal and lime for pH control. Treatment solids are removed using a settling pond which is located downstream of the effluent treatment plant; no effluent was released in the fall of 2007 during this changeover.

3.2 Quirke Lake

Quirke Lake is the largest lake in the Serpent River watershed and has two deep basins (>80 m depth). The lake is the direct receiving environment for several decommissioned TMAs: Quirke, Denison, Panel, and Stanrock, as well as the Spanish-American and Can-Met mines. Of these sources, the Quirke, Denison, and Panel TMAs represented the largest load contributions to the lake. Mining at the Quirke mine (Quirke I) started in 1953, and continued until 1961, then restarted in 1968 and until 1971. Quirke mine II started production in 1967 and ran until 1990 when it was shut down. The Quirke TMA has been operating since 1956 (Rio Algom 1995) and was flooded after decommissioning in 1990 (Minnow 2009). The Denison mine was in production from 1957 to 1992; production was increased in 1977 by 30%, and then doubled in 1982 (Table 3.1; SENES 1998). Denison Mine decommissioning took place between 1992 and 1998. The Denison TMA has been operating since 1957, and was flooded in 1997 during decommissioning. The Panel mine complex was in production from 1958 to 1961, which was followed by an expansion period

Table 3.1: The historical daily production of mills that influenced McCabe, Quirke, and Nordic Lakes.

Receiving Lake	Mill	TMA	Era	Mill Production (tons per day)	Reference
McCabe	Miliken	Stanleigh	1957 - 1964	2,720	Rio Algom 2000
	Stanleigh	Stanleigh	1957 - 1960	3,000	
	Stanleigh	Stanleigh	1983 - 1996	4,550	
Quirke	Quirke	Quirke I	1956 - 1961	2,700	Rio Algom 1995
		Quirke II	1967 - 1990	6,400	
	Denison	Denison	1957 - 1977	5,000	SENES 1998
			1977 - 1982	6,350	
			1982 - 1992	13,600	
	Panel	Panel	1958 - 1961	2,800	Rio Algom 1995
			1979 - 1990	3,000	
Nordic	Lacnor	Lacnor	1957 - 1960	2,720	Rio Algom 2000
	Nordic	Nordic Main	1957 - 1968	3,000	

(1973 to 1979) and further production from 1979 to 1990 (Rio Algom 1995). The Panel TMA consists of two basins; the south basin flooded in 1978 and the main basin flooded in 1994. The Panel TMA is also located in closest proximity to the eastern basin of Quirke Lake where the sediment core was collected (Figure 3.1). Compared to Panel, the Denison and Quirke Mines, which discharged into the Serpent River upstream of Quirke Lake, likely had less influence on the eastern basin of the lake because of a group of islands that separate the eastern and western basins of Quirke Lake. Therefore, the Panel Mine probably had a dominating influence on the sediments where the 2012 core was collected.

Treatment of all TMA effluent was predominantly with lime for pH control. Barium chloride was introduced to treat for ^{226}Ra in 1967 at the Quirke TMA, at the Denison TMA in 1963 (SENES 1998) and at the Panel TMA in 1974 (Minnow 2009).

3.3 Nordic Lake

Nordic Lake is a small-sized lake with two basins separated by an island (Figure 2.3) and receives treated effluent from the Lacnor and Nordic TMAs. Currently, the vegetated Lacnor tailings have a spillway for effluent that flows into the vegetated main basin of the Nordic TMA. Seepage and run-off from the Nordic main TMA is directed into an effluent collection ditch and seepage from the western arm of the TMA is also directed into a series of ditches which lead to the effluent treatment plant (Figure 3.2). Lime is added at the treatment plant to control pH and to enhance metal removal by precipitation. Treated water then flows through Buckles Creek into Nordic Lake.

The Nordic TMA operated from 1957 to 1968, and the tailings were re-vegetated in the 1970s. The Lacnor TMA operated from 1957 to 1960 with the tailings re-vegetated in 1971 (Minnow 2011). Historically, barium chloride was used in Buckles Creek from 1965 to 1975 to help remove ^{226}Ra from the effluent which discharged from the northeast corner of the Nordic Main Basin (TMA) towards Nordic Lake (MacLaren 1978). In 1971, an effluent treatment plant started operating, treating water seepage and run-off from the TMAs. The treatment plant was located at the east end of the Nordic Settling Pond (Figure 3.2) treating with lime and barium chloride from 1971 until at least 1978 (MacLaren 1979). More recently, ^{226}Ra has been removed through its co-precipitation with iron (iron is removed at the effluent treatment plant with the addition of lime). Historical barium-radium treatment solids were settled out into Beaver Pond which was located upstream of Buckles Wetland, and historical treatment sludge also went in to Buckles Wetland. In 1974, the treatment solids were covered with fill and Buckles

Figure 3.1

minnow environmental inc.

Quirke Lake Sub-watershed Mine Sources

Ref: 2400
Date: March 2013

Source: Elliot Lake Research Field Station

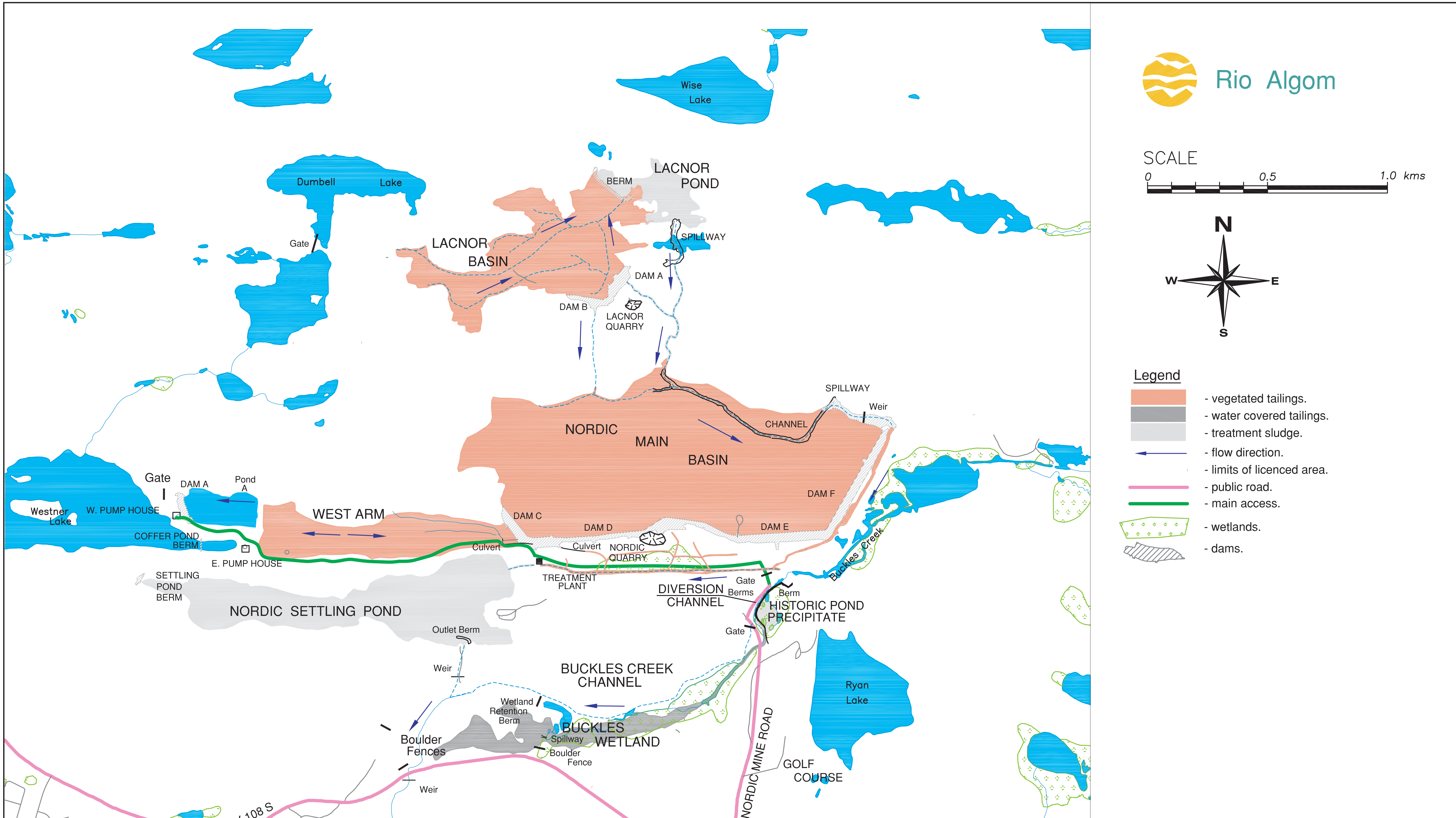


Figure 3.2 PAUL H. TORRANCE SURVEYING LTD. GEOMATICS SERVICES minnow environmental inc.

Lacnor and Nordic Tailings Management Areas

Ref: 2400
Date: March 2013

channel was diverted to flow around these historical tailings. However, these diversions were not maintained, and beavers were allowed to inhabit the area. This lead to seasonal flushing of the wetland, likely allowing some treatment sludge contaminants to flow into Nordic Lake (Golder 2005). Therefore, in 2005 the Buckles Creek diversion was re-instated and maintained, decreasing the loadings into Nordic Lake from this source.

4.0 RESULTS

As described in the study objectives (Section 1.3), sediment traps and deep-basin sediment cores were collected to achieve the goals of the study. The quality and deposition rate of currently depositing sediments were studied using sediment traps that had been deployed at the SRWMP benthic invertebrate community stations. Historical to current changes in sediment chemistry and deposition rate were investigated using deep-basin sediment core profiles. For each lake, the datasets (*i.e.,* sediment core metal profiles and sediment trap data) are related, and therefore the data interpretation is discussed on a lake-by-lake basis. Summaries of sediment core concentration profile data and supporting data are provided in Appendix D.

4.1 McCabe Lake

4.1.1 McCabe Lake Sediment Trap Chemistry

Sediment traps were deployed at McCabe Lake on 11th May, 2011 and were retrieved on the 12th to 15th October, 2011. Although the deployed days for specific traps were different, this was corrected for when calculating the deposition rate. The water in the traps was combined for each station, as was the sediment material, ultimately providing one replicate for each station.

Compared to McCabe Lake SRWMP Cycle 3 sediment quality, sediment trap material generally had lower concentrations (Table 4.1). Only barium concentrations have increased since 2009. All other metals showed a decrease or no change (nickel). Increased barium in sediment is likely due to increased use of barium for ^{226}Ra treatment at the Stanleigh effluent treatment plant (Minnow 2011). Therefore in general, an improvement in the quality of currently depositing sediment can be observed (14 to 57% decrease; Table 4.1).

4.1.2 McCabe Lake Sediment Trap Deposition Rates

The dry weight amount of sediment collected from each trap was combined within a station. This dry weight was used, in combination with the deployment period, as well as the diameter of the mouth of the trap, to calculate current deposition rates at the SRWMP Cycle 3 benthic invertebrate community stations. Current deposition rates for un-compacted surface material were calculated for each station (Table 4.2). Annual thickness of sedimentation among stations were consistent, ranging 0.40 to 0.44 mm/yr between stations, and were comparable to pre-mining Quirke Lake values reported by McKee *et al.* (1987) which ranged 0.31 to 0.55 mm/yr. These sedimentation rates are low

Table 4.1: Metal concentrations of material collected from sediment traps deployed from May to October, 2011 in McCabe Lake

Analyte	Units	Background[a]	LEL	SEL	McCabe Lake Sediment 2009[b]	2011 Sediment Trap Mean	Percent Decrease from 2009
Organic carbon	mg/kg					14,167	
Radium-226	Bq/g	0.27	0.6[c]	14.4[c]	13.8 (15)	9.4	31.9
Aluminum	mg/kg					15,889	
Antimony	mg/kg					0.9	
Arsenic	mg/kg					15.8	
Barium	mg/kg	481	--	--	2,090 (4,200)	10,684	Increased
Beryllium	mg/kg					0.8	
Boron	mg/kg					8.2	
Cadmium	mg/kg					1.6	
Chromium	mg/kg					27.0	
Cobalt	mg/kg	28.3	--	--	175 (290)	95.9	45.2
Copper	mg/kg					47.3	
Iron	mg/kg	54,783	20,000[d]	40,000[d]	75,400 (100,000)	45,076	40.2
Lead	mg/kg					111.8	
Manganese	mg/kg	6,918	460[d]	1100[d]	16,800 (35,000)	14,528	13.5
Molybdenum	mg/kg					9.5	
Nickel	mg/kg	29.7	23.4	484	100.8 (160)	104.8	No change
Selenium	mg/kg					2.9	
Silver	mg/kg					0.3	
Strontium	mg/kg					71.0	
Thallium	mg/kg					0.4	
Tin	mg/kg					7.1	
Titanium	mg/kg					444.6	
Uranium	mg/kg	6.5	104.4	5,874	326 (590)	141.5	56.6
Vanadium	mg/kg					30.2	
Zinc	mg/kg					237.5	

Increased mean concentrations in 2011 compared to McCabe Lake 2009 sediment concentrations.

[a]Upper background concentrations were calculated as the mean plus 2.145x standard deviation of sediment concentrations (Minnow 2011).

[b]Concentrations represent mean value where n=5, values in parentheses represent the maximum value.

[c]Values used to screen lakes, based on Thompson et al. 2005

[d]Provincial Sediment Quality Guidelines (MOE 1993)

LEL is lowest effect level; SEL is severe effect level

Table 4.2: Sedimentation rates calculated from sediment trap material deployed inMcCabe Lake, May to October, 2011.

		McCabe Lake Sediment Trap Station		
Parameter	**Units**	**1**	**2**	**3**
Date of deployment		11-May-11	11-May-11	11-May-11
Date of retrieval		12-Oct-11	15-Oct-11	15-Oct-11
Number of traps		1	6	5
Date of additional retrieval		14-Oct-11		
Number of traps		5		
Average deployment period	d	155.7	157	157
Area of one funnel	m^2	0.044	0.044	0.044
Number of traps		6	6	5
Total area	m^2	0.267	0.267	0.222
Total dry weight	g	11.018	10.559	8.560
Dry bulk density	kgm^{-3}	225	209	222
Sedimentation rate	$gm^{-2}yr^{-1}$	**96.79**	**91.96**	**89.46**
Annual accumulation thickness	$mmyr^{-1}$	**0.43**	**0.44**	**0.40**

relative to the frequency of monitoring because, based on these data, it would likely take over twenty years for 1 cm of sediment to accumulate at these benthic invertebrate community monitoring stations.

4.1.3 McCabe Lake Deep-basin Core Profile

As described in Section 2.2 several analytes were combined with historical information on mining operations, in order to construct markers in time that are compatible with the sediment core data. Starting from the earliest point in time and moving towards present, a timeline has been constructed on the basis of changes in sediment concentrations, relative to known changes in mine operations, treated effluent release, and lake conditions. The majority of evidence used to interpret the McCabe Lake sediment core is on the basis of the most reliable sources of data, including ^{137}Cs radioactivity, core observations, bulk density, and iron concentration. Other analytes may have a more reactive nature (e.g., bioactive trace elements such as copper) or may be trace elements whose behaviour may be dominated by confounding changes in major element concentrations (e.g., cobalt deposition may depend on iron deposition). Important lines of evidence and chronology for decision making for the interpretation of the McCabe Lake core are summarized in Figure 4.1.

A core was collected from the deepest basin of McCabe Lake, at 26 m depth, in October, 2011. The core was 55.5 cm long and showed observable sediment transitions at 8, and 17 cm, where the sediment changed from orange to black/brown, and from black/brown to lighter brown respectively (Photographs 5 and 6, Appendix B). The top 8 cm of orange sediment is suggestive of oxidized sediments containing iron. This means that metals that become soluble in a reducing environment such as iron, and manganese, and metals that are associated with iron and manganese, such as nickel, cobalt, and arsenic did not have increased mobility from a change in redox status (if the sediments become reducing). Metals from down core in more reducing environments have the potential to migrate up the core to this oxidized layer (Farmer *et al.* 1980). However this is not likely a dominant process in this core because known migratory elements do not show consistent profiles (*i.e.,* iron, manganese, nickel, cobalt and arsenic; Figure 4.2).

The sediment profiles of metals indicate no bioturbation, as bioturbation would typically lead to a constant concentration in the uppermost sections (Farmer 1991, Appleby 2002), potentially to several centimeters depth. The upper profiles show fine structure and do not show a consistent concentration with depth (Figure 4.2). Therefore, the relative changes in concentrations of these metals are a reliable reflection of the metal chemistry of depositing sediments at the time of deposition.

TIME MARKER	Approximate Year	Core Depth (cm)	OBSERVATION
	- -	0 - 8	Core observation that top 8 cm of orange indicates presence of oxidized iron and therefore no redox boundaries in this top section.
	- -	0 - 6	Fine structure in metal concentration profiles indicate bioturbation not observed and metal concentration profile likely reflects metal concentration at time of deposition (depending on known geochemical behaviour).
Start of mining opertations cycle. Cesium-137 atmospheric fallout.	1958	21.9	First peak of cesium-137. Onset of mining where sulphur, thallium, dry bulk density, and titanium all indicate change in chemistry and sedimentation at 22 cm.
Beginning of use of barium as treatment for Radium-226 in effluent.	1973	11.7	Barium profile becomes elevated relative to background concentrations, indicating start of use of barium.
Start of second phase of mining.	1983	6.9	Observation of second elevation in sulphur and thallium concentrations, indicating onset of second phase of mining.
Increased release of total suspended solids in effluent peaks in 1990.	1990	2.3	Observed increase in dry bulk density combined with a decrease in titanium concentration, indicating that anthropogenically associated inorganic particle deposition increased at 2.3 cm.
Iron loadings into lake decrease substantially.	2002	0.3	A decrease in mine associated iron (i.e. iron normalized to titanium) observed in 2002 at 0.3 cm.

Confirmation of established timeline

Core collected and sectioned in July 1996 (Beak 1996).	1996	between 0.3 and 2.3	Cores collected in 1996 show onset of mining (1958) at a 2 cm shift compared to the core collected in 2011. By shifting the 1996 core by 2 cm, a time marker for 1996 can be approximated.

Figure 4.1

Flow chart to represent major evidence and decision making for establishing the McCabe Lake core timeline (collected October, 2011).

Ref: 2400
Date: July 2013

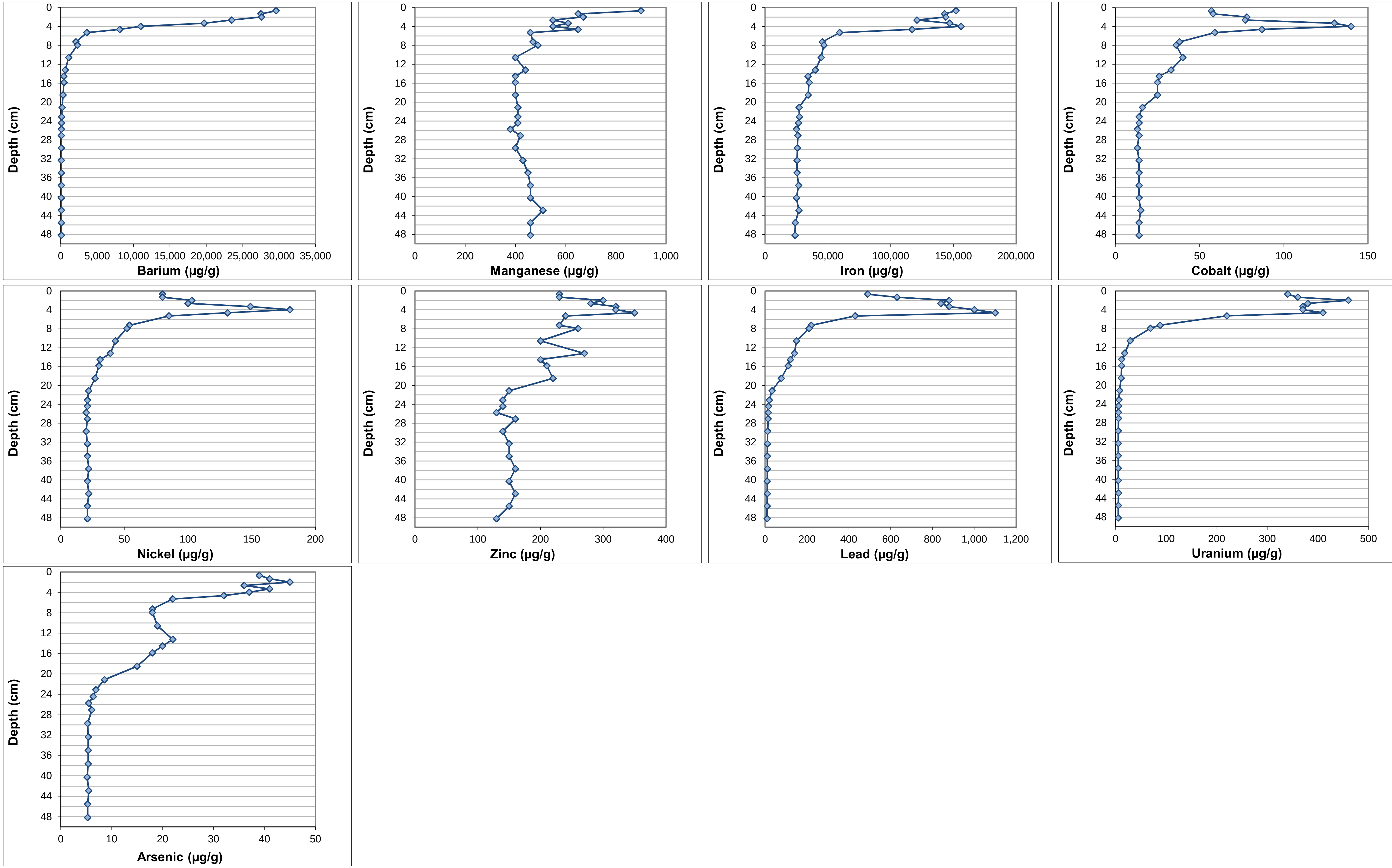


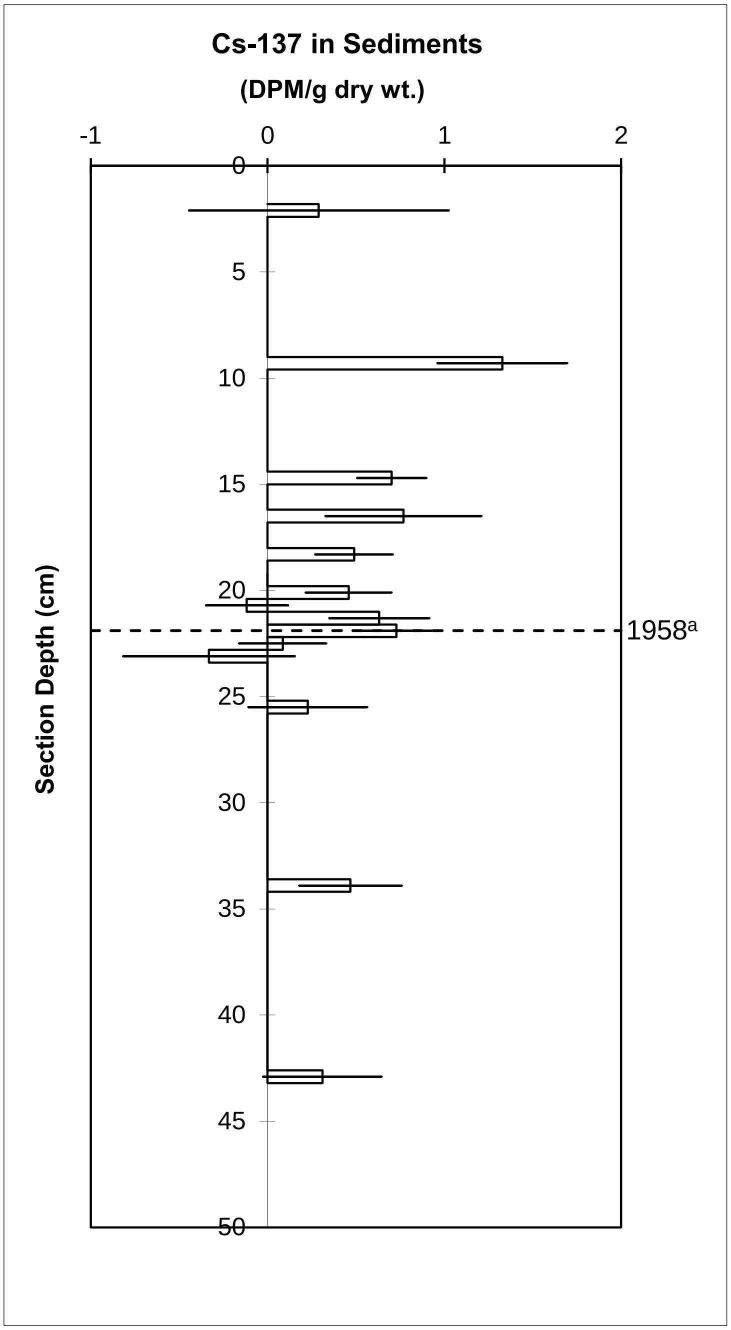
Figure 4.2: Metal concentration profiles in the sediment core collected from McCabe Lake, October, 2011.

A peak in ^{137}Cs activity was located at 22 cm, and based on little to no ^{137}Cs signal in deeper sections, this depth (22 cm) was identified as 1958 (Figure 4.3). As described in Section 2.2 the maximum atmospheric fallout of ^{137}Cs (from nuclear testing) occurred in 1958 and 1963. Since there was no testing before 1954, there would be no observable ^{137}Cs prior to this time because ^{137}Cs is an anthropogenically produced radionuclide (*i.e.,* it does not occur naturally).

The history of release of mine associated parameters into McCabe Lake can correspond to peaks in the structure of the sediment metal concentration profile such that additional markers of time can be applied to the core. Bulk density, sulphur, and metal concentrations were analyzed in selected sections of the core (Appendix Table D.1). The sulphur and thallium sediment concentration profiles both showed two peaks that commence at 22 and 7 cm (Figures 4.4 and 4.5). Although thallium is not a mine indicator it is known to associate with metal sulphide minerals (Blowes *et al.* 2005), and is likely co-located with sulphur because they have the same source. The sulphur peak that started at 22 cm is likely due to the onset of mining (in 1958), consistent with the location of the ^{137}Cs time marker of 1958. The second sulphur peak, also present in the thallium profile, is likely due to the onset of the second mining period in 1983, and therefore this represents a second time marker for the sediment core.

Barium was first introduced as treatment for ^{226}Ra in 1973. Inspection of the barium sediment concentration core profile shows an increase in barium concentration relative to background at 11.5 cm and this was interpreted as 1973 (Figure 4.6). This time marker is also consistent with the placement of the other time markers of 1958, and 1983.

Another indicator of mine influence is the general increase in inorganic fine particles during periods of mining. A way to measure this is using bulk density of sediment along the core profile. Typically bulk density should increase with depth because sediment compacts as weight is added from above (*i.e.,* due to sediment deposition). However, regions within the bulk density profile showing material with higher density can occur from a mining influence (increased deposition of fine inorganic particles) giving a more complex structure to the bulk density profile (Figure 4.7). It can be observed that prior to the onset of mining, the bulk density and titanium profiles show the same trend (*i.e.,* from 48 to 22 cm; Figure 4.7). However during the mining period (22 cm and up) the titanium and bulk density profiles are decoupled. This decoupling indicates that titanium is not associated with mining activity; furthermore titanium actually decreases in concentration when mining activity starts. The depletion of titanium when the bulk density profile shows a relatively large increase is likely due to the dilution of titanium due to an influx of mining



[a]1958 identified on the basis of the presence of this peak, and the absence of peaks below it. The greatest fallout of ^{137}Cs from the atmosphere was in 1958 and 1963.

Figure 4.3: The caesium-137 profile in the sediment core collected from McCabe Lake, October 2011.

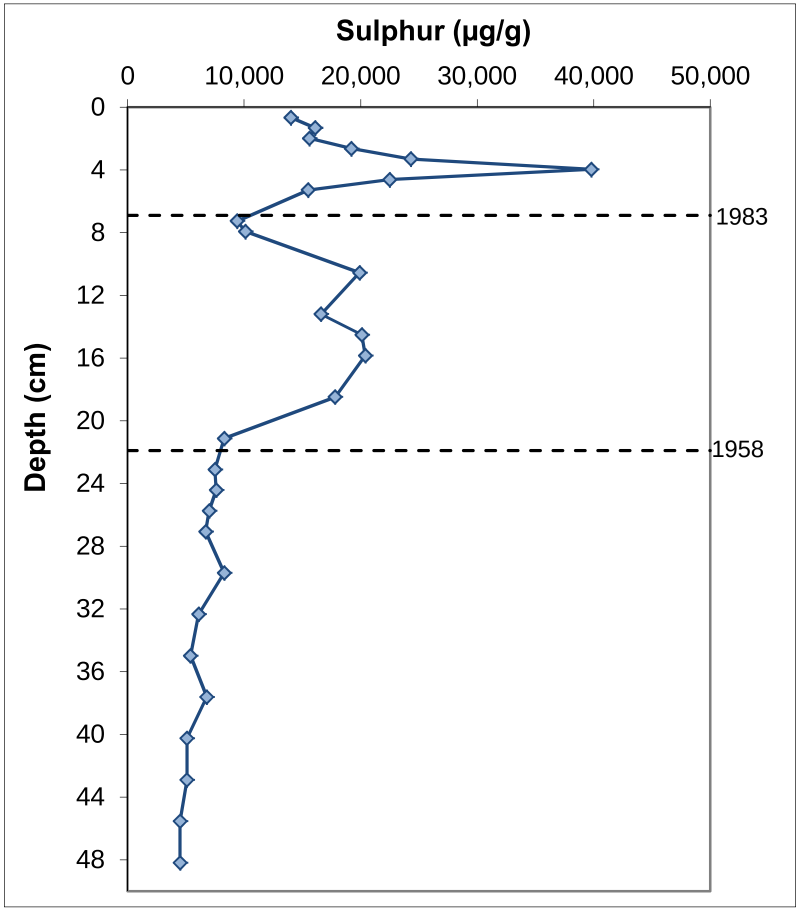


Figure 4.4: The sulphur profile in the sediment core from McCabe Lake, October 2011.

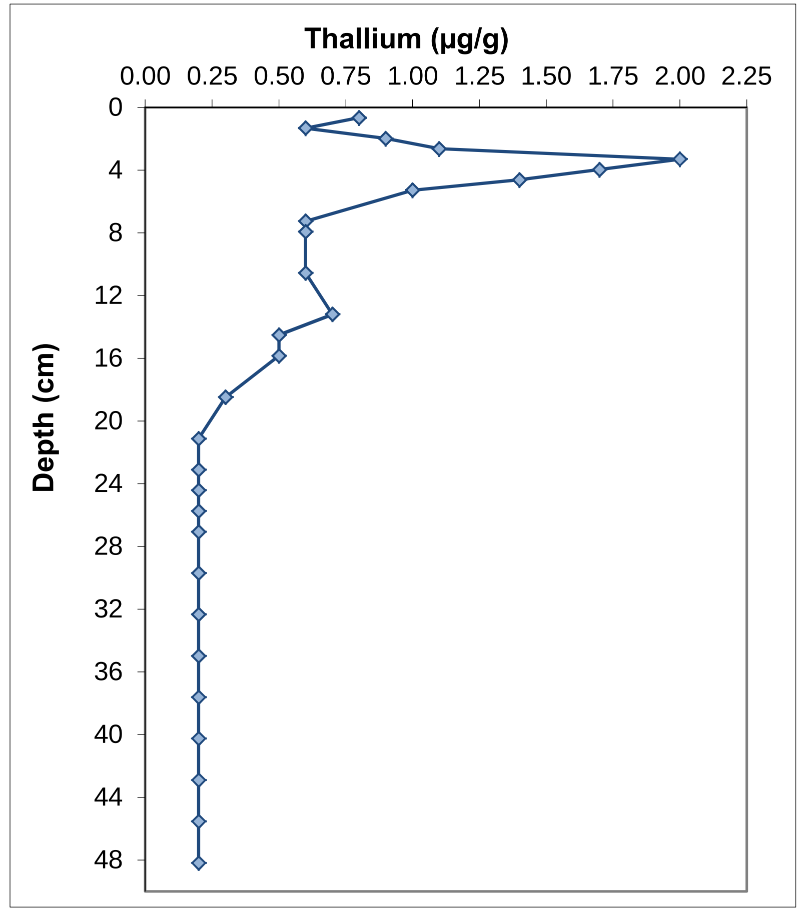


Figure 4.5: The thallium profile in the sediment core from McCabe Lake, October 2011.

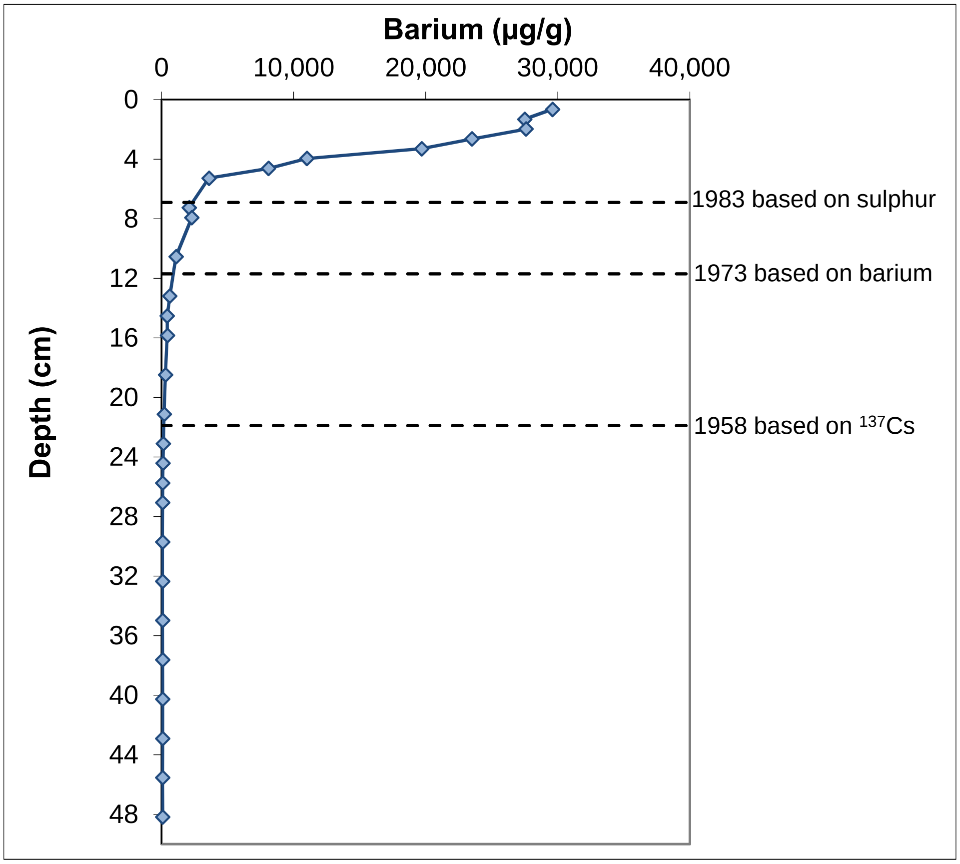


Figure 4.6: The barium profile in the sediment core collected from McCabe Lake, October 2011.

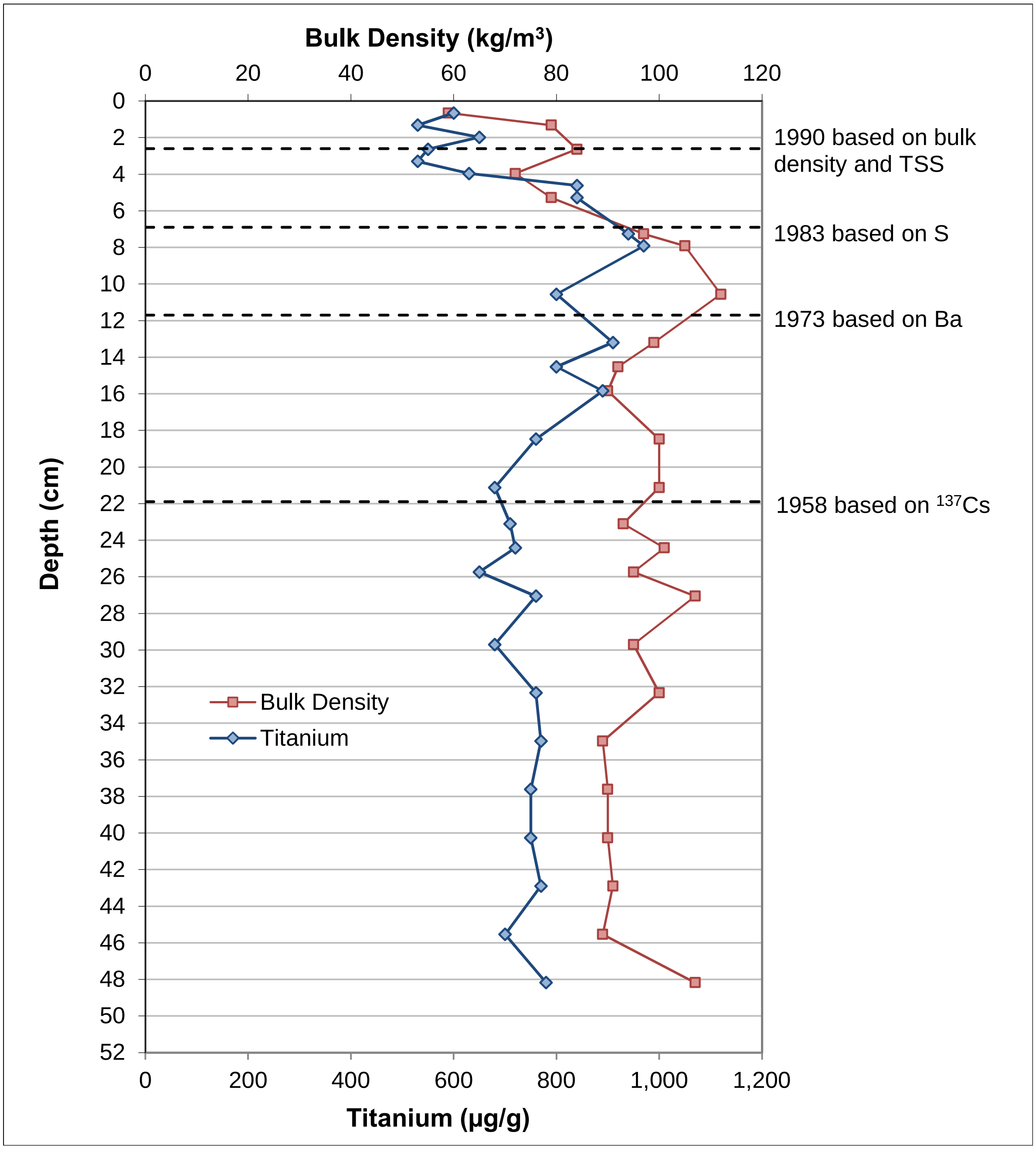


Figure 4.7: The bulk denisty and titanium profiles in the sediment core collected from McCabe Lake, October, 2011

associated materials. Therefore, in this environment, titanium can be used as a lithogenic marker (*i.e.,* natural inorganic deposition) that is not influenced by mining activity and the onset of where bulk density and titanium become decoupled (*i.e.,* 22 cm) can be attributed to the beginning of mining, consistent with ^{137}Cs and sulphur.

A comparison of annual loading (data from 1990 to 2009) and mean effluent concentrations indicated that patterns of mean annual effluent concentrations (data from 1986 to 1990) were generally relative to patterns of annual loadings (Appendix Figure D.1). Therefore, mean annual effluent concentrations were used to supplement loadings values prior to 1990.

In 1990, during mining and milling operations, there was higher release of total suspended solids in effluent compared to other years and following 1990, the mean annual total suspended solids concentrations decreased (Figure 4.8). Total suspended solids can be related to bulk density, as total suspended solids represent inorganic materials which would ultimately deposit and contribute to bulk density. Therefore, the maximum bulk density likely occurred in 1990. This could correspond to the increase in bulk density observed at 2.6 cm (Figure 4.7), which is also consistent with the observed decrease in titanium concentration at the same depth. Another analyte, iron is also compatible with this time marker of 1990 at 2.6 cm. Iron did not have a peak release in 1990, but earlier in 1988, and had decreased substantially by 1990 (Figure 4.8). The time marker of 1990 (at 2.6 cm) should therefore show a decrease in iron relative to deeper sediment sections, as is observed in the sediment iron concentration profile (Figure 4.2).

In 1997, iron and uranium loadings were high and the loadings in the subsequent discharge year (which was mid-2001 / 2002) were much decreased (Figure 4.9). Although this was observed for both iron and uranium, uranium is soluble in oxidized environments and deposition to sediment would not be a dominant process, therefore, iron was used as a more reliable indicator of sediment deposition. When normalized to titanium, iron (that is associated with mining activity) is observed to decrease in the uppermost section of the sediment core only (0 to 0.6 cm; Figure 4.10), indicating that the top sediment core section is likely representative of post-1997 sediment, which is effectively 2002 onwards (as there was no effluent release between 1997 and mid-2001). Using this observed decrease in mining associated-iron as a time marker for 2002, located in the upper most section of the core, results in an estimated current deposition rate of 0.6 mm/yr (Table 4.3).

To further substantiate the suggested timeline for this core (collected in October 2011), data from a core collected in July 1996 (Beak 1996) has been used for comparative

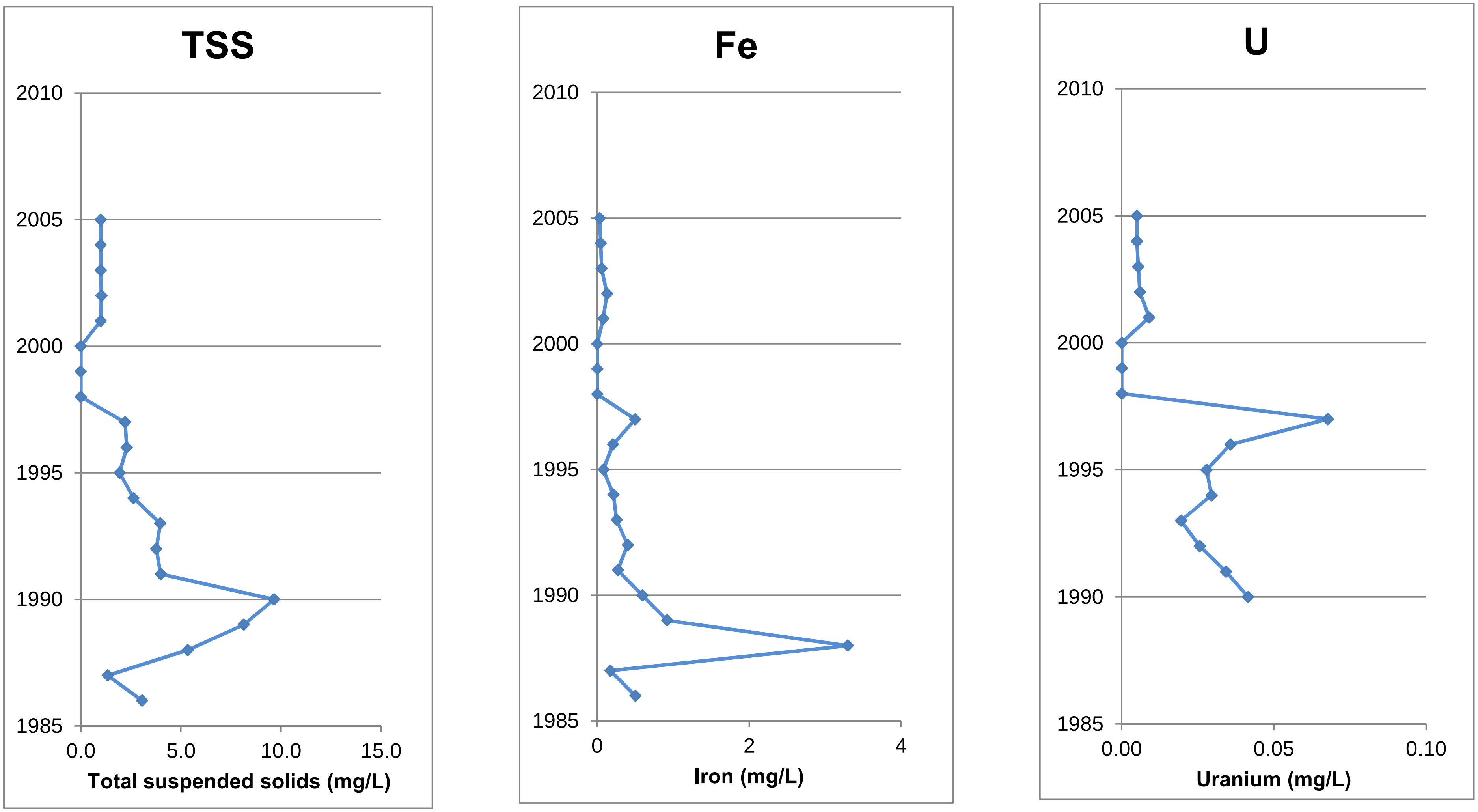


Figure 4.8: The mean annual total concentration of effluent constituents released into McCabe Lake from 1986 to 2005 (monitoring station CL-06).

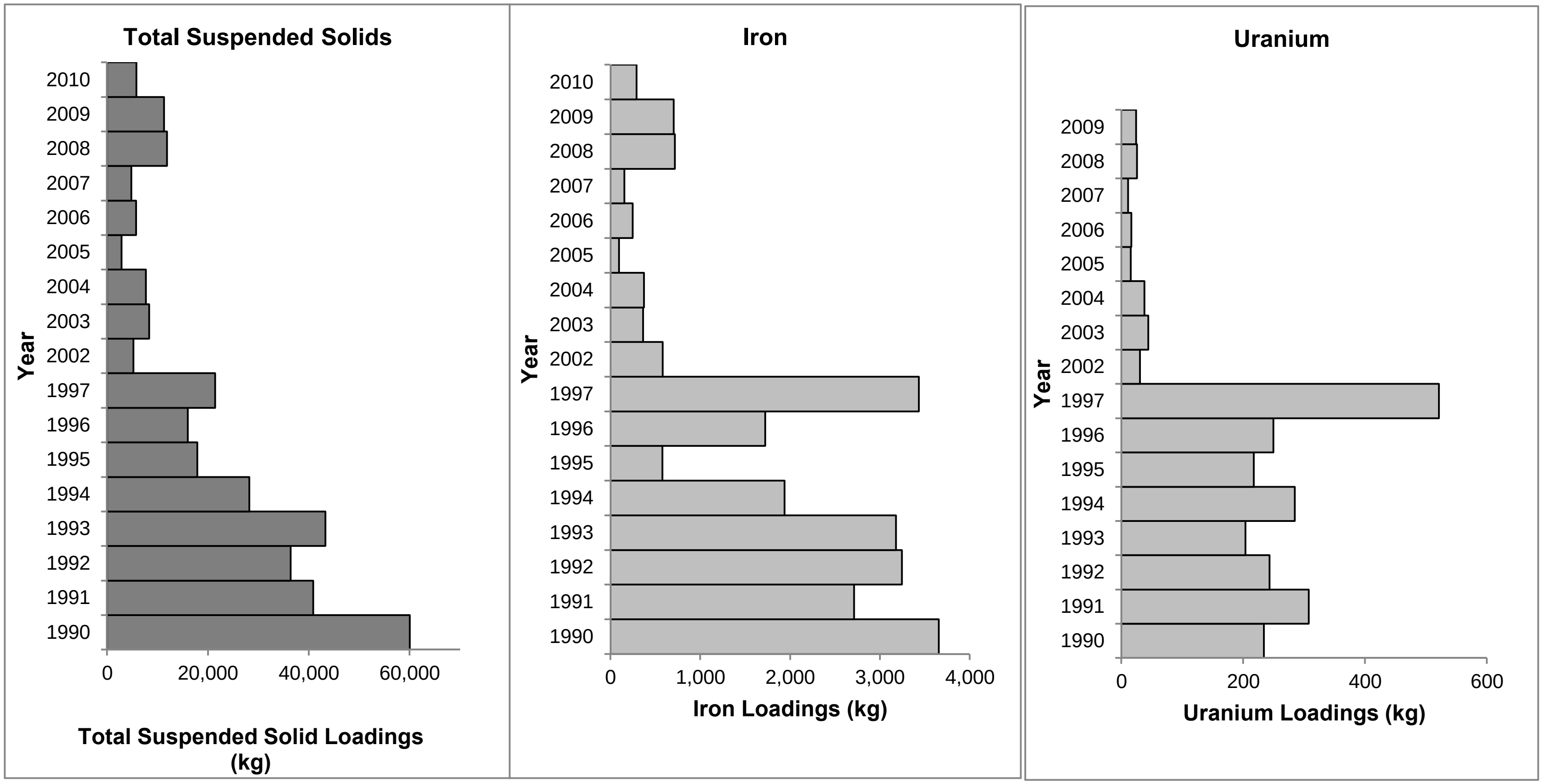


Figure 4.9: Annual metal loadings and total suspended sediment loadings into McCabe Lake from 1990 to 2009 or 2010.

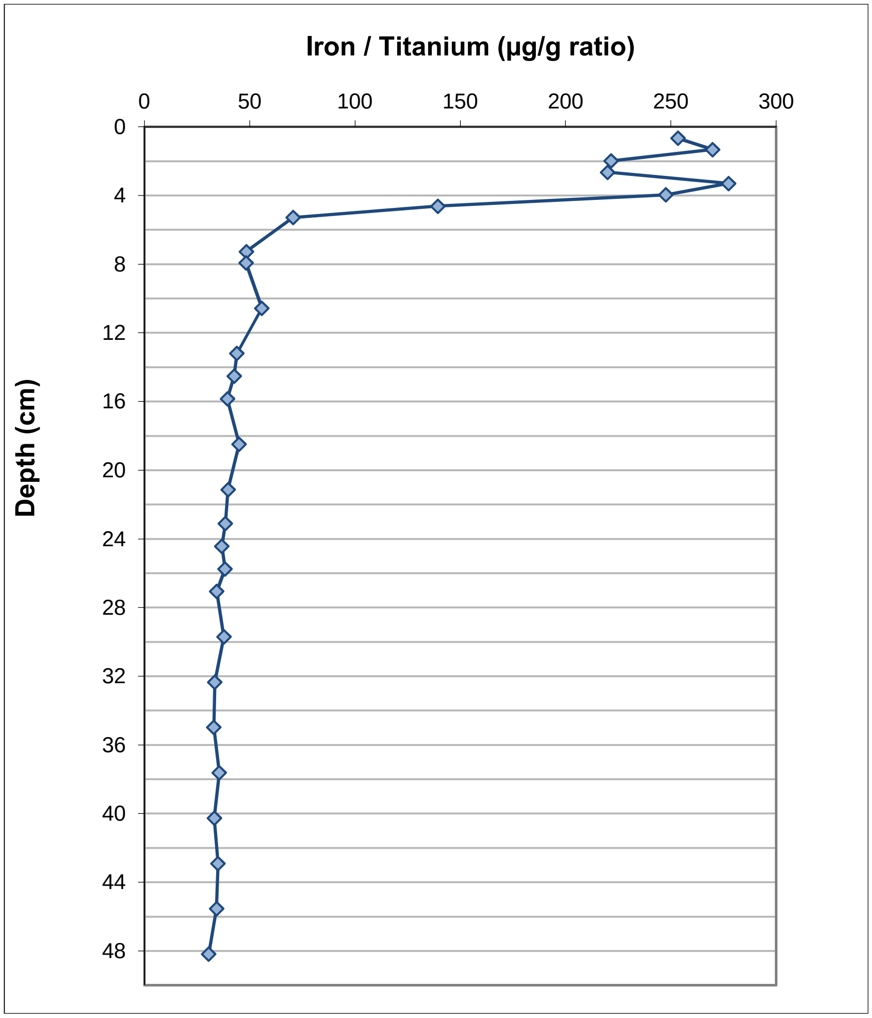


Figure 4.10: McCabe Lake sediment core iron profile normalized to titanium, October, 2011.

Table 4.3: Timeline and deposition rates inferred from the sediment metal profile at McCabe Lake

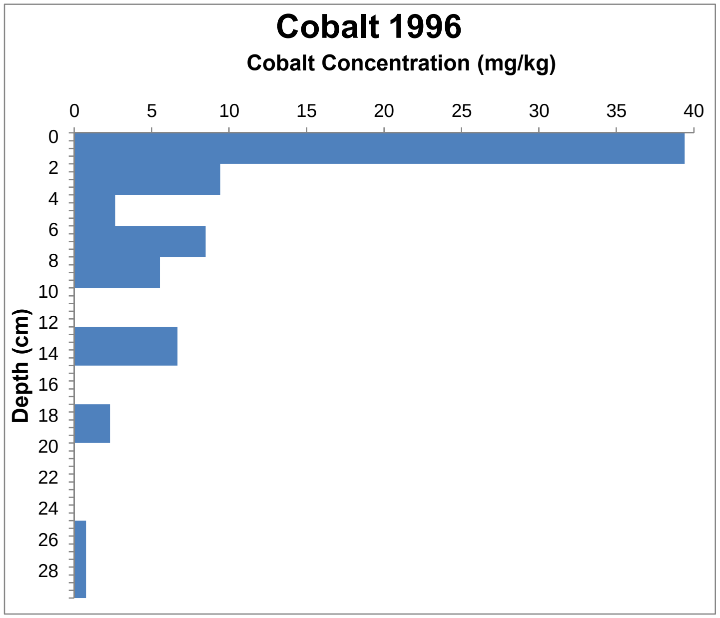
<table>
<tr><th>Core depth (cm)</th><th>Feature</th><th>Inferred date</th><th>Reason</th><th colspan="2">Estimated Deposition Rates</th></tr>
<tr><td>21.6-22.2</td><td>^{137}Cs peak, S, and Tl peak</td><td>1958</td><td>Onset of mining, and date of ^{137}Cs deposition to the atmosphere</td><td rowspan="2">6.8 mm/yr</td><td rowspan="2"></td></tr>
<tr><td>11.4-12.0</td><td>Increase in barium concentrations</td><td>1973</td><td>Treatment of ^{226}Ra first introduced</td></tr>
<tr><td>6.6-7.2</td><td>Elevated levels of sulphur and thallium, second peak</td><td>1983</td><td>Onset of second phase of mining</td><td rowspan="2">4.8 mm/yr</td><td rowspan="3">3.3 mm/yr</td></tr>
<tr><td>2.0-2.6</td><td>Increased release of total suspended solids.</td><td>1990</td><td>Co-incident with decreased titanium concentrations in the sediment profile</td></tr>
<tr><td>0.6-0</td><td>Decrease in iron and uranium loadings to lake</td><td>2002</td><td>Co-incident with decrease in iron (when normalized to titanium).</td><td rowspan="2">0.6 mm/yr</td></tr>
<tr><td>0</td><td>Top of sediment core</td><td>2011</td><td>The year the core was collected</td><td></td></tr>
</table>

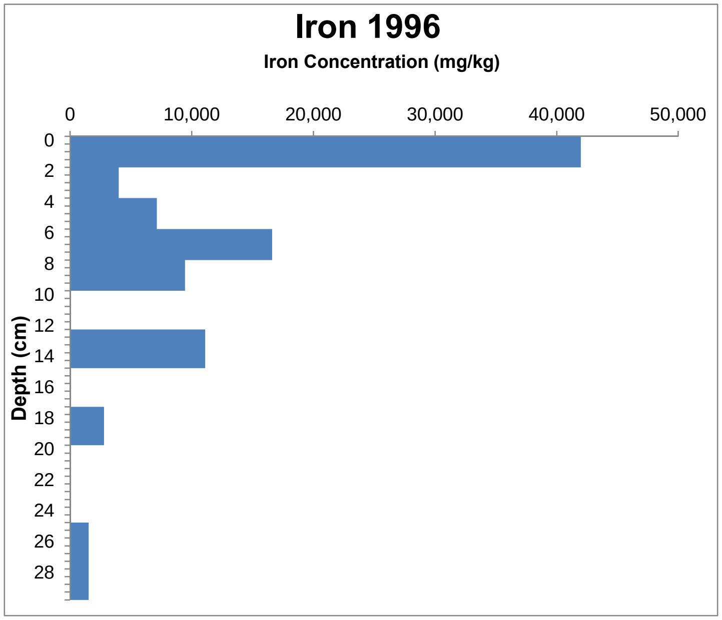
purposes. In 1996, the core was collected from the same deep-basin of McCabe Lake, but with a K-B corer (with a smaller inner diameter of 5 cm). The core was sectioned in less resolved slices which varied in width from 2 to 5 cm, and samples were sent to a different analytical laboratory (Zenon Environmental Laboratories, Burlington, Ontario). Despite these differences in core handling, general trends are discernable and can be matched to trends in the core from 2011. In the 2011 core, the onset of mining (1958) was determined to occur at around 22 cm, based on ^{137}Cs, sulphur and bulk density depth profiles. In addition to these elements, cobalt, iron, and nickel show an elevation in concentration (from background) at this depth (Figure 4.2). In comparison, the cobalt, nickel, and iron concentration profiles from the 1996 core, show an increase in concentration (from background) at the 20 cm sediment section (Figure 4.11). The 2 cm difference in the profiles between 1996 and 2011 is representative of an additional 2 cm of sediment which has deposited since 1996 (i.e. the sediment profile observed in 2011 is shifted down by 2 cm relative to the 1996 core profile). By shifting the 1996 core depth profile for cobalt, iron, and nickel by 2 cm it can be directly compared to the concentration trends in the 2011 McCabe Lake core (Figure 4.12). It can be observed that the concentration trends in the 1996 core crudely match the concentration trends in the 2011 core, although absolute concentrations are not comparable, this is likely due to the difference in analytical methods between the two laboratories, over a 15 year time period. This 2 cm deposition of sediment in 15 years (i.e. 1996 to 2011) represents an average deposition rate of 1.3 mm/yr, which is compatible with the two deposition rates presented for 1990 to 2002, and for 2002 to present (3.3 and 0.6 mm/yr respectively; Table 4.3). The top of the 1996 core presents a further time marker of 1996, which falls between the time markers of 2002 (at 0.6 cm) and 1990 (at 2.6 cm), and closer to the 1990 time marker, with or without the inclusion of sediment compaction. This time marker adds further weight of evidence for the assignment of time markers to the 2011 McCabe Lake core.

4.2 Quirke Lake

4.2.1 Quirke Lake Deep-basin core profile

As with McCabe Lake, the interpretation of the sediment core collected from Quirke Lake used a weight of evidence approach using sediment analytes that included consideration





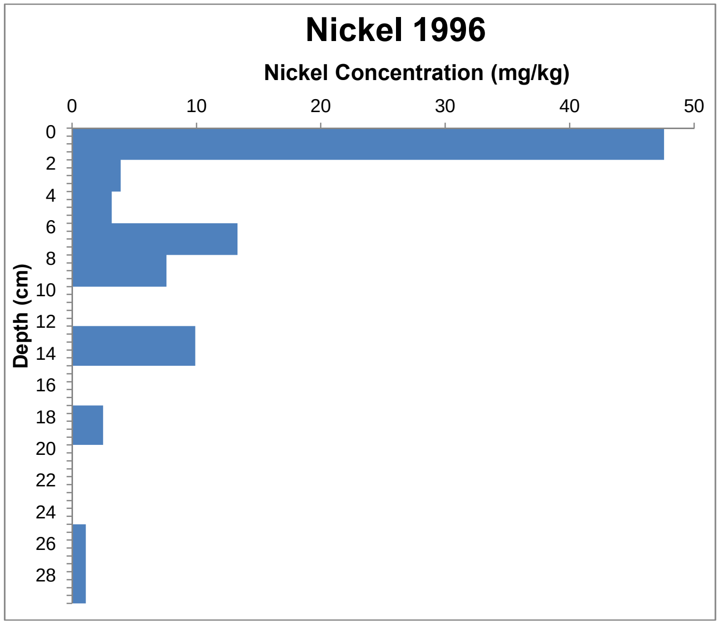


Figure 4.11: Cobalt, iron, and nickel dry weight concentrations in core sections collected from the McCabe Lake deep-basin in July 1996 (data from Beak 1996).

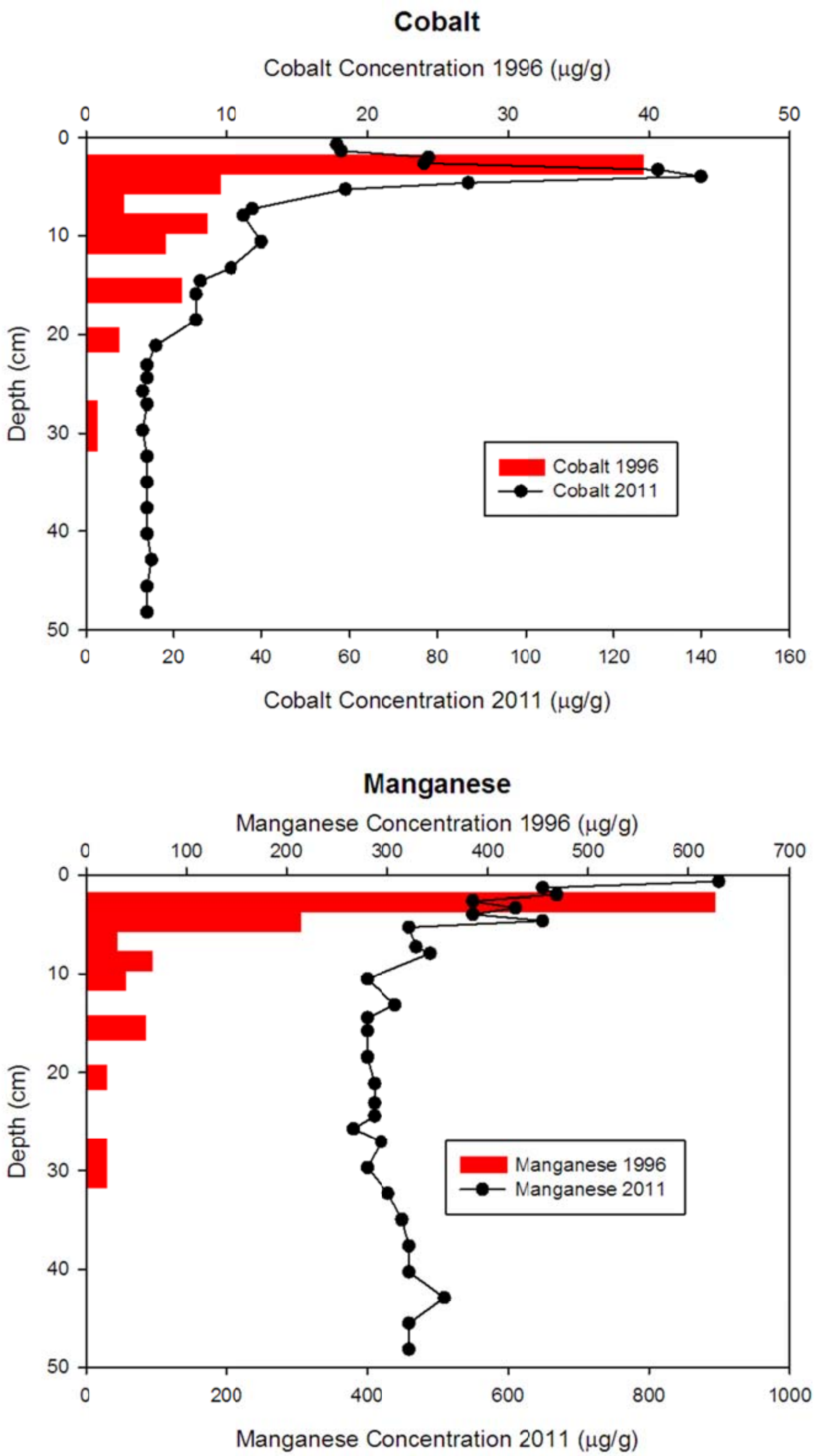
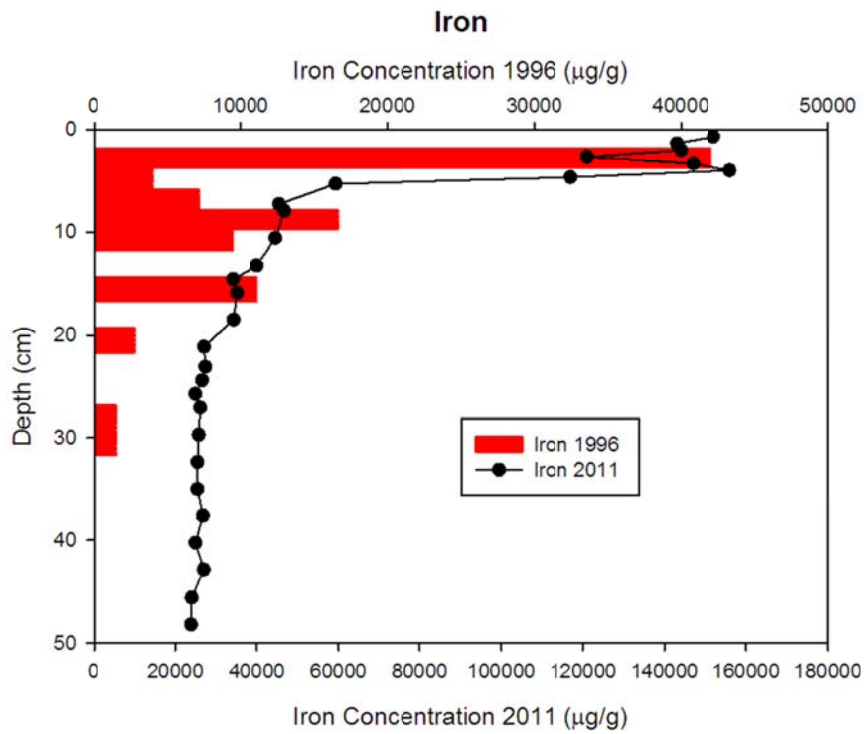


Figure 4.12a: Cobalt and manganese metal concentration profiles from the deep-basin in McCabe Lake collected in October, 2011 compared to the core collected in July, 1996 (Beak 1996), shifted by 2 cm.



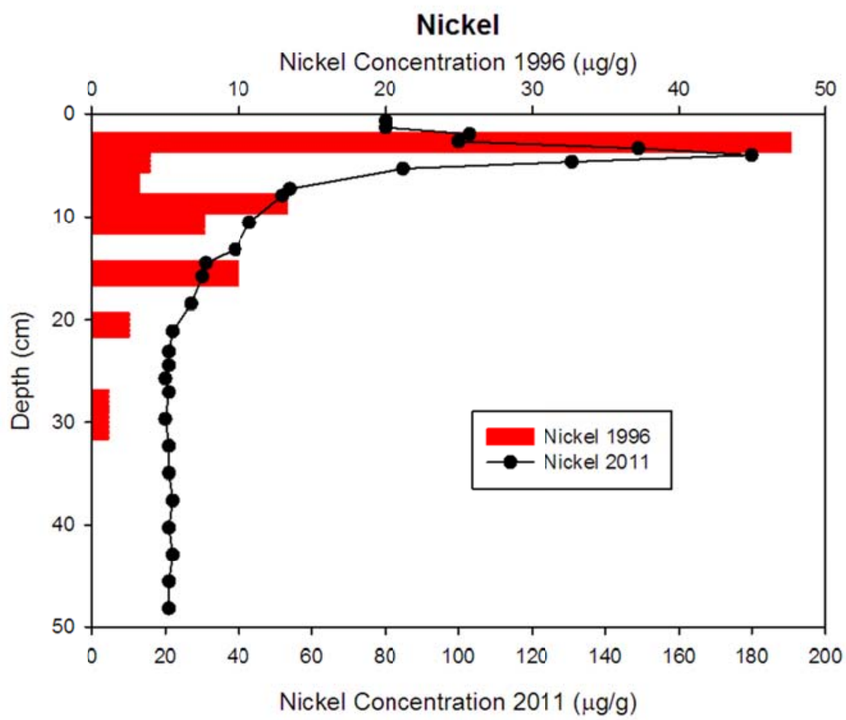


Figure 4.12b: Iron and nickel metal concentration profiles from the deep-basin in McCabe Lake collected in October, 2011 compared to the core collected in July, 1996 (Beak 1996), shifted by 2 cm.

of ^{137}Cs activity[1], iron, aluminum, titanium concentrations, bulk density profiles and other trace metals. Quirke Lake has also been studied in the past (McKee *et al.* 1987) using radionuclide activity profiles, pollen and diatomaceous shell abundance differences (indicative of pH changes). This study provided Quirke Lake sediment accumulation rates at the equivalent location to the core collected for this study, of 0.31 mm/yr and 1.6 mm/yr for pre-mining and during mining respectively (McKee *et al.* 1987). Accompanying metal concentration data were also collected at the same time but were not included in the publication (Beak 1985).

Of the several mines that have the potential to influence Quirke Lake sediments (Quirke, Denison, Spanish-American, Panel, Stanrock, and Can-met mines), Panel Mine in particular would be expected to have the greatest influence on sedimentation and sediment quality at the coring station used in the present study (Figure 3.1; *i.e.,* Panel TMA was in closest proximity to the core location). The other mines that have the potential to influence Quirke Lake are Denison and Quirke which discharge into the Serpent River upstream of Quirke Lake. However, materials associated with these mines would predominantly deposit in the west basin of the lake which is separated from the east basin by several islands that likely restrict water flow and promote settling in the west basin (Figure 2.2). Therefore, Panel TMA was considered to be the dominant influence on the core collected for the present study.

In 1984, cores were collected from three stations (stations 13, 14, 15) in Quirke Lake (Beak 1985). There were anomalies in the station 15 core metal profiles that were unexplained (Beak 1985). Therefore, the 2012 core was compared to cores from stations 13 and 14 which showed consistent patterns down-core. These cores were taken from the deepest points in the west basin and the south-west arm respectively. In order to achieve sufficient sample for metals analysis, three cores per station were collected using a K-B corer, and sediment core sections combined in the 1984 study. Therefore, it should be noted that it is possible for broadened or distorted peaks to have occurred in the 1984 dataset. In general, it is now preferred to collect sediment sections from a single core to prevent the broadening of any peaks, or the distortion of sediment profiles. More recent

[1] Although the ^{137}Cs data was collected and interpreted, it was not used to provide a time marker in the interpretation of the Quirke Lake core because all other available data showed the ^{137}Cs time marker to be inconsistent. A discussion of the ^{137}Cs time marker placement, in light of other data, is provided in Appendix C.

advancements in analytical techniques allow for smaller sample sizes to be used thereby allowing for a single core to be used in the current study.

The Quirke Lake sediment core was collected at 99.5 m depth in the eastern basin of Quirke Lake (Figure 2.2) on 5th May, 2012. The core was 39 cm long and showed an orange-brown surface layer of about 5 cm on top of a grey-brown layer from 5 to 22 cm. The remaining deeper sediment was primarily grey in colour and was not clearly distinguishable from the middle section of the core (Photograph 7, Appendix B). The top 5 cm of orange sediment is suggestive of oxidized sediments containing iron. This iron could be indicative of a redox boundary where deeper reducing sediments have resulted in the upward diffusion of iron and other associated metals to this oxidized layer. This process is called post-depositional migration and can cause the misinterpretation of a sediment core profile (Farmer 1991). However, another more likely explanation is that the high iron input from mining activity around Quirke Lake could have contributed to this high iron layer. The iron concentration profile is discussed in detail within this section.

Another process that can lead to the misinterpretation of lake history using sediment metal concentration profiles is sediment mixing as a result of bioturbation. Metal concentrations are typically uniform in the top layers of sediment when bioturbation or other mixing processes are occurring (Farmer 1991, Appleby 2002). In the core collected in 1984 from the same location, there was no indication of bioturbation (McKee *et al.* 1987). Similarly there was no uniformity in metal concentration in the uppermost sections of the 2012 core for lead, barium, iron, and manganese (Figure 4.13), nor for aluminum and titanium (Figure 4.14). Therefore, mixing in the top sections of sediment was not suspected.

Lead is a metal that once deposited, is generally considered to not exhibit post-depositional migration (Gallon *et al.* 2004). Although some studies have shown post-depositional migration of lead (Benoit and Hemond 1990), this has been associated with iron remobilization. However, if this were to occur lead and iron would demonstrate the same profile which is not observed in this core (Figure 4.13). Furthermore examination of the iron profile (discussed below) indicates that iron remobilization was not occurring in Quirke Lake.

The pre-mining atmospheric deposition of lead in Ontario lakes started to occur at the beginning of industrialization during the late 1800's, but in Ontario lead deposition was found to increase markedly from the 1920's and 1940's in a Lake Erie sediment core (Graney et al 1995; Appendix Figure D.2). The onset of elevated lead in the Quirke Lake core can be observed at 11 cm (see inset of Figure 4.13), allowing a time marker of 1930 to be placed for this period. It is important to note that there is no indication of mine

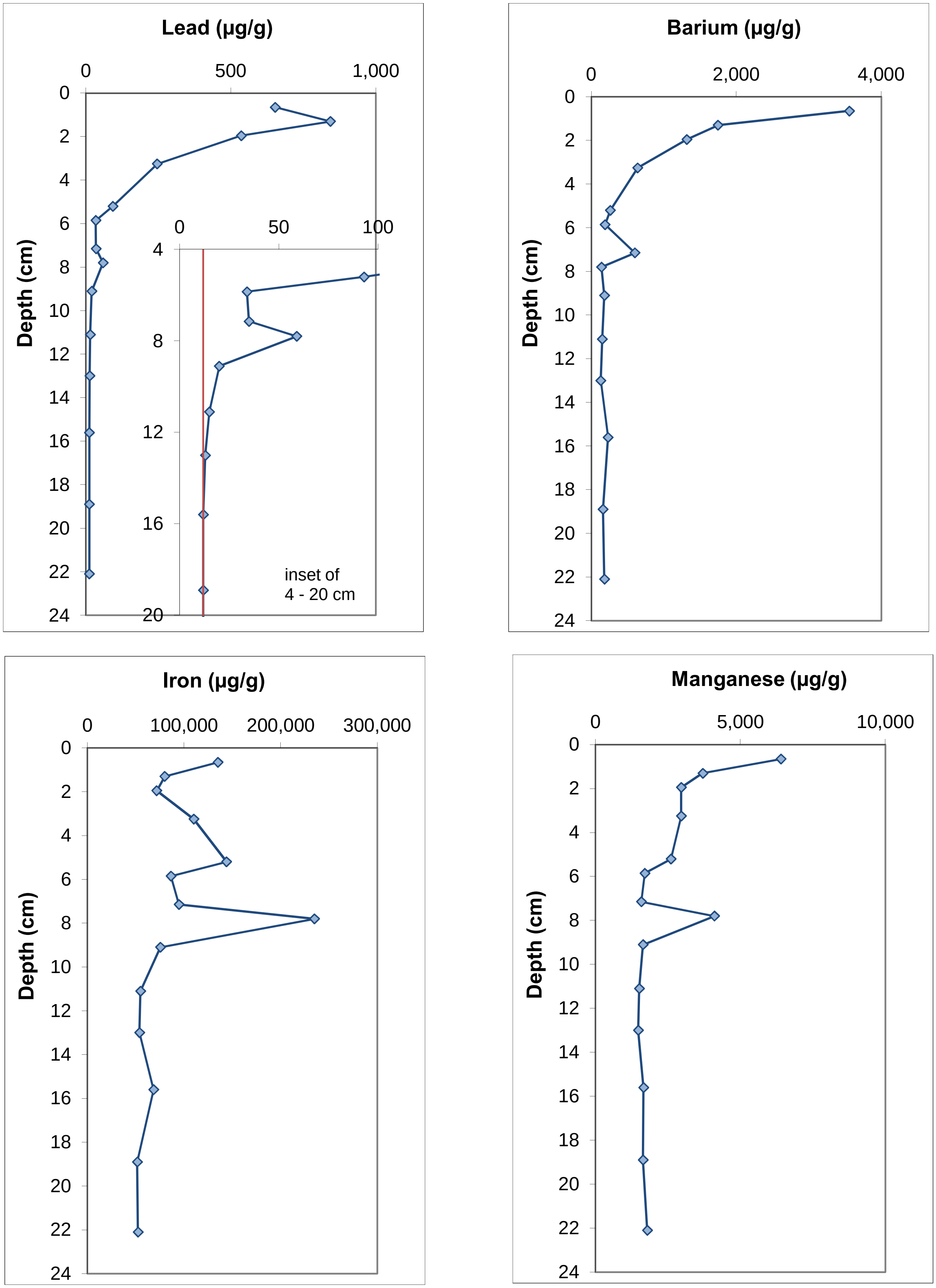


Figure 4.13: Lead, barium, iron, and manganese sediment concentration profiles from the core collected from the eastern deep basin of Quirke Lake, May 2012. Red line indicates background concentration.

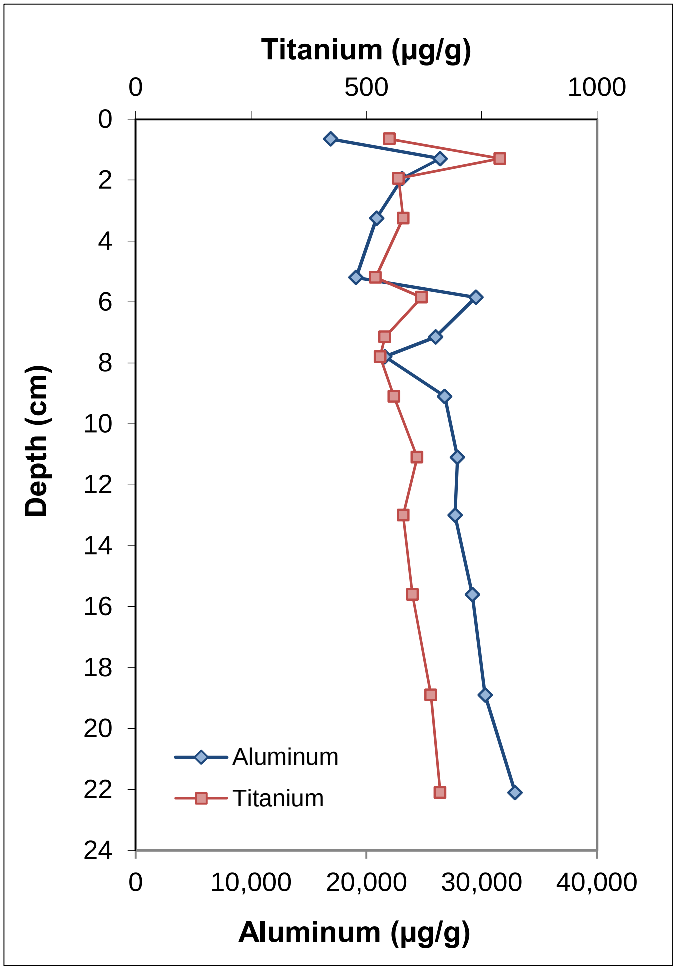


Figure 4.14: Titanium and aluminum concentration profiles in the sediment core collected from Quirke Lake, May 2012

influence deeper than 11 cm, (*i.e.,* at deeper than 11 cm, sediment has no anthropogenic influence) and as mining activity started in 1957, a depth of 11 cm for 1930 is a reasonable assumption. A subsequent decrease in atmospheric lead deposition did not occur until the early 1970's, and this is not observed in the Quirke Lake core. The decrease in atmospheric deposition of lead in the 1970's was masked by the increasing mining activity that occurred within the Quirke Lake basin at the same time. Although lead was not a key contaminant associated with mining, the elevated lead concentrations observed in Quirke Lake (maximum 850 µg/g dry weight) compared to Dunlop lake (maximum 15.5 µg/g) imply that lead was elevated due to mining activity.

Post-depositional mobilization is an obstruction in using sediment core metal concentration profiles to understand lake history. As noted above, metals such as titanium and aluminum are conservative tracers for natural inorganic deposition. The majority of aluminum in sediment is associated with clays, and as such aluminum (and titanium), are not subject to post-depositional mobilization within a sediment core (Farmer 1991; Brown et al 2000). The concentration profiles of aluminum and titanium both show similar patterns with depth (Figure 4.14), although aluminum clearly has a stronger profile. When aluminum is plotted alongside iron it can be observed that the two metals have opposite trends in concentration along the profile (Figure 4.15). Since iron and aluminum have different trends down-core it can be concluded that iron and aluminum are being deposited through different mechanisms (*i.e.,* different sources), therefore, as with titanium, aluminum can be considered a lithogenic marker (*i.e.,* not mining related). The reason that aluminum has an *opposite* profile to iron is most likely because large concentrations of iron were being deposited in sediment, diluting the aluminum concentration in the profile. The concentration of iron is about ten times that of aluminum. The current maximum iron concentration in Quirke Lake is 235,000 µg/g (dry weight) at 8 cm depth, and 135,000 µg/g at 0.6 cm depth. Background iron concentrations (11 to 22 cm) in Quirke Lake (52,000 µg/g dry weight) are similar to iron concentrations measured in the reference lake Semi-White Lake in 2009 (ranging 23,000 to 53,000 µg/g dry weight; Minnow 2011). Therefore, the maximum concentration in the Quirke Lake core is significantly elevated above background. These elevated sediment iron concentrations would probably have been due to the mining and milling of pyritic ores and associated release of iron into the lake (McKee *et al.* 1987). Although iron can be subject to diffusion from reducing sediments at depth to oxidizing sediments nearer the surface (Farmer *et al.* 1980) and this may have occurred to some extent, the predominant process responsible for the iron profile is the deposition of high concentrations of iron during mining. This is the case for several reasons: (1) aluminum does not migrate and since

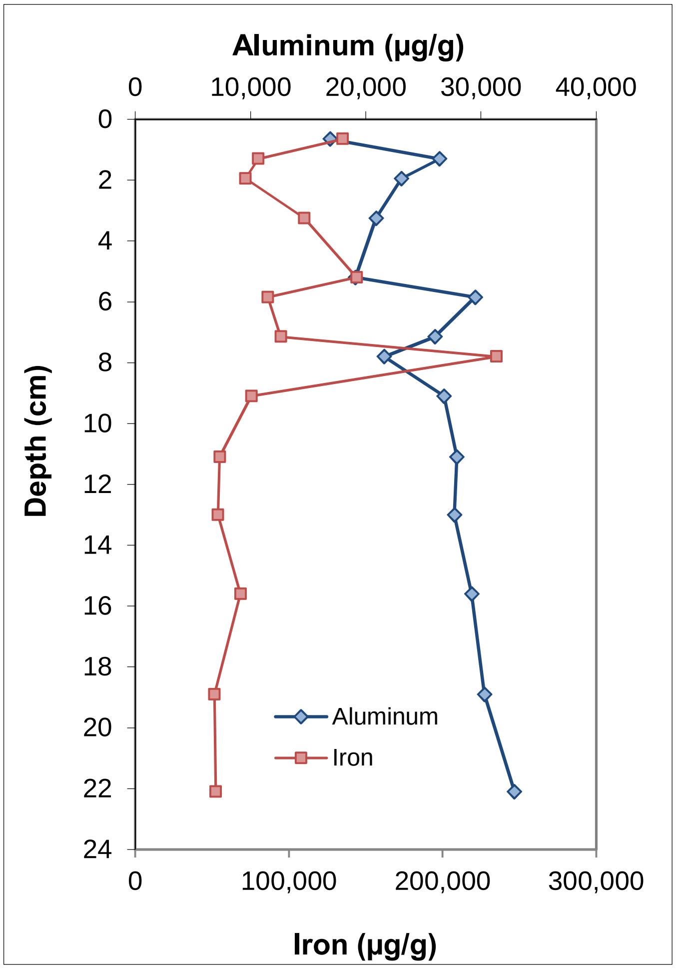


Figure 4.15: Iron and aluminum concentration profiles in the sediment core collected from Quirke Lake, May 2012

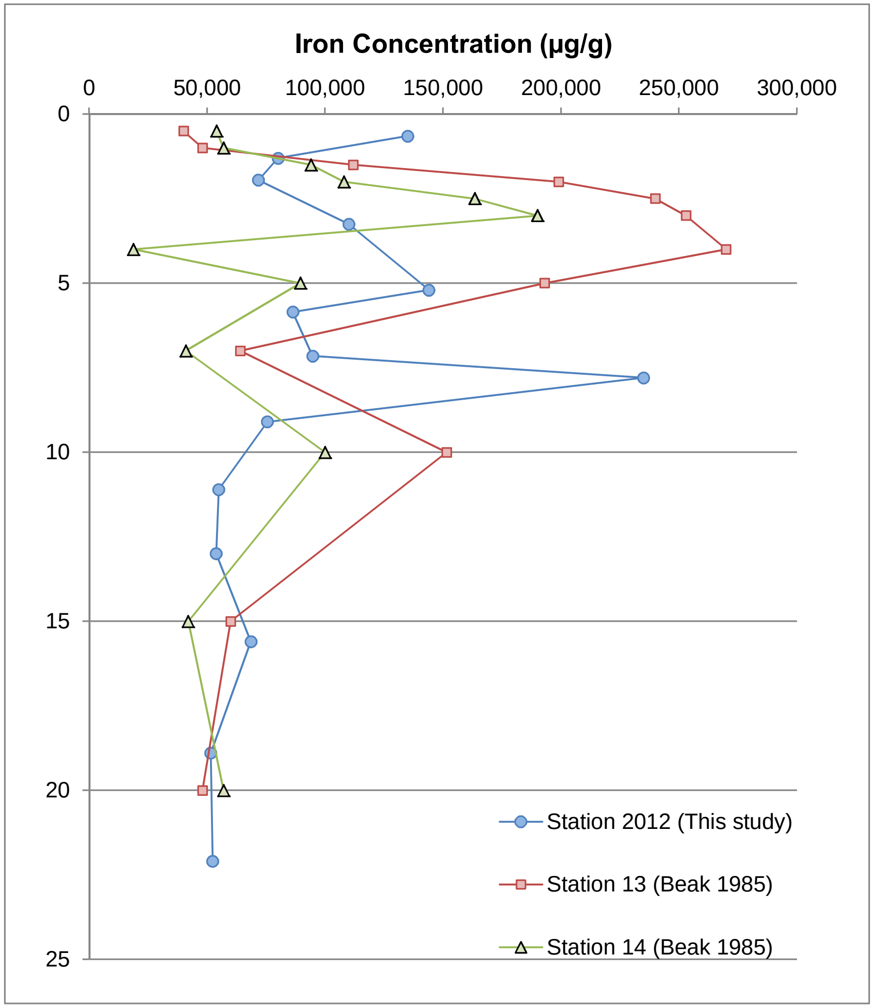
iron shows a similar (but opposite) trend in concentration down-core, this suggests that iron is also not diffusing to a significant enough degree that the pattern of iron deposition in this core is changing; (2) the approximate absolute concentrations of iron and aluminum have not changed since 1984 (Figure 4.16) indicating that loss of iron from diffusion has not occurred (Johnson *et al.* 1986); (3) it can also be noted that the opposite pattern of iron and aluminum concentrations was also present in 1984 (Figure 4.17), further indicating that iron has not significantly diffused post-deposition. On this basis the iron sediment core profile has been interpreted as an undisturbed history of deposition in Quirke Lake.

The iron concentration profile shows two peaks, the onset of the first deeper peak is at 9 cm and is likely related to the onset of mining around 1957, this time marker is consistent with the lead time marker of the 1930's at 11 cm (Figure 4.18).

Water quality data for the outflow of Quirke Lake was collected by the Ontario Ministry of Environment (1965 to 1992), and more recently (past several decades) by Rio Algom and Denison Mines. The combination of these water quality data provides iron, sulphate and pH levels from about 1965 to 2009 (Figures 4.19 to 4.21). Water pH was reported as low in the 1950's and 1960's (Rio Algom 1995), and continued to be less than pH 6 until around 1979 (Figure 4.19). The Panel Mine, the closest mine to the core station, closed in 1961, and did not re-open until 1979. A combination of decreased effluent contaminants due to the Panel Mine closure, and low pH may have resulted in a decrease in iron deposition in sediment. This suggested decrease in iron deposition may relate to the observed decrease in iron concentration in the sediment profile at 7 cm (Figure 4.22). Therefore, a time marker of 1961 has been assigned to the onset of decreased iron (at 7 cm).

The iron sediment concentration profile from 6 to 2 cm shows a second peak, likely indicative of the second era of mining at the Panel Mine (1979-1990). Consistent with this was the beginning of elevated barium concentrations in the sediment profile at 5 cm (Figure 4.13) which has been related to the start of effluent treatment with barium chloride in 1974 at the Panel Mine. Although mining was not underway in 1974, improvements in technology had been made that lead to the introduction of barium treatment to decrease radium-226 activities in effluent coming from the tailings management facilities across all mines. Barium treatment was introduced at several operations around this time period.

An increase in sulphur concentration in sediment is observed at 5 cm (Figure 4.23). This increase coincides with increasing sulphate in water in 1976 or before (Figure 4.21). This



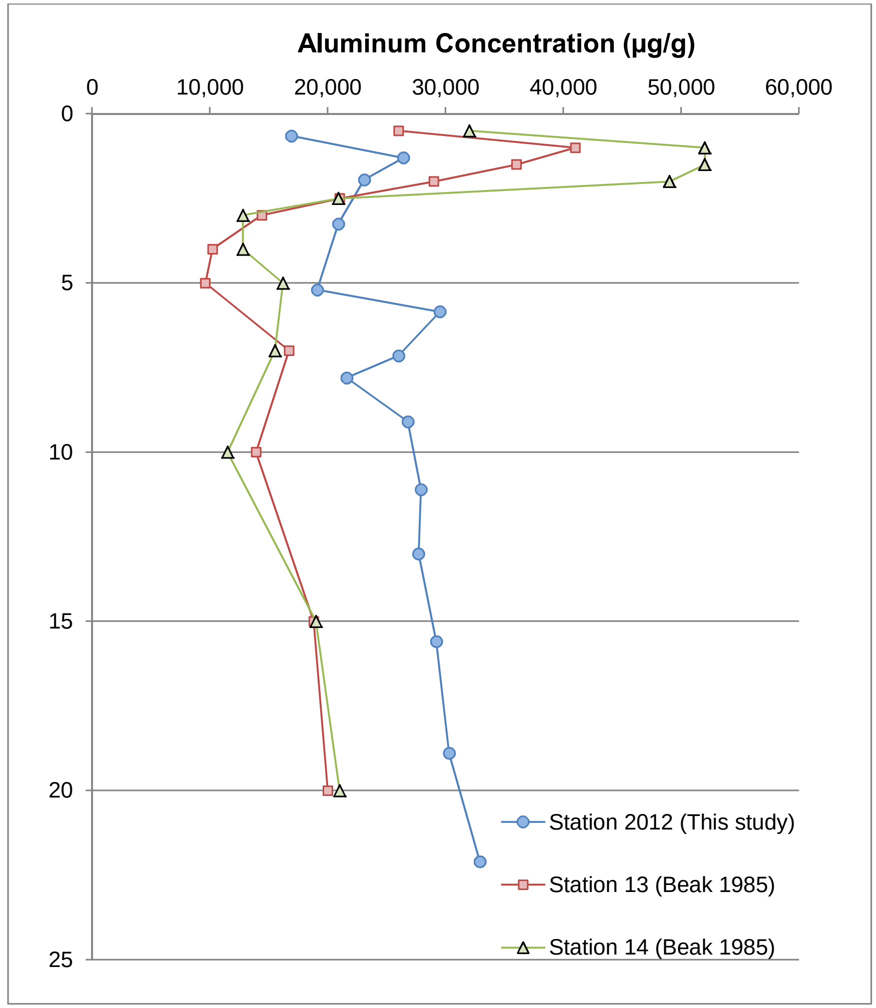


Figure 4.16: The iron and aluminum sediment concentrations profiles of the core collected from this study (May 2012) compared to the 1984 study (Beak 1985), in Quirke Lake.

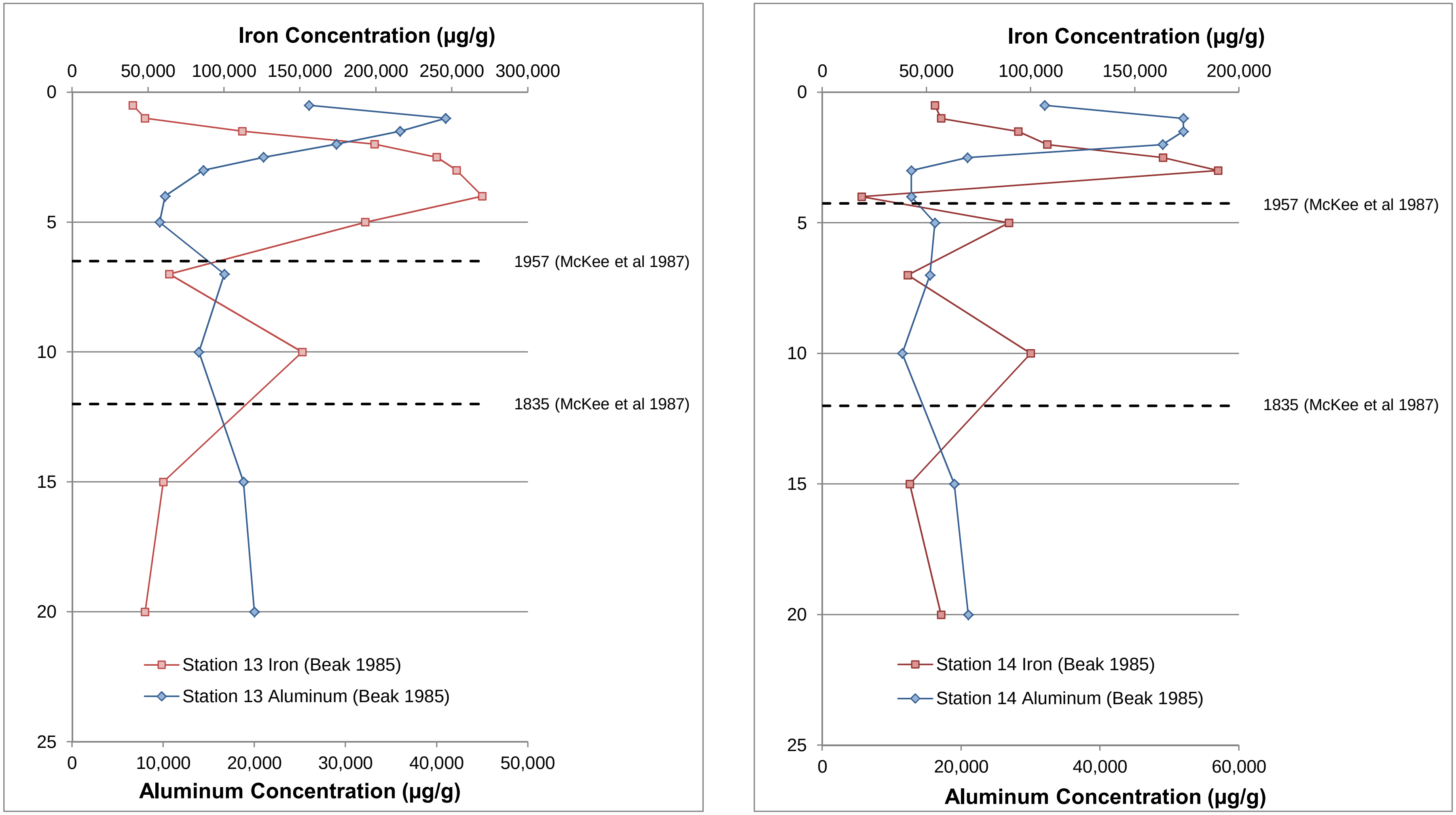


Figure 4.17: The iron and aluminum sediment core concentration profiles for each station from the 1984 study (Beak 1985), in Quirke Lake.

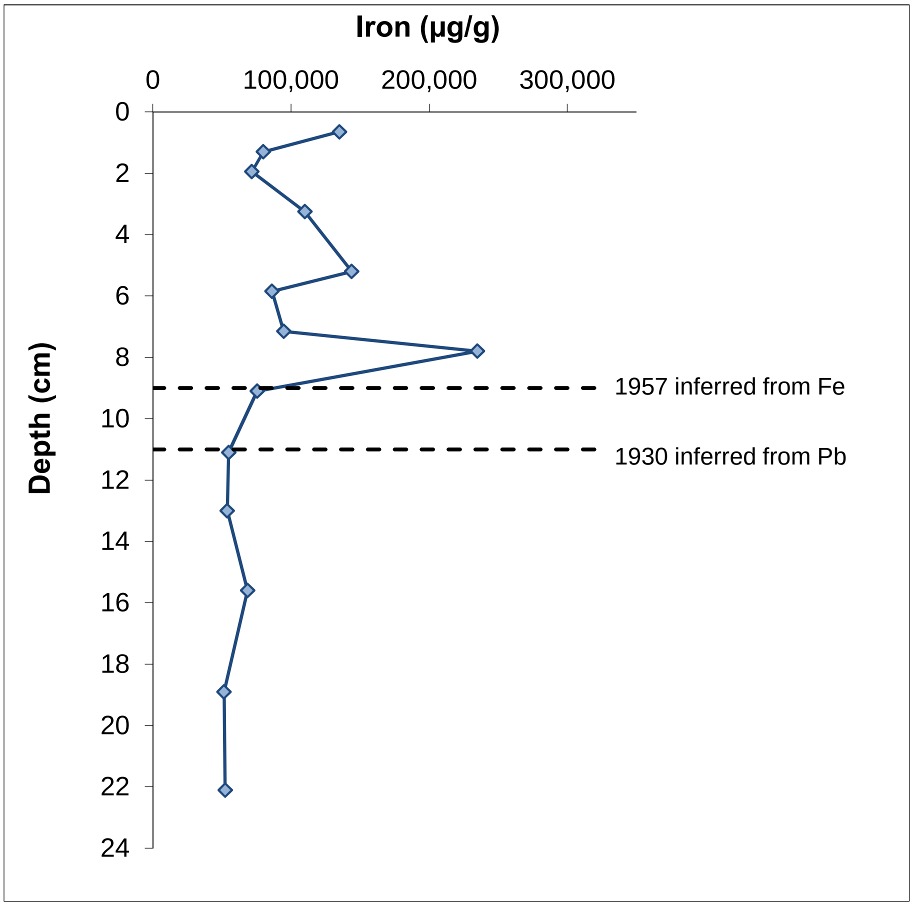


Figure 4.18: The Quirke Lake sediment core iron profile with suggested time markers, May 2012.

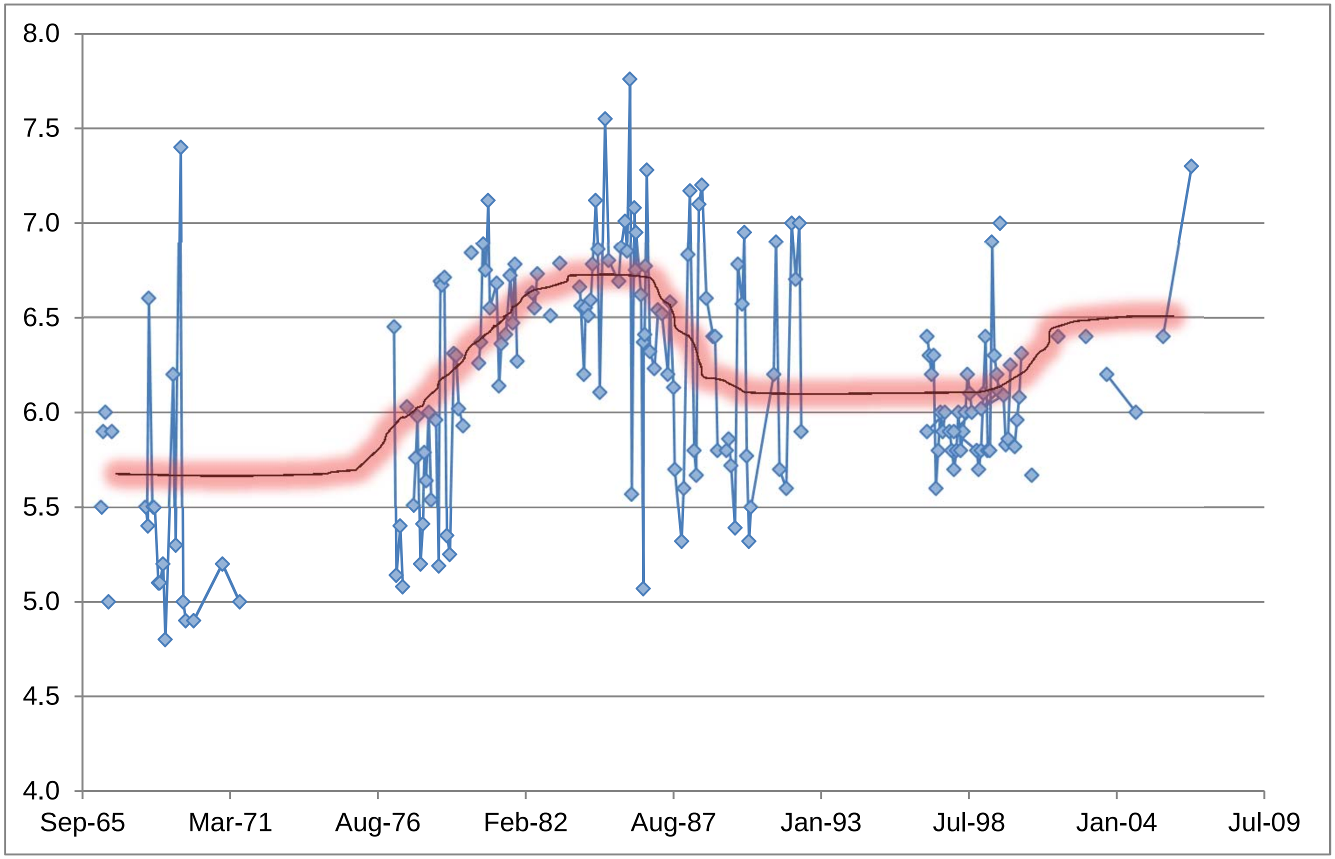


Figure 4.19: The pH of water at Quirke Lake outflow, 1965 to 2009

Indicates general trend in pH.

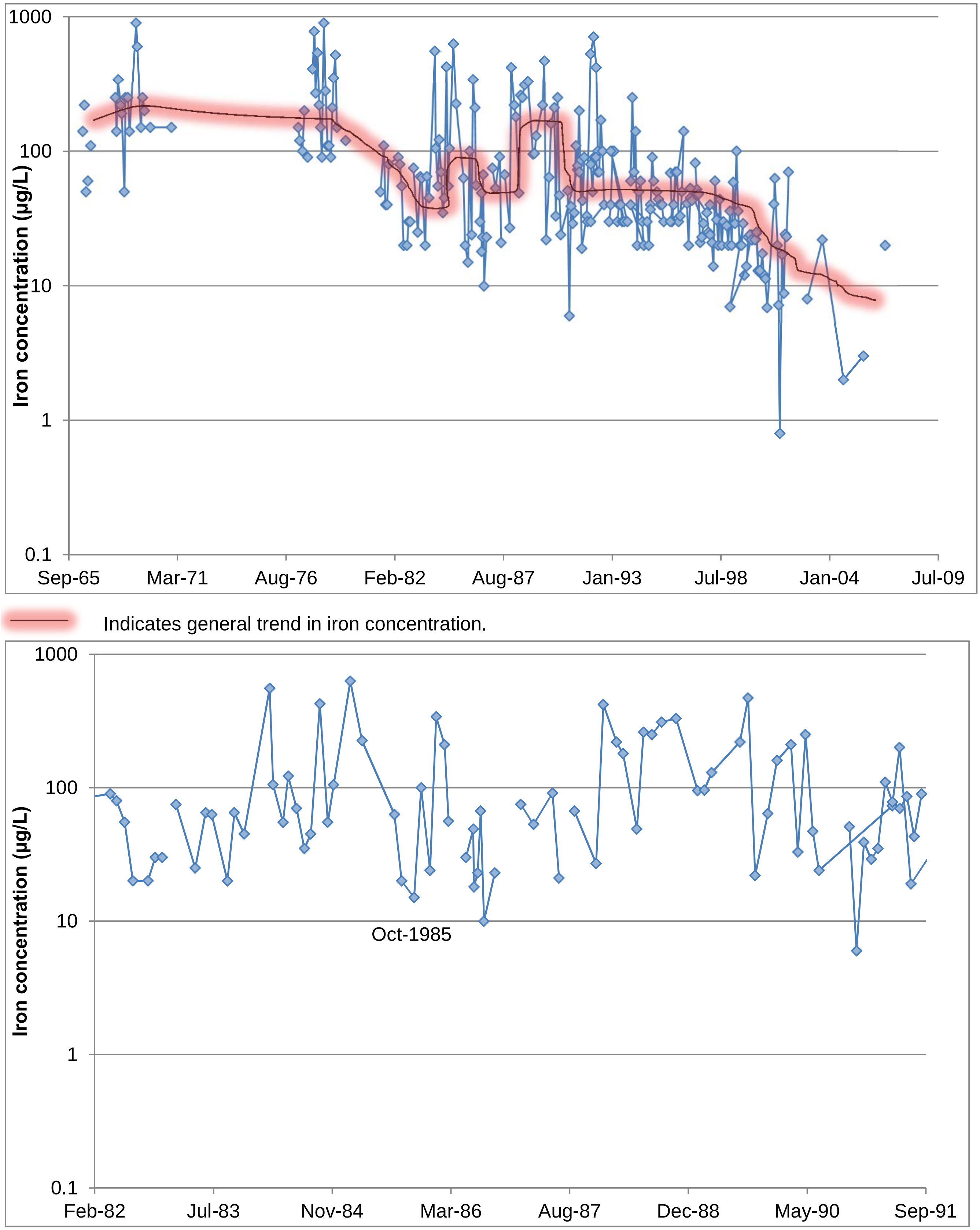


Figure 4.20: Iron concentrations in water at Quirke Lake outflow, 1965 to 2009, note iron concentrations are presented on a log scale.

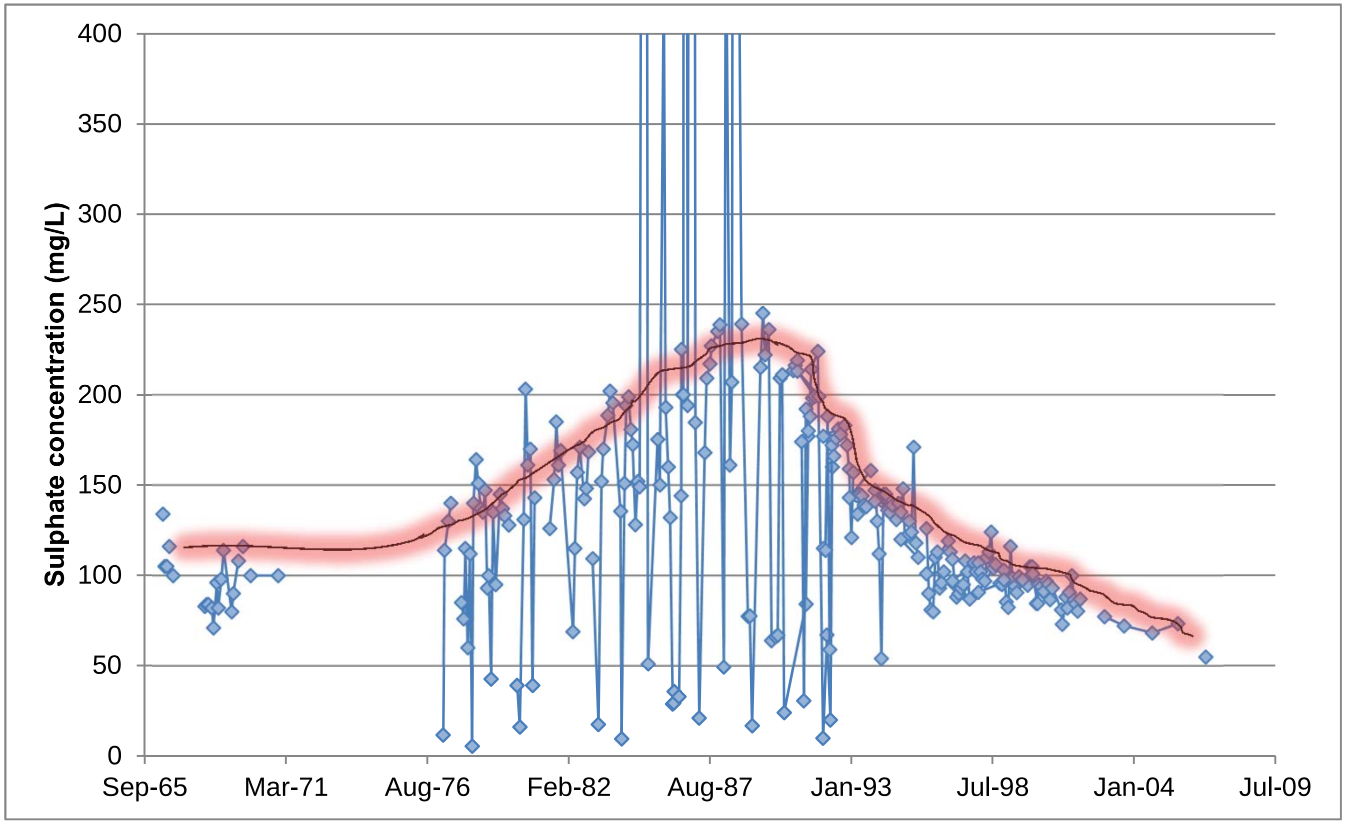


Figure 4.21: The sulphate concentrations in water at Quirke Lake outflow, 1965 to 2009

Indicates general trend in sulphate concentration.

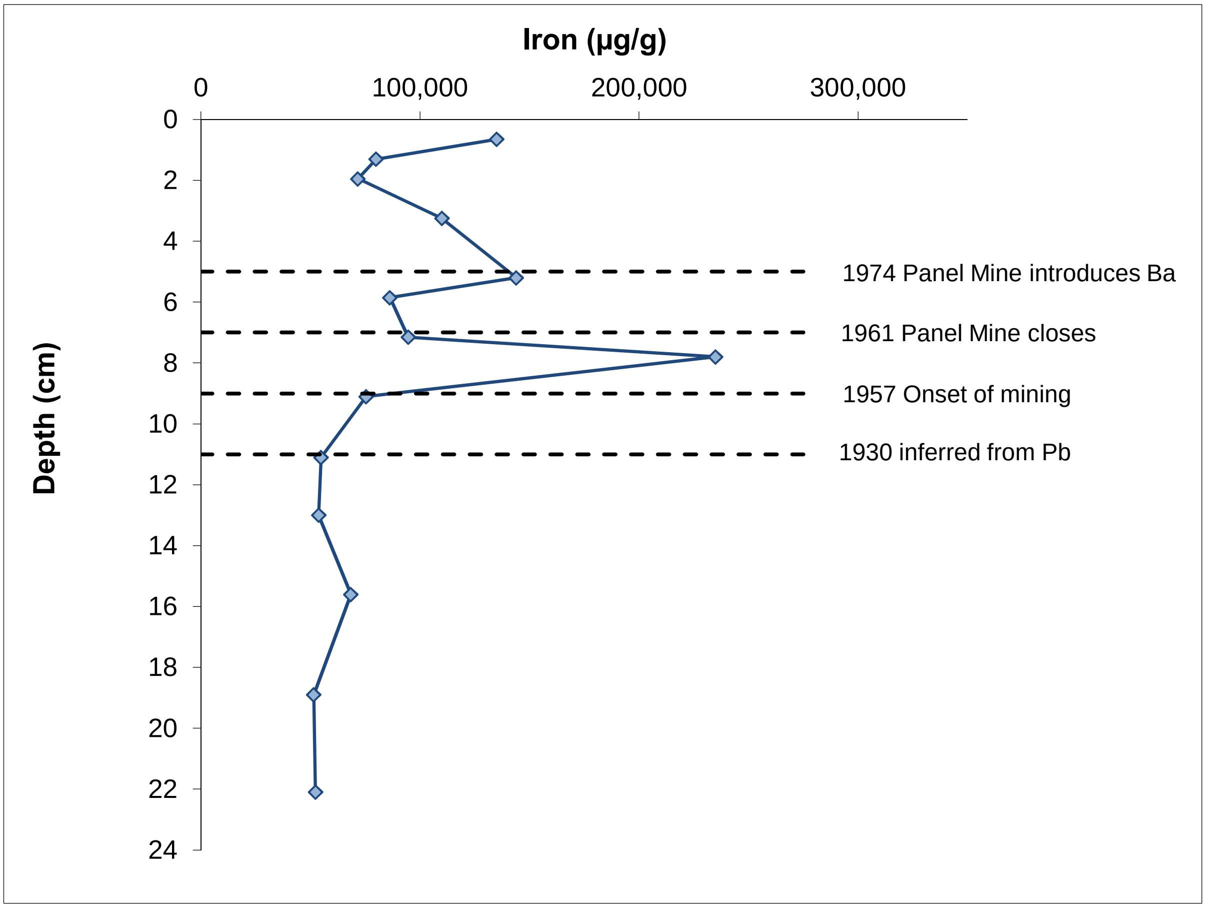


Figure 4.22: The Quirke Lake sediment core iron profile with suggested time markers, May 2012.

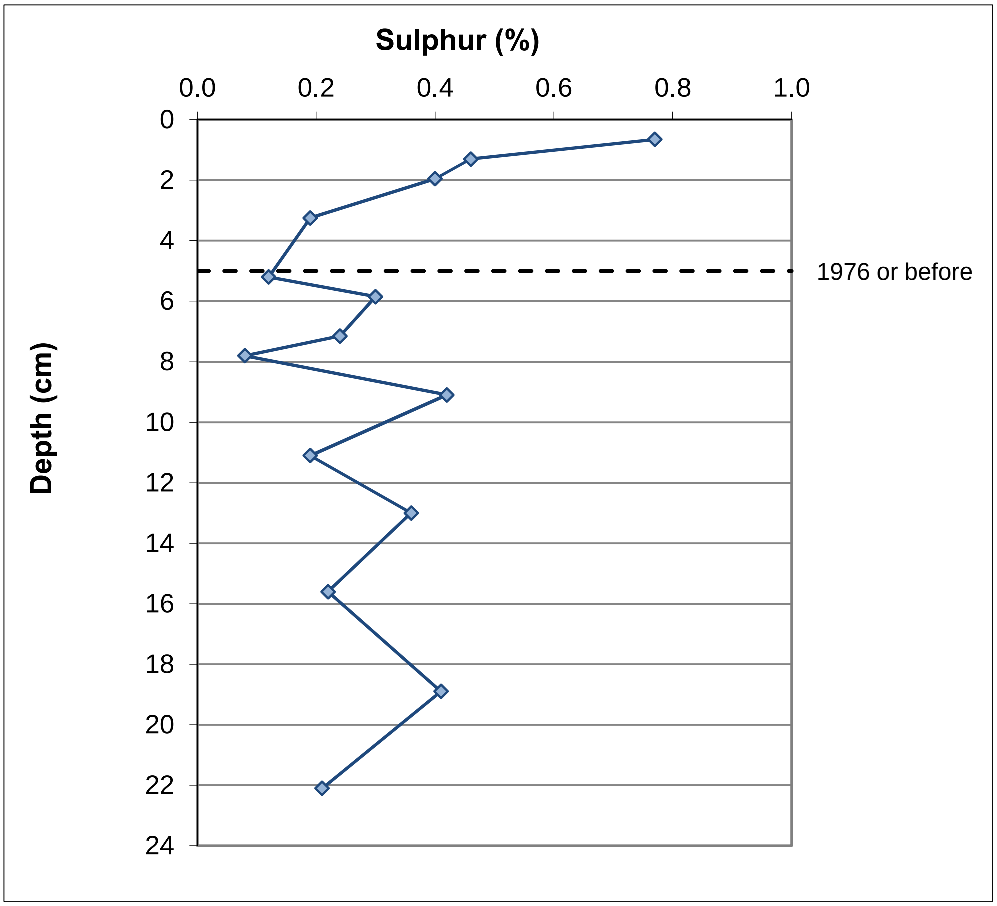


Figure 4.23: The Quirke Lake sediment concentration profile of sulphur, May 2012.

allows a further time marker of around 1976 at 5 cm, and this provides further validity to the placement of the mid-1970s at 5 cm.

During the mid-1980's the iron concentrations in water were increased again (Figure 4.20), potentially corresponding to sediment iron being generally high from 5 to 2 cm (Figure 4.24). This suggests that a time marker of the mid-1980s can be placed from 5 to 2 cm.

In the 1984 core, sediment iron concentrations were in decline in the upper-most layers at stations 13 and 14 (Figure 4.16). In the core collected for the current study, iron concentrations declined to 2 cm, and showed similar iron concentrations to the top most sections of the 1984 core (Figure 4.16). Sediment iron concentrations in the 2012 core then increase at 2 cm. Therefore, the top 2 cm of the 2012 core are potentially associated with sediment deposition after 1984. It can be observed that iron concentrations in water at Quirke Lake outflow declined to a minimum by October 1985, after which time, iron concentrations increased again until mine closure in 1990 (Figure 4.20) adding further evidence to the assigned time marker of 1984-1985 to the 2 cm depth.

By 1990, when the Panel and Quirke Mines were closed, decreases in water concentrations of iron, and sulphate were observed (Figures 4.20 and 4.21). A concurrent decline in sediment iron and sulphur would therefore be expected. In contrast, the lithogenic markers titanium and aluminum, should have increased because of the decrease in mining influence on the lake sediments. However, these patterns are not observed. Instead, sediment concentrations of iron and sulphur are increasing in the top 6 mm of the core, whilst aluminum and titanium are decreasing. Though the decrease in aluminum and titanium could be due to dilution from organic carbon (Famer 1991), it is more likely that they are still being diluted by the increased presence of iron. Although organic carbon was not measured for the Quirke Lake core, the organic content of sediment in Quirke Lake is typically low, due to its low productivity (McKee *et al.* 1987). Therefore, it is possible that the deposition rate in Quirke Lake is so slow that sediment quality improvements expected since 1990 are not yet visible within the resolution of the core sections (*i.e.,* the top 6 mm of core). The most conservative interpretation would be that the top 2 cm have been deposited since 1985. Based on the McKee *et al.* (1987) deposition rates derived for during mining (1.6 mm/yr) and pre-mining (0.31 mm/yr), a further five years of mining (1985-1990) would be expected to result in 8 mm (0.8 cm) of

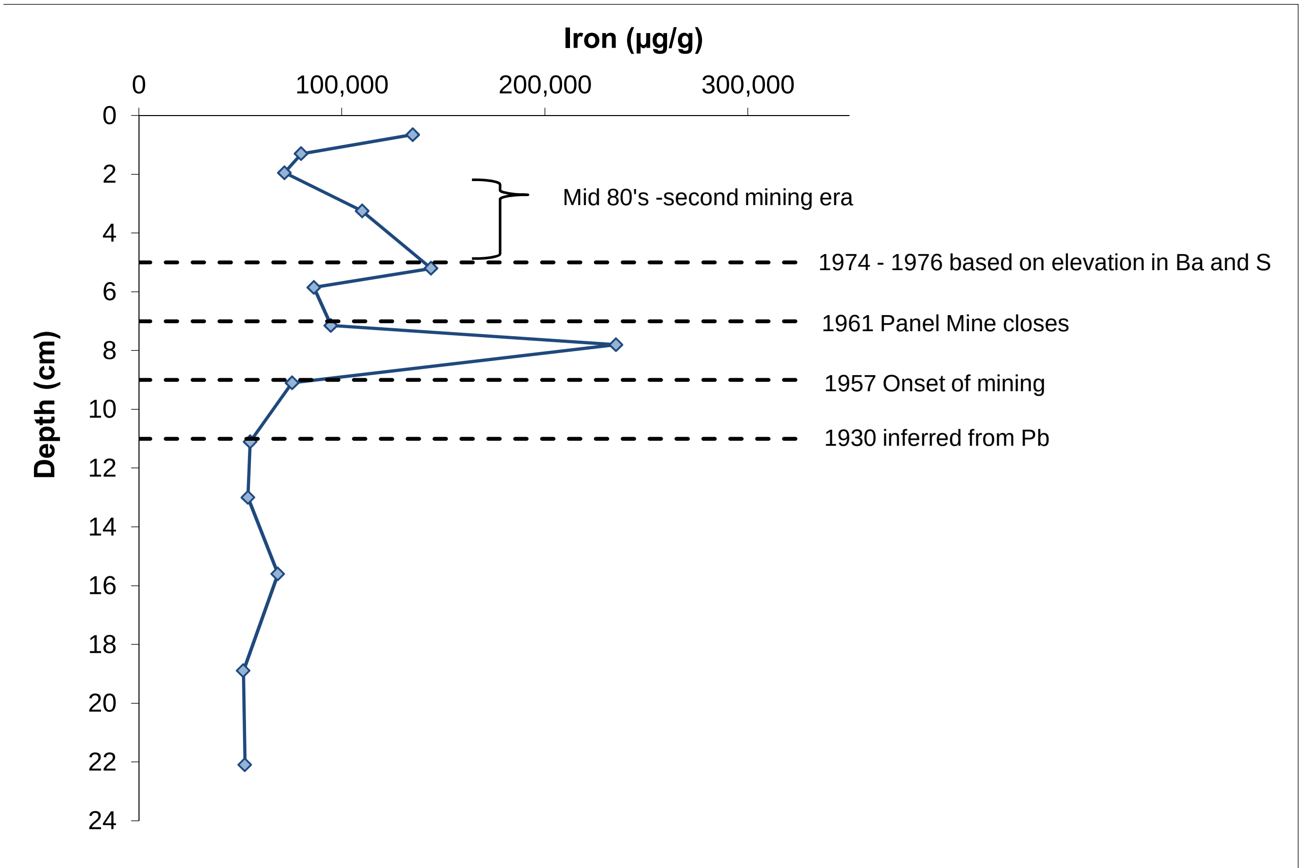


Figure 4.24: The Quirke Lake sediment core iron profile with suggested time markers, May 2012.

sediment deposition, with a further 22 years (1990-2012) of post-mining[2] deposition (*i.e.,* 22 years at 0.31 mm/yr) resulting in 7 mm (0.7 cm). This totals a calculated deposition of 15 mm (1.5 cm) in 28 years (though not allowing for sediment compaction), which is consistent with the interpreted 20 mm (2 cm) of sedimentation since 1985 based on the iron concentration profile and supporting evidence. Furthermore, since the top most section does not reflect the expected change in sediment quality since water quality improved in 1990, then the latest time period for the top most section would be 1990. This time marker would provide a deposition rate since 1990 of 6 mm in 22 years, resulting in a calculated deposition rate of 0.3 mm/yr, also consistent with the pre-mining deposition rate derived by McKee et al (1987). A summary of all time-markers with the iron sediment concentration profile also illustrates that these dates are generally consistent with each other (Figure 4.25). Therefore, the deposition rate of currently depositing sediment in the eastern deep basin of Quirke Lake is estimated at 0.3 mm/yr, or the accumulation of 1 cm of sediment in about 33 years; a very slow deposition rate, but consistent with previous studies (McKee *et al.* 1987).

4.3 Nordic Lake

4.3.1 Nordic Lake Sediment Trap Chemistry

Sediment traps were deployed at one station in Nordic Lake on 3rd May, 2012, and at two stations on 6th May, 2012. Sediment traps from all stations were retrieved on the 2nd October, 2012. The water in the traps was combined for each station, as was the material, ultimately providing one replicate for each station. Sediment traps that were considered compromised over the deployment period (or during retrieval) were not used (see Table 4.5).

When compared to Nordic Lake SRWMP Cycle 3 sediment quality, sediment trap material had decreased concentrations in four of seven of the mine-related metals (Table 4.4). Of the three metals that have increased since 2009 (barium, nickel and manganese), only manganese showed a large increase. Treated effluent that comes into Nordic Lake is originally from the vegetated tailings management areas (Lacnor and Nordic) and from Buckles Wetland that contained historical treatment sludge. It is possible that currently depositing barium is associated with historical tailings seepage from the wetland. This would likely be due to reducing conditions (probably seasonal) where barium sulphate precipitates dissolve through microbially mediated reductive dissolution, allowing for

[2] It would be expected that post-mining deposition rates are equivalent to pre-mining deposition rates.

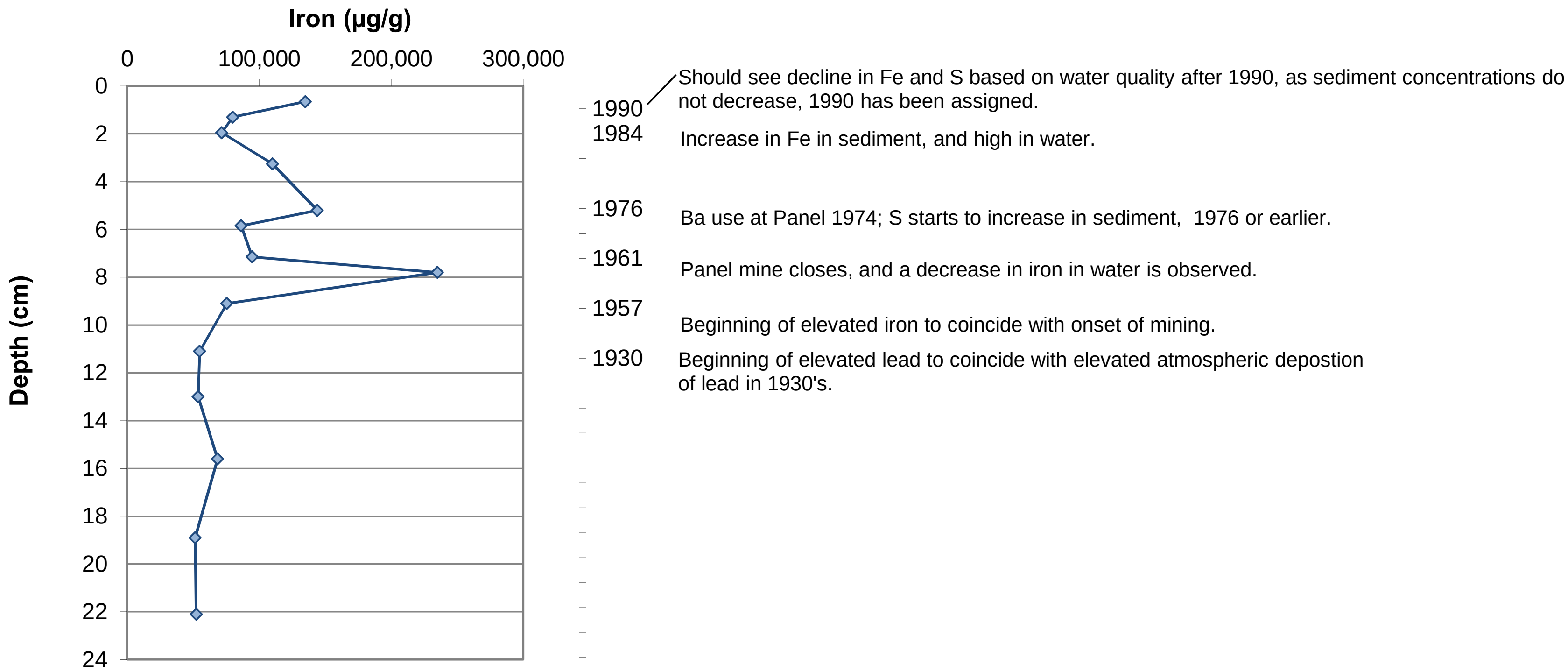


Figure 4.25: Summary of Quirke Lake timeline and main justification compared to the profile of iron in sediment.

Table 4.4: Metal concentrations of material collected from sediment traps deployed from May to October, 2012 in Nordic Lake.

Analyte	Units	Background[a]	LEL	SEL	Nordic Lake Sediment 2009[b]	2012 Sediment Trap Mean	Percent decrease from 2009
Aluminum	mg/kg					10,472	
Antimony	mg/kg					0.597	
Arsenic	mg/kg					14.9	
Barium	mg/kg	481	--	--	294 (390)	346	Increased
Beryllium	mg/kg					0.408	
Boron	mg/kg					9.09	
Cadmium	mg/kg					0.94	
Chromium	mg/kg					18.3	
Cobalt	mg/kg	28.3	--	--	109 (150)	88.1	19.2
Copper	mg/kg					37.6	
Iron	mg/kg	54,783	20,000[d]	40,000[d]	69,000 (110,000)	39,666	42.5
Lead	mg/kg					38.25	
Manganese	mg/kg	6,918	460[d]	1100[d]	19,460 (26,000)	39,337	Increased
Molybdenum	mg/kg					5.10	
Nickel	mg/kg	29.7	23.4	484	44.0 (52)	68.79	Increased
Selenium	mg/kg					1.35	
Silver	mg/kg					0.126	
Strontium	mg/kg					37.30	
Thallium	mg/kg					0.252	
Tin	mg/kg					1.10	
Titanium	mg/kg					685	
Uranium	mg/kg	6.5	104.4	5,874	154 (220)	93.7	39.2
Vanadium	mg/kg					26.3	
Zinc	mg/kg					202	
Radium-226	Bq/g	0.27	0.6[c]	14.4[c]	4.78 (6.8)	1.50	68.7

Exceeds mean concentrations from Nordic Lake 2009 sediment concentrations.

[a]Upper background concentrations were calculated as the mean plus 2.145x standard deviation of sediment concentrations (Minnow 2011).

[b]Concentrations represent mean value where n=5, values in parentheses represent the maximum value.

[c]Values used to screen lakes, based on Thompson et al. 2005

[d]Provincial Sediment Quality Guidelines (MOE 1993)

LEL is lowest effect level; SEL is severe effect level barium to migrate into Nordic Lake[3]. Manganese may be increasing in currently depositing sediments via a similar mechanism to barium (*i.e.,* reductive dissolution); but different from iron, as the iron concentration in currently depositing sediment is not increasing. Manganese reduction is faster than that of iron, and once reduced and solubilized its re-oxidation and resulting precipitation is significantly slower than iron (Martin 2005). Therefore, while iron may re-precipitate prior to release into Nordic Lake, manganese may take a sufficiently longer period of time for it to escape to Nordic Lake. Manganese oxidation (and precipitation) becomes significantly faster at pH values of greater than eight (Martin 2005). The pH of water at N-12, the source area monitoring program surface water station that is upstream of inflow to Nordic Lake ranged 6 to 7.5 from 2005 to 2009 (Minnow 2011), therefore, depending on the flow regime, it is possible that reduced manganese could be transported to Nordic Lake before it can oxidize and precipitate.

Despite increased concentrations in sediment trap chemistry for barium, manganese and nickel, currently depositing sediment quality is improving in general (*i.e.,* cobalt, iron, uranium, and radium-226).

4.3.2 Nordic Lake Sediment Trap Deposition Rates

The dry weight amount of sediment collected from each trap was combined within a station[4]. This dry weight was used, in combination with the deployment period, as well as the diameter of the mouth of the trap, to calculate current deposition rates at the SRWMP Cycle 3 benthic invertebrate community stations of Nordic Lake. Current deposition rates for un-compacted surface material were calculated for each station (Table 4.5). Annual thickness of sedimentation among stations were more variable with the northern-most sediment trap station (NL-12-02; Figure 2.3) having the greatest deposition rate of 1 mm/yr. This deposition was likely the highest because it was in closest proximity to the dominant inflow point for Nordic Lake. The other two sediment trap stations (NL-12-03 and NL-12-04) were located downstream of the deep basin and the most significant inflow to Nordic Lake. These traps had more consistent thickness of sedimentation of 0.67 and 0.55 mm/yr respectively. These sedimentation rates indicate that, while Nordic Lake has

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[3] While the barium concentrations in the sediment traps from Nordic Lake were greater than those observed in the 2009 SRWMP they remained less than the SRWMP background values. The radium-226 concentrations in the same sediment traps were found to be less than those observed in Nordic Lake as part of the 2009 SRWMP, suggesting that radium-226 concentrations are decreasing overtime.

[4] Calculations followed those described for McCabe Lake.

Table 4.5: Sedimentation rates calculated from sediment traps deployed in Nordic Lake May to October, 2012.

		Nordic Lake Sediment Trap Station		
Parameter	**Units**	**2**	**3**	**4**
Date of deployment		6-May-12	3-May-12	6-May-12
Date of Retrieval		2-Oct-12	2-Oct-12	2-Oct-12
Number of traps		3	5	5
Number of days deployed	days	149	152	149
Area of one funnel	m^2	0.044	0.044	0.044
Number of traps		3	5	5
Total Area	m^2	0.133	0.222	0.222
Total dry weight	g	12.66273	13.57524	8.590545
Dry bulk density	kgm^{-3}	220	218	173
Sedimentation rate	$gm^{-2}yr^{-1}$	**232.58**	**146.65**	**94.67**
Annual accumulation thickness	$mmyr^{-1}$	**1.06**	**0.67**	**0.55**

the greatest deposition rates of the three study lakes (McCabe Lake, Quirke Lake and Nordic Lake), sedimentation at these 15 m stations is not substantial. Based on the mean deposition rates (0.76 mm/yr), it would take 13 years to accrue 1 cm of new sediment. Based on the most rapidly depositing benthic station it would take ten years to achieve the same sediment material.

4.3.3 Nordic Lake Deep-basin core profile

As with McCabe and Quirke Lakes, the interpretation of the Nordic Lake sediment core used a weight of evidence approach. The deep-basin sediment core metal profile interpretation used sediment analytes that are not subject to post-depositional migration (*i.e.,* ^{137}Cs and ^{214}Pb, for an explanation of ^{214}Pb see below), as well as stable lead and barium that were determined to be not influenced by diagenetic processes.

An additional radionuclide measured during analysis of this sediment core was ^{214}Pb. ^{214}Pb is a very short-lived radionuclide (half-life of 27 minutes) in the ^{238}U decay series. Analysis of ^{214}Pb using gamma spectroscopy typically has high background interference rendering the measurement unreliable. However, in lakes influenced by uranium mining ^{214}Pb activities are sufficiently above background to be a useful parameter (*i.e.,* 20 to 50 times the background; Robert Flett, PhD, pers comm.). In this case, ^{214}Pb activity is useful because it can be used as a proxy for ^{226}Ra. ^{226}Ra is a pre-cursor to ^{214}Pb in the ^{238}U decay chain. As ^{214}Pb is very short lived (and ^{226}Ra is very long-lived) it can be assumed that ^{226}Ra and ^{214}Pb are in secular equilibrium (Evans 1955). Therefore, relative changes in ^{214}Pb activity reflect the relative changes in ^{226}Ra activity and ^{214}Pb activity can be used as an approximation for ^{226}Ra activity when the ^{214}Pb activities are elevated (*i.e.,* influenced by uranium mining).

The Nordic Lake sediment core was collected at 26.5 m depth in the eastern basin of Nordic Lake (Figure 2.3) on 3rd October, 2012. The core was 48 cm long and showed a black surface layer of about 5 cm on top of a grey-black layer from 5 to 11 cm. The remaining deeper sediment was primarily grey in colour and showed some black streaking (Photographs 8 and 9, Appendix B). The top black sediment is suggestive of reduced sediments, which upon slicing were accompanied by the odour of sulphides, confirming reduced conditions in the sediment[5]. As a more productive lake (compared to McCabe

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[5] Reduced sediments were only observed in Nordic Lake and thus a discussion of the possible implications of reducing conditions on sediment core profiles is provided for Nordic Lake where it was not discussed for the other two lakes assessed.

and Quirke Lakes), the sub-oxic to anoxic conditions in the sediment were not unexpected. However, the lake is shallow enough for complete mixing to occur in the spring and fall, such that the overlying water would provide oxygen to the sediment surface layer, this is important because it provides the potential for sediment to be oxidized during seasonal cycling. Therefore the surface sediments likely undergo seasonal cycling between oxidizing and reducing conditions and diagenesis can occur.

Diagenesis refers to the process where over time (and with depth) sediment chemistry changes due to microbial activity. Sediments containing organic carbon become reduced as oxygen is used up by the degradation of organic matter by micro-organisms. As the depth from the sediment surface increases, sediments become sub-oxic to anoxic, whereby the abundant redox-active metals, iron and manganese, become soluble, and diffuse along a concentration gradient up the core to the overlying water, or to the point in the sediment where oxygen is present. Once in oxidizing conditions they precipitate out as amorphous hydrous iron and manganese oxides (iron manganese oxyhydroxides). Many trace metals are also subject to post-depositional migration processes that are brought about by diagenesis. This is because these metals adsorb to amorphous iron and manganese oxyhydroxides and re-dissolve when the oxyhydroxides are reduced. This post-depositional migration of metals means that iron and manganese (and other metals associated with this process) may not be used as a historical record of lake deposition and contamination within this lake.

The sediment sections throughout the profile contained about 10 % total organic carbon (Appendix Table D.10) which is a sufficient concentration for reducing conditions to occur. In reducing sediments, as is likely the case for this core, iron and manganese may be diffusing into the water column, or more likely, rendered insoluble as metals sulphides, as indicated by the observed odour while sectioning the core. The sediment core concentration profiles of iron and manganese are very similar, showing a maximum at the sediment-water interface (Figure 4.26) and indicative that they are controlled by the same process (post-depositional migration). Most trace metals have the potential to be associated with iron and manganese post-depositional migration (Tessier *et al.* 1996; Williams 1992). Metals that are not considered to particularly associate with iron and manganese oxyhydroxides are lead, zinc, copper, and cadmium, although typically it also depends on additional factors such as the presence of humic acids (Graham and Farmer 2007).

Bioturbation is not suspected in the top sections of the sediment core. Typically bioturbation will occur in oxidized sediments, since organisms require oxygen to function.

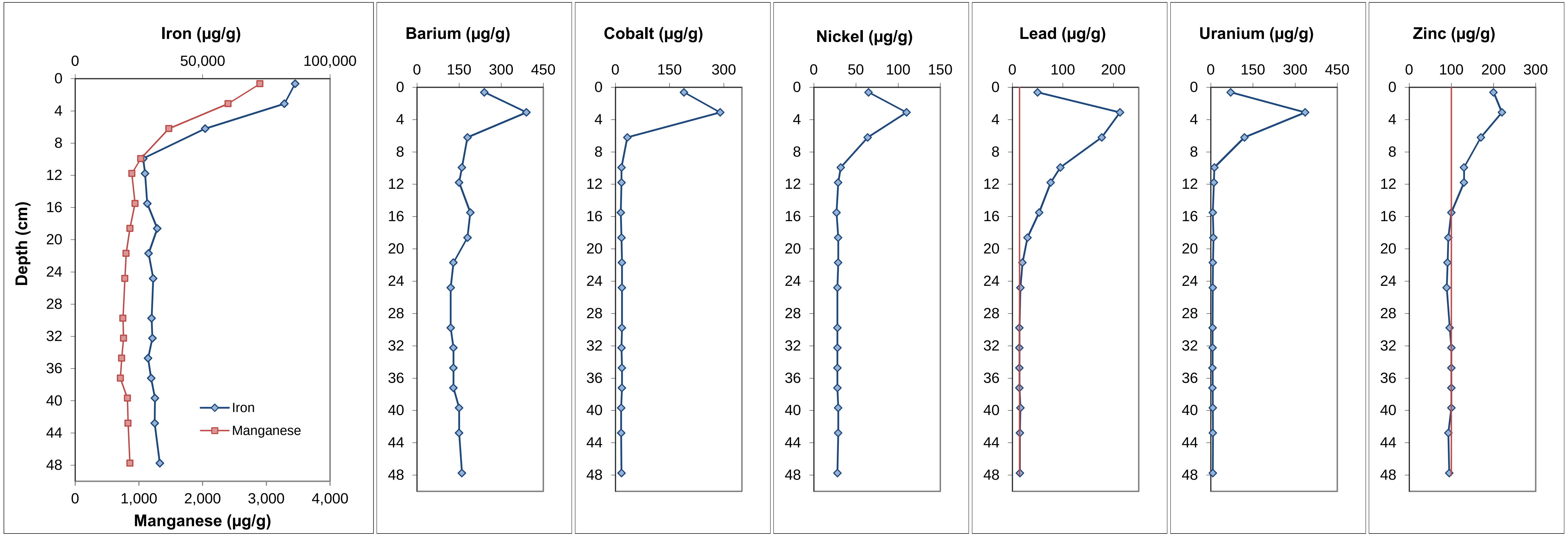

Figure 4.26: The iron and manganese sediment core concentration profiles compared to those of other trace metals, Nordic Lake, October 2012. Red lines indicate background concentrations.

Furthermore, homogeneity of sediment (*i.e.,* uniform metal concentrations in the top sections of the core) is not observed (Figure 4.26).

As with Quirke Lake, the onset of elevated stable lead (15.5 cm; Figure 4.26), can be assigned a time marker estimate of 1930. This is based on the increase in industrialization in the 1920's through to the 1940's which caused increased atmospheric deposition of lead. Elevated sediment lead concentrations were observed in this time period (1920's to 1940's) in a Lake Erie sediment core (Graney *et al.* 1995; Appendix Figure D.2).

A profile of ^{137}Cs activity in sediment indicated a significant peak at 5.6 cm (Figure 4.27), with an assigned date of 1963 (Flett Research Inc.). This was the year of the maximum atmospheric input of ^{137}Cs due to nuclear testing. Although lower ^{137}Cs activities can be observed at deeper than 5.6 cm; some downward migration can be expected (Crusius and Anderson 1995). In general, ^{137}Cs is not subject to upward post-depositional migration and therefore this time marker is considered reliable.

A profile of ^{214}Pb activity shows elevation at 7.4 cm, increasing to a peak at 5.6 cm (Figure 4.28). As ^{214}Pb can be considered a proxy for ^{226}Ra, the peak in ^{214}Pb is most likely indicative of mining activity. Although ^{226}Ra and barium can become associated with iron and manganese oxyhydroxides (Farmer 1991), the profile of both ^{214}Pb (proxy for ^{226}Ra), and barium (chemically similar behaviour to ^{226}Ra) do not match that of iron and manganese, therefore it is not expected that barium, or ^{226}Ra (and therefore ^{214}Pb) are subject to post-depositional migration. The onset of elevated ^{214}Pb at 7.4 cm provides a time marker for the beginning of mining activity which started in 1957.

An overlay of ^{214}Pb (proxy for ^{226}Ra) with barium indicates that the ^{214}Pb and barium peaks occur at different depths in the core; barium peaked at 3.1 cm and ^{214}Pb peaked at 5.6 cm (1963 based ^{137}Cs; Figure 4.29). ^{226}Ra decreased in activity at core depths less than 5.6 cm along with a congruent increase in sediment barium. The increase in barium and corresponding decrease in ^{226}Ra can be explained by the use of barium chloride between 1965 and 1975 to treat effluent for ^{226}Ra. The onset of barium occurred after 6.2 cm suggesting that 1965 occurred at a depth shallower than 6.2 cm (consistent with ^{137}Cs). The sediment barium concentration starts to decrease at 3.1 cm, likely associated with the cessation of barium chloride treatment in Buckles Creek in 1975. The decrease in barium that starts at 3.1 cm, provides a time marker of 1975. When normalized to aluminum (which corrects for dilution in the top section by organic carbon; Farmer 1991) it can be seen that barium does not decrease to background (Figure 4.30). This is likely because barium treatment continued at the effluent treatment plant and, the 1970's barium that is

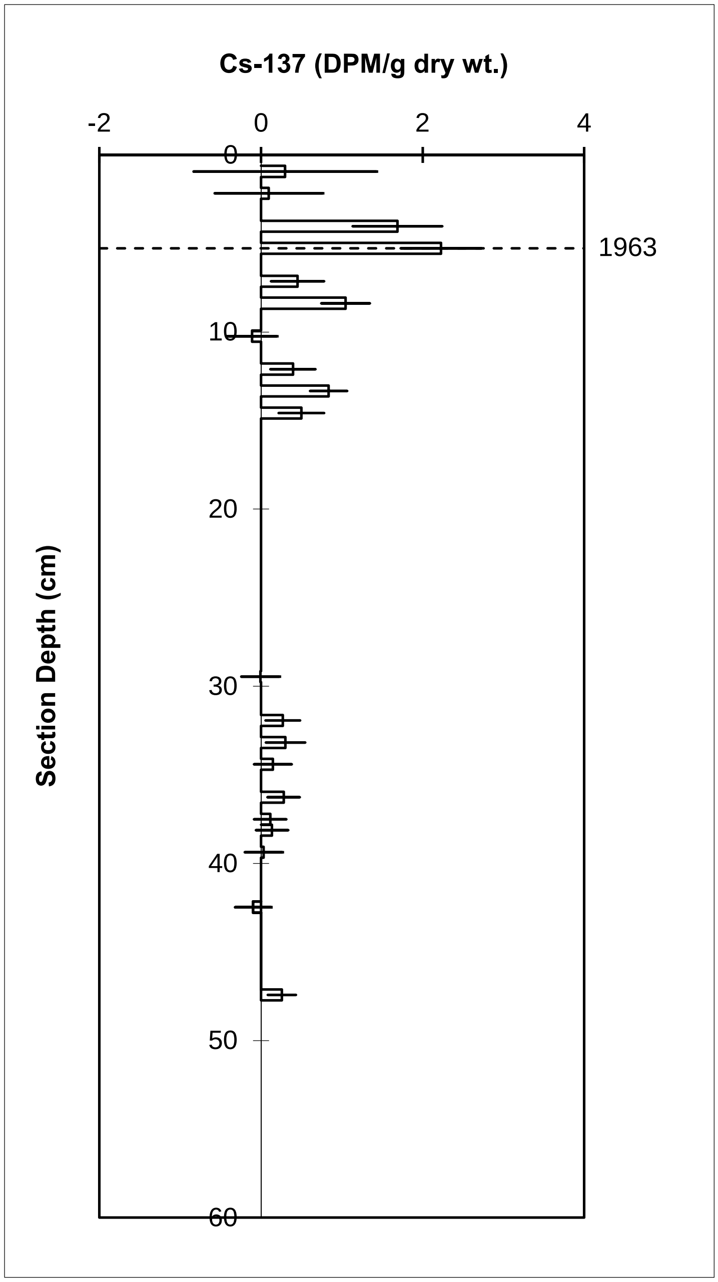

Figure 4.27: The ^{137}Cs activity profile in the sediment core collected from Nordic Lake, October 2012.

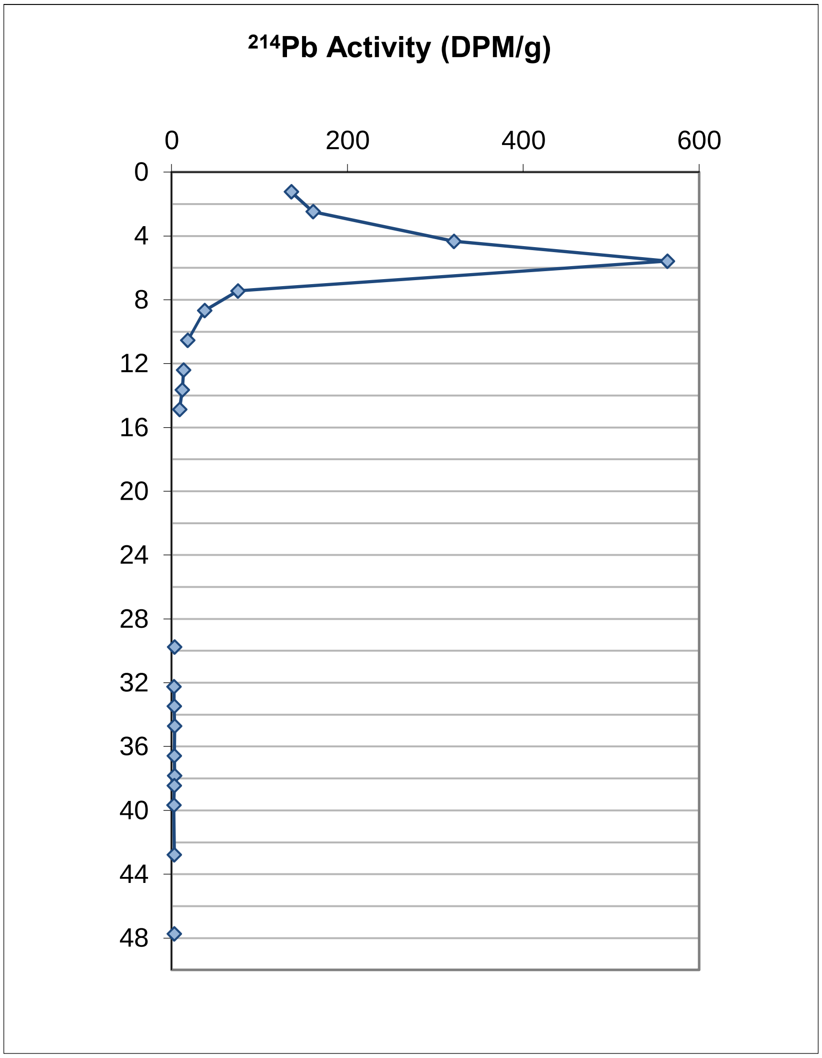

Figure 4.28: The ^{214}Pb activity profile in the sediment core collected from Nordic Lake, October 2012.

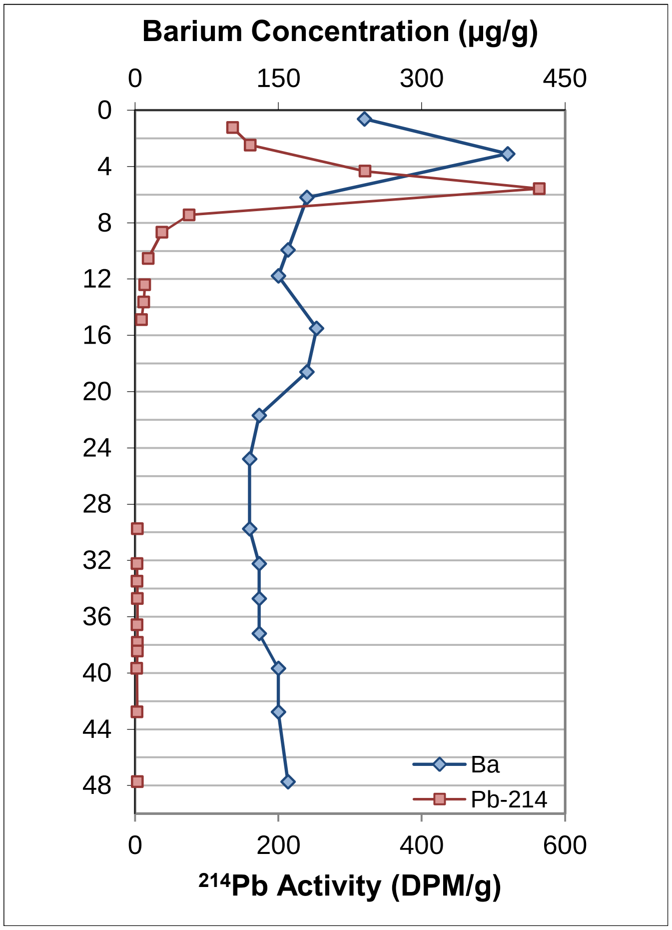

Figure 4.29: The barium concentration and ^{214}Pb activity profiles in the Nordic Lake core, October, 2012

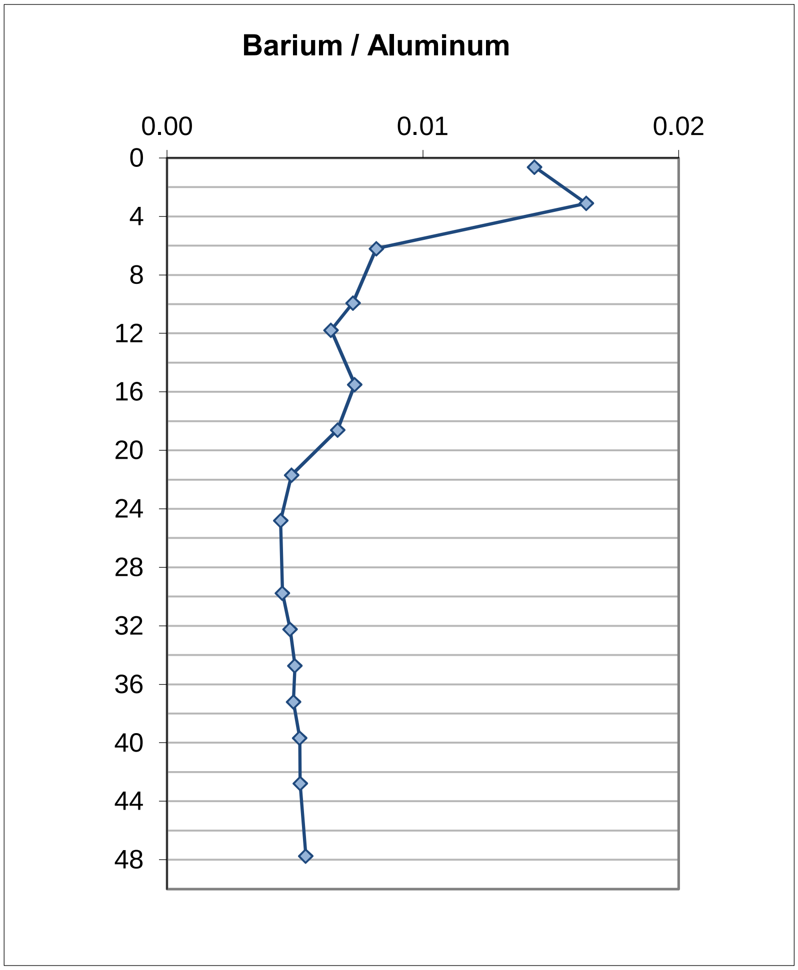

Figure 4.30: The barium sediment core concentration profile when normalized to aluminum (µg/g ratios), Nordic Lake, October 2012

associated with historical Buckles Wetland treatment sludge may still continue to deposit on a seasonal basis.

Above 3.1 cm both barium sediment concentration and ^{214}Pb activity decrease. The continued decrease in ^{214}Pb activity is potentially due to the reclamation and vegetation of the tailings management areas in 1974. A decrease in ^{214}Pb activity could be expected when the TMAs were vegetated, because the strategy behind the vegetation of tailings is to decrease the oxygen penetration to the tailings materials (Paktunc and Davé 2002). Oxygen reacts with pyritic tailings to dissolve the iron sulphide mineral, and release any other associated metals (including ^{226}Ra). In addition, although the exact time period is not covered, a decreasing trend in iron concentrations in Nordic Lake effluent can be observed from 1977 onwards (Figure 4.31) suggesting that water quality, was improving at around this time likely associated with the onset of improved treatment. Therefore, it is reasonable that ^{226}Ra activities may also be decreasing at this time. The ^{214}Pb profile suggests a time marker of 1974 at 2.5 cm and the barium concentration profile suggests a time marker of 1975 at 3.1 cm, therefore a final time marker of 1974 at 2.8 cm was used. A summary of all time-markers with the barium sediment concentration and the ^{214}Pb activity profile illustrates that these dates are consistent (Figure 4.32).

The increase in atmospheric deposition of stable lead at 15.5 cm provided the first time marker of 1930, though this time marker is largely estimated. This was followed by the onset of mining in 1957, identified using the beginning of elevated ^{214}Pb at 7.4 cm, which would result in the deposition of 8.1 cm of sediment in 27 years, providing a pre-mining deposition rate of 3 mm/yr.

The onset of mining in 1957 at 7.4 cm combined with the 1963 time marker from the ^{137}Cs profile at 5.6 cm indicated a deposition rate of 3 mm/yr during mining. This indicates that the pre-mining deposition rate was as high as the during-mining deposition rate. However, the pre-mining deposition rate may be high due to the uncertainty associated with the 1930 time marker or due to other activities that occurred in this era, such as logging and highway construction that would also increase deposition rate. Furthermore, the mining impact on the deposition rates of Nordic Lake was likely not as substantial as that for McCabe and Quirke Lakes, since the mills were operational for a shorter period of time (Table 3.1) and the inflow to Nordic Lake inflow was buffered by the capacity of the upstream wetland. As such, during mining deposition rates in Nordic Lake may be expected to be lower compared to other lakes. The relatively low impact of mining on Nordic Lake deposition rates is reflected in the bulk density profile which generally increases with depth as is typical of pristine lakes (Figure 4.33); mining can result in large

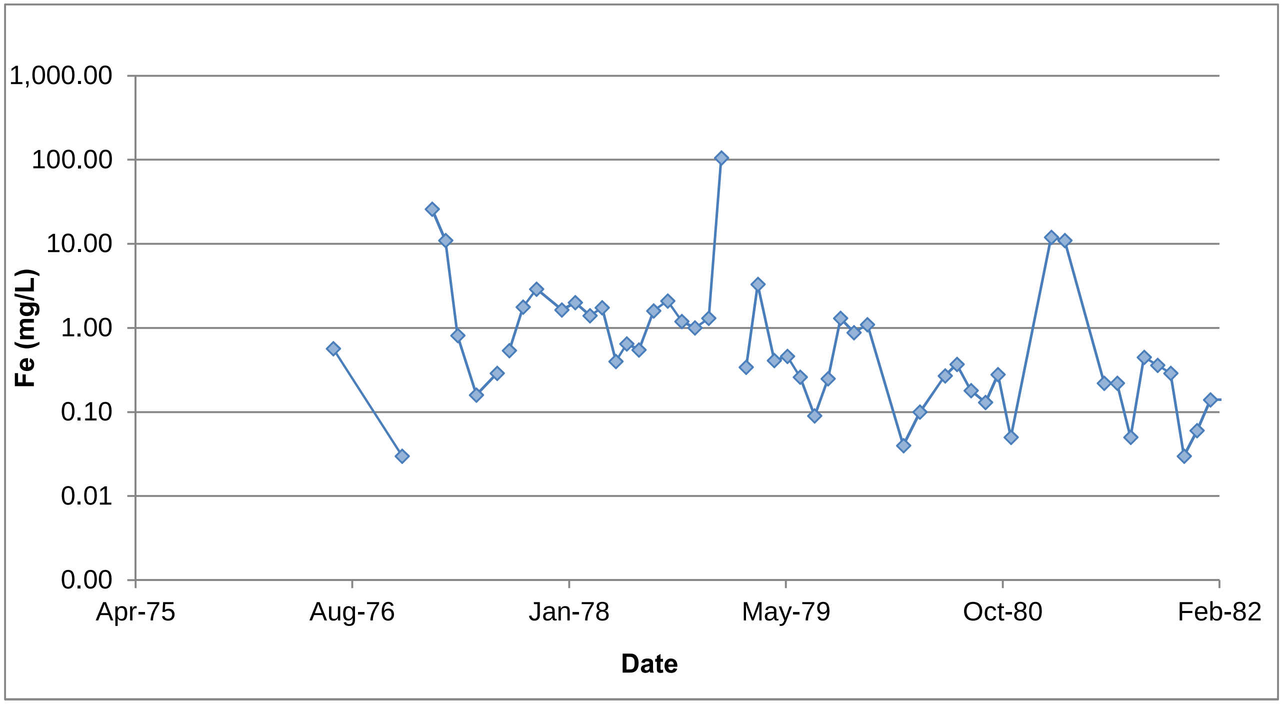

Figure 4.31: The concentration of iron in Nordic Lake effluent from 1976 to 1982.

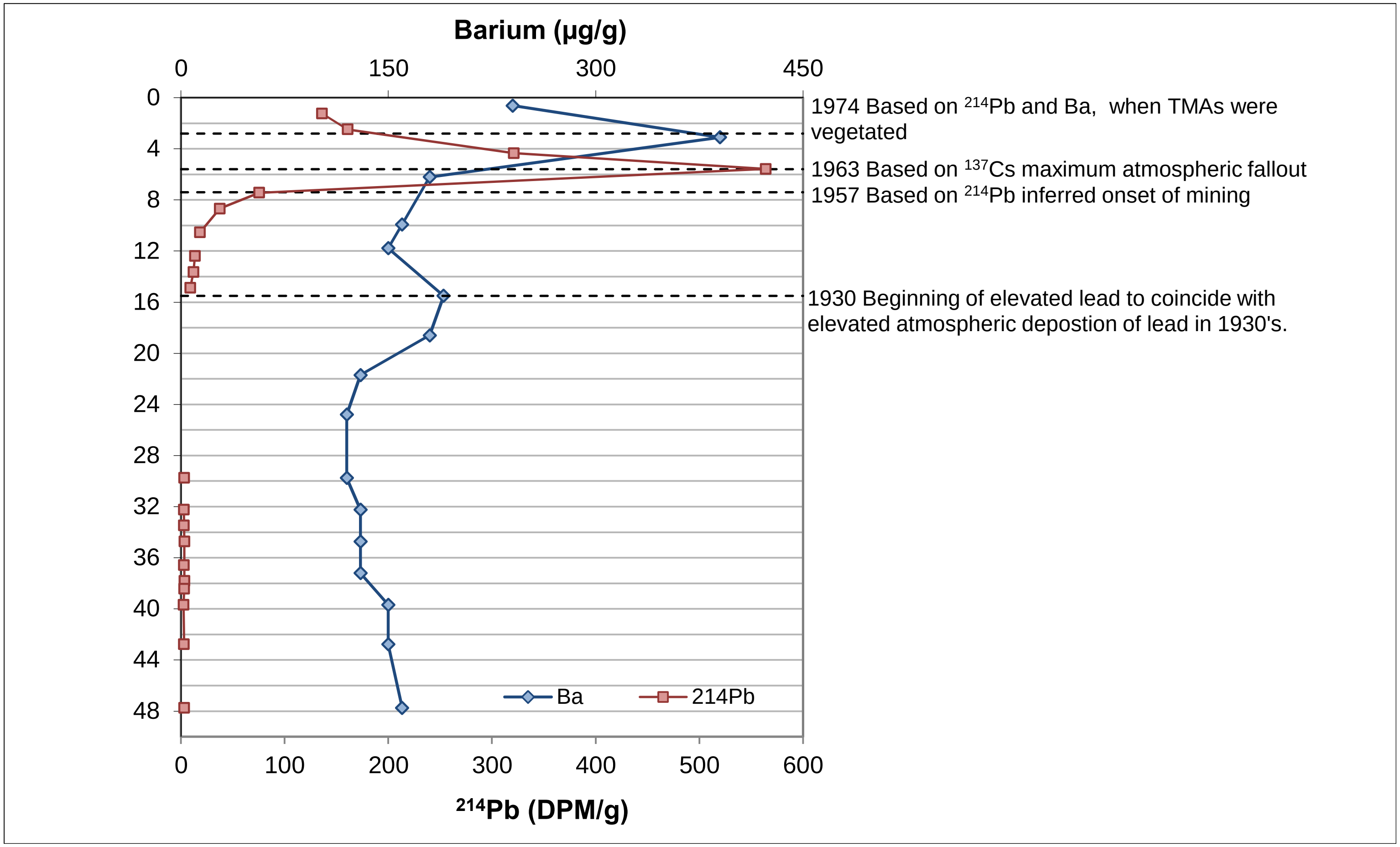

Figure 4.32: Summary of Nordic Lake timeline and main justification compared to the profiles of barium and ^{214}Pb in sediment.

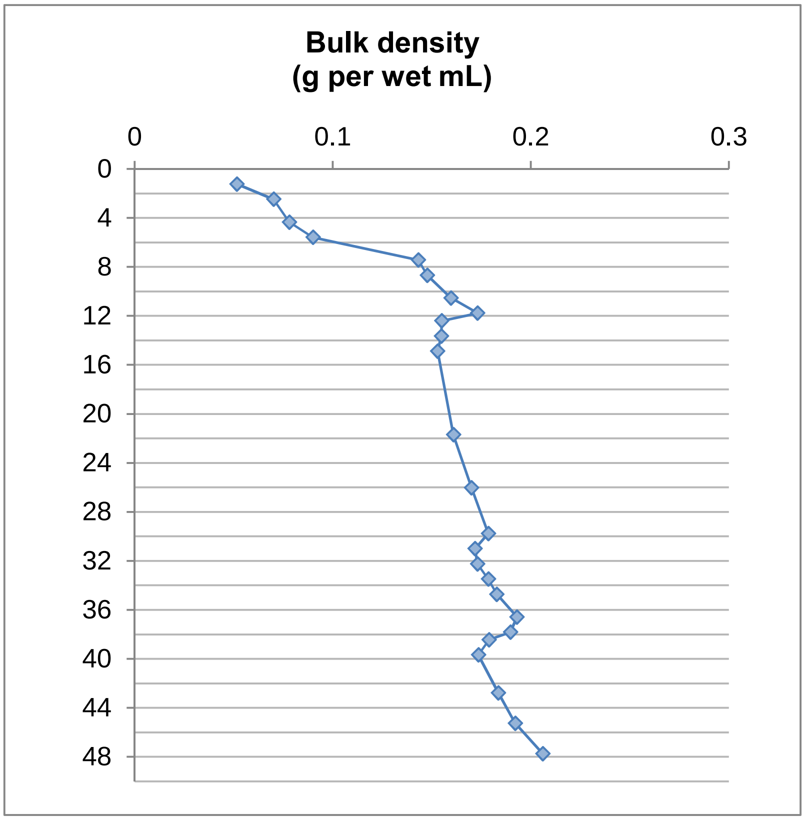

Figure 4.33: The bulk density profile of the Nordic Lake sediment core, October, 2012.

increases in bulk density when substantial amounts of fine material are deposited in the receiving lake).

The vegetation of tailings in 1974, decreased the release of ^{226}Ra (and therefore ^{214}Pb) into the lake, the resulting decrease in ^{214}Pb activity provided a time marker at 2.8 cm. This equates to the deposition of 2.8 cm in 11 years (between 1963 and 1974), or a deposition rate of 2.5 mm/yr. This slightly lower deposition rate likely reflects the decreased mill production (and associated loadings) and the closing of both mills by 1968.

A fourth time marker (*i.e.,* 2012 at 0 cm) can also be used to determine a current post-mining deposition rate. Sediment deposition of 2.8 cm from 1974 to 2012 (*i.e.,* 38 years) results in a deposition rate of 0.74 mm/yr. This deposition rate is higher than two of the 15-m sediment trap stations which ranged 0.55 to 0.67 mm/yr, but is lower than the 1 mm/yr sediment trap derived deposition rate (Table 4.5). It is possible that this sediment trap station, experiences slightly higher deposition due to its close proximity to the inflow into Nordic Lake, which may contain increased debris that settles out closer to the north end of the lake than the centre.

In conclusion, the deep-basin core provided a deposition rate of 0.74 mm/yr, and therefore it would take 13.5 years for 1 cm of sediment to accumulate. Using the average sediment trap deposition rate of 0.76 mm/yr, a very similar timeframe of 13 years would be necessary for the accumulation of 1 cm of sediment.

5.0 SUMMARY

A two year study was conducted over 2011 and 2012 to assess sediment deposition rates in three key receiving environments downstream of historical uranium mines in the Serpent River watershed. McCabe Lake was investigated in 2011, and Quirke and Nordic Lakes were investigated in 2012. The objective was to determine if the current frequency of the SRWMP (every five years) was a sufficient time to have deposited 1 cm of sediment at the 15-m benthic community stations in lakes that are part of the monitoring program. If less than 1 cm were deposited then an improvement in sediment quality cannot be expected on the timescale of five years. The three lakes were chosen to represent the slowest to the likely fastest sediment depositing lakes (from Quirke to Nordic Lake respectively).

Sediment cores were collected from the deepest points in all three lakes, and sediment traps were deployed at three 15-m benthic community stations in McCabe and Nordic Lakes.

The McCabe Lake study sediment traps showed that currently depositing sediment was generally improved in quality compared to the 2009 sediment quality data in the same locations from the SRWMP. The deposition rate determined by the sediment traps ranged 0.40 to 0.44 mm/yr. These sediment deposition rates were consistent throughout the lake, indicating low variability and good agreement between benthic stations.

The deep-basin sediment core was investigated in terms of establishing a timeline for the history of mining activity for the lake, and also to establish sediment recovery. The timeline for the McCabe Lake core was based on non-migratory analytes that included ^{137}Cs, and titanium, as well as the use of analytes associated with mining such as barium, and sulphur. Analytes associated with mining were combined with knowledge of the historical mine activities (including the use of water quality and effluent loadings to the lake) to help establish time markers along the core profile. The deposition rate for the current (non-mining) period was 0.6 mm/yr. This slightly higher rate compared to the sediment traps is consistent with the core being taken from the more depositional location in the lake. Therefore these results show that it would take 16.5 years for 1 cm of sediment to accumulate in the deepest part of McCabe Lake, while at the SRWMP benthic stations it would take 22 years.

The Quirke Lake study investigated sediment deposition in the deepest part of the lake at 99.5 m. The lake has significant public access and boating on it, and therefore sediment traps were not deployed (in case of disturbance during the deployment period). The deep-basin core used the non-migratory analytes lead and aluminum to help establish a timeline, along with iron, a strong marker for the mining signature. In addition, archived data from a survey in 1984 allowed for the comparison of metals profiles (Beak 1985), as well as pre- and during mining deposition rates (0.31 mm/yr and 1.6 mm/yr respectively) established for the lake from the same survey (McKee *et al.* 1987). In 1984 the pre-mining deposition rate was determined using non-migratory pollen and diatomaceous shells to establish a timeline. The post-mining deposition rate derived for the present study core was 0.3 mm/yr, which is in agreement with the pre-mining deposition rate derived in the previous study of 0.31 mm/yr (McKee *et al.* 1987). The deepest part of the lake would provide a conservative estimate for deposition rates at the much shallower 15-m SRWMP benthic stations. Based on the deep-basin deposition rate it would take 33 years to accumulate 1 cm of sediment.

Nordic Lake was considered to be the most productive of the three study lakes. Sediment traps were deployed at three 15-m benthic stations over the summer period of 2012, and hidden from sight to prevent any disturbance due to public access to the lake. Currently depositing sediment trap material was also generally improved compared to the top 1 cm of sediment collected during the 2009 SRWMP. However, barium, manganese and nickel concentrations remained unchanged or increased compared to 2009.

Sediment trap deposition rates were somewhat varied, two sediment trap stations showed lower deposition rates of 0.55 and 0.67 mm/yr, than the most northerly sediment trap station deposition rate of 1.06 mm/yr. The higher deposition rate at this station was attributed to the closer proximity of the station to the predominant inflow to the lake (which also contains treated effluent discharge from the Nordic and Lacnor TMAs). Although varied, these deposition rates were comparable to McCabe and Quirke Lake deposition rates, consistent with Nordic Lake being a more productive lake.

The Nordic Lake deep-basin core approximate timeline was based on the non-migratory analytes ^{137}Cs, ^{214}Pb, stable lead and barium that provided a current deposition rate estimate of 0.74 mm/yr. The Nordic Lake core was likely subject to migration of iron and manganese under reducing conditions such that some metals and mine indicators were not used. However, the increased deposition rate of 0.74 mm/yr was consistent with the other lakes and with the sediment trap deposition rates collected at the Nordic Lake SRWMP benthic stations (ranging 0.55 to 1.06 mm/yr). A deposition rate of 0.74 mm/yr would mean that it would take 13.5 years to accumulate 1 cm of sediment in the deep-basin. The deposition rates at the benthic stations also indicated that it would take between 10 and 18 years to accumulate 1 cm of sediment at the actual monitoring locations.

6.0 CONCLUSIONS

McCabe Lake, Quirke Lake and Nordic Lake represent three key receiving lakes in the Serpent River Watershed. They range in deep-basin sediment deposition rates from 0.3 mm/yr in Quirke Lake to 0.74 mm/yr in Nordic Lake. The sediment deposition rates at the benthic stations for the SRWMP indicated that even at the most rapidly depositing lake (Nordic Lake) it would take over ten years to accumulate 1 cm of sediment. This means that the frequency of the SRWMP (*i.e.,* five years) is too great to allow for significant improvement in benthic invertebrate communities and sediment quality to be detected/measured.

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APPENDIX A

DATA QUALITY ANALYSIS

APPENDIX A: DATA QUALITY ASSESSMENT

A1.0 INTRODUCTION

Data Quality Assessment (DQA) was conducted on data collected as part of this study. 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.

A1.1 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. DQA involves comparison of actual field and laboratory measurement performance to data quality objectives (DQOs) established for a particular study, such as evaluation of method detection limits, blank sample data, data precision (based on field and laboratory duplicate samples), and data accuracy (based on matrix spike recoveries and/or analysis of standards or certified reference materials).

DQOs were established at the outset of the field program that reflect reasonable and achievable performance expectations (Table A.1). Programs involving a large amount of samples and analytes usually result in some results that exceed the DQOs. This is particularly so for multi-element scans (e.g., ICP MS scans for metals) since the analytical conditions are not necessarily optimal for every element included in the scan. Generally, scan results may be considered acceptable if no more than 20% of the parameters fail to meet the DQOs. Overall, the intent of comparing data to DQOs was not to reject any measurement that did not meet the DQO, but to ensure any questionable data received more scrutiny to determine what effect, if any, this had on interpretation of results within the context of this project.

A1.2 Types of Quality Control Samples

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:

- **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. For fish tissue, laboratory duplicates represent separate aliquots of material collected after sample homogenization. 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 (or blank spikes) 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.

A2.0 WATER SAMPLES

A2.1 Method Detection Limits

Target laboratory method detection limits (MDL) for water sample analyses were established at levels below all potentially applicable water quality guidelines (Table A.2). All reported MDLs were at or below the target concentrations meaning that sample data for this project could be reliably interpreted relative to the guidelines.

A2.2 Data Precision

Laboratory Duplicate Samples

Close agreement was achieved between most laboratory duplicate samples with the exception of radium-226 which was slightly above the DQO (29%; Table A.3). However the absolute values were low and very close (i.e., 0.03 versus 0.04 Bq/L) indicating good analytical precision.

A2.3 Data Accuracy

Analyte recoveries for matrix spiked samples and quality control (QC) standards all met the DQO with the exception of radium-226 (Tables A.4 and A.5 respectively). The percent recovery for radium-226 from one quality control standard did not meet the DQO, therefore radium showed decreased accuracy in 2012 water samples. Overall, these data indicate very good analytical accuracy associated with the analysis of water samples.

A3.0 SEDIMENT SAMPLES

A3.1 Method Detection Limits

Target laboratory method detection limits (MDL) for sediment sample analyses were established at levels below all potentially applicable sediment quality guidelines (Table A.6).

A3.2 Data Precision

Laboratory Duplicate Samples

The majority of laboratory duplicate samples met DQO with the exception of boron, silver, and radium-226 for one instance each (Table A.7). In the case of silver and radium-226 absolute values were close to each other and low in concentration (within 3 times the detection limit). Boron had a larger difference between absolute values, possibly indicating inadvertent laboratory contamination, as the value in one of the replicates was much larger than all other boron samples. Overall, the results of the laboratory duplicate analyses indicated good precision.

A3.3 Data Accuracy

Recoveries of most QC standard samples met respective DQOs (Table A.8) with the exception of one sample for antimony, cadmium, and iron. Of these analytes iron was found to be over-recovered in one QC standard. The laboratory considers whether QC standards data are acceptable on a case-by-case basis, with absolute and relative recoveries considered together with the magnitude of the concentration. Following this approach, the iron recovery in the sediment standard were considered acceptable by the laboratory. Additional quality control measures in the same batch were within specified limits. Overall, there were no other indications of problems with the analysis and the results were considered acceptable. All recoveries of matrix spikes met DQOs (Table A.9), these data indicate adequate analytical accuracy associated with the analysis of sediment samples.

A4.0 DATA QUALITY STATEMENT

The DQA results indicated that water and sediment chemistry were of acceptable quality and thus considered adequate to serve the objectives of the sediment deposition investigation.

A5.0 REFERENCES

BCMOE (British Columbia Ministry of Environment). 2006. British Columbia Approved Water Quality Guidelines (Criteria), 2006 Edition. Updated August 2006. For parameters with both maximum and 30-day average values, the 30-d average is shown.

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Table A.1: Data quality objectives for environmental samples.

Quality Control Measure	Quality Control Sample Type	Study Component	
		Water Quality	Sediment Quality
Method Detection Limits (MDL)	Comparison actual MDL versus target MDL	MDL for each parameter should be at least as low as applicable guidelines, ideally ≤1/10th guideline value[a]	MDL for each parameter should be at least as low as applicable guidelines, ideally ≤1/10th guideline value[a]
Blank Analysis	Field or Laboratory Blank	≤two-times the laboratory MDL	≤two-times the laboratory MDL
Field Precision	Field Duplicates	≤25% RPD[b]	≤40% RPD
Laboratory Precision	Laboratory Duplicates	≤25% RPD	≤35% RPD
	Sub-Sampling Error	n/a	n/a
Accuracy	Recovery of Blank Spikes	80-120%	75-125%
	Recovery of Matrix Spikes	75-125%	75-125%
	Recovery of Certified Reference Material, QC Standards	85-115%	70-130%
	Organism Recovery	n/a	n/a

[a] or below predictions, if applicable and no guideline exists for the substance.
[b] RPD - Relative Percent Difference
n/a - not applicable

Table A.2: Laboratory method detection limits (MDLs) relative to targets and to water quality guidelines. Any highlighted values indicate MDLs that were above the target concentration.

Analytes	Units	Method Detection Limit		Water quality criteria							
		Target	Achieved	Canadian water quality guideline (for protection of freshwater aquatic life)[a]	British Columbia Approved (freshwater)[b]		British Columbia Working (freshwater)[u]	Saskatchewan[c]	Ontario Provincial Water Quality Objective[d]	Canadian Drinking Water Quality Guideline[a]	Canadian Council of Ministers of the Environment (CCME) proposed guidelines
					30-d (chronic)	Maximum	30-d (chronic)[I]				
Conductivity	µS/cm										
Dissolved Organic Carbon	mg/L	0.2	0.2		within 20% of the 30-d median background background (total)						
Dissolved Sulphate (SO_4)	mg/L	0.2	0.2			50-100[F]				500[g]	
Hardness (as $CaCO_3$)	mg/L	1	1								
Nitrate (N)	mg/L				3						
Nitrate plus Nitrite (N)	mg/L	0.04	0.04								
Nitrite (N)	mg/L			0.06	0.02-0.2[D]				0.06	3.2	
pH, Soluble (2:1)	pH units			6.5-9.0	6.5-9.0[K]				6.5-8.5	6.5-8.5	
Total Kjeldhal Nitrogen	mg/L	0.42	0.42								
Total Nitrogen (N)	mg/L										
Total Phosphorus (P)	mg/L	0.01	0.01		0.005-0.015 (lakes)[J]				0.03 for rivers[e]		
Total Suspended Solids	mg/L			no more than 5 mg/L above background[f]							
Total Aluminum (Al)	mg/L	0.0005	0.0005	0.005 - 0.100[h]	0.05 (dissolved at >6.5 pH)[E]			0.005 - 0.100[h]	0.015 - 0.075[e]	0.1	
Total Antimony (Sb)	mg/L	0.0002	0.0002				0.02[v]		0.02[e]	0.006	
Total Arsenic (As)	mg/L	0.0001	0.0001	0.005		0.005		0.005	0.005[e]	0.005 proposed	
Total Barium (Ba)	mg/L	0.0005	0.0005				1 (30-day)			1.0	
Total Beryllium (Be)	mg/L	0.0001	0.0001				0.0053		0.011 - 1.1[j]		
Total Bismuth (Bi)	mg/L										
Total Boron (B)	mg/L	0.01	0.01			1.2			0.2[e]	5.000	
Total Cadmium (Cd)	**ug/L**	0.01	0.01	0.017 or more depending on hardness[j]			0.01-0.06[G]	0.017 or more depending on hardness[j]	0.1 - 0.5[e]	5	0.13 - 0.92[k]
Total Calcium (Ca)	mg/L	0.1	0.1				<4->8[w]				
Total Chromium (Cr)	mg/L	0.0005	0.0005	0.001 (hexavalent), 0.0089 (trivalent)			0.001 (hexavalent), 0.0089 (trivalent), (maximum)	0.001 (hexavalent), 0.0089 (trivalent)	0.001 (hexavalent), 0.0089 (trivalent)	0.05	
Total Cobalt (Co)	mg/L	0.0001	0.0001		0.004				0.0009		
Total Copper (Cu)	mg/L	0.0002	0.0002	0.002-0.004[l]	0.002 or (0.04) *(avg hardness)			0.002-0.004[l]	0.001-0.005[e]	1.0[g]	
Total Iron (Fe)	mg/L	0.0005	0.0005	0.3	1 (total), 0.35 (dissolved)		0.3 (30-day)	0.3	0.300	0.3[g]	
Total Lead (Pb)	mg/L	0.0001	0.0001	0.001 - 0.007[m]	depends on hardness[q]			0.001 - 0.007[m]	0.001 - 0.005[e]	0.010	
Total Lithium (Li)	mg/L						0.014-0.870[x]				
Total Magnesium (Mg)	mg/L	0.1	0.1								
Total Manganese (Mn)	mg/L	0.0005	0.0005		0.7-1.9[r]					0.05[k]	
Total Mercury (Hg)	**ug/L**			0.026[n] (0.004)[o]	0.00125-0.02 (total), 0.0001 (MeHg)[L]			0.026[n]	0.2 (filtered)	1.0	
Total Molybdenum (Mo)	mg/L	0.0001	0.0001	0.073	1				0.04[e]		
Total Nickel (Ni)	mg/L	0.0001	0.0001	0.025 - 0.150[p]			0.025 - 0.150 (maximum)[y]	0.025 - 0.150[p]	0.025		
Total Potassium (K)	mg/L						373 - 432[H]				
Total Selenium (Se)	mg/L	0.0001	0.0001	0.001		0.002		0.001	0.100	0.01	
Total Silicon (Si)	mg/L										
Total Silver (Ag)	mg/L	0.0001	0.00005	0.0001	0.00005/0.0015[s]			0.0001	0.0001		
Total Sodium (Na)	mg/L									200[g]	
Total Strontium (Sr)	mg/L	0.0005	0.0005								
Total Sulphur (S)	mg/L										
Total Thallium (Tl)	mg/L	0.0002	0.0002	0.0008			0.0008[z]		0.0003[e]		
Total Tin (Sn)	mg/L	0.0001	0.0001								
Total Titanium (Ti)	mg/L	0.0002	0.0002				2-4.6[A]				
Total Uranium (U)	mg/L	0.0001	0.0001				0.3-0.5[B]	0.015	0.005[e]	0.020	
Total Vanadium (V)	mg/L	0.0001	0.0001				0.006-0.02[C]		0.006[e]		
Total Zinc (Zn)	mg/L	0.0005	0.0005	0.030	0.0075-0.165[t]			0.030	0.02[e]	5.0	0.0082 - 0.13[k]
Total Zirconium (Zr)	mg/L								0.004		
Radium-226	Bq/L	0.005	0.005					0.11			

(grey box) achieved method detection limit greater than requested method detection limit

[a] CCME (Canadian Council of Ministers of the Environment). 1999. Canadian Environmental Quality Guidelines. 1999 (plus updates), Canadian Council of Ministers of the Environment, Winnipeg

[b] BCMOE (British Columbia Ministry of Environment). 2006. British Columbia Approved Water Quality Guidelines (Criteria), 2006 Edition. Updated August 2006. For parameters with both maximum and 30-day average values, the 30-d average is shown.

[c] Saskatchewan Environment. 2006. Surface Water Quality Objectives. Interim Edition. EPB356. July 2006. 9pp.

[d] OMOE (Ontario Ministry of Environment and Energy). 1994. Policies, Guidelines, Provincial Water Quality Objectives of the Ministry of the Environment and Energy (Ontario), July 1994

[e] interim objective

[f] not measured in this report

[g] Canadian drinking water quality guideline, aesthetic objective (CCME 1999).

[h] 0.005 mg/L at pH<6.5; 0.1 mg/L at pH ≥ 6.5

[i] 0.011 for hardness <75 mg/L and 1.1 for hardness >75 mg/L

[j] CWQG for cadmium = $10^{\{0.86[\log(hardness)] - 3.2\}}$ in ug/L

[k] hardness-dependent guideline; hardness values of approximately 50 to 700 mg/L as reported in Minnow 2008 used to calculate guideline range

[l] 0.002 at [$CaCO_3$] = 0-120 mg/L, 0.003 at [$CaCO_3$] = 120-180 mg/L, 0.004 at [$CaCO_3$] > 180 mg/L

[m] 0.001 at [$CaCO_3$] = 0-60 mg/L, 0.002 at [$CaCO^3$] = 60-120 mg/L, 0.004 at [$CaCO_3$] = 120-180 mg/L, 0.007 at [$CaCO_3$] > 180 mg/L

[n] Inorganic mercury

[o] Organic mercury

[p] 0.025 at [$CaCO_3$] = 0-60 mg/L, 0.065 at [$CaCO^3$] = 60-120 mg/L, 0.110 at [$CaCO_3$] = 120-180 mg/L, 0.150 at [$CaCO_3$] > 180 mg/L

[q] 3.31 + e(1.273 ln (mean hardness) - 4.704) for >8 mg/L water hardness

[r] for hardnesses ranging from 25 and 300mg/L (equation 7.5 + 0.75*(hardness-90))

[s] hardnesses of ≤100mg/L and >100mg/L

[t] for hardnesses ranging from 25 to 300mg/L

[u] Nagpal, N.K., Pommen, L.W., and Swain, L.G. 2006. A Compendium of Working Water Quality Guidelines for British Columbia. Ministry of Environment, Science and Information Branch.

[v] proposed Ontario guideline

[w] high sensitivity <4, moderate sensitivity 4-8, low sensitivity >8

[x] secondary chronic value (0.014), final chronic value (0.096), aquatic maximum value (0.870)

[y] maximum values, at hardness 0 to 60 mg/L (0.025), 60 to 120 mg/L (0.065), 120 to 180 mg/L (0.11), >180 mg/L (0.15)

[z] 30-day average, site specific objective for the lower Columbia River, BC

[A] median threshold level for *Scenedesmus* (2 mg/L), MTL for *Daphnia* (4.6 mg/L)

Table A.3: Laboratory duplicate results for water sample analyses. Any highlighted values did not meet data quality objective of ≤ 25% relative percent difference.

Analytes	Units	Relative Percent Difference (RPD)					
		SRC Job Number					
		2011-06830 MCBL Water			2012-4503 QUIL and NORL Water		
		Replicate 1	Replicate 2	RPD	Replicate 1	Replicate 2	RPD
Total Aluminum (Al)	mg/L				0.005	0.0051	2
Total Antimony (Sb)	mg/L				<0.0002	<0.0002	0
Total Arsenic (As)	ug/L	0.5	0.5	0	9.1	9	1
Total Barium (Ba)	mg/L				0.12	0.12	0
Total Beryllium (Be)	mg/L				<0.0001	<0.0001	0
Total Boron (B)	mg/L				<0.01	<0.01	0
Total Cadmium (Cd)	mg/L				0.00001	0.00001	0
Total Calcium (Ca)	mg/L	483	504	4	6.7	6.8	1
Total Chromium (Cr)	mg/L				<0.0005	<0.0005	0
Total Cobalt (Co)	mg/L				0.0071	0.007	1
Total Copper (Cu)	mg/L	0.16	0.16	0	<0.0002	<0.0002	0
Total Iron (Fe)	mg/L				3.54	3.55	0
Total Lead (Pb)	mg/L	0.0002	0.0002	0	<0.0001	<0.0001	0
Total Magnesium (Mg)	mg/L	405	413	2	2.7	2.7	0
Total Manganese (Mn)	mg/L				1.33	1.34	1
Total Molybdenum (Mo)	mg/L				0.0017	0.0017	0
Total Nickel (Ni)	mg/L	0.0068	0.007	3	0.0007	0.0008	13
Total Selenium (Se)	mg/L				<0.0001	<0.0001	0
Total Silver (Ag)	mg/L				< 0.00005	< 0.00005	0
Total Strontium (Sr)	mg/L				0.044	0.044	0
Total Thallium (Tl)	mg/L				<0.0002	<0.0002	0
Total Tin (Sn)	mg/L				<0.0001	<0.0001	0
Total Titanium (Ti)	mg/L				<0.0002	<0.0002	0
Total Uranium (U)	ug/L				<0.1	<0.1	0
Total Vanadium (V)	mg/L				0.0002	0.0002	0
Total Zinc (Zn)	mg/L	0.0018	0.0019	5	<0.0005	<0.0005	0
Radium-226	Bq/L	0.8	0.8	0	0.03	0.04	29

Table A.4: Laboratory matrix spike recoveries for water sample analyses. Any highlighted values did not meet data quality objective of 75 - 125% recovery.

Analytes	Percent Recovery	
	SRC Job Number	
	2011-06830 MCBL Water	2012-4503 QUIL and NORL Water
Total Aluminum (Al)	114	103
Total Antimony (Sb)	101	98
Total Arsenic (As)	100	99
Total Barium (Ba)	102	95
Total Beryllium (Be)	95	96
Total Boron (B)	95	98
Total Cadmium (Cd)	99	96
Total Calcium (Ca)	97	
Total Chromium (Cr)	99	98
Total Cobalt (Co)	98	98
Total Copper (Cu)	101	99
Total Iron (Fe)	103	99
Total Lead (Pb)	99	99
Total Magnesium (Mg)	99	100
Total Manganese (Mn)	99	
Total Molybdenum (Mo)	100	99
Total Nickel (Ni)	98	99
Total Selenium (Se)	102	96
Total Silver (Ag)	99	100
Total Strontium (Sr)	99	100
Total Thallium (Tl)	98	96
Total Tin (Sn)	99	98
Total Titanium (Ti)	102	103
Total Uranium (U)	97	97
Total Vanadium (V)	100	96
Total Zinc (Zn)	98	100

NC - not calculated by lab if spike amount was too small relative to sample concentration to permit quantification of spike recovery.

Table A.5: Quality control standard results for water sample analyses. Any highlighted values did not meet data quality objective of 85 - 115% recovery.

Analytes	Units	SRC Job Number					
		2011-06830 MCBL Water			2012-4503 QUIL and NORL Water		
		Target	Achieved	% Recovery	Target	Achieved	% Recovery
Total Aluminum (Al)	mg/L	0.059	0.058	98%	0.0604	0.0598	99%
Total Antimony (Sb)	mg/L	0.0033	0.0035	105%	0.00324	0.00325	100%
Total Arsenic (As)	ug/L	3.99	4.04	101%	3.99	3.86	97%
Total Barium (Ba)	mg/L	0.146	0.149	102%	0.146	0.148	101%
Total Beryllium (Be)	mg/L	0.0130	0.0128	98%	0.0134	0.0132	99%
Total Boron (B)	mg/L	0.077	0.074	96%	0.0776	0.0796	103%
Total Cadmium (Cd)	mg/L	0.00407	0.00409	100%	0.00413	0.00418	101%
Total Calcium (Ca)	mg/L	10	10	101%	10.3	10.9	106%
Total Chromium (Cr)	mg/L	0.0444	0.0440	99%	0.0456	0.0452	99%
Total Cobalt (Co)	mg/L	0.0644	0.0630	98%	0.0644	0.0646	100%
Total Copper (Cu)	mg/L	0.167	0.162	97%	0.167	0.167	100%
Total Iron (Fe)	mg/L	0.224	0.220	98%	0.224	0.221	99%
Total Lead (Pb)	mg/L	0.0079	0.0079	100%	0.00797	0.00789	99%
Total Magnesium (Mg)	mg/L	15	14	93%	16	15	96%
Total Manganese (Mn)	mg/L	0.0473	0.0462	98%	0.0473	0.0472	100%
Total Molybdenum (Mo)	mg/L	0.0671	0.0638	95%	0.066	0.062	94%
Total Nickel (Ni)	mg/L	0.0825	0.0799	97%	0.0825	0.0828	100%
Total Selenium (Se)	mg/L	0.00818	0.00838	102%	0.00843	0.00832	99%
Total Silver (Ag)	mg/L	0.0099	0.0096	97%	0.00933	0.00946	101%
Total Strontium (Sr)	mg/L	0.244	0.244	100%	0.247	0.250	101%
Total Thallium (Tl)	mg/L	0.0083	0.0083	99%	0.0083	0.0084	101%
Total Tin (Sn)	mg/L	0.0114	0.0115	101%	0.0117	0.0115	98%
Total Titanium (Ti)	mg/L	0.0147	0.0145	99%	0.0147	0.0148	101%
Total Uranium (U)	ug/L	14.0	13.9	99%	14	14	100%
Total Vanadium (V)	mg/L	0.0445	0.0435	98%	0.0445	0.0435	98%
Total Zinc (Zn)	mg/L	0.379	0.369	97%	0.379	0.367	97%
Radium-226	Bq/L	20.6	21.1	102%	20.1	15.4	77%

Table A.6: Laboratory method detection limits (MDLs) for sediment samples relative to targets and to guidelines. Highlighted values indicate target MDL was not achieved.

	Analytes	Units	Target MDL	Achieved MDL	Sediment Quality Guidelines						
					Canada[a]			British Columbia[b]		Ontario[e]	
					ISQG[c]	PEL[d]	LEL[h]	ISQG[c]	PEL[d]	LEL[f]	SEL[g]
Non-Metals	Total Organic Carbon	g/kg	1	1						10	100
Metals	Total Aluminum (Al)	mg/kg	20	20							
	Total Antimony (Sb)	mg/kg	0.2	0.2							
	Total Arsenic (As)	mg/kg	0.1	0.1	5.9	17	17	5.9	17	6	33
	Total Barium (Ba)	mg/kg	0.5	0.5							
	Total Beryllium (Be)	mg/kg	0.1	0.1							
	Total Boron (B)	mg/kg	1	1							
	Total Cadmium (Cd)	mg/kg	0.1	0.1	0.6	3.5	3.5	0.6	3.5	0.6	10
	Total Calcium (Ca)	mg/kg	1	1							
	Total Chromium (Cr)	mg/kg	0.5	0.5	37.3	90	90	37.3	90	26	110
	Total Cobalt (Co)	mg/kg	0.2	0.2							
	Total Copper (Cu)	mg/kg	0.5	0.5	35.7	197	197	35.7	197	16	110
	Total Iron (Fe)	mg/kg	20	20				21,200	43,766	20,000	40,000
	Total Lead (Pb)	mg/kg	0.1	0.1	35.0	91.3	91.3	35	91	31	250
	Total Magnesium (Mg)	mg/kg	1	1							
	Total Manganese (Mn)	mg/kg	0.5	0.5						460	1,100
	Total Molybdenum (Mo)	mg/kg	0.1	0.1							
	Total Nickel (Ni)	mg/kg	0.1	0.1				16	75	16	75
	Total Phosphorus (P)	mg/kg	1	1						600	2,000
	Total Selenium (Se)	mg/kg	0.1	0.1				2			
	Total Silver (Ag)	mg/kg	0.1	0.1				0.5			
	Total Strontium (Sr)	mg/kg	0.5	0.5							
	Total Thallium (Tl)	mg/kg	0.2	0.2							
	Total Tin (Sn)	mg/kg	0.1	0.1							
	Total Titanium (Ti)	mg/kg	0.5	0.5							
	Total Uranium (U)	mg/kg	0.1	0.1							
	Total Vanadium (V)	mg/kg	0.1	0.1							
	Total Zinc (Zn)	mg/kg	0.5	0.5	123	315	315	123	315	120	820
Radio-nuclides	Radium-226	Bq/kg	10	5-50[i]			600				

[a] CCME (Canadian Council of Ministers of the Environment). 1999. Canadian Environmental Quality Guidelines. 1999 plus updates, Winnipeg, MB.)

[b] BCMOE (British Columbia Ministry of Environment). 2006. A compendium of Working Water Quality Guidelines for British Columbia. Updated August 2006.)

[c] Interim sediment quality guideline

[d] Probable effect level

[e] OMOE (Ontario Ministry of Environment). 1993. Guidelines For The Protection and Management Of Aquatic Sediment Quality In Ontario. August 1993, Reprinted October, 1996. MOE (1993).

[f] Lowest effect level.

[g] Severe effect level.

[h] Thompson et al, 2005.

[i] Sediment samples with higher than target MDL always had activities well above the MDL.

Table A.7: Laboratory duplicate results for analysis of sediment samples. Highlighted values did not meet the data quality objective of ≤ 35% relative percent difference.

Analytes	Units	Relative Percent Difference (RPD)																				
		SRC Job Number																				
		2012-5020 MCBL Sediment Core															2012-11240 NORL Sediment Trap			2012-6777 MCBL Sediment Core		
		Replicate 1	Replicate 2	RPD	Replicate 3	Replicate 4	RPD	Replicate 5	Replicate 6	RPD	Replicate 7	Replicate 8	RPD	Replicate 9	Replicate 10	RPD	Replicate 1	Replicate 2	RPD	Replicate 1	Replicate 2	RPD
Total Organic Carbon	%																					
Aluminum (Al)	ug/g	31,000	33,200	7	30,700	29,900	3	27,900	29,700	6							33,300	34,600	4	14,100	12,900	9
Antimony (Sb)	ug/g	1.5	1.5	0	0.2	0.2	0	0.2	0.2	0							21	22	5	0.6	0.7	15
Arsenic (As)	ug/g	18	18	0	5.2	5.3	2	6	6	12							1,530	1,650	8	6.9	6.8	1
Barium (Ba)	ug/g	2,300	2,400	4	90	90	0	100	100	0	89	87	2	92	96	4	100	110	10	170	160	6
Beryllium (Be)	ug/g	1.2	1.1	9	1.2	1.2	0	1.0	1.1	10							0.6	0.6	0	0.5	0.5	0
Boron (B)	ug/g	100	30	108	1.0	1.0	0	1.0	1.0	0							14	15	7	23	22	4
Cadmium (Cd)	ug/g	3.0	2.9	3	1.4	1.4	0	1.3	1.4	7							0.3	0.4	29	0.6	0.8	29
Calcium (Ca)	ug/g	11,900	12,400	4	9,800	9,700	1	11,700	11,300	3												
Chromium (Cr)	ug/g	48	47	2	45	44	2	44	46	4							120	130	8	30	28	7
Cobalt (Co)	ug/g	40	40	0	36	36	0	14	14	0	13	14	7				350	380	8	7.4	7.4	0
Copper (Cu)	ug/g	70	80	13	40	40	0	55	54	2	41	40	2	39	42	7	860	930	8	17	16	6
Iron (Fe)	ug/g	46,800	49,100	5	24,900	24,300	2	24,900	26,700	7							44,400	45,700	3	17,600	17,000	3
Lead (Pb)	ug/g	210	220	5	9	8	12	12	13	8	9.8	9.6	2	14	15	7	57	63	10	11	11	0
Manganese (Mn)	ug/g	480	520	8	460	440	4	380	420	10							2,720	3,010	10	520	520	0
Molybdenum (Mo)	ug/g	4.1	4.1	0	1.9	1.9	0	1.7	1.8	6							1.5	1.6	6	2	2	0
Nickel (Ni)	ug/g	56	59	5	19	20	5	52	52	0	21	21	0	20	21	5	398	427	7	24	23	4
Selenium (Se)	ug/g	4.0	3.9	3	2.2	2.1	5	2.0	2.1	5							3.7	3.8	3	0.5	0.4	22
Silver (Ag)	ug/g	0.4	0.4	0	0.1	0.1	0	0.1	0.2	67							2.6	2.7	4	<0.1	<0.1	
Strontium (Sr)	ug/g	70	70	0	30	30	0	68	67	1	29	28	4	28	30	7	64	68	6	96	94	2
Tin (Sn)	ug/g	4.9	4.8	2	0.5	0.5	0	0.5	0.6	18							0.8	0.8	0	2.0	1.4	35
Thallium (Tl)	ug/g	0.6	0.6	0	0.2	0.2	0	0.2	0.2	0							0.6	0.6	0	0.3	0.3	0
Titanium (Ti)	ug/g	970	1,000	3	750	730	3	650	720	10							2,220	2,270	2	660	600	10
Uranium (U)	ug/g	69	73	6	5.0	5.0	0	69	68	1	5.2	5.1	2	5.4	5.6	4	1.0	1.0	0	1.9	1.9	0
Vanadium (V)	ug/g	53	52	2	49	48	2	44	47	7							102	109	7	72	69	4
Zinc (Zn)	ug/g	260	260	0	150	140	7	130	150	14							720	800	11	78	75	4
Radium-226 (Ra)	Bq/g																0.8	1.0	23	14	13	7

Table A.7: Laboratory duplicate results for analysis of sediment samples. Highlighted values did not meet the data quality objective of ≤ 35% relative percent difference.

Analytes	Units	Relative Percent Difference (RPD)																				
		SRC Job Number																				
		2011-10769 MCBL Sediment Trap						2012-12232 QUILSediment Core			2012-8091 MCBL Sediment Core						2013-824 QUIL and NORL Sediment Core					
		Replicate 1	Replicate 2	RPD	Replicate 3	Replicate 4	RPD	Replicate 1	Replicate 2	RPD	Replicate 1	Replicate 2	RPD	Replicate 3	Replicate 4	RPD	Replicate 1	Replicate 2	RPD	Replicate 3	Replicate 4	RPD
Total Organic Carbon	%																8.69	8.68	0			
Aluminum (Al)	ug/g	19100	16800	13				32,900	32,600	1							23,800	23,600	1	26,600	25,400	5
Antimony (Sb)	ug/g	1	0.8	22				0.2	0.2	0							1.0	1.0	0	0.2	0.2	0
Arsenic (As)	ug/g	18	16	12				7.6	7.7	1							25	25	0	4.9	5.0	2
Barium (Ba)	ug/g	9200	8200	11				180	180	0							390	390	0	120	120	0
Beryllium (Be)	ug/g	0.9	0.8	12				1.5	1.4	7							1.0	1.0	0	0.8	0.8	0
Boron (B)	ug/g	8	8	0				6.0	5.0	18							10	10	0	7	6	15
Cadmium (Cd)	ug/g	1.5	1.6	6				1.6	1.7	6							1.3	1.4	7	0.8	0.7	13
Calcium (Ca)	ug/g																					
Chromium (Cr)	ug/g	31	28	10				47	47	0							35	35	0	50	48	4
Cobalt (Co)	ug/g	88	80	10	90	90	0	21	21	0							290	280	4	18	18	0
Copper (Cu)	ug/g	51	46	10				75	78	4							100	100	0	41	41	0
Iron (Fe)	ug/g	53200	48500	9				51,500	52,300	2							82,100	82,100	0	30,000	28,900	4
Lead (Pb)	ug/g	140	120	15				12	12	0							213	213	0	14	14	0
Manganese (Mn)	ug/g	6900	6000	14				1,790	1,780	1							2,280	2,260	1	750	740	1
Molybdenum (Mo)	ug/g	9.4	8.3	12				3.3	3.4	3							5.3	5.4	2	2.4	2.3	4
Nickel (Ni)	ug/g	95	86	10				25	24	4							110	109	1	28	28	0
Selenium (Se)	ug/g	3.0	2.7	11				3.5	3.5	0							3.8	3.6	5	1.4	1.4	0
Silver (Ag)	ug/g	0.3	0.2	40				0.2	0.2	0							0.3	0.3	0	0.2	0.2	0
Strontium (Sr)	ug/g	72	64	12				27	24	12							54	53	2	48	45	6
Tin (Sn)	ug/g	3.3	3.0	10				0.5	0.4	22							2.6	2.6	0	0.6	0.6	0
Thallium (Tl)	ug/g	0.6	0.4	40				0.4	0.4	0							0.3	0.3	0	0.2	0.2	0
Titanium (Ti)	ug/g	580	530	9				660	570	15							850	810	5	1,140	1,060	7
Uranium (U)	ug/g	153	142	7				12	12	0							336	334	1	7	7	0
Vanadium (V)	ug/g	36	32	12				62	61	2							43	42	2	79	77	3
Zinc (Zn)	ug/g	250	230	8				180	180	0							220	220	0	96	96	0
Radium-226 (Ra)	Bq/g	0.89	0.78	13	7.2	6.8	6				0.02	0.03	40	53	44	19						

Table A.8: Quality control standard results for sediment sample analyses. Any highlighted values did not meet data quality objective of 70 - 130% recovery.

Analytes	Unit	Percent Recovery														
		SRC Job Number														
		2013-824 QUIL and NORL Sediment Core			2012-12232 QUIL Core Chem Profile			2012-5020 MCBL Sediment Core			2012-6777 MCBL Sediment Core					
		Target	Achieved	% Recovery	Target	Achieved	% Recovery	Target	Achieved	% Recovery	Target	Achieved	RPD	Target	Achieved	% Recovery
Organic Carbon	%	6	6	94%												
Total Aluminum (Al)	ug/g	23,600	23,200	98%	23,600	20,300	86%	23,600	26,700	113%	23,600	22,600	96%			
Total Antimony (Sb)	ug/g															
Total Arsenic (As)	ug/g	17	17	102%	16.8	16.6	99%	16.8	17.0	101%	16.8	17.7	105%			
Total Barium (Ba)	ug/g	97	83	86%	96.9	84.2	87%	91.9	108.0	118%	91.9	93.7	102%			
Total Beryllium (Be)	ug/g	0.56	0.57	102%	0.56	0.49	87%	0.71	0.66	93%	0.71	0.52	73%			
Total Boron (B)	ug/g															
Total Cadmium (Cd)	ug/g	0.24	0.28	119%	0.24	0.27	114%	0.30	0.26	88%	0.30	0.24	80%			
Total Calcium (Ca)	ug/g							8,300	7,660	92%						
Total Chromium (Cr)	ug/g	40	37	93%	39.6	31.8	80%	40.8	44.6	109%	40.8	38.6	95%			
Total Cobalt (Co)	ug/g	14	14	101%	14.3	13.1	92%	14.3	14.9	104%	14.3	14.8	103%			
Total Copper (Cu)	ug/g	45	50	112%	44.7	45.1	101%	44.7	49.6	111%	44.7	47.7	107%			
Total Iron (Fe)	ug/g	40,500	37,600	93%	40,500	33,100	82%	40,500	45,200	112%	40,500	43,300	107%			
Total Lead (Pb)	ug/g	14	15	107%	14	14	101%	13.3	13.4	101%	13.3	14.6	110%			
Total Manganese (Mn)	ug/g	1,290	1,190	92%	1,290	1,110	86%	1,170	1,380	118%	1,170	1,400	120%			
Total Molybdenum (Mo)	ug/g	0.83	0.81	97%	0.83	0.72	86%	0.73	0.86	119%	0.73	0.92	127%			
Total Nickel (Ni)	ug/g	20	20	103%	19.8	17.9	90%	19.7	21.1	107%	19.7	20.7	105%			
Total Selenium (Se)	ug/g	0.40	0.46	114%	0.40	0.40	99%	0.40	0.45	113%	0.40	0.51	127%			
Total Silver (Ag)	ug/g	0.23	0.25	106%	0.23	0.23	100%	0.22	0.26	120%	0.22	0.24	110%			
Total Strontium (Sr)	ug/g	26	22	86%	26	24	92%	25.5	29.4	115%	25.5	21.9	86%			
Total Tin (Sn)	ug/g	1.40	1.35	96%	1.40	1.17	84%	1.40	1.62	116%	1.40	1.36	97%			
Total Titanium (Ti)	ug/g	2,600	2,190	84%	2,600	1,720	66%	2,790	3,520	126%	2,790	2,770	99%			
Total Uranium (U)	ug/g	1.19	1.01	85%	1.2	1.0	80%	1.4	1.3	91%	1.4	1.2	82%			
Total Vanadium (V)	ug/g	75	73	97%	75.1	63.1	84%	75.2	84.0	112%	75.2	79.1	105%			
Total Zinc (Zn)	ug/g	75	70	93%	74.8	72.0	96%	80.1	82.6	103%	80.1	81.6	102%			
Radium-226	Bq/L										0.427	0.385	90%	21.4	20.9	98%

Table A.8: Quality control standard results for sediment sample analyses. Any highlighted values did not meet data quality objective of 70 - 130% recovery.

Analytes	Unit	Percent Recovery																	
		SRC Job Number																	
		2012-11240 NORL Sediment Traps												2012-8091 MCBL Sediment Core					
		Target	Achieved	% Recovery	Target	Achieved	% Recovery	Target	Achieved	% Recovery	Target	Achieved	% Recovery	Target	Achieved	% Recovery	Target	Achieved	% Recovery
Organic Carbon	%																		
Total Aluminum (Al)	ug/g	23,600	20,400	86%															
Total Antimony (Sb)	ug/g																		
Total Arsenic (As)	ug/g	16.8	16.5	98%															
Total Barium (Ba)	ug/g	96.9	84.9	88%															
Total Beryllium (Be)	ug/g	0.65	0.55	85%															
Total Boron (B)	ug/g																		
Total Cadmium (Cd)	ug/g	0.26	0.21	80%															
Total Calcium (Ca)	ug/g																		
Total Chromium (Cr)	ug/g	39.6	31.8	80%															
Total Cobalt (Co)	ug/g	14.3	13.6	95%															
Total Copper (Cu)	ug/g	44.7	45.4	102%															
Total Iron (Fe)	ug/g	40,500	33,400	82%															
Total Lead (Pb)	ug/g	14.0	13.7	98%															
Total Manganese (Mn)	ug/g	1,230	1,170	95%															
Total Molybdenum (Mo)	ug/g	0.83	0.75	90%															
Total Nickel (Ni)	ug/g	21.4	18.7	87%															
Total Selenium (Se)	ug/g	0.40	0.45	113%															
Total Silver (Ag)	ug/g	0.25	0.27	108%															
Total Strontium (Sr)	ug/g	25.9	18.7	72%															
Total Tin (Sn)	ug/g	1.40	1.24	89%															
Total Titanium (Ti)	ug/g	2,600	2,900	112%															
Total Uranium (U)	ug/g	1.4	1.2	85%															
Total Vanadium (V)	ug/g	75.1	63.1	84%															
Total Zinc (Zn)	ug/g																		
Radium-226	Bq/L	20.1	19.4	97%	0.427	0.465	109%	2.13	2.15	101%	20.1	22.2	110%	19.5	19.3	99%	2.13	2.2	103%

Table A.8: Quality control standard results for sediment sample analyses. Any highlighted values did not meet data quality objective of 70 - 130% recovery.

Analytes	Unit	Percent Recovery SRC Job Number 2011-10769 MCBL Sediment Trap								
		Target	Achieved	% Recovery	Target	Achieved	% Recovery	Target	Achieved	% Recovery
Organic Carbon	%									
Total Aluminum (Al)	ug/g	23,600	28,900	122%						
Total Antimony (Sb)	ug/g	6.11	1.64	27%						
Total Arsenic (As)	ug/g	16.8	19.8	118%						
Total Barium (Ba)	ug/g	91.9	104.0	113%						
Total Beryllium (Be)	ug/g	0.710	0.791	111%						
Total Boron (B)	ug/g	6.31	5.59	89%						
Total Cadmium (Cd)	ug/g	0.300	0.105	35%						
Total Calcium (Ca)	ug/g									
Total Chromium (Cr)	ug/g	40.8	43.9	108%						
Total Cobalt (Co)	ug/g	14.3	17.1	120%						
Total Copper (Cu)	ug/g	44.7	52.7	118%						
Total Iron (Fe)	ug/g	40,500	54,100	134%						
Total Lead (Pb)	ug/g	13.3	15.7	118%						
Total Manganese (Mn)	ug/g	1,170	1,500	128%						
Total Molybdenum (Mo)	ug/g	0.727	0.734	101%						
Total Nickel (Ni)	ug/g	19.7	23.8	121%						
Total Selenium (Se)	ug/g	0.400	0.445	111%						
Total Silver (Ag)	ug/g	0.215	0.222	103%						
Total Strontium (Sr)	ug/g	26	27	106%						
Total Tin (Sn)	ug/g	1.40	1.05	75%						
Total Titanium (Ti)	ug/g	1,770	2,300	130%						
Total Uranium (U)	ug/g	1.06	1.31	124%						
Total Vanadium (V)	ug/g	75.2	85.2	113%						
Total Zinc (Zn)	ug/g	80.1	96.1	120%						
Radium-226	Bq/L	20.6	18.4	89%	20.6	20.1	98%	20.6	19.1	93%

Table A.9: Recoveries of matrix spikes for sediment sample analyses. Highlighted values did not meet data quality objective of 75 - 125% recovery.

Analytes	SRC Job Number 2011-10769 MCBL Sediment Trap	
	% Recovery	% Recovery
Total Radium-226 (Ra)	89	105

NC - not calculated by lab if spike amount was too small relative to sample concentration to permit quantification of spike recovery.

APPENDIX B

PHOTOGRAPHS

Photo 1: Sediment traps for deployment at McCabe Lake, May, 2011.

Photo 2: Sediment trap retrieved from Nordic Lake, October, 2012.

Photo 3: Representative sediment trap retrieved from McCabe Lake, October, 2011.

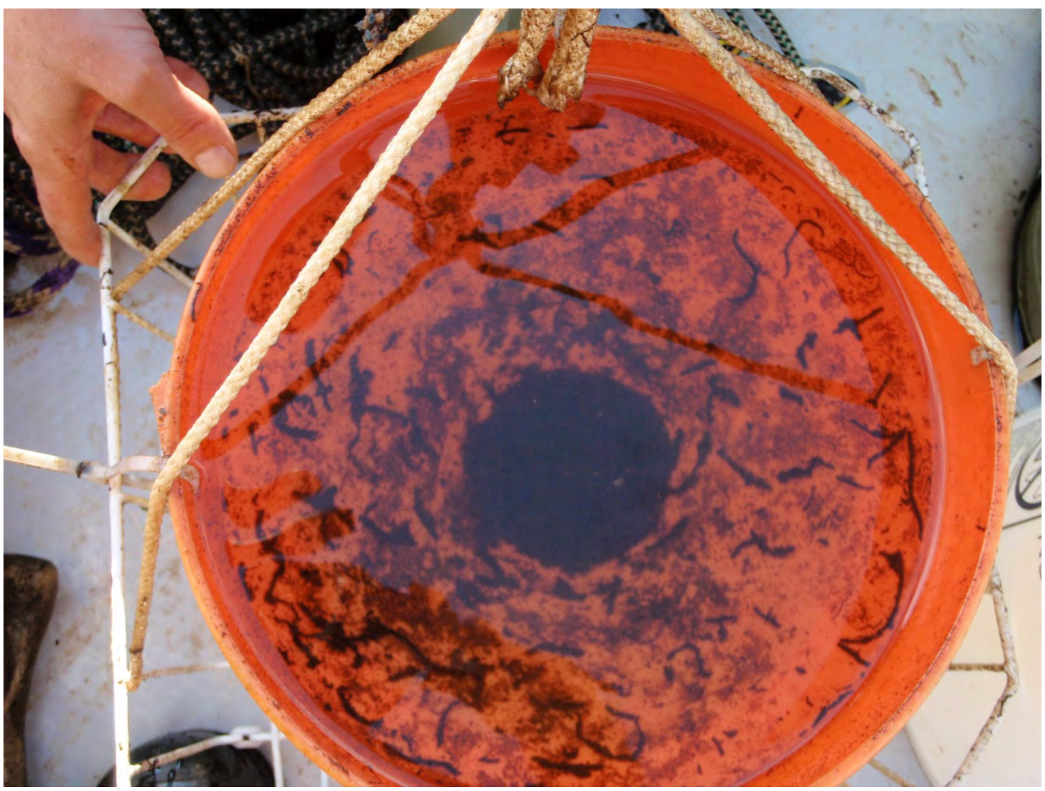


Photo 4: Representative sediment trap retrieved from Nordic Lake, October, 2012.

Photo 5: McCabe Lake deep basin core, October 2011.

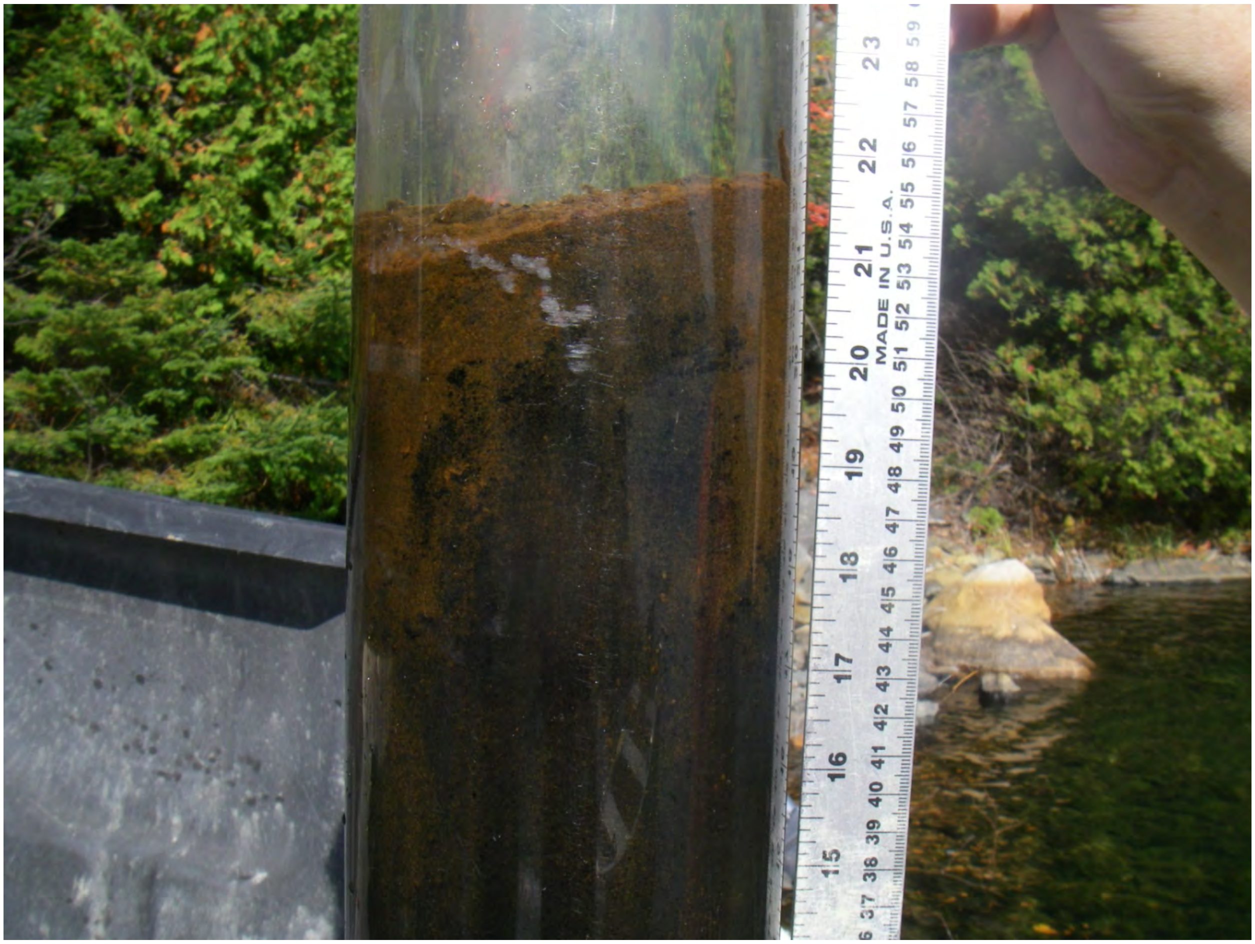


Photo 6: McCabe Lake deep basin core, top layering, October, 2011.

Photo 7: Quirke Lake deep basin core, May 2012.

Photo 8: Nordic Lake deep-basin core, October, 2012.

Photo 9: Nordic Lake deep basin core, sediment-water interface, October, 2012.

APPENDIX C

DISCUSSION OF QUIRKE LAKE ^{137}Cs DATA

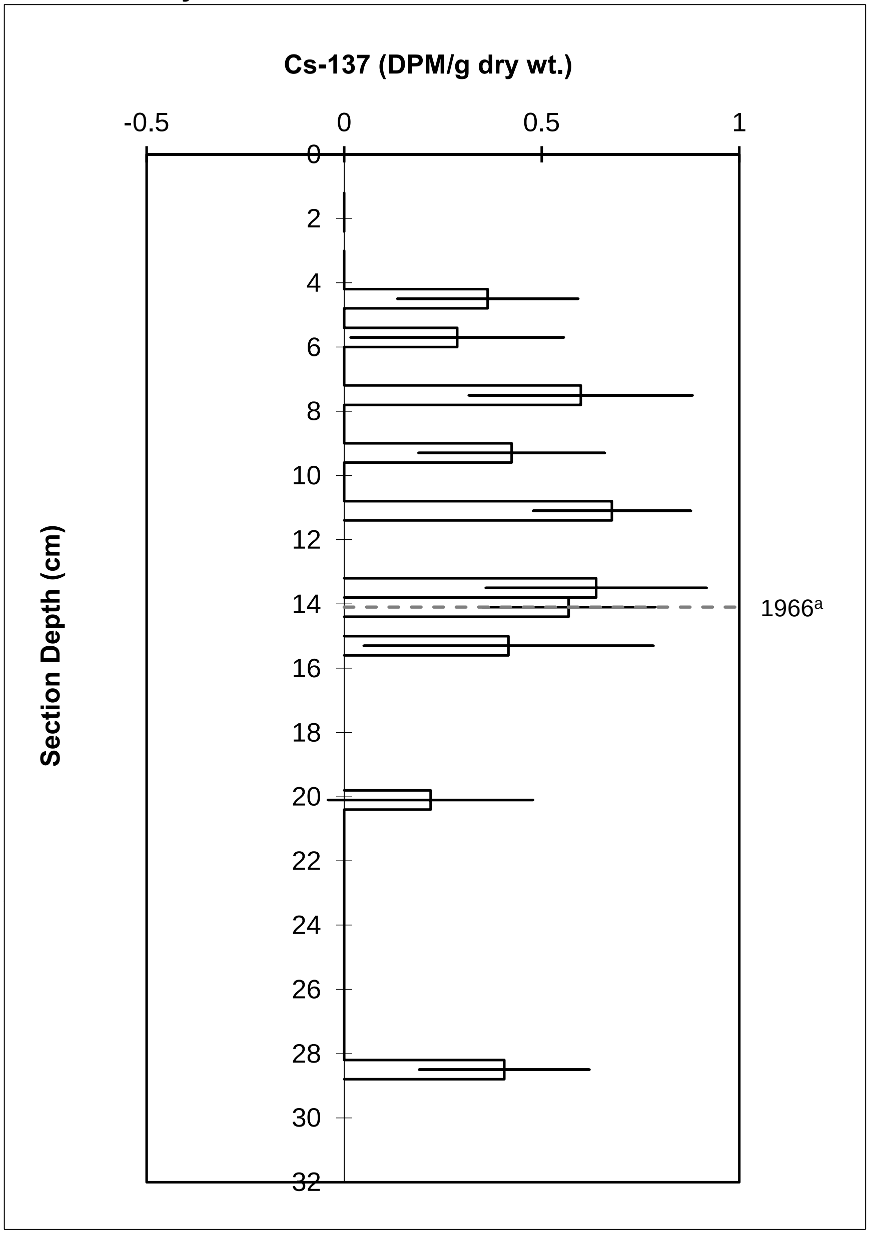
APPENDIX C

Discussion of ^{137}Cs data from Quirke Lake

The ^{137}Cs data collected from select sections in Quirke Lake sediment core provided a profile suggesting that both atmospheric deposition and the upstream watershed were sources of ^{137}Cs. This is because the ^{137}Cs profile did not show a clear peak indicative of a time marker, but showed a broad set of peaks moving up the core profile (Figure C.1) consistent with a watershed source of ^{137}Cs (Heit and Miller 1987). Although the ^{137}Cs signal was very low, a significant peak of ^{137}Cs was identified at 14.5 cm (i.e., higher than three standard deviations above the background). This ^{137}Cs-based time marker was assigned as 1966.

This depth would indicate that sediment has been deposited at a much greater rate than previously determined by McKee et al. (1987), and by other analytes, particularly lead (Figure 4.13) from the present study, which agree well with the findings of McKee et al. (1987). Determining a timeline for a sediment core should involve the use of several analytes that are limnologically consistent with each other in order to come to a conclusion using a weight of evidence approach. The ^{137}Cs data was difficult to interpret in Quirke Lake because the ^{137}Cs activities were low; ^{137}Cs would have been depositing at a time when mining activity was high (1958 to 1966) and lakewater quite acidic (Rio Algom 1995), and this would potentially act to dilute the ^{137}Cs signal or decrease ^{137}Cs adsorption to depositing particles respectively. ^{137}Cs does have potential to migrate down core, and typically shows an asymptotic drop off in activity with depth from the source of downward migration (i.e., the first significant peak at depth). The timeline from the 1984 study (consistent with this study) was constructed using pollen and diatomaceous shells and these particles are not subject to post-depositional migration. In the present study, lead and aluminum (non-migrating elements) were used to establish that there was not a strong argument for iron migration down (or up) the core; lead is less likely to migrate down the core than ^{137}Cs (Crusius and Anderson 1995). Both lead and iron provided time markers that were consistent with each other and with the deposition rates provided by McKee et al. (1987). Therefore, in light of all data available for the interpretation of this sediment core and corresponding lake history, and other data from the 1984 study, were deemed stronger, particularly because they were consistent with each other. For these reasons, the ^{137}Cs data was not used to help establish a time marker for the Quirke Lake sediment core.

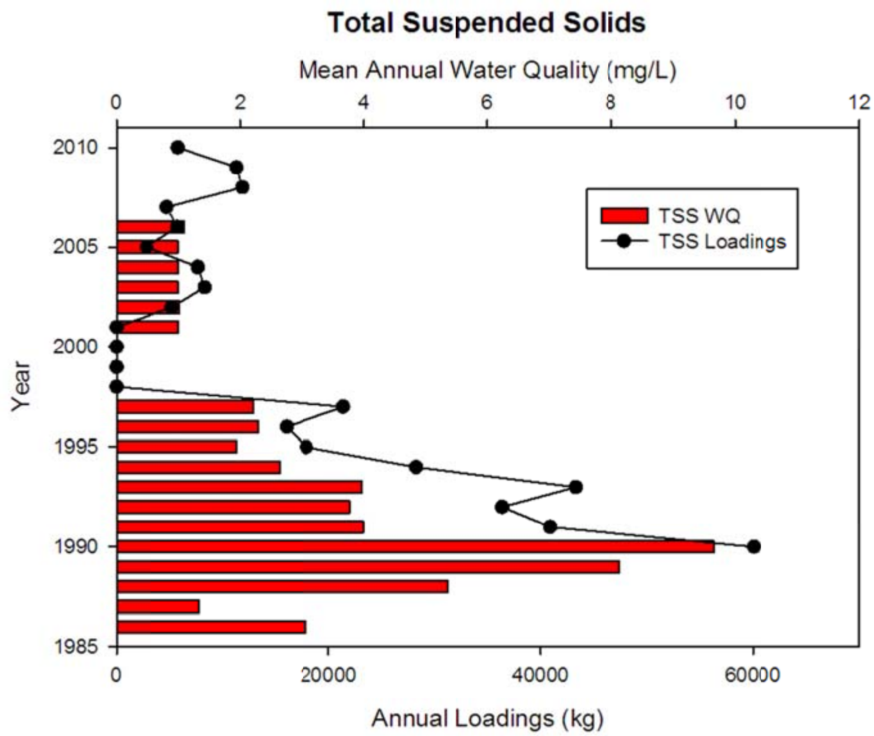
Figure C.1: The 137Cs sediment profile collected from Quirke Lake, May 2012.



[a]1966 was identified as the time marker for the first significant peak from depth; the date pertains to when the highest ^{137}Cs inventory of atmospheric fallout occurred.

APPENDIX D

RAW DATA AND ADDITIONAL FIGURES



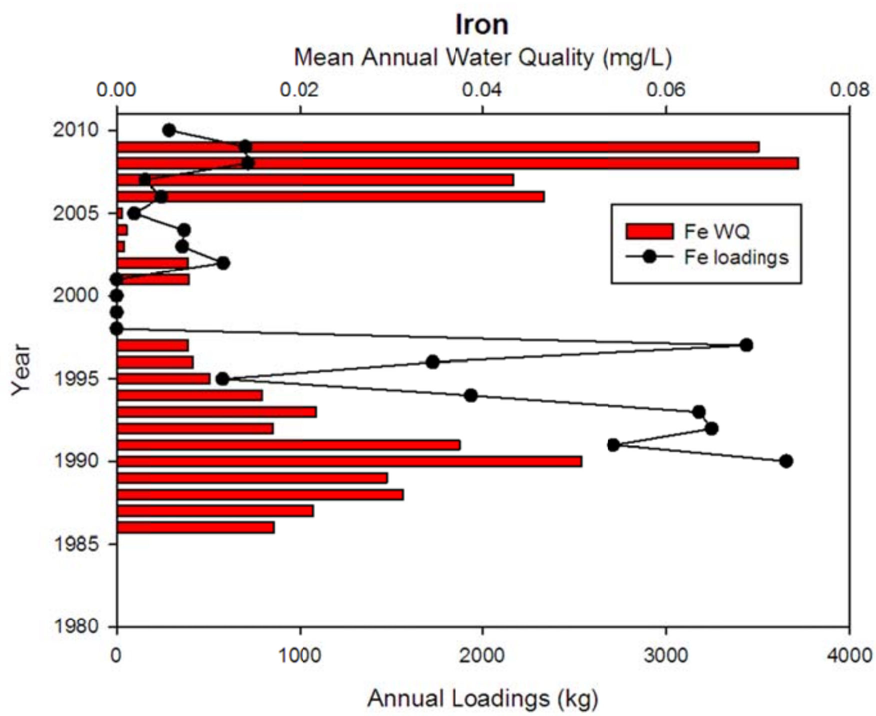
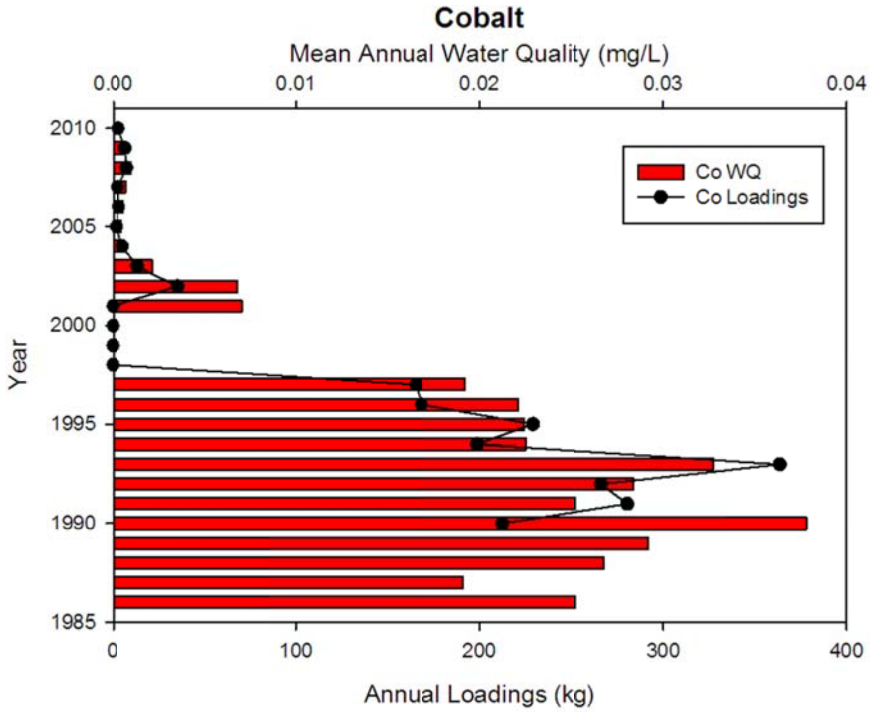


Figure D.1a: The total suspended solid and iron annual loadings and mean annual water quality of effluent discharged into McCabe Lake (monitoring station CL-06) from 1986 to 2011.



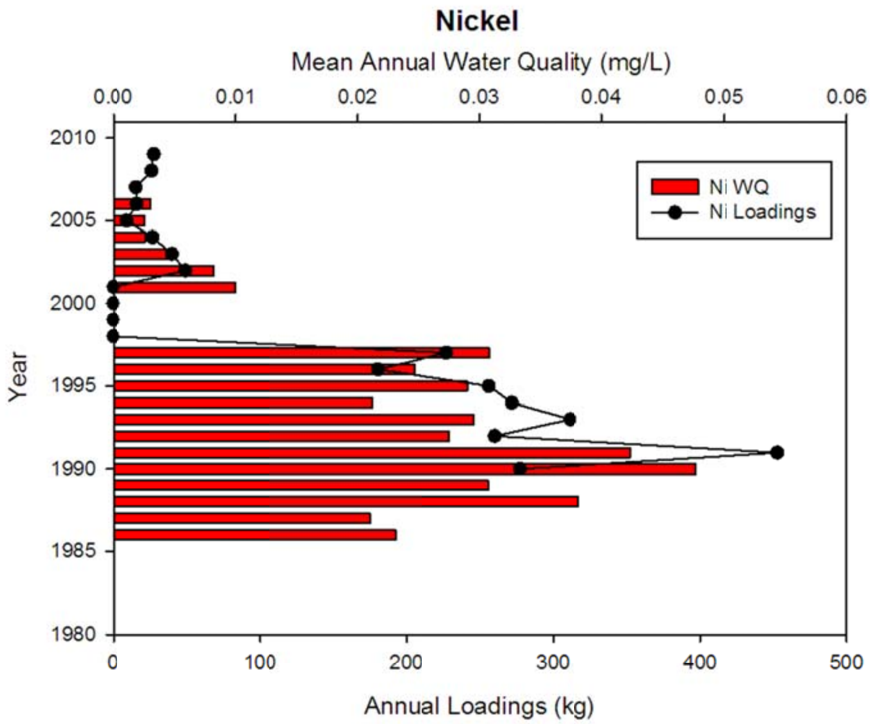
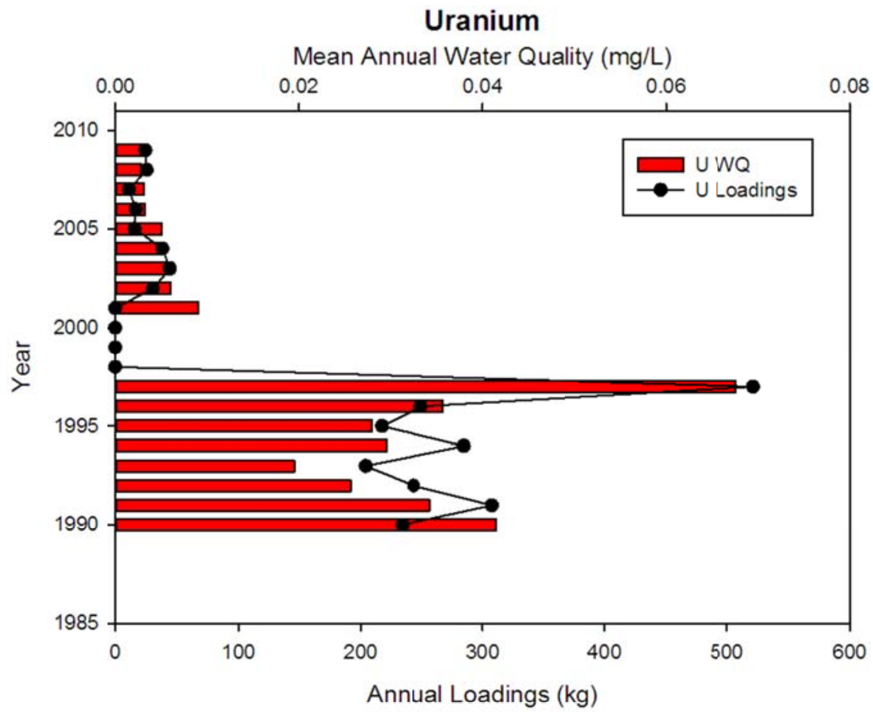


Figure D.1b: The cobalt and nickel annual loadings and mean annual water quality of effluent discharged into McCabe Lake (monitoring station CL-06) from 1986 to 2011.



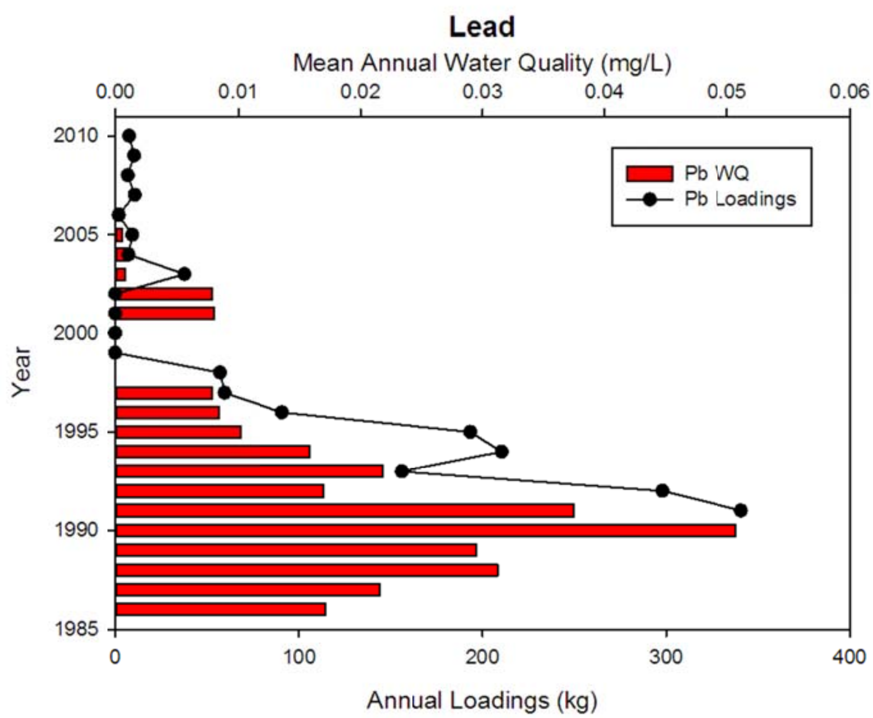


Figure D.1c: The uranium and lead annual loadings and mean annual water quality of effluent discharged into McCabe Lake (monitoring station CL-06) from 1986 to 2011.

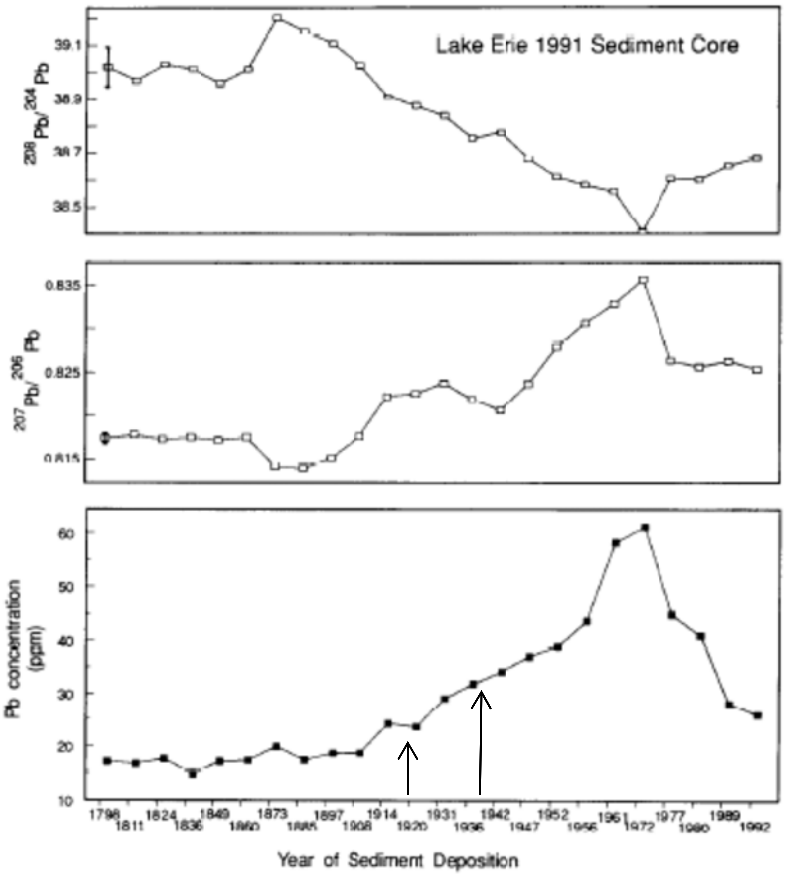


Figure D.2: Temporal changes in lead isotopic ratios and concentrations obtained from dilute acid leaches of sediment from the Lake Erie 1991 core. Adapted from Graney et al. 1995. Arrows indicate onset period of increasing lead concentration in the sediment core (from 1920 to 1940).

Table D.1: McCabe Lake sediment chemistry raw data, October 2011.

Sample Name	Depth	Organic carbon	Bulk density	Sulfur	^{226}Ra	Aluminum	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Calcium	Chromium	Cobalt	Nickel	Copper	Iron
	cm	%	kg/m3	μg/g	Bq/g	μg/g	μg/g	μg/g	μg/g	μg/g	μg/g	μg/g	μg/g	μg/g	μg/g	μg/g	μg/g	μg/g
12/10/2011 MCBL-OCT-DEEP - 0-0.5	0.7	11.30	59.00	14,000	33	28,200	1.80	39.0	29,600	1.30	52.00	1.10	9,450	36	57	80	170	152,000
12/10/2011 MCBL-OCT-DEEP - 0.5-1.0	1.3	10.90	79.00	16,100	43	29,300	1.70	41.0	27,500	1.40	7.00	0.90	9,910	34	58	80	160	143,000
10/12/2011 MCBL-OCT-DEEP-1.0-1.5	2.0		-	15600	42	32500	1.8	45	27600	1.6	11	1.9		39	78	103	160	144000
12/10/2011 MCBL-OCT-DEEP - 1.5-2.0	2.6	11.50	84.00	19,200		34,500	1.70	36.0	23,500	1.50	<1	1.10	9,410	38	77	100	160	121,000
10/12/2011 MCBL-OCT-DEEP-2.0-2.5	3.3		-	24300	33	28100	2.3	41	19700	1.4	9	2.1		38	130	149	160	147000
12/10/2011 MCBL-OCT-DEEP - 2.5-3.0	4.0	11.70	72.00	39,800		28,800	3.00	37.0	11,000	1.30	97.00	2.00	11,300	45	140	180	170	156,000
10/12/2011 MCBL-OCT-DEEP-3.0-3.5	4.6		-	22500	14	29800	2.4	32	8100	1.2	10	2.2		44	87	131	110	117000
12/10/2011 MCBL-OCT-DEEP - 3.5-4.0	5.3	13.20	79.00	15,500		29,000	1.70	22.0	3,600	1.20	88.00	2.20	11,900	46	59	85	74	59,300
12/10/2011 MCBL-OCT-DEEP - 5.0-5.5	7.3	13.80	97.00	9,400		30,600	1.50	18.0	2,100	1.20	66.00	2.80	11,900	49	38	54	56	45,500
12/10/2011 MCBL-OCT-DEEP - 5.5-6.0	7.9	13.20	105.00	10,100		31,100	1.50	18.0	2,300	1.20	30.00	3.00	11,900	48	36	52	55	46,800
12/10/2011 MCBL-OCT-DEEP - 7.5-8.0	10.6	13.20	112.00	19,900		26,300	1.20	19.0	1,100	1.00	<1	3.70	11,400	42	40	43	47	44,600
12/10/2011 MCBL-OCT-DEEP - 9.5-10.0	13.2	13.60	99.00	16,600		29,900	1.30	22.0	630	1.20	25.00	4.30	12,100	47	33	39	47	40,000
12/10/2011 MCBL-OCT-DEEP - 10.5-11.0	14.5	13.60	92.00	20,100		26,400	1.20	20.0	430	1.10	<1	3.70	10,600	43	26	31	42	34,100
12/10/2011 MCBL-OCT-DEEP - 11.5-12.0	15.8	13.80	90.00	20,400		26,800	1.30	18.0	450	1.00	33.00	3.70	11,500	42	25	30	42	35,100
12/10/2011 MCBL-OCT-DEEP - 13.5-14.0	18.5	14.10	100.00	17,800		27,600	1.30	15.0	320	1.00	<1	2.40	11,700	43	25	27	41	34,200
12/10/2011 MCBL-OCT-DEEP - 15.5-16.0	21.1	15.30	100.00	8,300		28,300	0.40	8.6	200	1.10	<1	1.50	11,800	43	16	22	40	27,000
12/10/2011 MCBL-OCT-DEEP - 17.0-17.5	23.1	15.20	93.00	7,500		29,900	0.20	6.9	130	1.10	<1	1.40	11,400	46	14	21	41	27,300
12/10/2011 MCBL-OCT-DEEP - 18.0-18.5	24.4	15.20	101.00	7,600		29,000	<0.2	6.4	110	1.10	<1	1.40	11,300	47	14	21	41	26,500
12/10/2011 MCBL-OCT-DEEP - 19.0-19.5	25.7	15.10	95.00	7,000		27,900	<0.2	5.5	92	1.10	<1	1.30	11,700	44	13	20	39	24,900
12/10/2011 MCBL-OCT-DEEP - 20.0-20.5	27.1	15.50	107.00	6,700		29,800	<0.2	6.1	98	1.20	30.00	1.30	11,500	46	14	21	41	26,100
12/10/2011 MCBL-OCT-DEEP - 22.0-22.5	29.7	15.30	95.00	8,300		29,000	<0.2	5.3	84	1.10	<1	1.30	10,900	45	13	20	39	25,700
12/10/2011 MCBL-OCT-DEEP - 24.0-24.5	32.3	15.30	100.00	6,100		29,600	<0.2	5.4	89	1.20	12.00	1.30	11,500	46	14	21	39	25,400
12/10/2011 MCBL-OCT-DEEP - 26.0-26.5	35.0	15.20	89.00	5,400		30,600	<0.2	5.4	87	1.20	<1	1.40	10,800	46	14	21	40	25,400
12/10/2011 MCBL-OCT-DEEP - 28.0-28.5	37.6	15.00	90.00	6,800		30,600	<0.2	5.4	88	1.20	<1	1.40	10,700	48	14	22	42	26,700
12/10/2011 MCBL-OCT-DEEP - 30.0-30.5	40.3	15.30	90.00	5,100		30,700	<0.2	5.2	89	1.20	<1	1.40	9,800	45	14	21	41	24,900
12/10/2011 MCBL-OCT-DEEP - 32.0-32.5	42.9	15.70	91.00	5,100		33,400	<0.2	5.5	99	1.30	<1	1.40	9,360	48	15	22	43	26,900
12/10/2011 MCBL-OCT-DEEP - 34.0-34.5	45.5	15.50	89.00	4,500		30,100	<0.2	5.3	85	1.10	<1	1.50	9,060	45	14	21	42	24,000
12/10/2011 MCBL-OCT-DEEP - 36.0-36.5	48.2	15.40	107.00	4,500		29,800	<0.2	5.3	92	1.10	<1	1.40	10,700	44	14	21	42	23,800

Table D.1: McCabe Lake sediment chemistry raw data, October 2011.

Sample Name	Manganese	Uranium	Lead	Molybdenum	Selenium	Silver	Strontium	Thallium	Tin	Titanium	Vanadium	Zinc
	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g
12/10/2011 MCBL-OCT-DEEP - 0-0.5	900	340	490	22.0	6.80	0.40	450	0.8	3.8	600	38	230
12/10/2011 MCBL-OCT-DEEP - 0.5-1.0	650	360	630	18.0	7.30	0.40	460	0.6	3.5	530	35	230
10/12/2011 MCBL-OCT-DEEP-1.0-1.5	670	460	880	17	8	0.4	510	0.9	4.1	650	40	300
12/10/2011 MCBL-OCT-DEEP - 1.5-2.0	550	380	840	13.0	7.90	0.40	410	1.1	3.7	550	38	280
10/12/2011 MCBL-OCT-DEEP-2.0-2.5	610	370	880	21	8.3	0.4	370	2	4.2	530	38	320
12/10/2011 MCBL-OCT-DEEP - 2.5-3.0	550	370	1,000	31.0	9.80	0.70	200	1.7	5.8	630	41	320
10/12/2011 MCBL-OCT-DEEP-3.0-3.5	650	410	1100	24	8.6	0.6	170	1.4	6.7	840	46	350
12/10/2011 MCBL-OCT-DEEP - 3.5-4.0	460	220	430	12.0	5.80	0.50	96	1.0	5.4	840	49	240
12/10/2011 MCBL-OCT-DEEP - 5.0-5.5	470	88	220	4.4	4.00	0.40	67	0.6	5.0	940	53	230
12/10/2011 MCBL-OCT-DEEP - 5.5-6.0	490	69	210	4.1	4.00	0.40	68	0.6	4.9	970	53	260
12/10/2011 MCBL-OCT-DEEP - 7.5-8.0	400	29	150	4.2	3.40	0.30	47	0.6	4.3	800	46	200
12/10/2011 MCBL-OCT-DEEP - 9.5-10.0	440	18	140	2.9	3.30	0.30	44	0.7	4.6	910	52	270
12/10/2011 MCBL-OCT-DEEP - 10.5-11.0	400	12	120	1.8	2.90	0.30	37	0.5	4.0	800	49	200
12/10/2011 MCBL-OCT-DEEP - 11.5-12.0	400	12	110	1.9	3.00	0.30	38	0.5	3.9	890	49	210
12/10/2011 MCBL-OCT-DEEP - 13.5-14.0	400	11	77.0	2.2	2.60	0.20	34	0.3	2.3	760	47	220
12/10/2011 MCBL-OCT-DEEP - 15.5-16.0	410	7.90	33.0	1.9	2.30	0.20	32	< 0.2	0.9	680	47	150
12/10/2011 MCBL-OCT-DEEP - 17.0-17.5	410	6.60	20.0	1.8	2.20	0.20	31	< 0.2	0.6	710	46	140
12/10/2011 MCBL-OCT-DEEP - 18.0-18.5	410	5.90	16.0	1.8	2.20	0.20	30	< 0.2	0.6	720	46	140
12/10/2011 MCBL-OCT-DEEP - 19.0-19.5	380	5.40	15.0	1.7	2.10	0.10	29	< 0.2	0.5	650	44	130
12/10/2011 MCBL-OCT-DEEP - 20.0-20.5	420	5.80	14.0	1.8	2.30	0.20	31	< 0.2	0.6	760	48	160
12/10/2011 MCBL-OCT-DEEP - 22.0-22.5	400	5.20	12.0	1.7	2.10	0.10	29	< 0.2	0.5	680	46	140
12/10/2011 MCBL-OCT-DEEP - 24.0-24.5	430	5.20	11.0	1.7	2.10	0.20	30	< 0.2	0.5	760	48	150
12/10/2011 MCBL-OCT-DEEP - 26.0-26.5	450	5.20	10.0	1.8	2.10	0.10	30	0.2	0.5	770	49	150
12/10/2011 MCBL-OCT-DEEP - 28.0-28.5	460	5.30	11.0	1.7	2.10	0.10	30	0.2	0.5	750	50	160
12/10/2011 MCBL-OCT-DEEP - 30.0-30.5	460	5.30	9.8	1.9	2.20	0.10	29	0.2	0.5	750	49	150
12/10/2011 MCBL-OCT-DEEP - 32.0-32.5	510	5.80	10.0	2.0	2.30	0.20	31	0.2	0.5	770	52	160
12/10/2011 MCBL-OCT-DEEP - 34.0-34.5	460	5.40	9.5	1.9	2.20	0.20	28	< 0.2	0.5	700	49	150
12/10/2011 MCBL-OCT-DEEP - 36.0-36.5	460	5.30	9.4	1.9	2.10	0.10	28	< 0.2	0.5	780	50	130

Table D.2: McCabe Lake sediment ^{137}Cs data, October, 2011.

Sample Name	Depth (cm)	Cs-137 activity (DPM/g dry wt)	1 Std Dev. Counting Error (DPM/g dry wt.)
MCBL-OCT-deep-1.5-2.0cm	2.6	0.29	0.73
MCBL-OCT-deep-7.5-8.0cm	10.6	1.33	0.37
MCBL-OCT-deep-12.0-12.5cm	16.5	0.70	0.20
MCBL-OCT-deep-13.5-14.0cm	18.5	0.77	0.44
MCBL-OCT-deep-15.0-15.5cm	20.5	0.49	0.22
MCBL-OCT-deep-16.5-17.0cm	22.4	0.46	0.24
MCBL-OCT-deep-17.0-17.5cm	23.1	-0.12	0.23
MCBL-OCT-deep-17.5-18.0cm	23.8	0.63	0.28
MCBL-OCT-deep-18.0-18.5cm	24.4	0.73	0.20
MCBL-OCT-deep-18.5-19.0cm	25.1	0.09	0.25
MCBL-OCT-deep-19.0-19.5cm	25.7	-0.33	0.48
MCBL-OCT-deep-21.0-21.5cm	28.4	0.23	0.34
MCBL-OCT-deep-28.0-28.5cm	37.6	0.47	0.29
MCBL-OCT-deep-35.5-36.0cm	47.5	0.31	0.34

Table D.3: Metal concentrations of material collected from sediment traps deployed from May to October, 2011 in McCabe Lake

Analyte	Units	MCBL-ST-01	MCBL-ST-02	MCBL-ST-03
Organic carbon	mg/kg	22,000	13,000	7,500
Radium-226	Bq/g	11.8	7.9	8.3
Aluminum	mg/kg	14,370	14,361	18,936
Antimony	mg/kg	0.8	0.9	1.0
Arsenic	mg/kg	13.7	14.8	18.8
Barium	mg/kg	14,108	8,819	9,126
Beryllium	mg/kg	0.7	0.7	0.9
Boron	mg/kg	8.8	7.9	7.9
Cadmium	mg/kg	1.7	1.8	1.5
Chromium	mg/kg	25.4	24.7	30.7
Cobalt	mg/kg	107.6	92.9	87.2
Copper	mg/kg	46.0	45.5	50.5
Iron	mg/kg	40,993	41,347	52,889
Lead	mg/kg	97.84	98.88	138.69
Manganese	mg/kg	19,830	16,880	6,874
Molybdenum	mg/kg	9.3	9.8	9.3
Nickel	mg/kg	114.5	105.8	94.1
Selenium	mg/kg	2.9	2.9	3.0
Silver	mg/kg	0.3	0.2	0.3
Strontium	mg/kg	78.3	63.3	71.3
Thallium	mg/kg	0.2	0.4	0.6
Tin	mg/kg	2.2	15.8	3.3
Titanium	mg/kg	363.6	395.5	574.6
Uranium	mg/kg	136.6	136.4	151.6
Vanadium	mg/kg	27.4	27.7	35.7
Zinc	mg/kg	236.7	228.1	247.8

Table D.4: Annual Mean Water Quality Data for Stanleigh Treatment Plant Effluent (CL-06), 1986-2005

Year	pH	Conductivity µmho/cm	TSS mg/L	Acid mg/L	Sulfate mg/L	Radium (T) Bq/L	Barium mg/L	Cobalt mg/L	Copper mg/L	Iron mg/L	Lead mg/L	Manganese mg/L	Nickel mg/L	Selenium mg/L	Silver mg/L	Uranium mg/L	Zinc mg/L
1986	7.6	-	< 3.1	3.23	799	0.143	0.1	0.025	0.010	0.502	0.017	0.330	0.023	-	-	-	0.066
1987	6.4	-	1.3	8.08	874	0.091	< 0.1	0.019	0.010	0.173	0.022	0.207	0.021	-	-	-	0.032
1988	-	-	5.3	3.56	806	0.219	< 0.1	0.027	0.010	3.296	0.031	0.208	0.038	-	-	-	0.046
1989	-	-	8.1	2.02	841	0.341	< 0.1	0.029	0.013	0.919	0.030	0.290	0.031	-	-	-	0.031
1990	-	-	9.6	4.29	869	0.485	< 0.1	0.038	0.012	0.594	0.051	0.450	0.048	-	-	0.042	0.018
1991	8.0	-	4.0	7.06	1267	0.644	-	0.025	0.020	0.272	0.038	0.262	0.042	-	-	0.034	0.017
1992	-	-	3.8	0.00	1277	0.180	-	0.028	0.014	0.402	0.017	0.193	0.028	-	-	0.026	0.020
1993	-	-	4.0	-	1393	0.335	-	0.033	0.020	0.256	0.022	0.149	0.030	-	-	0.020	0.019
1994	7.4	-	2.6	4.85	1352	0.120	-	0.023	0.011	0.214	0.016	0.254	0.021	-	-	0.030	0.014
1995	-	-	1.9	4.38	1385	0.160	0.039	0.022	0.009	0.084	< 0.010	0.193	0.029	-	-	0.028	0.022
1996	-	-	2.3	3.50	1175	0.154	-	0.022	0.006	0.208	0.008	0.194	0.025	-	-	0.036	0.013
1997	-	-	2.2	2.32	780	0.051	0.035	0.019	0.004	0.500	0.008	0.245	0.031	0.0251	0.0100	0.068	0.009
2001	-	-	1.0	2.00	428	0.034	-	0.007	0.003	0.079	0.008	0.821	0.010	-	-	0.009	0.009
2002	7.3	511.5	< 1.0	1.94	345	0.100	0.121	0.007	0.004	0.129	0.008	0.712	0.008	< 0.0020	< 0.0001	0.006	0.012
2003	7.4	512.4	< 1.0	-	301	0.082	0.136	0.002	< 0.001	0.057	0.001	0.423	0.005	0.0003	0.0007	0.005	0.004
2004	7.3	436.0	< 1.0	-	246	0.123	0.154	0.001	0.004	0.047	0.001	0.229	0.003	0.0003	0.0014	< 0.005	0.004
2005	7.4	413.2	1.0	-	193	0.124	0.149	0.0005	0.001	0.033	0.001	0.123	0.003	0.0004	0.0004	0.005	0.005
2006	7.3	-	1.1	-	198	0.144	0.205	0.0006	0.0009	0.047	-	0.089	0.003	-	-	0.003	0.003
2007	7.3	-	-	-	188	0.180	0.204	0.0007	-	0.043	-	0.099	-	-	-	0.003	-
2008	7.3	-	-	-	140	0.174	0.554	0.0010	-	0.074	-	0.124	-	-	-	0.003	-
2009	7.4	-	-	-	146	0.170	0.578	0.0007	-	0.07	-	0.142	-	-	-	0.003	-

Table D.5: Annual loadings to McCabe Lake from the effluent treatment plant (CL-06) between 1990 and 2010.

Year	Total Suspended Solids (kg)	Iron (kg)	Cobalt (kg)	Nickel (kg)	Lead (kg)	Uranium (kg)	Zinc (kg)
1990	60,072	3,656	212	277	341	234	99
1991	40,895	2,713	281	453	298	308	170
1992	36,395	3,245	266	260	156	243	164
1993	43,290	3,177	364	312	210	204	201
1994	28,226	1,936	199	272	193	285	190
1995	17,919	580	229	256	91	217	186
1996	16,031	1,723	168	180	59	250	67
1997	21,407	3,434	165	227	57	521	80
2002	5,246	583	35	49	37	31	62
2003	8,336	362	13	40	7	44	36
2004	7,701	372	5	27	9	38	27
2005	2,838	95	2	10	2	16	10
2006	5,777	248	3	16	11	17	18
2007	4,783	155	2	16	7	11	14
2008	11,862	716	8	26	10	26	44
2009	11,320	703	7	28	8	24	41
2010	5,822	291	3				

Table D.6: Metal concentrationts in the deep-basin core collected from Quirke Lake, May 2012.

Sample Name	Depth	Moisture	Sulfur	Aluminum	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Manganese	Molybdenum	Nickel
	cm	% (by weight)	%	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g
10/3/2012 QUIL - 0 TO 0.5	0.65	92.57	0.77	16900	3.4	53	3560	0.5	7	0.8	56	70	130	135000	653	6400	120	35
10/03/2012 QUIL 0.5-1.0	1.3		0.46	26400	2.7	37	1750	0.8	9	0.8	54	52	120	80000	844	3700	63	42
10/3/2012 QUIL - 1.0 TO 1.5	1.95	92.13	0.4	23100	2.5	40	1320	0.8	6	1.4	43	45	100	71700	536	2960	42	33
10/3/2012 QUIL - 2.0 TO 2.5	3.25		0.19	20900	2.1	54	640	1	6	1.1	39	33	71	110000	246	2960	23	25
10/3/2012 QUIL - 3.5 TO 4.0	5.2		0.12	19100	1.4	27	260	1	4	1	32	24	45	144000	93	2600	9.6	20
10/03/2012 QUIL 4.0-4.5	5.85		0.3	29500	0.2	11	190	1.3	5	0.7	41	20	72	86300	34	1700	3.6	32
10/3/2012 QUIL - 5.0 TO 5.5	7.15	89.14	0.24	26000	0.4	13	600	1.2	5	0.9	40	16	58	94700	35	1580	4.6	24
10/03/2012 QUIL 5.5-6.0	7.8		0.08	21600	1.2	38	140	1.4	5	1.6	34	36	51	235000	59	4100	14	23
10/3/2012 QUIL - 6.5 TO 7.0	9.1	89.61	0.42	26800	0.2	9.2	180	1.4	4	1.6	42	22	63	75500	20	1640	3.6	28
10/3/2012 QUIL - 8.0 TO 8.5	11.1	88.79	0.19	27900	0.2	6.4	150	1.4	5	2.5	47	23	66	54900	15	1510	3.3	30
10/3/2012 QUIL - 9.5 TO 10.0	13		0.36	27700	0.2	7.3	130	1.4	5	2	45	20	64	53800	13	1480	3.8	26
10/3/2012 QUIL - 11.5 TO 12.0	15.6		0.22	29200	<0.2	7.7	230	1.4	5	2	45	40	70	68500	12	1660	4.3	29
10/3/2012 QUIL - 14.0 TO 14.5	18.9	88.46	0.41	30300	0.2	9.5	160	1.4	5	1.5	46	22	71	51500	12	1640	3.4	26
10/3/2012 QUIL - 16.5 TO 17.0	22.1		0.21	32900	<0.2	7.6	180	1.5	6	1.6	47	21	75	52300	12	1790	3.3	25

Table D.6: Metal concentrationts in the deep-basin core collected from Quirke Lake, May 2012.

Sample Name	Selenium	Silver	Strontium	Thallium	Tin	Titanium	Uranium	Vanadium	Zinc
	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g
10/3/2012 QUIL - 0 TO 0.5	13	1	52	0.3	8	550	810	49	86
10/03/2012 QUIL 0.5-1.0	9.9	0.8	45	0.7	8.3	790	680	57	110
10/3/2012 QUIL - 1.0 TO 1.5	7.6	0.7	31	0.6	8.2	570	505	53	130
10/3/2012 QUIL - 2.0 TO 2.5	5.9	0.5	25	0.3	6.4	580	205	50	130
10/3/2012 QUIL - 3.5 TO 4.0	3.4	0.3	21	0.2	2.8	520	26	44	140
10/03/2012 QUIL 4.0-4.5	3.6	0.2	28	< 0.2	0.5	620	11	56	140
10/3/2012 QUIL - 5.0 TO 5.5	3.2	0.2	28	< 0.2	0.5	540	12	53	140
10/03/2012 QUIL 5.5-6.0	3.7	0.2	24	< 0.2	1.5	530	19	48	190
10/3/2012 QUIL - 6.5 TO 7.0	3	0.2	22	0.2	0.4	560	12	57	170
10/3/2012 QUIL - 8.0 TO 8.5	3.3	0.2	23	0.4	0.4	610	13	57	150
10/3/2012 QUIL - 9.5 TO 10.0	3.3	0.2	23	0.3	0.4	580	12	57	140
10/3/2012 QUIL - 11.5 TO 12.0	3.5	0.2	24	0.6	0.4	600	10	61	120
10/3/2012 QUIL - 14.0 TO 14.5	3.6	0.3	24	0.5	0.4	640	12	61	180
10/3/2012 QUIL - 16.5 TO 17.0	3.5	0.2	27	0.4	0.5	660	12	62	180

Table D.7: Quirke Lake sediment ^{137}Cs and bulk density data, May, 2012.

Sample Name	Lower Depth (cm)	Cs-137 activity (DPM/g dry wt)	1 Std Dev. Counting Error (DPM/g dry wt.)	Bulk density (dry g / wet mL)
QUIL-0.5-1.0	1.3	NA		0.074
QUIL-2.0-2.5	3.3	NA		0.106
QUIL-3.5-4.0	5.2	0.36	0.23	0.148
QUIL-4.0-4.5	5.9	NA		0.068
QUIL-4.5-5.0	6.5	0.29	0.27	0.144
QUIL-5.5-6.0	7.8	NA		0.091
QUIL-6.0-6.5	8.5	0.60	0.28	0.115
QUIL-7.5-8.0	10.4	0.42	0.24	0.135
QUIL-9.0-9.5	12.4	0.68	0.20	0.139
QUIL-9.5-10.0	13.0	NA		0.137
QUIL-10.5-11.0	14.3	NA		0.139
QUIL-11.0-11.5	15.0	0.64	0.28	0.131
QUIL-11.5-12.0	15.6	0.57	0.22	0.135
QUIL-12.0-12.5	16.3	NA		0.134
QUIL-12.5-13.0	16.9	0.42	0.37	0.134
QUIL-16.5-17.0	22.1	0.22	0.26	0.134
QUIL-23.5-24.0	31.2	0.41	0.22	0.155

NA: not analyzed

Table D.8 Historical pH, iron and sulphate concentrations at the Quirke Lake outflow. [a]

Date	Total Iron (µg/L)	pH	Total Sulphate (mg/L)
6-Jun-66	140	5.5	134
4-Jul-66	220	5.9	105
3-Aug-66	50	6	105
6-Sep-66	60	5	116
31-Oct-66	110	5.9	100
24-Jan-68	250	5.5	83
18-Feb-68	140	5.4	84
13-Mar-68	340	6.6	84
2-May-68	220	5.5	82
22-May-68	190	5.5	71
10-Jul-68	50	5.1	96
30-Jul-68	250	5.1	82
11-Sep-68	250	5.2	98
12-Oct-68	140	4.8	114
5-Feb-69	900	6.2	80
28-Feb-69	600	5.3	90
10-May-69	150	7.4	108
10-Jun-69	250	5	
15-Jul-69	200	4.9	116
30-Oct-69	150	4.9	100
24-Nov-70	150	5.2	100
15-Jul-71		5	
11-Apr-77	150	6.45	11.5
4-May-77	120	5.14	114
26-Jun-77	100	5.4	130
31-Jul-77	200	5.08	140
30-Sep-77	90	6.03	
29-Dec-77	410	5.51	85
29-Jan-78	780	5.76	76
21-Feb-78	270	5.98	115
27-Mar-78	540	5.2	60
29-Apr-78	220	5.41	112
26-May-78	150	5.79	5.4
18-Jun-78	90	5.64	140
23-Jul-78	900	6	164
24-Aug-78	280	5.54	151
28-Sep-78	110		137
28-Oct-78	110	5.96	135
30-Nov-78	90	5.19	147
28-Dec-78	210	6.69	93
18-Jan-79	350	6.67	100
19-Feb-79	520	6.71	42.5
21-Mar-79	150	5.35	135
28-Apr-79		5.25	95
27-Jun-79		6.31	145
31-Jul-79		6.3	137
31-Aug-79	120	6.02	133
31-Oct-79		5.93	128
21-Feb-80		6.84	39
30-Mar-80			16
29-May-80		6.26	131
23-Jun-80		6.37	203
23-Jul-80		6.89	161
29-Aug-80		6.75	170
28-Sep-80		7.12	39
28-Oct-80		6.55	143

Date	Total Iron (µg/L)	pH	Total Sulphate (mg/L)
27-Jan-81		6.68	
27-Feb-81		6.14	
29-Mar-81		6.36	
30-May-81	50	6.41	126
30-Jul-81	110	6.72	153
30-Aug-81	40	6.47	185
30-Sep-81	40	6.78	161
30-Oct-81	80	6.27	169
24-Apr-82	90		69
21-May-82	80	6.63	115
24-Jun-82	55	6.55	157
29-Jul-82	20	6.73	171
30-Sep-82	20		142.5
31-Oct-82	30		148.2
30-Nov-82	30		168.3
26-Jan-83	75	6.51	109.3
17-Apr-83	25		17.33
31-May-83	65	6.785	152
26-Jun-83	63		169.95
31-Aug-83	20		188.5
29-Sep-83	65		202
9-Nov-83	45		195.35
25-Feb-84	555	6.66	135.6
10-Mar-84	105	6.56	9.43
21-Apr-84	55	6.2	151
13-May-84	122	6.55	194
17-Jun-84	70	6.51	198.8
20-Jul-84	35	6.59	180.75
16-Aug-84	45	6.78	172.35
23-Sep-84	425	7.12	128.12
26-Oct-84	55	6.86	152.1
20-Nov-84	105	6.105	149.05
29-Jan-85	630	7.55	1392.75
20-Mar-85	225	6.8	51
3-Aug-85	63	6.69	175.2
3-Sep-85	20	6.87	150
25-Oct-85	15	7.01	433
24-Nov-85	100	6.85	193
31-Dec-85	24	7.76	160
26-Jan-86	340	5.57	132
2-Mar-86	210	7.08	28.65
19-Mar-86	56	6.75	29.3
23-Mar-86		6.95	35.65
31-May-86	30	6.62	32.8
1-Jul-86	49	5.07	144
4-Jul-86	18	6.37	225
20-Jul-86	23	6.41	200
1-Aug-86	67	6.77	200
15-Aug-86	10	7.28	1410
30-Sep-86	23	6.32	194
30-Nov-86		6.23	1895
17-Jan-87	75	6.54	184.6
12-Mar-87	53	6.52	20.9
31-May-87	91	6.2	168
27-Jun-87	21	6.58	209
13-Aug-87		6.13	217

[a] Data from Ontario Ministry of Environment

Table D.8 Historical pH, iron and sulphate concentrations at the Quirke Lake outflow. [a]

Date	Total Iron (µg/L)	pH	Total Sulphate (mg/L)
31-Aug-87	67	5.7	227
30-Nov-87	27	5.32	235
31-Dec-87	420	5.6	238.6
24-Feb-88	220	6.83	49.2
23-Mar-88	180	7.17	481
20-May-88	49	5.8	161
17-Jun-88	260	5.67	207
22-Jul-88	250	7.1	1250
1-Sep-88	310	7.2	591
1-Nov-88	330	6.6	239
31-Jan-89	95	6.4	77.4
28-Feb-89	96	6.4	77.7
31-Mar-89	130	5.8	16.6
28-Jul-89	220	5.8	215
31-Aug-89	470	5.86	245
30-Sep-89	22	5.72	222
22-Nov-89	64	5.39	236
31-Dec-89	160	6.78	63.9
28-Feb-90	210	6.57	66.1
29-Mar-90	33	6.95	67
30-Apr-90	250	5.77	209
31-May-90	47	5.32	211
26-Jun-90	24	5.5	24
30-Apr-91	73	6.2	84.1
31-May-91	200	6.9	177
18-Jul-91	19	5.7	214
16-Oct-91	33	5.6	224
30-Dec-91	530	7	9.72
22-Feb-92	710	6.7	67.2
12-Apr-92	420	7	19.9
6-May-92	100	5.9	160
1-Nov-90	51		213.4
1-Dec-90	6		216.2
1-Jan-91	39		219.0
1-Feb-91	29		
1-Mar-91	35		174.0
1-Apr-91	110		30.5
1-May-91	78		192.0
1-Jun-91	70		180.0
1-Jul-91	86		188.0
1-Aug-91	43		198.0
1-Sep-91	90		199.0
1-Jan-91	150		213.0
1-Nov-91	30		199.0
1-Jan-92	80		115.0
1-Feb-92	50		114.0
1-Mar-92	90		188.0
1-Apr-92	90		59.0
1-May-92	70		172.0
1-Jun-92	70		166.0
1-Jul-92	170		176.0
1-Aug-92	100		181.0
1-Sep-92	40		178.0
1-Jan-92	30		177.0
1-Nov-92			183.0

Date	Total Iron (µg/L)	pH	Total Sulphate (mg/L)
1-Dec-92	30		172.0
1-Jan-93	40		159.0
1-Feb-93	100		121.0
1-Mar-93	100		157.0
1-May-93	30		134.0
1-Jun-93	40		145.0
1-Jul-93	40		144.0
1-Aug-93	30		139.0
1-Sep-93	30		138.0
1-Jan-93	100		143.0
1-Nov-93	30		158.0
1-Dec-93	0		
1-Jan-94	60		147.0
1-Feb-94	250		130.0
1-Mar-94	70		112.0
1-Apr-94	140		54.0
1-May-94	20		145.0
1-Jun-94	50		145.0
1-Jul-94	60		136.0
1-Aug-94	30		135.0
1-Sep-94	20		139.0
1-Jan-94	40		141.0
1-Nov-94	30		131.0
1-Dec-94	20		140.0
1-Jan-95	40		135.0
1-Feb-95	90		148.0
1-Mar-95	60		121.0
1-May-95	50		130.0
1-Jun-95	44		124.0
1-Jul-95	40		171.0
1-Aug-95	40		118.0
1-Sep-95	30		110.0
1-Jan-95	37		120.0
1-Jan-96	69		126.0
1-Feb-96	30		90.0
1-Mar-96	40		81.0
1-Apr-96	70		80.0
1-May-96	70		110.0
1-Jun-96	30		113.0
1-Jul-96	33		93.0
1-Aug-96	50		96.0
1-Sep-96	140		102.0
1-Jan-96	30		101.0
1-Nov-96	41		119.0
1-Dec-96	20		113.0
1-Jan-97	45	6.40	109.0
1-Feb-97	43	6.30	95.0
1-Mar-97	0	6.20	88.0
1-Apr-97	82	6.30	90.0
1-May-97	52	5.60	93.0
1-Jun-97	48	5.80	95.0
1-Jul-97	21	6.00	108.0
1-Aug-97	23	5.90	102.0
1-Sep-97	29	6.00	87.0
1-Jan-97	53	5.90	97.0

[a] Data from Ontario Ministry of Environment

Table D.8 Historical pH, iron and sulphate concentrations at the Quirke Lake outflow. [a]

Date	Total Iron (µg/L)	pH	Total Sulphate (mg/L)
1-Nov-97	35	5.90	107.0
1-Dec-97	25	5.80	102.0
1-Jan-98	24	5.70	107.0
1-Feb-98	21	5.80	102.0
1-Mar-98	14	6.00	98.0
1-Apr-98	60	5.80	96.9
1-May-98	31	5.90	110.0
1-Jun-98	20	6.00	113.0
1-Jul-98	44	6.20	124.0
1-Aug-98	20	6.10	104.0
1-Sep-98	30	6.00	106.2
1-Jan-98	40	5.90	90.7
1-Nov-98	28	5.80	95.6
1-Dec-98	20	5.70	94.9
1-Jan-99	36	5.80	103.0
1-Feb-99	20	6.10	85.5
1-Mar-99	59	6.40	82.4
1-Apr-99	29	5.80	116.0
1-May-99	100	5.80	98.5
1-Jun-99	36	6.90	94.1
1-Jul-99	20	6.30	90.6
1-Aug-99	20	6.20	99.4
1-Sep-99	29	6.11	97.3
1-Jan-99	7	6.02	97.7
1-Nov-99	14	6.09	95.9
1-Dec-99	23	5.83	94.6
1-Jan-00	24	5.86	105.0
1-Feb-00	22	6.25	101.0
1-Mar-00			
1-Apr-00	22	5.82	84.5
1-May-00	25	5.96	95.0
1-Jun-00	13	6.08	94.0
1-Jul-00	13	6.31	91.2
20-Sep-99	12.0	7.0	97.7
31-Jan-00	24.0		105
10-Feb-00	21.9		101
18-Apr-00	22.1		84.5
4-May-00	24.5		95.0
6-Jun-00	12.9		94.0
12-Jul-00	12.5		91.2
17-Aug-00	17.4		96.9
13-Sep-00	12.1		95.4
12-Oct-00	11.3		86.7
15-Nov-00	6.9	5.7	93.0
20-Mar-01	40.5		81.0
4-Apr-01	62.7		73.0
23-May-01	20.0		88.1
13-Jun-01	7.2		82.0
11-Jul-01	0.8		90.7
15-Aug-01	17.1		99.9
19-Sep-01	8.8		86.5
10-Oct-01	24.2		84.3
7-Nov-01	23.2	6.4	80.3
12-Dec-01	70.0		87.0
20-Nov-02		6.4	
21-Nov-02	8.0		77.3
26-Aug-03	22.0	6.2	72.2
26-Sep-04	2.0	6.0	68.3
24-Sep-05	3		73.4
27-Sep-05		6.4	
23-Oct-06	20	7.3	55

[a] Data from Ontario Ministry of Environment

Table D.9: The sediment metal concentrations from cores collected from Quirke Lake in 1984 (Beak 1985).

Station	Depth	U	Zn	Mn	Mn	Cu	Fe	Pb	Ni	Al
	cm	ug/g	ug/g	mg/g	ug/g	ug/g	ug/g	ug/g	ug/g	ug/g
13	0.25	1,150	68	0.46	460	164	40,000	340	22	26,000
13	0.75	1,400	62	0.33	330	230	48,000	460	19	41,000
13	1.25	1,230	49	0.5	500	200	112,000	630	14	36,000
13	1.75	1,380	44	0.54	540	198	199,000	890	9	29,000
13	2.25	1,130	42	0.52	520	161	240,000	740	7	21,000
13	2.75	848	37	0.45	450	125	253,000	620	10	14,400
13	3.5	663	54	0.8	800	105	270,000	570	16	10,200
13	4.5	989	76	0.74	740	111	193,000	770	25	9,600
13	6.5	517	153	25	25,000	99	64,000	455	32	16,700
13	9.5	11	177	3.65	3,650	51	151,500	112	26	13,900
13	14.5	26	148	1.3	1,300	750	60,000	29	26	18,800
13	19.5	11	129	1.52	1,520	84	48,000	8	24	20,000
14	0.25	1,610	86	0.9	900	210	54,000	480	25	32,000
14	0.75	1,360	68	0.95	950	240	57,000	580	20	52,000
14	1.25	1,670	72	1.33	1,330	270	94,000	900	20	52,000
14	1.75	1,920	76	1.5	1,500	240	108,000	940	24	49,000
14	2.25	1,590	92	1.7	1,700	190	163,000	735	29	20,900
14	2.75	781	106	2.35	2,350	149	190,000	715	39	12,800
14	3.5	989	125	3.2	3,200	158	18,800	1,040	37	12,800
14	4.5	990	132	5.4	5,400	153	89,500	1,500	40	16,200
14	6.5	135	260	64	64,000	100	41,000	340	49	15,500
14	9.5	17	200	4.8	4,800	44	100,000	60	24	11,500
14	14.5	21	170	5.4	5,400	81	42,000	21	58	19,000
14	19.5	12	188	4.9	4,900	86	57,000	22	40	21,000
15	0.25	1,390	135	2	2,000	193	107,000	880	30	20,000
15	0.75	1,540	164	3.6	3,600	157	99,000	830	35	18,700
15	1.25	1,580	210	5.2	5,200	168	100,000	1,090	48	17,700
15	1.75	1,470	250	11.6	11,600	140	90,000	985	55	18,300
15	2.25	902	270	1.18	1,180	123	61,000	780	56	19,500
15	2.75	1,090	315	24	24,000	124	65,000	640	64	18,100
15	3.5	687	360	47	47,000	114	51,000	540	72	16,500
15	4.5	252	380	70	70,000	82	103,000	240	64	13,500
15	6.5	45	270	17.8	17,800	66	132,000	61	34	14,800
15	9.5	18	210	9.7	9,700	76	240,000	40	39	18,700
15	14.5	11	181	7	7,000	82	66,000	6	31	19,600
15	19.5	12	175	6.2	6,200	87	54,000	3	34	21,000

Table D.10: Metal concentrationts in the deep-basin core collected from Nordic Lake, October 2012.

Sample Name	Depth	TOC	Sulfur	Aluminum	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Manganese	Molybdenum	Nickel
	cm	%	%	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g
NORL-OCT-Deep-0-0.5	0.62		3.7	16,700	1.2	12	240	0.6	10	1.1	35	190	57	86,300	50	2,900	5.3	65
NORL-OCT-Deep-2.0-2.5	3.1	9.29	3.53	23,800	1	25	390	1	10	1.3	35	290	100	82,100	213	2,400	5.3	110
NORL-OCT-Deep-4.5-5.0	6.2	10.3	6.46	22,000	1.4	21	180	0.8	10	2	38	33	57	51,000	177	1,470	3	64
NORL-OCT-Deep-7.5-8.0	9.92	9.8	0.9	22,000	1.5	13	160	0.7	9	2.4	41	17	39	26,700	95	1,030	1.3	32
NORL-OCT-Deep-9.0-9.5	11.78	10	0.67	23,400	1.2	11	150	0.7	9	2	42	17	38	27,400	76	890	1.4	29
NORL-OCT-Deep-12.0-12.5	15.5	12.2	0.38	25,900	0.7	7.8	190	0.8	10	1.1	46	15	44	28,300	53	940	1.3	27
NORL-OCT-Deep-14.5-15.0	18.6	11.4	0.47	27,000	0.4	6.8	180	0.8	9	0.8	47	17	42	32,200	30	860	2.6	29
NORL-OCT-Deep-17.0-17.5	21.7	11.4	0.33	26,700	< 0.2	6.3	130	0.9	7	0.8	48	18	43	28,800	20	800	3.3	29
NORL-OCT-Deep-19.5-20.0	24.8	11.3	0.24	27,000	< 0.2	5.2	120	0.8	7	0.7	48	18	44	30,600	16	780	2.7	28
NORL-OCT-Deep-23.5-24.0	29.76	10.8	0.23	26,600	< 0.2	4.9	120	0.8	7	0.8	50	18	41	30,000	14	750	2.4	28
NORL-OCT-Deep-25.5-26.0	32.24	11.2	0.35	27,000	< 0.2	4.8	130	0.8	7	0.7	50	17	41	30,300	14	760	1.9	28
NORL-OCT-Deep-27.5-28.0	34.72	10.4	0.21	26,000	< 0.2	4.7	130	0.8	6	0.8	49	18	40	28,600	14	730	1.8	28
NORL-OCT-Deep-29.5-30.0	37.2	9.97	0.18	26,300	< 0.2	4.6	130	0.8	6	0.8	48	18	40	29,800	14	710	2.4	28
NORL-OCT-Deep-31.5-32.0	39.68	12	0.23	28,900	< 0.2	4.9	150	0.9	7	0.8	50	16	48	31,300	16	820	2.3	29
NORL-OCT-Deep-34.0-34.5	42.78	11.5	0.22	28,800	< 0.2	4.6	150	0.9	7	0.7	50	16	48	31,200	15	830	2.5	29
NORL-OCT-Deep-38.0-38.5	47.74	11.1	0.22	29,500	< 0.2	5.1	160	0.9	7	0.8	51	17	45	33,200	15	860	2.4	28

Table D.10: Metal concentrationts in the deep-basin core collected from Nordic Lake, October 2012.

Sample Name	Selenium	Silver	Strontium	Thallium	Tin	Titanium	Uranium	Vanadium	Zinc
	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g
NORL-OCT-Deep-0-0.5	2.4	0.2	57	0.2	1.7	720	71	40	200
NORL-OCT-Deep-2.0-2.5	3.8	0.3	54	0.3	2.6	850	336	43	220
NORL-OCT-Deep-4.5-5.0	3	0.3	44	0.4	4.6	840	120	54	170
NORL-OCT-Deep-7.5-8.0	2.2	0.3	49	0.4	3.8	980	13	64	130
NORL-OCT-Deep-9.0-9.5	2	0.3	53	0.4	2.9	1,060	11	68	130
NORL-OCT-Deep-12.0-12.5	1.8	0.2	55	0.2	1.2	1,000	7.3	81	100
NORL-OCT-Deep-14.5-15.0	1.6	0.2	54	< 0.2	0.7	1,040	9.4	81	93
NORL-OCT-Deep-17.0-17.5	1.5	0.2	49	< 0.2	0.6	1,030	7.5	81	91
NORL-OCT-Deep-19.5-20.0	1.5	0.2	48	0.2	0.6	1,070	7.1	82	89
NORL-OCT-Deep-23.5-24.0	1.4	0.2	48	< 0.2	0.6	1,140	6.6	79	96
NORL-OCT-Deep-25.5-26.0	1.4	0.2	47	0.2	0.6	1,120	6.7	80	100
NORL-OCT-Deep-27.5-28.0	1.3	0.2	46	< 0.2	1.5	1,120	6.2	76	100
NORL-OCT-Deep-29.5-30.0	1.3	0.2	46	0.2	0.9	1,150	6.3	78	100
NORL-OCT-Deep-31.5-32.0	1.5	0.2	46	0.2	0.6	1,110	7.7	86	100
NORL-OCT-Deep-34.0-34.5	1.5	0.2	48	0.2	0.6	1,170	7.5	85	93
NORL-OCT-Deep-38.0-38.5	1.7	0.2	49	0.2	0.7	1,230	7.3	86	95

Table D.11: Nordic Lake sediment ^{137}Cs and bulk density data, October, 2012.

Sample Name	Lower Depth (cm)	Cs-137 activity (DPM/g dry wt)	1 Std Dev. Counting Error (DPM/g dry wt.)	Dry weight of core section (g)	Bulk density (dry g / wet mL)
NORL-OCT-Deep-0-0.5	0.62	NA		0.4289	0.009 [a]
NORL-OCT-Deep-2.0-2.5	3.1	NA		2.1365	0.044 [a]
NORL-OCT-Deep-4.5-5.0	6.2	NA		3.4286	0.070 [a]
NORL-OCT-Deep-7.5-8.0	9.9	NA		4.8751	0.100 [a]
NORL-OCT-Deep-9.0-9.5	11.8	NA		NA	0.173
NORL-OCT-Deep-12.0-12.5	15.5	NA		3.4249	0.070 [a]
NORL-OCT-Deep-14.5-15.0	18.6	NA		4.3578	0.090 [a]
NORL-OCT-Deep-17.0-17.5	21.7	NA		NA	0.161
NORL-OCT-Deep-19.5-20.0	24.8	NA		4.5465	0.093 [a]
NORL-OCT-Deep-20.5-21.0	26.0	NA		NA	0.170
NORL-OCT-Deep-23.5-24.0	29.8	-0.01	0.24	NA	0.179
NORL-OCT-Deep-24.5-25.0	31.0	NA		NA	0.172
NORL-OCT-Deep-25.5-26.0	32.2	0.27	0.21	NA	0.173
NORL-OCT-Deep-26.5-27.0	33.5	0.30	0.24	NA	0.179
NORL-OCT-Deep-27.5-28.0	34.7	0.15	0.23	NA	0.183
NORL-OCT-Deep-29.0-29.5	36.6	0.28	0.20	NA	0.193
NORL-OCT-Deep-30.0-30.5	37.8	0.11	0.20	NA	0.190
NORL-OCT-Deep-30.5-31.0	38.4	0.13	0.20	NA	0.179
NORL-OCT-Deep-31.5-32.0	39.7	0.03	0.23	NA	0.174
NORL-OCT-Deep-34.0-34.5	42.8	-0.10	0.22	NA	0.184
NORL-OCT-Deep-36.0-36.5	45.3	NA		NA	0.192
NORL-OCT-Deep-38.0-38.5	47.7	0.26	0.17	NA	0.206

NA: not analyzed

[a] Value calculated based on dry weight of core section and assumed volume of 48.67 mL (volume of a 6.2 mm core section)

Table D.12: Metal concentrations of material collected from sediment traps deployed from May to October, 2012 in Nordic Lake

Analyte	Units	NORL-12-02	NORL-12-03	NORL-12-04
Aluminum	mg/kg	12,193	9,141	10,081
Antimony	mg/kg	0.671	0.575	0.543
Arsenic	mg/kg	18.9	11.6	14.0
Barium	mg/kg	462	248	328
Beryllium	mg/kg	0.479	0.383	0.362
Boron	mg/kg	9.59	8.63	9.06
Cadmium	mg/kg	1.15	0.77	0.91
Chromium	mg/kg	21.4	17.6	16.0
Cobalt	mg/kg	119.9	56.4	87.9
Copper	mg/kg	42.7	30.9	39.2
Iron	mg/kg	51,864	28,410	38,722
Lead	mg/kg	46.53	29.24	38.97
Manganese	mg/kg	53,489	28,178	36,344
Molybdenum	mg/kg	7.20	3.43	4.68
Nickel	mg/kg	88.08	50.17	68.12
Selenium	mg/kg	1.63	1.15	1.27
Silver	mg/kg	0.192	0.096	0.091
Strontium	mg/kg	42.29	32.92	36.69
Thallium	mg/kg	0.383	0.192	0.181
Tin	mg/kg	1.34	1.05	0.91
Titanium	mg/kg	728	679	648
Uranium	mg/kg	113.2	76.8	91.1
Vanadium	mg/kg	31.8	22.1	24.9
Zinc	mg/kg	225	156	225
Radium-226	Bq/g	1.14	1.45	1.91

Table D.13: Nordic Lake annual loadings of total suspended solids (TSS), sulphate, radium-226 and metals

Year	TSS (kg)	Sulphate (kg)	^{226}Ra (MBq)	Barium (kg)	Uranium (kg)	Iron (kg)	Manganese (kg)	Cobalt (kg)	Selenium (kg)	Silver (kg)	Copper (kg)	Lead (kg)	Nickel (kg)	Zinc (kg)	Source
1986	35,943	208,264	961	250		1,124	824	30			35	70	37	25	Minnow 2009
1987	1,288	1,333,107	605	393		4,097	1,254	54			42	92	55	46	
1988		5,246,244	1,014	919		29,372	2,599	123			79	144	84	94	
1989		2,761,852	690	477		16,771	1,151	53			48	87	39	34	
1990		3,896,056	974	565	56	4,585	688	66			64	182	88	25	
1991		4,065,769	1,051	329	59	3,286	217	46			33	99	56	13	
1992		3,855,699	554												
1993		3,569,655	640			5,325									
1994		2,876,375	384		42	18,524									
1995		3,946,608	625	88	35	10,789	495	38		38	30	76	38	19	
1996		3,178,341	950	53	40	11,108	299	23		23	18	46	23	11	
1997		3,243,500	1,147	46	216	19,312	223	17		17	10	34	17	8	
1998		2,896,158	511	96	91	3,238	670	39		39	42	79	39	40	
1999	1,450	2,426,339	529	114	29	4,037	901	38	5	38	52	107	50	48	
2000	6,705	1,389,378	504	60	13	2,127	376	4	3	2	1	0	6	10	
2001	10,883	2,001,353	1,132	145	27	4,208	578	7	2	1	7	2	10	19	
2002	10,000	2,073,599	715	133	23	6,100	644	7	2	1	7	2	11	14	
2003	6,410	2,970,567	1,370	259	34	5,256	970	13	2	6	13	1	18	19	
2004	4,592	2,883,973	2,232	374	38	10,269	1,260	15	2	7	7	1	8	26	
2005	5,790	2,042,643	780	141	20	5,827	690	9	1	2	14	2	16	52	
2006		2,225,082	318	89	14	7,457	861	13							Minnow 2011
2007		1,502,245	237	65	10	5,552	473	8							
2008		2,225,663	377	103	19	5,320	863	12							
2009		1,884,869	538	136	15	4,661	609	7							

Table D.14 Historical iron concentrations at the Nordic Settling Pond effluent outflow [a]

Date	Total Iron (mg/L)
15-Jul-76	0.57
21-Dec-76	0.03
28-Feb-77	26
31-Mar-77	11
28-Apr-77	0.81
10-Jun-77	0.16
28-Jul-77	0.29
25-Aug-77	0.54
26-Sep-77	1.78
27-Oct-77	2.9
24-Dec-77	1.64
24-Jan-78	2
27-Feb-78	1.4
27-Mar-78	1.74
28-Apr-78	0.4
23-May-78	0.65
20-Jun-78	0.55
24-Jul-78	1.6
25-Aug-78	2.1
27-Sep-78	1.2
27-Oct-78	1
28-Nov-78	1.3
27-Dec-78	105
22-Feb-79	0.34
21-Mar-79	3.3
28-Apr-79	0.41
28-May-79	0.46
27-Jun-79	0.26
30-Jul-79	0.09
30-Aug-79	0.25
28-Sep-79	1.3
29-Oct-79	0.88
29-Nov-79	1.1
20-Feb-80	0.04
29-Mar-80	0.1
26-May-80	0.27
22-Jun-80	0.37
25-Jul-80	0.18
27-Aug-80	0.13
25-Sep-80	0.28
25-Oct-80	0.05
26-Jan-81	12
26-Feb-81	11
28-May-81	0.22
27-Jun-81	0.22
28-Jul-81	0.05
28-Aug-81	0.45
28-Sep-81	0.36
28-Oct-81	0.29
28-Nov-81	0.03
28-Dec-81	0.06
28-Jan-82	0.14
28-Feb-82	0.14

[a] Data from Ontario Ministry of Environment

Table D.15 The ^{214}Pb acitivities in sediment core sections from McCabe Lake, Quirke Lake, and Nordic Lake.

Lake	Sample Name	Core depth (cm)	^{214}Pb Activity (DPM/g)	Counting error (1 standard deviation, DPM/g)
McCabe Lake	MCBL-OCT-deep-1.5-2.0cm	2.6	2487.40	4.97
	MCBL-OCT-deep-7.5-8.0cm	10.6	197.34	1.67
	MCBL-OCT-deep-12.0-12.5cm	16.5	51.16	0.82
	MCBL-OCT-deep-13.5-14.0cm	18.5	33.16	1.11
	MCBL-OCT-deep-15.0-15.5cm	20.5	23.32	0.65
	MCBL-OCT-deep-16.5-17.0cm	22.4	12.90	0.55
	MCBL-OCT-deep-17.0-17.5cm	23.1	9.28	0.45
	MCBL-OCT-deep-17.5-18.0cm	23.8	9.00	0.51
	MCBL-OCT-deep-18.0-18.5cm	24.4	11.38	0.59
	MCBL-OCT-deep-18.5-19.0cm	25.1	9.48	0.49
	MCBL-OCT-deep-19.0-19.5cm	25.7	7.34	0.69
	MCBL-OCT-deep-21.0-21.5cm	28.4	6.93	0.60
	MCBL-OCT-deep-28.0-28.5cm	37.6	2.53	0.42
	MCBL-OCT-deep-35.5-36.0cm	47.5	2.56	0.45
Quirke Lake	QUIL-3.5-4.0	5.2	18.60	0.54
	QUIL-4.5-5.0	6.5	4.47	0.38
	QUIL-6.0-6.5	8.5	3.25	0.41
	QUIL-7.5-8.0	10.4	5.67	0.42
	QUIL-9.0-9.5	12.4	4.65	0.35
	QUIL-11.0-11.5 cm	15.0	6.17	0.48
	QUIL-11.5-12.0	15.6	3.97	0.36
	QUIL-12.5-13.0	16.9	4.37	0.49
	QUIL-16.5-17.0	22.1	2.89	0.38
	QUIL-23.5-24.0	31.2	2.63	0.33
Nordic Lake	NORL-OCT-Deep-0.5-1.0cm	1.2	136.15	3.13
	NORL-OCT-Deep-1.5-2.0cm	2.5	160.94	2.02
	NORL-OCT-Deep-3.0-3.5cm	4.3	321.13	2.49
	NORL-OCT-Deep-4.0-4.5cm	5.6	564.06	2.85
	NORL-OCT-Deep-5.5-6.0cm	7.4	75.55	0.93
	NORL-OCT-Deep-6.5-7.0cm	8.7	37.56	0.76
	NORL-OCT-Deep-8.0-8.5cm	10.5	18.40	0.55
	NORL-OCT-Deep-9.5-10.0cm	12.4	13.72	0.58
	NORL-OCT-Deep-10.5-11.0cm	13.6	12.25	0.50
	NORL-OCT-Deep-11.5-12.0cm	14.9	9.19	0.48
	NORL-OCT-Deep-23.5-24.0 cm	29.8	3.43	0.33
	NORL-OCT-Deep 25.5-26.0 cm	32.2	2.92	0.29
	NORL-OCT-Deep 26.5-27.0 cm	33.5	3.11	0.34
	NORL-OCT-Deep 27.5-28.0 cm	34.7	3.57	0.32
	NORL-OCT-Deep-29.0-29.5 cm	36.6	3.13	0.29
	NORL-OCT-Deep 30.0-30.5 cm	37.8	3.50	0.29
	NORL-OCT-Deep 30.5-31.0 cm	38.4	3.27	0.29
	NORL-OCT-Deep-31.5-32.0 cm	39.7	2.69	0.30
	NORL-OCT-Deep-34.0-34.5 cm	42.8	3.17	0.31
	NORL-OCT-Deep-38.0-38.5 cm	47.7	3.21	0.25

APPENDIX V
CORRESPONDENCE

Addendum to the Cycle 5 Study Design for the SRWMP, SAMP, AND TOMP (March 2020)

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March 26, 2020

Rio Algom Limited
Elliot Lake, Ontario

Re: Addendum to the Cycle 5 Study Design for the SRWMP, SAMP, and TOMP

Dear Tony Lambert and Holly Heffner,

It has been identified that within the Serpent River Watershed Water Quality Monitoring Program (SRWMP) Cycle 5 study design (Minnow 2019), station SR-15 (the outlet of May Lake) was erroneously listed as having a quarterly sampling frequency, when the frequency should have been semi-annually. Within the SRWMP, water quality sampling stations located at lake outlets are monitored either twice per year or once per year, depending on the hydraulic residence time of the lake. Based on May Lake's hydraulic residence time, SR-15 has historically been sampled twice per year. Station SR-15 was removed from the SRWMP as part of the SRWMP Cycle 3 study design based on water quality that consistently achieved the SRWMP benchmarks for all parameters (Minnow 2009). At that time, a monitoring trigger was developed such that monitoring at station SR-15 would be reinstated if concentrations of mine-related parameters increased upstream (Minnow 2009). Due to increasing radium-226 and barium at the outlet of McCabe Lake (station SR-06), twice per year sampling of station SR-15 was reinstated following recommendations made in the Cycle 4 State of the Environment (SOE) interpretive report (Minnow 2016). The Cycle 5 study design should have reflected this existing sampling frequency. An updated Table 5.1 is provided herein. Please let me know if you require any further clarification.

Sincerely,

Minnow Environmental Inc.

Jess Tester

Jess Tester, B.Sc., Aquatic Scientist

cc: Cynthia Russel, Managing Director, Minnow Environmental

References

Minnow Environmental (Minnow). 2009. Serpent River Watershed Monitoring Program, Cycle 3 Study Design. Prepared for Rio Algom Limited and Denison Mines Inc., Elliot Lake, Ontario. May. Project 2200.

Minnow. 2016. Serpent River Watershed Cycle 4 (2010 to 2014) State of the Environment Report. Prepared for Rio Algom Limited and Denison Mines Inc., Elliot Lake, Ontario. March. Project 2555.

Minnow. 2019. Cycle 5 Study Design for the SRWMP, SAMP, and TOMP. Prepared for Rio Algom Limited and Denison Mines Inc., Elliot Lake, Ontario. April. Project 18-55.

Table 5.1: Cycle 5 SRWMP Water Quality Stations, Parameters, and Frequencies

Reference vs Mine-exposed	Station	Location / Description	Type	Frequency	Parameters[a]
Reference	D-4	Dunlop Lake Outlet (Q-14)	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	
	SR-17	Unnamed Creek Drain Lake 3 at Hwy 108		Q	
Mine-exposed	D-6	Cinder Lake Outlet	lake	Q	barium, iron, manganese, pH, radium-226, sulphate and uranium
	DS-18	Halfmoon Lake Outlet	stream	Q	barium, iron, pH, radium-226, sulphate and uranium
	SR-15	May Lake Outlet	stream	S	
	M-01	Sherriff Creek at 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			16	45	

Q = quarterly, S = semi-annually, A = annually.

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