Cameco

April 8, 2019

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VIA EMAIL & COURIER

Mr. George Bihun
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Environmental Protection Branch
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Prince Albert, SK S6V 6G1

Mr. Richard Snider
Project Officer, Beaverlodge Project
Canadian Nuclear Safety Commission
Uranium Mines & Mills Division
Suite 520, 101 – 22nd Street East
Saskatoon, SK S7K 0E1

Dear Mr. Bihun and Mr. Snider:

File no. BVL.42205 / BVL.42305

Beaverlodge: Year 33 Transition Phase Monitoring Annual Report (2018)

The Beaverlodge Year 33 Transition Phase Monitoring Annual Report is submitted to the Canadian Nuclear Safety Commission (CNSC) (two copies) in compliance with the WFOL-W5-2120.0/2023 dated May 27, 2013, and to the Saskatchewan Ministry of Environment (one copy) in compliance with the Beaverlodge Surface Lease Agreement dated December 24, 2006.

This annual report summarizes environmental conditions, site activities and status for the 12 month period from January 1, 2018 through December 31, 2018. Where applicable, historical environmental data has also been included and discussed as part of the overall assessment of the decommissioned sites. This report also provides an outlook regarding proposed projects, activities and remedial programs for the Beaverlodge site with a focus on 2019.

If you have any questions or comments, please contact the undersigned at 306-956-6784.

Yours truly,

Michael Webster

Michael Webster
Reclamation Co-ordinator
Compliance and Licensing, SHEQ
Cameco Corporation

MSW:ss

Attachments

c: Stony Rapids Conservation Officer – Saskatchewan Ministry of Environment (letter and memory stick)
K. Coates – Labour Relations and Workplace Safety (letter and memory stick)
D. Classen – Urdel Limited (letter and memory stick)
D. Thomas – Northern Mines and Monitoring Secretariat (letter and report)
Northern Settlement of Uranium City (letter and report)
Regulatory Records – Cameco (letter and electronic version of report)

BEAVERLODGE PROJECT

Cameco
Energizing the World

Beaverlodge Project 2018 Annual Report

Year 33 Transition Phase Monitoring

Prepared for:
Canadian Nuclear Safety Commission
Compliance Report for Licence: WFOL-W5-2120.0/2023 &
Saskatchewan Ministry of Environment
Compliance Report: Beaverlodge Surface Lease

Prepared and Submitted by:
Cameco Corporation

April 2019

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INTRODUCTION

1.0 INTRODUCTION

This report is submitted in compliance with Canadian Nuclear Safety Commission (CNSC) Waste Facility Operating Licence WFOL-W5-2120.0/2023 issued to Cameco Corporation (Cameco) for the decommissioned Beaverlodge mine and mill site (*CNSC 2013b*).

The report is also submitted in compliance with the Beaverlodge Surface Lease Agreement between the Province of Saskatchewan and Cameco Corporation, dated December 24, 2006.

The report describes observations and activities on the decommissioned Beaverlodge site between January 1, 2018 and December 31, 2018. Results of environmental monitoring programs conducted for Beaverlodge during this period are provided in the report and, where applicable, historical environmental data has been included and discussed as part of the overall assessment of the decommissioned properties. The status of current projects and activities conducted as of the end of December 2018 are provided, along with an overview of anticipated activities planned for 2019.

SECTION 2.0

GENERAL INFORMATION

2.0 GENERAL INFORMATION

2.1 Organizational Information

2.1.1 CNSC Licence/Provincial Surface Lease

The CNSC Waste Facility Operating Licence WFOL-W5-2120.0/2023 and the Province of Saskatchewan - Beaverlodge Surface Lease, December 24, 2006 are issued to:

Cameco Corporation
2121 - 11th Street West
Saskatoon, Saskatchewan S7M 1J3
Telephone: (306) 956-6200
Fax: (306) 956-6201

2.1.2 Officers and Directors

The officers and board of directors of Cameco as at December 31, 2018 are as follows:

Officers

Tim Gitzel	President and Chief Executive Officer
Brian Reilly	Senior Vice-President and Chief Operating Officer
Alice Wong	Senior Vice-President and Chief Corporate Officer
Grant Isaac	Senior Vice-President and Chief Financial Officer
Sean Quinn	Senior Vice-President, Chief Legal Officer and Corporate Secretary

Members of the Board of Directors

Ian Bruce, chair	Catherine Gignac	Kathryn Jackson
Daniel Camus	Tim Gitzel	Don Kayne
John Clappison	Jim Gowans	Anne McLellan
Donald Deranger		

2.2 CNSC Licence

On May 27, 2013 the CNSC notified Cameco that the Commission had renewed the Waste Facility Operating Licence for a period of 10 years, from June 1, 2013 until May 31, 2023.

The 10-year licence term will allow implementation of selected remedial options and post remediation monitoring. The goal for the Beaverlodge properties is the successful transfer of the properties to the Province of Saskatchewan's Institutional Control (IC) Program.

2.3 Provincial Surface Lease

The current provincial surface lease for the decommissioned Beaverlodge properties was issued to Cameco on December 24, 2006 with an expiry date of December 24, 2026.

2.4 Beaverlodge History

The decommissioned Beaverlodge mine/mill properties are located north of Lake Athabasca, northeast of Beaverlodge Lake, in the northwest corner of Saskatchewan at approximately N59° 33’15” and W108° 27’15” (**Figure 2.4**).

Uranium-bearing minerals were first discovered in the Beaverlodge area in 1934. Since there was little demand for uranium at that time, further prospecting and development in the region was delayed for almost 10 years. In 1944 Eldorado Mining and Refining Ltd., a crown corporation owned by the Government of Canada, commenced detailed exploration in the area of Fishhook Bay on the north shore of Lake Athabasca. Between 1944 and 1948 Eldorado Mining and Refining Ltd. continued to explore the area around Beaverlodge Lake, discovering the Martin Lake and Ace Zones in 1946.

Exploration and initial development of a number of separate ore bodies continued until 1951 when Eldorado Mining and Refining Ltd. developed the Fay shaft and headframe. The following year, the foundations were laid for a 450 tonnes per day (t/day) carbonate-leach mill which started production in 1953. Mill production expanded to 680 t/day in 1954 and increased to 1800 t/day in 1956. A small acid-leach circuit was added in 1957 to handle a small amount of ore containing sulphides. Non-sulphide ore was sent directly to the carbonate circuit, while the sulphide concentrate was treated in the acid-leach circuit.

During mining, the primary focus was on an underground area north and east of Beaverlodge Lake where the Ace, Fay and Verna shafts were located. Production from these areas continued until 1982. Over the entire 30-year production period (1952 to 1982) the majority of the ore used to feed the mill came from these areas; however, a number of satellite mines, primarily in the Ace Creek watershed, were also developed and operated for shorter periods of time. During the mill operating period, tailings were separated into fine and coarse fractions. The fine fraction (approximately 60% of the tailings) was placed into water bodies within the Fulton Creek watershed, and the course fraction (remaining 40% of the tailings) was deposited underground for use as backfill.

During the early years of operation, uranium mining and milling activities conducted at the Beaverlodge site were undertaken using what were considered acceptable practices at the time. However, these practices did not have the same level of rigor for the protection of the environment as is currently expected. Although the Atomic Energy Control Board (AECB) licensed the Beaverlodge activities, environmental protection legislation and regulation existed neither federally nor provincially and therefore was not a consideration during the early operating period. It was not until the mid-1970s, some 22-plus years after operations began, that effluent treatment processes were initiated at the Beaverlodge site in response to discussions with provincial and federal regulatory authorities.

At the request of the AECB, a conceptual decommissioning plan was submitted in June 1981. On December 3, 1981 Eldorado Nuclear Limited (formerly Eldorado Mining and Refining Ltd.) announced that its operation at Beaverlodge would be shut down.

Mining operations at the Beaverlodge site ceased on June 25, 1982 and the mill discontinued processing ores in mid-August 1982. Eldorado Resources Limited (formerly

Eldorado Nuclear Limited) initiated site decommissioning in 1982 and completed it in 1985. Letters were issued by AECB indicating that the sites had been satisfactorily remediated (*MacLaren Plansearch 1987*). Transition-phase monitoring was then initiated to monitor the status of the remediation efforts.

On February 22, 1988 the Government of Canada and the Province of Saskatchewan publicly announced their intention to establish an integrated uranium company as the initial step in privatizing their respective uranium investments.

On October 5, 1988 Cameco, a Canadian Mining and Energy Corporation, was created from the merger of the assets of the Saskatchewan Mining Development Corporation and Eldorado Resources Ltd. Following the merger, management (monitoring and maintenance) of the decommissioned Beaverlodge properties became the responsibility of Cameco, while the Government of Canada, through Canada Eldor Inc. (CEI), retained responsibility for the financial liabilities associated with the properties.

In 1990, the corporate name was changed to Cameco, with shares of Cameco being traded on both the Toronto and New York stock exchanges.

The management of the Beaverlodge monitoring program and any special projects associated with the properties is the responsibility of the Reclamation Co-Coordinator, SHEQ - Compliance and Licensing, Cameco.

2.5 The Path Forward Plan

2.5.1 Institutional Control Program

In 2007, after significant consultation with various stakeholders, including the CNSC, the mining industry, aboriginal organizations and communities in the major mining regions of the province, the Government of Saskatchewan proclaimed *The Reclaimed Industrial Sites Act (2014)* and its associated regulations to establish and enforce the Institutional Control Program (IC Program). The IC Program establishes a formal process for transferring decommissioned mining and milling properties to provincial responsibility once remediation has been completed and a period of monitoring has shown the properties to be safe, secure and stable.

2.5.2 The Beaverlodge Management Framework

The Beaverlodge Management Framework and supporting documents were developed in 2009 by Cameco and the Joint Regulatory Group (JRG), which included the CNSC, Environment and Climate Change Canada (ECCC), the Department of Fisheries and Oceans Canada (DFO), and Saskatchewan Ministry of Environment (SMOE). The intent of the Beaverlodge Management Framework is to provide a clear scope and objectives for the management of the Beaverlodge properties along with a systematic process for assessing site-specific risks to allow decisions to be made regarding the transfer of Beaverlodge properties to the IC Program. The framework has been reviewed by public stakeholders, including the Northern Saskatchewan Environmental Quality Committee (NSEQC), as well as residents and leaders of the Uranium City community. A simplified version is provided below in **Figure 2.5-1**.

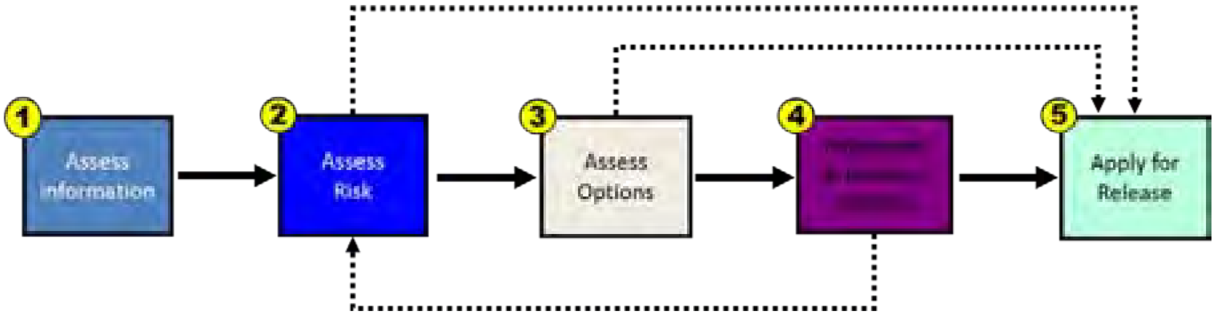

Figure 2.5-1
Simplified Beaverlodge Management Framework

As a part of the Beaverlodge Management Framework, Cameco and their consultants have gathered significant information regarding environmental conditions on the properties since 2009 (Box 1 of **Figure 2.5-1**). From 2009 to 2012 more than 20 environmental studies were completed in the Beaverlodge area, with reports summarizing this information provided to the regulatory agencies for review. The information gathered by Cameco and its consultants, combined with historical information, was used to develop the Beaverlodge Quantitative Site Model (QSM) in 2012.

A list of potential remedial options was initially developed during a 2009 stakeholder workshop. The workshop included residents of Uranium City and the Athabasca subcommittee of the NSEQC, along with industry and regulatory representatives. Following the workshop, a scoping level engineering cost assessment was completed for the potential remedial options identified.

The QSM was developed to assess ecological and human health risk from the 2012 baseline water and sediment quality (Box 2 of **Figure 2.5-1**) established by information gathered in the first phase of the Management Framework. The QSM provides insight into the interactions between potential contaminant sources and transport in the Beaverlodge area watersheds, which established the predicted rates of natural recovery for the system. In addition, the QSM was developed with a feature that allows the simulation of potential remedial activities and compares results to the baseline option (natural recovery). This comparison allowed an assessment of the potential environmental benefits and other effects of implementing each remedial option alone or in combination with other options.

A second remedial options workshop was conducted in 2012 with local and regional stakeholders, as well as industry and regulatory participants. This workshop presented the various remedial options discussed during the 2009 workshop, options identified during the 2012 workshop, and the expected environmental benefits as evaluated in the QSM. Participant feedback regarding the various remedial options was gathered and summarized.

The results of this workshop informed the assessment of potential remedial options (Box 3 of **Figure 2.5-1**) and were instrumental in development of the Beaverlodge path forward plan. The path forward plan describes specific remedial activities selected to improve local environmental conditions. In addition, the path forward plan also describes the monitoring expectations to assess the success of the implemented activities (Box 4 of **Figure 2.5-1**).

Following the detailed assessment of potential remedial options and discussion with stakeholders, five options were selected for implementation at the Beaverlodge properties to prepare the sites for transfer to the IC Program. The options consisted of:

1. Completion of a site wide surficial gamma survey and assessment.
2. Securing historic mine openings from access.
3. Decommission identified boreholes.
4. Re-establishment of the Zora Creek flow path.
5. Final inspection and cleanup of properties.

Once it has been shown that the selected remedial activities have been successfully implemented, and once properties are shown to meet the site performance objectives of “safe, secure and stable”, an application will be made to transfer the property to the Province of Saskatchewan’s IC Program for long-term monitoring and maintenance (Box 5 of **Figure 2.5-1**).

The remaining licensed Beaverlodge properties will continue to be managed in accordance with the Beaverlodge Management Framework and related timelines, with additional groups of properties expected to be released in stages over the next several years. As properties are assessed to meet the performance objectives, an application will be made to have these properties Released from Decommissioning and Reclamation by SMOE, released from CNSC licensing, and transferred to the IC Program for long-term monitoring and maintenance. Ultimately, it is Cameco’s intent to transfer all Beaverlodge properties to the Province of Saskatchewan’s IC Program for long-term monitoring and maintenance.

2.5.3 Performance Objectives and Indicators

Criteria to determine the eligibility for release from CNSC licensing were presented to the Commission with the intent that each of the properties associated with the decommissioned Beaverlodge mine and mill site will be assessed through the Beaverlodge Management Framework. The performance objectives for the decommissioned Beaverlodge site were later defined and presented to the Commission as “safe, secure, and stable/improving” (*CNSC 2014*).

- Safe – The site is safe for unrestricted public access. This objective is to ensure that the long-term safety is maintained.
- Secure – There must be confidence that long-term risks to public health and safety have been assessed by qualified person and are acceptable.

- Stable/Improving – Environmental conditions (e.g. water quality) on and downstream of the decommissioned properties are stable and continue to naturally recover as predicted.

Site specific performance indicators were established as a measure to determine if a site is meeting the performance objectives. The applicable indicators vary depending on the nature of the property, but generally include ensuring that risks associated with residual gamma radiation and crown pillars are acceptable, mine openings to surface are secure, flowing boreholes (if present) are sealed, and the site is free from historical mining debris. To ensure the performance objectives of safe and secure continue to be met, once the properties have been transferred to the IC program, inspections are scheduled as part of the IC monitoring and maintenance plan.

The stable/improving objective is also related to the performance indicators discussed in the previous paragraph, however is more relevant to monitoring water quality. In order to verify that conditions on and downstream of the properties are stable/improving, Cameco will continue to monitor the progress of natural recovery and the expected localized improvements from the additional remedial measures implemented at the properties until they are transferred to the IC program. To ensure the performance objective of stable/improving continues to be met once properties have been transferred to the IC program, a long-term monitoring program will be implemented at the time of transfer.

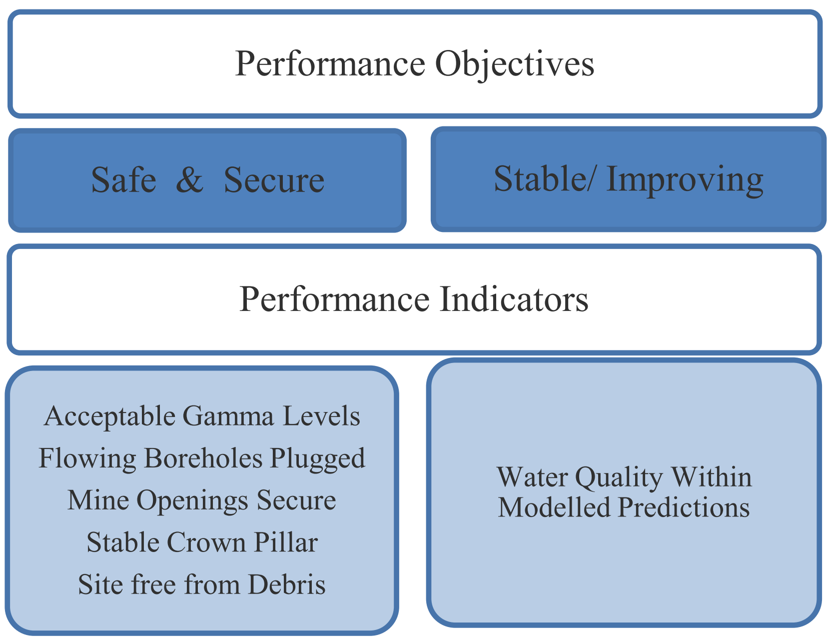

Figure 2.5-2
Beaverlodge Performance Objectives

Table 2.5-1
Beaverlodge Performance Indicators

Performance Indicators	Description	Acceptance Criteria
Acceptable Gamma Levels	Cameco will complete a site wide gamma survey which will indicate where additional material may need to be applied to cover existing waste rock or tailings. Following the application of the cover material, a final survey will be completed of the remediated areas verifying that the cover was adequate.	Reasonable use scenario demonstrating gamma levels at the site are acceptable.
Boreholes Plugged	Cameco will plug all identified boreholes on the site to prevent groundwater outflow to the surface.	All boreholes have been sealed.
Stable Caps on Vertical Mine Openings	Exposed concrete caps on the vertical mine openings will be replaced with new engineered covers designed to improve the long-term safety of the site.	Caps have been replaced and signed off by a qualified person.
Stable Crown Pillar	Based on the surface subsidence in the Lower Ace Creek area, a crown pillar assessment will be completed for the four areas that have mine workings close to surface including Hab, Dubyna, Bolger/Verna, and Lower Ace Creek.	Crown pillar assessed, remediated if required, and signed off by a qualified person.
Site Free From Debris	Inspection and removal of residual debris will be completed prior to releasing the properties from CNSC licensing and transferring them into the provincial Institutional Control Program.	Site free of former mining debris at the time of transfer to institutional control.
Water Quality Within Modelled Predictions	Water quality monitoring will be compared to model predictions to verify: 1. That remedial options expected to result in localized improvements are having the desired effects; and 2. That natural recovery on and downstream of the decommissioned properties is continuing as predicted.	Water quality data is stable/improving.

2.5.4 Release of the Beaverlodge Properties to Institutional Control

In 2009, five Beaverlodge properties located in two satellite areas (Eagle and Emar) were successfully transferred to the IC Program.

Based on the path forward plan, developed following the remedial options workshops, Cameco established a work plan and schedule to prepare the remaining properties for transfer to the IC Program. The work plan and schedule was presented at the CNSC annual update meeting to the Commission in October 2014.

The work plan and schedule provides the proposed timeline for transferring groups of properties to the IC Program during the current licence term, which expires in 2023. The plan, as presented, is to follow a staged approach, initially assessing and preparing sites with little disturbance and negligible risk, followed by the properties affected by mining and milling activities. In following this staged approach, once it can be shown that a property has been adequately remediated and meets the performance objective of safe, secure and stable, a request will be made by Cameco to obtain the regulatory releases required to facilitate transferring the properties to the IC program.

A submission requesting the release of the properties from the provincial surface lease and CNSC licensing requirements, along with a custodial transfer to the IC Program was submitted for regulatory review in April 2016. Following receipt of review comments in June 2016, Cameco submitted two addendums in August and October 2016. The first addendum addressed the majority of SMOE comments from the April 2016 submission and the second provided an updated IC cost estimate and gamma scan results for the Bolger Pit. Cameco received a Letter of Intent from SMOE in February 2017 indicating they will grant a Release from Decommissioning and Reclamation, provided the properties are released from CNSC licensing.

An additional six properties were requested to be formally transferred into the IC program in April 2018. Following receipt of review comments in April (CNSC) and November 2018 (SMOE), Cameco submitted a response to regulatory comments in December 2018. Both CNSC and SMOE have indicated that the properties have met all the requirements and steps are now being taken to coordinate the required releases.

The process to release properties from CNSC licensing is expected to require a CNSC hearing. It is anticipated that a hearing will be held in 2019 to release the 20 properties (14 from 2016; and 6 from 2018) from CNSC licensing. If a release is granted, then the properties will be transferred to the IC Program managed by Saskatchewan Ministry of Energy and Resources.

SECTION 3.0

SITE ACTIVITIES

3.0 SITE ACTIVITIES

The performance of the Beaverlodge site compared to the performance objectives is assessed through routine inspections conducted by Cameco personnel, third party consultants and/or members of the Joint Regulatory Group (JRG). In addition, special monitoring/investigation projects are completed where required to gather information to support characterization of the site, and aid in assessing the performance of specific components of the decommissioned areas. Results from the activities completed each year as well as updates on the status of the remediation projects at the Beaverlodge properties are communicated through regular meetings with the public. The following section outlines activities related to the Beaverlodge properties during the reporting period.

3.1 Routine Inspections and Engagement Activities

3.1.1 Joint Regulatory Group Inspections

The JRG is comprised of representatives of various federal and provincial regulatory agencies including:

- Canadian Nuclear Safety Commission (CNSC)
- The Department of Fisheries and Oceans Canada (DFO)
- Environment and Climate Change Canada (ECCC)
- Saskatchewan Ministry of Environment (SMOE)

JRG inspections are conducted to ensure: that conditions on the properties do not impact the health and safety of people; the continued protection of the environment; and that the requirements of the licence continue to be met. In 2018, representatives from Cameco, the CNSC, and SMOE completed a compliance inspection of the decommissioned Beaverlodge properties from May 28 to June 1.

The objective of the inspection was to complete a general assessment of the safety, security and stability of the Beaverlodge site, while focussing on the properties scheduled for transfer to the IC Program and identifying any remaining issues prior to transferring the selected properties. In addition, the inspection was completed to verify compliance with Cameco's approved licence documents, elements of the *Saskatchewan Environmental Management and Protection Act (2010)* and associated Regulations.

As a result of this inspection the CNSC issued one recommendation for follow-up in support of the application for release from CNSC licensing and transfer of properties URA 3, URA 5, EXC URA 5, ACE 5, JO-NES, and HAB 2A to the Province of Saskatchewan's IC Program. The recommendation was related to debris removal/process and sealing a borehole located on the HAB 2A property. Cameco responded to the recommendation on December 18, 2018 outlining debris removal actions including improved process for clean-up and future debris removal, as well as planned HAB 2A borehole sealing.

SMOE issued an Inspection Report on September 24, 2018. No new action items or recommendations were issued within the report. However, ten “Remediation Items Identified on Inspection to Address Before Release” were referenced from the previous year (*SMOE 2018*).

Most items identified on the inspection report involved debris housekeeping (i.e., pump house removal, timber removal, etc.) on the Beaverlodge properties, which were addressed in 2018. To ensure items have been adequately addressed, inspections are planned for 2019. Summaries of the work completed can be found in **Section 3.2.**

3.1.2 Geotechnical Inspection

Following the 2010 geotechnical inspection, the frequency of the third-party inspections of the Fookes Delta and outlet structures at Marie and Fookes reservoirs was adjusted from every three years to every five years. The first third-party inspection following the change in frequency was conducted in 2015, with the next scheduled third-party inspection to occur in 2020. To accommodate the change in frequency of the third-party inspections, an inspection of the Fookes delta and two outlet structures is completed annually by Cameco personnel during the JRG visit using a checklist developed by Cameco and SRK Consulting (Canada) Inc. (SRK).

The Geotechnical Inspection Checklist requires the assessment of the condition of the Fookes and Marie outlet structures and Fookes Tailings Delta. In addition, the checklist requires photographic record of each area. Should any significant changes to the deltas or to the outlet structures be observed, then a third-party inspection would be completed regardless of the regular schedule.

The Geotechnical Inspection Checklist was updated to include identified crown pillar areas at the Hab, Dubyna and Ace areas in response to recommendations from the site wide crown pillar assessment (*SRK 2015b*). Based on the site wide crown pillar assessment, visual inspections of these areas was recommended annually until 2019, at which time the frequency of the inspections will be reassessed.

The 2018 inspection was completed by Cameco personnel and included the following areas:

1. The Fookes tailings delta.
2. The outlet spillways at Fookes and Marie Reservoirs.
3. The Crown Pillar areas at Ace, Hab and Dubyna.

An overview of the inspection results at each location is provided below. For a general map showing the locations of these areas and detailed findings, including photographic records, please refer to the inspection report provided in **Appendix A**.

3.1.2.1 Fookes Tailings Delta

The 2015 third-party inspection of the Fookes Tailings Delta did not note any areas of concern and concluded that the delta was stabilized sufficiently to move towards final close out and transfer to IC. Until the area is transferred to IC, SRK recommended a continued internal annual inspection with a more formal inspection completed by a third party in 2020 (*SRK 2016a*).

The 2018 inspection completed by Cameco and the JRG did not note any new tailings boils or tailings exposure. No significant changes or concerns with the performance of the sand cover were noted. There was no evidence of new vehicular traffic on the delta since the berms were repaired and reinforced, and vegetative growth cover in the area has been notably progressing. It was noted that the drainage area on the northeastern side of the delta and the drainage channel to Fookes Reservoir contained water and was performing as designed, as no standing water was observed on any other portion of the Fookes Delta.

3.1.2.2 Fookes and Marie Outlet Spillways

Observations made during the 2015 third-party inspection suggest that the condition of the grout-intruded rip-rap along the length of the Fookes Reservoir and Marie Reservoir outlet spillways were very similar to their condition during previous inspections. While some cracking and displacement of the grout has been observed, this was anticipated in the design and these structures continue to perform as expected. As such, SRK was of the opinion that it would be reasonable for these structures to be considered for transfer into the IC Program (*SRK 2016a*).

Flows in 2018 increased compared to the previous year’s measurements, which were much lower than those observed in recent years and were some of the lowest measured since 2011. Mean flows measured at TL-7 ranged from 5.1 to 110.0 L/s in 2018. These flows were reflected in the outlet structures, with flowing water observed running through the structures in April and September. The outlet structures were noted to be performing as expected and no additional concerns were noted during the 2018 inspections.

3.1.2.3 Crown Pillar Areas

The Ace area crown pillar was remediated with additional cover material in 2016. The 2018 follow-up inspection of this area found no signs of tension cracks or visible depressions. Inspections of the crown pillar areas at the Hab and Dubyna sites in 2018 showed no evidence of tension cracks or slumping.

3.1.3 Community Engagement and Consultation: Public Meeting

Cameco continues to engage residents of northern Saskatchewan in relation to the decommissioned Beaverlodge properties. Keeping residents informed of its activities and hearing, understanding and addressing concerns is important to the company maintaining good relationships. The Northern Hamlet of Uranium City has become well versed in the activities occurring at the sites and as a result, feedback received centers on employment opportunities.

Cameco provides project plan updates and opportunities for feedback annually. The following groups are the focus of such engagement activities:

- The Northern Hamlet of Uranium City – Only community with year round road access to the Beaverlodge site;
- Yáthi Néné Land and Resource Office – Cameco updated its 1999 Impact Management Agreement with the Athabasca Basin communities and signed a

Collaboration Agreement in June 2016. As a result the Yáthi Néné Land and Resource Office was established representing leadership of the Athabasca First Nations and Athabasca communities;

- Athabasca Joint Engagement and Environment Subcommittee (AJES) – which is a Collaborative Agreement (CA) specific subcommittee and includes representatives from each of the Athabasca communities and first nations. The CA is geared towards Cigar Lake and Rabbit Lake activities, therefore engagement related to Beaverlodge is similar to that with the EQC; and,
- Athabasca sub-committee of the Environment Quality Committee (EQC) – includes representatives from each of the Athabasca communities and first nations.

A public meeting was held on May 29, 2018 i n Uranium City to provide an update on the Beaverlodge properties to the residents of Uranium City. Representatives of the Northern Saskatchewan Environmental Quality Committee, CNSC, Government of Saskatchewan, and Cameco were in attendance in addition to 13 community members. Cameco's primary goal of the 2018 engagement process was to discuss the 2017 activities completed on the decommissioned Beaverlodge properties and the 2018/2019 plans for transferring properties to the provincial IC program.

Presentations were also provided during the May 29 meeting by the Ministry of Energy and Resources, the CNSC, and SMOE. The presentations focused on describing how the various agencies assess the Beaverlodge properties and determine if they have met the requirements to be transferred to the IC program. This provided an opportunity for community members to ask questions of the regulatory agencies in attendance.

Questions raised during the meeting focused on buildings located in the Uranium City area that are the responsibility of SMOE with no questions raised related to the Beaverlodge project. The Cameco presentation and meeting minutes are provided in **Appendix B**.

On June 6, 2018 Cameco and Orano held a workshop in Saskatoon for the environmental subcommittee representatives of each of the communities Cameco has signed Collaboration Agreement's with. This included the Athabasca communities, English River First Nation, Pinehouse and Lac La Ronge Indian Band. The objective of the Workshop was to bring awareness of the role communities have in the decommissioning process – from the beginning of Uranium mining to the end of Uranium mining.

General updates on Beaverlodge were also provided during regularly scheduled EQC meetings in 2018.

3.1.4 CNSC Update Meeting

In 2013, the Commission granted Cameco a 10-year Waste Facility Operating Licence (WFOL) effective from June 1, 2013 to May 31, 2023. The licence term is intended to provide adequate time for Cameco to implement the proposed remedial options identified in the Path Forward report (*Cameco 2012*) and complete necessary follow-up monitoring.

CNSC staff have been directed by the Commission to provide annual reports on the performance of Cameco's decommissioned Beaverlodge Mine and Mill site as part of the annual safety performance reports on uranium mines and mills in Canada (*CNSC 2013a*). Cameco provided support to CNSC staff who presented the information to the

Commission as part of the Regulatory Oversight Report for Uranium Mines, Historic and Decommissioned Sites in Canada on December 12, 2018 (CNSC 2018).

3.2 2018 Remediation Activities to Prepare Sites for Transfer to IC Program

Cameco has prepared a work plan and schedule, based on the path forward recommendations (*Cameco 2012*), which was presented to the CNSC at the 2013 re-licensing hearing. The work plan describes the site activities required to address residual human health and ecological risk, while demonstrating conditions on the properties are stable and/or improving. As outlined in **Section 2.5.2**, the remediation activities selected for advancement at the Beaverlodge properties included:

1. Site wide surficial gamma survey and assessment.
2. Rehabilitating historic mine openings.
3. Re-establishment of the Zora Creek flow path.
4. Final inspection and cleanup of properties.
5. Decommission identified boreholes.

Additional projects initiated or completed in 2018 in response to property specific concerns included:

6. Environmental Performance Report and Environmental Risk Assessment
7. Crown Pillar Remediation

Ultimately, the Beaverlodge properties are being managed for acceptance into the Saskatchewan IC Program, and all future works undertaken are intended to support the management framework established to move towards this goal. The following section provides an overview of the activities completed to address the work plan presented to the CNSC in 2013, as well as the significant activities that were completed in 2018 in order to move the properties towards transfer to the IC Program.

3.2.1 Site Wide Gamma Assessment

In 2014, SENES Consultants and Cameco developed the Beaverlodge gamma radiation survey plan in consultation with the CNSC and SMOE (*ARCADIS SENES 2014*). Information obtained from this survey, including a public land use survey, was then used to complete the risk assessment. The assessment estimated the potential risks from radiation exposure at the Beaverlodge properties based on spatial considerations, use of the properties and measured gamma radiation levels. The assessment also considered the consumption of country foods and other exposure pathways.

Overall, the evaluation found that from a risk perspective, the gamma radiation levels on the Beaverlodge properties are acceptable regardless of approach taken (conservative or realistic, by individual sub-areas or cumulative) and predicted doses are below the public dose limit of 1 mSv/year. Based on this evaluation, no further remedial actions were justified at these sites to reduce gamma exposure levels (*ARCADIS 2015*).

If additional remediation activities are implemented on a property, some areas of waste rock that were scanned during the 2014 survey may be disturbed. If this is the case, in preparation for transferring properties into the IC Program, follow up gamma scans will be completed after excavation work and the results compared to the values obtained in the original 2014 survey, in order to ensure gamma levels remain at or below what was previously recorded. In 2018, no follow-up gamma surveys were required to fulfill this objective.

3.2.2 Rehabilitate Historic Mine Openings

A plan and method for sealing vertical mine openings to surface was submitted and approved by the regulatory agencies in 1982. The decommissioning of the vertical mine openings met the requirement of *The Mines Regulations* (1978) that require a bulkhead of reinforced concrete at bedrock or the top of the concrete collar. The decommissioning plan provided to the regulators outlined a set of principles to be followed for closing the mine openings, however proper documentation (i.e., As-built drawings) detailing exactly how each opening was decommissioned was not generated.

The province of Saskatchewan requires engineer stamped documentation regarding the final closure method prior to properties being considered for transfer to the IC Program. As a result, Cameco is in the process of completing additional remediation on all exposed vertical mine openings to ensure the long term security of the openings and to generate the required documentation to facilitate a transfer to the IC program.

From 2013 to 2018, Cameco used historic photos and mine drawings paired with recent aerial photos to complete a site wide investigation of mine opening locations. The table below presents a summary of the openings listed in the original decommissioning report and the status of each.

Once mine openings are located, the area surrounding the opening is excavated to bedrock and options to remediate the opening are assessed and discussed with the regulatory agencies. The option that has been most frequently implemented at Beaverlodge for remediation of the existing mine openings is to cover the mine opening with a stainless steel cover. The new steel covers will ensure the safety and security of the mine openings for the long-term, with an estimated design life of over 1,200 years. This remedial option is also based on well understood engineering principles, has been successfully implemented elsewhere and is advantageous due to its practicality (i.e., ease of installation, future inspections, and replacement) and economic factors (i.e., lower cost for remote area installation). Considering that reinforced concrete is prescribed in *The Mines Regulations, 2003* as the accepted method of sealing mine openings, Cameco has requested and has received an exemption from the regulation for each remediated mine opening. Cameco also provides the engineered plans to SMOE and the CNSC for review. As-built drawings are generated and provided to the regulatory agencies to ensure proper documentation is maintained regarding the remediation of these vertical mine openings.

To date, 18 stainless steel covers were installed on vertical mine openings and designs have been approved for an additional two covers. An overview of the remediation progress for historic mine openings undertaken to date is provided in **Table 3.2.1**.

Table 3.2-1
Mine Openings

Site	Opening	Property	Location		1985 Status	Current Status/Notes
Ace	Shaft	ACE MC	643697	6605390	Exposed	Steel cover installed in 2016.
Ace	2157 Raise	ACE 1	643366	6605115	Exposed	Steel cover installed in 2017.
Ace	2157 Finger Raise	ACE 1	643338	6605106	Exposed	Steel cover installed in 2017.
Ace	130 Raise	ACE MC	643773	6605394	Exposed	Steel cover installed in 2017.
Ace	195 Access Raise	ACE 1	643512	6605180	Buried	Leave “as-is”; Buried by substantial waste rock below the Dorrclone.
Ace	195 Raise	ACE 1	643512	6605180	Buried	Leave “as-is”; Buried by substantial waste rock below the Dorrclone.
Ace	105*2 Raise	ACE 1	643584	6605288	Exposed	Engineered rock cover installed in 2018.
Ace	201 Raise	ACE MC	643615	6605277	Backfilled	Leave “as-is”. Removed concrete cap and excavated below, no indication of a raise opening. Raise area was backfilled, no further remediation planned at this location.
Dubyna	810394 Raise	JONES	647794	6608256	Exposed	Steel cover installed in 2017.
Dubyna	820694 Raise	JONES	647820	6608451	Exposed	Steel cover installed in 2017.
Eagle	Shaft	EAGLE 7			Exposed	Concrete cap installed in 2001.
Fay	Shaft	URA 4	642668	6604711	Located	Initiated investigation to determine potential remediation.
Fay	Custom Ore Raise	URA 4	642623	6604658	Buried	Additional investigation required to determine location of the raise. Believed to be inside the crusher adit.
Fay	Custom Ore Bin	URA 4	642625	6604658	Exposed	Confirmed opening to the crusher.
Fay	CB-1 Access Raise	URA 7	642558	6604563	Buried	Inclined access raise located. Plan to seal as an adit.
Fay	Surface Dump Raise	URA 4	642595	6604639	Exposed	Steel cover installed in 2018.
Fay	Sorting Plant Raise	URA 7	642603	6604520	Buried	Located, will require a site-specific plan for sealing the raise- likely backfill.
Fay	Sorting Plant Bin	URA 7	642603	6604520	Buried	Beside the raise, will also be backfilled.
Fay	Fine Ore Dump	URA 4			Buried	Not located, further investigation of the Fay shaft required.
Fay	Pipe Drift Raise	URA 4			Buried	Leave “as-is”. Small diameter raise (borehole) for piping, backfilled in reservoir.
Fay	25373 Raise	URA 3	642253	6604665	Exposed	Steel cover installed in 2017.
Fay	24094 Raise (Vent)	URA 4	642702	6604632	Exposed	Steel cover installed in 2018.
Fishhook	Shaft	N/A	646825	6594690	Exposed	Steel cover planned for 2020.
Fishhook	Raise	N/A			Backfilled	Leave “as-is”. Records indicate raise was backfilled to bedrock with waste rock, slab concrete placed over, and covered.
Hab	Vent Plant Raise	EXC 1	645542	6612182	Inaccessible	Steel cover designed, planned for installation in 2019.
Hab	13904 Raise	EXC 1	645229	6612203	Exposed	Steel cover installed in 2017.
Hab	13905 Raise	EXC 1	645246	6612213	Exposed	Steel cover installed in 2017.
Hab	13918 Raise	HAB 1	645292	6612236	Buried	No further remediation required- backfilled in Hab pit.
Hab	13927 Raise	HAB 1	645295	6612230	Exposed	Steel cover installed in 2017.
Hab	13909 Raise	HAB 1	645308	6612255	Buried	No further remediation required- backfilled in Hab pit.
Hab	13929 Raise	HAB 1	645352	6612255	Buried	No further remediation required- backfilled in Hab pit.
Hab	13810 Raise	HAB 2A	645561	6611886	Backfilled	Steel cover installed in 2017.
Hab	Shaft	HAB 2	645568	6612133	Exposed	Steel cover installed in 2018.
Verna	Shaft	ACE 8	645470	6606022	Exposed	Steel cover installed in 2018.
Verna	026594 Raise	NW 3 EX	645659	6606028	Exposed	Steel cover designed, planned for installation in 2019.
Verna	026594 Finger Raise	NW 3 EX	645668	6606030	Exposed	Steel cover installed in 2018.
Verna	Bored Raise	ACE 3	644806	6605250	Exposed	Steel cover installed in 2017.
Verna	Verna Manway	NW 3 EX	645669	6606035	Exposed	Steel cover installed in 2018.

In 2018, stainless steel covers were installed at the Hab Shaft, Verna Shaft, Fay Vent Raise, Fay Dump Raise and two of the three raises associated with Verna (026594 Finger Raise and Manway).

An alternative design (to stainless steel cover) was required to remediate the Ace 105#2 vent raise as a result of the Ace Stope Area crown pillar remediation. The remediation of the Ace Stope Area, which included the 105#2 raise, required the addition of 2 m of waste rock as cover material. This would have resulted in the stainless steel cover to be buried, potentially damaging the cover and preventing future inspection of the steel. Therefore, Cameco proposed an alternative design, which involved placement of large boulders that would effectively seal and lock the 105#2 raise while being incorporated into the Ace Stope Area crown pillar remediation. An exemption, regarding the engineered rock cover, from *The Mines Regulations, 2003,* Section 407(2) was granted in March 2019 and an approval from SMOE was provided in April 2018 (PD18-066). The remediation of the 105#2 raise occurred in the summer of 2018.

Following inspections of the stainless steel covers conducted in September 2017, Kova Engineering recommended that minor surficial flaws identified on caps installed in 2016 and 2017 be corrected prior to final pickling and passivation. Following the completion of this work and the installation of the stainless steel covers in 2018, Kova Engineering completed their final inspection of all 18 caps installed to date and issued the As-Built drawings to Cameco. The As-Built drawings were provided for record to the regulatory agencies in December 2018.

Engineering design drawings for an additional two stainless steel covers were submitted to SMOE and the Saskatchewan Ministry of Labour Relations and Workplace Safety for review and approval on December 19, 2018. Exemption from *The Mines Regulations, 2003* and an Approval to Construct, Alter, or Extend Pollutant Control Facilities, Approval No. PD19-019 were received on January 3, 2019 and January 22, 2019, respectively. The covers are currently being fabricated and are planned to be installed in 2019.

3.2.3 Re-establishment of the Zora Creek flow path

Final construction work on the Zora Creek Reconstruction was completed in 2016. A detailed description of the work conducted along with final As-built drawings was submitted to the CNSC and SMOE in a report titled "*Bolger Flow Path Reconstruction: 2016 Final As-Built Report*" (*SRK 2017a*) on March 10, 2017.

Cameco retained the services of SRK Consulting to complete the geotechnical inspection of the Zora Creek Reconstruction in 2018 **(Appendix C**). The 2017 report did not note any concerns with the physical stability of the excavated channel and it was noted that the conditions of the channel have not changed significantly since the previous year's inspection. Based on the results of the geotechnical assessments completed in 2017 and 2018, and the fact that there has been negligible geotechnical change to the channel since 2016, SRK Consulting has recommended that the next geotechnical inspection should be completed in five years, or earlier if requested by Cameco.

A description of the 2018 water quality results for sample stations ZOR-01, ZOR-02, AC-6A, and AC-8 are provided in **Section 4.4.1.** Water quality from this area will continue to be monitored in order to evaluate the success of implementing this remedial option.

3.2.4 Final Inspection and Clean-up of the Properties

Prior to transferring sites to the IC Program, a final site inspection and clean-up must be conducted in order to identify and remove debris from the properties, and ensure the site is in a safe and stable condition.

In 2015, Kingsmere Resources conducted an inspection of properties proposed for transfer to the IC Program. Final inspections and clean-up of all remaining properties was completed in 2016 and 2017. The inspections consisted of walking transects over the entire property unless safety consideration, surface features or significant vegetation prohibited access to a specific area. The inspection routes were tracked with a GPS and plotted on detailed aerial photos of the properties. Any foreign material or debris on the properties was marked for later collection or removed immediately, with the majority of clean-up activities taking place in 2016 and 2017.

During the three-year campaign, more than 2,465 person-hours and numerous pieces of equipment were dedicated to locating debris and cleaning up the former Beaverlodge mine and mill properties. Clean-up activities were conducted in six separate campaigns over more than 60 days. All of the mine related foreign material and debris collected from the former Beaverlodge properties was deposited in a designated disposal area in either the former Bolger pit or Lower Fay pit (*Kinsgmere 2018a*).

Prior to properties being transferred to the IC program, the regulatory agencies will typically conduct a final inspection of the property to ensure the clean-up and remediation is adequate. During this process, additional minor amounts of debris may be identified for clean-up or additional effort may be required to address other concerns raised by the regulatory agencies. In 2018, SMOE identified three clean-up remediation projects in or near water to be completed prior to transferring the properties to the IC program. The identified projects included the following:

- Removal of the former Eldorado town site pump house and associated debris on the shore of Beaverlodge Lake;
- Removal of the former Ace Lake pump house foundation and associated debris; and,
- Removal of dimensional timber from within Zora Lake.

The projects were completed during the summer of 2018 and were managed in accordance with the conditions listed in AHPP18-064 and AHPP18-065, which were issued to Cameco by the Saskatchewan Ministry of Environment on April 30, 2018

Debris Disposal

Over the course of the 2015 to 2017 site clean-up campaigns, approximately 1,358 m^3 of exploration core and 1,148 m^3 of mine related debris and foreign material was deposited in the Bolger and Fay Pits, respectively. Details of the site wide inspection and clean-up program were submitted in a stand-alone report on March 23, 2018.

The materials disposed of in the Bolger and Fay Pits generally has included debris such as tires, culverts, steel drums, drill stems and casings, transmission line infrastructure, stave pipeline and wire wrap, hoses and piping, as well as signs, which are all in addition to the exploration drill core and broken concrete from historic building foundations. In 2018, additional debris identified during regulatory inspections or generated during the remediation of the Ace Lake and Beaverlodge Lake Pumphouses, was collected and disposed of in the Fay Pit. Approximately 10 m^3 of woody debris, 40 m^3 of metal and 140 m^3 of concrete/rebar was placed in the Fay Pit is 2018. The table below has been updated to reflect the volume of waste disposed of in 2018.

Table 3.2-2
Summary of the materials (m^3) deposited to Bolger and Fay Pits since 2015

	Bolger	Fay	**Total**
Debris	82	592	**674**
Core	1303	116	**1419**
Concrete	0	630	**630**
Total	**1358**	**1338**	**2723**

3.2.5 Decommission Identified Boreholes

A search of drilling records on file with the Government of Saskatchewan, followed by field investigations was conducted in 2010 (*SRK 2011*). This investigation resulted in numerous historic boreholes dating from the Eldorado operation (exploration drill holes) being identified and sealed over the next two years. Since 2013, additional non-flowing historic boreholes have been discovered during regulatory inspections as well as during the final property inspections and have since been sealed.

In 2018, 28 dry boreholes were sealed with grout, and the casings cut at ground level (*Kinsgmere 2018a*). Collectively, 206 boreholes have been decommissioned since 2011 across the Beaverlodge properties.

As a permanent record of borehole locations associated with the Beaverlodge properties, Cameco maintains a master list that includes the GPS locations and the method of closure completed for each borehole in the Annual Report (**Appendix D**). Two boreholes located off property were listed as OP 04 and OP 05 in the 2017 Annual Report; however, after comments were received from the CNSC concerning these boreholes, the names were changed to BH-NW02 and BH-NW01, respectively. The BH-NW01 borehole was incorrectly labelled as Dry when located, which has also been corrected on the master list. If additional boreholes are discovered, the GPS locations and status will be added to this record. As sites are transferred to the IC Program, this permanent record will be transferred to the Province of Saskatchewan.

3.2.6 Crown Pillar Remediation

In October 2013, it was noted there was a failure in the crown pillar associated with the Ace Stope area. Initial remediation to secure the subsidence area consisted of a gravel and sand cover, with fencing restricting access. Although the majority of the remediation was completed in August 2016, the final cover was considered complete once the remediation of the 105#2 Raise was incorporated into the cover. The cover of the crown pillar included backfilling the areas above the stopes with approximately two metres of broken concrete and sorted waste rock, followed by capping with low gamma waste rock.

An interim As-built report was submitted to the CNSC and SMOE on March 15, 2017 (*SRK 2017b*). Comments were received from the CNSC on July 11, 2017 with a response from Cameco sent on August 2, 2017, followed by acceptance by the CNSC on August 3, 2017. Inspection of the area was completed in 2018 and showed the area performing as expected with no signs of subsidence (tension cracks, slumping) noted. This inspection was performed as part of the Cameco Geotechnical Inspection Report with results and photos provided in **Appendix A**.

The final As-built report for the 105#2 Raise describes how remediation of this raise fits with the crown pillar remediation project and is expected for submission in 2019

As per recommendations from SRK, monitoring of the area will continue on an annual basis for the next two years to verify performance of the cover. Evaluation of the required frequency will take place at that time and are anticipated to continue under the IC Program in the long-term.

3.3 Additional Studies

3.3.1 Environmental Performance Report and Environmental Risk Assessment

Cameco retained the services of Canada North Environmental Services (CanNorth) to prepare the Beaverlodge Environmental Performance Report (EPR) covering the 2013 to 2017 reporting period. The report was submitted on October 29, 2018 to fulfill the requirements stated in the Beaverlodge Surface Lease Agreement dated December 24, 2006. The EPR also fulfills the requirement to submit a State of Environment report as identified in Section 5.3.4 of the Beaverlodge - Facility License Manual, which is one of the key documents submitted in support of CNSC licence number WFOL-W5-2120.0/2023.

Monitoring data from the period (2013 to 2017) were analyzed for spatial and temporal trends compared to previous data, guidelines, and water quality predictions made using the Beaverlodge QSM and predictions from environmental risk assessments when available. Evaluation focused on data collected from the aquatic (surface water, hydrology, fish chemistry) environment, although data related to waste rock, waste, meteorology, and radon levels were also considered.

Included as an appendix to the EPR was the 2018 Beaverlodge Environmental Risk Assessment (ERA). The results of the assessment, completed in accordance with CSA

N288.6-12 standard for ERAs at Class 1 Nuclear Facilities and Uranium Mines and Mills, are consistent with previously accepted assessments.

Two recommendations were made in the EPR that still require acceptance from the regulatory agencies before proceeding;

- Stop collecting environmental radon progeny samples from the site, as measured concentrations have remained stable over many years and risks due to radon progeny exposure from the site are negligible,
- Monitoring of seeps, which have low and intermittent flows, should be removed from the Beaverlodge Environmental Monitoring Program (EMP). The objective of the seep monitoring program is to establish long-term water quality trend information. This has been accomplished and, for the most part, concentrations have remained relatively constant since 2004. Additionally, water quality in the downstream receiving environment is monitored as part of the EMP at Station AC-14.

The EPR and accompanying ERA results continue to support the conclusion that the risks on the Beaverlodge properties have been managed in accordance with the Beaverlodge Management Framework and Cameco will continue moving forward with plans to obtain a release from decommissioning and reclamation from SMOE, exemption from CNSC licensing, and acceptance into the IC Program.

3.3.2 Beaverlodge Area Fish Assessment

In 2017, a Beaverlodge Fish Chemistry Program was undertaken as a follow up to community member inquiries. Since 2000, fish chemistry information has been collected from Verna, Ace, Beaverlodge, Dubyna, Martin and Cinch lakes, Ace Creek, as well as Crackingstone Inlet, and Prospectors Bay of Lake Athabasca. In late August 2017, flesh and ovary samples of lake trout, lake whitefish, northern pike, and white sucker were collected from Ace Lake, Ace Bay, Fulton Bay of Beaverlodge Lake, Martin Lake (inflow and outflow), and Verna Lake. Northern pike were collected only from waterbodies in which lake trout were not present (i.e., Verna Lake), and white sucker were collected from those lakes in which lake whitefish were not present (i.e., Fulton Bay). Samples were submitted for chemical analysis (radionuclides, metals, and percent moisture) and fish ageing.

Data from this special investigation was used to update the fish tissue concentrations incorporated into the EPR (*CanNorth 2018*) and related memos were provided, upon request, to the CNSC in January 2019. The data has also been provided to the Public Health and Preventive Medicine Consultant and Medical Health Officer for the Saskatchewan Health Authority in order to inform future assessments of the Fish Consumption Advisory in place for the Martin and Beaverlodge lakes in the event that fish tissue concentrations have changed since the last sampling period.

SECTION 4.0

ENVIRONMENTAL MONITORING PROGRAMS

4.0 ENVIRONMENTAL MONITORING PROGRAMS

Cameco retains a local contractor (Urdel Ltd.) to conduct the required water quality and radon sampling throughout the year. While collecting samples, employees from Urdel Ltd., also perform cursory inspections and report any unusual conditions to Cameco.

4.1 Site Specific Objectives

The annual report provides water quality comparisons made against the site specific water quality predictions developed in the Beaverlodge Quantitative Site Model (*SENES 2012*).

4.1.1 Modelled Predictions (Performance Indicators)

The performance objectives of safe, secure and stable/improving have been established as benchmarks for entering the provincial IC Program. Performance indicators consisting of modelled water quality for several stations were developed to assess when the performance objective has been met for the associated properties. The predictions provide an expected range to which water quality trends will be compared when defining whether the station is stable or improving.

These predicted water quality concentrations were originally modelled as part of the development of the QSM and provided the foundation for assessing the outcome of remedial options presented in the Path Forward report (*Cameco 2012*). With the path forward strategy accepted by the regulatory agencies, the water quality performance indicators were updated and incorporated in the 2013 Status of the Environment (SOE) report (*SENES 2013*). A revised EPR was submitted in October 2018 that included updates to the model based on data gathered since 2013. For the purposes of this report, comparisons are made to the accepted 2013 predicted values (*SENES 2013)*.

As shown in **Table 4.1-1**, some individual annual average results are outside the maximum and minimum predictions generated using the Beaverlodge QSM (*SENES 2012*) and the model inputs employed in the 2013 Beaverlodge SOE (*SENES 2013*). Although it is not the expectation that water quality results will be within the predicted maximum and minimum bounds every year, 2018 water quality and corresponding trends are evaluated and discussed below.

Table 4.1-1
Comparison of Key Parameter Annual Averages to QSM Predictions

Uranium	2018	SEQG	2018 QSM Bounding Range			Comments
	Concentration (µg/l)					
Ace Lake (AC-8)	12.50	15	7.06	to	14.00	Below SEQG.
Beaverlodge Lake (BL-5)	124.5	15	98.6	to	136.0	2018 average within bounds.
Dubyna Lake (DB-6)	193.5	15	60.5	to	133.0	Annual average exceeded the upper bound in 2018. Trend will be monitored.

Uranium	2018	SEQG	2018 QSM Bounding Range			Comments
	Concentration (µg/l)					
Greer Lake (TL-9)	172.3	15	263.0	to	316.0	Trending below lower bound.
Lower Ace (AC-14)	35.8	15	14.2	to	31.4	Annual average exceeded the upper bound in 2018. Trend will be monitored.
Marie Reservoir (TL-4)	187.3	15	304.0	to	375.0	Trending below lower bound.
Meadow Fen (TL-7)	238.4	15	320.0	to	413.0	Trending below lower bound.
Pistol Lake (AN-5)	163.2	15	180.0	to	400.0	Trending below lower bound.
Verna Lake (AC-6A)	278.5	15	110.0	to	237.0	2018 average above predictions but improving following construction activities related to the Zora Stream Reconstruction. Trend will be monitored.

Radium-226	2018	SEQG	2018 QSM Bounding Range			Comments
	Activity Level (Bq/l)					
Ace Lake (AC-8)	0.020	0.11	0.0112	to	0.017	Below
Beaverlodge Lake (BL-5)	0.025	0.11	0.0357	to	0.046	Below
Dubyna Lake (DB-6)	0.040	0.11	0.0177	to	0.03	Below
Fookes Reservoir (TL-3)	1.43	0.11	1.08	to	1.34	Annual average exceeded the upper bound in 2018. Trend will be monitored.
Greer Lake (TL-9)	2.33	0.11	1.64	to	2.32	Annual average is beginning to exceed the upper bound. Trend will be monitored.
Lower Ace (AC-14)	0.050	0.11	0.0244	to	0.049	Below
Marie Reservoir (TL-4)	1.73	0.11	1.38	to	1.76	2018 average within
Meadow Fen (TL-7)	1.74	0.11	1.33	to	1.71	Annual average is beginning to exceed the upper bound. Trend will be monitored.
Pistol Lake (AN-5)	0.646	0.11	0.382	to	0.899	2018 average within
Verna Lake (AC-6A)	0.10	0.11	0.0742	to	0.181	Below SEQG.

Selenium	2018	SEQG	2018 QSM Bounding Range	Comments
	Concentration (mg/l)			
Ace Lake (AC-8)	0.0001	0.001	0.0001 to 0.0001	Below SEQG.
Beaverlodge Lake (BL-5)	0.0022	0.001	0.0021 to 0.0027	2018 average within bounds.
Dubyna Lake (DB-6)	0.0001	0.001	0.0001 to 0.0001	Below SEQG.
Fookes Reservoir (TL-3)	0.0023	0.001	0.0032 to 0.0037	Trending below lower bound.
Greer Lake (TL-9)	0.0022	0.001	0.0032 to 0.0039	Trending below lower bound.
Lower Ace (AC-14)	0.0002	0.001	0.0001 to 0.0001	Below SEQG.
Marie Reservoir (TL-4)	0.0013	0.001	0.0030 to 0.0033	Trending below lower bound.
Meadow Fen (TL-7)	0.0018	0.001	0.0031 to 0.0035	Trending below lower bound.
Pistol Lake (AN-5)	0.0001	0.001	0.0001 to 0.0001	Below SEQG.
Verna Lake (AC-6A)	0.0002	0.001	0.0001 to 0.0001	Below SEQG.

Recent uranium trends observed at Verna Lake have deviated from model predictions. It is expected that these deviations are due to the model not accounting for construction activities related to the Zora Creek Reconstruction Project that disturbed the system in 2015/2016. Now that the project is complete, water quality is expected to continually improve in Verna Lake. Continued monitoring at Verna Lake in 2019, will assist with determining the efficacy of the reconstruction project and evaluating recovery since construction activities.

Uranium concentrations at Dubyna Lake (DB-6) have shown a slight decline since 2008, but overall are above the predicted upper bound. As identified in the EPR (*CanNorth 2018*), this may indicate that remedial activities in this area (i.e., plugging of flowing boreholes) were not as effective as anticipated. The potential risks associated with the reduced borehole plugging effectiveness are low and largely unchanged as compared to those assuming a higher reduction in load and that the overall conclusions of the assessment are unchanged (*CanNorth 2018*).

During the most recent EPR (*CanNorth* 2018), an assessment of measured precipitation values, showed that model assumptions underestimated the variability of flows in the area. This underestimation of flow variability is suspected to be a contributing factor where observed measurements are outside of predictions. Maximum and minimum water quality predictions were generated by running several variations of a range of key parameter values through the model. One of the key parameters was a predicted range of flow rates expected to be observed in the modelled watersheds. The maximum and minimum flows used for modeling purposes were generated based on regional annual precipitation data for the period from 1983 to 2010. Overall, the range of flow rates used in the model runs were approximately +/- 15% of the nominal value measured from 1983 to 2010 (85% to 115% of the base case flows). Flow measured since 2010 has shown significantly greater variability.

The assessment of water quality predictions is identified as a step on the Beaverlodge Management Framework when determining a properties eligibility for transfer to the IC program. If water quality predictions are being met and the property is chemically and physically stable, the properties will be considered for transfer to the IC Program. If the water quality predictions are above predictions, additional assessment may be required, evaluating the risk and potentially additional remediation.

4.2 Transition-Phase Monitoring

During transition-phase monitoring, the results of four separate monitoring programs have been evaluated to assess the performance of the Beaverlodge site. These include water quality, ambient radon, air quality, and gamma radiation surveys.

The original gamma radiation surveys were completed in the first year of the transition phase (1985/1986) monitoring. Following this, gamma surveys were conducted on an

ad-hoc basis or in support of applications to release specific properties from decommissioning and reclamation. In 2014, a detailed survey of the disturbed areas on all Beaverlodge properties was conducted and a risk assessment completed (see **Section 3.2.1)** that considered the gamma survey results and the expected land use by Uranium City. Gamma surveys in the future will be completed on an ad-hoc basis where required.

The air quality monitoring program for dust fall and high volume sampling was discontinued following the third year of the transition-phase monitoring as all sampling results met the established close-out objectives.

Currently, two routine environmental monitoring programs continue as per the Beaverlodge EMP: water quality and ambient radon. Recent changes to the Beaverlodge EMP, including voluntary and QA/QC sampling, were approved by the CNSC and SMOE in June 2018.

4.3 Water Quality Monitoring Program

This section provides a summary of water quality trends at each of the licensed monitoring stations at the Beaverlodge Site. An initial comparison to the Saskatchewan Environmental Quality Guidelines (SEQG; *Government of Saskatchewan 2019*) will be made and if the data shows a stable trend below the SEQG, no detailed discussion will be provided. If the data is above the SEQG, a comparison to the modelled predictions will be made. As surface water quality guidelines are not intended to be applied within tailings management areas, they are not discussed for stations TL-3, TL-4, TL-6, or TL-7.

The water quality summary in this section focuses on the three main constituents of potential concern identified at the Beaverlodge properties (selenium, uranium and radium^{226}). TDS is also included as a general indicator of water quality.

The two watersheds affected by the historical mining activities are Ace Creek and Fulton Creek. **Figure 4.3** provides an overview of the various stations at which water quality is monitored. Within the Ace Creek watershed, the routine sampling stations (from upstream to downstream) include:

AN-5 Pistol Creek downstream of the decommissioned Hab mine site.

DB-6 Dubyna Creek downstream of the decommissioned Dubyna mine site and before the creek enters Ace Creek upstream of Ace Lake.

AC-6A Verna Lake discharge to Ace Lake.

AC-8 Ace Lake outlet to Ace Creek.

AC-14 Lower Ace Creek at the discharge into Beaverlodge Lake.

The Fulton Creek watershed contains the bulk of the decommissioned tailings deposited during operations. Within the Fulton Creek watershed, the regulatory approved sampling stations (from upstream to downstream) include:

AN-3 Fulton Lake (represents un-impacted or background condition).

TL-3 Discharge of Fookes Reservoir.

TL-4 Discharge of Marie Reservoir (which flows into Meadow Fen).

TL-6 Discharge of Minewater Reservoir (which flows into Meadow Fen).

TL-7 Discharge of Meadow Fen upstream of Greer Lake.

TL-9 Fulton Creek downstream of Greer Lake and before it enters Beaverlodge Lake.

Additional sampling stations located downstream of the Beaverlodge site include:

BL-3 Located in Fulton Bay, Beaverlodge Lake immediately opposite the Fulton Creek discharge.

BL-4 Located in a central location within Beaverlodge Lake.

BL-5 Outlet of Beaverlodge Lake.

ML-1 Outlet of Martin Lake.

CS-1 Crackingstone River at Bridge.

CS-2 Crackingstone Bay in Lake Athabasca.

Figures 4.3.1-1 to **4.4-8** are graphical representations of the historical annual average concentrations of uranium (U), radium^{226} (^{226}Ra), selenium (Se), and total dissolved solids (TDS) at each station with comparisons to their respective SEQG values where applicable, as well as comparisons to the predicted future recovery of waterbodies that were presented in the SOE (*SENES 2013*). It should be noted that Se monitoring began at selected water stations in 1996. Prior to 1996, Se was not identified as a contaminant of concern at Beaverlodge. As there are no guidelines for TDS under the current SEQG, no comparison to guidelines have been made.

Sections 4.3.1 and **4.3.2** cover the water quality results and trends at each of the water quality stations located within each watershed. **Section 4.3.3** covers the water quality trends at each of the water quality locations in Beaverlodge Lake and downstream. Trends are identified through visual interpretation of the graphs and include trends in the short-term (less than five years) and in the long-term trends (10 to 30 years).

The detailed water quality results for the current reporting period, January 2018 to December 2018, are provided in **Appendix E**.

4.3.1 Ace Creek Watershed

AN-5 Pistol Lake

Station AN-5 is located in Pistol Creek downstream of the decommissioned Hab satellite mine (**Figure 4.3**). While there are six scheduled samples at AN-5, only five were collected in 2018. There was no water at AN-5 in March, therefore no sample was collected.

A historical summary of annual average ^{226}Ra, U, Se, and TDS concentrations at AN-5, along with the predicted recovery, are presented in **Figures 4.3.1-1** to **4.3.1-4**. The annual averages from 2014 to 2018 are presented in **Table 4.3.1-1**.

The long-term trend for ^{226}Ra at AN-5 is predicted to remain relatively constant into the future with notable fluctuations in the year to year annual average concentration. However, there is no statistically significant trend over the recent period (2008 to 2017; EPR 2018). As shown in **Appendix E**, seasonal fluctuation varied in magnitude between 0.35 Bq/L and 1.00 Bq/L in 2018. The average concentration at AN-5 decreased from 0.798 Bq/L in 2017 to 0.646 Bq/L in 2018 and was within the modelled predictions. This is the lowest annual average recorded in the past five years. Within this same time frame, annual averages have all been within modelled predictions with the exception of 2015 (1.07 Bq/L), which was due to high seasonal variability (*CanNorth 2018*).

Uranium concentrations have shown a distinct seasonal fluctuation as well, with the highest concentrations occurring in the winter months, which decrease through the spring and summer months, followed by an increase again in fall. Uranium concentrations measured throughout the year varied in magnitude between 47 µg/L and 343 µg/L. Overall, the long-term trend for U at AN-5 has shown a decrease in concentrations post-decommissioning. In comparison to modelled predictions, the annual average concentrations of U have been trending just below the predicted range. The lower bound predicted concentration for U in 2018 was 180 µg/L and recorded average concentration was measured at 163.2 µg/L for 2018.

Similar to U and ^{226}Ra, TDS concentrations exhibit a seasonal fluctuation that affects the annual average; however, the long-term trend has remained relatively consistent.

In order to better understand the variability observed at AN-5, the sensitivity of predicted concentrations at the outlet of Pistol Lake to various model assumptions within the QSM was assessed (*CanNorth 2018*). This investigation found that the range of flow observed in the area was much higher than the variability assumed within the QSM. If this higher precipitation/flow variation is considered, the model results show that a wider range of values for U and ^{226}Ra levels observed at AN-5 are reasonable and should be expected. The high seasonality observed at AN-5 is expected due to the small, shallow nature of Pistol Lake, which would amplify the effects of seasonal influences such as ice cover. The risk evaluation included in the ERA (*CanNorth 2018*) also found that any potential risks to wildlife in the Pistol Lake area are related to U levels, not ^{226}Ra. As U appears to be recovering more quickly than predicted (**Figures 4.3.1-2**), any predicted potential risks are conservative in nature.

Selenium values at AN-5 are consistently below SEQG, and the annual average concentration reported in 2018 was below detection limits at <0.0001 mg/L.

DB-6 Dubyna Lake

Station DB-6 is located in Dubyna Creek, downstream of Dubyna Lake and the decommissioned Dubyna satellite mine, before the creek enters Ace Creek, and upstream of Ace Lake (**Figure 4.3**). There were a total of six scheduled samples at DB-6 in 2018, but only four were collected due to frozen conditions in January and March.

A historical summary of annual average ^{226}Ra, U, TDS, and Se concentrations at DB-6, along with the predicted recovery, are presented in **Figures 4.3.1-5** to **4.3.1-8**. The annual averages from 2014 to 2018 are presented in **Table 4.3.1-2**.

Uranium concentrations at DB-6 have shown a consistent long-term decreasing trend. Following the plugging of three flowing boreholes in 2011 and 2012 water quality continued to improve; however, at a slower rate than predicted. Beginning in 2015, concentrations measured at DB-6 have been slightly above the upper predicted bound, with the 2018 average exceeding the upper predicted bound by 60.5 µg/L.

Cameco has initiated a search for potential additional sources of U along the shoreline of Dubyna Lake in response to the annual U averages that have exceeded the modelled predictions in recent years. In particular, a cursory search of conductivity found increased conductivity levels in the lake adjacent to the mine, but no clear sources could be identified. An evaluation of the potential risk to aquatic biota was completed as part of the recent ERA (*CanNorth 2018*). As part of the sensitivity evaluation discussed in the ERA, the risk evaluation for Dubyna Lake was also reexamined using measured concentrations from the last five years in the pathways portion of the Beaverlodge QSM tool instead of the predicted values, which are marginally lower. This evaluation found that even if recovery is occurring at a slightly slower rate than predicted, the overall outcome of the assessment are unchanged. The U trend at this location will continue to be monitored.

The long-term trend for ^{226}Ra at DB-6 has been relatively consistent and has remained below the SEQG since 1981.

Selenium has remained relatively stable since 2004. The water quality trend for Se has also remained below the SEQG since the analytical laboratory detection limit for Se was lowered.

The TDS trend has been relatively consistent since decommissioning, and no changes were observed in 2018.

AC-6A Verna Lake

Water quality monitoring at this station began in May 2010, and is located at a culvert between Verna Lake and Ace Lake (**Figure 4.3**). Flows from Verna Lake are largely dependent on precipitation, and as such, not all scheduled samples can be collected during low flow years. Increased sample frequency at AC-6A began in 2015 in order to track changes in water quality as a result of the implementation of the Zora Creek Reconstruction project. In 2018, there were 12 samples scheduled; however, due to ice cover and lack of water, only 4 samples were collected.

A historical summary of annual average ^{226}Ra, U, TDS and Se concentrations at AC-6A along with the predicted recovery, are presented in **Figures 4.3.1-9** to **4.3.1-12.** The annual averages from 2014 to 2018 are presented in **Table 4.3.1-3**.

The annual average U concentration decreased from 331.0 µg/L in 2016 to 279.3 µg/L in 2017, with an additional modest decrease to 278.5 µg/L reported in 2018. Although this concentration is still above the modelled predictions, it is expected to continue to decrease as a result of the Zora Creek Reconstruction project. A description of the activities associated with the Zora Creek Reconstruction project and the water quality monitoring program is provided in **Section 4.4.1**. Results will continue to be monitored.

The current annual average ^{226}Ra concentration of 0.1 Bq/L is slightly lower than the 2017 annual average of 0.115 Bq/L. Based on the modelled predictions, ^{226}Ra is trending within the upper and lower bounds. The annual average concentration of ^{226}Ra reported in 2018 at this station was slightly below the SEQG concentration of 0.11 Bq/L.

Selenium at station AC-6A continues to measure well below the SEQG concentration of 0.001 mg/L.

Total dissolved solids concentrations have remained relatively stable at this station since 2004, ranging from 160.7 mg/L (2004) to 203.5 mg/L (2012). The 2018 annual average was 197.0 mg/L.

AC-8 Ace Lake

Station AC-8 is located at the discharge of Ace Lake into Lower Ace Creek. Ace Lake is the receiving environment for waters discharged from DB-6, AN-5, and AC-6A (**Figure 4.3**). Both of the scheduled samples for AC-8 were collected in 2018.

A historical summary of annual average ^{226}Ra, U, TDS, and Se concentrations at AC-8 along with the predicted recovery, are presented in **Figures 4.3.1-13** to **4.3.1-16**. The annual averages from 2014 to 2018 are presented in **Table 4.3.1-4**.

The long-term trend for annual average U concentrations has followed a slowly decreasing trend since decommissioning. Since 2012, the annual average U concentration has been below the SEQG and within the modelled predictions.

The long-term trend for ^{226}Ra concentrations is below the SEQG value of 0.11 Bq/L.

Selenium concentrations have also remained stable and well below the SEQG.

The long-term trend for concentrations of TDS have remained relatively stable at this station since 1982.

AC-14 Lower Ace Creek

Station AC-14 is located in Lower Ace Creek at the discharge into Beaverlodge Lake (**Figure 4.3**). All 12 of the scheduled samples were collected in 2018.

A historical summary of annual average ^{226}Ra, U, TDS, and Se concentrations at AC-14 along with the predicted recovery, are presented in **Figures 4.3.1-17** to **4.3.1-20.** The annual averages from 2014 to 2018 are presented in **Table 4.3.1-5**.

While U concentrations at station AC-14 have been following an overall downward trend since decommissioning, the short-term trend has fluctuated around 30 µg/L and has exhibited less variability than results reported prior to 2009. The 2018 average concentration of 35.8 µg/L slightly exceeds the upper bound predicted concentration of 32.6 µg/L.

The long-term trend for the annual average ^{226}Ra concentration measured at this station has been consistently below the SEQG concentration since 1989, following the decommissioning of the Beaverlodge mine/mill complex.

Since the analytical laboratory detection limit for Se was lowered, Se concentrations have been below the SEQG value at AC-14.

Total dissolved solids concentrations have remained relatively stable at this station since decommissioning with one anomaly occurring in 1991.

4.3.2 Fulton Creek Watershed

As discussed previously, surface water quality guidelines are not intended to be applied within tailings management areas, and thus they are not compared to water quality at stations TL-3, TL-4, TL-6, or TL-7. No predictions are provided for station AN-3 as this station is considered a reference area, un-impacted by historic mining activities.

AN-3 Fulton Lake

Station AN-3 is located at the outflow of Fulton Lake prior to Fookes Reservoir and was not impacted by mining activities in the area (**Figure 4.3**). Water quality at this station is typical of background water quality in the region. Since 1986, sampling has been conducted on an annual basis.

A historical summary of ^{226}Ra, U, TDS, and Se concentrations at AN-3 are presented in **Figures 4.3.2-1** to **4.3.2-4**. The annual averages from 2014 to 2018 are presented in **Table 4.3.2-1**.

As expected with a reference location, the long-term trend for concentrations of U, ^{226}Ra, recorded at AN-3 have remained relatively stable and below their respective SEQG concentrations. TDS has also remained stable since before decommissioning in 1985. Selenium concentrations at AN-3 have been at or below the detectable laboratory limits since 1998.

TL-3 Fookes Reservoir

Station TL-3 is located at the discharge of Fookes Reservoir, which received the majority of tailings during operation, and is the first sampling location within the recovering Tailings Management Area (TMA; **Figure 4.3**). Three of the four scheduled samples were collected in 2018. A sample was not collected in March as Fulton Creek was dry at the time.

A historical summary of annual average ^{226}Ra, U, TDS, and Se concentrations at TL-3 along with the predicted recovery, are presented in **Figures 4.3.2-5** to **4.3.2-10**. The annual averages from 2014 to 2018 are presented in **Table 4.3.2-2**.

Overall, the long-term trend for the mean concentration of U has shown a decrease since 1991. The most recent five annual averages measured from 2014 to 2018 have also been below the lower bound for the modelled predictions.

The long-term trend for ^{226}Ra has been slowly increasing since 1988, with a 2018 average activity of 1.43 Bq/L. Elevated ^{226}Ra and barium concentrations observed along with decreasing sulphate concentrations are likely due to re-solubilisation through chemical disequilibrium and biological processes of the barium-radium-sulphate co-precipitate formed in the Beaverlodge TMA during operations. As barium treatment did not occur in the area upstream of TL-4, this precipitate was likely formed due to naturally occurring barium. It is also important to note that although the short-term QSM predictions depicted in **Figures 4.3.2-7** show an increasing concentration, there is a subsequent decline predicted for concentrations over the long-term (*SENES 2012*).

In the long-term Se has been slowly decreasing in concentration since decommissioning. In 2018, the Se concentration measured 0.0023 mg/L, which is below the lower bounds of the modelled predictions at TL-3.

Total dissolved solids concentrations have also slowly decreased in the long-term.

TL-4 Marie Reservoir

Station TL-4 is located within the Fulton Creek drainage downstream of TL-3 and at the discharge of Marie Reservoir (**Figure 4.3**). Three of four scheduled samples were collected in 2018. Samples were not collected in March as this station was dry.

A historical summary of annual average ^{226}Ra, U, TDS, and Se concentrations at TL-4 along with the predicted recovery, are presented in **Figures 4.3.2-11** to **4.3.2-16**. The annual averages from 2014 to 2018 are presented in **Table 4.3.2-3**.

Annual concentrations of U and TDS at TL-4 have decreased over the long-term. In 2018, the decreasing trend continued with the lowest annual average U concentrations at TL-4 reported to date at 187.3 µg/L and 181.3 mg/L, respectively. The most recent five years have had annual average concentrations below the lower bound of the modelled predictions.

Similar to TL-3, ^{226}Ra concentrations have shown an increasing trend for approximately the past 17 years at TL-4, but has been within the model predicted range for the last 3 years. It is also important to note that although the short-term QSM predictions depicted in **Figures 4.3.2-13** show an increasing concentration, there is a subsequent decline predicted for concentrations over the long-term (*SENES 2012*).

Selenium has shown a slow and steady reduction over time with a 2018 annual average concentration of 0.0013 mg/L being reported, which was below the lower bound of the modelled prediction.

TL-6 Minewater Reservoir

Station TL-6 is located at the discharge of Minewater Reservoir (**Figure 4.3**), which was used temporarily for tailings deposition in 1953, then as a settling pond for treated mine water during the last 10 years of Beaverlodge operations. During decommissioning activities, the water level in Minewater Reservoir was lowered and efforts were made to relocate settled precipitate sludge to the Fay shaft. Although a large volume of precipitate was relocated, these efforts were not successful in removing all sludge, which is reflected by the water quality observed to date.

This water quality station represents the outflow of a small drainage area and generally exhibits ephemeral flows dependent on local precipitation. As a result, not all scheduled samples are typically collected. Of the four scheduled samples, two were collected during 2018. No water was available due to ice in April and September.

The analysis performed as part of the QSM showed that the contributions of loads from the Minewater Reservoir influencing the downstream Meadow Fen area are quite small, estimated at no more than 10%. As such, model predictions were not generated for TL-6. Contributions from this station are incorporated in the model predictions at the downstream station (TL-7).

A historical summary of annual average ^{226}Ra, U, TDS, and Se concentrations at TL-6 is presented in **Figures 4.3.2-17** to **4.3.2-20**. The annual averages from 2014 to 2018 are presented in **Table 4.3.2-4**.

Since decommissioning, U concentrations have been experiencing a decreasing trend at station TL-6 with a more consistent trend over the short-term. Annual average concentrations have ranged between 143.7 µg/L and 288.5 µg/L over the last five years with an annual average of 171.5 µg/L in 2018.

The annual average ^{226}Ra concentration has shown considerable fluctuation with an increasing trend being observed since decommissioning. From 1996 to present, concentrations of sulphate have been generally decreasing while barium has demonstrated a similar trend to that observed for ^{226}Ra. Cameco hypothesizes this is a result of dissolution of remnant barium-radium-sulphate precipitate that was generated during the active treatment of minewater during operations. The annual average activity in 2018 was 7.0 Bq/L.

Monitoring of Se at TL-6 was initiated in 1996, with highly variable concentrations being observed until 2004. The 2018 annual average of 0.0026 mg/L is within range of values previously observed at this station.

Total dissolved solids experienced an initial downward trend post-decommissioning, with concentrations stabilizing around 500 mg/L since 2005.

TL-7 Meadow Fen

Station TL-7 is located at the discharge of Meadow Fen (**Figure 4.3**) in the TMA. Of the twelve scheduled samples for the 2018 reporting period, nine samples were collected due to ice cover from January to April preventing sample collection.

A historical summary of annual average ^{226}Ra, U, TDS, and Se concentrations at TL-7 along with the predicted recovery, are presented in **Figures 4.3.2-21** to **4.3.2-26**. The annual averages from 2014 to 2018 are presented in **Table 4.3.2-5**.

Since decommissioning, U and TDS have been experiencing a downward trend in their long-term concentrations. The annual average U concentration at TL-7 has been below the lower bound of the modelled predictions since they were developed in 2013.

Radium^{226} is experiencing an upward trend similar to the upstream stations in the TMA. A skewed annual average was recorded in 2017 due to a single elevated sample result collected in August following a large rainfall event that occurred the day prior to sampling. This influx of freshwater likely resulted in a dissociation of $BaRaSO_4$ and elevated ^{226}Ra concentrations. As expected in 2018, the concentrations dropped to an annual average of 1.75 Bq/L, 0.04 Bq/L over the predicted upper bound. It is also important to note that although the short-term QSM predictions depicted in **Figures 4.3.2-23** show an increasing concentration, there is a subsequent decline predicted for concentrations over the long-term (*SENES 2012*).

Since 1995, annual average Se concentrations at TL-7 have been decreasing in the long-term. In recent years, the annual average Se measurements have remained relatively stable and are currently below the lower bound of the modelled predictions.

TL-9 Greer Lake

Station TL-9 is located downstream of Greer Lake immediately before the water enters Beaverlodge Lake (**Figure 4.3)**. Sampling at this station began in 1981 and continued until 1985 at which time it was discontinued. Sampling resumed in 1990 in order to re-assess the water quality entering Beaverlodge Lake. In 2018, 6 of 12 scheduled samples were collected. Samples were not collected due to unsafe ice conditions or frozen conditions, resulting in no flowing water.

A historical summary of annual average ^{226}Ra, U, TDS, and Se concentrations at TL-9 along with the predicted recovery, are presented in **Figures 4.3.2-27** to **4.3.2-32**. Average concentrations at TL-9 from 2014 to 2018 can be found in **Table 4.3.2-6**.

The long-term and short-term trends for U at TL-9 have shown a decrease in annual average concentrations following decommissioning. Compared to the modelled predictions, U concentrations since 2013 have been below the predicted range.

Since 1990, ^{226}Ra has been experiencing an overall upward trend in concentrations despite occasional fluctuations over the past twenty years. However, since 2013, concentrations have decreased overall and was near the modelled upper bound prediction (2.23 Bq/L) in 2018 (2.33 Bq/L). This trend will continue to be monitored.

Routine monitoring of Se at TL-9 was not conducted until 1996, at which time it was identified as a contaminant of concern. Selenium at station TL-9 has shown a decreasing trend over the long-term. In 2018, the average concentration was below the modelled predictions with a concentration of 0.0022 mg/L.

The long-term trend for TDS concentration has been decreasing since decommissioning.

4.3.3 Downstream Monitoring Stations

While Beaverlodge Lake is the receiving environment for water from the decommissioned Beaverlodge properties, it is also the receiving environment for contaminants discharged from at least nine other non-Eldorado abandoned uranium mine sites and one former uranium mill tailings area (Lorado Uranium Mining Ltd. mill site) within the Beaverlodge Lake watershed.

BL-3 Fulton Bay

Station BL-3 is located in Fulton Bay of Beaverlodge Lake, approximately 100 metres from the Fulton Creek discharge (**Figure 4.3**). Sampling at this station was originally carried out during the operational mining and milling phase in order to monitor the near-field impacts of the operations on Beaverlodge Lake.

Post-decommissioning sampling at this location commenced during the 1998-1999 reporting period, and has continued since that time. Sampling frequency increased from semi-annual to quarterly in 2004 in order to better assess the conditions in Beaverlodge Lake. During the 2018 reporting period, all four scheduled samples were collected.

A historical summary of annual average ^{226}Ra, U, TDS, and Se concentrations at BL-3 are presented in **Figures 4.3.3-1** to **4.3.3-4**. The annual averages from 2014 to 2018 are presented in **Table 4.3.3-1**.

Annual concentrations of U and Se at BL-3 have generally been trending downward; however, remained fairly stable since 2016. The annual average U concentration was 127.5 µg/L in 2016, 128.5 µg/L in 2017, and 129.8 µg/L in 2018. The annual average Se concentration remained constant at 0.0023 mg/L during these three years.

^{226}Ra activity has been variable year to year; however, all measured activity continues to remain below the SEQG value of 0.11 Bq/L.

The long-term trend for annual average concentrations of TDS has remained relatively stable since 2001.

BL-4 Beaverlodge Lake Centre

Station BL-4 is located in the approximate center of the north end of Beaverlodge Lake (**Figure 4.3**). Samples collected at this station are a 3-depth composite. The sampling frequency at BL-4 was increased from semi-annual to quarterly in 2004 in order to better reflect any potential changes or seasonal trends. Following approval of the revised water sampling program, semi-annual sampling was resumed in 2011 at BL-4. Both samples were collected in 2018.

A historical summary of annual average ^{226}Ra, U, TDS, and Se concentrations at BL-4 are presented in **Figures 4.3.3-5** to **4.3.3-8**. The annual averages from 2014 to 2018 are presented in **Table 4.3.3-2**.

The long-term trend for U at BL-4 has shown an overall decreasing trend since decommissioning. The annual average concentration of U at BL-4 was 126 µg/L in 2018, and is consistent with the continued decreasing trend observed for this station. The concentration reported in 2018 also represents the lowest concentration observed at this station to date.

The 2018 annual average ^{226}Ra concentration was 0.025 Bq/L and remains below the SEQG value of 0.11 Bq/L. The annual average has been between 0.02 Bq/L and 0.04 Bq/L consistently since 2003.

Selenium concentrations have fluctuated over the long-term; however, a decreasing trend since 2008 has been observed over the short-term. In 2017 and 2018, the average Se concentration was 0.0024 mg/L, which is the lowest annual average Se concentration measured at this station to date.

The long-term trend for annual average concentrations of TDS has remained relatively stable since 2005.

BL-5 Beaverlodge Lake Outlet

Station BL-5 provides a measure of water quality as it flows out of Beaverlodge Lake (**Figure 4.3)**. This sampling station was implemented in the revised water sampling program in January 2011 in order to provide a point of reference to compare Beaverlodge Lake water quality and downstream Martin Lake water quality. Two of the four scheduled samples for 2018 were collected. No water was available for collection during December and March as the sample location was frozen.

A historical summary of annual average ^{226}Ra, U, TDS, and Se concentrations at BL-5, along with the predicted recovery, are presented in **Figures 4.3.3-9** to **4.3.3-12**. The annual averages from 2014 to 2018 are presented in **Table 4.3.3-3**.

The 2018 annual average concentrations for U and Se were measured at 124.5 µg/L and 0.0022 mg/L, respectively. Both U and Se are within the bounds of the modelled predictions.

Radium^{226} was measured at 0.025 Bq/L in 2018, which is below the corresponding SEQG value of 0.11 Bq/L, as well as below the lower bound of the modelled predictions.

Similar to the other Beaverlodge Lake stations, TDS concentrations at station BL-5 have remained relatively stable at around 150 mg/L since measurements began in 2011.

ML-1 Martin Lake

Station ML-1 is located at the outlet of Martin Lake (**Figure 4.3**) and was implemented in the revised water sampling program in January 2011 to measure water quality downstream of Beaverlodge Lake. All four samples scheduled were collected at ML-1 in 2018.

A table comparing the average concentrations for all measured parameters from 2014 to 2018 is presented in **Table 4.3.3-4**. The data is also presented graphically in **Figures 4.3.3-13** to **4.3.3-16**.

Since monitoring started at ML-1, the U concentrations have ranged from 47.5 µg/L (2016) to 69.3 µg/L (2011). The 2018 average is within the range of values previously observed at this station at 60.75 µg/L.

The 2018 annual average ^{226}Ra concentration of 0.007 Bq/L was below the SEQG.

The observed Se concentrations have shown a relatively stable trend since 2012, with the 2018 annual average at the SEQG concentration of 0.001 mg/L.

The average TDS concentrations have remained stable since sampling started and was 123.75 mg/L for the 2018 reporting year.

CS-1 Crackingstone River

Station CS-1 is located near the bridge in Crackingstone River approximately half way between the outlet of Martin Lake and Lake Athabasca (**Figure 4.3**). Its purpose is to monitor water quality downstream of Uranium City. This station was implemented as part of the water sampling program in January 2011, with the first scheduled sample collected in September 2011. There was one sample collected at CS-1 in 2018, as scheduled.

A table comparing the annual concentrations for all measured parameters from 2014 to 2018 is presented in **Table 4.3.3-5**. The same information is presented graphically in **Figures 4.3.3-17** to **4.3.3-20**.

The U concentration at CS-1 was 62 µg/L in 2018, which is similar to previously measured values over the past five years (Appendix E, Table 4.3.3-5). Both the Se and ^{226}Ra concentrations were below their respective SEQG values; Se with a value of 0.0009 mg/L and ^{226}Ra below the laboratory detection limit of 0.005 Bq/L.

Total dissolved solids concentrations have remained relatively stable, fluctuating between 100 mg/L and 150 mg/L since 2011.

CS-2 Crackingstone Bay

Station CS-2 is located in Crackingstone Bay on Lake Athabasca (**Figure 4.3**), approximately 1 km from the mouth of the Crackingstone River. As with station CS-1, station CS-2 was implemented in 2011. There was one sample collected at CS-2 in 2018, as scheduled.

The measured parameter concentrations are presented in **Table 4.3.3-6**, while a graphical presentation of U, Se, ^{226}Ra, and TDS trends can be found in **Figures 4.3.3-21** to **Figures 4.3.3-24**.

The U concentration at station CS-2 in 2018 was 0.5 µg/L, which is below SEQG value and is consistent with results typically observed at this station. As mentioned in the 2016 annual report, the U concentration reported in 2016 is likely due to sample collection error and is not representative of the water quality at the sample location.

Radium^{226} and Se concentrations remain below their respective SEQG. The ^{226}Ra concentration was below the laboratory detection limit of 0.005 Bq/L. The Se concentration was measured below the detection limit of 0.0001 mg/L. Total dissolved solids concentrations have remained relatively stable since 2012 and were measured at 53.0 mg/L in 2018.

4.4 Additional Water Quality Sampling

4.4.1 ZOR-01 and ZOR-02

Cameco prepared the Beaverlodge Path Forward Report (*Cameco 2012*), which describes the activities required to prepare the Beaverlodge properties for transfer to the IC Program. One of the potential remedial measures identified in the 2012 Path Forward Report was the flow path reconstruction of the Zora Lake outflow. This project was initiated in 2014 and completed in 2016 and involved relocating a portion of the waste rock pile to re-establish Zora Creek flow and reduce the contact between water from Zora Creek and the Bolger waste rock pile before reaching Verna Lake (**Figure 4.4**).

As a result of the implementation of the project to re-establish the Zora Creek flow path, monthly water sampling was implemented in August 2013 to monitor water quality at the discharge from Zora Lake outflow (ZOR-01) and the outlet from the waste rock pile, which flowed into Verna Lake (ZOR-02). As ZOR-01 station is at the outlet of Zora Lake, which is the lake upstream of the new flow path, it represents the baseline for comparing water quality to ZOR-02. Water samples are collected only during open water conditions and where flow is sufficient for sample collection.

In 2018, samples were collected at both stations from May to October. In the remaining months, ice cover or dry conditions prevented sampling at both stations.

The measured parameter concentrations for the current reporting period for ZOR-01 and ZOR-02 are presented in **Table 4.4-1** and **Table 4.4-2**, respectively. A graphical representation of the data is presented in **Figures 4.4-1** to **4.4-8**.

Sampling completed at ZOR-02 prior to 2015 represents water quality as it flowed through the Bolger waste rock pile prior to entering Verna Lake. Sampling completed during 2015 at this station represents construction activities during relocation of the waste rock, and samples from 2016 on represent water flowing through the newly created flow path.

From the beginning of sampling in 2013 to date, ^{226}Ra, U, Se, and TDS concentrations at ZOR-01 have remained relatively stable. Radium^{226} and Se have both remained below their respective SEQG values, while U fluctuates around the SEQG value.

Selenium and TDS at ZOR-02 have also remained relatively stable, with Se remaining below the SEQG value. The U and ^{226}Ra concentrations are above the SEQG and have been variable since sampling began at ZOR-02.

In 2018, the U and ^{226}Ra concentrations at ZOR-02 peaked in June at 461 µg/L and 0.34 Bq/L, respectively. With regard to U, concentrations leaving the new flow path continue to show fluctuating concentrations; however, the range of fluctuation in 2018 appears to be more stable than prior to and during construction. **Figure 4.4-9** shows the results of water sample data collected at ZOR-02 through the various phases of pre-construction, construction and post construction. Also provided are general trend lines showing the relative improvement in water quality post-construction. The fluctuations in U concentrations observed through construction and following construction are reflected in the concentration of U measured at AC-6A, which increased as expected, immediately following construction but has been steadily decreasing since.

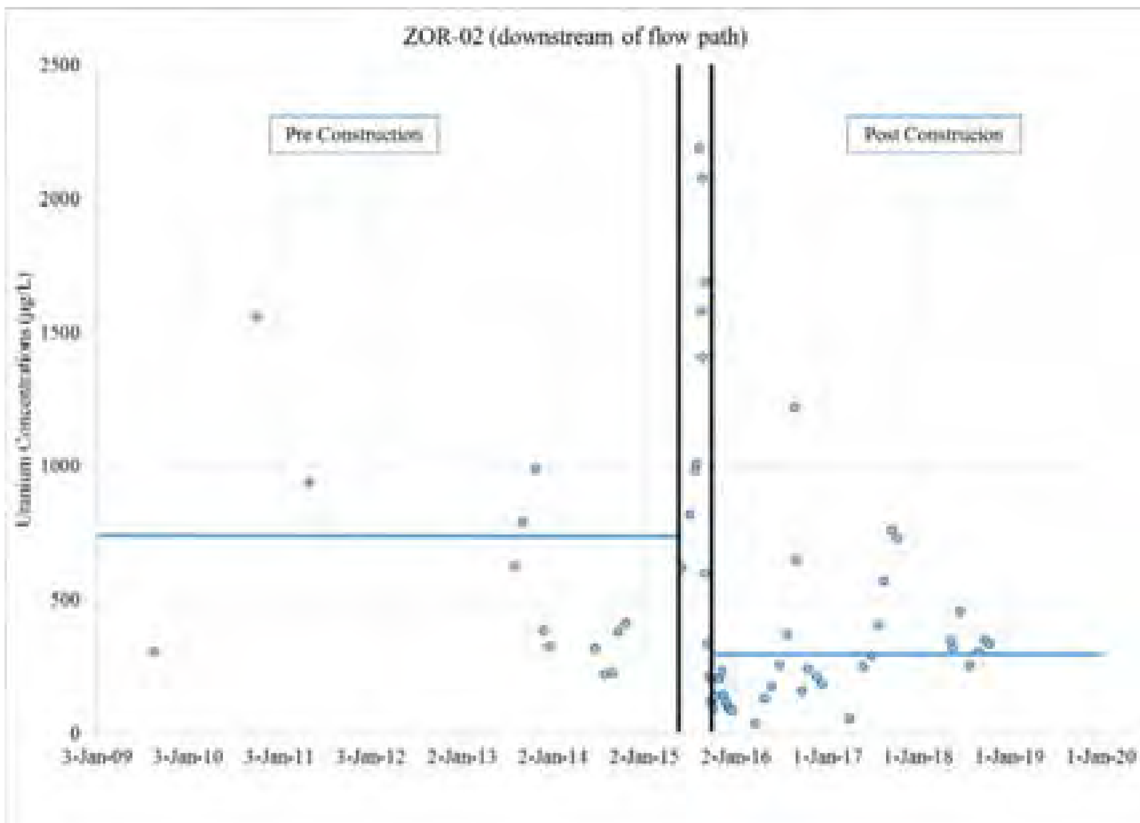

Figure 4.4-9
ZOR-02 Uranium Concentrations Pre and Post Construction

A summary of annual mean U and ^{226}Ra data from 2010 to 2018 at the three stations is presented in **Table 4.4-3**. As AC-6A flows into Ace Lake, data from the outlet of Ace Lake (AC-8) is presented for reference. Of note, the water quality measure in Ace Lake has remained below the provincial water quality guideline values since 2012.

4.4.2 Sealed Boreholes and Seeps

Boreholes have been identified on most Beaverlodge properties and are likely the result of the original exploration and mine development activities. Following decommissioning, the Beaverlodge mine was allowed to flood. As a result, boreholes that intersect or otherwise have made hydraulic connection with the now flooded mine workings have the potential to discharge water. In 2018, areas associated with formerly flowing (now sealed) boreholes were inspected and it was confirmed that boreholes have remained sealed and that no new flows have been identified.

In addition, surface water seeps have been identified at the base of the waste rock pile along Ace Creek, and are associated with the main decommissioned facilities. Seeps 1, 2, and 3 are located at the point at which they emerge from the waste rock pile. The source of Seeps 4 and 5 are undetermined as they exit the waste rock pile and are therefore sampled where they enter Ace Creek. Although not part of the licensed sampling program, water quality samples are collected opportunistically during the spring and fall hydrology monitoring program from these locations.

A summary of average water quality measured at the five seeps is provided in **Table 4.4-4** for five-year periods, which correspond with the EPR constituents of potential concern and time periods. In addition, values measured in 2018 are also included for comparison. As discussed in the EPR, most parameter concentrations have remained relatively consistent since 2004.

4.5 QA/QC Analysis

Cameco’s QA/QC program involves the collection of field and trip blank, blind, and duplicate samples in order to assure that field sampling and laboratory analyses produce reliable and accurate results.

Field blanks are used to identify contamination arising from equipment, preservatives, sampling techniques and handling, and the general ambient conditions during sampling. Field blanks are collected by obtaining analyte-free water from the laboratory, transporting the water into the field, and taking it through all sample collection, handling and processing steps that the primary samples undergo. Field blanks are transported, stored and analyzed in the same manner as primary samples.

Trip blanks are used to determine if any errors are being introduced through transport, storage, sample bottles, preservatives or analysis. Samples of analyte-free water are sent from the laboratory to the field and then back to the laboratory along with primary samples. The trip blank sample seal remains unbroken in the field. Blind replicate samples involve the collection of two homogenous samples of water from a single sampling location, with the water sent to the same analytical laboratory to test the labs ability to duplicate results through their analytical methods. The blind samples are labelled differently, as a result the identity of the field blind replicate sample is known only to the submitter and not to the analyst. Blind samples check the labs ability to provide consistent results and are sent out in May, June, and July.

Duplicate samples involve collection of two homogeneous samples of water from a single sample location that is sent for analysis to two different labs to determine if the labs analyzing the samples obtain similar results. Duplicate samples are sent out in June and December to Saskatchewan Research Council (SRC) and Maxxam Laboratories.

In a case where results from the regular monitoring and results from the blind sample vary, SRC would be contacted to determine the source of inconsistency in the results. If there were discrepancies in the blank or duplicate laboratory results, it would be at the discretion of the Reclamation Coordinator to investigate the discrepancy and determine if corrective action is warranted.

Results with an absolute difference greater than 50% are investigated. Results above the 50% absolute difference that cannot be explained are subject to further investigation. If either value is greater than five times the entered detection limit and are outside their associated range of entered uncertainty (= Value +/- Entered Uncertainty) then samples are considered noncompliant and additional investigation is required.

Blank Samples

Station TL-7 trip and laboratory blank samples were prepared, collected, and analyzed in August 2018. When results from TL-7 TB (trip blank) and TL-7 FB (field blank) were compared, all results were found to be within acceptable range of variation. A new pH/conductivity meter was being used during this sampling period and field pH values were recorded lower than historic values due to difficulties calibrating the equipment.

Blind Replicate Samples (Split samples)

Blind replicate samples were collected in May 2018 at stations AC-14 (Blind-1) and DB-6 (Blind-2). When results from Blind-1 and Blind-2 were compared with sample results for AC-14 and DB-6, respectively, all results were found to be within acceptable range of variation.

In June 2018, samples sent to Maxxam laboratories were lost in transit resulting in all QA/QC sampling for the month of June being moved to July. Stations Blind-6 and Blind-4 were then compared with sample results for TL-7 and TL-9, respectively, and all results were found to be within acceptable range of variation. Routine July blind samples were collected at AC-6A (Blind-3) and TL-6 (Blind-5) to be sent to SRC for analysis as well. All results were found to be within an acceptable range of variation.

Duplicate Samples (Side by side samples)

In December 2017, the scheduled duplicate samples at station TL-9 and TL-7 were not collected due to dry conditions at these stations. Dry conditions at TL-9 continued until the next routine duplicate sampling was scheduled in June. In April 2018, a replacement sample was collected at TL-7. Selenium results for this sample were flagged by Cameco’s QA/QC check, but due to employee turnover and delayed responses from Maxxam laboratories, the sample was disposed of before a re-check was requested. Both TL-9 and TL-7 duplicate samples scheduled for June were lost in transit and as such were re-sampled the following month. All results were found to be within acceptable range of variation between the Maxxam and SRC results.

Duplicate samples for TL-7 and TL-9 were again collected in December 2018. Iron results at TL-7 were flagged by Cameco's QA/QC check and laboratories were subsequently contacted for a re-check. Saskatchewan Research Council informed Cameco that a re-check had been performed and the re-check result confirmed the original result within measurement uncertainty. Maxxam was also contacted for a re-check, but due to delayed communications the sample was not available for re-analysis.

Laboratory QA/QC reports are presented in **Appendix F**.

4.6 Hydrology

4.6.1 Introduction

Water flows are measured year-round in the Ace Creek watershed at the outlet of Ace Lake (station AC-8). This station has a well-defined flow rating curve and is ice-free year round making it an ideal location to estimate regional flows in the Beaverlodge area. In the Fulton Creek watershed, glaciation prevents year-round flow data collection; therefore, estimates of the flow rate during the winter months at station TL-7 are calculated using flow rates from AC-8.

4.6.2 Hydrological Data

Missinipi Water Solutions Inc. was retained by Cameco to complete an assessment of the stage and flow data for stream flow monitoring stations at Fulton Creek (TL-7) and Ace Lake (AC-8) for the period January 1, 2018 to December 31, 2018. The report can be found in **Appendix G.**

At AC-8, all mean monthly flow rates in 2018 were within a historic five year range, with the exception of values recorded between November and April, which were the lowest mean monthly flow rates recorded since 2013. Snowmelt occurred in late April resulting in the highest average flow rate of the year occurring in May at 1.993 m^3/s. The average annual flow rate for 2018 was 0.453 m^3/s.

Flow rates at TL-7 from May to July were higher than the average annual flow (0.0227 m^3/s) with the highest recorded mean monthly flow rate recorded in May (0.11 m^3/s) similar to AC-8. In comparison, flow rates recorded in August to December were below the average annual flow (0.0227 m^3/s) with the lowest recorded mean monthly flow rates recorded in the late fall to early winter months (October to December).

Climate records for Uranium City indicate that 2018 tended to be drier than normal. The flow records, especially later in the year, generally reflected this climate condition.

4.7 Air Quality

This section presents a summary of the results of historic and on-going radon monitoring at 10 separate locations in and around the mill site, various satellite areas and at Uranium City.

4.7.1 Ambient Radon Monitoring

As part of the transitional phase monitoring program, radon levels have been monitored on and around the Beaverlodge mine and mill site and at other locations in the region since 1985. The sampling regime used RadTrak, track-etch type radon gas monitors (Tech/Ops Landauer Inc. Glenwood, Illinois) until 2016, when the model was discontinued. At that time, Landauer (now known as Radonova) informed various Cameco mine site contacts that a new track etch cup model was being introduced. Cameco contacted Landauer customer service on November 25, 2016 and again on December 12, 2016, and they recommended the new Rapidos model if previous monitoring involved legacy Radtrak detectors in outdoor environments. This was contradictory to the recommendation Landauer provided to one of Cameco's other mine sites, which recommended the use the Radtrak2 model. In response, Cameco initiated a comparison study with the goal of determining the best model for Cameco sites. Both Rapidos and the RadTrak2 sampling devices were installed in and around Uranium City in 2017. The study consisted of three stations ranging in historic exposures with four devices at each station (two Rapidos and two RadTrak2s). One set of devices (a Rapidos and a RadTrak2) had an exposure duration of 6 months and the remaining set had an exposure duration of 12 months. Radon measurements were quite comparable, however after 12 months in the field, two of the Rapidos measurements were outside the standard deviations that were applied to a 7-year average of previous Beaverlodge data. The deviations were at the low exposure and high exposure areas. Cameco concluded that the RadTrak2 devices are better suited for long-term monitoring. As such, Cameco installed RadTrak2 devices for the second round of radon sampling that took place in 2018 and will continue to monitor radon with this model.

Monitors are collected and replaced semi-annually from ten stations established throughout the area, illustrated in **Figure 4.7.1-1** and listed below:

- Beacon Hill
- Eldorado Town Site
- End of Airstrip
- Ace Creek
- Fay Waste Rock Pile
- Fookes Delta
- Marie Delta
- Donaldson Lake
- Fredette Lake
- Uranium City

Table 4.7.1 presents a summary of the radon monitoring conducted at the 10 sites for the 2018 monitoring period and compares it to the previous four years, as well as to1982 data. Although the entire suite of stations monitored in 1982 is not applicable for comparison to the current monitoring results, the applicable stations have been included in the summary table and **Figure 4.7.1-2** compares the most recent five years of data to operational levels. Although an increasing trend has been observed since 2014 at Fookes Delta, levels are below those observed in 2013 (not presented). Overall, measured radon levels have remained relatively constant in recent years and are much lower than during operation. The radon levels measured for the background stations display a rapid decrease to background levels as the distance from the former mine and mill site increases. As such, it was recommended in the EPR that the requirement for radon monitoring be removed from the Beaverlodge EMP (*CanNorth 2018*).

SECTION 5.0

OUTLOOK

5.0 OUTLOOK

This section of the report describes those tasks and activities planned for 2019.

5.1 Regular Scheduled Monitoring

Representatives of Cameco continue to implement the Beaverlodge EMP, assessing:

- water
- radon in air
- regional hydrology
- sealed boreholes and seeps

Additional water samples will be collected monthly when water is flowing at the sample locations ZOR-01 and ZOR-02. These sampling locations have been established to create a baseline and to monitor the success of the Zora Creek Reconstruction project through the Bolger Waste Rock Pile. The flow path reconstruction is discussed in more detail in **Section 3.2.3**.

Based on EPR findings (*CanNorth 2018*), it is also anticipated that revisions to the EMP will be proposed in 2019.

5.2 Planned Public Meetings

Cameco has developed a Public Information Program (PIP) for Beaverlodge that describes communication with stakeholders. The PIP formalizes the communication process, ensuring that Cameco's activities or plans at the decommissioned Beaverlodge properties are effectively communicated to the public in a manner that complies with established guidelines. It is based on the PLAN-DO-CHECK-ACT model outlined in internationally recognized management standards.

Each year Cameco hosts a public meeting in Uranium City, typically with the CNSC and SMOE in attendance, to review the results of any activities completed since the previous meeting and to preview the plans for the upcoming year, including any activities or planned studies that are to be completed. This meeting also provides an opportunity for Cameco to engage local residents regarding the plan and schedule for transferring properties to the Province of Saskatchewan's IC program. This engagement opportunity allows residents to provide feedback to Cameco and the JRG regarding potential concerns with the properties and their suitability for transfer to the IC program.

With renewal of the NSEQC Ministerial Order at the end of 2017, Cameco resumed its updates on the Beaverlodge activities to the representatives at least annually. These updates can occur as part of a larger presentation related to all Cameco activities during the NSEQC general meetings or be specific to Beaverlodge, depending on the amount of activity occurring on the site. In 2019, Cameco plans to host the Athabasca representatives of the NSEQC in Uranium City during a public meeting with local residents in Q2. In addition, Cameco plans to invite members of the AJES to attend as community engagement and environmental stewardship representatives for the Athabasca Basin under the Ya'thi Néné collaboration agreement. The public meeting is typically followed by a tour of the properties, focusing on any changes that have occurred since the previous tour.

In addition to the public meeting, Cameco will plan to provide an overview of the IC program and activities occurring at Beaverlodge during a least one AJES meeting in 2019.

5.3 Planned Regulatory Inspections

The JRG conducts an annual inspection of the Beaverlodge properties, often in conjunction with the annual Uranium City public meeting, usually in June or July. The regulatory inspection involves travelling to the Beaverlodge properties and ensuring that site conditions remain safe, stable, and secure. In addition, activities to address previous inspection recommendations are assessed to confirm that the activity or action was completed to the satisfaction of the regulatory agencies. As Cameco continues the process of transferring properties to the Province of Saskatchewan IC Program, inspections will focus on the properties being requested for release.

5.4 2019 Work Plan

Ultimately, the Beaverlodge properties are being managed for acceptance into the provincial IC program, and future works undertaken will support the Beaverlodge Management Framework established to move properties towards this goal.

Cameco has prepared a work-plan and schedule based on the Path Forward, which was presented to the Commission during the 2013 relicensing process. The Path Forward describes the site activities required to address residual human health and ecological risk while demonstrating conditions on the properties are stable and/or improving. The Path Forward has been vetted through the JRG and reviewed with local and regional stakeholders.

As outlined in **Section 2.5,** the remediation activities identified in the path forward work plan for the Beaverlodge properties include:

1. Site wide gamma assessment.
2. Rehabilitate historic mine openings.
3. Decommission identified boreholes.
4. Re-establishment of the Zora Creek flow path.
5. Final inspection and cleanup of properties.

The following section describes the planned activities associated with the work plan as well as some of the additional activities that will be occurring in the upcoming years to prepare the properties for transfer to the IC Program.

5.4.1 Site Wide Gamma Assessment

The site wide gamma scanning program and assessment was completed in 2014 and 2015. As minor reclamation and site cleanup activities are completed as part of preparing the sites for transfer to the IC Program, some areas of waste rock may be disturbed. The disturbed waste rock will be scanned once all work in the area is complete, and the results will be compared to the 2014 site wide surficial gamma survey. Final gamma survey results will be provided to the regulatory agencies once completed and records will be maintained by the Province of Saskatchewan once the property is accepted into the IC program. It is not anticipated that any additional gamma scanning will be required in 2019.

5.4.2 Historic Mine Openings Rehabilitation

Assessment

In 2019, Cameco will be investigating the remaining vertical openings (raises and shafts) in order to develop plans and complete designs for the final remediation of each. The investigation will include an assessment of stainless steel covers and potential backfill options for some openings where backfill may be feasible.

Rehabilitation

Engineering design plans for an additional two stainless steel covers were submitted to SMOE and the Saskatchewan Ministry of Labour Relations and Workplace Safety on December 19, 2018 for their review. Exemption from *The Mines Regulations, 2003* was received from the Saskatchewan Ministry of Labour Relations and Workplace Safety on January 3, 2019. An Approval to Modify a Pollutant Control Facility (PD19-019) was received on January 22, 2019 from SMOE. The covers are currently being fabricated and are planned to be installed in 2019.

5.4.3 Decommission identified boreholes

A master list of all boreholes found on the properties, and their status, is provided in **Appendix D**. If any additional boreholes are located prior to properties being transferred to the IC program they will be sealed and their status recorded in the master list.

5.4.4 Re-establishment of the Zora Creek flow path

Final construction of the Zora Creek flow path was completed in 2016, at which time a geotechnical inspection was completed. A geotechnical inspection was also completed by SRK Consulting in 2017 and again in 2018, to ensure the constructed channel was performing as expected. There were no immediate or significant areas of concern with regards to the geotechnical performance and/or stability of the reconstructed flow path identified. Based on the results of the geotechnical assessments completed in 2017 and 2018, SRK recommended the next inspection be completed in five years (**Appendix C**). Water quality sampling will continue as outlined in **Section 5.1** and monitoring data will be used to determine whether the water quality downstream of the Zora Creek flow path is recovering as expected as a result of the re-establishment of the flow path.

5.4.5 Final Inspection and Clean-up of the Properties

This project was largely completed from 2015 to 2017. However, as individual properties go through final assessment to ensure all performance indicators have been met, minor amounts of debris may be encountered. This debris will be flagged, removed by a local contractor and disposed of in the Lower Ace Pit.

5.4.6 Work in Addition to the Path Forward Activities

Ace Creek Watershed Hydrologic Monitoring

The Ace Creek watershed hydrologic monitoring program is in addition to the routine hydrologic monitoring that occurs at AC-8 and TL-7. This program will continue to monitor the flows originating from the various sub-watersheds feeding Ace Creek. The information from this program is used to support the pathways model predictions for the Ace Creek area.

Site Inspection Follow-Up

SMOE issued an Inspection Report on September 24, 2018. No new action items or recommendations were issued within the report. However, ten "Remediation Items Identified on Inspection to Address Before Release" were referenced from the previous year (*SMOE 2018*).

Most items identified on the inspection report involved debris housekeeping (i.e., pump house removal, timber removal, etc.) on the Beaverlodge properties, which were addressed in 2018. To ensure items have been adequately addressed to the satisfaction of the Ministry, follow-up inspections are planned for 2019.

SECTION 6.0

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6.0 REFERENCES

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TABLES

TABLES

Table 4.3.1-1 AN-5 Summary Statistics and Comparison to Historical Results

		Previous Period Averages				Year 2018 Statistics					
		2014	2015	2016	2017	Avg	Count	Count < DL	StDev	Min	Max
M Ions	Alk (mg/l)	102.8	132.2	92.0	109.4	103.4	5	0	38.7	51.0	155.0
	Ca (mg/l)	29.8	38.8	28.0	32.2	30.8	5	0	9.4	17.0	40.0
	Cl (mg/l)	0.70	1.28	0.60	0.74	0.82	5	0	0.41	0.40	1.30
	CO3 (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	5	5	0.0	1.0	1.0
	Cond-L (µS/cm)	216	284	202	226	204	5	0	56	118	266
	Hardness (mg/l)	103	136	96	111	107	5	0	34	58	141
	HCO3 (mg/l)	125.5	161.0	112.2	133.6	126.0	5	0	47.3	62.0	189.0
	K (mg/l)	1.2	1.3	1.1	1.1	1.3	5	0	0.5	0.8	1.8
	Na (mg/l)	3.4	4.8	3.0	3.7	3.7	5	0	1.5	1.9	5.6
	OH (mg/l)	1.0	1.0	1.0	1.0	1.0	5	5	0.0	1.0	1.0
	SO4 (mg/l)	14.8	18.3	14.4	12.5	13.6	5	0	3.0	10.0	18.0
	Sum of Ions (mg/l)	182	235	166	192	184	5	0	63	98	263
Metal	As (µg/l)	0.4	0.4	0.3	0.4	0.3	5	0	0.1	0.2	0.4
	Ba (mg/l)	0.121	0.149	0.111	0.136	0.124	5	0	0.041	0.068	0.180
	Cu (mg/l)	0.0010	0.0006	0.0012	0.0004	0.0007	5	0	0.0005	0.0004	0.0016
	Fe (mg/l)	0.210	0.327	0.209	0.322	0.208	5	0	0.182	0.062	0.520
	Mo (mg/l)	0.0026	0.0030	0.0027	0.0028	0.0032	5	0	0.0010	0.0019	0.0042
	Ni (mg/l)	0.00068	0.00050	0.00070	0.00058	0.00048	5	0	0.00016	0.00030	0.00070
	Pb (mg/l)	0.0004	0.0003	0.0002	0.0002	0.0001	5	3	0.0001	0.0001	0.0002
	Se (mg/l)	0.0001	0.0001	0.0001	0.0001	0.0001	5	4	0.0000	0.0001	0.0001
	U (µg/l)	119.000	174.667	130.400	168.400	163.200	5	0	132.122	47.000	343.000
	Zn (mg/l)	0.003	0.001	0.001	0.001	0.001	5	3	0.000	0.001	0.001
Nutrient	C-(org) (mg/l)	8.200	11.000	11.000	8.500	8.200	1	0		8.200	8.200
	NH3-N (mg/l)	0.05	0.21	0.05	0.05	0.04	1	0		0.04	0.04
	NO3 (mg/l)	0.040	0.050	0.113	0.090	0.092	5	3	0.073	0.040	0.190
Phys Para	pH-L (pH Unit)	7.65	7.59	7.64	7.74	7.80	5	0	0.16	7.68	8.04
	TDS (mg/l)	143.00	184.67	133.80	150.80	148.00	5	0	42.01	95.00	201.00
	Temp-H20 (°C)	11.7	6.1	9.2	9.3	7.2	5	0	5.9	0.2	16.1
	TSS (mg/l)	1.250	2.000	1.400	1.000	1.000	5	4	0.000	1.000	1.000
Rads	Pb210 (Bq/L)	0.06	0.09	0.03	0.05	0.22	1	0		0.22	0.22
	Po210 (Bq/L)	0.010	0.070	0.020	0.010	0.008	1	0		0.008	0.008
	Ra226 (Bq/L)	0.655	1.070	0.686	0.798	0.646	5	0	0.267	0.350	1.000

Table 4.3.1-2 DB-6 Summary Statistics and Comparison to Historical Results

		Previous Period Averages				Year 2018 Statistics					
		2014	2015	2016	2017	Avg	Count	Count < DL	StDev	Min	Max
M Ions	Alk (mg/l)	92.0	89.8	90.0	87.8	85.5	4	0	7.2	79.0	94.0
	Ca (mg/l)	36.2	34.8	34.5	32.5	34.0	4	0	4.4	29.0	39.0
	Cl (mg/l)	0.64	0.70	0.62	0.58	0.63	4	0	0.10	0.50	0.70
	CO3 (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	4	4	0.0	1.0	1.0
	Cond-L (µS/cm)	228	226	222	207	204	4	0	21	183	234
	Hardness (mg/l)	113	108	107	101	106	4	0	14	90	122
	HCO3 (mg/l)	112.4	109.5	109.7	107.0	104.3	4	0	8.9	96.0	115.0
	K (mg/l)	0.7	0.6	0.8	0.7	0.9	4	0	0.2	0.8	1.1
	Na (mg/l)	2.0	2.0	2.0	1.9	2.0	4	0	0.2	1.8	2.3
	OH (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	4	4	0.0	1.0	1.0
	SO4 (mg/l)	24.4	24.0	22.8	22.3	21.0	4	0	2.8	19.0	25.0
	Sum of Ions (mg/l)	182	177	176	170	168	4	0	17	154	189
Metal	As (µg/l)	0.2	0.1	0.1	0.1	0.1	4	0	0.0	0.1	0.1
	Ba (mg/l)	0.047	0.047	0.045	0.042	0.044	4	0	0.006	0.038	0.051
	Cu (mg/l)	0.0013	0.0005	0.0008	0.0005	0.0007	4	0	0.0002	0.0006	0.0009
	Fe (mg/l)	0.024	0.014	0.018	0.013	0.047	4	0	0.026	0.016	0.080
	Mo (mg/l)	0.0019	0.0021	0.0020	0.0021	0.0021	4	0	0.0002	0.0019	0.0022
	Ni (mg/l)	0.00026	0.00020	0.00023	0.00018	0.00020	4	0	0.00000	0.00020	0.00020
	Pb (mg/l)	0.0001	0.0001	0.0001	0.0001	0.0001	4	4	0.0000	0.0001	0.0001
	Se (mg/l)	0.0001	0.0001	0.0001	0.0001	0.0001	4	2	0.0000	0.0001	0.0001
	U (µg/l)	169.000	192.750	159.000	153.750	193.500	4	0	64.686	128.000	253.000
	Zn (mg/l)	0.002	0.001	0.001	0.001	0.001	4	3	0.000	0.001	0.001
Nutrient	C-(org) (mg/l)	9.100	8.800	8.650	8.200	8.600	1	0		8.600	8.600
	NH3-N (mg/l)	0.05	0.04	0.05	0.05	0.05	1	0		0.05	0.05
	NO3 (mg/l)	0.310	0.210	0.185	0.073	0.065	4	3	0.050	0.040	0.140
Phys Para	pH-L (pH Unit)	7.75	7.78	7.82	7.87	7.94	4	0	0.08	7.87	8.06
	TDS (mg/l)	154.40	154.50	146.50	144.25	146.50	4	0	13.82	132.00	165.00
	Temp-H20 (°C)	10.3	10.5	8.4	13.1	8.6	4	0	5.5	3.8	16.6
	TSS (mg/l)	1.000	1.000	1.000	1.250	1.000	4	4	0.000	1.000	1.000
Rads	Pb210 (Bq/L)	0.07	0.02	0.08	0.26	0.24	1	0		0.24	0.24
	Po210 (Bq/L)	0.009	0.008	0.006	0.008	0.005	1	1		0.005	0.005
	Ra226 (Bq/L)	0.038	0.038	0.040	0.033	0.040	4	0	0.014	0.030	0.060

Table 4.3.1-3 AC-6A Summary Statistics and Comparison to Historical Results

		Previous Period Averages				Year 2018 Statistics					
		2014	2015	2016	2017	Avg	Count	Count < DL	StDev	Min	Max
M Ions	Alk (mg/l)	102.5	105.2	107.7	103.2	95.0	4	0	3.6	92.0	100.0
	Ca (mg/l)	43.5	44.7	44.4	41.2	40.0	4	0	0.8	39.0	41.0
	Cl (mg/l)	0.45	0.81	0.65	0.55	0.48	4	0	0.10	0.40	0.60
	CO3 (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	4	4	0.0	1.0	1.0
	Cond-L (µS/cm)	285	306	302	287	264	4	0	11	250	277
	Hardness (mg/l)	144	151	151	140	137	4	0	3	132	140
	HCO3 (mg/l)	125.0	128.3	131.4	126.0	115.8	4	0	4.5	112.0	122.0
	K (mg/l)	0.8	0.9	1.0	0.8	0.9	4	0	0.1	0.8	0.9
	Na (mg/l)	2.3	2.5	2.5	2.3	2.3	4	0	0.1	2.2	2.4
	OH (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	4	4	0.0	1.0	1.0
	SO4 (mg/l)	45.5	52.9	50.5	46.2	47.0	4	0	1.4	45.0	48.0
	Sum of Ions (mg/l)	226	240	239	226	215	4	0	6	212	224
Metal	As (µg/l)	0.3	0.2	0.2	0.2	0.2	4	0	0.0	0.2	0.2
	Ba (mg/l)	0.024	0.021	0.023	0.023	0.021	4	0	0.001	0.020	0.022
	Cu (mg/l)	0.0003	0.0003	0.0003	0.0009	0.0005	4	0	0.0001	0.0003	0.0006
	Fe (mg/l)	0.036	0.011	0.009	0.012	0.012	4	0	0.005	0.008	0.019
	Mo (mg/l)	0.0008	0.0010	0.0011	0.0012	0.0010	4	0	0.0001	0.0009	0.0011
	Ni (mg/l)	0.00015	0.00010	0.00011	0.00013	0.00010	4	2	0.00000	0.00010	0.00010
	Pb (mg/l)	0.0001	0.0001	0.0001	0.0002	0.0001	4	4	0.0000	0.0001	0.0001
	Se (mg/l)	0.0002	0.0002	0.0002	0.0002	0.0002	4	0	0.0001	0.0001	0.0002
	U (µg/l)	154.000	389.278	331.000	279.333	278.500	4	0	30.260	242.000	312.000
	Zn (mg/l)	0.001	0.001	0.001	0.001	0.001	4	4	0.000	0.001	0.001
Nutrient	C-(org) (mg/l)		7.300	7.100				0			
	NH3-N (mg/l)		0.04	0.04				0			
	NO3 (mg/l)	0.040	0.046	0.062	0.130	0.043	4	3	0.005	0.040	0.050
Phys Para	pH-L (pH Unit)	7.70	7.80	7.88	7.88	7.96	4	0	0.05	7.91	8.03
	TDS (mg/l)	196.50	198.61	195.80	181.67	197.00	4	0	22.64	179.00	230.00
	Temp-H20 (°C)	22.1	6.6	9.3	12.8	14.4	4	0	4.3	8.6	18.0
	TSS (mg/l)	1.000	1.000	1.000	1.667	1.250	4	3	0.500	1.000	2.000
Rads	Pb210 (Bq/L)		0.03	0.02				0			
	Po210 (Bq/L)		0.005	0.005				0			
	Ra226 (Bq/L)	0.150	0.109	0.108	0.115	0.100	4	0	0.016	0.080	0.120

Table 4.3.1-4 AC-8 Summary Statistics and Comparison to Historical Results

		Previous Period Averages				Year 2018 Statistics					
		2014	2015	2016	2017	Avg	Count	Count < DL	StDev	Min	Max
M Ions	Alk (mg/l)	52.5	53.0	52.0	54.5	52.0	2	0	5.7	48.0	56.0
	Ca (mg/l)	16.5	17.0	17.0	16.5	17.0	2	0	1.4	16.0	18.0
	Cl (mg/l)	0.90	0.95	0.80	0.85	0.90	2	0	0.14	0.80	1.00
	CO3 (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	2	2	0.0	1.0	1.0
	Cond-L (µS/cm)	119	121	122	117	112	2	0	15	101	122
	Hardness (mg/l)	55	55	56	55	56	2	0	4	53	59
	HCO3 (mg/l)	64.0	64.5	63.5	66.5	63.0	2	0	7.1	58.0	68.0
	K (mg/l)	0.8	0.6	0.6	0.8	0.8	2	0	0.1	0.7	0.9
	Na (mg/l)	1.5	1.5	1.5	1.5	1.6	2	0	0.1	1.5	1.6
	OH (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	2	2	0.0	1.0	1.0
	SO4 (mg/l)	6.9	7.0	7.4	6.9	6.6	2	0	0.6	6.2	7.0
	Sum of Ions (mg/l)	94	94	95	96	93	2	0	10	86	100
Metal	As (µg/l)	0.2	0.2	0.2	0.2	0.2	2	0	0.1	0.1	0.2
	Ba (mg/l)	0.024	0.024	0.023	0.022	0.023	2	0	0.001	0.022	0.024
	Cu (mg/l)	0.0005	0.0008	0.0003	0.0003	0.0005	2	0	0.0001	0.0004	0.0005
	Fe (mg/l)	0.033	0.041	0.040	0.026	0.032	2	0	0.014	0.022	0.042
	Mo (mg/l)	0.0009	0.0010	0.0011	0.0011	0.0010	2	0	0.0000	0.0010	0.0010
	Ni (mg/l)	0.00015	0.00020	0.00015	0.00015	0.00015	2	0	0.00007	0.00010	0.00020
	Pb (mg/l)	0.0001	0.0003	0.0001	0.0001	0.0001	2	2	0.0000	0.0001	0.0001
	Se (mg/l)	0.0001	0.0001	0.0001	0.0001	0.0001	2	2	0.0000	0.0001	0.0001
	U (µg/l)	11.500	13.500	14.500	12.500	12.500	2	0	0.707	12.000	13.000
	Zn (mg/l)	0.001	0.003	0.001	0.001	0.001	2	2	0.000	0.001	0.001
Nutrient	C-(org) (mg/l)	6.800	7.000	7.400	6.900	7.000	1	0		7.000	7.000
	NH3-N (mg/l)	0.04	0.06	0.08	0.08	0.08	1	0		0.08	0.08
	NO3 (mg/l)	0.040	0.040	0.050	0.210	0.200	2	1	0.226	0.040	0.360
Phys Para	pH-L (pH Unit)	7.54	7.52	7.62	7.53	7.67	2	0	0.04	7.64	7.70
	TDS (mg/l)	86.00	80.50	85.50	85.50	86.50	2	0	0.71	86.00	87.00
	Temp-H20 (°C)	5.2	0.9	7.2	7.9	4.0	2	0	5.1	0.4	7.6
	TSS (mg/l)	1.000	2.000	1.000	1.000	1.000	2	2	0.000	1.000	1.000
Rads	Pb210 (Bq/L)	0.02	0.02	0.02	0.03	0.02	1	1		0.02	0.02
	Po210 (Bq/L)	0.005	0.006	0.006	0.005	0.006	1	0		0.006	0.006
	Ra226 (Bq/L)	0.020	0.030	0.015	0.025	0.020	2	0	0.000	0.020	0.020

Table 4.3.1-5 AC-14 Summary Statistics and Comparison to Historical Results

		Previous Period Averages				Year 2018 Statistics					
		2014	2015	2016	2017	Avg	Count	Count < DL	StDev	Min	Max
M Ions	Alk (mg/l)	52.3	53.6	53.3	52.6	51.8	12	0	4.1	45.0	58.0
	Ca (mg/l)	17.2	17.5	17.4	17.3	17.4	12	0	1.8	15.0	21.0
	Cl (mg/l)	1.19	1.25	0.99	1.16	1.53	12	0	1.11	0.90	5.00
	CO3 (mg/l)	1.0	1.0	1.0	1.1	1.0	12	12	0.0	1.0	1.0
	Cond-L (µS/cm)	124	126	124	123	121	12	0	18	97	171
	Hardness (mg/l)	57	58	57	57	57	12	0	6	49	69
	HCO3 (mg/l)	63.8	65.4	64.9	63.6	63.3	12	0	4.9	55.0	71.0
	K (mg/l)	0.7	0.6	0.8	0.7	0.9	12	0	0.1	0.7	1.1
	Na (mg/l)	1.9	1.9	1.8	2.0	2.2	12	0	1.0	1.5	5.4
	OH (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	12	12	0.0	1.0	1.0
	SO4 (mg/l)	8.5	8.6	8.9	9.2	9.3	12	0	4.5	5.7	23.0
	Sum of Ions (mg/l)	97	99	97	98	98	12	0	11	83	125
Metal	As (µg/l)	0.2	0.2	0.2	0.2	0.1	12	0	0.1	0.1	0.2
	Ba (mg/l)	0.025	0.026	0.024	0.024	0.024	12	0	0.002	0.020	0.027
	Cu (mg/l)	0.0010	0.0006	0.0004	0.0004	0.0006	12	0	0.0001	0.0005	0.0008
	Fe (mg/l)	0.082	0.062	0.058	0.066	0.051	12	0	0.009	0.042	0.066
	Mo (mg/l)	0.0010	0.0010	0.0012	0.0011	0.0010	12	0	0.0001	0.0009	0.0011
	Ni (mg/l)	0.00026	0.00020	0.00019	0.00018	0.00020	12	0	0.00000	0.00020	0.00020
	Pb (mg/l)	0.0006	0.0004	0.0002	0.0002	0.0003	12	0	0.0001	0.0001	0.0004
	Se (mg/l)	0.0001	0.0002	0.0001	0.0001	0.0002	12	2	0.0003	0.0001	0.0013
	U (µg/l)	28.000	33.091	28.727	33.500	35.833	12	0	27.242	20.000	118.000
	Zn (mg/l)	0.003	0.001	0.001	0.001	0.001	12	11	0.000	0.001	0.001
Nutrient	C-(org) (mg/l)	7.800	7.067	7.500	7.250	7.125	4	0	0.411	6.600	7.500
	NH3-N (mg/l)	0.07	0.07	0.08	0.10	0.12	4	0	0.01	0.11	0.13
	NO3 (mg/l)	0.174	0.237	0.157	0.155	0.126	12	5	0.117	0.040	0.340
Phys Para	pH-L (pH Unit)	7.73	7.71	7.65	7.75	7.86	12	0	0.06	7.75	7.94
	TDS (mg/l)	81.00	83.82	90.36	85.00	86.33	12	0	12.33	66.00	111.00
	Temp-H20 (°C)	7.3	1.1	8.8	8.5	7.6	12	0	8.2	0.1	20.3
	TSS (mg/l)	1.250	1.364	1.000	1.100	1.417	12	9	1.443	1.000	6.000
Rads	Pb210 (Bq/L)	0.03	0.02	0.03	0.03	0.02	4	3	0.01	0.02	0.03
	Po210 (Bq/L)	0.012	0.008	0.007	0.007	0.008	4	0	0.002	0.005	0.010
	Ra226 (Bq/L)	0.057	0.075	0.038	0.047	0.050	12	0	0.014	0.030	0.070

Table 4.3.2-1 AN-3 Summary Statistics and Comparison to Historical Results

		Previous Period Averages				Year 2018 Statistics					
		2014	2015	2016	2017	Avg	Count	Count < DL	StDev	Min	Max
M Ions	Alk (mg/l)	76.0	70.0	66.0	68.0	70.0	1	0		70.0	70.0
	Ca (mg/l)	20.0	20.0	21.0	19.0	21.0	1	0		21.0	21.0
	Cl (mg/l)	0.60	0.60	0.60	0.60	0.60	1	0		0.60	0.60
	CO3 (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	1	1		1.0	1.0
	Cond-L (µS/cm)	145	146	145	136	135	1	0		135	135
	Hardness (mg/l)	70	69	72	66	72	1	0		72	72
	HCO3 (mg/l)	93.0	85.0	80.0	83.0	85.0	1	0		85.0	85.0
	K (mg/l)	0.6	0.6	0.8	0.8	0.8	1	0		0.8	0.8
	Na (mg/l)	1.9	1.8	1.9	1.8	2.0	1	0		2.0	2.0
	OH (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	1	1		1.0	1.0
	SO4 (mg/l)	4.3	4.2	4.4	4.2	4.4	1	0		4.4	4.4
	Sum of Ions (mg/l)	125	117	114	114	119	1	0		119	119
Metal	As (µg/l)	0.1	0.1	0.1	0.1	0.1	1	1		0.1	0.1
	Ba (mg/l)	0.017	0.016	0.018	0.016	0.017	1	0		0.017	0.017
	Cu (mg/l)	0.0005	0.0002	0.0005	0.0003	0.0006	1	0		0.0006	0.0006
	Fe (mg/l)	0.010	0.008	0.010	0.011	0.015	1	0		0.015	0.015
	Mo (mg/l)	0.0015	0.0017	0.0019	0.0017	0.0018	1	0		0.0018	0.0018
	Ni (mg/l)	0.00020	0.00020	0.00010	0.00010	0.00020	1	0		0.00020	0.00020
	Pb (mg/l)	0.0001	0.0001	0.0001	0.0001	0.0001	1	1		0.0001	0.0001
	Se (mg/l)	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	1	1		0.0001	0.0001
	U (µg/l)	1.400	1.700	1.700	1.700	1.800	1	0		1.800	1.800
	Zn (mg/l)	0.001	0.001	0.001	0.001	0.001	1	1		0.001	0.001
Nutrient	C-(org) (mg/l)	7.500	7.500	7.600	7.700	7.900	1	0		7.900	7.900
	NH3-N (mg/l)	0.06	0.08	0.06	0.07	0.10	1	0		0.10	0.10
	NO3 (mg/l)	0.040	0.040	0.050	0.040	0.040	1	1		0.040	0.040
Phys Para	pH-L (pH Unit)	7.77	7.86	7.66	7.58	7.89	1	0		7.89	7.89
	TDS (mg/l)	97.00	93.00	92.00	99.00	109.00	1	0		109.00	109.00
	Temp-H20 (°C)	10.1	11.4	12.5	14.2	9.5	1	0		9.5	9.5
	TSS (mg/l)	1.000	2.000	1.000	1.000	2.000	1	0		2.000	2.000
Rads	Pb210 (Bq/L)	<0.02	<0.02	<0.02	<0.02	<0.02	1	1		0.02	0.02
	Po210 (Bq/L)	<0.005	<0.005	<0.005	<0.005	<0.005	1	1		0.005	0.005
	Ra226 (Bq/L)	0.005	0.008	0.007	0.006	0.005	1	1		0.005	0.005

Table 4.3.2-2 TL-3 Summary Statistics and Comparison to Historical Results

		Previous Period Averages				Year 2018 Statistics					
		2014	2015	2016	2017	Avg	Count	Count < DL	StDev	Min	Max
M Ions	Alk (mg/l)	137.3	138.0	132.8	126.7	126.0	3	0	15.5	111.0	142.0
	Ca (mg/l)	27.5	29.0	29.0	28.0	28.7	3	0	3.1	26.0	32.0
	Cl (mg/l)	3.25	3.25	2.68	2.37	2.60	3	0	0.36	2.30	3.00
	CO3 (mg/l)	1.0	1.0	1.0	1.0	1.0	3	3	0.0	1.0	1.0
	Cond-L (µS/cm)	331	329	309	291	287	3	0	41	243	325
	Hardness (mg/l)	91	97	97	93	94	3	0	9	86	104
	HCO3 (mg/l)	167.5	167.8	162.0	154.3	153.3	3	0	19.0	135.0	173.0
	K (mg/l)	1.0	1.1	1.2	1.1	1.2	3	0	0.1	1.1	1.3
	Na (mg/l)	36.3	33.0	29.3	27.0	29.7	3	0	3.1	27.0	33.0
	OH (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	3	3	0.0	1.0	1.0
	SO4 (mg/l)	34.8	32.0	29.8	25.7	27.3	3	0	2.3	26.0	30.0
	Sum of Ions (mg/l)	276	272	260	244	248	3	0	28	223	278
Metal	As (µg/l)	0.9	0.8	0.8	0.7	0.8	3	0	0.1	0.7	0.8
	Ba (mg/l)	0.036	0.037	0.037	0.037	0.039	3	0	0.003	0.036	0.042
	Cu (mg/l)	0.0010	0.0009	0.0013	0.0009	0.0011	3	0	0.0002	0.0010	0.0013
	Fe (mg/l)	0.012	0.011	0.016	0.016	0.016	3	0	0.003	0.013	0.019
	Mo (mg/l)	0.0143	0.0127	0.0119	0.0109	0.0117	3	0	0.0015	0.0100	0.0130
	Ni (mg/l)	0.00030	0.00033	0.00030	0.00027	0.00033	3	0	0.00006	0.00030	0.00040
	Pb (mg/l)	0.0005	0.0004	0.0006	0.0006	0.0008	3	0	0.0003	0.0005	0.0010
	Se (mg/l)	0.0032	0.0027	0.0023	0.0021	0.0023	3	0	0.0003	0.0020	0.0026
	U (µg/l)	316.750	271.750	248.000	222.333	243.000	3	0	25.942	222.000	272.000
	Zn (mg/l)	0.001	0.001	0.002	0.001	0.001	3	2	0.000	0.001	0.001
Nutrient	C-(org) (mg/l)	7.300	7.300	7.200	7.600	7.500	1	0		7.500	7.500
	NH3-N (mg/l)	0.05	0.06	0.03	0.05	0.06	1	0		0.06	0.06
	NO3 (mg/l)	0.040	0.040	0.045	0.107	0.040	3	3	0.000	0.040	0.040
Phys Para	pH-L (pH Unit)	8.05	8.06	8.05	8.01	8.23	3	0	0.05	8.18	8.26
	TDS (mg/l)	207.75	204.75	198.50	189.67	202.67	3	0	13.87	191.00	218.00
	Temp-H20 (°C)	8.2	8.9	9.6	11.0	10.9	3	0	7.9	4.5	19.7
	TSS (mg/l)	1.000	1.500	1.000	1.667	1.000	3	3	0.000	1.000	1.000
Rads	Pb210 (Bq/L)	0.07	0.10	0.09	0.46	0.10	1	0		0.10	0.10
	Po210 (Bq/L)	0.040	0.040	0.030	0.050	0.060	1	0		0.060	0.060
	Ra226 (Bq/L)	1.200	1.375	1.170	1.267	1.433	3	0	0.231	1.300	1.700

Table 4.3.2-3 TL-4 Summary Statistics and Comparison to Historical Results

		Previous Period Averages				Year 2018 Statistics					
		2014	2015	2016	2017	Avg	Count	Count < DL	StDev	Min	Max
M Ions	Alk (mg/l)	141.5	135.8	127.5	126.0	121.0	3	0	10.4	114.0	133.0
	Ca (mg/l)	24.0	21.8	23.5	25.0	23.0	3	0	1.7	22.0	25.0
	Cl (mg/l)	3.45	3.10	2.73	2.45	2.50	3	0	0.17	2.40	2.70
	CO3 (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	3	3	0.0	1.0	1.0
	Cond-L (µS/cm)	333	321	306	303	271	3	0	25	248	297
	Hardness (mg/l)	83	77	82	85	80	3	0	6	76	87
	HCO3 (mg/l)	172.5	165.8	155.5	154.0	147.7	3	0	12.5	139.0	162.0
	K (mg/l)	1.1	1.2	1.2	1.0	1.3	3	0	0.2	1.1	1.4
	Na (mg/l)	40.5	39.3	34.5	33.5	31.3	3	0	2.5	29.0	34.0
	OH (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	3	3	0.0	1.0	1.0
	SO4 (mg/l)	32.0	29.5	29.0	27.5	23.0	3	0	1.7	22.0	25.0
	Sum of Ions (mg/l)	280	266	252	250	234	3	0	19	221	256
Metal	As (µg/l)	1.4	1.5	1.1	1.0	0.9	3	0	0.1	0.8	1.0
	Ba (mg/l)	0.073	0.081	0.071	0.072	0.076	3	0	0.005	0.071	0.081
	Cu (mg/l)	0.0007	0.0007	0.0006	0.0007	0.0005	3	0	0.0001	0.0004	0.0006
	Fe (mg/l)	0.024	0.058	0.060	0.069	0.048	3	0	0.003	0.045	0.050
	Mo (mg/l)	0.0110	0.0102	0.0101	0.0105	0.0081	3	0	0.0004	0.0076	0.0084
	Ni (mg/l)	0.00055	0.00058	0.00050	0.00050	0.00047	3	0	0.00006	0.00040	0.00050
	Pb (mg/l)	0.0003	0.0003	0.0005	0.0003	0.0002	3	0	0.0000	0.0002	0.0002
	Se (mg/l)	0.0021	0.0017	0.0017	0.0018	0.0013	3	0	0.0001	0.0012	0.0014
	U (µg/l)	280.250	241.000	235.250	224.500	187.333	3	0	14.189	172.000	200.000
	Zn (mg/l)	0.001	0.001	0.001	0.001	0.001	3	3	0.000	0.001	0.001
Nutrient	C-(org) (mg/l)	8.300	9.200	8.000		9.000	1	0		9.000	9.000
	NH3-N (mg/l)	0.06	0.08	0.06		0.09	1	0		0.09	0.09
	NO3 (mg/l)	0.040	0.040	0.045	0.140	0.043	3	2	0.006	0.040	0.050
Phys Para	pH-L (pH Unit)	8.05	8.03	8.05	7.96	8.10	3	0	0.03	8.07	8.12
	TDS (mg/l)	208.50	202.25	197.50	191.50	181.33	3	0	13.05	169.00	195.00
	Temp-H20 (°C)	8.2	8.3	9.3	8.4	10.8	3	0	7.7	4.4	19.3
	TSS (mg/l)	1.250	1.250	1.000	2.500	1.333	3	1	0.577	1.000	2.000
Rads	Pb210 (Bq/L)	0.08	0.04	0.03		0.10	1	0		0.10	0.10
	Po210 (Bq/L)	0.020	0.030	0.030		0.020	1	0		0.020	0.020
	Ra226 (Bq/L)	1.775	2.075	1.600	1.650	1.733	3	0	0.451	1.300	2.200

Table 4.3.2-4 TL-6 Summary Statistics and Comparison to Historical Results

		Previous Period Averages				Year 2018 Statistics					
		2014	2015	2016	2017	Avg	Count	Count < DL	StDev	Min	Max
M Ions	Alk (mg/l)	310.0	281.3	260.0	226.3	228.0	2	0	4.2	225.0	231.0
	Ca (mg/l)	46.5	42.7	60.5	47.7	41.0	2	0	2.8	39.0	43.0
	Cl (mg/l)	49.50	47.67	31.50	24.67	31.00	2	0	5.66	27.00	35.00
	CO3 (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	2	2	0.0	1.0	1.0
	Cond-L (µS/cm)	838	743	728	542	558	2	0	14	548	568
	Hardness (mg/l)	167	156	207	158	144	2	0	11	136	152
	HCO3 (mg/l)	378.0	343.0	317.0	276.0	278.0	2	0	5.7	274.0	282.0
	K (mg/l)	2.6	2.3	2.1	1.4	2.1	2	0	0.4	1.8	2.4
	Na (mg/l)	129.0	105.0	87.5	60.0	72.0	2	0	2.8	70.0	74.0
	OH (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	2	2	0.0	1.0	1.0
	SO4 (mg/l)	74.5	45.0	72.0	34.7	33.0	2	0	9.9	26.0	40.0
	Sum of Ions (mg/l)	693	598	584	454	468	2	0	9	461	474
Metal	As (µg/l)	4.4	4.0	1.4	1.9	2.5	2	0	1.5	1.4	3.5
	Ba (mg/l)	1.145	0.893	0.940	0.867	0.955	2	0	0.247	0.780	1.130
	Cu (mg/l)	0.0009	0.0003	0.0007	0.0003	0.0007	2	0	0.0006	0.0003	0.0011
	Fe (mg/l)	3.530	4.887	0.560	2.247	2.945	2	0	3.613	0.390	5.500
	Mo (mg/l)	0.0019	0.0010	0.0020	0.0010	0.0014	2	0	0.0015	0.0003	0.0024
	Ni (mg/l)	0.00055	0.00043	0.00045	0.00033	0.00040	2	0	0.00014	0.00030	0.00050
	Pb (mg/l)	0.0011	0.0002	0.0003	0.0003	0.0004	2	0	0.0004	0.0001	0.0007
	Se (mg/l)	0.0033	0.0019	0.0021	0.0018	0.0026	2	0	0.0014	0.0016	0.0036
	U (µg/l)	284.500	143.667	288.500	161.667	171.500	2	0	200.111	30.000	313.000
	Zn (mg/l)	0.002	0.001	0.001	0.001	0.001	2	0	0.000	0.001	0.001
Nutrient	C-(org) (mg/l)	34.000	32.000	30.500	30.500	55.000	1	0		55.000	55.000
	NH3-N (mg/l)	0.11	0.16	0.10	0.26			0			
	NO3 (mg/l)	0.090	0.130	0.070	0.053	0.040	2	2	0.000	0.040	0.040
Phys Para	pH-L (pH Unit)	8.00	7.80	8.00	7.81	7.89	2	0	0.23	7.73	8.05
	TDS (mg/l)	596.50	501.67	472.00	373.33	408.00	2	0	1.41	407.00	409.00
	Temp-H20 (°C)	16.5	8.6	10.5	14.6	12.1	2	0	2.1	10.6	13.6
	TSS (mg/l)	6.500	7.667	1.500	4.000	3.500	2	0	2.121	2.000	5.000
Rads	Pb210 (Bq/L)	0.14	0.08	0.07	0.06	0.37	1	0		0.37	0.37
	Po210 (Bq/L)	0.090	0.030	0.030	0.090	0.050	1	0		0.050	0.050
	Ra226 (Bq/L)	9.600	5.333	6.050	5.700	7.000	2	0	2.687	5.100	8.900

Table 4.3.2-5 TL-7 Summary Statistics and Comparison to Historical Results

		Previous Period Averages				Year 2018 Statistics					
		2014	2015	2016	2017	Avg	Count	Count < DL	StDev	Min	Max
M Ions	Alk (mg/l)	140.1	139.9	124.5	115.8	139.7	9	0	26.8	113.0	185.0
	Ca (mg/l)	23.7	24.0	22.9	23.3	26.7	9	0	5.2	22.0	34.0
	Cl (mg/l)	4.38	7.89	4.27	5.78	3.78	9	0	1.25	2.60	6.00
	CO3 (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	9	9	0.0	1.0	1.0
	Cond-L (µS/cm)	329	341	291	281	316	9	0	59	263	407
	Hardness (mg/l)	82	85	80	80	93	9	0	18	77	119
	HCO3 (mg/l)	170.8	170.7	151.9	141.3	170.4	9	0	32.7	138.0	226.0
	K (mg/l)	1.2	1.1	1.2	1.0	1.7	9	0	0.8	1.1	3.2
	Na (mg/l)	39.9	40.4	32.9	29.8	35.0	9	0	7.3	30.0	46.0
	OH (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	9	9	0.0	1.0	1.0
	SO4 (mg/l)	30.4	29.0	25.2	23.5	26.2	9	0	5.3	21.0	35.0
	Sum of Ions (mg/l)	276	279	258	230	270	9	0	53	222	354
Metal	As (µg/l)	1.3	1.3	1.1	1.0	1.1	9	0	0.4	0.7	1.9
	Ba (mg/l)	0.205	0.366	0.199	0.478	0.347	9	0	0.175	0.160	0.760
	Cu (mg/l)	0.0007	0.0005	0.0007	0.0005	0.0007	9	0	0.0004	0.0003	0.0017
	Fe (mg/l)	0.047	0.066	0.060	0.094	0.104	9	0	0.187	0.017	0.600
	Mo (mg/l)	0.0104	0.0094	0.0084	0.0061	0.0096	9	0	0.0030	0.0069	0.0160
	Ni (mg/l)	0.00050	0.00053	0.00054	0.00048	0.00048	9	0	0.00011	0.00040	0.00070
	Pb (mg/l)	0.0003	0.0002	0.0002	0.0002	0.0003	9	2	0.0002	0.0001	0.0006
	Se (mg/l)	0.0023	0.0019	0.0016	0.0018	0.0018	9	0	0.0009	0.0010	0.0038
	U (µg/l)	272.545	226.556	196.900	125.000	238.444	9	0	87.371	152.000	394.000
	Zn (mg/l)	0.001	0.001	0.001	0.001	0.001	9	6	0.002	0.001	0.006
Nutrient	C-(org) (mg/l)	9.450	9.100	8.533	9.400	9.800	3	0	2.816	7.700	13.000
	NH3-N (mg/l)	0.06	0.07	0.08	0.01	0.07	3	0	0.03	0.04	0.09
	NO3 (mg/l)	0.120	0.113	0.071	0.050	0.070	9	5	0.042	0.040	0.160
Phys Para	pH-L (pH Unit)	7.93	7.92	7.91	7.83	7.99	9	0	0.26	7.57	8.32
	TDS (mg/l)	208.09	214.44	188.10	177.75	211.63	8	0	43.98	163.00	271.00
	Temp-H20 (°C)	9.4	8.0	10.0	8.7	8.1	9	0	7.1	0.0	19.1
	TSS (mg/l)	1.000	1.222	1.111	1.000	1.125	8	5	0.354	1.000	2.000
Rads	Pb210 (Bq/L)	0.03	0.04	0.03	0.10	0.22	3	0	0.22	0.07	0.47
	Po210 (Bq/L)	0.020	0.017	0.020	0.010	0.023	3	0	0.015	0.010	0.040
	Ra226 (Bq/L)	1.645	1.667	1.590	2.250	1.744	9	0	0.368	1.100	2.100

Table 4.3.2-6 TL-9 Summary Statistics and Comparison to Historical Results

		Previous Period Averages				Year 2018 Statistics					
		2014	2015	2016	2017	Avg	Count	Count < DL	StDev	Min	Max
M Ions	Alk (mg/l)	143.2	125.5	128.8	130.0	116.3	6	0	8.5	110.0	132.0
	Ca (mg/l)	25.3	20.8	24.2	25.4	20.3	6	0	2.3	18.0	24.0
	Cl (mg/l)	4.52	4.60	4.31	3.79	3.90	6	0	0.28	3.60	4.30
	CO3 (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	6	6	0.0	1.0	1.0
	Cond-L (µS/cm)	330	299	303	304	268	6	0	14	250	293
	Hardness (mg/l)	88	77	86	88	76	6	0	6	69	84
	HCO3 (mg/l)	174.7	153.3	157.1	158.6	141.8	6	0	10.4	134.0	161.0
	K (mg/l)	1.2	1.0	1.3	1.1	1.2	6	0	0.1	1.1	1.3
	Na (mg/l)	38.6	35.8	34.3	31.6	30.8	6	0	2.3	29.0	35.0
	OH (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	6	6	0.0	1.0	1.0
	SO4 (mg/l)	28.3	25.1	25.7	24.1	21.2	6	0	1.6	20.0	24.0
	Sum of Ions (mg/l)	279	247	235	251	226	6	0	16	213	255
Metal	As (µg/l)	1.6	1.6	1.3	1.3	1.3	6	0	0.2	1.0	1.6
	Ba (mg/l)	0.670	0.655	0.447	0.467	0.657	6	0	0.037	0.610	0.710
	Cu (mg/l)	0.0008	0.0008	0.0005	0.0006	0.0005	6	0	0.0001	0.0003	0.0006
	Fe (mg/l)	0.065	0.037	0.050	0.052	0.044	6	0	0.026	0.018	0.082
	Mo (mg/l)	0.0109	0.0105	0.0083	0.0090	0.0084	6	0	0.0012	0.0070	0.0100
	Ni (mg/l)	0.00050	0.00041	0.00044	0.00044	0.00033	6	0	0.00008	0.00020	0.00040
	Pb (mg/l)	0.0008	0.0008	0.0006	0.0008	0.0005	6	0	0.0003	0.0002	0.0010
	Se (mg/l)	0.0028	0.0040	0.0021	0.0024	0.0022	6	0	0.0006	0.0017	0.0029
	U (µg/l)	267.800	244.500	210.273	195.286	172.333	6	0	51.968	117.000	257.000
	Zn (mg/l)	0.002	0.001	0.001	0.001	0.001	6	3	0.000	0.001	0.001
Nutrient	C-(org) (mg/l)	10.000	9.333	9.150	8.750	9.400	3	0	0.346	9.000	9.600
	NH3-N (mg/l)	0.07	0.07	0.06	0.06	0.08	3	0	0.04	0.04	0.11
	NO3 (mg/l)	0.427	0.643	0.203	0.357	0.177	6	0	0.040	0.130	0.220
Phys Para	pH-L (pH Unit)	8.08	8.02	8.02	8.01	8.16	6	0	0.11	7.97	8.28
	TDS (mg/l)	210.30	189.50	194.10	191.71	177.83	6	0	15.72	163.00	208.00
	Temp-H20 (°C)	9.6	9.6	8.7	9.4	10.1	6	0	7.7	1.0	19.3
	TSS (mg/l)	2.000	1.500	1.600	1.714	1.333	6	4	0.516	1.000	2.000
Rads	Pb210 (Bq/L)	0.06	0.07	0.08	0.05	0.20	3	0	0.17	0.10	0.39
	Po210 (Bq/L)	0.040	0.053	0.030	0.030	0.037	3	0	0.021	0.020	0.060
	Ra226 (Bq/L)	2.480	2.275	1.955	2.071	2.333	6	0	0.463	1.800	3.000

Table 4.3.3-1 BL-3 Summary Statistics and Comparison to Historical Results

		Previous Period Averages				Year 2018 Statistics					
		2014	2015	2016	2017	Avg	Count	Count < DL	StDev	Min	Max
M Ions	Alk (mg/l)	73.5	72.5	70.8	69.8	69.5	4	0	7.2	60.0	76.0
	Ca (mg/l)	22.0	21.5	22.0	21.3	21.5	4	0	1.3	20.0	23.0
	Cl (mg/l)	12.50	12.50	12.00	13.25	12.50	4	0	0.58	12.00	13.00
	CO3 (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	4	4	0.0	1.0	1.0
	Cond-L (µS/cm)	249	255	240	237	236	4	0	16	220	252
	Hardness (mg/l)	77	76	77	75	76	4	0	4	71	81
	HCO3 (mg/l)	89.5	88.5	86.3	85.3	84.8	4	0	8.9	73.0	93.0
	K (mg/l)	1.0	1.0	1.1	1.1	1.2	4	0	0.1	1.1	1.2
	Na (mg/l)	19.3	19.0	18.5	18.5	18.5	4	0	1.0	18.0	20.0
	OH (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	4	4	0.0	1.0	1.0
	SO4 (mg/l)	31.0	31.5	38.3	30.5	30.5	4	0	1.7	29.0	33.0
	Sum of Ions (mg/l)	181	180	184	175	175	4	0	12	160	189
Metal	As (µg/l)	0.3	0.3	0.3	0.2	0.2	4	0	0.1	0.2	0.3
	Ba (mg/l)	0.042	0.044	0.041	0.036	0.036	4	0	0.001	0.035	0.037
	Cu (mg/l)	0.0020	0.0009	0.0018	0.0009	0.0019	4	0	0.0014	0.0006	0.0037
	Fe (mg/l)	0.007	0.007	0.011	0.006	0.009	4	0	0.005	0.004	0.014
	Mo (mg/l)	0.0036	0.0037	0.0035	0.0036	0.0036	4	0	0.0003	0.0034	0.0040
	Ni (mg/l)	0.00370	0.00308	0.00143	0.00283	0.00578	4	0	0.00763	0.00020	0.01700
	Pb (mg/l)	0.0002	0.0001	0.0002	0.0001	0.0003	4	0	0.0003	0.0001	0.0008
	Se (mg/l)	0.0025	0.0026	0.0023	0.0023	0.0023	4	0	0.0002	0.0022	0.0025
	U (µg/l)	135.000	138.000	127.500	128.500	129.750	4	0	7.890	123.000	141.000
	Zn (mg/l)	0.004	0.003	0.005	0.003	0.007	4	0	0.004	0.004	0.013
Nutrient	C-(org) (mg/l)	3.200	3.200	3.100	3.300	3.200	1	0		3.200	3.200
	NH3-N (mg/l)	0.05	0.07	0.08	0.06	0.08	1	0		0.08	0.08
	NO3 (mg/l)	0.040	0.040	0.085	0.050	0.060	4	3	0.040	0.040	0.120
Phys Para	pH-L (pH Unit)	7.79	7.83	7.80	7.85	7.96	4	0	0.05	7.92	8.02
	TDS (mg/l)	144.75	144.50	144.00	143.50	156.75	4	0	16.32	142.00	175.00
	Temp-H20 (°C)	7.0	6.0	8.6	7.5	6.4	4	0	7.1	0.0	15.4
	TSS (mg/l)	1.000	1.000	1.000	1.000	1.250	4	3	0.500	1.000	2.000
Rads	Pb210 (Bq/L)	0.02	0.02	0.02	0.11	0.09	1	0		0.09	0.09
	Po210 (Bq/L)	0.005	0.005	0.005	0.005	0.005	1	1		0.005	0.005
	Ra226 (Bq/L)	0.055	0.065	0.058	0.035	0.035	4	0	0.006	0.030	0.040

Table 4.3.3-2 BL-4 Summary Statistics and Comparison to Historical Results

		Previous Period Averages				Year 2018 Statistics					
		2014	2015	2016	2017	Avg	Count	Count < DL	StDev	Min	Max
M Ions	Alk (mg/l)	72.5	70.0	69.0	67.5	69.0	2	0	2.8	67.0	71.0
	Ca (mg/l)	21.0	22.0	21.0	20.5	21.5	2	0	0.7	21.0	22.0
	Cl (mg/l)	13.00	13.00	12.50	12.50	12.50	2	0	0.71	12.00	13.00
	CO3 (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	2	2	0.0	1.0	1.0
	Cond-L (µS/cm)	245	245	250	234	232	2	0	12	223	240
	Hardness (mg/l)	75	78	74	73	76	2	0	2	74	77
	HCO3 (mg/l)	88.5	85.5	84.0	82.5	84.5	2	0	3.5	82.0	87.0
	K (mg/l)	1.0	1.0	1.1	1.2	1.2	2	0	0.1	1.1	1.2
	Na (mg/l)	19.0	19.0	18.5	18.5	18.5	2	0	0.7	18.0	19.0
	OH (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	2	2	0.0	1.0	1.0
	SO4 (mg/l)	31.5	31.5	31.5	30.0	30.0	2	0	1.4	29.0	31.0
	Sum of Ions (mg/l)	180	178	174	171	174	2	0	8	168	179
Metal	As (µg/l)	0.3	0.3	0.3	0.2	0.3	2	0	0.0	0.3	0.3
	Ba (mg/l)	0.035	0.033	0.036	0.034	0.035	2	0	0.002	0.033	0.036
	Cu (mg/l)	0.0016	0.0016	0.0010	0.0010	0.0012	2	0	0.0003	0.0010	0.0014
	Fe (mg/l)	0.006	0.005	0.006	0.005	0.004	2	0	0.002	0.003	0.006
	Mo (mg/l)	0.0035	0.0036	0.0037	0.0037	0.0036	2	0	0.0002	0.0034	0.0037
	Ni (mg/l)	0.00180	0.00835	0.00310	0.00290	0.00120	2	0	0.00028	0.00100	0.00140
	Pb (mg/l)	0.0002	0.0001	0.0001	0.0001	0.0003	2	0	0.0001	0.0002	0.0003
	Se (mg/l)	0.0026	0.0025	0.0025	0.0024	0.0024	2	0	0.0003	0.0022	0.0026
	U (µg/l)	135.000	130.500	133.000	130.000	126.000	2	0	1.414	125.000	127.000
	Zn (mg/l)	0.004	0.003	0.002	0.003	0.005	2	0	0.005	0.001	0.008
Nutrient	C-(org) (mg/l)	3.700	3.100	3.200	3.300	3.400	2	0	0.283	3.200	3.600
	NH3-N (mg/l)	0.08	0.05	0.08	0.08	0.11	2	0	0.01	0.10	0.12
	NO3 (mg/l)	0.085	0.140	0.050	0.045	0.050	2	1	0.014	0.040	0.060
Phys Para	pH-L (pH Unit)	7.75	7.81	7.93	7.73	7.97	2	0	0.05	7.93	8.00
	TDS (mg/l)	145.00	139.50	142.00	140.00	141.00	2	0	8.49	135.00	147.00
	Temp-H20 (°C)	5.6	5.9	7.7	8.4	4.6	2	0	4.2	1.6	7.6
	TSS (mg/l)	1.000	1.000	1.000	1.000	1.000	2	2	0.000	1.000	1.000
Rads	Pb210 (Bq/L)	0.02	0.02	0.03	0.09	0.05	2	1	0.04	0.02	0.08
	Po210 (Bq/L)	<0.005	<0.005	<0.005	<0.008	<0.005	2	2	0.000	0.005	0.005
	Ra226 (Bq/L)	0.025	0.035	0.040	0.030	0.025	2	0	0.007	0.020	0.030

Table 4.3.3-3 BL-5 Summary Statistics and Comparison to Historical Results

		Previous Period Averages				Year 2018 Statistics					
		2014	2015	2016	2017	Avg	Count	Count < DL	StDev	Min	Max
M Ions	Alk (mg/l)	73.4	71.8	69.8	68.0	67.0	2	0	0.0	67.0	67.0
	Ca (mg/l)	21.8	21.3	20.8	20.3	20.5	2	0	0.7	20.0	21.0
	Cl (mg/l)	13.20	12.75	12.50	13.00	12.00	2	0	0.00	12.00	12.00
	CO3 (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	2	2	0.0	1.0	1.0
	Cond-L (µS/cm)	255	249	244	235	224	2	0	3	222	226
	Hardness (mg/l)	77	75	74	72	73	2	0	2	71	74
	HCO3 (mg/l)	89.8	87.8	85.3	83.0	82.0	2	0	0.0	82.0	82.0
	K (mg/l)	1.0	0.9	1.0	1.0	1.1	2	0	0.0	1.1	1.1
	Na (mg/l)	19.8	19.0	18.5	18.7	18.0	2	0	0.0	18.0	18.0
	OH (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	2	2	0.0	1.0	1.0
	SO4 (mg/l)	32.4	31.8	36.5	30.0	29.5	2	0	0.7	29.0	30.0
	Sum of Ions (mg/l)	184	179	180	171	168	2	0	0	168	168
Metal	As (µg/l)	0.3	0.2	0.2	0.2	0.2	2	0	0.0	0.2	0.2
	Ba (mg/l)	0.036	0.035	0.035	0.033	0.033	2	0	0.000	0.033	0.033
	Cu (mg/l)	0.0006	0.0002	0.0002	0.0002	0.0004	2	0	0.0001	0.0003	0.0005
	Fe (mg/l)	0.006	0.003	0.004	0.003	0.006	2	0	0.002	0.004	0.007
	Mo (mg/l)	0.0037	0.0037	0.0036	0.0036	0.0035	2	0	0.0001	0.0034	0.0035
	Ni (mg/l)	0.00016	0.00020	0.00023	0.00017	0.00020	2	0	0.00000	0.00020	0.00020
	Pb (mg/l)	0.0002	0.0001	0.0001	0.0001	0.0003	2	1	0.0002	0.0001	0.0004
	Se (mg/l)	0.0027	0.0025	0.0025	0.0023	0.0022	2	0	0.0000	0.0022	0.0022
	U (µg/l)	139.800	136.500	132.500	129.667	124.500	2	0	0.707	124.000	125.000
	Zn (mg/l)	0.002	0.001	0.001	0.001	0.001	2	1	0.000	0.001	0.001
Nutrient	C-(org) (mg/l)	3.900	3.000	2.900	3.200	3.200	1	0		3.200	3.200
	NH3-N (mg/l)	0.08	0.06	0.05	0.07	0.09	1	0		0.09	0.09
	NO3 (mg/l)	0.040	0.040	0.050	0.053	0.040	2	2	0.000	0.040	0.040
Phys Para	pH-L (pH Unit)	7.82	7.85	7.79	7.82	7.97	2	0	0.08	7.91	8.02
	TDS (mg/l)	148.80	142.50	143.75	140.33	149.00	2	0	9.90	142.00	156.00
	Temp-H20 (°C)	5.6	7.7	8.6	9.7	11.8	2	0	5.9	7.6	16.0
	TSS (mg/l)	1.200	1.000	1.000	1.333	1.000	2	2	0.000	1.000	1.000
Rads	Pb210 (Bq/L)	0.03	0.02	0.02	0.12	0.06	1	0		0.06	0.06
	Po210 (Bq/L)	<0.005	<0.005	<0.005	<0.005	<0.005	1	1		0.005	0.005
	Ra226 (Bq/L)	0.028	0.028	0.030	0.030	0.025	2	0	0.007	0.020	0.030

Table 4.3.3-4 ML-1 Summary Statistics and Comparison to Historical Results

		Previous Period Averages				Year 2018 Statistics					
		2014	2015	2016	2017	Avg	Count	Count < DL	StDev	Min	Max
M Ions	Alk (mg/l)	69.0	66.5	64.0	65.5	66.3	4	0	5.2	60.0	71.0
	Ca (mg/l)	20.0	19.8	20.0	19.5	20.3	4	0	1.7	18.0	22.0
	Cl (mg/l)	7.60	6.95	6.08	6.98	7.38	4	0	0.67	6.70	8.30
	CO3 (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	4	4	0.0	1.0	1.0
	Cond-L (µS/cm)	191	186	179	183	181	4	0	15	160	196
	Hardness (mg/l)	68	67	68	67	69	4	0	5	62	75
	HCO3 (mg/l)	84.0	80.8	77.8	80.0	80.8	4	0	6.4	73.0	87.0
	K (mg/l)	1.0	0.9	1.0	1.1	1.2	4	0	0.1	1.1	1.3
	Na (mg/l)	10.8	9.7	9.0	10.5	10.6	4	0	1.2	9.3	12.0
	OH (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	4	4	0.0	1.0	1.0
	SO4 (mg/l)	17.5	15.5	15.5	18.8	17.8	4	0	1.7	16.0	20.0
	Sum of Ions (mg/l)	146	138	134	142	143	4	0	10	131	154
Metal	As (µg/l)	0.2	0.2	0.2	0.2	0.2	4	0	0.0	0.2	0.2
	Ba (mg/l)	0.043	0.044	0.043	0.043	0.043	4	0	0.003	0.040	0.046
	Cu (mg/l)	0.0015	0.0005	0.0007	0.0004	0.0009	4	0	0.0007	0.0003	0.0018
	Fe (mg/l)	0.012	0.014	0.016	0.014	0.014	4	0	0.005	0.008	0.019
	Mo (mg/l)	0.0018	0.0018	0.0017	0.0019	0.0019	4	0	0.0002	0.0017	0.0022
	Ni (mg/l)	0.00015	0.00015	0.00018	0.00013	0.00018	4	0	0.00005	0.00010	0.00020
	Pb (mg/l)	0.0002	0.0001	0.0001	0.0001	0.0002	4	2	0.0001	0.0001	0.0002
	Se (mg/l)	0.0010	0.0009	0.0008	0.0010	0.0010	4	0	0.0001	0.0009	0.0012
	U (µg/l)	57.750	49.500	47.500	58.500	60.750	4	0	9.215	50.000	72.000
	Zn (mg/l)	0.004	0.001	0.002	0.001	0.002	4	1	0.001	0.001	0.003
Nutrient	C-(org) (mg/l)	6.450	7.033	6.633	6.300	6.075	4	0	1.024	5.400	7.600
	NH3-N (mg/l)	0.06	0.08	0.07	0.14	0.12	4	0	0.03	0.08	0.14
	NO3 (mg/l)	0.165	0.223	0.148	0.120	0.125	4	3	0.170	0.040	0.380
Phys Para	pH-L (pH Unit)	7.87	7.70	7.71	7.73	7.97	4	0	0.16	7.82	8.19
	TDS (mg/l)	117.00	114.50	114.25	117.75	123.75	4	0	7.50	116.00	132.00
	Temp-H20 (°C)	8.0	8.5	11.6	7.9	7.8	4	0	8.4	0.2	19.5
	TSS (mg/l)	1.000	1.250	1.500	1.500	1.500	4	2	0.577	1.000	2.000
Rads	Pb210 (Bq/L)	0.02	0.02	0.03	0.09	0.04	4	3	0.05	0.02	0.11
	Po210 (Bq/L)	<0.005	<0.005	<0.005	<0.005	<0.005	4	4	0.000	0.005	0.005
	Ra226 (Bq/L)	0.012	0.015	0.009	0.014	0.007	4	0	0.001	0.006	0.007

Table 4.3.3-5 CS-1 Summary Statistics and Comparison to Historical Results

		Previous Period Averages				Year 2018 Statistics					
		2014	2015	2016	2017	Avg	Count	Count < DL	StDev	Min	Max
M Ions	Alk (mg/l)	70.0	66.0	59.0	64.0	64.0	1	0		64.0	64.0
	Ca (mg/l)	20.0	19.0	19.0	19.0	20.0	1	0		20.0	20.0
	Cl (mg/l)	7.80	7.60	6.40	8.10	7.20	1	0		7.20	7.20
	CO3 (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	1	1		1.0	1.0
	Cond-L (µS/cm)	190	192	178	179	180	1	0		180	180
	Hardness (mg/l)	69	66	65	65	68	1	0		68	68
	HCO3 (mg/l)	85.0	80.0	72.0	78.0	78.0	1	0		78.0	78.0
	K (mg/l)	1.0	0.8	1.1	1.1	1.1	1	0		1.1	1.1
	Na (mg/l)	11.0	11.0	9.6	11.0	11.0	1	0		11.0	11.0
	OH (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	1	1		1.0	1.0
	SO4 (mg/l)	18.0	17.0	16.0	17.0	17.0	1	0		17.0	17.0
	Sum of Ions (mg/l)	148	140	128	139	139	1	0		139	139
Metal	As (µg/l)	0.2	0.2	0.2	0.2	0.2	1	0		0.2	0.2
	Ba (mg/l)	0.042	0.042	0.042	0.042	0.040	1	0		0.040	0.040
	Cu (mg/l)	0.0002	0.0002	0.0002	0.0005	0.0003	1	0		0.0003	0.0003
	Fe (mg/l)	0.026	0.036	0.037	0.046	0.021	1	0		0.021	0.021
	Mo (mg/l)	0.0019	0.0021	0.0019	0.0020	0.0020	1	0		0.0020	0.0020
	Ni (mg/l)	0.00010	0.00010	0.00010	0.00010	0.00010	1	0		0.00010	0.00010
	Pb (mg/l)	0.0001	0.0001	0.0001	0.0001	0.0001	1	1		0.0001	0.0001
	Se (mg/l)	0.0010	0.0009	0.0009	0.0009	0.0009	1	0		0.0009	0.0009
	U (µg/l)	63.000	54.000	52.000	62.000	62.000	1	0		62.000	62.000
	Zn (mg/l)	0.001	0.001	0.001	0.001	0.001	1	1		0.001	0.001
Nutrient	C-(org) (mg/l)	6.000	6.200	6.000	6.300	5.800	1	0		5.800	5.800
	NH3-N (mg/l)	0.05	0.08	0.06	0.08	0.09	1	0		0.09	0.09
	NO3 (mg/l)	0.040	0.040	0.050	0.040	0.040	1	1		0.040	0.040
Phys Para	pH-L (pH Unit)	7.76	7.82	7.67	7.59	7.98	1	0		7.98	7.98
	TDS (mg/l)	119.00	123.00	109.00	118.00	124.00	1	0		124.00	124.00
	Temp-H20 (°C)	10.6	10.1	12.5	11.8	9.3	1	0		9.3	9.3
	TSS (mg/l)	1.000	2.000	1.000	1.000	1.000	1	0		1.000	1.000
Rads	Pb210 (Bq/L)	0.02	0.02	0.02	0.11	0.07	1	0		0.07	0.07
	Po210 (Bq/L)	<0.005	<0.005	<0.005	<0.005	<0.005	1	1		0.005	0.005
	Ra226 (Bq/L)	0.006	0.005	0.010	0.010	0.005	1	1		0.005	0.005

Table 4.3.3-6 CS-2 Summary Statistics and Comparison to Historical Results

		Previous Period Averages				Year 2018 Statistics					
		2014	2015	2016	2017	Avg	Count	Count < DL	StDev	Min	Max
M Ions	Alk (mg/l)	32.0	30.0	38.0	25.0	27.0	1	0		27.0	27.0
	Ca (mg/l)	7.6	7.3	12.0	6.1	7.1	1	0		7.1	7.1
	Cl (mg/l)	3.40	3.50	4.70	3.30	3.10	1	0		3.10	3.10
	CO3 (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	1	1		1.0	1.0
	Cond-L (µS/cm)	78	79	116	63	64	1	0		64	64
	Hardness (mg/l)	28	28	43	23	27	1	0		27	27
	HCO3 (mg/l)	39.0	37.0	46.0	30.0	33.0	1	0		33.0	33.0
	K (mg/l)	0.7	0.5	0.9	0.9	0.8	1	0		0.8	0.8
	Na (mg/l)	3.0	2.9	5.6	2.6	2.8	1	0		2.8	2.8
	OH (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	1	1		1.0	1.0
	SO4 (mg/l)	4.2	4.2	9.0	3.6	3.7	1	0		3.7	3.7
	Sum of Ions (mg/l)	60	58	81	48	53	1	0		53	53
Metal	As (µg/l)	0.2	0.2	0.2	0.2	0.1	1	0		0.1	0.1
	Ba (mg/l)	0.012	0.012	0.024	0.011	0.011	1	0		0.011	0.011
	Cu (mg/l)	0.0007	0.0002	0.0002	0.0002	0.0022	1	0		0.0022	0.0022
	Fe (mg/l)	0.010	0.006	0.022	0.004	0.006	1	0		0.006	0.006
	Mo (mg/l)	0.0002	0.0003	0.0010	0.0002	0.0002	1	0		0.0002	0.0002
	Ni (mg/l)	0.00230	0.00020	0.00010	0.00020	0.00460	1	0		0.00460	0.00460
	Pb (mg/l)	0.0001	0.0001	0.0001	0.0001	0.0001	1	0		0.0001	0.0001
	Se (mg/l)	0.0001	0.0001	0.0004	0.0001	0.0001	1	1		0.0001	0.0001
	U (µg/l)	1.600	2.400	21.000	0.400	0.500	1	0		0.500	0.500
	Zn (mg/l)	0.002	0.001	0.001	0.001	0.004	1	0		0.004	0.004
Nutrient	C-(org) (mg/l)	3.200	3.200	4.100	3.200	3.300	1	0		3.300	3.300
	NH3-N (mg/l)	0.02	0.02	0.02	0.01	0.01	1	1		0.01	0.01
	NO3 (mg/l)	0.090	0.040	0.060	0.040	0.040	1	1		0.040	0.040
Phys Para	pH-L (pH Unit)	7.38	7.51	7.41	7.23	7.57	1	0		7.57	7.57
	TDS (mg/l)	54.00	51.00	71.00	37.00	53.00	1	0		53.00	53.00
	Temp-H20 (°C)	8.6	11.2	12.6	9.4	10.1	1	0		10.1	10.1
	TSS (mg/l)	1.000	2.000	1.000	1.000	1.000	1	0		1.000	1.000
Rads	Pb210 (Bq/L)	<0.02	<0.02	<0.02	<0.02	<0.02	1	1		0.02	0.02
	Po210 (Bq/L)	0.005	0.005	0.006	0.005	0.005	1	1		0.005	0.005
	Ra226 (Bq/L)	0.005	0.010	0.007	0.005	0.005	1	1		0.005	0.005

Table 4.4-1 ZOR-01 Summary Statistics and Comparison to Historical Results

		Previous Period Averages				Year 2018 Statistics					
		2014	2015	2016	2017	Avg	Count	Count < DL	StDev	Min	Max
M Ions	Alk (mg/l)	94.4	100.2	102.7	97.0	95.5	6	0	6.1	87.0	104.0
	Ca (mg/l)	29.4	31.8	32.5	30.7	31.2	6	0	1.8	30.0	34.0
	Cl (mg/l)	0.26	0.29	0.87	0.28	0.33	6	0	0.05	0.30	0.40
	CO3 (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	6	6	0.0	1.0	1.0
	Cond-L (µS/cm)	207	224	226	218	213	6	0	13	200	233
	Hardness (mg/l)	104	113	115	108	110	6	0	6	105	119
	HCO3 (mg/l)	115.2	122.2	125.3	118.1	116.5	6	0	7.5	106.0	127.0
	K (mg/l)	0.6	0.7	0.8	0.7	0.8	6	0	0.1	0.7	0.9
	Na (mg/l)	1.6	1.7	1.8	1.8	1.8	6	0	0.1	1.6	2.0
	OH (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	6	6	0.0	1.0	1.0
	SO4 (mg/l)	17.0	18.9	19.1	18.7	18.8	6	0	1.0	17.0	20.0
	Sum of Ions (mg/l)	171	184	189	178	178	6	0	10	166	193
Metal	As (µg/l)	0.2	0.2	0.2	0.2	0.2	6	0	0.1	0.1	0.2
	Ba (mg/l)	0.020	0.022	0.023	0.021	0.022	6	0	0.002	0.020	0.026
	Cu (mg/l)	0.0022	0.0009	0.0006	0.0010	0.0009	6	0	0.0005	0.0003	0.0017
	Fe (mg/l)	0.018	0.010	0.008	0.009	0.009	6	0	0.009	0.004	0.026
	Mo (mg/l)	0.0008	0.0008	0.0009	0.0009	0.0008	6	0	0.0001	0.0008	0.0009
	Ni (mg/l)	0.00032	0.00017	0.00024	0.00020	0.00013	6	0	0.00005	0.00010	0.00020
	Pb (mg/l)	0.0005	0.0002	0.0001	0.0002	0.0001	6	5	0.0001	0.0001	0.0003
	Se (mg/l)	0.0001	0.0001	0.0001	0.0001	0.0001	6	0	0.0000	0.0001	0.0001
	U (µg/l)	13.000	15.290	14.570	16.111	15.833	6	0	0.983	14.000	17.000
	Zn (mg/l)	0.003	0.001	0.001	0.003	0.001	6	2	0.000	0.001	0.002
Nutrient	C-(org) (mg/l)	9.000		8.600	8.400	8.200	1	0		8.200	8.200
	NH3-N (mg/l)	0.05		0.06	0.05	0.07	1	0		0.07	0.07
	NO3 (mg/l)	0.060	0.063	0.040	0.202	0.040	6	6	0.000	0.040	0.040
Phys Para	pH-L (pH Unit)	7.94	7.89	7.92	7.93	8.08	6	0	0.09	7.97	8.21
	TDS (mg/l)	127.00	140.45	148.10	143.56	147.83	6	0	13.32	130.00	167.00
	Temp-H20 (°C)	9.4	9.2	12.6	11.4	11.9	6	0	7.1	1.3	19.3
	TSS (mg/l)	1.400	1.300	2.100	2.222	1.333	6	4	0.516	1.000	2.000
Rads	Pb210 (Bq/L)	0.05		0.02	0.02	0.02	1	0		0.02	0.02
	Po210 (Bq/L)	0.005		0.010	0.006	0.009	1	0		0.009	0.009
	Ra226 (Bq/L)	0.026	0.029	0.022	0.027	0.030	6	0	0.009	0.020	0.040

Table 4.4-2 ZOR-02 Summary Statistics and Comparison to Historical Results

		Previous Period Averages				Year 2018 Statistics					
		2014	2015	2016	2017	Avg	Count	Count < DL	StDev	Min	Max
M Ions	Alk (mg/l)	113.8	121.7	108.5	102.6	95.3	7	0	18.8	58.0	114.0
	Ca (mg/l)	44.4	55.1	41.1	45.3	41.3	7	0	6.8	28.0	48.0
	Cl (mg/l)	0.42	0.74	0.52	0.56	0.54	7	2	0.33	0.20	1.00
	CO3 (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	7	7	0.0	1.0	1.0
	Cond-L (µS/cm)	289	303	277	308	272	7	0	44	183	318
	Hardness (mg/l)	146	183	140	152	138	7	0	24	90	161
	HCO3 (mg/l)	138.6	148.4	132.3	125.3	116.3	7	0	22.9	71.0	139.0
	K (mg/l)	0.6	0.9	0.9	0.9	0.8	7	0	0.2	0.5	1.0
	Na (mg/l)	1.9	2.7	2.1	2.5	2.0	7	0	0.5	1.0	2.6
	OH (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	7	7	0.0	1.0	1.0
	SO4 (mg/l)	41.6	67.8	40.6	56.5	46.9	7	0	6.3	40.0	55.0
	Sum of Ions (mg/l)	237	288	231	241	216	7	0	36	146	254
Metal	As (µg/l)	0.2	0.4	0.2	0.3	0.2	7	0	0.0	0.1	0.2
	Ba (mg/l)	0.021	0.032	0.028	0.037	0.026	7	0	0.007	0.014	0.035
	Cu (mg/l)	0.0036	0.0028	0.0019	0.0019	0.0015	7	0	0.0003	0.0012	0.0019
	Fe (mg/l)	0.032	0.420	0.138	0.660	0.200	7	0	0.137	0.087	0.440
	Mo (mg/l)	0.0013	0.0018	0.0016	0.0018	0.0014	7	0	0.0002	0.0010	0.0017
	Ni (mg/l)	0.00032	0.00053	0.00026	0.00035	0.00023	7	0	0.00008	0.00020	0.00040
	Pb (mg/l)	0.0003	0.0029	0.0002	0.0004	0.0002	7	2	0.0001	0.0001	0.0003
	Se (mg/l)	0.0003	0.0004	0.0003	0.0003	0.0003	7	0	0.0001	0.0002	0.0004
	U (µg/l)	313.800	595.182	300.900	424.500	340.571	7	0	62.335	256.000	461.000
	Zn (mg/l)	0.001	0.001	0.001	0.001	0.001	7	7	0.000	0.001	0.001
Nutrient	C-(org) (mg/l)	6.300		8.100	6.500	6.800	1	0		6.800	6.800
	NH3-N (mg/l)	0.04		0.05	0.28	0.17	1	0		0.17	0.17
	NO3 (mg/l)	0.664	0.382	0.428	1.029	0.613	7	0	0.229	0.250	1.000
Phys Para	pH-L (pH Unit)	7.96	7.89	7.94	7.89	7.98	7	0	0.11	7.76	8.09
	TDS (mg/l)	185.40	238.73	183.10	205.25	188.71	7	0	35.33	120.00	231.00
	Temp-H20 (°C)	12.6	5.8	9.2	10.1	8.2	7	0	6.2	0.7	16.1
	TSS (mg/l)	1.000	13.318	1.300	2.000	1.429	7	3	1.134	1.000	4.000
Rads	Pb210 (Bq/L)	0.09		0.02	0.42	0.34	1	0		0.34	0.34
	Po210 (Bq/L)	0.080		0.020	0.030	0.010	1	0		0.010	0.010
	Ra226 (Bq/L)	0.336	0.667	0.219	0.311	0.253	7	0	0.046	0.200	0.340

Table 4.4-3 Downstream Water Quality

Year	Flow Path (ZOR-02)		Verna Lake (AC-6A)		Ace Lake (AC-8)	
	Uranium (ug/L)	Radium (Bq/L)	Uranium (ug/L)	Radium (Bq/L)	Uranium (ug/L)	Radium (Bq/L)
2010	1560	0.400	263.0	0.1	15.3	0.015
2011	940.0	1.200			16.5	0.015
2012			117.0	0.085	13.5	0.009
2013	624.8	0.368	201.0	0.140	11.5	0.020
2014	313.8	0.336	154.0	0.150	11.5	0.020
2015	595.2	0.667	389.3	0.109	13.5	0.030
2016*	300.9	0.219	331.0	0.108	14.5	0.015
2017*	424.5	0.311	279.3	0.115	12.5	0.025
2018	340.6	0.253	278.5	0.100	12.5	0.020

* The values reported for uranium in 2016 and 2017 for ZOR-02 in this table have been updated (from the 2017 annual report) to reflect the concentrations reported in the summary tables of those respective annual reports, which are considered to be correct.

Table 4.4-4 Long-term Seep Water Quality

		Units	Mean Concentration			
			2003-2007	2008-2012	2013-2017	2018
Major Ions	Calcium	mg/l	217.3	244.2	130.8	118.2
	Chloride	mg/l	78.67	91.33	100.20	26.00
	Hardness	mg/l	649	729	413	348
	Sulfate	mg/l	446.7	618.3	261.4	267.8
Metals	Arsenic	µg/l	0.5	0.7	0.5	0.6
	Barium	mg/l	0.056	0.063	0.044	0.030
	Copper	mg/l	0.0036	0.0039	0.0038	0.0032
	Iron	mg/l	0.263	0.750	0.349	0.243
	Lead	mg/l	0.0013	0.0038	0.0181	0.0018
	Nickel	mg/l	0.00167	0.00292	0.00104	0.00212
	Selenium	mg/l	0.0218	0.0267	0.0128	0.0250
	Uranium	µg/l	3966.667	4803.333	3252.000	2704.000
	Zinc	mg/l	0.012	0.023	0.004	0.004
Physical Parameters	pH-Laboratory	pH Unit	7.67	7.79	7.91	7.94
	Total Dissolved Solids	mg/l	787.94	1271.67	729.60	564.60
	Total Suspended Solids	mg/l	4.000		9.000	7.800
Radionuclides	Lead-210	Bq/L		0.58		
	Polonium-210	Bq/L		0.266		
	Radium 226	Bq/L	0.510	0.820	0.638	0.588
	Thorium-230	Bq/L		0.2233		

Table 4.7.1 Radon Track Etch Summary

	Annual Average (Bq/m3)					
	1982	**2014**	**2015**	**2016**	**2017**	**2018**
Ace Creek Track Etch Cup	395.9	216.5	210.9	186.7	252.5	257.5
Beacon Hill Track Etch Cup	51.8	9.3	9.3	13.1	35.0	12.5
Donaldson Lake Track Etch Cup		7.4	5.6	12.4	22.5	9.5
Eldorado Townsite Track Etch Cup	136.9	16.7	20.4	24.1	43.0	25.0
End of Airstrip Track Etch Cup	88.8	7.4	5.6	8.7	29.0	8.5
Fay Waste Rock Track Etch Cup	188.7	35.2	38.9	51.1	58.5	43.0
Fookes Delta Track Etch Cup	217.8	75.9	77.7	89.5	91.0	100.0
Fredette Lake Track Etch Cup		11.1	5.6	9.7	29.0	9.0
Marie Delta Track Etch Cup	144.5	75.9	88.8	75.2	104.0	94.5
Uranium City Town Track Etch Cup		7.4	5.6	7.7	29.5	5.5

FIGURES

FIGURES

Figure 2.4
Beaverlodge Location Map

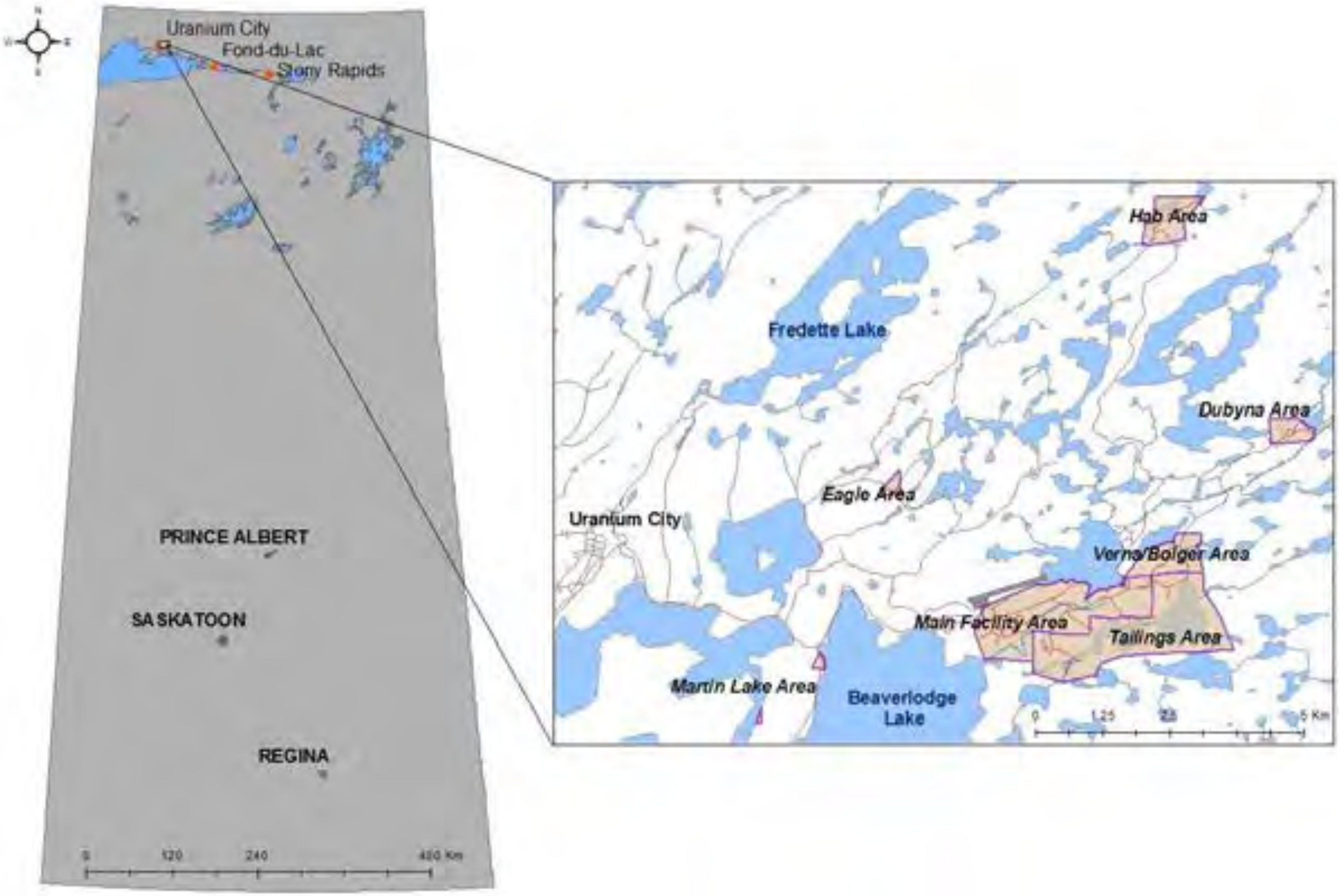


Figure 4.3
Water Quality Monitoring Station Locations

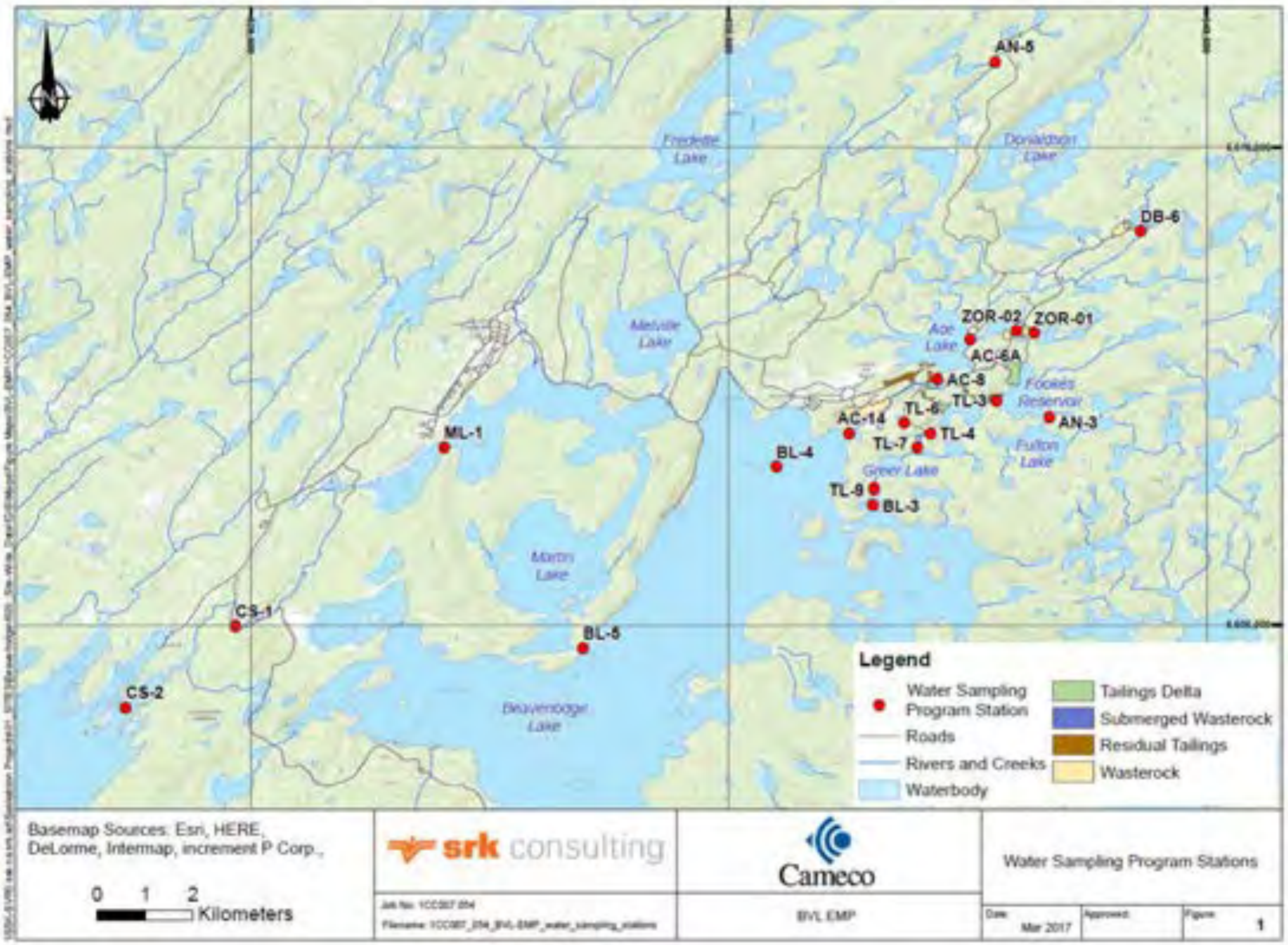


Figure 4.3.1-1 AN-5 Pistol Creek below Hab Site

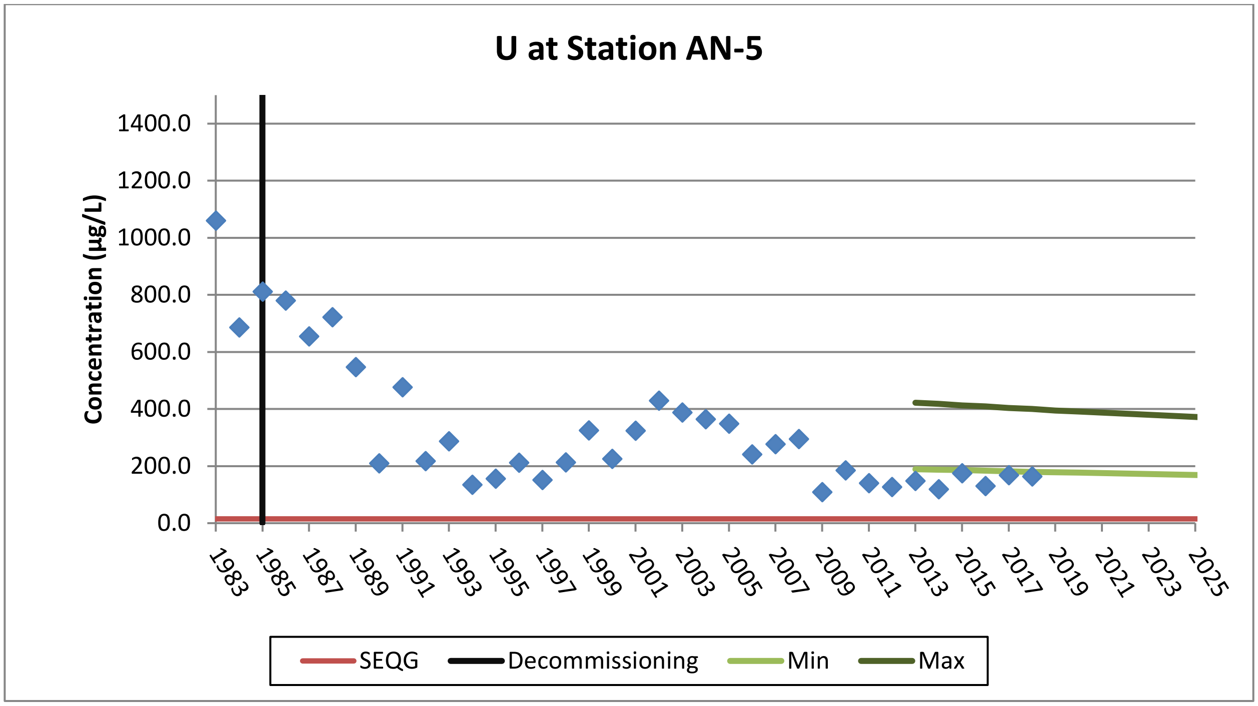


Figure 4.3.1-2 AN-5 Pistol Creek below Hab Site

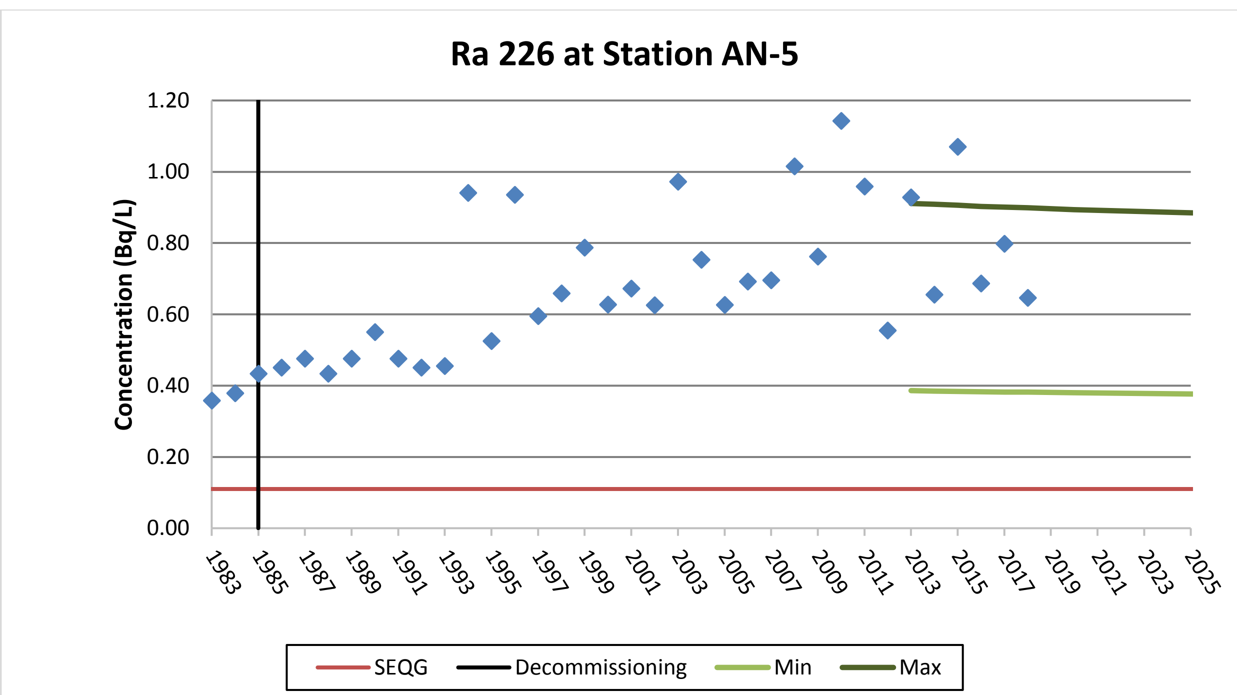
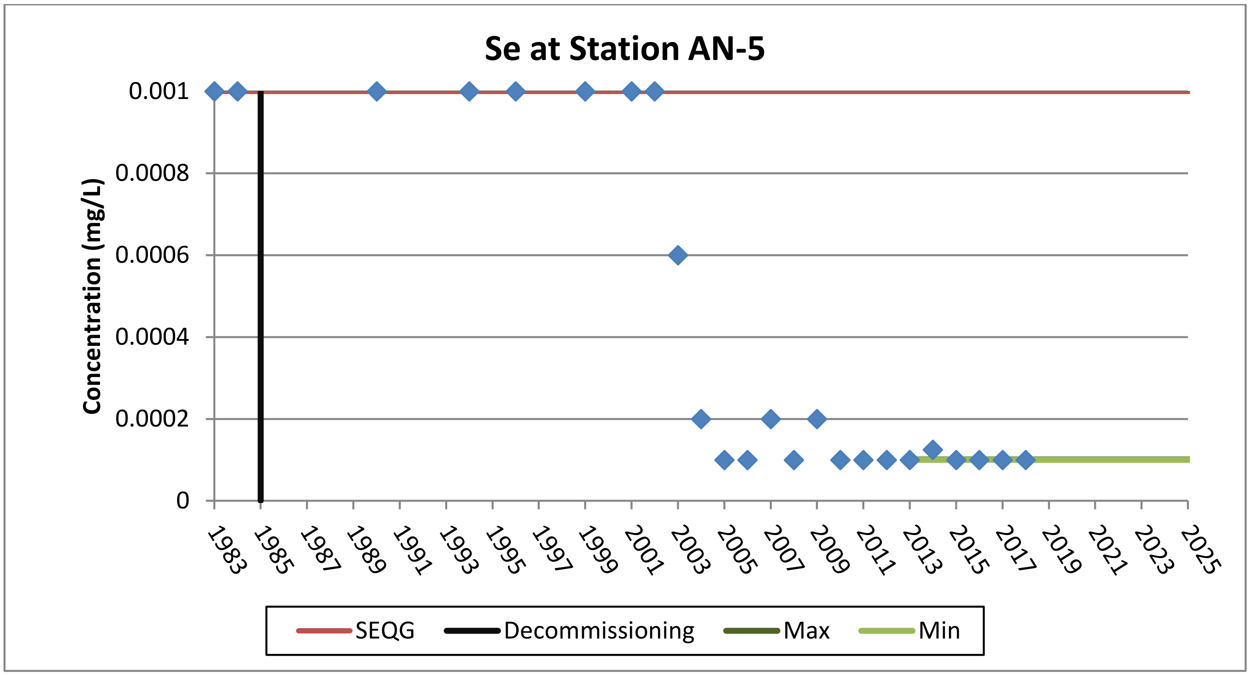


Figure 4.3.1-3 AN-5 Pistol Creek below Hab Site



Note: Method detection limit changed from 0.001 mg/L to 0.0001 mg/L in 2003.

Figure 4.3.1-4 AN-5 Pistol Creek below Hab Site

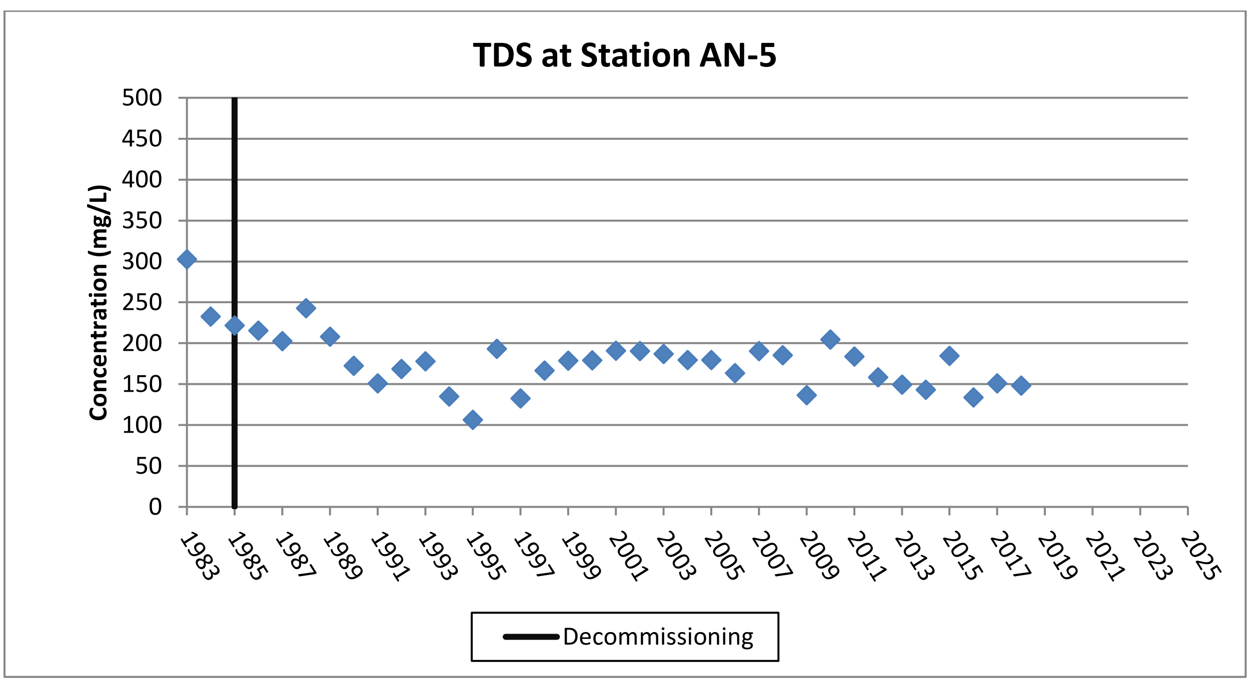


Figure 4.3.1-5 DB-6 Dubyna Creek

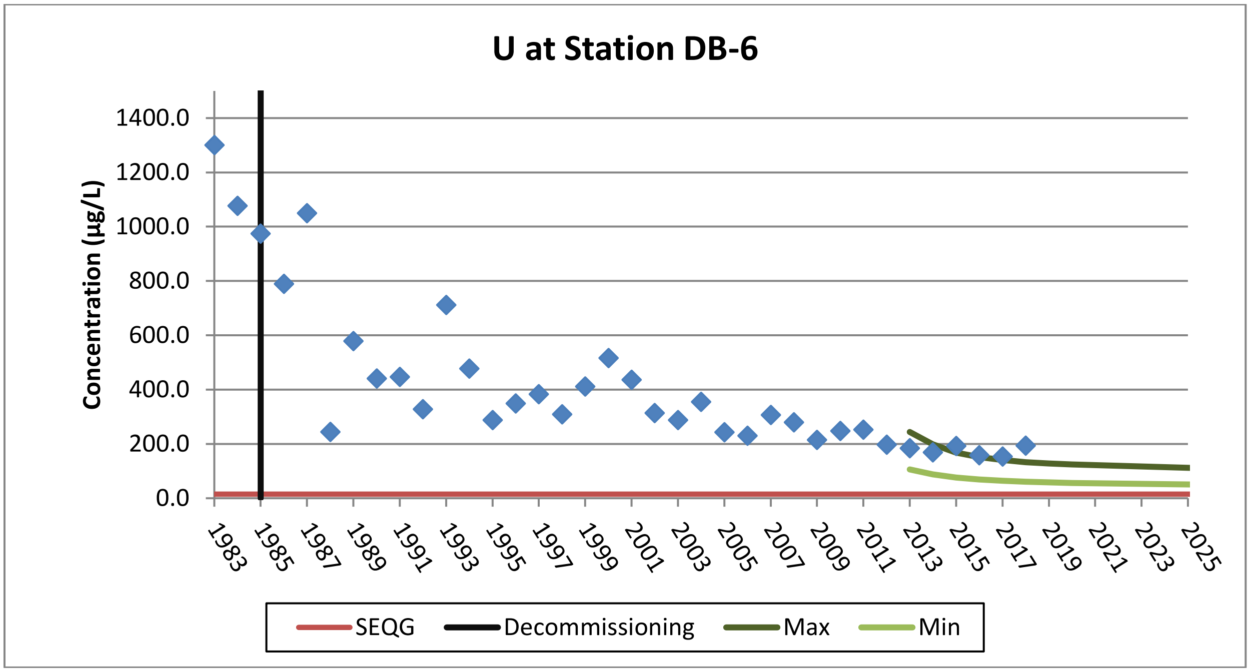


Figure 4.3.1-6 DB-6 Dubyna Creek

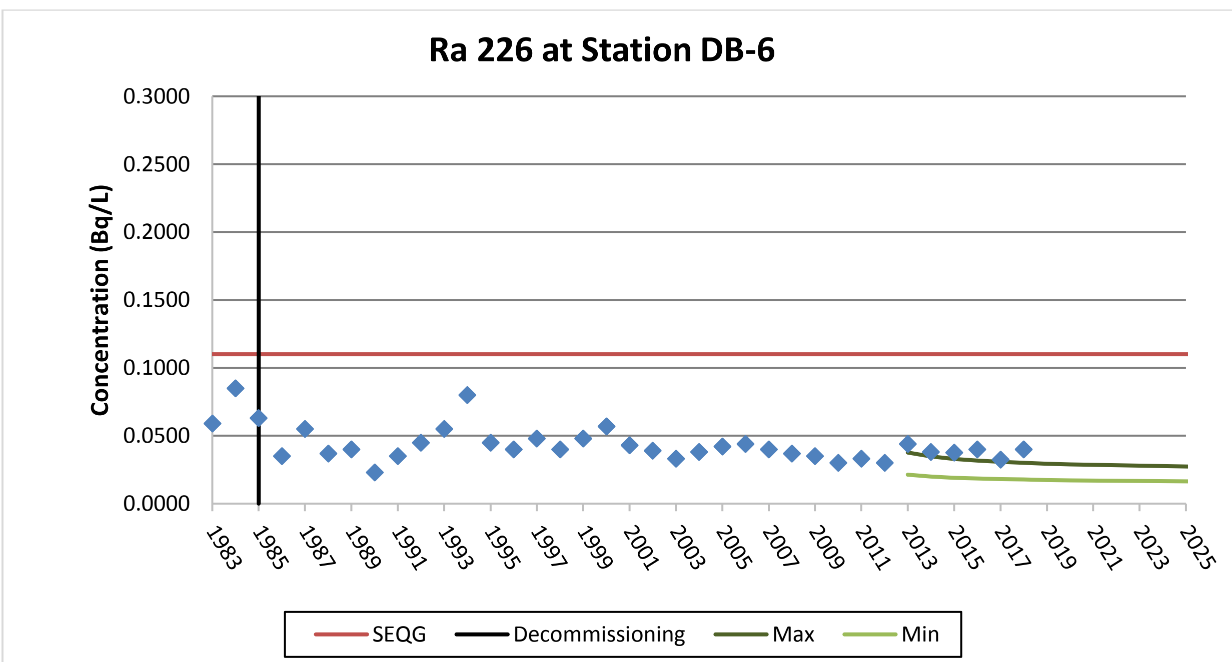
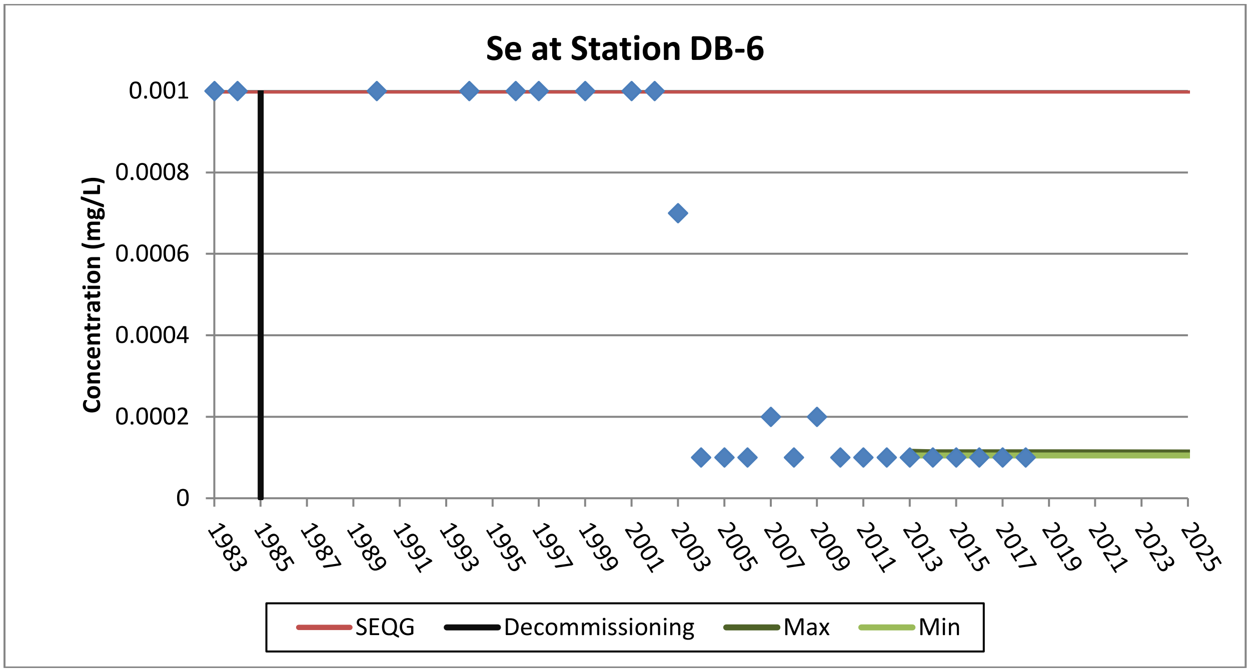


Figure 4.3.1-7 DB-6 Dubyna Creek



Note: Method detection limit changed from 0.001 mg/L to 0.0001 mg/L in 2003.

Figure 4.3.1-8 DB-6 Dubyna Creek

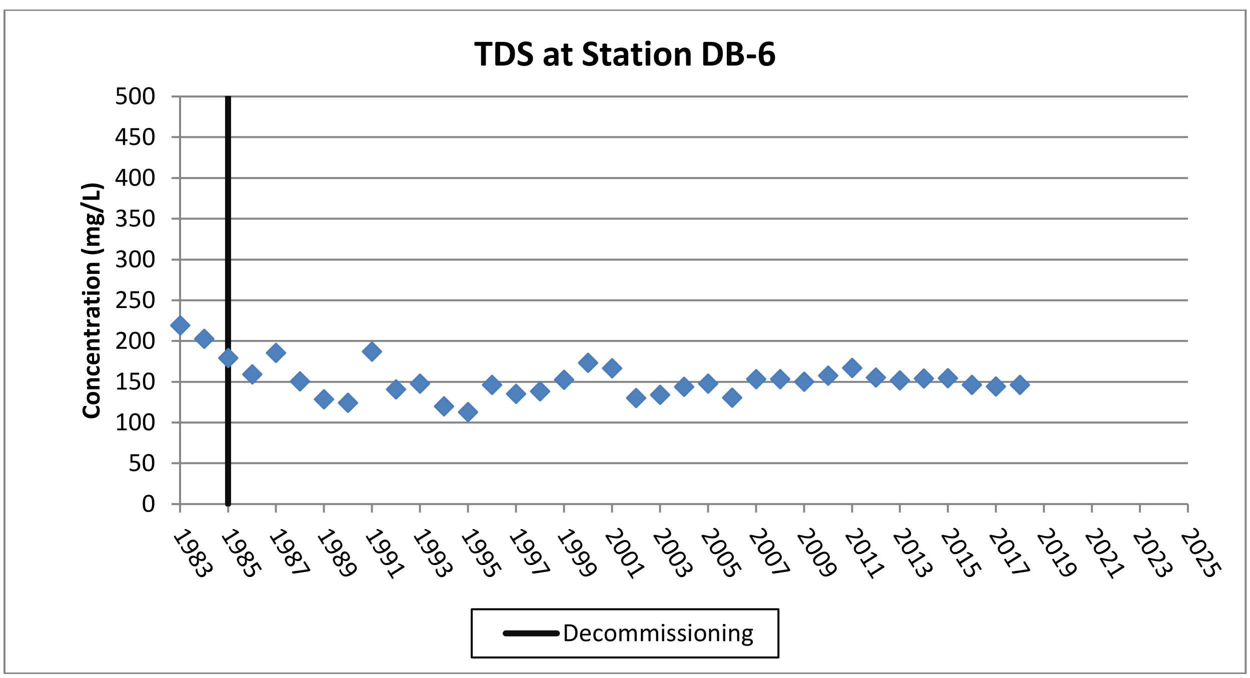


Figure 4.3.1-9 AC-6A Verna Lake Discharge to Ace Lake

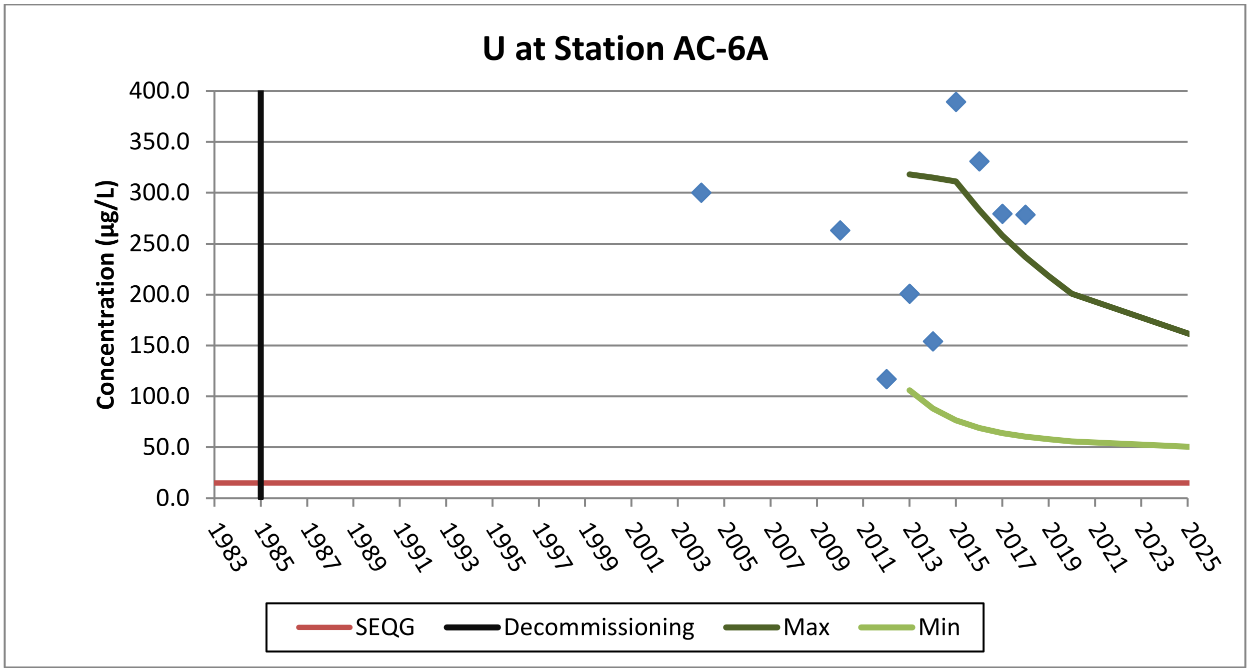


Figure 4.3.1-10 AC-6A Verna Lake Discharge to Ace Lake

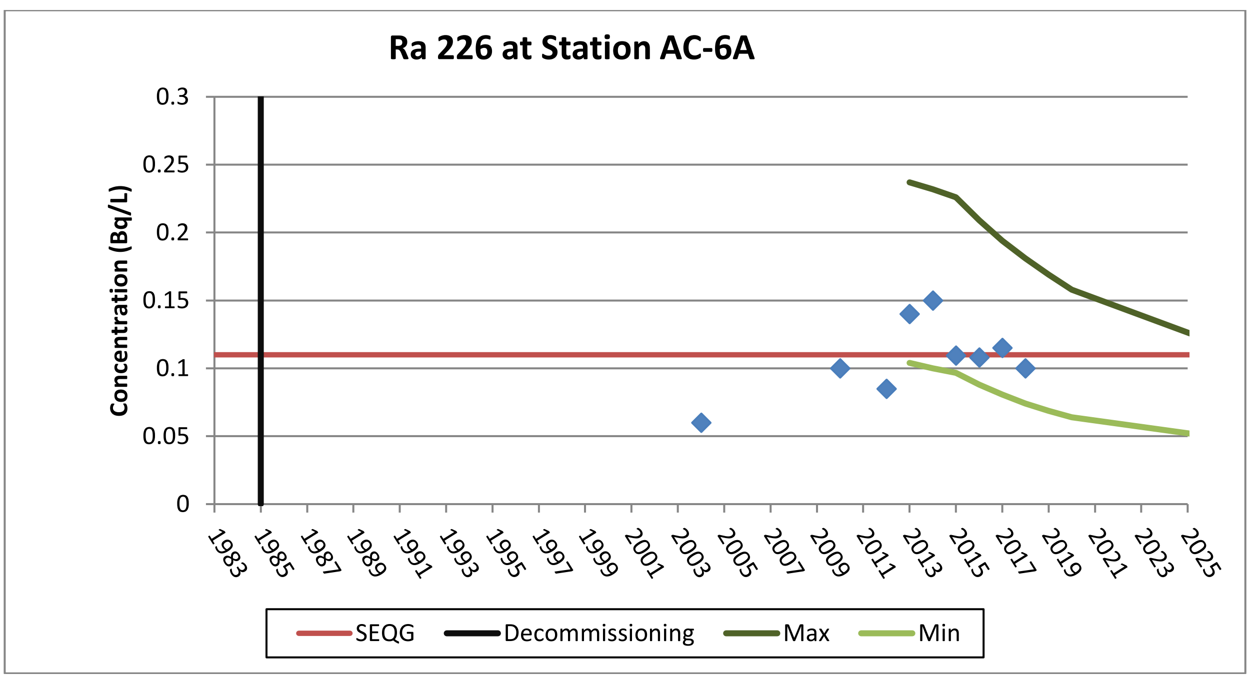
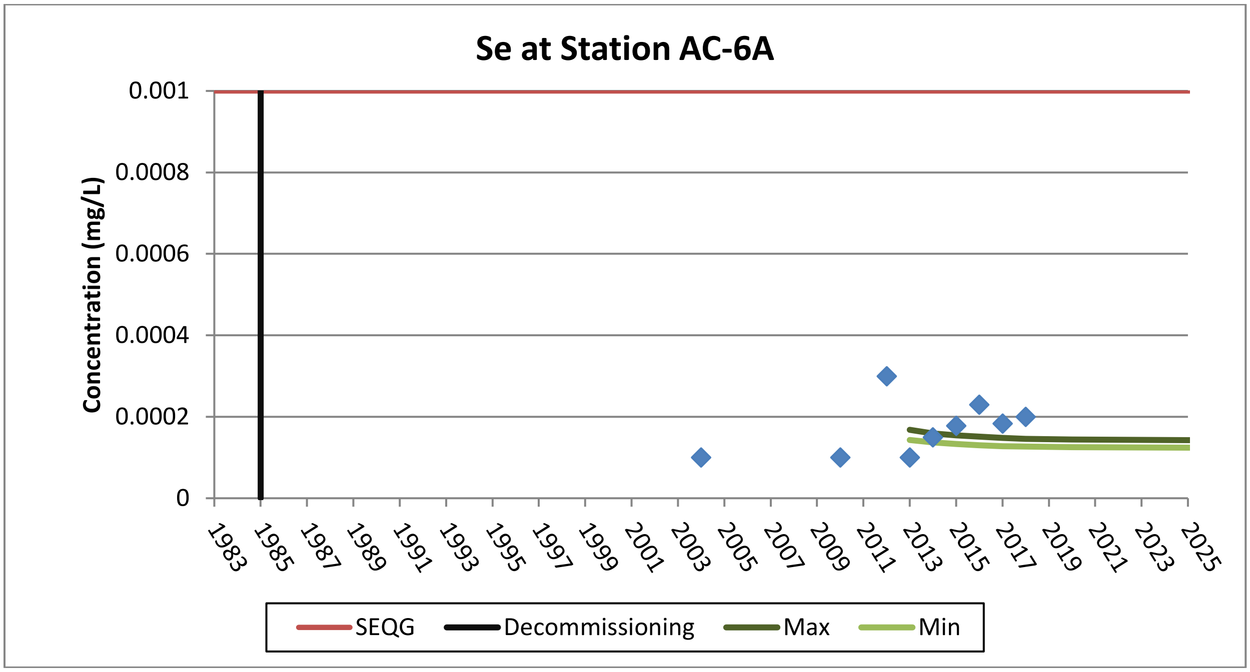


Figure 4.3.1-11 AC-6A Verna Lake Discharge to Ace Lake



Note: Method detection limit changed from 0.001 mg/L to 0.0001 mg/L in 2003.

Figure 4.3.1-12 AC-6A Verna Lake Discharge to Ace Lake

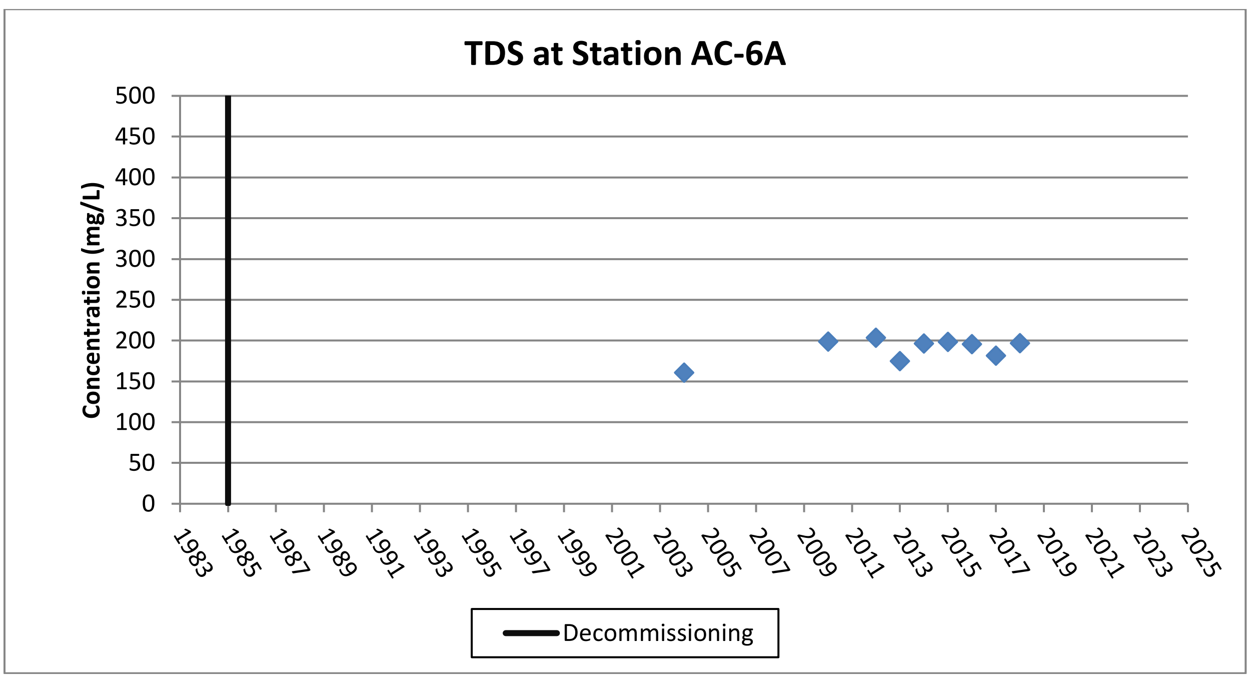


Figure 4.3.1-13 AC-8 Ace Lake Outlet to Ace Creek

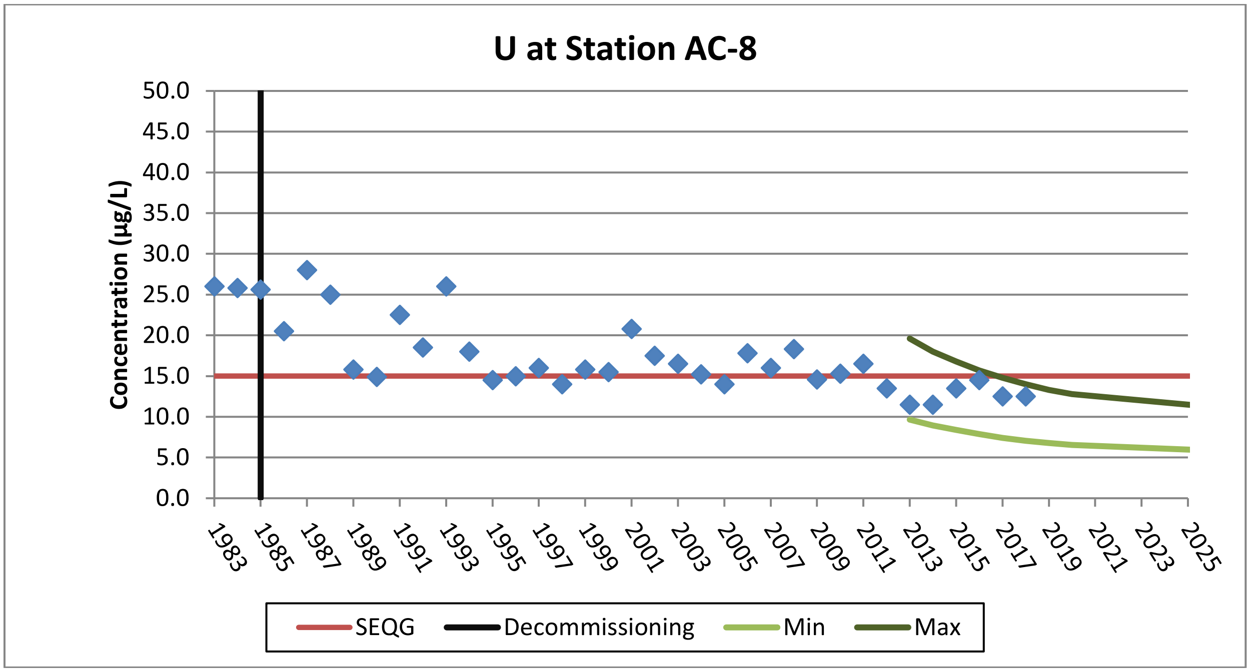


Figure 4.3.1-14 AC-8 Ace Lake Outlet to Ace Creek

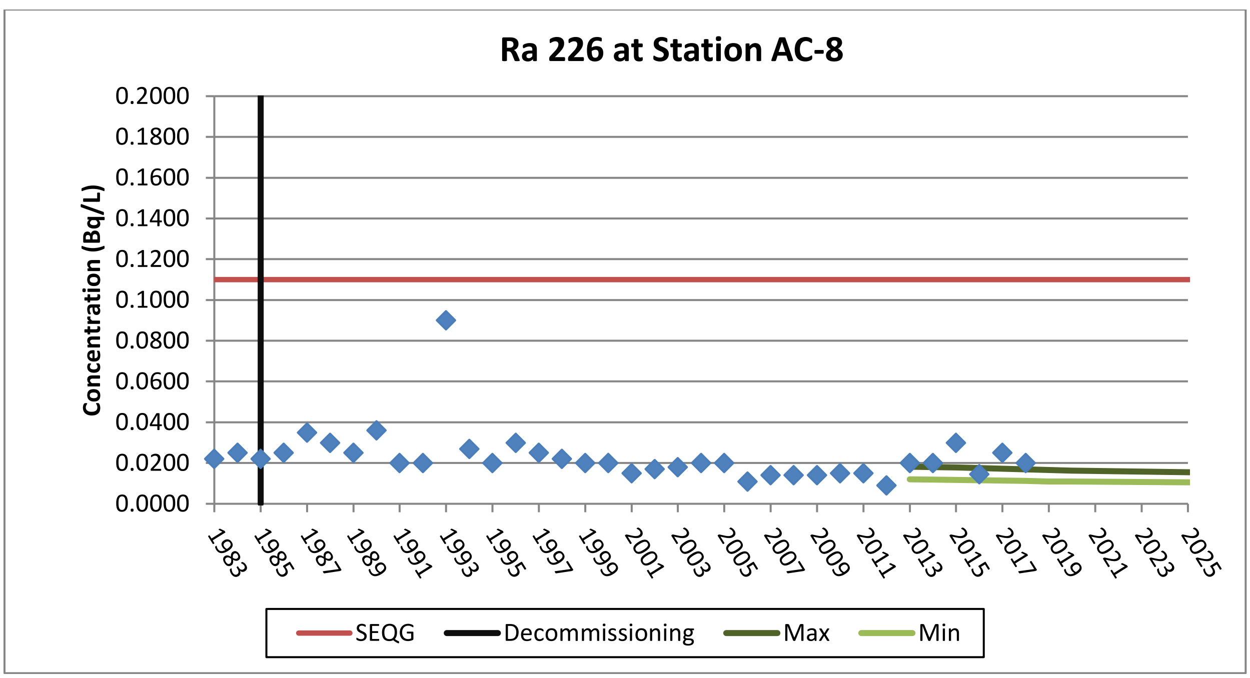
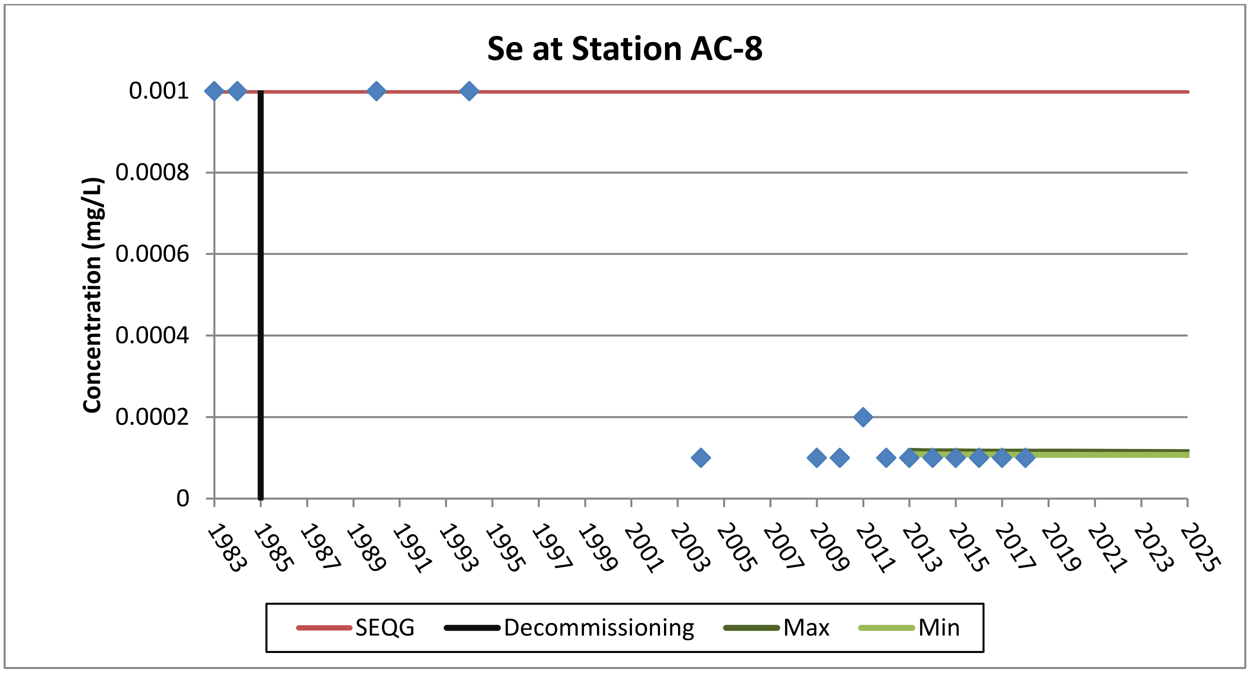


Figure 4.3.1-15 AC-8 Ace Lake Outlet to Ace Creek



Note: Method detection limit changed from 0.001 mg/L to 0.0001 mg/L in 2003.

Figure 4.3.1-16 AC-8 Ace Lake Outlet to Ace Creek

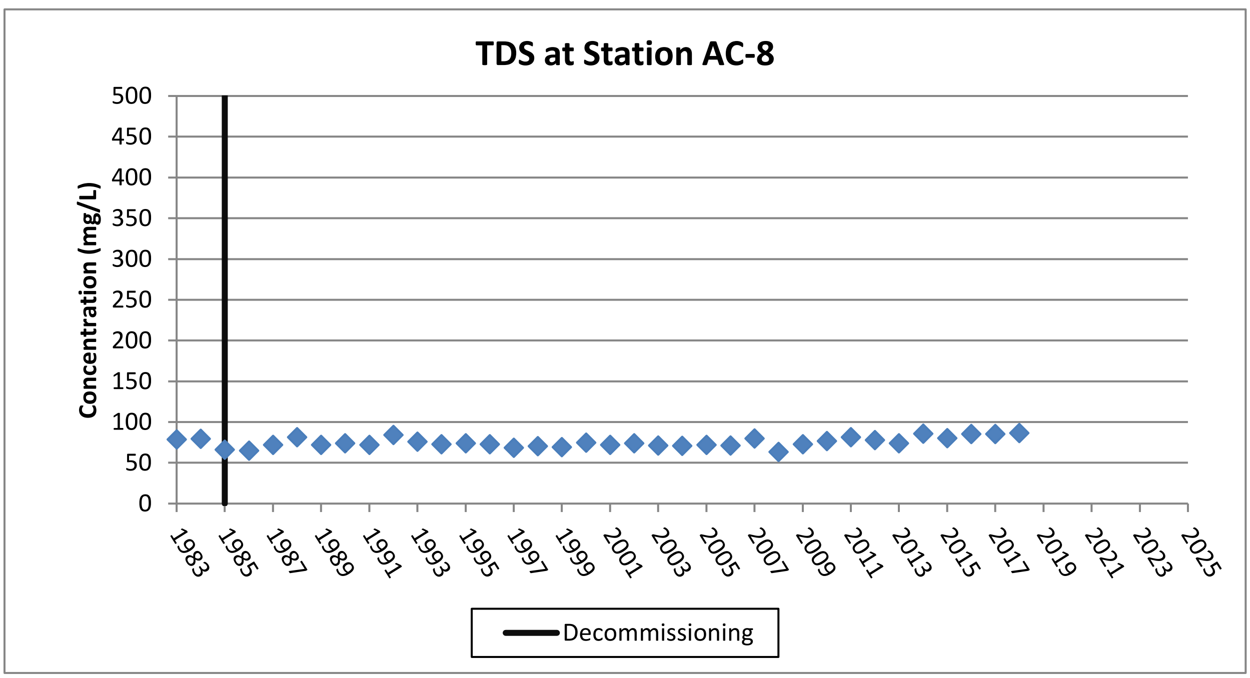


Figure 4.3.1-17 AC-14 - Ace Creek

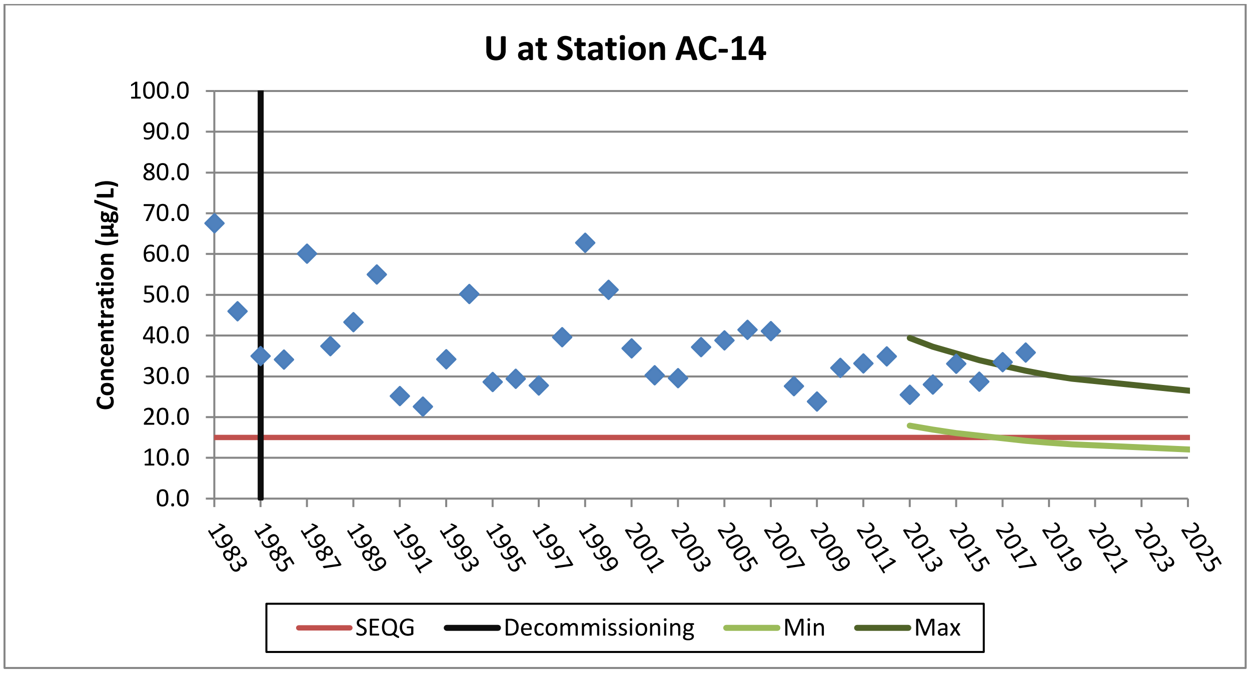


Figure 4.3.1-18 AC-14 - Ace Creek

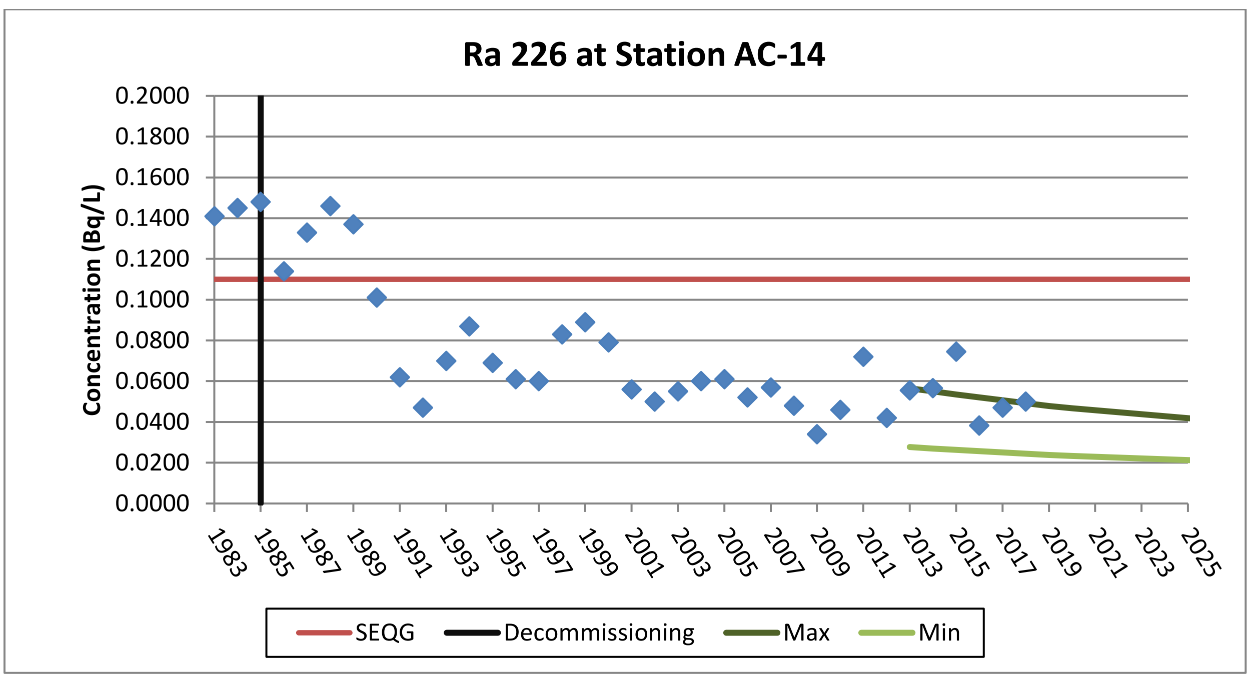
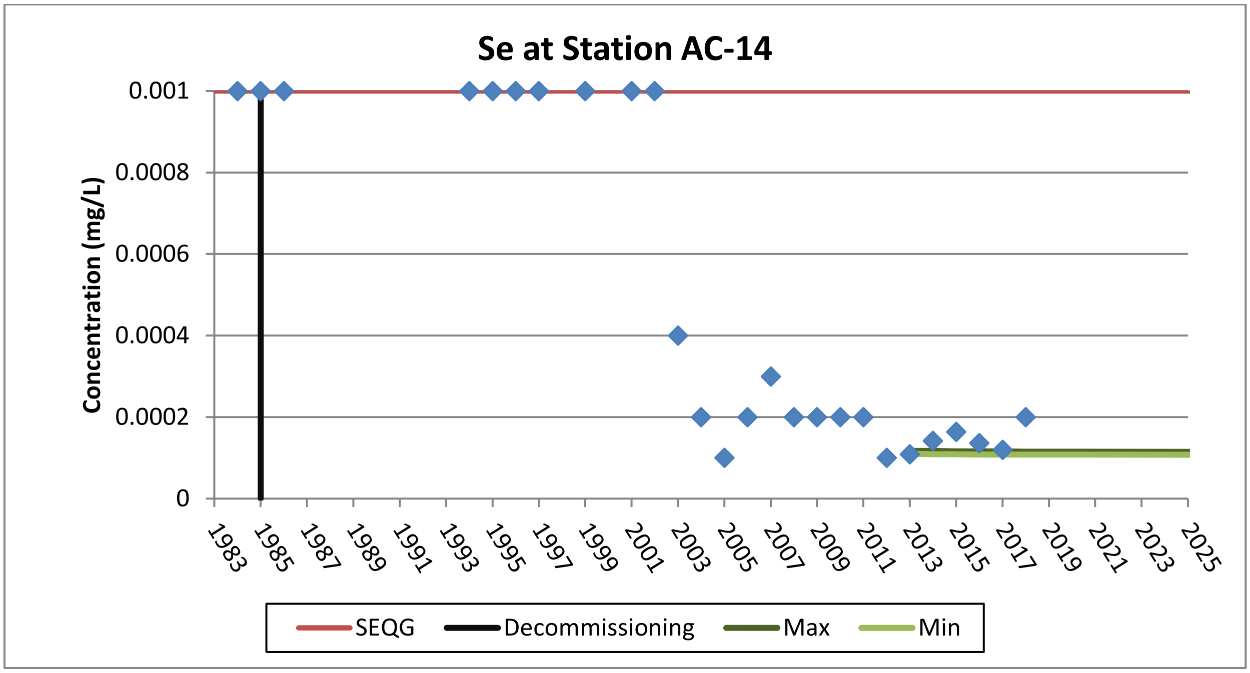


Figure 4.3.1-19 AC-14 - Ace Creek



Note: Method detection limit changed from 0.001 mg/L to 0.0001 mg/L in 2003.

Figure 4.3.1-20 AC-14 - Ace Creek

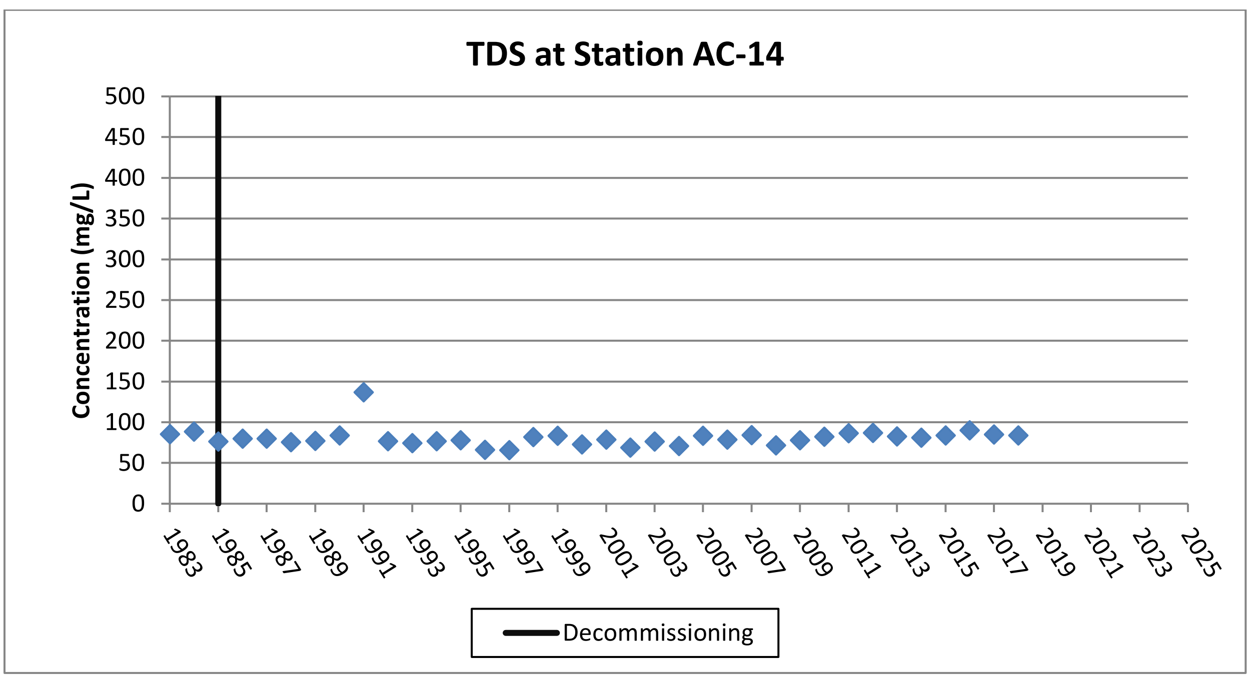
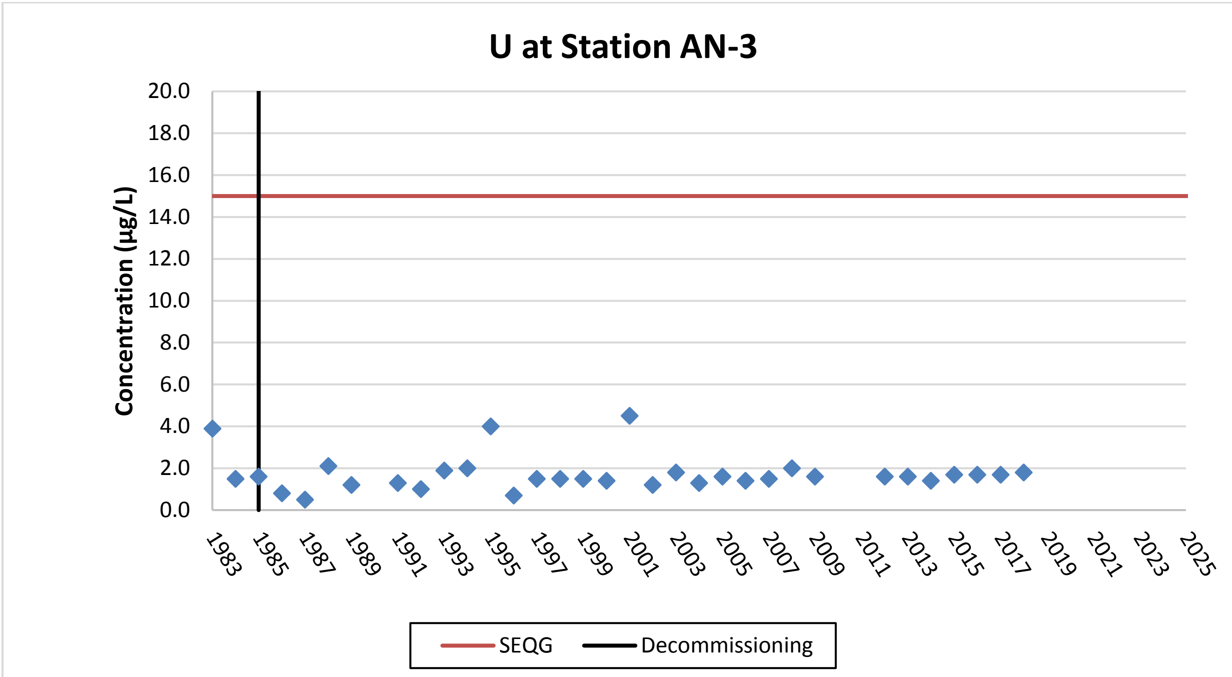
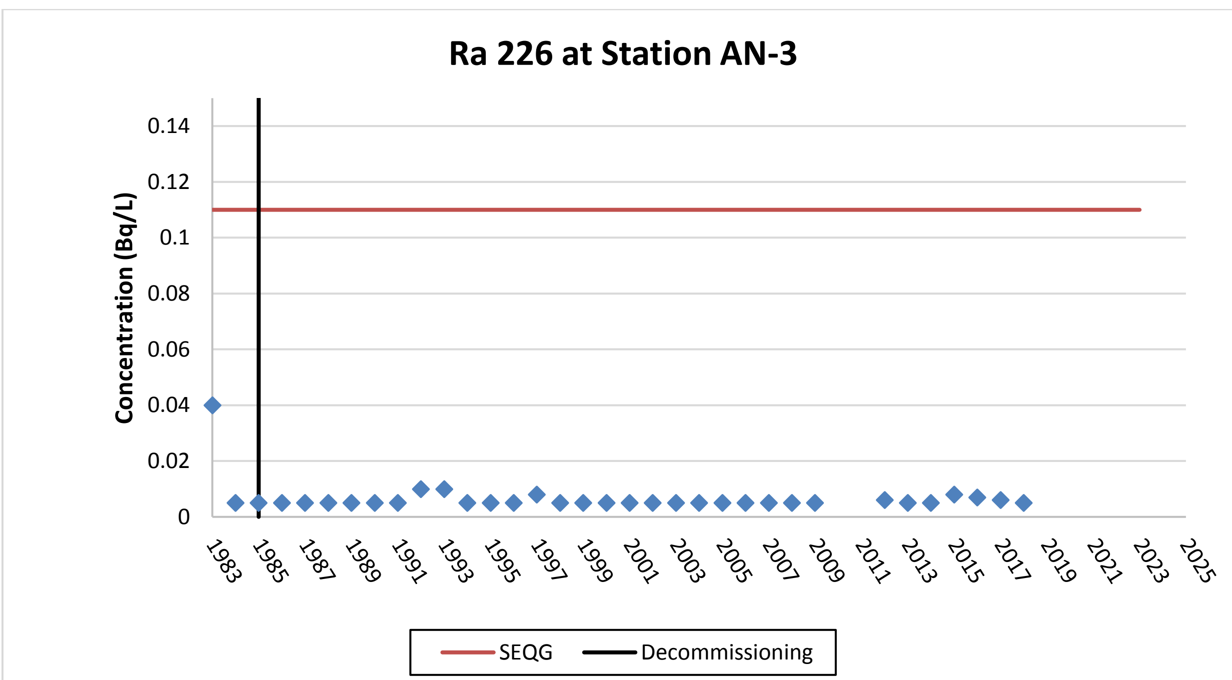


Figure 4.3.2-1 AN-3 Fulton Lake (Upstream of TL Stations)



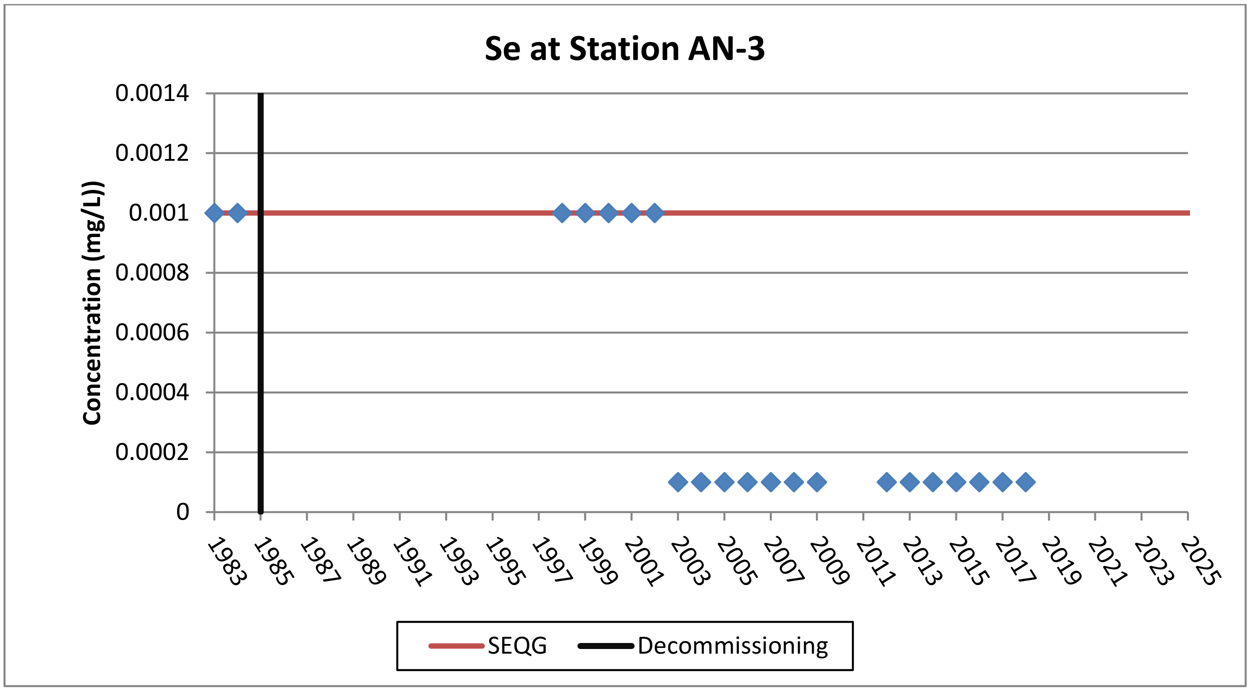
**The 2010 and 2011 scheduled sampling was not completed due to a lack of water flow.*

Figure 4.3.2-2 AN-3 Fulton Lake (Upstream of TL Stations)



**The 2010 and 2011 scheduled sampling was not completed due to a lack of water flow.*

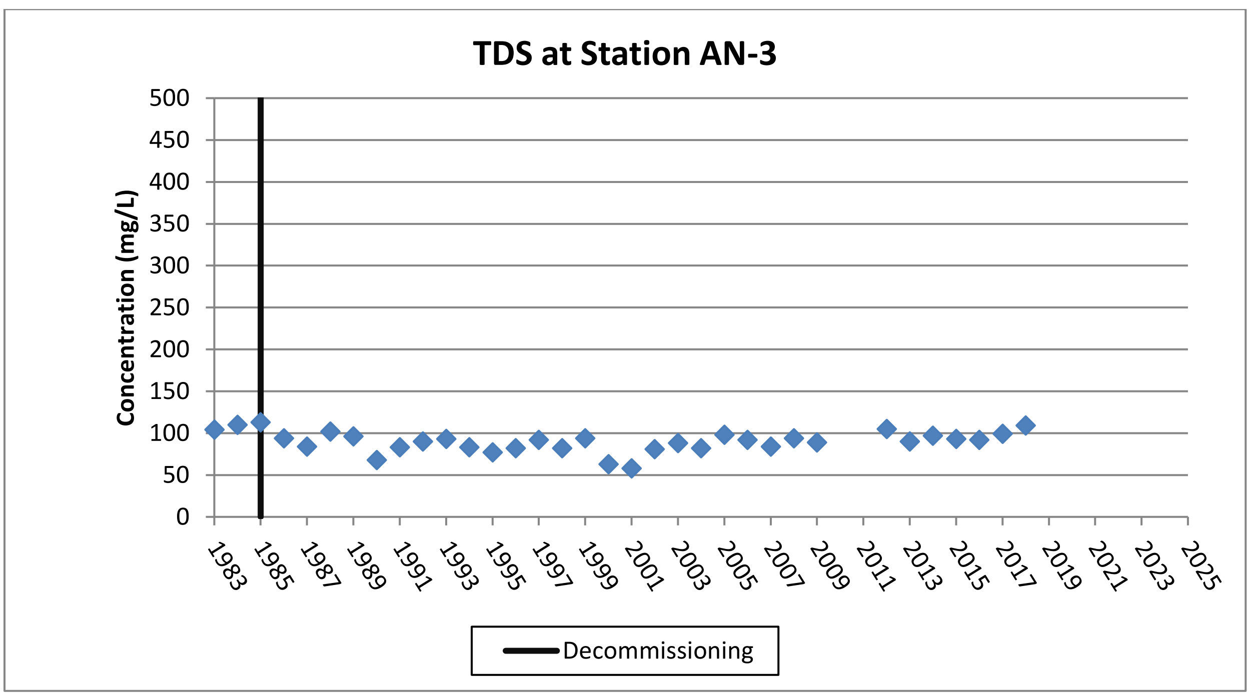
Figure 4.3.2-3 AN-3 Fulton Lake (Upstream of TL Stations)



**The 2010 and 2011 scheduled sampling was not completed due to a lack of water flow.*

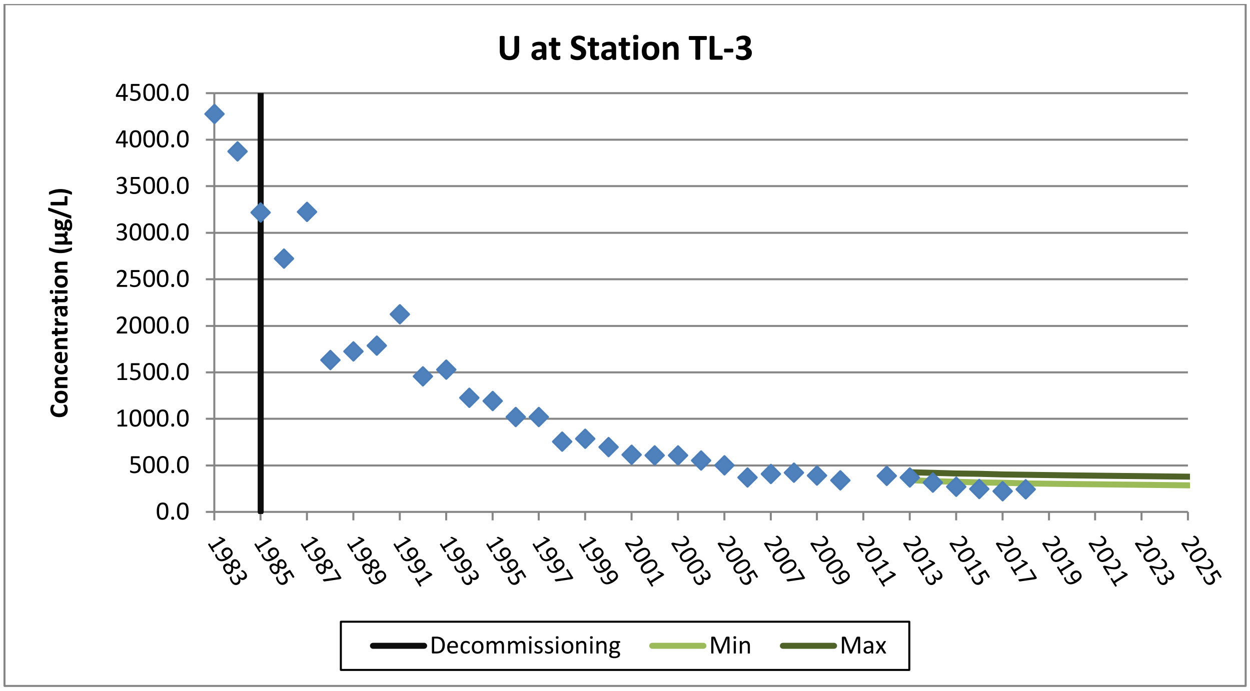
Note: Method detection limit changed from 0.001 mg/L to 0.0001 mg/L in 2003.

Figure 4.3.2-4 AN-3 Fulton Lake (Upstream of TL Stations)



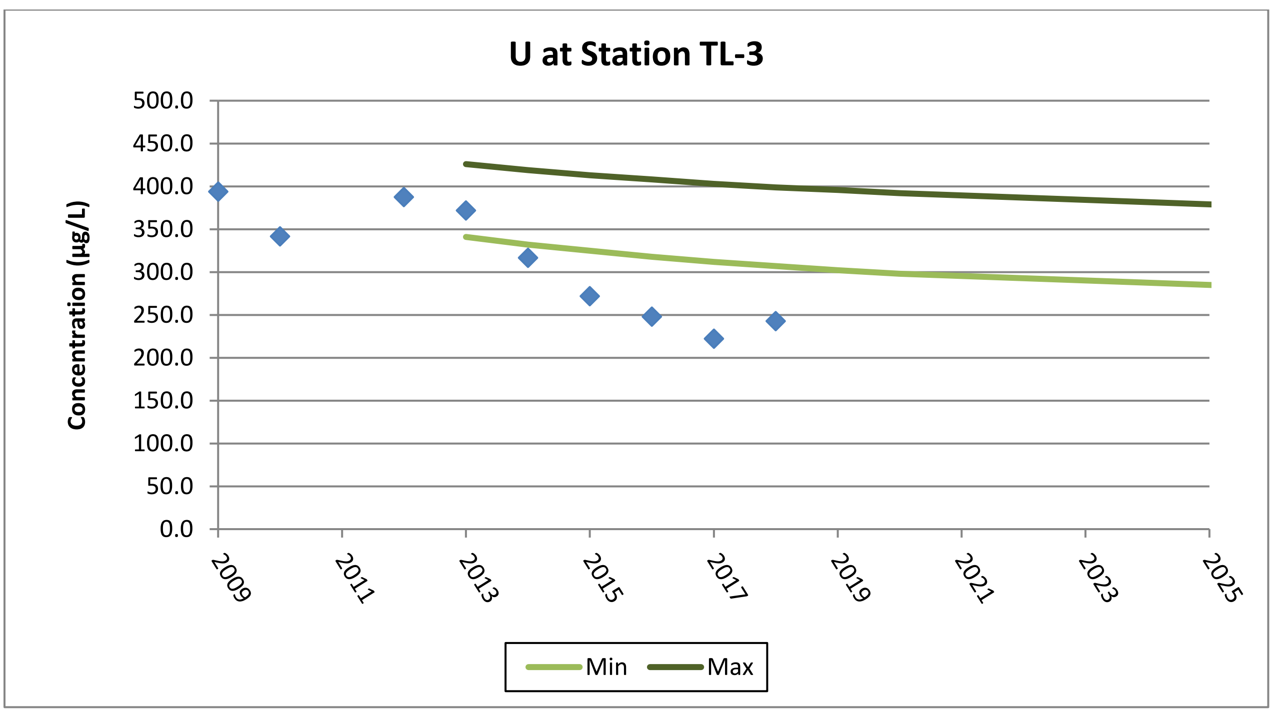
**The 2010 and 2011 scheduled sampling was not completed due to a lack of water flow.*

Figure 4.3.2-5 TL-3 Fookes Reservoir Discharge



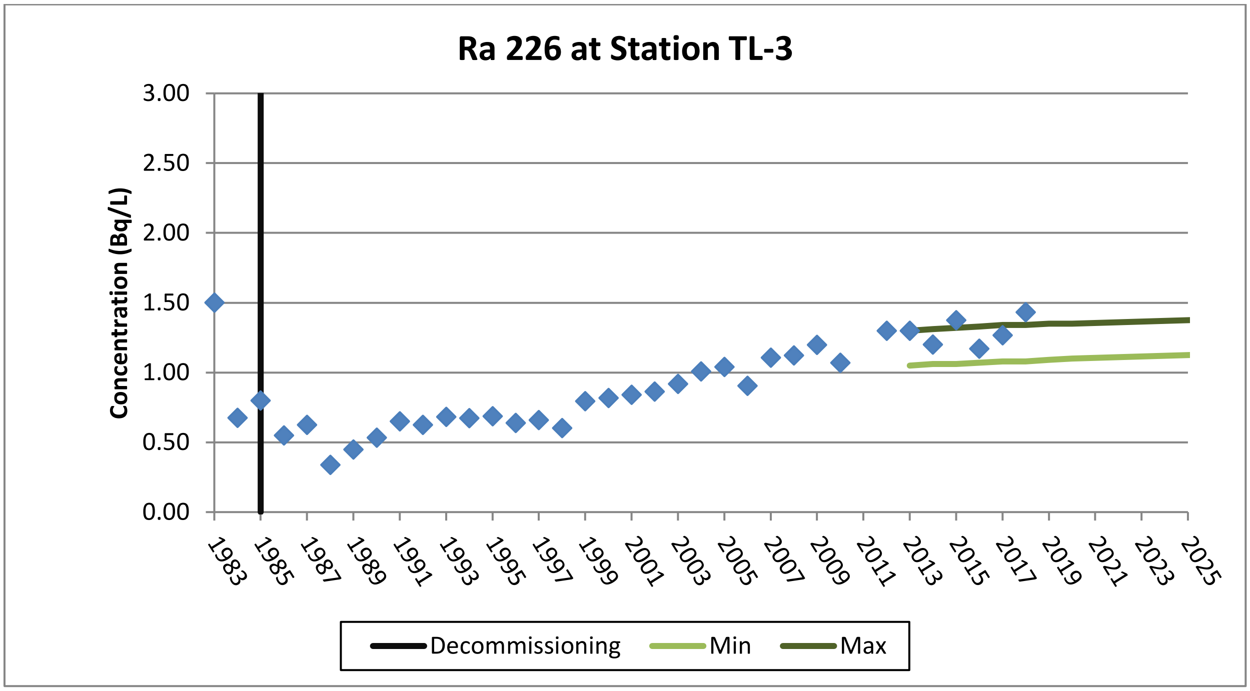
**No data available for 2011 due to a lack of water flow.*

Figure 4.3.2-6 TL-3 Fookes Reservoir Discharge – Detailed Trend



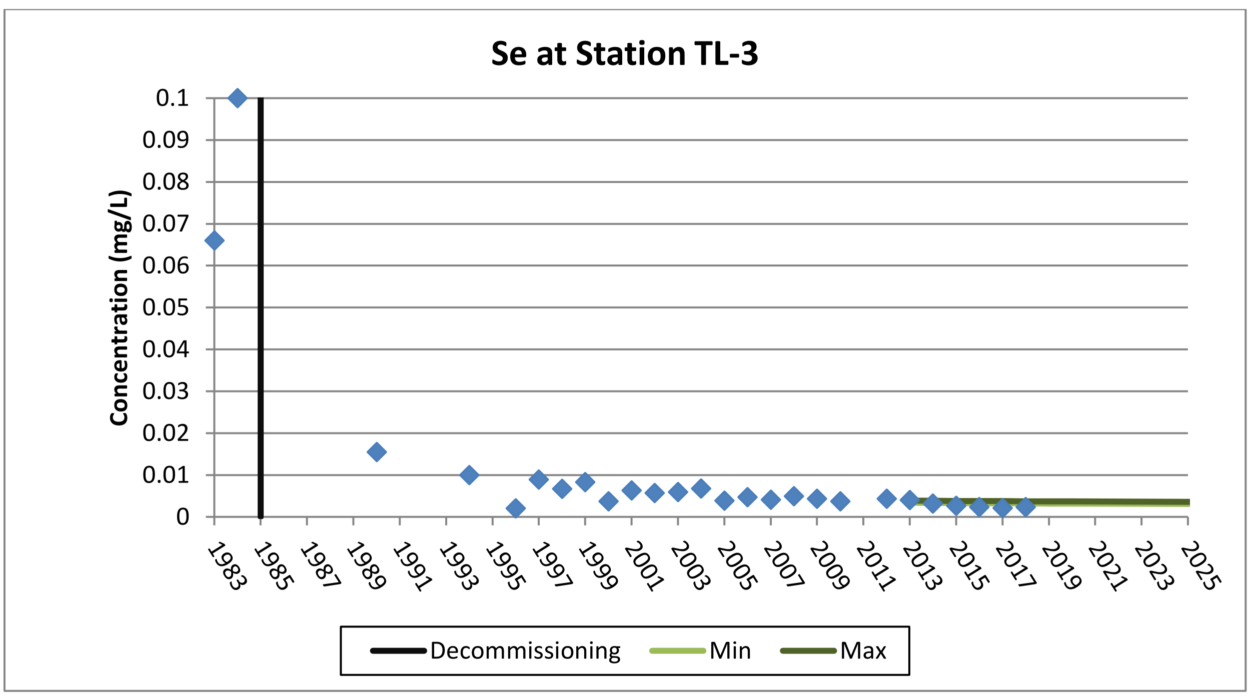
**No data available for 2011 due to a lack of water flow.*

Figure 4.3.2-7 TL-3 Fookes Reservoir Discharge



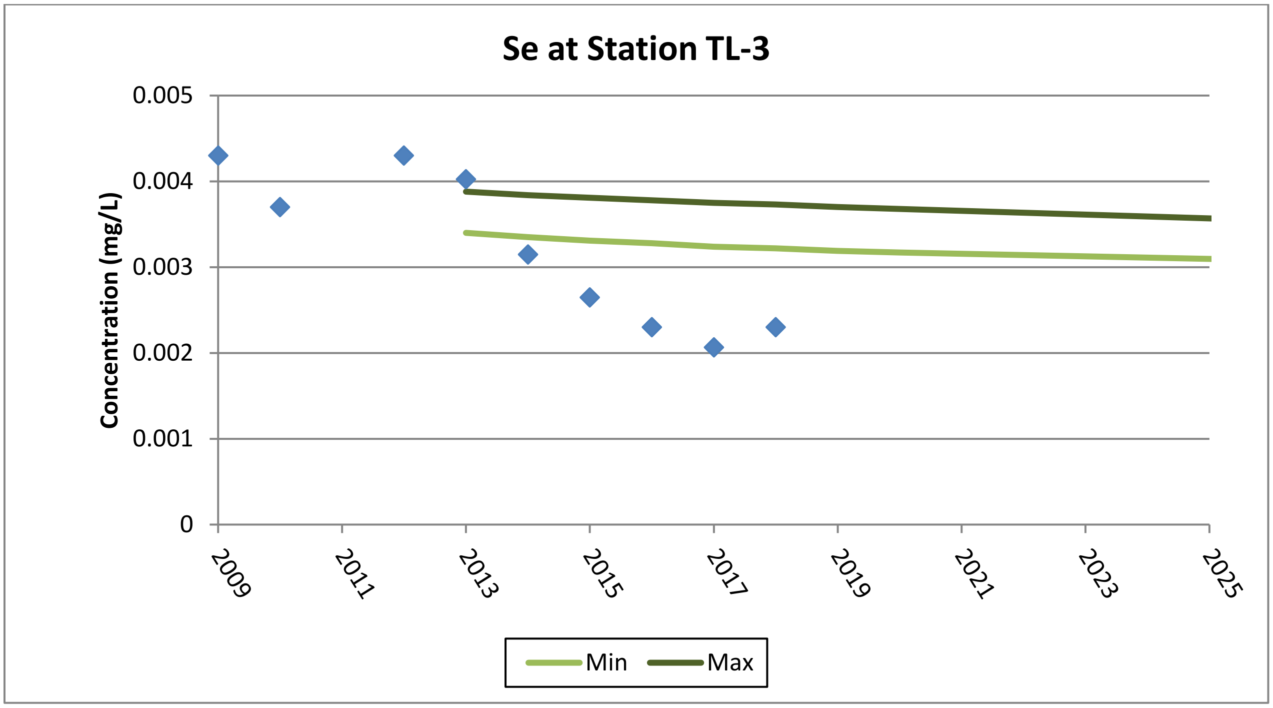
**No data available for 2011 due to a lack of water flow.*

Figure 4.3.2-8 TL-3 Fookes Reservoir Discharge



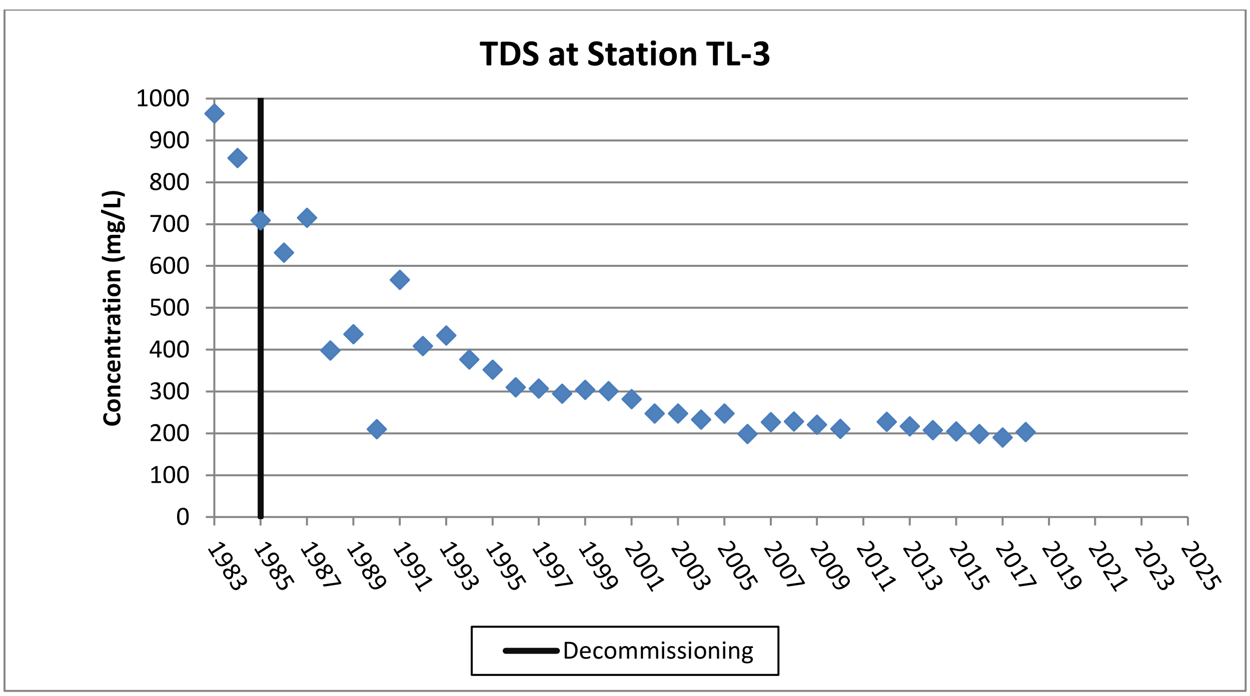
**No data available for 2011 due to a lack of water flow.*

Figure 4.3.2-9 TL-3 Fookes Reservoir Discharge – Detailed Trend



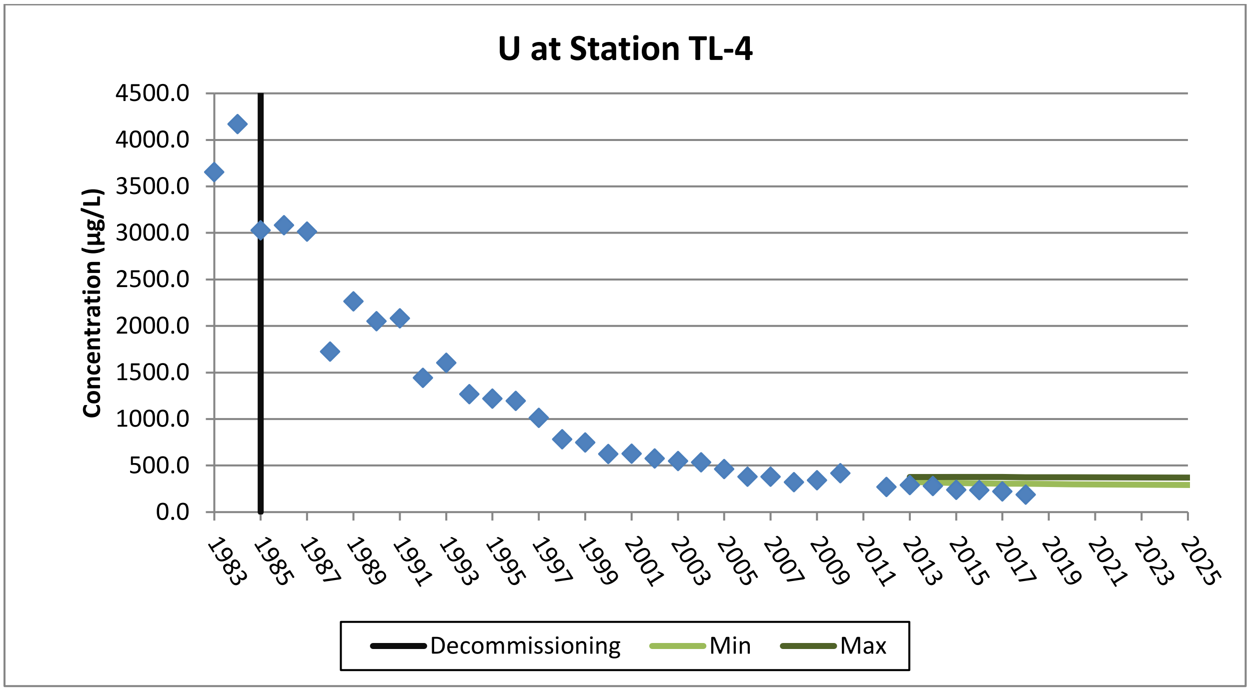
**No data available for 2011 due to a lack of water flow.*

Figure 4.3.2-10 TL-3 Fookes Reservoir Discharge



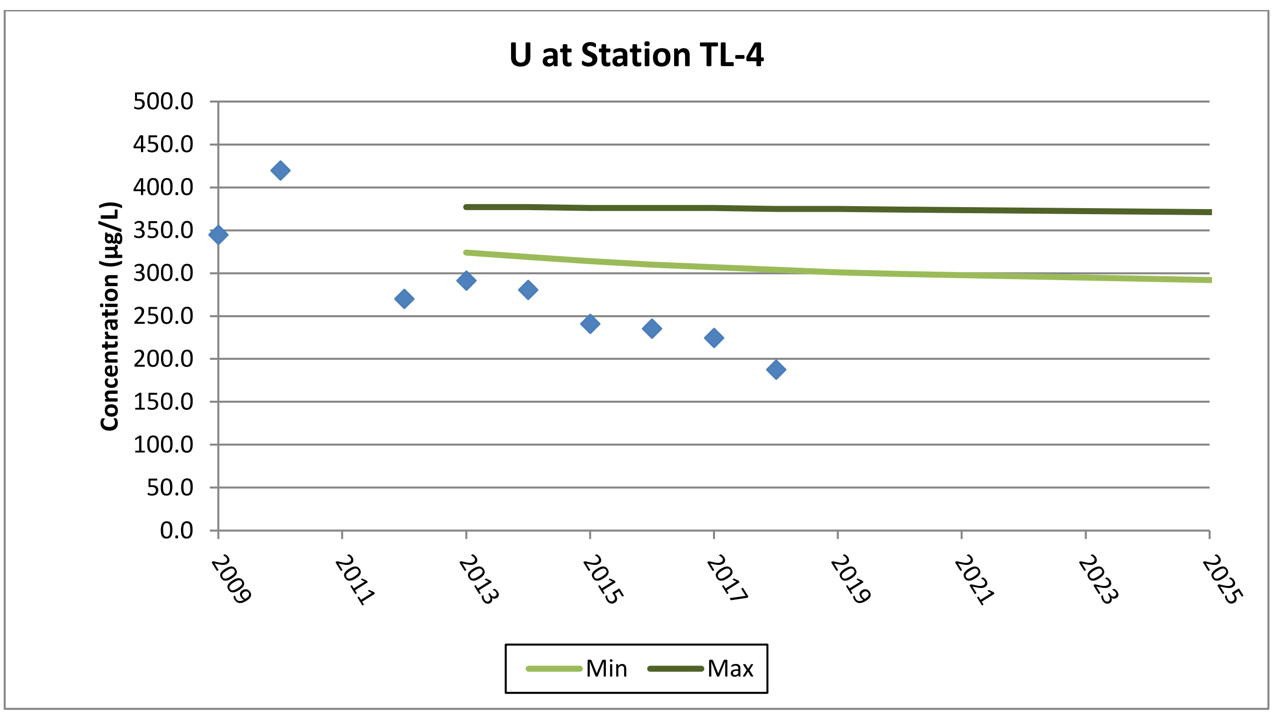
**No data available for 2011 due to a lack of water flow.*

Figure 4.3.2-11 TL-4 Marie Reservoir Discharge



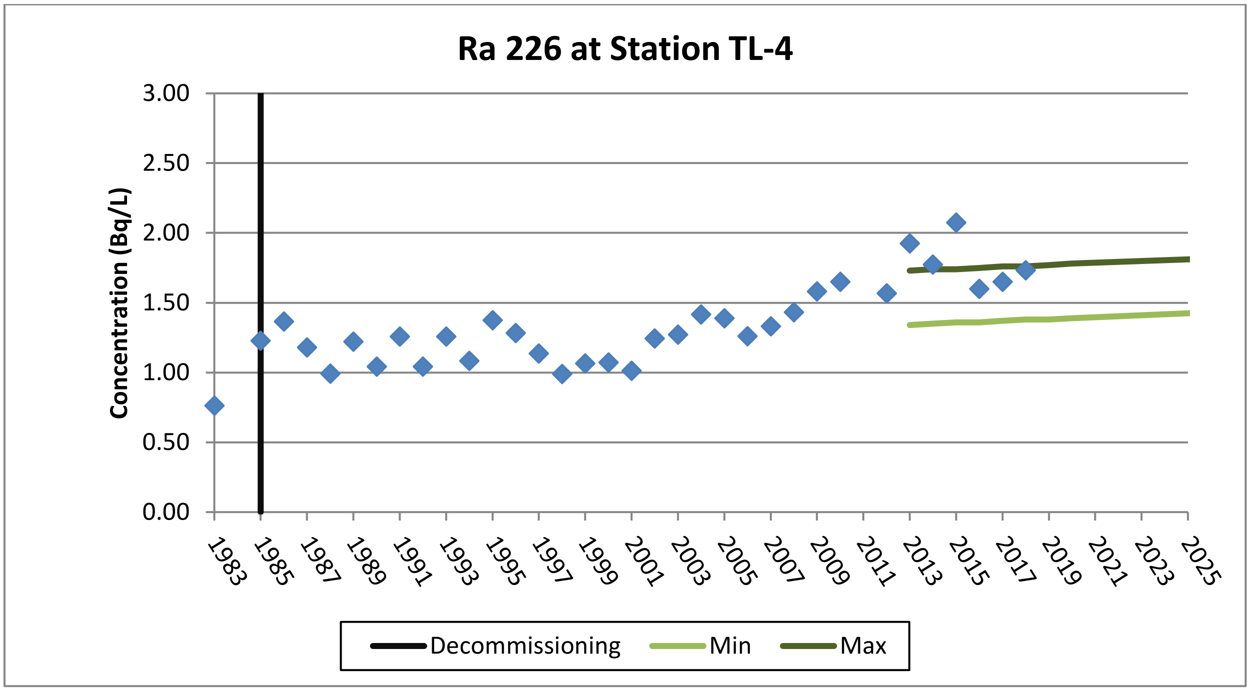
**No data available for 2011 due to a lack of water flow.*

Figure 4.3.2-12 TL-4 Marie Reservoir Discharge – Detailed Trend



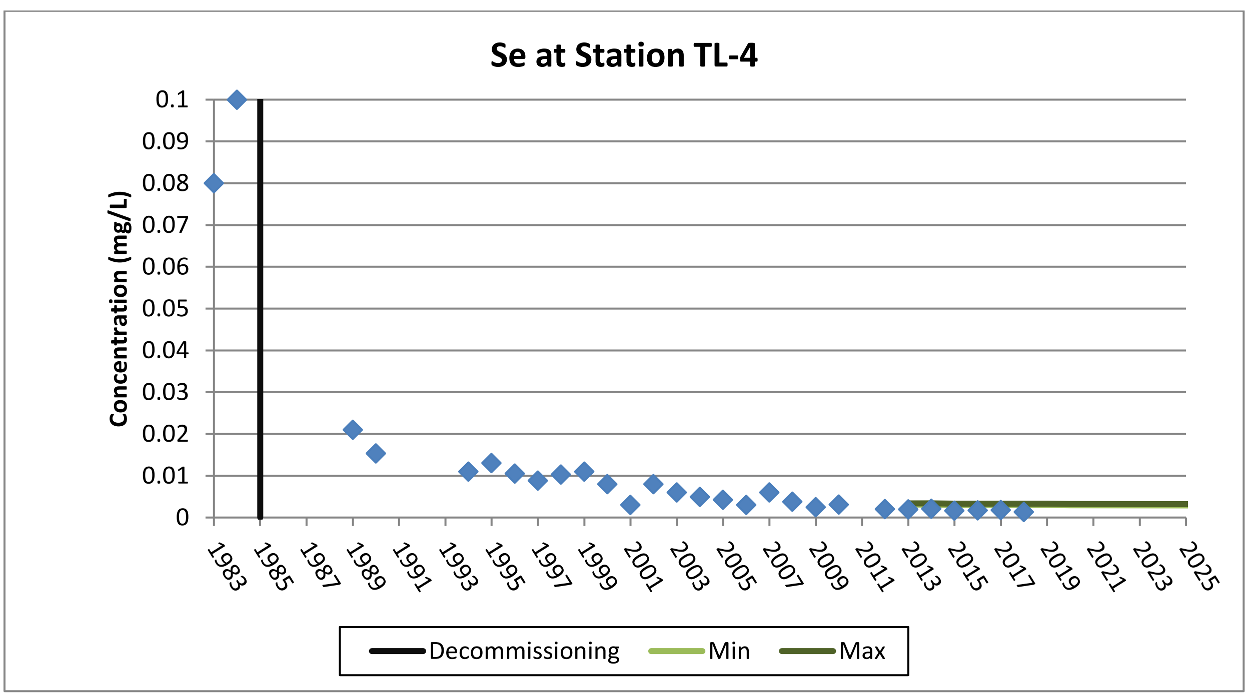
**No data available for 2011 due to a lack of water flow.*

Figure 4.3.2-13 TL-4 Marie Reservoir Discharge



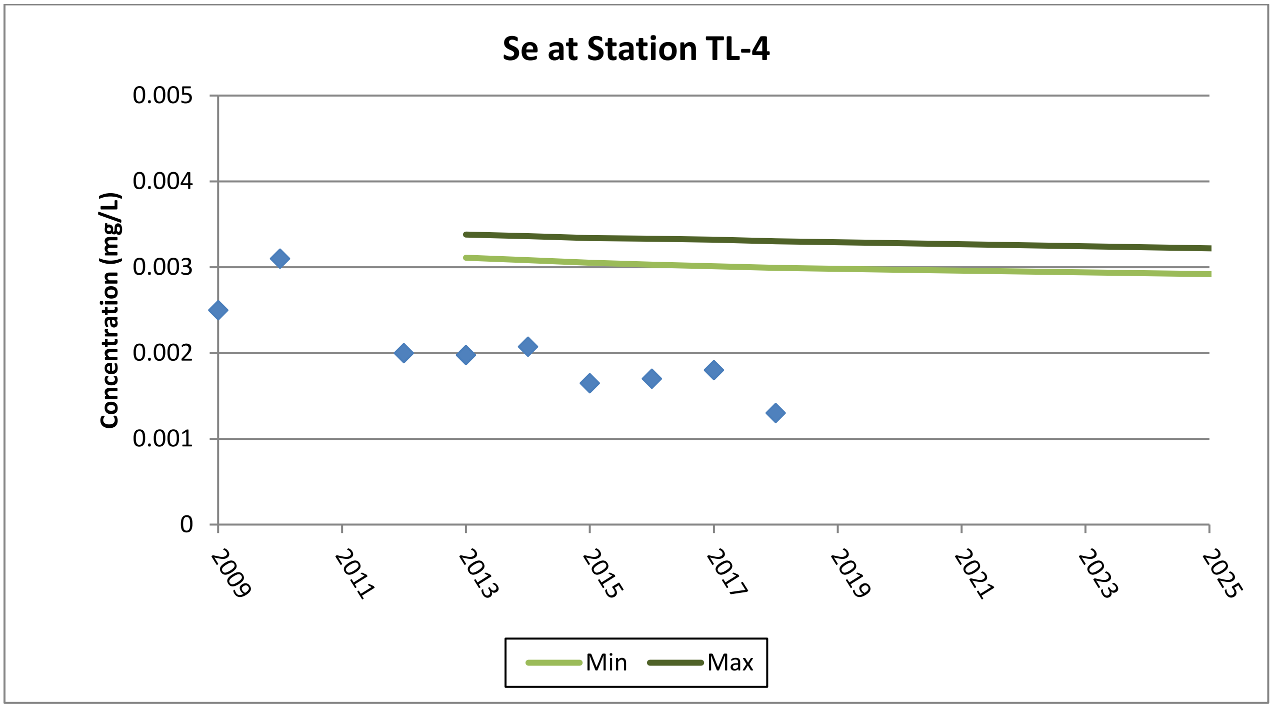
**No data available for 2011 due to a lack of water flow.*

Figure 4.3.2-14 TL-4 Marie Reservoir Discharge



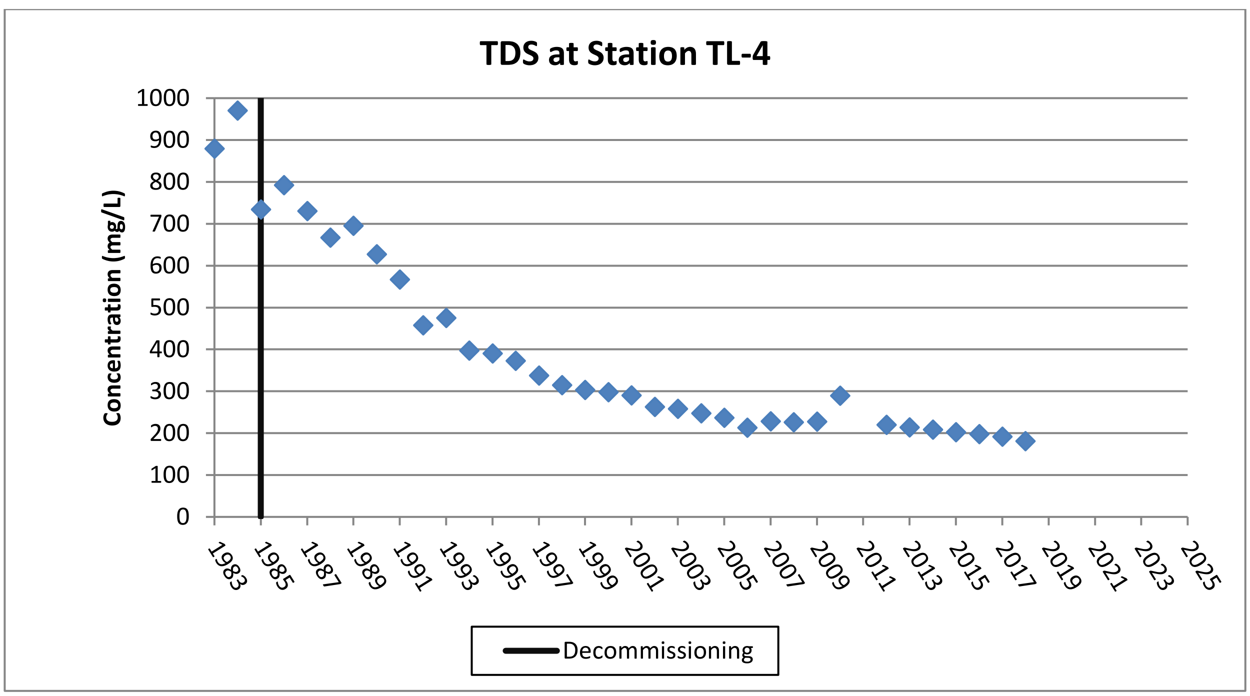
**No data available for 2011 due to a lack of water flow.*

Figure 4.3.2-15 TL-4 Marie Reservoir Discharge – Detailed Trend



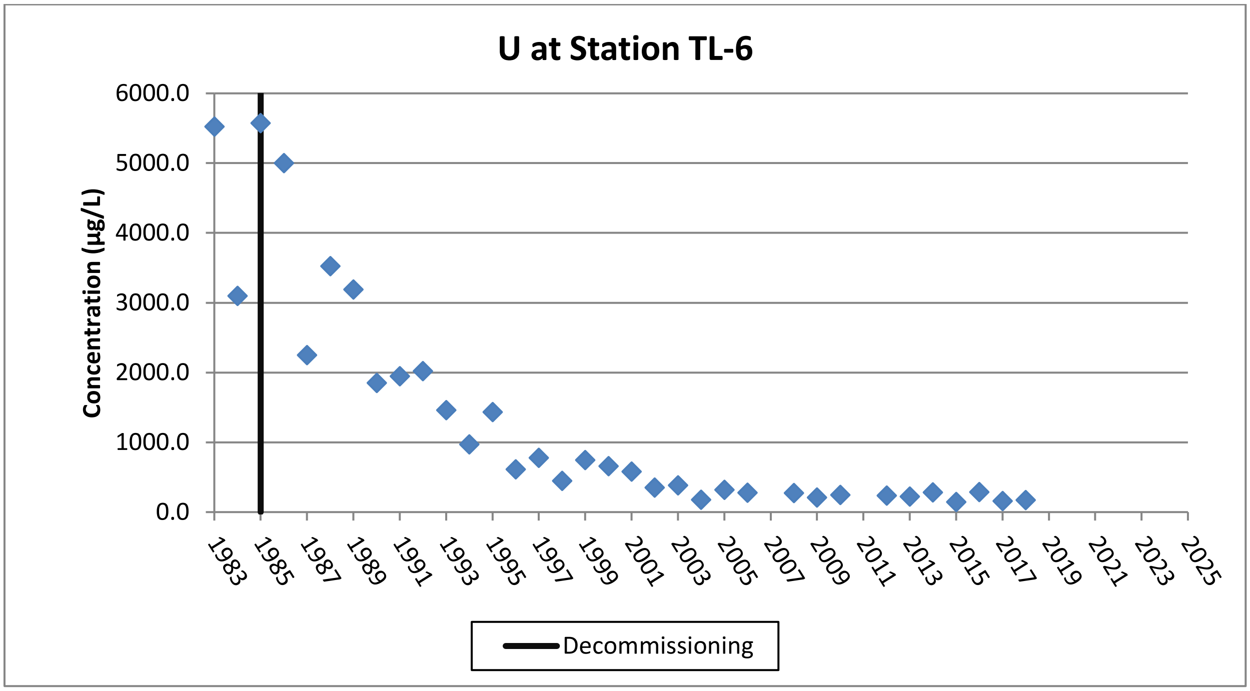
**No data available for 2011 due to a lack of water flow.*

Figure 4.3.2-16 TL-4 Marie Reservoir Discharge



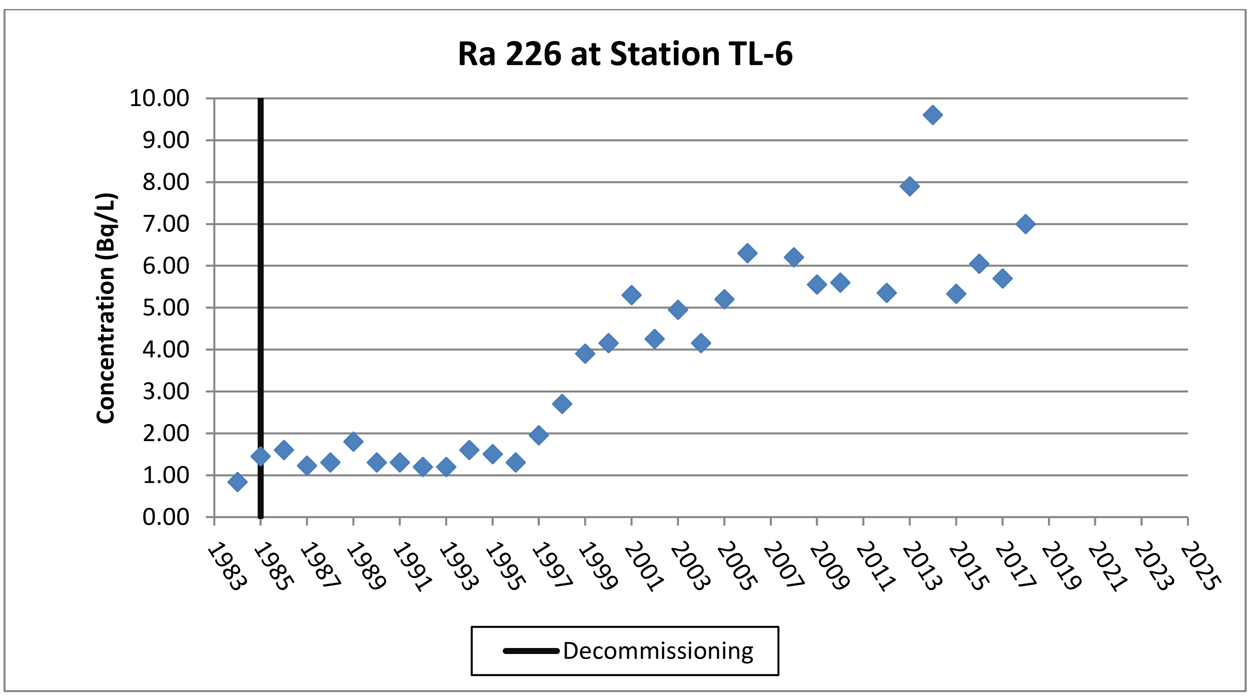
**No data available for 2011 due to a lack of water flow.*

Figure 4.3.2-17 TL-6 Minewater Reservoir Discharge



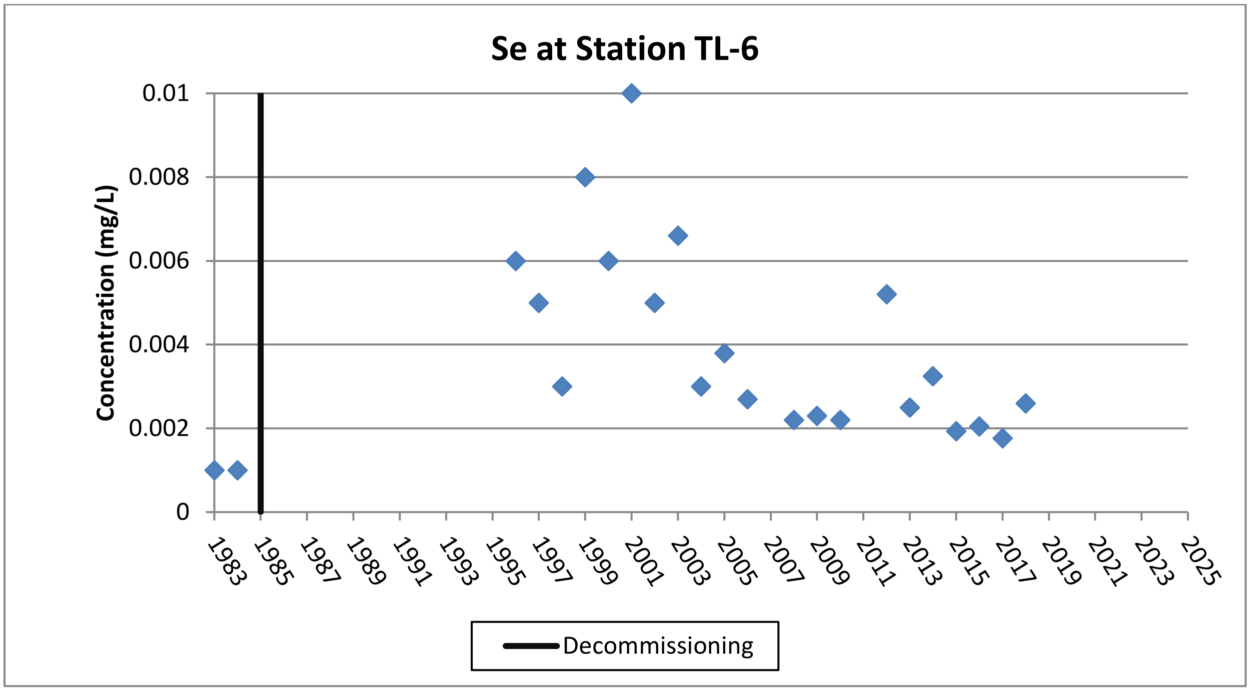
**No data available for 2007 and 2011 due to a lack of water flow.*

Figure 4.3.2-18 TL-6 Minewater Reservoir Discharge



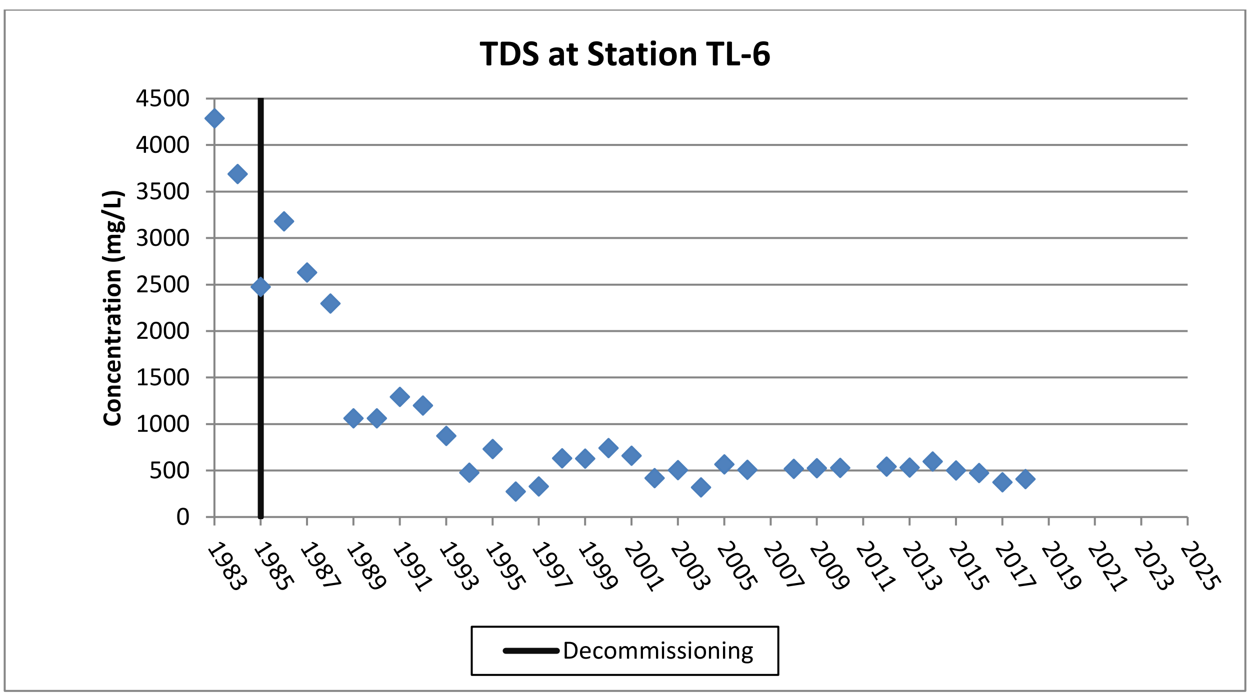
**No data available for 2007 and 2011 due to a lack of water flow.*

Figure 4.3.2-19 TL-6 Minewater Reservoir Discharge



**No data available for 2007 and 2011 due to a lack of water flow.*

Figure 4.3.2-20 TL-6 Minewater Reservoir Discharge



**No data available for 2007 and 2011 due to a lack of water flow.*

Figure 4.3.2-21 TL-7 Meadow Fen Discharge

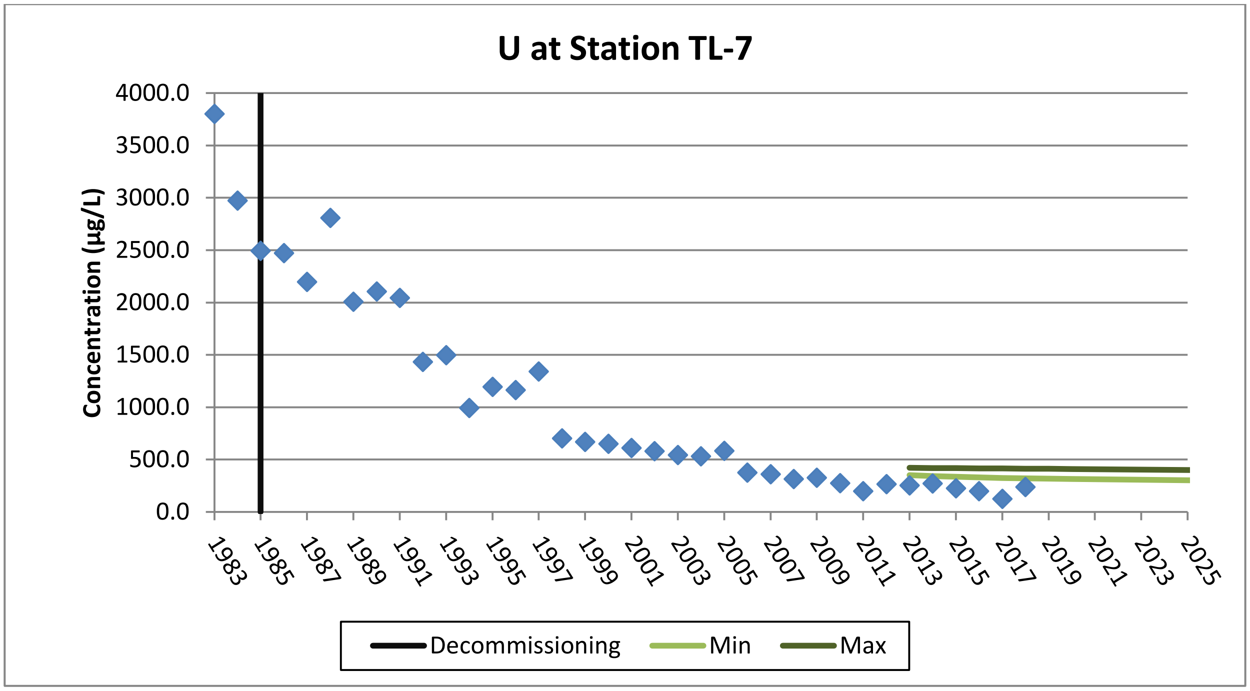


Figure 4.3.2-22 TL-7 Meadow Fen Discharge - Detailed Trend

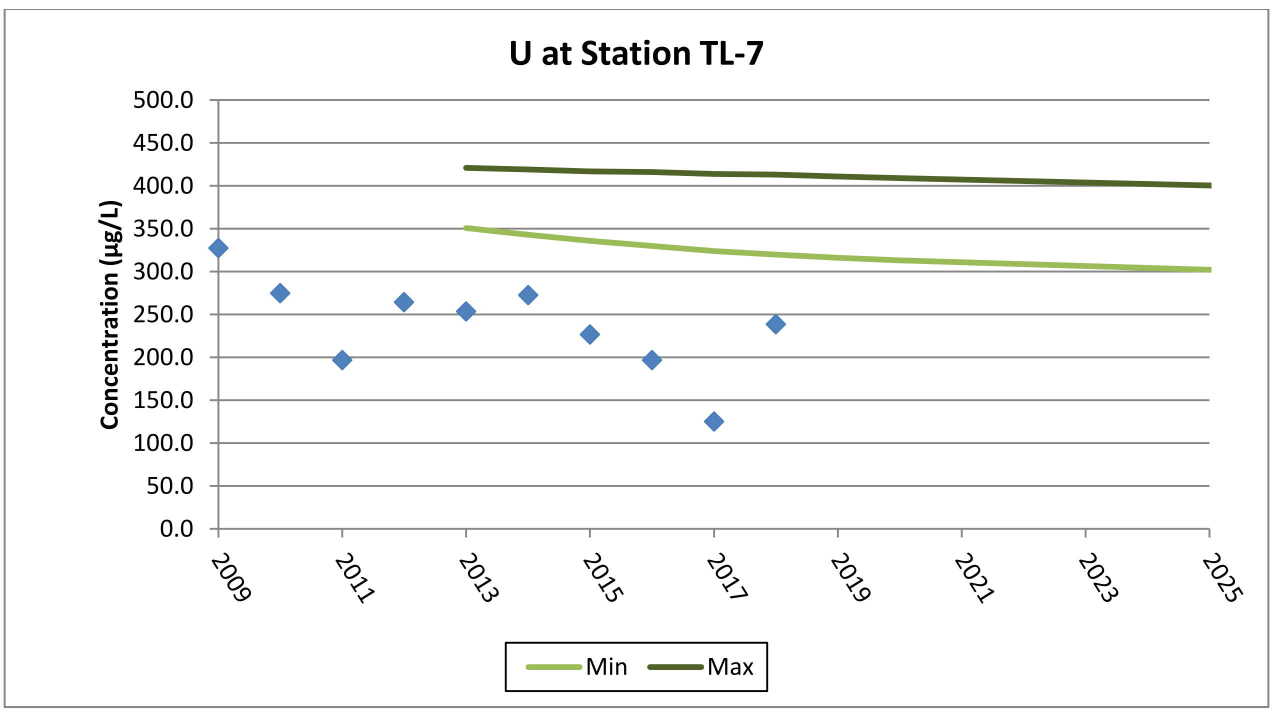


Figure 4.3.2-23 TL-7 Meadow Fen Discharge

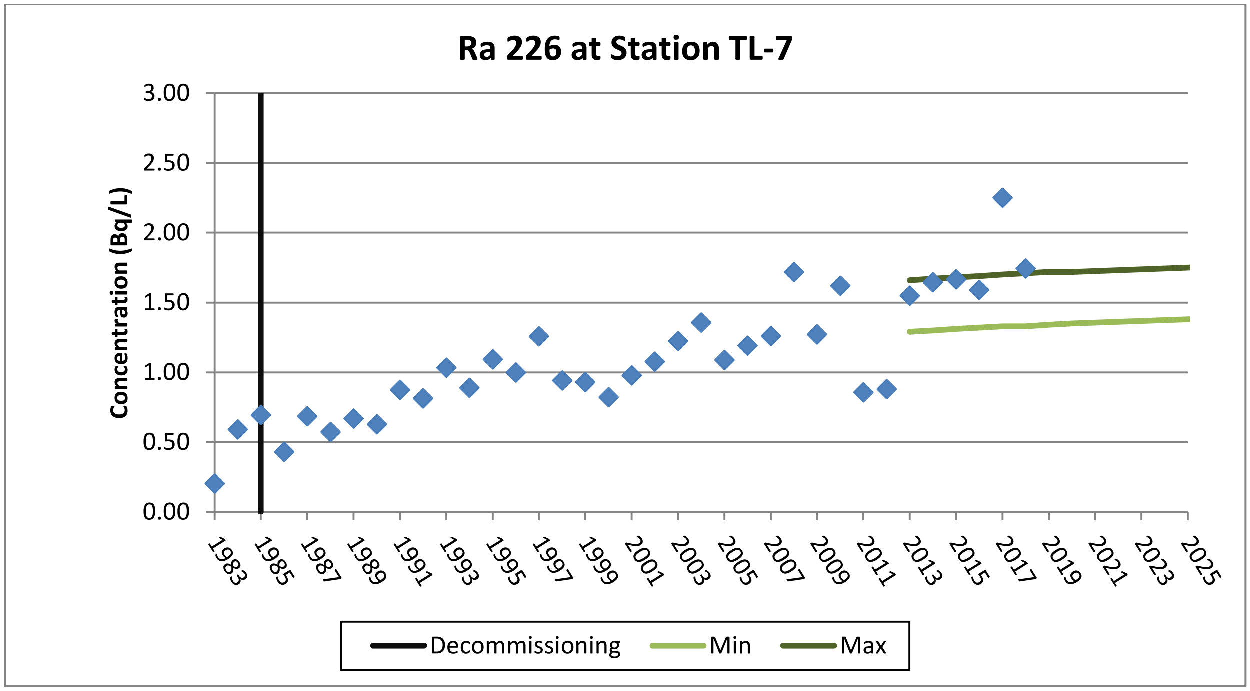


Figure 4.3.2-24 TL-7 Meadow Fen Discharge

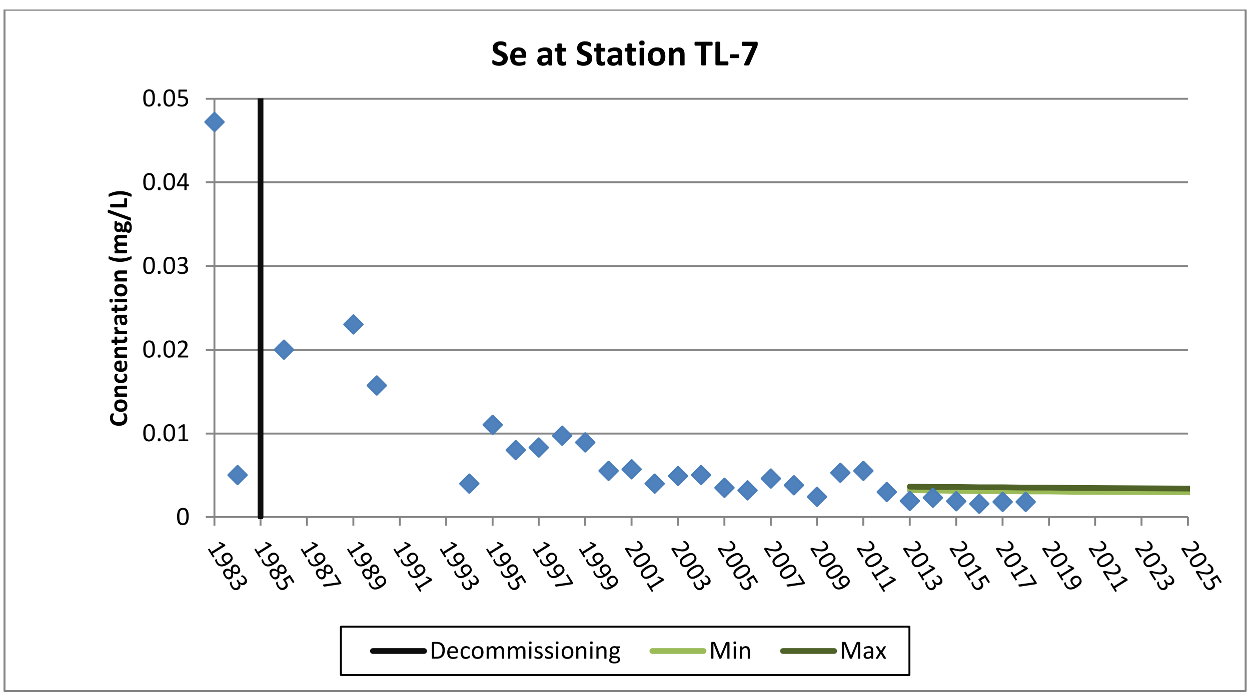


Figure 4.3.2-25 TL-7 Meadow Fen Discharge – Detailed Trend

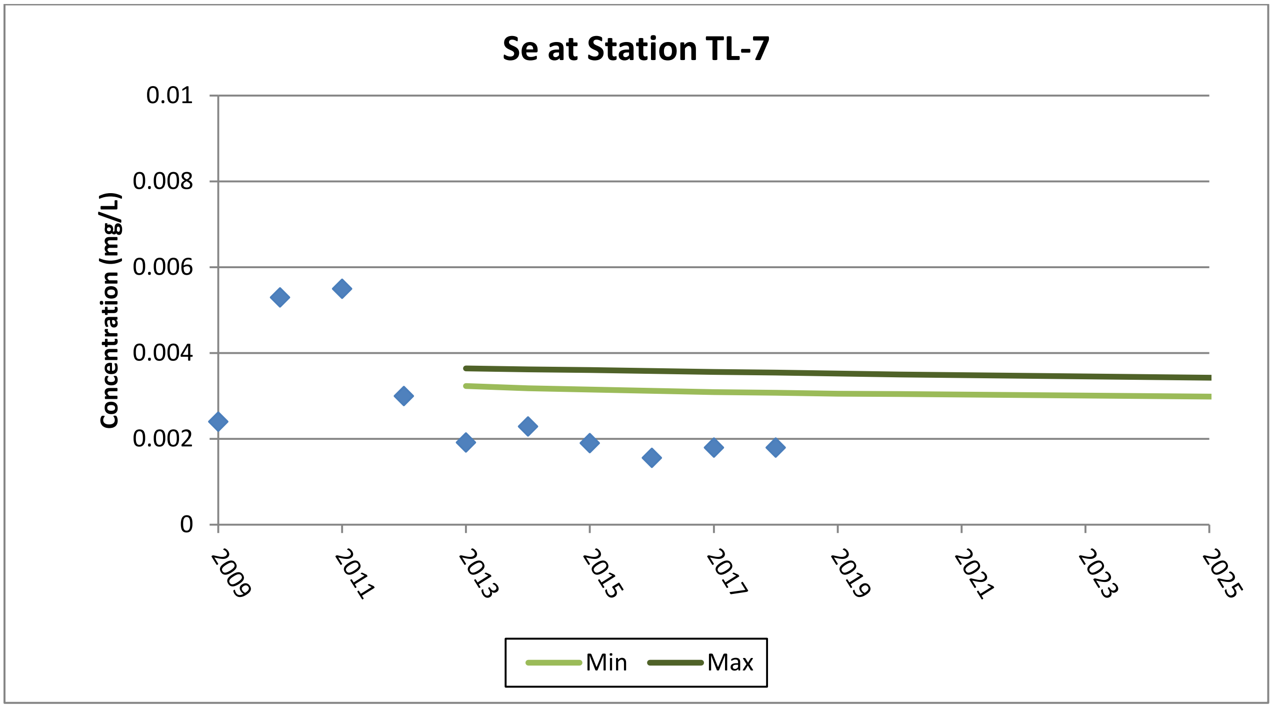


Figure 4.3.2-26 TL-7 Meadow Fen Discharge

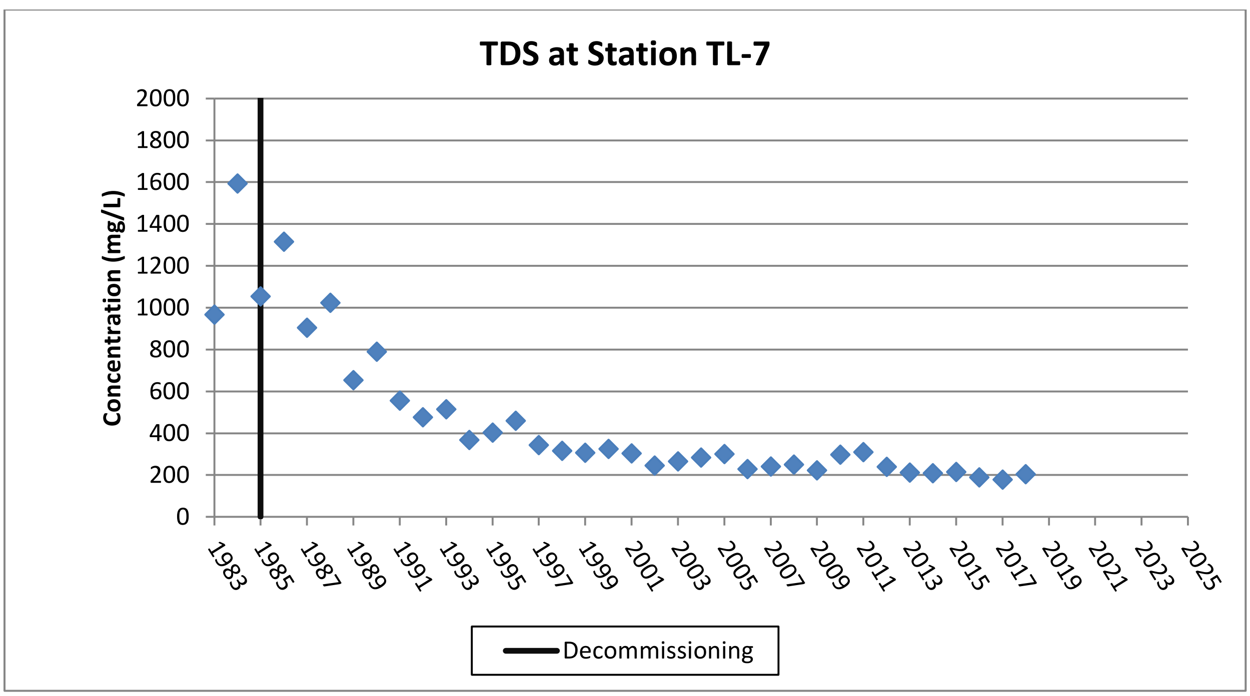
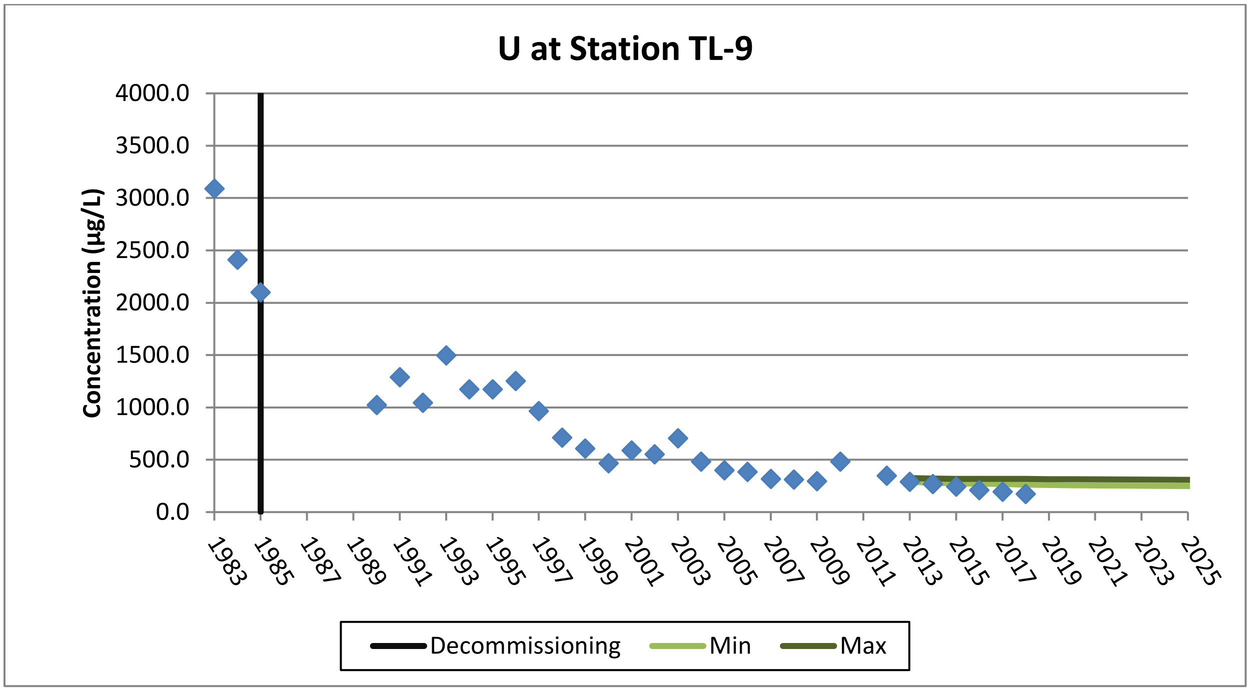
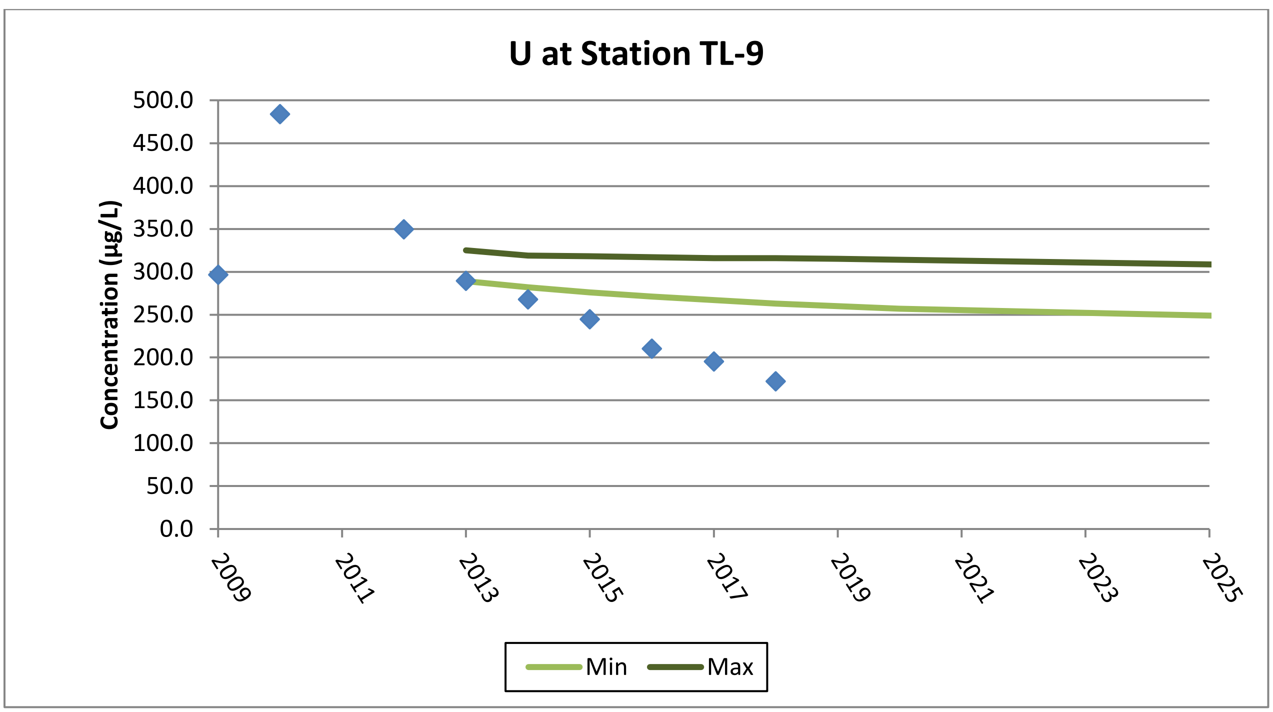


Figure 4.3.2-27 TL-9 Fulton Creek Downstream of Greer Lake



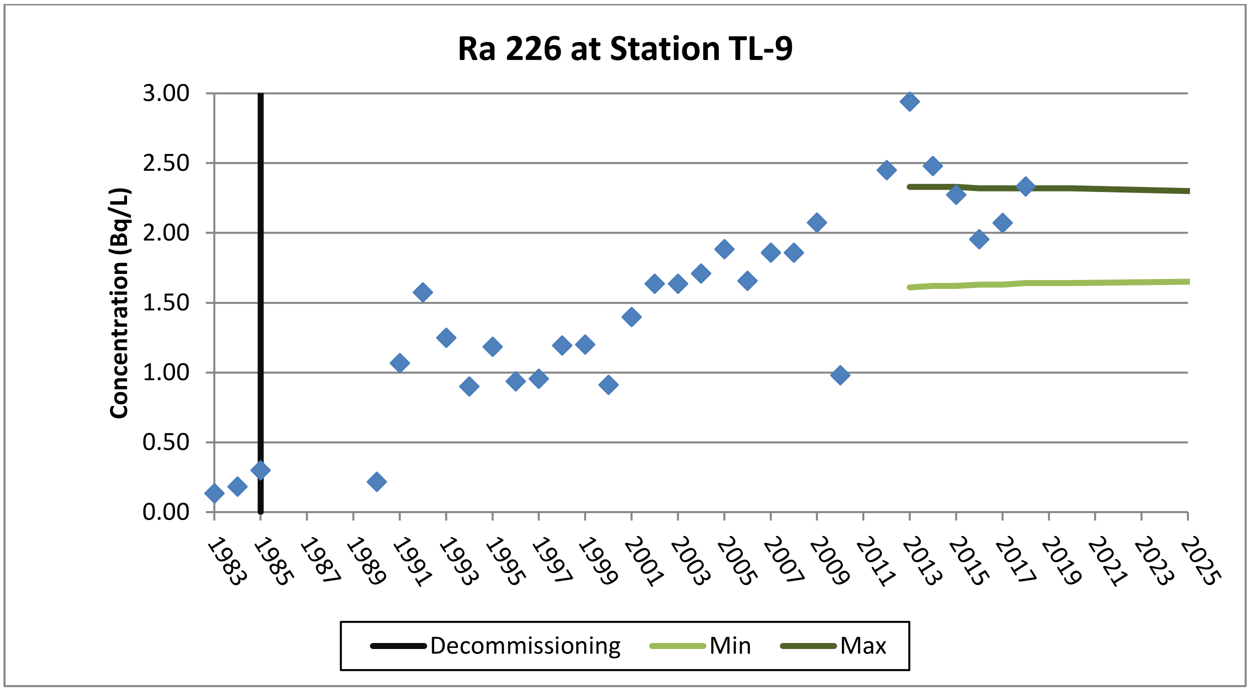
**There was no water flow at TL-9 in 2011.*

Figure 4.3.2-28 TL-9 Fulton Creek Downstream of Greer Lake – Detailed Trend



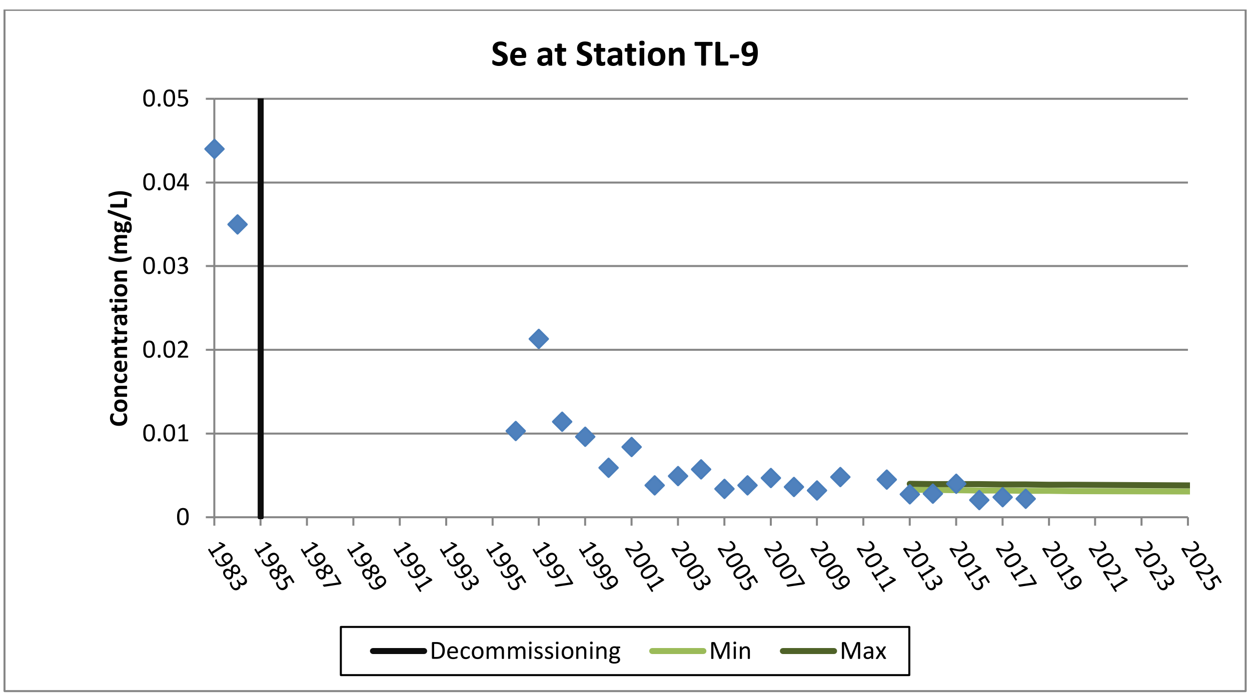
**There was no water flow at TL-9 in 2011.*

Figure 4.3.2-29 TL-9 Fulton Creek Downstream of Greer Lake



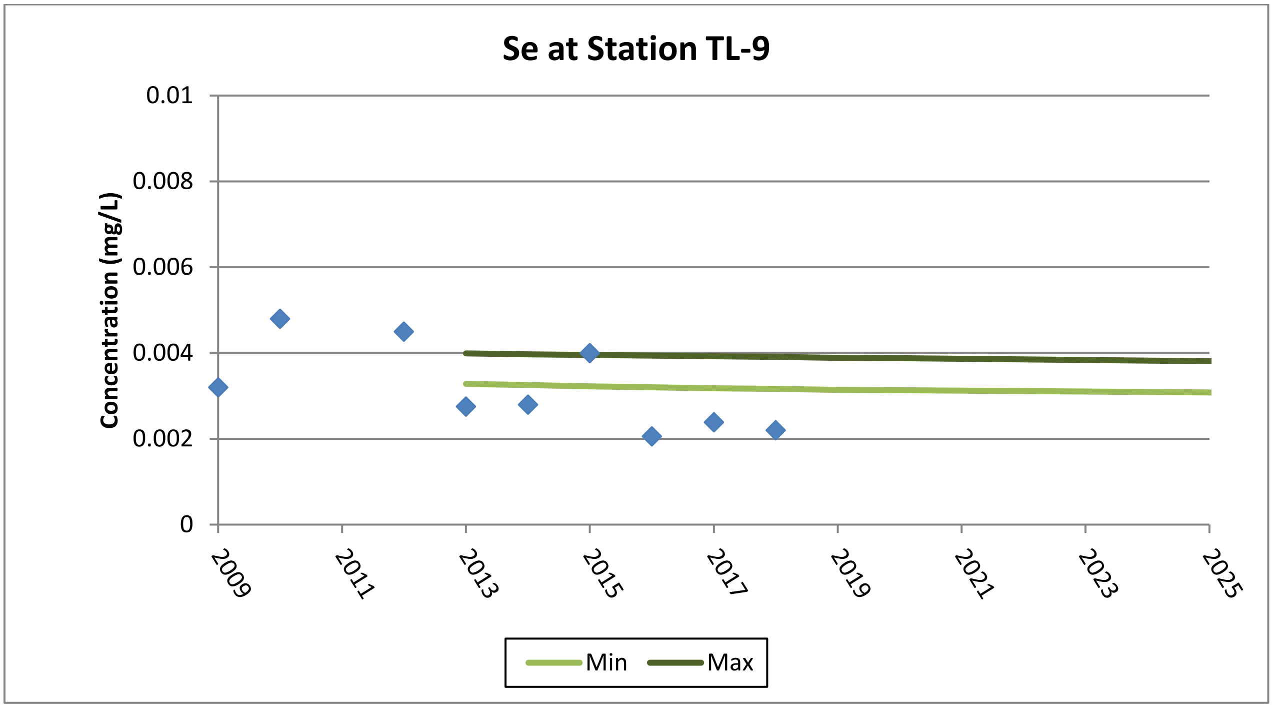
**There was no water flow at TL-9 in 2011.*

Figure 4.3.2-30 TL-9 - Fulton Creek Downstream of Greer Lake



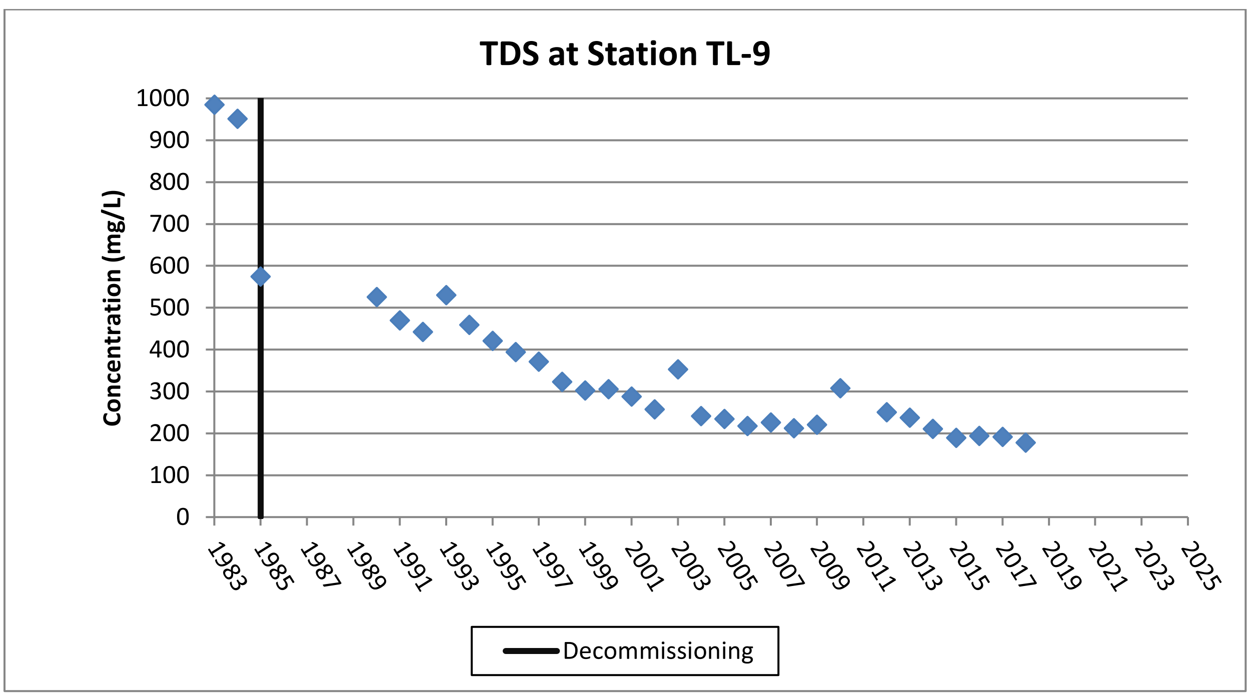
**There was no water flow at TL-9 in 2011.*

Figure 4.3.2-31 TL-9 - Fulton Creek Downstream of Greer Lake – Detailed Trend



**There was no water flow at TL-9 in 2011.*

Figure 4.3.2-32 TL-9 - Fulton Creek Downstream of Greer Lake



**There was no water flow at TL-9 in 2011.*

Figure 4.3.3-1 BL-3 - Beaverlodge Lake Opposite Fulton Creek Discharge

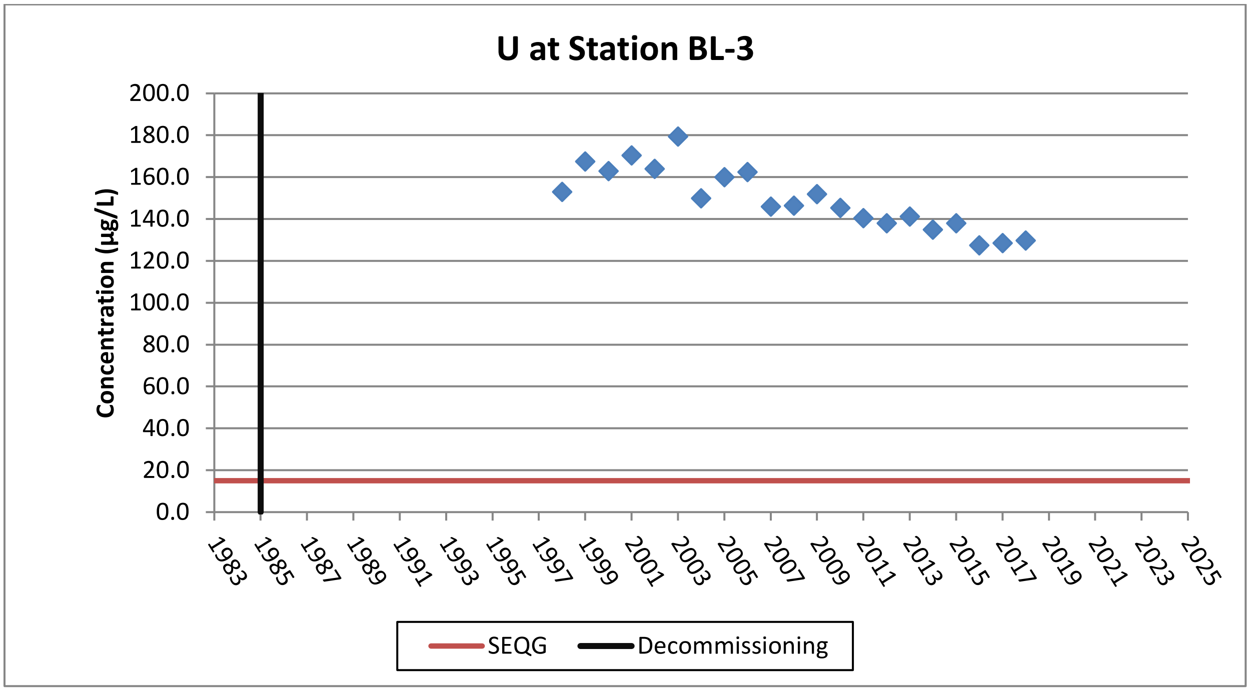


Figure 4.3.3-2 BL-3 - Beaverlodge Lake Opposite Fulton Creek Discharge

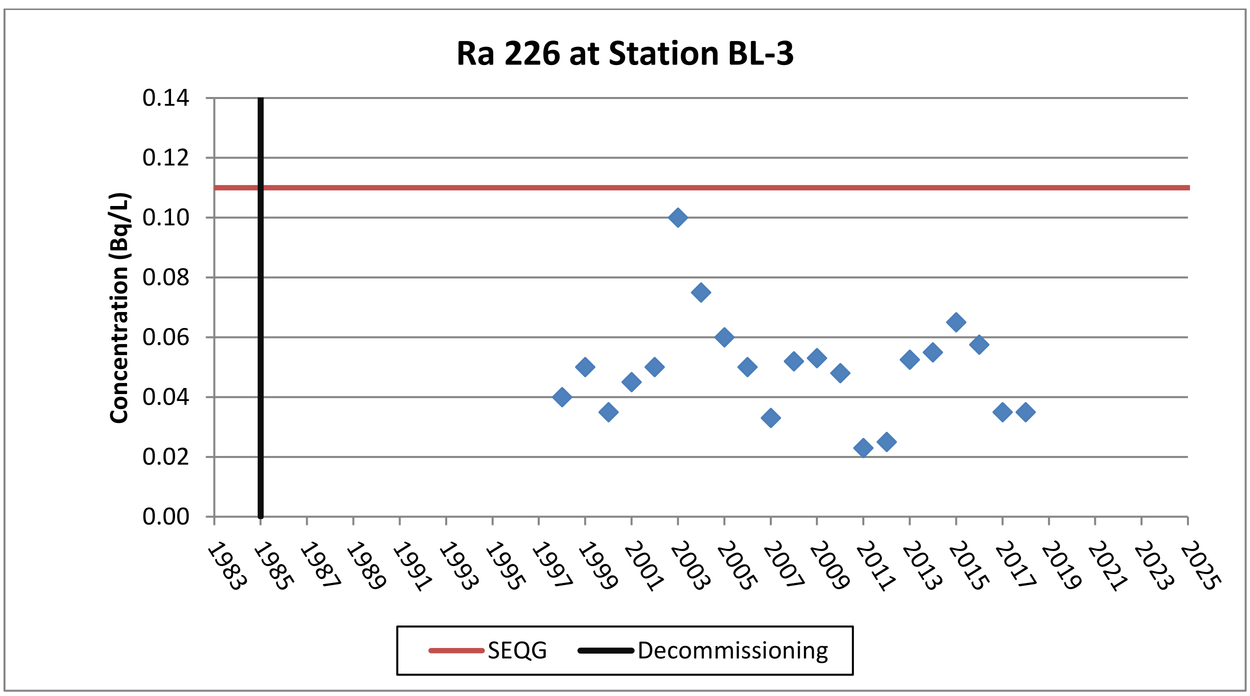
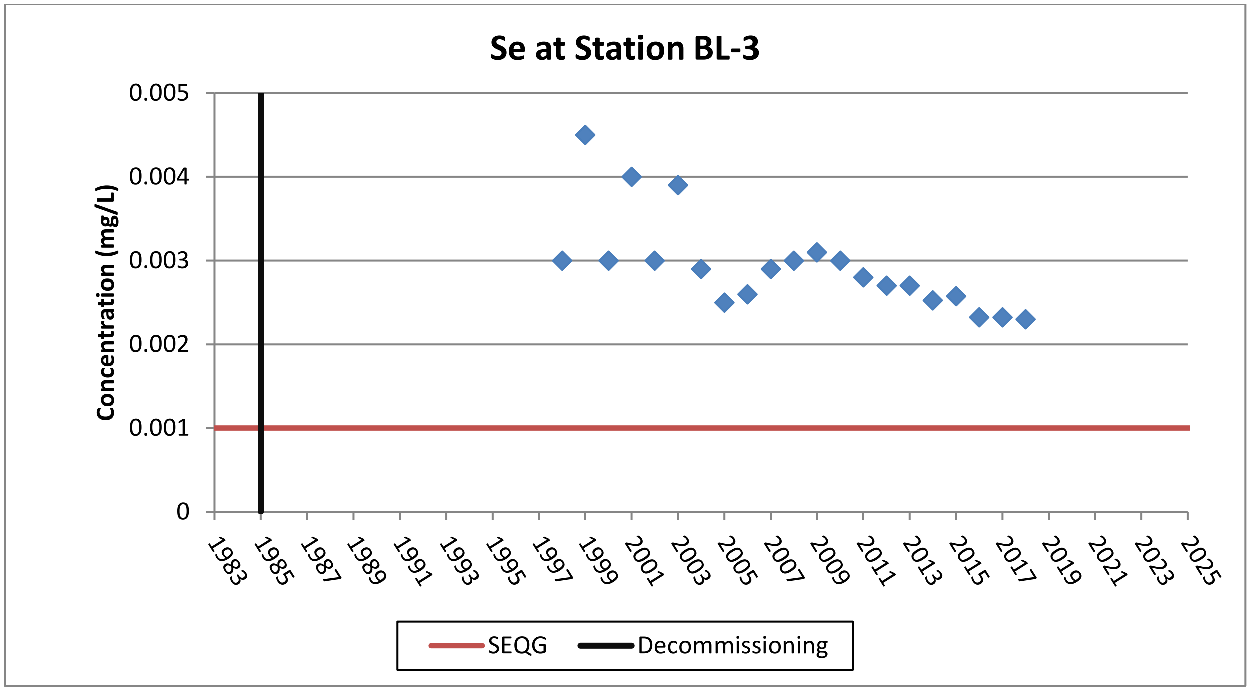


Figure 4.3.3-3 BL-3 - Beaverlodge Lake Opposite Fulton Creek Discharge



Note: Method detection limit changed from 0.001mg/L to 0.0001mg/L in 2003.

Figure 4.3.3-4 BL-3 - Beaverlodge Lake Opposite Fulton Creek Discharge

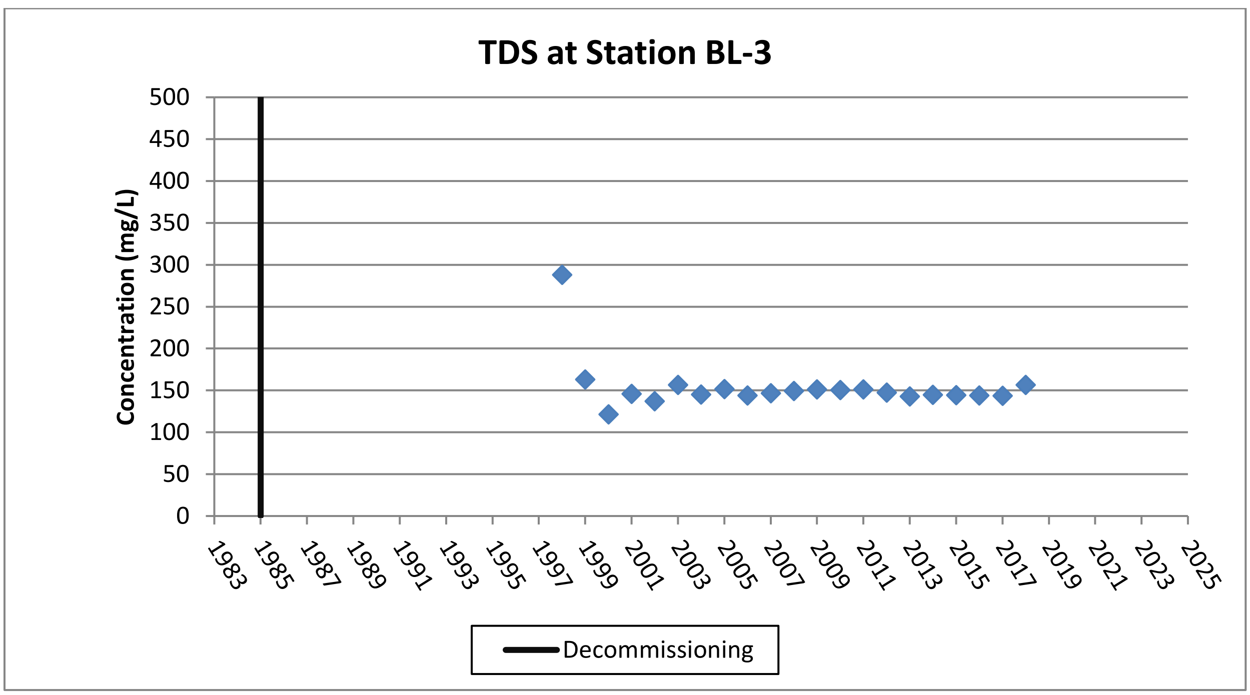


Figure 4.3.3-5 BL-4 Beaverlodge Lake Centre

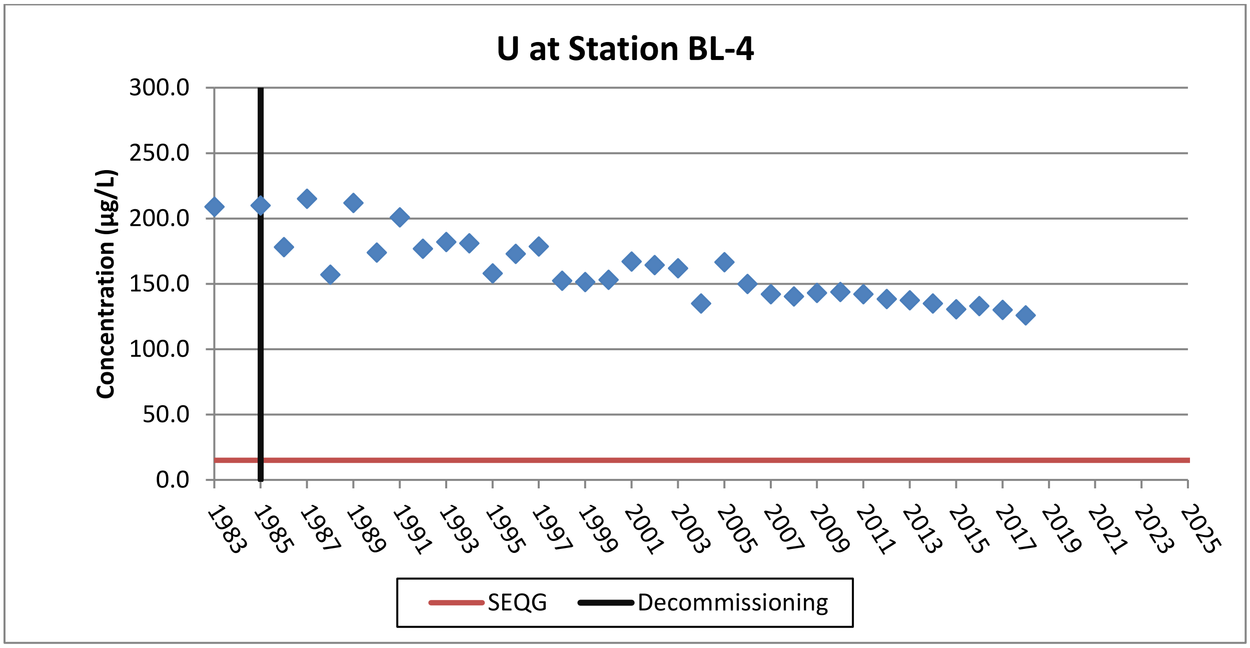


Figure 4.3.3-6 BL-4 Beaverlodge Lake Centre

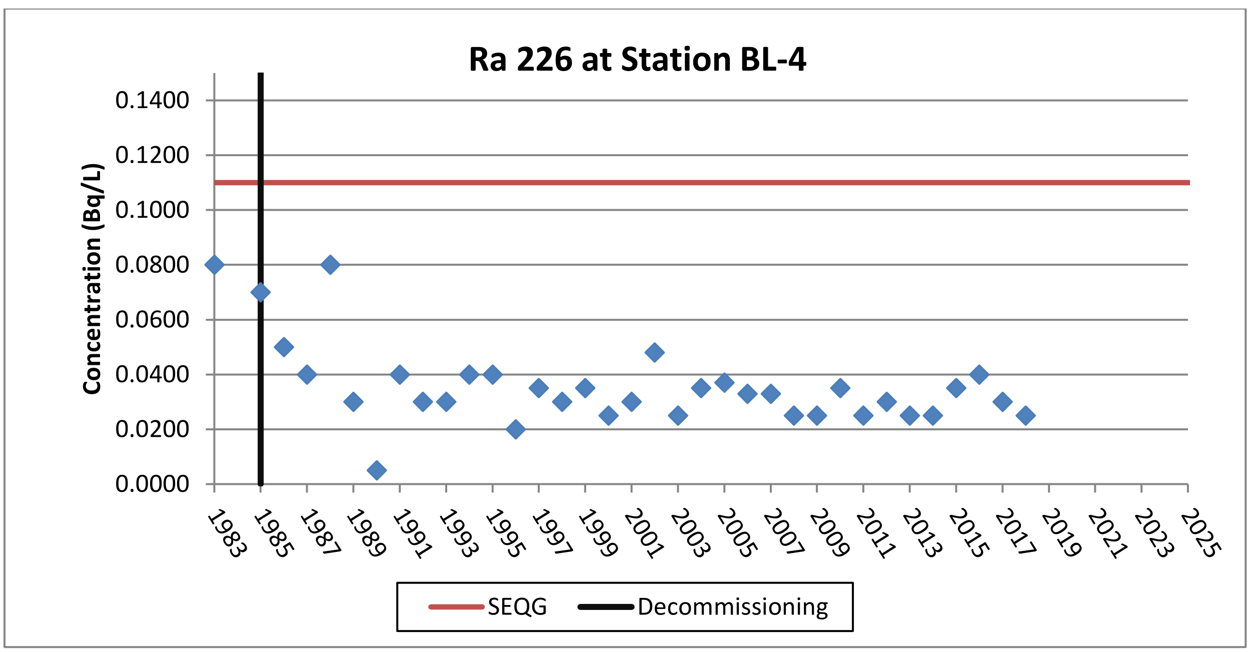
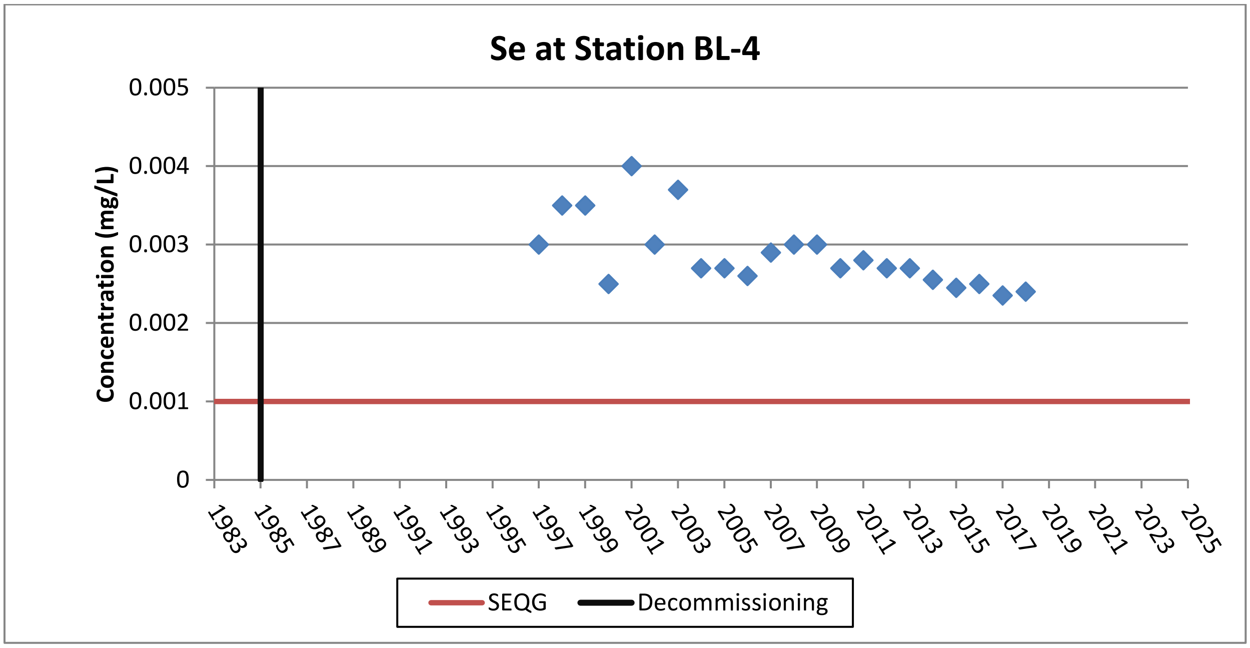


Figure 4.3.3-7 BL-4 Beaverlodge Lake Centre



Note: Method detection limit changed from 0.001mg/L to 0.0001mg/L in 2003.

Figure 4.3.3-8 BL-4 Beaverlodge Lake Centre

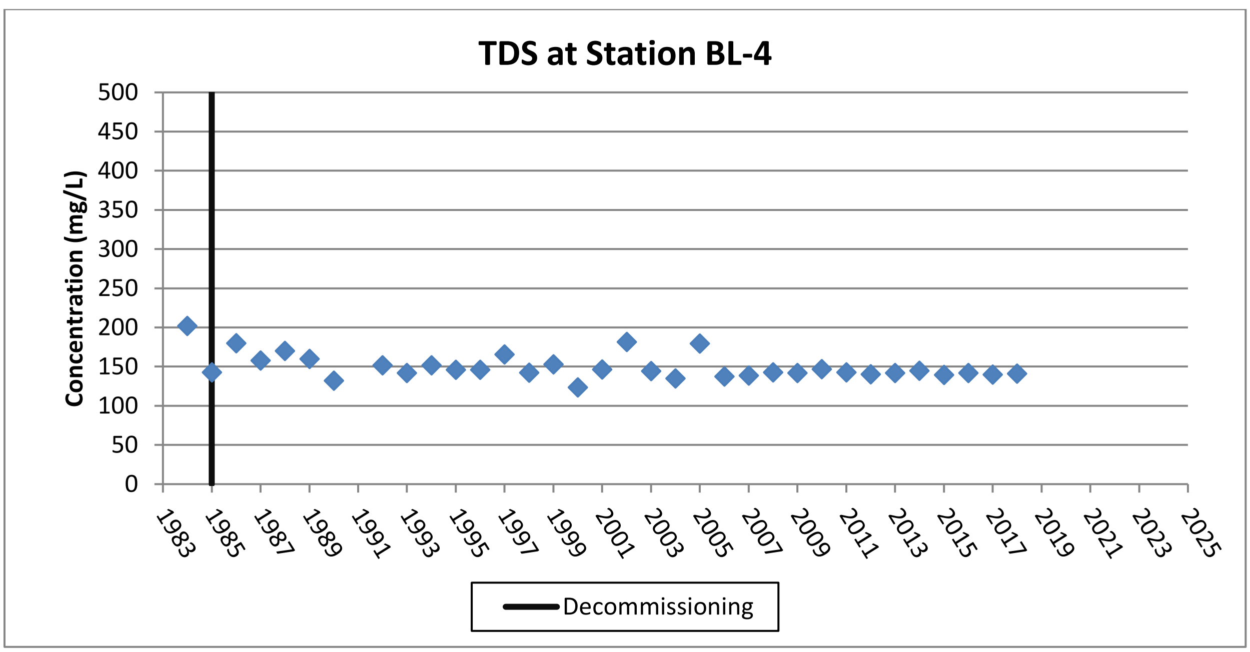
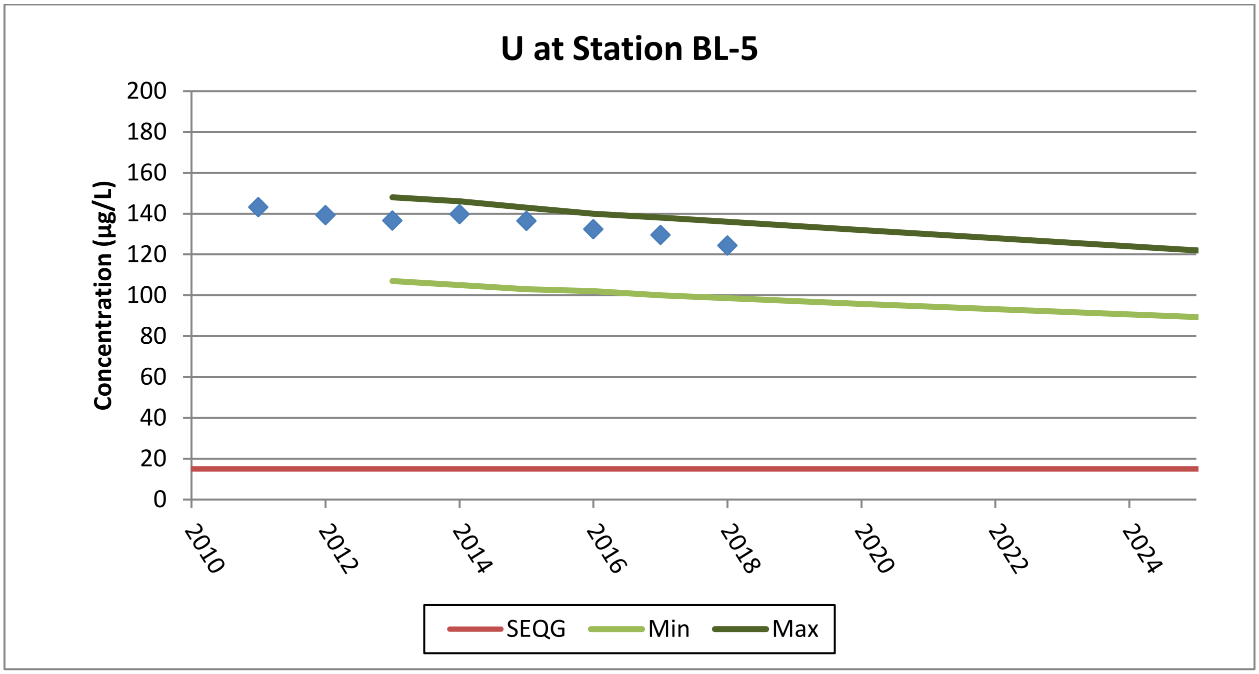
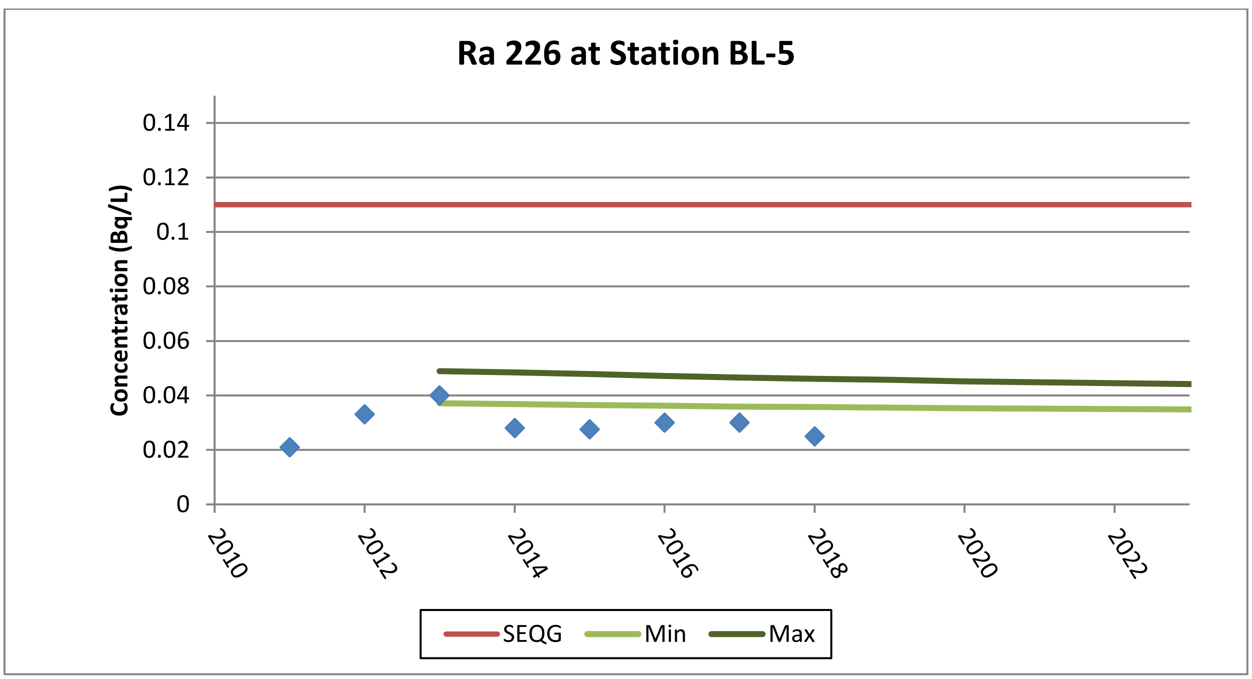


Figure 4.3.3-9 BL-5 Beaverlodge Lake Outlet



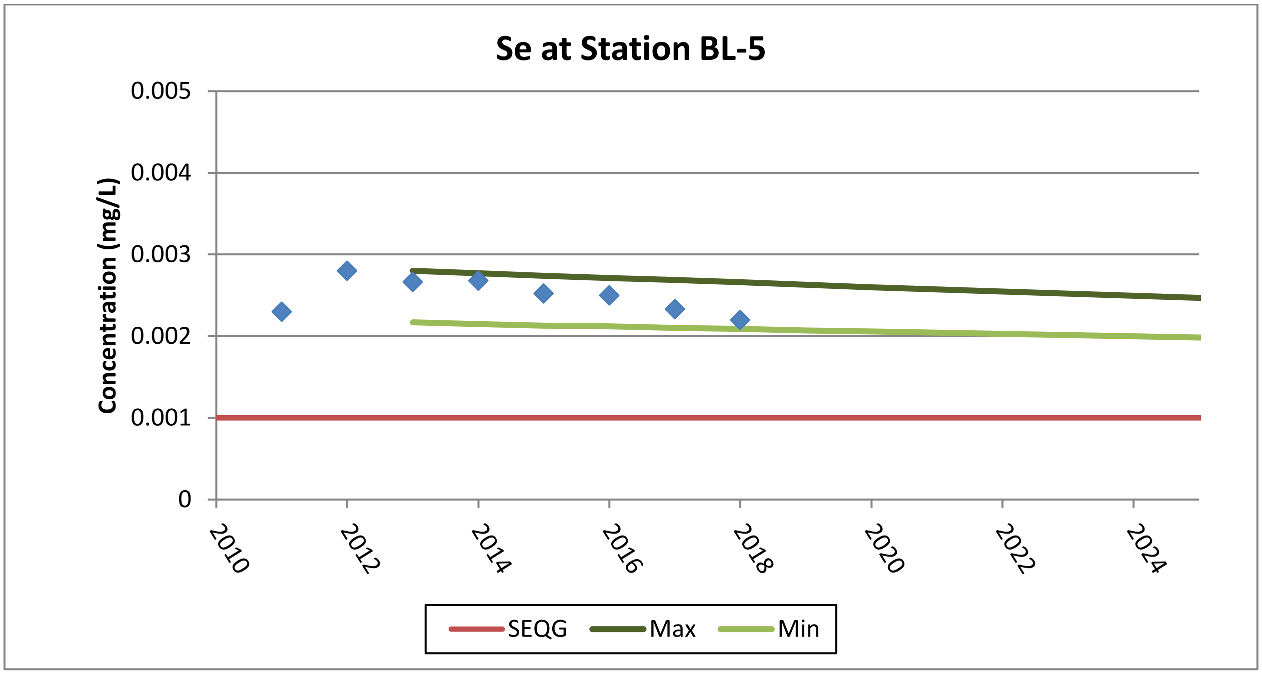
** Station implemented in water sampling program in 2011.*

Figure 4.3.3-10 BL-5 Beaverlodge Lake Outlet



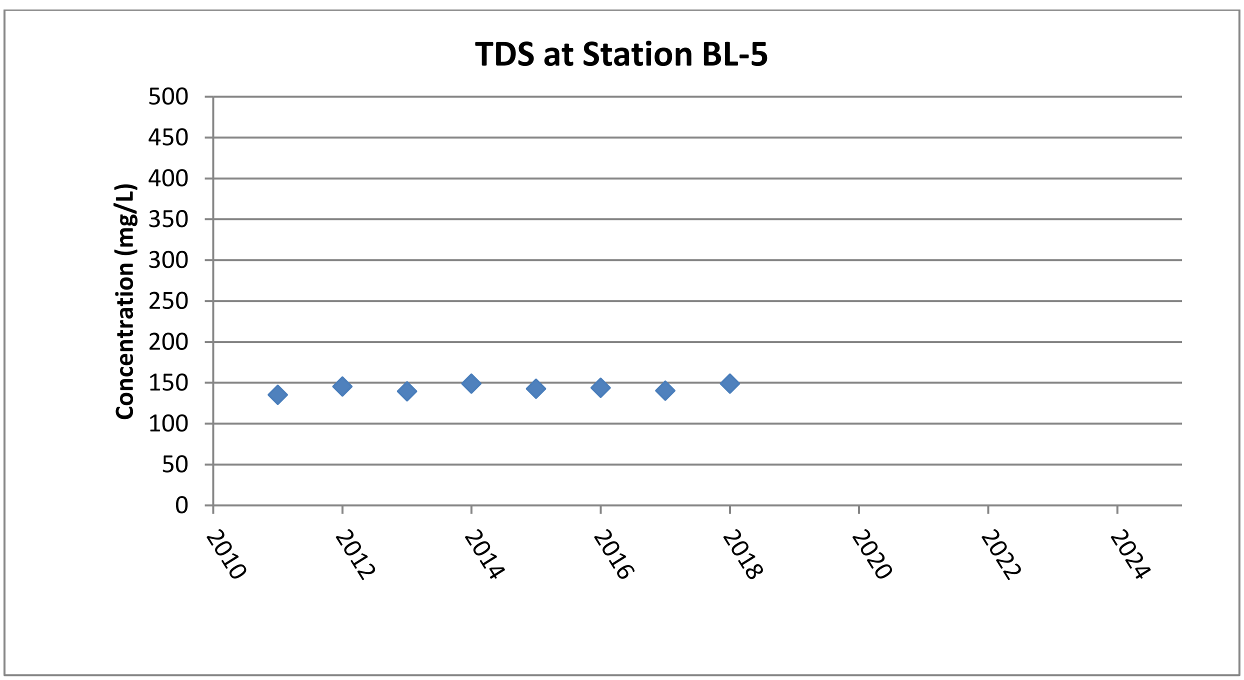
** Station implemented in water sampling program in 2011.*

Figure 4.3.3-11 BL-5 Beaverlodge Lake Outlet



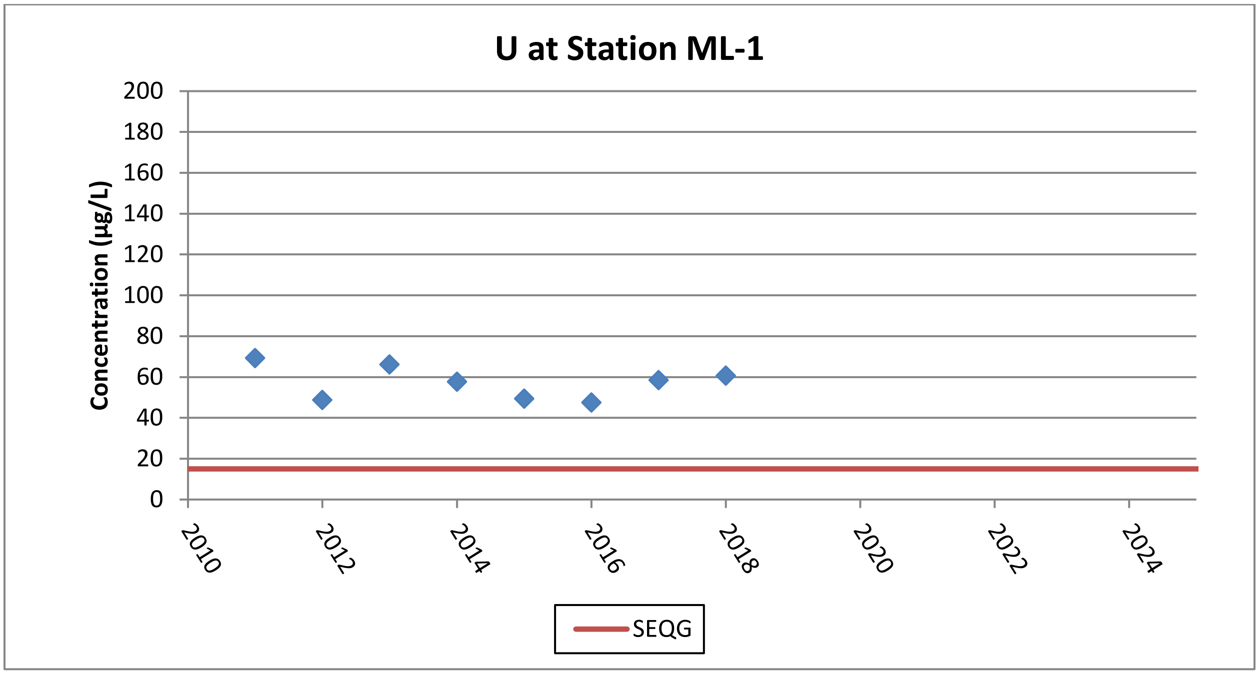
** Station implemented in water sampling program in 2011.*

Figure 4.3.3-12 BL-5 Beaverlodge Lake Outlet



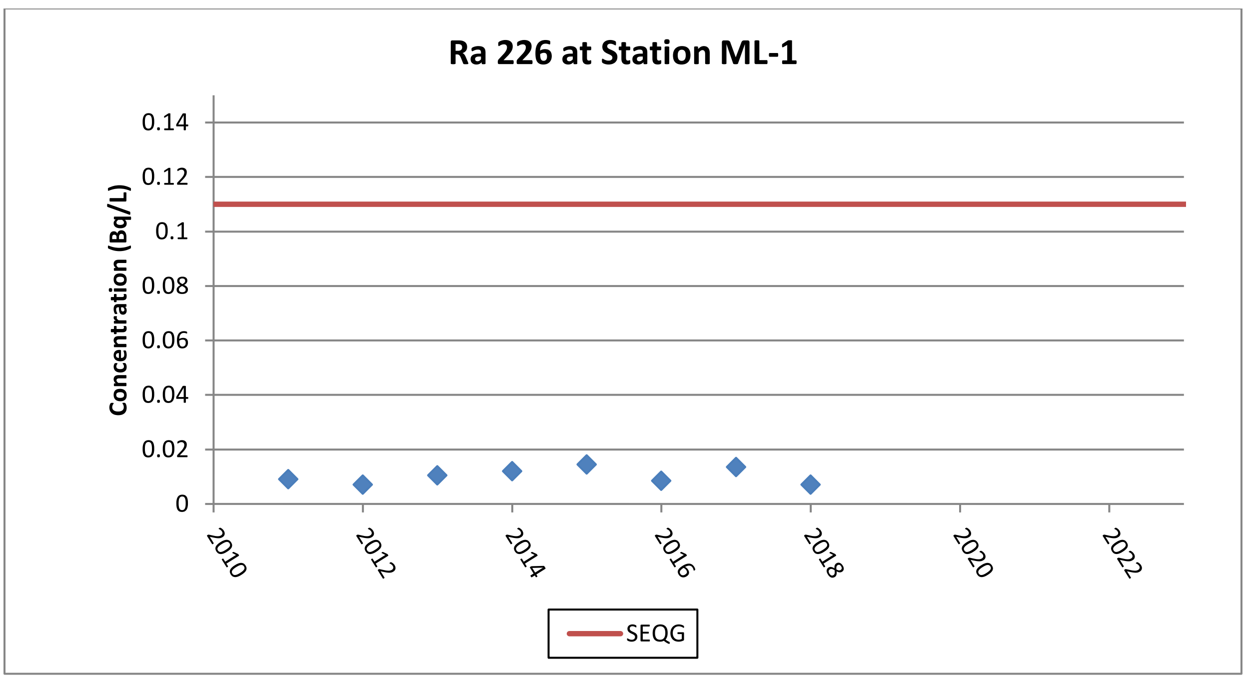
** Station implemented in water sampling program in 2011.*

Figure 4.3.3-13 ML-1 Outlet of Martin Lake



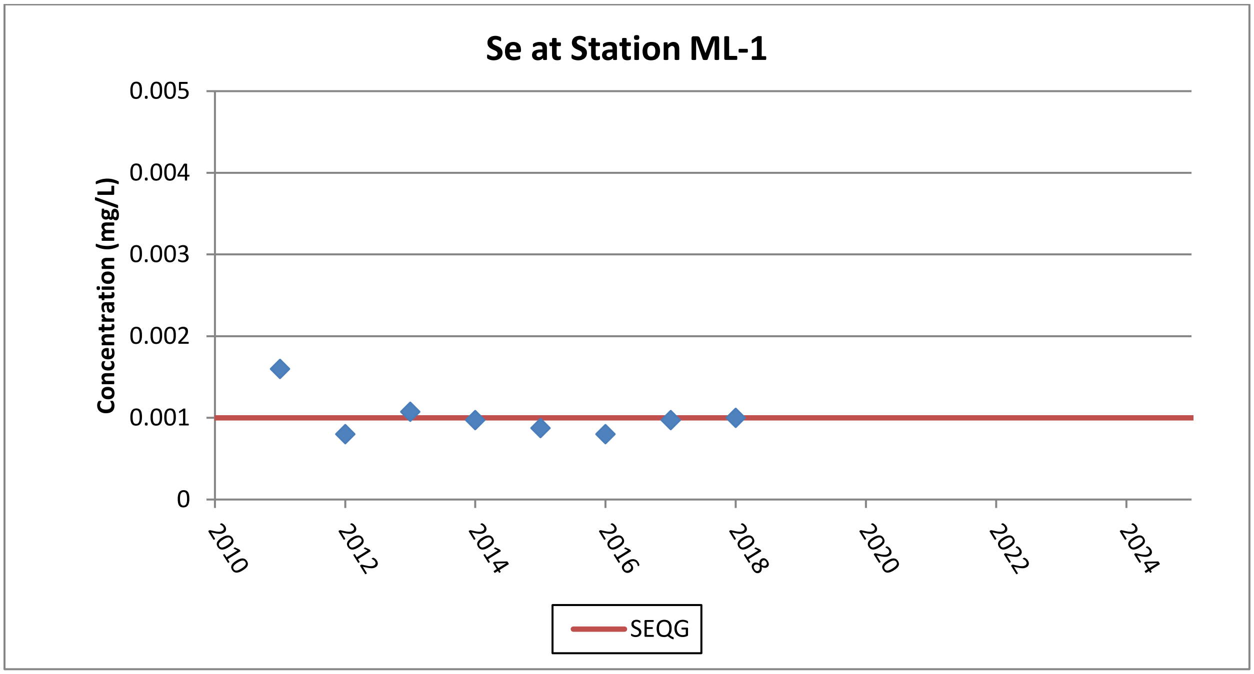
**Station implemented in water sampling program in 2011.*

Figure 4.3.3-14 ML-1 Outlet of Martin Lake



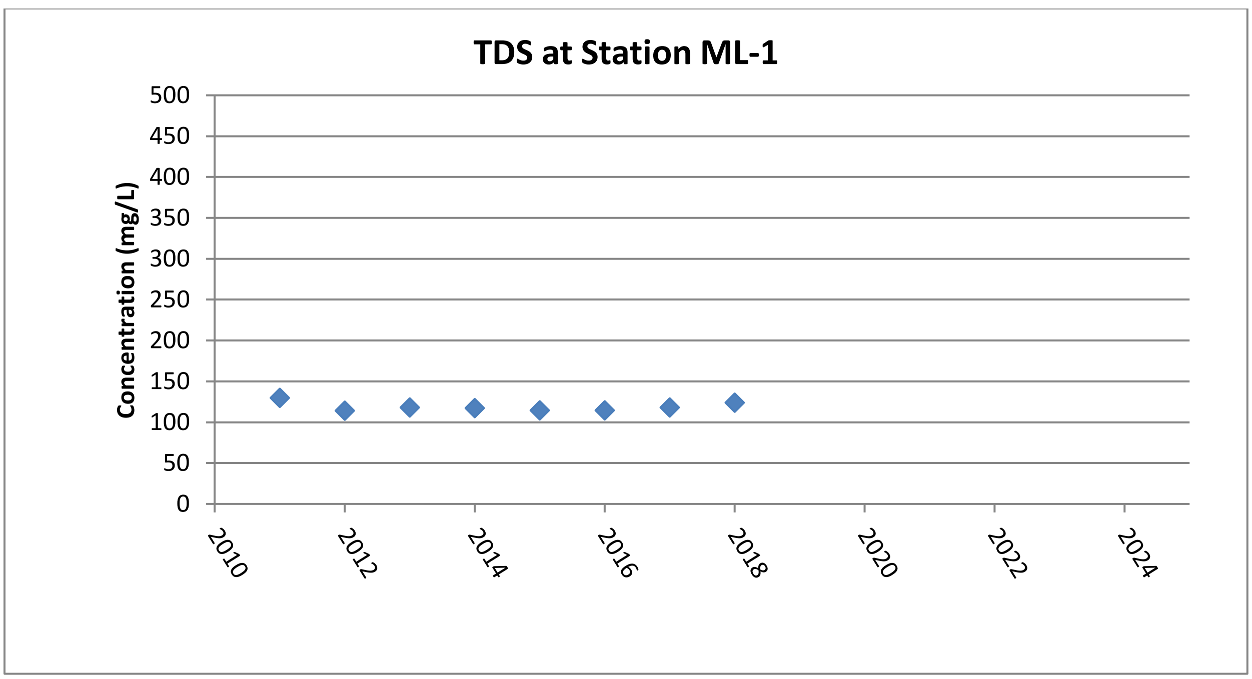
**Station implemented in water sampling program in 2011.*

Figure 4.3.3-15 ML-1 Outlet of Martin Lake



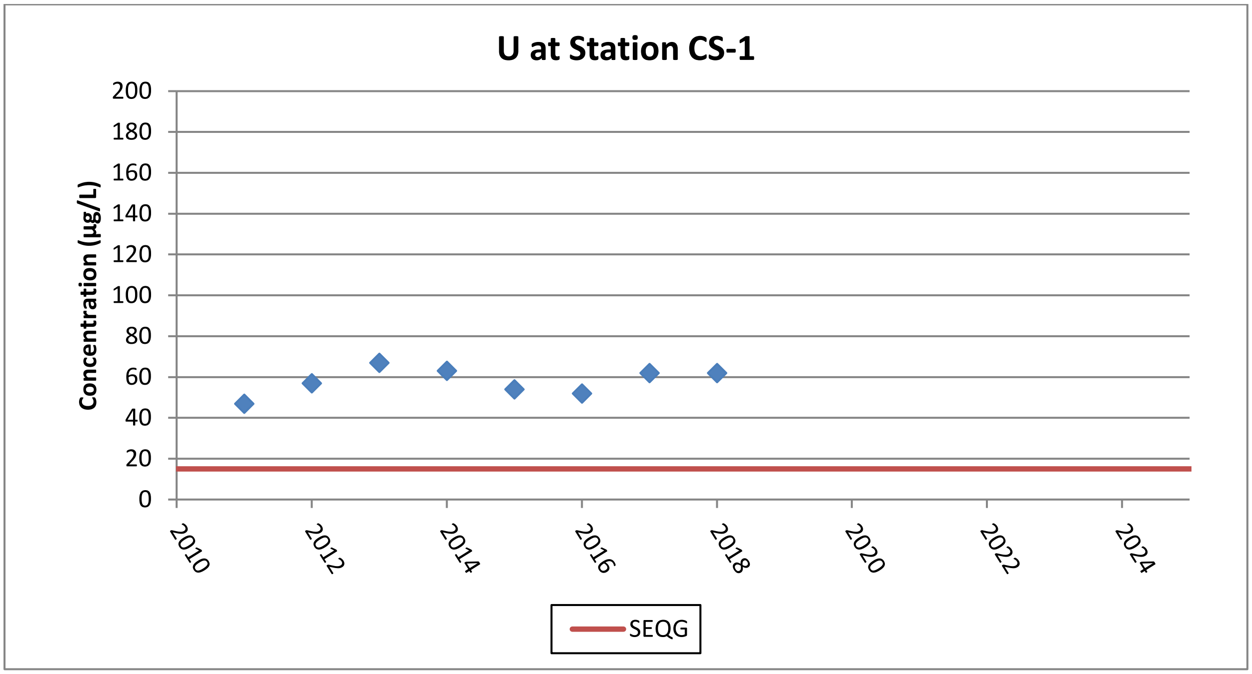
**Station implemented in water sampling program in 2011.*

Figure 4.3.3-16 ML-1 Outlet of Martin Lake



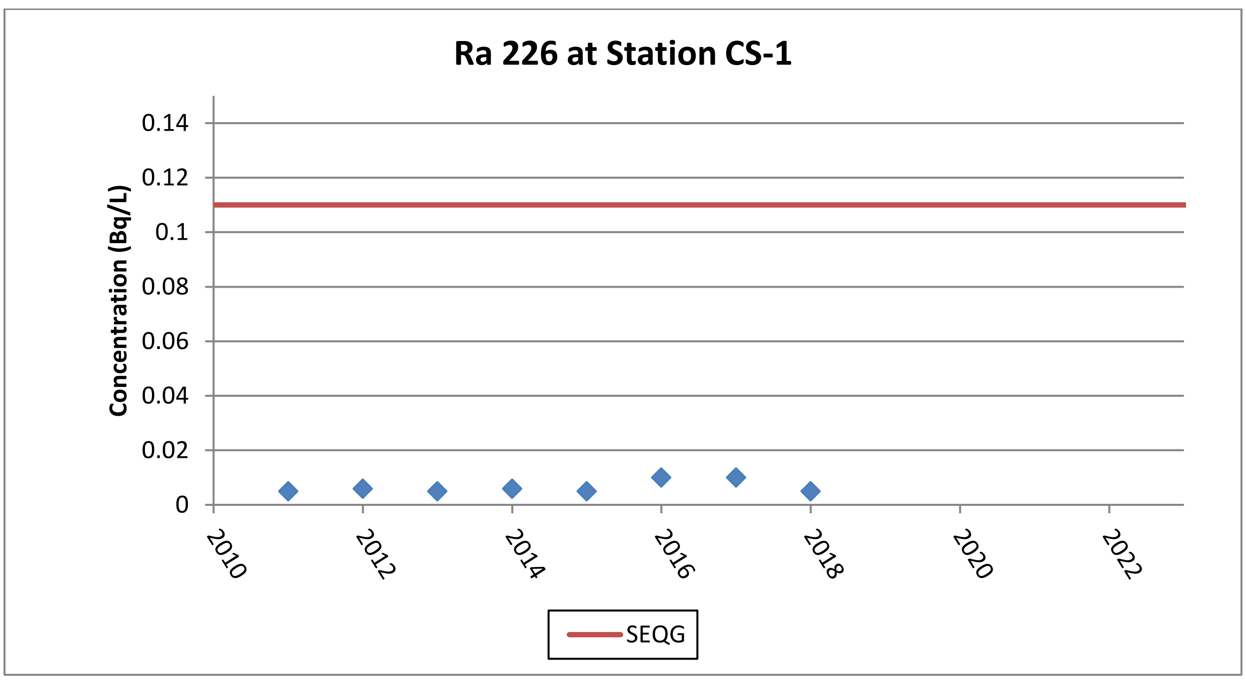
**Station implemented in water sampling program in 2011.*

Figure 4.3.3-17 CS-1 Crackingstone River at Bridge



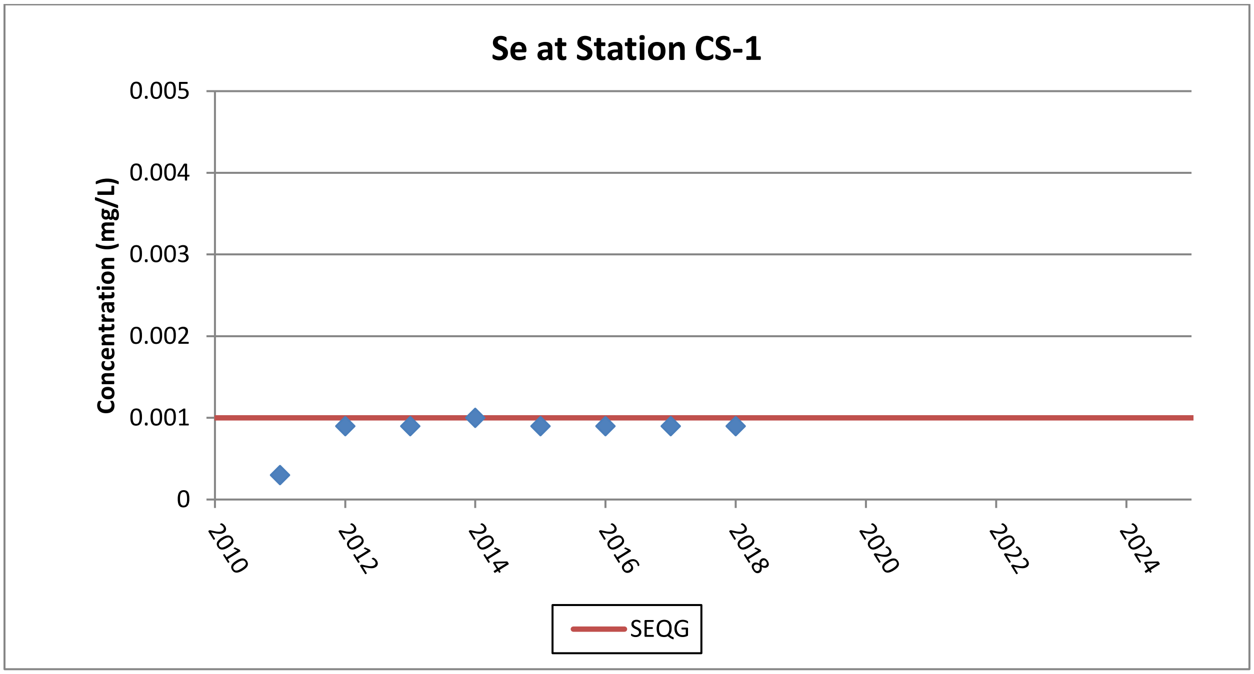
**Station implemented in water sampling program in 2011.*

Figure 4.3.3-18 CS-1 Crackingstone River at Bridge



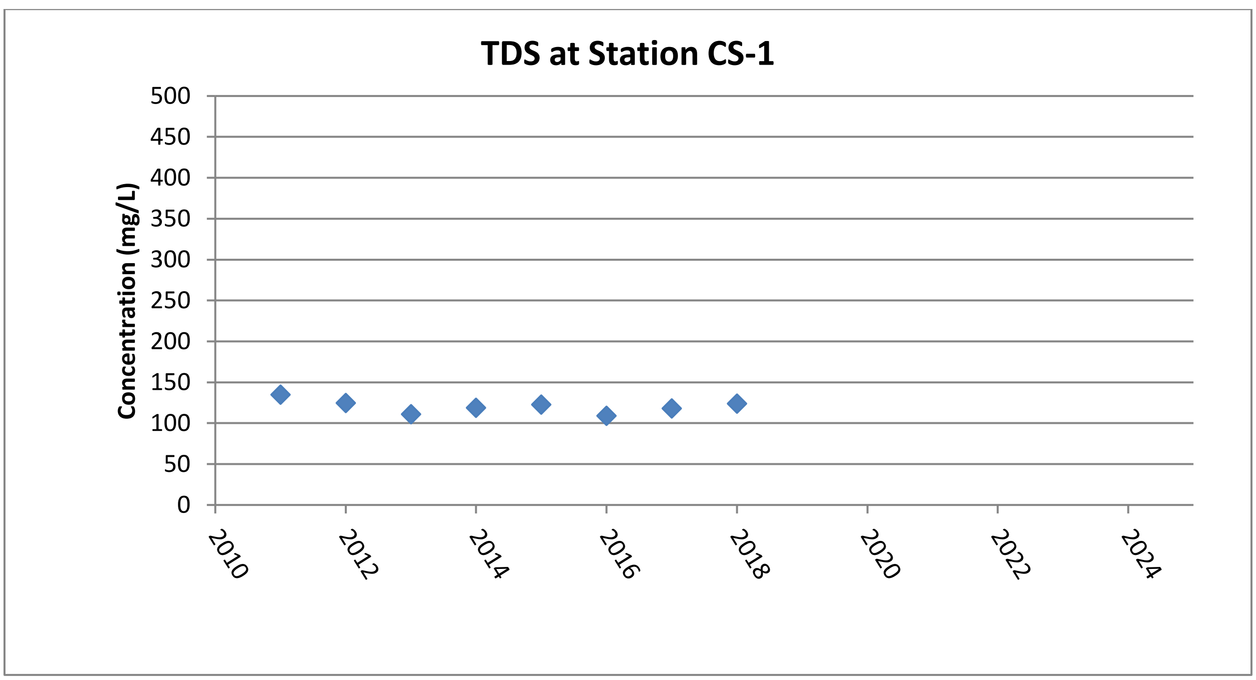
**Station implemented in water sampling program in 2011.*

Figure 4.3.3-19 CS-1 Crackingstone River at Bridge



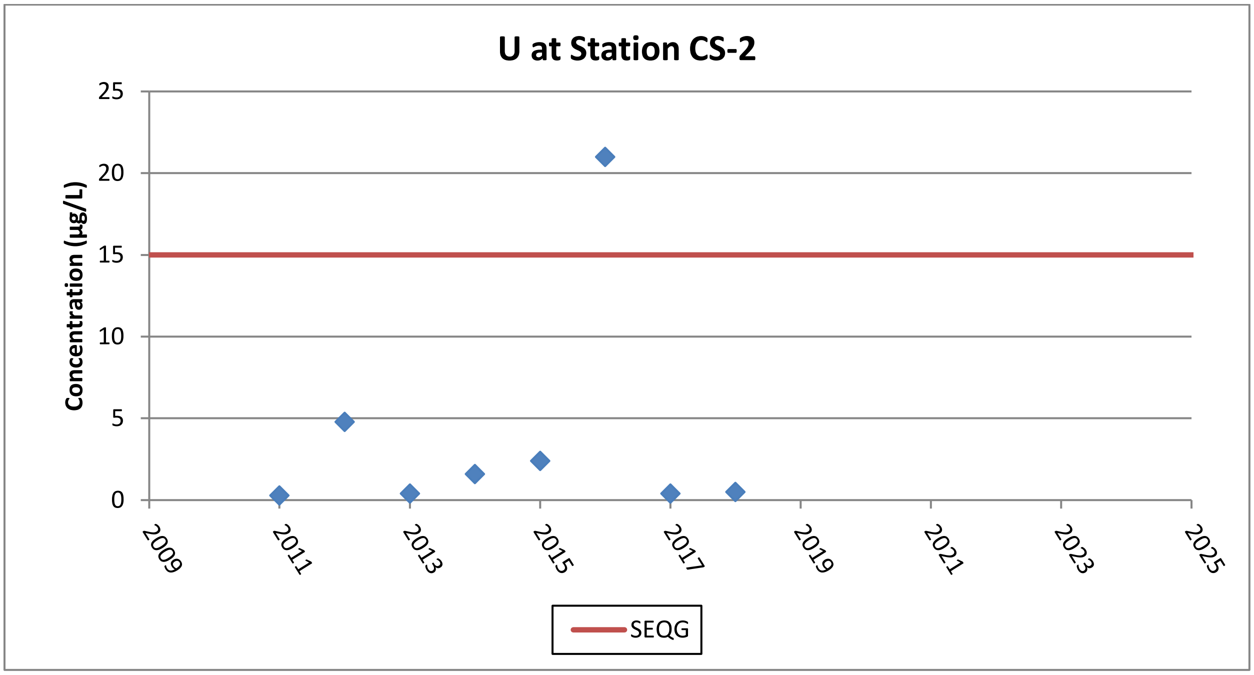
**Station implemented in water sampling program in 2011.*

Figure 4.3.3-20 CS-1 Crackingstone River at Bridge



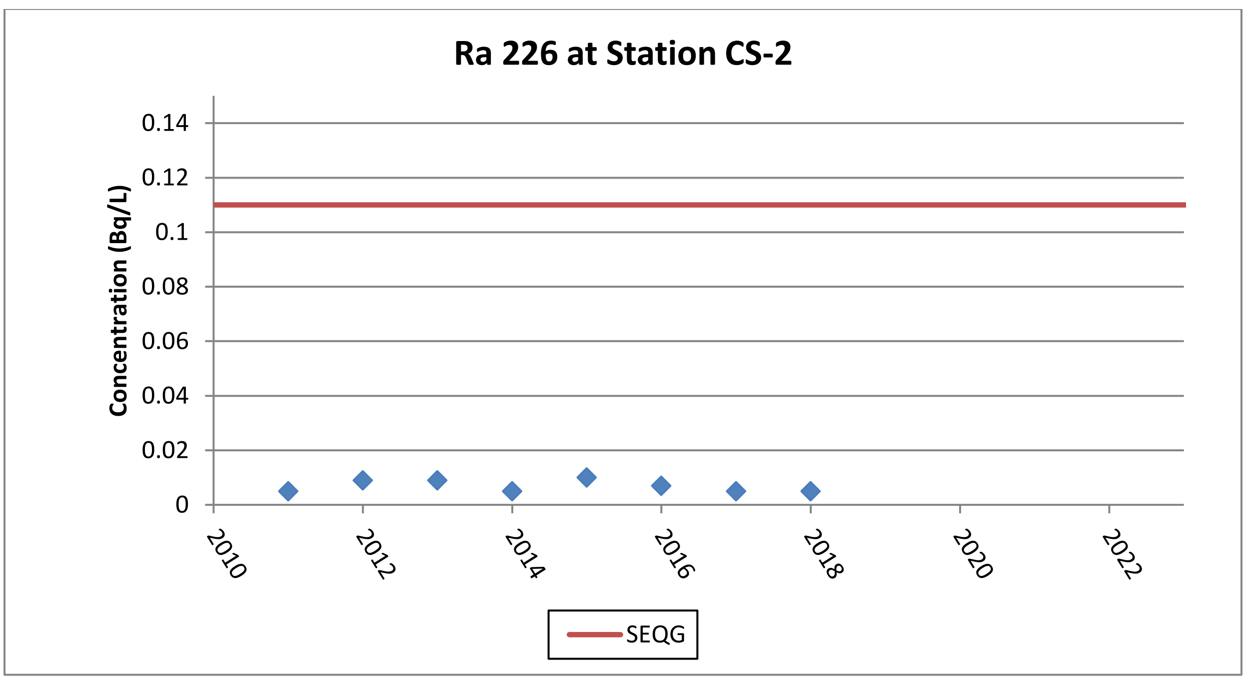
**Station implemented in water sampling program in 2011.*

Figure 4.3.3-21 CS-2 Crackingstone Bay



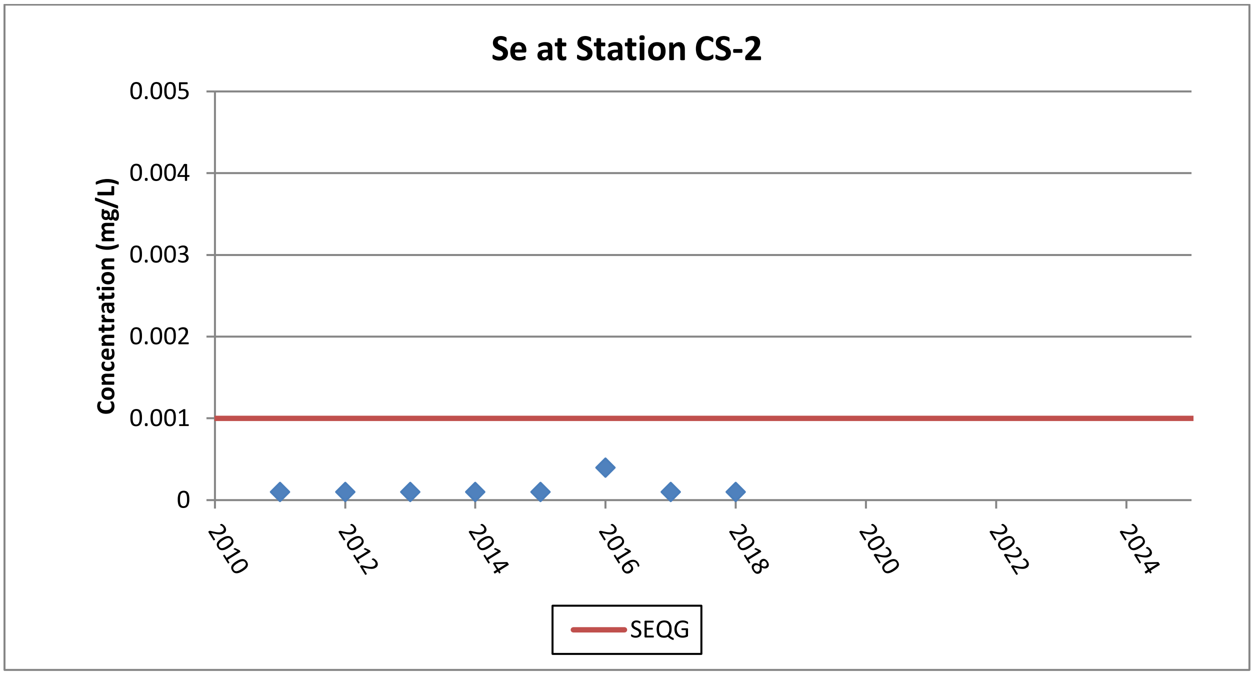
**Station implemented in water sampling program in 2011.*

Figure 4.3.3-22 CS-2 Crackingstone Bay



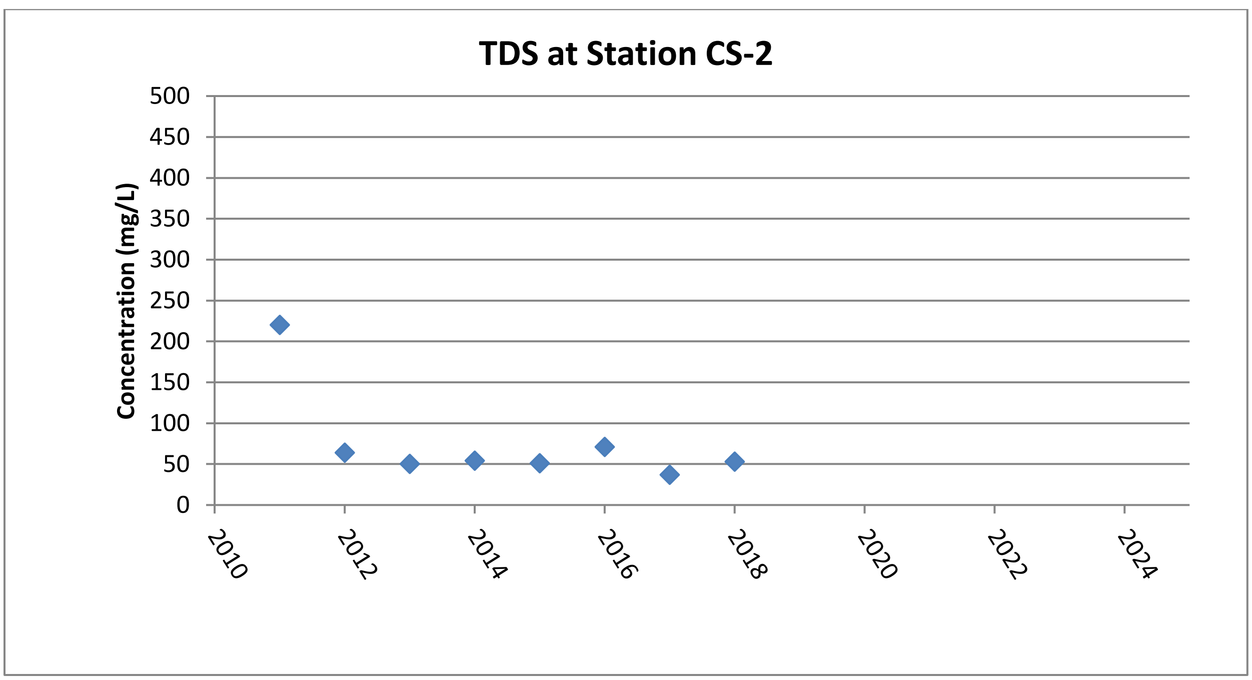
**Station implemented in water sampling program in 2011.*

Figure 4.3.3-23 CS-2 Crackingstone Bay



**Station implemented in water sampling program in 2011.*

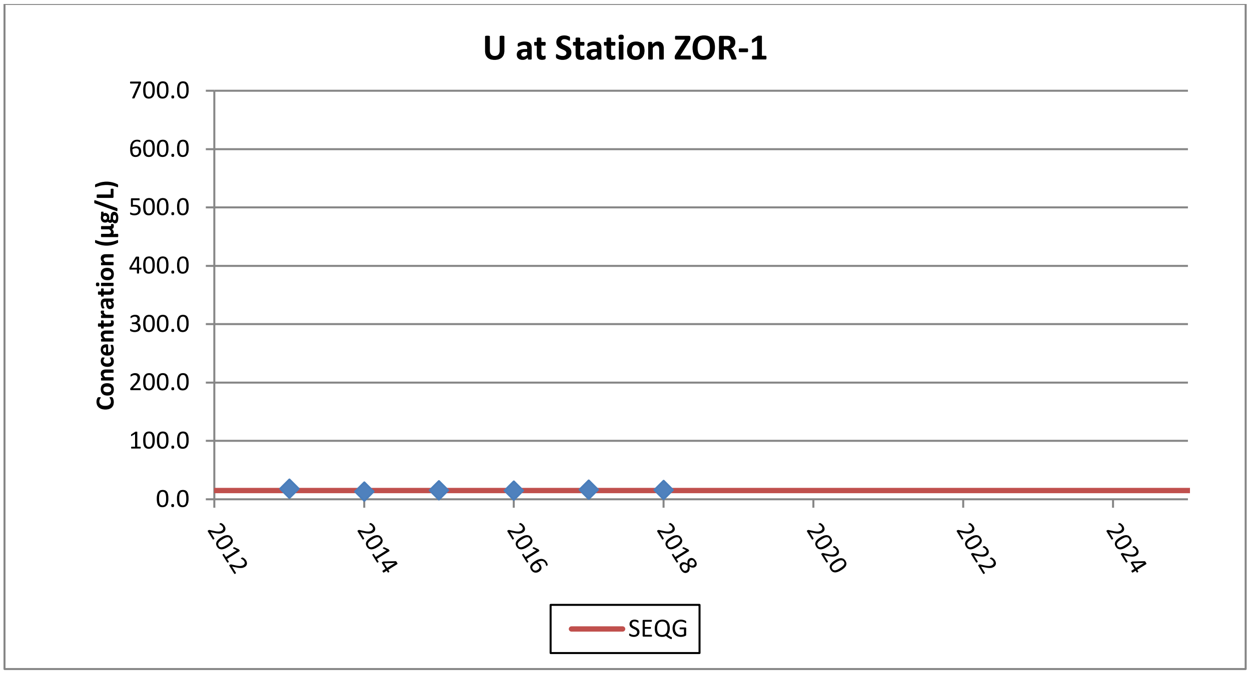
Figure 4.3.3-24 CS-2 Crackingstone Bay



**Station implemented in water sampling program in 2011.*

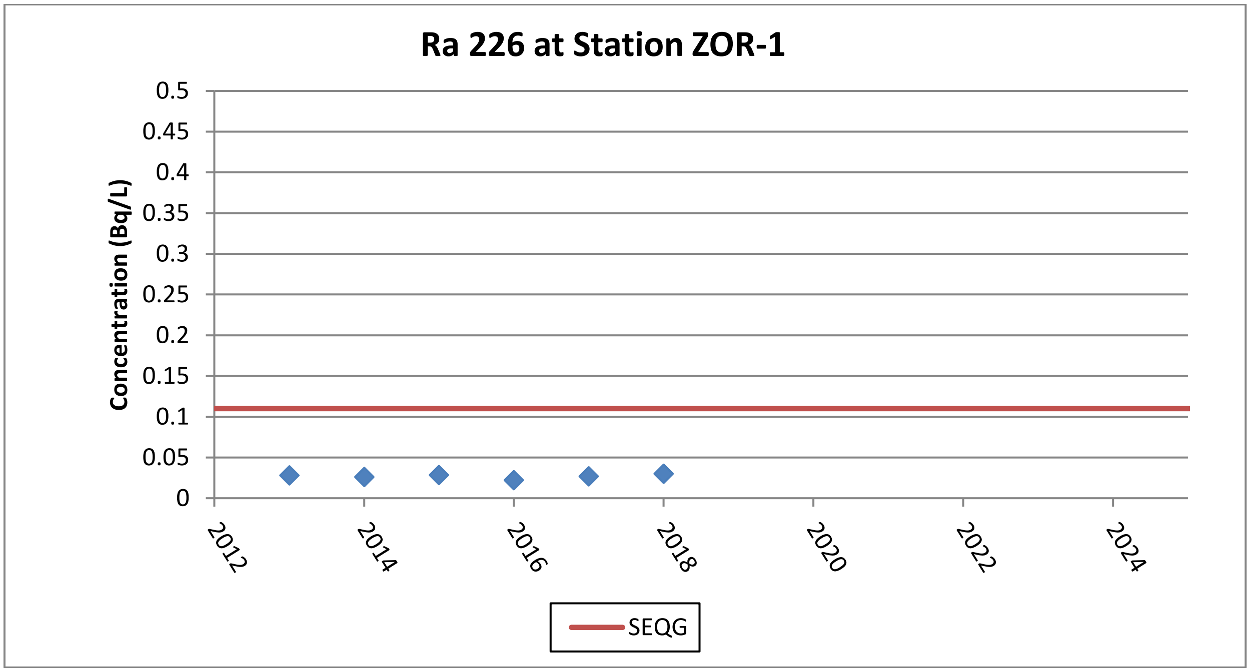
Figure 4.4
ZOR-1 and ZOR-2 sampling locations

Figure 4.4-1 ZOR-01 Outlet of Zora Lake



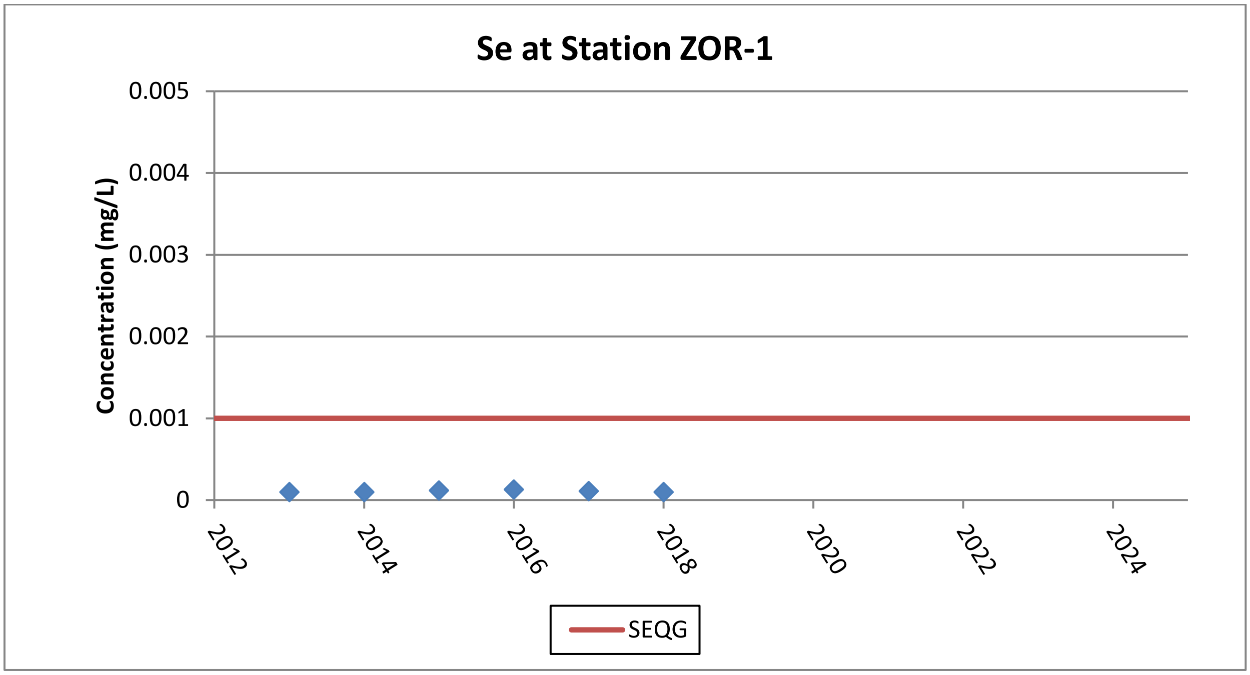
**Station implemented in water sampling program in 2013.*

Figure 4.4-2 ZOR-01 Outlet of Zora Lake



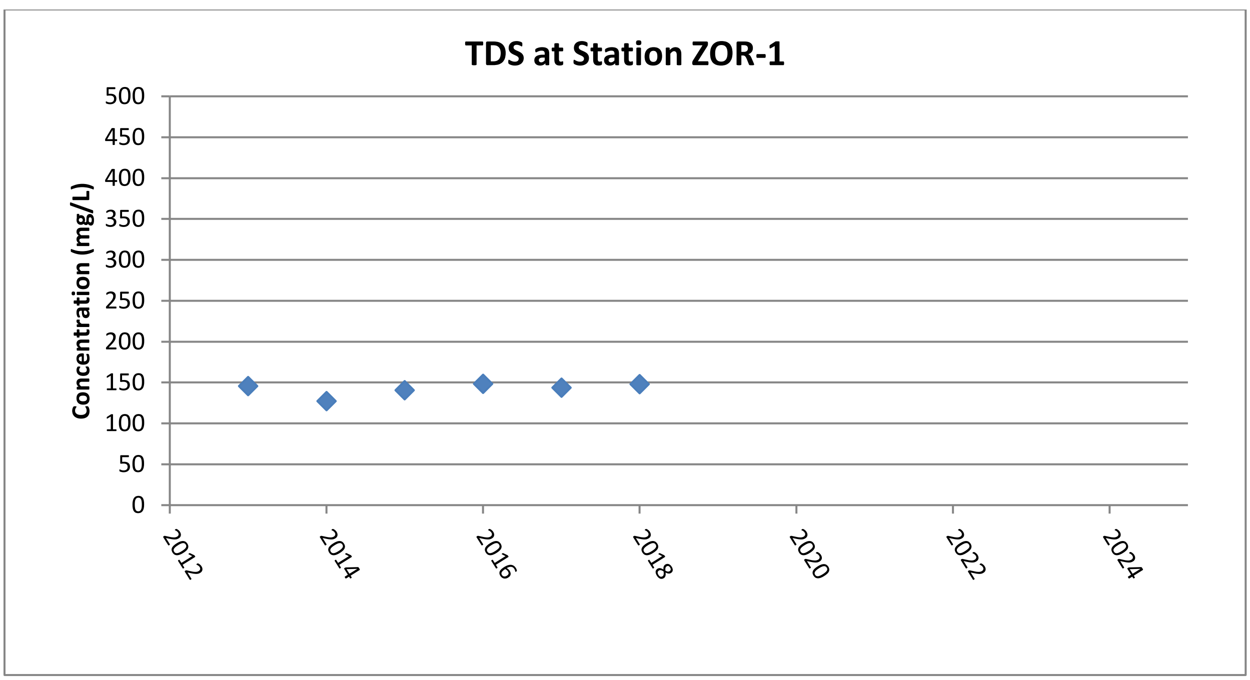
**Station implemented in water sampling program in 2013.*

Figure 4.4-3 ZOR-01 Outlet of Zora Lake



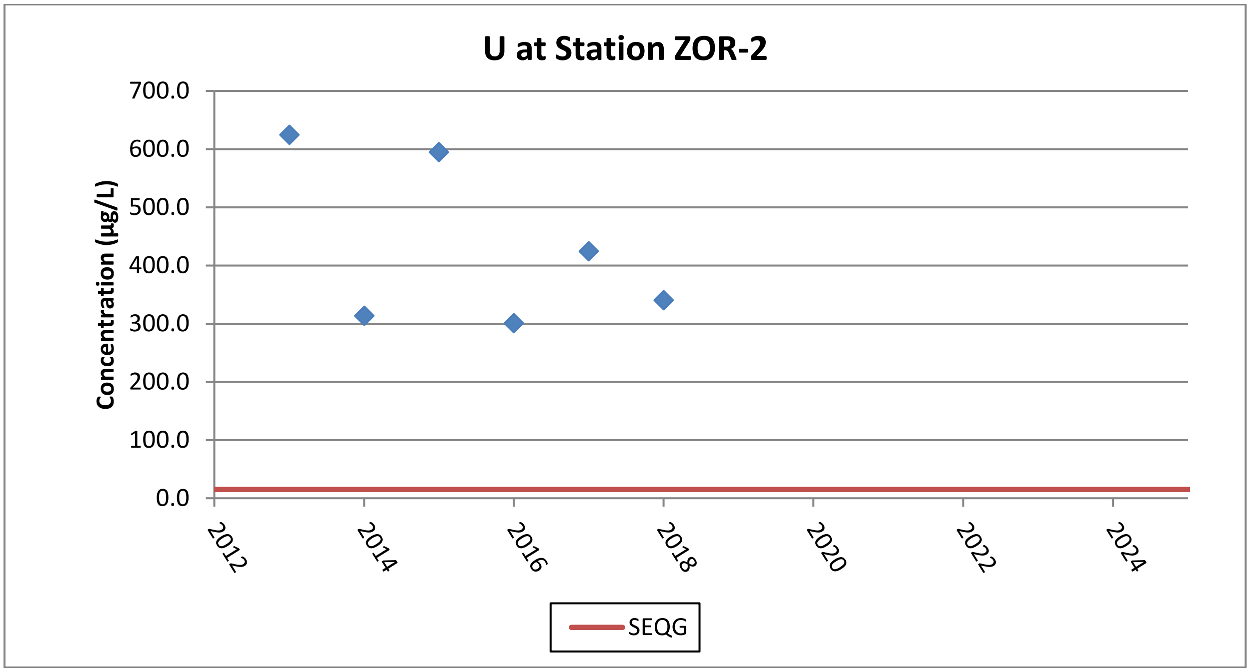
**Station implemented in water sampling program in 2013.*

Figure 4.4-4 ZOR-01 Outlet of Zora Lake



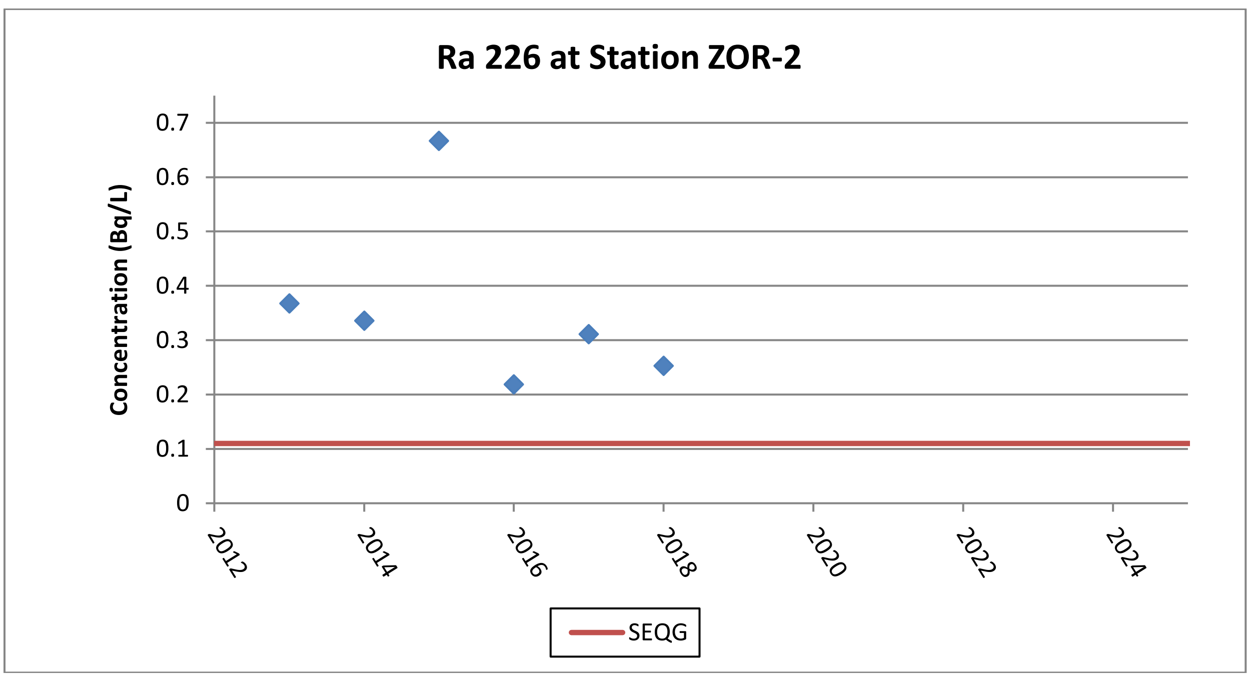
**Station implemented in water sampling program in 2013.*

Figure 4.4-5 ZOR-02 Outlet of the Zora Creek Flow Path



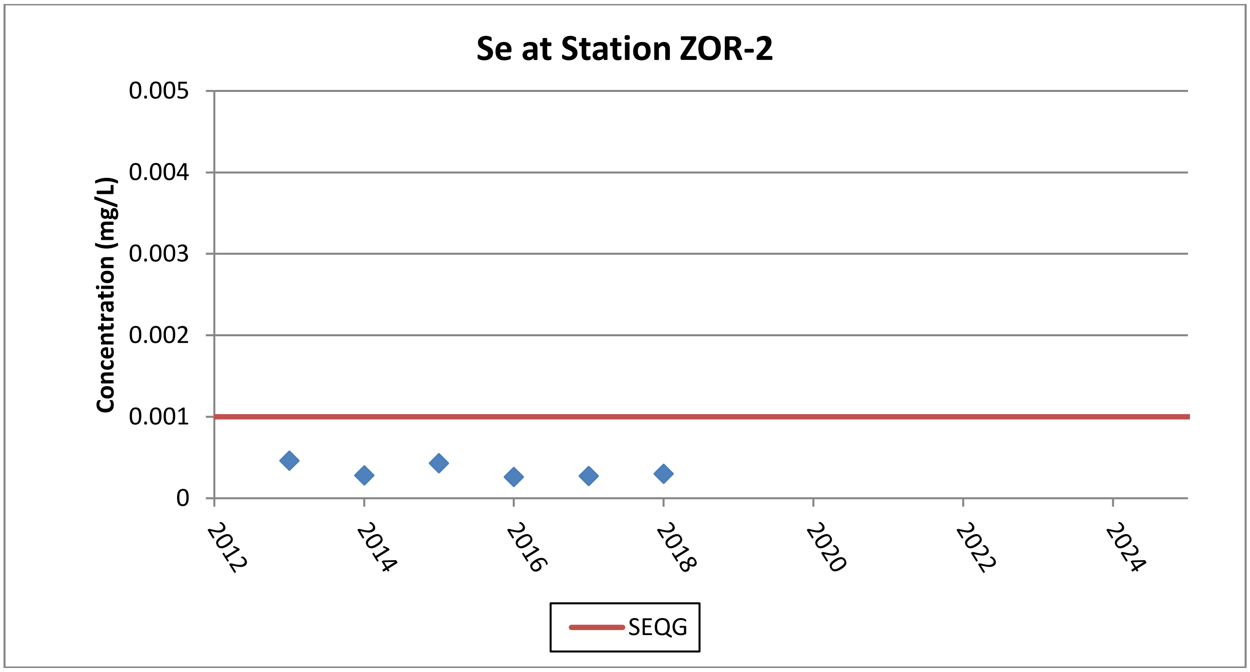
**Station implemented in 2013.*

Figure 4.4-6 ZOR-02 Outlet of the Zora Creek Flow Path



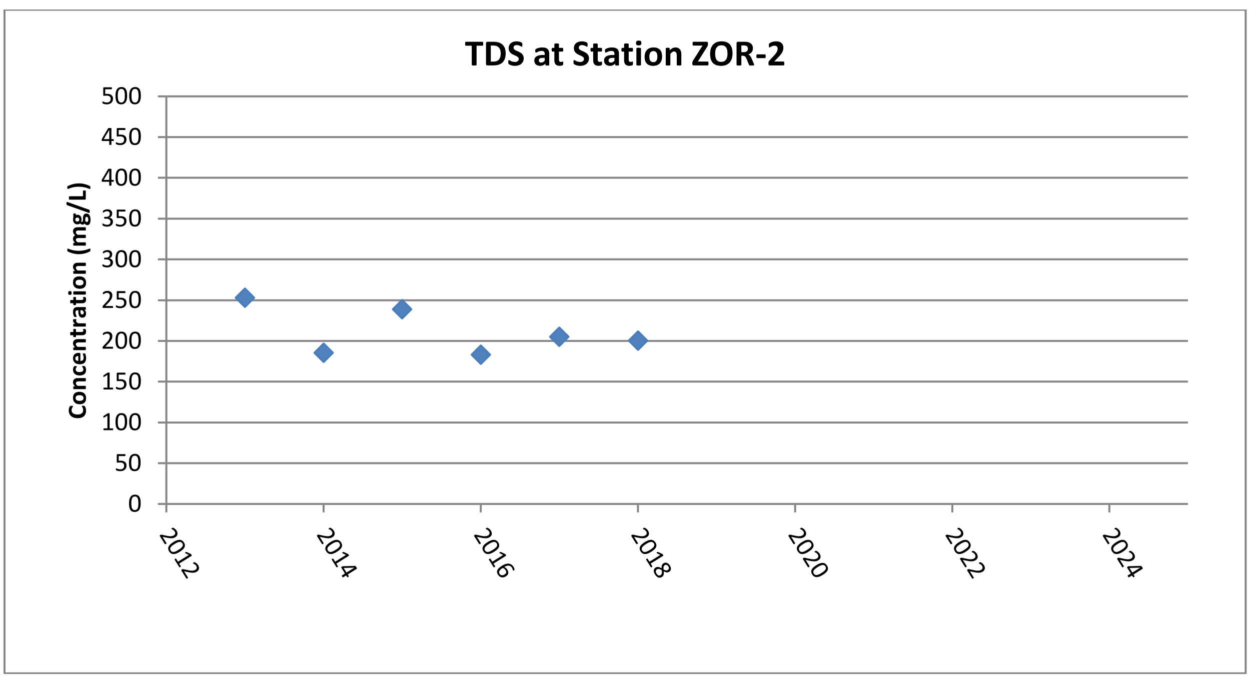
**Station implemented in 2013.*

Figure 4.4-7 ZOR-02 Outlet of the Zora Creek Flow Path



**Station implemented in water sampling program in 2013.*

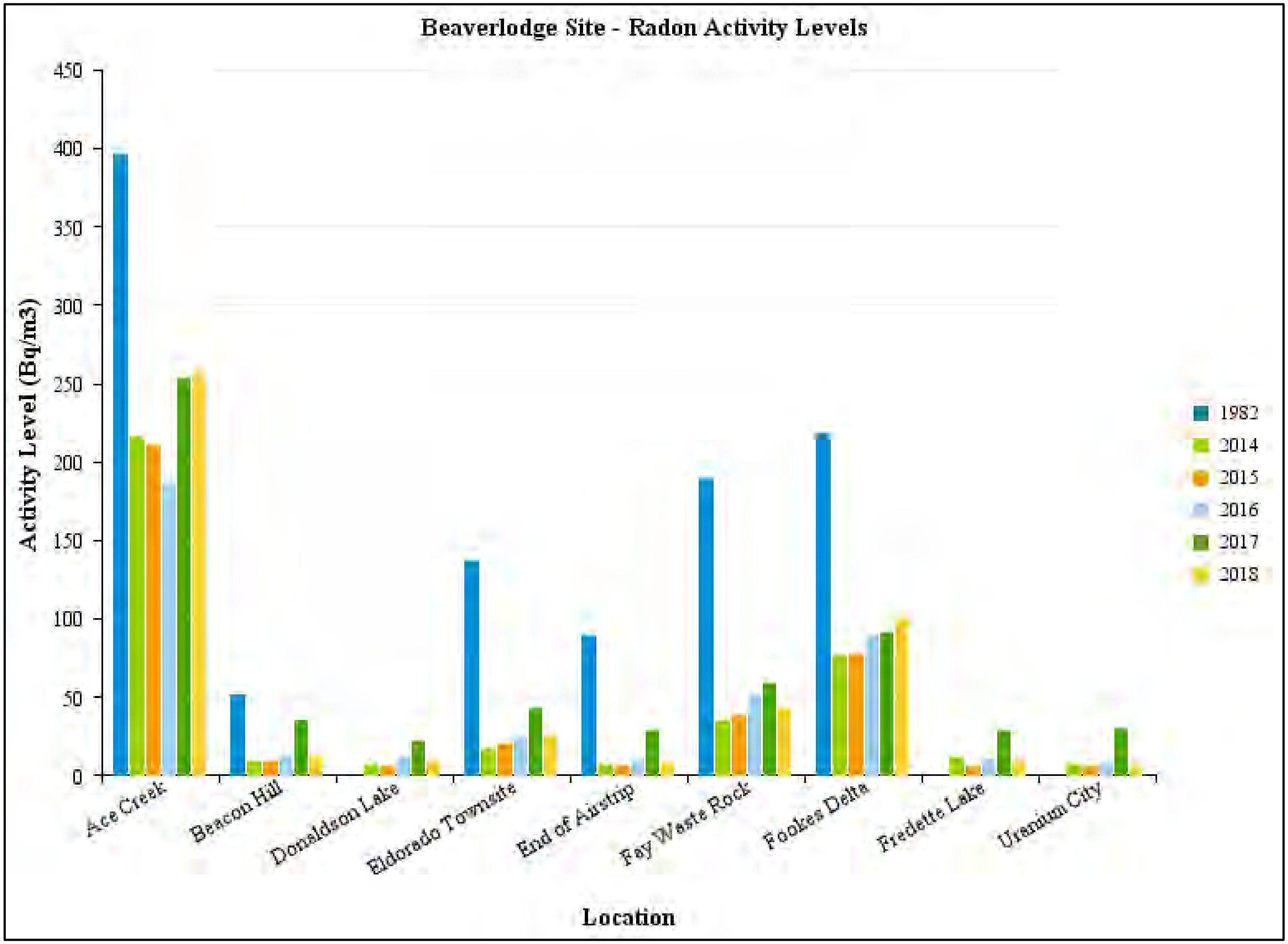
Figure 4.4-8 ZOR-02 Outlet of the Zora Creek Flow Path



**Station implemented in water sampling program in 2013.*

Figure 4.7.1-1 - Air Sampling Locations

Figure 4.7.1-2 Radon Summary (2014 - 2018 versus 1982)



**Data reporting methods were reviewed in 2017, leading to the correction of values in the above figure.*

APPENDIX A

APPENDIX A

BEAVERLODGE

Beaverlodge

Decommissioned Beaverlodge Mine/Mill Site

2018 Geotechnical Inspection Report

March 2019

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1.0 INTRODUCTION

From May 28 - June 1, 2018 Cameco, along with representatives of the Canadian Nuclear Safety Commission (CNSC) and the Saskatchewan Ministry of Environment (SMOE), conducted an annual inspection of the Beaverlodge properties. As part of this inspection, the cover at the Fookes tailings delta was inspected. The two outlet spillways at Fookes and Marie reservoirs were inspected by Cameco in September 2018.

Prior to 2010, geotechnical inspections were completed on a three-year schedule by a qualified engineer. Past inspections of these areas were conducted by SRK Consulting (SRK) in September 1998, September 2001, June 2004, August 2007 and May 2010, with all reports submitted to the regulatory agencies.

Following the May 2010 inspection, SRK recommended the frequency of formal inspections by a qualified engineer be reduced from three to five years. In addition, SRK recommended that Cameco conduct annual inspections of the areas to ensure structures were performing as expected. SRK and Cameco collaborated in the development of an inspection checklist. The checklist was reviewed and accepted by the CNSC and SMOE.

In 2011, Cameco initiated internal annual inspections of the areas identified above using the criterion based checklist. Annual inspections were completed by Cameco until 2015, when a formal inspection was completed by a qualified engineer. The 2015 inspection was conducted by SRK and indicated that overall; the Fookes tailings cover and the two outlet structures were performing as expected. The report concluded that it would be reasonable for Cameco to move towards final close out and a return to Institutional Control for the properties associated with the cover and outlet structures (*SRK, 2016*). SRK recommended that in the meantime, documented inspections by Cameco and/or regulators should continue on an annual basis until the next scheduled inspection by a geotechnical engineer, which is planned for 2020. The inspection frequency will be re-evaluated following the 2020 inspection. **Figure 1** provides the locations of the tailings delta, outlet structures.

In addition to the geotechnical inspections outlined above, Cameco conducted inspections of crown pillar areas at the Hab, Dubyna and Ace properties in 2018. These inspections were conducted based on recommendations following the assessment of site wide crown pillars conducted by SRK in 2014/2015 (*SRK, 2015*). Additional details are provided in **Section 5.0**, including **Figures 3**, **Figure 4**, and **Figure 5,** which provide the locations of applicable crown pillar monitoring.

2.0 OUTLET STRUCTURE INSPECTIONS (FOOKES & MARIE RESERVOIR)

Both spillway structures consist of a rip-rap lined open channel (with trapezoidal cross-section), which discharge into a rip-rap lined stilling basin. The rip-rap lining in both the spillway channels and the stilling basins was intruded with grout for added erosion protection; however the rip-rap in the spillway was designed to be stable in the absence of grout intrusion. The spillways are capable of passing a 500-year flood event with a depth of 0.3 m (680 L/sec) and 0.35 m (760 L/sec) at the entrances of the Fookes and Marie reservoir outlet spillways, respectively.

2.1 General Observations

Flow in the Uranium City area was higher in the last few years when compared to the initial inspection years of 2011 to 2012. Precipitation has increased on average from 2013 to 2018, which is supported by Cameco's hydrometric monitoring. Mean flows measured at TL-7 (outlet of the tailings area) ranged from an annual average of 7.9-4.5 L/s over 2013 to 2018 compared to an average of 0.2-4.0 L/s measured in 2011 and 2012.

2018 flows increased compared to the previous year's measurements, which were much lower than those observed in recent years and were some of the lowest measured since 2011. Mean flows measured at TL-7 ranged from 5.1 to 110.0 L/s in 2018. These flows were reflected in the outlet structures, with flowing water observed running through the structures in April and September.

It was noted that beaver activity at the outlet of Marie Reservoir has resulted in construction of a dam. Marie Reservoir appears to be approximately 0.3 m above the drainage channel at the entrance to the outlet structure. This condition will be monitored during future inspections to ensure the integrity of the outlet structure is not compromised. There are currently no plans to remove this structure as it is naturally occurring. A photo of the Marie Outlet structure documenting the beaver dam is located in **Section 4.0**.

Comparisons of photos between inspection years is presented in **Section 4.0**. Inspections typically take place in the summer (June or July); however, 2018 photos presented were taken during the fall.

2.2 Inspection Checklist for Outlet Structures

The specific elements to be evaluated during these inspections include the following:

I. Check the condition of the spillway channel, with a view to confirming the grout-intruded rip-rap is still in place.

II. Check the condition of the rip-rap on either side of the spillway, with a view to confirming no erosion has occurred due to overtopping associated with an extreme flood event.

III. Document conditions with photographs.

Figure 1 - Geotechnical Inspection locations

2.3 Marie Reservoir Outlet Inspection

I. *Check the condition of the spillway channel, with a view to confirming the grout-intruded rip-rap is still in place.*

Previously, SRK Consulting identified that the grout-intruded rip-rap is relatively intact, except near the spillway entrance where one large block and several smaller ones on the right side of the spillway (looking downstream from Marie Reservoir) have been displaced due to ice-jacking.

In addition to the comparison photos provided in **Section 4.0,** photos taken during the 2018 inspection providing photographic record of the condition of the Marie Reservoir spillway channel are included in **Appendix A**. The spillway remains in a similar condition as observed in previous inspections.

It should be noted that cracking and displacement of the grout-intruded rip-rap was anticipated in the original design and does not affect the performance of the outlet spillway. The grout that was intruded into the rip-rap is meant to serve purely as a binding agent to increase the effective block size of the rip-rap, allowing it to more effectively resist erosion. It has been acknowledged by SRK that additional cracking and grout degradation will occur with time (*SRK, 2016*).

The observations and photographic record from the 2018 inspection supports the observations made by SRK that the spillway continues to perform as designed.

II. *Check the condition of the rip-rap on either side of the spillway, with a view to confirming no erosion has occurred due to overtopping associated with an extreme flood event*

Observations indicate the Marie Reservoir outlet spillway has, in general, changed little since 2004. The grout-intruded rip-rap is relatively intact except near the spillway entrance where one large block slab and several smaller ones on the left side of the spillway (looking upstream) continued to be displaced due to ice-jacking (**Appendix A, Photo A1**).

There is no evidence that water has overtopped the rip-rap in this area. Photographic evidence comparing past internal inspections show loose stones on the frost heaved section and other debris in the channel have not moved (or moved very little) from year to year. Photographic comparison to previous inspection photos is provided in **Section 4.0**.

2.4 Fookes Reservoir Outlet Inspection

I. *Check the condition of the spillway channel, with a view to confirming the grout-intruded rip-rap is still in place*

Similar to the Marie Outlet, SRK Consulting also identified that the grout-intruded rip-rap along the length of the Fookes Reservoir outlet spillway shows signs of cracking. In addition, there has been some ice-jacking, with the most significant displacements located near the upper part of the spillway (i.e., on the sides of the spillway, within 5 to 6 m of the spillway entrance; **Appendix B, Photo B3)**. The base of the channel does not show signs of displacement, and the middle to lower parts of the spillway remain in good condition. SRK noted during the 2015 inspection that the spillway continues to operate satisfactorily.

In addition to the comparison photos provided in **Section 4.0,** photos taken during the 2018 inspection providing photographic record of the condition of the Fookes Reservoir spillway channel are included in **Appendix B**. The overall condition of the spillway in 2018 was observed to be similar to previous inspections, and the spillway continues to perform as designed.

II. Check the condition of the rip-rap on either side of the spillway, with a view to confirming no erosion has occurred due to overtopping associated with an extreme flood event

Photographic comparison to previous inspections results show that debris in the Fookes Outlet channel has generally not moved from year-to-year. There is no evidence that overtopping of the rip-rap areas of the spillway has occurred. As a result, Cameco has concluded that the channel has been able to accommodate the flows and no erosion of the channel has occurred. Photographic comparison to previous inspection photos is provided in **Section 4.0**.

3.0 FOOKES TAILINGS DELTA

3.1 General Observations

Historically, the area along the northeast side of the Fookes delta has contained standing water. The Fookes delta cover in this area was purposefully graded to establish an overall preferential gradient towards Fookes Reservoir. **Figure 2** provides an overview of the cover design (*SRK, 2008*), with the surface drainage paths outlined. As per the SRK design for the Fookes cover, the northern drainage ditch area of the delta was never intended to provide fully channelized flow to Fookes Reservoir. As a result, some ponding in higher precipitation years was anticipated and may be expected to occur.

During the May 2018 inspection of Fookes Delta, it was noted that the drainage area on the northeastern side of the delta and the drainage channel to Fookes Reservoir contained water and was performing as designed, as no standing water was observed on any other portion of the Fookes Delta (**Appendix C, Photos C7 and C8**).

Generally the cover was in good condition showing no areas of excessive erosion. There was no evidence of new vehicular traffic on the delta since the berms located at the access points were repaired and reinforced. There has also been notable progressive growth of vegetative cover over the last several years. Although vegetation coverage on parts of the inner delta remains sparse, it is well established within 50 m of the shoreline and the engineered drainage structures. The vegetation continues to gradually encroach and thicken over the cover.

Photographic comparison to previous inspection photos is provided in **Section 4.0**. Of note is the continued encroachment of vegetation since 2013. Photos showing the conditions encountered during the site inspection are provided in **Appendix C**.

3.2 Inspection Checklist

I. Check for evidence of new tailing boils or tailings exposure due to frost action

II. Check for evidence of significant erosion of the cover material
   a. Trench along the northeast edge of the delta (sand flows, erosion of waste rock, slumping, etc.) – maintain photographic and GPS record (identify areas of concern on map).
   b. Cover limit along its contact with Fookes Reservoir – maintain photographic and GPS record (identify areas of concern on map) where sand from the delta cover extends into the reservoir.

III. Ensure erosion-protection devices are performing as expected on former north access road
   a. Waterbars (chevrons)
   b. Diversion ditches
   c. Erosion of cover adjacent to the former access road

IV. Ensure earthen berms are in place to limit access to the delta

3.3 Fookes Cover Inspection

I. Check for evidence of new tailing boils or tailings exposure due to frost action

No new boil development was noted on the tailings delta.

II. Check for evidence of significant erosion of the cover material

The shoreline, where the edge of the cover contacts Fookes Reservoir, was inspected and was in good condition. While the 2015 SRK inspection did note some erosion due to wave action, the overall condition of the shoreline was considered good with vegetation continuing to establish itself in the area. Photos taken in 2018 showed significant vegetation coverage along the shoreline.

The 2018 inspection showed that water is being captured in the drainage channels as per design and there is no evidence of any significant erosion of the cover.

The remainder of the sand cover was in good condition and showed no signs of excessive erosion. As vegetation continues to establish on the shoreline it will provide additional armoring and increase the stability of the cover.

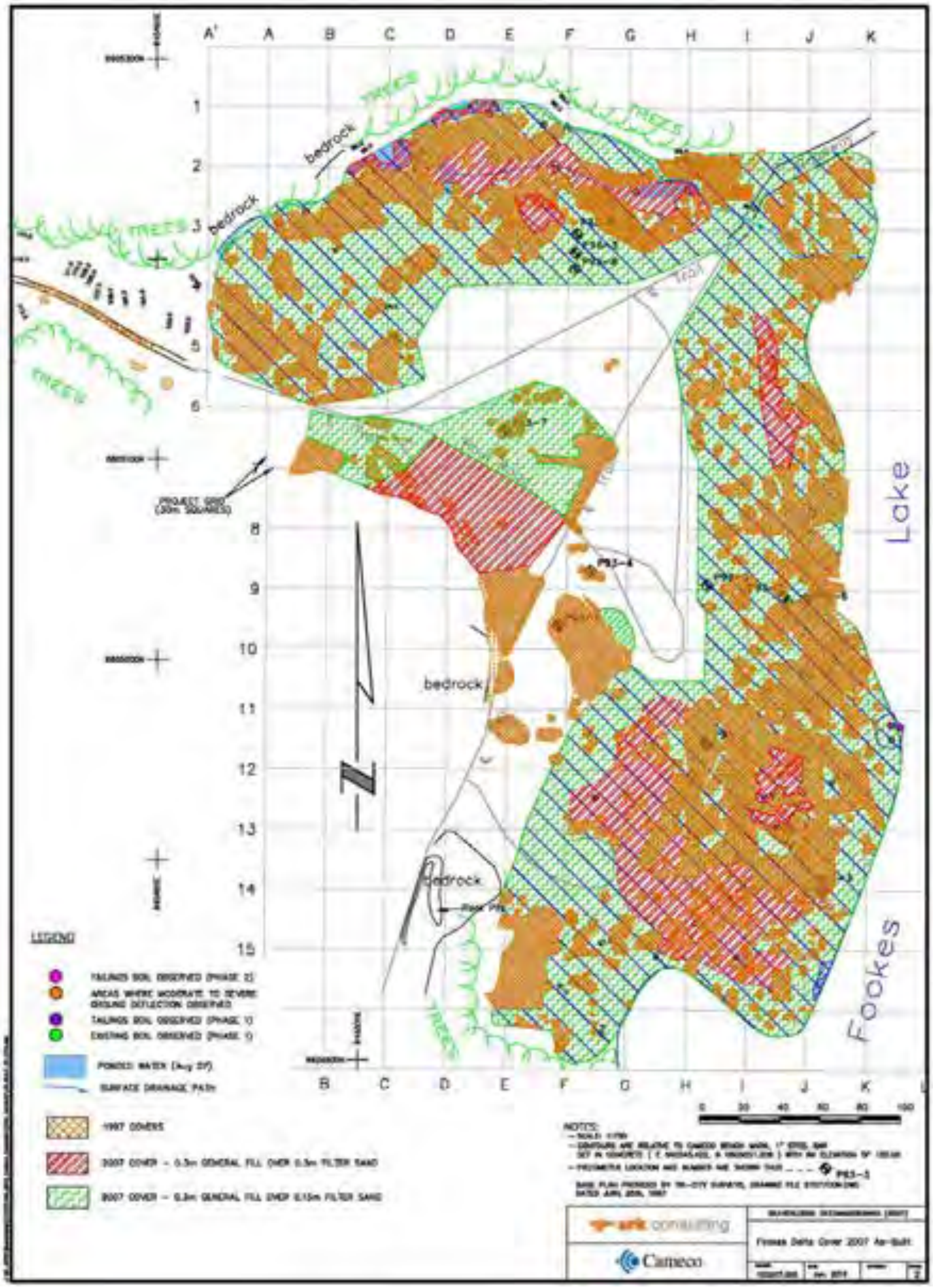
III. Ensure erosion protection devices are performing as expected on former north access road

As part of the design and installation of the covers in 2005 and 2007, the area considered most vulnerable to erosion was in the area on and below the access ramp at the northwest corner of the tailings delta (*SRK, 2010*). The general condition of the ramp is very good. Access to this ramp is closed off by a windrow of material at the top of the ramp. The water bars (chevrons) are performing as expected and show little sign of erosion (**Appendix C, Photo C1**).

In addition to the chevrons, run-out structures were installed to carry away excessive water during extreme run-off events. These run-out structures are also in good shape with no observed additional eroded material beyond that observed during previous inspections (**Appendix C, Photo C2**).

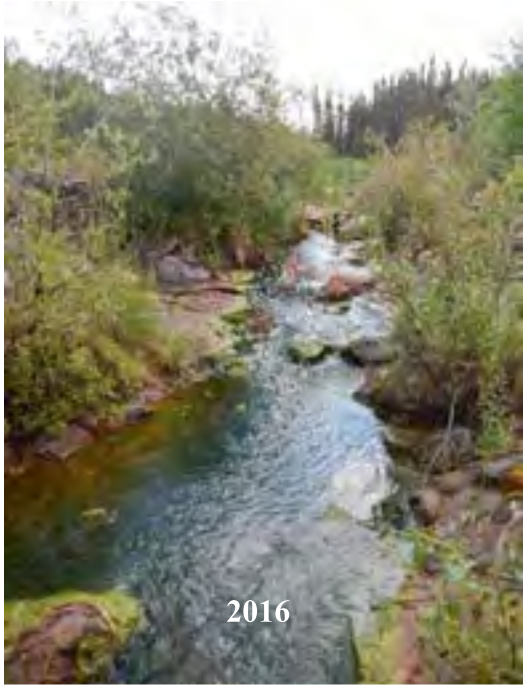
IV. Ensure earthen berms are in place to limit access to the delta

Since the earthen berms protecting the east and west access points to the Fookes Delta were repaired and reinforced in 2011 and 2012 respectively, there has not been any new evidence of passenger vehicular traffic accessing the tailings delta. It has been noted that there are occasional quad tracks on the tailings delta, which should not affect the integrity of the cover.


Fookes Lake
bedrock
TREES
PROJECT GRID (30m SQUARES)
LEGEND
TAILINGS BOIL OBSERVED (PHASE 2)
AREAS WHERE MODERATE TO SEVERE GROUND DEFLECTION OBSERVED
TAILINGS BOIL OBSERVED (PHASE 1)
EXISTING BOIL OBSERVED (PHASE 1)
PONDED WATER (Aug 07)
SURFACE DRAINAGE PATH
1997 COVERS
2007 COVER – 0.3m GENERAL FILL OVER 0.3m FILTER SAND
2007 COVER – 0.3m GENERAL FILL OVER 0.15m FILTER SAND
NOTES:
PB3-4
PB3-1
Fookes Delta Cover 2007 As-Built
Cameco

4.0 PHOTOGRAPHIC COMPARISONS

Beaver dam constuction at the outlet structure for Marie Reservoir (September 2018)



Marie Outlet Structure looking upstream

Marie Outlet Structure looking downstream

Marie Reservoir Outlet Structure – Ice jacked block of grout intruded rip-rap

Fookes Outlet Structure looking upstream

Fookes Outlet Structure looking downstream

Drainage area looking NW towards access point

The 2017 photo was not taken from same location as other two photos. The 2017 photo shows the Fookes shoreline located near the top centre of the 2018 photo

Fookes Cover Shoreline

Chevrons in place on north access point to the Fookes delta

5.0 CROWN PILLAR AREAS

In 2016, the Inspection Checklist was updated to include the identified crown pillar areas at the Hab, Dubyna and Ace areas as per recommendations from SRK. Visual inspections of these areas will be completed from 2017 to 2019, at which time the frequency of monitoring will be reassessed.

5.1 Site Wide Assessment

SRK was retained by Cameco Corporation to undertake a geotechnical assessment of the crown pillar stability at six historic Beaverlodge sites in 2014 (*SRK, 2015*). This included the Ace, Dubyna, Verna, Hab, Martin Lake, and main Fay shaft areas. The overall goal of the assessment was to determine the potential for long term ground surface subsidence above the crown pillars and complete an investigation into potential, associated safety risks.

From the review and evaluation of historic records, the Ace site was determined to present the most notable potential for subsidence to occur in the future. The Dubyna and Hab sites were found to have crown pillars that were relatively near surface, and thus were examined further. Based on the configuration of the underground workings at the remaining properties that were assessed, it was determined that no additional examination or remediation would be warranted.

5.2 Dubyna and Hab

Based on their assessment, SRK recommended visual monitoring of the crown pillar areas associated with the Dubyna and Hab Areas. Specifically, looking for the development of tension cracks and observable changes in ground elevation. It is important to note that some areas identified with the thinnest estimated crown pillar thickness are contained within former open pits that have been partially filled with waste rock. If the crown pillars were to fail below the pit area, surface expression in the waste rock backfill would likely occur, however is expected to be minor. Therefore, the residual safety consequence for crown pillar failure at these remote locations is expected to be low (*SRK, 2015*).

Table 1 below provides GPS points for locations associated with the Dubyna area where visual monitoring was recommended. As shown in **Figure 3**, at the end of Section 5, the area between these points are expected to coincide with the Level 1 stoping area where crown pillar thicknesses would be expected to be the thinnest.

Table 1: Visual Monitoring Location Recommendations for Dubyna

Location	Position	Elevation (approx.)	Comment
DUB-01	Zone:12 V 647946, 6608477	339 m	In mine waste backfill
DUB-02	Zone:12 V 647973, 6608480	339 m	Near edge of waste rock backfill
DUB-03	Zone:12 V 647997, 6608487	333 m	Close to lake

Similar to the Dubyna site, the recommended option for the Hab 039 Zone was to conduct visual monitoring looking for the development of tension cracks and/or any observable changes in ground elevation (depressions developing). The residual safety consequence for crown pillar failure at this site is also expected to be low due to its remote location and the fact that the pit has been backfilled with moderately graded to larger sized waste rock (*SRK, 2015*).

Table 2 below highlights locations associated with the Hab area where visual monitoring was recommended. As shown in **Figure 4**, at the end of section 5, these locations are expected align roughly with the 2nd level workings where some stoping was completed above the Hab 039 Zone area.

Table 2: Visual Monitoring Location Recommendations for Hab

Location	Position	Elevation (approx.)	Comment
HAB039-01	Zone:12 V 645272, 6612203	408 m	Near the edge of the mine waste backfill
HAB039-02	Zone:12 V 645339, 6612234	415 m	Covered by mine waste backfill in the pit
HAB039-03	Zone:12 V 645384, 6612251	419 m	Covered by mine waste backfill, near the edge of the pit rim
HAB039-04	Zone:12 V 645373, 6612211	408 m	Approximately above the 2nd level workings
HAB039-05	Zone:12 V 645298, 6612178	403 m	Approximately above the 2nd level workings

5.3 Ace Stope Area

While reviews of the Dubyna and Hab area concluded that visual monitoring of crown pillar condition was sufficient, the likelihood of additional failure of the crown pillar in the Ace Stope Area warranted additional remediation. Several options were proposed and ultimately it was decided to proceed with placing a cover of coarse material over the areas identified as having potential for future subsidence.

An optimized cover design to address identified areas of concern for future subsidence, based on the configuration of the historic stopes associated with the Ace mining area was selected.

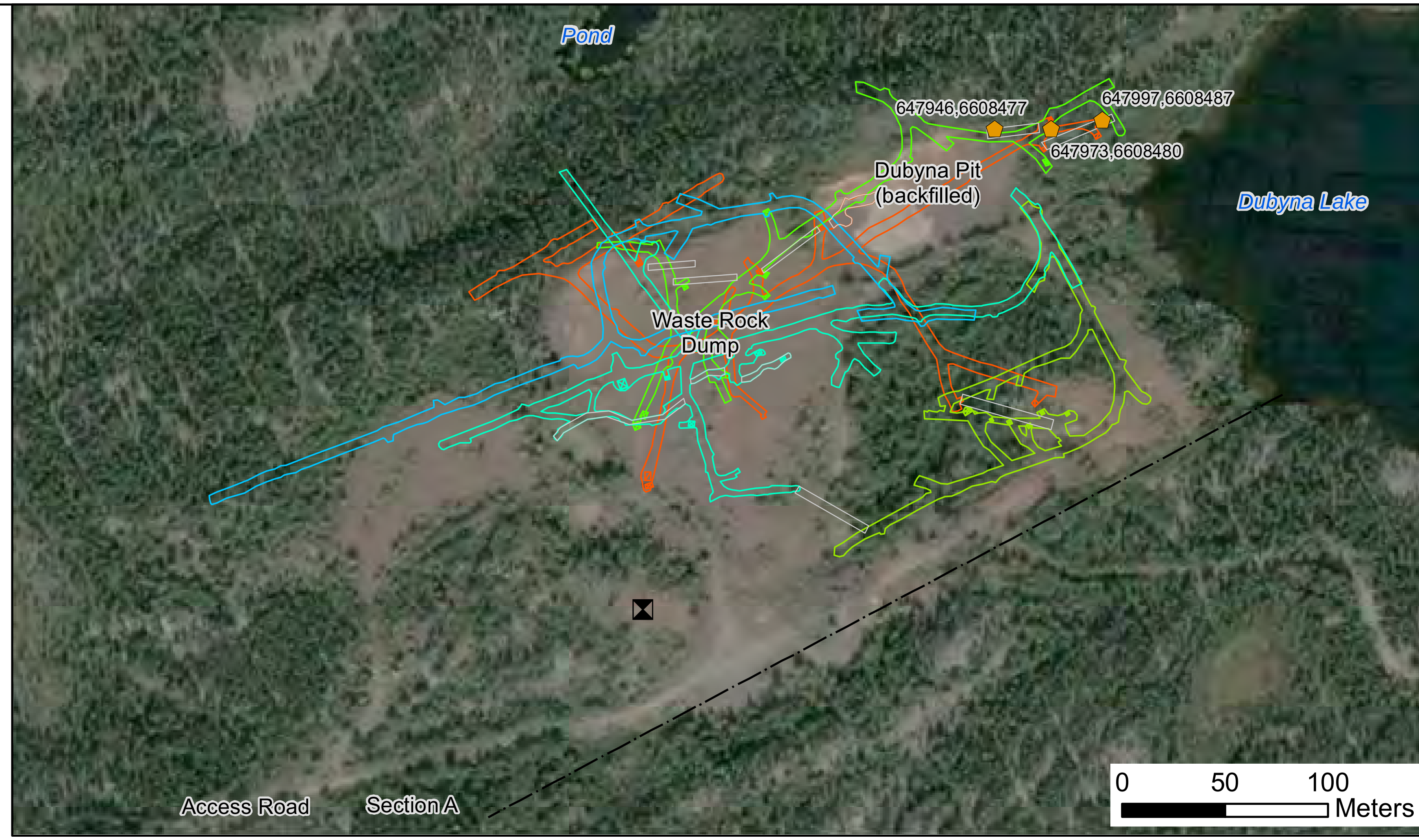
Placement of the cover material began on July 25th, 2016 under the supervision of SRK and was completed on September 2nd, 2016. The cover includes two main sections that run along strike with, and directly above, the historic stopes. The cover itself consists of a 1.5 to 2 meter base placed over the identified areas of risk and is comprised of a combination of broken concrete sourced from the building pads at the Fay mill site and sorted waste rock. Once the base was completed, a final 0.5 m layer of waste rock was placed on top. **Figure 5** provides the layout of the cover along with the locations of historic subsidence observed in the area.

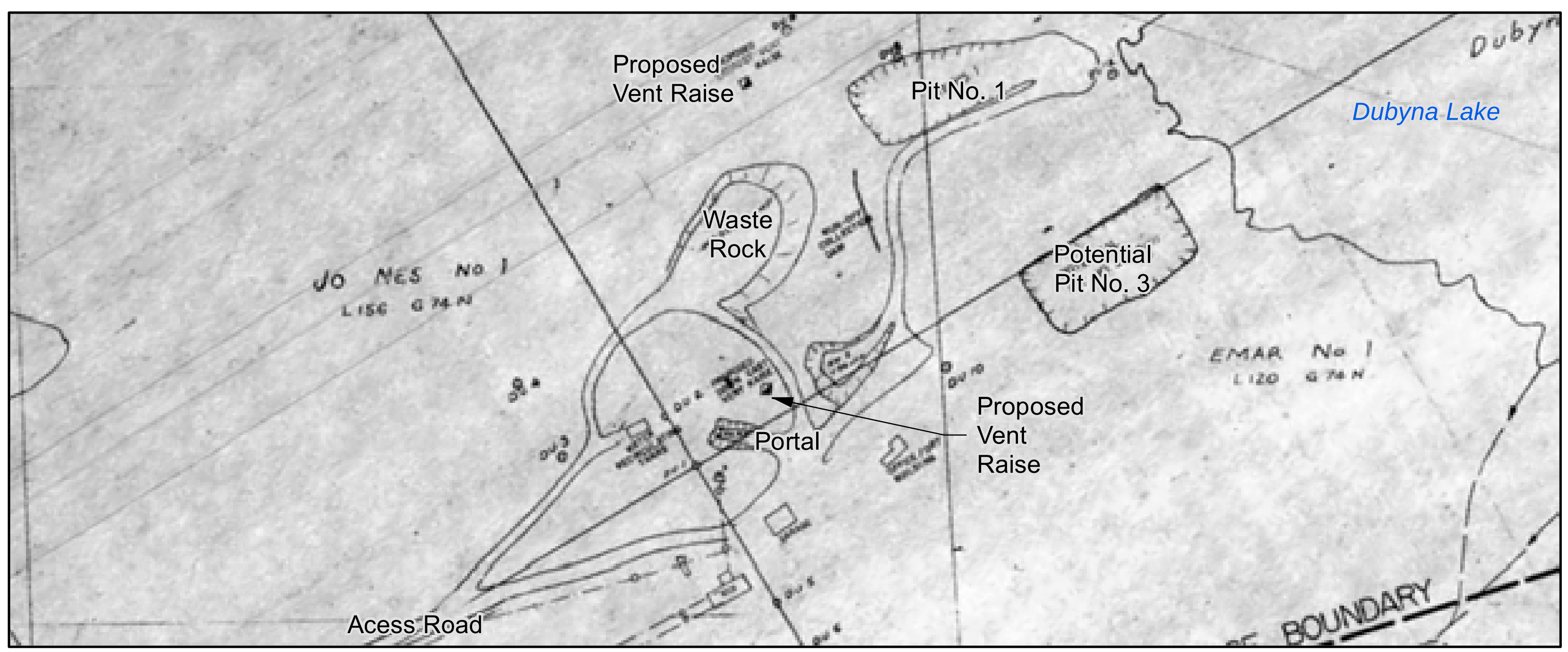
5.4 Inspections

Crown pillar inspections were conducted at the Ace area, with an emphasis on the newly placed cover material, as well as at (and between) the Hab and Dubyna monitoring points. Photographs of the covered Ace stope area are provided in **Appendix D**, with photographs of the crown pillar areas requiring inspection at Dubyna and Hab provided in **Appendix E** and **Appendix F**, respectively.

At the Ace site, the cover material over the stopes was inspected by walking the toe of the cover material, as well as the interface between the cover material and natural ground. No signs of tensions cracks or visible depressions were observed along the Ace stope cover material in 2018.

The crown pillar monitoring points at Hab and Dubyna were located, and a visual walking inspection was completed between and around the points. Observations at both areas did not show any evidence of tension cracks or slumping in 2018.





October 1978 Property Plan

Legend

- Approximate Stope Areas
- Visual Monitoring Locations

Dubyna Mine Workings

- LEVEL 1
- LEVEL 2S
- LEVEL 2W
- LEVEL 3
- LEVEL 4

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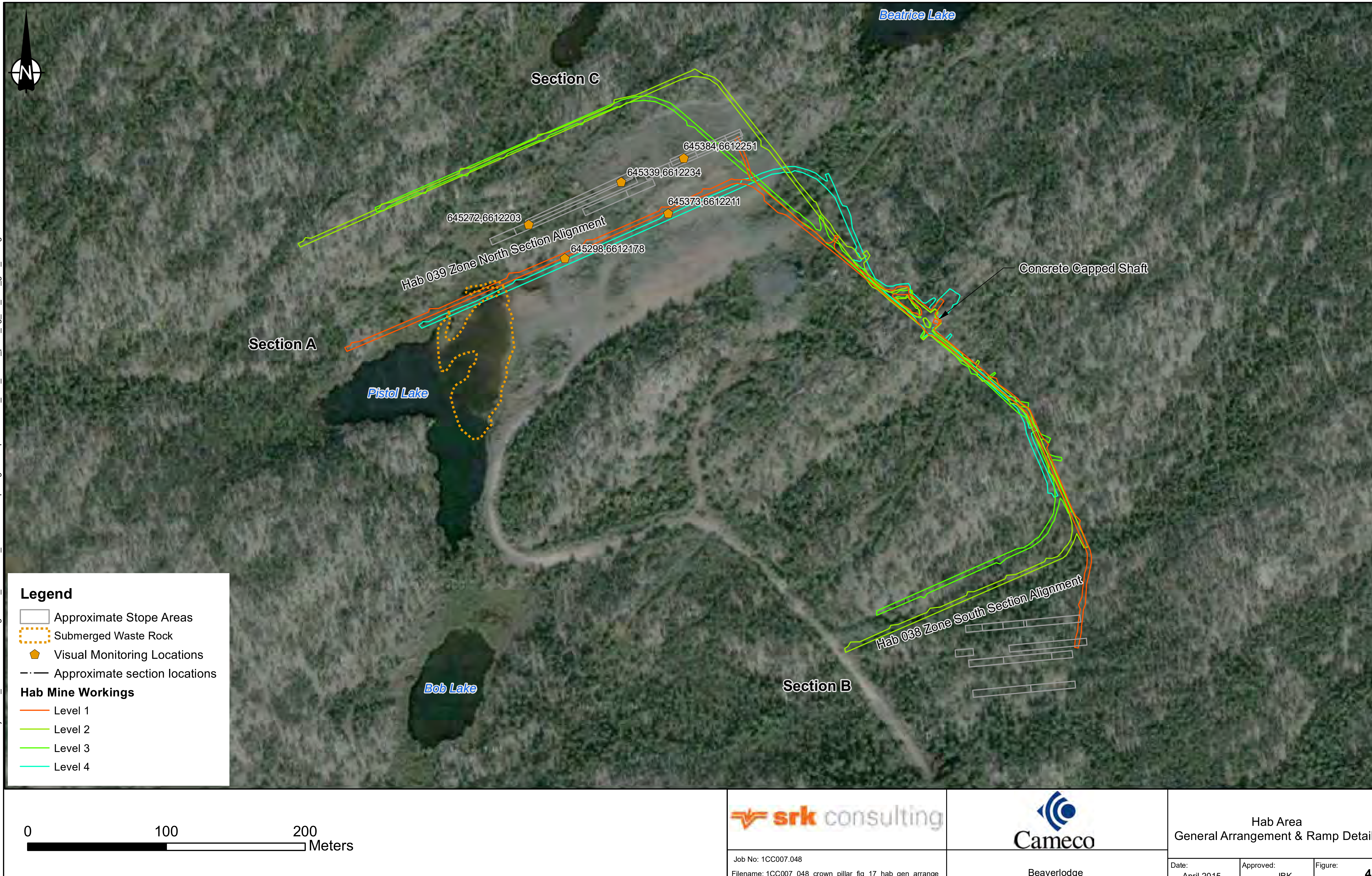
srk consulting	Cameco	Dubyna Area General Arrangement
Job No: 1CC007.048 Filename: 1CC007_048_crown_pillar_fig_14_dubyna_gen_arrange	Beaverlodge	Date: April 2015 · Approved: JBK · Figure: 3



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srk consulting

Job No: 1CC007.048

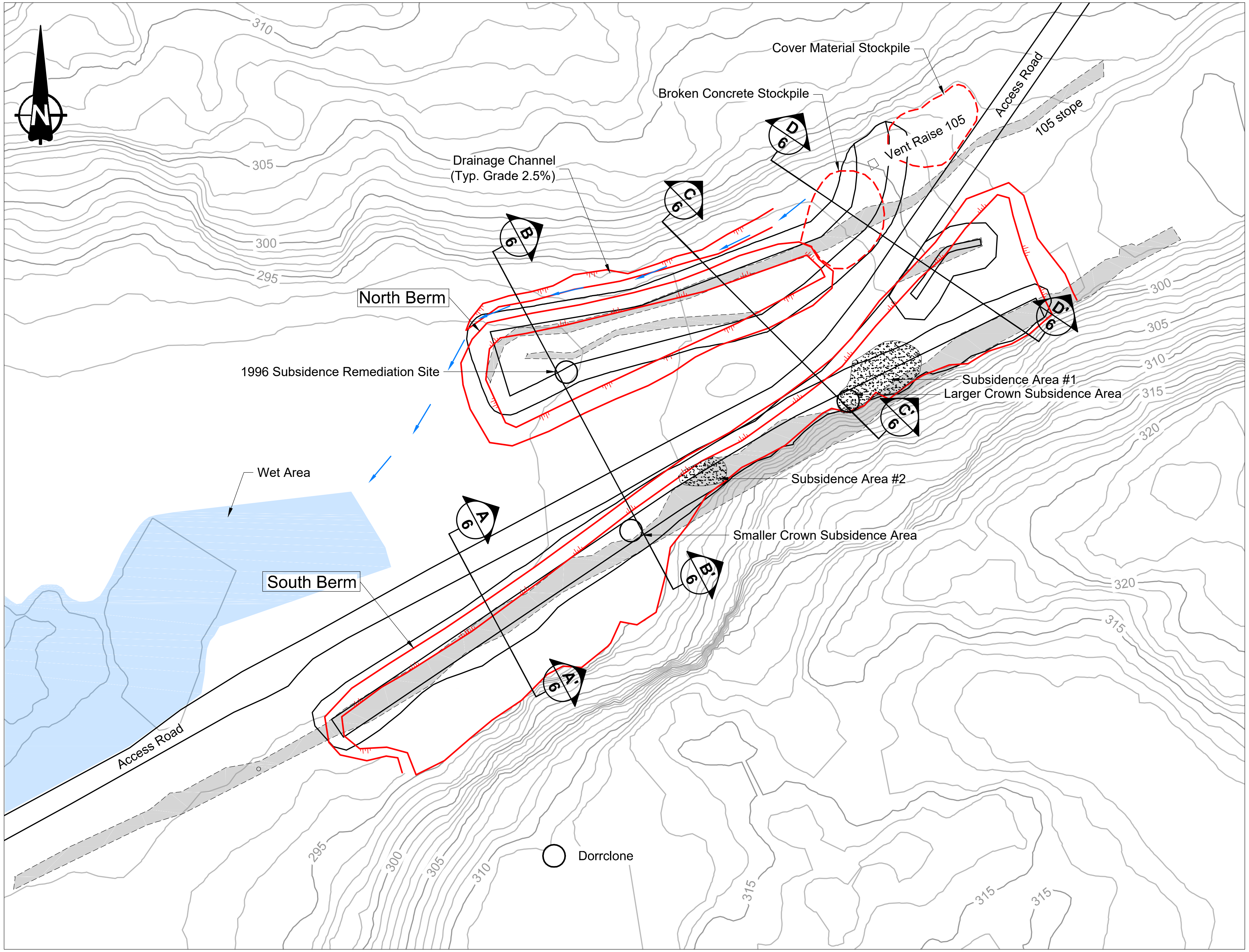
Filename: 1CC007_048_crown_pillar_fig_17_hab_gen_arrange

Cameco

Beaverlodge

Hab Area
General Arrangement & Ramp Details

Date:	Approved:	Figure:
April 2015	JBK	4



Plan Map

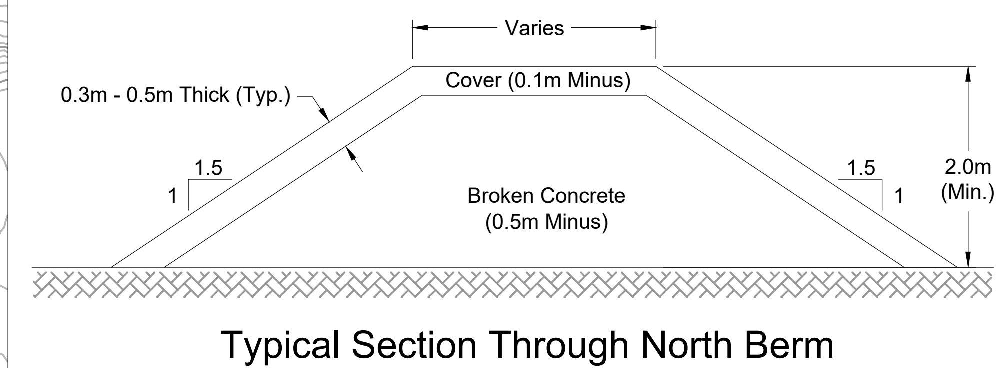
0m 5 10 15 20 25 30

LEGEND

- Drainage Channel Centerline and Flow Direction
- Stope Outline
- Proposed Subsidence Berm
- As-Built Subsidence Berm
- Approximate Stockpile Footprints

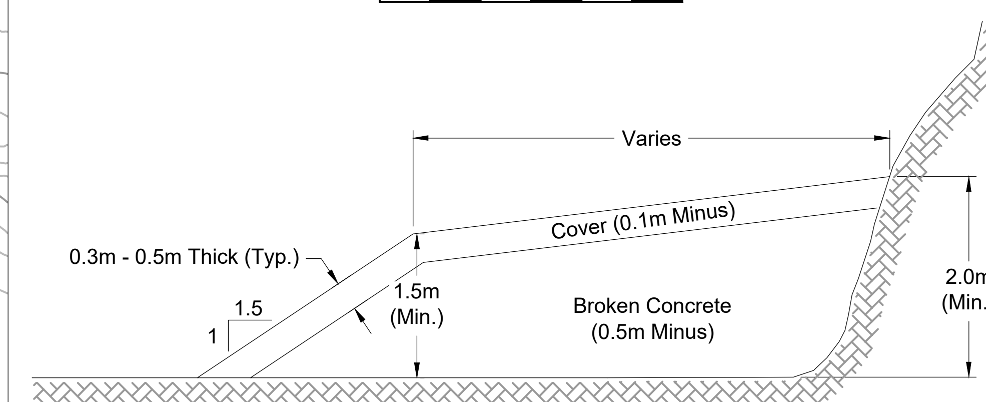
REFERENCE

Contours shown at 1.0m intervals and are based on 2009-2010 LiDAR survey.



Typical Section Through North Berm

0m 0.5 1.0 1.5 2.0 2.5 3.0



Typical Section Through South Berm

0m 0.5 1.0 1.5 2.0 2.5 3.0

DRAWING NO.	DRAWING TITLE	NO.	DESCRIPTION	CHK'D	APP'D	DATE	NO.	DESCRIPTION	CHK'D	APP'D	DATE
							AB1	As-Built	TPP	CS	16/12/21
REFERENCE DRAWINGS		REVISIONS									

Original Drawings Stamped and Signed by Engineer

This drawing is uncontrolled when printed unless stamped and signed with original ink and recorded on a Distribution Register.

PROFESSIONAL ENGINEERS STAMP

srk consulting

DESIGN: TPP | DRAWN: TAH | REVIEWED: TPP

CHECKED: TPP | APPROVED: CS | DATE: 2016/12/21

FILE NAME: 1CC007.062 - PP.dwg

Cameco

Beaverlodge

SRK JOB NO.: 1CC007.062

Ace Subsidence Remedial Work

DRAWING TITLE: As-Built Plan and Sections

DRAWING NO. ACE-03 | Figure 5 OF 5 | REVISION NO. AB1

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6.0 REFERENCES

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SRK Consulting (2010). Beaverlodge Project: Inspection of Fookes Delta and Outlet Structures at Fookes Reservoir and Marie Reservoir. Report prepared for Cameco Corporation, September, 2010.

SRK Consulting (Canada) Inc. (2015). Beaverlodge Property – Crown Pillar Assessment (2014 – 2015), Project Number: 1CC007.048. Report submitted to Cameco Corporation, July 2015.

SRK Consulting (2016). Beaverlodge Project: Inspection of Select Areas within the Fookes and Marie Reservoirs and Ace Creek Catchment. Report prepared for Cameco Corporation, January, 2016.

7.0 APPENDICES

Appendix A – Marie Reservoir Outlet photos

Appendix B – Fookes Reservoir Outlet photos

Appendix C – Fookes Tailings Delta photos

Appendix D – Ace crown pillar inspection photos

Appendix E – Dubyna crown pillar inspection photos

Appendix F – Hab crown pillar inspection photos

APPENDIX A

Marie Outlet Photos

Photo A1 - Marie Reservoir Spillway looking upstream (September 2018)

Photo A2 - Marie Reservoir Spillway looking upstream (September 2018)

Photo A3 - Marie Reservoir Spillway looking downstream at stilling basin (September 2018)

Photo A4 - Marie Reservoir Spillway stilling basin (September 2018)

Photo A5- Marie Reservoir outlet - formation of beaver dam (September 2018)

APPENDIX B

Fookes Outlet Photos

Photo B1 - Fookes Reservoir Spillway looking upstream (September 2018)

Photo B2 - Fookes Reservoir Spillway looking downstream (September 2018)

Photo B3 - Fookes Reservoir Spillway (September 2018)

Photo B4 - Fookes Reservoir Spillway stilling basin (September 2018)

APPENDIX C

Fookes Delta Cover Photos

Photo C1 - Fookes Delta; Chevrons in place on north access point looking south to the Fookes delta (May 2018)

Photo C2 - Fookes Delta; Drainage runout structure from chevrons along north access point (May 2018)

Photo C3 - Fookes Delta; looking south towards Fookes Reservoir. Photo taken from centrally located boulder (May 2018)

Photo C4 - Fookes Delta; looking west. Photo taken from centrally located boulder (May 2018)

Photo C5 - Fookes Reservoir shoreline looking west (May 2018)

Photo C6 - Fookes Reservoir shoreline looking east (May 2018)

Photo C7- Fookes Delta drainage channel filled with spring runoff. Photo taken upstream of Photo C8 looking north (May 2018)

Photo C8 - Fookes Delta drainage channel filled with spring runoff. Photo taken near Fookes Reservoir looking north (May 2018)

APPENDIX D

Ace Crown Pillar Area Photos

Photo D1 - Stope 201/103 crown pillar cover looking east

Photo D2 - Stope 201 crown pillar cover along bedrock contact with ridge, looking east

Photo D3 - Stope 201 crown pillar cover along bedrock contact with ridge, looking west

Photo D4 - Stope 103/201 crown pillar cover, looking south

Photo D5 - Stope 208 crown pillar cover, looking west

Photo D6 - Panorama photo looking south-west showing Stope 103/201 crown pillar cover on the left and Stop 208 crown pillar cover on the right. Vent Raise 105 is in the foreground (on the right) and has since been remeidated.

APPENDIX E

Dubyna Crown Pillar Photos

Photo E1 - Dubyna Crown Pillar Inspection Location #1 looking west towards Inspection Location #2.

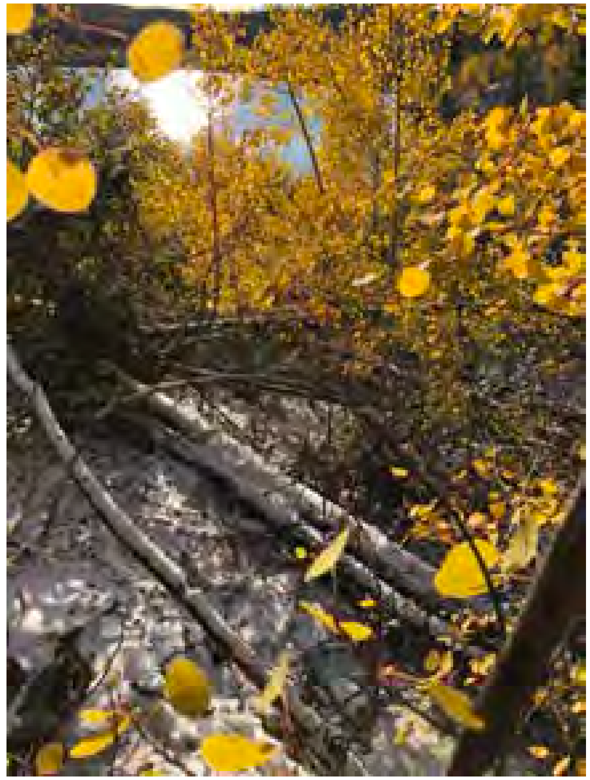


Photo E2 - Dubyna Crown Pillar Inspection Location #2 looking west towards Inspection Location #3.

Photo E3 - Dubyna Crown Pillar Inspection Location #3 looking east towards Inspection Location #2.

APPENDIX F

Hab Crown Pillar Photos

Photo F1 - Hab Crown Pillar Inspection looking east from Inspection Point Hab 039-01 to Hab 039-02.

Photo F2 - Hab Crown Pillar Inspection looking back from Inspection Point Hab 039-02 to Hab 039-01

Photo F3 - Hab Crown Pillar Inspection looking east from Inspection Point Hab 039-02 to Hab 039-03.

Photo F4 - Hab Crown Pillar Inspection looking back from Inspection Point Hab 039-03 to Hab 039-02.

Photo F5 - Hab Crown Pillar Inspection looking west from Inspection Point Hab 039-03 to Hab 039-04.

Photo F6 - Hab Crown Pillar Inspection looking back (east) from Inspection Point Hab 039-04 to Hab 039-03.

Photo F7 - Hab Crown Pillar Inspection looking west from Inspection Point Hab 039-04 to Hab 039-05.

APPENDIX B

APPENDIX B

MEETING TO DISCUSS THE
BEAVERLODGE DECOMMISSIONED PROPERTIES
2017 and 2018 ACTIVITIES

Northern Settlement of Uranium City

Community Meeting Report:

Cameco compiles a community meeting report, which is made available to local residents. The report is part of the continual dialogue with Uranium City residents regarding Cameco's remediation work on the decommissioned Beaverlodge properties as they are prepared for transfer to the Province of Saskatchewan's Institutional Control (IC) program.

Meeting Information:

Date:	May 29th, 2018
Location:	Uranium City
Time:	11:30 am – 1:30 pm (presentation followed by site tour 1:30 to 3:00 pm)
Recorder:	Cameco
Handouts:	Cameco presentation made available in hard copy; and electronically upon request.

1. Meeting Participants

Cameco publicized a community update meeting in Uranium City in prominent gathering places around the community along with mail box stuffing, which brought together 13 members of the community, five representatives from the Northern Saskatchewan Environmental Quality Committee. Two representative from the Canadian Nuclear Safety Commission (CNSC), four representatives from the Government of Saskatchewan. Also in attendance were five Cameco staff.

2. Meeting Purpose and Objectives

Community engagement activities for the decommissioned Beaverlodge properties aim to seek out project-related questions and concerns, which are then addressed in a meaningful way by Cameco. Cameco's intention for the meeting was to review the 2017 activities completed on the decommissioned Beaverlodge properties and the 2018/2019 plans for transferring properties to the provincial IC program. All interested community members were encouraged to attend.

3. Meeting Agenda

11:30 am – 12:00 pm	Lunch
12:00 pm – 1:30 pm	Cameco Presentation: Beaverlodge Decommissioned Properties • Activities update • Status of 2017 activities • Activities to complete in 2018 • Future activities o Cameco is proposing to transfer 20 properties to the Province of Saskatchewan's Institutional Control Program (likely in 1st half of 2019)
	Regulatory Presentations: Canadian Nuclear Safety Commission Roles and Responsibilities Saskatchewan Ministry of Environment Roles and Responsibilities Saskatchewan Ministry of Energy and Resources • Institutional Control Program and How it Works
1:30 pm – 3:00 pm	Site Tour

4. Meeting Logistics

Lunch was provided to all participants prior to the PowerPoint presentations being made by Cameco and the regulatory agencies. Participants were encouraged to ask questions during the presentation to facilitate immediate discussion regarding questions raised. . The meeting was followed by a site tour lead by the Cameco project manager to show the EQC and interested Uranium City residents some of the project work completed over the last couple of years.

5. Presentation Overview

The presentation developed by Cameco for this meeting highlighted the history of Beaverlodge, the development of the management programs guiding decisions being made regarding additional remediation and the objective to ensure the properties are adequately prepared for transfer to the Saskatchewan IC program. The presentation then focused on what activities have been completed to date and what will occur next in order to move the Beaverlodge properties into IC. Twenty properties will be prepared for transfer to the IC program in 2019.

6. Questions Raised

There were no questions raised by participants during or following the Cameco presentation. During the regulatory presentation there were a few questions directed to the Saskatchewan Ministry of Environment regarding buildings located in the Uranium City area. They Q and A are paraphrased below. .

Question:	What will happen to the lodge at Beaverlodge?
Government of Saskatchewan Ministry of Environment:	The Ministry of Environment's Land Branch has taken over ownership of the lodge.
Question:	What about the Butler Building?
Government of Saskatchewan Ministry of Environment:	The Ministry of Environment's Land Branch is responsible for the Butler Building and the old heavy duty shop.
Question:	Can a person go into and salvage those buildings?
Government of Saskatchewan Ministry of Environment:	No, they are government property and there maybe health concerns with asbestos in the former heavy duty shop and possibly in the Butler building.

7. Follow-up from Previous Meeting

There was no follow-up required from the 2017 community engagement meeting as all participant comments and questions were fully responded to during the meeting.

8. Upcoming Engagement

Cameco along with its regulators, SMOE and CNSC, will plan a meeting with the community of Uranium City and Athabasca representatives from the NSEQC in the summer of 2019. This meeting will focus on project status updates and plans for transferring properties to the IC program.

May 29, 2018

Beaverlodge Presentation

Uranium City and the NSEQC - Athabasca Sub-Committee

Shawn Hiller

cameco.com

Cameco

Beaverlodge Timeline

Operating

1952 to 1982

Low-grade ore (by today's standard)

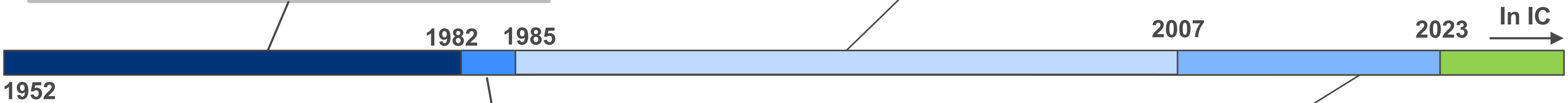
20 million kg of yellowcake

Main site + satellite mines

Transition Phase Monitoring

1985 to present

Routine monitoring and inspections



Decommissioning and reclamation

Implemented 1982 – 1985

Decommissioning plan approved by regulators of the day

Completed remediation accepted by regulatory agencies

To Institutional Control

2007 implemented Act & Regulations

Beaverlodge Management Framework

The Path Forward Plan

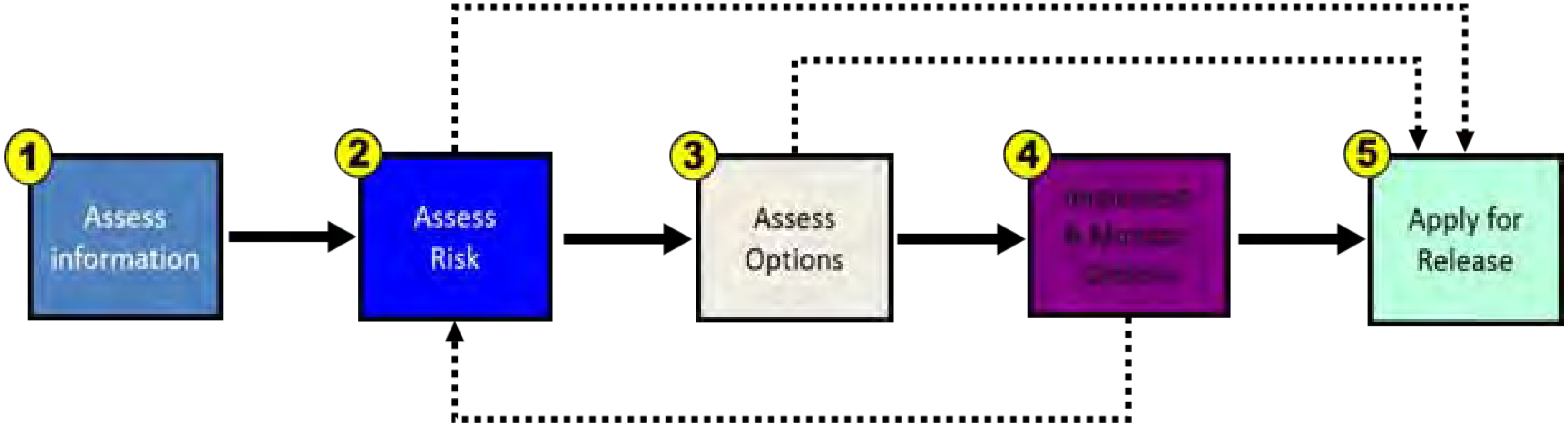
Site remediation

The Road to IC
Beaverlodge Management Framework

The goal: to transfer all properties to the Institutional Control Program

To do this, we needed a "map":

- Cameco worked with regulatory agencies and stakeholders to develop the approved **Beaverlodge Management Framework**
- The Framework outlined a **step by step process** for how the properties would be assessed and the final remedial options would be **selected, monitored and evaluated** for success prior to transfer to IC



The Road to IC
Assessing the Site and Selecting Remedial Options

- **Gathered information** to form the basis for assessing the properties
  - From 2009 to 2012 **more than 20** environmental studies were completed in the Beaverlodge area
- Compiled all this information into the **Quantitative Site Model**
  - The **QSM** was a tool that allowed for the assessment of various potential remedial options
- Conducted **Remedial Options Workshops** in 2009 and 2012 with local and regional stakeholders
  - Presentation of various **remedial options**, along with their outcomes using the **QSM**
  - Participant feedback regarding the potential remedial options was gathered and summarized

The Road to IC

The Beaverlodge Path Forward

- Results from the workshops were used to develop the **Beaverlodge Path Forward**
  - Overall the workshops (using the **QSM**) showed that continued **natural recovery**, paired with ***select remedial options*** was the best way to proceed for the Beaverlodge properties
- These ***select remedial options*** consisted of:
  1) Completion of a site wide surficial gamma survey and assessment.
  2) Securing historic mine openings from access.
  3) Decommission identified boreholes.
  4) Re-establishment of the Zora Creek flow path.
  5) Final inspection and cleanup of properties.

The Road to IC
The Beaverlodge Path Forward

- **The** **Path Forward Plan** was presented to the Commission at the 2013 relicensing hearing
  - The Commission **accepted** the proposed Path Forward and granted Cameco a 10-year licence to implement the select remedial options
- The Plan also included **Performance Criteria** to evaluate success of remediation prior to transfer of the properties back to province
  - The high level Criteria are defined as the ***Performance Objectives***:

Safe for general public access

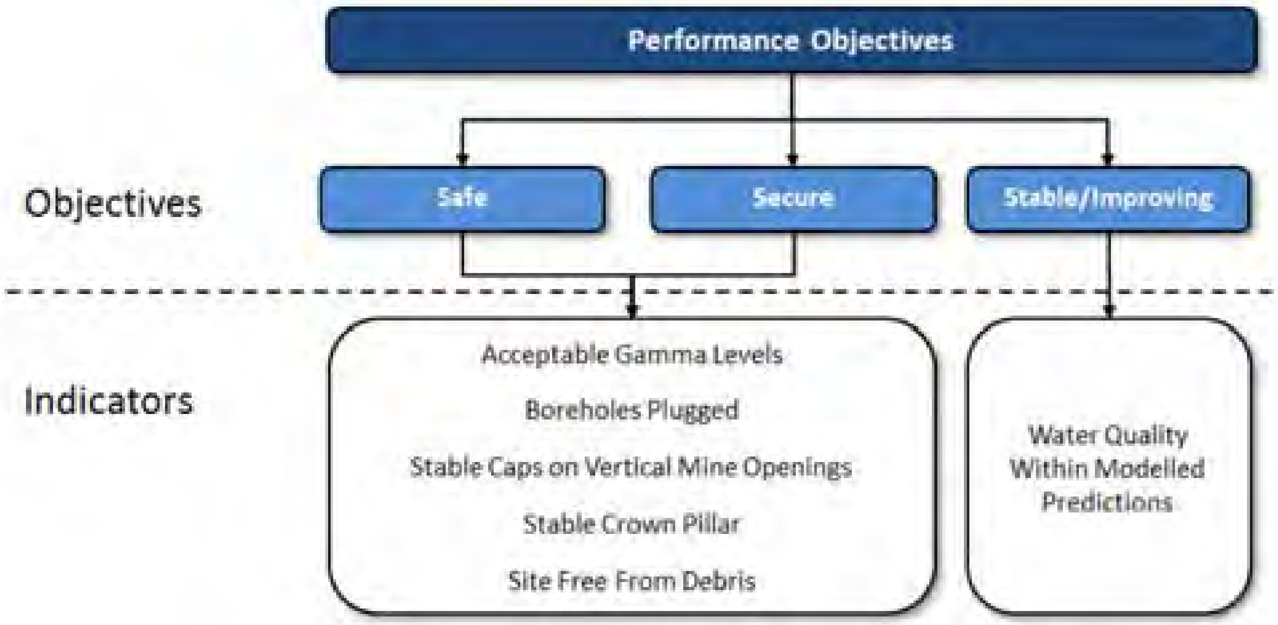
Secure; Confidence that long term risks have been assessed by a qualified person and are acceptable

Stable/Improving; Environmental conditions (e.g. water quality) on and downstream of the decommissioned properties are stable and continue to naturally recover as predicted

The Road to IC

Criteria for Release – Performance Indicators

The **Performance Objectives** were then broken down into specific **Performance Indicators** that each property would be evaluated on:



Once these criteria are met, the properties are eligible for:

1) ***release*** from SkMOE decommissioning and reclamation requirements; and

2) ***exemption*** from CNSC licensing

The Road to IC
Schedule

Properties being transferred in a staged approach

5 satellite properties transferred in 2009

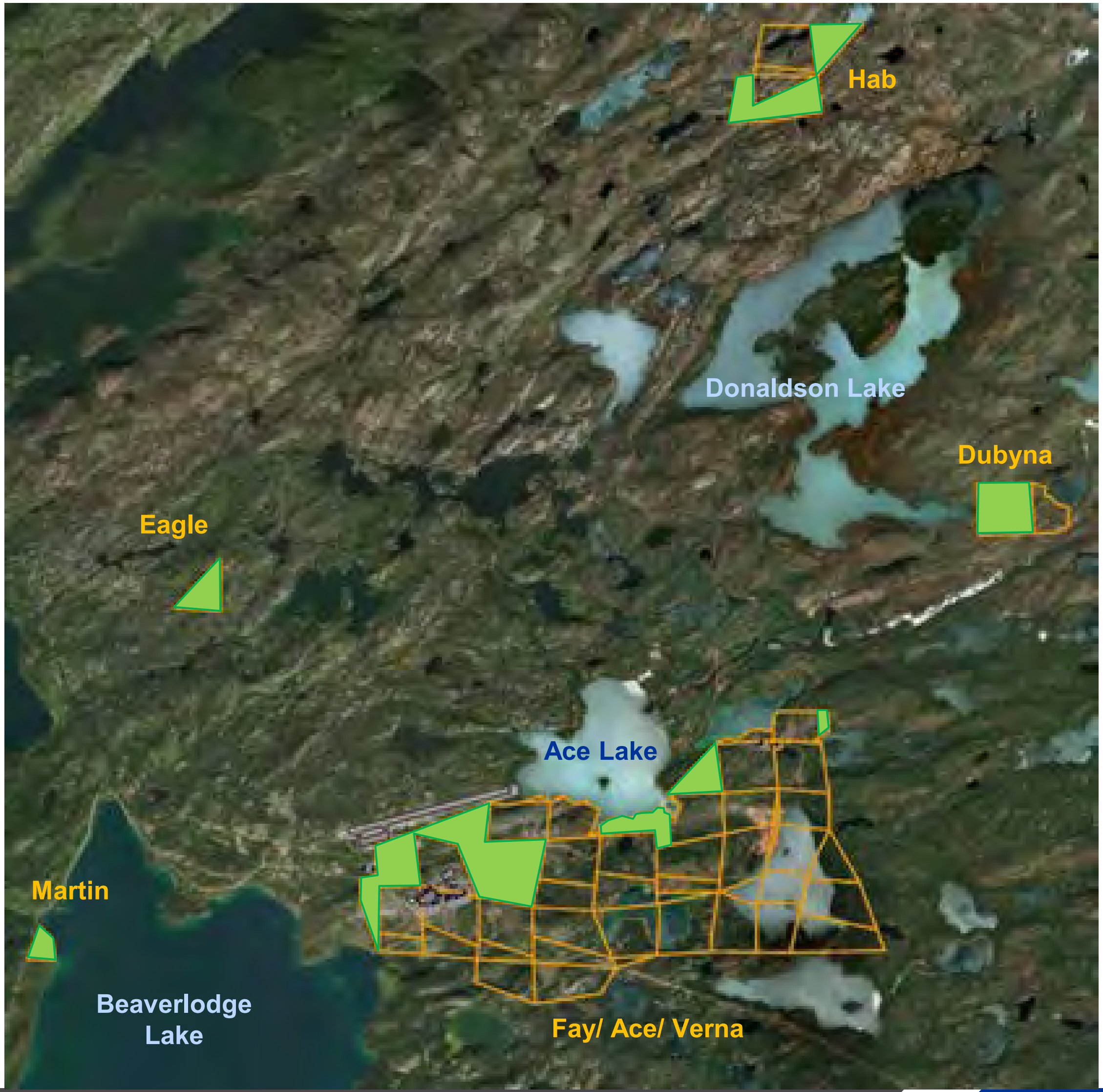
- Small properties with minimal activity

20 properties proposed for transfer now

- Report requesting transfer for 14 properties in 2016
  - Reviewed by regulatory agencies
  - Received *letter of intent* from SkMOE
- Report covering a further 6 properties submitted this year

Remaining properties planned for transfer by 2023

The Road to IC
The 20 Properties



Property Evaluations
Performance Indicators for the 14 properties

Performance Indicators	Acceptable Gamma Levels	Site Free From Debris	Boreholes Plugged	Stable Caps on Vertical Mine Openings	Stable Crown Pillar	Water Quality Within Modelled Predictions
Acceptance Criteria	Reasonable use scenario demonstrating gamma levels at the site are acceptable.	Final site inspection and removal of remnant debris	All boreholes have been plugged at the time of transfer to institutional control.	Caps have been replaced and signed off by a qualified person.	Crown pillar assessed, remediated if required, and signed off by a qualified person.	Water quality is stable/improving
HAB 3	✓	✓	✓	N/A	✓	N/A
HAB 6	✓	✓	✓	N/A	N/A	N/A
EXC 2	✓	✓	✓	N/A	N/A	N/A
RA 6	✓	✓	N/A	✓	✓	N/A
RA 9	✓	✓	N/A	✓	✓	N/A
EAGLE 1	✓	✓	✓	N/A	N/A	N/A
BOLGER 2	✓	✓	✓	N/A	N/A	N/A
ATO 26	✓	✓	N/A	N/A	N/A	N/A
EXC ATO 26	✓	✓	N/A	N/A	N/A	N/A
URA MC	✓	✓	✓	N/A	N/A	N/A
EXC ACE 1	✓	✓	N/A	N/A	N/A	N/A
ACE 10	✓	✓	N/A	N/A	N/A	N/A
ACE 2	✓	✓	N/A	N/A	N/A	N/A
EXC ACE 3	✓	✓	N/A	N/A	N/A	N/A

Property Evaluations
Performance Indicators for the 6 properties

Performance Indicators	Acceptable Gamma Levels	Site Free From Debris	Boreholes Plugged	Stable Caps on Vertical Mine Openings	Stable Crown Pillar	Water Quality Within Modelled Predictions
Acceptance Criteria	Reasonable use scenario demonstrating gamma levels at the site are acceptable.	Final site inspection and removal of remnant debris	All boreholes have been plugged at the time of transfer to institutional control.	Caps have been replaced and signed off by a qualified person.	Crown pillar assessed, remediated if required, and signed off by a qualified person.	Water quality is stable/improving
URA 5	✓	✓	✓	N/A	N/A	N/A
EXC URA 5	✓	✓	N/A	N/A	N/A	N/A
URA 3	✓	✓	✓	✓	N/A	N/A
ACE 5	N/A	✓	✓	N/A	N/A	N/A
JO-NES	✓	✓	✓	✓	✓	N/A
HAB 2A	✓	✓	✓	✓	N/A	N/A

How did we determine the check marks?

… Lot’s of work over the past several years

Meeting the Performance Objectives

Acceptable Gamma Levels

Plan to collect data

Method for scanning gamma on the properties was developed in 2014 and approved by CNSC and SkMOE

Field Surveys

Field scanning of all disturbed areas associated with the licensed properties completed in the fall of 2014

Land use survey conducted in December 2014

What to do with the data

Method for assessing the risk proposed and accepted by the regulatory agencies

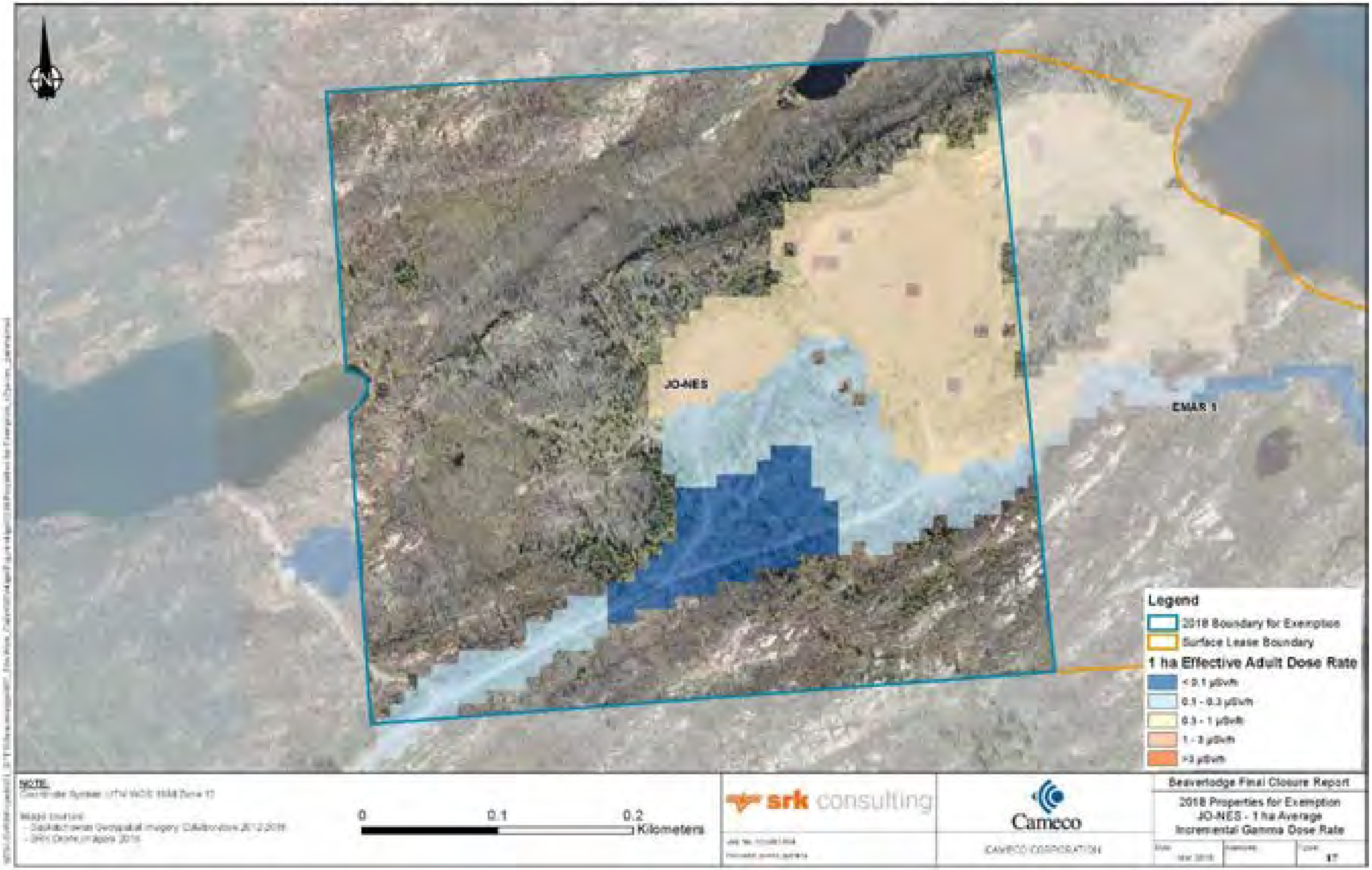
Final Risk Assessment

Risk assessment based on expected land use was then completed in 2015, which concluded that **members of the public remained safe**

Using a conservative estimate of potential doses based on surveyed land use, public exposure remained below the public dose limit on the Beaverlodge sites

Meeting the Performance Objectives

Acceptable Gamma Levels



Meeting the Performance Objectives

Site Free From Debris

- Three year campaign of property inspections and cleanup of historic debris finished from 2015 to 2017
  - Site inspections conducted in the spring and fall
  - Teams of people carrying GPS walked across the properties and flagged debris for collection and removal
  - All of the mine related debris was deposited in a designated disposal area in either the former Bolger pit or Lower Fay pit

More than 2,465 person-hours

2,533 cubic meters of material collected

75 non flowing boreholes sealed

1 flowing borehole sealed

Meeting the Performance Objectives
Site Free From Debris

Inspection tracks for the Fay/ Ace Verna complex

Meeting the Performance Objectives

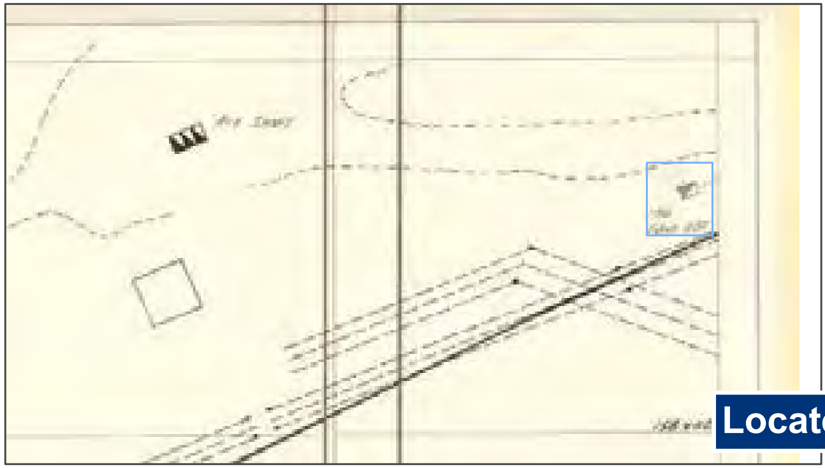
Site Free From Debris- Utility Line Remediation

- **While performing final inspection of ACE 5 property, discovered infrastructure related to power lines on the property**
  - The Beaverlodge Utility Line Remediation Options Assessment report with planned path forward was reviewed with SkMOE and CNSC during the Annual Inspection in July 2016
  - Plan accepted with conditions by SkMOE on April 3, 2017
- **Cleanup of the infrastructure completed in October 2017**

More than 500 person-hours

147 cubic meters of material collected

Meeting the Performance Objectives
Mine Openings Secure



Locate & Expose Cap

Clean cap and surrounding bedrock

Completed cap at Ace 130 Raise

Meeting the Performance Objectives
Mine Openings Secure

2016

Trial Install

Fabricated and installed steel cap at the Ace Shaft

Started process for additional 11 based on success of the initial install

2017

Easily Accessible

Fabricated and installed 11 steel caps at several properties

Measured and designing 6 steel caps for install in 2018

2018

Large Caps

Fabricate and install 6 steel caps

Measure and design 3 remaining steel caps

2019

Unique Caps

Fish Hook Bay, Verna Main Vent Raise and Fay Shaft

Steel caps complete

Meeting the Performance Objectives
Crown Pillars Secure

Site Wide Crown Pillar Assessment in 2014-2015

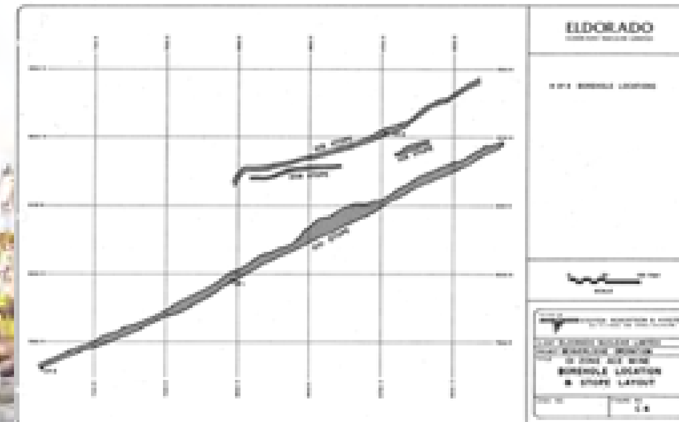
- Review of historic mine drawings and layouts was completed and identified 3 areas that required a closer look
- No areas of concern located on the properties currently up for transfer

Ace
• Completed field investigation with GPR and drilling • Determined Ace crown pillar at increased risk of potential future subsidence • Completed additional remediation: • Applied broken concrete and waste rock cover to areas at risk of subsidence

No further remediation work is required, and areas will be monitored visually.

Meeting the Performance Objectives

Crown Pillars Secure



Meeting the Performance Objectives
Water Quality Within Modelled Predictions

- No water quality predictions associated with the 20 properties currently up for transfer

- Water quality predictions made in the **Path Forward Report**
- Comparisons to these are made every five years in the **Environmental Performance Report**
  - The EPR summarizes the last five years of data to assess trends and compare the water quality data to the predictions
- Next EPR is currently underway
  - Will be used to start evaluating the predictions and current trends
  - The EPR after that (~2022) will be used to show properties are ready for transfer

Conclusions
Planned IC Transfer

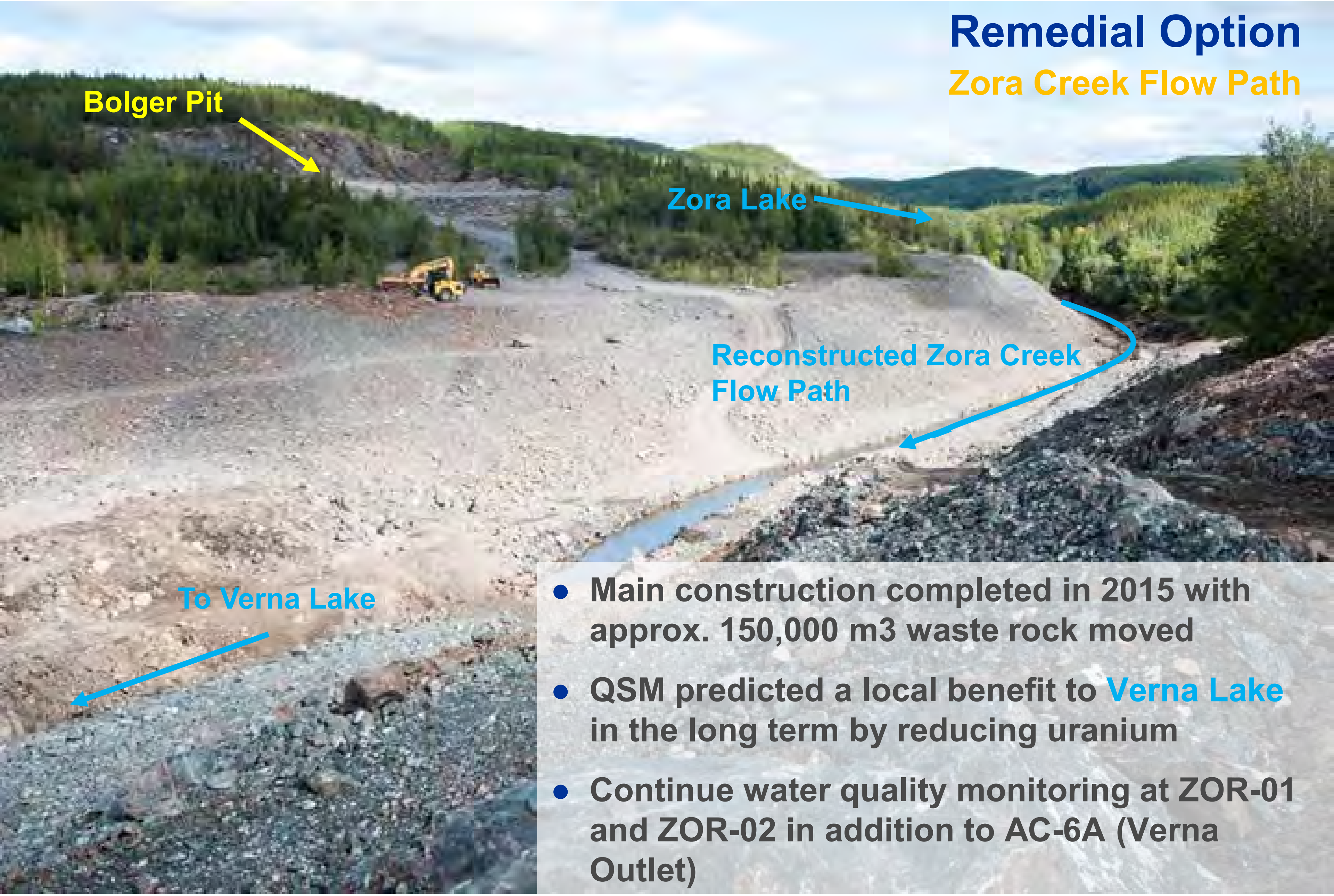
- The 20 properties proposed for transfer **meet the Performance Objectives** of **Safe, Secure and Stable/Improving**
- Expect to transfer the properties into the **IC Registry** next year
  - Requires agreement between several regulatory agencies
  - Properties will continue to be monitored and managed

Additional Site Activities

- Couple more discussion points not directly related to the 20 properties:
  - Zora Flow Path (Remedial Option)
  - Fish Assessment

Remedial Option

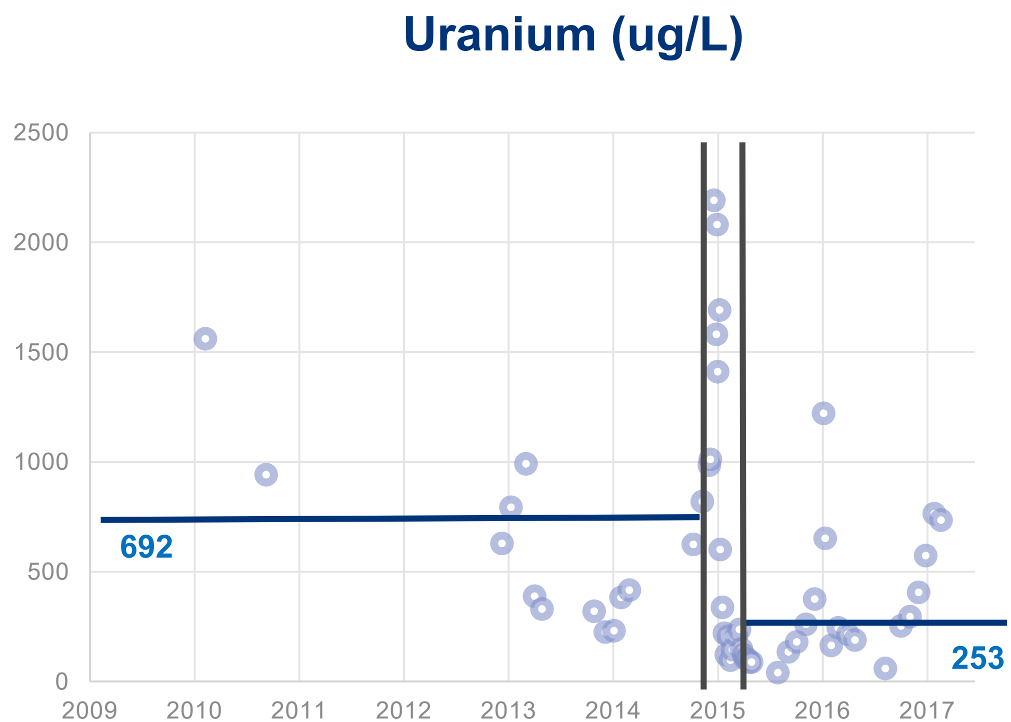
Zora Creek Flow Path



- Main construction completed in 2015 with approx. 150,000 m3 waste rock moved
- QSM predicted a local benefit to Verna Lake in the long term by reducing uranium
- Continue water quality monitoring at ZOR-01 and ZOR-02 in addition to AC-6A (Verna Outlet)

Remedial Option
Zora Creek Flow Path

- **Decreases in uranium concentrations exiting the new flow path:**



- **Expect to see continued improvement in Verna Lake**
- **Of note: Ace Lake (downstream of Verna) meets the surface water quality guidelines for uranium**

Fish Assessment

- **Fish Sampling and Chemical Analysis Program**
  - Question raised during 2016 public meeting regarding age of other data (Martin Lake for example). Data more than 15 years old.
  - CanNorth performed fish study in Verna, Ace, Beaverlodge, and Martin Lake (south and north basins) in 2017.
  - Expect the information will support the continuation of the Healthy Fish Consumption Guideline.

Public Information Program

- **Public Information Program**
  - Public Disclosure Protocol
  - http://www.cameco.com/northernsk/cameco_in_north/public_disclosure/
- **Cameco Northern Website**
  - http://www.cameco.com/northernsk
- **Beaverlodge website**
  - www.beaverlodgesites.com

Regulatory Oversight

- **SkMOE and CNSC will be in Uranium City conducting a regulatory inspection until June 1, 2018**

- **CNSC Contact Information**
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APPENDIX C

APPENDIX C

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Memo

To:	Mike Webster, Remediation Coordinator Compliance & Licensing	**Client:**	Cameco Corporation
From:	Trevor Podaima, PEng	**Project No:**	1CC007.065
Reviewed By:	Mark Liskowich, PGeo	**Date:**	February 19, 2019
Subject:	Bolger Flow Path Reconstruction - 2018 Geotechnical Inspection		

1 Introduction

1.1 Background

Historically, the Bolger Waste Rock Pile (the Site) consisted of waste rock and overburden from the historic Bolger Pit and Verna Shaft (Figure 1). This pile occupied a narrow valley next to the pit, which overlaid the former location of both Down Lake and a small creek (Zora Creek). Zora Creek linked Zora Lake to Down Lake, which then drained into Verna Lake. Zora Creek flowed intermittently (low to no flows in winter) through the base of the waste rock pile. The waste rock pile also contained a build-up of ice that impeded flow of water through the pile, which increased the extent of contact between creek water and the waste rock.

In June 2014, the Bolger Flow Path Reconstruction (the Project) commenced, which in general consisted of excavating a channel through the Site to re-establish flow in Zora Creek and limit the waste rock in direct contact with Zora Creek and water previously stored within the pile (Figure 2). The reconstructed flow path was predicted to result in improved water quality in Zora Creek, which may lead to improved water quality in Verna Lake. The Project was carried out over three construction seasons and was completed in late August 2016 (SRK 2017a).

The as-built channel configuration consists of a top excavation width that varies across the top flanks between approximately 40 and 90 m, a minimum base width of 2 m and a total channel length of approximately 400 m. To achieve this geometry, a series of benches (approximately 5 m wide by 6 m high) were excavated with overall side slopes that varied between approximately 1.6 horizontal:1.0 vertical (H:V) to 3.7H:1V (average is approximately 2.5H:1V). The configuration of the reconstructed channel is shown in Figures 2, 3 and 4.

The following should be read in conjunction with Figure 3, which includes the stationing along the channel. From Station 0+000 to Station 0+090 m, the bottom 0.5 to 1.0 m of the channel was sub-cut into overburden and lined with erosion protection material comprised of boulders with sand and gravel. From Station 0+090 to Station 0+260, this sub-cut was excavated through waste rock where a small portion of the historical Down Lake remains. This portion of the channel has ponded water that varies seasonally, from approximately 0.5 m to 0.8 m in depth. From Station 0+260 to Station 0+275, the channel is founded in bedrock. From Station 0+275 to Station 0+313, the northern side slope of the channel is in bedrock and the southern side slope is comprised of waste rock. The settling basin is founded in natural ground and is contained by bedrock outcrops. The ponding depth throughout the channel at the time of the inspection is shown in Figure 3. Full details of the as constructed channel are provided in the As-Built Report (SRK 2017a).

1.2 Scope of Work

Cameco Corporation retained SRK Consulting (Canada) Inc. to carry out a geotechnical inspection of the Site in 2018, which is the second geotechnical inspection subsequent to completion of the re-established channel. This work fulfills the recommendation in the Design Report (SRK 2014) to complete a geotechnical inspection in each of the first two years following construction.

This memo focuses on the geotechnical components of the inspection and concludes with recommendations for maintenance and future inspections. Trevor Podaima, PEng with SRK, conducted the geotechnical inspection on August 25, 2018. The detailed site inspection was carried out on foot to visually inspect the various components of the reconstructed Zora Creek flow path. The weather during the inspection was overcast with occasional sun and calm.

It should be noted the following sections read similar to the geotechnical inspection completed in 2017 as the conditions of the channel have not changed significantly since the 2017 inspection.

2 Inspection

2.1 General

The inspection was carried out in accordance with the Field Inspection Form and Check List prepared specifically for the Bolger Flow Path Reconstruction. The form and check list were developed as part of Cameco’s response to the Canadian Nuclear Safety Commission (CNSC) comments regarding the Final As-Built Report for the Bolger Flow Path Reconstruction (SRK 2017a) and the requirement to provide a template that could be followed for future inspections. The inspection forms focus on the key design components of the reconstructed flow path, which include: access roads, channel side slopes, channel base, channel inlet and channel outlet. The checklist was developed for assessment of each of these design components, which includes: stability, vegetation, rip-rap, seepage, ponding, sediment accumulation, channel blockages and channel flow. Completed inspection forms are included in Appendix A, which form the basis of this memo. The following should be read in conjunction with Figures 1 to 7, which include specific inspection photos. Photo locations are illustrated on Figure 3.

2.2 Access Roads

The front gate is locked restricting public vehicle access to the Site (Figure 2). On-site traffic controls included speed limit signage of 30 km/hr and road blockages reducing road width to promote decreased speeds prior to driving down towards the excavated channel.

Recommendations:

- No recommendations, as the access roads are in good condition.

2.3 Channel Inlet

A beaver dam and heavy vegetation were observed at the inlet of the channel restricting flow from Zora Lake into the channel (Figure 6, Photos 4, 5 and 6). The flow rate was observed at approximately 1 L/s. Conditions at the inlet appeared to be consisted with the 2017 inspection with respect to the size of the beaver dam and the water level of Zora Lake. The only apparent change was that in 2017, a portion of the flow was directed to the south which then entered the channel as seepage through the south sidewall of the channel from approximately Station 0+015 to 0+030. This was not observed in the 2018 inspection as water flow was not directed to the south side of the inlet, which is likely attributed to a lower lake level at the time of the inspection.

As stated in the 2017 inspection, based on discussions with Cameco it is understood that the beaver dam was present well prior to channel excavation. The beaver dam has a stepped configuration that creates a cascading effect as the flow from Zora Lake migrates through the dam and into the channel. The beaver dam does not impact the geotechnical stability of the channel; however, should there be a global failure of the beaver dam, it is likely that scour of the channel will occur as well as sedimentation loading downstream. Such failure will not result in instability of the channel, but maintenance may be required.

Recommendations:

- No maintenance is required at the channel inlet; however, the inlet should be re-inspected as part of future geotechnical inspections, and if required, will include options for removing the blockages.

2.4 Channel Side Slope Crests

Consistent with the 2017 inspection, several small voids (typically 0.15 to 0.3 m) in the waste rock were observed, which reflects how the material was originally placed to form the Bolger Pile. Such voids make the site difficult to traverse, but this does not impact the geotechnical stability or performance of the channel. The vegetation growth was none to very sparse on the channel side slope crests. Overall the crests were in good condition and there are no geotechnical concerns. Current conditions of the side slope crests are shown in Figure 4.

Recommendations:

- None.

2.5 Channel Side Slopes

The condition of the channel side slopes were consistent with the 2017 inspection. Similar to the channel side slope crests discussed in Section 2.4, there were several small voids (0.15 to 0.3 m is size) observed throughout the channel side slopes (Figure 8, Photo 11). Although portions of the slopes do not have a tight-knit surface, such voids/configuration does not impact the geotechnical stability or performance of the channel. Surficial ravelling may occur over time in these select areas, but it is expected to be minor. The channel side slope configuration includes benches, which can accommodate such ravelling should it occur and reduce the likelihood of blockages in the channel.

Part of the inspection was focused specifically along the north side slope from approximately Station 0+015 to Station 0+060 (Figure 7, Photo 8). As noted in the 2017 inspection and in the As-Built Report (SRK 2017a, and 2017b, respectively), the lower portion of this channel slope was steeper than the design slope. At the time of the inspection, there were no signs of geotechnical instability or surficial ravelling. Consistent with 2017, this configuration is not deemed a geotechnical stability concern.

There was no vegetation on the side slopes at the time of inspection. A high-water mark was observed and measured at approximately 0.29 m above the current water level (Figure 8, Photo 12). Iron staining was evident from approximately Station 0+240 and Station 0+285 along the bottom portion of the side slopes and the base of the channel, which are founded in bedrock (Figure 9, Photos 14, 15 and 16). This is consistent with last year’s inspection and as discussed with Cameco, it is understood that the water quality data indicates there is no evidence of acid rock drainage.

<u>Recommendations:</u>

- Cameco to continue water quality monitoring within and downstream of the channel.

2.6 Channel Base

Overall, vegetation was observed to be sparse throughout the channel with the exception of the inlet from approximately Station 0+015 to Station 0+030 where it is moderate (Figure 6, Photo 7). Similar to last year’s inspection, this heavier vegetation growth was not restricting channel flow and is therefore not a concern related to channel performance.

Sediment accumulation was observed throughout most of the channel, which was more noticeable at four localized locations: Station 0+075 to 0+080; Station 0+090 to 0+115; Station 0+215 to 0+225 and Station 0+240 to 0+250. Photos of these locations are provided in the inspection forms in Appendix A (specifically Photos 8 to 12, respectively).

Station 0+075 is within the portion of the channel founded in natural ground, which is armored with sandy gravel and boulders. The sediment accumulation is minor (approximately 4 cm thick) and was not impeding flow. No action is required to remove this sedimentation.

Station 0+090 is where the channel transitions from overburden to waste rock and sedimentation accumulation is consistent with both observations in 2016 subsequent to the placement of the erosion control material and during the 2017 inspection. The sediment was not impeding the flow of the channel and does not need to be removed. Since there are no apparent changes since 2016, leaving the sediment in-place is not expected to impact channel performance. Low flow conditions are present from approximately Station 0+100 to Station 0+250 as this is the section of channel where a portion of the Historical Down Lake existed (SRK 2017a). The channel base from Station 0+100 to 0+215 appeared to be in good condition (Figure 7, Photo 9 and Figure 8, Photo 10).

Station 0+215 is immediately downstream of the channel crossing where channel flow appeared to be stagnant up until approximately Station 0+250 (Figure 9, Photos 15 and 16). Similar to the 2017 inspection, this area was observed to have lake bottom sediment that was easily re-suspended when the surface is agitated. This location is primarily comprised of lake bottom sediments (i.e. not sedimentation subsequent channel construction) as this portion of the channel was founded on the western extent of the historical Down Lake. During construction of the channel, a test pit was excavated at this location, which confirmed that approximately 1.5 m of lake bottom sediments overlie a dense fine silt and sand (SRK 2017a). There are no geotechnical related concerns with the sediment; however, should it become resuspended due to scour, transportation of sediments downstream may occur.

The channel crossing at Station 0+215 (Figure 8, Photos 10 and 13) was observed to be slightly above the invert elevation of the channel flow where flow was predominately through the voids of the waste rock. At the time of the inspection, minnows were observed just upstream of the channel crossing.

At Station 0+240 channel flow begins to increase; however, there is still noticeable sedimentation in the channel (approximately 6 cm thick) up until approximately Station 0+275. This sediment is not impeding flow and therefore does not need to be removed. There is a slight increase to channel flow at Station 0+275 and a more noticeable increase at approximately Station 0+290. The increases in flow velocity are directly related to the channel invert, which becomes lower at these stations. The channel base downstream of Station 0+090 has a 1% grade (SRK 2017a), which promotes positive downstream drainage and results in a thinner flow depth of approximately 4 cm (Figure 10, Photo 17). Flow depths above the channel base at various locations along the re-established channel are provided in Figure 3.

<u>Recommendations:</u>

- Cameco to continue water quality monitoring (including TSS) downstream of the re-established channel.

2.7 Channel Outlet

The channel outlet was observed to have sparse vegetation and heavy sedimentation (Figure 10, Photos 17 and 18). At the time of the inspection, discharge was observed to be clear and flowing at a rate of approximately 1 L/s based on the rather low flow conditions in late August 2018. No apparent change at channel outlet since the 2017 geotechnical inspection.

The v-notch weir situated downstream of the channel outlet was also inspected, which appeared to be in good working condition. The location of the weir is shown in Figure 3 and the status of the weir at the time of the inspection is shown in Figure 11, Photo 19.

For reference, the location of where downstream flow enters Verna Lake is shown in Figure 11, Photos 20 and 21. No concerns were identified along the flow path downstream of the re-established drainage channel.

Recommendations:

- No maintenance is required at this time; however, accumulated sediment should be monitored during future inspections.

2.8 Bolger Pit

The Bolger Pit, which was further backfilled with waste rock as part of the channel reconstruction was inspected and there were no geotechnical concerns (Figure 5, Photo 3).

Recommendations:

- No maintenance is required at this time.

2.9 Water Quality

Water quality was not reviewed as part of the geotechnical inspection as this data is reviewed, assessed and presented as part of the Beaverlodge Project 2017 Annual Report – Year 32 Transition Phase Monitoring (Cameco 2018).

Recommendations:

- Not applicable.

3 Conclusions

The memo provides a geotechnical performance assessment of the reconstructed Zora Creek flow path. This is the second inspection completed by SRK since the completion of the channel reconstruction in 2016. The findings are based on a walkover inspection on August 25, 2018 where there were no immediate or significant areas of concern with regards to the geotechnical performance and/or stability of the reconstructed flow path.

Based on the results of the geotechnical assessments completed in 2017 and 2018, and the fact that there has been negligible geotechnical changes to the channel since 2016, the next geotechnical inspection should be completed in five years (summer/fall of 2023), or earlier if requested by Cameco.

This draft memo, “Bolger Flow Path Reconstruction - 2018 Geotechnical Inspection”, was prepared by: SRK Consulting (Canada) Inc.

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Mark Liskowich, PGeo
Principal Consultant

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The opinions expressed in this report have been based on the information available to SRK at the time of preparation. SRK has exercised all due care in reviewing information supplied by others for use on this project. Whilst SRK has compared key supplied data with expected values, the accuracy of the results and conclusions from the review are entirely reliant on the accuracy and completeness of the supplied data. SRK does not accept responsibility for any errors or omissions in the supplied information, except to the extent that SRK was hired to verify the data.

4 References

Cameco Corporation (Cameco 2018). Beaverlodge Project 2017 Annual Report – Year 32 Transition Phase Monitoring.

SRK Consulting (Canada) Inc. (SRK 2014). Beaverlodge – Design Report for the Flow Path Reconstruction at the Bolger Waste Rock Pile. SRK Project Number 1CC007.044. Report prepared for Cameco Corporation, February 2014.

SRK Consulting (Canada) Inc. (SRK 2017a). Bolger Flow Path Reconstruction 2016 Final As-Built Report. SRK Project Number 1CC007.062. Report prepared for Cameco Corporation, February 2017.

SRK Consulting (Canada) Inc. (SRK 2017b). Bolger Flow Path Reconstruction – 2017 Geotechnical Inspection Memo. SRK Project Number 1CC007.061. Memo prepared for Cameco Corporation, December 11, 2017.

Figures

LEGEND

- Historical Flow Path
- Waste Rock Extents

NOTES

1. Inferred historical flow path prior to channel excavation.

0m 3 6 9 12

srk consulting

Cameco

SRK JOB NO.: 1CC007.065

FILE NAME: 1CC007.065 - PreExisting Conditions.dwg

Bolger Flow Path Reconstruction

2018 Geotechnical Inspection

Conditions Prior to Flow Path Reconstruction

DATE:	APPROVED:	FIGURE:
February 2019	TPP	1

P:\01_SITES\Beaverlodge\!040_AutoCAD\Bolger 2018 Geotech Inspection\1CC007.065 - PreExisting Conditions.dwg

NOTES

1. Channel as-built configuration September 2016.

REFERENCE

NAD83 UTM Zone 12.
Imagery collaboration 2012 - 2016, and SRK Drone Imagery 2016.

0m 50 100 150 200m

srk consulting

Cameco

2018 Geotechnical Inspection

Bolger Site Overview
Subsequent Flow Path Reconstruction

SRK JOB NO.: 1CC007.065

FILE NAME: 1CC007.065 - Site.dwg

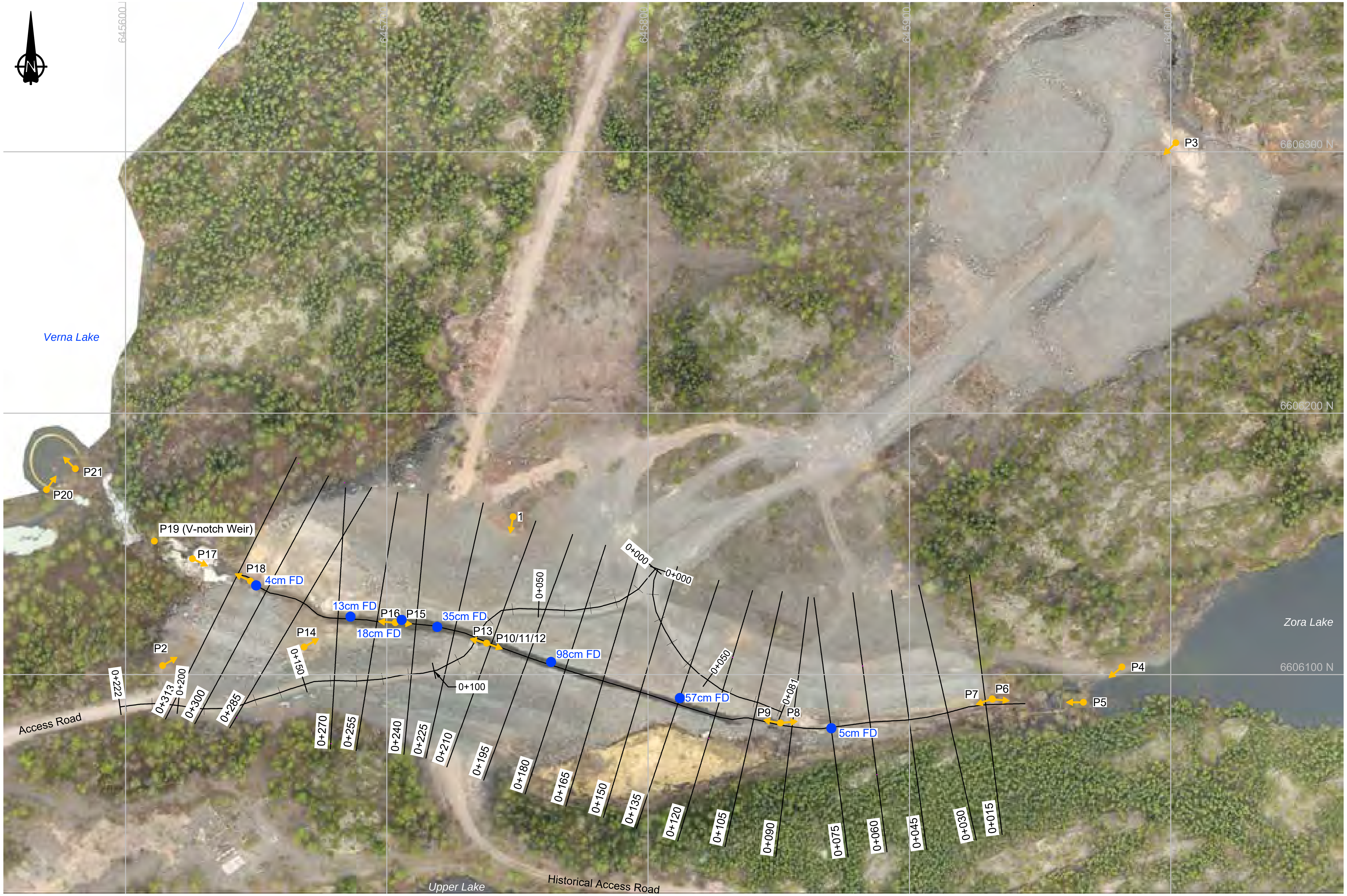
Beaverlodge

DATE: February 2019

APPROVED: TPP

FIGURE: 2

P:\01_SITES\Beaverlodge\040_AutoCAD\Bolger 2018 Geotech Inspection\1CC007.065 - Site.dwg



LEGEND

Photo Direction and Location

Flow Depth Above Channel Base

NOTES

1. All dimensions are in meters unless noted otherwise.

REFERENCE

NAD83 UTM Zone 12.
Imagery from Saskatchewan Geospatial Imagery collaboration 2012-2016, and SRK Drone Imagery 2016.

srk consulting

Cameco

2018 Geotechnical Inspection

As-built Plan View with Channel Section Stations

Bolger Flow Path Reconstruction

Job No.: 1CC007.061	Date: February 2019	Approved: TPP	Figure: 3
Filename: 1CC007.065 - GA.dwg			

P:\01_SITES\Beaverlodge\040_AutoCAD\Bolger 2018 Geotech Inspection\1CC007.065 - GA.dwg

Photo 1: Looking South at Bolger Flow Path Reconstruction

Photo 2: Looking Northeast at Bolger Flow Path Reconstruction

srk consulting	Cameco	2018 Geotechnical Inspection Site Inspection Photos
Job No: 1CC007.065 Filename: Bolger Flow Path Inspection Photos.pptx	Bolger Flow Path Reconstruction	Date: February 2019 · Approved: TPCP · Figure: 4

Photo 3: Looking Southwest at backfilled Bolger Pit

srk consulting	Cameco	**2018 Geotechnical Inspection** **Site Inspection Photos**
Job No: 1CC007.065 Filename: Bolger Flow Path Inspection Photos.pptx	**Bolger Flow Path Reconstruction**	Date: February 2019 · Approved: TPCP · Figure: **5**

Photo 4 – Looking West at Beaver Dam situated at Channel Inlet

Photo 5 – Looking West, close-up photo of Beaver Dam at Channel Inlet (vegetation/ponding)

Photo 6: Looking East at Channel Inlet

Photo 7 – Looking West at Channel Inlet

srk consulting	Cameco	2018 Geotechnical Inspection		
		Site Inspection Photos		
Job No: 1CC007.065 Filename: Bolger Flow Path Inspection Photos.pptx	Bolger Flow Path Reconstruction	Date: February 2019	Approved: TPCP	Figure: 6

Photo 9 – Looking Northwest (downstream) from Station 0+045

Photo 8 – Looking Southeast (upstream) from Station 0+045

srk consulting	Cameco	2018 Geotechnical Inspection
		Site Inspection Photos
Job No: 1CC007.065 Filename: Bolger Flow Path Inspection Photos.pptx	Bolger Flow Path Reconstruction	Date: February 2019 · Approved: TPCP · Figure: 7

Photo 10 – Looking Southeast (upstream) from Station 0+215

Photo 11 – Example of a typical waste rock void on crest and slopes.

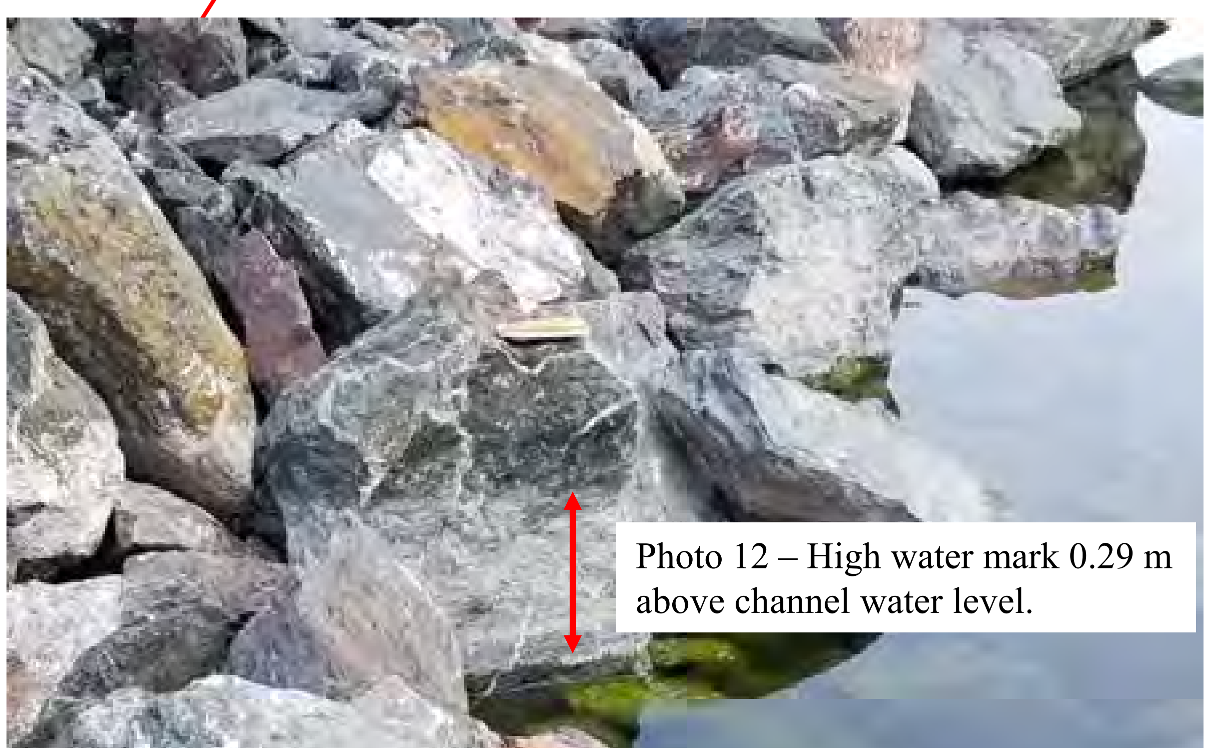


Photo 12 – High water mark 0.29 m above channel water level.

Photo 13 – Looking Northwest (downstream) from Station 0+215

srk consulting	Cameco	2018 Geotechnical Inspection
		Site Inspection Photos
Job No: 1CC007.065 Filename: Bolger Flow Path Inspection Photos.pptx	Bolger Flow Path Reconstruction	Date: February 2019 / Approved: TPCP / Figure: 8

Photo 14 – Looking Southeast (upstream) from Station 0+250

Photo 15 – Looking Southeast (upstream) from Station 0+250

Photo 16 – Looking Northwest (downstream) from Station 0+250

srk consulting	Cameco	2018 Geotechnical Inspection		
		Site Inspection Photos		
Job No: 1CC007.065 Filename: Bolger Flow Path Inspection Photos.pptx	Bolger Flow Path Reconstruction	Date: February 2019	Approved: TPCP	Figure: 9

Photo 17 – Looking Southeast (upstream) near Station 0+315.

Photo 18 – Looking Northwest (downstream) from Station 0+305.

srk consulting	Cameco	2018 Geotechnical Inspection		
		Site Inspection Photos		
Job No: 1CC007.065 Filename: Bolger Flow Path Inspection Photos.pptx	Bolger Flow Path Reconstruction	Date: February 2019	Approved: TPCP	Figure: 10

Photo 19 – V-notch weir used to estimate flow rate.

Photo 21 – Outlet of Channel into Verna Lake.

Photo 20 – Looking North where channel flow discharges into Verna Lake.

srk consulting	Cameco	2018 Geotechnical Inspection
		Site Inspection Photos
Job No: 1CC007.065 Filename: Bolger Flow Path Inspection Photos.pptx	Bolger Flow Path Reconstruction	Date: February 2019 / Approved: TPCP / Figure: 11

Appendix A: Inspection Forms

FIELD INSPECTION FORM
CHANNEL INSPECTION
BOLGER FLOW PATH RECONSTRUCTION

All parts of this inspection form should be completed. Adverse conditions should be described and location stated. Additional information and relevant photographs should be attached.

Inspector: Trevor Podaima   Inspector's Employer: SRK Consulting (Canada) Inc.

Inspection Date: 25/08/2018
(DD/MM/YR)

Weather: 12 deg Celsius (Temperature) | Light wind to the northwest (Wind Direction/Strength (light/high/gusting)) | Sunny/Partial Clouds (General Conditions)

ACCESS ROADS

A) Access Roads

Photographs: Traffic control Road blockage and speed limit sign at ramp access to Bolger Flow Path Channel (Photo 1)

Entrance restricted to public ☒ yes ☐ none

Main entry to Bolger site is locked and restricted to the public (Steel gate).
On-site traffic control includes waste rock road blockage and speed limit signs of 30 km/hr to reduce traffic speeds on site.

Maintenance required No maintenance required.

CHANNEL SIDESLOPES AND CREST

A) Stability

Photographs: Typical void in waste rock (Photo 2)

cracking ☒ none ☐
settlement ☒ none ☐
erosion ☒ none ☐
animal burrows ☒ none ☐
other ☒ Voids in waste rock observed, which are related to how waste rock was originally placed, no geotechnical concern.

B) Vegetation

Photographs: Overall site, looking southwest (Photo 3)

none ☐
sparse ☒ Vegetation growth is very sparse to none.
moderate ☐
heavy ☐

Additional Comments:

Do any inspection items require corrective action? If yes, what is the degree of severity? Is immediate action required or monitor?

- Voids on crests are not a geotechnical concern.
- No corrective action is required.

FIELD INSPECTION FORM
CHANNEL INSPECTION
BOLGER FLOW PATH RECONSTRUCTION

Inspector: TPCP Inspector's Employer: SRK Inspection Date: 25/08/2018 (DD/MM/YR)

CHANNEL SIDE SLOPES AND CREST

A) Stability Photographs: North Slope at East End of Channel – Station 0+015 (Photo 4)

scour at base	☒ none	☐	
cracking	☒ none	☐	
slumping	☒ none	☐	
rilling	☒ none	☐	
bulging	☒ none	☐	
sloughing	☒ none	☐	
erosion	☒ none	☐	
animal burrows	☒ none	☐	
other		☒	North slope at east end of channel observed to be over-steepened at toe.

B) Vegetation Photographs: N/A

none	☒	No vegetation observed on channel side slopes comprised on waste rock.
sparse	☒	Sparse vegetation observed on channel side slopes comprised of gravel and boulder rip rap (Station 0+000 to 0+025). Vegetation does not impact the performance of the channel.
moderate	☐	
heavy	☐	

C) Rip-rap Photographs: Channel and high water mark (Photo 5)

erosion/movement	☒ none	☐	
dis-coloration	☒ none	☐	
high water mark visible	☐ none	☒	High water mark measured at 0.29 m above current water level.
adequate armor	☒ yes	☐	
other	☐ yes	☐	

FIELD INSPECTION FORM
CHANNEL INSPECTION
BOLGER FLOW PATH RECONSTRUCTION

Inspector: TPCP   Inspector's Employer: SRK   Inspection Date: 25/08/2018 (DD/MM/YR)

CHANNEL SIDE SLOPES AND CREST (Continued)

E) Seepage

Photographs: N/A

Seepage ☒ none ☐ Location 1 No seepage was observed along channel side slopes at the time of inspection.

Rate: ☐ damp ☐ trickle ☐ steady ☐ _____ (L/s)

Clarity: ☐ clear ☐ muddy ☐ ____________

Sample taken: ☐ yes ☒ no

Photographs: None

☐ Location 2 ____________

Rate: ☐ damp ☐ trickle ☐ steady ☐ _____ (L/s)

Clarity: ☐ clear ☐ muddy ☐ ____________

Sample taken: ☐ yes ☐ no

Additional Comments:

Do any inspection items require corrective action? If yes, what is the degree of severity? Is immediate action required or monitor?

- No corrective action is required.
- Waste rock on channel side slopes contains voids in select areas and in general does not form a tightly knit mass. This condition is related to how the waste rock was originally graded and does not pose a geotechnical concern in regards to global stability. Surficial raveling may occur over time, which will not impact the overall stability of the slopes. Should surficial raveling occur, this material would collect along the waste rock bench situated along the toe of the slopes, which will not impede channel flow.

FIELD INSPECTION FORM
CHANNEL INSPECTION
BOLGER FLOW PATH RECONSTRUCTION

Inspector: TPCP   Inspector's Employer: SRK   Inspection Date: 25/08/2018 (DD/MM/YR)

CHANNEL BASE

A) Rip-rap   Photographs: N/A

erosion/movement ☒ none ☐
dis-coloration ☒ none ☐
Adequate armor ☒ Yes ☐
other ☐

B) Ponding   Photographs: There is positive drainage; however, low flow conditions are present from approximately Station 0+100 to Station 0+250. This is the section of the channel where a portion of the Historical Down Lake existed. Photo 14 shows what appeared to be minnows just upstream of the access road at approximately Station 0+215.

Positive drainage ☒   No ☐   Location 1

Clarity: ☒ clear ☐ muddy ☐

Sample taken: ☐ yes ☒ no

C) Sediment Accumulation   Photographs: Downstream sedimentation accumulation (Photos 6 and 7)

Present ☒   none ☐   Location 1 Minor sedimentation in base of channel at Station 0+075 (consistent with past inspection in 2017).

Sample taken: ☐ yes ☒ no

Photographs: Downstream sedimentation accumulation (Photos 8 and 9)

Present ☒   ☐   Location 2 Minor sedimentation in base of channel at Station 0+090 to 0+115 (consistent with past inspection in 2017).

Sample taken: ☐ yes ☒ no

Photographs: Downstream sedimentation accumulation (Photos 10 and 11)

Present ☒   ☐   Location 3 Heavy sediment accumulation west of channel road crossing at Station 0+215 to 0+225 (consistent with past inspection in 2017).

Sample taken: ☐ yes ☒ no

Photographs: Downstream sedimentation accumulation (Photo 12)

Present ☒   ☐   Location 4 Minor sediment accumulation between Station 0+240 to 0+250 (consistent with past inspection in 2017).

Sample taken: ☐ yes ☒ no

FIELD INSPECTION FORM
CHANNEL INSPECTION
BOLGER FLOW PATH RECONSTRUCTION

Inspector: TPCP   Inspector's Employer: SRK   Inspection Date: 25/08/2018 (DD/MM/YR)

CHANNEL BASE (Continued)

D) Vegetation

Photographs: Upstream Vegetation (Photos 8 and 9)

- none ☐
- sparse ☒ Sparse vegetation and moss were observed along the channel base at Station 0+090 to 0+115. Location consistent with location of accumulated sedimentation.
- moderate ☐
- heavy ☐

E) Blockage

Photographs: Sedimentation build up (Photos 6, 7, 8, 9, 10, 11, 12, and 13)

- none ☐
- debris ☒ Minor blockage at Station 0+090 due to siltation and vegetation (no change since 2017 inspection). No current issues with channel flow. Due to size (height of channel), future build-up of sedimentation/vegetation is not expected to restrict flow of water.
- beaver dam ☐
- siltation ☒ Flow becomes stagnant at Station 0+215, heavy siltation (understood to be primarily lake bottom sediments) on west side (downstream side) of road crossing.
- vegetation ☐
- other ☐

None: ☒
Correction action taken: ☐
To follow: ☐
Priority Rating (Immediate Action or Monitor): ______

Additional Comments:

Do any inspection items require corrective action? If yes, what is the degree of severity? Is immediate action required or monitor?

- Sedimentation is extremely fluffy (i.e. easily suspended). Sedimentation is believed to be lake bottom sediments from historical Down Lake and is thickest at Stations 0+090 and 0+215. Currently, this sedimentation does not impact the performance of the channel.
- Vegetation is currently not a concern.
- Vegetation and sedimentation accumulation should be monitored during future inspections.

FIELD INSPECTION FORM
CHANNEL INSPECTION
BOLGER FLOW PATH RECONSTRUCTION

Inspector: TPCP Inspector's Employer: SRK Inspection Date: 25/08/2018 (DD/MM/YR)

CHANNEL INLET

A) Blockage

Photographs: Beaver Dam, Vegetation and Ponding (Photos 15 and 16)

- none ☐
- debris ☒ Heavy wood debris and vegetation is observed and restricting flow at the channel inlet.
- beaver dam ☒ A beaver dam is creating a blockage and restricting flow at the channel inlet.
- siltation ☐
- ice ☐

Correction action: ☐ taken ☐ to follow

Priority Rating (Immediate Action or Monitor):

B) Erosion

Photographs: N/A

erosion/movement of rip rap ☐ none ☒

C) Vegetation

Photographs: Vegetation and Ponding (Photos 15 and 16)

- none ☐
- sparse ☐
- moderate ☐
- heavy ☒ Heavy vegetation is restricting flow at the channel inlet. Water level from the lake to the inlet was observed to be ponding and stepping down in water level as it migrates through the blockages to the channel base. (No change since 2017 Inspection).

D) Flow

Photographs: N/A

In-flow ☐ none ☒ Rate: ☐ damp ☐ trickle ☒ steady ☐ 1 (L/s)

Clarity: ☒ clear ☐ muddy Notes: Flow rate is approximate

Sample taken: ☐ yes ☒ no

FIELD INSPECTION FORM
CHANNEL INSPECTION
BOLGER FLOW PATH RECONSTRUCTION

Inspector: TPCP Inspector's Employer: SRK Inspection Date: 25/08/2018
(DD/MM/YR)

CHANNEL INLET (Continued)

Additional Comments:

Do any inspection items require corrective action? If yes, what is the degree of severity? Is immediate action required or monitor?

- Water is continuing to migrate through the beaver dam, wood debris and heavy vegetation. The invert of Zora Lake appeared to be consistent with the level during the 2017 inspection (i.e. the Beaver Dam is not increasing the Zora Lake water level).
- Inlet conditions should be re-inspected during future inspections to check that water continues to flow and that it is not increasing the Zora Lake water level.
- No corrective action is required.

FIELD INSPECTION FORM
CHANNEL INSPECTION
BOLGER FLOW PATH RECONSTRUCTION

Inspector: TPCP   Inspector's Employer: SRK   Inspection Date: 25/08/2018 (DD/MM/YR)

CHANNEL OUTLET

A) Blockage

Photographs: Sedimentation at outlet (Photos 17 and 18)

- none ☐
- debris ☐
- beaver dam ☐
- siltation ☒ Heavy siltation/sedimentation in basin outlet. Flow is not impeded but in large flow events sediment may be suspended.
- ice ☐

Correction action: ☐ taken ☐ to follow

Priority Rating (Immediate Action or Monitor):

B) Erosion

Photographs: N/A

erosion/movement of rip rap ☐ none ☒

C) Vegetation

Photographs: N/A

- none ☐
- sparse ☒
- moderate ☐
- heavy ☐

D) Flow

Photographs: V-Notch Weir (Photos 19 and 20)

Discharge ☐ none ☒ Rate: ☐ damp ☐ trickle ☒ steady ☒ 1 (L/s)

Clarity: ☒ clear ☐ muddy Notes: Flow rate is approximate

Sample taken: ☐ yes ☒ no

FIELD INSPECTION FORM
CHANNEL INSPECTION
BOLGER FLOW PATH RECONSTRUCTION

Inspector: TPCP Inspector's Employer: SRK Inspection Date: 25/08/2018
(DD/MM/YR)

CHANNEL OUTLET (Continued)

Additional Comments:

Do any inspection items require corrective action? If yes, what is the degree of severity? Is immediate action required or monitor?

- Flow depth at V-Notch Weir was approximately 9 cm at time of inspection (see Photo 20).
- No immediate concerns with the channel outlet. Sedimentation should be monitored during future inspections.
- No corrective action required.

FIELD INSPECTION FORM
CHANNEL INSPECTION BOLGER
FLOW PATH RECONSTRUCTION

Inspector: TPCP Inspector's Employer: SRK Inspection Date: 25/08/2018 (DD/MM/YR)

PHOTOS – Access Roads

1

2

Comments:

Photos:
1. Road blockage using large boulders with speed limit sign.
2. Typical waste rock void on crest and slopes.

FIELD INSPECTION FORM
CHANNEL INSPECTION BOLGER
FLOW PATH RECONSTRUCTION

Inspector: TPCP Inspector's Employer: SRK Inspection Date: 25/0802018
(DD/MM/YR)

PHOTOS – Channel Side Slope Crest

3 

Comments:

Photo:
3. Overall site photo showing little to no vegetation on channel crest and slopes.

FIELD INSPECTION FORM
CHANNEL INSPECTION BOLGER FLOW PATH RECONSTRUCTION

Inspector: TPCP Inspector's Employer: SRK Inspection Date: 25/08/2018 (DD/MM/YR)

PHOTOS – Channel Side Slopes

4

Comments:

Photos:
4. North slope at east end of channel observed to be over-steepened at toe.

FIELD INSPECTION FORM
CHANNEL INSPECTION BOLGER
FLOW PATH RECONSTRUCTION

Inspector: TPCP Inspector's Employer: SRK Inspection Date: 25/08/2018
(DD/MM/YR)

PHOTOS – Channel Base

5

Comments:

Photos:
5. Channel looking east from approximately Station 0+210 and high water mark.

FIELD INSPECTION FORM
CHANNEL INSPECTION BOLGER
FLOW PATH RECONSTRUCTION

Inspector: MER/CDB Inspector's Employer: SRK Inspection Date: 29/09/2017
(DD/MM/YR)

PHOTOS – Channel Base

6

7

Comments:

Photos:
6. Downstream sediment accumulation at Station 0+075.
7. Close up photo of sedimentation, which is approximately 4 cm thick.

FIELD INSPECTION FORM
CHANNEL INSPECTION BOLGER
FLOW PATH RECONSTRUCTION

Inspector: TPCP Inspector's Employer: SRK Inspection Date: 25/08/2018
(DD/MM/YR)

PHOTOS – Channel Base

8

9

Comments:

Photos:
8. Sedimentation in Rip Rap at Station 0+090 to 0+015.
9. Close up photo of sedimentation, which is approximately 6 cm thick.

FIELD INSPECTION FORM
CHANNEL INSPECTION BOLGER
FLOW PATH RECONSTRUCTION

Inspector: TPCP Inspector's Employer: SRK Inspection Date: 25/08/2018
(DD/MM/YR)

PHOTOS – Channel Base

10

11

Comments:

Photos:
10. Sedimentation downstream of road crossing near Station 0+225.
11. Close up photo of sedimentation, which is approximately 18 cm thick.

FIELD INSPECTION FORM
CHANNEL INSPECTION BOLGER
FLOW PATH RECONSTRUCTION

Inspector: TPCP Inspector's Employer: SRK Inspection Date: 25/08/2018
(DD/MM/YR)

PHOTOS – Channel Base

12

Comments:

Photos:
12. Sedimentation between Stations 0+240 to 250, approximately 6 cm thick.

FIELD INSPECTION FORM
CHANNEL INSPECTION BOLGER FLOW PATH RECONSTRUCTION

Inspector: TPCP Inspector's Employer: SRK Inspection Date: 25/08/2018 (DD/MM/YR)

PHOTOS – Channel Base

13

14

Comments:

Photos:

13. Waste rock access road at approximately Station 0+215.
14. What appeared to be minnows upstream of the access road.

FIELD INSPECTION FORM
CHANNEL INSPECTION BOLGER
FLOW PATH RECONSTRUCTION

Inspector: TPCP Inspector's Employer: SRK Inspection Date: 25/08/2018 (DD/MM/YR)

PHOTOS – Channel Inlet

15

16

Comments:

Photos:
15. Channel inlet looking west from shoreline of Zora Lake. Beaver Dam is restricting flow into channel.
16. Channel inlet looking east from Station 0+015.

FIELD INSPECTION FORM
CHANNEL INSPECTION BOLGER
FLOW PATH RECONSTRUCTION

Inspector: TPCP Inspector's Employer: SRK Inspection Date: 25/08/2018
(DD/MM/YR)

PHOTOS – Channel Outlet

17

18

Comments:

Photos:

17. Channel outlet looking northwest. Sediment buildup upstream of rip rap outlet that is not restricting flow.
18. Channel outlet looking southeast. Sediment buildup is not restricting flow and under the flow conditions at the time of the inspection was observed to be stable (i.e. sediment was not being transported by flow).

FIELD INSPECTION FORM
CHANNEL INSPECTION BOLGER
FLOW PATH RECONSTRUCTION

Inspector: TPCP Inspector's Employer: SRK Inspection Date: 25/08/2018
(DD/MM/YR)

PHOTOS – Channel Outlet

19


20


Comments:

Photos:
19. V-notch weir situated approximately 20 m downstream of channel outlet.
20. Flow depth at v-notch weir was approximately 9 cm.

APPENDIX D

APPENDIX D

Table 1: Borehole summary including the coordinates of exploration drill holes located to date in and adjacent to the former Eldorado Beaverlodge properties. The table also identifies the condition of each hole when it was initially identified and the year in which each was permanently plugged.

Area	Designation	Coordinate System: WGS 84 UTM Zone 12		Status When Located	Year Remediated
		Easting	Northing		
Ace	AC 01	644022.013	6605350.955	Dry	2013
	AC 02	643881.016	6605325.928	Dry	2013
	AC 03	643969.014	6605393.956	Dry	2013
	AC 04	643958.014	6605381.941	Dry	2013
	AC 05	643943.013	6605376.906	Dry	2013
	AC 06	643929.017	6605371.911	Dry	2013
	AC 07	643914.011	6605366.988	Dry	2013
	AC 08	643877.856	6605963.863	Dry	2013
	AC 09	643888.017	6605351.946	Dry	2013
	AC 10	643876.015	6605374.894	Dry	2013
	AC 11	643965.016	6605324.914	Dry	2013
	AC 12	643877.017	6605339.931	Dry	2013
	AC 13	643857.016	6605337.938	Dry	2013
	AC 14	643848.015	6605331.908	Dry	2013
	AC 15	643792.014	6605338.902	Dry	2013
	AC 16	643560.257	6605183.669	Dry	2017
	AC 17	644021.3	6604729.1	Dry	2017
	AC 18	642872.1	6604789.8	Dry	2018
Lower Ace	BH-001	641929.000	6604081.000	Discharging	2012
	BH-002	641956.000	6604091.000	Discharging	2011
	BH-003	641922.000	6604146.000	Discharging	2011
	BH-004	641932.000	6604142.000	Discharging	2012
	BH-005	641966.000	6604143.000	Discharging	2011
	BH-006	641972.000	6604165.000	Discharging	2011
	BH-007	642090.000	6604218.000	Discharging	2011
	BH-009	642110.000	6604137.000	Discharging	2012
	BH-014	642168.000	6604158.000	Discharging	2011
	BH-15	642101.665	6604192.497	Dry/seep around	2016
	BH-16	643009.193	6604465.019	Dry	2017
	BH-17	642993.852	6604455.146	Dry	2017
	BH-18	642995.637	6604466.051	Dry	2017
	BH-19	642978.88	6604452.098	Dry	2017
	BH-20	643007.541	6604467.124	Dry	2017
	BH-21	642966.862	6604445.757	Dry	2017
	BH-22	642959.407	6604439.281	Dry	2017
	BH-23	642954.958	6604432.3	Dry	2017
	BH-24	642940.515	6604415.339	Dry	2017
	BH-25	642930.8	6604406.299	Dry	2017
	BH-26	642972.143	6604451.532	Dry	2017
	BH-27	643250.316	6604979.231	Dry	2017
	BH-28	643113.492	6604895.363	Dry	2017
	BH-29	643174.26	6604925.548	Dry	2017
	BH-30	643285.271	6604977.469	Dry	2017
	BH-31	642101.048	6604195.52	Discharging	2017
	BH-32	642260.649	6604592.012	Dry	2017
	BH-33	642423.877	6604597.892	Dry	2017
	BH-34	642401.708	6604647.831	Dry	2017
	BH-35	642268.019	6604629.757	Dry	2017
	BH-36	643698.938	6605341.629	Dry	2017
	BH-37	642456.049	6604665.374	2 holes/dry	2017
	BH-38	642424.846	6604667.596	Dry	2017
	BH-39	643709.725	6605142.015	Dry	2017
	BH-40	642242.735	6604550.461	Dry	2017
	BH-41	642296.4	6604025.8	Dry	2017

Area	Designation	Coordinate System: WGS 84 UTM Zone 12		Status When Located	Year Remediated
		Easting	Northing		
	BH-42	642552.3	6604731.0	Dry	2017
	BH-43	642254.0	6604397.0	Dry	Remediation planned for 2019
Ace-Verna	Ace 01	645193.055	6605813.101	Dry	2016
	EXC 01	644740.299	6605272.359	Dry	2016
	Ace 02	645409.239	6605930.196	Dry	2017
	Ace 03	645627.645	6605877.357	Dry	2017
	Ace 04	645187.707	6605816.337	Dry	2017
Dubyna	DB 01	648069.018	6608350.909	Dry	Not located
	DB 02	648021.018	6608416.903	Discharging	2011
	DB 03	648010.017	6608430.961	Discharging	2012
	DB 04	648009.018	6608430.921	Dry	2013
	DB 05	648074.019	6608329.926	Dry	2013
	DB 06	648059.016	6608350.960	Dry	Not located
	DB 07	648060.013	6608305.962	Dry	2013
	DB 08	648047.018	6608326.964	Dry	2013
	DB 09	648004.013	6608445.996	Dry	2011
	DB 10	647927.019	6608395.914	Dry	2013
	DB 11	647906.016	6608372.901	Dry	2013
	DB 12	647907.015	6608373.943	Dry	2013
	DB 13	647922.017	6608349.899	Dry	2013
	DB 13A	647937.016	6608388.951	Dry	2013
	DB 14	647942.019	6608319.921	Discharging	2011
	DB 15	647912.017	6608307.923	Dry	2013
	DB 16	648002.017	6608424.960	Discharging	2012
	DB 17	647310.016	6608147.994	Dry	2013
	DB 18	647296.012	6608143.988	Dry	2013
	DB 19	647294.014	6608148.926	Dry	2013
	DB 20	647291.018	6608147.917	Dry	2013
	DB 21	647289.015	6608145.943	Dry	2013
	DB 22	647285.016	6608153.923	Dry	2013
	DB 23	647282.019	6608145.891	Dry	2013
	DB 24	647351.018	6608172.904	Dry	2013
	DB 25	648014.014	6608458.988	Discharging	2011
	DB 26	647374.017	6608190.976	Dry	2013
	DB 27	647379.020	6608180.916	Dry	2013
	DB 28	647715.679	6608234.967	Dry	2017
	DB 29	647513.47	6608225.766	Dry	2017
	DB 30	647413.386	6608235.144	Dry	2017
	DB 31	647411.222	6608290.178	Dry	2017
	DB 32	647603.393	6608298.979	Dry	2017
	DB 33	646948.652	6608333.328	Dry	2017
	DB 34	645934.9	6607576.0	2 holes/dry	2016
	DB 35	645991.5	6607578.2	Dry	2017
	DB 36	647421.0	6608222.0	Dry	2017
	DB 37	647661.2	6608361.3	Dry	2017
	DB 38	647561.2	6608066.9	Dry	2017
	DB 39	647742.5	6608236.0	Dry	2017
	DB 40	647593.6	6608297.4	Dry	2017
	DB 41	647611	6608249.4	Dry	2018
	DB 42	647579.4	6608258.1	Dry	2018
	DB 43	647579.4	6608255	Dry	2018
	DB 44	647585.8	6608256.1	Dry	2018
	DB 45	647572	6608231.8	Dry	2018
	DB 46	647521.1	6608238.1	2 holes/Dry	2018
	DB 47	647572.5	6608251.3	Dry	2018
	DB 48	647575.6	6608248.3	Dry	2018

Area	Designation	Coordinate System: WGS 84 UTM Zone 12		Status When Located	Year Remediated
		Easting	Northing		
	DB 49	647572.3	6608242.3	Dry	2018
	DB 50	647558.3	6608239.3	Dry	2018
	DB 51	647547	6608230.5	Dry	2018
	DB 52	647578.7	6608236.1	Dry	2018
	DB 53	647427.7	6608225.5	Dry	2018
	DB 54	647419	6608244.3	Dry	2018
	DB 55	647413.4	6608238.8	Dry	2018
	DB 56	647395.2	6608229.4	Dry	Unknown
	DB 57	647406.3	6608226.8	Dry	2018
	DB 58	647417.4	6608225.7	Dry	2018
	DB 59	647245.6	6608220.8	Dry	2018
	DB 60	647613.1	6608506.8	2 holes/Dry	2018
	DB 61	647683.9	6608518.9	Dry	2018
	DB 62	647785.2	6608518.5	Dry	2018
	DB 63	647703.9	6608176.9	Dry	2018
Hab	HAB 01	645518.015	6612550.898	Dry	2013
	HAB 02	645531.009	6612559.987	Dry	2013
	HAB 03	645560.017	6612566.911	Dry	2013
	HAB 04	645559.011	6612570.997	Dry	2013
	HAB 05	645570.017	6612585.916	Dry	2013
	HAB 06	645516.013	6612592.957	Dry	2013
	HAB 07	645490.014	6612737.978	Dry	2013
	HAB 08	645473.016	6612730.963	Dry	2013
	HAB 09	645458.015	6612730.938	Dry	2013
	HAB 10	645444.016	6612727.941	Dry	2013
	HAB 11	645428.014	6612729.995	Dry	2013
	HAB 12	645531.017	6612306.940	Dry	2013
	HAB 13	645454.012	6612205.961	Dry	2013
	HAB 14	645203.016	6612156.978	Dry	2013
	HAB 15	645180.016	6612129.889	Dry	2013
	HAB 16	645197.013	6612184.948	Dry	2013
	HAB 17	645236.014	6612327.921	Dry	2013
	HAB 18	645265.016	6612338.968	Dry	2013
	HAB 19	645265.016	6612338.968	Dry	2013
	HAB 20*	645244.013	6612340.940	Dry	No Remediation
	HAB 21*	645216.013	6612306.969	Dry	No Remediation
	HAB 22*	645206.015	6612316.948	Dry	No Remediation
	HAB 23	645196.016	6612315.891	Dry	2013
	HAB 24*	645157.014	6612278.930	Dry	No Remediation
	HAB 25*	645195.017	6612271.932	Dry	No Remediation
	HAB 26*	645193.013	6612334.948	Dry	No Remediation
	HAB 27	645199.014	6612341.981	Dry	2013
	HAB 28	645237.012	6612367.979	Dry	2013
	HAB 29	645186.014	6612187.977	Dry	2013
	HAB 30	645196.016	6612166.962	Dry	2013
	HAB 31	645188.016	6612161.970	Dry	2013
	HAB 32	645188.016	6612161.970	Dry	2013
	HAB 33	645184.017	6612166.942	Dry	2013
	HAB 34	645185.015	6612332.966	Dry	2013
	HAB 35	645170.015	6612318.896	Dry	2013
	HAB 36	645146.014	6612300.909	Dry	2013
	Hab 37	645635.866	6611795.114	Dry	2016
	Hab 38	645957.616	6612503.136	Dry	2016
	HAB 39	645944.833	6612429.845	Dry	2016
	Hab 40 & 41	645134.075	6611789.562	2 holes/dry	2016
	Hab 42 & 43	645047.948	6611855.227	2 holes/dry	2016

Area	Designation	Coordinate System: WGS 84 UTM Zone 12		Status When Located	Year Remediated
		Easting	Northing		
	Hab 44	645155.8	6612277.4	Dry	2016
	Hab 45	645120.288	6612036.091	Dry	2017
	Hab 46	645119.989	6612043.82	Dry	2017
	Hab 47	645737.923	6612087.024	Dry	2017
	Hab 48	645053.768	6611971.583	Dry	2017
	Hab 49 & 50	645291.031	6612001.84	2 holes/dry	2017
	Hab 51	644786.442	6611947.92	Dry	2017
	Hab 52	645309.971	6612079.678	Dry	2017
	Hab 53	644794.3	6611948.2	Dry	2017
	Hab 54	645613.7	6611925.2	Dry	2017
	Hab 55	645670.8	6612093.7	Dry	2017
	Hab 56	645653.1	6612056.8	Dry	2017
	Hab 57	645680.6	6612065.6	Dry	2017
	Hab 58	644798.2	6612050.6	Dry	2017
	Hab 59	645648.7	6611994.7	Dry	2017
	Hab 60	645671.6	6612016.6	Dry	2017
	Hab 61	645622.4	6611980.3	Dry	2017
	Hab 62	645076.2	6611788.8	Dry	2017
	Hab 63	645737	6612086.1	Dry	2018
	Hab 64	645685.9	6612061.4	Dry	2018
	Hab 65	645655.5	6612055.3	Dry	2018
Verna-Bolger	VR 01	645583.015	6605976.917	Dry	2013
	VR 02	645612.016	6605959.984	Dry	2013
	VR 03	645987.422	6606161.403	Dry	2016
	VR 04	644794.274	6611948.222	Dry	2017
	VR 05	645751.166	6606305.443	Dry	2017
	VR 06	645976.488	6606405.551	Dry	2017
	VR 07	645353.123	6606311.983	Dry	2017
	VR 08 & 09	645934.866	6607575.955	2 holes/dry	2016
	VR 10	645991.476	6607578.159	Dry	2017
Eagle	EG 01	640289.749	6607204.128	Dry	2016
	EG 02	640322.527	6607209.033	Dry	2016
	EG 03	640292.348	6607226.853	Dry	2016
	EG 04	640328.697	6607263.213	Dry	2016
	EG 05	640351.111	6607264.052	Dry	2016
	EG 06	640486.081	6607170.013	Dry	2016
Martin Lake	MC 1	638979.011	6604055.980	Dry	2013
Off Property	OP 01	647251.597	6607892.5	Dry	2017
	OP 02	646998.6	6605635.1	Dry	2017
	OP 03	647108.6	6605695.2	Dry	2017
	BH-NW02	641471.0	6604205.0	Dry	2017
	BH-NW01	641343.6	6604130.1	Discharging	2017

*Recent exploration activity (Not Eldorado/Cameco)

APPENDIX E

APPENDIX E

Detailed Water Quality Results

AN-5

		22/01/18	17/05/18	24/07/18	23/09/18	20/11/18
M Ions	Alk (mg/l)	155.0	51.0	88.0	101.0	122.0
	Ca (mg/l)	40.0	17.0	27.0	31.0	39.0
	Cl (mg/l)	1.30	0.50	0.40	0.70	1.20
	Cond-L (µS/cm)	238	118	190	208	266
	Hardness (mg/l)	141	58	93	108	137
	K (mg/l)	1.8	0.8	0.8	1.3	1.7
	Na (mg/l)	5.6	1.9	2.7	3.4	4.7
	OH (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0
	SO4 (mg/l)	15.0	12.0	10.0	13.0	18.0
	Sum of Ions (mg/l)	263	98	154	180	223
Metal	As (µg/l)	0.4	0.3	0.3	0.2	0.2
	Ba (mg/l)	0.180	0.068	0.120	0.110	0.140
	Cu (mg/l)	0.0007	0.0016	0.0004	0.0004	0.0004
	Fe (mg/l)	0.520	0.100	0.170	0.062	0.190
	Mo (mg/l)	0.0041	0.0042	0.0019	0.0024	0.0033
	Ni (mg/l)	0.00070	0.00060	0.00040	0.00030	0.00040
	Pb (mg/l)	0.0002	0.0002	<0.0001	<0.0001	<0.0001
	Se (mg/l)	0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	U (µg/l)	343.000	47.000	56.000	109.000	261.000
	Zn (mg/l)	0.001	0.001	<0.001	<0.001	<0.001
Nutrient	C-(org) (mg/l)				8.200	
	NH3-N (mg/l)				0.04	
	NO3 (mg/l)	0.150	<0.040	<0.040	<0.040	0.190
Phys Para	pH-L (pH Unit)	7.72	7.68	7.68	8.04	7.88
	TDS (mg/l)	201.00	95.00	133.00	132.00	179.00
	Temp-H20 (°C)	0.2	8.8	16.1	6.3	4.7
	TSS (mg/l)	1.000	<1.000	<1.000	<1.000	<1.000
Rads	Pb210 (Bq/L)				0.22	
	Po210 (Bq/L)				0.008	
	Ra226 (Bq/L)	1.000	0.350	0.740	0.410	0.730

DB-6

		17/05/18	24/07/18	23/09/18	20/11/18
M Ions	Alk (mg/l)	80.0	79.0	89.0	94.0
	Ca (mg/l)	29.0	32.0	36.0	39.0
	Cl (mg/l)	0.70	0.50	0.60	0.70
	Cond-L (µS/cm)	183	198	202	234
	Hardness (mg/l)	90	100	112	122
	K (mg/l)	0.8	0.8	1.0	1.1
	Na (mg/l)	1.8	1.8	2.0	2.3
	OH (mg/l)	<1.0	<1.0	<1.0	<1.0
	SO4 (mg/l)	19.0	19.0	21.0	25.0
	Sum of Ions (mg/l)	154	155	174	189
Metal	As (µg/l)	0.1	0.1	0.1	0.1
	Ba (mg/l)	0.038	0.039	0.047	0.051
	Cu (mg/l)	0.0006	0.0006	0.0006	0.0009
	Fe (mg/l)	0.016	0.044	0.080	0.049
	Mo (mg/l)	0.0019	0.0019	0.0022	0.0022
	Ni (mg/l)	0.00020	0.00020	0.00020	0.00020
	Pb (mg/l)	<0.0001	<0.0001	<0.0001	<0.0001
	Se (mg/l)	<0.0001	0.0001	<0.0001	0.0001
	U (µg/l)	148.000	128.000	253.000	245.000
	Zn (mg/l)	<0.001	<0.001	<0.001	0.001
Nutrient	C-(org) (mg/l)			8.600	
	NH3-N (mg/l)			0.05	
	NO3 (mg/l)	<0.040	<0.040	<0.040	0.140
Phys Para	pH-L (pH Unit)	7.92	7.87	7.90	8.06
	TDS (mg/l)	132.00	142.00	147.00	165.00
	Temp-H20 (°C)	7.1	16.6	7.0	3.8
	TSS (mg/l)	<1.000	<1.000	<1.000	<1.000
Rads	Pb210 (Bq/L)			0.24	
	Po210 (Bq/L)			<0.005	
	Ra226 (Bq/L)	0.030	0.060	0.040	0.030

AC-6A

		17/05/18	28/06/18	24/07/18	28/08/18
M Ions	Alk (mg/l)	95.0	100.0	93.0	92.0
	Ca (mg/l)	39.0	41.0	40.0	40.0
	Cl (mg/l)	0.60	0.50	0.40	0.40
	Cond-L (µS/cm)	260	250	277	267
	Hardness (mg/l)	132	140	137	138
	K (mg/l)	0.9	0.8	0.8	0.9
	Na (mg/l)	2.2	2.3	2.3	2.4
	OH (mg/l)	<1.0	<1.0	<1.0	<1.0
	SO4 (mg/l)	45.0	48.0	47.0	48.0
	Sum of Ions (mg/l)	212	224	212	213
Metal	As (µg/l)	0.2	0.2	0.2	0.2
	Ba (mg/l)	0.020	0.022	0.020	0.020
	Cu (mg/l)	0.0005	0.0006	0.0003	0.0004
	Fe (mg/l)	0.011	0.019	0.012	0.008
	Mo (mg/l)	0.0011	0.0009	0.0010	0.0011
	Ni (mg/l)	0.00010	0.00010	<0.00010	<0.00010
	Pb (mg/l)	<0.0001	<0.0001	<0.0001	<0.0001
	Se (mg/l)	0.0002	0.0002	0.0002	0.0001
	U (µg/l)	312.000	242.000	268.000	292.000
	Zn (mg/l)	<0.001	<0.001	<0.001	<0.001
Nutrient	NO3 (mg/l)	0.050	<0.040	<0.040	<0.040
Phys Para	pH-L (pH Unit)	7.96	7.91	7.94	8.03
	TDS (mg/l)	192.00	230.00	187.00	179.00
	Temp-H20 (°C)	8.6	18.0	17.4	13.5
	TSS (mg/l)	2.000	<1.000	<1.000	<1.000
Rads	Ra226 (Bq/L)	0.100	0.120	0.100	0.080

AC-8

		17/03/18	23/09/18
M Ions	Alk (mg/l)	56.0	48.0
	Ca (mg/l)	18.0	16.0
	Cl (mg/l)	1.00	0.80
	Cond-L (µS/cm)	122	101
	Hardness (mg/l)	59	53
	K (mg/l)	0.9	0.7
	Na (mg/l)	1.6	1.5
	OH (mg/l)	<1.0	<1.0
	SO4 (mg/l)	7.0	6.2
	Sum of Ions (mg/l)	100	86
Metal	As (µg/l)	0.2	0.1
	Ba (mg/l)	0.024	0.022
	Cu (mg/l)	0.0004	0.0005
	Fe (mg/l)	0.042	0.022
	Mo (mg/l)	0.0010	0.0010
	Ni (mg/l)	0.00020	0.00010
	Pb (mg/l)	<0.0001	<0.0001
	Se (mg/l)	<0.0001	<0.0001
	U (µg/l)	13.000	12.000
	Zn (mg/l)	<0.001	<0.001
Nutrient	C-(org) (mg/l)		7.000
	NH3-N (mg/l)		0.08
	NO3 (mg/l)	0.360	<0.040
Phys Para	pH-L (pH Unit)	7.70	7.64
	TDS (mg/l)	87.00	86.00
	Temp-H20 (°C)	0.4	7.6
	TSS (mg/l)	<1.000	<1.000
Rads	Pb210 (Bq/L)		<0.02
	Po210 (Bq/L)		0.006
	Ra226 (Bq/L)	0.020	0.020

AC-14

		22/01/18	25/02/18	17/03/18	21/04/18	17/05/18	28/06/18	24/07/18	28/08/18	24/09/18	14/10/18	20/11/18	08/12/18
M Ions	Alk (mg/l)	56.0	58.0	56.0	53.0	50.0	45.0	45.0	50.0	51.0	51.0	53.0	54.0
	Ca (mg/l)	18.0	18.0	18.0	21.0	15.0	15.0	15.0	16.0	18.0	18.0	19.0	18.0
	Cl (mg/l)	1.20	1.00	1.20	5.00	1.20	1.00	0.90	1.20	1.40	1.60	1.50	1.20
	Cond-L (µS/cm)	127	125	127	171	104	97	111	110	117	125	119	122
	Hardness (mg/l)	59	60	59	69	49	50	50	53	59	58	62	60
	K (mg/l)	0.8	0.9	0.9	1.1	0.7	0.7	0.7	0.8	0.8	0.8	1.1	0.9
	Na (mg/l)	1.8	1.8	1.8	5.4	1.5	1.6	1.7	1.9	2.4	2.4	2.2	2.0
	OH (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	SO4 (mg/l)	5.7	7.9	7.7	23.0	6.8	6.9	7.2	8.4	10.0	10.0	9.3	8.2
	Sum of Ions (mg/l)	99	104	101	125	89	83	84	93	98	98	102	100
Metal	As (µg/l)	0.1	0.1	0.1	0.2	0.1	0.1	0.2	0.2	0.1	0.1	0.2	0.2
	Ba (mg/l)	0.027	0.026	0.025	0.024	0.022	0.022	0.020	0.024	0.024	0.024	0.026	0.025
	Cu (mg/l)	0.0006	0.0005	0.0005	0.0008	0.0005	0.0005	0.0005	0.0006	0.0006	0.0006	0.0007	0.0006
	Fe (mg/l)	0.062	0.046	0.048	0.065	0.048	0.066	0.052	0.046	0.042	0.043	0.053	0.044
	Mo (mg/l)	0.0011	0.0010	0.0010	0.0011	0.0009	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010
	Ni (mg/l)	0.00020	0.00020	0.00020	0.00020	0.00020	0.00020	0.00020	0.00020	0.00020	0.00020	0.00020	0.00020
	Pb (mg/l)	0.0004	0.0003	0.0002	0.0004	0.0003	0.0002	0.0002	0.0001	0.0002	0.0003	0.0004	0.0003
	Se (mg/l)	0.0001	<0.0001	0.0001	0.0013	0.0001	<0.0001	0.0001	0.0001	0.0001	0.0002	0.0002	0.0001
	U (µg/l)	25.000	20.000	22.000	118.000	21.000	22.000	24.000	26.000	43.000	46.000	34.000	29.000
	Zn (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001
Nutrient	C-(org) (mg/l)			7.400			7.500			7.000			6.600
	NH3-N (mg/l)			0.12			0.12			0.11			0.13
	NO3 (mg/l)	0.080	0.270	0.330	0.340	0.120	<0.040	<0.040	<0.040	<0.040	<0.040	0.090	0.080
Phys Para	pH-L (pH Unit)	7.83	7.88	7.86	7.94	7.92	7.83	7.86	7.88	7.79	7.87	7.93	7.75
	TDS (mg/l)	93.00	66.00	89.00	111.00	68.00	93.00	78.00	82.00	94.00	85.00	83.00	94.00
	Temp-H20 (°C)	0.2	0.1	0.1	0.2	6.8	20.3	18.6	14.5	7.5	0.5	18.6	3.5
	TSS (mg/l)	<1.000	<1.000	<1.000	<1.000	1.000	<1.000	<1.000	<1.000	<1.000	<1.000	6.000	1.000
Rads	Pb210 (Bq/L)			<0.02			<0.02			0.03			<0.02
	Po210 (Bq/L)			0.008			0.010			0.005			0.010
	Ra226 (Bq/L)	0.060	0.030	0.040	0.060	0.070	0.060	0.040	0.030	0.040	0.050	0.070	0.050

AN-3

		23/09/18
M Ions	Alk (mg/l)	70.0
	Ca (mg/l)	21.0
	Cl (mg/l)	0.60
	Cond-L (µS/cm)	135
	Hardness (mg/l)	72
	K (mg/l)	0.8
	Na (mg/l)	2.0
	OH (mg/l)	<1.0
	SO4 (mg/l)	4.4
	Sum of Ions (mg/l)	119
Metal	As (µg/l)	<0.1
	Ba (mg/l)	0.017
	Cu (mg/l)	0.0006
	Fe (mg/l)	0.015
	Mo (mg/l)	0.0018
	Ni (mg/l)	0.00020
	Pb (mg/l)	<0.0001
	Se (mg/l)	<0.0001
	U (µg/l)	1.800
	Zn (mg/l)	<0.001
Nutrient	C-(org) (mg/l)	7.900
	NH3-N (mg/l)	0.10
	NO3 (mg/l)	<0.040
Phys Para	pH-L (pH Unit)	7.89
	TDS (mg/l)	109.00
	Temp-H20 (°C)	9.5
	TSS (mg/l)	2.000
Rads	Pb210 (Bq/L)	<0.02
	Po210 (Bq/L)	<0.005
	Ra226 (Bq/L)	<0.005

TL-3

		28/06/18	23/09/18	08/12/18
M Ions	Alk (mg/l)	111.0	125.0	142.0
	Ca (mg/l)	26.0	28.0	32.0
	Cl (mg/l)	2.50	2.30	3.00
	Cond-L (µS/cm)	243	292	325
	Hardness (mg/l)	86	92	104
	K (mg/l)	1.1	1.1	1.3
	Na (mg/l)	27.0	29.0	33.0
	OH (mg/l)	<1.0	<1.0	<1.0
	SO4 (mg/l)	26.0	26.0	30.0
	Sum of Ions (mg/l)	223	244	278
Metal	As (µg/l)	0.7	0.8	0.8
	Ba (mg/l)	0.036	0.038	0.042
	Cu (mg/l)	0.0010	0.0011	0.0013
	Fe (mg/l)	0.013	0.019	0.016
	Mo (mg/l)	0.0100	0.0120	0.0130
	Ni (mg/l)	0.00030	0.00030	0.00040
	Pb (mg/l)	0.0005	0.0010	0.0009
	Se (mg/l)	0.0020	0.0022	0.0026
	U (µg/l)	222.000	235.000	272.000
	Zn (mg/l)	<0.001	<0.001	0.001
Nutrient	C-(org) (mg/l)		7.500	
	NH3-N (mg/l)		0.06	
	NO3 (mg/l)	<0.040	<0.040	<0.040
Phys Para	pH-L (pH Unit)	8.26	8.26	8.18
	TDS (mg/l)	199.00	191.00	218.00
	Temp-H20 (°C)	19.7	8.6	4.5
	TSS (mg/l)	<1.000	<1.000	<1.000
Rads	Pb210 (Bq/L)		0.10	
	Po210 (Bq/L)		0.060	
	Ra226 (Bq/L)	1.300	1.300	1.700

TL-4

		28/06/18	23/09/18	08/12/18
M Ions	Alk (mg/l)	114.0	116.0	133.0
	Ca (mg/l)	22.0	22.0	25.0
	Cl (mg/l)	2.40	2.40	2.70
	Cond-L (µS/cm)	248	269	297
	Hardness (mg/l)	76	77	87
	K (mg/l)	1.1	1.3	1.4
	Na (mg/l)	29.0	31.0	34.0
	OH (mg/l)	<1.0	<1.0	<1.0
	SO4 (mg/l)	22.0	22.0	25.0
	Sum of Ions (mg/l)	221	226	256
Metal	As (µg/l)	1.0	0.8	0.9
	Ba (mg/l)	0.076	0.071	0.081
	Cu (mg/l)	0.0005	0.0004	0.0006
	Fe (mg/l)	0.050	0.045	0.048
	Mo (mg/l)	0.0076	0.0083	0.0084
	Ni (mg/l)	0.00050	0.00040	0.00050
	Pb (mg/l)	0.0002	0.0002	0.0002
	Se (mg/l)	0.0012	0.0012	0.0014
	U (µg/l)	172.000	190.000	200.000
	Zn (mg/l)	<0.001	<0.001	<0.001
Nutrient	C-(org) (mg/l)		9.000	
	NH3-N (mg/l)		0.09	
	NO3 (mg/l)	<0.040	<0.040	0.050
Phys Para	pH-L (pH Unit)	8.10	8.07	8.12
	TDS (mg/l)	195.00	180.00	169.00
	Temp-H20 (°C)	19.3	8.6	4.4
	TSS (mg/l)	<1.000	1.000	2.000
Rads	Pb210 (Bq/L)		0.10	
	Po210 (Bq/L)		0.020	
	Ra226 (Bq/L)	2.200	1.300	1.700

TL-6

		17/05/18	24/07/18
M Ions	Alk (mg/l)	231.0	225.0
	Ca (mg/l)	39.0	43.0
	Cl (mg/l)	27.00	35.00
	Cond-L (µS/cm)	548	568
	Hardness (mg/l)	136	152
	K (mg/l)	2.4	1.8
	Na (mg/l)	74.0	70.0
	OH (mg/l)	<1.0	<1.0
	SO4 (mg/l)	40.0	26.0
	Sum of Ions (mg/l)	474	461
Metal	As (µg/l)	1.4	3.5
	Ba (mg/l)	0.780	1.130
	Cu (mg/l)	0.0011	0.0003
	Fe (mg/l)	0.390	5.500
	Mo (mg/l)	0.0024	0.0003
	Ni (mg/l)	0.00050	0.00030
	Pb (mg/l)	0.0007	0.0001
	Se (mg/l)	0.0036	0.0016
	U (µg/l)	313.000	30.000
	Zn (mg/l)	0.001	0.001
Nutrient	C-(org) (mg/l)	55.000	
	NO3 (mg/l)	<0.040	<0.040
Phys Para	pH-L (pH Unit)	8.05	7.73
	TDS (mg/l)	407.00	409.00
	Temp-H20 (°C)	10.6	13.6
	TSS (mg/l)	2.000	5.000
Rads	Pb210 (Bq/L)	0.37	
	Po210 (Bq/L)	0.050	
	Ra226 (Bq/L)	5.100	8.900

TL-7

		21/04/18	17/05/18	28/06/18	24/07/18	28/08/18	23/09/18	14/10/18	20/11/18	08/12/18
M Ions	Alk (mg/l)	185.0	124.0	122.0	113.0	121.0	123.0	132.0	163.0	174.0
	Ca (mg/l)	34.0	23.0	22.0	22.0	23.0	24.0	26.0	32.0	34.0
	Cl (mg/l)	6.00	3.80	3.10	2.90	2.60	2.60	3.00	5.00	5.00
	Cond-L (µS/cm)	407	276	263	271	271	281	306	379	394
	Hardness (mg/l)	119	79	77	77	80	83	90	113	118
	K (mg/l)	2.2	1.2	1.1	1.2	1.2	1.3	1.1	3.2	2.6
	Na (mg/l)	46.0	30.0	30.0	30.0	30.0	31.0	30.0	43.0	45.0
	OH (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	SO4 (mg/l)	32.0	24.0	21.0	22.0	22.0	23.0	25.0	32.0	35.0
	Sum of Ions (mg/l)	354	238	232	222	232	238	252	322	342
Metal	As (µg/l)	1.9	1.1	1.2	1.0	0.8	0.7	0.7	1.2	1.7
	Ba (mg/l)	0.280	0.160	0.210	0.270	0.380	0.300	0.330	0.430	0.760
	Cu (mg/l)	0.0007	0.0006	0.0004	0.0005	0.0003	0.0006	0.0005	0.0006	0.0017
	Fe (mg/l)	0.600	0.057	0.056	0.052	0.021	0.017	0.024	0.038	0.073
	Mo (mg/l)	0.0100	0.0084	0.0069	0.0073	0.0073	0.0088	0.0086	0.0130	0.0160
	Ni (mg/l)	0.00070	0.00050	0.00040	0.00040	0.00040	0.00040	0.00040	0.00050	0.00060
	Pb (mg/l)	0.0006	0.0003	0.0001	0.0001	<0.0001	<0.0001	0.0002	0.0002	0.0006
	Se (mg/l)	0.0029	0.0016	0.0013	0.0012	0.0010	0.0011	0.0015	0.0020	0.0038
	U (µg/l)	299.000	199.000	152.000	160.000	154.000	215.000	233.000	340.000	394.000
	Zn (mg/l)	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.006
Nutrient	C-(org) (mg/l)			8.700			7.700			13.000
	NH3-N (mg/l)			0.04			0.08			0.09
	NO3 (mg/l)	<0.040	<0.040	<0.040	<0.040	<0.040	0.080	0.080	0.110	0.160
Phys Para	pH-L (pH Unit)	7.62	8.31	8.10	8.00	7.99	8.32	7.93	8.08	7.57
	TDS (mg/l)	271.00		163.00	185.00	178.00	187.00	191.00	247.00	271.00
	Temp-H20 (°C)	0.0	6.6	19.1	18.0	13.5	5.7	0.5	5.6	3.9
	TSS (mg/l)	<1.000		<1.000	1.000	<1.000	<1.000	<1.000	1.000	2.000
Rads	Pb210 (Bq/L)			0.07			0.13			0.47
	Po210 (Bq/L)			0.020			0.010			0.040
	Ra226 (Bq/L)	1.300	1.500	2.100	2.100	2.000	1.100	1.700	1.900	2.000

TL-9

		28/06/18	24/07/18	28/08/18	24/09/18	14/10/18	08/12/18
M Ions	Alk (mg/l)	120.0	112.0	110.0	110.0	114.0	132.0
	Ca (mg/l)	24.0	20.0	18.0	19.0	19.0	22.0
	Cl (mg/l)	4.10	3.70	3.70	3.60	4.00	4.30
	Cond-L (µS/cm)	267	266	250	259	271	293
	Hardness (mg/l)	84	74	69	73	72	84
	K (mg/l)	1.2	1.1	1.1	1.2	1.2	1.3
	Na (mg/l)	29.0	29.0	30.0	30.0	32.0	35.0
	OH (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	SO4 (mg/l)	20.0	20.0	20.0	21.0	22.0	24.0
	Sum of Ions (mg/l)	230	217	213	215	223	255
Metal	As (µg/l)	1.3	1.6	1.4	1.0	1.1	1.3
	Ba (mg/l)	0.680	0.640	0.610	0.630	0.670	0.710
	Cu (mg/l)	0.0006	0.0005	0.0004	0.0003	0.0004	0.0006
	Fe (mg/l)	0.047	0.082	0.065	0.028	0.021	0.018
	Mo (mg/l)	0.0078	0.0070	0.0074	0.0087	0.0093	0.0100
	Ni (mg/l)	0.00040	0.00040	0.00030	0.00030	0.00020	0.00040
	Pb (mg/l)	0.0005	0.0010	0.0006	0.0002	0.0002	0.0004
	Se (mg/l)	0.0018	0.0019	0.0017	0.0019	0.0029	0.0029
	U (µg/l)	163.000	131.000	117.000	158.000	208.000	257.000
	Zn (mg/l)	0.001	0.001	<0.001	<0.001	<0.001	0.001
Nutrient	C-(org) (mg/l)	9.600			9.000		9.600
	NH3-N (mg/l)	0.04			0.10		0.11
	NO3 (mg/l)	0.130	0.200	0.170	0.210	0.130	0.220
Phys Para	pH-L (pH Unit)	8.24	8.10	8.13	7.97	8.21	8.28
	TDS (mg/l)	163.00	175.00	170.00	179.00	172.00	208.00
	Temp-H20 (°C)	19.3	17.2	13.9	6.1	1.0	3.2
	TSS (mg/l)	<1.000	2.000	<1.000	<1.000	<1.000	2.000
Rads	Pb210 (Bq/L)	0.10			0.10		0.39
	Po210 (Bq/L)	0.060			0.020		0.030
	Ra226 (Bq/L)	2.800	3.000	2.100	1.800	2.100	2.200

BL-3

		17/03/18	28/06/18	24/09/18	08/12/18
M Ions	Alk (mg/l)	74.0	60.0	68.0	76.0
	Ca (mg/l)	22.0	20.0	21.0	23.0
	Cl (mg/l)	12.00	13.00	12.00	13.00
	Cond-L (µS/cm)	248	220	224	252
	Hardness (mg/l)	77	71	74	81
	K (mg/l)	1.2	1.1	1.1	1.2
	Na (mg/l)	18.0	18.0	18.0	20.0
	OH (mg/l)	<1.0	<1.0	<1.0	<1.0
	SO4 (mg/l)	30.0	30.0	29.0	33.0
	Sum of Ions (mg/l)	179	160	170	189
Metal	As (µg/l)	0.2	0.2	0.3	0.2
	Ba (mg/l)	0.036	0.036	0.035	0.037
	Cu (mg/l)	0.0024	0.0010	0.0037	0.0006
	Fe (mg/l)	0.006	0.004	0.013	0.014
	Mo (mg/l)	0.0036	0.0034	0.0035	0.0040
	Ni (mg/l)	0.00200	0.00390	0.01700	0.00020
	Pb (mg/l)	0.0002	0.0001	0.0008	0.0002
	Se (mg/l)	0.0024	0.0022	0.0022	0.0025
	U (µg/l)	129.000	123.000	126.000	141.000
	Zn (mg/l)	0.007	0.004	0.013	0.004
Nutrient	C-(org) (mg/l)			3.200	
	NH3-N (mg/l)			0.08	
	NO3 (mg/l)	0.120	<0.040	<0.040	<0.040
Phys Para	pH-L (pH Unit)	7.92	7.92	7.96	8.02
	TDS (mg/l)	142.00	166.00	144.00	175.00
	Temp-H20 (°C)	1.5	15.4	8.6	0.0
	TSS (mg/l)	<1.000	<1.000	<1.000	2.000
Rads	Pb210 (Bq/L)			0.09	
	Po210 (Bq/L)			<0.005	
	Ra226 (Bq/L)	0.030	0.040	0.040	0.030

BL-4

		17/03/18	24/09/18
M Ions	Alk (mg/l)	71.0	67.0
	Ca (mg/l)	22.0	21.0
	Cl (mg/l)	13.00	12.00
	Cond-L (µS/cm)	240	223
	Hardness (mg/l)	77	74
	K (mg/l)	1.2	1.1
	Na (mg/l)	19.0	18.0
	OH (mg/l)	<1.0	<1.0
	SO4 (mg/l)	31.0	29.0
	Sum of Ions (mg/l)	179	168
Metal	As (µg/l)	0.3	0.3
	Ba (mg/l)	0.036	0.033
	Cu (mg/l)	0.0014	0.0010
	Fe (mg/l)	0.003	0.006
	Mo (mg/l)	0.0037	0.0034
	Ni (mg/l)	0.00100	0.00140
	Pb (mg/l)	0.0003	0.0002
	Se (mg/l)	0.0026	0.0022
	U (µg/l)	127.000	125.000
	Zn (mg/l)	0.008	0.001
Nutrient	C-(org) (mg/l)	3.600	3.200
	NH3-N (mg/l)	0.12	0.10
	NO3 (mg/l)	0.060	<0.040
Phys Para	pH-L (pH Unit)	8.00	7.93
	TDS (mg/l)	135.00	147.00
	Temp-H20 (°C)	1.6	7.6
	TSS (mg/l)	<1.000	<1.000
Rads	Pb210 (Bq/L)	<0.02	0.08
	Po210 (Bq/L)	<0.005	<0.005
	Ra226 (Bq/L)	0.030	0.020

BL-5

		28/06/18	24/09/18
M Ions	Alk (mg/l)	67.0	67.0
	Ca (mg/l)	20.0	21.0
	Cl (mg/l)	12.00	12.00
	Cond-L (µS/cm)	222	226
	Hardness (mg/l)	71	74
	K (mg/l)	1.1	1.1
	Na (mg/l)	18.0	18.0
	OH (mg/l)	<1.0	<1.0
	SO4 (mg/l)	30.0	29.0
	Sum of Ions (mg/l)	168	168
Metal	As (µg/l)	0.2	0.2
	Ba (mg/l)	0.033	0.033
	Cu (mg/l)	0.0003	0.0005
	Fe (mg/l)	0.004	0.007
	Mo (mg/l)	0.0034	0.0035
	Ni (mg/l)	0.00020	0.00020
	Pb (mg/l)	<0.0001	0.0004
	Se (mg/l)	0.0022	0.0022
	U (µg/l)	124.000	125.000
	Zn (mg/l)	<0.001	0.001
Nutrient	C-(org) (mg/l)		3.200
	NH3-N (mg/l)		0.09
	NO3 (mg/l)	<0.040	<0.040
Phys Para	pH-L (pH Unit)	8.02	7.91
	TDS (mg/l)	156.00	142.00
	Temp-H20 (°C)	16.0	7.6
	TSS (mg/l)	<1.000	<1.000
Rads	Pb210 (Bq/L)		0.06
	Po210 (Bq/L)		<0.005
	Ra226 (Bq/L)	0.030	0.020

ML-1

		17/03/18	28/06/18	24/09/18	08/12/18
M Ions	Alk (mg/l)	71.0	60.0	64.0	70.0
	Ca (mg/l)	21.0	18.0	20.0	22.0
	Cl (mg/l)	6.70	7.20	7.30	8.30
	Cond-L (µS/cm)	188	160	180	196
	Hardness (mg/l)	71	62	68	75
	K (mg/l)	1.3	1.1	1.1	1.2
	Na (mg/l)	9.3	10.0	11.0	12.0
	OH (mg/l)	<1.0	<1.0	<1.0	<1.0
	SO4 (mg/l)	16.0	17.0	18.0	20.0
	Sum of Ions (mg/l)	146	131	140	154
Metal	As (µg/l)	0.2	0.2	0.2	0.2
	Ba (mg/l)	0.046	0.040	0.041	0.045
	Cu (mg/l)	0.0018	0.0003	0.0006	0.0008
	Fe (mg/l)	0.018	0.011	0.019	0.008
	Mo (mg/l)	0.0017	0.0018	0.0020	0.0022
	Ni (mg/l)	0.00020	0.00010	0.00020	0.00020
	Pb (mg/l)	<0.0001	<0.0001	0.0002	0.0002
	Se (mg/l)	0.0009	0.0009	0.0010	0.0012
	U (µg/l)	50.000	58.000	63.000	72.000
	Zn (mg/l)	0.003	<0.001	0.001	0.002
Nutrient	C-(org) (mg/l)	7.600	5.700	5.400	5.600
	NH3-N (mg/l)	0.14	0.08	0.11	0.14
	NO3 (mg/l)	0.380	<0.040	<0.040	<0.040
Phys Para	pH-L (pH Unit)	7.82	7.98	8.19	7.90
	TDS (mg/l)	116.00	128.00	119.00	132.00
	Temp-H20 (°C)	0.2	19.5	7.5	3.9
	TSS (mg/l)	<1.000	<1.000	2.000	2.000
Rads	Pb210 (Bq/L)	<0.02	<0.02	<0.02	0.11
	Po210 (Bq/L)	<0.005	<0.005	<0.005	<0.005
	Ra226 (Bq/L)	0.006	0.007	0.006	0.007

CS-1

		22/09/18
M Ions	Alk (mg/l)	64.0
	Ca (mg/l)	20.0
	Cl (mg/l)	7.20
	Cond-L (µS/cm)	180
	Hardness (mg/l)	68
	K (mg/l)	1.1
	Na (mg/l)	11.0
	OH (mg/l)	<1.0
	SO4 (mg/l)	17.0
	Sum of Ions (mg/l)	139
Metal	As (µg/l)	0.2
	Ba (mg/l)	0.040
	Cu (mg/l)	0.0003
	Fe (mg/l)	0.021
	Mo (mg/l)	0.0020
	Ni (mg/l)	0.00010
	Pb (mg/l)	<0.0001
	Se (mg/l)	0.0009
	U (µg/l)	62.000
	Zn (mg/l)	<0.001
Nutrient	C-(org) (mg/l)	5.800
	NH3-N (mg/l)	0.09
	NO3 (mg/l)	<0.040
Phys Para	pH-L (pH Unit)	7.98
	TDS (mg/l)	124.00
	Temp-H20 (°C)	9.3
	TSS (mg/l)	1.000
Rads	Pb210 (Bq/L)	0.07
	Po210 (Bq/L)	<0.005
	Ra226 (Bq/L)	<0.005

CS-2

		22/09/18
M Ions	Alk (mg/l)	27.0
	Ca (mg/l)	7.1
	Cl (mg/l)	3.10
	Cond-L (µS/cm)	64
	Hardness (mg/l)	27
	K (mg/l)	0.8
	Na (mg/l)	2.8
	OH (mg/l)	<1.0
	SO4 (mg/l)	3.7
	Sum of Ions (mg/l)	53
Metal	As (µg/l)	0.1
	Ba (mg/l)	0.011
	Cu (mg/l)	0.0022
	Fe (mg/l)	0.006
	Mo (mg/l)	0.0002
	Ni (mg/l)	0.00460
	Pb (mg/l)	0.0001
	Se (mg/l)	<0.0001
	U (µg/l)	0.500
	Zn (mg/l)	0.004
Nutrient	C-(org) (mg/l)	3.300
	NH3-N (mg/l)	<0.01
	NO3 (mg/l)	<0.040
Phys Para	pH-L (pH Unit)	7.57
	TDS (mg/l)	53.00
	Temp-H20 (°C)	10.1
	TSS (mg/l)	1.000
Rads	Pb210 (Bq/L)	<0.02
	Po210 (Bq/L)	<0.005
	Ra226 (Bq/L)	<0.005

ZOR-01

		17/05/18	28/06/18	24/07/18	28/08/18	23/09/18	14/10/18
M Ions	Alk (mg/l)	97.0	87.0	90.0	97.0	98.0	104.0
	Ca (mg/l)	30.0	30.0	30.0	30.0	33.0	34.0
	Cl (mg/l)	0.40	0.30	0.40	0.30	0.30	0.30
	Cond-L (µS/cm)	203	200	211	207	222	233
	Hardness (mg/l)	105	107	106	108	117	119
	K (mg/l)	0.7	0.7	0.8	0.8	0.8	0.9
	Na (mg/l)	1.6	1.7	1.8	1.8	1.8	2.0
	OH (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	SO4 (mg/l)	17.0	19.0	19.0	19.0	19.0	20.0
	Sum of Ions (mg/l)	175	166	170	178	183	193
Metal	As (µg/l)	0.1	0.1	0.1	0.2	0.2	0.2
	Ba (mg/l)	0.021	0.021	0.020	0.020	0.022	0.026
	Cu (mg/l)	0.0011	0.0009	0.0009	0.0003	0.0004	0.0017
	Fe (mg/l)	0.007	0.007	0.005	0.004	0.004	0.026
	Mo (mg/l)	0.0008	0.0008	0.0008	0.0009	0.0009	0.0008
	Ni (mg/l)	0.00010	0.00020	0.00010	0.00010	0.00010	0.00020
	Pb (mg/l)	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0003
	Se (mg/l)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
	U (µg/l)	14.000	16.000	16.000	16.000	16.000	17.000
	Zn (mg/l)	0.001	0.001	0.001	<0.001	<0.001	0.002
Nutrient	C-(org) (mg/l)					8.200	
	NH3-N (mg/l)					0.07	
	NO3 (mg/l)	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
Phys Para	pH-L (pH Unit)	8.01	8.07	8.14	8.21	8.06	7.97
	TDS (mg/l)	130.00	167.00	141.00	140.00	156.00	153.00
	Temp-H20 (°C)	8.0	19.3	19.3	14.7	8.7	1.3
	TSS (mg/l)	2.000	<1.000	<1.000	<1.000	2.000	<1.000
Rads	Pb210 (Bq/L)					0.02	
	Po210 (Bq/L)					0.009	
	Ra226 (Bq/L)	0.020	0.040	0.030	0.030	0.020	0.040

ZOR-02

		08/05/18	17/05/18	28/06/18	24/07/18	28/08/18	23/09/18	14/10/18
M Ions	Alk (mg/l)	58.0	96.0	89.0	95.0	103.0	112.0	114.0
	Ca (mg/l)	28.0	38.0	44.0	40.0	44.0	48.0	47.0
	Cl (mg/l)	0.20	0.50	0.40	0.30	0.40	<1.00	<1.00
	Cond-L (µS/cm)	183	258	284	268	283	318	308
	Hardness (mg/l)	90	128	148	135	148	161	158
	K (mg/l)	0.5	0.8	0.8	0.8	0.9	1.0	0.8
	Na (mg/l)	1.0	1.8	2.0	1.9	2.2	2.6	2.2
	OH (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	SO4 (mg/l)	40.0	42.0	55.0	41.0	47.0	55.0	48.0
	Sum of Ions (mg/l)	146	208	220	209	230	254	248
Metal	As (µg/l)	0.2	0.2	0.2	0.2	0.2	0.2	0.1
	Ba (mg/l)	0.014	0.023	0.027	0.024	0.027	0.035	0.030
	Cu (mg/l)	0.0019	0.0013	0.0017	0.0016	0.0017	0.0012	0.0013
	Fe (mg/l)	0.440	0.140	0.120	0.087	0.140	0.350	0.120
	Mo (mg/l)	0.0010	0.0015	0.0017	0.0015	0.0015	0.0014	0.0012
	Ni (mg/l)	0.00040	0.00020	0.00020	0.00020	0.00020	0.00020	0.00020
	Pb (mg/l)	0.0003	0.0002	0.0001	0.0002	0.0002	<0.0001	<0.0001
	Se (mg/l)	0.0004	0.0003	0.0004	0.0003	0.0003	0.0002	0.0002
	U (µg/l)	349.000	321.000	461.000	256.000	308.000	352.000	337.000
	Zn (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nutrient	C-(org) (mg/l)						6.800	
	NH3-N (mg/l)						0.17	
	NO3 (mg/l)	0.740	0.250	1.000	0.510	0.530	0.620	0.640
Phys Para	pH-L (pH Unit)	7.76	8.09	7.95	8.00	8.06	7.96	8.04
	TDS (mg/l)	120.00	181.00	231.00	186.00	189.00	218.00	196.00
	Temp-H20 (°C)	0.8	5.6	13.5	16.1	12.7	8.0	0.7
	TSS (mg/l)	4.000	1.000	<1.000	1.000	1.000	<1.000	<1.000
Rads	Pb210 (Bq/L)						0.34	
	Po210 (Bq/L)						0.010	
	Ra226 (Bq/L)	0.200	0.220	0.340	0.260	0.280	0.230	0.240

APPENDIX F

APPENDIX F

Beaverlodge Operation
Quality Control/Quality Assurance for Environmental Sample Analysis

Parent Field	**Station: AC-14**				**Child Field**	**Station: Blind-1**				
Date: 2018/05/17					**Date: 2018/05/17**					
Assigned: SRC Lab					**Assigned: SRC Lab**					
Parameter	**Value**	**Method**	**Entered DL**	**Entered Uncertainty**	**Parameter**	**Value**	**Method**	**Entered DL**	**Entered Uncertainty**	**% Absolute Difference**
Alk	50.0	Acid Titration	1.0	8.0	Alk	49.0	Acid Titration	1.0	7.0	2.0
As	0.1	ICP-MS	0.1	0.1	As	0.2	ICP-MS	0.1	0.1	66.7
Ba	0.022	ICP-MS	0.001	0.003	Ba	0.022	ICP-MS	0.001	0.003	0.000
CO3	< 1.0	Acid Titration	1.0		CO3	< 1.0	Acid Titration	1.0		0.0
Ca	15.0	ICP-OES	0.1	2.0	Ca	15.0	ICP-OES	0.1	2.0	0.0
Cl	1.20	Ion Chromatograph y	0.10	0.30	Cl	1.10	Ion Chromatograph y	0.10	0.30	8.70
Cond-F	127				Cond-F	127				0
Cond-L	104	Conductivity Meter	1	10	Cond-L	105	Conductivity Meter	1	10	1
Cu	0.0005	ICP-MS	0.0002	0.0003	Cu	0.0005	ICP-MS	0.0002	0.0003	0.0000
Fe	0.048	ICP-MS	0.001	0.007	Fe	0.048	ICP-MS	0.001	0.007	0.000
HCO3	61.0	Acid Titration	1.0	9.0	HCO3	60.0	Acid Titration	1.0	9.0	1.7
Hardness	49	Calculated	1	7	Hardness	49	Calculated	1	7	0
K	0.7	ICP-OES	0.1	0.2	K	0.7	ICP-OES	0.1	0.2	0.0
Mo	0.0009	ICP-MS	0.0001	0.0003	Mo	0.0009	ICP-MS	0.0001	0.0003	0.0000
NO3	0.120	Automated Hydrazine Reduction	0.040	0.070	NO3	0.110	Automated Hydrazine Reduction	0.040	0.060	8.696
Na	1.5	ICP-OES	0.1	0.4	Na	1.6	ICP-OES	0.1	0.4	6.5
Ni	0.00020	ICP-MS	0.00010	0.00010	Ni	0.00020	ICP-MS	0.00010	0.00010	0.00000
OH	< 1.0	Acid Titration	1.0		OH	< 1.0	Acid Titration	1.0		0.0
Pb	0.0003	ICP-MS	0.0001	0.0001	Pb	0.0003	ICP-MS	0.0001	0.0001	0.0000
Ra226	0.070	Alpha Septroscopy	0.010	0.030	Ra226	0.040	Alpha Septroscopy	0.005	0.020	54.545
SO4	6.8	ICP-OES	0.2	1.0	SO4	6.9	ICP-OES	0.2	1.0	1.5
Se	0.0001	ICP-MS	0.0001	0.0001	Se	0.0001	ICP-MS	0.0001	0.0001	0.0000
Sum of Ions	89	Calculated	1	10	Sum of Ions	88	Calculated	1	10	1
TDS	68.00	Gravimetric	5.00	20.00	TDS	94.00	Gravimetric	5.00	20.00	32.10
TSS	1.000	Gravimetric	1.000	1.000	TSS	1.000	Gravimetric	1.000	1.000	0.000
Temp-H20	6.8				Temp-H20	6.8				0.0
U	21.000	ICP-MS	0.100	2.000	U	21.000	ICP-MS	0.100	2.000	0.000
Zn	< 0.001	ICP-MS	0.001		Zn	< 0.001	ICP-MS	0.001		0.000
pH-F	7.9200	pH Meter	0.0700	0.8000	pH-F	7.9600	pH Meter	0.0700	0.8000	0.5038
pH-L	7.92	pH Meter	0.07	0.80	pH-L	7.96	pH Meter	0.07	0.80	0.50

Note: % Absolute Difference = abs(A-B)/((A+B)/2) Followup required where value is greater than 50%

Parent Field	Station: AC-6A				Child Field	Station: Blind-3				
Date: 2018/07/24					Date: 2018/07/24					
Assigned: SRC Lab					Assigned: SRC Lab					
Parameter	Value	Method	Entered DL	Entered Uncertainty	Parameter	Value	Method	Entered DL	Entered Uncertainty	% Absolute Difference
Alk	93.0	Acid Titration	1.0	10.0	Alk	93.0	Acid Titration	1.0	10.0	0.0
As	0.2	ICP-MS	0.1	0.1	As	0.2	ICP-MS	0.1	0.1	0.0
Ba	0.020	ICP-MS	0.001	0.003	Ba	0.020	ICP-MS	0.001	0.003	0.000
CO3	< 1.0	Acid Titration	1.0		CO3	< 1.0	Acid Titration	1.0		0.0
Ca	40.0	ICP-OES	0.1	4.0	Ca	41.0	ICP-OES	0.1	4.0	2.5
Cl	0.40	Ion Chromatograph y	0.10	0.10	Cl	0.40	Ion Chromatograph y	0.10	0.10	0.00
Cond-F	259				Cond-F	259				0
Cond-L	277	Conductivity Meter	1	30	Cond-L	276	Conductivity Meter	1	30	0
Cu	0.0003	ICP-MS	0.0002	0.0002	Cu	0.0003	ICP-MS	0.0002	0.0002	0.0000
Fe	0.012	ICP-MS	0.001	0.002	Fe	0.014	ICP-MS	0.001	0.002	15.385
HCO3	113.0	Acid Titration	1.0	10.0	HCO3	113.0	Acid Titration	1.0	10.0	0.0
Hardness	137	Calculated	1	10	Hardness	140	Calculated	1	10	2
K	0.8	ICP-OES	0.1	0.3	K	0.9	ICP-OES	0.1	0.3	11.8
Mo	0.0010	ICP-MS	0.0001	0.0002	Mo	0.0009	ICP-MS	0.0001	0.0003	10.5263
NO3	< 0.040	Automated Hydrazine Reduction	0.040		NO3	< 0.040	Automated Hydrazine Reduction	0.040		0.000
Na	2.3	ICP-OES	0.1	0.3	Na	2.3	ICP-OES	0.1	0.3	0.0
Ni	< 0.00010	ICP-MS	0.00010		Ni	< 0.00010	ICP-MS	0.00010		0.00000
OH	< 1.0	Acid Titration	1.0		OH	< 1.0	Acid Titration	1.0		0.0
Pb	< 0.0001	ICP-MS	0.0001		Pb	< 0.0001	ICP-MS	0.0001		0.0000
Ra226	0.100	Alpha Septroscopy	0.005	0.020	Ra226	0.100	Alpha Septroscopy	0.005	0.020	0.000
SO4	47.0	ICP-OES	0.2	5.0	SO4	48.0	ICP-OES	0.2	5.0	2.1
Se	0.0002	ICP-MS	0.0001	0.0001	Se	0.0002	ICP-MS	0.0001	0.0001	0.0000
Sum of Ions	212	Calculated	1	20	Sum of Ions	215	Calculated	1	20	1
TDS	187.00	Gravimetric	5.00	30.00	TDS	192.00	Gravimetric	5.00	30.00	2.64
TSS	< 1.000	Gravimetric	1.000		TSS	< 1.000	Gravimetric	1.000		0.000
Temp-H20	17.4				Temp-H20	17.4				0.0
U	268.000	ICP-MS	0.100	30.000	U	265.000	ICP-MS	0.100	30.000	1.126
Zn	< 0.001	ICP-MS	0.001		Zn	< 0.001	ICP-MS	0.001		0.000
pH-F	7.9400	pH Meter	0.0700	0.8000	pH-F	7.9600	pH Meter	0.0700	0.8000	0.2516
pH-L	7.94	pH Meter	0.07	0.80	pH-L	7.96	pH Meter	0.07	0.80	0.25

Note: % Absolute Difference = abs(A-B)/((A+B)/2) Followup required where value is greater than 50%

Parent Field **Station: DB-6**

Date: 2018/05/17

Assigned: SRC Lab

Parameter	Value	Method	Entered DL	Entered Uncertainty
Alk	80.0	Acid Titration	1.0	10.0
As	0.1	ICP-MS	0.1	0.1
Ba	0.038	ICP-MS	0.001	0.006
CO3	<1.0	Acid Titration	1.0	
Ca	29.0	ICP-OES	0.1	3.0
Cl	0.70	Ion Chromatography	0.10	0.10
Cond-F	210			
Cond-L	183	Conductivity Meter	1	20
Cu	0.0006	ICP-MS	0.0002	0.0003
Fe	0.016	ICP-MS	0.001	0.002
HCO3	98.0	Acid Titration	1.0	10.0
K	0.8	ICP-OES	0.1	0.3
Mo	0.0019	ICP-MS	0.0001	0.0005
NO3	<0.040	Automated Hydrazine Reduction	0.040	
Na	1.8	ICP-OES	0.1	0.4
Ni	0.00020	ICP-MS	0.00010	0.00010
OH	<1.0	Acid Titration	1.0	
Pb	<0.0001	ICP-MS	0.0001	
Ra226	0.030	Alpha Septroscopy	0.005	0.010
SO4	19.0	ICP-OES	0.2	3.0
Se	<0.0001	ICP-MS	0.0001	
Sum of Ions	154	Calculated	1	20
TDS	132.00	Gravimetric	5.00	20.00
TSS	<1.000	Gravimetric	1.000	
Temp-H20	7.1			
U	148.000	ICP-MS	0.100	10.000
Zn	<0.001	ICP-MS	0.001	
pH-F	7.9200	pH Meter	0.0700	0.8000
pH-L	7.92	pH Meter	0.07	0.80

Child Field **Station: Blind-2**

Date: 2018/05/17

Assigned: SRC Lab

Parameter	Value	Method	Entered DL	Entered Uncertainty	% Absolute Difference
Alk	80.0	Acid Titration	1.0	10.0	0.0
As	0.1	ICP-MS	0.1	0.1	0.0
Ba	0.038	ICP-MS	0.001	0.006	0.000
CO3	< 1.0	Acid Titration	1.0		0.0
Ca	29.0	ICP-OES	0.1	3.0	0.0
Cl	0.70	Ion Chromatography	0.10	0.10	0.00
Cond-F	210				0
Cond-L	185	Conductivity Meter	1	20	1
Cu	0.0006	ICP-MS	0.0002	0.0003	0.0000
Fe	0.016	ICP-MS	0.001	0.002	0.000
HCO3	98.0	Acid Titration	1.0	10.0	0.0
K	0.8	ICP-OES	0.1	0.3	0.0
Mo	0.0018	ICP-MS	0.0001	0.0004	5.4054
NO3	< 0.040	Automated Hydrazine Reduction	0.040		0.000
Na	1.8	ICP-OES	0.1	0.4	0.0
Ni	0.00020	ICP-MS	0.00010	0.00010	0.00000
OH	< 1.0	Acid Titration	1.0		0.0
Pb	< 0.0001	ICP-MS	0.0001		0.0000
Ra226	0.040	Alpha Septroscopy	0.005	0.020	28.571
SO4	19.0	ICP-OES	0.2	3.0	0.0
Se	< 0.0001	ICP-MS	0.0001		0.0000
Sum of Ions	154	Calculated	1	20	0
TDS	155.00	Gravimetric	5.00	20.00	16.03
TSS	< 1.000	Gravimetric	1.000		0.000
Temp-H20	7.1				0.0
U	146.000	ICP-MS	0.100	10.000	1.361
Zn	< 0.001	ICP-MS	0.001		0.000
pH-F	7.9300	pH Meter	0.0700	0.8000	0.1262
pH-L	7.93	pH Meter	0.07	0.80	0.13

Note: % Absolute Difference = abs(A-B)/((A+B)/2) Followup required where value is greater than 50%

Parent Field	Station: TL-6				Child Field	Station: Blind-5				
Date: 2018/07/24					Date: 2018/07/24					
Assigned: SRC Lab					Assigned: SRC Lab					
Parameter	**Value**	**Method**	**Entered DL**	**Entered Uncertainty**	**Parameter**	**Value**	**Method**	**Entered DL**	**Entered Uncertainty**	**% Absolute Difference**
Alk	225.0	Acid Titration	1.0	20.0	Alk	232.0	Acid Titration	1.0	20.0	3.1
As	3.5	ICP-MS	0.1	0.5	As	3.6	ICP-MS	0.1	0.5	2.8
Ba	1.130	ICP-MS	0.001	0.100	Ba	1.120	ICP-MS	0.001	0.100	0.889
CO3	< 1.0	Acid Titration	1.0		CO3	< 1.0	Acid Titration	1.0		0.0
Ca	43.0	ICP-OES	0.1	4.0	Ca	43.0	ICP-OES	0.1	4.0	0.0
Cl	35.00	Automated Colorimetry using Mercuric Thiocyanate	1.00	5.00	Cl	35.00	Automated Colorimetry using Mercuric Thiocyanate	1.00	5.00	0.00
Cond-F	547				Cond-F	547				0
Cond-L	568	Conductivity Meter	1	60	Cond-L	566	Conductivity Meter	1	60	0
Cu	0.0003	ICP-MS	0.0002	0.0002	Cu	0.0003	ICP-MS	0.0002	0.0002	0.0000
Fe	5.500	ICP-MS	0.005	0.600	Fe	5.400	ICP-MS	0.005	0.500	1.835
HCO3	274.0	Acid Titration	1.0	30.0	HCO3	283.0	Acid Titration	1.0	30.0	3.2
K	1.8	ICP-OES	0.1	0.4	K	1.8	ICP-OES	0.1	0.4	0.0
Mo	0.0003	ICP-MS	0.0001	0.0002	Mo	0.0004	ICP-MS	0.0001	0.0002	28.5714
NO3	< 0.040	Automated Hydrazine Reduction	0.040		NO3	< 0.040	Automated Hydrazine Reduction	0.040		0.000
Na	70.0	ICP-OES	0.1	7.0	Na	72.0	ICP-OES	0.1	7.0	2.8
Ni	0.00030	ICP-MS	0.00010	0.00020	Ni	0.00030	ICP-MS	0.00010	0.00020	0.00000
OH	< 1.0	Acid Titration	1.0		OH	< 1.0	Acid Titration	1.0		0.0
Pb	0.0001	ICP-MS	0.0001	0.0001	Pb	0.0001	ICP-MS	0.0001	0.0001	0.0000
Ra226	8.900	Alpha Septroscopy	0.020	0.900	Ra226	8.300	Alpha Septroscopy	0.020	0.800	6.977
SO4	26.0	ICP-OES	0.2	3.0	SO4	26.0	ICP-OES	0.2	3.0	0.0
Se	0.0016	ICP-MS	0.0001	0.0004	Se	0.0014	ICP-MS	0.0001	0.0004	13.3333
Sum of Ions	461	Calculated	1	50	Sum of Ions	472	Calculated	1	50	2
TDS	409.00	Gravimetric	5.00	60.00	TDS	414.00	Gravimetric	5.00	60.00	1.22
TSS	5.000	Gravimetric	1.000	2.000	TSS	5.000	Gravimetric	1.000	2.000	0.000
Temp-H20	13.6				Temp-H20	13.6				0.0
U	30.000	ICP-MS	0.100	3.000	U	30.000	ICP-MS	0.100	3.000	0.000
Zn	0.001	ICP-MS	0.001	0.001	Zn	0.001	ICP-MS	0.001	0.001	0.000
pH-F	7.7300	pH Meter	0.0700	0.8000	pH-F	7.7000	pH Meter	0.0700	0.8000	0.3889
pH-L	7.73	pH Meter	0.07	0.80	pH-L	7.70	pH Meter	0.07	0.80	0.39

Note: % Absolute Difference = abs(A-B)/((A+B)/2) Followup required where value is greater than 50%

Parent Field	Station: TL-7				Child Field	Station: Blind-6				
Date: 2018/07/24					Date: 2018/07/24					
Assigned: SRC Lab					Assigned: SRC Lab					
Parameter	**Value**	**Method**	**Entered DL**	**Entered Uncertainty**	**Parameter**	**Value**	**Method**	**Entered DL**	**Entered Uncertainty**	**% Absolute Difference**
Alk	113.0	Acid Titration	1.0	10.0	Alk	114.0	Acid Titration	1.0	10.0	0.9
As	1.0	ICP-MS	0.1	0.2	As	1.000	ICP-MS	0.100	0.200	0.000
Ba	0.270	ICP-MS	0.001	0.030	Ba	0.260	ICP-MS	0.001	0.030	3.774
C-(org)	8.200	Persulfate-UV or Heated-Persulfate Oxidation	0.200	1.000	C-(org)	8.600	Persulfate-UV or Heated-Persulfate Oxidation	0.200	1.000	4.762
CO3	< 1.0	Acid Titration	1.0		CO3	< 1.0	Acid Titration	1.0		0.0
Ca	22.0	ICP-OES	0.1	2.0	Ca	22.0	ICP-OES	0.1	2.0	0.0
Cl	2.90	Ion Chromatograph y	0.10	0.40	Cl	2.80	Ion Chromatograph y	0.10	0.40	3.51
Cond-F	252				Cond-F	252				0
Cond-L	271	Conductivity Meter	1	30	Cond-L	272	Conductivity Meter	1	30	0
Cu	0.0005	ICP-MS	0.0002	0.0003	Cu	0.0005	ICP-MS	0.0002	0.0003	0.0000
Fe	0.052	ICP-MS	0.001	0.005	Fe	0.049	ICP-MS	0.001	0.007	5.941
HCO3	138.0	Acid Titration	1.0	10.0	HCO3	139.0	Acid Titration	1.0	10.0	0.7
Hardness	77	Calculated	1	10	Hardness	77	Calculated	1	10	0
K	1.2	ICP-OES	0.1	0.3	K	1.2	ICP-OES	0.1	0.3	0.0
Mo	0.0073	ICP-MS	0.0001	0.0010	Mo	0.0072	ICP-MS	0.0001	0.0010	1.3793
NH3-N	0.06	Automated Ammonium Molybdate Colorimetric	0.01	0.03	NH3-N	0.07	Automated Ammonium Molybdate Colorimetric	0.01	0.03	15.38
NO3	< 0.040	Automated Hydrazine Reduction	0.040		NO3	< 0.040	Automated Hydrazine Reduction	0.040		0.000
Na	30.0	ICP-OES	0.1	3.0	Na	30.0	ICP-OES	0.1	3.0	0.0
Ni	0.00040	ICP-MS	0.00010	0.00020	Ni	0.00040	ICP-MS	0.00010	0.00020	0.00000
OH	< 1.0	Acid Titration	1.0		OH	< 1.0	Acid Titration	1.0		0.0
P-(TP)	< 0.01	ICP-MS	0.01		P-(TP)	< 0.01	ICP-MS	0.01		0.00
Pb	0.0001	ICP-MS	0.0001	0.0001	Pb	0.0001	ICP-MS	0.0001	0.0001	0.0000
Pb210	0.11	Beta Counting	0.02	0.06	Pb210	0.04	Beta Counting	0.02	0.03	93.33
Po210	0.010	Alpha Septroscopy	0.005	0.007	Po210	0.020	Alpha Septroscopy	0.005	0.010	66.667
Ra226	2.100	Alpha Septroscopy	0.020	0.200	Ra226	2.300	Alpha Septroscopy	0.005	0.200	9.091
SO4	22.0	ICP-OES	0.2	2.0	SO4	22.0	ICP-OES	0.2	2.0	0.0
Se	0.0012	ICP-MS	0.0001	0.0003	Se	0.0014	ICP-MS	0.0001	0.0004	15.3846
Sum of Ions	222	Calculated	1	20	Sum of Ions	222	Calculated	1	20	0
TDS	185.00	Gravimetric	5.00	30.00	TDS	179.00	Gravimetric	5.00	30.00	3.30
TSS	1.000	Gravimetric	1.000	1.000	TSS	< 1.000	Gravimetric	1.000		0.000
Temp-H20	18.0				Temp-H20	18.0				0.0
U	160.000	ICP-MS	0.100	20.000	U	161.000	ICP-MS	0.100	20.000	0.623
Zn	< 0.001	ICP-MS	0.001		Zn	< 0.001	ICP-MS	0.001		0.000
pH-F	8.0000	pH Meter	0.0700	0.8000	pH-F	7.9900	pH Meter	0.0700	0.8000	0.1251
pH-L	8.00	pH Meter	0.07	0.80	pH-L	7.99	pH Meter	0.07	0.80	0.13

Note: % Absolute Difference = abs(A-B)/((A+B)/2) Followup required where value is greater than 50%

Parent Field	Station: TL-7 Duplicate			
Date: 2018/04/21				
Assigned: Maxxam				
Parameter	Value	Method	Entered DL	Entered Uncertainty
As	1.7		0.2	
Ba	0.290		0.010	
Cu	0.0011		0.0002	
Fe	0.630		0.060	
Mo	0.0100		0.0002	
Ni	0.00099		0.00050	
Pb	0.0006		0.0002	
Ra226	1.690	Alpha Septroscopy	0.010	
Se	0.0013		0.0002	
U	290.000		0.100	
Zn	< 0.003		0.003	

Child Field	Station: TL-7				
Date: 2018/04/21					
Assigned: SRC Lab					
Parameter	Value	Method	Entered DL	Entered Uncertainty	% Absolute Difference
As	1.9	ICP-MS	0.1	0.5	11.1
Ba	0.280	ICP-MS	0.001	0.030	3.509
Cu	0.0007	ICP-MS	0.0002	0.0003	44.4444
Fe	0.600	ICP-MS	0.001	0.060	4.878
Mo	0.0100	ICP-MS	0.0001	0.0010	0.0000
Ni	0.00070	ICP-MS	0.00010	0.00030	34.31953
Pb	0.0006	ICP-MS	0.0001	0.0002	4.8780
Ra226	1.300	Alpha Septroscopy	0.020	0.200	26.087
Se	0.0029	ICP-MS	0.0001	0.0004	76.1905
U	299.000	ICP-MS	0.100	30.000	3.056
Zn	0.001	ICP-MS	0.001	0.001	107.692

Note: % Absolute Difference = abs(A-B)/((A+B)/2) Followup required where value is greater than 50%

Parent Field	Station: TL-7 Duplicate				Child Field	Station: TL-7				
Date: 2018/07/24					Date: 2018/07/24					
Assigned: Maxxam					Assigned: SRC Lab					
Parameter	**Value**	**Method**	**Entered DL**	**Entered Uncertainty**	**Parameter**	**Value**	**Method**	**Entered DL**	**Entered Uncertainty**	**% Absolute Difference**
Pb210	<0.10	Beta Method	0.10		Pb210	0.11	Beta Counting	0.02	0.06	9.52
Po210	0.013	Alpha Septroscopy	0.010		Po210	0.010	Alpha Septroscopy	0.005	0.007	26.087
Ra226	1.730	Alpha Septroscopy	0.010		Ra226	2.100	Alpha Septroscopy	0.020	0.200	19.321
U	150.000	ICP-MS	1.000		U	160.000	ICP-MS	0.100	20.000	6.452

Note: % Absolute Difference = abs(A-B)/((A+B)/2) Followup required where value is greater than 50%

Parent Field	Station: TL-7 Duplicate				Child Field	Station: TL-7				
Date: 2018/12/08					Date: 2018/12/08					
Assigned: Maxxam					Assigned: SRC Lab					
Parameter	Value	Method	Entered DL	Entered Uncertainty	Parameter	Value	Method	Entered DL	Entered Uncertainty	% Absolute Difference
As	1.6	ICP-MS	0.2	0.3	As	1.7	ICP-MS	0.1	0.4	6.1
Ba	0.830	ICP-MS	0.010	0.077	Ba	0.760	ICP-MS	0.001	0.080	8.805
Cu	0.0015	ICP-MS	0.0002	0.0004	Cu	0.0017	ICP-MS	0.0002	0.0004	12.5000
Fe	0.140	ICP-MS	0.060	0.060	Fe	0.073	ICP-MS	0.001	0.007	62.911
Mo	0.0170	ICP-MS	0.0002	0.0031	Mo	0.0160	ICP-MS	0.0001	0.0020	6.0606
Ni	0.00058	ICP-MS	0.00050	0.00050	Ni	0.00060	ICP-MS	0.00010	0.00030	3.38983
Pb	0.0004	ICP-MS	0.0002	0.0002	Pb	0.0006	ICP-MS	0.0001	0.0002	37.6238
Ra226	1.730	Alpha Septroscopy	0.010	0.080	Ra226	2.000	Alpha Septroscopy	0.020	0.200	14.477
Se	0.0034	ICP-MS	0.0002	0.0003	Se	0.0038	ICP-MS	0.0001	0.0006	11.1111
U	400.000	ICP-MS	0.100	26.000	U	394.000	ICP-MS	0.100	40.000	1.511
Zn	0.004	ICP-MS	0.003	0.003	Zn	0.006	ICP-MS	0.001	0.001	29.167

Note: % Absolute Difference = abs(A-B)/((A+B)/2) Followup required where value is greater than 50%

Parent Field **Station: TL-7 FB**

Date: 2018/08/28

Assigned: SRC Lab

Parameter	Value	Method	Entered DL	Entered Uncertainty
Alk	< 1.0	Acid Titration	1.0	
As	< 0.1	ICP-MS	0.1	
Ba	< 0.001	ICP-MS	0.001	
CO3	< 1.0	Acid Titration	1.0	
Ca	< 0.1	ICP-OES	0.1	
Cl	< 0.10	Ion Chromatography	0.10	
Cond-F	350			
Cond-L	< 1	Conductivity Meter	1	
Cu	< 0.0002	ICP-MS	0.0002	
Fe	< 0.001	ICP-MS	0.001	
HCO3	< 1.0	Acid Titration	1.0	
Hardness	< 1	Calculated	1	
K	< 0.1	ICP-OES	0.1	
Mo	< 0.0001	ICP-MS	0.0001	
NO3	< 0.040	Automated Hydrazine Reduction	0.040	
Na	0.1	ICP-OES	0.1	0.1
Ni	< 0.00010	ICP-MS	0.00010	
OH	< 1.0	Acid Titration	1.0	
Pb	< 0.0001	ICP-MS	0.0001	
Ra226	< 0.020	Alpha Septroscopy	0.020	
SO4	< 0.2	ICP-OES	0.2	
Se	< 0.0001	ICP-MS	0.0001	
Sum of Ions	< 1	Calculated	1	
TDS	< 5.00	Gravimetric	5.00	
TSS	< 1.000	Gravimetric	1.000	
U	< 0.100	ICP-MS	0.100	
Zn	< 0.001	ICP-MS	0.001	
pH-F	7.1000			
pH-L	5.51	pH Meter	0.07	0.80

Child Field **Station: TL-7 TB**

Date: 2018/08/28

Assigned: SRC Lab

Parameter	Value	Method	Entered DL	Entered Uncertainty	% Absolute Difference
Alk	< 1.0	Acid Titration	1.0		0.0
As	< 0.1	ICP-MS	0.1		0.0
Ba	< 0.001	ICP-MS	0.001		0.000
CO3	< 1.0	Acid Titration	1.0		0.0
Ca	< 0.1	ICP-OES	0.1		0.0
Cl	< 0.10	Ion Chromatography	0.10		0.00
Cond-F		Conductivity Meter			
Cond-L	< 1	Conductivity Meter	1		0
Cu	< 0.0002	ICP-MS	0.0002		0.0000
Fe	< 0.001	ICP-MS	0.001		0.000
HCO3	< 1.0	Acid Titration	1.0		0.0
Hardness	< 1	Calculated	1		0
K	< 0.1	ICP-OES	0.1		0.0
Mo	< 0.0001	ICP-MS	0.0001		0.0000
NO3	< 0.040	Automated Hydrazine Reduction	0.040		0.000
Na	0.1	ICP-OES	0.1	0.1	0.0
Ni	< 0.00010	ICP-MS	0.00010		0.00000
OH	< 1.0	Acid Titration	1.0		0.0
Pb	< 0.0001	ICP-MS	0.0001		0.0000
Ra226	< 0.020	Alpha Septroscopy	0.020		0.000
SO4	< 0.2	ICP-OES	0.2		0.0
Se	< 0.0001	ICP-MS	0.0001		0.0000
Sum of Ions	< 1	Calculated	1		0
TDS	< 5.00	Gravimetric	5.00		0.00
TSS	< 1.000	Gravimetric	1.000		0.000
U	< 0.100	ICP-MS	0.100		0.000
Zn	< 0.001	ICP-MS	0.001		0.000
pH-F	5.7000	pH Meter	0.0700	0.8000	21.8750
pH-L	5.70	pH Meter	0.07	0.80	3.39

Note: % Absolute Difference = abs(A-B)/((A+B)/2) Followup required where value is greater than 50%

Parent Field	Station: TL-9				Child Field	Station: Blind-4				
Date: 2018/07/24					Date: 2018/07/24					
Assigned: SRC Lab					Assigned: SRC Lab					
Parameter	**Value**	**Method**	**Entered DL**	**Entered Uncertainty**	**Parameter**	**Value**	**Method**	**Entered DL**	**Entered Uncertainty**	**% Absolute Difference**
Alk	112.0	Acid Titration	1.0	10.0	Alk	112.0	Acid Titration	1.0	10.0	0.0
As	1.6	ICP-MS	0.1	0.4	As	1.600	ICP-MS	0.100	0.400	0.000
Ba	0.640	ICP-MS	0.001	0.060	Ba	0.640	ICP-MS	0.001	0.060	0.000
C-(org)	9.100	Persulfate-UV or Heated-Persulfate Oxidation	0.200	1.000	C-(org)	9.400	Persulfate-UV or Heated-Persulfate Oxidation	0.200	1.000	3.243
CO3	< 1.0	Acid Titration	1.0		CO3	< 1.0	Acid Titration	1.0		0.0
Ca	20.0	ICP-OES	0.1	2.0	Ca	20.0	ICP-OES	0.1	2.0	0.0
Cl	3.70	Ion Chromatograph y	0.10	0.60	Cl	3.60	Ion Chromatograph y	0.10	0.50	2.74
Cond-F	242				Cond-F	242				0
Cond-L	266	Conductivity Meter	1	30	Cond-L	268	Conductivity Meter	1	30	1
Cu	0.0005	ICP-MS	0.0002	0.0003	Cu	0.0005	ICP-MS	0.0002	0.0003	0.0000
Fe	0.082	ICP-MS	0.001	0.008	Fe	0.090	ICP-MS	0.001	0.009	9.302
HCO3	137.0	Acid Titration	1.0	10.0	HCO3	137.0	Acid Titration	1.0	10.0	0.0
Hardness	74	Calculated	1	10	Hardness	74	Calculated	1	10	0
K	1.1	ICP-OES	0.1	0.3	K	1.1	ICP-OES	0.1	0.3	0.0
Mo	0.0070	ICP-MS	0.0001	0.0010	Mo	0.0069	ICP-MS	0.0001	0.0010	1.4388
NH3-N	0.09	Automated Ammonium Molybdate Colorimetric	0.01	0.04	NH3-N	0.09	Automated Ammonium Molybdate Colorimetric	0.01	0.04	0.00
NO3	0.200	Automated Hydrazine Reduction	0.040	0.090	NO3	0.200	Automated Hydrazine Reduction	0.040	0.090	0.000
Na	29.0	ICP-OES	0.1	3.0	Na	29.0	ICP-OES	0.1	3.0	0.0
Ni	0.00040	ICP-MS	0.00010	0.00020	Ni	0.00040	ICP-MS	0.00010	0.00020	0.00000
OH	< 1.0	Acid Titration	1.0		OH	< 1.0	Acid Titration	1.0		0.0
P-(TP)	< 0.01	ICP-MS	0.01		P-(TP)	0.01	ICP-MS	0.01	0.01	0.00
Pb	0.0010	ICP-MS	0.0001	0.0002	Pb	0.0010	ICP-MS	0.0001	0.0002	0.0000
Pb210	0.10	Beta Counting	0.02	0.06	Pb210	0.08	Beta Counting	0.02	0.05	22.22
Po210	0.060	Alpha Septroscopy	0.005	0.020	Po210	0.070	Alpha Septroscopy	0.005	0.020	15.385
Ra226	3.000	Alpha Septroscopy	0.020	0.300	Ra226	2.700	Alpha Septroscopy	0.005	0.300	10.526
SO4	20.0	ICP-OES	0.2	2.0	SO4	20.0	ICP-OES	0.2	2.0	0.0
Se	0.0019	ICP-MS	0.0001	0.0005	Se	0.0020	ICP-MS	0.0001	0.0003	5.1282
Sum of Ions	217	Calculated	1	20	Sum of Ions	217	Calculated	1	20	0
TDS	175.00	Gravimetric	5.00	30.00	TDS	159.00	Gravimetric	5.00	20.00	9.58
TSS	2.000	Gravimetric	1.000	1.000	TSS	1.000	Gravimetric	1.000	1.000	66.667
Temp-H20	17.2				Temp-H20	17.2				0.0
U	131.000	ICP-MS	0.100	10.000	U	129.000	ICP-MS	0.100	10.000	1.538
Zn	0.001	ICP-MS	0.001	0.001	Zn	0.001	ICP-MS	0.001	0.001	0.000
pH-F	8.1000	pH Meter	0.0700	0.8000	pH-F	8.0900	pH Meter	0.0700	0.8000	0.1235
pH-L	8.10	pH Meter	0.07	0.80	pH-L	8.09	pH Meter	0.07	0.80	0.12

Note: % Absolute Difference = abs(A-B)/((A+B)/2) Followup required where value is greater than 50%

Parent Field	**Station: TL-9 Duplicate**			
Date: 2018/07/24				
Assigned: Maxxam				
Parameter	**Value**	**Method**	**Entered DL**	**Entered Uncertainty**
Pb210	<0.10	Beta Method	0.10	
Po210	0.076	Alpha Septroscopy	0.010	
Ra226	2.300	Alpha Septroscopy	0.010	
U	120.000	ICP-MS	1.000	

Child Field	**Station: TL-9**				
Date: 2018/07/24					
Assigned: SRC Lab					
Parameter	**Value**	**Method**	**Entered DL**	**Entered Uncertainty**	**% Absolute Difference**
Pb210	0.10	Beta Counting	0.02	0.06	0.00
Po210	0.060	Alpha Septroscopy	0.005	0.020	23.529
Ra226	3.000	Alpha Septroscopy	0.020	0.300	26.415
U	131.000	ICP-MS	0.100	10.000	8.765

Note: % Absolute Difference = abs(A-B)/((A+B)/2) Followup required where value is greater than 50%

Parent Field	**Station: TL-9 Duplicate**				**Child Field**	**Station: TL-9**				
Date: 2018/12/08					**Date: 2018/12/08**					
Assigned: Maxxam					**Assigned: SRC Lab**					
Parameter	**Value**	**Method**	**Entered DL**	**Entered Uncertainty**	**Parameter**	**Value**	**Method**	**Entered DL**	**Entered Uncertainty**	**% Absolute Difference**
As	1.6	ICP-MS	0.2	0.3	As	1.3	ICP-MS	0.1	0.3	20.7
Ba	0.770	ICP-MS	0.010	0.072	Ba	0.710	ICP-MS	0.001	0.070	8.108
Cu	0.0008	ICP-MS	0.0002	0.0003	Cu	0.0006	ICP-MS	0.0002	0.0003	27.3381
Fe	<0.060	ICP-MS	0.060		Fe	0.018	ICP-MS	0.001	0.003	107.692
Mo	0.0100	ICP-MS	0.0002	0.0018	Mo	0.0100	ICP-MS	0.0001	0.0010	0.0000
Ni	<0.00050	ICP-MS	0.00050		Ni	0.00040	ICP-MS	0.00010	0.00020	22.22222
Pb	0.0004	ICP-MS	0.0002	0.0002	Pb	0.0004	ICP-MS	0.0001	0.0001	2.4691
Ra226	2.040	Alpha Septroscopy	0.010		Ra226	2.200	Alpha Septroscopy	0.020	0.200	7.547
Se	0.0048	ICP-MS	0.0002	0.0004	Se	0.0029	ICP-MS	0.0001	0.0004	49.3506
U	260.000	ICP-MS	0.100	17.000	U	257.000	ICP-MS	0.100	20.000	1.161
Zn	<0.003	ICP-MS	0.003		Zn	0.001	ICP-MS	0.001	0.001	107.692

Note: % Absolute Difference = abs(A-B)/((A+B)/2) Followup required where value is greater than 50%

APPENDIX G

APPENDIX G

2018 Hydrometric Monitoring near Beaverlodge Mine

Cameco Corporation
February 2019

MISSINIPI WATER SOLUTIONS INC.
FILE NUMBER: MWS-18-001
PO BOX 32089 ERINDALE
SASKATOON, SK CANADA S7S 1N8

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1.0 INTRODUCTION

The development of uranium mines in the area of Beaverlodge Lake near Uranium City, Saskatchewan began in the 1950s. At that time, the Beaverlodge operations were owned by Eldorado Mining and Refining Ltd., a crown corporation of the Government of Canada and consisted of a mill and underground mine, in addition to numerous satellite mine sites in the area. The Beaverlodge mill and associated mine sites (the Site) were closed in 1982 and decommissioning and reclamation works were completed in 1985. The project transferred into a monitoring and maintenance phase following decommissioning and reclamation. The site is currently managed by Cameco Corporation (Cameco) on behalf of the Government of Canada. (SRK Consulting, 2009)

Monitoring activities have continued since the closure of the Site and include routine sampling such as measurement of water quality and water quantity. Cameco has retained Missinipi Water Solutions Inc. (MWSI) to perform annual hydrological monitoring in areas associated with the Site and downstream. This report documents field and desktop activities carried out by MWSI related to the development of flow records at the Site. The scope of work covered in this report includes hydrometric monitoring and reporting for the following stations:

- AC-6A – Verna Lake to Ace Lake;
- AC-6B – Ace Creek Upstream of Ace Lake;
- AC-8 – Ace Lake Outflow;
- AC-14 – Ace Creek Upstream of Beaverlodge Lake;
- BL-5 – Beaverlodge Lake Outflow;
- CS-1 – Crackingstone River;
- Mickey Lake Outflow;
- TL-6 – Minewater Reservoir Outflow; and,
- TL-7 – Fulton Creek Weir.

Spot measurements were completed at the outflow from Zora Lake and the inflow to Verna Lake along the same stream alignment. The locations of permanent monitoring stations are presented in Figure 1.

Other activities were carried out at the request of Cameco in addition to the above noted flow monitoring and included visual inspection of boreholes in the area and installation of time lapse cameras at known seep locations. Details of those activities are summarized in this report following discussion of stream discharge monitoring.

Figure 1: Site Location Map

2.0 METHODS AND EQUIPMENT

Two field programs were undertaken during 2018. The first occurred between April 25 and May 6 and ran concurrently with other work in the Uranium City area. The second program ran from September 28 to 30.

At each monitoring station discharge was measured either by in-stream velocity measurements via the Mid-Section Method (Terzi, 1981) or direct volumetric measurement. Water levels were recorded either by elevation surveys using an engineer's rod and level or by reading a staff gauge. Automated water level readings were recorded using stage dataloggers (Solinst Leveloggers). To perform in-stream velocity measurements either a Sontek FlowTracker or a Price-style meter was used; volumetric measurements were performed by filling a vessel of known volume and timing with a stop watch. All equipment used for measuring flow velocity are regularly checked for quality data acquisition and calibrated as required with most recent calibrations in 2017. The calibration sheet for the Price-style meter used in this project is provided in Appendix A. The Price-style meters are not used often so calibration is undertaken on an as needed basis; the flow meters are checked against each other annually as a verification step. Facilities do not exist in Canada to calibrate the FlowTracker; however, the meter performs a beam check at the start of each measurement and has been tested by MWSI side-by-side to the calibrated Price-style meters in a flume with acceptable agreement in velocity measurements. Water levels are reported in reference to locally established benchmarks and are not corrected to geodetic elevation. MWSI's survey equipment is regularly checked via the two-peg method (Anderson and Mikhail, 1998).

The current deployment of Solinst Leveloggers were initially installed in 2012. To prevent freezing dataloggers at TL-6, TL-7, AC-14, and AC-6A are removed each fall. At this time their voltage and battery capacity were checked and appeared to be within guidelines provided by Solinst Canada. These loggers are not calibrated beyond the condition in which they are provided from factory but are checked by field surveys of water level. The loggers removed from the field are checked against each other to confirm that individual loggers are reporting similar responses in a controlled environment, but no immediate problems have been identified. Dataloggers deployed through the winter will be checked during the next field program.

To calculate the hydrograph at each station, the measurements of stage and discharge are used to develop a rating curve. The resulting curve is then applied to the datalogger stage data records following compensation of the datalogger with barometric pressure and correction of the record to measured water levels. The flow rate estimated from the rating curve and stage record forms the hydrograph which is presented for each station as both half-hourly discharge and daily average discharge. The daily average discharge is presented in a summary table for each station. The rating curves reported in this document are continuations of the data presented by MWSI (2018).

Cameco must exercise caution regarding the use of any hydrograph data which are calculated from extrapolation above the highest or below the lowest measured data on the rating curve for any given monitoring station. Rating curves are typically exponential in nature and may become inaccurate beyond the measured range of data.

Stage-discharge relationships (rating curves) have been developed for open water conditions using measured discharges and water levels. In addition, stage-discharge relationships can be estimated when weirs are constructed to standardized dimensions and verified by field data. These relationships allow discharge to be estimated using measured water levels during open water conditions; however, if the channel configuration changes due to debris or physical change to the channel the stage-discharge relationship is no longer valid and the calculation of discharge based on stage height may not reflect actual conditions at the station (i.e. backwater over a station resulting in false discharge peaks). In this situation, it is often possible to correlate flows from one station to another; a station with good flow records and unimpeded by backwater conditions, can be used to estimate flows at a station where snow, ice and other backwater causing conditions exist.

Winter flow manual discharge measurements have not been carried out at any of these sites apart from AC-8 in 2006. At that time AC-8 was observed to be flowing unimpeded by ice or snow encroachment on the weir and the upstream stream bed. AC-8 stage logger data collected through ice covered periods typically do not indicate back water effects normally observed at other channels where ice and snow cover are known to occur. All other stations with dataloggers installed year-round appear to have ice and snow influence on the hydraulic characteristics of the channel thus altering the stage and discharge relationships; therefore, winter hydrographs for all other stations are estimated based on AC-8.

3.0 CLIMATIC CONDITIONS

The climate stations at Uranium City and Stony Rapids, SK reported 363 days (out of 365) and 261 days of climate data, respectively. Climate data are collected and reported by Environment Canada (2019) for these stations. The winter of 2017/2018 (MWSI, 2018 and Environment Canada, 2018) appeared to be somewhat above normal as far as precipitation totals from October to April. Similar to 2017, the spring melt occurred slightly earlier than usual beginning at the end of April rather than later in May. Elevated temperatures in April initiated some melt conditions but freshet did not appear to occur at that time. Beyond April, precipitation totals were above normal in May and June then below normal for the remainder of the year. Precipitation totals for Uranium City and Stony Rapids are presented in Table 1.

Table 1: Climate Conditions

Year	Month	Uranium City				Stony Rapids			
		Precipitation (mm)	Normal Precipitation (mm)[(a)]	Percent of Normal	Recorded Days of Data	Precipitation (mm)	Normal Precipitation (mm)[(b)]	Percent of Normal	Recorded Days of Data
2018	January	31.3	19.3	162.2	31/31	6.0*	18.1	33.1	19/31
	February	10.0*	15.5	64.5	27/28	0.0*	13.3	0.0	16/28
	March	12.3	17.8	69.1	31/31	0.0*	18.2	0.0	22/31
	April	17	16.9	100.6	30/30	20.1*	18	111.7	24/30
	May	33.2	17.5	189.7	31/31	20.4*	26.3	77.6	14/31
	June	56.6	31.3	180.8	30/30	62.4*	44.4	140.5	19/30
	July	31.4*	47.1	66.7	30/31	53.9*	56.3	95.7	20/31
	August	11.8	42.4	27.8	31/31	12.9*	63.9	20.2	23/31
	September	29.9	33.7	88.7	30/30	4.7*	48.4	9.7	22/30
	October	12.3	29.1	42.3	31/31	7.3*	30.1	24.3	22/31
	November	17.2	28	61.4	30/30	2.9*	27.6	10.5	29/30
	December	22.7	23.6	96.2	31/31	7.6	18.7	40.6	31/31
Totals		285.7*	322.2	88.7	363/365	198.2*	383.3	51.7	261/365

Notes: (a) Uranium City Normals, Golder (2011); (b) Stony Rapids Normals, Golder (2011); * indicates incomplete data set.

4.0 STREAM DISCHARGE MONITORING

This section presents the measured discharge, measured water level (stage), rating curves, hydrographs and daily average discharge data for each station. Relevant observations at each station are also provided for each location. Monitoring periods reported in this section may differ from station to station dependent on whether a data logger was installed through the winter or if winter discharge records indicate an influence on stage height from ice/snow encroachment. In some cases, records have been extended either forwards, backwards or both to create a full record for 2018 based on AC-8. The only datalogger downloaded with a record extending beyond October 2018 is AC-8; any station with a flow record extending beyond this period (AC-6B, CS-1 and TL-7) is synthesized from AC-8. Based on historical data collection the AC-8 winter data do not show evidence of ice and snow encroachment at the weir; other stations through ice covered periods show substantial fluctuations in the stage record. For this reason AC-8 is often used as a proxy to define the trend of winter water levels.

Only stations where flow is known to typically occur year-round (AC-6B, CS-1 and TL-7) have had their records extended except for AC-14 which is similar to AC-8. Through discussion with Cameco, hydrograph reporting for Mickey Lake Outflow and BL-5 has been discontinued due to concerns over the stability of the rating curves at each station. Mickey Lake Outflow is immediately below a degrading beaver dam and BL-5 has shown evidence of “drift” in the rating curve consistent with a potentially changing hydraulic geometry. Mickey Lake Outflow and BL-5 are still monitored for stage and discharge when accessibility allows.

4.1 AC-6A – VERNA LAKE TO ACE LAKE

A v-notch weir installed in 2011 is used to monitor discharge from Verna Lake to Ace Lake at station AC-6A. The weir is mounted to an existing culvert through the road which follows the perimeter of Ace Lake. Photo 1 and Photo 2 were taken during the 2018 spring and fall field programs, respectively. The rating curve data are presented in Table 2 and graphically in Figure 2. The 2018 hydrograph for AC-6A is shown in Figure 3 and the data are presented in Table 3. The invert of the v-notch is located at 0.273 m on the staff gauge which corresponds to the “zero flow” point on the rating curve.

Photo 1: AC-6A – May 5, 2018

Photo 2: AC-6A – September 29, 2018

Table 2: AC-6A Stage and Discharge Measurements

Measurement Date & Time	Water Level (m)	Discharge (m^3/s)
2012-05-07 14:54	0.307	0.0005
2012-05-08 8:06	0.315	0.0008
2012-05-09 18:16	0.317	0.0008
2013-10-12 11:47	<0.273	0.0000
2014-05-04 9:50	0.323	0.0015
2014-05-08 12:05	0.303	0.0004
2014-10-09 16:00	<0.273	0.0000
2015-05-02 15:45	<0.273	0.0000
2015-10-02 14:35	0.389	0.0078
2015-10-03 13:18	0.399	0.0081
2015-10-04 14:00	0.393	0.0080
2016-05-04 12:15	0.468	0.0266
2016-05-05 18:00	0.486	0.0374
2016-10-07 12:00	0.418	0.0177
2017-04-27 16:00	0.376	0.0063
2017-05-06 11:30	0.389	0.0073
2017-10-14 12:30	<0.273	0.0000
2018-04-25 16:00	<0.273	0.0000
2018-05-05 11:14	0.341	Not measured
2018-09-29 11:06	<0.273	0.0000

Figure 2: AC-6A Rating Curve

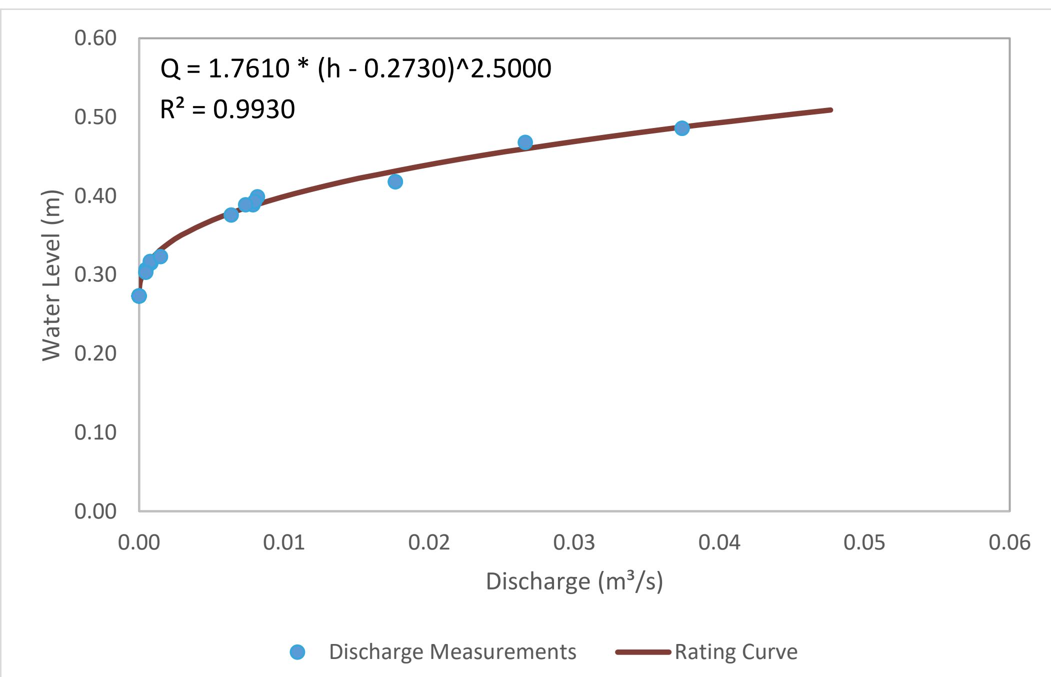


Figure 3: AC-6A 2018 Hydrograph

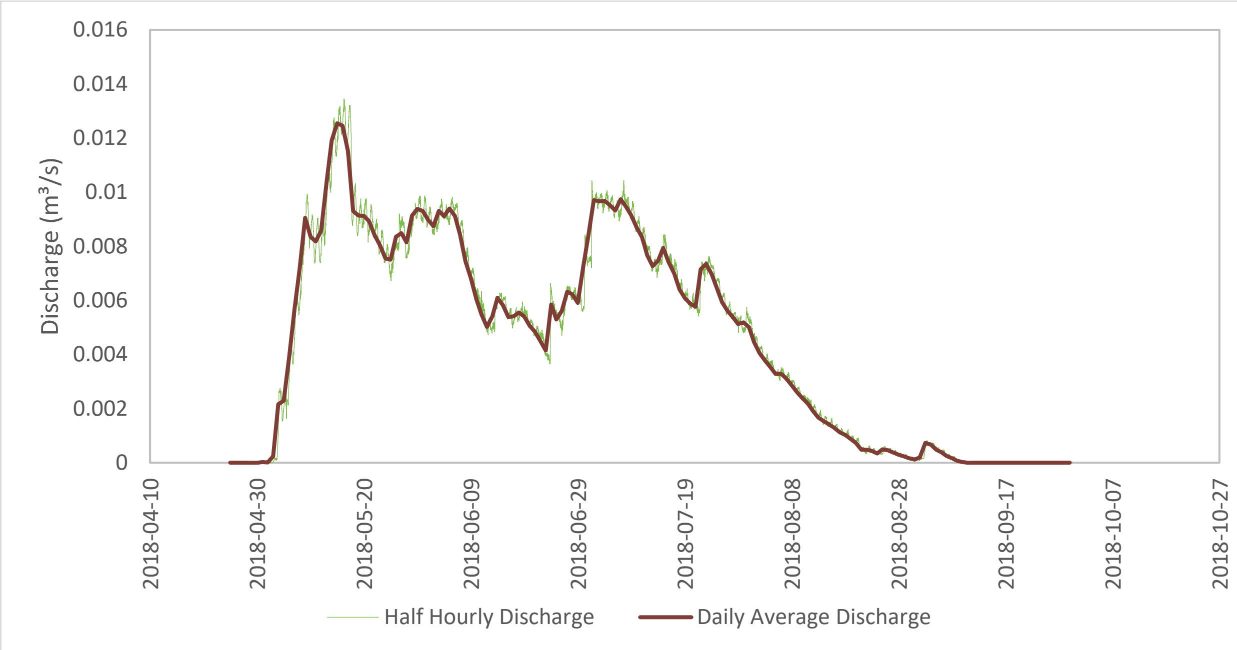


Table 3: AC-6A 2018 Daily Average Discharge (m^3/s)

Day	Apr	May	Jun	Jul	Aug	Sep
1		0.0000	0.0090	0.0084	0.0045	0.0002
2		0.0000	0.0087	0.0097	0.0041	0.0007
3		0.0002	0.0093	0.0097	0.0038	0.0007
4		0.0022	0.0091	0.0097	0.0035	0.0005
5		0.0023	0.0094	0.0095	0.0033	0.0004
6		0.0039	0.0091	0.0093	0.0033	0.0002
7		0.0057	0.0084	0.0097	0.0031	0.0002
8		0.0072	0.0074	0.0095	0.0029	0.0001
9		0.0091	0.0068	0.0091	0.0026	0.0000
10		0.0084	0.0060	0.0087	0.0024	0.0000
11		0.0082	0.0055	0.0083	0.0022	0.0000
12		0.0086	0.0050	0.0077	0.0019	0.0000
13		0.0104	0.0054	0.0073	0.0017	0.0000
14		0.0119	0.0061	0.0075	0.0015	0.0000
15		0.0125	0.0058	0.0079	0.0014	0.0000
16		0.0125	0.0054	0.0074	0.0013	0.0000
17		0.0115	0.0054	0.0070	0.0011	0.0000
18		0.0093	0.0055	0.0064	0.0010	0.0000
19		0.0091	0.0054	0.0061	0.0009	0.0000
20		0.0091	0.0051	0.0059	0.0007	0.0000
21		0.0089	0.0048	0.0058	0.0005	0.0000
22		0.0084	0.0045	0.0071	0.0005	0.0000
23		0.0080	0.0041	0.0074	0.0004	0.0000
24		0.0076	0.0059	0.0070	0.0003	0.0000
25	0.0000	0.0075	0.0053	0.0065	0.0005	0.0000
26	0.0000	0.0084	0.0056	0.0059	0.0005	0.0000
27	0.0000	0.0085	0.0063	0.0056	0.0004	0.0000
28	0.0000	0.0081	0.0062	0.0054	0.0003	0.0000
29	0.0000	0.0091	0.0059	0.0051	0.0002	0.0000
30	0.0000	0.0094	0.0072	0.0052	0.0002	
31		0.0093		0.0050	0.0001	
Average		0.0076	0.0065	0.0074	0.0016	0.0001

4.2 AC-6B – ACE CREEK UPSTREAM OF ACE LAKE

AC-6B is located on Ace Creek upstream of Ace Lake. The station is located immediately upstream of a bridge structure which provides the hydraulic control for the cross-section. The station was visited in the spring (Photo 3) and fall (Photo 4) of 2018. In 2017 the sensor was lost and a replacement was installed in the spring of 2018. Table 4 and Figure 4 present the measured flow data numerically and graphically (rating curve). The 2018 hydrograph is provided as Figure 5 and the daily average discharge data are presented in Table 5.

Photo 3: AC-6B – May 5, 2018

Photo 4: AC-6B – September 29, 2018

Table 4: AC-6B Stage and Discharge Measurements

Measurement Date & Time	Water Level (m)	Discharge (m^3/s)
2010-04-27	98.907	0.7724
2010-07-01	98.832	0.2823
2010-09-17 15:25	98.793	0.1678
2011-05-18 12:50	98.848	0.4747
2011-08-28 9:14	98.824	0.2385
2011-10-05	98.823	0.2759
2012-05-07 18:00	99.208	3.4606
2012-09-29 10:36	98.854	0.3937
2013-05-15 13:40	99.185	3.5821
2013-05-16 13:50	99.212	4.0941
2013-10-12 10:20	98.785	0.2057
2014-05-08 10:35	99.032	2.0231
2014-10-10 9:20	98.690	0.1140
2015-05-02 14:30	98.788	0.3213
2015-10-03 12:10	98.868	0.6203
2016-05-04 11:05	99.142	3.1934
2016-10-07 10:30	98.963	1.0768
2017-05-06 10:30	98.900	0.8753
2017-10-14 10:30	98.691	0.0842
2018-05-05 9:44	99.100	2.3828
2018-09-29 9:43	98.740	0.1011

Figure 4: AC-6B Rating Curve

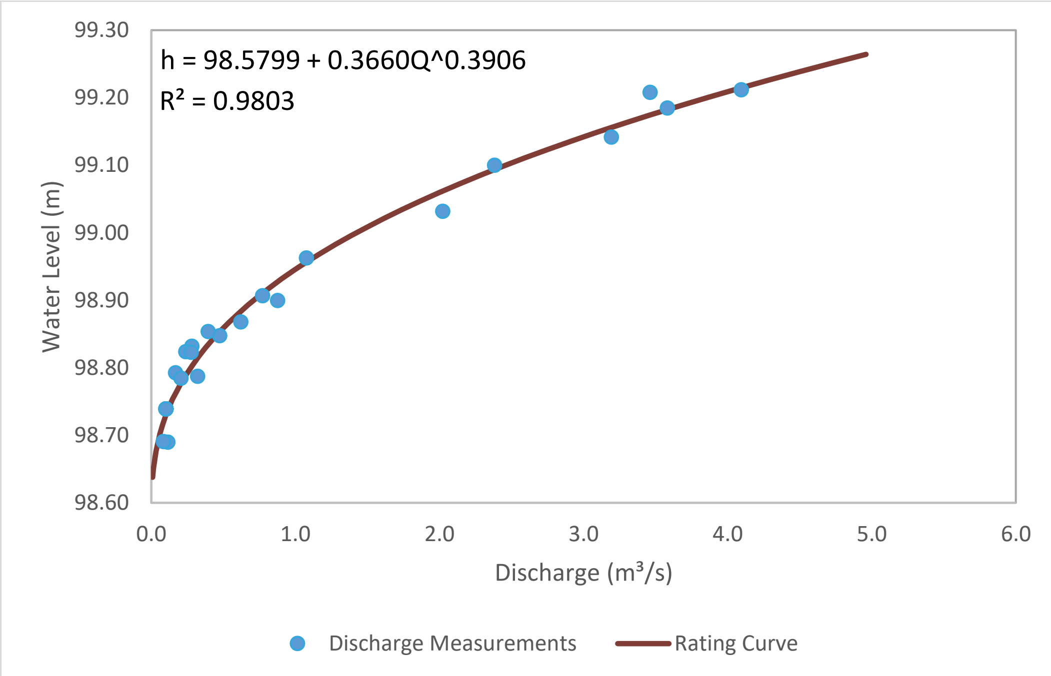


Figure 5: AC-6B 2018 Hydrograph

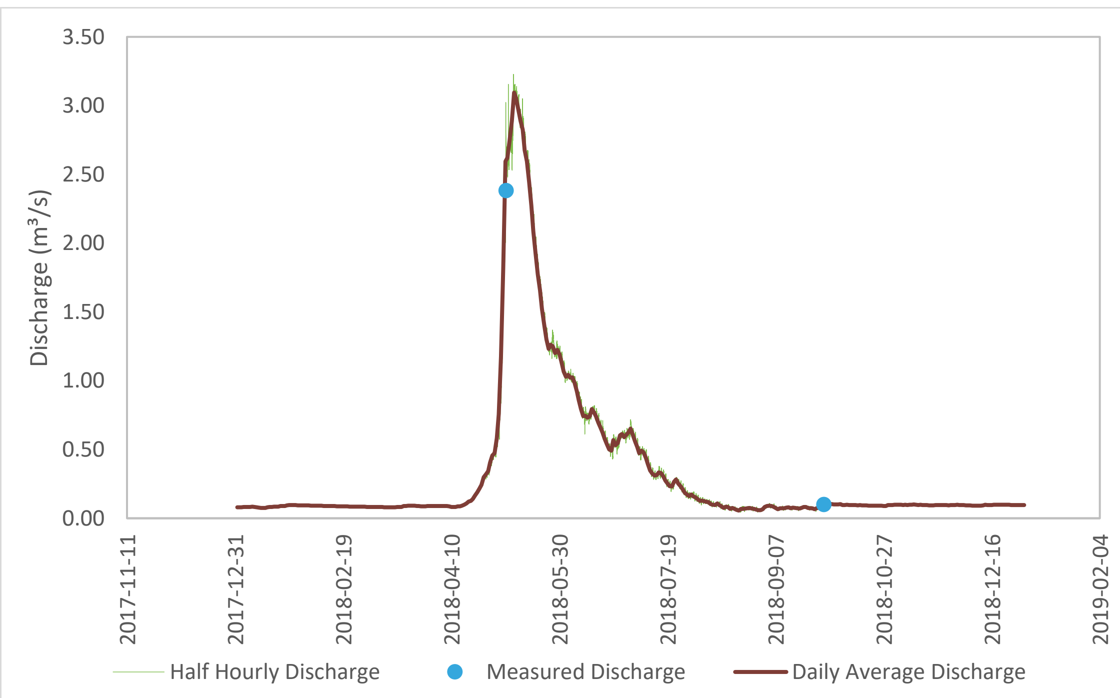


Table 5: AC-6B 2018 Daily Average Discharge (m^3/s)

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0.079	0.094	0.083	0.088	0.582	1.065	0.626	0.152	0.066	0.106	0.098	0.097
2	0.080	0.093	0.083	0.089	0.754	1.030	0.653	0.138	0.082	0.103	0.099	0.096
3	0.080	0.093	0.083	0.089	1.175	1.042	0.605	0.125	0.090	0.103	0.099	0.095
4	0.081	0.092	0.082	0.089	1.813	1.022	0.560	0.129	0.091	0.102	0.098	0.095
5	0.082	0.092	0.082	0.089	2.595	1.024	0.517	0.124	0.090	0.102	0.096	0.094
6	0.082	0.092	0.082	0.090	2.619	0.984	0.472	0.119	0.085	0.101	0.097	0.093
7	0.083	0.091	0.082	0.090	2.748	0.925	0.491	0.116	0.076	0.102	0.097	0.092
8	0.084	0.091	0.081	0.089	2.887	0.860	0.477	0.104	0.066	0.097	0.099	0.092
9	0.083	0.090	0.081	0.086	3.095	0.794	0.439	0.099	0.073	0.096	0.099	0.092
10	0.080	0.090	0.081	0.083	3.055	0.744	0.395	0.096	0.072	0.098	0.100	0.092
11	0.078	0.090	0.080	0.082	2.973	0.745	0.348	0.107	0.073	0.097	0.097	0.092
12	0.076	0.089	0.080	0.082	2.891	0.730	0.325	0.095	0.076	0.095	0.097	0.094
13	0.074	0.089	0.080	0.086	2.825	0.741	0.309	0.086	0.079	0.096	0.098	0.099
14	0.075	0.088	0.080	0.088	2.676	0.795	0.315	0.076	0.073	0.096	0.097	0.097
15	0.079	0.088	0.080	0.091	2.594	0.769	0.333	0.085	0.078	0.094	0.097	0.096
16	0.082	0.088	0.082	0.098	2.444	0.740	0.329	0.081	0.075	0.096	0.097	0.096
17	0.083	0.087	0.082	0.108	2.272	0.697	0.306	0.069	0.072	0.094	0.094	0.098
18	0.084	0.087	0.083	0.121	2.089	0.659	0.274	0.076	0.071	0.094	0.094	0.099
19	0.084	0.087	0.090	0.126	1.928	0.619	0.255	0.069	0.076	0.093	0.095	0.099
20	0.085	0.086	0.090	0.140	1.773	0.579	0.233	0.060	0.083	0.092	0.095	0.098
21	0.088	0.086	0.090	0.167	1.657	0.538	0.230	0.056	0.081	0.092	0.095	0.099
22	0.089	0.086	0.090	0.188	1.522	0.502	0.266	0.069	0.076	0.091	0.096	0.099
23	0.090	0.085	0.091	0.217	1.408	0.491	0.281	0.069	0.074	0.091	0.095	0.098
24	0.095	0.085	0.091	0.242	1.300	0.567	0.252	0.071	0.074	0.091	0.096	0.097
25	0.097	0.085	0.089	0.298	1.232	0.531	0.233	0.074	0.066	0.091	0.096	0.096
26	0.096	0.084	0.088	0.319	1.261	0.547	0.211	0.075	0.073	0.091	0.095	0.095
27	0.096	0.084	0.088	0.344	1.250	0.603	0.187	0.071	0.078	0.090	0.096	0.095
28	0.095	0.084	0.088	0.405	1.200	0.613	0.173	0.068	0.080	0.090	0.097	0.095
29	0.095		0.088	0.457	1.223	0.590	0.162	0.064	0.094	0.095	0.097	0.095
30	0.094		0.089	0.473	1.192	0.608	0.172	0.058	0.110	0.097	0.098	0.095
31	0.094		0.089		1.137		0.159	0.058		0.097		0.095
Average	0.085	0.088	0.085	0.167	1.941	0.738	0.342	0.088	0.078	0.096	0.097	0.096

4.3 MICKEY LAKE OUTFLOW

The outflow from Mickey Lake represents the watershed in which the former Hab Mine was located. The discharge measurement location was in use since 2010 but concerns over the reliability of this location had been previously raised and subsequently the sensor was relocated to AC-8 (as a backup) during the spring 2017 program. Spot measurements of discharge were completed in 2017 and continued in 2018 during the spring and fall field programs (Photo 5 and Photo 6). The updated rating curve data are provided in Table 6 and the rating curve is presented in Figure 6.

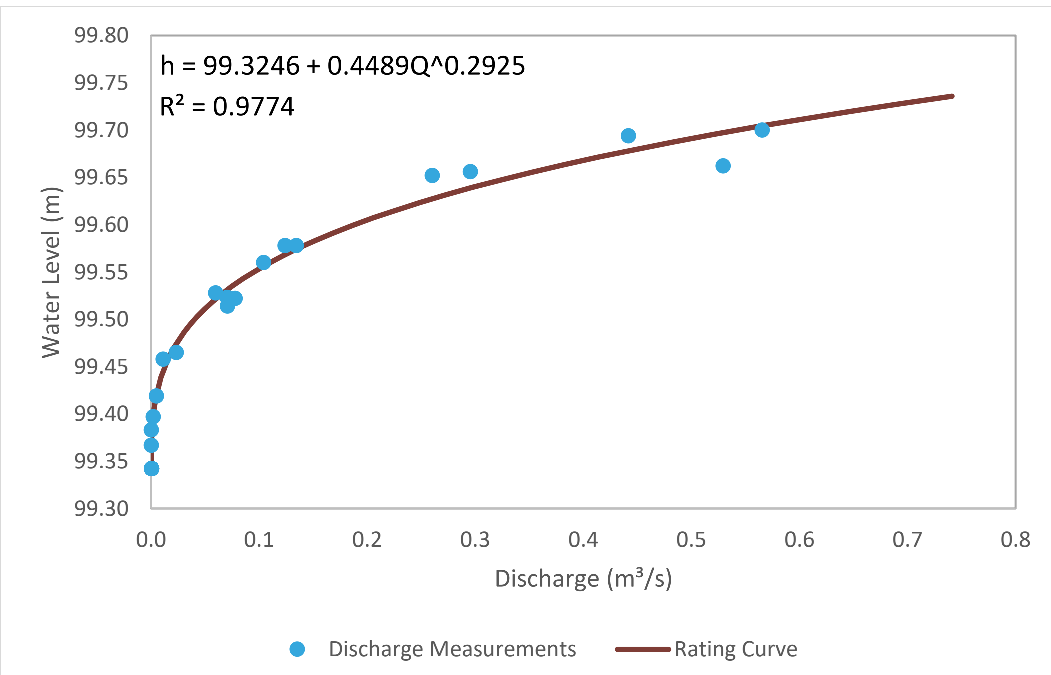
Photo 5: Mickey Lake Outflow – May 5, 2018

Photo 6: Mickey Lake Outflow – September 29, 2018

Table 6: Mickey Lake Outflow Stage and Discharge Measurements

Measurement Date & Time	Water Level (m)	Discharge (m^3/s)
2010-04-27	99.528	0.0597
2010-07-01	99.458	0.0110
2010-09-17	99.367	0.0003
2011-05-18 11:35	99.523	0.0703
2011-10-05	99.465	0.0234
2012-05-09 17:30	99.662	0.5295
2012-09-29 8:25	99.514	0.0705
2013-05-15 12:10	99.700	0.5655
2013-10-12 9:30	99.419	0.0049
2014-05-08 9:10	99.652	0.2603
2014-10-10 13:05	99.397	0.0020
2015-05-03 15:30	99.522	0.0778
2015-10-02 11:10	99.560	0.1040
2016-05-04 9:30	99.694	0.4418
2016-10-07 9:29	99.578	0.1240
2017-05-06 8:30	99.578	0.1345
2017-10-14 9:30	99.383	0.0001
2018-05-05 8:40	99.656	0.2954
2018-09-29 8:49	99.342	0.0005

Figure 6: Mickey Lake Outflow Rating Curve



4.4 AC-8 – ACE LAKE OUTFLOW

The outflow from Ace Lake has been monitored for over three decades at a concrete box weir located at the outlet of the lake. The station was visited by MWSI in the spring (Photo 7) and fall (Photo 8) of 2018. The field monitoring data are provided in Table 7 and the rating curve is presented in Figure 7. The hydrograph for 2018 is shown as Figure 8. Daily average discharge data are presented in Table 8 and the long term monthly data are provided in Table 9.

Photo 7: AC-8 – May 5, 2018

Photo 8: AC-8 – September 29, 2018

Table 7: AC-8 Stage and Discharge Measurements

Measurement Date & Time	Water Level (m)	Discharge (m^3/s)
2005-08-16	99.451	0.4151
2006-01-24	99.446	0.4044
2006-05-24	99.848	1.6914
2010-04-30	99.593	0.7530
2010-07-01	99.407	0.2857
2010-09-11 10:15	99.335	0.1438
2011-05-16 15:30	99.442	0.3026
2011-05-22 8:11	99.481	0.4443
2011-08-28	99.407	0.2611
2011-10-03	99.428	0.3006
2012-05-08 15:09	100.003	2.9464
2012-05-10 9:06	100.066	3.8907
2012-09-29 11:20	99.541	0.5555
2013-05-15 14:58	99.886	1.9917
2013-10-12 12:45	99.374	0.2129
2014-05-08 11:53	99.853	1.6840
2014-10-10 11:10	99.320	0.1172
2015-05-02 16:00	99.409	0.2899
2015-10-03 15:00	99.624	0.8705
Weir Invert	99.179	0.0000
2016-05-04 12:50	99.900	2.2535
2016-08-11 14:30	99.608	0.5906
2016-10-07 12:20	99.725	1.2544
2017-05-06 12:36	99.520	0.5859
2017-10-14 13:05	99.278	0.0714
2018-04-25 17:05	99.357	Not Measured
2018-05-04 17:21	99.605	Not Measured
2018-05-05 12:00	99.680	1.0290
2018-09-29 11:30	99.318	0.1201

Figure 7: AC-8 Rating Curve

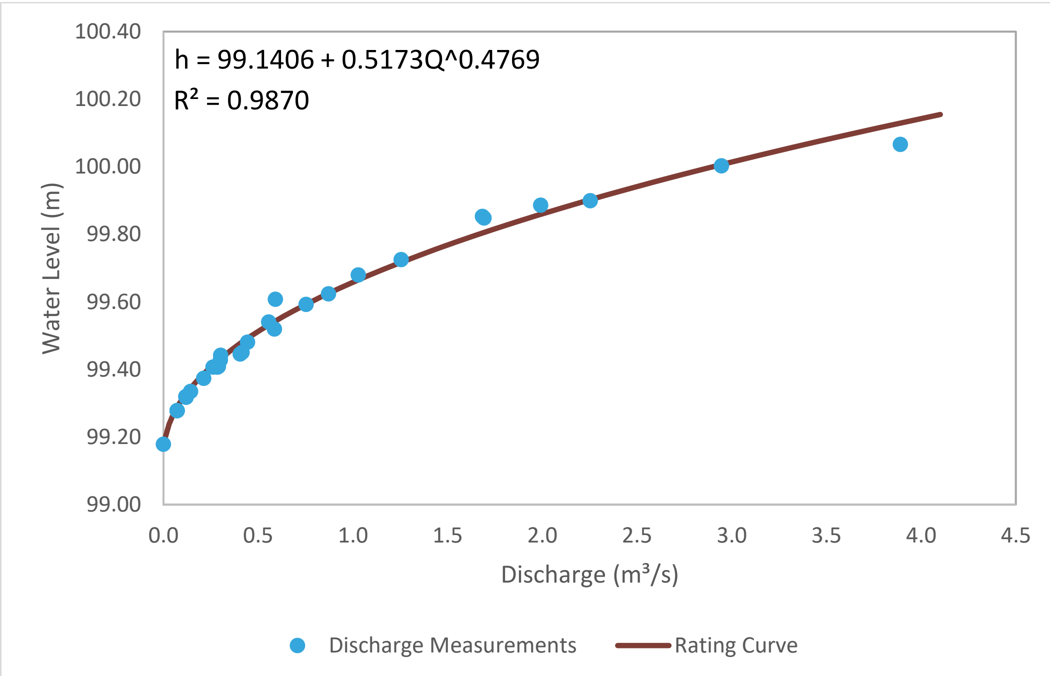


Figure 8: AC-8 2018 Hydrograph

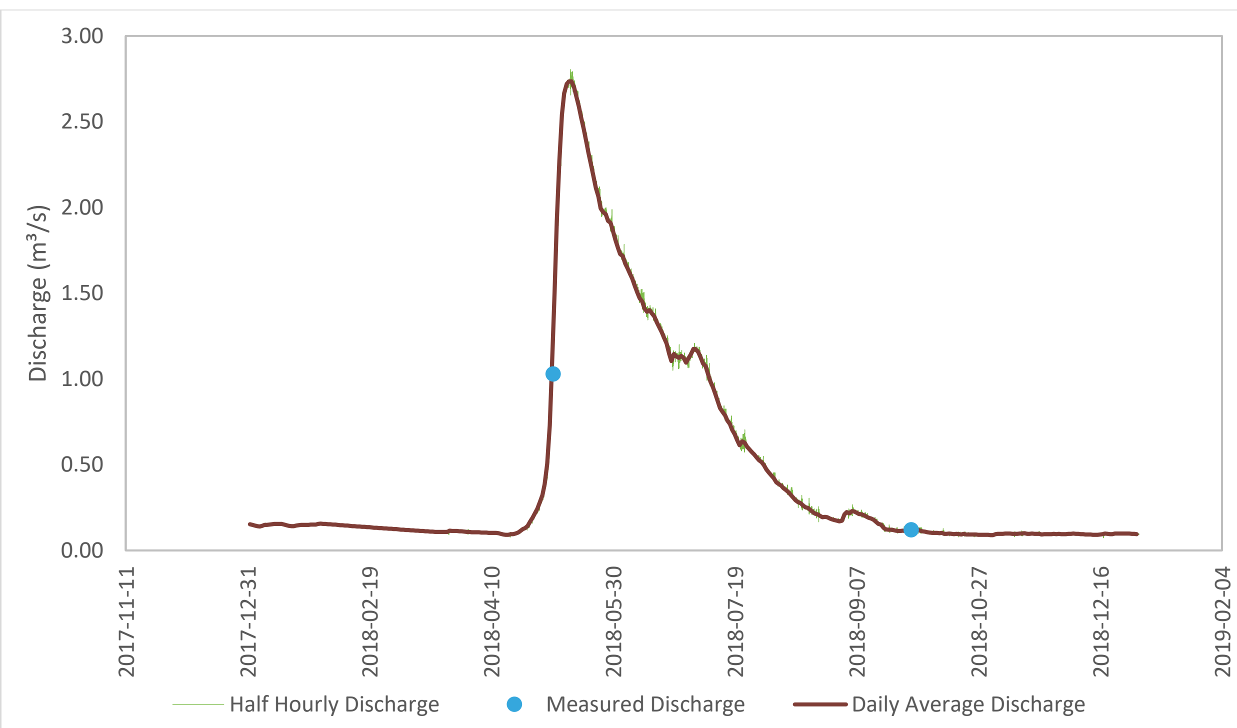


Table 8: AC-8 2018 Daily Average Discharge (m³/s)

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0.153	0.154	0.125	0.107	0.322	1.764	1.143	0.472	0.174	0.121	0.090	0.095
2	0.149	0.153	0.124	0.106	0.386	1.727	1.175	0.453	0.211	0.120	0.090	0.096
3	0.146	0.152	0.123	0.106	0.505	1.716	1.173	0.438	0.223	0.115	0.095	0.097
4	0.142	0.151	0.122	0.106	0.730	1.671	1.156	0.422	0.217	0.112	0.097	0.097
5	0.140	0.150	0.121	0.105	1.082	1.646	1.123	0.397	0.230	0.110	0.097	0.098
6	0.143	0.149	0.120	0.104	1.502	1.613	1.090	0.387	0.227	0.106	0.098	0.097
7	0.149	0.148	0.119	0.104	1.921	1.584	1.075	0.378	0.220	0.103	0.099	0.096
8	0.150	0.147	0.118	0.104	2.272	1.540	1.032	0.364	0.213	0.103	0.099	0.095
9	0.151	0.146	0.117	0.103	2.541	1.502	0.986	0.353	0.210	0.102	0.098	0.095
10	0.153	0.145	0.116	0.102	2.665	1.470	0.951	0.339	0.205	0.102	0.096	0.094
11	0.155	0.144	0.115	0.102	2.720	1.451	0.915	0.324	0.197	0.101	0.097	0.093
12	0.155	0.142	0.114	0.102	2.735	1.411	0.870	0.308	0.190	0.102	0.097	0.092
13	0.155	0.141	0.113	0.100	2.735	1.392	0.830	0.292	0.186	0.097	0.099	0.092
14	0.154	0.140	0.112	0.097	2.700	1.401	0.808	0.281	0.180	0.096	0.099	0.092
15	0.150	0.139	0.111	0.093	2.647	1.383	0.787	0.276	0.166	0.098	0.100	0.092
16	0.147	0.138	0.110	0.091	2.588	1.364	0.757	0.263	0.154	0.097	0.097	0.092
17	0.144	0.137	0.110	0.090	2.524	1.332	0.737	0.252	0.151	0.095	0.097	0.094
18	0.142	0.136	0.109	0.094	2.459	1.303	0.703	0.248	0.133	0.096	0.098	0.099
19	0.142	0.135	0.108	0.095	2.383	1.272	0.677	0.236	0.122	0.096	0.097	0.097
20	0.146	0.134	0.108	0.098	2.317	1.240	0.641	0.223	0.121	0.094	0.097	0.096
21	0.148	0.133	0.108	0.104	2.248	1.207	0.614	0.215	0.121	0.096	0.097	0.096
22	0.148	0.132	0.108	0.114	2.178	1.148	0.635	0.211	0.118	0.094	0.094	0.098
23	0.149	0.131	0.108	0.125	2.114	1.105	0.628	0.201	0.116	0.094	0.094	0.099
24	0.148	0.130	0.115	0.130	2.063	1.146	0.605	0.193	0.114	0.093	0.095	0.099
25	0.148	0.129	0.114	0.143	1.994	1.132	0.589	0.196	0.114	0.092	0.095	0.098
26	0.151	0.128	0.114	0.169	1.973	1.122	0.574	0.193	0.115	0.092	0.095	0.099
27	0.151	0.127	0.113	0.190	1.960	1.134	0.559	0.187	0.113	0.091	0.096	0.099
28	0.151	0.126	0.113	0.219	1.922	1.123	0.542	0.181	0.109	0.091	0.095	0.098
29	0.155		0.112	0.243	1.910	1.096	0.526	0.176	0.122	0.091	0.096	0.097
30	0.157		0.110	0.281	1.865	1.119	0.514	0.172	0.126	0.091	0.096	0.096
31	0.156		0.108		1.812		0.497	0.170		0.091		0.095
Average	0.149	0.140	0.114	0.124	1.993	1.371	0.804	0.284	0.163	0.099	0.096	0.096

Table 9: AC-8 Monthly Average Discharge (m^3/s)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1980	0.151	0.150	0.149	0.221	0.204	0.156	0.145	0.145	0.145	0.163	0.151	0.146	0.161
1981	0.146	0.145	0.145	0.169	0.392	0.178	0.182	0.192	0.194	0.190	0.198	0.188	0.193
1982	0.169	0.167	0.176	0.196	0.577	0.459	0.279	0.185	0.146	0.157	0.154	0.162	0.236
1983	0.177	0.164	0.151	0.223	0.750	0.574	0.414	0.334	0.251	0.226	0.206	0.194	0.305
1984	0.189	0.192	0.208	0.413	0.501	0.723	0.789	0.564	0.399	0.571	0.790	0.725	0.505
1985	0.471	0.378	0.335	0.395	2.768	1.366	0.551	0.332	0.256	0.215	0.174	0.169	0.618
1986	0.181	0.186	0.185	0.218	0.462	0.541	0.608	0.544	0.343	0.233	0.201	0.193	0.325
1987	0.191	0.208	0.221	0.219	1.988	0.685	0.260	0.116	0.102	0.103	0.135	0.138	0.364
1988	0.154	0.114	0.108	0.100	0.361	0.817	1.120	0.819	0.254	0.181	0.202	0.191	0.368
1989	0.178	0.176	0.156	0.160	1.912	1.427	0.361	0.166	0.115	0.120	0.154	0.172	0.425
1990	0.197	0.183	0.169	0.108	0.556	0.764	0.317	0.175	0.145	0.151	0.250	0.333	0.279
1991	0.262	0.219	0.207	0.436	2.038	1.962	0.788	0.395	0.393	0.431	0.464	0.398	0.666
1992	0.319	0.254	0.215	0.247	2.634	1.386	0.663	0.489	0.408	1.223	0.985	0.508	0.778
1993	0.302	0.221	0.183	0.190	0.862	0.513	0.356	1.006	0.594	0.314	0.382	0.400	0.444
1994	0.277	0.225	0.205	0.186	3.014	1.459	0.339	0.117	0.097	0.105	0.130	0.131	0.524
1995	0.113	0.106	0.104	0.129	1.698	1.401	0.900	0.493	1.002	0.511	0.378	0.325	0.597
1996	0.252	0.190	0.155	0.146	0.272	0.524	1.408	0.499	0.341	0.286	0.293	0.262	0.386
1997	0.229	0.202	0.167	0.171	0.593	0.970	1.251	1.897	4.109	3.439	1.629	0.617	1.273
1998	0.369	0.291	0.246	0.279	1.236	0.410	0.614	0.404	0.260	0.208	0.208	0.199	0.394
1999	0.169	0.160	0.165	0.156	0.467	0.608	0.408	0.216	0.203	0.161	0.153	0.166	0.253
2000	0.166	0.136	0.129	0.136	0.307	0.305	0.267	0.274	0.674	0.824	1.211	0.744	0.431
2001	0.365	0.298	0.236	0.203	1.176	0.763	0.457	0.360	0.355	0.597	0.457	0.365	0.469
2002	0.350	0.220	0.176	0.189	1.304	2.353	0.516	2.216	1.102	0.688	0.561	0.437	0.843
2003	0.288	0.246	0.201	0.179	2.240	2.284	0.668	0.522	0.458	0.422	0.410	0.345	0.689
2004	0.253	0.250	0.301	0.214	0.206	1.996	0.455	0.219	0.169	0.170	0.176	0.166	0.381
2005	0.143	0.164	0.150	0.191	1.158	1.077	0.549	0.443	0.456	0.464	0.728	0.579	0.509
2006	0.433	0.321	0.229	0.397	2.280	0.978	0.365	0.240	0.226	0.228	0.220	0.200	0.510
2007	0.199	0.171	0.156	0.175	0.734	0.573	0.370	0.321	0.477	0.483	0.874	0.635	0.431
2008	0.463	0.343	0.294	0.252	1.110	1.125	0.361	0.318	0.265	0.509	0.735	0.495	0.523
2009	0.242	0.180	0.124	0.175	1.066	0.852	1.478	0.681	0.454	0.432	0.431	0.414	0.544
2010	0.341	0.280	0.217	0.309	0.744	0.430	0.238	0.105	0.167	0.199	0.178	0.181	0.282
2011	0.173	0.140	0.113	0.092	0.299	0.319	0.207	0.240	0.358	0.250	0.224	0.241	0.221
2012	0.259	0.221	0.215	0.248	2.467	1.114	0.699	0.560	0.666	0.517	0.621	0.535	0.677
2013	0.351	0.280	0.247	0.237	1.891	1.579	0.637	0.324	0.240	0.218	0.237	0.243	0.540
2014	0.235	0.217	0.190	0.170	2.224	2.344	1.163	0.465	0.176	0.163	0.175	0.163	0.640
2015	0.154	0.163	0.137	0.153	0.362	0.305	0.318	0.464	1.366	0.659	0.589	0.446	0.426
2016	0.339	0.279	0.204	0.192	2.155	1.239	0.681	0.834	2.446	1.095	0.721	0.536	0.893
2017	0.333	0.245	0.178	0.195	1.165	0.698	0.231	0.125	0.082	0.078	0.113	0.132	0.298
2018	0.149	0.140	0.114	0.124	1.993	1.371	0.804	0.284	0.163	0.099	0.096	0.096	0.453
Mean	0.250	0.211	0.186	0.210	1.235	0.990	0.570	0.464	0.514	0.438	0.410	0.322	0.483

4.5 AC-14 – ACE CREEK UPSTREAM OF BEAVERLODGE LAKE

Ace Creek is monitored approximately 250 m upstream of Beaverlodge Lake at station AC-14. The site was visited twice in 2018 during the spring and fall field programs (Photo 9 and Photo 10). Field measurement data are summarized in Table 10 and the rating curve is presented as Figure 9. The 2018 hydrograph is shown in Figure 10 with daily average discharge data presented in Table 11.

Photo 9: AC-14 – May 5, 2018

Photo 10: AC-14 – September 29, 2018

Table 10: AC-14 Stage and Discharge Measurements

Measurement Date & Time	Water Level (m)	Discharge (m^3/s)
2005-08-16	No WL Measured	0.3561
2006-01-24	No WL Measured	0.5261
2006-05-25	No WL Measured	1.4651
2009-05-22	No WL Measured	1.4820
2009-09-27 11:00	No WL Measured	0.4276
2009-09-27 11:30	No WL Measured	0.4644
2010-04-30	No WL Measured	0.7067
2010-07-01	No WL Measured	0.2985
2010-09-13 16:05	No WL Measured	0.1596
2011-05-18 9:05	98.291	0.3680
2011-05-18 10:00	98.300	0.4034
2011-08-28	98.276	0.2498
2011-10-05	98.288	0.3034
2012-05-08 11:39	98.480	3.0369
2012-09-29 15:30	98.328	0.5166
2013-05-15 16:55	98.429	2.0341
2013-05-16 13:04	98.503	3.0361
2013-10-12 14:28	98.255	0.1819
2014-05-08 14:41	98.418	1.8495
2014-10-10 14:57	98.225	0.1632
2015-05-03 9:30	98.252	0.2976
2015-10-01 10:50	98.395	0.9294
2015-10-03 16:30	98.324	0.8194
2016-05-04 16:14	98.457	2.4539
2016-10-07 15:55	98.390	1.1979
2017-05-06 14:30	98.320	0.6327
2017-10-14 15:00	98.177	0.0748
2018-05-05 15:03	98.376	1.0486
2018-09-29 14:45	98.232	0.1166

Figure 9: AC-14 Rating Curve

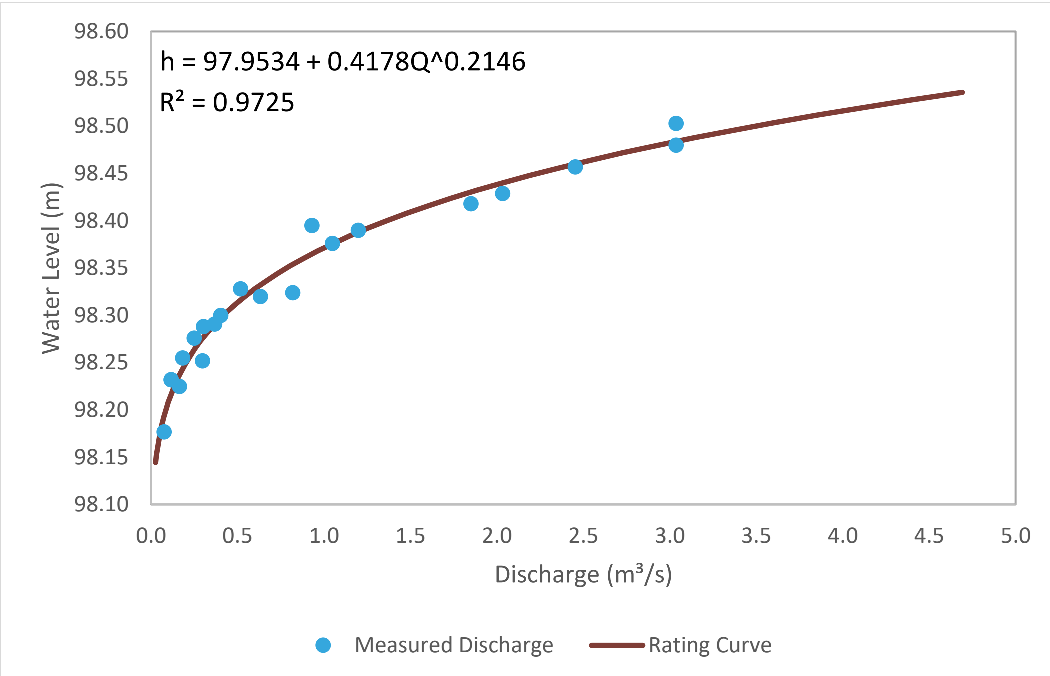


Figure 10: AC-14 2018 Hydrograph

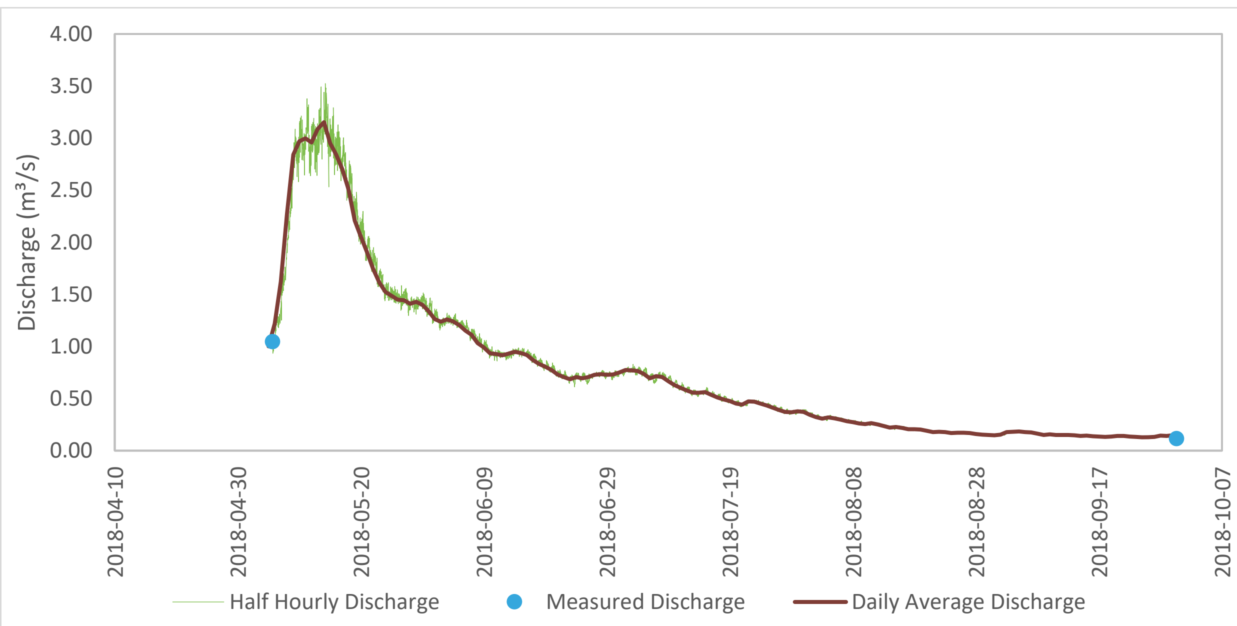


Table 11: AC-14 2018 Daily Average Discharge (m^3/s)

Day	May	Jun	Jul	Aug	Sep
1		1.263	0.749	0.343	0.152
2		1.238	0.773	0.323	0.179
3		1.259	0.770	0.308	0.181
4		1.242	0.765	0.318	0.186
5	1.002	1.203	0.736	0.310	0.179
6	1.219	1.151	0.694	0.298	0.176
7	1.621	1.112	0.716	0.284	0.162
8	2.264	1.033	0.707	0.272	0.150
9	2.842	0.993	0.668	0.262	0.156
10	2.971	0.933	0.629	0.256	0.151
11	2.999	0.927	0.602	0.264	0.150
12	2.959	0.916	0.577	0.253	0.151
13	3.087	0.930	0.555	0.236	0.148
14	3.154	0.949	0.557	0.221	0.141
15	2.952	0.936	0.563	0.228	0.144
16	2.841	0.919	0.534	0.220	0.139
17	2.703	0.871	0.509	0.205	0.136
18	2.505	0.832	0.491	0.207	0.133
19	2.208	0.804	0.475	0.202	0.136
20	2.056	0.774	0.452	0.189	0.142
21	1.907	0.732	0.442	0.179	0.140
22	1.748	0.706	0.473	0.180	0.136
23	1.612	0.685	0.469	0.177	0.133
24	1.523	0.706	0.451	0.170	0.128
25	1.487	0.694	0.432	0.173	0.129
26	1.451	0.707	0.412	0.172	0.131
27	1.443	0.728	0.392	0.169	0.145
28	1.412	0.734	0.373	0.159	0.141
29	1.429	0.727	0.368	0.154	0.149
30	1.402	0.732	0.378	0.149	
31	1.343		0.373	0.148	
Average	2.079	0.915	0.551	0.227	0.149

4.6 TL-6 – MINEWATER RESERVOIR OUTFLOW

The area known as Minewater Reservoir directs runoff towards the Fulton Drainage via a channel blasted through bedrock. A v-notch weir installed in 2011 is the monitoring station identified as TL-6. Photo 11 is from the spring field program of 2018 while Photo 12 was taken during the fall. Stage and discharge monitoring data are compiled in Table 12 and the rating curve is presented in Figure 11. The 2018 hydrograph is provided in Figure 12 with the daily average discharge data presented in Table 13.

Photo 11: TL-6– May 6, 2018

Photo 12: TL-6 – September 28, 2018

Table 12: TL-6 Stage and Discharge Measurements

Measurement Date & Time	Water Level (m)	Discharge (m^3/s)
2012-05-07 15:30	0.363	0.00230
2012-05-09 19:08	0.358	0.00190
2012-09-27 18:00	0.299	0.00020
2013-05-12 18:00	0.420	0.00780
Notch Invert	0.260	0.00000
2013-05-16 8:50	0.260	0.00000
2013-05-16 10:30	0.410	0.00720
2013-10-12 17:03	0.281	0.00005
2014-05-04 10:16	0.384	0.00459
2014-05-07 16:30	0.340	0.00159
2014-10-09 14:00	0.276	0.00003
2015-05-02 17:11	0.282	0.00006
2015-10-01 15:30	0.327	0.00079
2015-10-02 13:25	0.337	0.00120
2015-10-04 18:20	0.337	0.00106
2016-05-01 13:00	0.460	
2016-05-04 14:17	0.412	0.00611
2016-10-08 11:00	0.341	0.00127
2017-04-27 15:30	No WL Measured	0.00012
2017-05-06 16:00	0.373	0.00281
2017-10-14 17:00	0.275	0.00001
2018-04-25 16:40	No WL Measured	0.00005
2018-05-06 15:59	0.391	0.00313
2018-07-26 15:28	0.275	0.00002
2018-09-28 16:17	0.272	0.00001

Figure 11: TL-6 Rating Curve

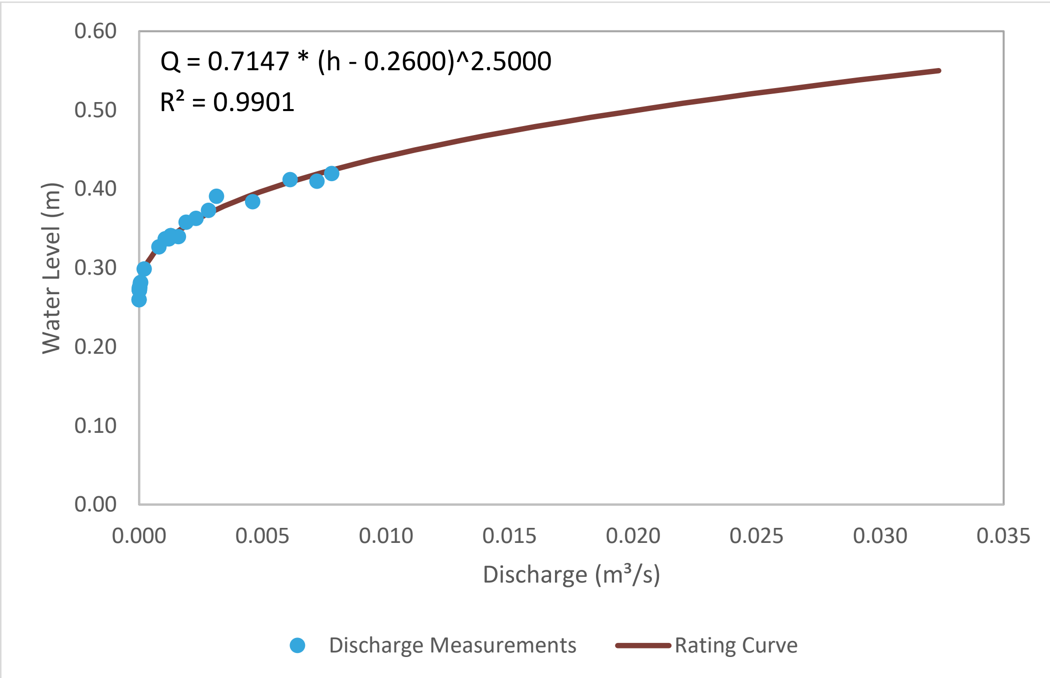


Figure 12: TL-6 2018 Hydrograph

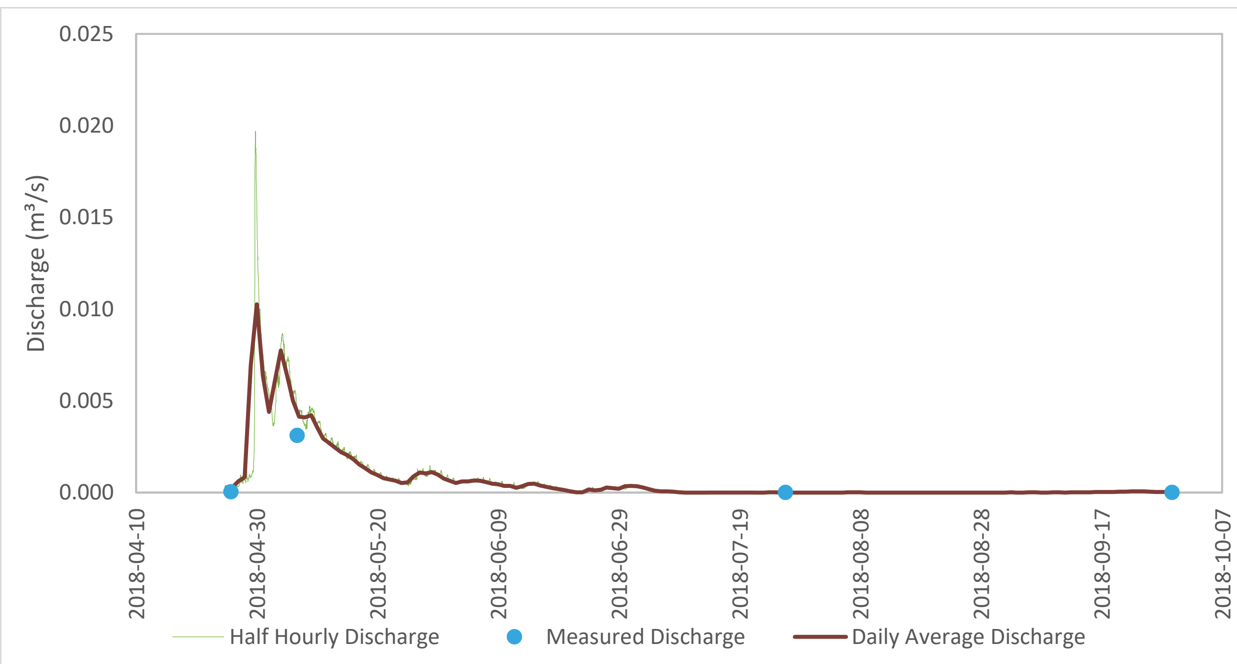


Table 13: TL-6 2018 Daily Average Discharge (m^3/s)

Day	Apr	May	Jun	Jul	Aug	Sep
1		0.0063	0.0006	0.0004	0.0000	0.0000
2		0.0044	0.0005	0.0004	0.0000	0.0000
3		0.0061	0.0006	0.0003	0.0000	0.0000
4		0.0078	0.0006	0.0002	0.0000	0.0000
5		0.0064	0.0007	0.0001	0.0000	0.0000
6		0.0050	0.0006	0.0001	0.0000	0.0000
7		0.0041	0.0006	0.0001	0.0000	0.0000
8		0.0041	0.0005	0.0000	0.0000	0.0000
9		0.0042	0.0004	0.0000	0.0000	0.0000
10		0.0036	0.0004	0.0000	0.0000	0.0000
11		0.0029	0.0004	0.0000	0.0000	0.0000
12		0.0027	0.0003	0.0000	0.0000	0.0000
13		0.0024	0.0003	0.0000	0.0000	0.0000
14		0.0022	0.0005	0.0000	0.0000	0.0000
15		0.0020	0.0005	0.0000	0.0000	0.0000
16		0.0018	0.0004	0.0000	0.0000	0.0000
17		0.0015	0.0003	0.0000	0.0000	0.0000
18		0.0013	0.0002	0.0000	0.0000	0.0000
19		0.0011	0.0002	0.0000	0.0000	0.0000
20		0.0010	0.0001	0.0000	0.0000	0.0000
21		0.0008	0.0001	0.0000	0.0000	0.0001
22		0.0007	0.0000	0.0000	0.0000	0.0001
23		0.0007	0.0000	0.0000	0.0000	0.0001
24		0.0005	0.0002	0.0000	0.0000	0.0001
25	0.0003	0.0005	0.0001	0.0000	0.0000	0.0001
26	0.0003	0.0009	0.0002	0.0000	0.0000	0.0000
27	0.0006	0.0011	0.0003	0.0000	0.0000	0.0000
28	0.0008	0.0010	0.0002	0.0000	0.0000	0.0000
29	0.0069	0.0011	0.0002	0.0000	0.0000	
30	0.0103	0.0010	0.0003	0.0000	0.0000	
31		0.0008		0.0000	0.0000	
Average		0.0026	0.0003	0.0000	0.0000	0.0000

4.7 TL-7 – FULTON CREEK WEIR

The headwaters of TL-7 include Fulton Lake as part of the Fulton drainage but also receive water from Fookes and Marie Reservoirs which were used as tailings disposal locations during the operation of the Beaverlodge Mill in addition to receiving water from TL-6. TL-7 is also a long-term monitoring station having operated since Site closure (similar record length to AC-8). TL-7 frequently glaciates through the winter months as water free-falls over the v-notch thus impounding a large volume of ice behind the structure. The ice impoundment can take several weeks to thaw and often the datalogger is not installed until later in the year (after the passing of snowmelt runoff). In 2018, the weir was partially open during the spring field program and the datalogger was installed during that site visit (Photo 13). At that time, it was not possible to measure the flow rate. The fall field program flow condition is shown in Photo 14. The rating curve data are provided in Table 14 and shown graphically in Figure 13.

Estimates of the flow rate at TL-7 are calculated for the winter months from flow rates at AC-8 using the following relationship:

$$Q_{TL-7} = 0.053 * Q_{AC-8}$$

The above equation is used when measured data at TL-7 are not available. Figure 14 presents the 2018 hydrograph for TL-7 while Table 15 and Table 16 present the 2018 daily average discharge data and the long term monthly average discharge data, respectively.

Photo 13: TL-7– May 6, 2018

Photo 14: TL-7 – September 28, 2018

Table 14: TL-7 Stage and Discharge Measurements

Measurement Date & Time	Water Level (m)	Discharge (m^3/s)
2011-05-21	0.005	0.0012
2011-10-03	0.003	0.0002
2012-05-07 16:30	0.096	0.0000
2012-05-09 19:30	0.090	0.0000
2012-09-27 17:30	0.115	0.0082
2013-05-12 9:15	Not Measured	0.0815
2013-05-16 11:50	Not Measured	0.1328
2013-10-13 14:54	0.142	0.0109
2014-10-09 15:15	0.139	0.0112
2014-10-10 8:40	0.140	0.0094
2015-10-02 13:00	0.262	0.0499
2015-10-04 18:03	0.252	0.0455
2016-05-04 14:45	0.394	Not Measured
2016-10-08 11:30	0.342	0.0915
2017-10-14 17:35	0.025	0.0001
2018-09-28 16:34	0.135	0.0102

Figure 13: TL-7 Rating Curve

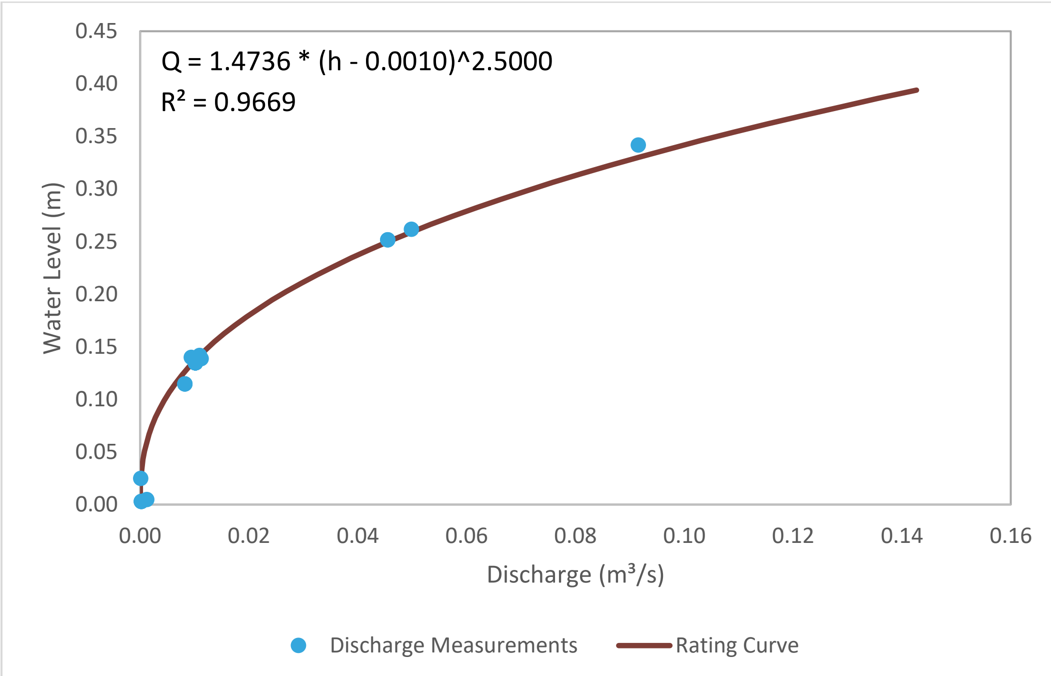


Figure 14: TL-7 2018 Hydrograph

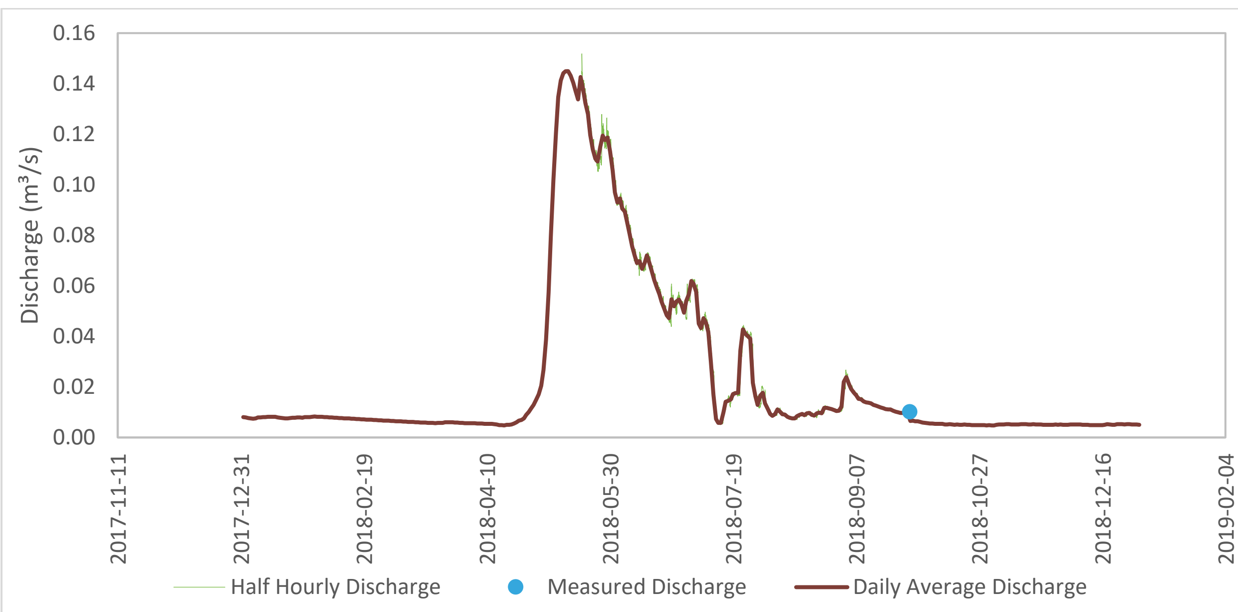


Table 15: TL-7 2018 Daily Average Discharge (m³/s)

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0.0081	0.0082	0.0066	0.0057	0.0171	0.0970	0.0566	0.0135	0.0122	0.0064	0.0048	0.0050
2	0.0079	0.0081	0.0066	0.0056	0.0204	0.0930	0.0619	0.0115	0.0220	0.0064	0.0048	0.0051
3	0.0077	0.0081	0.0065	0.0056	0.0267	0.0946	0.0607	0.0093	0.0240	0.0061	0.0050	0.0051
4	0.0076	0.0080	0.0065	0.0056	0.0387	0.0905	0.0576	0.0086	0.0212	0.0059	0.0051	0.0051
5	0.0074	0.0080	0.0064	0.0056	0.0573	0.0894	0.0451	0.0093	0.0192	0.0058	0.0051	0.0052
6	0.0076	0.0079	0.0064	0.0055	0.0796	0.0847	0.0433	0.0111	0.0178	0.0056	0.0052	0.0052
7	0.0079	0.0078	0.0063	0.0055	0.1018	0.0805	0.0472	0.0103	0.0167	0.0055	0.0052	0.0051
8	0.0079	0.0078	0.0063	0.0055	0.1204	0.0756	0.0454	0.0092	0.0153	0.0055	0.0052	0.0051
9	0.0080	0.0077	0.0062	0.0055	0.1347	0.0719	0.0417	0.0090	0.0151	0.0054	0.0052	0.0050
10	0.0081	0.0077	0.0062	0.0054	0.1413	0.0690	0.0297	0.0082	0.0143	0.0054	0.0051	0.0050
11	0.0082	0.0076	0.0061	0.0054	0.1442	0.0697	0.0168	0.0079	0.0139	0.0054	0.0052	0.0049
12	0.0082	0.0075	0.0061	0.0054	0.1449	0.0668	0.0074	0.0075	0.0138	0.0054	0.0051	0.0049
13	0.0082	0.0075	0.0060	0.0053	0.1450	0.0690	0.0057	0.0075	0.0136	0.0051	0.0052	0.0049
14	0.0081	0.0074	0.0060	0.0051	0.1431	0.0720	0.0058	0.0084	0.0129	0.0051	0.0053	0.0048
15	0.0080	0.0074	0.0059	0.0049	0.1403	0.0690	0.0098	0.0090	0.0127	0.0052	0.0053	0.0049
16	0.0078	0.0073	0.0059	0.0048	0.1372	0.0654	0.0141	0.0094	0.0122	0.0051	0.0052	0.0049
17	0.0076	0.0073	0.0058	0.0048	0.1338	0.0623	0.0145	0.0088	0.0119	0.0050	0.0051	0.0050
18	0.0075	0.0072	0.0058	0.0050	0.1426	0.0594	0.0150	0.0095	0.0116	0.0051	0.0052	0.0052
19	0.0075	0.0072	0.0057	0.0050	0.1382	0.0568	0.0172	0.0097	0.0112	0.0051	0.0051	0.0051
20	0.0077	0.0071	0.0057	0.0052	0.1322	0.0537	0.0176	0.0090	0.0111	0.0050	0.0051	0.0051
21	0.0078	0.0070	0.0057	0.0055	0.1280	0.0511	0.0177	0.0087	0.0111	0.0051	0.0051	0.0051
22	0.0079	0.0070	0.0057	0.0060	0.1197	0.0483	0.0344	0.0096	0.0107	0.0050	0.0050	0.0052
23	0.0079	0.0069	0.0057	0.0066	0.1140	0.0472	0.0428	0.0098	0.0102	0.0050	0.0050	0.0053
24	0.0079	0.0069	0.0061	0.0069	0.1104	0.0547	0.0410	0.0096	0.0100	0.0050	0.0050	0.0052
25	0.0079	0.0068	0.0060	0.0076	0.1091	0.0519	0.0401	0.0118	0.0098	0.0049	0.0051	0.0052
26	0.0080	0.0068	0.0060	0.0090	0.1148	0.0539	0.0391	0.0118	0.0098	0.0049	0.0051	0.0053
27	0.0080	0.0067	0.0060	0.0101	0.1194	0.0546	0.0216	0.0114	0.0098	0.0048	0.0051	0.0052
28	0.0080	0.0067	0.0060	0.0116	0.1176	0.0527	0.0164	0.0112	0.0094	0.0048	0.0050	0.0052
29	0.0082		0.0059	0.0129	0.1187	0.0494	0.0129	0.0108	0.0065	0.0048	0.0051	0.0052
30	0.0083		0.0058	0.0149	0.1132	0.0540	0.0165	0.0105	0.0067	0.0048	0.0051	0.0051
31	0.0082		0.0057		0.1058		0.0177	0.0106		0.0048		0.0050
Average	0.0079	0.0074	0.0060	0.0066	0.1100	0.0669	0.0294	0.0098	0.0132	0.0053	0.0051	0.0051

Table 16: TL-7 Monthly Average Discharge (m³/s)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1980	0.0037	0.0037	0.0036	0.0061	0.0054	0.0038	0.0035	0.0035	0.0035	0.0041	0.0037	0.0035	0.0040
1981	0.0035	0.0035	0.0035	0.0044	0.0124	0.0046	0.0047	0.0050	0.0051	0.0049	0.0052	0.0049	0.0051
1982	0.0043	0.0042	0.0045	0.0051	0.0201	0.0151	0.0080	0.0048	0.0035	0.0039	0.0038	0.0041	0.0068
1983	0.0045	0.0041	0.0037	0.0064	0.0279	0.0200	0.0132	0.0101	0.0070	0.0061	0.0055	0.0051	0.0095
1984	0.0049	0.0050	0.0055	0.0135	0.0168	0.0267	0.0297	0.0195	0.0126	0.0203	0.0297	0.0267	0.0176
1985	0.0156	0.0117	0.0101	0.0127	0.1452	0.0598	0.0190	0.0100	0.0072	0.0058	0.0044	0.0043	0.0255
1986	0.0046	0.0048	0.0048	0.0059	0.0151	0.0187	0.0216	0.0174	0.0089	0.0064	0.0053	0.0050	0.0099
1987	0.0050	0.0055	0.0060	0.0059	0.0828	0.0249	0.0101	0.0004	0.0001	0.0000	0.0032	0.0033	0.0123
1988	0.0039	0.0026	0.0024	0.0022	0.0180	0.0336	0.0376	0.0242	0.0095	0.0047	0.0053	0.0050	0.0124
1989	0.0045	0.0045	0.0038	0.0040	0.0989	0.0646	0.0113	0.0042	0.0026	0.0028	0.0038	0.0043	0.0174
1990	0.0052	0.0047	0.0044	0.0024	0.0201	0.0288	0.0095	0.0045	0.0035	0.0037	0.0070	0.0100	0.0087
1991	0.0074	0.0059	0.0055	0.0144	0.0993	0.0942	0.0299	0.0125	0.0124	0.0139	0.0152	0.0125	0.0269
1992	0.0095	0.0071	0.0058	0.0069	0.1133	0.0396	0.0324	0.0167	0.0227	0.0730	0.0708	0.0189	0.0347
1993	0.0089	0.0060	0.0047	0.0050	0.0339	0.0175	0.0109	0.0413	0.0210	0.0093	0.0119	0.0126	0.0153
1994	0.0080	0.0061	0.0054	0.0048	0.2115	0.0530	0.0069	0.0032	0.0023	0.0030	0.0031	0.0031	0.0259
1995	0.0026	0.0024	0.0023	0.0030	0.0822	0.0672	0.0687	0.0621	0.0407	0.0171	0.0117	0.0097	0.0308
1996	0.0071	0.0049	0.0038	0.0035	0.0160	0.0168	0.0350	0.0292	0.0103	0.0083	0.0085	0.0074	0.0126
1997	0.0063	0.0053	0.0042	0.0043	0.0207	0.0385	0.0530	0.0896	0.2373	0.1897	0.0740	0.0218	0.0621
1998	0.0114	0.0084	0.0068	0.0080	0.0522	0.0130	0.0216	0.0129	0.0074	0.0056	0.0056	0.0053	0.0132
1999	0.0043	0.0040	0.0041	0.0038	0.0157	0.0214	0.0130	0.0058	0.0054	0.0040	0.0038	0.0042	0.0075
2000	0.0042	0.0033	0.0030	0.0032	0.0091	0.0090	0.0076	0.0082	0.0089	0.0480	0.0962	0.0089	0.0175
2001	0.0067	0.0056	0.0053	0.0062	0.0817	0.0443	0.0093	0.0110	0.0041	0.0016	0.0149	0.0112	0.0168
2002	0.0107	0.0060	0.0045	0.0049	0.0559	0.0244	0.0121	0.0632	0.0446	0.0056	0.0193	0.0141	0.0221
2003	0.0083	0.0068	0.0053	0.0046	0.1105	0.1132	0.0518	0.0296	0.0247	0.0247	0.0130	0.0104	0.0336
2004	0.0071	0.0070	0.0088	0.0057	0.0055	0.0456	0.0076	0.0026	0.0018	0.0013	0.0045	0.0042	0.0085
2005	0.0035	0.0041	0.0037	0.0050	0.0481	0.0438	0.0184	0.0139	0.0144	0.0147	0.0263	0.0196	0.0180
2006	0.0134	0.0090	0.0057	0.0133	0.1154	0.0459	0.0124	0.0073	0.0062	0.0062	0.0060	0.0053	0.0205
2007	0.0052	0.0045	0.0041	0.0051	0.0364	0.0212	0.0052	0.0017	0.0030	0.0187	0.0380	0.0226	0.0138
2008	0.0152	0.0104	0.0086	0.0071	0.0489	0.0474	0.0112	0.0095	0.0075	0.0173	0.0272	0.0166	0.0189
2009	0.0029	0.0022	0.0015	0.0021	0.0277	0.0204	0.0422	0.0146	0.0069	0.0061	0.0061	0.0055	0.0115
2010	0.0041	0.0034	0.0026	0.0046	0.0167	0.0066	0.0002	0.0001	0.0002	0.0004	0.0002	0.0003	0.0033
2011	0.0002	0.0000	0.0000	0.0000	0.0003	0.0002	0.0003	0.0004	0.0003	0.0002	0.0000	0.0000	0.0002
2012	0.0000	0.0000	0.0000	0.0000	0.0040	0.0090	0.0107	0.0042	0.0079	0.0039	0.0047	0.0041	0.0040
2013	0.0030	0.0009	0.0000	0.0000	0.0988	0.0837	0.0338	0.0171	0.0127	0.0116	0.0125	0.0129	0.0239
2014	0.0125	0.0115	0.0101	0.0090	0.0941	0.1699	0.0976	0.0398	0.0174	0.0091	0.0093	0.0087	0.0407
2015	0.0082	0.0086	0.0073	0.0081	0.0179	0.0057	0.0025	0.0146	0.0689	0.0350	0.0312	0.0236	0.0193
2016	0.0180	0.0148	0.0108	0.0110	0.1361	0.0721	0.0142	0.0246	0.1335	0.0678	0.0382	0.0284	0.0475
2017	0.0177	0.0130	0.0094	0.0103	0.0337	0.0107	0.0002	0.0001	0.0001	0.0001	0.0000	0.0000	0.0079
2018	0.0079	0.0074	0.0060	0.0066	0.1100	0.0669	0.0294	0.0098	0.0132	0.0053	0.0051	0.0051	0.0227
Mean	0.0070	0.0057	0.0049	0.0059	0.0553	0.0385	0.0207	0.0166	0.0205	0.0170	0.0163	0.0096	0.0182

4.8 BL-5 – BEAVERLODGE LAKE OUTFLOW

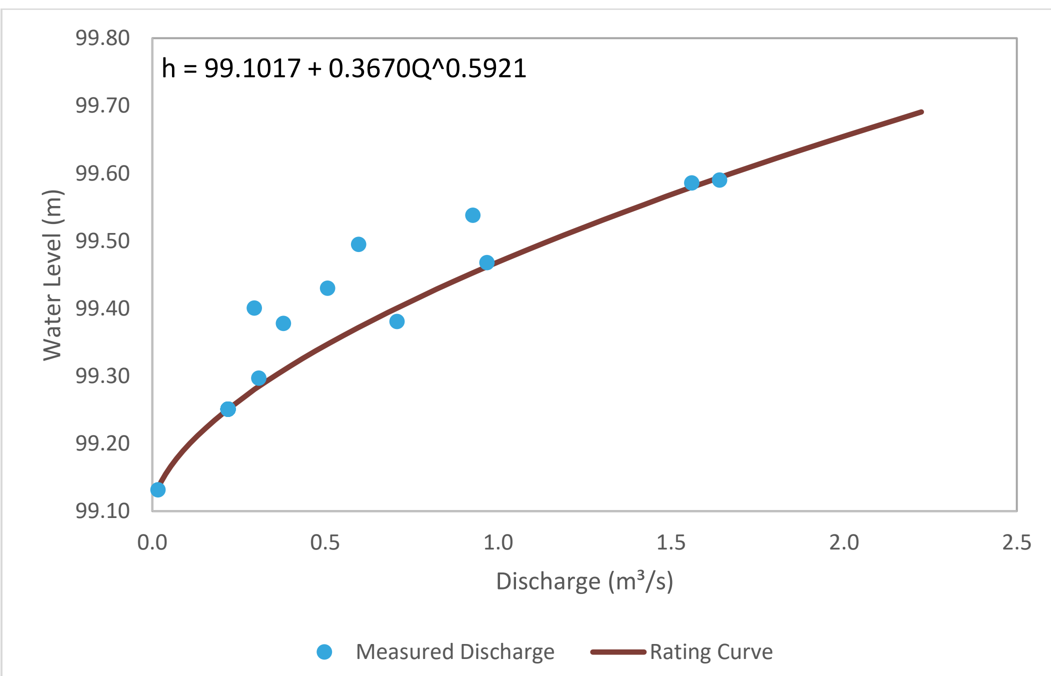
Station BL-5 monitors discharge at the outlet of Beaverlodge Lake. The station was visited during the 2018 fall field program (Photo 15). This location has been known to be impacted by either beaver activity, debris jam or the sudden release of debris jam; any such change to the geometry of the channel impacts the reliability of the rating curve typically evident in drifting points from the rating curve. As such, it was recommended to discontinue the preparation of an annual hydrograph at this station (MWSI, 2018). Field measurements are continued at this location and a stage datalogger remains installed should the need for water level data in Beaverlodge Lake ever be required. The summary data are presented in Table 17 and the rating curve presented in Figure 15.

Photo 15: BL-5 – September 30, 2018

Table 17: BL-5 Stage and Discharge Measurements

Measurement Date & Time	Water Level (m)	Discharge (m^3/s)
2010-09-15 16:40	99.589	0.7815
2011-05-18 9:00	99.507	0.3176
2011-10-04 12:51	99.448	0.0958
2012-06-04 18:45	99.640	0.7122
2012-09-28 12:25	99.538	0.9270
2013-07-21	99.586	1.5600
2013-10-13 12:00	99.401	0.2946
2014-05-04 15:00	99.430	0.5072
2014-10-10 17:00	99.378	0.3790
2015-05-02 9:00	99.297	0.3079
2015-10-01 12:40	99.495	0.5962
2016-08-11 11:35	99.468	0.9674
2016-10-07 17:10	99.590	1.6405
2017-04-27 14:30	99.381	0.7079
2017-10-15 12:00	99.132	0.0164
2018-09-30 9:30	99.251	0.2193

Figure 15: BL-5 Rating Curve



4.9 CS-1 – CRACKINGSTONE RIVER

Station CS-1 on the Crackingstone River is located downstream of Cinch Lake which receives discharge from Beaverlodge Lake through Martin Lake. The Crackingstone River ultimately discharges to Bushell Bay of Lake Athabasca and flow monitoring occurs at a bridge crossing. Field monitoring occurred in the spring (Photo 16) and fall of 2018 (Photo 17). The measurement data for CS-1 are presented in Table 18 and the rating curve is shown in Figure 16. Figure 17 depicts the hydrograph for 2018. The daily average discharge data are presented in Table 19.

Photo 16: CS-1 – May 6, 2018

Photo 17: CS-1 – September 30, 2018

Table 18: CS-1 Stage and Discharge Measurements

Measurement Date & Time	Water Level (m)	Discharge (m^3/s)
2010-09-19 17:00	0.248	1.1410
2011-05-17 14:20	0.121	0.5550
2011-08-29	-0.065	0.0200
2011-10-03	-0.040	0.0340
2012-05-08 17:31	0.340	1.7901
2012-09-27 14:53	0.418	2.3729
2013-05-16 9:00	0.550	3.9647
2013-05-16 16:50	0.560	Not Measured
2013-10-12 18:00	0.150	0.7082
2014-05-07 10:30	0.380	1.9275
2014-10-10 18:45	0.160	0.7403
2015-05-02 13:00	0.178	0.6533
2015-10-04 9:30	0.358	1.8307
2016-05-05 13:00	0.520	3.8811
2016-10-08 16:40	0.570	4.2456
2017-05-07 14:30	0.385	2.2372
2017-10-16 9:25	0.040	0.1588
2018-05-06 14:30	0.288	1.2873
2018-09-30 12:00	0.114	0.4900

Figure 16: CS-1 Rating Curve

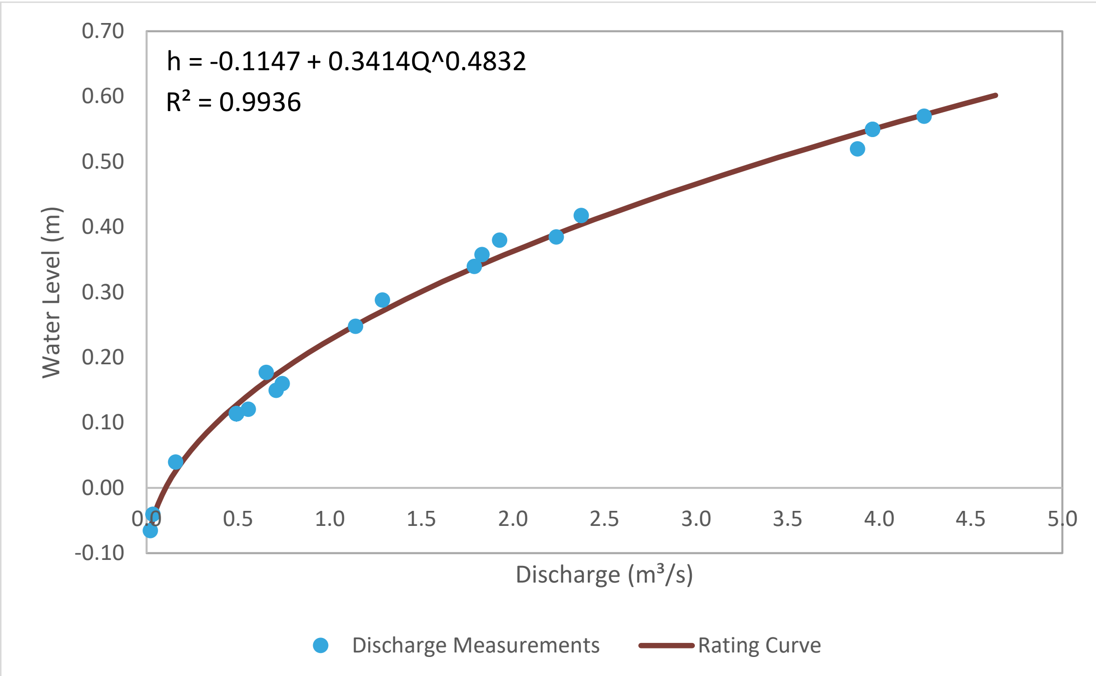


Figure 17: CS-1 2016 Hydrograph

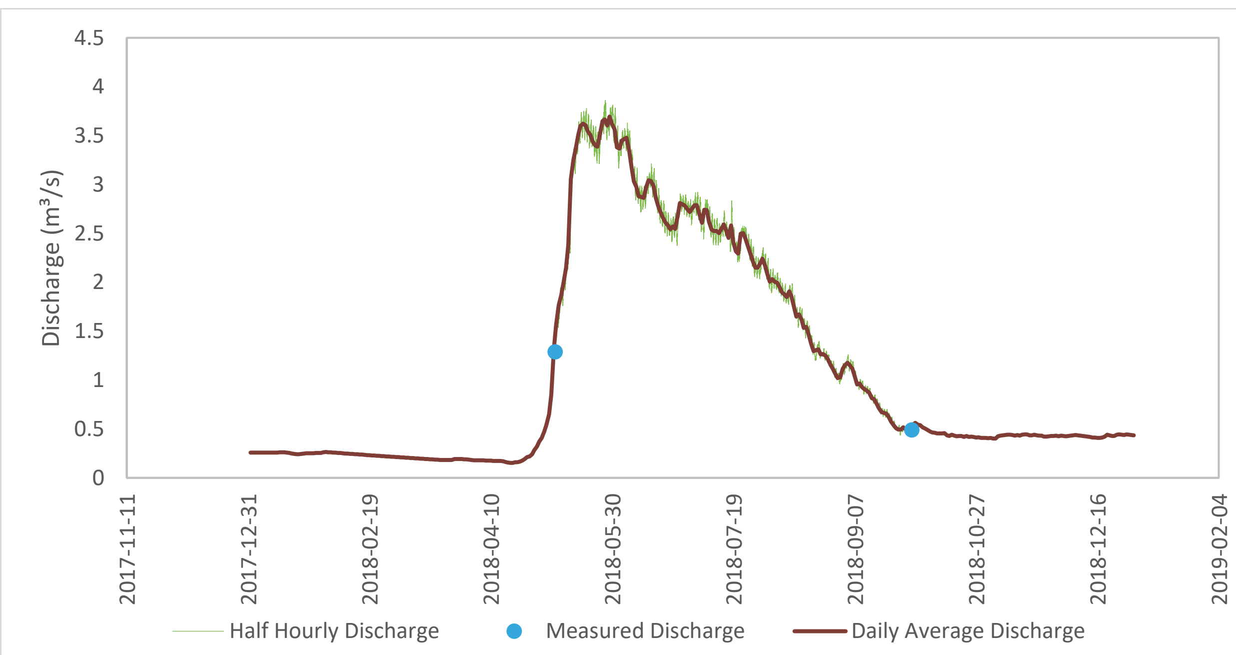


Table 19: CS-1 2016 Daily Average Discharge (m³/s)

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0.258	0.265	0.214	0.186	0.409	3.380	2.719	2.171	1.028	0.548	0.406	0.430
2	0.258	0.263	0.213	0.183	0.475	3.367	2.755	2.088	1.115	0.563	0.408	0.428
3	0.258	0.261	0.211	0.181	0.545	3.449	2.788	2.005	1.152	0.542	0.403	0.425
4	0.258	0.259	0.209	0.180	0.651	3.464	2.787	2.031	1.179	0.539	0.402	0.428
5	0.258	0.257	0.208	0.178	0.852	3.478	2.697	2.004	1.151	0.516	0.426	0.432
6	0.258	0.255	0.206	0.179	1.318	3.355	2.607	1.996	1.119	0.502	0.433	0.434
7	0.258	0.253	0.204	0.178	1.566	3.175	2.743	1.953	1.033	0.491	0.434	0.439
8	0.258	0.251	0.203	0.176	1.764	3.033	2.738	1.897	0.955	0.475	0.437	0.435
9	0.258	0.250	0.201	0.176	1.868	2.974	2.618	1.875	0.964	0.463	0.441	0.431
10	0.258	0.248	0.199	0.175	1.993	2.880	2.538	1.849	0.930	0.462	0.441	0.427
11	0.258	0.246	0.198	0.174	2.145	2.873	2.522	1.909	0.907	0.455	0.439	0.424
12	0.258	0.244	0.196	0.172	2.380	2.861	2.527	1.850	0.894	0.454	0.431	0.420
13	0.262	0.242	0.194	0.173	3.054	2.967	2.503	1.745	0.869	0.454	0.436	0.417
14	0.262	0.241	0.193	0.172	3.254	3.041	2.543	1.649	0.815	0.459	0.432	0.413
15	0.262	0.239	0.191	0.169	3.361	3.036	2.591	1.672	0.804	0.433	0.442	0.412
16	0.260	0.237	0.190	0.163	3.506	2.992	2.527	1.622	0.757	0.429	0.444	0.410
17	0.254	0.235	0.188	0.157	3.600	2.858	2.455	1.534	0.713	0.440	0.446	0.410
18	0.249	0.233	0.186	0.154	3.622	2.782	2.582	1.543	0.673	0.432	0.436	0.413
19	0.243	0.232	0.185	0.153	3.606	2.713	2.407	1.473	0.663	0.425	0.434	0.421
20	0.240	0.230	0.183	0.159	3.544	2.661	2.317	1.373	0.656	0.430	0.440	0.441
21	0.240	0.228	0.183	0.161	3.509	2.611	2.294	1.296	0.622	0.428	0.435	0.435
22	0.246	0.226	0.182	0.166	3.443	2.585	2.498	1.307	0.576	0.420	0.433	0.429
23	0.250	0.225	0.183	0.175	3.400	2.542	2.503	1.316	0.540	0.429	0.432	0.429
24	0.250	0.223	0.183	0.192	3.387	2.570	2.443	1.262	0.507	0.420	0.420	0.440
25	0.252	0.221	0.183	0.212	3.512	2.546	2.365	1.265	0.494	0.420	0.421	0.444
26	0.251	0.219	0.193	0.219	3.650	2.677	2.298	1.246	0.495	0.418	0.423	0.441
27	0.251	0.218	0.192	0.242	3.666	2.812	2.215	1.210	0.515	0.413	0.427	0.439
28	0.255	0.216	0.192	0.286	3.603	2.796	2.148	1.156	0.494	0.414	0.427	0.444
29	0.255		0.191	0.322	3.694	2.781	2.151	1.115	0.507	0.409	0.431	0.441
30	0.256		0.190	0.369	3.617	2.748	2.192	1.064	0.489	0.409	0.425	0.439
31	0.262		0.189		3.564		2.242	1.020		0.408		0.436
Average	0.255	0.240	0.195	0.193	2.663	2.934	2.494	1.597	0.787	0.455	0.430	0.429

4.10 ZORA LAKE OUTFLOW AND VERNA LAKE INFLOW

Zora Lake is upstream of Verna Lake and flows through a recently completed stream reconstruction project. Cameco requested that MWSI monitor discharge, if possible, at the outlet of Zora Lake and the subsequent inflow to Verna Lake. Measurements were completed at both stations during the spring and fall field programs. The measurement section at Zora is shown in Photo 18 and the inflow to Verna is depicted in Photo 19. During the spring, the small weir typically used to measure flow was covered in ice and a traditional measurement of stage and discharge was required. The discharge measurements at Zora outflow and Verna inflow are provided in Table 20.

Photo 18: Zora Outflow – May 6, 2018

Photo 19: Verna Inflow – May 6, 2018

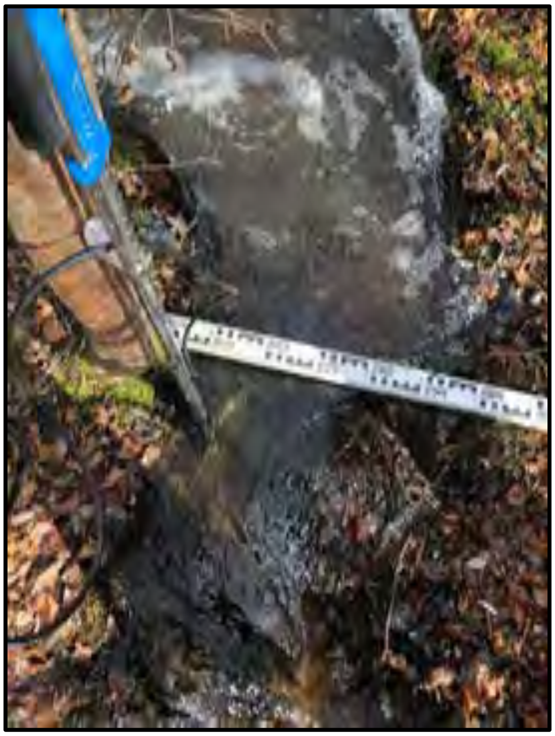


Table 20: Zora Outflow and Verna Inflow Discharge Measurements

Measurement Date & Time	Zora Outflow Discharge (m^3/s)	Verna Inflow Discharge (m^3/s)
2017-04-27	0.0027	Not Measurable (Glaciation)
2017-05-05	0.0030	Not Measurable (Glaciation)
2017-10-15	0.0000	0.0006
2018-05-06	0.0278	0.0273
2018-09-28	0.0012	0.0080

5.0 BOREHOLE SURVEY

During the spring and fall field programs in 2018 the sealed boreholes that had previously been flowing were inspected for any signs of new flow. As in previous years, BH-007 was noted to have a very small, unmeasurable seepage. All other boreholes were dry at the time of observation with no evidence of new flow.

6.0 SEEP DISCHARGE MONITORING

During the spring field program, samples were collected on behalf of Cameco at Seeps 1 through 5 but flow rates were not sufficient for accurate measurement. Some ponded water was evident but not appreciably flowing.

During the fall field program only Seep 1 had flow which was negligible and not measurable. The remaining seeps appeared to be affected by freezing temperatures.

7.0 DATALOGGER INSTALLATION TABLE

The Solinst Levelogger products have evolved since their initial designs. At the Site, three versions of the Levelogger products are in use which include the Gold series, Edge series and LTC series dataloggers. The two Gold dataloggers (Table 21) are at AC-8 where one is the in-stream logger and the other is the barometric pressure logger. A second logger was added at AC-8 in 2018 for redundancy as well as at AC-14, these loggers are a newer style known as the LTC. All other dataloggers at Site are the Edge series and were installed in 2012.

Table 21: Datalogger Inventory

Location	Logger Type	Sensor Serial Number	Purchase Year
AC-14	LTC	1074783	2018
AC-14	Edge	2002607	2012
AC-6A	Edge	2008664	2012
AC-6B, lost briefly and found in 2018	Edge	2000172	2012
AC-6B, previously Mickey Lake Outflow	Edge	2000174	2012
AC-8	Gold	1050150	2010
AC-8	LTC	1075605	2018
AC-8 Barometric Pressure	Gold	1050563	2010
BL-5	Edge	2000175	2012
CS-1	Edge	2000176	2012
Fay Shaft, lost down shaft	Edge	2002243	2012
TL-6	Edge	2008162	2012
TL-7	Edge	2008671	2012

Through verbal communication between Solinst and MWSI, some criteria to gauge logger “health” were provided based on the amperage and voltage of the loggers. MWSI performed diagnostic checks in the field and found that several of the loggers were operating within a normal operating range. Solinst also specified amperage and voltage levels which should be viewed as “immediate replacement”. The only datalogger in this range was the barometric pressure logger at AC-8 which is being recommended for replacement. MWSI is not concerned about the service life of the other dataloggers at this time.

8.0 RECOMMENDATIONS

Based on observations during the 2018 field program MWSI makes the following recommendations:

- Dedicate a second logger at TL-7 to be left through the winter; and,
- Replace the barometric pressure datalogger.

9.0 SUMMARY AND CLOSURE

Cameco has retained MWSI for monitoring and reporting of discharges in the vicinity of the former Beaverlodge Mine. This reporting consists of the monitoring data and other pertinent observations recorded during field programs in 2018.

Climate records for Uranium City indicate that 2018 tended to be drier than normal. The flow records, especially later in the year, generally reflected this climate condition.

This report has been prepared by MWSI for the exclusive use of Cameco. MWSI is not responsible for any unauthorized use or modification of this document. All third parties relying on information presented herein do so at their own risk.

MWSI appreciates the opportunity to work with Cameco on this project. Should Cameco have any questions regarding this document please contact the undersigned.

Respectfully submitted,

Missinipi Water Solutions Inc.

Tyrel J. Lloyd, M.Eng., P.Eng.

Senior Water Resources Engineer

10.0 REFERENCES

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APPENDIX A – CALIBRATION RECORDS

Environment Canada Environnement Canada

National Calibration Service
Service National D'Etalonnage

CURRENT METER S/N:	**Gurley 12**	CERTIFICATE #:	**17-251**
PROPELLER:	**N/A.**	DATE OF CAL.	**30-Aug-17**
CURRENT METER TYPE:	**Price (Gurley)1205 Mini**	METER CONDITION:	**Repaired**
METER OWNER:	**Missinipi Water Solutions**	CAL. BY: **R. McFadyen**	
SUSPENSION:	**Wading Rod**	WATER TEMP.:	**21.9° C**

The calibration was carried out in accordance with ISO 3455 (2007):
Hydrometry — Calibration of current meters in straight open tanks

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The combined standard uncertainty of this calibration is: 0.03 m/sec.
Uncertainties include those of the accredited facilities to whom these measurements are traceable.

The following velocity equation has been derived from the calibration data as shown below:

Velocity in m/sec = 0.3108 x Current Meter Revs (N) + 0.0058
The standard error of estimate in m/sec for this equation is: 0.0045

The combined standard uncertainty (u_c) in m/sec associated with this equation using the RSS method is:

$$uc = \sqrt{(0.03)^2 + (0.005)^2} = 0.030$$

The expanded uncertainty (*U*) in m/sec associated with this equation is: 0.061
using a coverage factor k=2 for a level of confidence of ~95% assuming normal distribution.