Cameco

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March 15, 2017

VIA COURIER

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

Mr. George Bihun
Environmental Project Officer
Saskatchewan Ministry of Environment
Environmental Protection Branch
6th Floor, 800 Central Avenue
P.O. Box 3003
Prince Albert, SK S6V 6G1

Dear Ms. Greencorn and Mr. Bihun:

File no. BVL.42205 / BVL.42305

Beaverlodge: Year 31 Transition Phase Monitoring Annual Report (2016)

The Beaverlodge Year 31 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, 2016 through December 31, 2016. 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 2017.

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

Yours truly,

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

MW:sdh

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)
R. Ejeckam – Environment Canada (letter and memory stick)
Fisheries & Oceans Canada (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 report)

BEAVERLODGE PROJECT

Cameco
Energizing the World

Beaverlodge Project 2016 Annual Report

Year 31 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

March 2017

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SECTION 1.0

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 2013).

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, 2016 and December 31, 2016. 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 2016 are provided, along with an overview of anticipated activities planned for 2017.

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, 2016 are as follows:

Officers

Tim Gitzel	President and Chief Executive Officer
Robert Steane	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

Board of Directors

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

In 2016 James Curtiss and Nancy Hopkins left the Board of Directors.

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 until 1944 when 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 small 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 with approximately 60% of the tailings placed into water bodies (fine fraction) within the Fulton Creek watershed with the remainder being deposited underground for use as backfill (coarse fraction).

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 did not exist either federally or 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 shutdown.

Mining operations at the Beaverlodge site ceased on June 25, 1982 and the mill discontinued processing ores in mid-August 1982. At that time Eldorado Resources Limited (formerly Eldorado Nuclear Limited) initiated site decommissioning. The decommissioning work was completed 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 Corporation, 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 simply Cameco Corporation 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**.

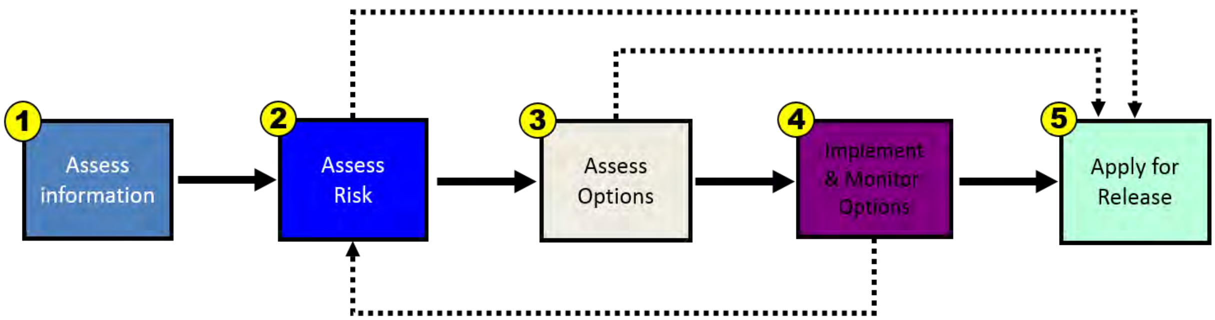


Figure 2.5.1 Simplified Beaverlodge Management Framework

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 Northern Saskatchewan Environment Quality Committee, 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 as well as other options identified during the 2012 workshop, along with their 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 Institutional Control 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, exempted 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 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 initially presented at the CNSC annual update meeting to the Commission in October 2013.

The work plan and schedule provides the proposed timeline for transferring groups of properties to the IC Program during the current license term of 2013 to 2023. The plan, as presented, is to follow a staged approach assessing and preparing sites with little disturbance and negligible risk first and then progressing to 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 would be made to obtain the regulatory releases and exemptions required to facilitate transferring the property to the IC program.

In 2015, the work plan and schedule called for submission of documentation to support the transfer of 15 properties to the IC Program. A draft 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 August 2015. Comments were received from SMOE in December 2015, and after addressing the review comments a final application to release 14 properties was submitted in April 2016. One property was removed from the application as it required additional assessment of remnant power distribution related infrastructure (power poles and lines).

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 exempted from CNSC Licensing. Cameco is anticipating an abridged hearing in the first half of 2017. If an exemption is granted, then the Release from Decommissioning and Reclamation by SMOE will take effect and the properties will be transferred to the IC program managed by Saskatchewan Ministry of Economy (ECON).

As part of the staged release schedule, a request to release an additional 10 properties is currently under development and will be submitted to the SMOE and CNSC in 2017.

SECTION 3.0

SITE ACTIVITIES

3.0 SITE ACTIVITIES

The performance of the remediated areas of the Beaverlodge site is assessed through routine inspections conducted by Cameco personnel, third party consultants and/or 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 aide 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 related activities around 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 license continue to be met. In 2016 representatives from Cameco, the CNSC, and SMOE completed a compliance inspection of the decommissioned Beaverlodge properties from July 11 to July 15.

The objective of the inspection was to conduct a general assessment 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 *Nuclear Safety and Control Act (1997)* and associated Regulations; while ensuring the properties remained safe, secure and stable.

Following the inspection, the CNSC and SMOE provided Cameco with one recommendation. The recommendation stated Cameco should perform a final gamma scan on the waste rock pile adjacent to Pistol Lake that had been regraded to fill a water collection point and on the Bolger Pit waste rock extending onto the Bolger 2 property following the relocation of waste rock from the Zora Flow Path Reconstruction project.

Gamma scans of these areas were completed in the fall of 2016 and the results were provided to the JRG on December 9, 2016.

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 new frequency was conducted in 2015, with the next scheduled third party inspection to occur in 2020. To accommodate the change in frequency of 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 Delta. In addition, the checklist requires a photographic record of each area. Should any changes to the deltas or to the outlet structures be observed, then a third-party inspection would be completed regardless of the regular schedule.

In 2016, 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 CNSC review of the crown pillar assessment (CNSC 2016a), visual inspections of these areas will be completed annually for the next three years, at which time the frequency of monitoring will be reassessed.

The 2016 inspection was completed by Cameco with the JRG representatives and included the following areas:

1. The Fookes Reservoir Delta.
2. the two 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**.

Fookes Reservoir Delta

As discussed in last year's annual report, the 2015 third party inspection did not note any areas of concern and concluded that the delta was generally stabilized sufficiently to move towards final close out and transfer to Institutional Control. Until the area is transferred to IC, SRK recommended a continued internal annual inspection with a more formal inspection completed by a third party every five years (SRK 2016a). The inspection completed by Cameco and the JRG in 2016 did not note any significant changes or concerns with the performance of the sand cover. Vegetation of the cover was noted to be continuing to progress.

Fookes and Marie Outlet Spillways

Observations made during the third party inspection in 2015 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).

No additional concerns were noted during the 2016 inspections, which were conducted in both July and September following a period of heavy precipitation. The outlet structures were noted to be performing well under the elevated flow conditions.

Crown Pillar Areas

The Ace area crown pillar was remediated with additional cover material in 2016, while cursory inspections were completed at the Hab and Dubyna locations. No signs of tension cracks or visible depressions were observed in 2016. Inspections of the Ace, Hab and Dubyna areas will be conducted and recorded in 2017.

3.1.3 Community Engagement and Consultation: Public Meeting

Historically the EQC has always been invited to attend a public meeting and site tour in Uranium City. In 2016, the Ministerial Order for the Northern Saskatchewan Environmental Quality Committee required renewal. To ensure efficacy, the Saskatchewan Ministry of Government Relations completed a comprehensive review of the program. The NSEQC has not yet been reinstated and as a result did not host or attend any meetings in 2016. It is anticipated that the renewal will go forward and the Ministerial Order will be signed sometime in 2017.

A public meeting was held on September 20, 2016 in Uranium City to provide information regarding the Beaverlodge properties to the residents of Uranium City. A site tour of the recently completed Zora Flow path at the Verna site was also provided to those interested.

Community engagement activities for the Beaverlodge Decommissioned Properties aim to seek out project-related questions and concerns, which are then addressed in a meaningful way by Cameco. Cameco's primary goal for the 2016 meeting was to discuss the 14 properties proposed for transfer to the IC Program, provide an overview of the IC transfer process, and to provide an opportunity for community feedback. In addition to discussing the anticipated transfer of properties to IC, Cameco presented a summary of the project work completed on site in 2016. The presentation is provided in **Appendix B**.

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.

With the renewed Waste Facility Operating License for the Beaverlodge properties, requires an update the CNSC Commission Members on the status of the activities occurring on the Beaverlodge properties on an annual basis. Cameco provided a status update of the work completed at the site 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 14, 2016 (CNSC 2016b).

3.2 2016 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-licencing 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. 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.

Additional projects initiated or completed in 2016 in response to property specific concerns included:

6. Utility Corridor Assessment.
7. Crown Pillar Remediation.
8. Concrete Pad Remediation.
9. Waste Haul Adit Remediation.
10. Unmanned Aerial Vehicle (UAV drone) Photography.

Ultimately, the Beaverlodge properties are being managed for acceptance into the provincial IC Program, and all future works undertaken are intended to support the management framework established to move towards this goal. In support of the management framework the following section describes some of the significant activities that were completed in 2016 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. The main purpose of the gamma radiation survey was to gather sufficient data to support a risk assessment in order to determine the safety and security of the properties in regards to gamma radiation. The survey included areas disturbed by mining and milling infrastructure, areas of known tailings spills within the licensed properties, access roads as well as appropriate background reference areas (ARCADIS SENES 2014).

A risk assessment was conducted by Arcadis Canada Inc. based on the gamma survey and a public land use survey. 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 while also taking into consideration the consumption of country foods and exposure to other 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). Based on this evaluation, no remedial actions are justified at these sites to reduce gamma exposure levels (ARCADIS 2015).

As remediation activities are completed on the properties, some areas of waste rock that were scanned during the 2014 Survey are disturbed. Examples of this include relocation of historic exploration core to the Bolger Pit, regrading waste rock to fill a water collection point near Pistol Lake and resloping the backfilled waste rock in the Bolger Pit. In preparation for transferring properties into the IC Program, follow up gamma scans will be completed where necessary and the results compared to the values obtained in the original 2014 Survey to ensure gamma levels remain at or below what was previously observed and assessed.

A final gamma survey was completed at both the waste rock pile adjacent to Pistol Lake as well as the Bolger Pit area in August and September 2016 following relocation of waste rock on both properties. The gamma survey results indicated that the average gamma activity at both the Hab area near Pistol Lake and the Bolger Pit area remain within the values observed in the 2014 Survey. In following the risk-based criteria established for the Beaverlodge properties, measured gamma activity of this level poses negligible risk to humans and wildlife.

3.2.2 Rehabilitate Historic Mine Openings

The Beaverlodge Mine closure reports developed following the cessation of mining states that in 1982 thirty seven vertical openings (from underground mine workings to surface) were identified as requiring closure on the Beaverlodge properties. The closure reports stated that “vertical openings be sealed with reinforced concrete bulkheads”.

A plan and method for sealing surface openings was submitted and approved by the regulatory agencies in 1982. As a result of the original decommissioning activities all vertical openings were covered with concrete. The plan and method described in 1982 and approved by the regulatory agencies outlines a set of principles to be followed for closing mine openings but does not provide “as-built drawings” detailing exactly how each opening was decommissioned. The province of Saskatchewan will require engineer stamped documentation regarding the final closure method prior to properties being considered for transfer to the IC Program.

Vertical mine openings were sealed with concrete during decommissioning, however some concrete caps were covered with waste rock making it difficult to locate and assess all caps. Cameco used historic photos and drawings paired with recent aerial photos to complete a site wide investigation of all mine opening locations. With the mine openings located, options to complete final remediation were assessed and covering the existing caps with stainless steel was selected as the preferred option in most cases. 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 1000 years. An investigation into remediating openings by backfilling with waste rock where appropriate is also planned for 2017.

Initially three covers were planned for installation in 2016 and Kova Engineering was retained to measure, design and oversee fabrication of the stainless steel covers. Once the designs were complete, a request for exemption from the *Saskatchewan Mine Regulations*, Section 407 (2) was submitted to the Ministry of Labour Relations and Workplace Safety on December 18, 2015. Cameco received exemption from the Executive Director on February 10, 2016.

Uranium City Contracting (UCC) was contracted to fabricate, haul and install the stainless steel covers. Following fabrication and transport to Uranium City in the spring of 2016, plans were made to complete installation in June. The Ace Shaft stainless steel cover was installed in 2016 while the remaining covers were delayed pending a review of alternative options for sealing. During final inspection by the design engineer, some minor weld defects were noted and these will be addressed during the 2017 field season. These defects are not expected to affect the performance of the cover and are aesthetic in nature.

Designs for additional stainless steel covers were also completed in 2016. Kova Engineering made two site vists in order to measure 10 additional concrete caps and design the stainless steel covers with input from UCC to ensure optimal design. In addition to the 10 new covers, a revised design for one of the previously fabricated covers was completed as well.

A request for exemption from the *Saskatchewan Mine Regulations*, Section 407 (2) was submitted November 9, 2016 to allow the use of stainless steel to cover the 11 mine openings. Cameco received an exemption for the 11 caps from the Ministry of Labour Relations and Workplace Safety on December 5, 2016. The stainless steel covers are being fabricated in early 2017, and are planned to be installed later in the year.

3.2.3 Decommission Identified Boreholes

A search of drilling records on file with the Government of Saskatchewan followed by site verification was conducted in 2011. This resulted in numerous boreholes being identified and sealed over the next two years. Since 2013, additional non-flowing boreholes have been discovered during regulatory inspections as well as during the final property inspections. Fifteen boreholes were located in 2015, which were then sealed in 2016. Fifty new boreholes were also identified as part of the 2016 site inspections, some of which were sealed in 2016 with the remainder planned for 2017.

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 C**). As additional boreholes are discovered the GPS locations are added to this record. As sites are transferred to the IC Program this permanent record will be transferred to the Province of Saskatchewan.

3.2.4 Re-establishment of the Zora Creek flow path

The Bolger Waste Rock Pile is located about 11km east of Uranium City and is the result of development of Bolger Pit and Verna Shaft. The Waste Rock Pile spanned a narrow valley adjacent to the Bolger Pit which overlies the former location of both Down Lake and a small creek linking Zora, Down and Verna lakes. The creek, often referred to as Zora Creek, flows intermittently, however it flows through the base of the waste rock pile when flowing.

SRK Consulting was contracted by Cameco to design and construct an excavation through the Bolger Waste Rock Pile to re-establish the Zora Creek flow path, reducing contact between Zora Creek water and the waste rock. Based on the Quantitative Site Model developed by SENES Consultants (SENES 2012), the reconstructed flow path is predicted to result in improved water quality in Zora Creek, and to have a measureable improvement to the water quality of downstream Verna Lake.

The project was conducted in two phases, with work in 2014 consisting primarily of characterization activities. Only a small amount of waste rock, approximately 14,000 m^3, was excavated from the Bolger Waste Rock Pile in 2014 (SRK 2015a).

The second phase, excavation of the proposed flow path, was conducted from May 2015 through to October 2015. Over this period a channel between Zora and Verna Lakes was re-established allowing uninterrupted flow to resume. Some minor alterations in the channel alignment from the original design were necessary to accommodate "field fit" adjustments to optimize the flow path. A detailed description of the work conducted along with interim drawings has been provided to the regulatory agencies and is titled "2015 Construction As-Built Update" (SRK 2016b).

Final construction work was completed in 2016. Minor items were required to complete the project and included additional rip-rap placement at the inlet, removing frozen material at the south-west end of the channel, resloping waste rock that was placed in the Bolger Pit and repairing the access road.

A final habitat assessment of Verna Lake (downstream of the new flow path) was also completed in 2016 by CanNorth (**Appendix D**). The report concluded that the slight siltation of the shoreline near Zora Creek is not expected to result in serious harm to fish in Verna Lake, since the impacts on fish habitat are expected to be temporary and are confined to a small area where the type of habitat is not limiting.

Water quality from this area will continue to be monitored to evaluate the success of implementing this remedial action. A detailed description of the work conducted along with final drawings has been provided to the CNSC and SMOE in a report titled - 2016 SRK As-Built Report (SRK 2017).

The focus for 2017 will be monitoring channel performance and as such no further construction work is planned. The only activity planned for 2017 is to remove the sediment curtain currently installed in Verna Lake.

3.2.5 Final Inspection and Cleanup of the Properties

Final Inspection and Cleanup

Prior to transferring sites to the IC Program a final site inspection and clean-up must be conducted 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 the 15 properties initially proposed for transfer to the IC Program. Inspections of all remaining properties was completed in 2016. 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, and any foreign material and debris on the properties was marked for later collection or removed immediately.

All properties were inspected in 2016, with some gaps identified for further inspection in 2017. All foreign material collected was deposited in the former Bolger Pit area or a small pit located near the mill.

Bolger Pit Waste Disposal

The Bolger Pit was selected as the disposal location as it was used by Eldorado Resources as a disposal area for similar materials during decommissioning. As a condition of using Bolger Pit as a disposal location Cameco is required to provide information regarding the type and volume of waste being disposed of in the pit on an annual basis.

The former Bolger Pit has been backfilled as a result of the Zora Flow Path Reconstruction project (see **Section 3.2.4**), however a small portion in the north west corner of the pit, against the pit wall (approximate 59°34’10.9”N 108°24’58.3”W), was left open to allow disposal of waste materials encountered during property inspections. In total 50 loads of core and core boxes were deposited in the Bolger Pit in 2016, this translates to an approximate volume of 650 m3.

In 2016, it became apparent that historic core boxes had begun to limit the available disposal room in Bolger Pit. Options to increase the room for disposal in the Bolger Pit were investigated, however the newly placed waste rock from the Zora Creek project was compacted making it difficult to create additional disposal space. As a result, a new disposal area in the Fay Pit was developed for site inspection debris. The Fay Pit is a small pit located west of the old mill that was used to dispose of mill site debris during decommissioning. As waste is placed in the pit Cameco will continue to provide information regarding the type and volume of waste being disposed of on an annual basis. The debris will be covered with waste rock and compacted and a gamma scan will then be completed on the final cover.

An additional 950 m^3 of debris found during the site inspections was deposited as well. Materials disposed of included tires, broken concrete, culverts, steel drums and debris, drill stems and casings, transmission line infrastructure, stave pipeline and wire wrap, hoses and piping, as well as some signs.

3.2.6 Utility Corridor Assessment

In 2015 during the inspection process, utility corridors that contained historic power line infrastructure were located on the ACE 5 property. Additional investigation revealed that historic infrastructure was located on and between several of the properties. In response, Cameco commissioned Kingsmere Resource Services Inc. to complete an assessment of the extent of the infrastructure remaining as well as to provide an assessment of potential remediation options.

After completing the inventory, five options were considered regarding the future of the remaining infrastructure within the utility corridors on and between the former Eldorado properties. The options ranged from leaving existing materials in place to removal of all material and hauling to a licensed disposal facility.

The proposed remediation includes:

1. Removing all pole stubs from steel brackets.
2. Distributing the pole stubs randomly over an area adjacent to the site.
3. Dismantling all crib sets and crib material and spreading material over the site to a height no greater than 0.3 meter.
4. Transporting all other foreign materials (brackets, guywires, insulators, wire, etc.) to the former Bolger pit (or other suitable location) for disposal.
5. Placing a rock cover over the material in former Bolger pit or other acceptable disposal location.

The assessment results and Cameco's preferred remediation strategy were discussed with SMOE and CNSC during the regulatory inspection in July 2016. A report (Kingsmere 2016) was then submitted to CNSC and SMOE in November 2016 that identified Cameco's preferred remediation strategy as discussed above.

3.2.7 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. In 2014, it was identified that the remediation work completed in 2013 had partially eroded and a long term solution was needed to permanently secure this settled area. The area remained fenced off and residents were notified of ground instability in the area.

As part of developing a long term remediation plan Cameco initiated an investigation of crown pillars on all Beaverlodge properties in 2014. A report assessing the crown pillars and related risks on all properties was submitted in 2015 for regulatory review (SRK 2015b). Regulatory comments on the Crown Pillar Assessment report were received on February 12, 2016 and Cameco in turn responded to the comments and outlined the preferred remediation option for the Ace Stope Area – "covering the areas of concern with a mixture of waste rock and broken concrete". Approval from the CNSC was received in May 10, 2016 with one recommendation: an annual visual monitoring frequency for the crown pillars for the first three years, followed by an assessment to adjust the monitoring frequency as necessary.

Prior to implementing the preferred remedial option of covering the entire Ace Stope Area, some new information was discovered which included a historic investigation of the crown pillar areas at the Ace Mine conducted in 1983. Using this additional information, the design of the cover placement was optimized to correspond with the location of the stopes. Remediation of the area was completed mainly in August 2016, and included backfilling the areas above the stopes with approximately two metres of broken concrete and sorted waste rock, followed by capping with clean waste rock.

3.2.8 Concrete Pad Remediation

Concrete pads from the Fay, Ace and Verna sites were broken up and removed. Some of this broken concrete was used as a fill material above the Ace crown pillar area, while the remainder was disposed of in the Fay Pit.

3.2.9 UAV Imagery

In 2015/2016 Cameco utilized an unmanned aerial vehicle (UAV) to capture aerial images for most of the Beaverlodge properties identified in the surface lease.
The detailed images from this project are used for figures included in submissions of documentation to support the transfer of properties to the IC Program, locating mine openings, and assessing the site for areas of subsidence. The UAV imagery captured in 2015/2016 can be used as a baseline for future evaluation of the properties via UAV. For example, assessing vegetation regrowth, identification of areas of subsidence, identification of human intervention/utilization of the site.

3.2.10 Ace Creek Trestle Bridge Concrete Footing Removal

As requested by Cameco, Outside Environmental Consulting Ltd. completed an environmental review for the removal of concrete footings from Ace Creek on March 4, 2016. The footings were historically associated with a trestle bridge supporting a tailings pipeline that crossed Ace Creek while milling was active in the area. The pipeline was removed during decommissioning, with the trestle bridge being removed in 2004, the footings were left in place in the creek. The footings were not causing any noticeable environmental issues, such as flow alterations or bed or bank scour, but were identified as a potential safety concern.

An Aquatic Habitat Permit for in-water work was obtained from SMOE June 24, 2016 authorizing Cameco to proceed with the removal of the concrete footings on Ace Creek. In September, the footings were removed vertically using a backhoe with a bucket and thumb attachment with no digging into the substrate, and no contact with the stream bank or the stream-side vegetation. Construction monitoring of footing removal noted no concerns with respect to water quality, or with respect to other environmental risk relating to aquatic habitat. Further detail can be found in **Appendix E**.

3.2.11 Waste Haul Adit Remediation

While reviewing the 2016 UAV photos, an area of subsidence was identified at a location corresponding to the approximate location of the backfilled mill waste haulage adit. The waste haulage adit provided access to a tunnel that extended back from the sorted waste rock pile to the ore sorting system at the mill. Following the inspection it was decided that the backfill would be removed from the opening in order to identify the cause of the subsidence and determine the best way to implement long term remediation for the horizontal opening.

The entrance to the waste haul adit was excavated over the course of two days (July 19-20, 2016) at which point the exposed adit opening was inspected. During the course of the excavation, it was discovered material was largely end-dumped a short distance into the opening, in addition several large pieces of scrap steel were located and removed from the fill in front of the opening. These factors contributed to the waste rock shifting into the adit over time resulting in the subsidence observed above the backfilled opening.

In reviewing remediation options it was determined that sealing an adit by backfilling with waste rock to a depth twice the adit height has been used successfully in other mining jurisdictions including Ontario, Colorado, and Utah. As such the adit was sealed by packing waste rock to a sufficient depth into the adit using a specially constructed extension tool attached to a wheeled loader while avoiding direct access to the opening by machine and operators.

A summary of the remediation along with a request for exemption from the *Saskatchewan Mine Regulations*, Section 407 (2)(3), for the Sealing of a Horizontal Mine Opening was submitted November 21, 2016 and was granted in early 2017.

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 have been established as benchmarks for entering the provincial Institutional Control 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 of water quality values to which water quality trends will be compared when defining whether the station is stable or improving.

These predictions 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 document (Cameco 2012). With the path forward strategy accepted by the regulatory agencies, the water quality performance indicators were updated and incorporated in the Status of the Environment (SOE) report (SENES 2013) which was finalized at the end of 2013. The next SOE will be completed in 2018, which will include updates to the model based on data gathered since the 2013 update. If applicable at that time, water quality trends that lie outside the predicted ranges will undergo a reassessment of risk and an evaluation of potential remedial options if required.

During preparation of the annual report it was noted that some individual annual average data was outside the maximum and minimum predictions generated using the Beaverlodge QSM (SENES 2012) and the model inputs employed in the 2008 – 2012 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, where trends are beginning to deviate from the expected trends an evaluation of the results was conducted to determine the potential contributing factors.

A comparison of 2016 annual averages to the model predictions, along with a description of differences is provided below.

Table 4.1.1
Comparison of Key Parameter Annual Averages to Modeled Predictions

Uranium	2016	SEQG	Bounding Range			Comments
	Concentration (µg/l)					
Pistol Lake (AN-5)	130.4	15	184	to	409	Trending below lower bound
Dubyna Lake (DB-6)	159	15	69.1	to	152	Trend starting to exceed the upper bound, will be monitored
Verna Lake (AC-6A)	331	15	131	to	283	Currently above predictions but lower than the previous year, expected to return within bounds in 2017.
Ace Lake (AC-8)	14.5	15	7.86	to	15.7	Below SEQG
Lower Ace (AC-14)	28.7	15	15.4	to	34	2016 average within bounds
Fookes Reservoir (TL-3)	248	15	318	to	408	Trending below lower bound
Marie Reservoir (TL-4)	235.3	15	310	to	376	Trending below lower bound
Meadow Fen (TL-7)	196.9	15	330	to	416	Trending below lower bound
Greer Lake (TL-9)	210.3	15	271	to	317	Trending below lower bound
Beaverlodge Lake (BL-5)	132.5	15	102	to	140	2016 average within bounds
Radium-226	**2016**	**SEQG**	**Bounding Range**			**Comments**
	Activity Level (Bq/l)					
Pistol Lake (AN-5)	0.686	0.11	0.383	to	0.903	2016 average within bounds
Dubyna Lake (DB-6)	0.04	0.11	0.0184	to	0.0316	Below SEQG
Verna Lake (AC-6A)	0.108	0.11	0.088	to	0.209	Below SEQG
Ace Lake (AC-8)	0.0145	0.11	0.0115	to	0.0175	Below SEQG
Lower Ace (AC-14)	0.038	0.11	0.0257	to	0.0521	Below SEQG
Fookes Reservoir (TL-3)	1.17	0.11	1.07	to	1.33	2016 average within bounds
Marie Reservoir (TL-4)	1.6	0.11	1.36	to	1.75	2016 average within bounds
Meadow Fen (TL-7)	1.59	0.11	1.32	to	1.69	2016 average within bounds
Greer Lake (TL-9)	1.95	0.11	1.63	to	2.32	2016 average within bounds
Beaverlodge Lake (BL-5)	0.03	0.11	0.0362	to	0.0472	Below SEQG
Selenium	**2016**	**SEQG**	**Bounding Range**			**Comments**
	Concentration (mg/l)					
Pistol Lake (AN-5)	0.0001	0.001	0.0001	to	0.000101	Below SEQG
Dubyna Lake (DB-6)	0.0001	0.001	0.000105	to	0.000113	Below SEQG
Verna Lake (AC-6A)	0.0002	0.001	0.00013	to	0.000151	Below SEQG
Ace Lake (AC-8)	0.0001	0.001	0.000108	to	0.000115	Below SEQG
Lower Ace (AC-14)	0.0001	0.001	0.000108	to	0.000116	Below SEQG
Fookes Reservoir (TL-3)	0.0023	0.001	0.00328	to	0.00378	Trending below lower bound
Marie Reservoir (TL-4)	0.0017	0.001	0.00303	to	0.00333	Trending below lower bound
Meadow Fen (TL-7)	0.0016	0.001	0.00312	to	0.00358	Trending below lower bound
Greer Lake (TL-9)	0.0021	0.001	0.0032	to	0.00394	Trending below lower bound
Beaverlodge Lake (BL-5)	0.0025	0.001	0.00212	to	0.00271	2016 average within bounds

It is believed that the recent trends observed at Verna Lake that deviate from the model predictions are largely attributable to the model not accounting for the disturbance of the system that resulted from the Zora Reconstruction project. Now that the project is complete, water quality is expected to improve in Verna Lake over the next two years.

Recently observed flow rates are also suspected to be a contributing factor to the observed deviations 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).

The range of measured flows at AC-8 and TL-7 in recent years have been well outside the historically observed range and therefore the predicted variability as well. Flows were particularly inconsistent at station TL-7. In the last six years, the mean annual flow rate has ranged from 0.2 L/s in 2011 to 47.5 L/s in 2016, this is 1.1% and 260%, respectively, of the average of all the annual mean flow rates from 1980-2016 (18.3 L/s).

It is expected that these variations in flow affect contaminant sources differently. For constituents which have largely diffusion limited transport, it is expected that high flows would serve to dilute the system, resulting in lower levels; this is typically seen for uranium, selenium, TDS and radium (in the Ace Creek Watershed). The opposite effect is observed for radium^{226} in the Fulton Creek Watershed, where diluted levels of TDS (and sulphates) result in increased solubility of the radium precipitates associated with barium and calcium in the sediments leading to higher concentrations in the water column. These trends are reversed for low flow conditions, as was the case in 2010.

The development of the SOE report includes a review of the previous five years of monitoring data along with comparisons to both regulatory guidelines and performance objectives, and if required, updates to the model will be incorporated. Predicted water quality will be re-assessed as part of work performed for the next Beaverlodge SOE, in 2018, to take into account the extreme flow variation which has occurred in recent years. It is expected that when greater variability in the annual flows and loads are employed in the QSM (SENES 2012), that the revised minimum and maximum water quality predictions (bounding curves) will more accurately reflect the variable conditions observed in recent years. If monitoring data are still outside of the bounding curves Cameco will then re-assess the risk and potential remedial options as required.

Section 4.3 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 2016) 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 SOE 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.

Once properties are shown to be meeting their respective water quality predictions and are chemically and physically stable, in accordance to those predicted values in the SOE, properties will be considered for transfer to the IC Program.

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 closed-out 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 (1985/86) 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.

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, which include water quality and ambient radon.

4.3 Water Quality Monitoring Program

This section summarizes the results of the approved water sampling program at Beaverlodge. The current water sampling program was approved by the CNSC and SMOE for implementation in 2011; there have been no permanent changes to the monitoring program since. 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 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 permanent, routinely sampled 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 to 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 below the discharge of Greer Lake and before it enters Beaverlodge Lake.

Additional permanent 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 and comparisons to their respective SEQG values where applicable, and comparisons to the predicted future recovery of water bodies 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 has 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 noted 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). For the purposes of this report, no statistical methods were applied in the discussion surrounding trends at each station.

The detailed water quality results for the current reporting period, January 2016 to December 2016, are provided in **Appendix F**.

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**). There were a total of six scheduled samples at AN-5 in 2016. In March no sample was collected as the station was frozen.

A historical summary of annual average ^{226}Ra activity and 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 2012 to 2016 are presented in **Table 4.3.1-1**.

The long-term trend for ^{226}Ra at AN-5 has been gradually increasing with fluctuations in the year to year annual average measured activity. As shown in **Appendix F**, seasonal fluctuation also varied in magnitude between 0.36 Bq/L and 1.4 Bq/L in 2016 resulting in an average ^{226}Ra measured activity of 0.69 Bq/L for AN-5. The 2016 average activity at AN-5 was much lower than the 2015 annual average of 1.10 Bq/L and was within the modelled predictions. Annual averages have fluctuated between 0.6 Bq/L and over 1 Bq/L over the last six years. The significance of this trend will be re-evaluated during the next SOE.

Uranium values have shown a distinct seasonal fluctuation as well, with the highest concentrations occurring in the winter months and late spring to late fall yielding lower values. Uranium concentrations measured throughout the year varied in magnitude between 39 µg/L and 234 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 slightly lower than the predicted range. The lower bound predicted for uranium in 2016 was 184 µg/L and recorded average concentration was measured at 130.4 µg/L for 2016.

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.

Se values at AN-5 are consistently below SEQG, and the annual average concentration noted in 2016 was <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, upstream of Ace Lake (**Figure 4.3**). All six scheduled samples were collected in 2016 at DB-6.

A historical summary of annual average ^{226}Ra activity and 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 2012 to 2016 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 concentrations measured in 2015 were above those measured in 2014. The 2016 average concentration also falls outside of modelled predictions for this station, however it was lower than 2015. Monitoring of this trend will continue in 2017.

Cameco has initiated a search for additional sources of uranium along the shoreline of Dubyna Lake in response to the annual uranium averages that have exceeded the modelled predictions in recent years. An evaluation of risk will be completed with the 2018 SOE and will be used to determine if additional remediation is warranted.

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 lab detection limit for Se was lowered.

The TDS trend has been relatively consistent since decommissioning, and no changes were observed in 2016.

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 during low flow years not all scheduled samples are collected. Increased sample frequency at AC-6A began in 2015, with 10 samples collected in 2016 to track changes in water quality as a result of the implementation of the Zora Flow Path Reconstruction project.

A historical summary of annual average ^{226}Ra activity and 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 2012 to 2016 are presented in **Table 4.3.1-3**. Detailed results discussed below are provided in **Appendix F**.

The annual average U concentration decreased from 386.6 µg/l in 2015 to 331 µg/l in 2016. Although this concentration is still above the modelled predictions it is expected to continue to decrease as a result of the Zora Creek project. A description of the activities associated with the Zora Creek Project and the associated water quality monitoring program is provided in the 2016 As-Built Report (SRK 2017).

The current annual average ^{226}Ra measured activity of 0.11 Bq/L is consistent with the 2015 annual average. Based on the modelled predictions, ^{226}Ra is trending within the upper and lower bounds.

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

TDS has remained relatively stable at this station since 2004, with no changes in 2016.

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 2016.

A historical summary of annual average ^{226}Ra activity and 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 2012 to 2016 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 measured ^{226}Ra activity is below the SEQG of 0.11 Bq/L and within modelled predictions.

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

Long-term trends for concentrations of TDS have remained relatively stable at this station since 1982.

AC-14 Lower Ace Creek

AC-14 is located in Lower Ace Creek at the discharge into Beaverlodge Lake (**Figure 4.3**). Eleven out of 12 of the scheduled samples were collected in 2016, with the exception being the November sample where safety was a concern due to ice conditions.

A historical summary of annual average ^{226}Ra activity and 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 2012 to 2016 are presented in **Table 4.3.1-5**.

Uranium concentrations at station AC-14 have been following a downward trend since decommissioning. The 2016 average concentration of 28.7 µg/L remains within the modelled predictions for this station.

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

Since 2001, Se concentrations have been at or below the SEQG at this station.

TDS 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 applied to 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

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 on an annual basis.

A historical summary of annual average ^{226}Ra activity and 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 2012 to 2016 are presented in **Table 4.3.2-1**.

As expected with a reference location, the long-term trend for concentrations of U, Se, and ^{226}Ra recorded at AN-3 have remained relatively stable and below their respective SEQG. Selenium concentrations at AN-3 have been at or below the detectable laboratory limits since routine analysis began in 2000.

TL-3 Fookes Reservoir

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**). All four scheduled samples were collected in 2016.

A historical summary of annual average ^{226}Ra activity and 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.** Water did not flow at station TL-3 from May 2010 until freshet in the spring of 2012 and as such there is no data at this station during that period. The annual averages from 2012 to 2016 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 three annual averages measured from 2014 to 2016 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 2016 average activity of 1.17 Bq/L. Elevated and increasing ^{226}Ra and barium levels 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. In 2016, ^{226}Ra activity decreased from the previous year and is within the bounds of the modelled predictions.

In the long-term Se has been slowly decreasing in concentration since decommissioning. In 2016, the Se concentration measured 0.0023 mg/L which is below the lower bounds of the modelled predictions at TL-3.

TDS concentrations have also slowly decreased in the long-term indicating improving conditions at this station.

TL-4 Marie Reservoir

TL-4 is located within the Fulton Creek drainage downstream of TL-3 and at the discharge of Marie Reservoir (**Figure 4.3**). All four scheduled samples were collected in 2016.

A historical summary of annual average ^{226}Ra activity and 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.** Water did not flow at TL-4 from October 2010 until freshet in the spring of 2012, as such there is no data at this station during that period. The annual averages from 2012 to 2016 are presented in **Table 4.3.2-3.**

Annual concentrations of U and TDS at TL-4 have decreased over the long term indicating improving conditions at this station. In 2016, the decreasing trend continued with the lowest annual average U at TL-4 to date of 235.3 µg/L. The most recent four years have had annual average concentrations below the lower bound of the modelled predictions.

Similar to TL-3, ^{226}Ra activity has shown an increasing trend for approximately the past 15 years at TL-4 but decreased in 2016, returning to the modelled predicted range.

Selenium has shown a slow and steady reduction over time and had an annual average concentration of 0.0017 mg/l which was below the lower bound of the modelled prediction in 2016.

TL-6 Minewater Reservoir

TL-6 is located at the discharge of Minewater Reservoir which was used temporarily for tailings deposition in 1953 and settling of treated mine water during the last 10 years of Beaverlodge operations (**Figure 4.3**). 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 can be collected every year. Of the three scheduled samples, two were collected for 2016 as no water was available during the July sampling.

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

A historical summary of annual average ^{226}Ra activity and 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 2012 to 2016 are presented in **Table 4.3.2-4**.

Since decommissioning, U concentrations have been experiencing a decreasing trend at station TL-6. The annual average of 288.5 µg/L in 2016 was higher than the 143.7 µg/L observed in 2015, however it is in line with concentrations measured at this station in the past.

The annual measured activity of ^{226}Ra has shown considerable fluctuation and an increasing trend 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 2016 was 6.05 Bq/L. This result is similar to the 2015 result and is in line with the activities measured at TL-6 prior to the increased values observed in 2013 and 2014.

Monitoring of Se at TL-6 was initiated in 1996, with concentrations fluctuating until 2004. The 2016 annual average of 0.0021 mg/L is within range of values previously observed at this station.

TDS experienced a significant downward trend post-decommissioning, with concentrations stable around 500 mg/L since 2005.

TL-7 Meadow Fen

TL-7 is located at the discharge of Meadow Fen (**Figure 4.3**) in the TMA. Of the twelve scheduled samples for the 2016 reporting period, three samples were not collected due to glaciation or a lack of flow in February, March and April which prevented sample collection. An additional sample was collected at the beginning of May once the sample location was free from glaciation.

A historical summary of annual average ^{226}Ra activity and 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 2012 to 2016 are presented in **Table 4.3.2-5.**

Since decommissioning, U and TDS have been experiencing a downward trend in their long-term concentrations, while ^{226}Ra is experiencing an upward trend similar to the upstream stations in the TMA. The annual average U concentration at TL-7 has been below the lower bound of the modelled predictions since they were developed in 2013. ^{226}Ra currently remains within the bounds of the modelled predictions with a 2016 average activity of 1.59 Bq/L.

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 while measuring below the lower bound of the modelled predictions.

TL-9 Greer Lake

TL-9 is located downstream of Greer Lake (**Figure 4.3)** immediately before the water enters Beaverlodge Lake. 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. Similar to the upstream stations in the Fulton Creek watershed, there was no water flowing at TL-9 from June 2010 to May 2012. In 2016, 11 out of 12 of the scheduled samples were collected. The November sample was not collected due to safety concerns related to ice conditions.

A historical summary of annual average ^{226}Ra activity and 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 2012 to 2016 can be found in **Table 4.3.2-6.**

The long-term trend for U at TL-9 has shown a decrease in annual concentrations following decommissioning. Concentrations in the short term have continued to follow that trend, with a decrease in U from 244.5 µg/L to 210.3 µg/L, between 2015 and 2016. 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 measured activity despite occasional fluctuations over the past twenty years. However since 2013, activity has decreased and was within the modelled prediction range for 2015 and 2016. 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 is another parameter at station TL-9 that has shown a decreasing trend over the long term. In 2016, the average concentration was below the modelled predictions with a concentration of 0.0021 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.

Previous experience has shown that at least some of the abandoned sites are likely contributing some level of contamination (heavy metals and radionuclides) to the watershed and ultimately to Beaverlodge Lake and Martin Lake, particularly during spring runoff and periods of heavy precipitation.

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 1998-99 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 2016 reporting period, all four scheduled samples were collected.

A historical summary of annual average ^{226}Ra activity and 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 2012 to 2016 are presented in **Table 4.3.3-1.**

Annual concentrations of U and Se at BL-3 have generally been trending downward. The annual average U concentration went from 138 µg/L in 2015 to 127.5 µg/L in 2016. Similarly the annual average Se concentration went from 0.0026 mg/L in 2015 to 0.0023 mg/L in 2016.

^{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)** and is collected as a 3-depth composite. The sampling frequency 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 2016.

A historical summary of annual average ^{226}Ra activity and 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 2012 to 2016 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 for 2016 was 133 µg/L.

Annual average ^{226}Ra activity remains below the SEQG of 0.11 Bq/L and have been consistently between 0.02 Bq/L and 0.04 Bq/L since 2003.

Selenium concentrations have fluctuated over the long term; however, the short-term trend has been downward since 2008. In 2016, the average Se concentration was 0.0025 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 is located at the Beaverlodge Lake outlet (**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. All four scheduled samples for 2016 were collected.

A historical summary of annual average ^{226}Ra activity and 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 2012 to 2016 are presented in **Table 4.3.3-3.**

The 2016 annual average concentrations for U and Se were measured at 132.5 µg/L and 0.0025 mg/L. Both U and Se are within the bounds of the modelled predictions.

Radium^{226} was measured at 0.03 Bq/L in 2016, which is below the corresponding SEQG of 0.11 Bq/L.

Similar to the other Beaverlodge Lake stations, Total Dissolved Solids 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 2016; however December results were suspect as concentrations were measured well below expected readings. In response, a water sample was collected from this station in early January 2017 and values were found to be as expected. These new values were treated as a re-check and labelled with the original December sample date. The sample collected in January did not contain enough water for the analysis of Pb-210, Po-210, TOC, NH3 and Total P. Equipment failure due to extreme cold resulted in the temperature not being recorded for the January re-check sample. A table comparing the average concentrations for all measured parameters from 2012 to 2016 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 shown a slight decrease year to year. For the 2016 reporting period, the average U concentration was 34.6 µg/L; however, this average is skewed by a single low value recorded in March 2016 (22 µg/L). A re-sample was not collected.

The 2016 annual average ^{226}Ra activity was below the SEQG at 0.008 Bq/L.

The observed Se concentrations have shown a decreasing trend since 2013, with the 2016 annual average below the SEQG.

The average TDS concentrations have remained stable since sampling started and was 107.75 mg/L for the 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 2016.

A table comparing the annual concentrations for all measured parameters from 2012 to 2016 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 52 µg/L in 2016, which is similar to the value measured in 2015. Both the Se concentration and ^{226}Ra activity had values below their respective SEQG; Se a value of 0.0009 mg/L and ^{226}Ra measured a value of 0.01 Bq/L. Total dissolved solid 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 of Lake Athabasca (**Figure 4.3**) approximately 1km 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 2016.

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 **4.3.3-24.**

Uranium concentrations at station CS-2 were last recorded to be 21 µg/L. This result is anomalously high and it is suspected the sample was collected too close to the mouth of the Crackingstone River and is more representative of what is flowing into Crackingstone Bay than what would normally be measured at CS-2. This trend will continue to be monitored.

Radium activity and Se concentrations were still below their respective SEQG. In 2016 TDS was measured at a value of 71 mg/L. The ^{226}Ra activity was 0.007 Bq/L while the Se concentration was measured at 0.0004 mg/L.

4.4 Additional Water Quality Sampling

Cameco has assessed additional remedial measures and developed a path forward for the Beaverlodge properties that will facilitate the eventual transfer of the properties to the IC Program. One of the potential remedial measures taken into consideration in the 2012 Path Forward Report (Cameco 2012) 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 to 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 scheduled beginning in August 2013 to monitor water quality at the discharge from Zora Lake outflow (ZOR-01) and the outlet from the waste rock pile flowing into Verna Lake (ZOR-02). Water samples are collected only during open water conditions and where flow is sufficient for sample collection. In 2016, samples were collected at these two stations for every month except January and February, due to ice buildup at the sample locations. 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.**

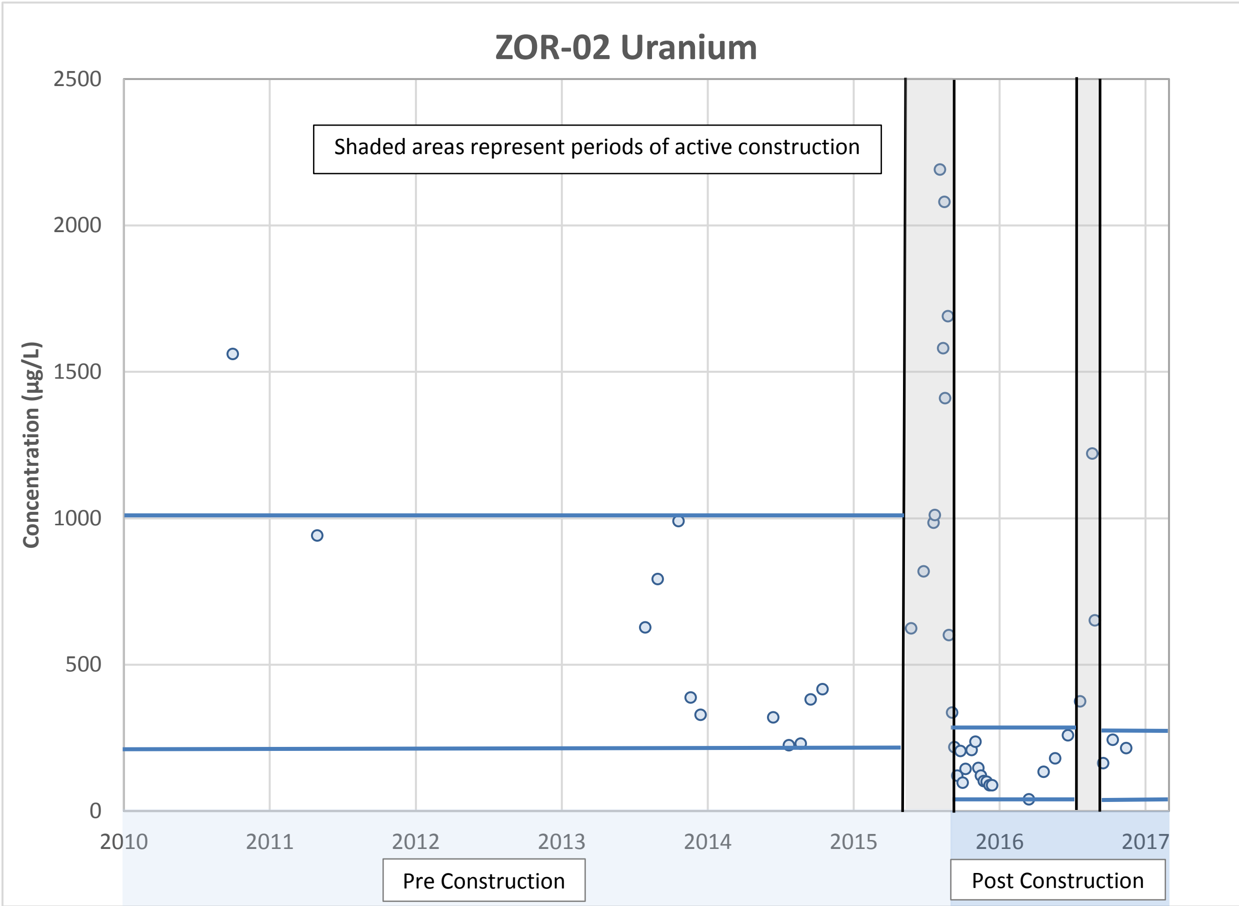
Uranium concentrations, Se concentrations and ^{226}Ra activity at ZOR-02 increased through the summer of 2016, peaking in August. The increase is attributable to construction activities which occurred in August as well as melting ice within the waste rock pile. In addition, higher than normal precipitation rates in August may have also led to increased flushing of contaminants from the newly exposed waste rock within the excavated area of the channel.

Table 4.4-2a
ZOR-02 Uranium Concentrations

Sample Period	Uranium	Radium	TDS
	µg/L	Bq/L	mg/L
Pre-construction[1]	310	0.34	190
2016[2]	180	0.16	170
2016 construction period[3]	750	0.44	240

1. Concentration based on 5 samples collected between June 18, 2014 and October 19, 2014
2. Concentration average excludes samples taken during the construction period on July 26, August 25 and September 1, 2016
3. Concentration average only includes samples taken during construction period from July-September 2016.

Figure 4.4-5a
ZOR-02 Uranium Concentrations Pre and Post Construction



4.5 QA/QC Analysis

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

Blind replicate samples involve the collection of two homogeneous samples of water from the same sampling location, with the water sent to the same analytical lab to test the lab's ability to duplicate results through their analytical methods. The blind samples are labeled 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 are sent out in May, June, and July.

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

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 duplicate lab results, it would be at the discretion of the

Reclamation Coordinator to investigate the discrepancy and determine if corrective action is warranted.

The Beaverlodge QA/QC analysis methodology was reviewed in 2016 to incorporate detection limits and uncertainty as well as become analogous to other Cameco site's QA/QC analysis methods.

Results with an absolute difference greater than 50% are triggered for review. 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 outside their associated range of entered uncertainty (= Value +/- Entered Uncertainty) then samples are considered noncompliant and additional investigation is required.

Blind Replicate Samples

When the results from Blind-1 and Blind-2 were compared with sample results for AC-14 and DB-6 for the month of May, all results were found to be within acceptable range of variation.

June blind samples were collected at TL-9 (Blind-4) and TL-7 (Blind-6), and sent to SRC Lab for analysis. Three of the results met the threshold for investigation (absolute difference >50%), however all three were not greater than five times the detection limit and therefore no further investigation was required.

In July blind samples were scheduled for AC-6A (Blind-3) and TL-6 (Blind-5) to be sent to SRC for analysis. Blind-3 was collected successfully and all results were found to be within an acceptable range of variation. Blind-5, however, could not be collected due to lack of flow at TL-6 during this time.

Duplicate Samples

Duplicate samples for TL-7 and TL-9 were collected in June 2016 and sent to both SRC and Maxxam labs for analysis. A primary quality check was completed to compare sample results with the SRC results for TL-7 and TL-9. Two of the results met the threshold for investigation (absolute difference >50%) but results were not greater than five times the detection limits and therefore no further investigation was required.

In December, the scheduled duplicate samples at station TL-9 and TL-7 were collected and sent to Maxxam and compared to SRC results. A quality check was performed and eight results were over the threshold for investigation; however sample results were not greater than five times the detection limits and therefore no further investigation was required.

Beaverlodge QA/QC reports are presented in **Appendix G**.

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 data collection for flow, 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 Creek (AC-8) for the period January 1, 2016 to December 31, 2016. The report can be found in **Appendix H.**

At AC-8, the snow-melt runoff flow values measured in May and June increased from last year. The majority of precipitation fell during July and August resulting in increased flows into September and October. The average flow for September based on daily averages was 2.446 m^3/s where the annual average flow was 0.893 m^3/s for 2016.

The 2016 flow rate at TL-7 during the month of May was calculated using the AC-8 flow rate as reference. The estimated May flow rates of 0.136 m^3/s was among the highest historic (past 31 years) flow rate averages for this month. On October 8, 2016 the flow at TL-7 was measured at (0.0915 m^3/s). This elevated flow is indicative of the large rainfalls experienced in August. The mean annual flow for 2016 TL-7 was 0.0475 m^3/s which is also consistent with previous years, however it is higher than the long term average of 0.0183 m^3/sec.

Regarding precipitation, the overall climate records for Uranium City indicate that 2016 was above normal based on annual totals with large rainfalls in August following a somewhat dry and early summer. Flow records developed for each station reflect this observation as the peak flows in 2016 occurred both during snow-melt runoff and following rain events in August and September.

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 uses Terrace, track-etch type radon gas monitors (Tech/Ops Landauer Inc. Glenwood, Illinois). Monitors are collected and replaced semi-annually from ten stations established throughout the area. Due to changes in the Landauer ordering system, new track-etch cups were not delivered in July as expected. This resulted in the January to July radon monitoring period being extended to August 9, 2016. This extended monitoring period did not negatively impact radon results as the track-etch cups were collected within the allowable monitoring period as recommended by the manufacturer.

The ten radon monitoring stations are illustrated in **Figure 4.7.1-1** and are located in the following areas:

- Airport Beacon
- Eldorado Town Site
- Northwest of the Airport
- Ace Creek
- Fay Waste Rock Pile
- Fookes Delta
- Marie Lake Delta
- Donaldson Lake
- Fredette Lake
- Uranium City

Track-etch cups were set out at ten stations in the Beaverlodge area from January 2016 to August 2016 then again from August 2016 to March 2017. Cameco's field contractor was unable to retrieve the track etch cups until March 2017 and as a result radon data for the second half of 2016 will not be available for this report. This data will however be reported in the 2017 Annual Report.

Table 4.7.1 presents a summary of the radon monitoring conducted at the 10 sites for the 2016 monitoring period and compares it to the previous five years. 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.

SECTION 5.0

OUTLOOK

5.0 OUTLOOK

This section of the report describes those tasks and activities planned for 2017.

5.1 Regular Scheduled Monitoring

Representatives of Cameco continue to implement the Beaverlodge Environmental Monitoring Program, 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 named ZOR-01 and ZOR-02. These sampling locations have been established to create a baseline and to monitor the success of the Zora Creek flow path reconstruction through the Bolger Waste Rock Pile. The flow path reconstruction is discussed in more detail in **Section 3.2.4.**

5.2 Planned Public and NSEQC 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 review 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.

In 2016, the renewal of the Ministerial Order for the Northern Saskatchewan Environmental Quality Committee (NSEQC) was required. To ensure efficacy, the Saskatchewan Ministry of Government Relations completed a comprehensive review of the program. The NSEQC had not been reinstated by the end of 2016, as a result the NSEQC did not host or attend any meetings in 2016. It is expected that the Ministerial Order will be re-instated in 2017.

Once the Ministerial Order has been signed with the NSEQC Cameco will resume providing updates on the Beaverlodge activities to the NSEQC at least annually. These updates can occur as part of a larger presentation related to all Cameco activities or be specific to Beaverlodge, depending on the amount of activity occurring on the site. In the past when there have been significant activities occurring or consultation required Cameco will host an NSEQC meeting in Uranium City and invite local residents to attend. The meeting is then followed by a tour of the properties, typically focusing on any changes that have occurred since the previous tour.

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 checking that site conditions remain safe, stable, and secure. In addition, activities to address previous inspection recommendations are assessed to confirm that the activity 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.

As discussed in **Section 3.1.2,** inspections of the Marie and Fookes Reservoir outlet structures, Fookes Delta cover, and areas associated with crown pillars are completed annually by Cameco during the JRG inspection.

5.4 2017 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 towards this goal.

Cameco has prepared a path forward work-plan and schedule, which was presented to the Commission during the 2013 relicensing process. 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. The work plan has been vetted through the JRG and reviewed with local and regional stakeholders.

As outlined in **Section 2.5.2,** 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

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 will 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.

5.4.2 Historic Mine Openings Rehabilitation

Assessment

In 2017 Cameco will be investigating the remaining vertical openings (raises and shafts) in order to develop plans and complete designs for final remediation of the openings. The investigation will include an assessment of stainless steel covers and potential backfill options for some openings where backfill would be feasible.

Rehabilitation

Investigation and design of eleven stainless steel caps was completed in 2016, with fabrication and installation planned for 2017.

Kova Engineering was contracted in June 2016 to design the stainless steel caps. Uranium City Contracting will have the caps fabricated and shipped to Uranium City in early 2017. UCC will then install the caps, with KOVA providing installation QA/QC.

5.4.3 Decommission identified boreholes

In 2016, additional boreholes were discovered during final property inspections. Boreholes discovered during property inspections will be sealed prior to the property being transfer to the IC program. A record of all boreholes found on the properties, and their status, is provided in **Appendix C**.

5.4.4 Re-establishment of the Zora Creek flow path

Final construction of the Zora Creek flow path was completed in 2016, and included some additional excavation and grading along the southwest slopes, repairs to the access road and placement of additional rip rap material at the channel inlet. The only physical work expected to occur in 2017 is the removal of the sediment curtain from the inlet to Verna Lake.

The primary focus in 2017 will be monitoring channel performance. This will include continued water quality sampling and visual inspections. This monitoring data will be used to determine what, if any, additional work is needed in conjunction with the reconstructed Zora Creek flow path.

5.4.5 Final Inspection and Cleanup of the Properties

Final inspections and clean-up of the remaining properties was mostly completed in 2016. Remaining inspections and clean-up (if required) planned for 2017 include the Moran Pit area as well as completing some additional inspections to fill gaps not captured during the 2016 inspections.

5.4.6 Work in Addition to the Path Forward Activities

Transmission Line Remediation

During the final property inspections conducted in 2015, remnants of old power infrastructure including poles, supports and wires were discovered on some of the properties. An assessment of the transmission line infrastructure was completed in 2016 to evaluate the extent and risk posed by the remnant infrastructure and to assess potential remediation options. Based on the assessment, the final remediation option proposed by Cameco includes removal of all steel lines and brackets, while leaving the fallen wooden poles in-situ.

Ace Creek Watershed Hydrologic Monitoring

This 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 in the various sub-watersheds feeding Ace Creek. The information supplied by the additional monitoring will be used to support the pathways model predictions for the Ace Creek area.

Fish Assessment

A fish assessment is being planned in response to questions raised during the 2016 public meeting in Uranium City. Cameco plans to conduct analysis of fish tissues from multiple species in several lake in the Beaverlodge Area. The intent is to update the data available on fish tissue concentrations which can be used as part of the upcoming SOE. This data may also be used to update the Fish Consumption Advisory in place for the Martin and Beaverlodge lakes if fish tissue results have changed since the last sampling period.

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

Hab Site - upstream of confluence of hab and pistol creeks

		Previous Period Averages				Year 2016 Statistics					
		2012	2013	2014	2015	Avg	Count	Count < DL	StDev	Min	Max
M Ions	Alk (mg/l)	105.4	105.8	102.8	132.2	92.0	5	0	24.9	65.0	133.0
	Ca (mg/l)	33.6	33.6	29.8	38.8	28.0	5	0	6.0	22.0	38.0
	Cl (mg/l)	1.08	0.80	0.70	1.28	0.60	5	0	0.30	0.30	1.10
	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)	235	232	216	284	202	5	0	43	160	275
	Hardness (mg/l)	116	115	103	136	96	5	0	21	74	130
	HCO3 (mg/l)	128.6	129.2	125.5	161.0	112.2	5	0	30.4	79.0	162.0
	K (mg/l)	1.5	1.5	1.2	1.3	1.1	5	0	0.2	0.9	1.4
	Na (mg/l)	4.2	4.0	3.4	4.8	3.0	5	0	0.8	2.0	4.2
	OH (mg/l)	1.0	1.0	1.0	1.0	1.0	5	5	0.0	1.0	1.0
	SO4 (mg/l)	17.2	16.4	14.8	18.3	14.4	5	0	3.0	12.0	19.0
	Sum of Ions (mg/l)	194	193	182	235	166	5	0	41	122	234
Metal	As (µg/l)	0.3	0.3	0.4	0.4	0.3	5	0	0.1	0.3	0.4
	Ba (mg/l)	0.112	0.126	0.121	0.149	0.111	5	0	0.024	0.086	0.150
	Cu (mg/l)	0.0018	0.0009	0.0010	0.0006	0.0012	5	0	0.0007	0.0003	0.0022
	Fe (mg/l)	0.149	0.246	0.210	0.327	0.209	5	0	0.148	0.085	0.390
	Mo (mg/l)	0.0033	0.0029	0.0026	0.0030	0.0027	5	0	0.0007	0.0017	0.0034
	Ni (mg/l)	0.00058	0.00052	0.00068	0.00050	0.00070	5	0	0.00030	0.00040	0.00120
	Pb (mg/l)	0.0002	0.0004	0.0004	0.0003	0.0002	5	3	0.0001	0.0001	0.0003
	Se (mg/l)	0.0001	0.0001	0.0001	0.0001	0.0001	5	3	0.0000	0.0001	0.0001
	U (µg/l)	127.200	148.600	119.000	174.667	130.400	5	0	91.800	39.000	234.000
	Zn (mg/l)	0.003	0.002	0.003	0.001	0.001	5	1	0.000	0.001	0.001
Nutrient	C-(org) (mg/l)	11.000	8.100	8.200	11.000	11.000	1	0		11.000	11.000
	NH3-N (mg/l)	0.01	0.04	0.05	0.21	0.05	1	0		0.05	0.05
	NO3 (mg/l)	0.050	0.050	0.040	0.047	0.113	3	1	0.087	0.040	0.210
Phys Para	pH-L (pH Unit)	7.61	7.59	7.65	7.59	7.64	5	0	0.16	7.41	7.82
	TDS (mg/l)	158.20	149.40	143.00	184.67	133.80	5	0	19.64	117.00	167.00
	Temp-H20 (°C)	6.1	15.0	11.7	6.1	9.2	5	0	7.4	1.7	19.3
	TSS (mg/l)	1.200	3.000	1.250	2.000	1.400	5	2	0.894	1.000	3.000
Rads	Pb210 (Bq/L)	0.04	0.02	0.06	0.09	0.03	1	0		0.03	0.03
	Po210 (Bq/L)	0.008	0.010	0.010	0.070	0.020	1	0		0.020	0.020
	Ra226 (Bq/L)	0.554	0.928	0.655	1.070	0.686	5	0	0.415	0.360	1.400

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

Dubyna Lake discharge at road crossing

		Previous Period Averages				Year 2016 Statistics					
		2012	2013	2014	2015	Avg	Count	Count < DL	StDev	Min	Max
M Ions	Alk (mg/l)	90.0	92.4	92.0	89.8	90.0	6	0	6.4	80.0	98.0
	Ca (mg/l)	37.2	36.2	36.2	34.8	34.5	6	0	1.6	32.0	36.0
	Cl (mg/l)	0.70	0.62	0.64	0.70	0.62	6	0	0.17	0.40	0.90
	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)	230	228	228	226	222	6	0	19	201	246
	Hardness (mg/l)	116	112	113	108	107	6	0	5	100	112
	HCO3 (mg/l)	109.8	112.6	112.4	109.5	109.7	6	0	7.9	98.0	120.0
	K (mg/l)	0.9	1.0	0.7	0.6	0.8	6	0	0.1	0.6	1.0
	Na (mg/l)	2.1	2.1	2.0	2.0	2.0	6	0	0.2	1.8	2.2
	OH (mg/l)	1.0	1.0	1.0	1.0	1.0	6	6	0.0	1.0	1.0
	SO4 (mg/l)	26.7	25.2	24.4	24.0	22.8	6	0	2.0	20.0	25.0
	Sum of Ions (mg/l)	183	183	182	177	176	6	0	12	159	191
Metal	As (µg/l)	0.1	0.1	0.2	0.1	0.1	6	0	0.0	0.1	0.2
	Ba (mg/l)	0.047	0.048	0.047	0.047	0.045	6	0	0.004	0.040	0.050
	Cu (mg/l)	0.0006	0.0007	0.0013	0.0005	0.0008	6	0	0.0003	0.0005	0.0013
	Fe (mg/l)	0.017	0.017	0.024	0.014	0.018	6	0	0.004	0.013	0.024
	Mo (mg/l)	0.0021	0.0021	0.0019	0.0021	0.0020	6	0	0.0001	0.0018	0.0021
	Ni (mg/l)	0.00018	0.00024	0.00026	0.00020	0.00023	6	0	0.00005	0.00020	0.00030
	Pb (mg/l)	0.0001	0.0002	0.0001	0.0001	0.0001	6	5	0.0000	0.0001	0.0002
	Se (mg/l)	0.0001	0.0001	0.0001	0.0001	0.0001	6	3	0.0000	0.0001	0.0001
	U (µg/l)	197.333	184.200	169.000	192.750	159.000	6	0	28.948	110.000	190.000
	Zn (mg/l)	0.001	0.001	0.002	0.001	0.001	6	3	0.001	0.001	0.003
Nutrient	C-(org) (mg/l)	9.350	9.600	9.100	8.800	8.650	2	0	0.636	8.200	9.100
	NH3-N (mg/l)	0.02	0.10	0.05	0.04	0.05	2	0	0.02	0.03	0.06
	NO3 (mg/l)	0.162	0.076	0.238	0.210	0.185	4	0	0.191	0.060	0.470
Phys Para	pH-L (pH Unit)	7.73	7.73	7.75	7.78	7.82	6	0	0.14	7.63	8.01
	TDS (mg/l)	155.50	151.80	154.40	154.50	146.50	6	0	10.82	132.00	162.00
	Temp-H20 (°C)	5.3	14.1	10.3	10.5	8.4	6	0	8.0	1.7	21.3
	TSS (mg/l)	1.167	1.200	1.000	1.000	1.000	6	4	0.000	1.000	1.000
Rads	Pb210 (Bq/L)	0.02	0.02	0.07	0.02	0.08	2	1	0.08	0.02	0.13
	Po210 (Bq/L)	0.008	0.007	0.009	0.008	0.006	2	0	0.000	0.006	0.006
	Ra226 (Bq/L)	0.030	0.044	0.038	0.038	0.040	6	0	0.011	0.030	0.060

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

Verna Lake discharge to Ace Lake

		Previous Period Averages				Year 2016 Statistics					
		2012	2013	2014	2015	Avg	Count	Count < DL	StDev	Min	Max
M Ions	Alk (mg/l)	63.0	96.0	102.5	105.2	107.7	10	0	5.8	99.0	116.0
	Ca (mg/l)	32.0	42.0	43.5	44.7	44.4	10	0	2.0	42.0	48.0
	Cl (mg/l)	0.40	0.40	0.45	0.83	0.69	9	3	0.26	0.40	1.00
	CO3 (mg/l)	1.0	1.0	1.0	1.0	1.0	10	10	0.0	1.0	1.0
	Cond-L (µS/cm)	207	275	285	306	302	10	0	20	279	330
	Hardness (mg/l)	107	140	144	151	151	10	0	6	142	161
	HCO3 (mg/l)	77.0	117.0	125.0	128.3	131.4	10	0	7.2	121.0	142.0
	K (mg/l)	1.7	0.9	0.8	0.9	1.0	10	0	0.2	0.8	1.3
	Na (mg/l)	1.8	2.3	2.3	2.5	2.5	10	0	0.1	2.3	2.6
	OH (mg/l)	1.0	1.0	1.0	1.0	1.0	10	10	0.0	1.0	1.0
	SO4 (mg/l)	41.0	48.0	45.5	52.9	50.5	10	0	1.6	48.0	53.0
	Sum of Ions (mg/l)	161	219	226	240	240	10	0	9	227	254
Metal	As (µg/l)	0.3	0.2	0.3	0.2	0.2	10	0	0.1	0.2	0.4
	Ba (mg/l)	0.019	0.022	0.024	0.021	0.023	10	0	0.001	0.022	0.025
	Cu (mg/l)	0.0017	0.0010	0.0003	0.0003	0.0003	10	4	0.0001	0.0002	0.0003
	Fe (mg/l)	0.095	0.028	0.036	0.011	0.009	10	0	0.005	0.002	0.019
	Mo (mg/l)	0.0007	0.0010	0.0008	0.0010	0.0011	10	0	0.0002	0.0009	0.0016
	Ni (mg/l)	0.00030	0.00010	0.00015	0.00010	0.00011	10	4	0.00003	0.00010	0.00020
	Pb (mg/l)	0.0001	0.0001	0.0001	0.0001	0.0001	10	10	0.0000	0.0001	0.0001
	Se (mg/l)	0.0003	0.0001	0.0002	0.0002	0.0002	10	0	0.0001	0.0002	0.0004
	U (µg/l)	117.000	201.000	154.000	389.278	331.000	10	0	47.575	237.000	380.000
	Zn (mg/l)	0.001	0.001	0.001	0.001	0.001	10	9	0.000	0.001	0.001
Nutrient	C-(org) (mg/l)				7.300	7.100	1	0		7.100	7.100
	NH3-N (mg/l)				0.04	0.04	1	0		0.04	0.04
	NO3 (mg/l)	0.040	0.040	0.040	0.048	0.062	5	3	0.032	0.040	0.110
Phys Para	pH-L (pH Unit)	7.19	7.51	7.70	7.80	7.88	10	0	0.07	7.78	8.03
	TDS (mg/l)	203.50	175.00	196.50	198.61	195.80	10	0	9.95	184.00	218.00
	Temp-H20 (°C)	20.4	22.1	22.1	6.8	9.5	11	0	8.2	1.3	23.4
	TSS (mg/l)	1.000	1.000	1.000	1.000	1.000	10	9	0.000	1.000	1.000
Rads	Pb210 (Bq/L)	0.04			0.03	0.02	1	0		0.02	0.02
	Po210 (Bq/L)	0.030			0.005	0.005	1	1		0.005	0.005
	Ra226 (Bq/L)	0.085	0.140	0.150	0.109	0.108	10	0	0.011	0.080	0.120

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

Ace Lake discharge at weir

		Previous Period Averages				Year 2016 Statistics					
		2012	2013	2014	2015	Avg	Count	Count < DL	StDev	Min	Max
M Ions	Alk (mg/l)	50.5	52.0	52.5	53.0	52.0	2	0	2.8	50.0	54.0
	Ca (mg/l)	16.8	17.5	16.5	17.0	17.0	2	0	0.0	17.0	17.0
	Cl (mg/l)	1.08	0.95	0.90	0.95	0.80	2	0	0.14	0.70	0.90
	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)	115	116	119	121	122	2	0	6	118	126
	Hardness (mg/l)	55	58	55	55	56	2	0	0	56	56
	HCO3 (mg/l)	61.5	63.5	64.0	64.5	63.5	2	0	3.5	61.0	66.0
	K (mg/l)	0.8	0.9	0.8	0.6	0.6	2	0	0.0	0.6	0.6
	Na (mg/l)	1.6	1.6	1.5	1.5	1.5	2	0	0.1	1.4	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	6.8	6.9	7.0	7.4	2	0	0.2	7.2	7.5
	Sum of Ions (mg/l)	92	95	94	94	95	2	0	4	92	97
Metal	As (µg/l)	0.1	0.2	0.2	0.2	0.2	2	0	0.1	0.1	0.2
	Ba (mg/l)	0.023	0.024	0.024	0.024	0.023	2	0	0.000	0.023	0.023
	Cu (mg/l)	0.0003	0.0005	0.0005	0.0008	0.0003	2	0	0.0001	0.0002	0.0004
	Fe (mg/l)	0.034	0.037	0.033	0.041	0.040	2	0	0.009	0.033	0.046
	Mo (mg/l)	0.0010	0.0010	0.0009	0.0010	0.0011	2	0	0.0001	0.0010	0.0011
	Ni (mg/l)	0.00013	0.00015	0.00015	0.00020	0.00015	2	0	0.00007	0.00010	0.00020
	Pb (mg/l)	0.0001	0.0005	0.0001	0.0003	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)	13.500	11.500	11.500	13.500	14.500	2	0	0.707	14.000	15.000
	Zn (mg/l)	0.001	0.001	0.001	0.003	0.001	2	2	0.000	0.001	0.001
Nutrient	C-(org) (mg/l)	8.100	6.800	6.800	7.000	7.400	1	0		7.400	7.400
	NH3-N (mg/l)	0.02	0.06	0.04	0.06	0.08	1	0		0.08	0.08
	NO3 (mg/l)	0.120	0.175	0.240	0.190	0.050	1	0		0.050	0.050
Phys Para	pH-L (pH Unit)	7.62	7.55	7.54	7.52	7.62	2	0	0.06	7.57	7.66
	TDS (mg/l)	78.00	74.00	86.00	80.50	85.50	2	0	2.12	84.00	87.00
	Temp-H20 (°C)	5.2	4.7	5.2	5.8	7.2	2	0	7.1	2.2	12.2
	TSS (mg/l)	1.000	1.000	1.000	2.000	1.000	2	2	0.000	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)	0.008	0.005	0.005	0.006	0.006	1	0		0.006	0.006
	Ra226 (Bq/L)	0.009	0.020	0.020	0.030	0.015	2	0	0.008	0.009	0.020

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

Ace Creek discharge to Beaverlodge Lake

		Previous Period Averages				Year 2016 Statistics					
		2012	2013	2014	2015	Avg	Count	Count < DL	StDev	Min	Max
M Ions	Alk (mg/l)	53.0	52.5	52.3	53.6	53.3	11	0	1.7	50.0	56.0
	Ca (mg/l)	18.2	17.5	17.2	17.5	17.4	11	0	1.2	16.0	20.0
	Cl (mg/l)	1.68	1.24	1.19	1.25	1.15	11	0	0.56	0.80	2.80
	CO3 (mg/l)	1.0	1.0	1.0	1.0	1.0	11	11	0.0	1.0	1.0
	Cond-L (µS/cm)	129	126	124	126	124	11	0	10	110	147
	Hardness (mg/l)	60	57	57	58	57	11	0	4	52	65
	HCO3 (mg/l)	64.7	63.9	63.8	65.4	64.9	11	0	2.1	61.0	68.0
	K (mg/l)	0.8	0.8	0.7	0.6	0.8	11	0	0.1	0.6	1.0
	Na (mg/l)	2.2	1.9	1.9	1.9	1.8	11	0	0.3	1.6	2.8
	OH (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	11	11	0.0	1.0	1.0
	SO4 (mg/l)	9.5	8.3	8.5	8.6	8.9	11	0	2.1	7.1	13.0
	Sum of Ions (mg/l)	101	97	97	99	99	11	0	5	90	111
Metal	As (µg/l)	0.2	0.2	0.2	0.2	0.2	11	0	0.0	0.2	0.2
	Ba (mg/l)	0.024	0.024	0.025	0.026	0.024	11	0	0.001	0.022	0.026
	Cu (mg/l)	0.0005	0.0005	0.0010	0.0006	0.0004	11	0	0.0002	0.0003	0.0008
	Fe (mg/l)	0.070	0.065	0.082	0.062	0.058	11	0	0.018	0.044	0.100
	Mo (mg/l)	0.0010	0.0010	0.0010	0.0010	0.0012	11	0	0.0005	0.0008	0.0027
	Ni (mg/l)	0.00023	0.00022	0.00026	0.00020	0.00019	11	0	0.00005	0.00010	0.00030
	Pb (mg/l)	0.0003	0.0005	0.0006	0.0004	0.0002	11	4	0.0001	0.0001	0.0004
	Se (mg/l)	0.0001	0.0001	0.0001	0.0002	0.0001	11	3	0.0001	0.0001	0.0004
	U (µg/l)	34.917	25.455	28.000	33.091	28.727	11	0	19.147	20.000	86.000
	Zn (mg/l)	0.001	0.001	0.003	0.001	0.001	11	7	0.000	0.001	0.002
Nutrient	C-(org) (mg/l)	8.250	8.625	7.800	7.067	7.500	3	0	0.173	7.300	7.600
	NH3-N (mg/l)	0.09	0.08	0.07	0.07	0.08	3	0	0.02	0.06	0.09
	NO3 (mg/l)	0.088	0.147	0.141	0.209	0.157	7	1	0.181	0.040	0.500
Phys Para	pH-L (pH Unit)	7.72	7.61	7.73	7.71	7.65	11	0	0.12	7.46	7.81
	TDS (mg/l)	87.08	82.73	81.00	83.82	90.36	11	0	13.20	78.00	121.00
	Temp-H20 (°C)	7.2	8.2	8.1	8.1	8.8	10	0	8.5	1.7	22.3
	TSS (mg/l)	1.083	1.182	1.250	1.364	1.000	11	8	0.000	1.000	1.000
Rads	Pb210 (Bq/L)	0.02	0.03	0.03	0.02	0.03	4	2	0.01	0.02	0.03
	Po210 (Bq/L)	0.008	0.008	0.012	0.008	0.007	4	2	0.003	0.005	0.010
	Ra226 (Bq/L)	0.043	0.055	0.057	0.075	0.038	11	0	0.013	0.020	0.060

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

Fulton Lake discharge

		Previous Period Averages				Year 2016 Statistics					
		2012	2013	2014	2015	Avg	Count	Count < DL	StDev	Min	Max
M Ions	Alk (mg/l)	71.0	72.0	76.0	70.0	66.0	1	0		66.0	66.0
	Ca (mg/l)	21.0	21.0	20.0	20.0	21.0	1	0		21.0	21.0
	Cl (mg/l)	0.70	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)	144	145	145	146	145	1	0		145	145
	Hardness (mg/l)	72	72	70	69	72	1	0		72	72
	HCO3 (mg/l)	87.0	88.0	93.0	85.0	80.0	1	0		80.0	80.0
	K (mg/l)	0.9	0.9	0.6	0.6	0.8	1	0		0.8	0.8
	Na (mg/l)	2.0	2.0	1.9	1.8	1.9	1	0		1.9	1.9
	OH (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	1	1		1.0	1.0
	SO4 (mg/l)	4.5	4.4	4.3	4.2	4.4	1	0		4.4	4.4
	Sum of Ions (mg/l)	121	122	125	117	114	1	0		114	114
Metal	As (µg/l)	0.1	0.1	0.1	0.1	0.1	1	0		0.1	0.1
	Ba (mg/l)	0.017	0.017	0.017	0.016	0.018	1	0		0.018	0.018
	Cu (mg/l)	0.0005	0.0007	0.0005	0.0002	0.0005	1	0		0.0005	0.0005
	Fe (mg/l)	0.011	0.016	0.010	0.008	0.010	1	0		0.010	0.010
	Mo (mg/l)	0.0019	0.0017	0.0015	0.0017	0.0019	1	0		0.0019	0.0019
	Ni (mg/l)	0.00020	0.00030	0.00020	0.00020	0.00010	1	1		0.00010	0.00010
	Pb (mg/l)	0.0001	0.0009	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)	1.600	1.600	1.400	1.700	1.700	1	0		1.700	1.700
	Zn (mg/l)	0.003	0.001	0.001	0.001	0.001	1	1		0.001	0.001
Nutrient	C-(org) (mg/l)	7.600	7.100	7.500	7.500	7.600	1	0		7.600	7.600
	NH3-N (mg/l)	0.02	0.05	0.06	0.08	0.06	1	0		0.06	0.06
	NO3 (mg/l)	0.040	0.040	0.040	0.040	0.050	1	0		0.050	0.050
Phys Para	pH-L (pH Unit)	7.63	7.68	7.77	7.86	7.66	1	0		7.66	7.66
	TDS (mg/l)	105.00	90.00	97.00	93.00	92.00	1	0		92.00	92.00
	Temp-H20 (°C)	11.8	12.2	10.1	11.4	12.5	1	0		12.5	12.5
	TSS (mg/l)	1.000	1.000	1.000	2.000	1.000	1	1		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	0.005	0.005	0.005	1	1		0.005	0.005
	Ra226 (Bq/L)	0.006	0.005	0.005	0.008	0.007	1	0		0.007	0.007

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

Fookes Reservoir discharge

		Previous Period Averages				Year 2016 Statistics					
		2012	2013	2014	2015	Avg	Count	Count < DL	StDev	Min	Max
M Ions	Alk (mg/l)	140.3	142.8	137.3	138.0	132.8	4	0	7.4	124.0	141.0
	Ca (mg/l)	27.3	27.8	27.5	29.0	29.0	4	0	2.6	26.0	32.0
	Cl (mg/l)	4.33	3.75	3.25	3.25	2.68	4	0	0.43	2.10	3.00
	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)	353	346	331	329	309	4	0	22	294	342
	Hardness (mg/l)	91	92	91	97	97	4	0	9	86	108
	HCO3 (mg/l)	171.0	174.0	167.5	167.8	162.0	4	0	9.1	151.0	172.0
	K (mg/l)	1.4	1.4	1.0	1.1	1.2	4	0	0.2	1.0	1.4
	Na (mg/l)	43.7	40.8	36.3	33.0	29.3	4	0	5.7	21.0	34.0
	OH (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	4	4	0.0	1.0	1.0
	SO4 (mg/l)	43.0	40.5	34.8	32.0	29.8	4	0	3.9	24.0	33.0
	Sum of Ions (mg/l)	296	294	276	272	260	4	0	15	246	279
Metal	As (µg/l)	1.0	1.0	0.9	0.8	0.8	4	0	0.1	0.6	0.9
	Ba (mg/l)	0.036	0.037	0.036	0.037	0.037	4	0	0.002	0.035	0.040
	Cu (mg/l)	0.0016	0.0013	0.0010	0.0009	0.0013	4	0	0.0005	0.0008	0.0017
	Fe (mg/l)	0.011	0.010	0.012	0.011	0.016	4	0	0.006	0.010	0.024
	Mo (mg/l)	0.0173	0.0170	0.0143	0.0127	0.0119	4	0	0.0018	0.0096	0.0140
	Ni (mg/l)	0.00030	0.00035	0.00030	0.00033	0.00030	4	1	0.00014	0.00010	0.00040
	Pb (mg/l)	0.0007	0.0006	0.0005	0.0004	0.0006	4	0	0.0001	0.0005	0.0007
	Se (mg/l)	0.0043	0.0040	0.0032	0.0027	0.0023	4	0	0.0005	0.0017	0.0028
	U (µg/l)	387.667	372.000	316.750	271.750	248.000	4	0	45.920	184.000	293.000
	Zn (mg/l)	0.001	0.001	0.001	0.001	0.002	4	2	0.002	0.001	0.006
Nutrient	C-(org) (mg/l)	8.500	7.200	7.300	7.300	7.200	1	0		7.200	7.200
	NH3-N (mg/l)	0.01	0.04	0.05	0.06	0.03	1	0		0.03	0.03
	NO3 (mg/l)	0.040	0.040	0.053	0.045	0.045	2	1	0.007	0.040	0.050
Phys Para	pH-L (pH Unit)	8.11	8.09	8.05	8.06	8.05	4	0	0.07	7.98	8.13
	TDS (mg/l)	227.67	216.50	207.75	204.75	198.50	4	0	16.82	181.00	217.00
	Temp-H20 (°C)	16.1	11.5	8.2	8.9	9.6	4	0	9.0	2.0	20.8
	TSS (mg/l)	1.333	1.000	1.000	1.500	1.000	4	3	0.000	1.000	1.000
Rads	Pb210 (Bq/L)	0.08	0.11	0.07	0.10	0.09	1	0		0.09	0.09
	Po210 (Bq/L)	0.040	0.040	0.040	0.040	0.030	1	0		0.030	0.030
	Ra226 (Bq/L)	1.300	1.300	1.200	1.375	1.170	4	0	0.273	0.780	1.400

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

Marie Reservoir Outflow

		Previous Period Averages				Year 2016 Statistics					
		2012	2013	2014	2015	Avg	Count	Count < DL	StDev	Min	Max
M Ions	Alk (mg/l)	139.3	143.3	141.5	135.8	127.5	4	0	14.8	108.0	142.0
	Ca (mg/l)	18.0	21.3	24.0	21.8	23.5	4	0	2.4	21.0	26.0
	Cl (mg/l)	4.00	3.75	3.45	3.10	2.73	4	0	0.32	2.40	3.00
	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)	329	334	333	321	306	4	0	30	278	342
	Hardness (mg/l)	68	76	83	77	82	4	0	7	74	89
	HCO3 (mg/l)	170.0	174.8	172.5	165.8	155.5	4	0	17.9	132.0	173.0
	K (mg/l)	1.5	1.5	1.1	1.2	1.2	4	0	0.1	1.0	1.3
	Na (mg/l)	47.7	45.0	40.5	39.3	34.5	4	0	2.4	33.0	38.0
	OH (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	4	4	0.0	1.0	1.0
	SO4 (mg/l)	33.3	32.8	32.0	29.5	29.0	4	0	1.6	27.0	31.0
	Sum of Ions (mg/l)	280	285	280	266	252	4	0	23	225	278
Metal	As (µg/l)	1.9	1.6	1.4	1.5	1.1	4	0	0.1	1.0	1.3
	Ba (mg/l)	0.077	0.079	0.073	0.081	0.071	4	0	0.006	0.065	0.077
	Cu (mg/l)	0.0006	0.0007	0.0007	0.0007	0.0006	4	0	0.0002	0.0004	0.0009
	Fe (mg/l)	0.099	0.033	0.024	0.058	0.060	4	0	0.034	0.019	0.096
	Mo (mg/l)	0.0097	0.0106	0.0110	0.0102	0.0101	4	0	0.0006	0.0097	0.0110
	Ni (mg/l)	0.00057	0.00058	0.00055	0.00058	0.00050	4	0	0.00014	0.00030	0.00060
	Pb (mg/l)	0.0003	0.0006	0.0003	0.0003	0.0005	4	0	0.0002	0.0002	0.0007
	Se (mg/l)	0.0020	0.0020	0.0021	0.0017	0.0017	4	0	0.0003	0.0015	0.0021
	U (µg/l)	270.000	291.250	280.250	241.000	235.250	4	0	30.325	208.000	276.000
	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)	12.000	9.900	8.300	9.200	8.000	1	0		8.000	8.000
	NH3-N (mg/l)	0.03	0.12	0.06	0.08	0.06	1	0		0.06	0.06
	NO3 (mg/l)	0.040	0.040	0.053	0.040	0.045	2	1	0.007	0.040	0.050
Phys Para	pH-L (pH Unit)	7.97	8.06	8.05	8.03	8.05	4	0	0.09	7.93	8.16
	TDS (mg/l)	219.67	213.75	208.50	202.25	197.50	4	0	26.64	172.00	221.00
	Temp-H20 (°C)	10.8	11.4	8.2	8.3	9.3	4	0	9.2	1.9	21.0
	TSS (mg/l)	1.333	1.000	1.250	1.250	1.000	4	3	0.000	1.000	1.000
Rads	Pb210 (Bq/L)	0.02	0.06	0.08	0.04	0.03	1	0		0.03	0.03
	Po210 (Bq/L)	0.030	0.020	0.020	0.030	0.030	1	0		0.030	0.030
	Ra226 (Bq/L)	1.567	1.925	1.775	2.075	1.600	4	0	0.245	1.300	1.900

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

Minewater Reservoir Discharge

		Previous Period Averages				Year 2016 Statistics					
		2012	2013	2014	2015	Avg	Count	Count < DL	StDev	Min	Max
M Ions	Alk (mg/l)	286.0	288.0	310.0	281.3	260.0	2	0	41.0	231.0	289.0
	Ca (mg/l)	41.8	55.0	46.5	42.7	60.5	2	0	7.8	55.0	66.0
	Cl (mg/l)	59.50	47.00	49.50	47.67	31.50	2	0	4.95	28.00	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)	780	790	838	743	728	2	0	80	671	784
	Hardness (mg/l)	152	186	167	156	207	2	0	22	191	222
	HCO3 (mg/l)	348.8	351.0	378.0	343.0	317.0	2	0	49.5	282.0	352.0
	K (mg/l)	3.4	2.8	2.6	2.3	2.1	2	0	0.1	2.0	2.1
	Na (mg/l)	122.8	108.0	129.0	105.0	87.5	2	0	4.9	84.0	91.0
	OH (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	2	2	0.0	1.0	1.0
	SO4 (mg/l)	53.5	62.0	74.5	45.0	72.0	2	0	7.1	67.0	77.0
	Sum of Ions (mg/l)	641	638	693	598	584	2	0	75	531	637
Metal	As (µg/l)	3.3	3.0	4.4	4.0	1.4	2	0	0.0	1.4	1.4
	Ba (mg/l)	1.165	1.260	1.145	0.893	0.940	2	0	0.141	0.840	1.040
	Cu (mg/l)	0.0008	0.0006	0.0009	0.0003	0.0007	2	0	0.0001	0.0006	0.0008
	Fe (mg/l)	3.543	1.790	3.530	4.887	0.560	2	0	0.071	0.510	0.610
	Mo (mg/l)	0.0018	0.0016	0.0019	0.0010	0.0020	2	0	0.0001	0.0019	0.0021
	Ni (mg/l)	0.00045	0.00050	0.00055	0.00043	0.00045	2	0	0.00021	0.00030	0.00060
	Pb (mg/l)	0.0010	0.0002	0.0011	0.0002	0.0003	2	0	0.0001	0.0002	0.0004
	Se (mg/l)	0.0052	0.0025	0.0033	0.0019	0.0021	2	0	0.0001	0.0020	0.0021
	U (µg/l)	237.500	225.000	284.500	143.667	288.500	2	0	43.134	258.000	319.000
	Zn (mg/l)	0.001	0.001	0.002	0.001	0.001	2	0	0.000	0.001	0.001
Nutrient	C-(org) (mg/l)	39.000	36.000	34.000	32.000	30.500	2	0	0.707	30.000	31.000
	NH3-N (mg/l)	0.08	0.12	0.11	0.16	0.10	1	0		0.10	0.10
	NO3 (mg/l)	0.075	0.040	0.065	0.130	0.070	2	1	0.042	0.040	0.100
Phys Para	pH-L (pH Unit)	7.73	7.87	8.00	7.80	8.00	2	0	0.32	7.77	8.22
	TDS (mg/l)	541.75	532.00	596.50	501.67	472.00	2	0	45.25	440.00	504.00
	Temp-H20 (°C)	9.7	16.4	16.5	8.6	10.5	2	0	0.4	10.2	10.8
	TSS (mg/l)	8.000	2.000	6.500	7.667	1.500	2	1	0.707	1.000	2.000
Rads	Pb210 (Bq/L)	0.11	0.07	0.14	0.08	0.07	2	0	0.01	0.06	0.07
	Po210 (Bq/L)	0.090	0.050	0.090	0.030	0.030	2	0	0.000	0.030	0.030
	Ra226 (Bq/L)	5.350	7.900	9.600	5.333	6.050	2	0	0.212	5.900	6.200

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

Meadow Fen discharge at weir

		Previous Period Averages				Year 2016 Statistics					
		2012	2013	2014	2015	Avg	Count	Count < DL	StDev	Min	Max
M Ions	Alk (mg/l)	138.1	138.3	140.1	139.9	124.5	10	0	23.4	63.0	142.0
	Ca (mg/l)	25.8	21.4	23.7	24.0	22.9	10	0	3.6	14.0	27.0
	Cl (mg/l)	13.59	4.75	4.38	7.89	4.74	10	0	2.44	3.00	9.60
	CO3 (mg/l)	1.0	1.0	1.0	1.0	1.0	10	10	0.0	1.0	1.0
	Cond-L (µS/cm)	369	328	329	341	291	10	0	56	141	341
	Hardness (mg/l)	92	77	82	85	80	10	0	13	46	90
	HCO3 (mg/l)	168.5	168.8	170.8	170.7	151.9	10	0	28.5	77.0	173.0
	K (mg/l)	1.7	1.4	1.2	1.1	1.2	10	0	0.2	0.8	1.6
	Na (mg/l)	45.0	42.9	39.9	40.4	32.9	10	0	7.9	11.0	39.0
	OH (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	10	10	0.0	1.0	1.0
	SO4 (mg/l)	38.0	30.4	30.4	29.0	25.2	10	0	6.0	10.0	31.0
	Sum of Ions (mg/l)	299	275	276	279	244	10	0	44	125	277
Metal	As (µg/l)	1.7	1.5	1.3	1.3	1.1	10	0	0.2	0.9	1.4
	Ba (mg/l)	0.199	0.228	0.205	0.366	0.199	10	0	0.135	0.100	0.470
	Cu (mg/l)	0.0008	0.0006	0.0007	0.0005	0.0007	10	1	0.0006	0.0002	0.0020
	Fe (mg/l)	0.148	0.056	0.047	0.066	0.060	10	0	0.075	0.014	0.260
	Mo (mg/l)	0.0092	0.0097	0.0104	0.0094	0.0084	10	0	0.0023	0.0035	0.0110
	Ni (mg/l)	0.00069	0.00055	0.00050	0.00053	0.00054	10	0	0.00023	0.00020	0.00110
	Pb (mg/l)	0.0004	0.0005	0.0003	0.0002	0.0002	10	1	0.0001	0.0001	0.0005
	Se (mg/l)	0.0033	0.0019	0.0023	0.0019	0.0016	10	0	0.0004	0.0012	0.0022
	U (µg/l)	264.250	253.500	272.545	226.556	196.900	10	0	71.760	67.000	303.000
	Zn (mg/l)	0.001	0.001	0.001	0.001	0.001	10	5	0.001	0.001	0.004
Nutrient	C-(org) (mg/l)	13.000	10.133	9.450	9.100	8.533	3	0	0.681	8.000	9.300
	NH3-N (mg/l)	0.03	0.06	0.06	0.07	0.08	3	0	0.05	0.05	0.13
	NO3 (mg/l)	0.040	0.040	0.095	0.095	0.071	7	2	0.040	0.040	0.140
Phys Para	pH-L (pH Unit)	7.82	7.88	7.93	7.92	7.91	10	0	0.17	7.46	8.05
	TDS (mg/l)	239.38	211.50	208.09	214.44	188.10	10	0	32.96	108.00	241.00
	Temp-H20 (°C)	9.8	12.1	9.4	8.0	10.0	9	0	8.6	1.4	21.0
	TSS (mg/l)	1.000	1.000	1.000	1.222	1.111	9	7	0.333	1.000	2.000
Rads	Pb210 (Bq/L)	0.05	0.04	0.03	0.04	0.03	3	0	0.00	0.03	0.03
	Po210 (Bq/L)	0.060	0.033	0.020	0.017	0.020	3	0	0.000	0.020	0.020
	Ra226 (Bq/L)	0.880	1.550	1.645	1.667	1.590	10	0	0.338	1.200	2.300

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

Greer Lake discharge at Beaverlodge Lake

		Previous Period Averages				Year 2016 Statistics					
		2012	2013	2014	2015	Avg	Count	Count < DL	StDev	Min	Max
M Ions	Alk (mg/l)	152.6	156.1	143.2	125.5	128.8	10	0	14.5	108.0	149.0
	Ca (mg/l)	24.8	26.6	25.3	20.8	24.2	11	0	3.9	17.0	29.0
	Cl (mg/l)	9.00	6.90	4.52	4.60	4.28	10	0	0.36	4.00	4.90
	CO3 (mg/l)	1.0	1.0	1.0	1.0	1.0	10	10	0.0	1.0	1.0
	Cond-L (µS/cm)	374	366	330	299	303	10	0	35	261	356
	Hardness (mg/l)	93	95	88	77	86	11	0	11	64	102
	HCO3 (mg/l)	186.0	190.5	174.7	153.3	157.1	10	0	17.7	132.0	182.0
	K (mg/l)	1.8	1.7	1.2	1.0	1.3	11	0	0.1	1.1	1.5
	Na (mg/l)	46.8	43.9	38.6	35.8	34.3	11	0	4.1	30.0	41.0
	OH (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	10	10	0.0	1.0	1.0
	SO4 (mg/l)	34.9	30.6	28.3	25.1	25.7	11	0	3.9	21.0	32.0
	Sum of Ions (mg/l)	311	307	279	247	239	11	0	54	98	295
Metal	As (µg/l)	1.9	1.9	1.6	1.6	1.3	11	0	0.5	0.9	2.5
	Ba (mg/l)	1.099	1.089	0.670	0.655	0.447	11	0	0.140	0.280	0.620
	Cu (mg/l)	0.0008	0.0009	0.0008	0.0008	0.0005	11	1	0.0001	0.0002	0.0007
	Fe (mg/l)	0.055	0.054	0.065	0.037	0.050	11	0	0.067	0.011	0.240
	Mo (mg/l)	0.0144	0.0127	0.0109	0.0105	0.0083	11	0	0.0013	0.0065	0.0100
	Ni (mg/l)	0.00044	0.00049	0.00050	0.00041	0.00044	11	0	0.00011	0.00020	0.00060
	Pb (mg/l)	0.0009	0.0008	0.0008	0.0008	0.0006	11	1	0.0011	0.0001	0.0037
	Se (mg/l)	0.0045	0.0028	0.0028	0.0040	0.0021	11	0	0.0004	0.0015	0.0028
	U (µg/l)	349.250	289.200	267.800	244.500	210.273	11	0	66.161	131.000	296.000
	Zn (mg/l)	0.001	0.001	0.002	0.001	0.001	11	7	0.000	0.001	0.002
Nutrient	C-(org) (mg/l)	14.000	11.333	10.000	9.333	9.150	4	0	0.300	8.900	9.500
	NH3-N (mg/l)	0.07	0.12	0.07	0.07	0.06	4	0	0.02	0.05	0.08
	NO3 (mg/l)	0.236	0.240	0.310	0.580	0.203	7	2	0.188	0.040	0.570
Phys Para	pH-L (pH Unit)	8.00	8.00	8.08	8.02	8.02	10	0	0.11	7.80	8.21
	TDS (mg/l)	250.38	237.30	210.30	189.50	194.10	10	0	23.60	169.00	228.00
	Temp-H20 (°C)	8.6	9.2	9.6	9.6	8.7	11	0	8.2	1.4	20.8
	TSS (mg/l)	1.625	1.400	2.000	1.500	1.600	10	7	1.578	1.000	6.000
Rads	Pb210 (Bq/L)	0.08	0.13	0.06	0.07	0.08	4	0	0.05	0.03	0.13
	Po210 (Bq/L)	0.060	0.043	0.040	0.053	0.030	4	0	0.034	0.010	0.080
	Ra226 (Bq/L)	2.450	2.940	2.480	2.275	1.955	11	0	0.543	1.300	2.900

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

Beaverlodge Lake - 100m out from TL-9

		Previous Period Averages				Year 2016 Statistics					
		2012	2013	2014	2015	Avg	Count	Count < DL	StDev	Min	Max
M Ions	Alk (mg/l)	72.3	73.0	73.5	72.5	70.8	4	0	4.8	65.0	76.0
	Ca (mg/l)	21.8	22.3	22.0	21.5	22.0	4	0	2.7	20.0	26.0
	Cl (mg/l)	13.25	12.75	12.50	12.50	12.00	4	0	1.63	10.00	14.00
	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)	245	246	249	251	240	4	0	16	228	263
	Hardness (mg/l)	77	78	77	76	77	4	0	10	71	92
	HCO3 (mg/l)	88.0	89.0	89.5	88.5	86.3	4	0	6.1	79.0	93.0
	K (mg/l)	1.2	1.3	1.0	1.0	1.1	4	0	0.2	0.9	1.3
	Na (mg/l)	19.5	19.8	19.3	19.0	18.5	4	0	3.3	15.0	23.0
	OH (mg/l)	1.0	1.0	1.0	1.0	1.0	4	4	0.0	1.0	1.0
	SO4 (mg/l)	32.8	32.5	31.0	31.5	38.3	4	0	20.0	25.0	68.0
	Sum of Ions (mg/l)	182	183	181	180	184	4	0	33	161	232
Metal	As (µg/l)	0.3	0.3	0.3	0.3	0.3	4	0	0.1	0.2	0.3
	Ba (mg/l)	0.037	0.043	0.042	0.044	0.041	4	0	0.006	0.037	0.050
	Cu (mg/l)	0.0009	0.0027	0.0020	0.0009	0.0018	4	0	0.0024	0.0004	0.0053
	Fe (mg/l)	0.003	0.011	0.007	0.007	0.011	4	0	0.009	0.004	0.024
	Mo (mg/l)	0.0037	0.0038	0.0036	0.0037	0.0035	4	0	0.0004	0.0030	0.0038
	Ni (mg/l)	0.00140	0.00558	0.00370	0.00308	0.00143	4	0	0.00133	0.00020	0.00290
	Pb (mg/l)	0.0001	0.0004	0.0002	0.0001	0.0002	4	3	0.0002	0.0001	0.0005
	Se (mg/l)	0.0027	0.0027	0.0025	0.0026	0.0023	4	0	0.0002	0.0020	0.0025
	U (µg/l)	138.000	141.250	135.000	138.000	127.500	4	0	11.561	112.000	140.000
	Zn (mg/l)	0.002	0.004	0.004	0.003	0.005	4	0	0.007	0.001	0.016
Nutrient	C-(org) (mg/l)	3.400	4.800	3.200	3.200	3.100	1	0		3.100	3.100
	NH3-N (mg/l)	0.08	0.08	0.05	0.07	0.08	1	0		0.08	0.08
	NO3 (mg/l)	0.040	0.045	0.075	0.045	0.085	2	0	0.049	0.050	0.120
Phys Para	pH-L (pH Unit)	7.80	7.80	7.79	7.83	7.80	4	0	0.11	7.64	7.89
	TDS (mg/l)	147.50	142.75	144.75	144.50	144.00	4	0	18.69	134.00	172.00
	Temp-H20 (°C)	7.7	10.7	9.3	8.1	8.6	4	0	6.9	2.3	15.8
	TSS (mg/l)	1.000	1.000	1.000	1.000	1.000	4	4	0.000	1.000	1.000
Rads	Pb210 (Bq/L)	0.02	0.03	0.02	0.02	0.02	1	0		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)	0.025	0.053	0.055	0.065	0.058	4	0	0.029	0.040	0.100

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

Beaverlodge Lake - middle - composite of top, middle, bottom

		Previous Period Averages				Year 2016 Statistics					
		2012	2013	2014	2015	Avg	Count	Count < DL	StDev	Min	Max
M Ions	Alk (mg/l)	69.5	71.0	72.5	70.0	69.0	2	0	4.2	66.0	72.0
	Ca (mg/l)	21.5	21.5	21.0	22.0	21.0	2	0	0.0	21.0	21.0
	Cl (mg/l)	14.00	13.00	13.00	13.00	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)	241	241	245	245	250	2	0	8	244	256
	Hardness (mg/l)	76	76	75	78	74	2	0	0	74	74
	HCO3 (mg/l)	85.0	86.5	88.5	85.5	84.0	2	0	5.7	80.0	88.0
	K (mg/l)	1.3	1.3	1.0	1.0	1.1	2	0	0.2	0.9	1.2
	Na (mg/l)	20.0	19.5	19.0	19.0	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)	33.5	33.0	31.5	31.5	31.5	2	0	0.7	31.0	32.0
	Sum of Ions (mg/l)	181	180	180	178	174	2	0	7	169	179
Metal	As (µg/l)	0.3	0.2	0.3	0.3	0.3	2	0	0.0	0.3	0.3
	Ba (mg/l)	0.034	0.035	0.035	0.033	0.036	2	0	0.001	0.035	0.036
	Cu (mg/l)	0.0017	0.0019	0.0016	0.0016	0.0010	2	0	0.0001	0.0009	0.0011
	Fe (mg/l)	0.005	0.015	0.006	0.005	0.006	2	0	0.001	0.006	0.007
	Mo (mg/l)	0.0038	0.0036	0.0035	0.0036	0.0037	2	0	0.0001	0.0036	0.0038
	Ni (mg/l)	0.00240	0.00245	0.00180	0.00835	0.00310	2	0	0.00410	0.00020	0.00600
	Pb (mg/l)	0.0002	0.0005	0.0002	0.0001	0.0001	2	2	0.0000	0.0001	0.0001
	Se (mg/l)	0.0027	0.0027	0.0026	0.0025	0.0025	2	0	0.0001	0.0024	0.0026
	U (µg/l)	138.500	137.500	135.000	130.500	133.000	2	0	7.071	128.000	138.000
	Zn (mg/l)	0.004	0.005	0.004	0.003	0.002	2	0	0.000	0.002	0.003
Nutrient	C-(org) (mg/l)	3.450	3.850	3.700	3.100	3.200	2	0	0.424	2.900	3.500
	NH3-N (mg/l)	0.04	0.08	0.08	0.05	0.08	2	0	0.04	0.05	0.10
	NO3 (mg/l)	0.040	0.040	0.085	0.140	0.050	2	1	0.014	0.040	0.060
Phys Para	pH-L (pH Unit)	7.84	7.79	7.75	7.81	7.93	2	0	0.05	7.89	7.96
	TDS (mg/l)	140.50	142.00	145.00	139.50	142.00	2	0	11.31	134.00	150.00
	Temp-H20 (°C)	6.8	6.7	5.6	5.9	7.7	2	0	7.6	2.3	13.1
	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	0.02	0.02	0.03	2	1	0.01	0.02	0.04
	Po210 (Bq/L)	0.005	0.005	0.005	0.005	0.005	2	2	0.000	0.005	0.005
	Ra226 (Bq/L)	0.030	0.025	0.025	0.035	0.040	2	0	0.000	0.040	0.040

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

Beaverlodge Outlet

		Previous Period Averages				Year 2016 Statistics					
		2012	2013	2014	2015	Avg	Count	Count < DL	StDev	Min	Max
M Ions	Alk (mg/l)	70.5	69.7	73.4	71.8	69.8	4	0	5.1	63.0	75.0
	Ca (mg/l)	21.8	21.3	21.8	21.3	20.8	4	0	1.0	20.0	22.0
	Cl (mg/l)	14.00	13.00	13.20	12.75	12.50	4	0	1.00	12.00	14.00
	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)	248	241	255	249	244	4	0	16	230	266
	Hardness (mg/l)	77	75	77	75	74	4	0	3	71	78
	HCO3 (mg/l)	86.0	85.0	89.8	87.8	85.3	4	0	6.4	77.0	92.0
	K (mg/l)	1.2	1.2	1.0	0.9	1.0	4	0	0.1	0.9	1.1
	Na (mg/l)	20.0	19.3	19.8	19.0	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)	33.5	32.0	32.4	31.8	36.5	4	0	10.4	30.0	52.0
	Sum of Ions (mg/l)	182	177	184	179	180	4	0	8	172	188
Metal	As (µg/l)	0.3	0.2	0.3	0.2	0.2	4	0	0.1	0.2	0.3
	Ba (mg/l)	0.034	0.034	0.036	0.035	0.035	4	0	0.002	0.033	0.038
	Cu (mg/l)	0.0003	0.0004	0.0006	0.0002	0.0002	4	4	0.0000	0.0002	0.0002
	Fe (mg/l)	0.001	0.006	0.006	0.003	0.004	4	0	0.003	0.001	0.007
	Mo (mg/l)	0.0038	0.0037	0.0037	0.0037	0.0036	4	0	0.0002	0.0034	0.0039
	Ni (mg/l)	0.00018	0.00020	0.00016	0.00020	0.00023	4	0	0.00005	0.00020	0.00030
	Pb (mg/l)	0.0001	0.0004	0.0002	0.0001	0.0001	4	4	0.0000	0.0001	0.0001
	Se (mg/l)	0.0028	0.0027	0.0027	0.0025	0.0025	4	0	0.0002	0.0023	0.0028
	U (µg/l)	139.250	136.667	139.800	136.500	132.500	4	0	8.426	127.000	145.000
	Zn (mg/l)	0.001	0.001	0.002	0.001	0.001	4	4	0.000	0.001	0.001
Nutrient	C-(org) (mg/l)	3.300	3.400	3.900	3.000	2.900	1	0		2.900	2.900
	NH3-N (mg/l)	0.01	0.09	0.08	0.06	0.05	1	0		0.05	0.05
	NO3 (mg/l)	0.040	0.040	0.058	0.040	0.045	2	1	0.007	0.040	0.050
Phys Para	pH-L (pH Unit)	7.84	7.79	7.82	7.85	7.79	4	0	0.15	7.58	7.93
	TDS (mg/l)	145.50	139.33	148.80	142.50	143.75	4	0	14.57	130.00	160.00
	Temp-H20 (°C)	9.9	9.1	5.6	7.7	8.6	4	0	7.0	2.2	16.1
	TSS (mg/l)	1.000	1.000	1.200	1.000	1.000	4	4	0.000	1.000	1.000
Rads	Pb210 (Bq/L)	0.02	0.02	0.03	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)	0.033	0.040	0.028	0.028	0.030	4	0	0.008	0.020	0.040

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

Martin Lake outlet (North basin)

		Previous Period Averages				Year 2016 Statistics					
		2012	2013	2014	2015	Avg*	Count	Count < DL	StDev	Min	Max
M Ions	Alk (mg/l)	63.0	67.5	69.0	66.5	64.0	4	0	5.4	56.0	68.0
	Ca (mg/l)	19.5	20.0	20.0	19.8	20.0	4	0	0.8	19.0	21.0
	Cl (mg/l)	5.20	8.00	7.60	6.95	6.08	4	0	1.39	4.10	7.30
	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)	174	188	191	186	179	4	0	11	168	193
	Hardness (mg/l)	66	68	68	67	68	4	0	3	65	72
	HCO3 (mg/l)	76.8	82.5	84.0	80.8	77.8	4	0	6.7	68.0	83.0
	K (mg/l)	1.1	1.2	1.0	0.9	1.0	4	0	0.1	0.8	1.1
	Na (mg/l)	9.3	11.6	10.8	9.7	9.0	4	0	2.4	5.5	11.0
	OH (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	4	4	0.0	1.0	1.0
	SO4 (mg/l)	15.1	18.5	17.5	15.5	15.5	4	0	3.9	10.0	19.0
	Sum of Ions (mg/l)	132	147	146	138	134	4	0	11	124	144
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)	0.042	0.044	0.043	0.044	0.043	4	0	0.003	0.040	0.045
	Cu (mg/l)	0.0014	0.0015	0.0015	0.0005	0.0007	4	2	0.0007	0.0002	0.0016
	Fe (mg/l)	0.016	0.012	0.012	0.014	0.016	4	0	0.007	0.010	0.025
	Mo (mg/l)	0.0016	0.0020	0.0018	0.0018	0.0017	4	0	0.0005	0.0010	0.0020
	Ni (mg/l)	0.00015	0.00028	0.00015	0.00015	0.00018	4	1	0.00005	0.00010	0.00020
	Pb (mg/l)	0.0015	0.0006	0.0002	0.0001	0.0001	4	3	0.0001	0.0001	0.0002
	Se (mg/l)	0.0008	0.0011	0.0010	0.0009	0.0008	4	0	0.0003	0.0004	0.0010
	U (µg/l)	48.750	66.250	57.750	49.500	47.500	4	0	17.253	22.000	59.000
	Zn (mg/l)	0.002	0.002	0.004	0.001	0.002	4	1	0.002	0.001	0.005
Nutrient	C-(org) (mg/l)	7.325	5.825	6.450	6.550	6.633	3**	0	1.882	5.400	8.800
	NH3-N (mg/l)	0.06	0.06	0.06	0.07	0.07	3**	0	0.05	0.03	0.12
	NO3 (mg/l)	0.098	0.075	0.165	0.255	0.148	4	0	0.101	0.060	0.240
Phys Para	pH-L (pH Unit)	7.67	7.71	7.87	7.70	7.71	4	0	0.12	7.56	7.83
	TDS (mg/l)	113.75	117.75	117.00	114.50	114.25	4	0	10.18	107.00	129.00
	Temp-H20 (°C)	9.5	11.2	8.0	8.5	11.6	3***	0	8.5	2.5	19.3
	TSS (mg/l)	1.000	1.000	1.000	1.250	1.500	4	1	0.577	1.000	2.000
Rads	Pb210 (Bq/L)	0.02	0.02	0.02	0.02	0.03	3**	2	0.01	0.02	0.04
	Po210 (Bq/L)	<0.005	<0.005	<0.005	<0.005	<0.005	3**	3	0.000	0.005	0.005
	Ra226 (Bq/L)	0.007	0.011	0.012	0.015	0.009	4	0	0.002	0.006	0.010

*December 2016 data used in this table was a resample from January 2017, see text in report for more details
**Volume of water collected was insufficient to analyze for these parameters
***Temperature could not be taken in December 2016 as it was too cold for equipment

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

Crackingstone River at bridge

		Previous Period Averages				Year 2016 Statistics					
		2012	2013	2014	2015	Avg	Count	Count < DL	StDev	Min	Max
M Ions	Alk (mg/l)	64.0	66.0	70.0	66.0	59.0	1	0		59.0	59.0
	Ca (mg/l)	20.0	20.0	20.0	19.0	19.0	1	0		19.0	19.0
	Cl (mg/l)	7.60	7.90	7.80	7.60	6.40	1	0		6.40	6.40
	CO3 (mg/l)	1.0	1.0	1.0	1.0	1.0	1	1		1.0	1.0
	Cond-L (µS/cm)	181	186	190	192	178	1	0		178	178
	Hardness (mg/l)	68	70	69	66	65	1	0		65	65
	HCO3 (mg/l)	78.0	80.0	85.0	80.0	72.0	1	0		72.0	72.0
	K (mg/l)	1.1	1.1	1.0	0.8	1.1	1	0		1.1	1.1
	Na (mg/l)	11.0	11.0	11.0	11.0	9.6	1	0		9.6	9.6
	OH (mg/l)	1.0	1.0	1.0	1.0	1.0	1	1		1.0	1.0
	SO4 (mg/l)	17.0	17.0	18.0	17.0	16.0	1	0		16.0	16.0
	Sum of Ions (mg/l)	139	142	148	140	128	1	0		128	128
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	0.045	0.042	0.042	0.042	1	0		0.042	0.042
	Cu (mg/l)	0.0002	0.0006	0.0002	0.0002	0.0002	1	1		0.0002	0.0002
	Fe (mg/l)	0.026	0.086	0.026	0.036	0.037	1	0		0.037	0.037
	Mo (mg/l)	0.0020	0.0021	0.0019	0.0021	0.0019	1	0		0.0019	0.0019
	Ni (mg/l)	0.00010	0.00020	0.00010	0.00010	0.00010	1	1		0.00010	0.00010
	Pb (mg/l)	0.0001	0.0011	0.0001	0.0001	0.0001	1	1		0.0001	0.0001
	Se (mg/l)	0.0009	0.0009	0.0010	0.0009	0.0009	1	0		0.0009	0.0009
	U (µg/l)	57.000	67.000	63.000	54.000	52.000	1	0		52.000	52.000
	Zn (mg/l)	0.001	0.001	0.001	0.001	0.001	1	1		0.001	0.001
Nutrient	C-(org) (mg/l)	6.200	6.200	6.000	6.200	6.000	1	0		6.000	6.000
	NH3-N (mg/l)	0.03	0.06	0.05	0.08	0.06	1	0		0.06	0.06
	NO3 (mg/l)	0.040	0.040	0.040	0.040	0.050	1	0		0.050	0.050
Phys Para	pH-L (pH Unit)	7.76	7.68	7.76	7.82	7.67	1	0		7.67	7.67
	TDS (mg/l)	125.00	111.00	119.00	123.00	109.00	1	0		109.00	109.00
	Temp-H20 (°C)	11.0	13.1	10.6	10.1	12.5	1	0		12.5	12.5
	TSS (mg/l)	1.000	4.000	1.000	2.000	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	0.005	0.005	0.005	1	1		0.005	0.005
	Ra226 (Bq/L)	0.006	0.005	0.006	0.005	0.010	1	0		0.010	0.010

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

Crackingstone Bay

		Previous Period Averages				Year 2016 Statistics					
		2012	2013	2014	2015	Avg	Count	Count < DL	StDev	Min	Max
M Ions	Alk (mg/l)	31.0	29.0	32.0	30.0	38.0	1	0		38.0	38.0
	Ca (mg/l)	8.3	7.5	7.6	7.3	12.0	1	0		12.0	12.0
	Cl (mg/l)	3.60	3.40	3.40	3.50	4.70	1	0		4.70	4.70
	CO3 (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	1	1		1.0	1.0
	Cond-L (µS/cm)	81	74	78	79	116	1	0		116	116
	Hardness (mg/l)	30	28	28	28	43	1	0		43	43
	HCO3 (mg/l)	38.0	35.0	39.0	37.0	46.0	1	0		46.0	46.0
	K (mg/l)	0.8	0.9	0.7	0.5	0.9	1	0		0.9	0.9
	Na (mg/l)	3.5	2.8	3.0	2.9	5.6	1	0		5.6	5.6
	OH (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	1	1		1.0	1.0
	SO4 (mg/l)	5.0	3.9	4.2	4.2	9.0	1	0		9.0	9.0
	Sum of Ions (mg/l)	62	56	60	58	81	1	0		81	81
Metal	As (µg/l)	0.2	0.2	0.2	0.2	0.2	1	0		0.2	0.2
	Ba (mg/l)	0.014	0.012	0.012	0.012	0.024	1	0		0.024	0.024
	Cu (mg/l)	0.0002	0.0002	0.0007	0.0002	0.0002	1	0		0.0002	0.0002
	Fe (mg/l)	0.006	0.009	0.010	0.006	0.022	1	0		0.022	0.022
	Mo (mg/l)	0.0003	0.0002	0.0002	0.0003	0.0010	1	0		0.0010	0.0010
	Ni (mg/l)	0.00030	0.00030	0.00230	0.00020	0.00010	1	1		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)	0.0001	0.0001	0.0001	0.0001	0.0004	1	0		0.0004	0.0004
	U (µg/l)	4.800	0.400	1.600	2.400	21.000	1	0		21.000	21.000
	Zn (mg/l)	0.001	0.001	0.002	0.001	0.001	1	0		0.001	0.001
Nutrient	C-(org) (mg/l)	3.500	3.400	3.200	3.200	4.100	1	0		4.100	4.100
	NH3-N (mg/l)	0.01	0.01	0.02	0.02	0.02	1	0		0.02	0.02
	NO3 (mg/l)	0.040	0.040	0.090	0.040	0.060	1	0		0.060	0.060
Phys Para	pH-L (pH Unit)	7.51	7.37	7.38	7.51	7.41	1	0		7.41	7.41
	TDS (mg/l)	64.00	50.00	54.00	51.00	71.00	1	0		71.00	71.00
	Temp-H20 (°C)	12.4	10.4	8.6	11.2	12.6	1	0		12.6	12.6
	TSS (mg/l)	1.000	1.000	1.000	2.000	1.000	1	1		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	0.005	0.005	0.006	1	0		0.006	0.006
	Ra226 (Bq/L)	0.009	0.009	0.005	0.010	0.007	1	0		0.007	0.007

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

Mouth of Zora Creek

		Previous Period Averages				Year 2016 Statistics					
		2012	2013	2014	2015	Avg	Count	Count < DL	StDev	Min	Max
M Ions	Alk (mg/l)		103.6	94.4	100.8	102.7	10	0	5.5	96.0	113.0
	Ca (mg/l)		33.4	29.4	32.0	32.5	10	0	1.4	30.0	35.0
	Cl (mg/l)		0.24	0.26	0.28	0.87	10	0	1.46	0.30	5.00
	CO3 (mg/l)		<1.0	<1.0	<1.0	<1.0	10	10	0.0	1.0	1.0
	Cond-L (µS/cm)		229	207	226	226	10	0	14	212	248
	Hardness (mg/l)		118	104	114	115	10	0	5	106	124
	HCO3 (mg/l)		126.4	115.2	122.9	125.3	10	0	6.7	117.0	138.0
	K (mg/l)		0.9	0.6	0.7	0.8	10	0	0.1	0.6	1.0
	Na (mg/l)		1.9	1.6	1.8	1.8	10	0	0.1	1.7	2.2
	OH (mg/l)		<1.0	<1.0	<1.0	<1.0	10	10	0.0	1.0	1.0
	SO4 (mg/l)		19.6	17.0	18.9	19.1	10	0	1.0	18.0	21.0
	Sum of Ions (mg/l)		191	171	185	189	10	0	10	179	210
Metal	As (µg/l)		0.2	0.2	0.2	0.2	10	0	0.0	0.2	0.2
	Ba (mg/l)		0.023	0.020	0.022	0.023	10	0	0.001	0.021	0.025
	Cu (mg/l)		0.0010		0.0009	0.0006	10	3	0.0003	0.0002	0.0009
	Fe (mg/l)		0.011	0.018	0.009	0.008	10	0	0.003	0.003	0.011
	Mo (mg/l)		0.0009	0.0008	0.0008	0.0009	10	0	0.0001	0.0008	0.0011
	Ni (mg/l)		0.00022	0.00032	0.00017	0.00024	10	0	0.00013	0.00010	0.00060
	Pb (mg/l)		0.0007	0.0005	0.0002	0.0001	10	8	0.0000	0.0001	0.0002
	Se (mg/l)		0.0001	0.0001	0.0001	0.0001	10	0	0.0000	0.0001	0.0002
	U (µg/l)		18.200	13.000	15.460	14.570	10	0	2.758	7.700	18.000
	Zn (mg/l)		0.003	0.003	0.001	0.001	10	4	0.001	0.001	0.002
Nutrient	C-(org) (mg/l)		8.733	9.000		8.600	1	0		8.600	8.600
	NH3-N (mg/l)		0.03	0.05		0.06	1	0		0.06	0.06
	NO3 (mg/l)		0.040	0.060	0.059	0.062	6	4	0.037	0.040	0.130
Phys Para	pH-L (pH Unit)		7.91	7.94	7.90	7.92	10	0	0.16	7.67	8.12
	TDS (mg/l)		145.60	127.00	141.39	148.10	10	0	17.39	141.00	197.00
	Temp-H20 (°C)		11.5	9.4	17.8	10.4	10	0	8.6	1.8	23.8
	TSS (mg/l)		1.000	1.400	1.314	2.100	10	3	2.807	1.000	10.000
Rads	Pb210 (Bq/L)		0.02	0.05		0.02	1	1		0.02	0.02
	Po210 (Bq/L)		0.006	0.005		0.010	1	0		0.010	0.010
	Ra226 (Bq/L)		0.028	0.026	0.029	0.022	10	0	0.006	0.010	0.030

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

Bottom of waste rock pile

		Previous Period Averages				Year 2016 Statistics					
		2012	2013	2014	2015	Avg	Count	Count < DL	StDev	Min	Max
M Ions	Alk (mg/l)		122.4	113.8	121.9	108.5	10	0	4.7	100.0	114.0
	Ca (mg/l)		61.4	44.4	54.7	41.1	10	0	9.7	35.0	68.0
	Cl (mg/l)		1.00	0.42	0.72	0.51	10	1	0.22	0.30	1.00
	CO3 (mg/l)		<1.0	<1.0	<1.0	<1.0	10	10	0.0	1.0	1.0
	Cond-L (µS/cm)		382	289	354	277	10	0	48	247	406
	Hardness (mg/l)		199	146	182	140	10	0	29	121	219
	HCO3 (mg/l)		149.4	138.6	148.5	132.3	10	0	5.7	122.0	139.0
	K (mg/l)		1.0	0.6	0.9	0.9	10	0	0.2	0.6	1.3
	Na (mg/l)		2.4	1.9	2.7	2.1	10	0	0.2	1.8	2.7
	OH (mg/l)		<1.0	<1.0	<1.0	<1.0	10	10	0.0	1.0	1.0
	SO4 (mg/l)		78.2	41.6	82.9	40.6	10	0	25.4	21.0	110.0
	Sum of Ions (mg/l)		305	237	286	227	10	0	40	194	335
Metal	As (µg/l)		0.2	0.2	0.4	0.2	10	0	0.0	0.2	0.3
	Ba (mg/l)		0.025	0.021	0.033	0.028	10	0	0.004	0.024	0.036
	Cu (mg/l)		0.0034	0.0036	0.0029	0.0019	10	0	0.0012	0.0004	0.0049
	Fe (mg/l)		0.022	0.032	0.453	0.138	10	0	0.096	0.034	0.320
	Mo (mg/l)		0.0013	0.0013	0.0018	0.0016	10	0	0.0008	0.0009	0.0037
	Ni (mg/l)		0.00036	0.00032	0.00055	0.00026	10	0	0.00008	0.00020	0.00040
	Pb (mg/l)		0.0006	0.0003	0.0031	0.0002	10	2	0.0001	0.0001	0.0004
	Se (mg/l)		0.0005	0.0003	0.0004	0.0003	10	0	0.0001	0.0001	0.0006
	U (µg/l)		624.800	313.800	578.316	300.900	10	0	334.428	39.000	1220.000
	Zn (mg/l)		0.002	0.001	0.001	0.001	10	8	0.001	0.001	0.003
Nutrient	C-(org) (mg/l)		6.300	6.300		8.100	1	0		8.100	8.100
	NH3-N (mg/l)		0.04	0.04		0.05	1	0		0.05	0.05
	NO3 (mg/l)		0.920	0.664	0.440	0.428	6	1	0.461	0.040	1.300
Phys Para	pH-L (pH Unit)		7.91	7.96	7.88	7.94	10	0	0.08	7.79	8.04
	TDS (mg/l)		253.00	185.40	238.86	183.10	10	0	46.11	149.00	304.00
	Temp-H20 (°C)		1.1	12.6	5.8	9.2	10	0	8.1	1.8	22.0
	TSS (mg/l)		1.000	1.000	15.167	1.300	10	1	0.483	1.000	2.000
Rads	Pb210 (Bq/L)		0.19	0.09		0.02	1	1		0.02	0.02
	Po210 (Bq/L)		0.060	0.080		0.020	1	0		0.020	0.020
	Ra226 (Bq/L)		0.368	0.336	0.711	0.219	10	0	0.162	0.060	0.640

Table 4.7.1 Radon Track Etch Summary

	Annual Average pCi/L					
	1982	2012	2013	2014	2015	2016
Ace Creek Track Etch Cup	10.7	4.9	4.2	5.8	6.8	5.0
Airport Beacon Hill Track Etch Cup	1.4	1.7	1.1	0.2	0.3	0.3
Donaldson Lake Track Etch Cup	5.1	0.1	1.0	0.2	0.2	0.2
Eldorado Townsite Track Etch Cup	3.7	0.5	1.2	0.4	0.5	0.7
End of Airstrip Track Etch Cup	2.4	1.6	1.0	0.2	0.2	0.2
Fay Waste Rock Track Etch Cup	5.1	1.1	1.0	0.5	1.1	1.3
Fookes Delta Track Etch Cup	5.1	2.2	2.7	2.2	2.0	2.2
Fredette Lake Track Etch Cup	5.1	0.2	0.3	0.2	0.3	0.2
Marie Lake Track Etch Cup	5.1	3.4	2.8	1.8	2.8	2.0
Uranium City Town Track Etch Cup	5.1	0.1	0.2	0.2	0.2	0.2

*Data reporting methods were reviewed this year, leading to the correction of values in the above table
**2016 data represents only the firs half of the year, see Section 4.7 for more detail.

FIGURES

FIGURES

Figure 2.4
Beaverlodge Location Map

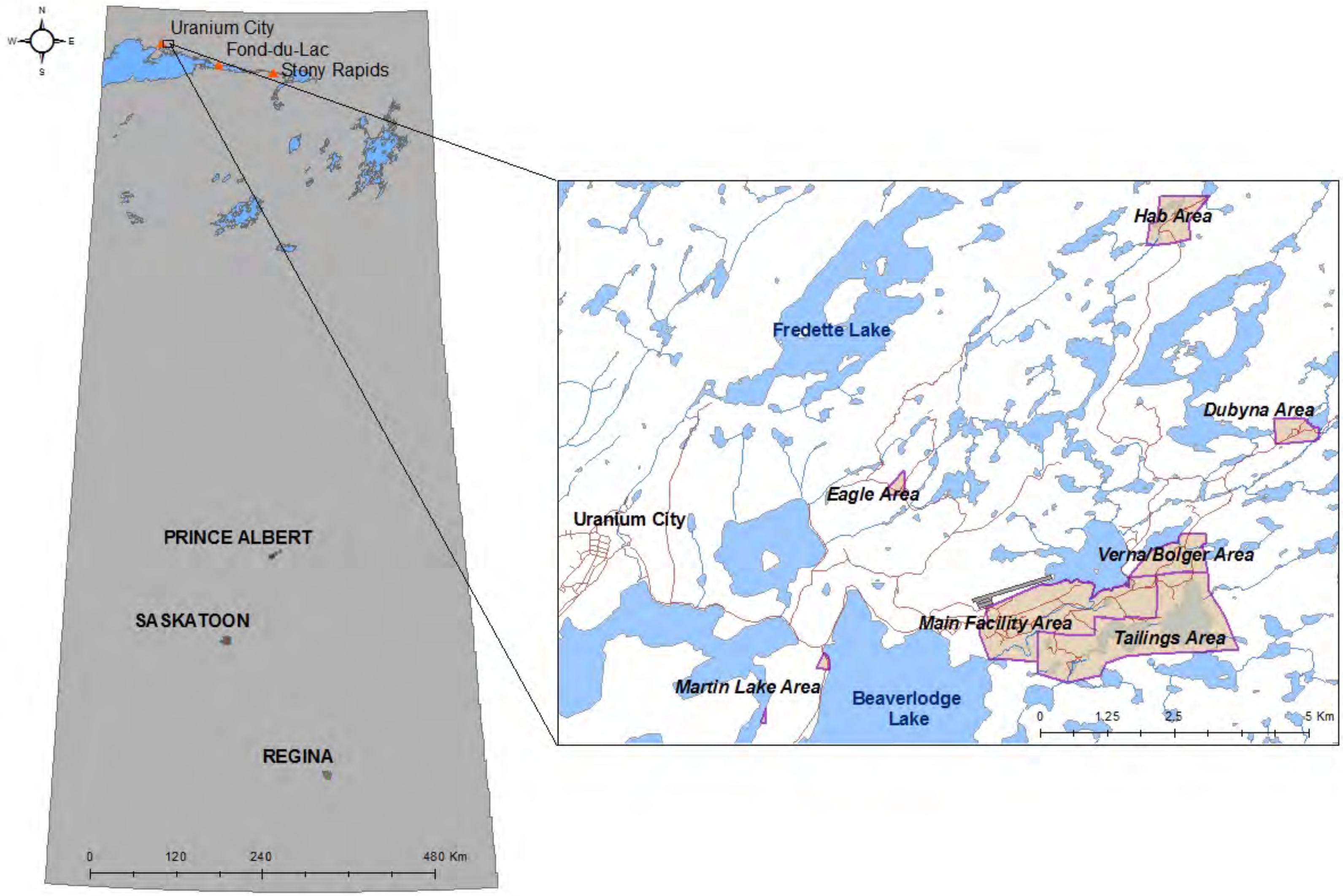


Figure 4.3
Water Quality Monitoring Station Locations

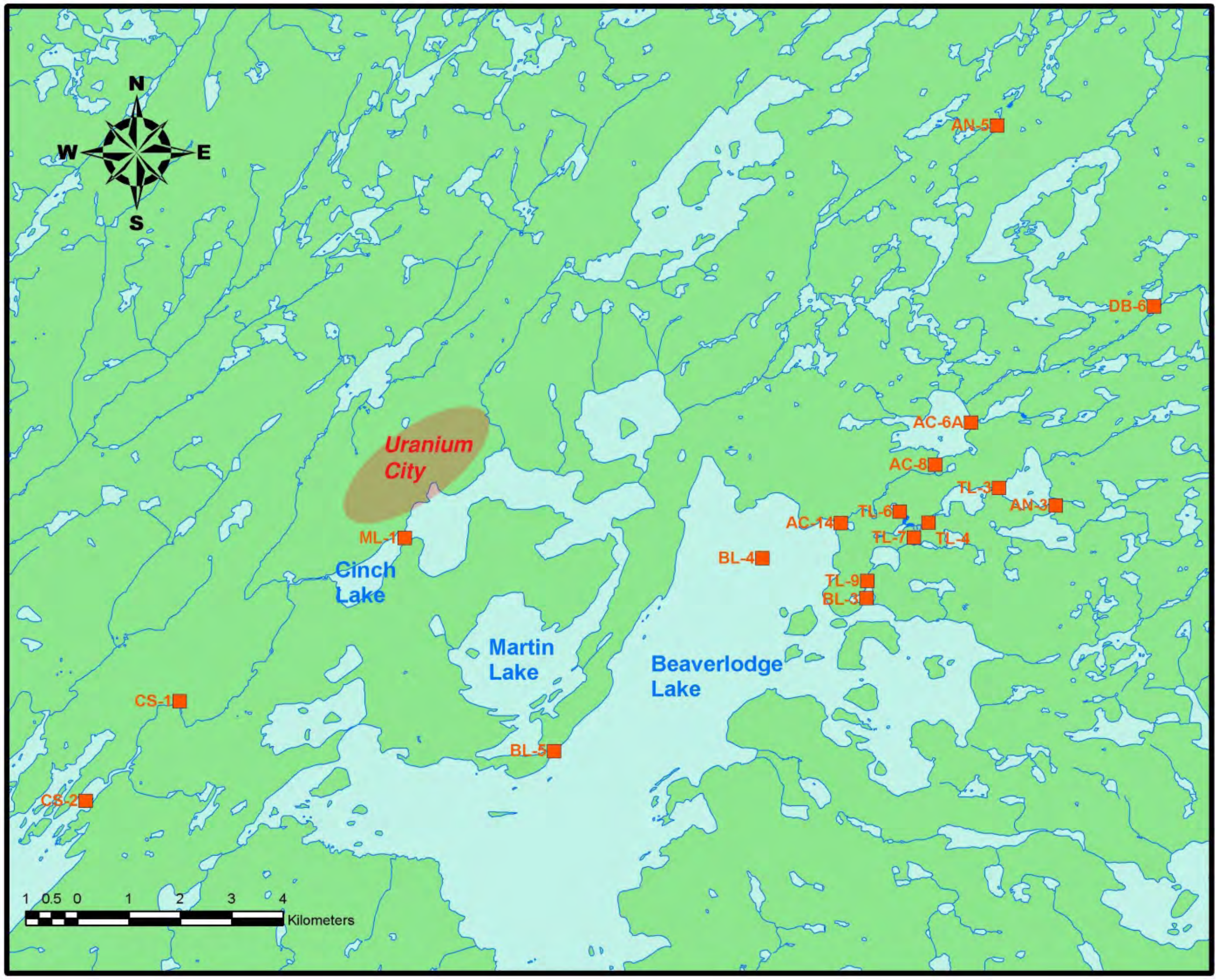


Figure 4.3.1-1 AN-5 Pistol Creek below Hab Site

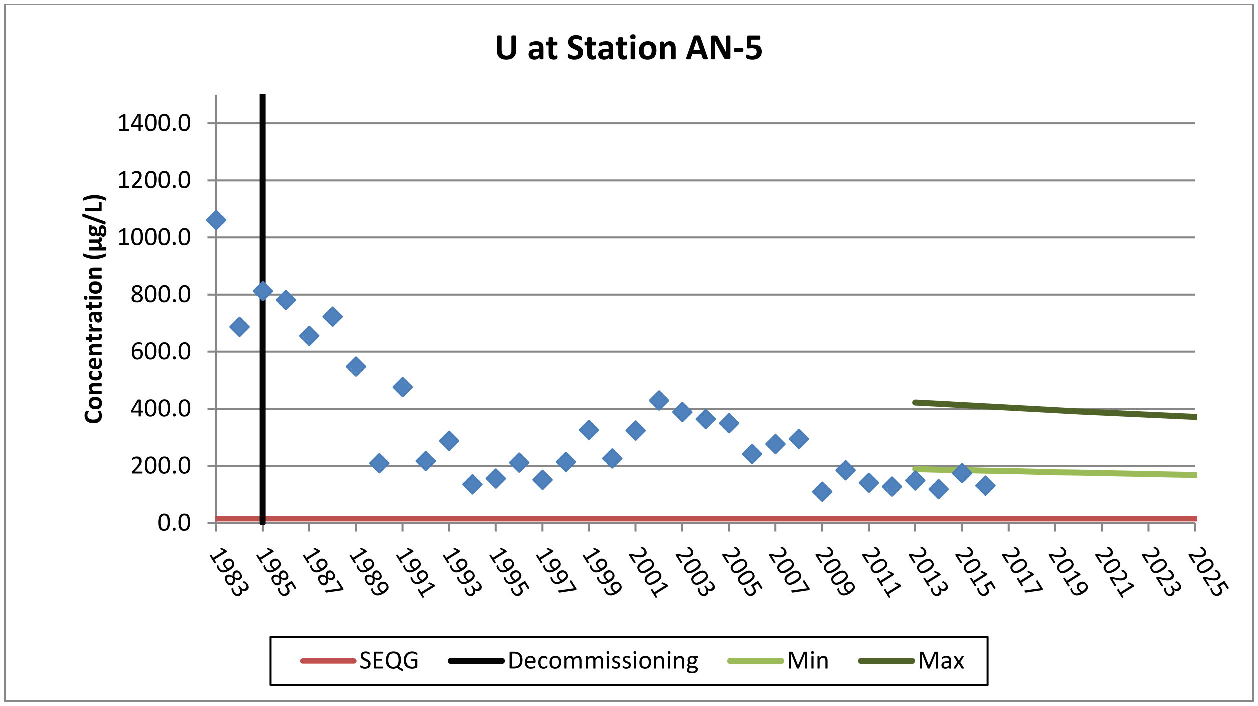


Figure 4.3.1-2 AN-5 Pistol Creek below Hab Site

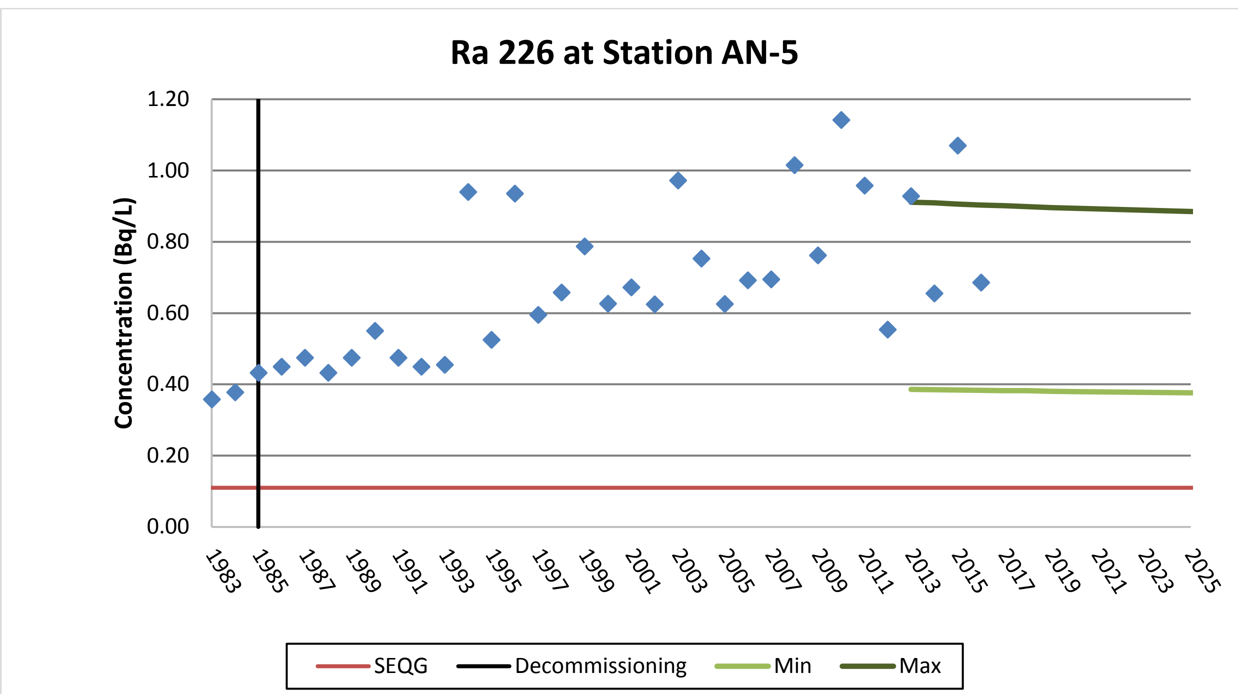
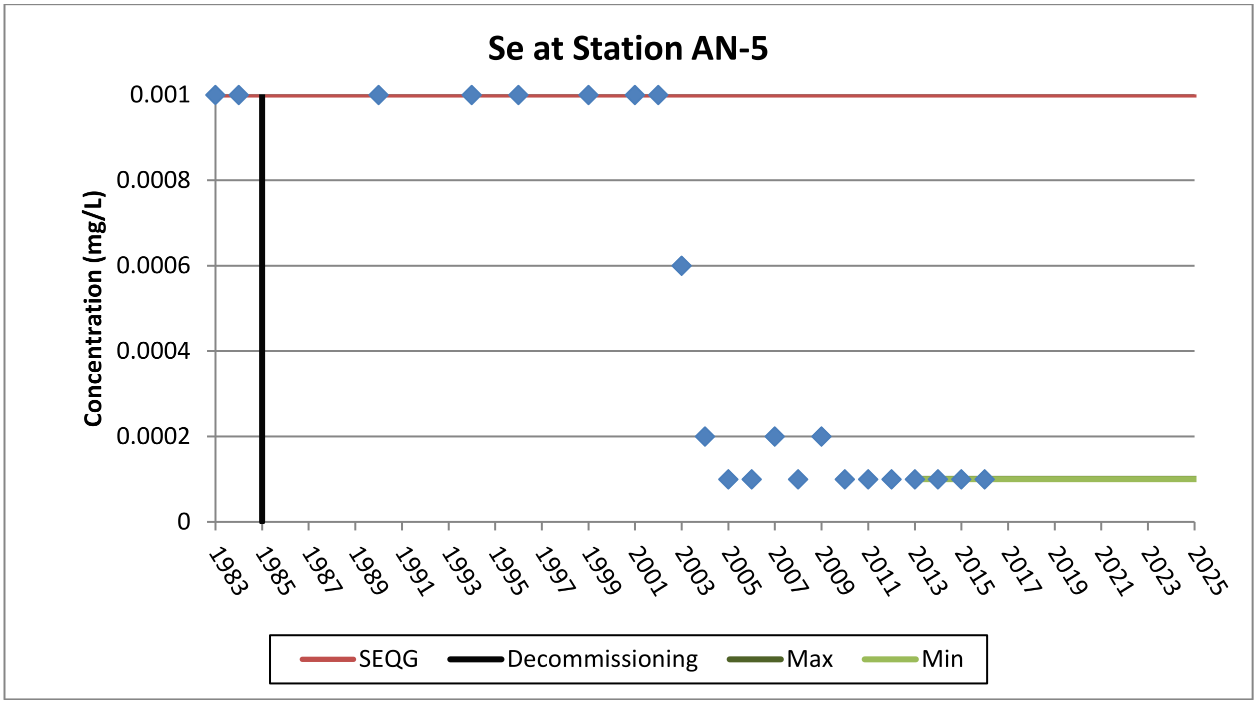


Figure 4.3.1-3 AN-5 Pistol Creek below Hab Site



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

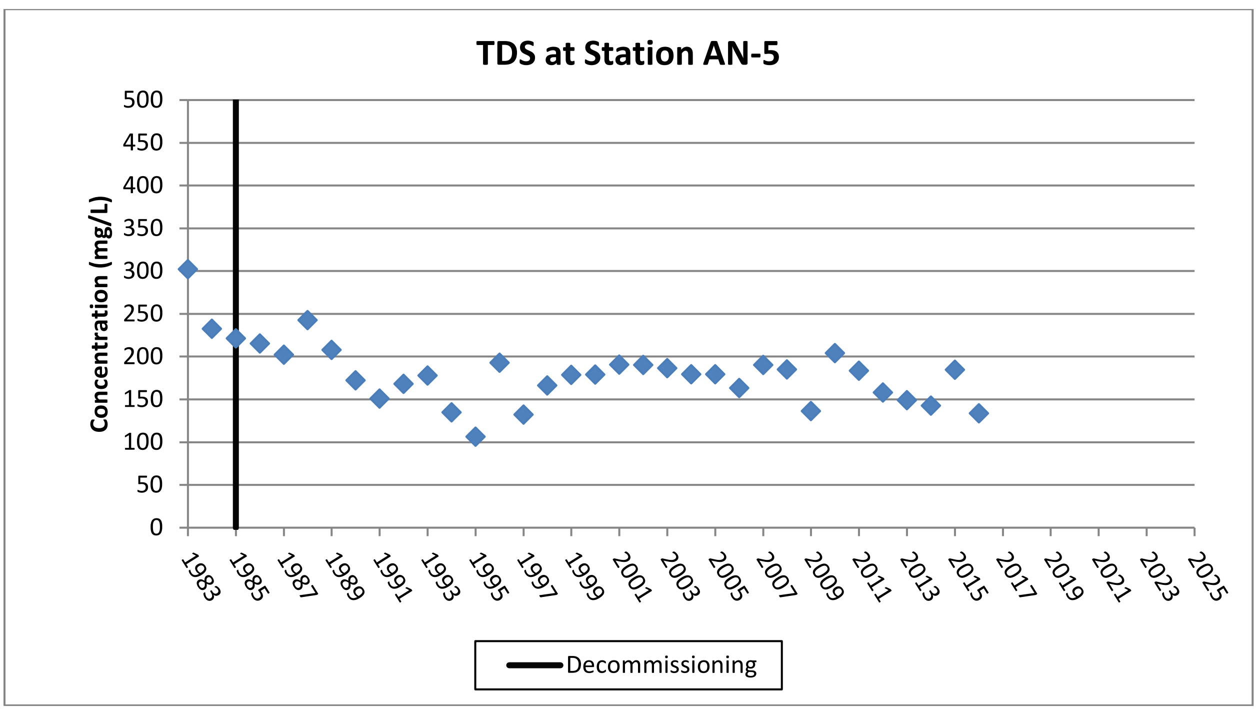


Figure 4.3.1-5 DB-6 Dubyna Creek

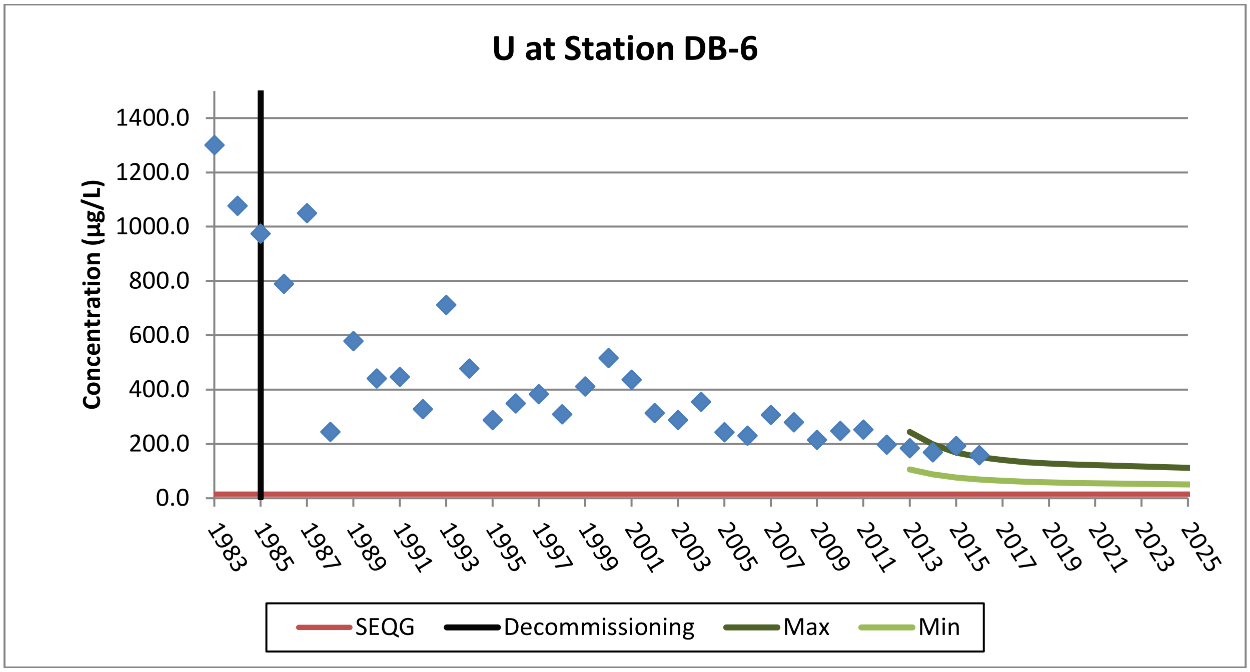


Figure 4.3.1-6 DB-6 Dubyna Creek

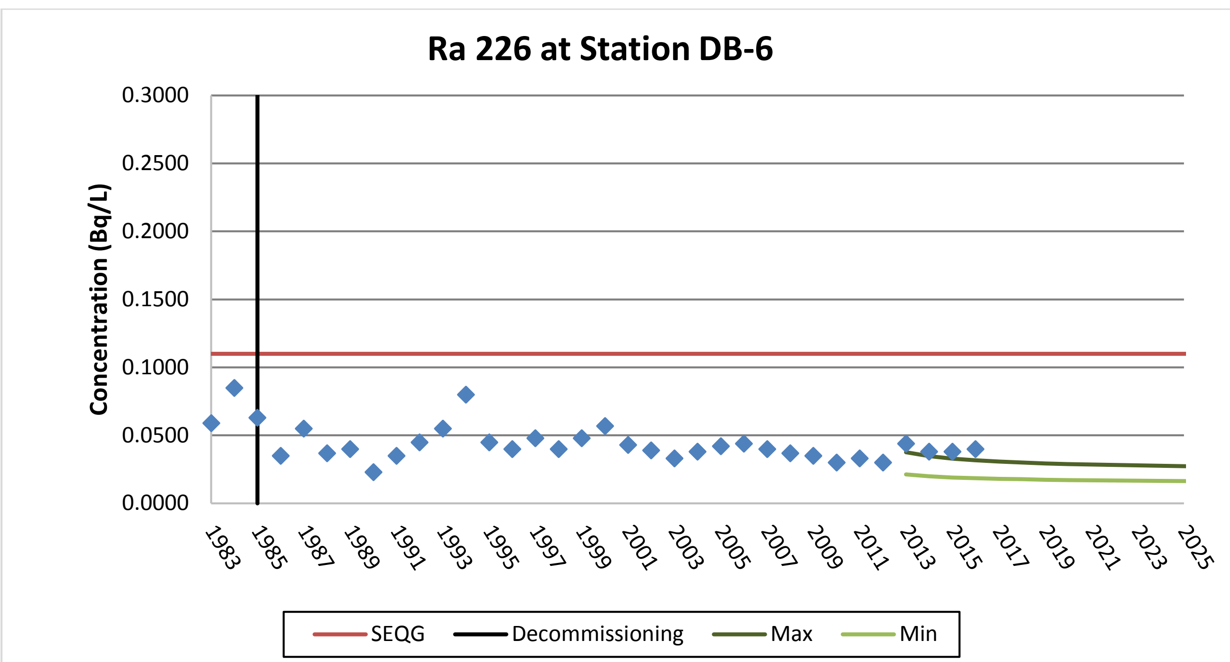
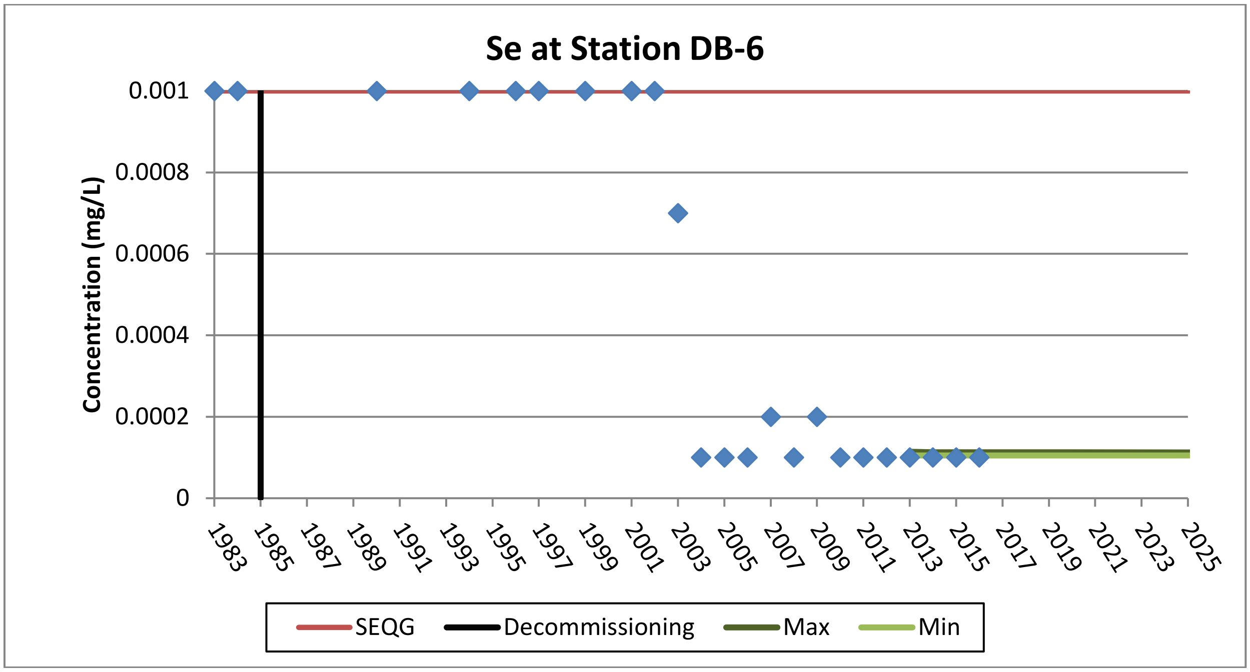


Figure 4.3.1-7 DB-6 Dubyna Creek



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

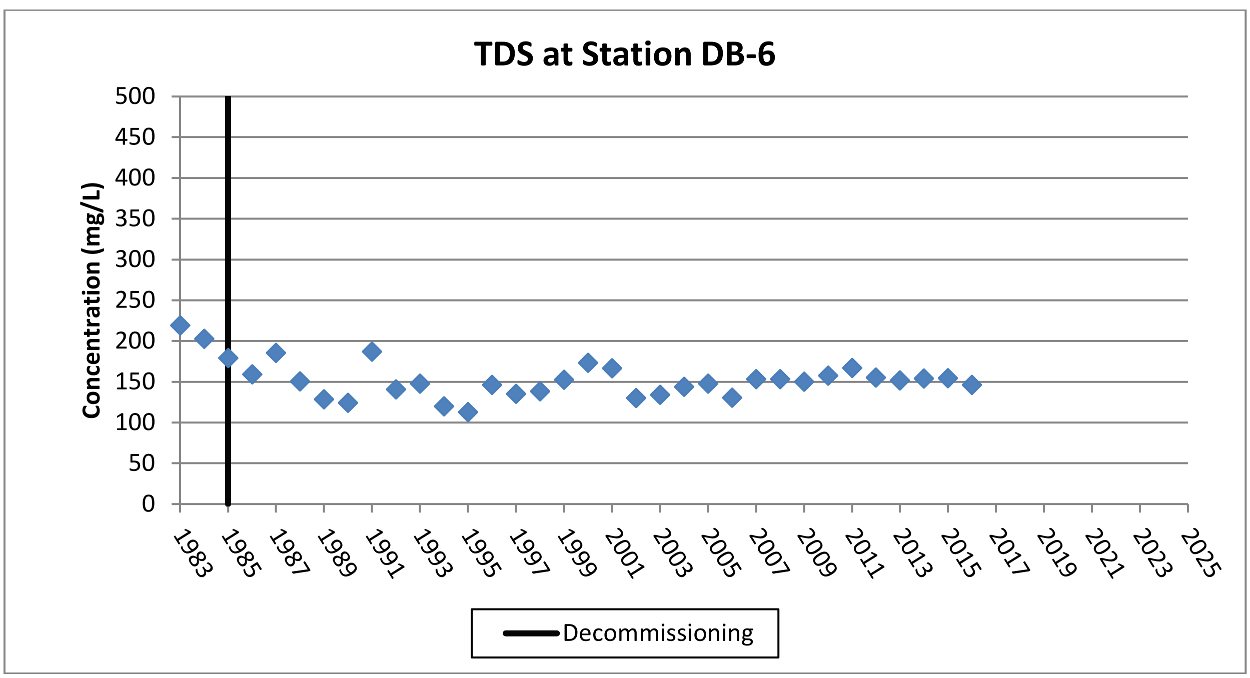


Figure 4.3.1-9 AC-6A Verna Lake Discharge to Ace Lake

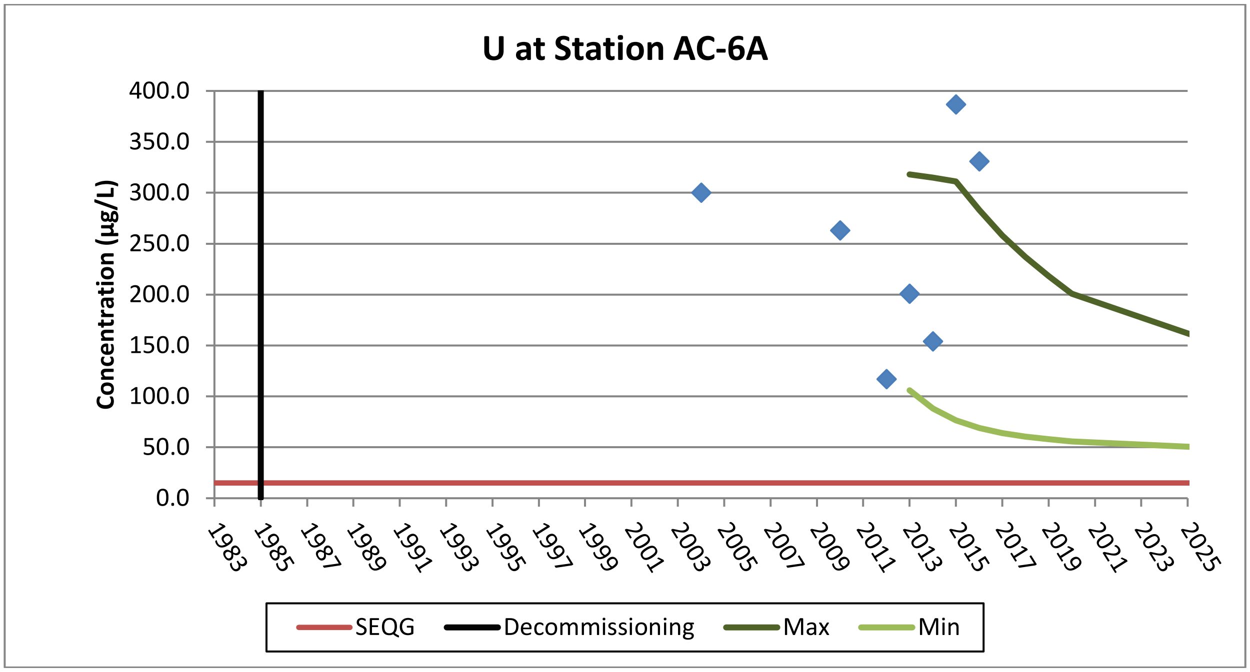


Figure 4.3.1-10 AC-6A Verna Lake Discharge to Ace Lake

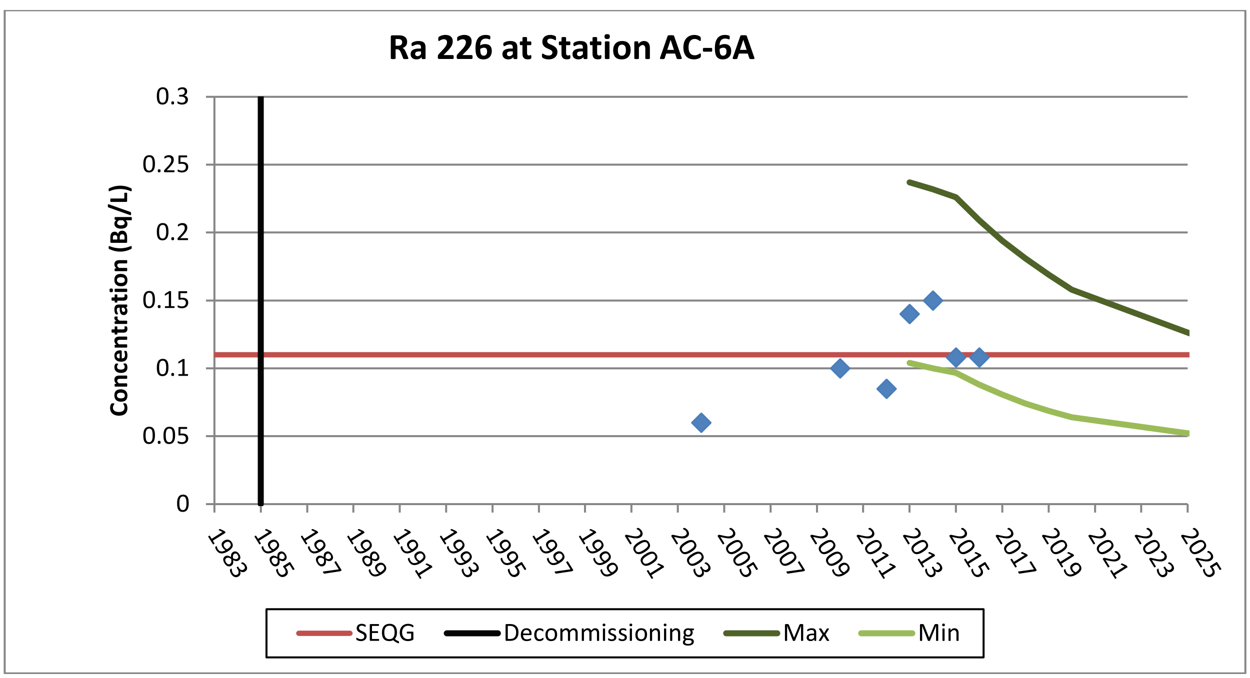
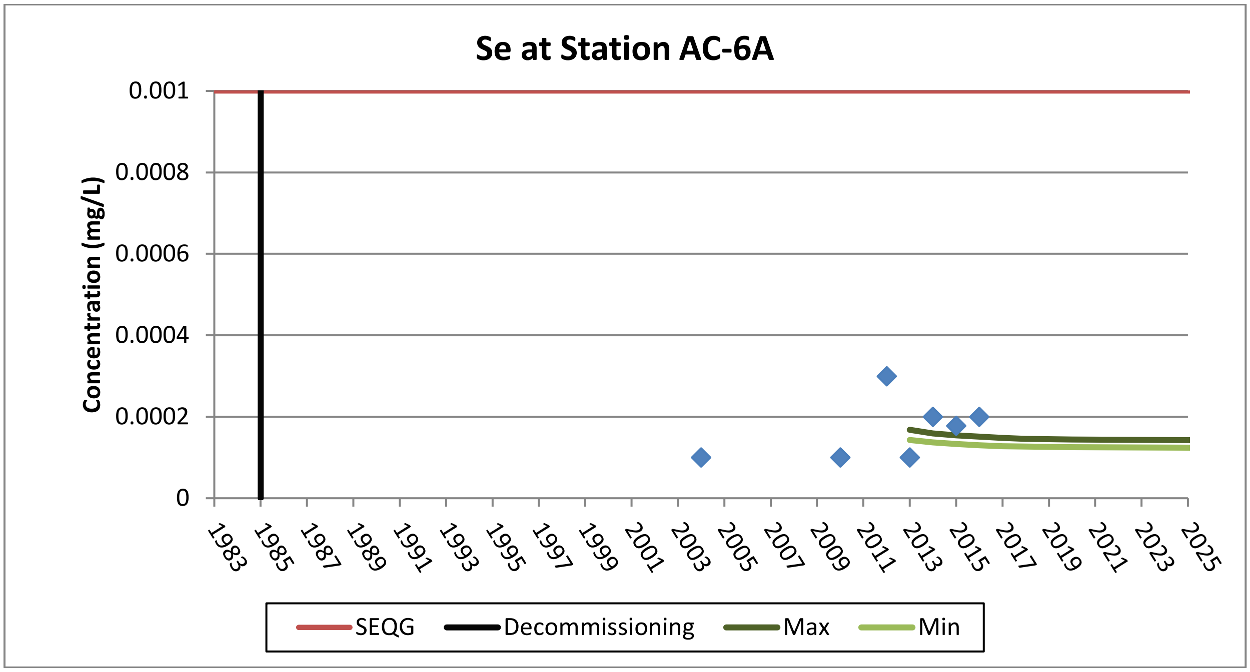


Figure 4.3.1-11 AC-6A Verna Lake Discharge to Ace Lake



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

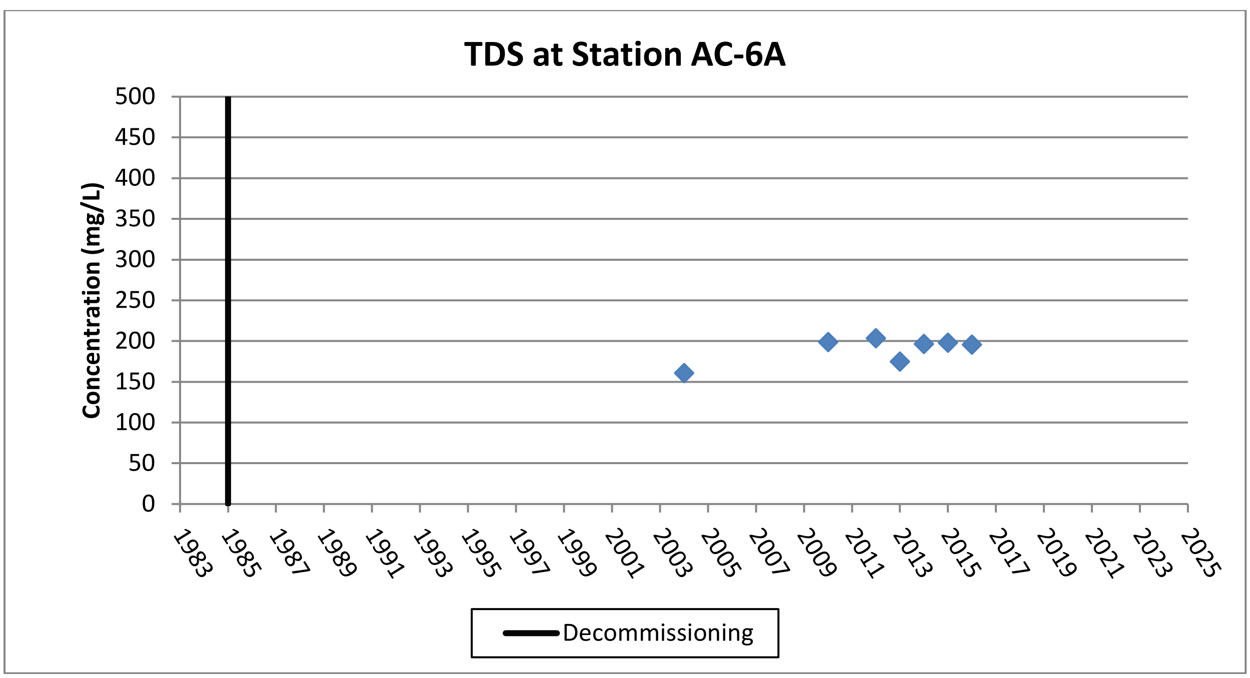


Figure 4.3.1-13 AC-8 Ace Lake Outlet to Ace Creek

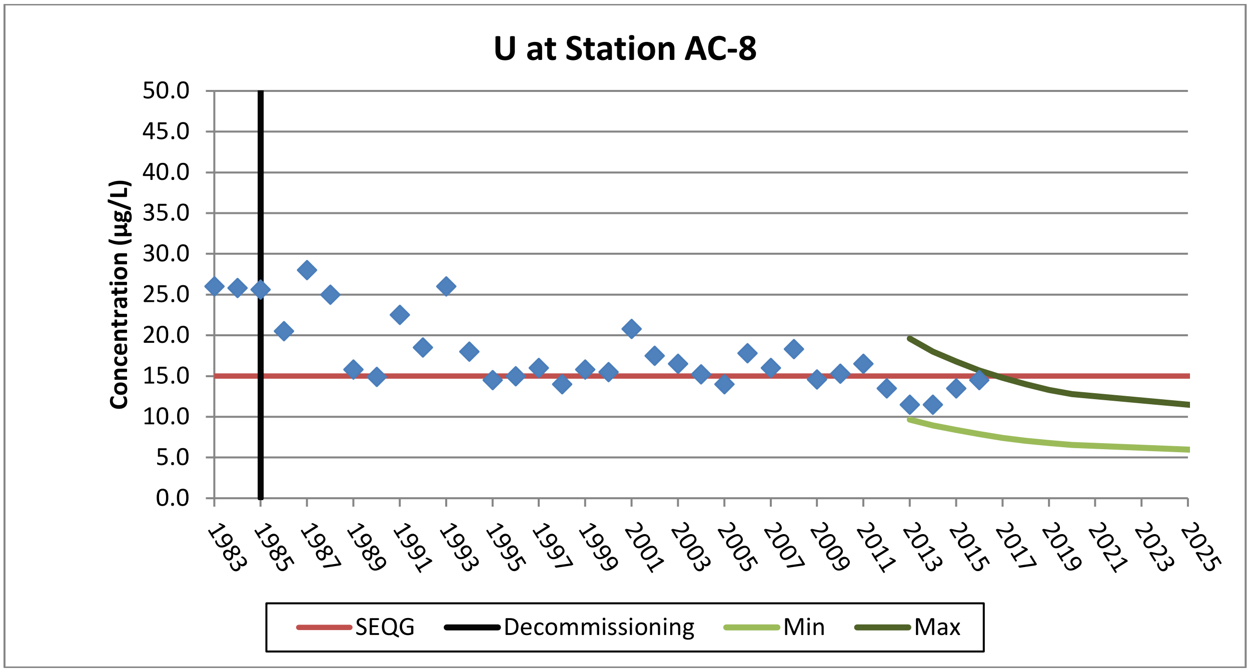


Figure 4.3.1-14 AC-8 Ace Lake Outlet to Ace Creek

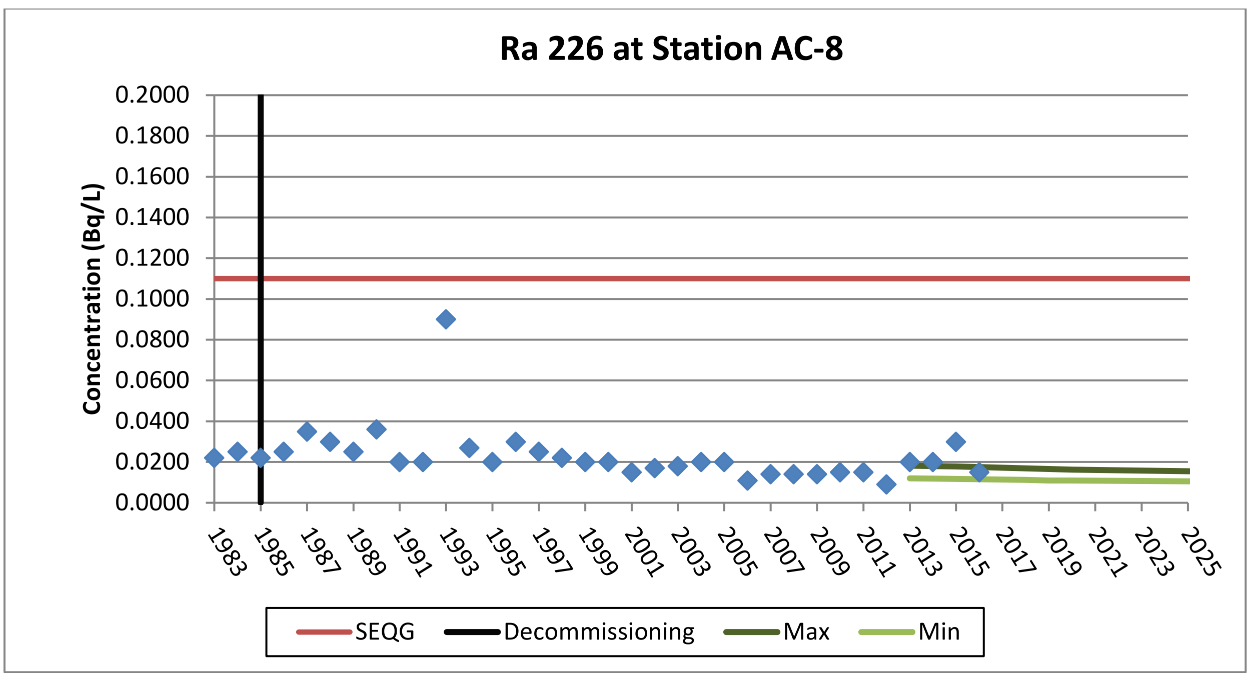
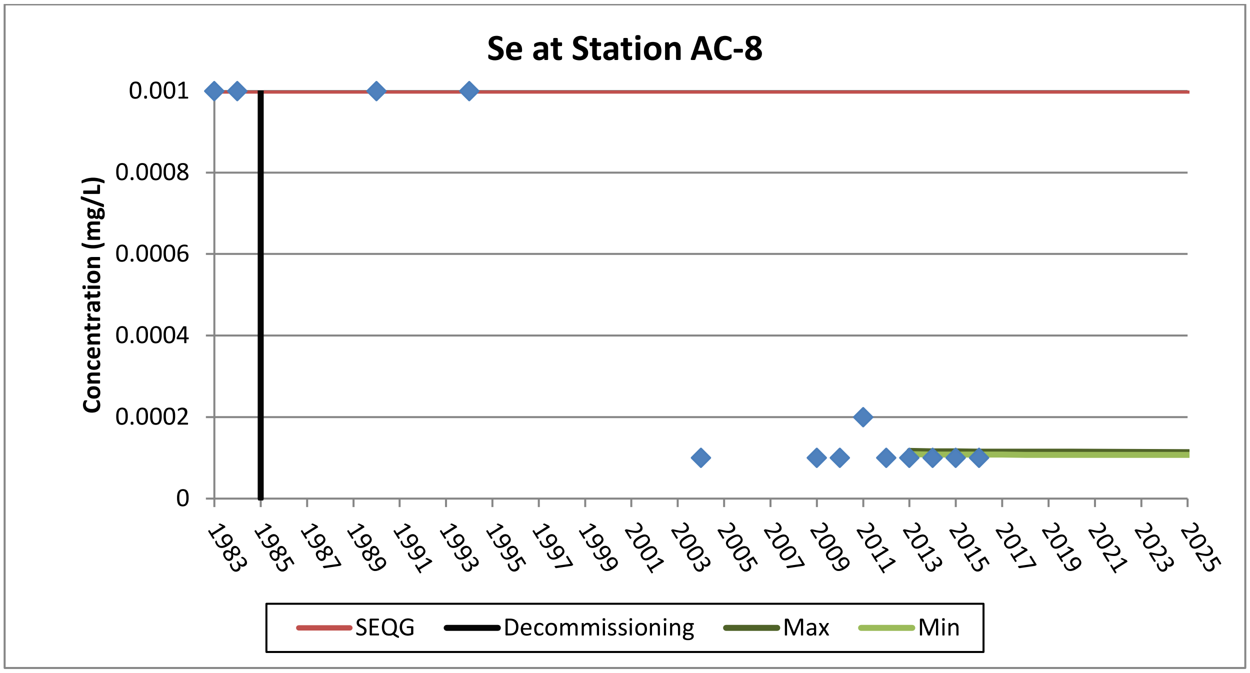


Figure 4.3.1-15 AC-8 Ace Lake Outlet to Ace Creek



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

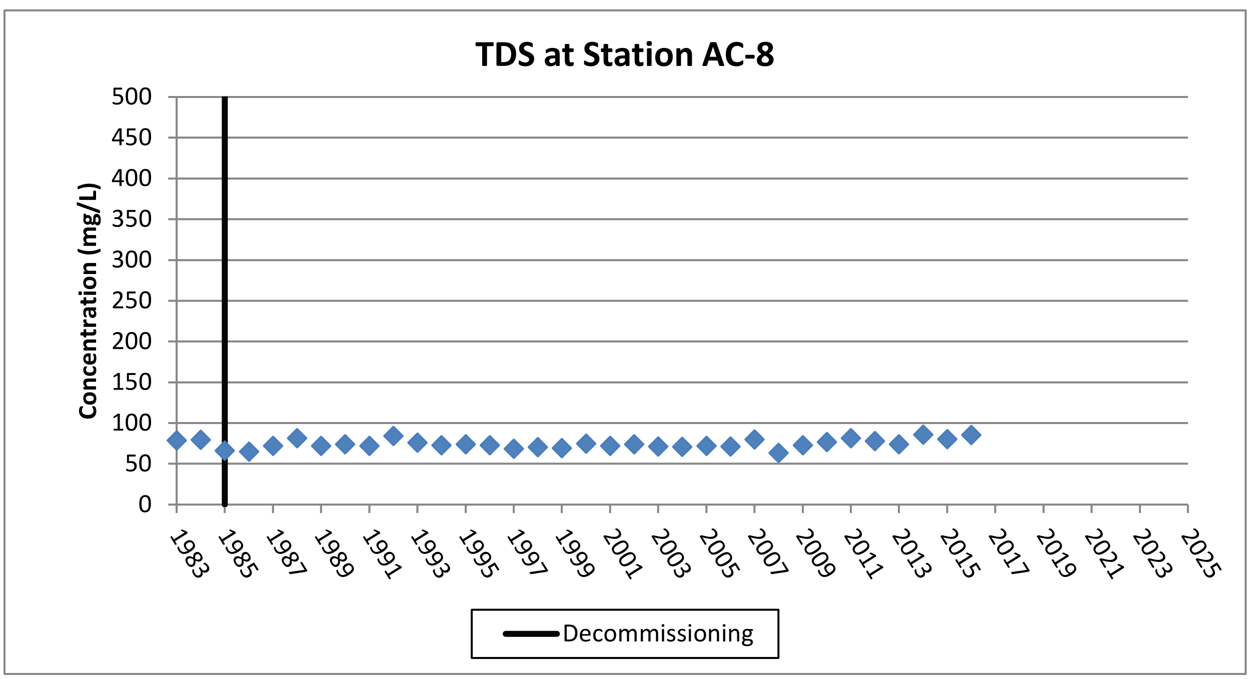


Figure 4.3.1-17 AC-14 - Ace Creek

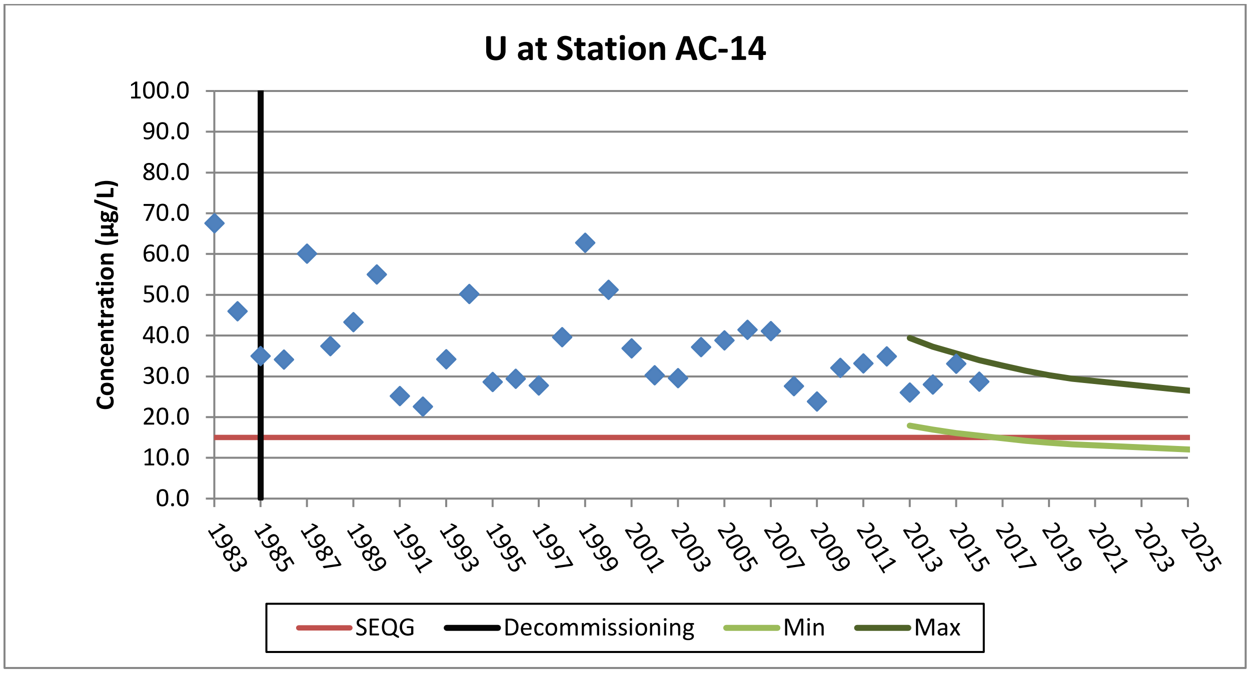


Figure 4.3.1-18 AC-14 - Ace Creek

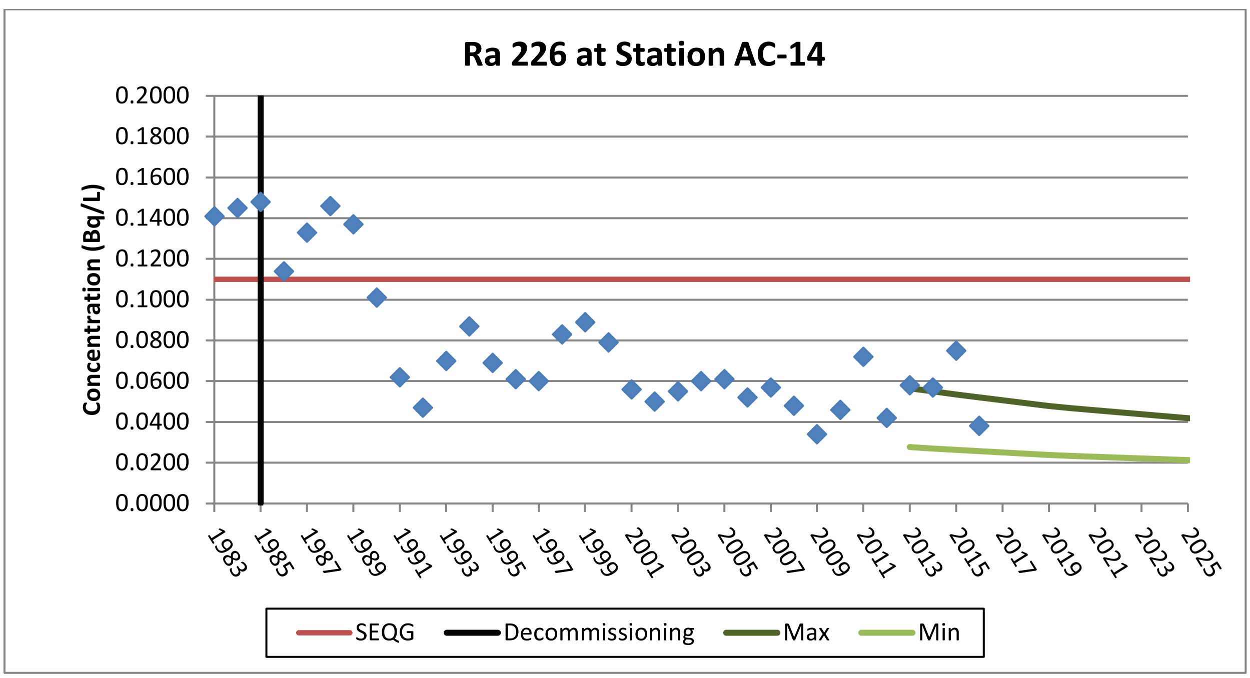
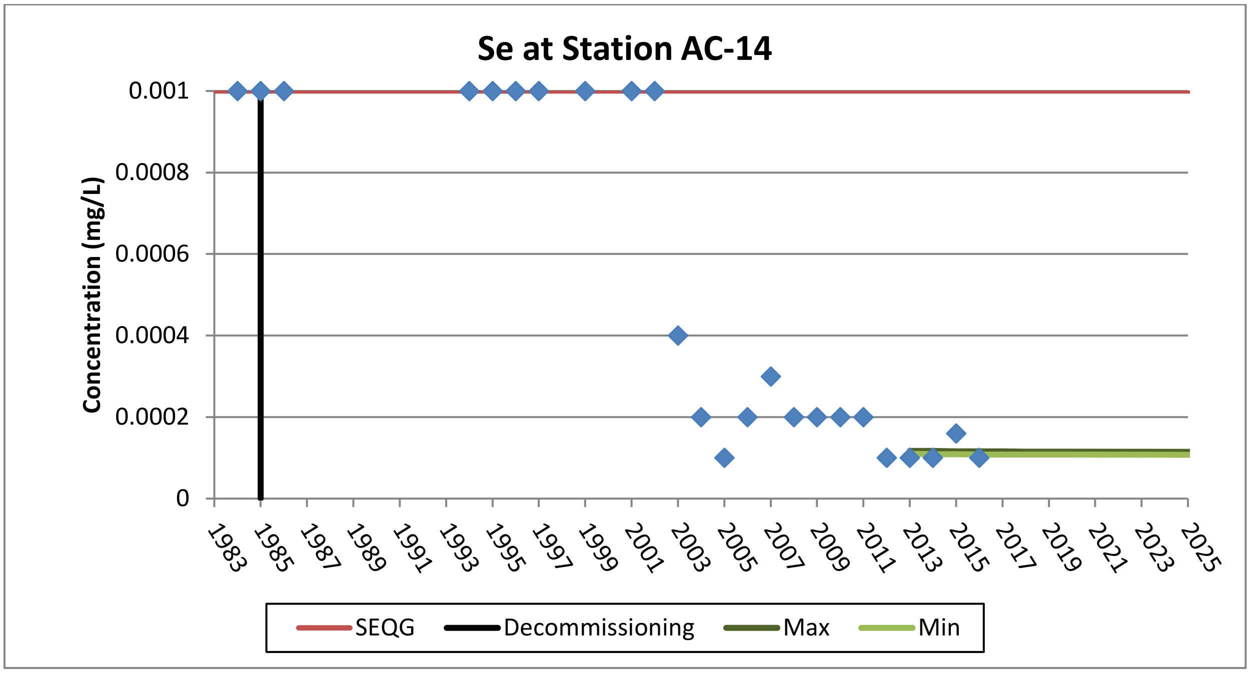


Figure 4.3.1-19 AC-14 - Ace Creek



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

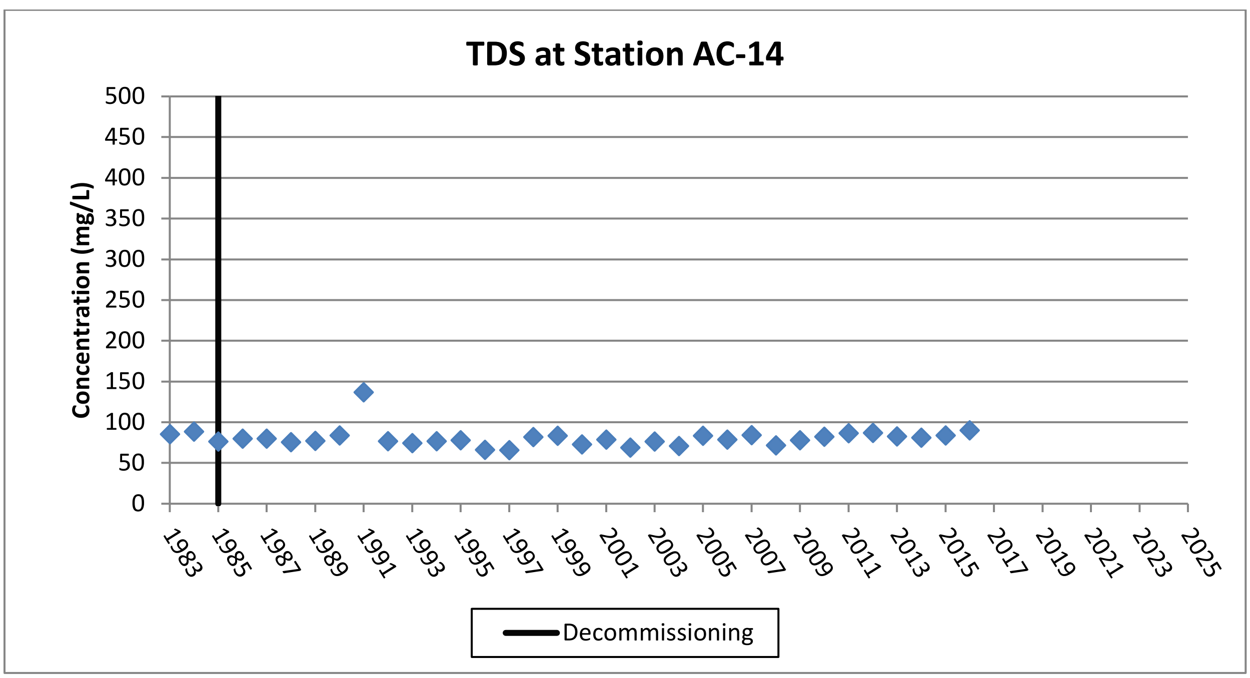
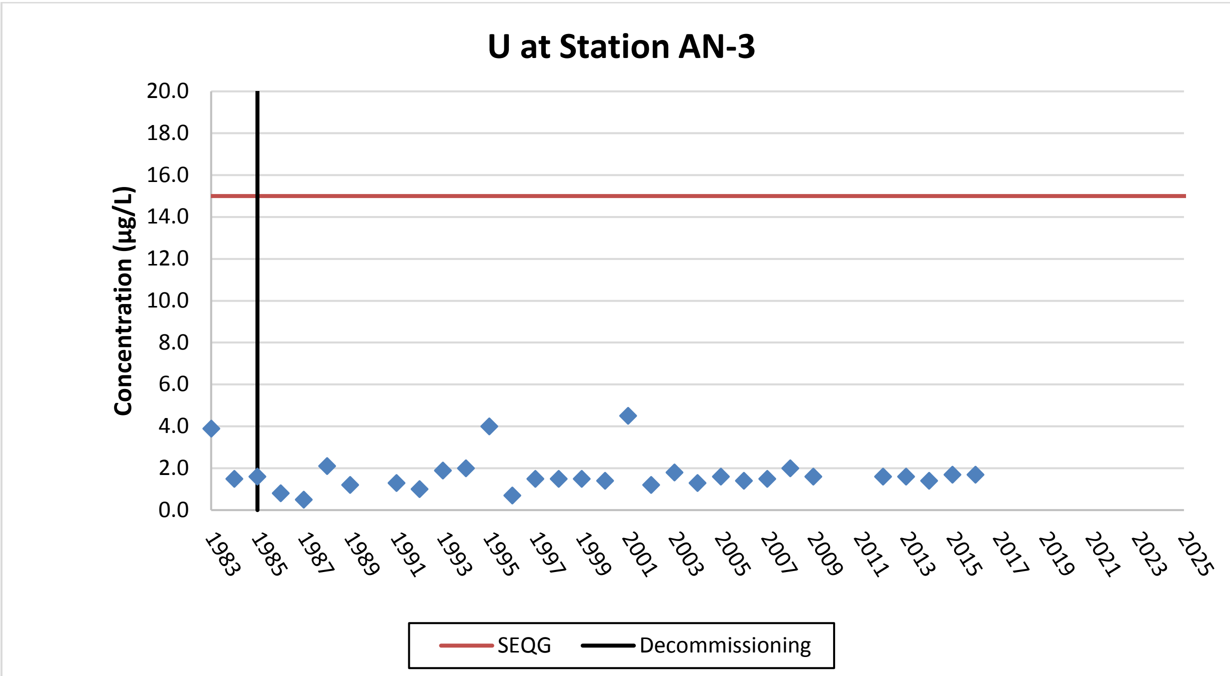
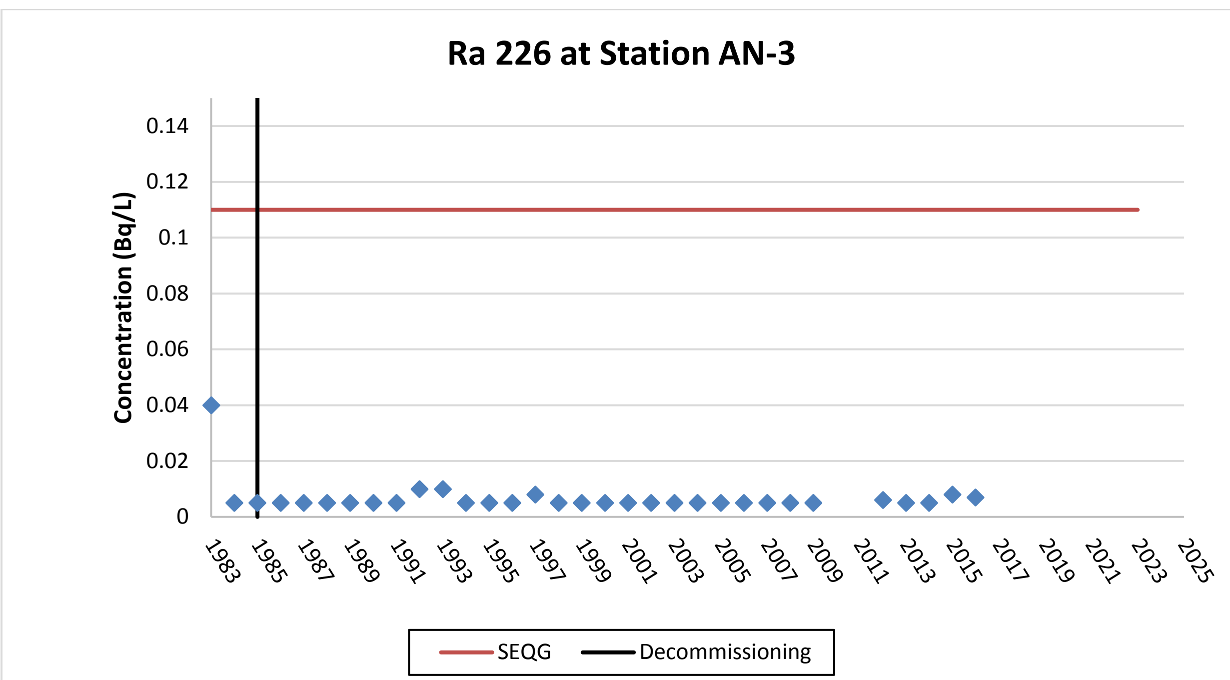


Figure 4.3.2-1 AN-3 Fulton Lake (Upstream of TL Stations)



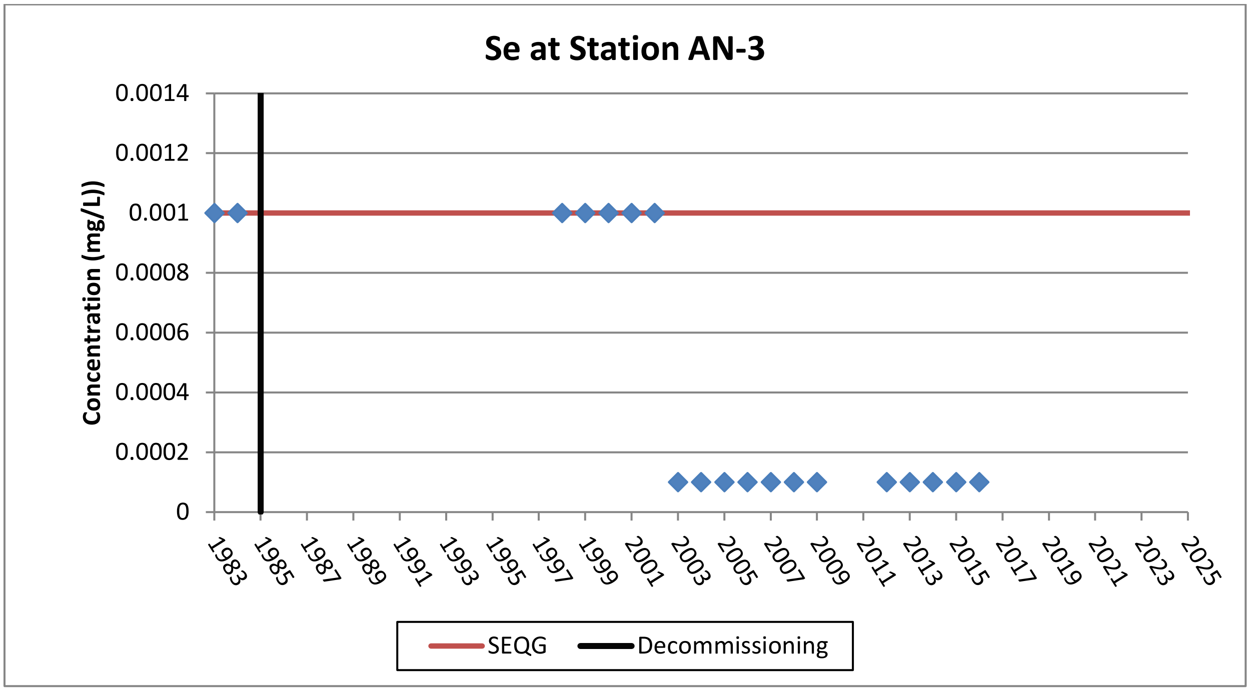
**The 2010 and 2011 scheduled sampling was not completed due to a lack of water flow.*

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*

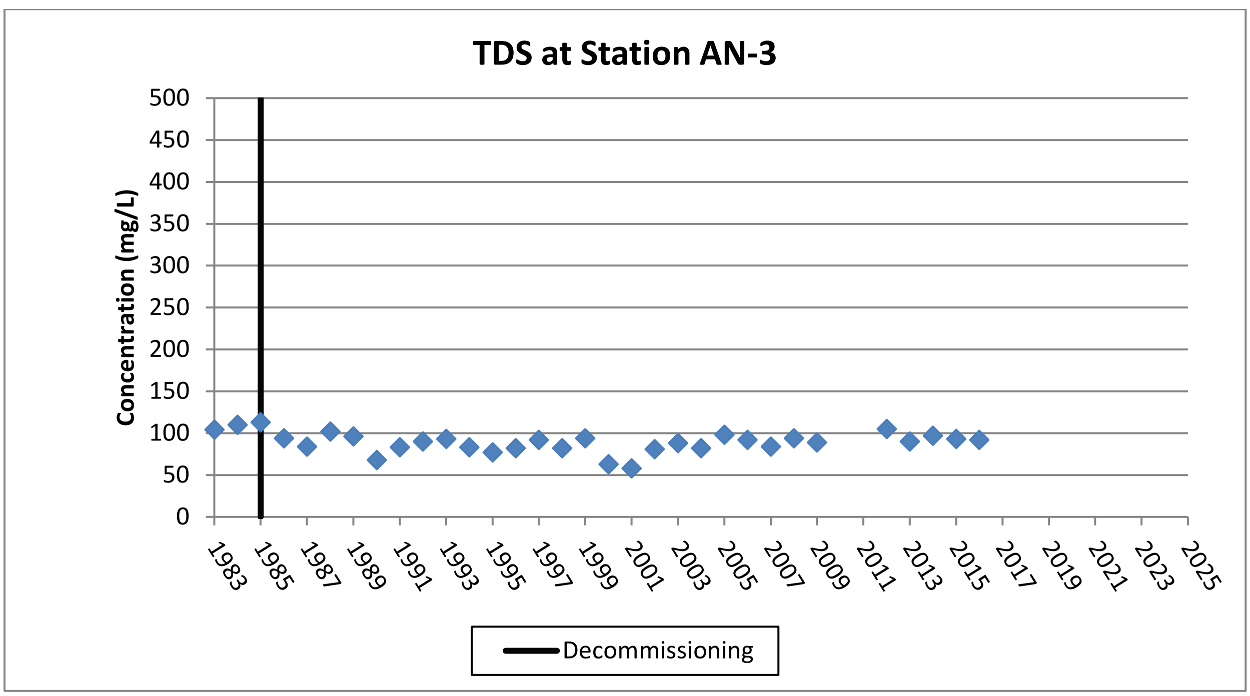
Figure 4.3.2-3 AN-3 Fulton Lake (Upstream of TL Stations)



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

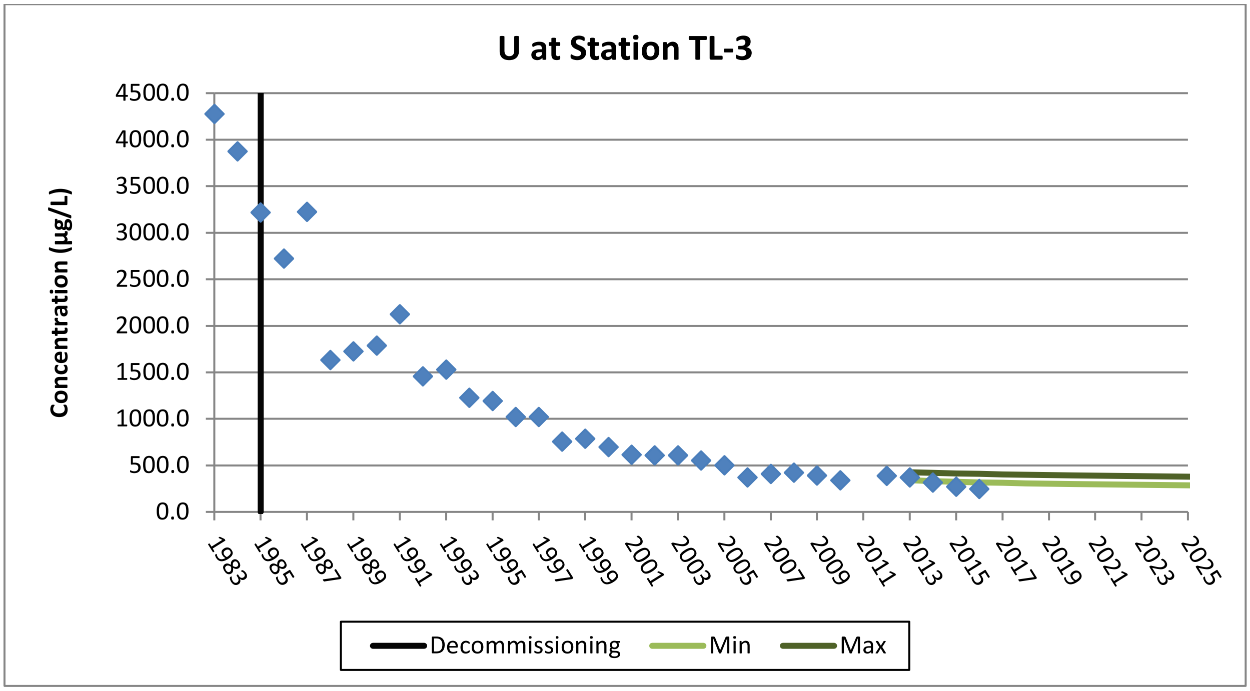
Note: Method detection limit changed from 0.001 mg/L to 0.0001 mg/L in 2003

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



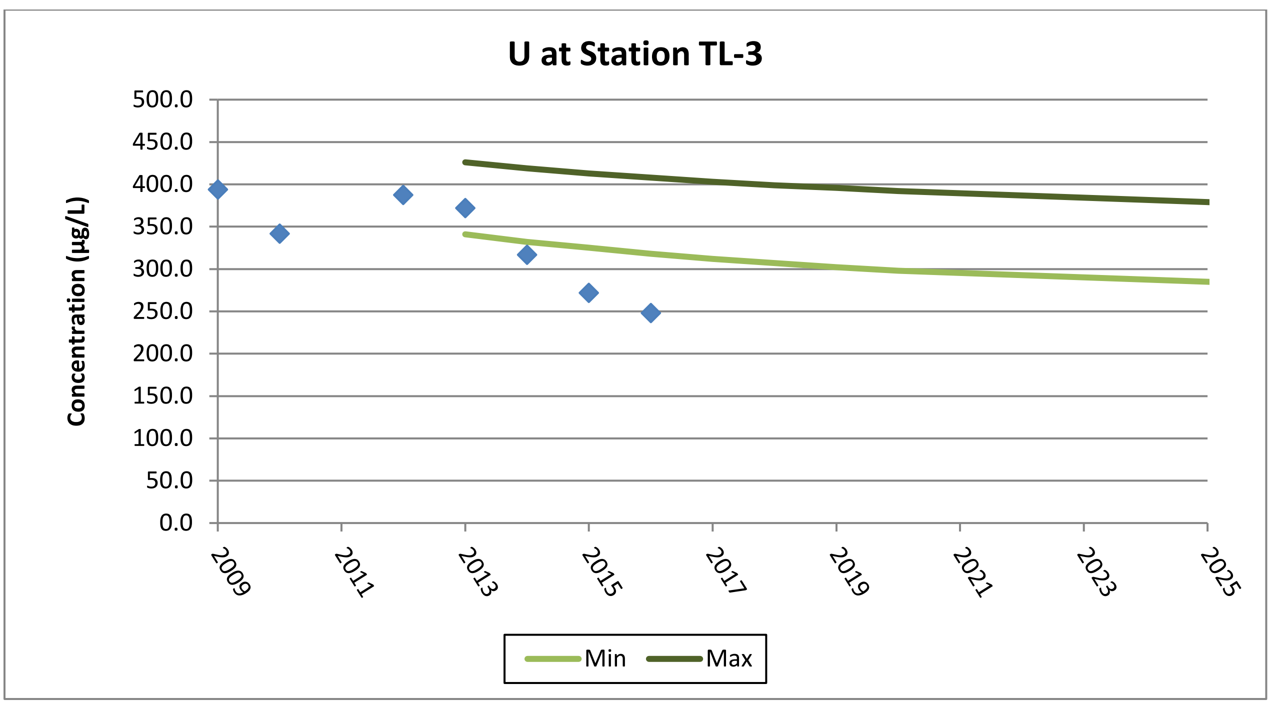
**The 2010 and 2011 scheduled sampling was not completed due to a lack of water flow*

Figure 4.3.2-5 TL-3 Fookes Reservoir Discharge



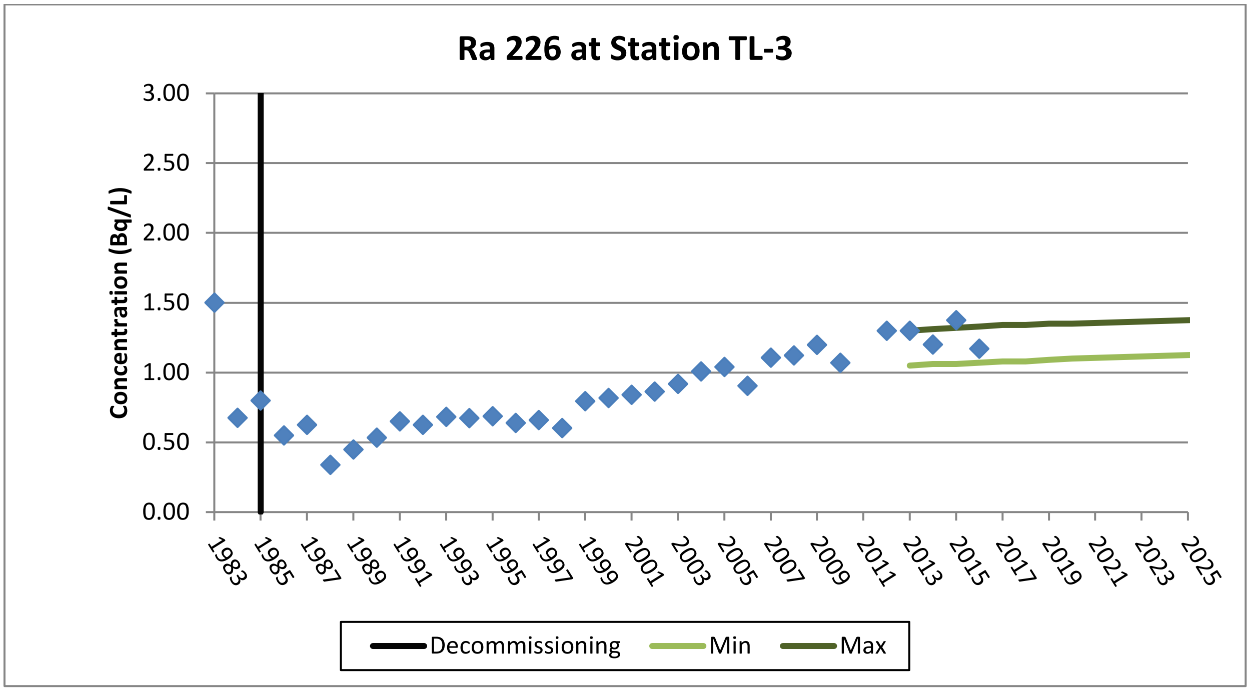
**No data available for 2011 due to a lack of water flow*

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



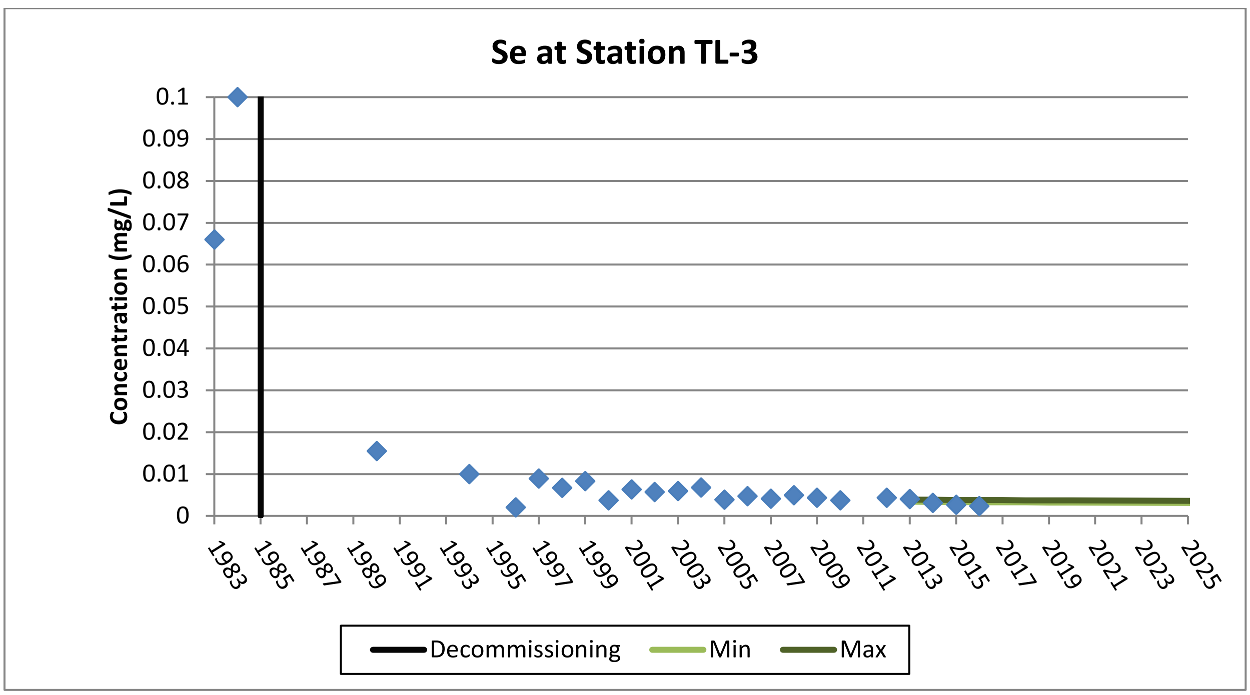
**No data available for 2011 due to a lack of water flow*

Figure 4.3.2-7 TL-3 Fookes Reservoir Discharge



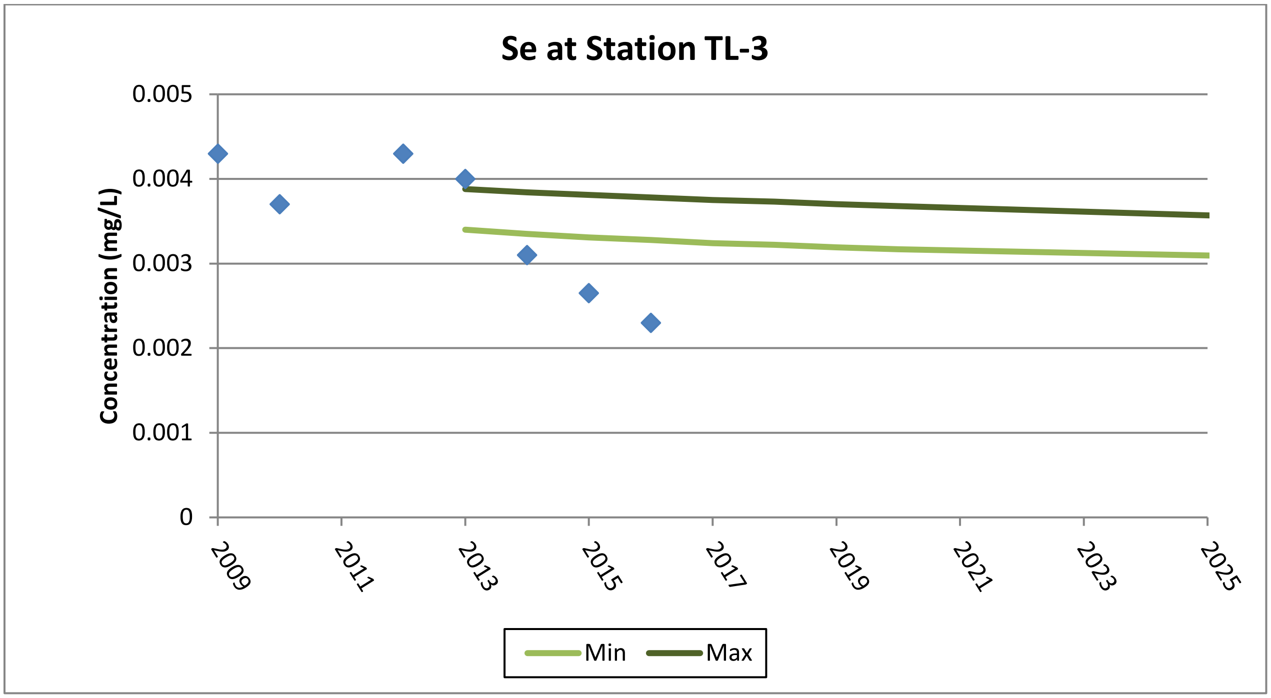
**No data available for 2011 due to a lack of water flow*

Figure 4.3.2-8 TL-3 Fookes Reservoir Discharge



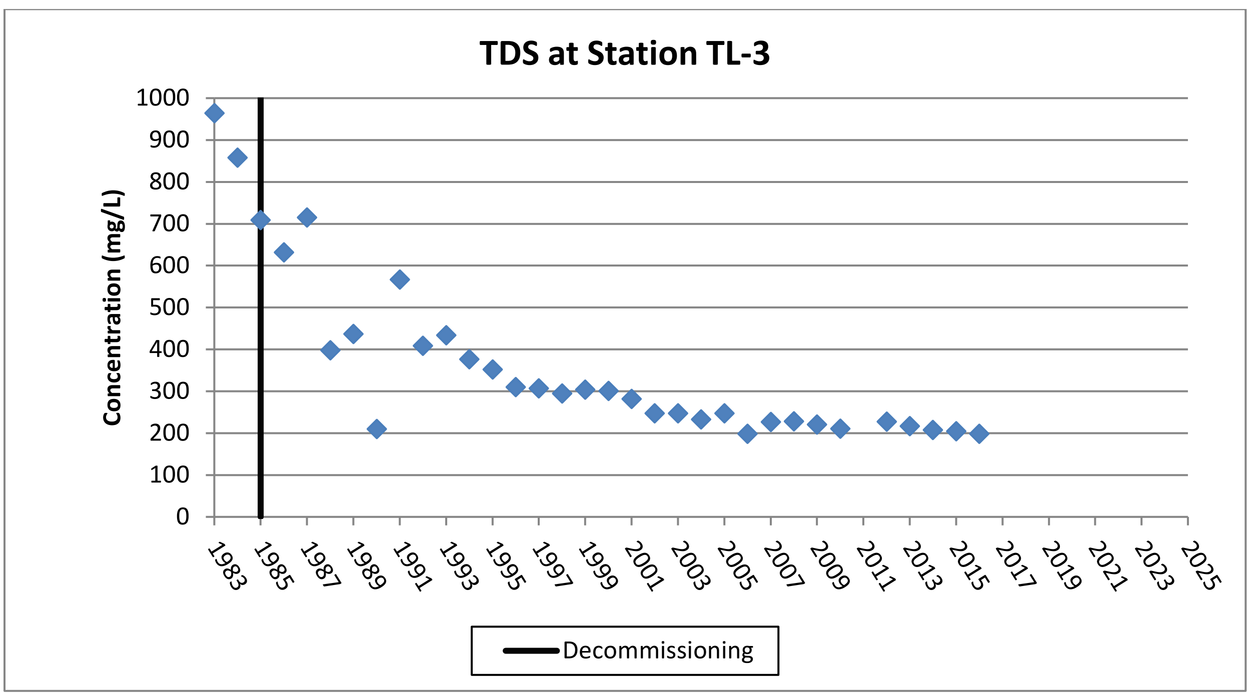
**No data available for 2011 due to a lack of water flow*

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



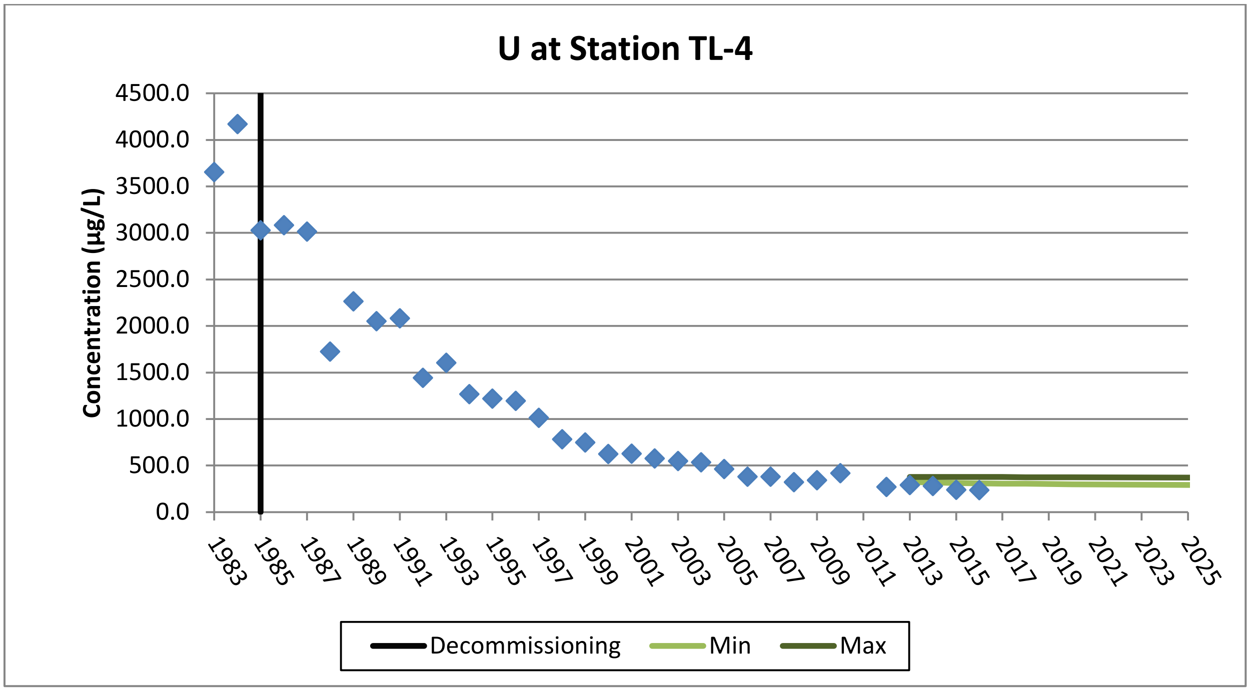
**No data available for 2011 due to a lack of water flow*

Figure 4.3.2-10 TL-3 Fookes Reservoir Discharge



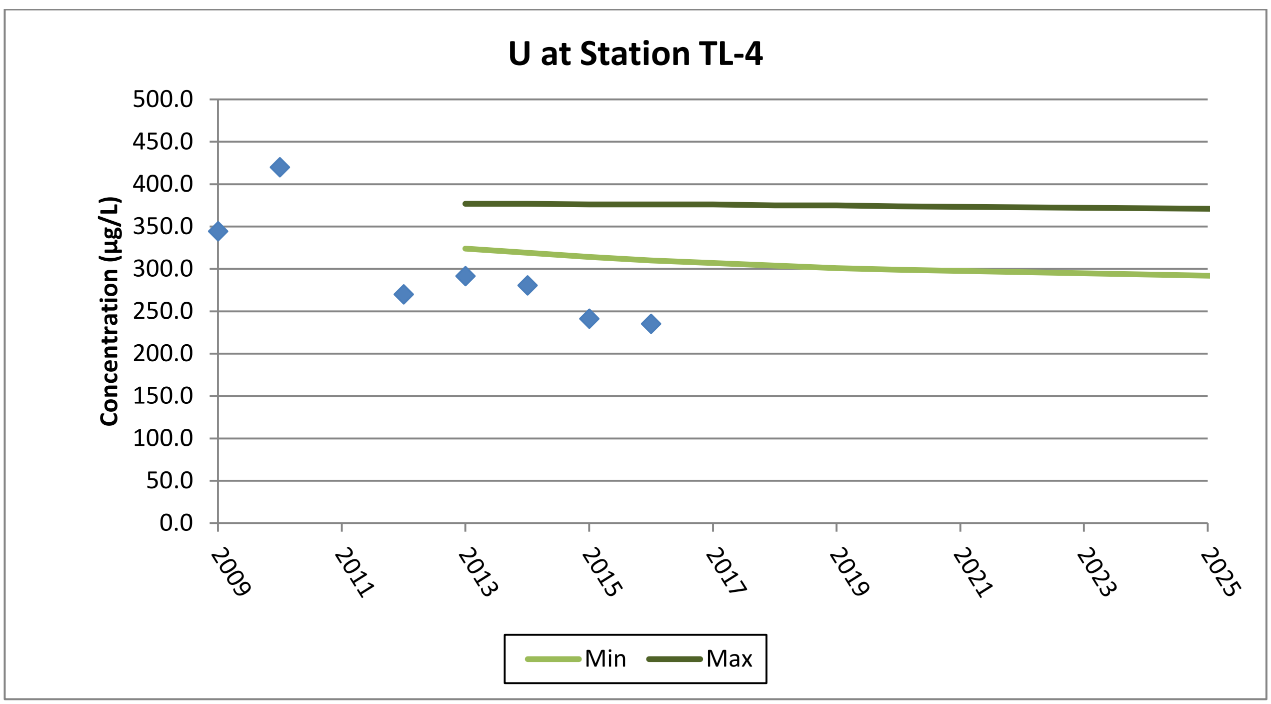
**No data available for 2011 due to a lack of water flow*

Figure 4.3.2-11 TL-4 Marie Reservoir Discharge



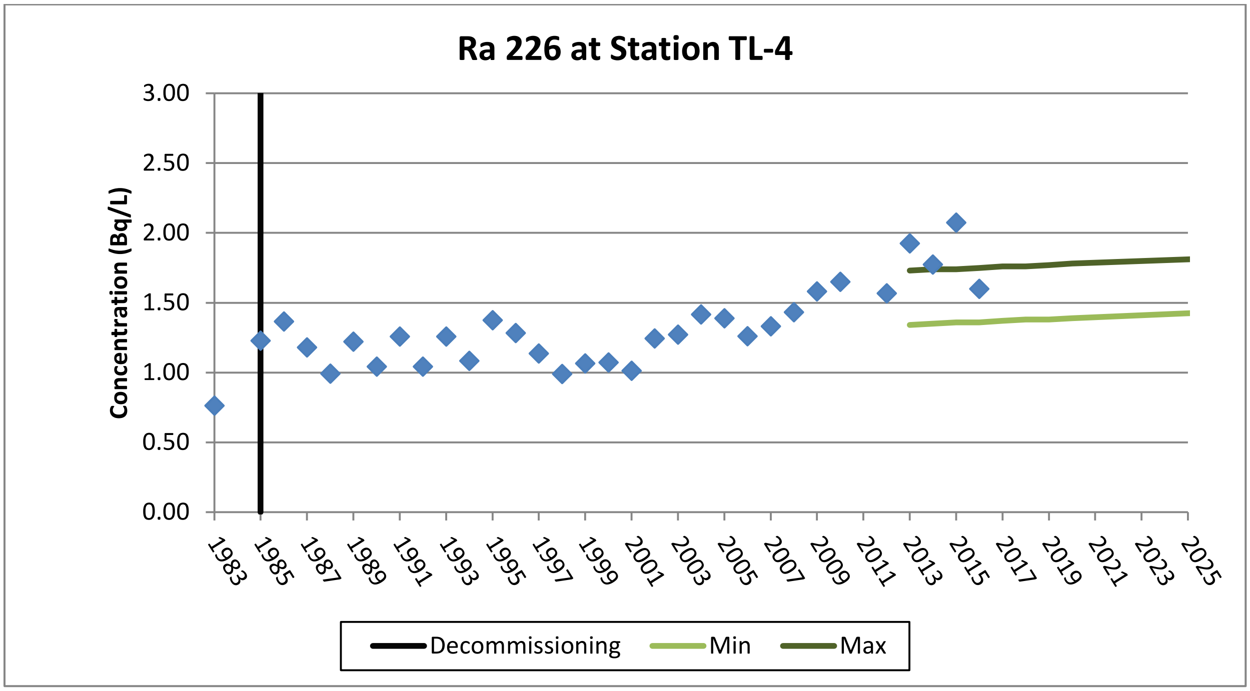
**No data available for 2011 due to a lack of water flow*

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



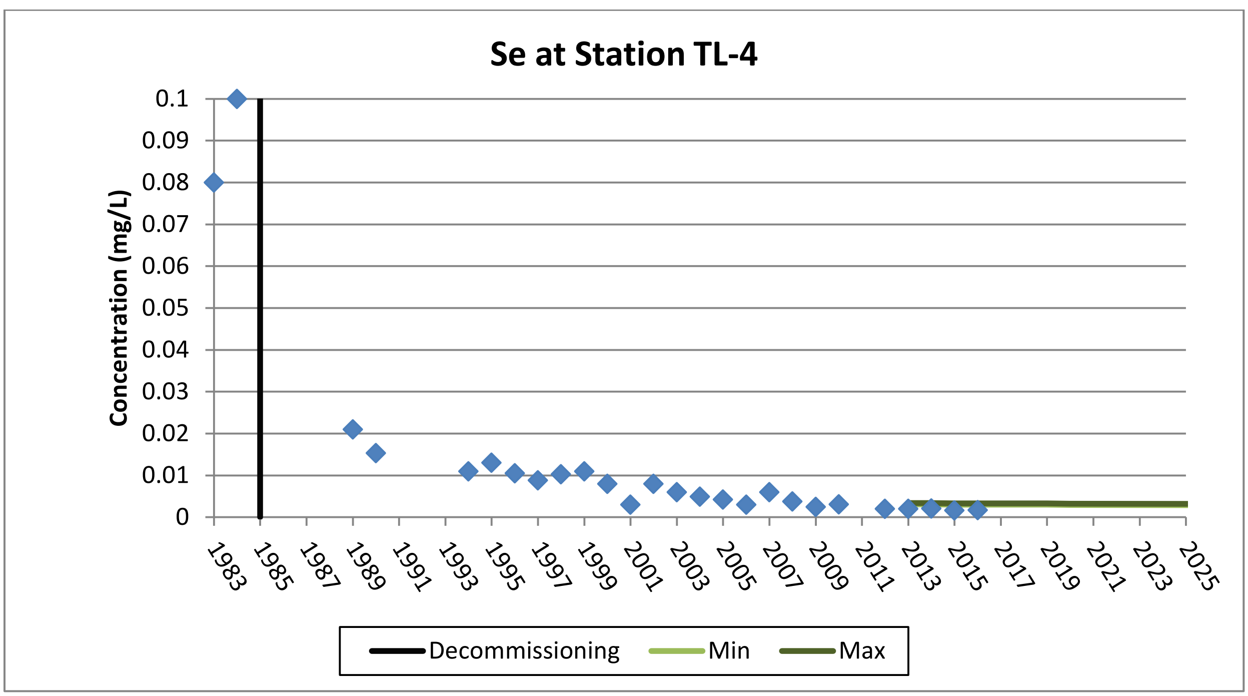
**No data available for 2011 due to a lack of water flow*

Figure 4.3.2-13 TL-4 Marie Reservoir Discharge



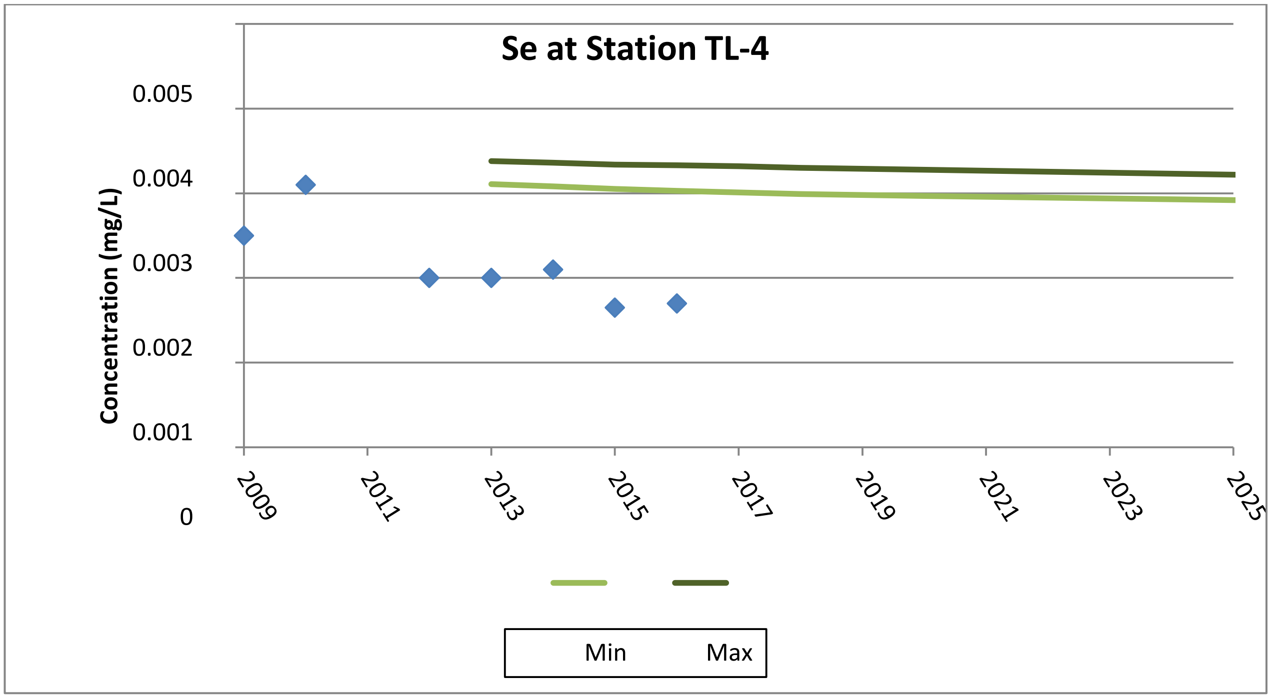
**No data available for 2011 due to a lack of water flow*

Figure 4.3.2-14 TL-4 Marie Reservoir Discharge



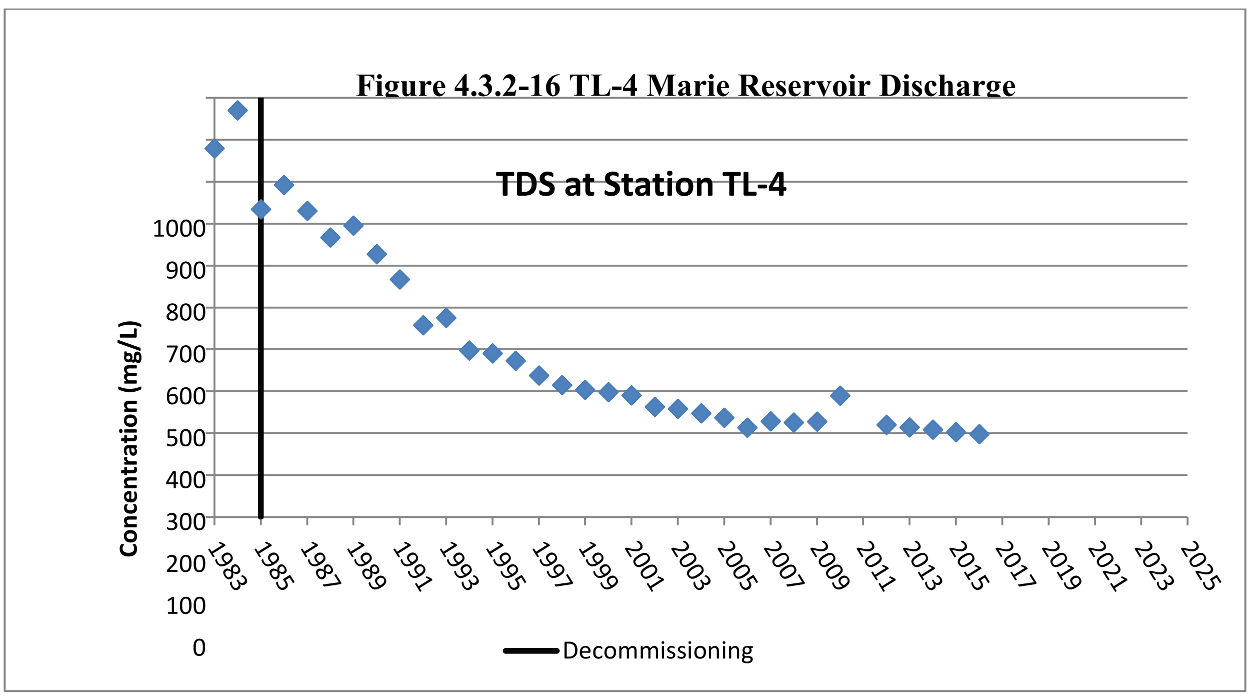
**No data available for 2011 due to a lack of water flow*

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



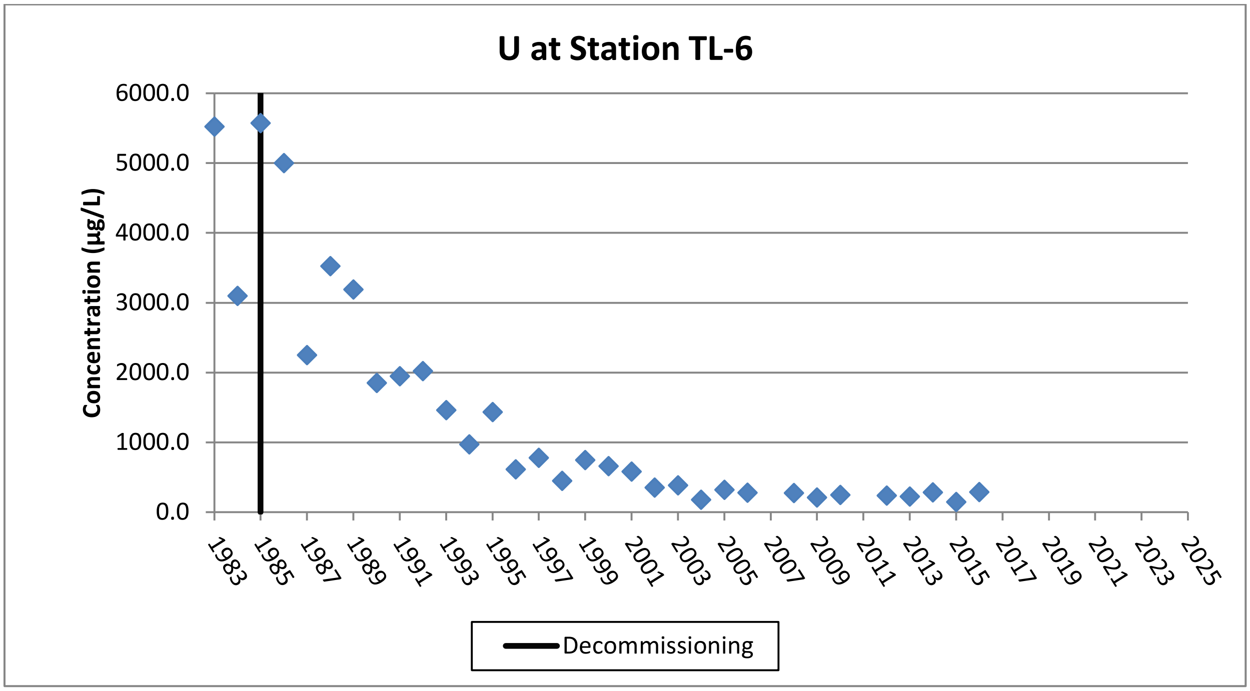
**No data available for 2011 due to a lack of water flow*

Figure 4.3.2-16 TL-4 Marie Reservoir Discharge



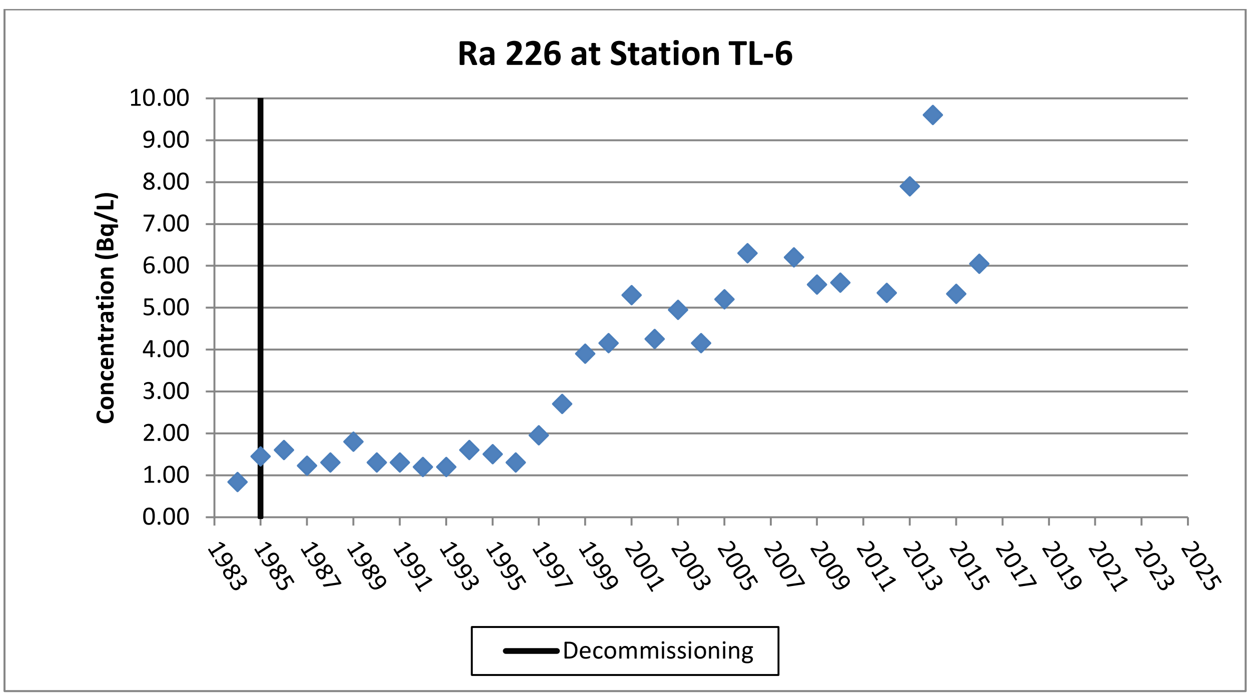
**No data available for 2011 due to a lack of water flow*

Figure 4.3.2-17 TL-6 Minewater Reservoir Discharge



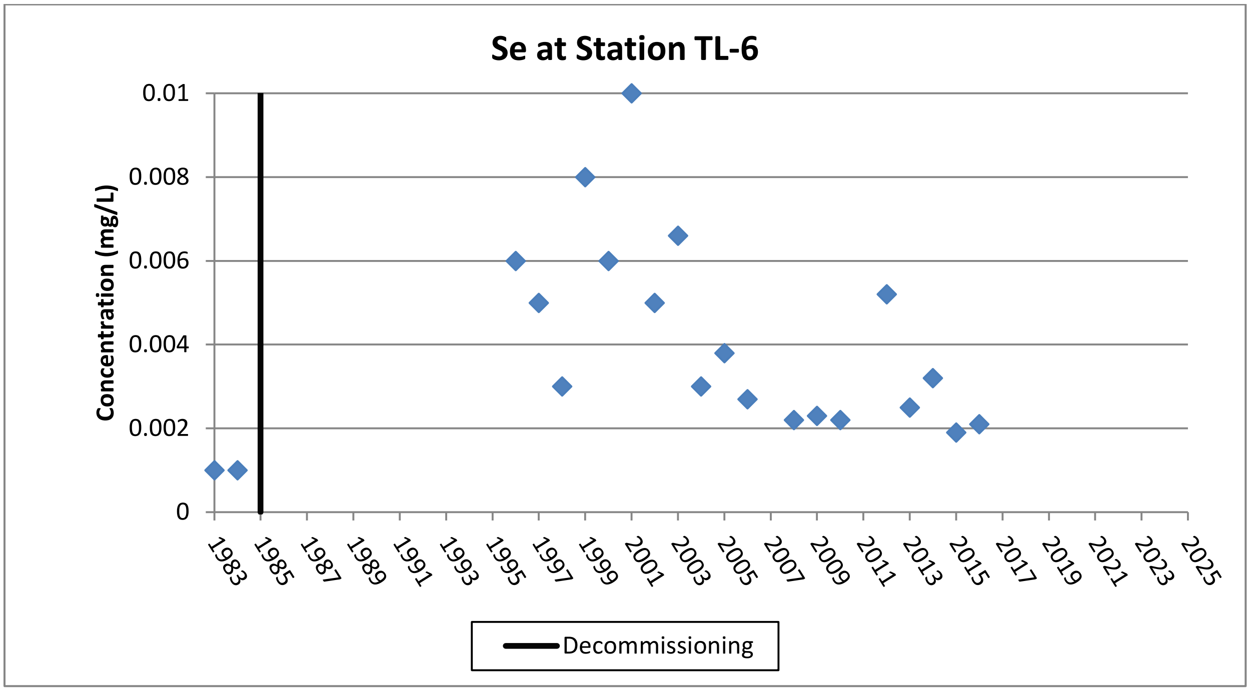
**No data available for 2007 and 2011 due to a lack of water flow*

Figure 4.3.2-18 TL-6 Minewater Reservoir Discharge



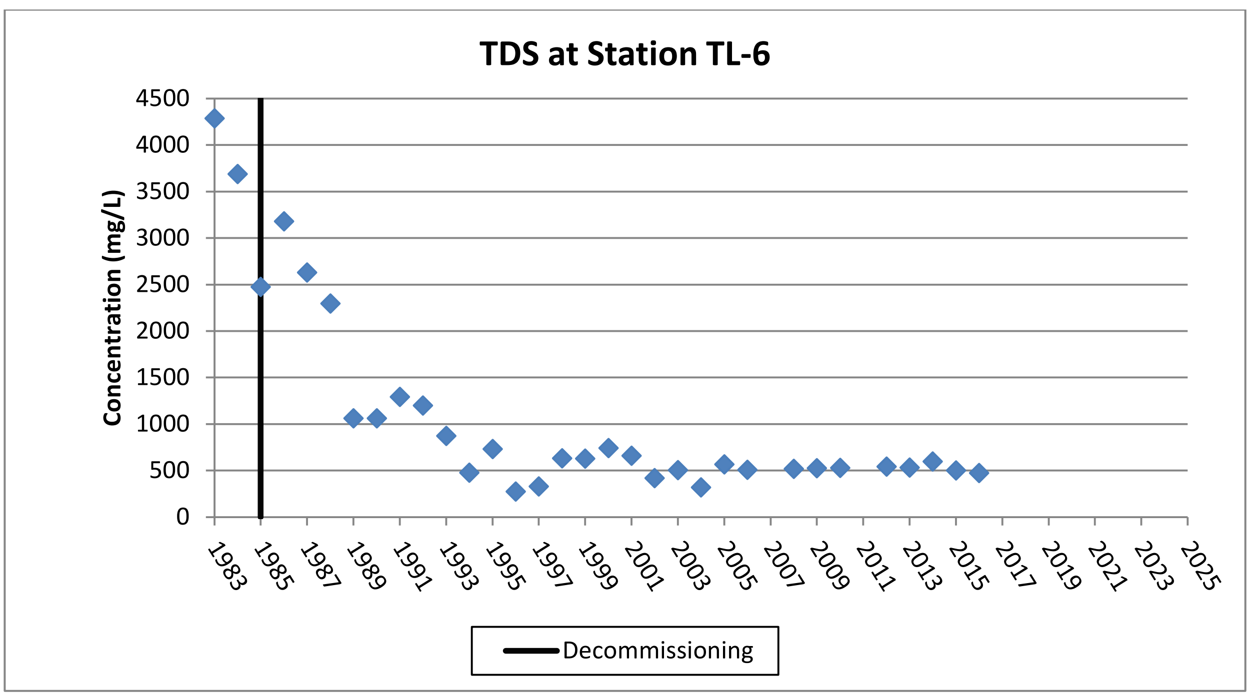
**No data available for 2007 and 2011 due to a lack of water flow*

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

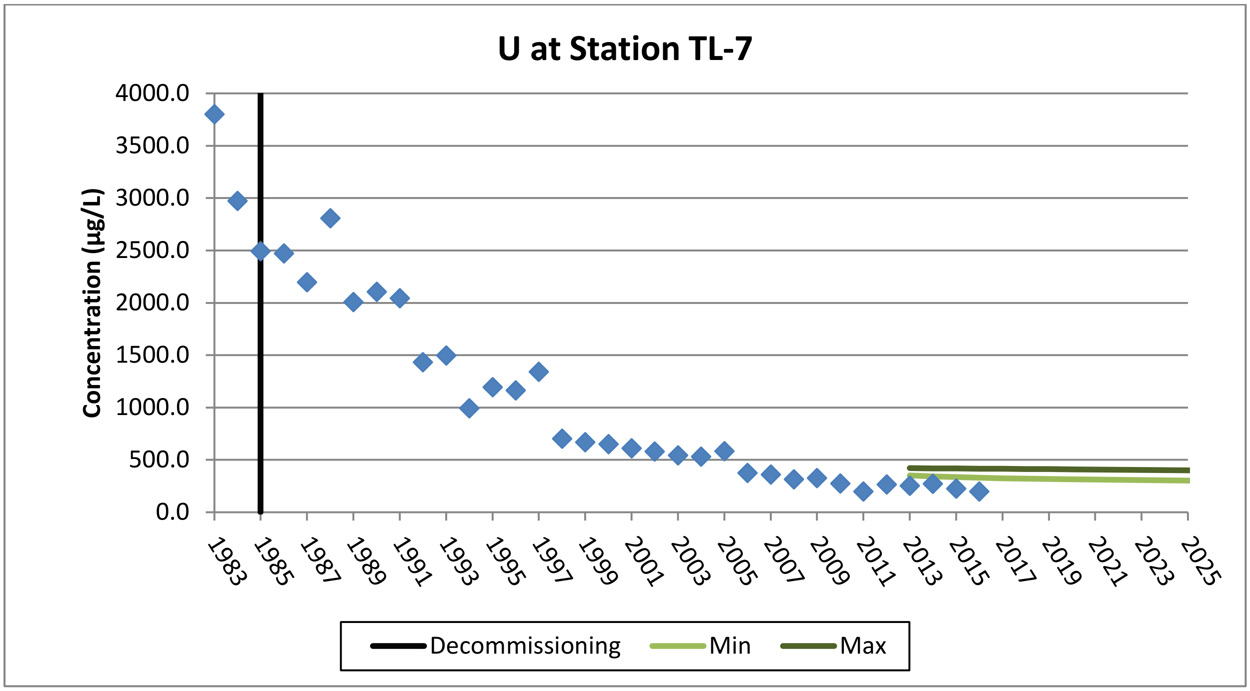


Figure 4.3.2-22 TL-7 Meadow Fen Discharge - Detailed Trend

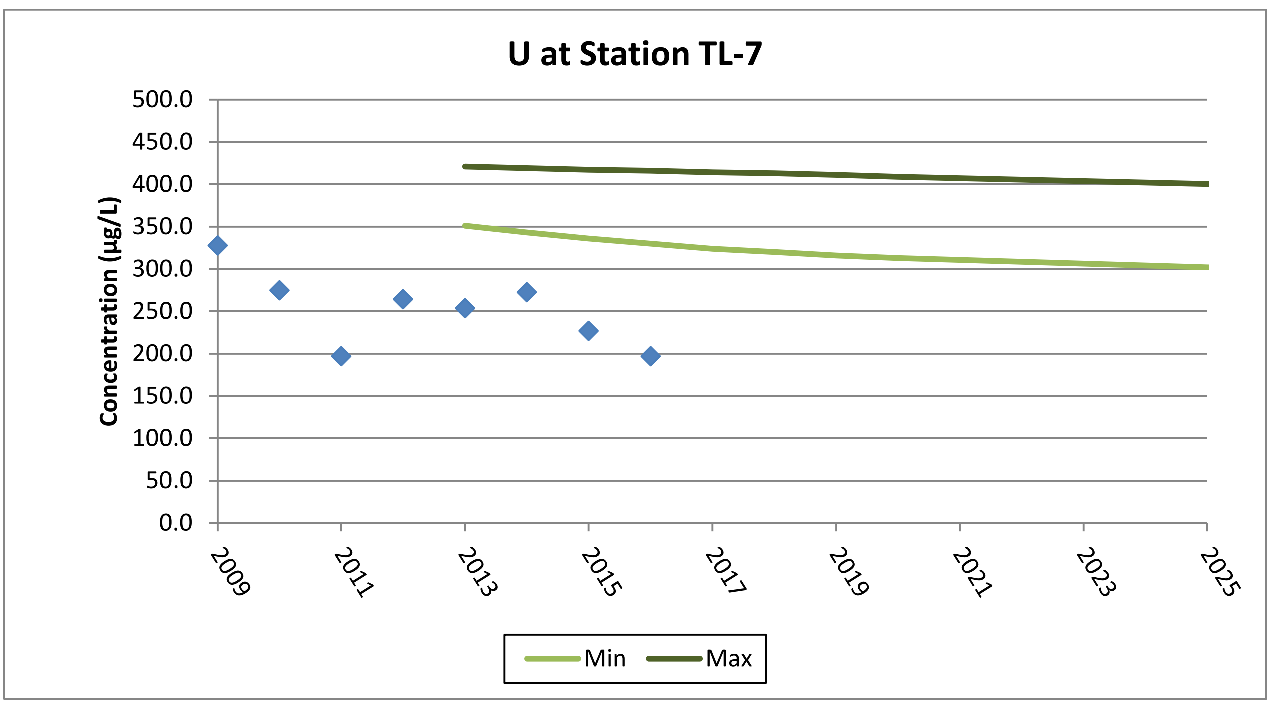


Figure 4.3.2-23 TL-7 Meadow Fen Discharge

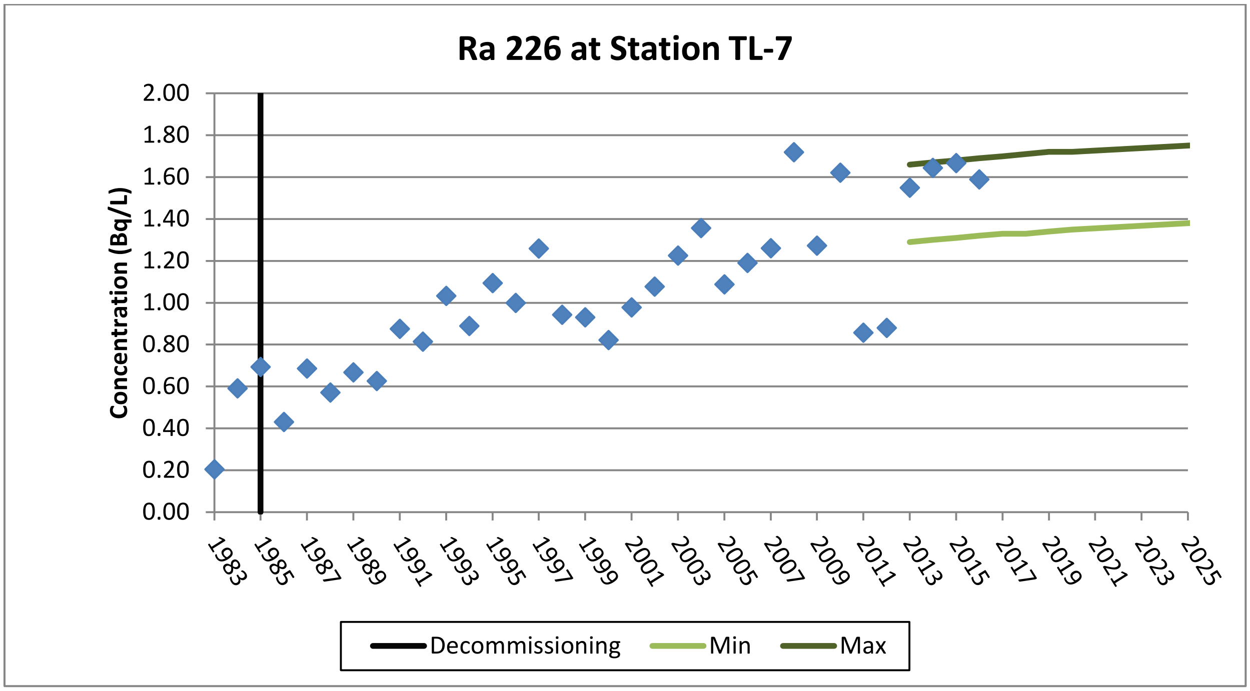


Figure 4.3.2-24 TL-7 Meadow Fen Discharge

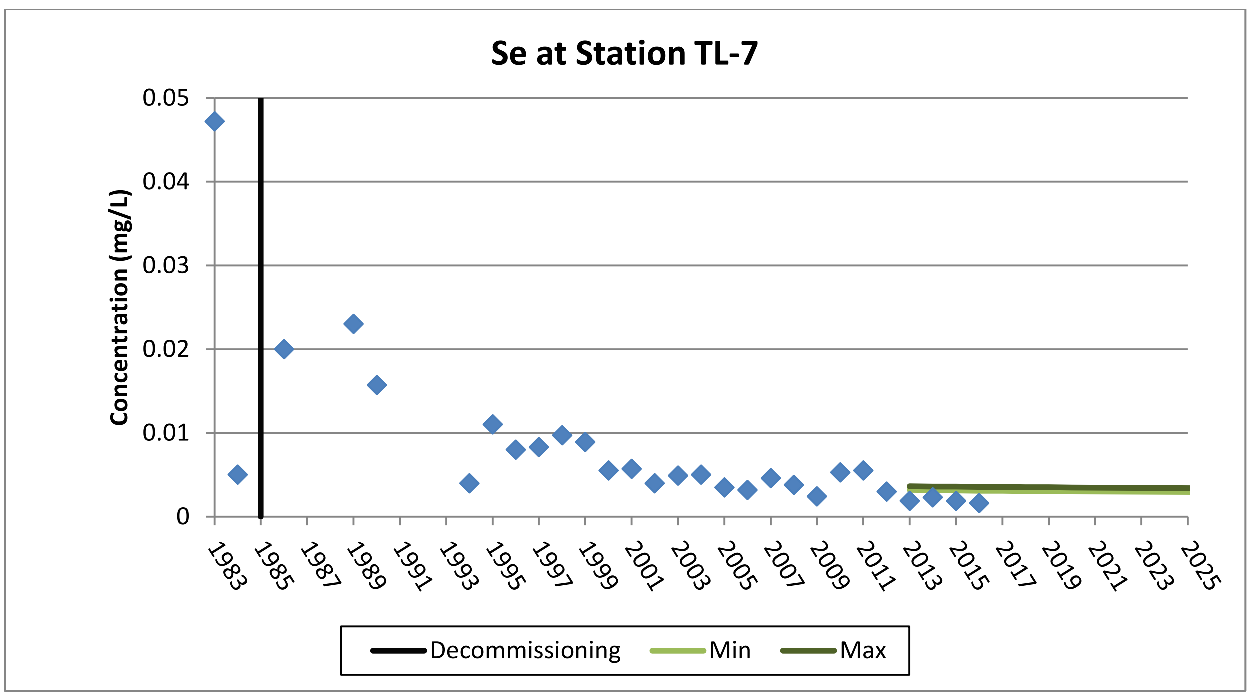


Figure 4.3.2-25 TL-7 Meadow Fen Discharge – Detailed Trend

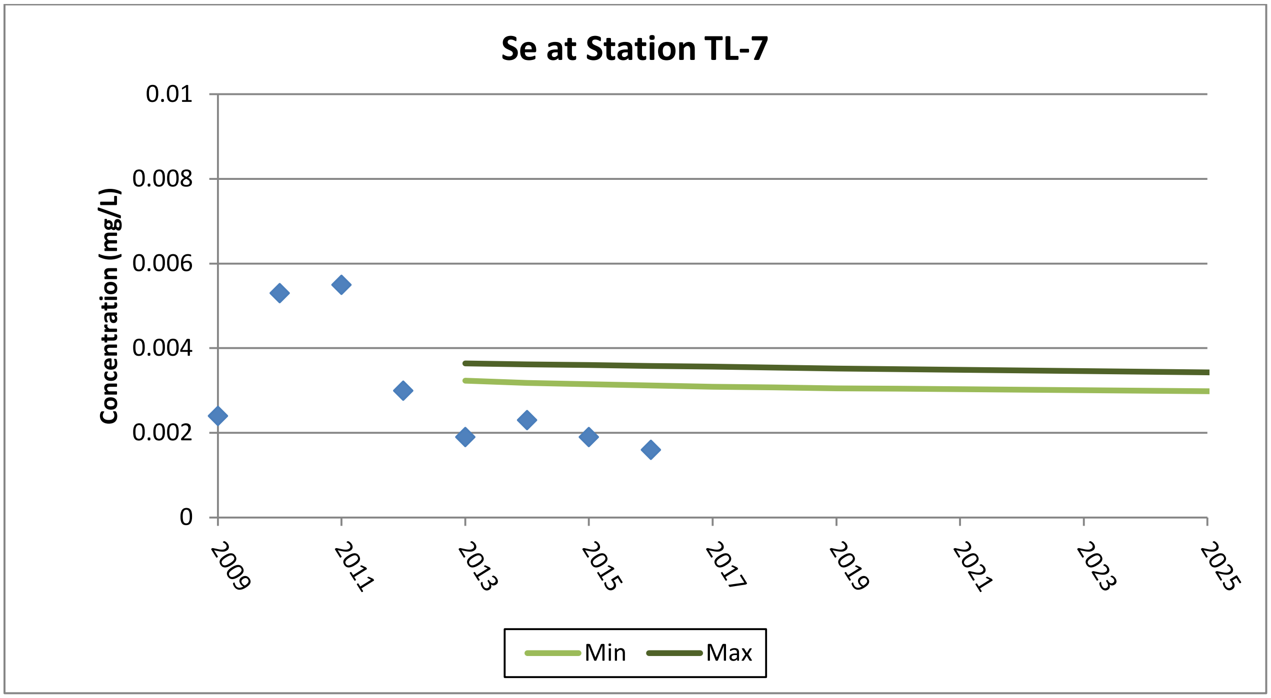


Figure 4.3.2-26 TL-7 Meadow Fen Discharge

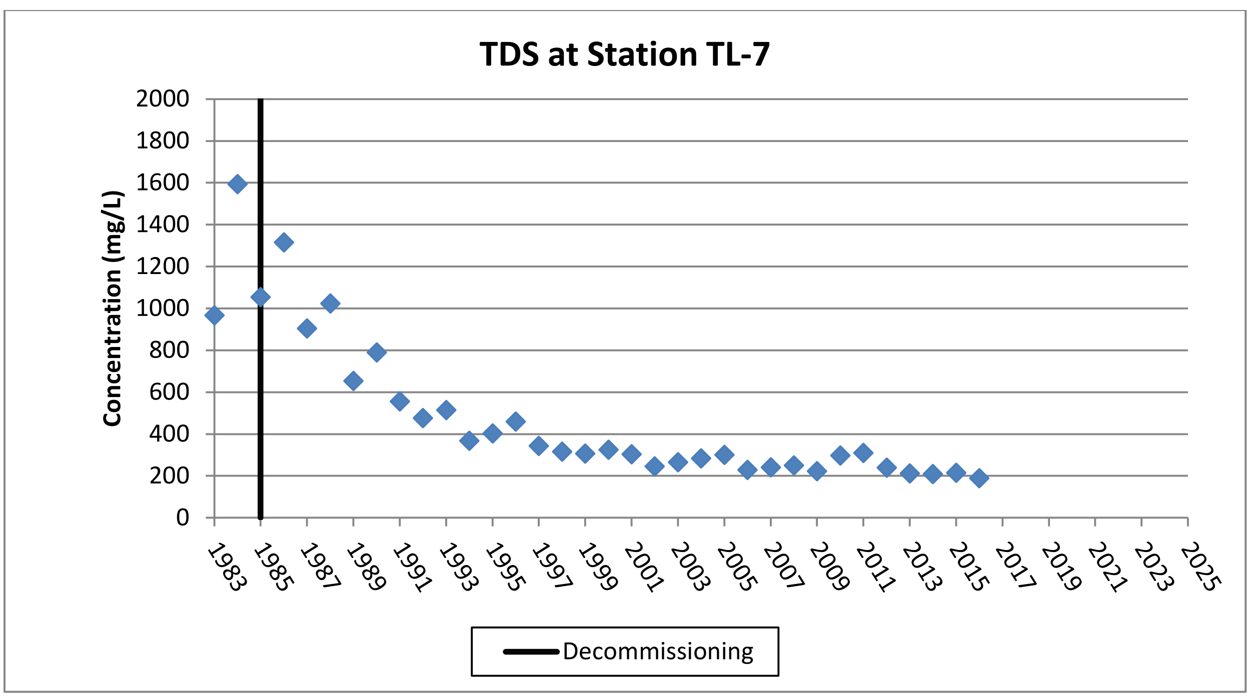
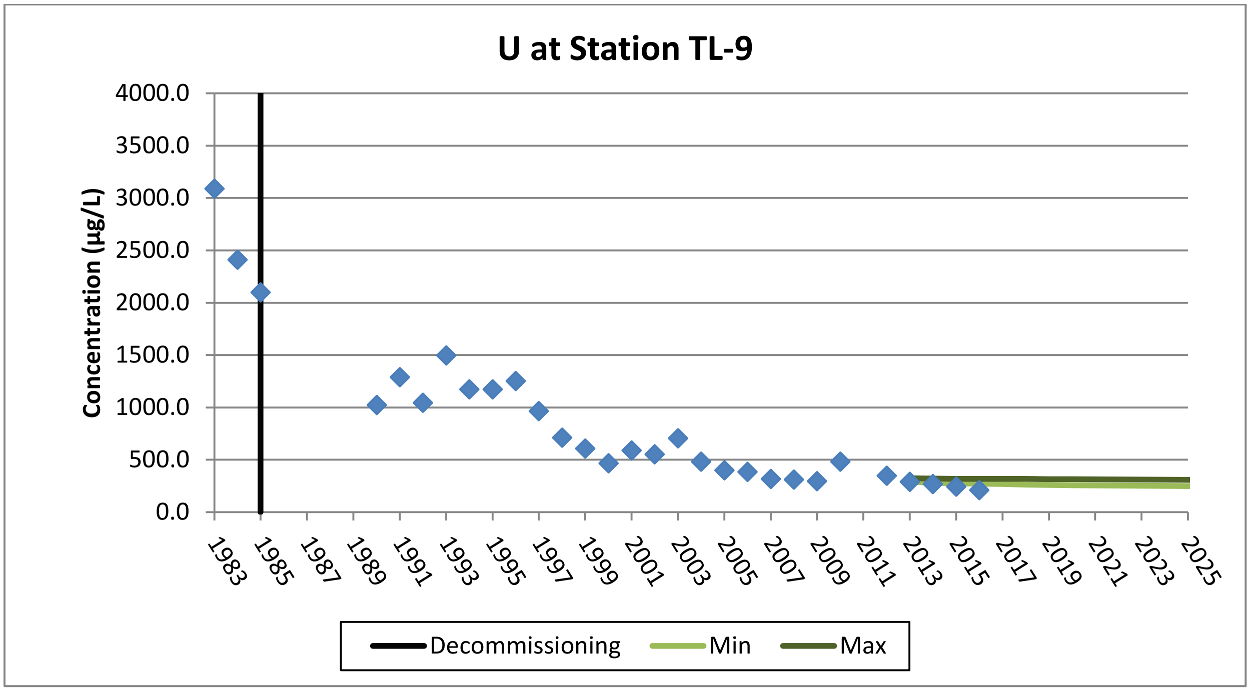
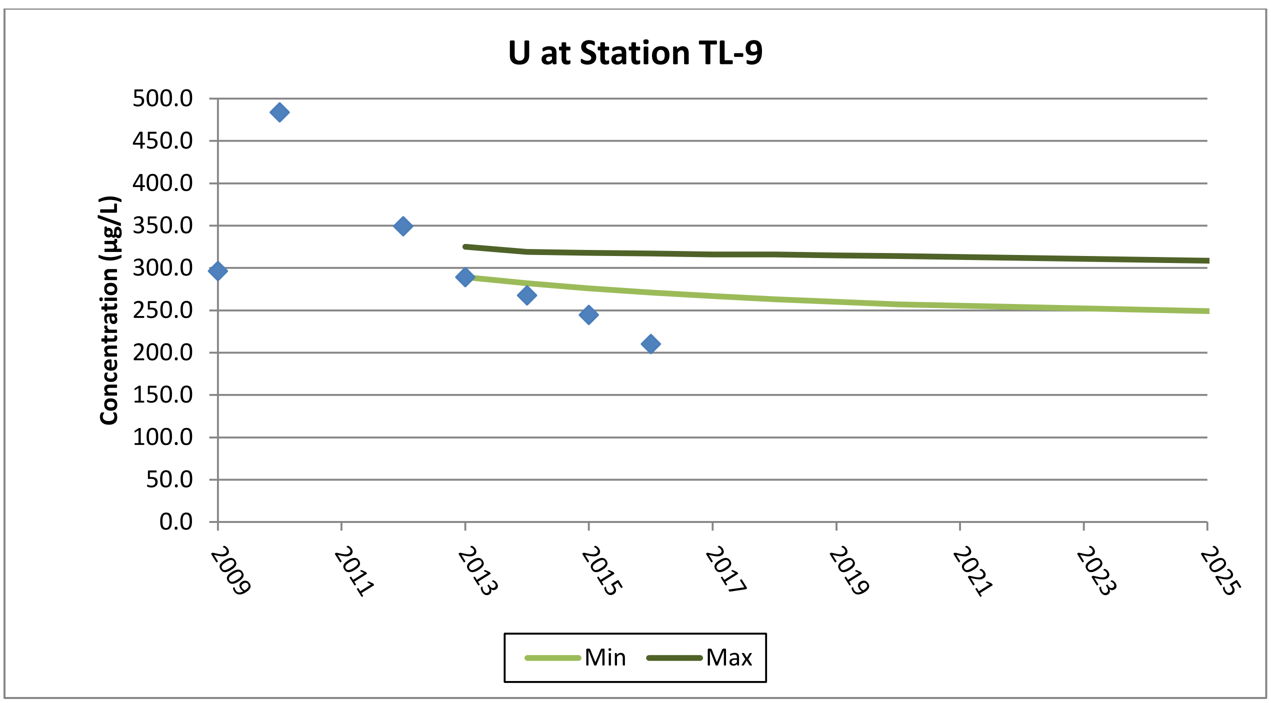


Figure 4.3.2-27 TL-9 Fulton Creek Below Greer Lake



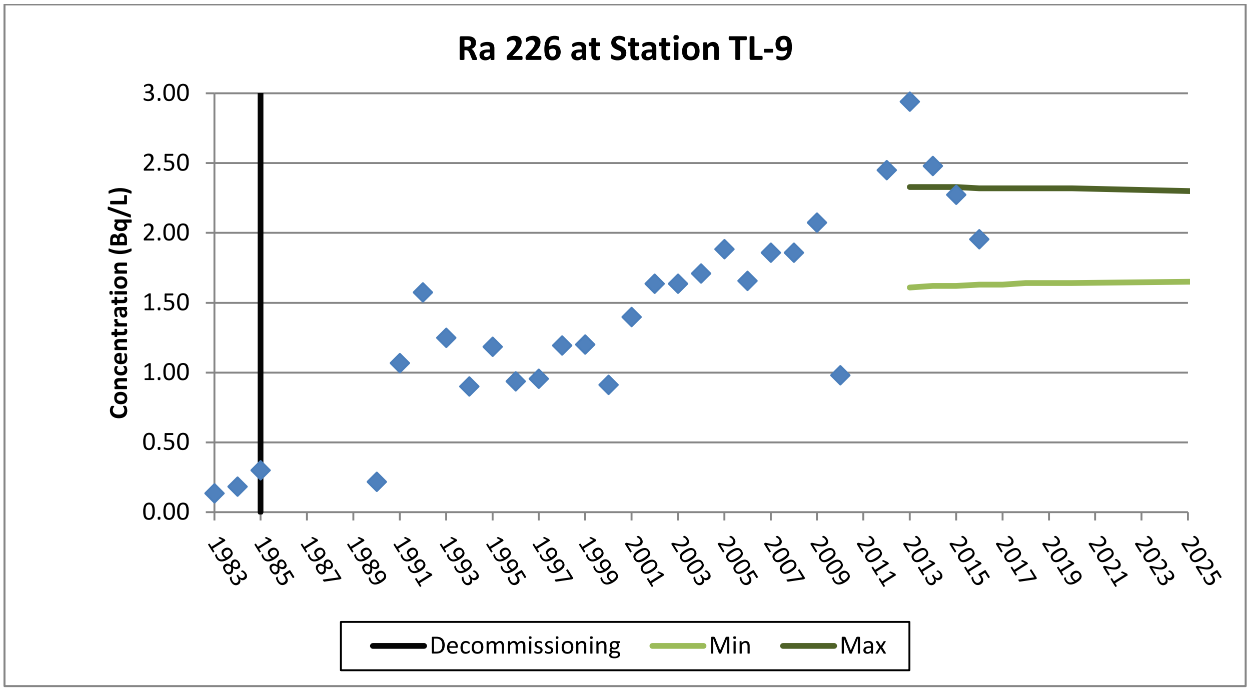
**There was no water flow at TL-9 in 2011.*

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



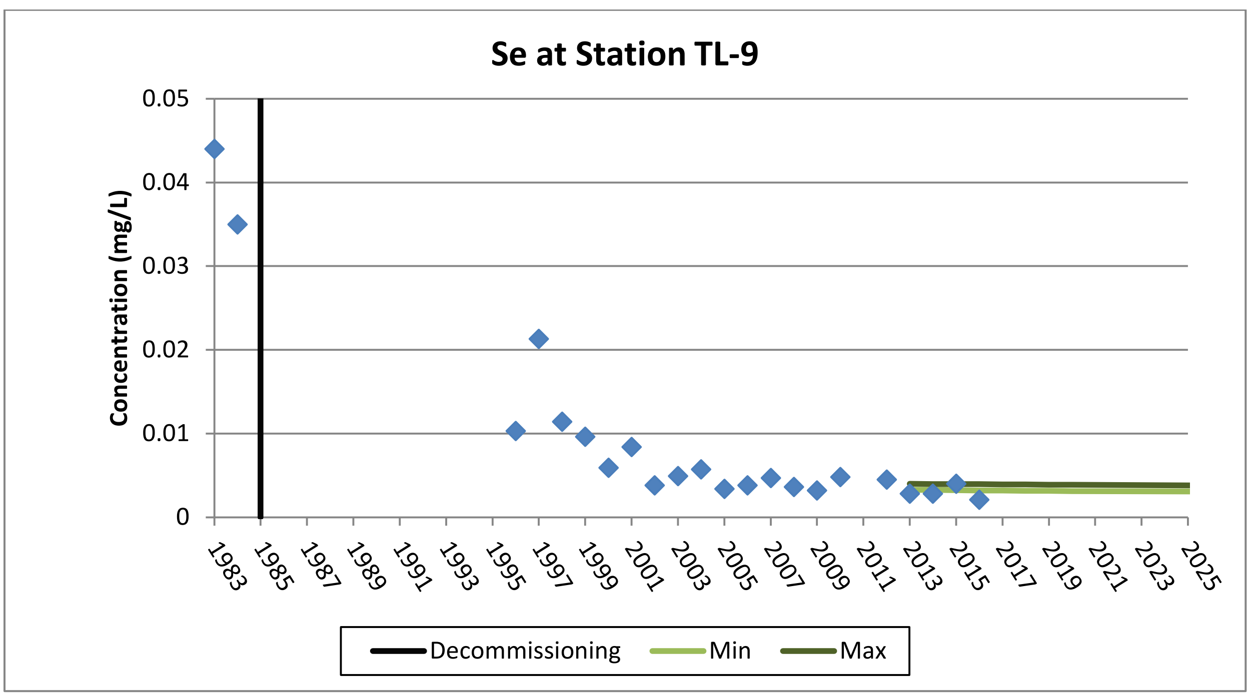
**There was no water flow at TL-9 in 2011.*

Figure 4.3.2-29 TL-9 Fulton Creek Below Greer Lake



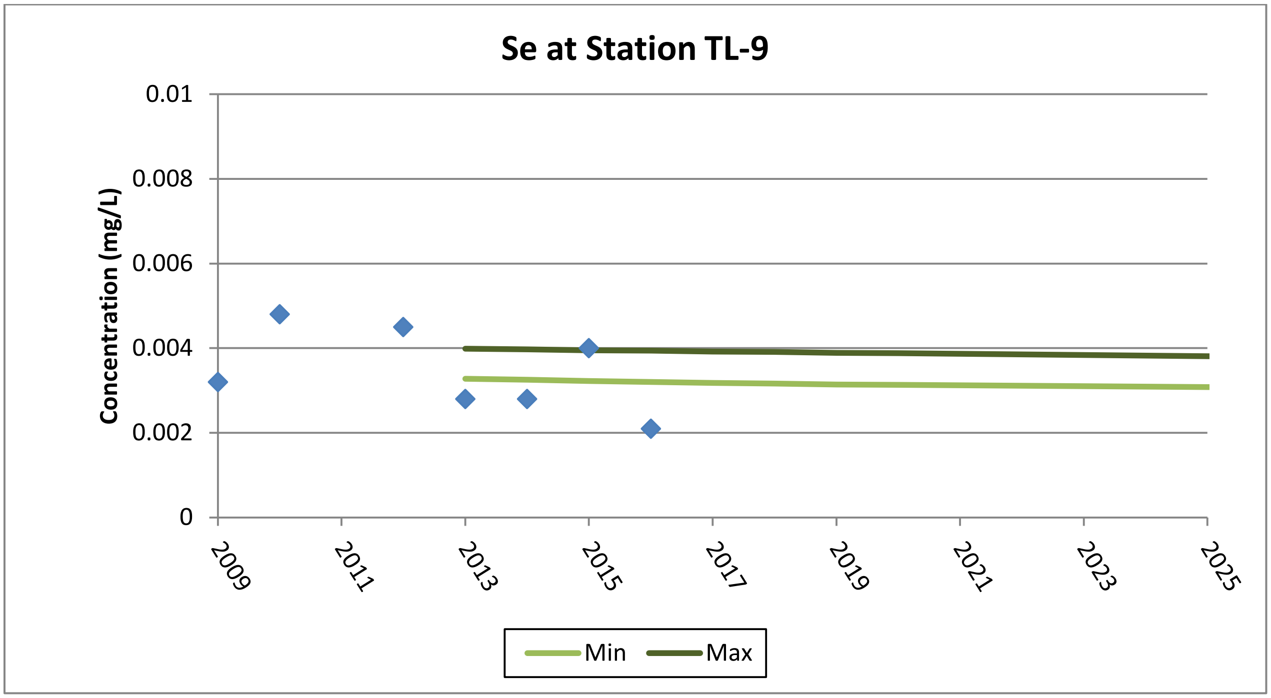
**There was no water flow at TL-9 in 2011.*

Figure 4.3.2-30 TL-9 - Fulton Creek Below Greer Lake



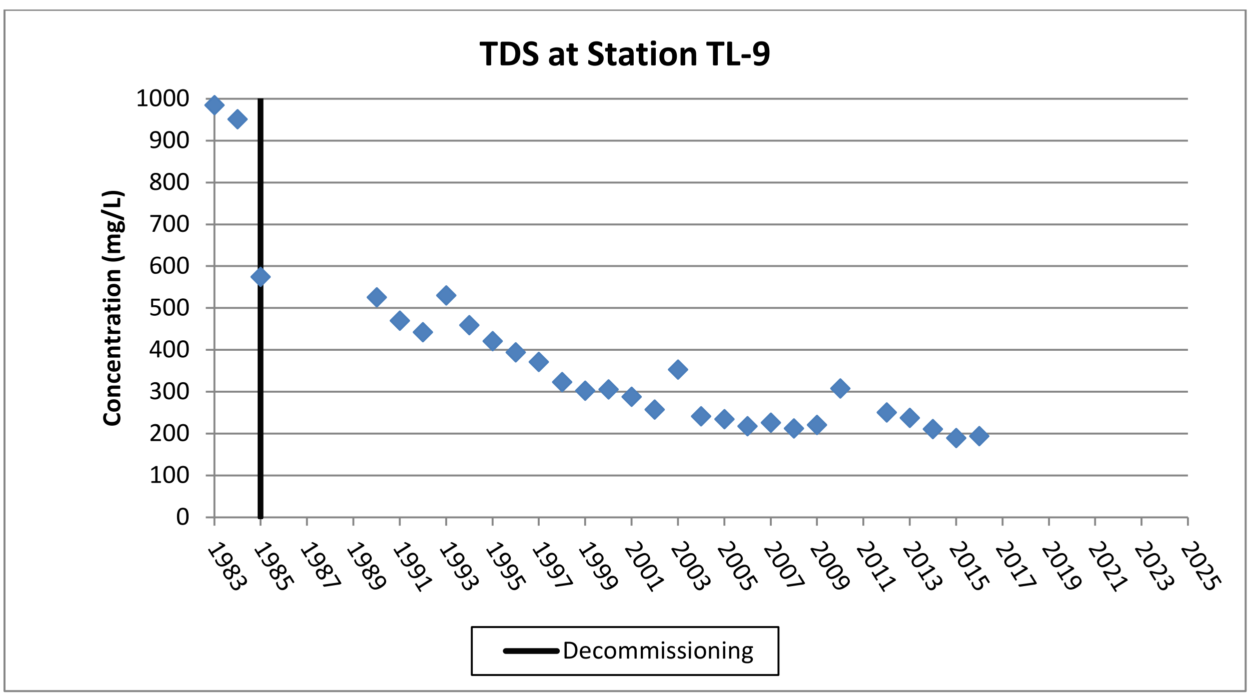
**There was no water flow at TL-9 in 2011.*

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



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

Figure 4.3.2-32 TL-9 - Fulton Creek Below 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

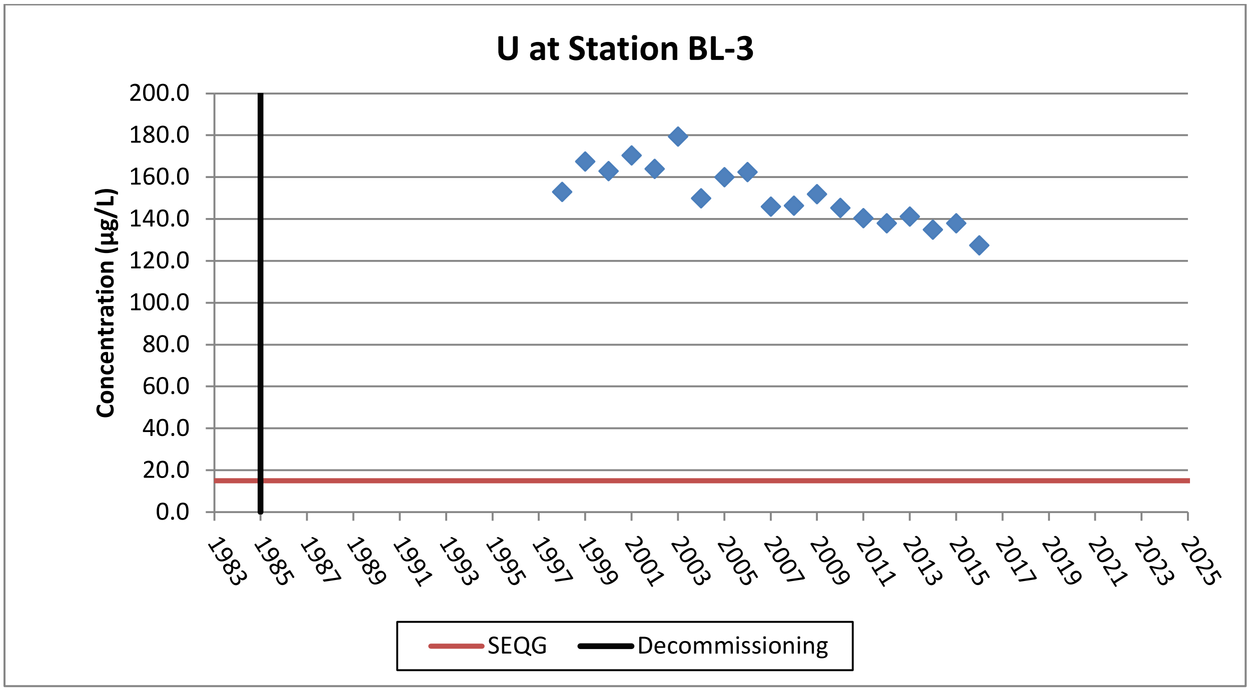


Figure 4.3.3-2 BL-3 - Beaverlodge Lake Opposite Fulton Creek Discharge

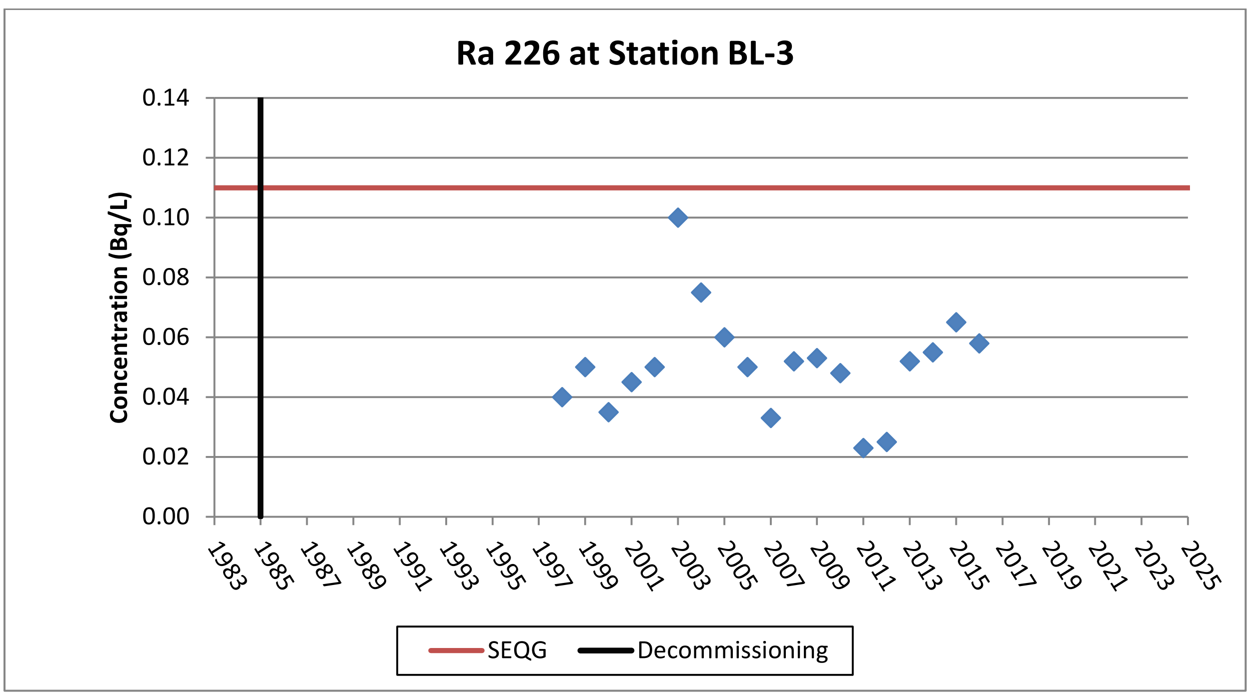
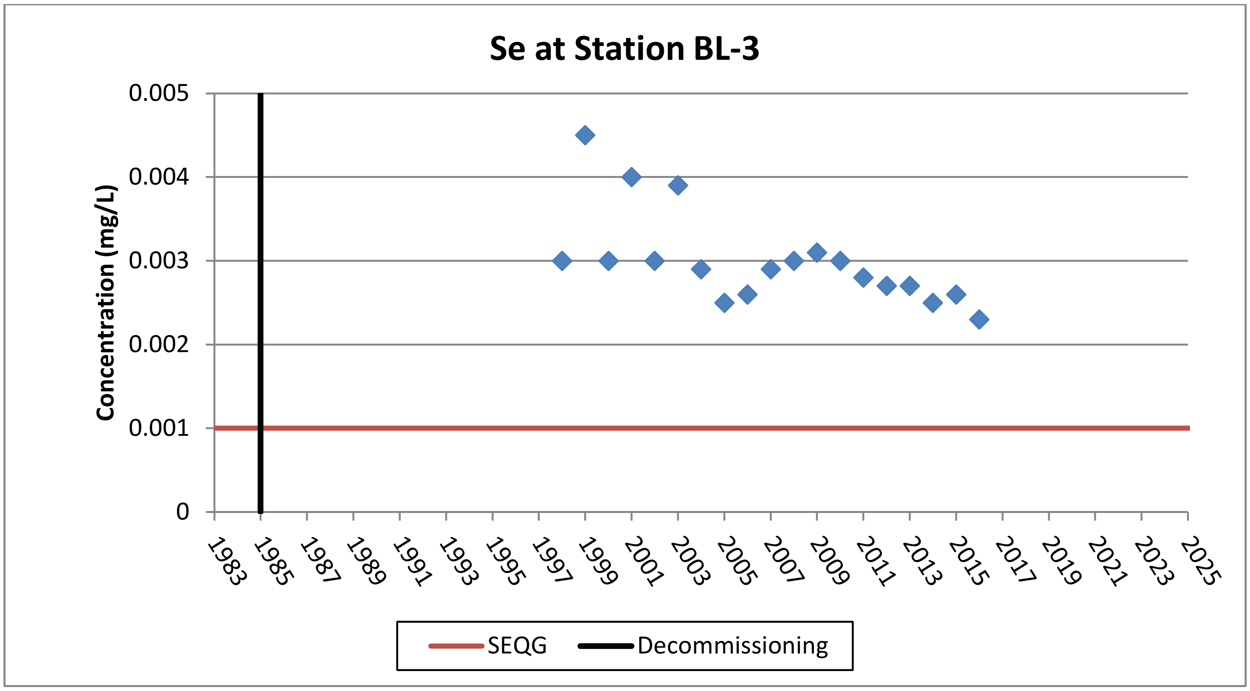


Figure 4.3.3-3 BL-3 - Beaverlodge Lake Opposite Fulton Creek Discharge



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

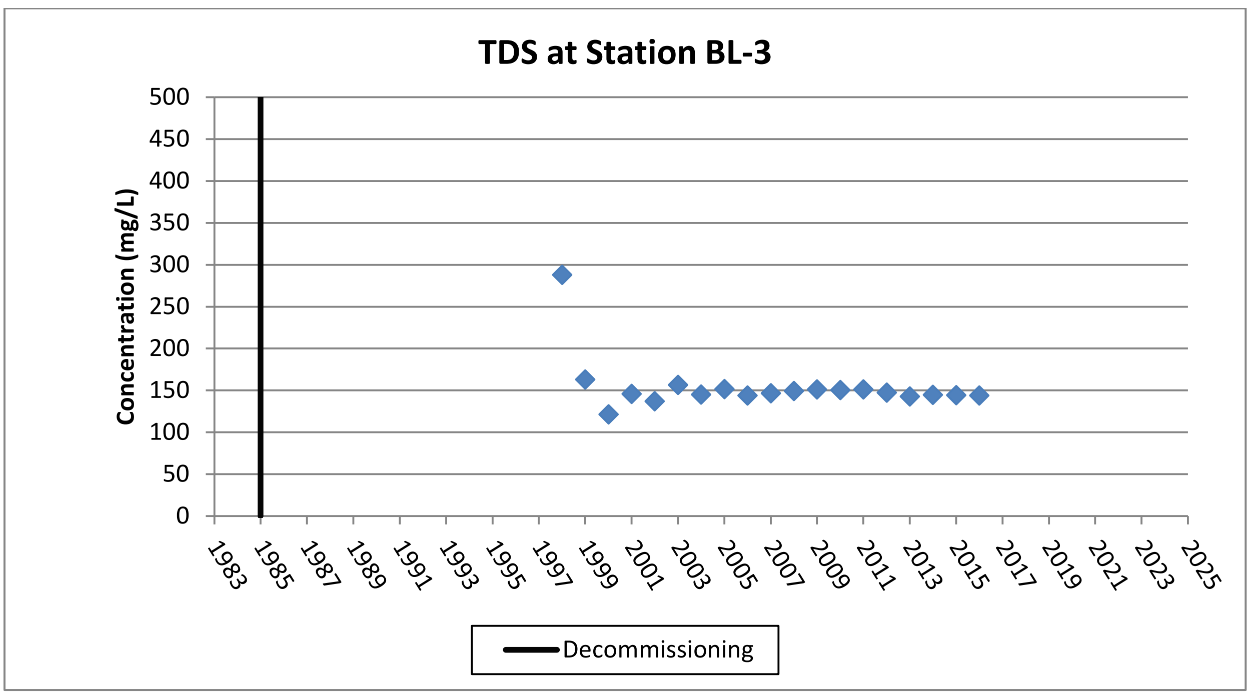


Figure 4.3.3-5 BL-4 Beaverlodge Lake Centre

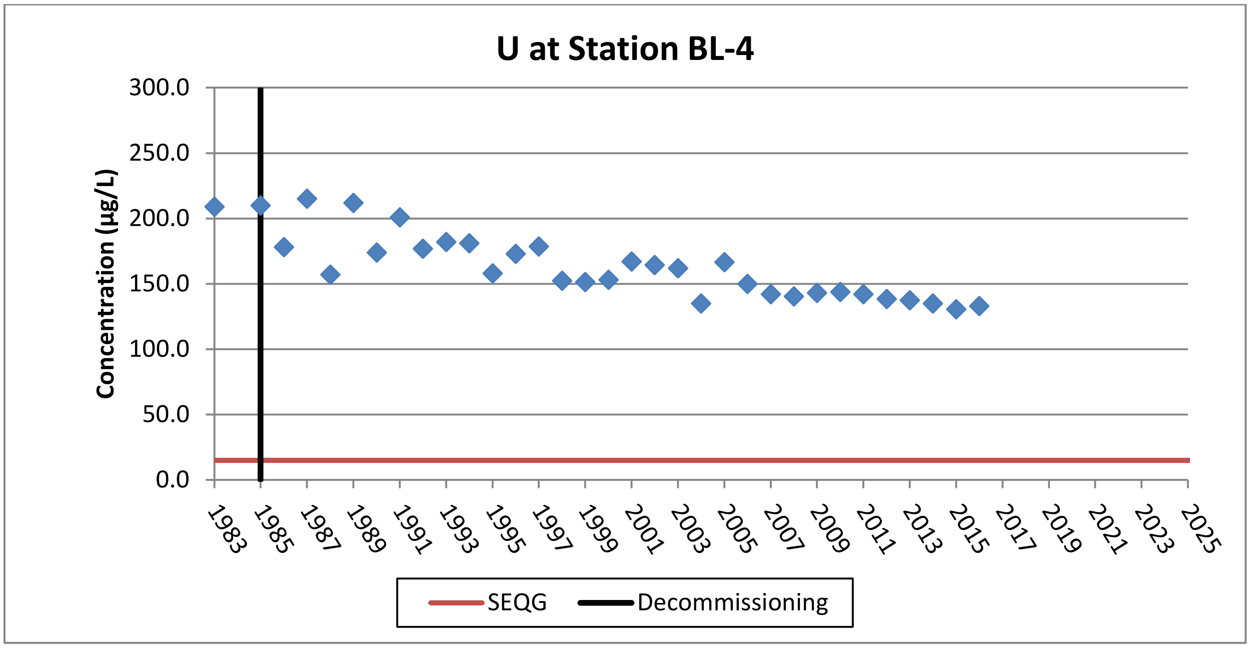


Figure 4.3.3-6 BL-4 Beaverlodge Lake Centre

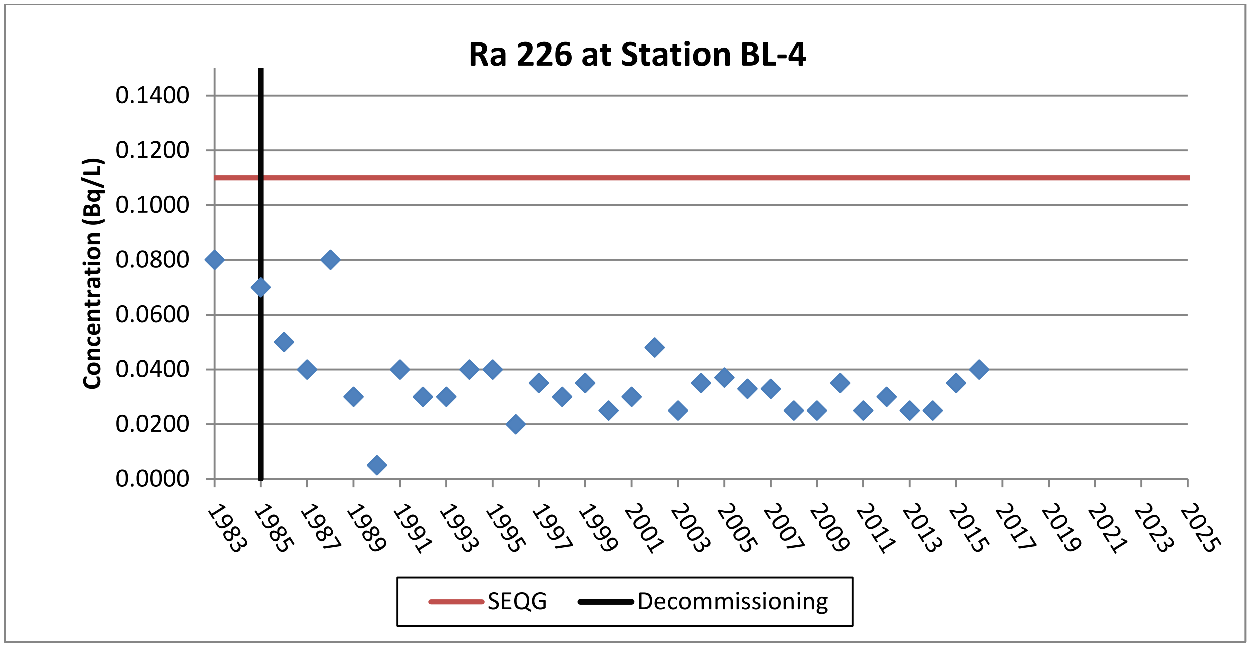
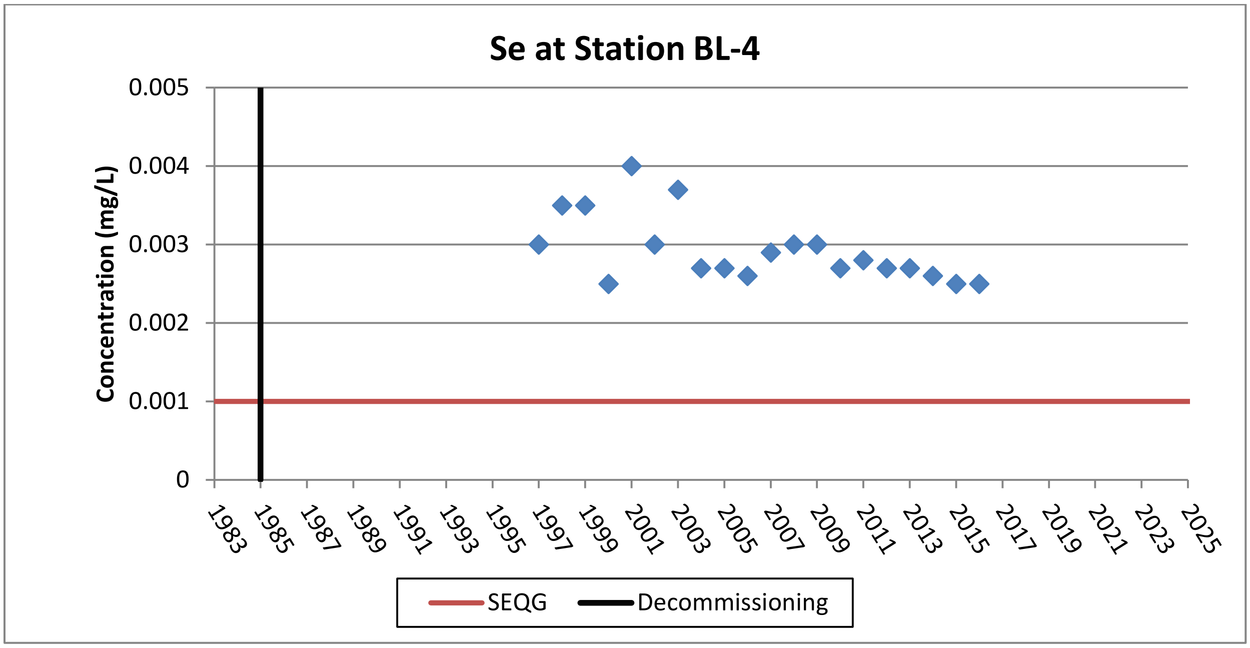


Figure 4.3.3-7 BL-4 Beaverlodge Lake Centre



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

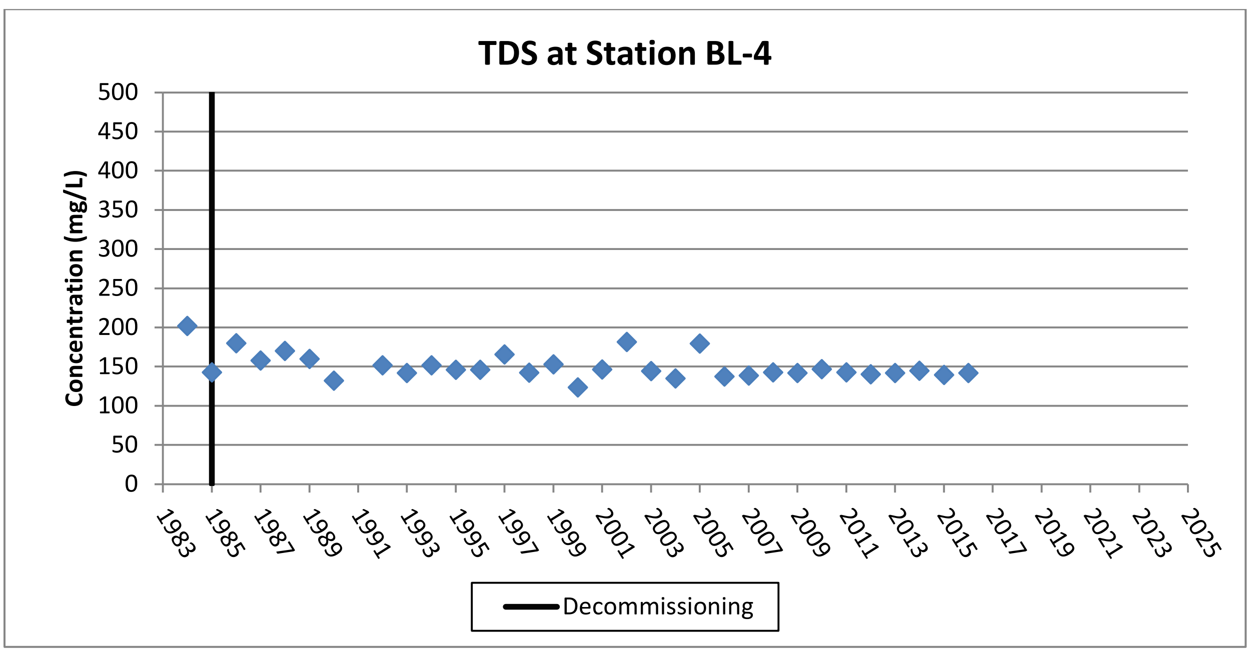
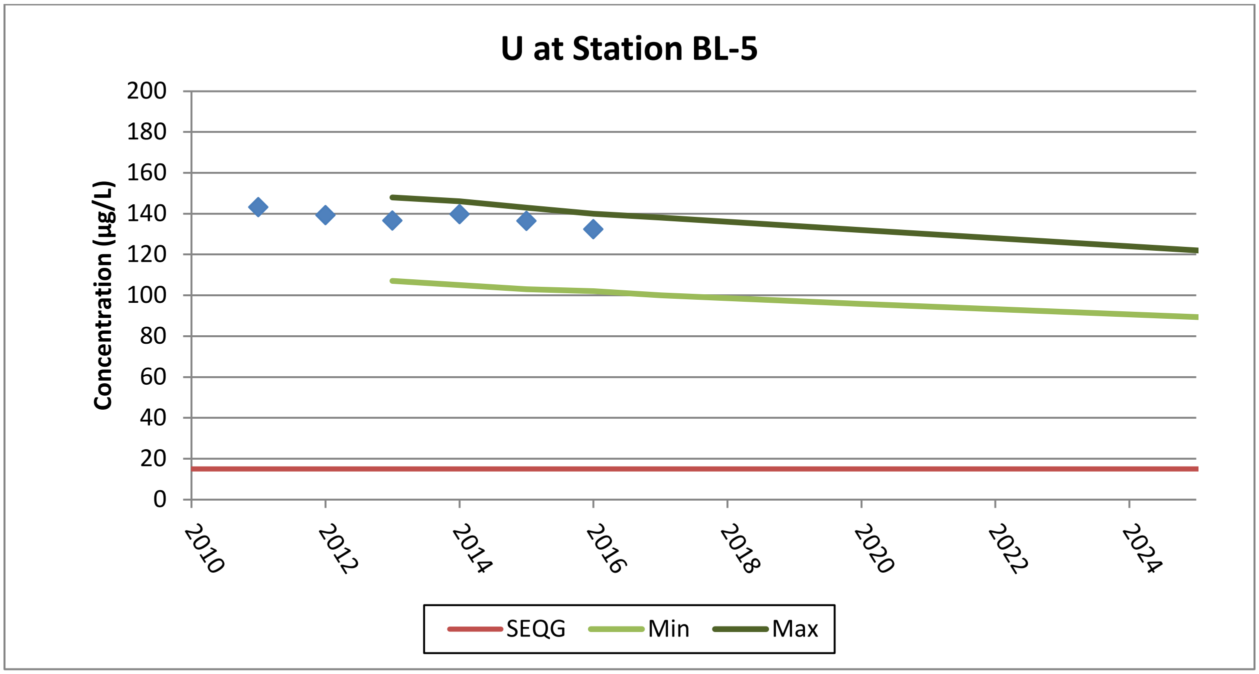
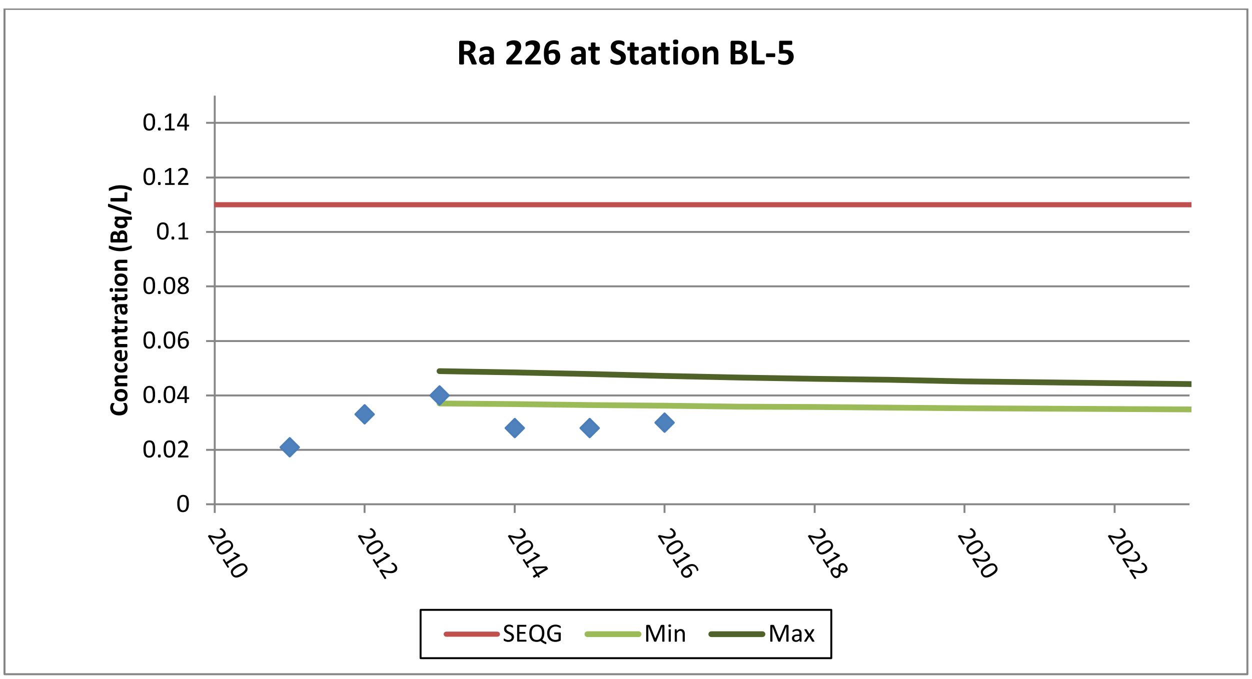


Figure 4.3.3-9 BL-5 Beaverlodge Lake Outlet



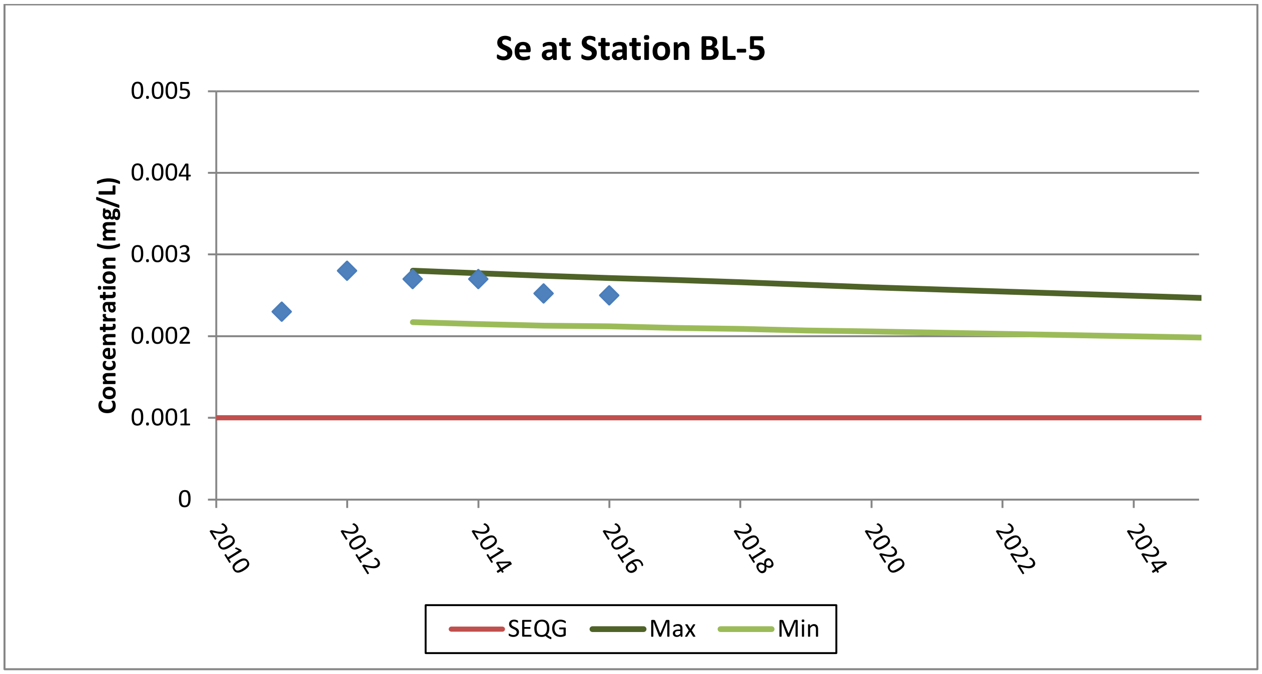
** Station implemented in water sampling program in 2011*

Figure 4.3.3-10 BL-5 Beaverlodge Lake Outlet



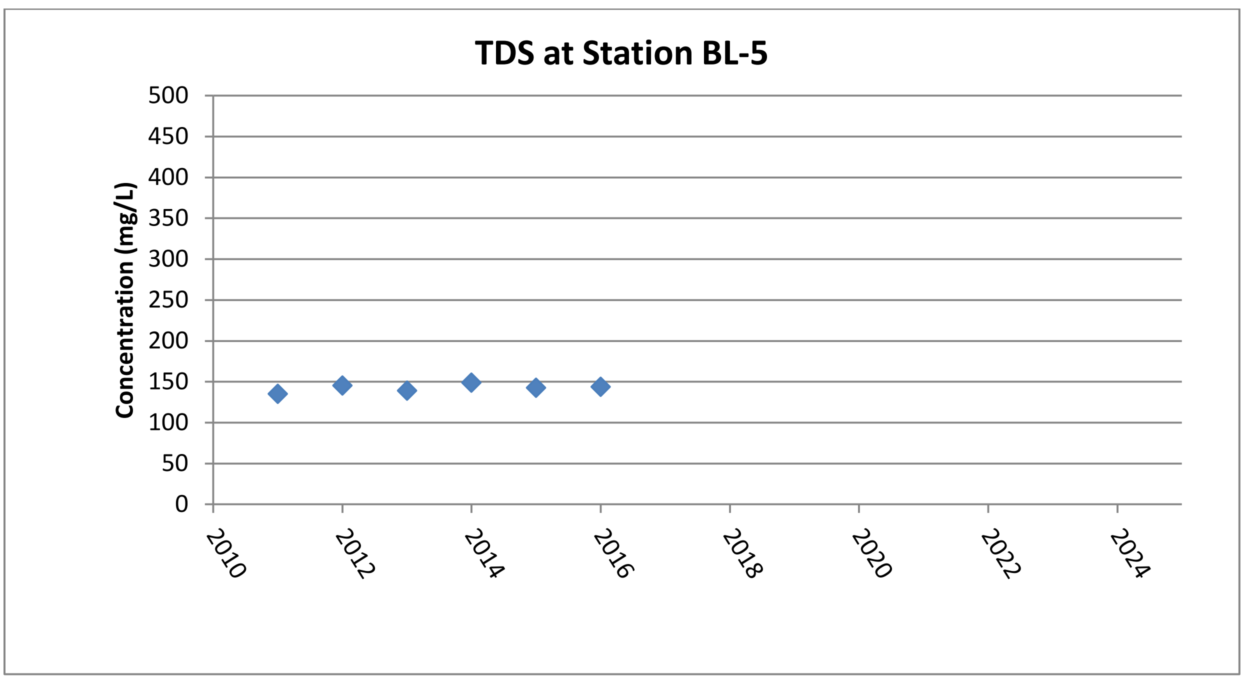
** Station implemented in water sampling program in 2011*

Figure 4.3.3-11 BL-5 Beaverlodge Lake Outlet



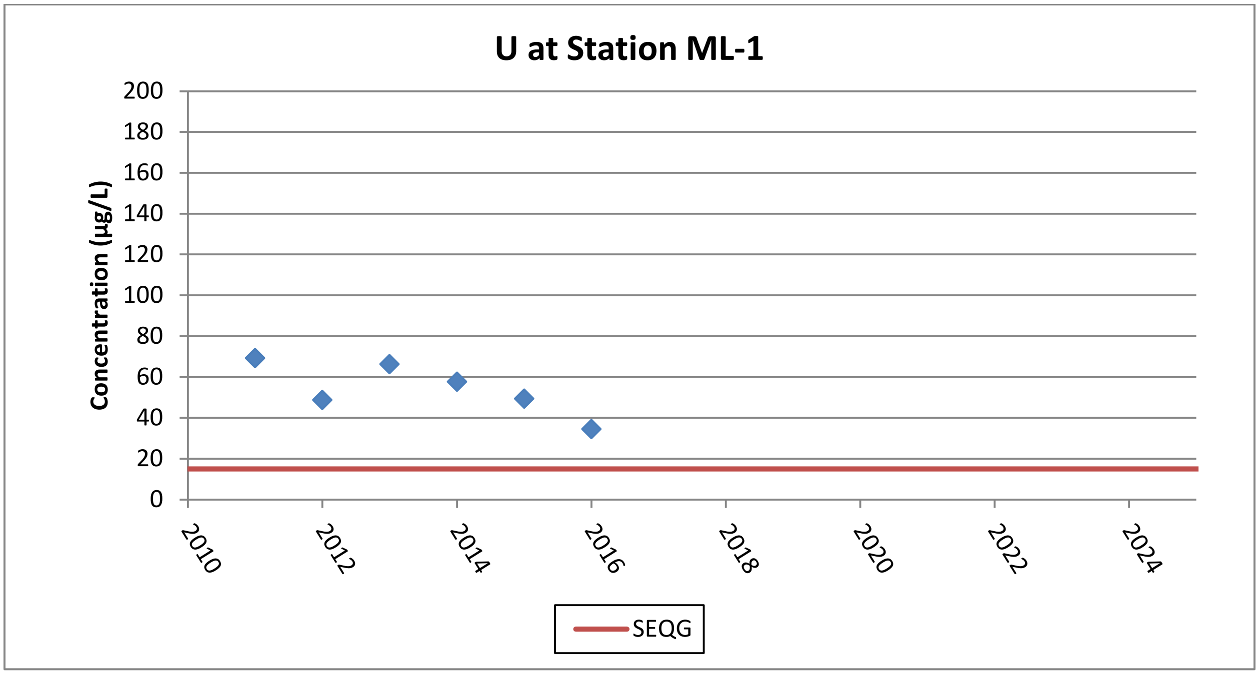
** Station implemented in water sampling program in 2011*

Figure 4.3.3-12 BL-5 Beaverlodge Lake Outlet



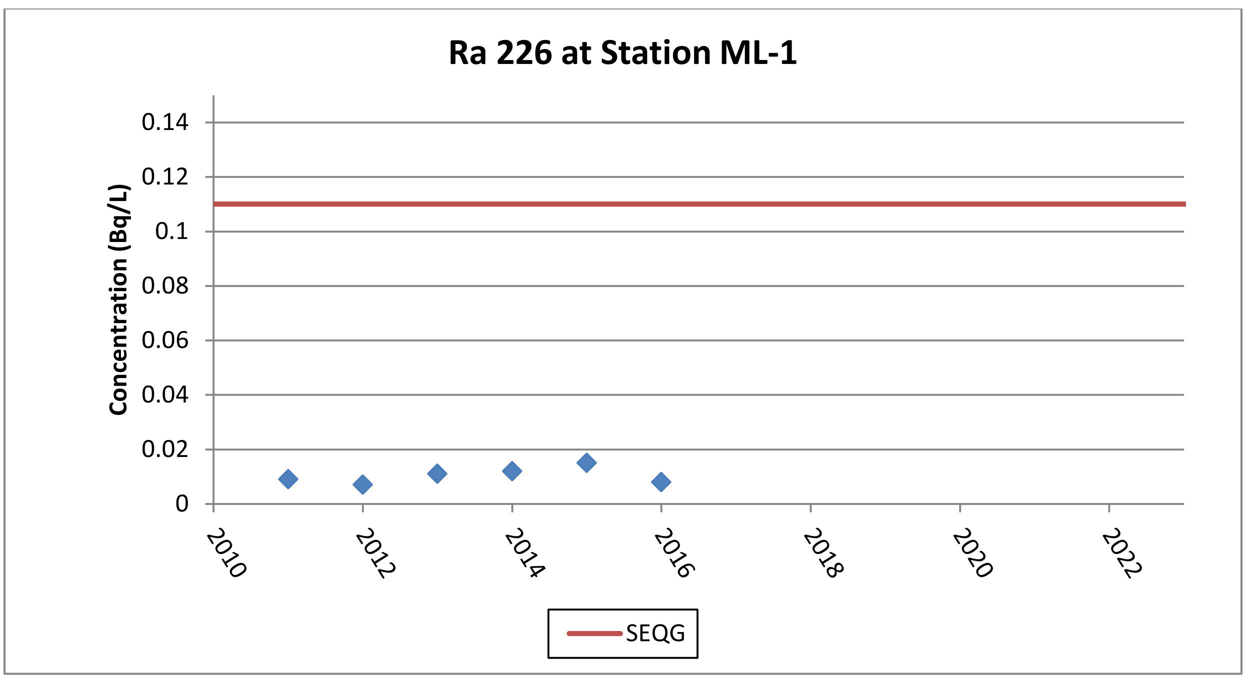
** Station implemented in water sampling program in 2011*

Figure 4.3.3-13 ML-1 Outlet of Martin Lake



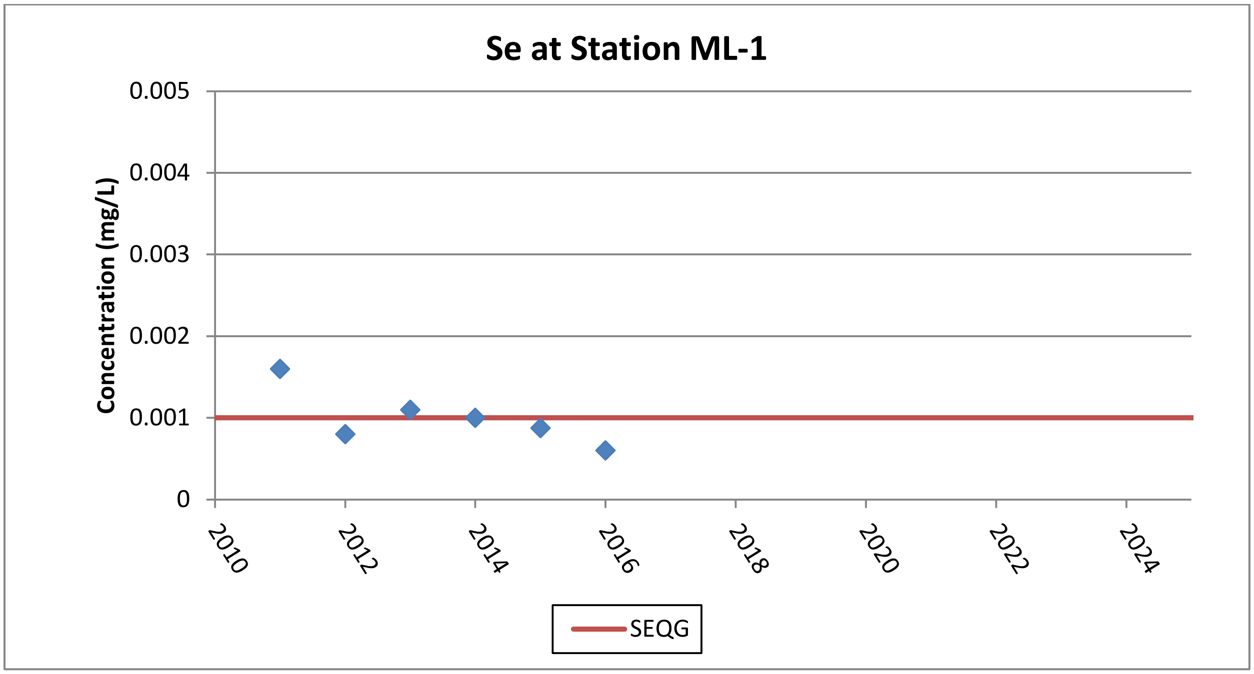
**Station implemented in water sampling program in 2011*

Figure 4.3.3-14 ML-1 Outlet of Martin Lake



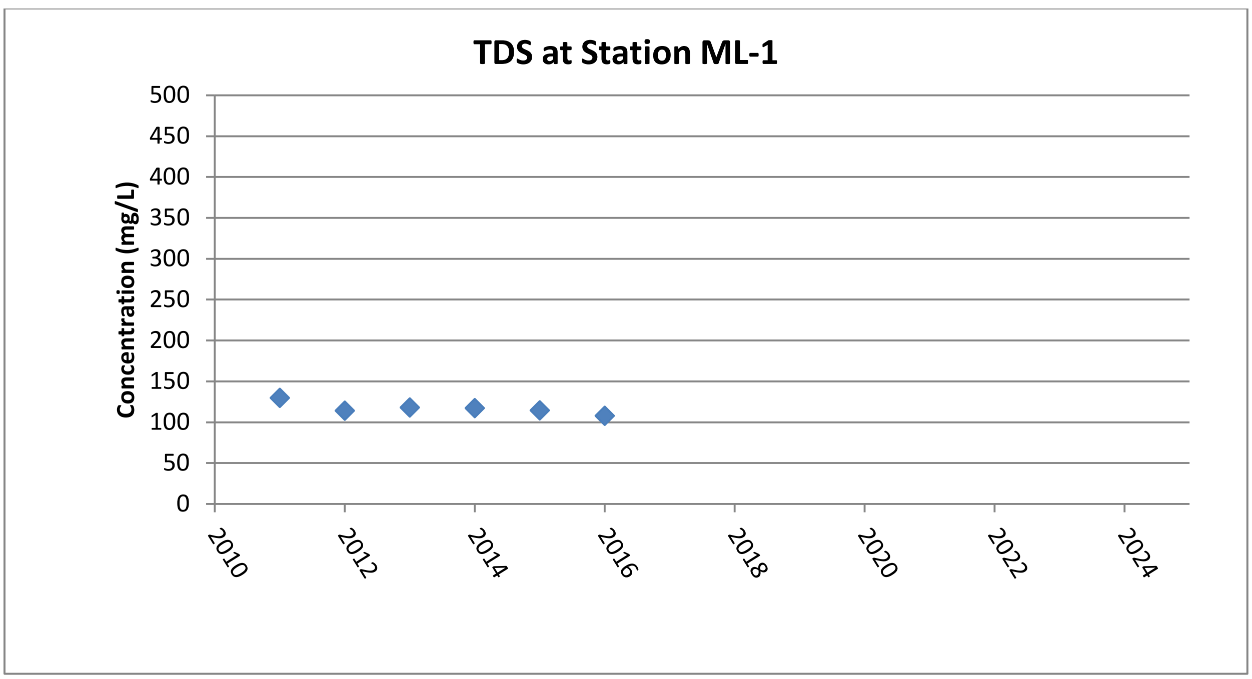
**Station implemented in water sampling program in 2011*

Figure 4.3.3-15 ML-1 Outlet of Martin Lake



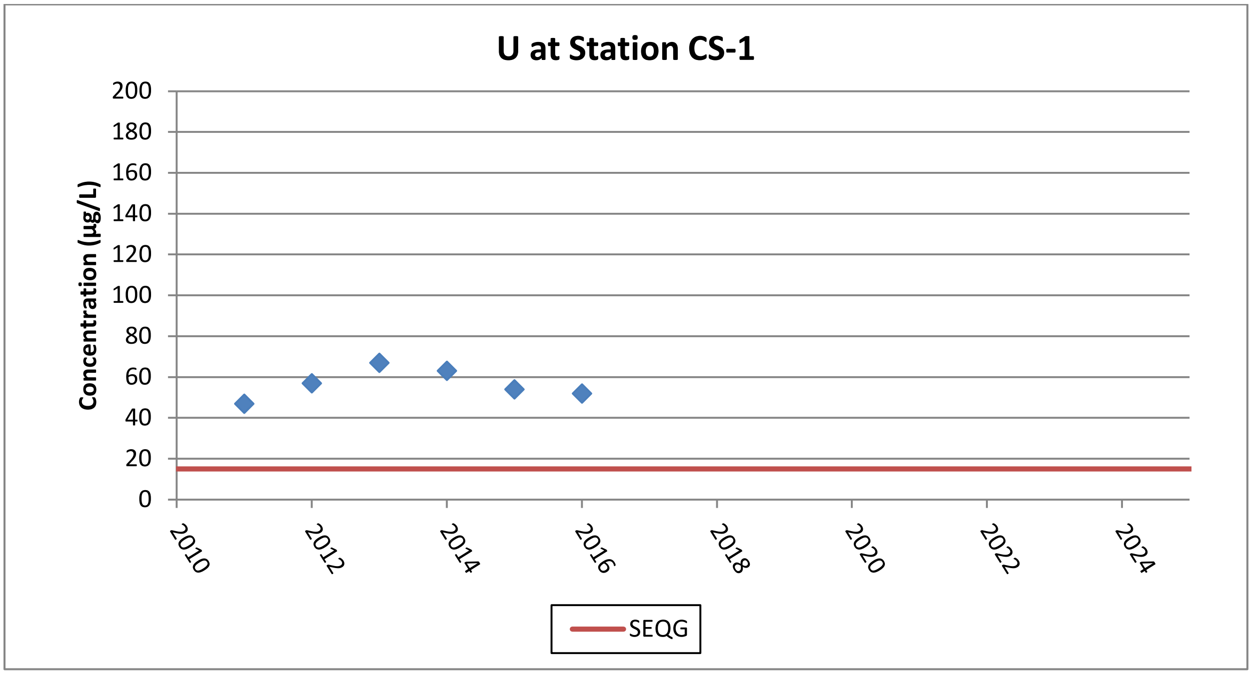
**Station implemented in water sampling program in 2011*

Figure 4.3.3-16 ML-1 Outlet of Martin Lake



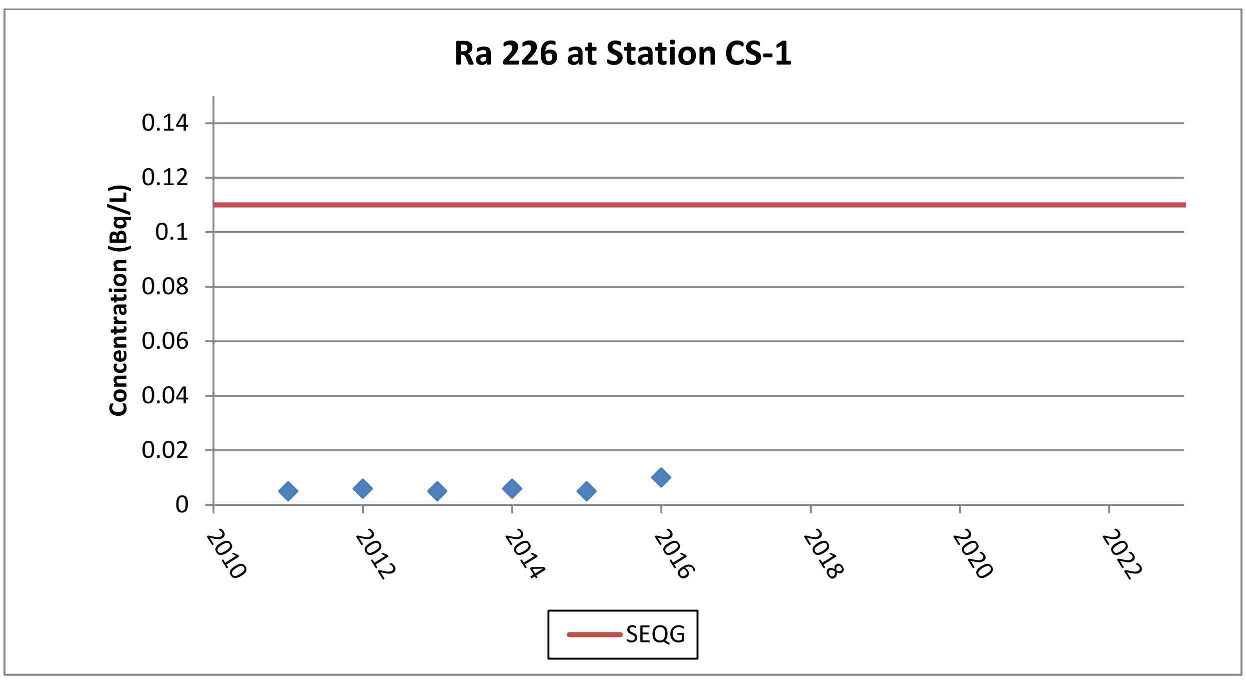
**Station implemented in water sampling program in 2011*

Figure 4.3.3-17 CS-1 Crackingstone River at Bridge



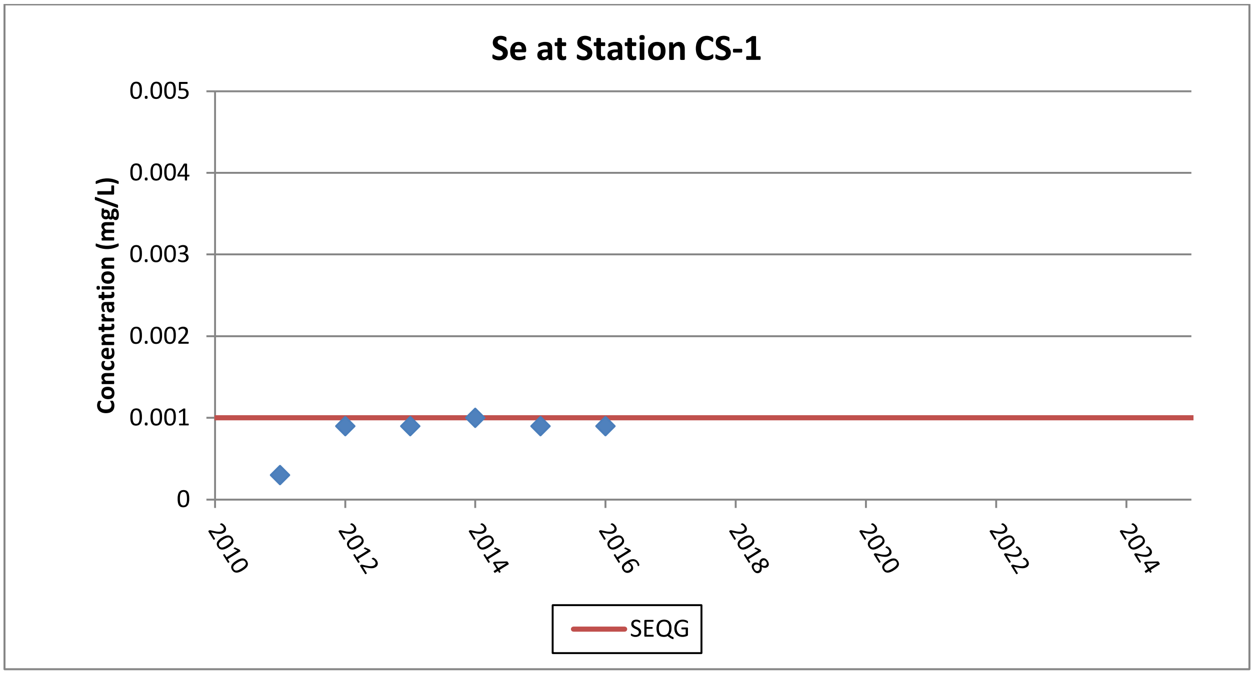
**Station implemented in water sampling program in 2011*

Figure 4.3.3-18 CS-1 Crackingstone River at Bridge



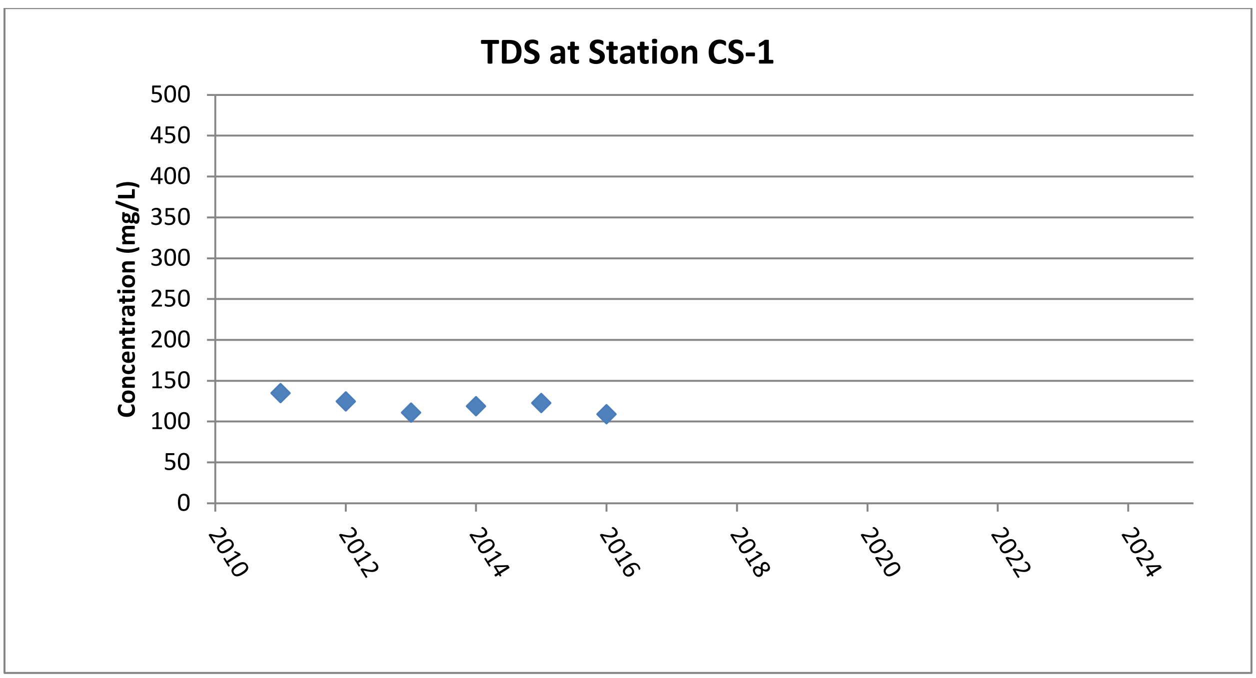
**Station implemented in water sampling program in 2011*

Figure 4.3.3-19 CS-1 Crackingstone River at Bridge



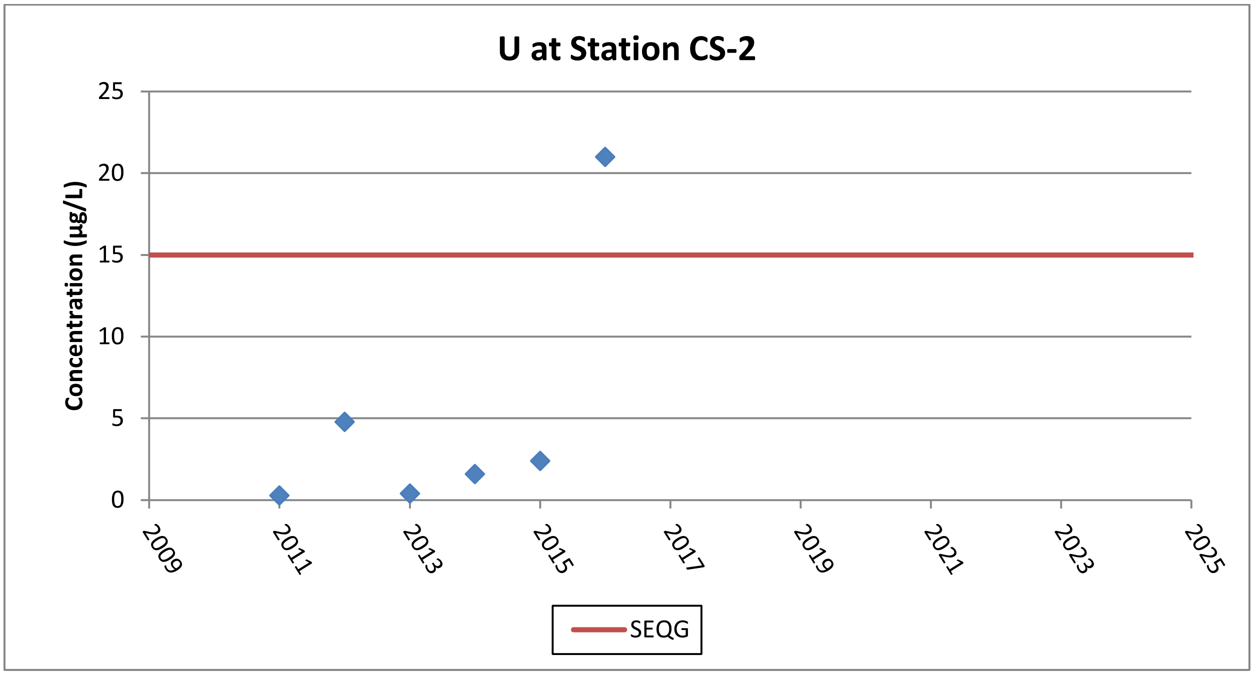
**Station implemented in water sampling program in 2011*

Figure 4.3.3-20 CS-1 Crackingstone River at Bridge



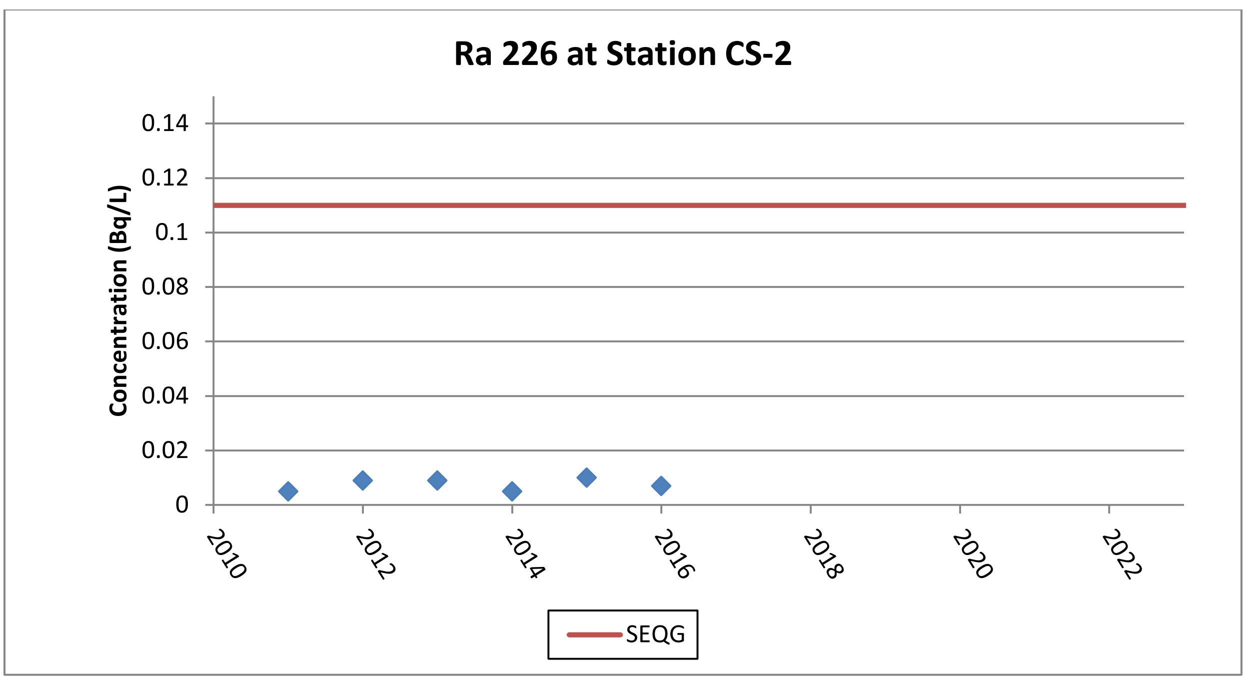
**Station implemented in water sampling program in 2011*

Figure 4.3.3-21 CS-2 Crackingstone Bay



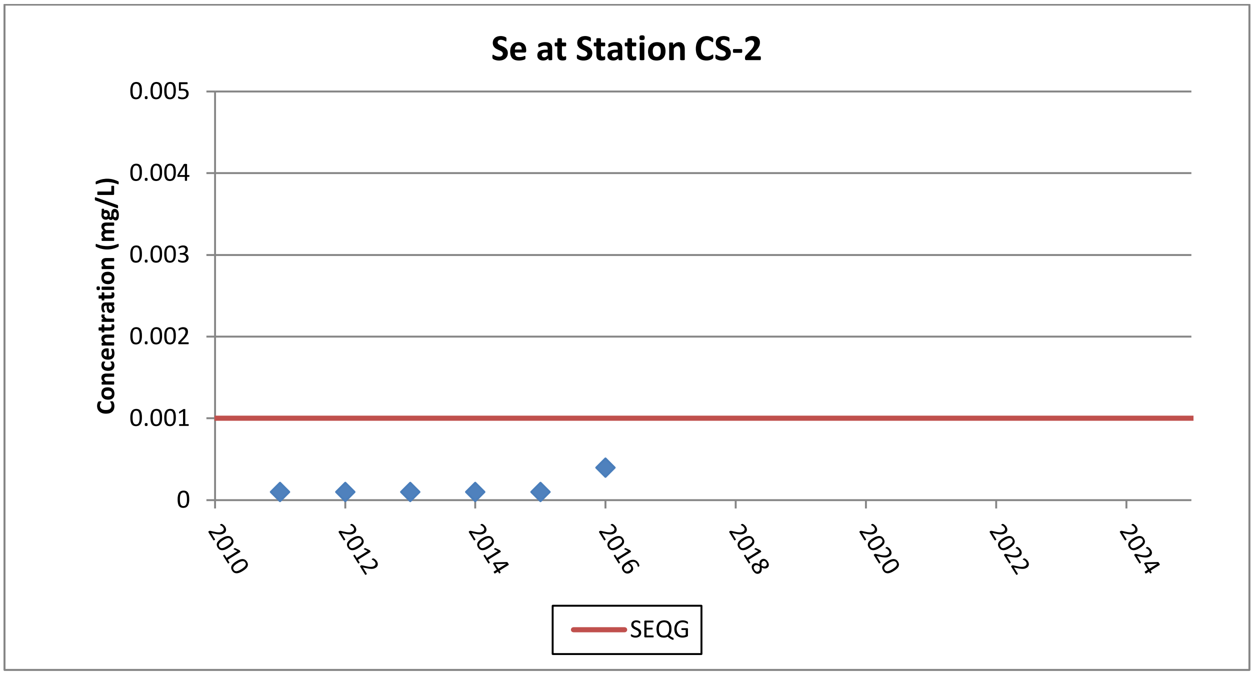
**Station implemented in water sampling program in 2011*

Figure 4.3.3-22 CS-2 Crackingstone Bay



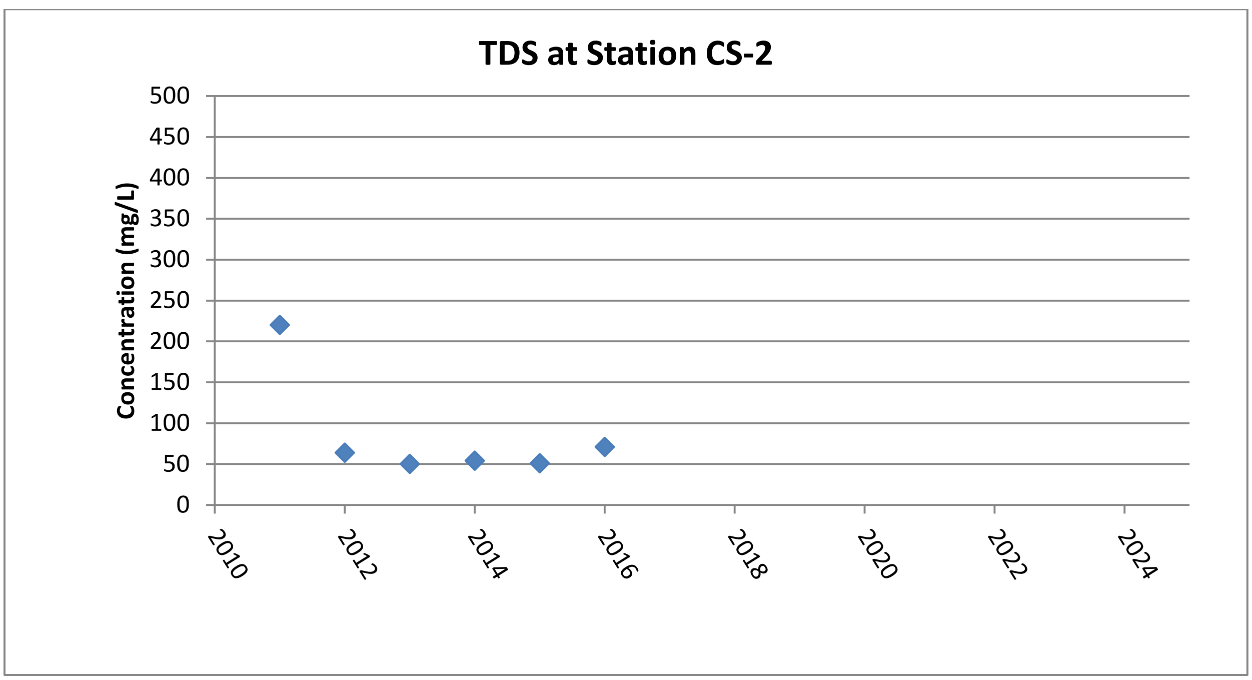
**Station implemented in water sampling program in 2011*

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

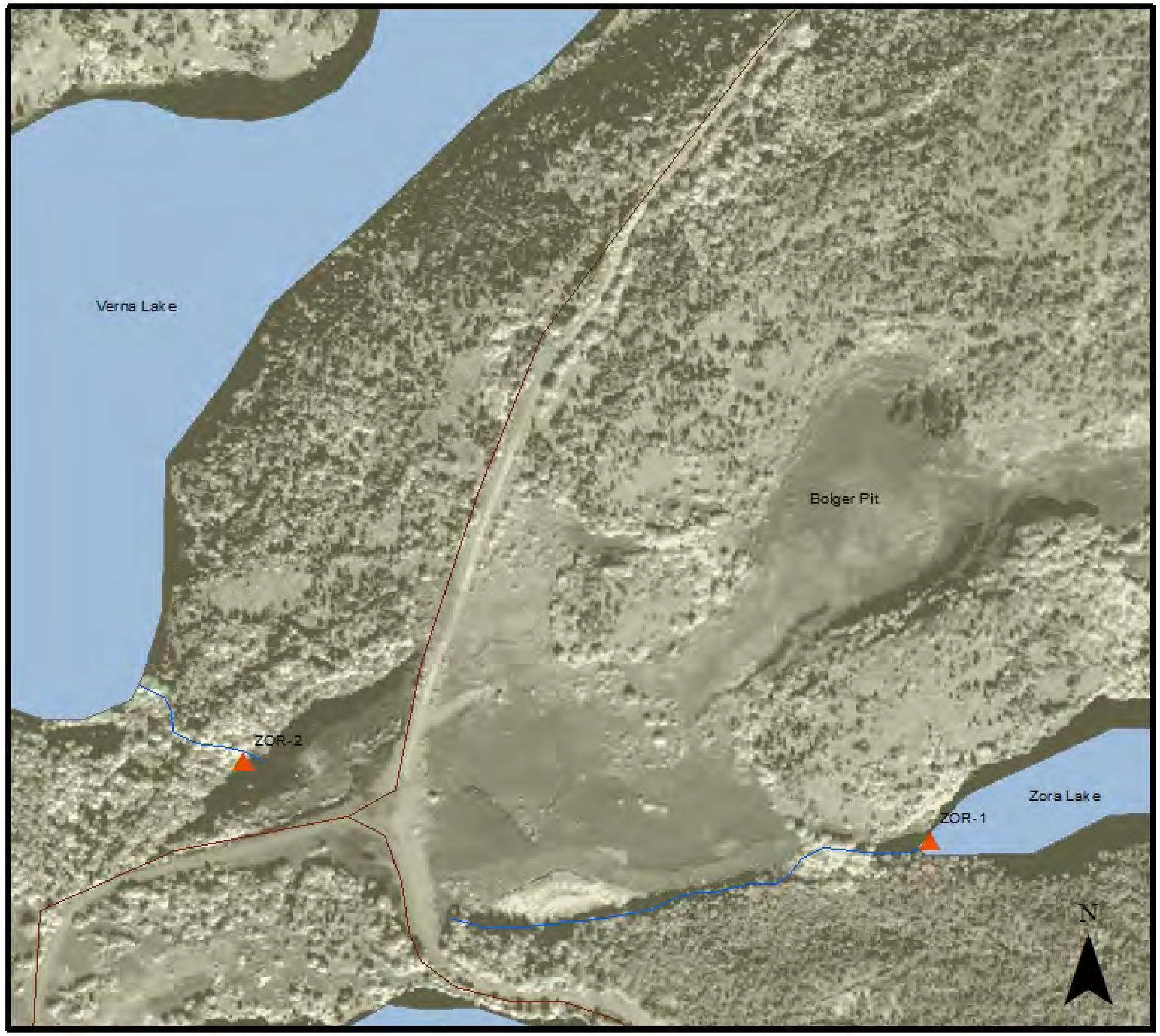
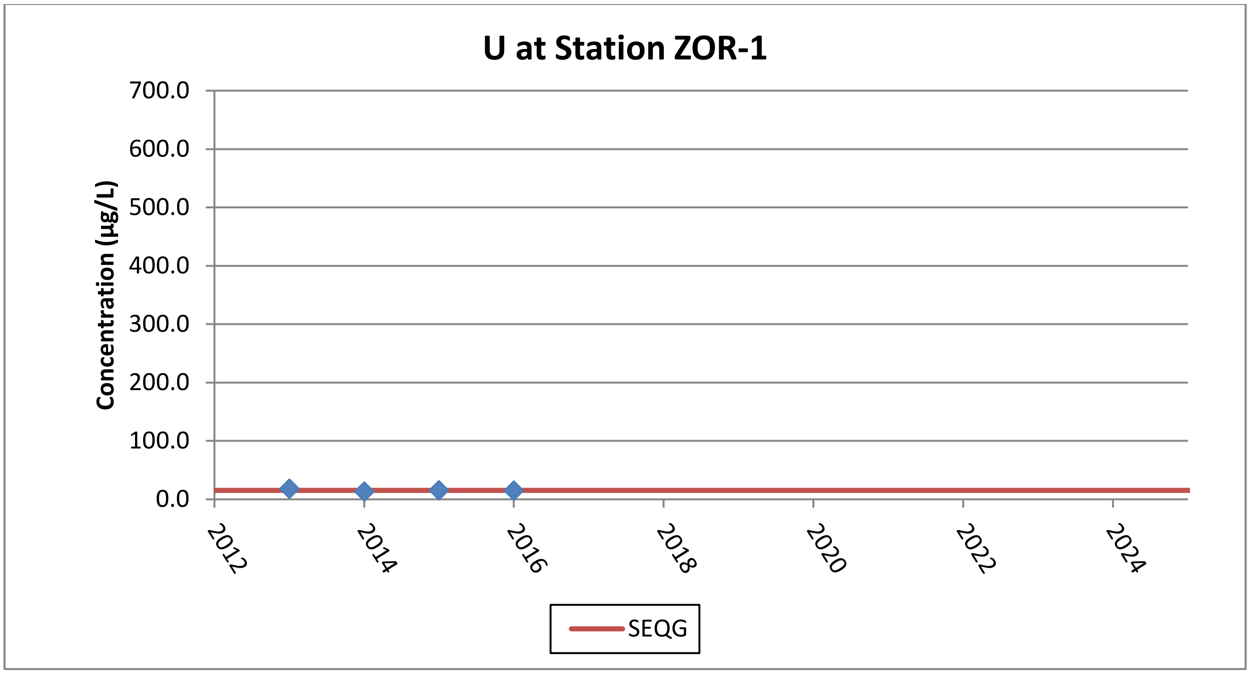
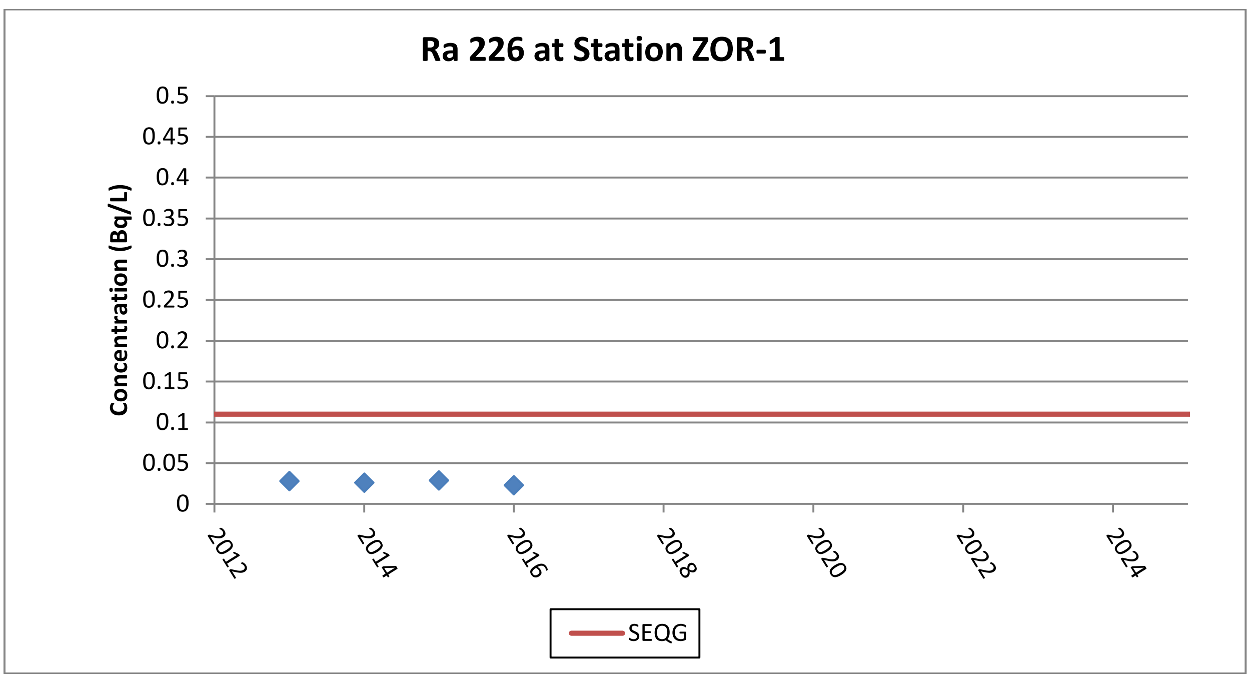


Figure 4.4-1 ZOR-01 Discharge from Zora Lake Outflow



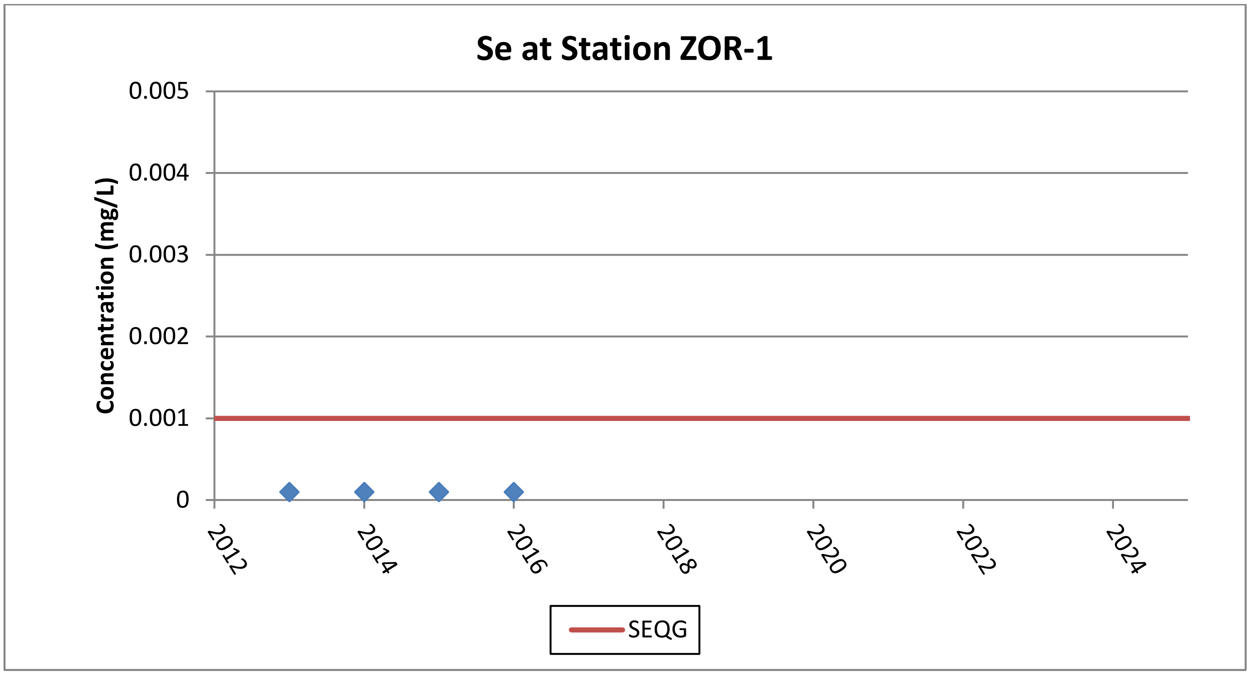
**Station implemented in water sampling program in 2013*

Figure 4.4-2 ZOR-01 Discharge from Zora Lake Outflow



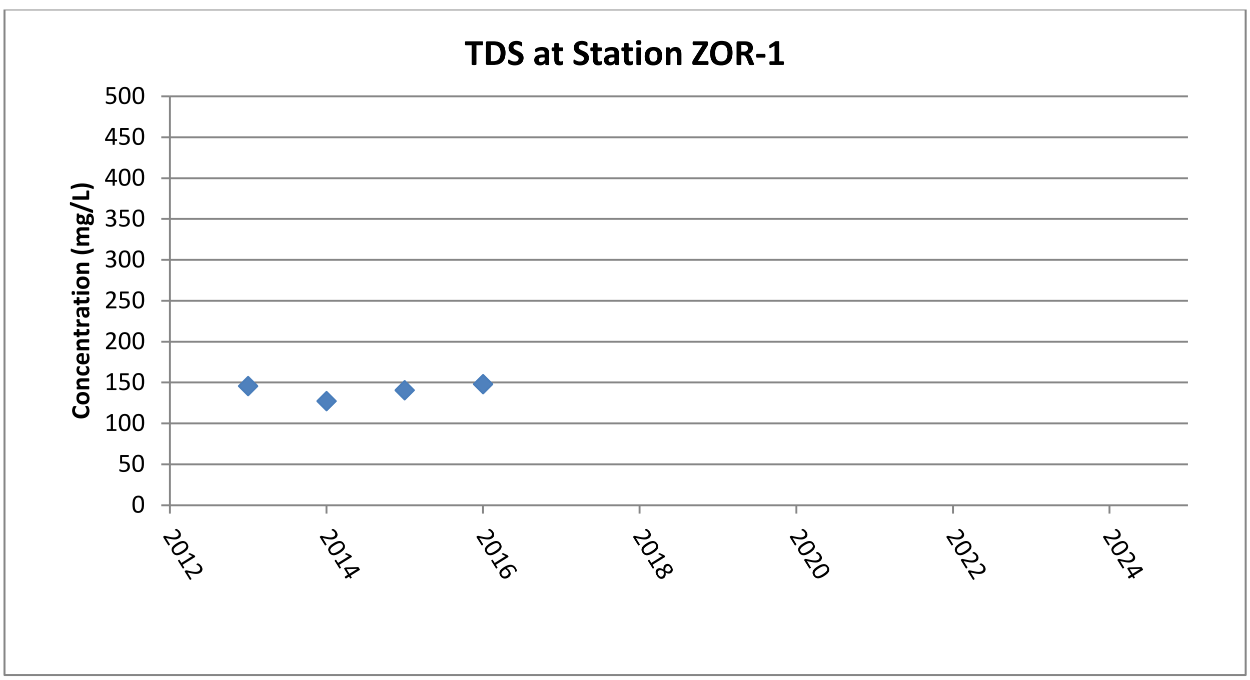
**Station implemented in water sampling program in 2013*

Figure 4.4-3 ZOR-01 Discharge from Zora Lake Outflow



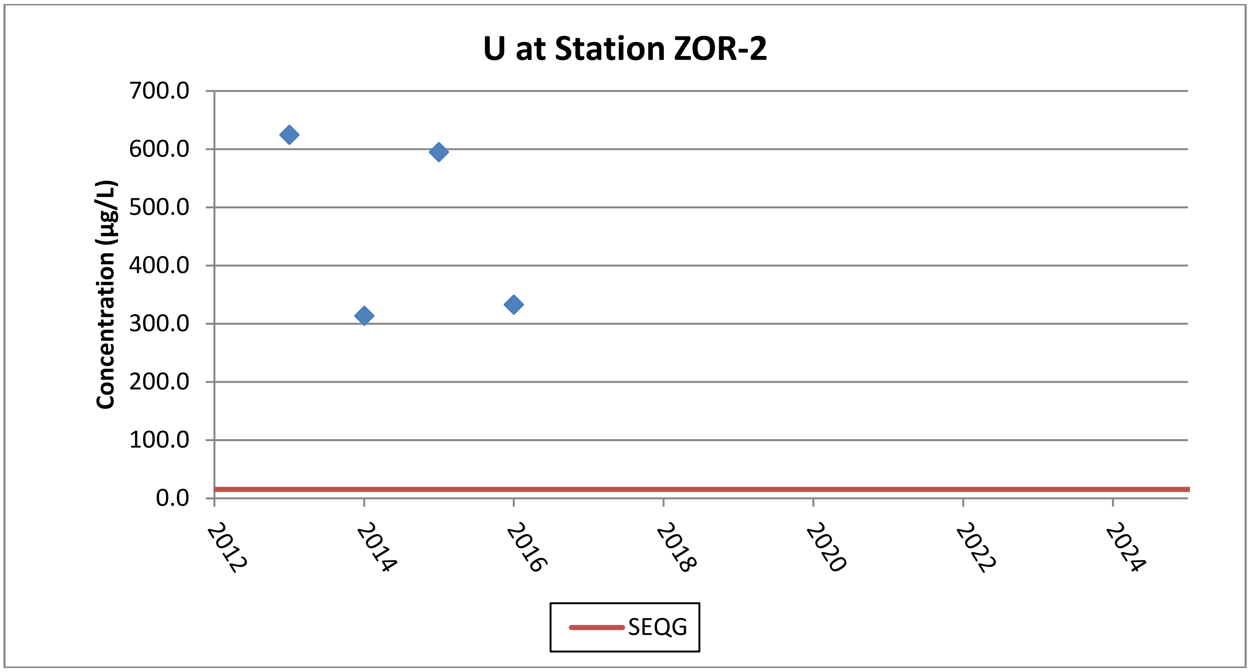
**Station implemented in water sampling program in 2013*

Figure 4.4-4 ZOR-01 Discharge from Zora Lake Outflow



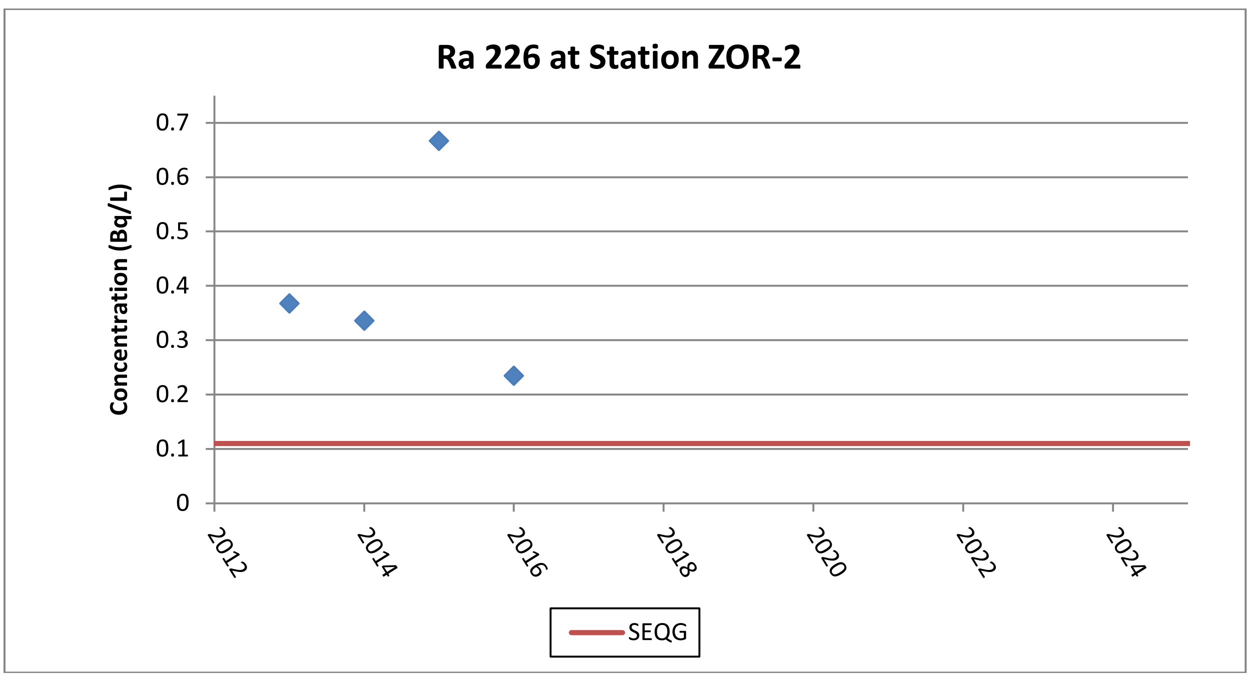
**Station implemented in water sampling program in 2013*

Figure 4.4-5 ZOR-02 Outlet from Waste Rock Pile to Verna Lake



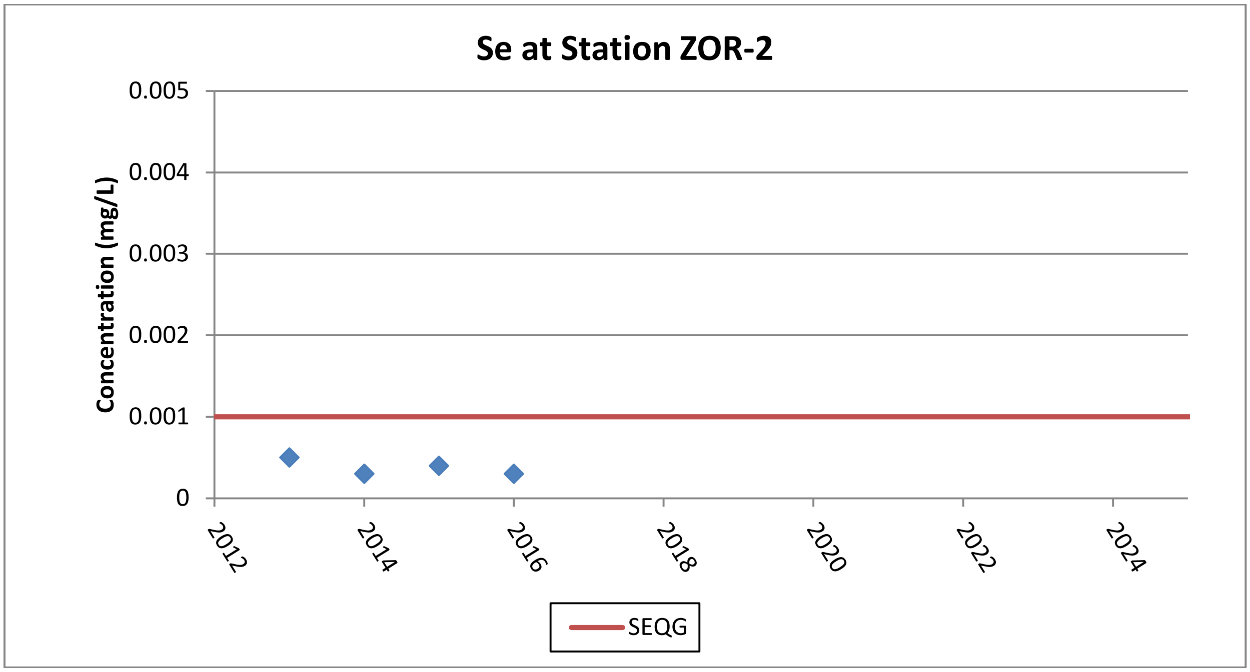
**Station implemented in 2013*

Figure 4.4-6 ZOR-02 Outlet from Waste Rock Pile to Verna Lake



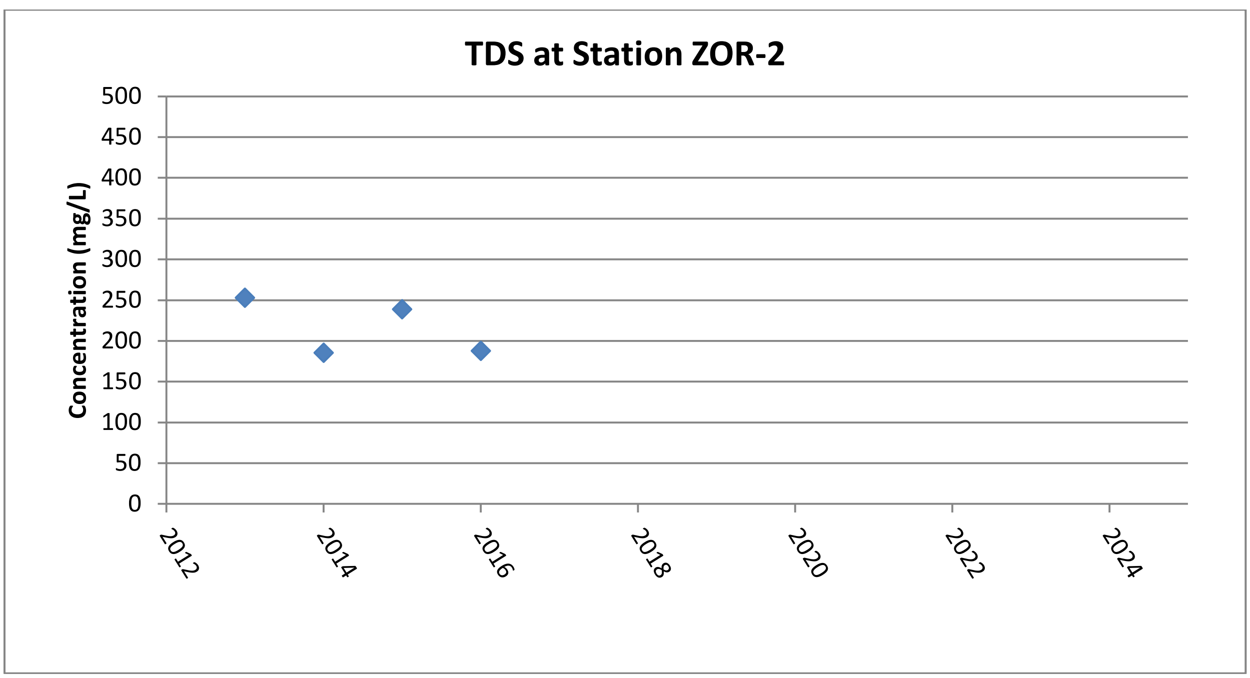
**Station implemented in 2013*

Figure 4.4-7 ZOR-02 Outlet from Waste Rock Pile to Verna Lake



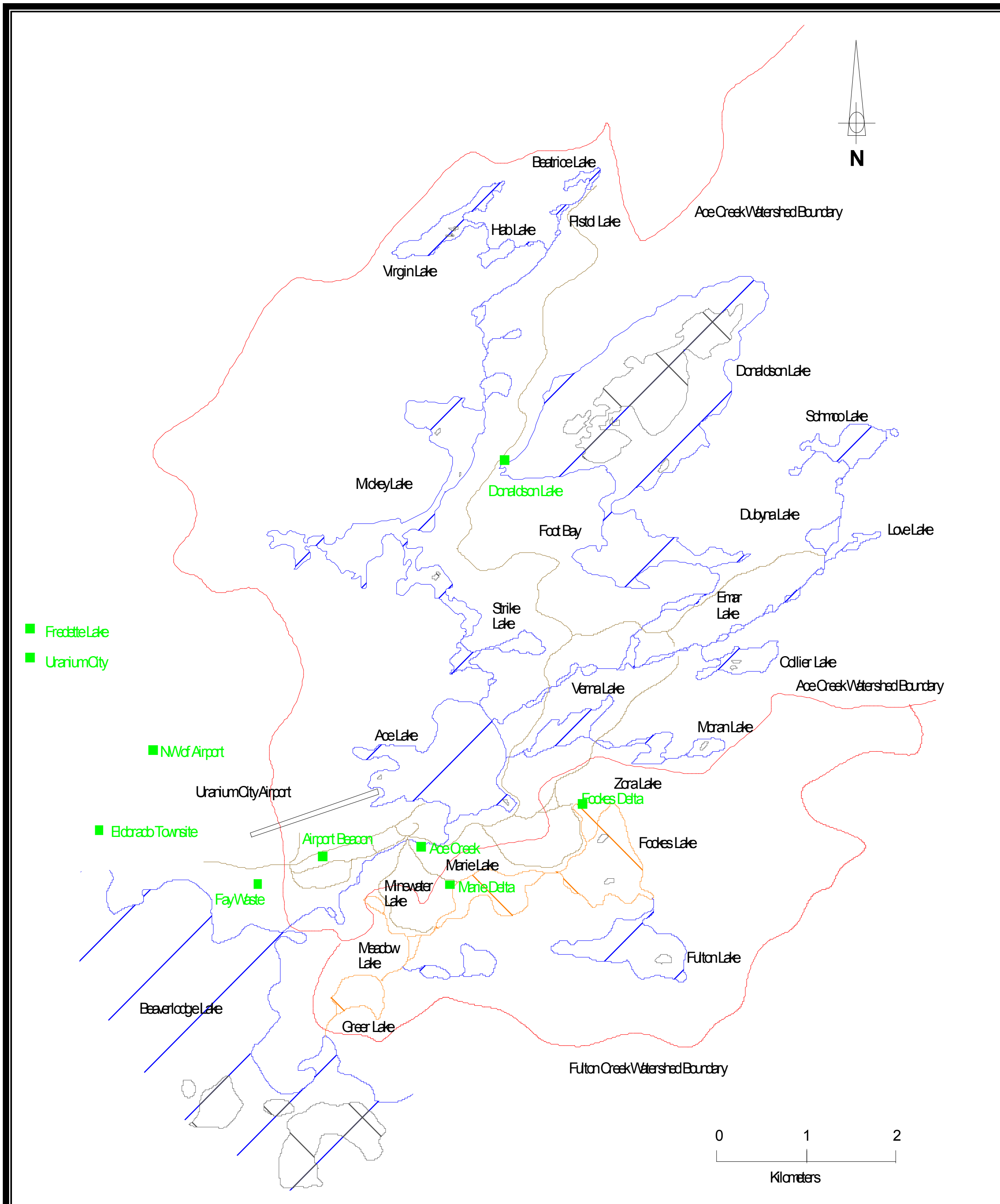
**Station implemented in water sampling program in 2013*

Figure 4.4-8 ZOR-02 Outlet from Waste Rock Pile to Verna Lake



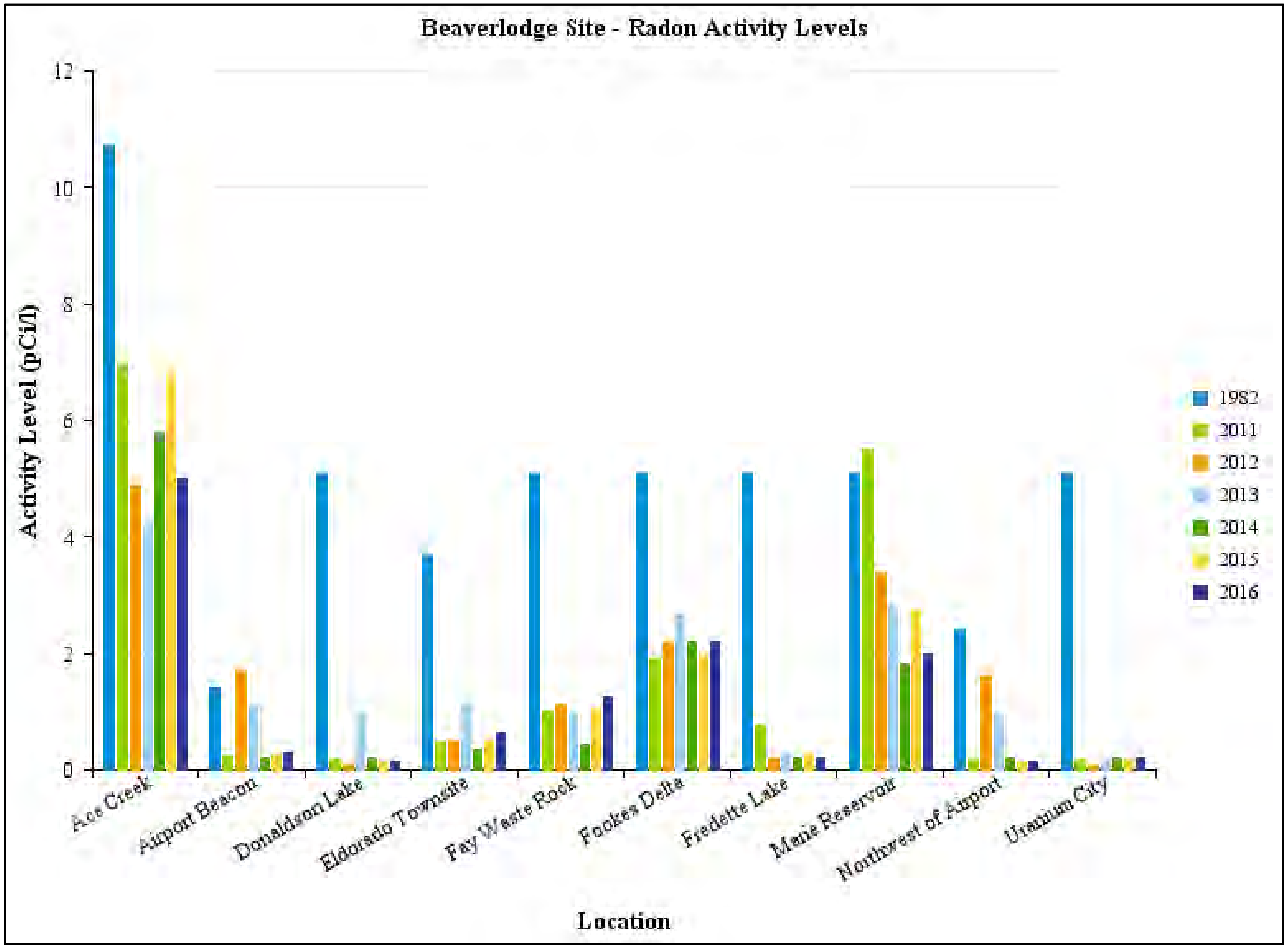
**Station implemented in water sampling program in 2013*

Figure 4.7.1-1 - Air Sampling Locations



Beavelodge Site - Air Sampling Locations

Figure 4.7.1-2 Radon Summary (2011 - 2016 versus 1982)



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

APPENDICES

APPENDICES

APPENDIX A

APPENDIX A

BEAVERLODGE

Cameco

Beaverlodge

Decommissioned Beaverlodge Mine/Mill Site

2016 Geotechnical Inspection Report

February 2017

Table of Contents

1.0 INTRODUCTION

From July 11-15, 2016 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 and the two outlet spillways at Fookes and Marie reservoirs were included. Figure 1 provides the locations of the tailings delta and outlet structures.

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 and/or the JRG conduct annual inspections of the areas to ensure structures were behaving as expected. SRK and Cameco collaborated in the development of an inspection checklist and the checklist was reviewed and accepted by the CNSC and SMOE.

In 2011 Cameco initiated internal annual inspections of these areas 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, planned for 2020. The inspection frequency will be re-evaluated following the 2020 inspection.

The 2016 inspection of the Fookes tailings delta and the outlet structures at Marie and Fookes reservoirs was conducted by Cameco and represent the sixth year of internal inspections. This report includes observations and recommendations made during the July 11 - 15, 2016 inspection of these areas as well as an additional inspection following a period of heavy precipitation in September 2016.

In addition to the geotechnical inspections outlined above, Cameco conducted cursory inspections of crown pillar areas at the Hab, Dubyna and Ace properties in 2016. The inspection was based on recommendations following the assessment of site wide crown pillars conducted by SRK in 2014/2015 (SRK 2015). As the crown pillar inspections are geotechnical in nature and inspection frequencies are recommended to be the same as the current annual geotechnical inspections, Cameco intends to conduct more formal and documented inspections of the crown pillars and include the results in this report going forward. Additional details are provided in Section 5.0.

2.0 OUTLET STRUCTURE INSPECTIONS (FOOKES & MARIE RESERVOIR)

Both spillway structures consist of a rip-rap lined open channel (with trapezoidal cross-section) discharging 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 has generally been higher for the last few years when compared to the initial inspection years of 2011 to 2012. Rainfall amounts have increased on average in 2013-2016, 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 20-40 L/s over 2013 to 2016 compared to an average of 0-4 L/s measured in 2011 and 2012.

The last few annual inspections occurred in mid-July resulting in increased vegetation growth in the area; however the similar inspection timeframes for the last three internal inspections makes photographic comparison between the two years relevant. Comparisons of photos between inspection years is presented in Section 4.0.

An additional inspection was completed opportunistically in September 2016, following a period of sustained heavy rainfall that raised water levels throughout the Beaverlodge area. Despite the higher than normal flows the outlet channels and stilling basins appeared to be functioning normally.

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.

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.

Photos taken during the July and September 2016 inspections provide photographic record of the condition of the Marie Reservoir spillway channel and are attached 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 2106 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 displace incrementally due to ice-jacking (Photo A5).

Despite the noted increased flows observed at the outlet of Marie Reservoir there is no evidence that water has overtopped the rip-rap in this area. Photographic evidence comparing the last four internal inspections show loose stones on the frost-heaved block of grout intruded rip-rap have not moved 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 (Photo B7). 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.

The overall condition of the spillway was observed to be similar as previous inspections in 2016. The photographic record shows there has been no notable change in the condition of the spillway when compared to previous inspections, and the spillway continues to perform as designed. Appendix B includes photos taken during the 2016 inspections, which provide photographic record of the condition of the Fookes Reservoir spillway channel.

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, despite the elevated flows observed during the last few inspections. As a result Cameco has concluded that the channel has been able to accommodate the flows and no erosion of the channel has occurred. In addition there was no evidence that overtopping of the rip-rap areas of the spillway has occurred. Photos B2 and B4 show the channel in September with high flows being managed effectively. Photo B8 shows the stilling basin performing as designed.

3.0 FOOKES TAILINGS DELTA

3.1 General Observations

After a period of drought which saw water levels in Fookes Reservoir drop in 2011 to the point that there was no discharge, water levels have since rebounded starting in 2014 and have remained high since then. On Fookes Delta it was noted that there was still standing water along the drainage area on the northeastern portion of the delta (Photo C1).

This area was noted to be allowing excess water to be directed away from the main tailings area tailings area, and/ or towards Fookes Lake. As per the SRK design for the Fookes cover, the northern drainage ditch area was never intended to provide fully channelized flow to Fookes Lake. Instead the cover in this area was purposefully graded to establish an overall preferential gradient towards Fookes Lake. Figure 2 provides an overview of the cover design (SRK 2008), with the surface drainage path and observed ponded water outlined. Some ponding, in higher precipitation years, was expected and may be expected to occur in future years at this area. The 2015 external geotechnical inspection completed by SRK confirmed that the drainage continues to function as designed. This ponding is not expected to compromise the constructed reverse filter and confining tailings cover.

No new boil development was noted through the cover in this northern drainage area of the tailings delta and, although evidence that excessive water has flowed in the drainage channels during runoff events, no evidence of any significant erosion was observed.

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, overall the condition of the shoreline was considered good with vegetation continuing to establish itself in the area. Photos taken in 2016 showed significant vegetation coverage along the shoreline.

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 Fookes Reservoir shoreline, and the engineered drainage structures. The vegetation continues to gradually spread and thicken over additional parts of the cover as well.

The Fookes Tailings Delta was inspected on July 18, 2016 and September 21, 2016. Photos showing the conditions encountered during this 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

As previously noted there continues to be standing water observed along the drainage areas on the northeastern portion of the tailings delta. Due to these conditions additional attention was placed on searching for new tailings boils, particularly in areas that were not covered with filter sand during the last cover application in 2007. No new tailings boils were noted on the cover.

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

As mentioned previously Fookes Reservoir water levels are higher than past years and there is more standing water in the drainage areas of the delta than have been observed in the past. Despite the elevated water table the sand cover was in good condition and showed no signs of excessive erosion. Photo C10a shows a picture of the shoreline where the water level meets the sand cover. A small amount of erosion of the sand cover can be seen due to wave action, which is to be expected. It is not anticipated that this small amount of erosion will affect the performance of the sand cover. As vegetation continues to establish on the shoreline it will provide additional armoring and increase the stability of the cover.

The small fractures noted in the sand cover during the 2011 inspection were not prevalent in any year since then, supporting the theory that they were caused by a low regional water table, which has rebounded. Future inspections will continue to look for evidence of fractures in 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 (Photo C3).

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 and have seen no additional eroded material beyond that observed during previous inspections (Photo C4).

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 vehicular traffic accessing the tailings delta.

4.0 PHOTOGRAPHIC COMPARISONS

Marie Outlet Structure looking upstream

Marie Outlet Structure looking downstream

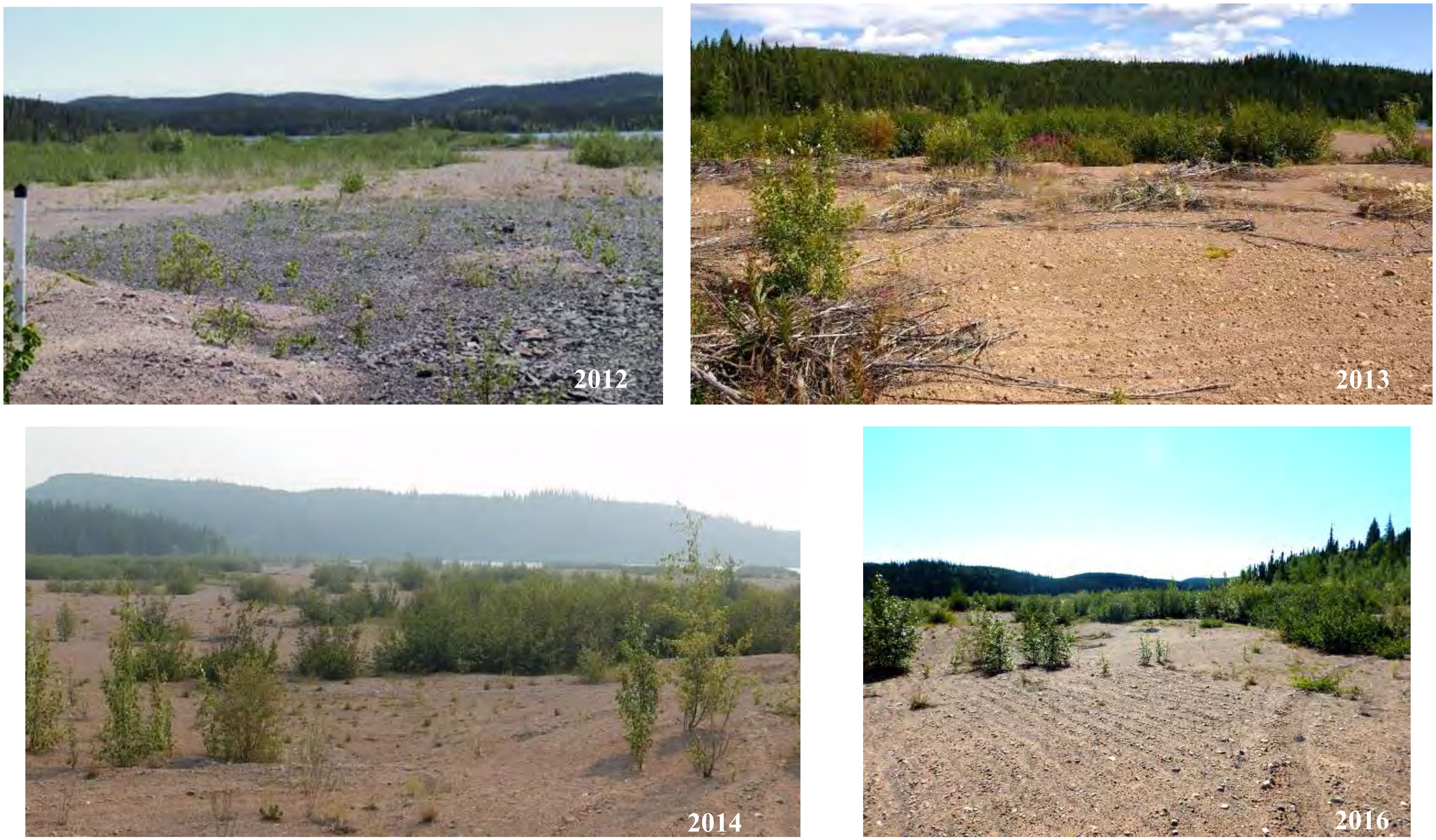
Marie Reservoir Outlet Structure – Ice jacked block of grout intruded rip-rap

Fookes Outlet Structure looking upstream

Fookes Outlet Structure looking downstream

Drainage area looking NW towards access point

Fookes Cover Shoreline



Fookes cover with vegetation growth

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 in response to a request for annual inspections by the CNSC. Visual inspections of these areas will be completed from 2017-2020, 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 to do 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 review, 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 the areas identified with the thinnest estimated crown pillar thickness are covered with waste rock. If the crown pillars were to fail below the pit area, surface expression in the waste rock backfill would likely occur but is expected to be small. Therefore, the residual safety consequence for crown pillar failure at this remote location is expected to be low (SRK, 2015).

Table 1 below provides points for locations around the Dubyna area where visual monitoring was recommended. As shown in Figure 3, these points are expected to coincide with the Level 1 stoping area where crown pillar thicknesses would be expected to be the thinnest (typically below backfilled waste rock).

Table 1: Visual Monitoring Location Recommendations for Dubyna

Location	Position	Elevation (approx.)	Comment
DUB-01	Zone:12 V 647976, 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 due to the fact that the pit has been backfilled with moderately graded to larger sized waste rock.

Table 2 below highlights locations around the Hab area where visual monitoring was recommended. As shown in Figure 4, 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 alone was sufficient, the potential risk posed by the Ace Stope Area was determined to require some 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 the potential for future subsidence.

An optimized cover was designed based on the configuration of the historic stopes associated with the Ace Stope Area, which were identified as the areas of concern for future subsidence. 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 sections that run along strike with, and directly above, the historic stopes. The cover itself consists of a 1.5-2 meter base placed over the identified areas of risk and is comprised of a combination of broken concrete sourced from the pads at the Fay mill site and sorted waste rock. Once the base was completed, a final 0.5 m layer of low gamma 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 inspection were focused on the Ace area in 2016, with only a cursory inspection of the Hab and Dubyna areas completed. No signs of tensions cracks or visible depressions were observed in 2016. More detailed inspections of the Hab and Dubyna areas will be conducted and recorded in 2017.

Photographs of the covered Ace stope area are provided in Appendix D.

6.0 REFERENCES

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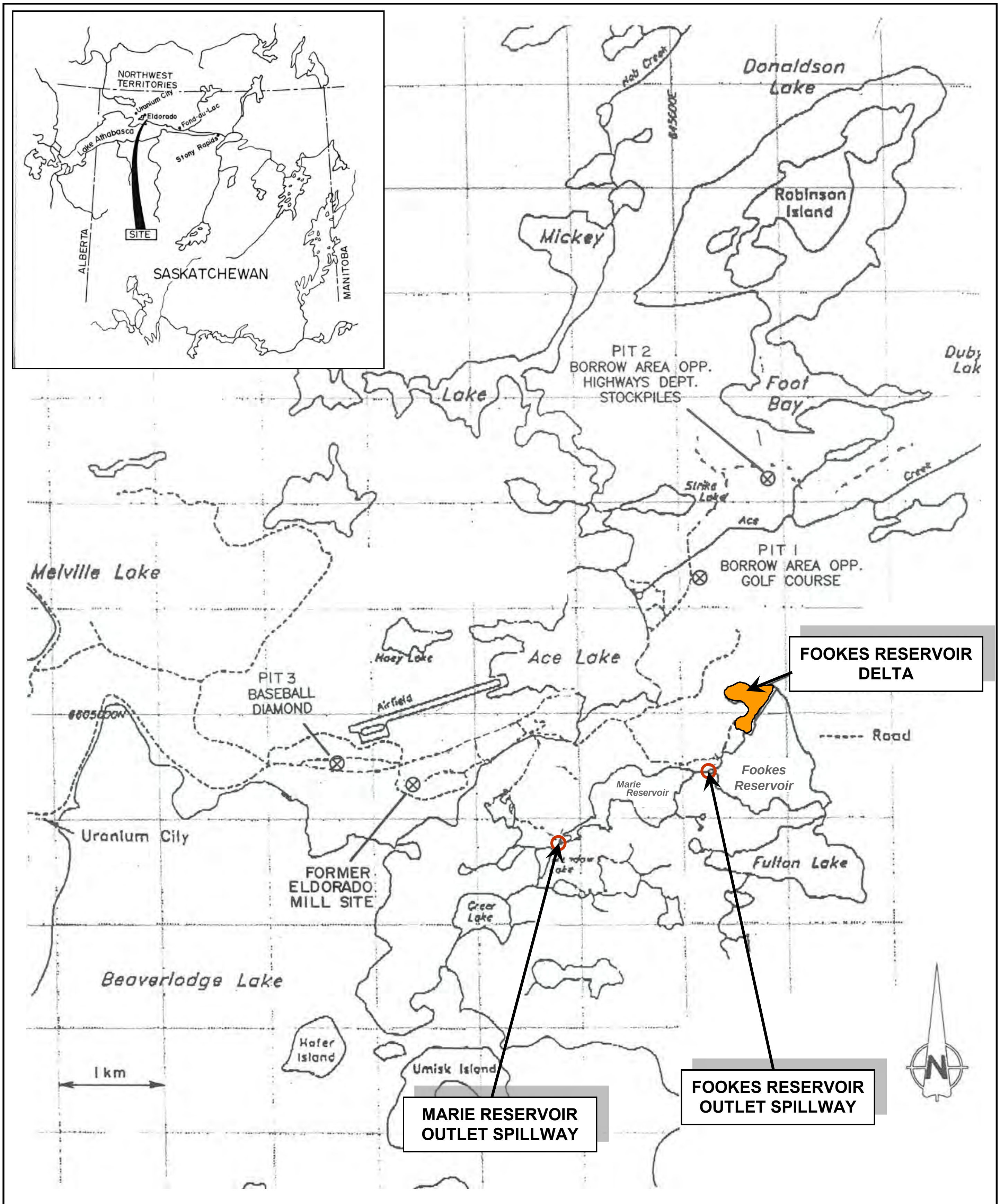
SRK Consulting (2008). Beaverlodge Decommissioning: 2007 Construction Activities at the Fookes Lake Delta. Report prepared for Cameco Corporation, February, 2008.

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.



srk consulting

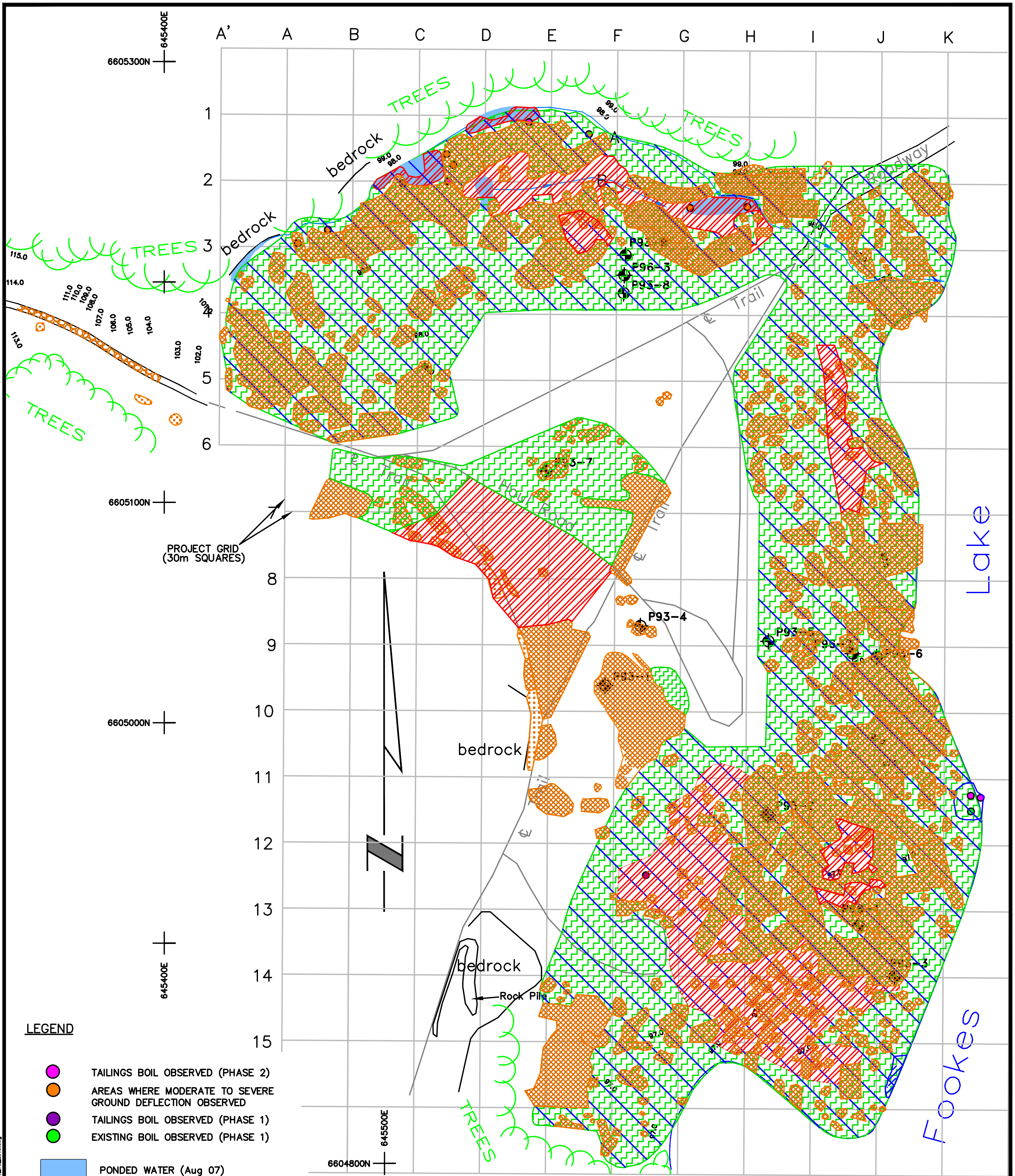
VANCOUVER

Cameco

Beaverlodge Inspection

Layout Map

Job No: 1CC007.055 Filename: Figure 1_Layout_20151204.pptx	Beaverlodge Mine Site	Date: Feb. 2016	Approved: CCS	Figure: 1



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:
- SCALE: 1:750
- CONTOURS ARE RELATIVE TO CAMECO BENCH MARK, 1" STEEL BAR SET IN CONCRETE (E 645545.422, N 6605051.209) WITH AN ELEVATION OF 100.00
- PIEZOMETER LOCATION AND NUMBER ARE SHOWN THUS – – – P93-3

BASE PLAN PROVIDED BY TRI-CITY SURVEYS, DRAWING FILE 97077CON.DWG DATED JUNE 25th, 1997

srk consulting

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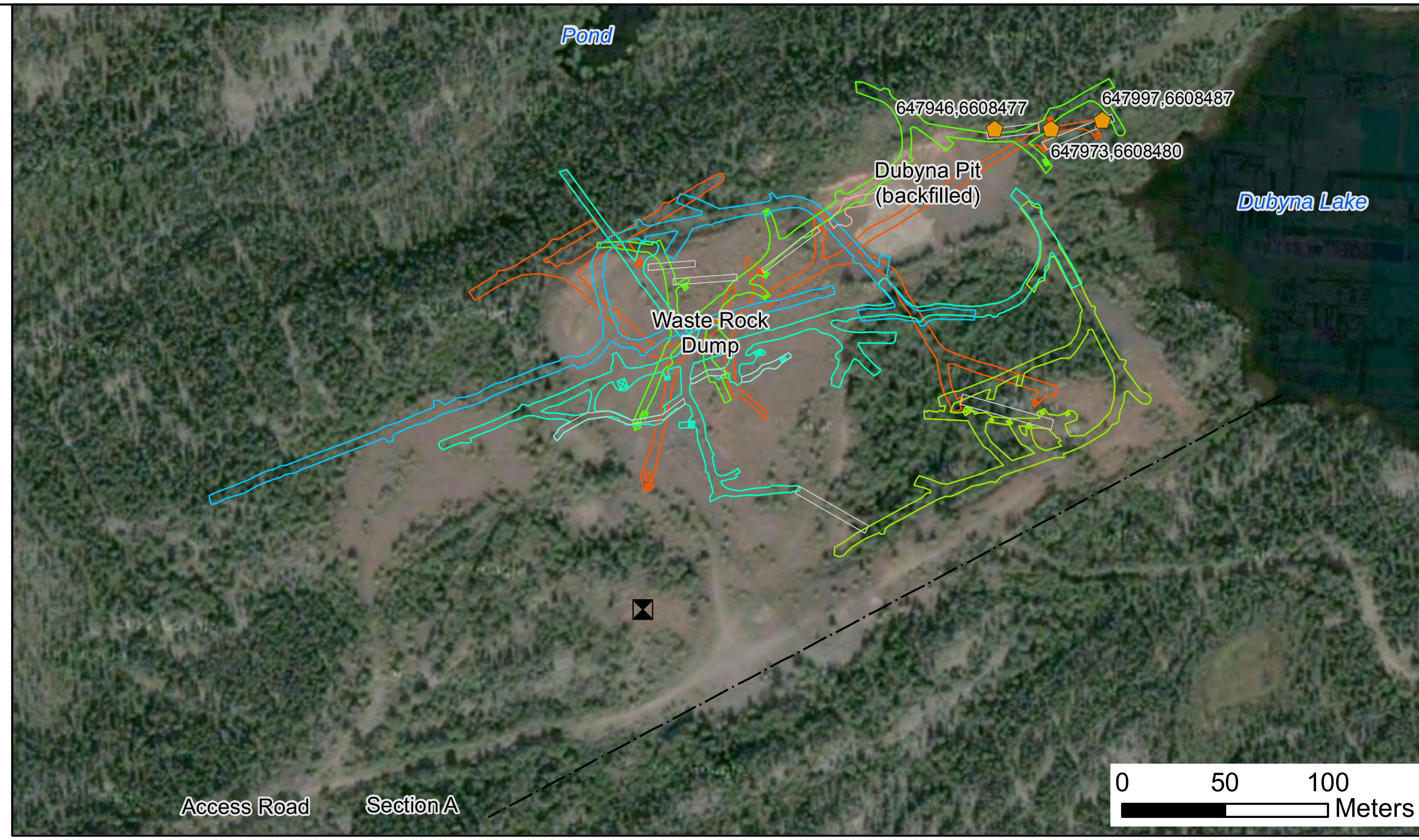
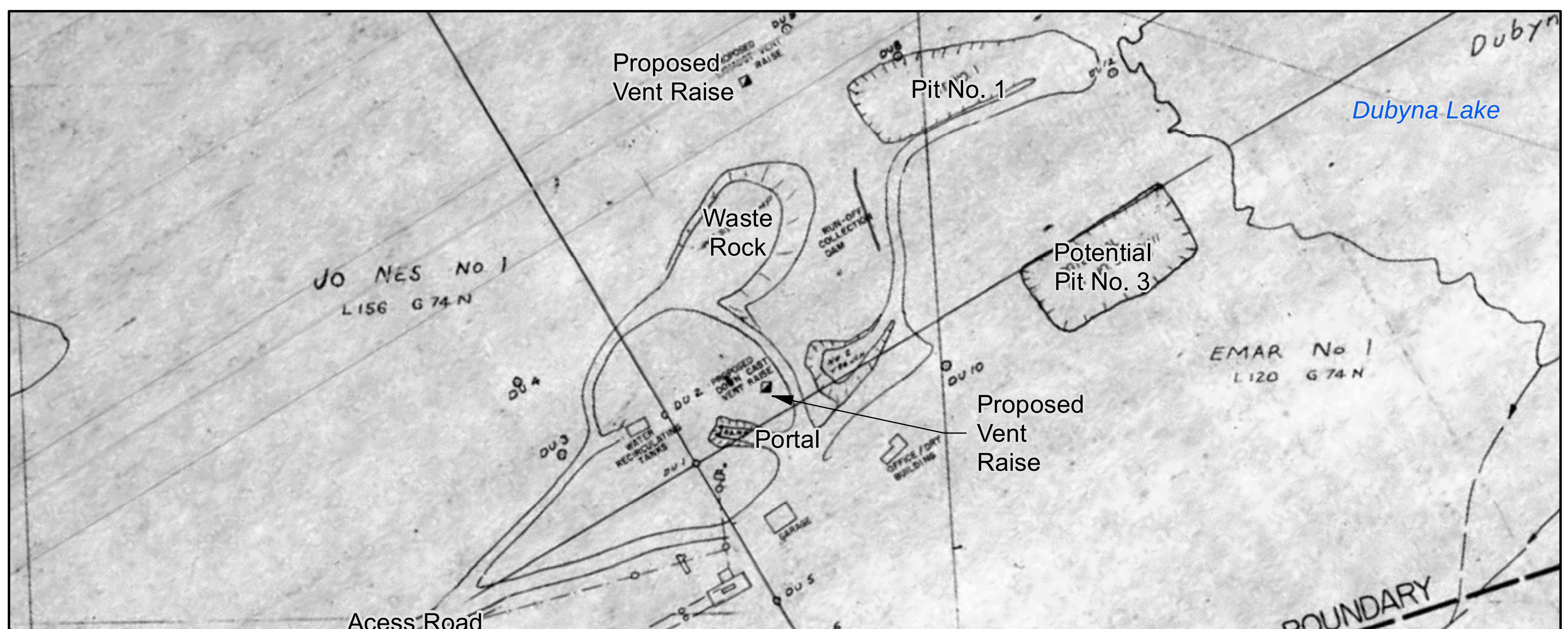
BEAVERLODGE DECOMMISSIONING (2007)

Fookes Delta Cover 2007 As-Built

PROJECT:	DATE:	APPROVED:	FIGURE:
1CC007.055	Jan. 2016		2





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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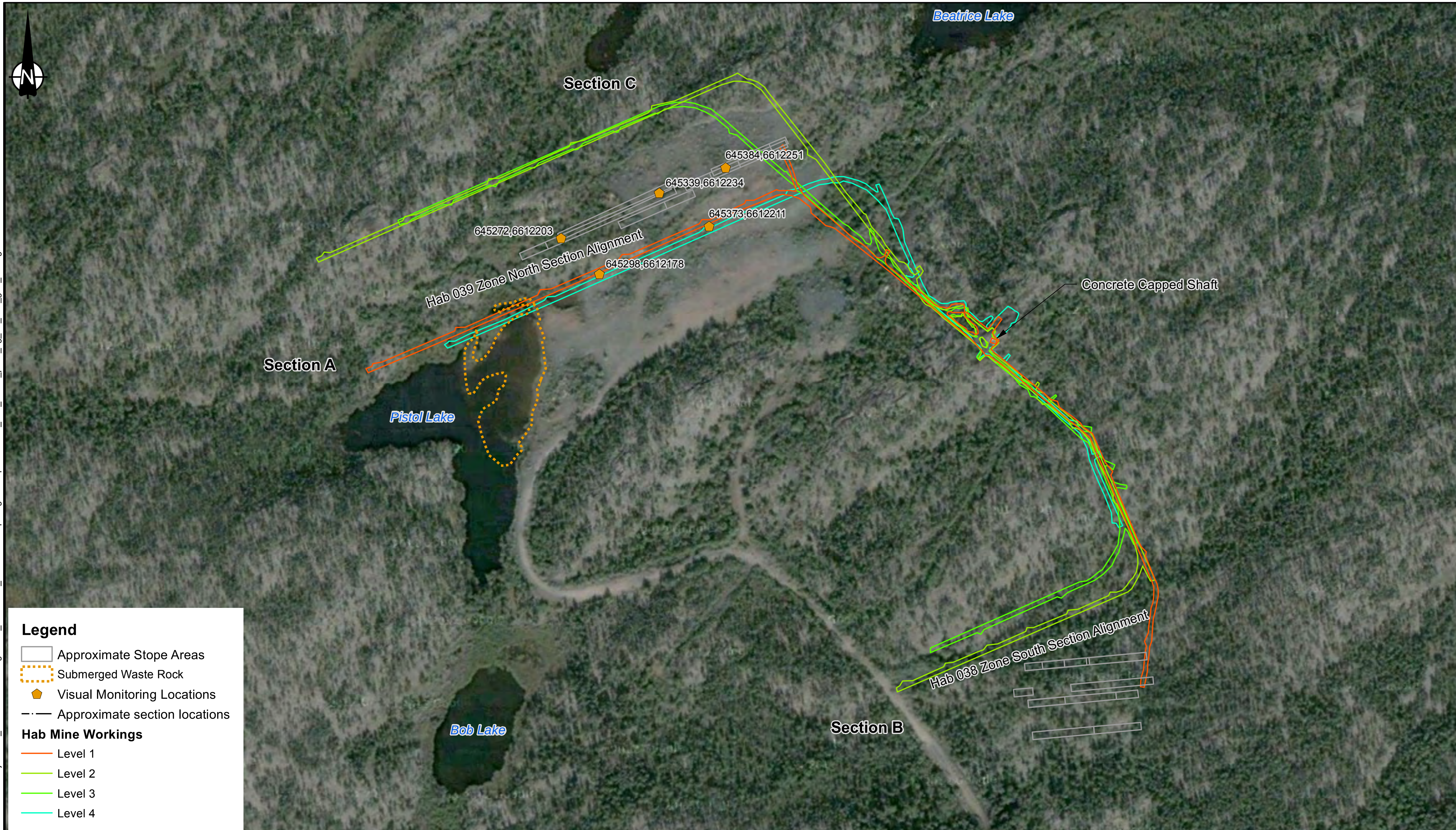
Dubyna Area
General Arrangement

Job No: 1CC007.048

Filename: 1CC007_048_crown_pillar_fig_14_dubyna_gen_arrange

Beaverlodge

Date:	Approved:	Figure:
April 2015	JBK	3



0 100 200 Meters

srk consulting

Job No: 1CC007.048

Filename: 1CC007_048_crown_pillar_fig_17_hab_gen_arrange

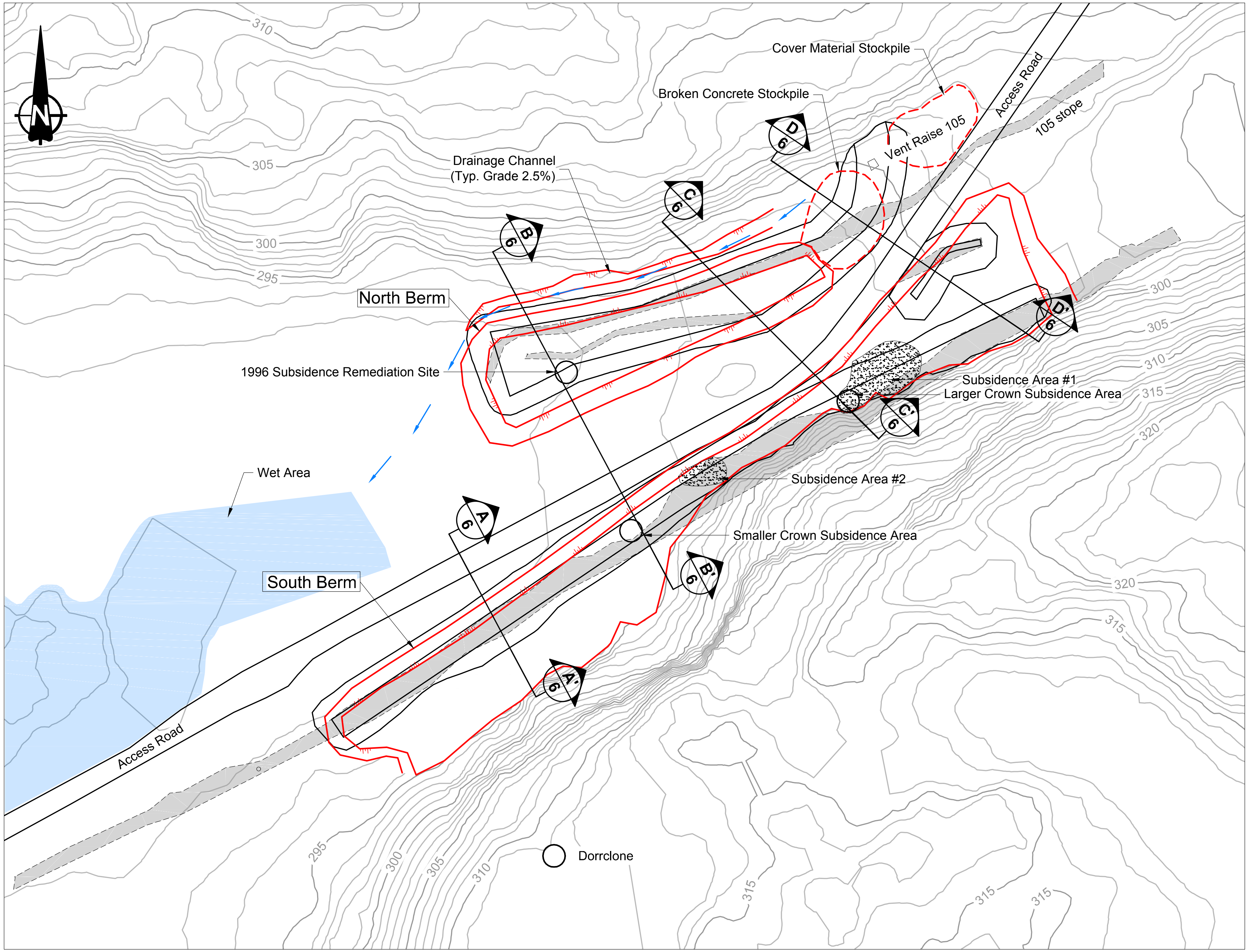
Cameco

Beaverlodge

Hab Area
General Arrangement & Ramp Details

Date:	Approved:	Figure:
April 2015	JBK	4

\\SSK-SVR0.ssk.na.srk.ad\Saskatoon Projects\01_SITES\Beaverlodge\!020_Site-Wide_Data\!GIS\Maps\Figure Maps\1CC007_048_crown_pillar_fig_17_hab_gen_arrange.mxd



Plan Map

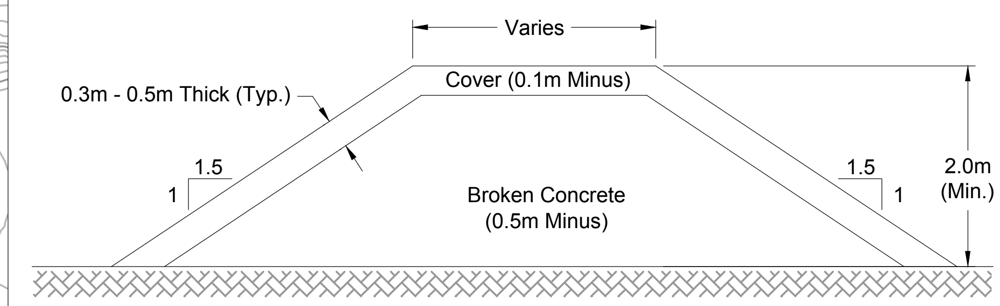
0m 5 10 15 20 25 30

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

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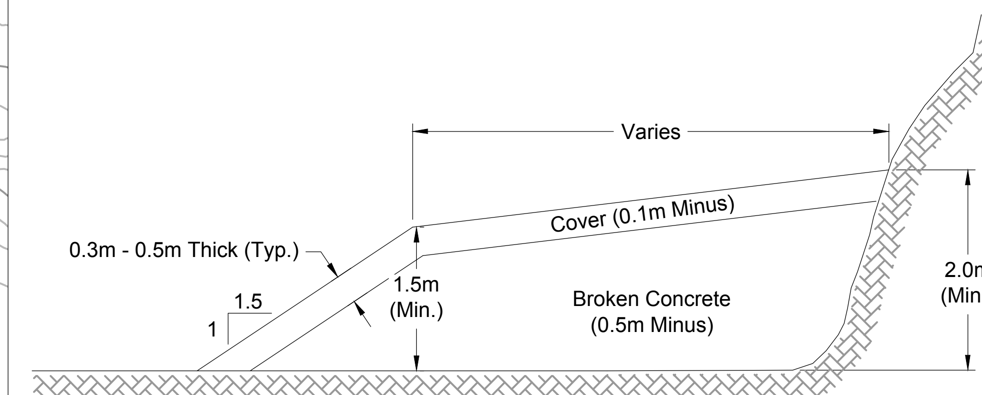

Typical Section Through South Berm

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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

P:\01_SITES\Beaverlodge\1040_AutoCAD\Ace Failure\Subsidence Remediation\As-Builts\1CC007.062 - PP.dwg

APPENDIX A

Marie Outlet Photos

Photo A1 – Marie Reservoir Spillway looking upstream

Photo A2 - Marie Reservoir Spillway looking upstream (September)

Photo A3 – Marie Reservoir Spillway (water flowing into stilling basin)

Photo A4 – Marie Reservoir Spillway looking downstream (water flowing into stilling basin - September)

Photo A5 – Displaced grout intruded rip rap at the entrance to the spillway

Photo A6 – North bank, showing better condition of the grout intruded rip rap in the middle of the spillway

APPENDIX B

Fookes Outlet Photos

Photo B1 – Fookes Reservoir Spillway looking upstream

Photo B2 – Fookes Reservoir Spillway looking upstream (September)

Photo B3 – Fookes Reservoir Spillway looking downstream (mid channel)

Photo B4 – Fookes Reservoir Spillway looking downstream (mid channel- September)

Photo B5 – Fookes Reservoir Spillway looking downstream towards the stilling basin

Photo B6 – Fookes Reservoir Spillway looking downstream towards the stilling basin (September)

Photo B7 – Evidence of grout displacement on both sides of the channel at the entrance

Photo B8 – Fookes stilling basin

APPENDIX C

Fookes Delta Photos

Photo C1 – Drainage collection area on NE edge of Fookes Tailings Delta (looking SE)

Photo C2 – Drainage channel on Fookes Delta with standing water (looking NW)

Photo C3 – Chevrons in place on north access point to the Fookes delta

Photo C4 – Run-out structure along north access road (looking east)

Photo C5a-c – Panoramic views of the Fookes cover with vegetation establishing

Photo C6 – View of vegetation establishing on the cover

Photo C7 – View of the Fookes cover

Photo C8 – View of the East Fookes shoreline looking N

Photo C9 – View of the Fookes shoreline looking S

Photo C10a-c – Additional photos of the shoreline showing established vegetation

APPENDIX D

Crown Pillar Area Photos

Photo D1 - View of the cover placed over 208 Stope

Photo D2 - Close up view of the 208 stope cover

Photo D3 – View of the 103 and 201 Stope cover

Photo D4 – View looking SW with 201 Stope cover in the background

Photo D5 – View of the road between cover placement looking NE

Photo D6 – View of the road over the hummocky area looking SW

APPENDIX B

APPENDIX B

September 20, 2016

Beaverlodge Public Meeting

Michael Webster

cameco.com

Cameco

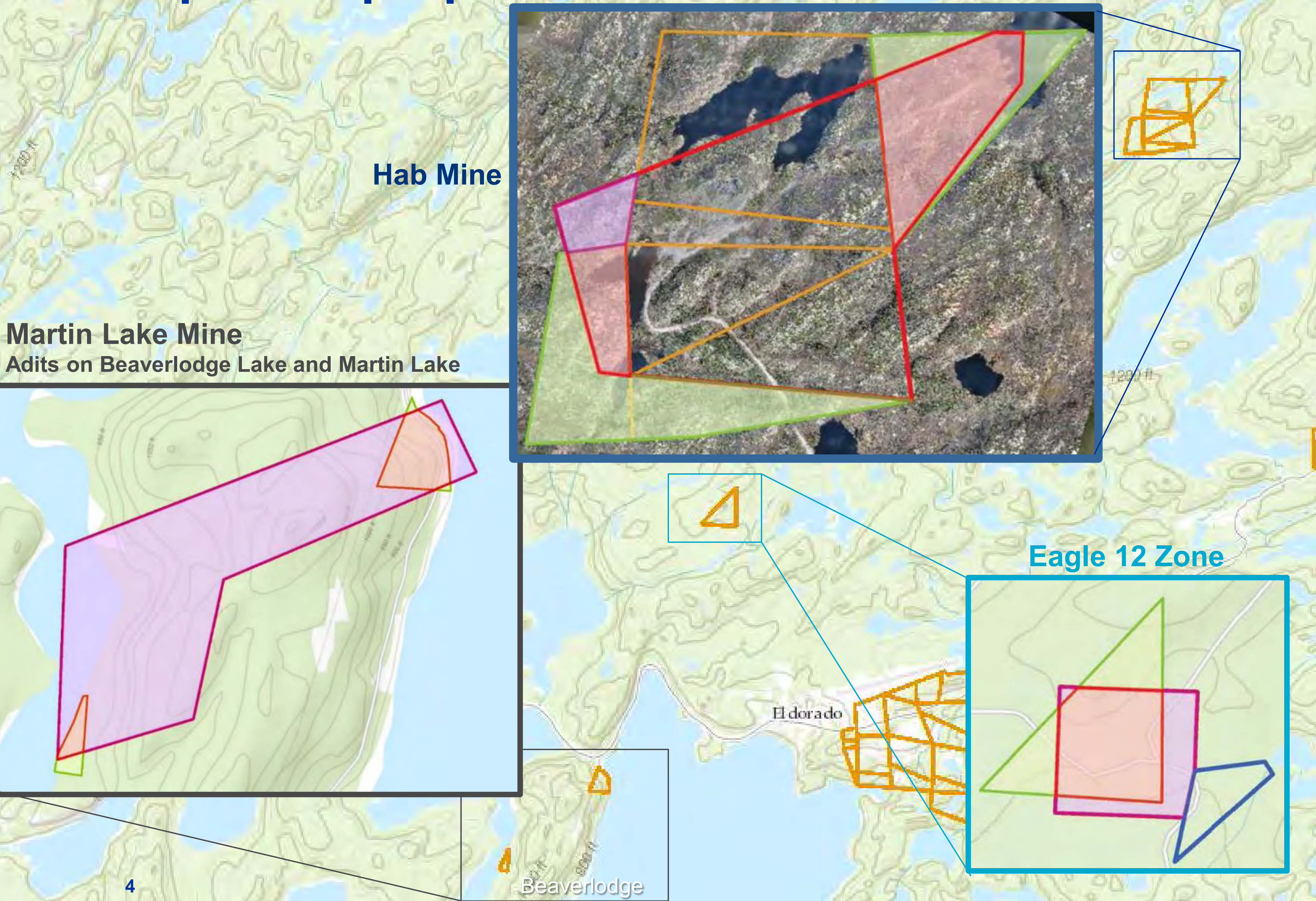
Beaverlodge Mine and Mill

- **Operated by Eldorado Nuclear Limited from 1953 until 1981**
- **Decommissioning was completed by Eldorado, following a regulatory approved plan, from 1982 to 1985**
- **In 1988 Eldorado Nuclear and Saskatchewan Mining and Development Corporation (SMDC) combined assets to form a publically traded company - Cameco**
- **Cameco manages the decommissioned facility on behalf of Canada Eldor Inc.**
  - Waste Facility Operating Licence (CNSC) held by Cameco Corporation
  - Surface Lease (Saskatchewan) negotiated with Cameco Corporation
  - Financial responsibility of Canada Eldor Inc. (federal Crown Corporation)

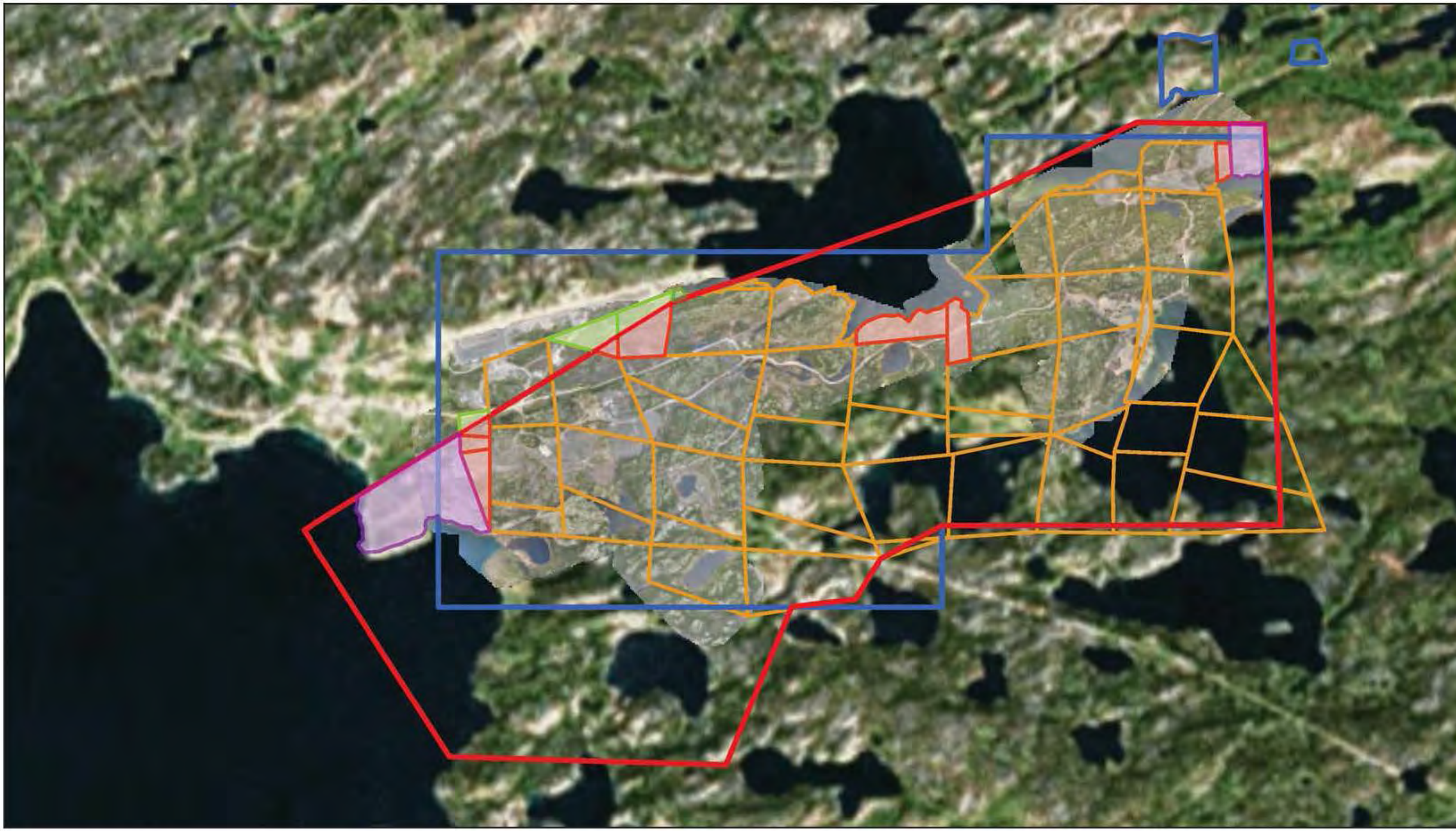
Institutional Control Program

- **Institutional Control Program introduced by the province in 2007**
- **Ultimate goal is to transfer all properties to the ICP over the next several years**
- **5 properties transferred in 2009**
- **14 properties (of the remaining 65) up for transfer this year**
  - Final inspection of all properties completed in 2015 and 2016
  - All garbage located on properties was removed and disposed of in Bolger Pit
- **Submitted all required paperwork to regulatory agencies for review**
- **ICP establishes long term monitoring and maintenance plan to be managed by the Province of Saskatchewan**
- **Funding provided up front to cover the cost of future monitoring and maintenance**

Properties proposed for transfer in 2016



Proposed properties for transfer in 2016



August 30, 2016

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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Proposed properties for transfer in 2016

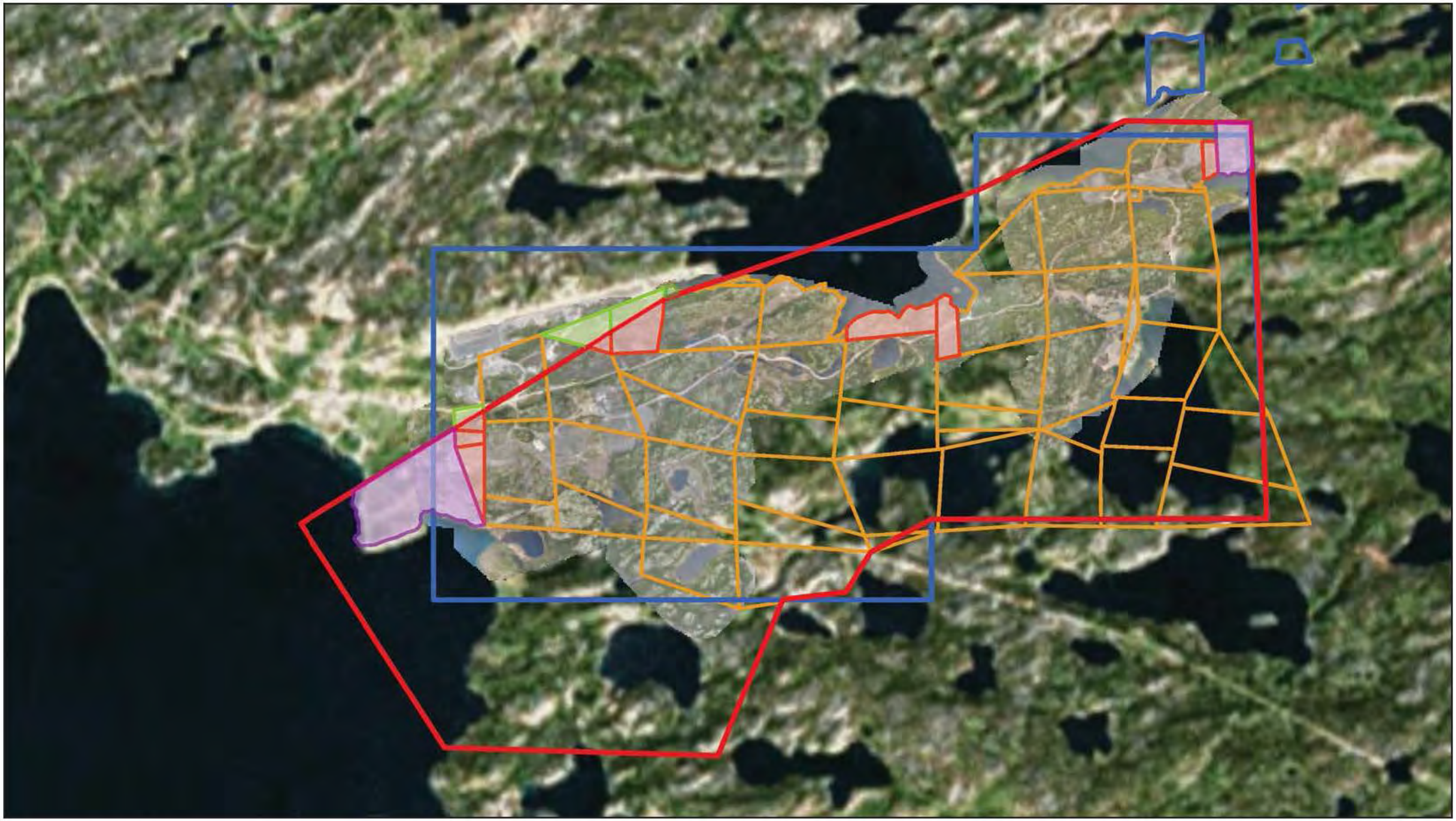
Next Steps

- Finalize the proposed boundaries for the Surface Lease Agreement
- Receive Release from Decommissioning and Reclamation from Saskatchewan Ministry of Environment
- Exemption from CNSC licensing – Application to be reviewed at an abridged hearing in the 1st quarter of 2017
- Anticipate acceptance of the properties into the Province of Saskatchewan IC Program by the end of March 2017

Future Property Transfers

Proposed schedule for the transfer of future properties to the Province of Saskatchewan's Institutional Control Program

Proposed properties for transfer in 2016



August 30, 2016

1:57,654

0 0.5 1 2 mi

0 0.75 1.5 3 km

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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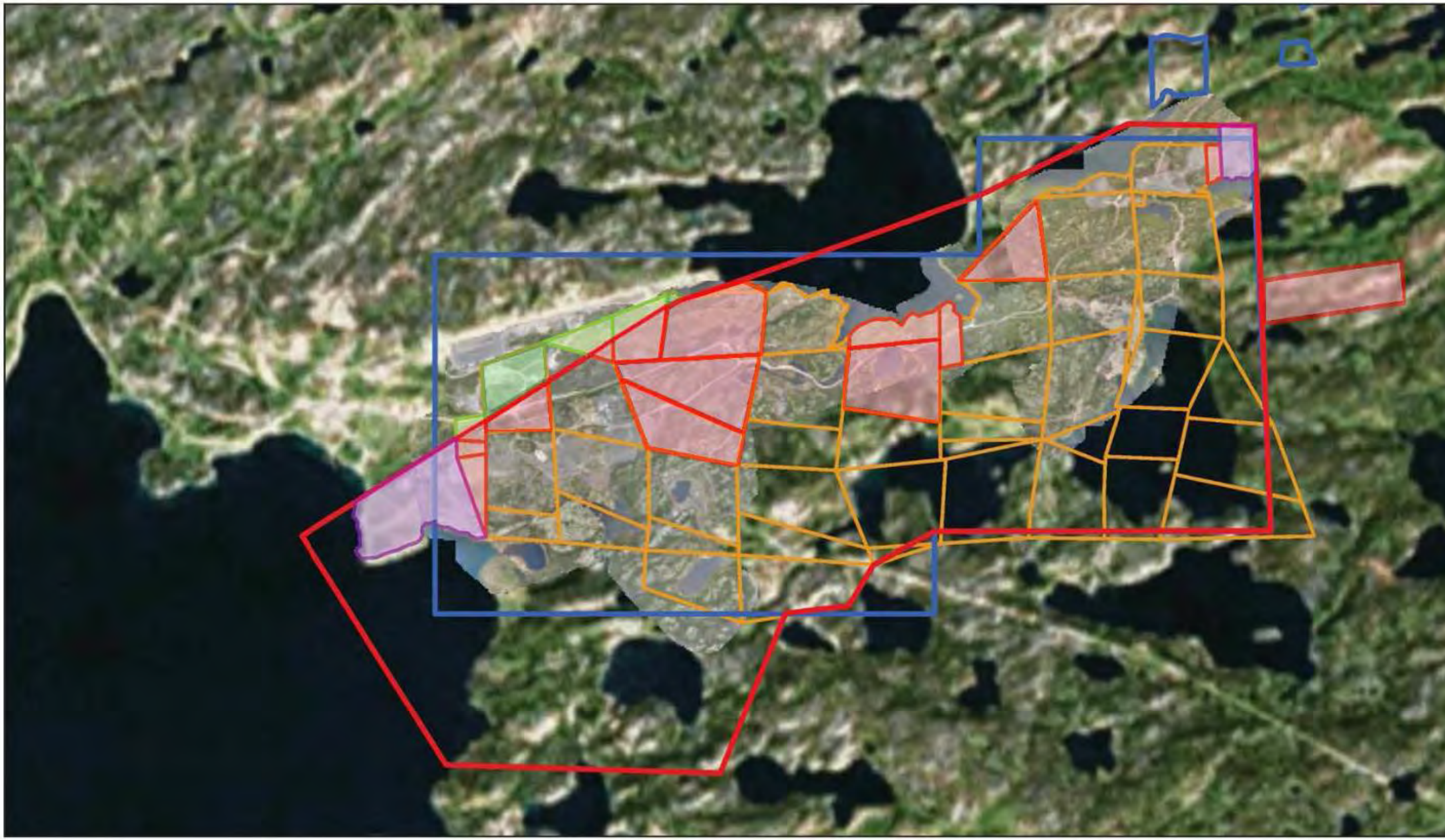
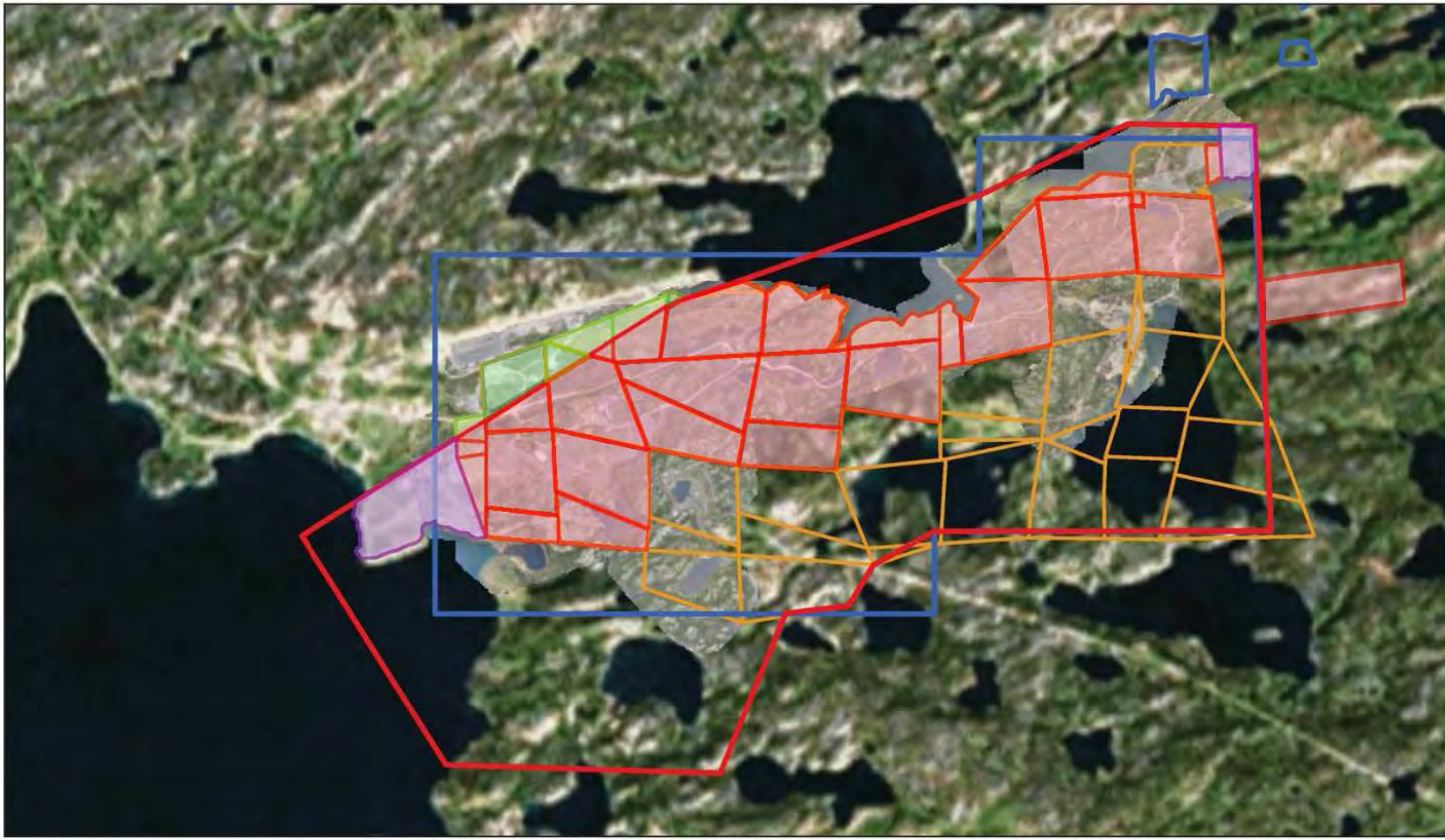
2018 Planned IC Transfer



2019 Planned IC Transfer



August 30, 2016

1:57,654

0 0.5 1 2 mi

0 0.75 1.5 3 km

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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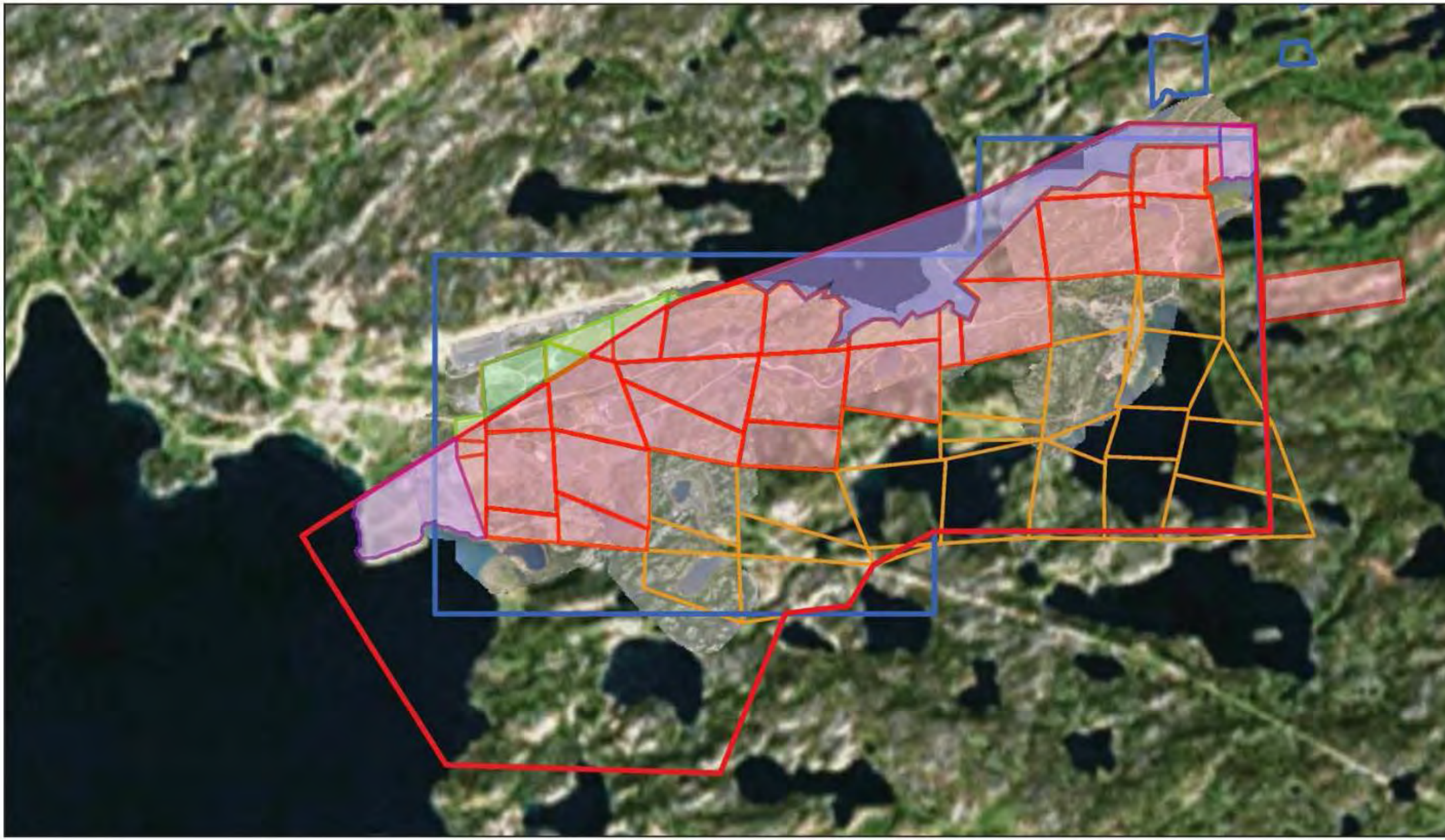
2022 Planned IC Transfer



August 30, 2016

1:57,654

0 0.5 1 2 mi

0 0.75 1.5 3 km

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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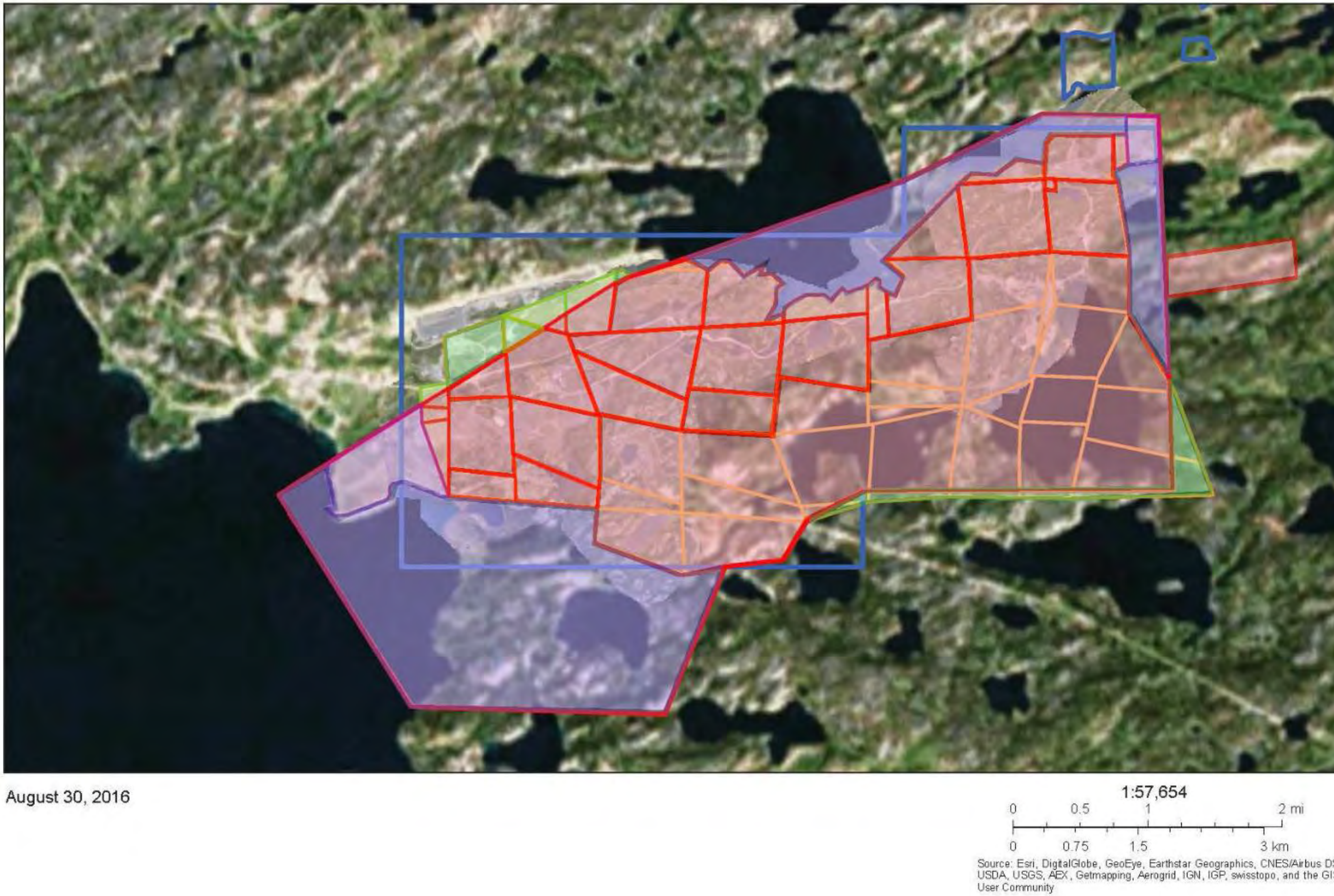
2023 Planned IC Transfer



Activities Update

- Zora Creek Reconstruction (Bolger Pit area)
- Concrete Cap Replacement
- Crown Pillar Remediation
- Powerline Infrastructure Assessment
- UAV Photos of Mining/Milling Areas
- Waste Haul Adit Remediation
- Property Inspection and Clean-up

Zora Creek Reconstruction

- **Why did we do it?**
  - Remedial options workshop
  - Predicted a local benefit to Verna Lake in the long term.
- **EQC and U-City public invited to tour the site each year**
  - If interested we will go there today

Zora Creek Reconstruction

May 2009 - Ice inside waste rock pile impedes flow from Zora Lake

September 2013 – Ice in waste rock pile melts allowing backed up water to flow

August 2015 – completed channel allows water to flow unimpeded from Zora to Verna Lake

Zora Creek Reconstruction

2014 preliminary work to characterize project

Zora Creek Reconstruction

Excavation of Zora Creek Through the Bolger Waste Rock Pile

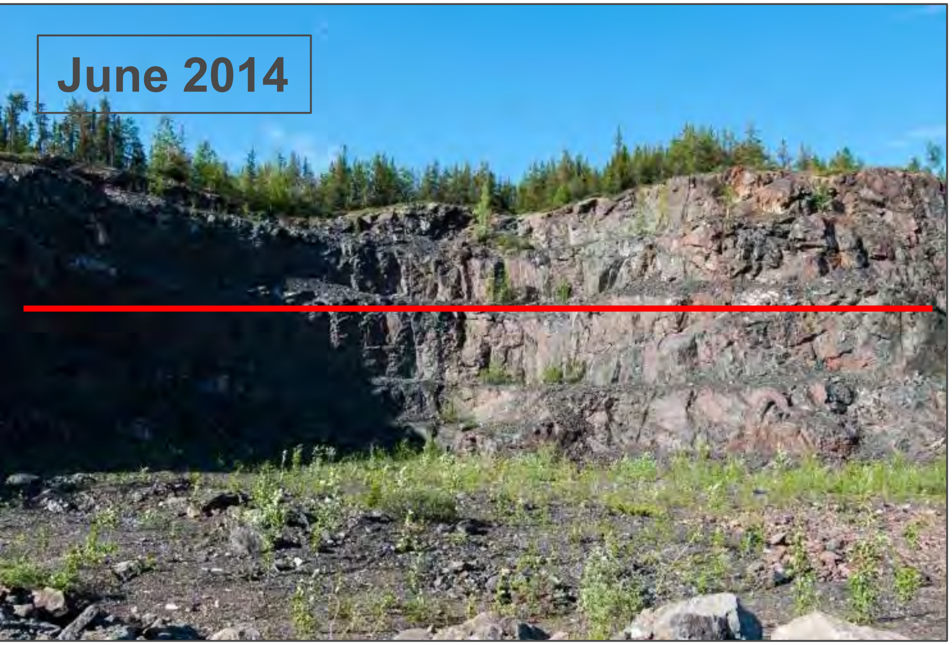
2015 channel excavation

June 2015

August 2016

Zora Creek Reconstruction

Red line indicates level of fill placed in Bolger Pit



Zora Creek Reconstruction

Excavation of Zora Creek Through the Bolger Waste Rock Pile

2016 Final Grading

- Excavation of previous frozen material
- Placement of erosion protection

Ice block in waste rock
August 2016

2015 – following excavation of the channel

2016 – following the placement of rip-rap

Concrete Cap Replacement

Locating:

- Vertical Mine openings were sealed with concrete during decommissioning, however some were covered with waste rock
- Used historic photos and drawings paired with recent aerial photos to complete investigation
- Of the 35 total vertical openings:
  - 34 were found, last opening is beside the Fay Shaft but has not been exposed yet
  - 25 will require additional remediation to ensure long term security and safety
  - 10 are considered to meet the current objectives (recently capped, backfilled)

Assessing remediation options:

- Cameco assessed several methods to secure the historic mine openings and selected covering the existing concrete caps with stainless steel
  - Longer lasting than concrete (1200 years), easier to install in remote locations
- Requires exemption from Mining Regulations for implementation
- Investigating backfilling 7 openings with concrete as well

Concrete Cap Replacement

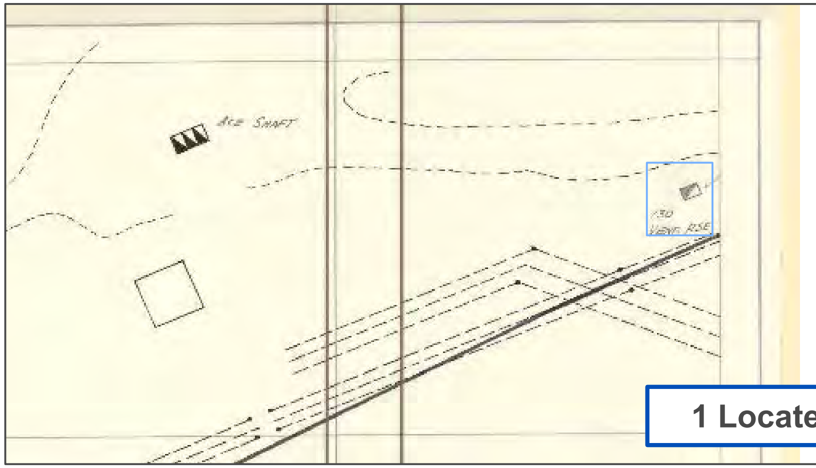
- **Schedule**
  - The current plan is to have all caps measured, designed, fabricated and installed over the next few years
    - Trial run in 2016, with a campaign to install the remaining caps in 2017 and 2018
    - Some caps are larger (ie. shafts) or are far from bedrock and will require some additional time to design a site specific capping solution

2016
- Locate and expose all mine openings
- Trial installation at the Ace Shaft
- Measure and design small caps

2017
- Fabricate and install stainless steel caps on small openings
- Measure and design caps for large mine openings

2018
- Fabricate and install remaining steel caps
- Steel cap installation at the main properties complete

Concrete Cap Replacement



1 Locate & Expose Cap

2 Clean cap and surrounding bedrock

3 Measure for steel cap design

Concrete Cap Replacement

Ace Shaft

- Exposed buried concrete cap and collar poured on bedrock
- Measured in 2015
- Fabricated cap and installed in 2016

Crown Pillar Remediation

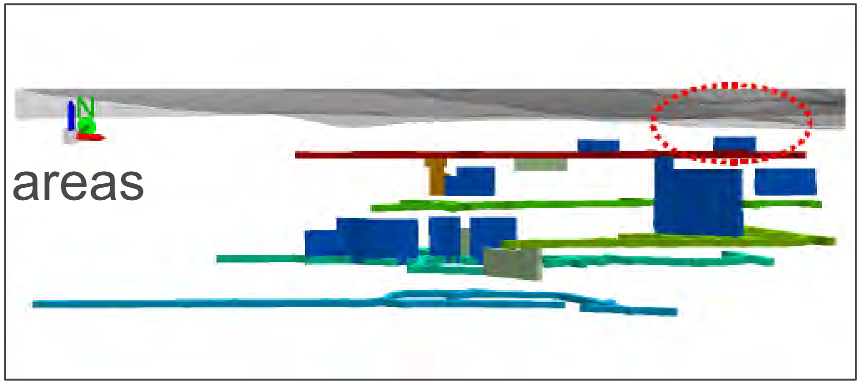
- **2013 noticed an area where slumping had occurred**
  - Applied a sand cover with the intention to monitor the area for additional slumping

Crown Pillar Remediation

- **2014/2015**
  - Sand appeared to erode along base of ridge (suspect washout as opposed to additional slumping)
  - Assessment of the Ace Stope area
    - Geophysical and geotechnical drilling
  - Assessment of all Crown Pillars associated with the Beaverlodge properties
    - Geophysical assessments
    - Table top assessment
      - Review of available historic plans, sections, and geological information related to each mining area.

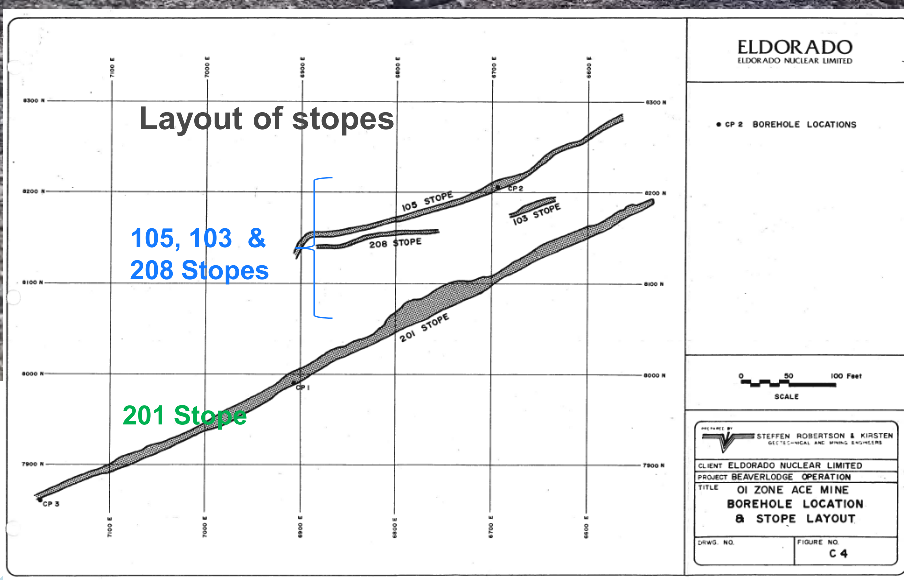
Crown Pillar Remediation

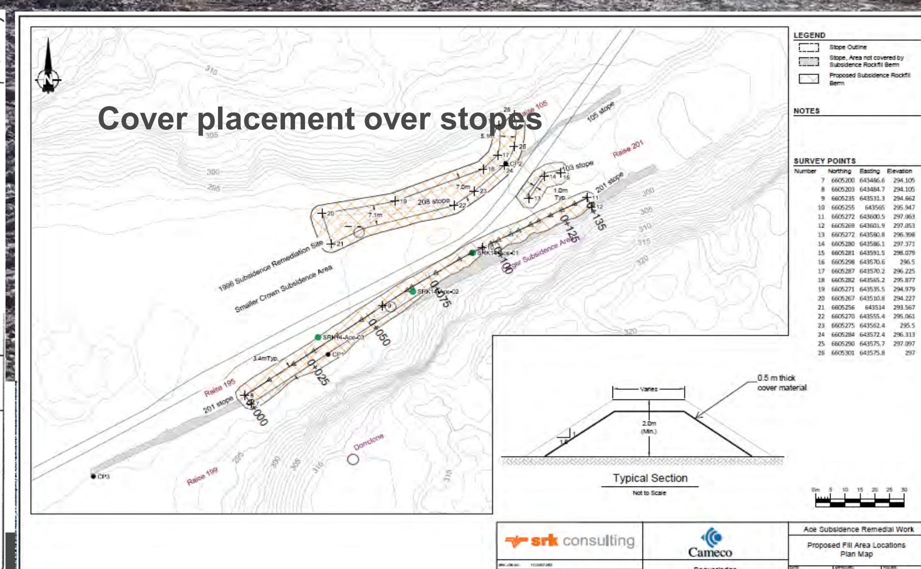
- **Risk Assessment Results**
  - Fay, Verna and Martin Lake mine areas
    - Crown pillars very thick
    - Very low risk of subsidence
  - Dubyna and Hab sites
    - Crown pillars closer to surface, however present a low risk of subsidence
    - Recommend visual monitoring of crown pillar areas every 5 years
  - Ace crown pillar is at risk (~20%) to see additional subsidence
    - Developed 5 potential remedial options for assessment
    - Decided on the application of a waste rock cover over areas of potential subsidence. Will reduce potential for surface expression of additional subsidence



3D View of the Dubyna workings and stopes near surface

Crown Pillar Remediation





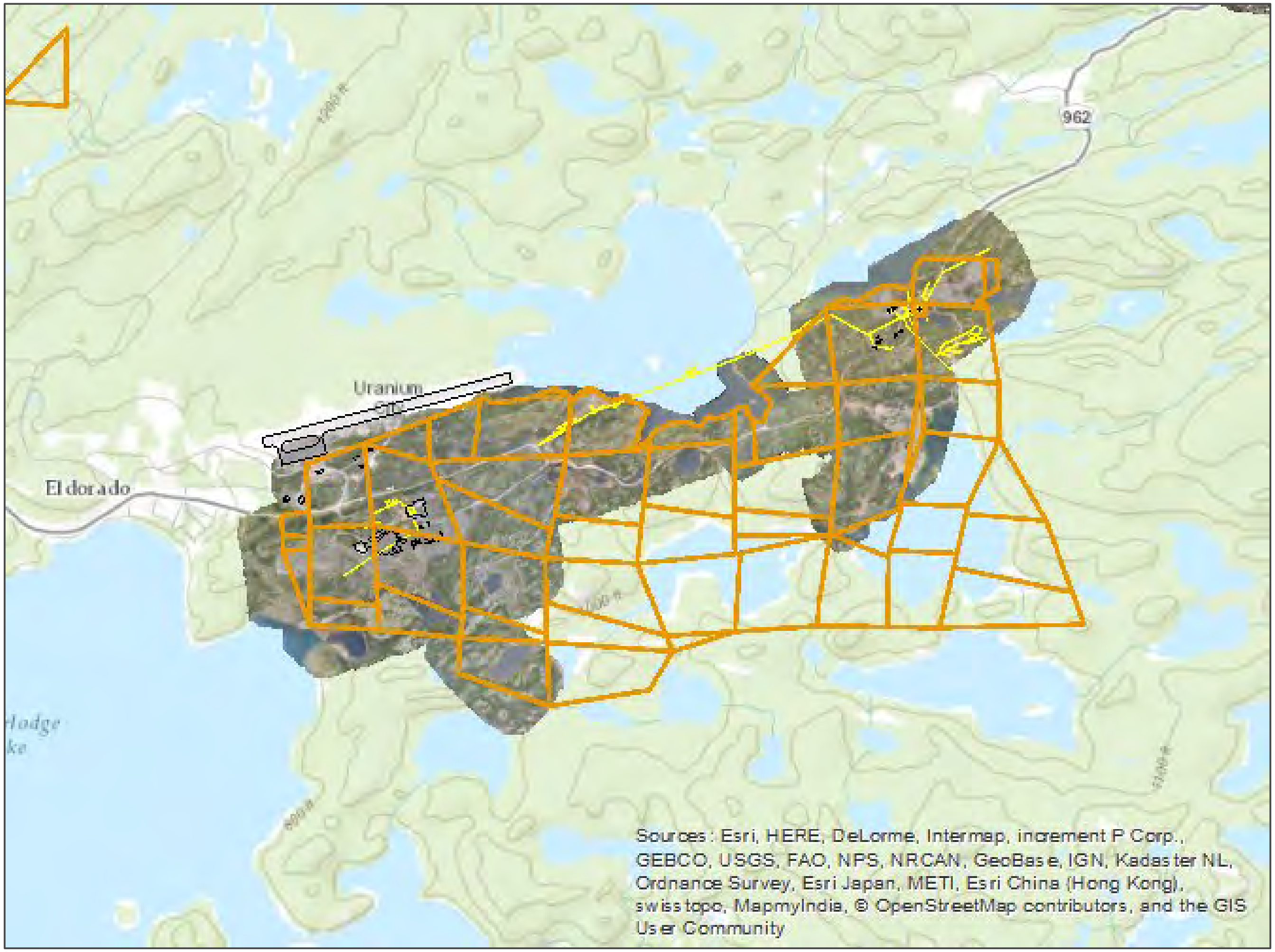
Powerline Assessment

- **Powerline Assessment**
  - Proposed transferring property ACE 5 to IC Program
    - Discovered infrastructure related to power lines on the property.
    - Therefore removed this property from the current proposal while investigating the extent of the issue on all Beaverlodge properties.
    - Investigation completed in June 2016
    - Reviewing findings and path forward with regulatory agencies

Powerline Assessment

UAV photos of Mining & Milling Areas

- Most of the accessible areas of the site complete
- Looking to fill in a couple of areas



UAV photos


Sources: Esri, HERE, DeLorme, Intermap, increment P Corp.,
GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL,
Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong),
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User Community


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Waste Haul Adit Remediation

- Previous slide shows area of slumping on UAV photo
- Remediation of waste haul adit completed

Exposing the adit

Adit exposed

Waste Haul Adit Remediation

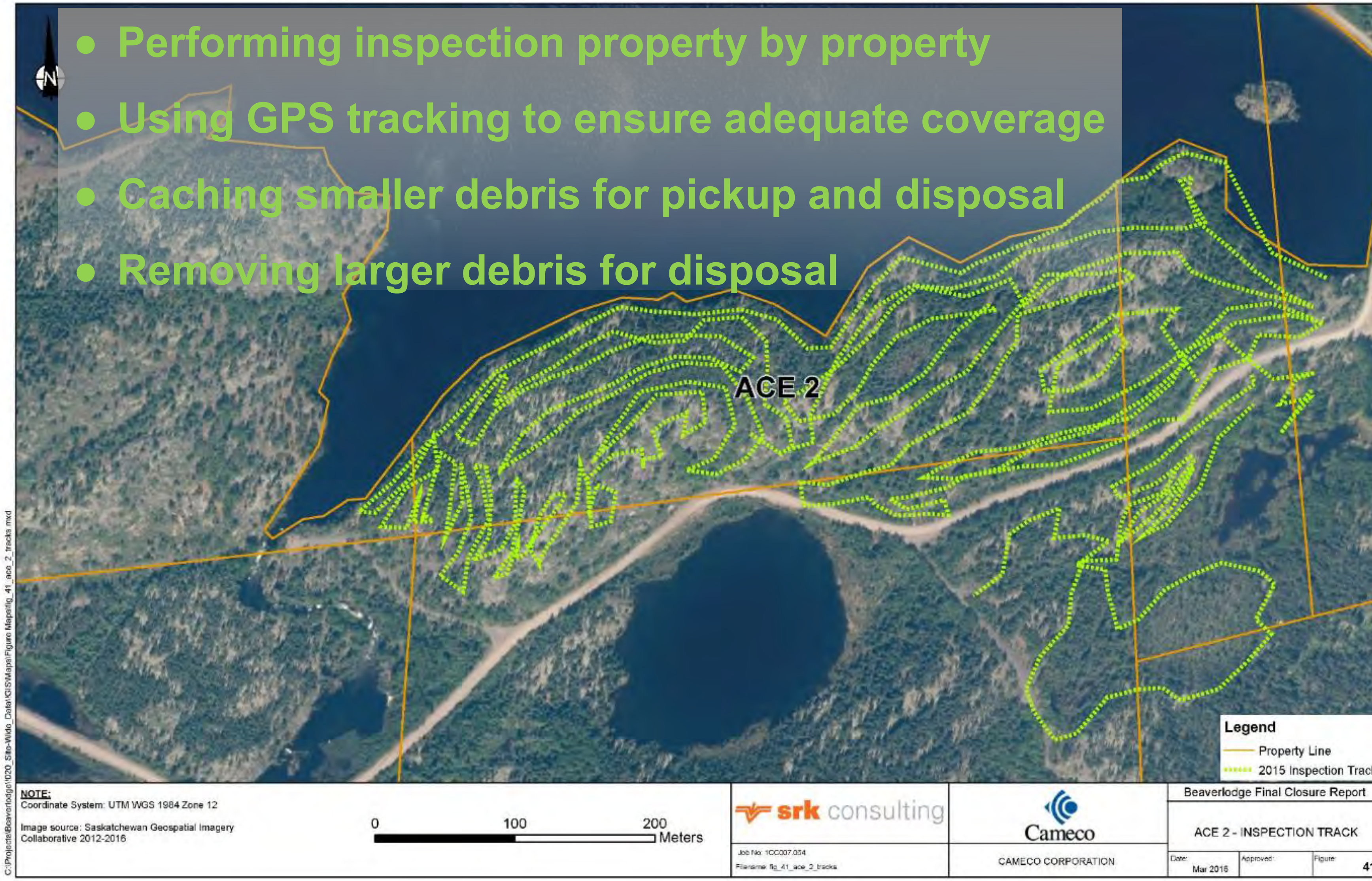
Packing waste rock into opening

Waste rock packed to top of opening

Project completed

Property Inspection and Clean-up

- Performing inspection property by property
- Using GPS tracking to ensure adequate coverage
- Caching smaller debris for pickup and disposal
- Removing larger debris for disposal



Inspection tracks for properties ACE 2 & EXC ACE 3

Future Activities

- **Continue Preparing Properties for Transfer to the IC Program**
  - Replacing concrete caps with stainless steel caps or alternative methods (complete backfill or plug/backfill with waste rock)
  - Remediation of Powerline infrastructure
    - Reviewing plan with Province plan to implement in 2017
  - Expect to transfer an additional 11 sites to the IC Program in 2018, which would leave 40 properties remaining
  - Begin discussions with Uranium City residents about access road closure
    - Will need to discuss access to the former sites and how much people use the sites and what is the expectations for continued access and who will be responsible.

Community Liasons

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Freddie Throassie
Black Lake
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Darlene Gazandlare
Hatchet Lake FN/Wollaston Lake
(306) 633-2123

APPENDIX C

APPENDIX C

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	Scheduled for 2017
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-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	641110.000	6604137.000	Discharging	2012
	BH-014	642168.000	6604158.000	Discharging	2011
	BH-15	642101.665	6604192.497	Dry/seep around	2016
	BH-Seep	641932.000	6604142.000		2012
	BH-16	643009.193	6604465.019	Dry	Scheduled for 2017
	BH-17	642993.852	6604455.146	Dry	Scheduled for 2017
	BH-18	642995.637	6604466.051	Dry	Scheduled for 2017
	BH-19	642978.88	6604452.098	Dry	Scheduled for 2017
	BH-20	643007.541	6604467.124	Dry	Scheduled for 2017
	BH-21	642966.862	6604445.757	Dry	Scheduled for 2017
	BH-22	642959.407	6604439.281	Dry	Scheduled for 2017
	BH-23	642954.958	6604432.3	Dry	Scheduled for 2017
	BH-24	642940.515	6604415.339	Dry	Scheduled for 2017
	BH-25	642930.8	6604406.299	Dry	Scheduled for 2017
	BH-26	642972.143	6604451.532	Dry	Scheduled for 2017
	BH-27	643250.316	6604979.231	Dry	Scheduled for 2017
	BH-28	643113.492	6604895.363	Dry	Scheduled for 2017
	BH-29	643174.26	6604925.548	Dry	Scheduled for 2017
	BH-30	643285.271	6604977.469	Dry	Scheduled for 2017
	BH-31	642101.048	6604195.52	Discharging	Scheduled for 2017
	BH-32	642260.649	6604592.012	Dry	Scheduled for 2017
	BH-33	642423.877	6604597.892	Dry	Scheduled for 2017
	BH-34	642401.708	6604647.831	Dry	Scheduled for 2017
	BH-35	642268.019	6604629.757	Dry	Scheduled for 2017
	BH-36	643698.938	6605341.629	Dry	Scheduled for 2017
	BH-37	642456.049	6604665.374	2 holes/dry	Scheduled for 2017
	BH-38	642424.846	6604667.596	Dry	Scheduled for 2017
	BH-39	643709.725	6605142.015	Dry	Scheduled for 2017

Area	Designation	Coordinate System: WGS 84 UTM Zone 12		Status When Located	Year Remediated
		Easting	Northing		
	BH-40	642242.735	6604550.461	Dry	Scheduled for 2017
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	Scheduled for 2017
	Ace 03	645627.645	6605877.357	Dry	Scheduled for 2017
	Ace 04	645187.707	6605816.337	Dry	Scheduled for 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	Scheduled for 2017
	DB 29	647513.47	6608225.766	Dry	Scheduled for 2017
	DB 30	647413.386	6608235.144	Dry	Scheduled for 2017
	DB 31	647411.222	6608290.178	Dry	Scheduled for 2017
	DB 32	647603.393	6608298.979	Dry	Scheduled for 2017
	DB 33	646948.652	6608333.328	Dry	Scheduled for 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
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

Area	Designation	Coordinate System: WGS 84 UTM Zone 12		Status When Located	Year Remediated
		Easting	Northing		
	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
	Hab 44	620185.770	7237167.323	Dry	2016
	Hab 45	645120.288	6612036.091	Dry	Scheduled for 2017
	Hab 46	645119.989	6612043.82	Dry	Scheduled for 2017
	Hab 47	645737.923	6612087.024	Dry	Scheduled for 2017
	Hab 48	645053.768	6611971.583	Dry	Scheduled for 2017
	Hab 49 & 50	645291.031	6612001.84	2 holes/dry	Scheduled for 2017
	Hab 51	644786.442	6611947.92	Dry	Scheduled for 2017
	Hab 52	645309.971	6612079.678	Dry	Scheduled for 2017
Martin Lake	MC 1	638979.011	6604055.980	Dry	2013
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	Scheduled for 2017
	VR 05	645751.166	6606305.443	Dry	Scheduled for 2017
	VR 06	645976.488	6606405.551	Dry	Scheduled for 2017
	VR 07	645353.123	6606311.983	Dry	Scheduled for 2017
	VR 08 & 09	645934.866	6607575.955	2 holes/dry	2016
	VR 10	645991.476	6607578.159	Dry	Scheduled for 2017
Fay	FAY 01	642552.256	6604730.954	Dry	Scheduled for 2017

Area	Designation	Coordinate System: WGS 84 UTM Zone 12		Status When Located	Year Remediated
		Easting	Northing		
Off Property	OP 01	647251.597	6607892.5	Dry	Scheduled for 2017

*Recent exploration activity (Not Eldorado/Cameco)

APPENDIX D

APPENDIX D

TECHNICAL MEMORANDUM

Date: November 4th, 2016

To: Mike Webster
Cameco Corporation

From: Angela Baier
Canada North Environmental Services

Subject: Summary of the Post-Construction Site Visit Conducted at the Zora Creek Diversion Project in September 2016

CanNorth Project No. 1899-1, Rev. 1

Introduction

The purpose of this memo is to provide Cameco Corporation (Cameco) with a summary of activities conducted by Canada North Environmental Services (CanNorth) at the Zora Creek Diversion Project (the Project) during a post-construction site visit in September 2016.

Remediation of the former Bolger waste rock pile, including reconstruction of the Zora Creek flow path, was undertaken in 2015. Following the 2015 construction season, CanNorth provided SRK and Cameco with a summary of technical support activities undertaken for the Project and recommendations for follow-up activities. In September 2016, CanNorth conducted a site visit to undertake a number of recommended follow-up activities, including the removal of sediment control measures installed in Verna Lake at the outlet of Zora Creek and completion of a post-construction aquatic habitat assessment in Verna Lake near the outlet of Zora Creek. Details are provided below.

Site Visit – September 2016

The site visit was conducted by an aquatic ecologist from CanNorth on September 13th, 2016. Photographs taken during the visit are provided in Appendix A.

Removal of Sediment Control Measures

With the exception of the outermost turbidity barrier in Verna Lake, sediment control measures in place in Verna Lake and in Zora Creek were removed by CanNorth on September 13th, 2016 with assistance from two laborers supplied by Uranium City Contracting Ltd. (UCC). This included the innermost turbidity curtain installed in Verna Lake at the outlet of Zora Creek (Appendix A, Photo 1), as well as sediment control measures in place along the section of Zora Creek between the reconstructed channel and Verna Lake.

The turbidity curtain was removed from Verna Lake by hand. It should be noted that there was a considerable amount of silt accumulated along the inside edge of the turbidity curtain prior to its removal. Care was taken to minimize its disturbance; however, as the bottom of the curtain was keyed in using sandbags, much of this silt was re-suspended into the water column during removal of the curtain (Appendix A, Photo 2). Turbidity measurements were taken inside the turbidity barrier before and after removal of the curtain. Turbidity inside the barrier measured 0.99 NTU just prior to the curtains' removal; two hours later, turbidity measured 7.07 NTU. Turbidity was also measured outside of the barrier after removal of the turbidity curtain and was recorded at 0.74 NTU, indicating that the barrier was successful in isolating the turbid water from the rest of Verna Lake (Appendix A, Photo 3).

Additionally, any materials that were placed into Verna Lake during the installation of the turbidity curtain, including ropes and sandbags, were removed from the water and disposed of appropriately. In some cases, material from sandbags that had degraded due to sun exposure was disposed of in upland vegetation immediately adjacent to the turbidity curtain (Appendix A, Photo 4), since these sandbags could not be easily moved; otherwise, the sandbags were transported across the lake and the material disposed of at the location where it was originally collected. Additional sections of sediment fence that were installed along the creek were also removed and disposed of, along with any materials that were used to reinforce them (i.e., sandbags; Appendix A, Photos 5 to 8).

Post-Construction Aquatic Habitat Assessment

A post-construction aquatic habitat assessment was conducted to document any potential impacts of the Project on aquatic habitat in Verna Lake. During construction in 2015, a flow event resulted in overtopping of the turbidity curtain and minor siltation of shoreline areas immediately adjacent to the Zora Creek outlet. As such, the study area for the assessment in September 2016 included a section of the shoreline in Verna Lake encompassing 100 m on either side of the Zora Creek outlet.

During the aquatic habitat assessment, the study area was divided into habitat sections based on physical habitat characteristics. The locations of distinct habitat sections were recorded using a handheld GPS device and on a map. The upland, riparian, and littoral zones of each habitat section were described (e.g., land use, slope, depth, substrate type, etc.) and photographs were taken. General vegetation in each zone was identified and bank stability was evaluated and documented with photographs. A legend detailing the habitat descriptors is provided in Table 1.

In addition, each habitat section was rated for its suitability as spawning habitat for the fish species known to occur in the study area, including northern pike (*Esox lucius*), lake whitefish (*Coregonus clupeaformis*), and white sucker (*Catostomus commersonii*) (SRK 2014). The suitability ratings range from not suitable (0) to most or highly suitable (3) and are based on the following characteristics:

Northern Pike[1]

Not Suitable (0) — an area that does not support aquatic plant growth and predominantly consists of a rock or sand substrate;

Marginal (1) — an area supporting a sparse growth of aquatic plants, usually sedges (*Carex* sp.);

Moderate (2) — an area that supports moderate to dense aquatic plant growth; and

Most Suitable (3) — an area similar to (2) but the substrate is found in water <0.5 m in depth with little or no current and is covered with aquatic plant material, particularly "feather" moss but also senesced aquatic plants.

Lake Whitefish[2]

Not Suitable (0) — an area with an organic or silt substrate, particularly with aquatic plant debris;

Marginal (1) — an area with sand and/or silt substrate but free of aquatic plant debris;

Moderate (2) — an area with a clean cobble and boulder substrate, in <3 m of water, particularly with spaces or crevices between the rock; and

Most Suitable (3) — an area similar to (2) but found in a shoal, reef, or stream, particularly if the area has the potential for some water movement during the over-winter incubation of spawned eggs.

White Sucker[3]

Not Suitable (0) — an area with an organic, silt, or sand substrate, particularly with aquatic plant debris;

Marginal (1) — an area with a predominantly sand and/or silt substrate with some gravel and/or cobble but free of aquatic plant debris;

Moderate (2) — an area with a clean gravel and/or cobble substrate, in <0.5 m of water with some water movement; and

[1] Sources: Krochak and Crosby 1975; Inskip 1982; IES 1985, 1986a; TAEM 1987, 1988, 1989a, 1989b, 1990; Scott and Crossman 1998.
[2] Sources: Qadri 1955, 1968; IES 1985, 1986a, 1986b; TAEM 1989a, 1989b, 1993; Scott and Crossman 1998.
[3] Sources: Harris 1962; Geen et al. 1966; Edwards 1983; Twomey et al. 1984; Scott and Crossman 1998.

Most Suitable (3) an area, particularly in a stream, with a clean gravel substrate, in <0.3 m of water with good water movement due to currents.

A total of five distinct habitat sections were delineated in Verna Lake in September 2016 (Figure 1; Table 2; Appendix A, Photos 9 to 16). The upland zone near the mouth of Zora Creek was moderately to steeply sloped and vegetated with mature mixed wood forests. The riparian zone was characterized by gentle to steep slopes, and was vegetated with a mixture of trees, shrubs, grasses, and sedges, forming a stable shoreline. Water depths 5 m from shore ranged from 1.2 m to 1.8 m deep (Table 2).

The substrate in Verna Lake was variable, consisting mostly of silt/clay mixed with cobble and/or boulder throughout the study area; however, near the mouth of Zora Creek, the substrate consisted of primarily silt/clay, organic material, and sand. Cover types for fish included sparse amounts of large woody debris, sparse to moderate amounts of aquatic vegetation, and sparse amounts of overhanging vegetation. Undercut banks were also observed in one habitat section (Table 2). Aquatic vegetation consisted mostly of emergent and submergent macrophytes such as sedge (*Carex* sp.), horsetail (*Equisetum* sp.), hornwort (*Ceratophyllum* sp.), and various moss/algae species.

Verna Lake was assessed for its suitability as spawning habitat for northern pike, lake whitefish, and white sucker. Moderately suitable (2) spawning habitat for northern pike was identified in three habitat sections (HS 1, 3, and 4; Table 2). Additionally, marginally (1) suitable spawning habitat for northern pike, lake whitefish, and white sucker was found in select habitat sections throughout the Verna Lake study area (Table 2). It should be noted that these suitability ratings are similar to those recorded during a pre-construction habitat assessment of Verna Lake conducted by CanNorth in 2013 (CanNorth 2013).

As previously noted, in 2015, a flow event resulted in overtopping of the turbidity curtain and minor siltation of shoreline areas immediately adjacent to the Zora Creek outlet. Some evidence of this siltation was still evident during the aquatic habitat assessment conducted in September 2016. It should be noted that the slight siltation of the shoreline near Zora Creek is not expected to result in serious harm to fish in Verna Lake, since the impacts on fish habitat are expected to be temporary and are confined to a small area where the type of habitat is not limiting.

Closure

Sediment and erosion control measures in place at the Project site were removed during a post-construction site visit conducted in September 2016, with the exception of the outermost turbidity barrier, which will stay in place in Verna Lake to allow the site to stabilize before the barrier is removed. It is recommended that the turbidity barrier be removed from the Verna Lake in 2017 when any remaining work at the site has been completed.

I trust that this memorandum presents the information you require. Should you have any further comments or questions, please contact the undersigned.

Angela Baier

Angela Baier, B.Sc., P.Biol.
Senior Aquatic Ecologist/Project Manager

Canada North Environmental Services Limited Partnership

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FIGURES

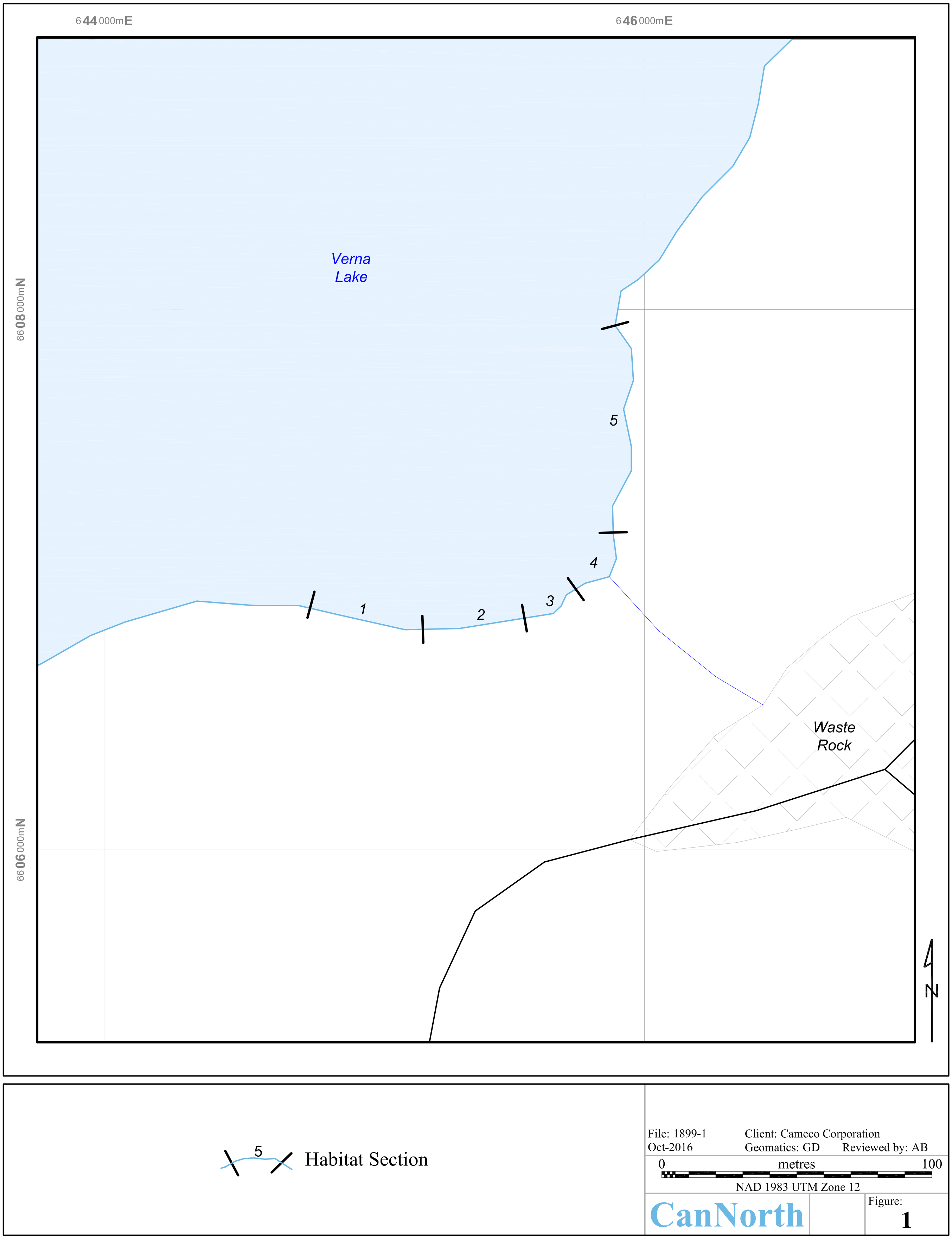

Figure 1. Location of aquatic habitat sections in Verna Lake, September 2016.

TABLES

TABLE 1

Legend for the aquatic habitat assessment in Verna Lake, September 2016.

Category	Descriptor	Symbol/Unit	Explanation
Upland Zone			
Land Use	Forest	FOR	Treed areas with a crown closure of 10% or more
	Agricultural	AG	Used primarily for the production of food and/or livestock
	Natural Grassland	NG	Dominated by grasses and other herbaceous plants
	Industrial	IND	Used primarily for industrial purposes
	Residential	RES	Areas where housing dominates
	Wetland	WL	Areas such as fens or bogs
Forest Condition	Mature	M	Features large trees forming a dense canopy
	Harvested	H	An area where >20% of the trees have been cut
	Burnt	B	A recently burned area of forest
	Regenerating	R	A burned or harvested area with new understory growth
	None	N	No forest is present
Canopy	Coniferous	C	Needle-leaved, cone-bearing trees or shrubs
	Deciduous	D	Trees or shrubs that lose their leaves seasonally
	Mixed	M	Mixture of both deciduous and coniferous species
	None	N	No forest is present
Slope	Steep	S	Slope is greater than 45^o
	Moderate	M	Slope is between 15^o and 45^o
	Gentle	G	Slope is less than 15^o
Riparian Zone			
Riparian Category	Forest to Bank	FB	Trees and shrubs extending to the bank
	Grass to Bank	GB	Grasses and sedges extending to the bank
	Wetland	WL	Riparian zone consisting of fen, bog, muskeg, etc.
Riparian Vegetation	Tree	T	>8 m tall with branches starting from central trunk
	Shrub	S	<8 m tall with branches starting from base of trunk
	Grass/Sedge	G/S	Linear leaved plants growing close to the ground
Riparian Bank Slope	Steep	S	Slope is greater than 45^o
	Moderate	M	Slope is between 15^o and 45^o
	Gentle	G	Slope is less than 15^o
Riparian Bank Stability	Stable	S	Banks well vegetated or covered with large boulders;
	Slightly Unstable	SU	>50% of banks are stable; possibly some undercut banks
	Moderately Unstable	MU	<50% of the banks are stable; lots of undercut banks
	Highly Unstable	HU	Massive bank slumping, silt deposition, exposed raw dirt

TABLE 1

Legend for the aquatic habitat assessment in Verna Lake, September 2016.

Category	Descriptor	Symbol/Unit	Explanation
Littoral Zone			
Substrate	Silt/clay Sand Gravel Cobble Boulder Bedrock Organic	%	Fine particles like mud or muck Gritty particles smaller than a ladybug (<2 cm in diameter) Ladybug to tennis ball-sized rock (2 cm to 6.5 cm in diameter) Tennis ball to basketball-sized rock (6.5 cm to 25.5 cm in diameter) Basketball to car-sized rock (25.5 cm to 400 cm in diameter) Continuous rock, bigger than a car (greater than 400 cm in diameter) Material such as decomposing plants, wood, etc.
Rock Cleanliness	-	C, S, M, D	Describe the cover of silt or algae on the rocks (C = Clean; S = Sparse <30%; M = Moderate 30% to 70%; D = Dense >70%)
Bottom Bank Slope	Steep Moderate Gentle	S M G	Slope is greater than 45^{o} Slope is between 15^{o} and 45^{o} Slope is less than 15^{o}
Cover	Large Woody Debris Aquatic Vegetation Rock Overhanging Vegetation Undercut Banks Surface Turbulence	A, S, M, D	Relative abundance of each cover type A = Absent S = Sparse distribution <30% M = Moderate distribution 30% to 70% D = Dense distribution >70%
Aquatic/Wetland Vegetation	Emergent Submergent Floating Moss/Algae	A, S, M, D	Relative abundance of each aquatic vegetation type A = Absent S = Sparse Distribution <30% M = Moderate Distribution 30% to 70% D = Dense Distribution >70%

TABLE 2

Detailed description of habitat sections delineated in Verna Lake, September 2016.

	Upland Zone				Riparian Zone				Littoral Zone																				Spawning Suitability Index		
									Substrate (%)								Cover						Aquatic/Wetland Vegetation				Bottom Slope				
Habitat Section #	Land Use	Forest Condition	Canopy	Slope	Vegetation Category	Vegetation Type	Bank Slope	Bank Stability	Silt/Clay	Sand	Gravel	Cobble	Boulder	Bedrock	Organic	Rock Cleanliness	Large Woody Debris	Aquatic Vegetation	Rock	Overhanging Vegetation	Undercut	Surface Turbulence	Emergent	Floating	Submergent	Moss/Algae	Slope	Depth 5 m from shore	Northern Pike	Lake Whitefish	White Sucker
1	FOR	M	M	M	FB	T/S/G/S	G	S	20	0	0	40	40	0	0	M	S	M	S	S	A	A	M	A	S	S	M	1.5	2	0	1
2	FOR	M	M	M	FB	T/S/G/S	G	S	40	0	0	20	30	0	10	M	S	S	S	S	A	A	S	A	S	S	M	1.5	1	0	0
3	FOR	M	M	M	FB	T/S/G/S	G	S	70	10	0	0	0	0	20	N/A	A	M	M	S	A	A	S	A	S	A	G	1.2	2	0	0
4	FOR	M	M	M	FB	T/S/G/S	G	S	20	0	0	0	50	0	30	M	A	M	S	S	S	A	M	A	S	A	G	1.5	2	0	0
5	FOR	M	M	S	FB	T/S/G/S	S	S	15	0	0	0	70	0	15	S	A	M	M	S	S	A	S	A	S	A	M	1.8	1	0	1

APPENDIX A

PHOTOGRAPHS

Photo 1. Photo showing removal of the inner turbidity curtain in Verna Lake, September 2016.

Photo 2. Photo showing re-suspension of silt and sediment in Verna Lake during removal of the inner turbidity curtain, September 2016.

Photo 3. Photo showing an upland view of the outer turbidity barrier in Verna Lake, September 2016.

Photo 4. Photo showing an example of sandbags being spoiled along the upland/shoreline of Verna Lake, September 2016.

Photo 5. Photo showing sediment fence installed in Zora Creek, September 2016.

Photo 6. Photo showing Zora Creek following removal of sediment fence and sandbags, September 2016.

Photo 7. Photo showing sediment fence installed in Zora Creek, September 2016.

Photo 8. Photo showing Zora Creek following removal of sediment fence and sandbags, September 2016.

Photo 9. Photo of Habitat Section 1 in Verna Lake, September 2016.

Photo 10. Photo of Habitat Section 1 in Verna Lake, September 2016.

Photo 11. Photo of Habitat Section 2 in Verna Lake, September 2016.

Photo 12. Photo of Habitat Section 3 in Verna Lake, September 2016.

Photo 13. Photo of Habitat Section 3 in Verna Lake, September 2016.

Photo 14. Photo of Habitat Section 4 in Verna Lake, September 2016.

Photo 15. Photo of Habitat Section 5 in Verna Lake, September 2016.

Photo 16. Photo of Habitat Section 5 in Verna Lake, September 2016.

APPENDIX E

APPENDIX E

Outside Environmental Consulting Ltd.

Memorandum
September, 30, 2016

To: Michael Webster

Reclamation Coordinator
Compliance & Licensing - SHEQ
Cameco Corporation
2121 11th Street West, Saskatoon SK S7M 1J3
Telephone: (306) 956-6784
E-mail: mike_webster@cameco.com

From: Darcy Lightle

Outside Environmental Consulting Ltd.
Biologist
Box 634, Prince Albert, SK. S6V5S2
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E-mail: dlightle@skyvelocity.ca

Subject: Concrete Pile removal in Ace Creek, near Uranium City. September 12, 2016.

Purpose:

This memo was prepared by Outside Environmental Consulting Ltd. (OEC) to provide Cameco with post construction documentation regarding the removal of concrete piles from Ace Creek, the outlet creek from Ace Lake, near Uranium City, SK.

Summary:

This memo outlines OEC's observations made during the removal of concrete piles from Ace Creek. Pile removal was completed on September 12, 2016, using a track hoe to remove the piles from the creek, and a rock truck to haul material from the site. Concrete pile removal was performed very cleanly, with each pile being removed vertically with no digging into the substrate required, and no contact with the stream bank or the stream-side vegetation. Construction monitoring of pile removal noted no concerns with respect to water quality, or with respect to other environmental risk relating to aquatic habitat.

Based on reasons stated below, it is OEC's opinion that work was performed in a manner that complied with permit requirements; and impacts to aquatic habitat were not beyond that which was either permitted, or proposed in the project proposal.

Discussion:

Background

When mining was still active in the area, the concrete piles supported a trestle bridge that conveyed a tailings pipeline across Ace Creek. The pipeline was removed during decommissioning and the trestle was removed in October 2004; however, the piles were left in place at that time (Figure 1). The piles had not been causing any noticeable environmental issues, such as flow alterations or bed or bank scour, but they had recently been identified as a potential safety concern, and were failing / crumbling to some extent. As a result Cameco decided to remove the piles from Ace Creek. The piles were located approximately 20 m upstream of a small weir that spans Ace Creek.

Outside
ENVIRONMENTAL CONSULTING LTD.

Figure 1. Piles as seen in low water, fall 2015.

Cameco planned pile removal to occur in the fall, when spawning fish were unlikely to be in the area, and mitigation//project implementation was designed to prevent impacts to the aquatic and shoreline environment. Mitigation and project considerations were outlined in a brief report to Cameco (Outside 2015), and a summary of these goals is outlined below:

- Time works to occur when spring or fall spawning fish are unlikely to be present in the creek (July 16th-Sept 30th of any year);
- Avoid removing stream bank vegetation;
- Operate machinery such that sediment is not introduced to the creek (from land) and remove the piles in a manner that minimizes the disturbance of any in-water sediment;
- Do not destabilize stream banks;
- Use clean machinery, refuel away from the creek. Prevent all fuel, grease etc. from entering the watercourse.

Monitoring Observations

Pile removal was started and completed within 30 minutes on September 12, 2016 (Figure 2). A track hoe and a rock truck were used for this work. Prior to removing the piles, a brief tailgate meeting occurred between the contractor and Outside Environmental to discuss site safety, permit conditions, and the key outcomes expected by environmental regulators.

All of the piles were able to be removed by reaching over stream bank vegetation with the back hoe, avoiding any need to remove or trim the vegetation. Piles were placed directly into a rock truck.

Floating debris that had accumulated on the weir downstream of the work area was also removed. Pieces of old docks, closed cell foam, and construction timber (such as 2x4's) from other areas on Ace Lake, were stacked up on the old weir, and were also removed without damaging any vegetation on the stream bank. This material was placed into the rock truck as well, and all debris was hauled to a Cameco/Ministry of Environment approved waste site. [Note: Additional project photos follow References.]

Turbidity Monitoring

Turbidity sampling was performed to guide in-water work in the event significant amounts of sediment was disturbed and mobilized during pile removal. Turbidity was measured in the field in Nephelometric Turbidity Units (NTU), using a Hach 2100Q turbidimeter. The turbidimeter was calibrated prior to monitoring. Sample vials were triple rinsed with sample water prior to analyzing. Samples were collected at mid-depth in the watercourse. The outside of each vial was cleaned and dried, then analyzed in the turbidimeter. Turbidity readings were recorded, along with observations of construction activities.

Turbidity measurements were taken at an upstream control location, approximately 10 m upstream of the piles/work area. Water was collected/sampled from the weir, downstream of the piles. Due to the extremely short nature of in-water work, OEC decided sampling was to be biased to catch any visible plume of sediment observed during pile removal. Results of the turbidity sampling are presented in Table 1.

Table 1. Turbidity Results during Pile Removal from Ace Creek. September 12, 2016.

Turbidity (NTU)	Time	Location	Comments
0.91	3:00 pm	10 m upstream of work site.	Control Sample
0.90	3:12 pm	At Weir	Instream work occurred ~3:10 to 3:25
0.89	3:14 pm	At Weir	
9.54	3:18 pm	At Weir	Short lived Visual plume – Left Downstream Bank
0.89	3:21 pm	At Weir	Work continues
0.83	3:25	At Weir	Work completed
0.79	3:30 pm	10 m upstream of work site	Control Sample

The Canadian Council of Ministers of the Environment (CCME 1999) protection for aquatic life guidelines indicate that for clear flowing water there should be an average maximum increase of not more than 8 NTUs from background levels for a short-term exposure (e.g., 24-h period) or not more than an average increase of 2 NTUs from background levels for a longer term exposure (e.g., 30-d period). For high flow or turbid waters, they recommend a maximum increase of 8 NTUs from background levels at any one time when background levels are between 8 and 80 NTUs and should not increase more than 10% of background levels when background is >80 NTUs.

Sampling during this program showed turbidity increased for less than 3 minutes. This measurement was taken from a narrow plume of sediment observed when one of the piles was pulled up from the creek bottom. The plume was visually gone within 1 minute of it being observed, and measurements made with the turbidity meter confirmed background levels were reached within 3 minutes of the observation. The timeframe in which this occurred is well below the 24 hr guideline recommended by the CCME.

Figure 2. Sequential photos of a pile being removed from Ace Creek. Machine does not enter the water. (OEC September 12, 2016)

Conclusion

Planning this work to occur during the open in-water work period, when fish and their habitat is least sensitive to impacts from sediment, minimized risk associated with this work. The brief discussion with the contractor prior to starting work, outlining regulatory and permit requirements was valuable in ensuring all workers on site were familiar with permit goals, and allowed the contractor to approach work in a manner that prevented significant environmental issues from occurring. Turbidity monitoring confirmed any sediment released during the instream work occurred for a very brief time (3 minutes) and is unlikely to have caused any negative affects to fish or aquatic habitat. And, finally, the removal of the piles addressed the potential safety concern Cameco had identified.

If you have any questions, or require further information, please contact the undersigned.

Yours Sincerely.

Darcy Lightle
Biologist, B.Sc.
Outside Environmental Consulting Ltd.

References

CCME. 1999. Total particulate matter. Canadian water quality guidelines for the protection of aquatic life. Canadian Environmental Quality Guidelines. Canadian Council of Ministers of the Environment, 1999. 13 pp.

Outside Environmental Consulting Ltd. 2015. Technical Memorandum to Cameco: In-water work associated with concrete pile removal on Ace Creek, near Uranium City, SK. Outside Environmental Consulting Ltd. 2015. 5 pp.

Project Photos


View of mid-channel pile being removed, and debris caught on downstream weir


Material being placed into rock truck

Floating debris being picked from downstream weir

Weir after material has been removed

Ace Creek channel after concrete piles have been removed

Ace Creek channel after concrete piles have been removed

APPENDIX F

APPENDIX F

Detailed Water Quality Results

AC-14

		12/01/16	28/02/16	20/03/16	26/04/16	25/05/16	26/06/16	26/07/16	25/08/16	25/09/16	16/10/16	13/12/16
M Ions	Alk (mg/l)	55.0	54.0	54.0	56.0	50.0	54.0	52.0	53.0	52.0	54.0	52.0
	Ca (mg/l)	17.0	18.0	18.0	20.0	16.0	16.0	16.0	18.0	18.0	17.0	17.0
	Cl (mg/l)	1.20	1.10	1.10		0.80	0.90	1.20	0.90	0.80	1.00	0.90
	CO3 (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	Cond-L (µS/cm)	123	126	129	147	110	114	120	129	123	118	122
	Hardness (mg/l)	56	60	59	65	52	53	54	58	59	56	56
	HCO3 (mg/l)	67.0	66.0	66.0	68.0	61.0	66.0	63.0	65.0	63.0	66.0	63.0
	K (mg/l)	0.8	0.7	0.6	0.6	0.8	0.7	0.9	0.9	0.8	0.7	1.0
	Na (mg/l)	1.7	1.8	1.7	2.8	1.6	1.7	1.7	2.0	1.7	1.6	1.6
	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
	SO4 (mg/l)	7.7	8.0	7.8	13.0	7.1	7.8	8.0	9.4	13.0	8.3	8.0
	Sum of Ions (mg/l)	99	100	99		90	96	94	100	101	98	96
Metal	As (µg/l)	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
	Ba (mg/l)	0.026	0.024	0.024	0.025	0.022	0.024	0.024	0.025	0.024	0.023	0.022
	Cu (mg/l)	0.0004	0.0003	0.0003	0.0004	0.0008	0.0003	0.0003	0.0004	0.0003	0.0003	0.0007
	Fe (mg/l)	0.060	0.048	0.046	0.058	0.051	0.082	0.100	0.045	0.044	0.046	0.054
	Mo (mg/l)	0.0011	0.0010	0.0010	0.0010	0.0008	0.0010	0.0010	0.0027	0.0011	0.0012	0.0010
	Ni (mg/l)	0.00020	0.00020	0.00010	0.00020	0.00030	0.00020	0.00020	0.00010	0.00020	0.00020	0.00020
	Pb (mg/l)	<0.0001	<0.0001	<0.0001	0.0002	0.0004	0.0003	0.0003	<0.0001	0.0001	0.0002	0.0002
	Se (mg/l)	0.0001	<0.0001	<0.0001	0.0004	<0.0001	0.0001	0.0001	0.0002	0.0001	0.0001	0.0001
	U (µg/l)	24.000	20.000	21.000	86.000	23.000	22.000	25.000	20.000	25.000	28.000	22.000
	Zn (mg/l)	<0.001	<0.001	<0.001	0.001	0.001	<0.001	<0.001	<0.001	0.001	<0.001	0.002
Phys Para	pH-L (pH Unit)	7.49	7.46	7.81	7.69	7.69	7.64	7.79	7.80	7.57	7.55	7.62
	TDS (mg/l)	78.00	92.00	82.00	121.00	84.00	82.00	78.00	95.00	87.00	88.00	107.00
	TSS (mg/l)	<1.000	<1.000	<1.000	<1.000	1.000	<1.000	1.000	<1.000	<1.000	1.000	<1.000
Rads	Ra226 (Bq/L)	0.020	0.030	0.030	0.030	0.030	0.050	0.060	0.060	0.040	0.040	0.030

AC-6A

		20/03/16	26/04/16	26/05/16	26/06/16	26/07/16	25/08/16	22/09/16	16/10/16	19/11/16	13/12/16
M Ions	Alk (mg/l)		108.0	106.0	113.0	102.0	99.0	101.0	108.0	110.0	114.0
	Ca (mg/l)		46.0	44.0	42.0	42.0	44.0	43.0	44.0	44.0	48.0
	Cl (mg/l)	<1.00		0.40	0.50	0.60	0.50	0.40	0.80		<1.00
	CO3 (mg/l)		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	Cond-L (µS/cm)	330	319	295	290	288	280	293	279	318	328
	Hardness (mg/l)		156	148	142	143	151	147	149	150	161
	HCO3 (mg/l)		132.0	129.0	138.0	124.0	121.0	123.0	132.0	134.0	139.0
	K (mg/l)		0.8	0.9	0.8	1.1	1.2	1.3	0.9	0.9	1.0
	Na (mg/l)		2.6	2.3	2.4	2.4	2.5	2.4	2.4	2.6	2.5
	OH (mg/l)		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	SO4 (mg/l)		53.0	49.0	48.0	48.0	51.0	51.0	51.0	51.0	52.0
	Sum of Ions (mg/l)			235	241	227	230	231	241	243	252
Metal	As (µg/l)		0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.4	0.2
	Ba (mg/l)		0.024	0.023	0.024	0.022	0.022	0.022	0.022	0.025	0.025
	Cu (mg/l)		0.0003	0.0003	<0.0002	0.0002	<0.0002	<0.0002	<0.0002	0.0003	0.0003
	Fe (mg/l)		0.006	0.010	0.019	0.016	0.013	0.007	0.007	0.002	0.009
	Mo (mg/l)		0.0010	0.0016	0.0009	0.0009	0.0011	0.0012	0.0011	0.0013	0.0012
	Ni (mg/l)		0.00010	0.00020	0.00010	0.00010	<0.00010	0.00010	<0.00010	<0.00010	<0.00010
	Pb (mg/l)		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Se (mg/l)		0.0002	0.0004	0.0002	0.0002	0.0002	0.0002	0.0002	0.0003	0.0002
	U (µg/l)		380.000	336.000	237.000	273.000	312.000	315.000	374.000	378.000	361.000
	Zn (mg/l)		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001
Phys Para	pH-L (pH Unit)		7.83	7.86	7.86	7.94	7.95	7.86	7.84	8.03	7.87
	TDS (mg/l)		192.00	196.00	190.00	184.00	190.00	192.00	192.00	196.00	218.00
	TSS (mg/l)		<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	1.000	<1.000	<1.000
Rads	Ra226 (Bq/L)		0.120	0.100	0.110	0.110	0.110	0.110	0.080	0.110	0.120

AC-8

		20/03/16	25/09/16
M Ions	Alk (mg/l)	54.0	50.0
	Ca (mg/l)	17.0	17.0
	Cl (mg/l)	0.90	0.70
	CO3 (mg/l)	<1.0	<1.0
	Cond-L (µS/cm)	126	118
	Hardness (mg/l)	56	56
	HCO3 (mg/l)	66.0	61.0
	K (mg/l)	0.6	0.6
	Na (mg/l)	1.6	1.4
	OH (mg/l)	<1.0	<1.0
	SO4 (mg/l)	7.2	7.5
	Sum of Ions (mg/l)	97	92
Metal	As (µg/l)	0.1	0.2
	Ba (mg/l)	0.023	0.023
	Cu (mg/l)	0.0002	0.0004
	Fe (mg/l)	0.046	0.033
	Mo (mg/l)	0.0010	0.0011
	Ni (mg/l)	0.00010	0.00020
	Pb (mg/l)	<0.0001	<0.0001
	Se (mg/l)	<0.0001	<0.0001
	U (µg/l)	14.000	15.000
	Zn (mg/l)	<0.001	<0.001
Phys Para	pH-L (pH Unit)	7.66	7.57
	TDS (mg/l)	87.00	84.00
	TSS (mg/l)	<1.000	<1.000
Rads	Pb210 (Bq/L)		
	Ra226 (Bq/L)	0.009	0.020

AN-3

		25/09/16
M Ions	Alk (mg/l)	66.0
	Ca (mg/l)	21.0
	Cl (mg/l)	0.60
	CO3 (mg/l)	<1.0
	Cond-L (µS/cm)	145
	Hardness (mg/l)	72
	HCO3 (mg/l)	80.0
	K (mg/l)	0.8
	Na (mg/l)	1.9
	OH (mg/l)	<1.0
	SO4 (mg/l)	4.4
	Sum of Ions (mg/l)	114
Metal	As (µg/l)	0.1
	Ba (mg/l)	0.018
	Cu (mg/l)	0.0005
	Fe (mg/l)	0.010
	Mo (mg/l)	0.0019
	Ni (mg/l)	<0.00010
	Pb (mg/l)	<0.0001
	Se (mg/l)	<0.0001
	U (µg/l)	1.700
	Zn (mg/l)	<0.001
Nutrient	NO3 (mg/l)	
Phys Para	pH-L (pH Unit)	7.66
	TDS (mg/l)	92.00
	TSS (mg/l)	<1.000
Rads	Pb210 (Bq/L)	
	Po210 (Bq/L)	
	Ra226 (Bq/L)	0.007

AN-5

		12/01/16	25/05/16	26/07/16	25/09/16	19/11/16
M Ions	Alk (mg/l)	133.0	87.0	90.0	65.0	85.0
	Ca (mg/l)	38.0	26.0	27.0	22.0	27.0
	Cl (mg/l)	1.10	0.60	0.50	0.30	0.50
	CO3 (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0
	Cond-L (µS/cm)	275	186	190	160	199
	Hardness (mg/l)	130	89	93	74	92
	HCO3 (mg/l)	162.0	106.0	110.0	79.0	104.0
	K (mg/l)	1.4	1.1	1.1	1.0	0.9
	Na (mg/l)	4.2	2.9	3.0	2.0	3.0
	OH (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0
	SO4 (mg/l)	19.0	12.0	12.0	13.0	16.0
	Sum of Ions (mg/l)	234	154	160	122	158
Metal	As (µg/l)	0.4	0.3	0.3	0.3	0.4
	Ba (mg/l)	0.150	0.100	0.110	0.086	0.110
	Cu (mg/l)	0.0008	0.0012	0.0003	0.0014	0.0022
	Fe (mg/l)	0.350	0.100	0.120	0.085	0.390
	Mo (mg/l)	0.0024	0.0034	0.0017	0.0027	0.0034
	Ni (mg/l)	0.00060	0.00060	0.00040	0.00070	0.00120
	Pb (mg/l)	<0.0001	0.0002	<0.0001	<0.0001	0.0003
	Se (mg/l)	<0.0001	<0.0001	<0.0001	0.0001	0.0001
	U (µg/l)	234.000	89.000	39.000	66.000	224.000
	Zn (mg/l)	0.001	0.001	0.001	<0.001	0.001
Phys Para	pH-L (pH Unit)	7.41	7.74	7.65	7.58	7.82
	TDS (mg/l)	167.00	126.00	124.00	117.00	135.00
	TSS (mg/l)	3.000	1.000	1.000	<1.000	<1.000
Rads	Ra226 (Bq/L)	1.400	0.560	0.660	0.360	0.450

BL-3

		20/03/16	26/06/16	25/09/16	13/12/16
M Ions	Alk (mg/l)	69.0	73.0	65.0	76.0
	Ca (mg/l)	21.0	20.0	21.0	26.0
	Cl (mg/l)	10.00	12.00	12.00	14.00
	CO3 (mg/l)	<1.0	<1.0	<1.0	<1.0
	Cond-L (µS/cm)	228	231	238	263
	Hardness (mg/l)	72	71	74	92
	HCO3 (mg/l)	84.0	89.0	79.0	93.0
	K (mg/l)	0.9	1.0	1.2	1.3
	Na (mg/l)	15.0	18.0	18.0	23.0
	OH (mg/l)	<1.0	<1.0	<1.0	<1.0
	SO4 (mg/l)	25.0	30.0	30.0	68.0
	Sum of Ions (mg/l)	161	175	167	232
Metal	As (µg/l)	0.3	0.2	0.3	0.3
	Ba (mg/l)	0.037	0.039	0.050	0.038
	Cu (mg/l)	0.0053	0.0004	0.0008	0.0006
	Fe (mg/l)	0.024	0.004	0.010	0.005
	Mo (mg/l)	0.0030	0.0035	0.0038	0.0038
	Ni (mg/l)	0.00040	0.00290	0.00220	0.00020
	Pb (mg/l)	0.0005	<0.0001	<0.0001	<0.0001
	Se (mg/l)	0.0020	0.0024	0.0024	0.0025
	U (µg/l)	112.000	129.000	129.000	140.000
	Zn (mg/l)	0.016	0.001	0.002	0.002
Phys Para	pH-L (pH Unit)	7.89	7.82	7.64	7.86
	TDS (mg/l)	134.00	136.00	134.00	172.00
	TSS (mg/l)	<1.000	<1.000	<1.000	<1.000
Rads	Ra226 (Bq/L)	0.040	0.050	0.100	0.040

BL-4

		20/03/16	25/09/16
M Ions	Alk (mg/l)	72.0	66.0
	Ca (mg/l)	21.0	21.0
	Cl (mg/l)		12.00
	CO3 (mg/l)	<1.0	<1.0
	Cond-L (µS/cm)	256	244
	Hardness (mg/l)	74	74
	HCO3 (mg/l)	88.0	80.0
	K (mg/l)	0.9	1.2
	Na (mg/l)	19.0	18.0
	OH (mg/l)	<1.0	<1.0
	SO4 (mg/l)	32.0	31.0
	Sum of Ions (mg/l)	179	169
Metal	As (µg/l)	0.3	0.3
	Ba (mg/l)	0.036	0.035
	Cu (mg/l)	0.0009	0.0011
	Fe (mg/l)	0.006	0.007
	Mo (mg/l)	0.0038	0.0036
	Ni (mg/l)	0.00020	0.00600
	Pb (mg/l)	<0.0001	<0.0001
	Se (mg/l)	0.0026	0.0024
	U (µg/l)	138.000	128.000
	Zn (mg/l)	0.003	0.002
Phys Para	pH-L (pH Unit)	7.96	7.89
	TDS (mg/l)		134.00
	TSS (mg/l)	<1.000	<1.000
Rads	Po210 (Bq/L)		
	Ra226 (Bq/L)	0.040	0.040

BL-5

		20/03/16	26/06/16	25/09/16	13/12/16
M Ions	Alk (mg/l)	75.0	72.0	63.0	69.0
	Ca (mg/l)	22.0	20.0	20.0	21.0
	Cl (mg/l)	14.00	12.00	12.00	12.00
	CO3 (mg/l)	<1.0	<1.0	<1.0	<1.0
	Cond-L (µS/cm)	266	230	237	243
	Hardness (mg/l)	78	71	71	74
	HCO3 (mg/l)	92.0	88.0	77.0	84.0
	K (mg/l)	0.9	1.0	1.0	1.1
	Na (mg/l)	20.0	18.0	18.0	18.0
	OH (mg/l)	<1.0	<1.0	<1.0	<1.0
	SO4 (mg/l)	33.0	30.0	52.0	31.0
	Sum of Ions (mg/l)	188	174	185	172
Metal	As (µg/l)	0.2	0.2	0.3	0.2
	Ba (mg/l)	0.038	0.033	0.035	0.034
	Cu (mg/l)	<0.0002	<0.0002	<0.0002	<0.0002
	Fe (mg/l)	0.001	0.005	0.007	0.006
	Mo (mg/l)	0.0039	0.0034	0.0036	0.0035
	Ni (mg/l)	0.00020	0.00020	0.00030	0.00020
	Pb (mg/l)	<0.0001	<0.0001	<0.0001	<0.0001
	Se (mg/l)	0.0028	0.0025	0.0024	0.0023
	U (µg/l)	145.000	128.000	130.000	127.000
	Zn (mg/l)	<0.001	<0.001	<0.001	<0.001
Nutrient	NO3 (mg/l)				
Phys Para	pH-L (pH Unit)	7.93	7.76	7.58	7.87
	TDS (mg/l)	152.00	133.00	130.00	160.00
	TSS (mg/l)	<1.000	<1.000	<1.000	<1.000
Rads	Po210 (Bq/L)				
	Ra226 (Bq/L)	0.030	0.020	0.040	0.030

CS-1

		25/09/16
M Ions	Alk (mg/l)	59.0
	Ca (mg/l)	19.0
	Cl (mg/l)	6.40
	CO3 (mg/l)	<1.0
	Cond-L (µS/cm)	178
	Hardness (mg/l)	65
	HCO3 (mg/l)	72.0
	K (mg/l)	1.1
	Na (mg/l)	9.6
	OH (mg/l)	<1.0
	SO4 (mg/l)	16.0
	Sum of Ions (mg/l)	128
Metal	As (µg/l)	0.2
	Ba (mg/l)	0.042
	Cu (mg/l)	<0.0002
	Fe (mg/l)	0.037
	Mo (mg/l)	0.0019
	Ni (mg/l)	<0.00010
	Pb (mg/l)	<0.0001
	Se (mg/l)	0.0009
	U (µg/l)	52.000
	Zn (mg/l)	<0.001
Nutrient	NO3 (mg/l)	
Phys Para	pH-L (pH Unit)	7.67
	TDS (mg/l)	109.00
	TSS (mg/l)	1.000
Rads	Pb210 (Bq/L)	
	Po210 (Bq/L)	
	Ra226 (Bq/L)	0.010

CS-2

		25/09/16
M Ions	Alk (mg/l)	38.0
	Ca (mg/l)	12.0
	Cl (mg/l)	4.70
	CO3 (mg/l)	<1.0
	Cond-L (µS/cm)	116
	Hardness (mg/l)	43
	HCO3 (mg/l)	46.0
	K (mg/l)	0.9
	Na (mg/l)	5.6
	OH (mg/l)	<1.0
	SO4 (mg/l)	9.0
	Sum of Ions (mg/l)	81
Metal	As (µg/l)	0.2
	Ba (mg/l)	0.024
	Cu (mg/l)	0.0002
	Fe (mg/l)	0.022
	Mo (mg/l)	0.0010
	Ni (mg/l)	<0.00010
	Pb (mg/l)	<0.0001
	Se (mg/l)	0.0004
	U (µg/l)	21.000
	Zn (mg/l)	0.001
Phys Para	pH-L (pH Unit)	7.41
	TDS (mg/l)	71.00
	TSS (mg/l)	<1.000
Rads	Pb210 (Bq/L)	
	Po210 (Bq/L)	
	Ra226 (Bq/L)	0.007

DB-6

		12/01/16	20/03/16	25/05/16	26/07/16	25/09/16	19/11/16
M Ions	Alk (mg/l)	98.0	96.0	89.0	88.0	80.0	89.0
	Ca (mg/l)	36.0	36.0	32.0	35.0	33.0	35.0
	Cl (mg/l)	0.90	0.70	0.60	0.50	0.40	0.60
	CO3 (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	Cond-L (µS/cm)	244	246	201	217	205	220
	Hardness (mg/l)	112	112	100	109	102	109
	HCO3 (mg/l)	120.0	117.0	108.0	107.0	98.0	108.0
	K (mg/l)		0.6	0.8	1.0	0.8	0.7
	Na (mg/l)	2.2	2.2	1.9	2.0	1.8	2.1
	OH (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	SO4 (mg/l)	25.0	25.0	21.0	23.0	20.0	23.0
	Sum of Ions (mg/l)	191	187	169	174	159	175
Metal	As (µg/l)	0.1	0.2	0.1	0.1	0.1	0.1
	Ba (mg/l)	0.050	0.050	0.042	0.044	0.040	0.044
	Cu (mg/l)	0.0005	0.0013	0.0010	0.0006	0.0006	0.0006
	Fe (mg/l)	0.013	0.024	0.014	0.019	0.022	0.016
	Mo (mg/l)	0.0021	0.0020	0.0018	0.0020	0.0020	0.0019
	Ni (mg/l)	0.00020	0.00030	0.00030	0.00020	0.00020	0.00020
	Pb (mg/l)	<0.0001	0.0002	<0.0001	<0.0001	<0.0001	<0.0001
	Se (mg/l)	<0.0001	0.0001	<0.0001	<0.0001	0.0001	0.0001
	U (µg/l)	190.000	162.000	150.000	186.000	110.000	156.000
	Zn (mg/l)	<0.001	0.003	0.001	<0.001	<0.001	0.001
Phys Para	pH-L (pH Unit)	7.63	7.74	7.91	7.91	7.72	8.01
	TDS (mg/l)	156.00	162.00	143.00	145.00	132.00	141.00
	TSS (mg/l)	<1.000	<1.000	1.000	1.000	<1.000	<1.000
Rads	Ra226 (Bq/L)	0.040	0.060	0.040	0.030	0.040	0.030

ML-1

		20/03/16	26/06/16	25/09/16	13/12/16
M Ions	Alk (mg/l)	66.0	66.0	56.0	68.0
	Ca (mg/l)	20.0	20.0	19.0	21.0
	Cl (mg/l)	4.10	7.30	6.20	6.70
	CO3 (mg/l)	<1.0	<1.0	<1.0	<1.0
	Cond-L (µS/cm)	168	180	174	193
	Hardness (mg/l)	67	68	65	72
	HCO3 (mg/l)	80.0	80.0	68.0	83.0
	K (mg/l)	1.0	1.0	1.1	0.8
	Na (mg/l)	5.5	11.0	9.3	10.0
	OH (mg/l)	<1.0	<1.0	<1.0	<1.0
	SO4 (mg/l)	10.0	19.0	16.0	17.0
	Sum of Ions (mg/l)	125	143	124	144
Metal	As (µg/l)	0.2	0.2	0.2	0.2
	Ba (mg/l)	0.045	0.041	0.040	0.045
	Cu (mg/l)	0.0016	<0.0002	<0.0002	0.0008
	Fe (mg/l)	0.025	0.010	0.011	0.017
	Mo (mg/l)	0.0010	0.0020	0.0018	0.0019
	Ni (mg/l)	0.00020	0.00020	<0.00010	0.00020
	Pb (mg/l)	0.0002	<0.0001	<0.0001	<0.0001
	Se (mg/l)	0.0004	0.0010	0.0008	0.0010
	U (µg/l)	22.000	59.000	52.000	57.000
	Zn (mg/l)	0.005	<0.001	0.001	0.001
Nutrient	NO3 (mg/l)				0.240
Phys Para	pH-L (pH Unit)	7.65	7.78	7.56	7.83
	TDS (mg/l)	113.00	108.00	107.00	129.00
	TSS (mg/l)	2.000	1.000	<1.000	2.000
Rads	Po210 (Bq/L)				
	Ra226 (Bq/L)	0.010	0.008	0.010	0.006

TL-3

		20/03/16	26/06/16	25/09/16	13/12/16
M Ions	Alk (mg/l)	141.0	136.0	124.0	130.0
	Ca (mg/l)	30.0	26.0	28.0	32.0
	Cl (mg/l)	3.00	2.60	3.00	2.10
	CO3 (mg/l)	<1.0	<1.0	<1.0	<1.0
	Cond-L (µS/cm)	342	294	301	298
	Hardness (mg/l)	99	86	93	108
	HCO3 (mg/l)	172.0	166.0	151.0	159.0
	K (mg/l)	1.0	1.0	1.2	1.4
	Na (mg/l)	34.0	31.0	31.0	21.0
	OH (mg/l)	<1.0	<1.0	<1.0	<1.0
	SO4 (mg/l)	33.0	31.0	31.0	24.0
	Sum of Ions (mg/l)	279	263	251	246
Metal	As (µg/l)	0.9	0.8	0.8	0.6
	Ba (mg/l)	0.040	0.035	0.037	0.036
	Cu (mg/l)	0.0017	0.0008	0.0009	0.0017
	Fe (mg/l)	0.010	0.013	0.016	0.024
	Mo (mg/l)	0.0140	0.0120	0.0120	0.0096
	Ni (mg/l)	0.00040	0.00030	<0.00010	0.00040
	Pb (mg/l)	0.0006	0.0005	0.0007	0.0005
	Se (mg/l)	0.0028	0.0024	0.0023	0.0017
	U (µg/l)	293.000	261.000	254.000	184.000
	Zn (mg/l)	0.006	<0.001	<0.001	0.002
Phys Para	pH-L (pH Unit)	8.13	8.08	8.00	7.98
	TDS (mg/l)	217.00	188.00	181.00	208.00
	TSS (mg/l)	<1.000	<1.000	<1.000	1.000
Rads	Ra226 (Bq/L)	1.400	1.200	1.300	0.780

TL-4

		20/03/16	26/06/16	25/09/16	13/12/16
M Ions	Alk (mg/l)	142.0	125.0	108.0	135.0
	Ca (mg/l)	26.0	21.0	22.0	25.0
	Cl (mg/l)	3.00	2.40	2.50	3.00
	CO3 (mg/l)	<1.0	<1.0	<1.0	<1.0
	Cond-L (µS/cm)	342	278	285	319
	Hardness (mg/l)	89	74	78	87
	HCO3 (mg/l)	173.0	152.0	132.0	165.0
	K (mg/l)	1.1	1.0	1.2	1.3
	Na (mg/l)	38.0	33.0	33.0	34.0
	OH (mg/l)	<1.0	<1.0	<1.0	<1.0
	SO4 (mg/l)	31.0	27.0	29.0	29.0
	Sum of Ions (mg/l)	278	242	225	263
Metal	As (µg/l)	1.3	1.1	1.0	1.1
	Ba (mg/l)	0.075	0.065	0.068	0.077
	Cu (mg/l)	0.0009	0.0004	0.0005	0.0007
	Fe (mg/l)	0.096	0.045	0.019	0.078
	Mo (mg/l)	0.0110	0.0098	0.0097	0.0099
	Ni (mg/l)	0.00060	0.00050	0.00030	0.00060
	Pb (mg/l)	0.0005	0.0004	0.0002	0.0007
	Se (mg/l)	0.0021	0.0015	0.0015	0.0017
	U (µg/l)	276.000	217.000	208.000	240.000
	Zn (mg/l)	<0.001	<0.001	<0.001	<0.001
Phys Para	pH-L (pH Unit)	8.06	8.16	7.93	8.05
	TDS (mg/l)	220.00	177.00	172.00	221.00
	TSS (mg/l)	<1.000	1.000	<1.000	<1.000
Rads	Ra226 (Bq/L)	1.900	1.600	1.300	1.600

TL-6

		25/05/16	25/09/16
M Ions	Alk (mg/l)	289.0	231.0
	Ca (mg/l)	66.0	55.0
	Cl (mg/l)	35.00	28.00
	CO3 (mg/l)	<1.0	<1.0
	Cond-L (µS/cm)	784	671
	Hardness (mg/l)	222	191
	HCO3 (mg/l)	352.0	282.0
	K (mg/l)	2.1	2.0
	Na (mg/l)	91.0	84.0
	OH (mg/l)	<1.0	<1.0
	SO4 (mg/l)	77.0	67.0
	Sum of Ions (mg/l)	637	531
Metal	As (µg/l)	1.4	1.4
	Ba (mg/l)	1.040	0.840
	Cu (mg/l)	0.0008	0.0006
	Fe (mg/l)	0.610	0.510
	Mo (mg/l)	0.0021	0.0019
	Ni (mg/l)	0.00060	0.00030
	Pb (mg/l)	0.0004	0.0002
	Se (mg/l)	0.0020	0.0021
	U (µg/l)	319.000	258.000
	Zn (mg/l)	0.001	0.001
Phys Para	pH-L (pH Unit)	7.77	8.22
	TDS (mg/l)	504.00	440.00
	TSS (mg/l)	2.000	<1.000
Rads	Ra226 (Bq/L)	6.200	5.900

TL-7

		12/01/16	04/05/16	25/05/16	26/06/16	26/07/16	25/08/16	25/09/16	16/10/16	19/11/16	13/12/16
M Ions	Alk (mg/l)	142.0	63.0	135.0	132.0	129.0	129.0	109.0	132.0	135.0	139.0
	Ca (mg/l)	24.0	14.0	27.0	22.0	21.0	23.0	23.0	24.0	25.0	26.0
	Cl (mg/l)	3.00		4.00	3.50	3.40	9.60	3.80	4.10	3.00	4.00
	CO3 (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	Cond-L (µS/cm)	339	141	306	290	291	312	294	284	313	341
	Hardness (mg/l)	84	46	90	77	74	84	82	84	86	90
	HCO3 (mg/l)	173.0	77.0	165.0	161.0	157.0	157.0	133.0	161.0	165.0	170.0
	K (mg/l)	1.3	0.8	1.3	0.8	1.2	1.3	1.3	1.2	1.2	1.6
	Na (mg/l)	39.0	11.0	34.0	34.0	35.0	38.0	34.0	33.0	35.0	36.0
	OH (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	SO4 (mg/l)	31.0	10.0	26.0	26.0	22.0	24.0	27.0	27.0	28.0	31.0
	Sum of Ions (mg/l)	277		263	253	245	259	228	256	263	275
Metal	As (µg/l)	1.2	1.0	0.9	1.3	1.4	1.1	0.9	0.9	0.9	
	Ba (mg/l)	0.100	0.130	0.140	0.200	0.430	0.470	0.140	0.120	0.120	
	Cu (mg/l)	0.0010	0.0020	0.0009	0.0003	0.0003	<0.0002	0.0005	0.0005	0.0005	
	Fe (mg/l)	0.021	0.260	0.025	0.084	0.077	0.054	0.024	0.014	0.015	
	Mo (mg/l)	0.0110	0.0035	0.0093	0.0082	0.0061	0.0068	0.0091	0.0093	0.0094	
	Ni (mg/l)	0.00060	0.00110	0.00060	0.00050	0.00040	0.00040	0.00020	0.00050	0.00050	
	Pb (mg/l)	0.0002	0.0005	0.0002	0.0002	0.0001	<0.0001	0.0001	0.0002	0.0002	
	Se (mg/l)	0.0022	0.0016	0.0013	0.0013	0.0012	0.0012	0.0015	0.0014	0.0018	
	U (µg/l)	303.000	67.000	218.000	168.000	118.000	153.000	193.000	244.000	239.000	
	Zn (mg/l)	0.004	0.001	0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	
Phys Para	pH-L (pH Unit)	7.86	7.46	8.02	7.90	7.94	8.01	7.96	7.96	8.05	7.90
	TDS (mg/l)	202.00	108.00	191.00	192.00	187.00	203.00	181.00	182.00	194.00	241.00
	TSS (mg/l)	<1.000	2.000	<1.000	<1.000	<1.000	<1.000	<1.000	1.000	<1.000	
Rads	Ra226 (Bq/L)	1.800	1.500	1.500	1.900	2.300	1.700	1.300	1.200	1.300	

TL-9

		12/01/16	28/02/16	20/03/16	26/04/16	25/05/16	26/06/16	26/07/16	25/08/16	25/09/16	16/10/16	13/12/16
M Ions	Alk (mg/l)		149.0	147.0	138.0	131.0	130.0	113.0	111.0	108.0	125.0	136.0
	Ca (mg/l)	24.0	28.0	27.0	29.0	26.0	23.0	17.0	18.0	24.0	23.0	27.0
	Cl (mg/l)		4.00	4.00		4.10	4.00	4.90	4.70	4.70	4.40	4.00
	CO3 (mg/l)		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	Cond-L (µS/cm)		356	352	331	292	282	269	261	290	273	328
	Hardness (mg/l)	86	97	94	102	88	81	64	70	87	83	95
	HCO3 (mg/l)		182.0	179.0	168.0	160.0	159.0	138.0	135.0	132.0	152.0	166.0
	K (mg/l)	1.3	1.2	1.2	1.2	1.2	1.1	1.3	1.4	1.3	1.2	1.5
	Na (mg/l)	38.0	41.0	39.0	39.0	30.0	31.0	32.0	33.0	31.0	30.0	33.0
	OH (mg/l)		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	SO4 (mg/l)	28.0	32.0	30.0	30.0	21.0	23.0	22.0	22.0	23.0	24.0	28.0
	Sum of Ions (mg/l)	98	295	287		248	247	221	220	223	241	266
Metal	As (µg/l)	1.3	1.1	1.0	1.1	1.0	1.6	2.5	1.5	1.0	0.9	0.9
	Ba (mg/l)	0.390	0.280	0.280	0.280	0.520	0.540	0.600	0.620	0.600	0.490	0.320
	Cu (mg/l)	0.0006	0.0007	0.0005	0.0006	0.0006	0.0005	0.0006	<0.0002	0.0004	0.0003	0.0005
	Fe (mg/l)	0.017	0.014	0.011	0.026	0.023	0.083	0.240	0.067	0.022	0.024	0.026
	Mo (mg/l)	0.0100	0.0100	0.0100	0.0091	0.0065	0.0074	0.0069	0.0068	0.0079	0.0081	0.0089
	Ni (mg/l)	0.00050	0.00050	0.00040	0.00050	0.00050	0.00050	0.00060	0.00030	0.00020	0.00040	0.00040
	Pb (mg/l)	0.0002	0.0002	0.0001	0.0002	<0.0001	0.0011	0.0037	0.0007	0.0001	0.0002	0.0003
	Se (mg/l)	0.0028	0.0025	0.0022	0.0023	0.0015	0.0018	0.0020	0.0020	0.0018	0.0018	0.0019
	U (µg/l)	296.000	286.000	276.000	282.000	150.000	166.000	131.000	133.000	161.000	195.000	237.000
	Zn (mg/l)	<0.001	0.001	<0.001	<0.001	<0.001	0.002	0.001	<0.001	<0.001	<0.001	0.001
Phys Para	pH-L (pH Unit)		7.80	8.08	7.99	8.21	8.07	8.04	8.11	7.94	8.01	7.97
	TDS (mg/l)		226.00	223.00	204.00	180.00	180.00	177.00	169.00	175.00	179.00	228.00
	TSS (mg/l)		<1.000	<1.000	<1.000	<1.000	2.000	6.000	<1.000	<1.000	1.000	<1.000
Rads	Ra226 (Bq/L)	1.600	1.500	1.600	1.300	2.100	2.200	2.900	2.700	2.400	1.800	1.400

ZOR-1

		20/03/16	26/04/16	25/05/16	26/06/16	26/07/16	25/08/16	22/09/16	16/10/16	19/11/16	13/12/16
M Ions	Alk (mg/l)	113.0	104.0	97.0	102.0	98.0	96.0	99.0	103.0	109.0	106.0
	Ca (mg/l)	35.0	33.0	32.0	30.0	31.0	32.0	32.0	33.0	33.0	34.0
	Cl (mg/l)	5.00		0.30	0.30	0.80	0.30	0.30	0.60	0.30	0.30
	CO3 (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	Cond-L (µS/cm)	248	240	212	214	217	215	223	214	235	243
	Hardness (mg/l)	124	117	113	106	109	114	114	116	117	120
	HCO3 (mg/l)	138.0	127.0	118.0	124.0	120.0	117.0	121.0	126.0	133.0	129.0
	K (mg/l)	0.7	0.6	0.8	0.7	0.9	1.0	1.0	0.8	0.7	0.8
	Na (mg/l)	1.9	1.9	1.8	1.7	1.7	1.8	1.7	1.8	2.2	1.8
	OH (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	SO4 (mg/l)	20.0	19.0	18.0	18.0	18.0	19.0	19.0	19.0	21.0	20.0
	Sum of Ions (mg/l)	210		179	182	180	180	183	190	199	194
Metal	As (µg/l)	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
	Ba (mg/l)	0.025	0.025	0.022	0.023	0.022	0.021	0.022	0.023	0.024	0.024
	Cu (mg/l)	<0.0002	<0.0002	0.0009	0.0004	0.0008	0.0009	<0.0002	0.0006	0.0009	0.0005
	Fe (mg/l)	0.011	0.010	0.011	0.003	0.008	0.008	0.007	0.009	0.007	0.006
	Mo (mg/l)	0.0008	0.0008	0.0008	0.0011	0.0009	0.0009	0.0009	0.0009	0.0009	0.0010
	Ni (mg/l)	0.00020	0.00010	0.00030	0.00020	0.00020	0.00020	0.00060	0.00020	0.00020	0.00020
	Pb (mg/l)	<0.0001	<0.0001	0.0002	<0.0001	<0.0001	0.0002	<0.0001	<0.0001	<0.0001	<0.0001
	Se (mg/l)	0.0001	0.0002	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0002
	U (µg/l)	18.000	17.000	14.000	7.700	15.000	15.000	15.000	14.000	14.000	16.000
	Zn (mg/l)	<0.001	<0.001	0.001	<0.001	0.001	0.002	<0.001	0.001	0.002	0.002
Phys Para	pH-L (pH Unit)	7.73	7.67	8.01	7.97	8.11	8.12	7.95	7.81	8.01	7.79
	TDS (mg/l)	150.00	141.00	141.00	142.00	141.00	143.00	142.00	143.00	141.00	197.00
	TSS (mg/l)	1.000	10.000	2.000	1.000	<1.000	<1.000	1.000	2.000	1.000	<1.000
Rads	Ra226 (Bq/L)	0.020	0.020	0.020	0.020	0.020	0.030	0.030	0.030	0.010	0.020

ZOR-2

		20/03/16	26/04/16	25/05/16	26/06/16	26/07/16	25/08/16	22/09/16	16/10/16	19/11/16	13/12/16
M Ions	Alk (mg/l)	110.0	100.0	106.0	109.0	111.0	114.0	103.0	106.0	114.0	112.0
	Ca (mg/l)	35.0	35.0	37.0	39.0	42.0	68.0	36.0	39.0	39.0	41.0
	Cl (mg/l)	<1.00		0.40	0.40	0.40	0.70	0.30	0.70	0.40	0.40
	CO3 (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	Cond-L (µS/cm)	251	247	254	268	290	406	250	250	272	284
	Hardness (mg/l)	123	121	128	133	142	219	126	135	135	141
	HCO3 (mg/l)	134.0	122.0	129.0	133.0	135.0	139.0	126.0	129.0	139.0	137.0
	K (mg/l)	0.7	0.6	0.8	0.8	1.1	1.3	0.8	0.9	0.7	0.9
	Na (mg/l)	2.0	1.8	2.0	2.1	2.2	2.7	1.9	2.0	2.1	2.1
	OH (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	SO4 (mg/l)	21.0	26.0	28.0	39.0	45.0	110.0	30.0	39.0	34.0	34.0
	Sum of Ions (mg/l)	202		206	224	235	335	204	220	225	225
Metal	As (µg/l)	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.2	0.2	0.2
	Ba (mg/l)	0.026	0.030	0.024	0.032	0.031	0.036	0.024	0.024	0.026	0.025
	Cu (mg/l)	0.0004	0.0010	0.0017	0.0017	0.0023	0.0022	0.0049	0.0010	0.0013	0.0021
	Fe (mg/l)	0.034	0.150	0.077	0.120	0.300	0.320	0.074	0.120	0.098	0.085
	Mo (mg/l)	0.0010	0.0009	0.0012	0.0018	0.0020	0.0037	0.0015	0.0014	0.0012	0.0012
	Ni (mg/l)	0.00020	0.00030	0.00030	0.00020	0.00040	0.00040	0.00020	0.00020	0.00020	0.00020
	Pb (mg/l)	<0.0001	0.0002	0.0002	0.0004	0.0002	0.0003	0.0004	<0.0001	0.0001	0.0002
	Se (mg/l)	0.0001	0.0003	0.0002	0.0003	0.0003	0.0006	0.0002	0.0002	0.0002	0.0002
	U (µg/l)	39.000	133.000	179.000	258.000	374.000	1220.000	163.000	242.000	214.000	187.000
	Zn (mg/l)	<0.001	0.003	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Phys Para	pH-L (pH Unit)	7.90	7.79	8.02	7.92	8.04	7.96	7.93	7.90	8.02	7.88
	TDS (mg/l)	152.00	149.00	157.00	176.00	188.00	304.00	155.00	171.00	172.00	207.00
	TSS (mg/l)	<1.000	2.000	1.000	1.000	1.000	2.000	1.000	1.000	1.000	2.000
Rads	Ra226 (Bq/L)	0.060	0.080	0.140	0.220	0.280	0.640	0.220	0.190	0.160	0.200

APPENDIX G

APPENDIX G

Beaverlodge Operation
Quality Control/Quality Assurance for Environmental Sample Analysis

Parent Field	Station: AC-14				Child Field	Station: Blind-1				
Date: 2016/05/25					Date: 2016/05/25					
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	10.0	Alk	50.0	Acid Titration	1.0	20.0	0.0
As	0.2	ICP-MS	0.1	0.1	As	0.2	ICP-MS	0.1	0.1	0.0
Ba	0.022	ICP-MS	0.001	0.003	Ba	0.023	ICP-MS	0.001	0.003	4.444
CO3	< 1.0	Acid Titration	1.0		CO3	< 1.0	Acid Titration	1.0		0.0
Ca	16.0	ICP-OES	0.1	2.0	Ca	16.0	ICP-OES	0.1	2.0	0.0
Cl	0.80	Ion Chromatograph y	0.10	0.10	Cl	0.90	Ion Chromatograph y	0.10	0.10	11.76
Cond-F	116				Cond-F	116				0
Cond-L	110	Conductivity Meter	1	7	Cond-L	110	Conductivity Meter	1	7	0
Cu	0.0008	ICP-MS	0.0002	0.0003	Cu	0.0008	ICP-MS	0.0002	0.0003	0.0000
Fe	0.051	ICP-MS	0.001	0.005	Fe	0.052	ICP-MS	0.001	0.005	1.942
HCO3	61.0	Acid Titration	1.0	9.0	HCO3	61.0	Acid Titration	1.0	9.0	0.0
Hardness	52	Calculated	1	8	Hardness	53	Calculated	1	8	2
K	0.8	ICP-OES	0.1	0.3	K	0.8	ICP-OES	0.1	0.3	0.0
Mo	0.0008	ICP-MS	0.0001	0.0003	Mo	0.0009	ICP-MS	0.0001	0.0003	11.7647
Na	1.6	ICP-OES	0.1	0.4	Na	1.6	ICP-OES	0.1	0.4	0.0
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	0.0004	ICP-MS	0.0001	0.0001	Pb	0.0004	ICP-MS	0.0001	0.0001	0.0000
Ra226	0.030	Alpha Septroscopy	0.005	0.010	Ra226	0.040	Alpha Septroscopy	0.005	0.020	28.571
SO4	7.1	ICP-OES	0.2	1.0	SO4	7.4	ICP-OES	0.2	1.0	4.1
Se	< 0.0001	ICP-MS	0.0001		Se	< 0.0001	ICP-MS	0.0001		0.0000
Sum of Ions	90	Calculated	1	10	Sum of Ions	91	Calculated	1	10	1
TDS	84.00	Gravimetric	5.00	10.00	TDS	83.00	Gravimetric	5.00	10.00	1.20
TSS	1.000	Gravimetric	1.000	1.000	TSS	< 1.000	Gravimetric	1.000		0.000
Temp-H20	11.3				Temp-H20	11.3				0.0
U	23.000	ICP-MS	0.100	2.000	U	24.000	ICP-MS	0.100	2.000	4.255
Zn	0.001	ICP-MS	0.001	0.001	Zn	0.001	ICP-MS	0.001	0.001	18.182
pH-F	7.6900	pH Meter	0.0700	0.1000	pH-F	7.7000	pH Meter	0.0700	0.1000	0.1300
pH-L	7.69	pH Meter	0.07	0.10	pH-L	7.70	pH Meter	0.07	0.10	0.13

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

Parent Field **Station: AC-6A**

Date: 2016/07/26

Assigned: SRC Lab

Parameter	Value	Method	Entered DL	Entered Uncertainty
Alk	102.0	Acid Titration	1.0	20.0
As	0.2	ICP-MS	0.1	0.1
Ba	0.022	ICP-MS	0.001	0.003
CO3	< 1.0	Acid Titration	1.0	
Ca	42.0	ICP-OES	0.1	4.0
Cl	0.60	Ion Chromatograph y	0.10	0.10
Cond-F	345			
Cond-L	288	Conductivity Meter	1	10
Cu	0.0002	ICP-MS	0.0002	0.0002
Fe	0.016	ICP-MS	0.001	0.002
HCO3	124.0	Acid Titration	1.0	10.0
Hardness	143	Calculated	1	10
K	1.1	ICP-OES	0.1	0.3
Mo	0.0009	ICP-MS	0.0001	0.0003
NO3	< 0.040	Automated Hydrazine Reduction	0.040	
Na	2.4	ICP-OES	0.1	0.4
Ni	0.00010	ICP-MS	0.00010	0.00010
OH	< 1.0	Acid Titration	1.0	
Pb	< 0.0001	ICP-MS	0.0001	
Ra226	0.110	Alpha Septroscopy	0.005	0.020
SO4	48.0	ICP-OES	0.2	5.0
Se	0.0002	ICP-MS	0.0001	0.0001
Sum of Ions	227	Calculated	1	20
TDS	184.00	Gravimetric	5.00	20.00
TSS	< 1.000	Gravimetric	1.000	
Temp-H20	23.4			
U	273.000	ICP-MS	0.100	30.000
Zn	< 0.001	ICP-MS	0.001	
pH-F	7.9400	pH Meter	0.0700	0.1000
pH-L	7.94	pH Meter	0.07	0.10

Child Field **Station: Blind-3**

Date: 2016/07/26

Assigned: SRC Lab

Parameter	Value	Method	Entered DL	Entered Uncertainty	% Absolute Difference
Alk	102.0	Acid Titration	1.0	20.0	0.0
As	0.2	ICP-MS	0.1	0.1	0.0
Ba	0.022	ICP-MS	0.001	0.003	0.000
CO3	< 1.0	Acid Titration	1.0		0.0
Ca	41.0	ICP-OES	0.1	4.0	2.4
Cl	0.60	Ion Chromatograph y	0.10	0.10	0.00
Cond-F	345				0
Cond-L	289	Conductivity Meter	1	10	0
Cu	0.0002	ICP-MS	0.0002	0.0002	0.0000
Fe	0.016	ICP-MS	0.001	0.002	0.000
HCO3	124.0	Acid Titration	1.0	10.0	0.0
Hardness	140	Calculated	1	10	2
K	1.1	ICP-OES	0.1	0.3	0.0
Mo	0.0010	ICP-MS	0.0001	0.0002	10.5263
NO3	< 0.040	Automated Hydrazine Reduction	0.040		0.000
Na	2.4	ICP-OES	0.1	0.4	0.0
Ni	0.00010	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	0.130	Alpha Septroscopy	0.005	0.020	16.667
SO4	47.0	ICP-OES	0.2	5.0	2.1
Se	0.0002	ICP-MS	0.0001	0.0001	0.0000
Sum of Ions	225	Calculated	1	20	1
TDS	186.00	Gravimetric	5.00	20.00	1.08
TSS	< 1.000	Gravimetric	1.000		0.000
Temp-H20	22.4				4.4
U	278.000	ICP-MS	0.100	30.000	1.815
Zn	< 0.001	ICP-MS	0.001		0.000
pH-F	7.9700	pH Meter	0.0700	0.1000	0.3771
pH-L	7.97	pH Meter	0.07	0.10	0.38

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

Parent Field	Station: DB-6				Child Field	Station: Blind-2				
Date: 2016/05/25					Date: 2016/05/25					
Assigned: SRC Lab					Assigned: SRC Lab					
Parameter	**Value**	**Method**	**Entered DL**	**Entered Uncertainty**	**Parameter**	**Value**	**Method**	**Entered DL**	**Entered Uncertainty**	**% Absolute Difference**
Alk	89.0	Acid Titration	1.0	20.0	Alk	84.0	Acid Titration	1.0	20.0	5.8
As	0.1	ICP-MS	0.1	0.1	As	0.1	ICP-MS	0.1	0.1	0.0
Ba	0.042	ICP-MS	0.001	0.006	Ba	0.042	ICP-MS	0.001	0.006	0.000
CO3	< 1.0	Acid Titration	1.0		CO3	< 1.0	Acid Titration	1.0		0.0
Ca	32.0	ICP-OES	0.1	3.0	Ca	35.0	ICP-OES	0.1	4.0	9.0
Cl	0.60	Ion Chromatograph y	0.10	0.10	Cl	0.60	Ion Chromatograph y	0.10	0.10	0.00
Cond-F	243				Cond-F	243				0
Cond-L	201	Conductivity Meter	1	10	Cond-L	202	Conductivity Meter	1	10	0
Cu	0.0010	ICP-MS	0.0002	0.0003	Cu	0.0008	ICP-MS	0.0002	0.0003	22.2222
Fe	0.014	ICP-MS	0.001	0.002	Fe	0.014	ICP-MS	0.001	0.002	0.000
HCO3	108.0	Acid Titration	1.0	10.0	HCO3	102.0	Acid Titration	1.0	10.0	5.7
K	0.8	ICP-OES	0.1	0.3	K	0.8	ICP-OES	0.1	0.3	0.0
Mo	0.0018	ICP-MS	0.0001	0.0004	Mo	0.0018	ICP-MS	0.0001	0.0004	0.0000
Na	1.9	ICP-OES	0.1	0.5	Na	2.0	ICP-OES	0.1	0.3	5.1
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		Pb	< 0.0001	ICP-MS	0.0001		0.0000
Ra226	0.040	Alpha Septroscopy	0.005	0.020	Ra226	0.040	Alpha Septroscopy	0.005	0.020	0.000
SO4	21.0	ICP-OES	0.2	2.0	SO4	22.0	ICP-OES	0.2	2.0	4.7
Se	< 0.0001	ICP-MS	0.0001		Se	< 0.0001	ICP-MS	0.0001		0.0000
Sum of Ions	169	Calculated	1	20	Sum of Ions	168	Calculated	1	20	1
TDS	143.00	Gravimetric	5.00	10.00	TDS	143.00	Gravimetric	5.00	10.00	0.00
TSS	1.000	Gravimetric	1.000	1.000	TSS	< 1.000	Gravimetric	1.000		0.000
Temp-H20	11.9				Temp-H20	11.9				0.0
U	150.000	ICP-MS	0.100	20.000	U	151.000	ICP-MS	0.100	20.000	0.664
Zn	0.001	ICP-MS	0.001	0.001	Zn	0.001	ICP-MS	0.001	0.001	46.154
pH-F	7.9100	pH Meter	0.0700	0.1000	pH-F	7.9100	pH Meter	0.0700	0.8000	0.0000
pH-L	7.91	pH Meter	0.07	0.10	pH-L	7.91	pH Meter	0.07	0.80	0.00

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

Parent Field	Station: TL-7			
Date: 2016/06/26				
Assigned: SRC Lab				
Parameter	Value	Method	Entered DL	Entered Uncertainty
Alk	132.0	Acid Titration	1.0	30.0
As	1.3	ICP-MS	0.1	0.3
Ba	0.200	ICP-MS	0.001	0.020
CO3	< 1.0	Acid Titration	1.0	
Ca	22.0	ICP-OES	0.1	2.0
Cond-F	355			
Cond-L	290	Conductivity Meter	1	10
Cu	0.0003	ICP-MS	0.0002	0.0002
Fe	0.084	ICP-MS	0.001	0.008
HCO3	161.0	Acid Titration	1.0	20.0
K	0.8	ICP-OES	0.1	0.3
Mo	0.0082	ICP-MS	0.0001	0.0010
Ni	0.00050	ICP-MS	0.00010	0.00030
OH	< 1.0	Acid Titration	1.0	
Pb	0.0002	ICP-MS	0.0001	0.0001
Se	0.0013	ICP-MS	0.0001	0.0003
TDS	192.00	Gravimetric	5.00	20.00
Temp-H20	20.4			
pH-F	7.9000	pH Meter	0.0700	0.1000
pH-L	7.90	pH Meter	0.07	0.10

Child Field	Station: Blind-6				
Date: 2016/06/26					
Assigned: SRC Lab					
Parameter	Value	Method	Entered DL	Entered Uncertainty	% Absolute Difference
Alk	132.0	Acid Titration	1.0	30.0	0.0
As	1.3	ICP-MS	0.1	0.3	0.0
Ba	0.200	ICP-MS	0.001	0.020	0.000
CO3	< 1.0	Acid Titration	1.0		0.0
Ca	22.0	ICP-OES	0.1	2.0	0.0
Cond-F	355				0
Cond-L	290	Conductivity Meter	1	10	0
Cu	0.0004	ICP-MS	0.0002	0.0003	28.5714
Fe	0.090	ICP-MS	0.001	0.009	6.897
HCO3	161.0	Acid Titration	1.0	20.0	0.0
K	0.9	ICP-OES	0.1	0.3	11.8
Mo	0.0085	ICP-MS	0.0001	0.0010	3.5928
Ni	0.00050	ICP-MS	0.00010	0.00030	0.00000
OH	< 1.0	Acid Titration	1.0		0.0
Pb	0.0002	ICP-MS	0.0001	0.0001	0.0000
Se	0.0014				7.4074
TDS	183.00				4.80
Temp-H20	20.4				0.0
pH-F	7.9000	pH Meter	0.0700	0.1000	0.0000
pH-L	7.90	pH Meter	0.07	0.10	0.00

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: 2016/06/26					Date: 2016/06/26					
Assigned: None-Selected					Assigned: SRC Lab					
Parameter	Value	Method	Entered DL	Entered Uncertainty	Parameter	Value	Method	Entered DL	Entered Uncertainty	% Absolute Difference
Pb210	0.10				Pb210	0.03	Beta Counting	0.02	0.02	107.69
Po210	0.022				Po210	0.020	Alpha Septroscopy	0.005	0.010	9.524
Ra226	1.930				Ra226	1.900	Alpha Septroscopy	0.020	0.300	1.567
U	170.000				U	168.000	ICP-MS	0.100	20.000	1.183

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: 2016/12/13					Date: 2016/12/13					
Assigned: None-Selected					Assigned: None-Selected					
Parameter	Value	Method	Entered DL	Entered Uncertainty	Parameter	Value	Method	Entered DL	Entered Uncertainty	% Absolute Difference
As	1.1				As	1.0				9.5
Ba	0.140				Ba	0.140				0.000
Cu	0.0018				Cu	0.0012				40.0000
Fe	< 0.100				Fe	0.024				122.581
Mo	0.0110				Mo	0.0110				0.0000
Ni	< 0.00100				Ni	0.00060				50.00000
Pb	0.0023				Pb	0.0003				153.8462
Ra226	1.250				Ra226	1.400				11.321
Se	< 0.0020				Se	0.0021				4.8780
U	270.000				U	266.000				1.493
Zn	< 0.005				Zn	0.002				103.030

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

Parent Field **Station: TL-9**

Date: 2016/06/26

Assigned: SRC Lab

Parameter	Value	Method	Entered DL	Entered Uncertainty
Alk	130.0	Acid Titration	1.0	30.0
As	1.6	ICP-MS	0.1	0.4
Ba	0.540	ICP-MS	0.001	0.050
CO3	<1.0	Acid Titration	1.0	
Ca	23.0	ICP-OES	0.1	2.0
Cond-F	342			
Cond-L	282	Conductivity Meter	1	10
Cu	0.0005	ICP-MS	0.0002	0.0003
Fe	0.083	ICP-MS	0.001	0.008
HCO3	159.0	Acid Titration	1.0	20.0
Hardness	81	Calculated	1	10
K	1.1	ICP-OES	0.1	0.3
Mo	0.0074	ICP-MS	0.0001	0.0010
Na	31.0	ICP-OES	0.1	3.0
Ni	0.00050	ICP-MS	0.00010	0.00030
OH	<1.0	Acid Titration	1.0	
Pb	0.0011	ICP-MS	0.0001	0.0003
Ra226	2.200	Alpha Septroscopy	0.020	0.200
SO4	23.0	ICP-OES	0.2	2.0
Se	0.0018	ICP-MS	0.0001	0.0004
Sum of Ions	247	Calculated	1	20
TDS	180.00	Gravimetric	5.00	20.00
TSS	2.000	Gravimetric	1.000	1.000
Temp-H20	19.7			
U	166.000	ICP-MS	0.100	20.000
Zn	0.002	ICP-MS	0.001	0.001
pH-F	8.0700	pH Meter	0.0700	0.1000
pH-L	8.07	pH Meter	0.07	0.10

Child Field **Station: Blind-4**

Date: 2016/06/26

Assigned: SRC Lab

Parameter	Value	Method	Entered DL	Entered Uncertainty	% Absolute Difference
Alk	131.0	Acid Titration	1.0	30.0	0.8
As	1.5	ICP-MS	0.1	0.4	6.5
Ba	0.540	ICP-MS	0.001	0.050	0.000
CO3	< 1.0	Acid Titration	1.0		0.0
Ca	23.0	ICP-OES	0.1	2.0	0.0
Cond-F	342				0
Cond-L	284	Conductivity Meter	1	10	1
Cu	0.0005	ICP-MS	0.0002	0.0003	0.0000
Fe	0.087	ICP-MS	0.001	0.009	4.706
HCO3	160.0	Acid Titration	1.0	20.0	0.6
Hardness	81	Calculated	1	10	0
K	1.1	ICP-OES	0.1	0.3	0.0
Mo	0.0076	ICP-MS	0.0001	0.0010	2.6667
Na	31.0	ICP-OES	0.1	3.0	0.0
Ni	0.00050	ICP-MS	0.00010	0.00030	0.00000
OH	< 1.0	Acid Titration	1.0		0.0
Pb	0.0012	ICP-MS	0.0001	0.0003	8.6957
Ra226	2.200	Alpha Septroscopy	0.005	0.200	0.000
SO4	23.0	ICP-OES	0.2	2.0	0.0
Se	0.0018	ICP-MS	0.0001	0.0004	0.0000
Sum of Ions	248	Calculated	1	20	0
TDS	187.00	Gravimetric	5.00	20.00	3.81
TSS	2.000	Gravimetric	1.000	1.000	0.000
Temp-H20	19.7				0.0
U	170.000	ICP-MS	0.100	20.000	2.381
Zn	< 0.001	ICP-MS	0.001		109.091
pH-F	8.0700	pH Meter	0.0700	0.1000	0.0000
pH-L	8.07	pH Meter	0.07	0.10	0.00

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

Parent Field	Station: TL-9 Duplicate			
Date: 2016/06/26				
Assigned: None-Selected				
Parameter	**Value**	**Method**	**Entered DL**	**Entered Uncertainty**
Pb210	0.10			
Po210	0.052			
Ra226	2.400			
U	180.000			

Child Field	Station: TL-9				
Date: 2016/06/26					
Assigned: SRC Lab					
Parameter	**Value**	**Method**	**Entered DL**	**Entered Uncertainty**	**% Absolute Difference**
Pb210	0.03	Beta Counting	0.02	0.02	107.69
Po210	0.080	Alpha Septroscopy	0.005	0.020	42.424
Ra226	2.200	Alpha Septroscopy	0.020	0.200	8.696
U	166.000	ICP-MS	0.100	20.000	8.092

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

Parent Field	Station: TL-9 Duplicate			
Date: 2016/12/13				
Assigned: Maxxam				
Parameter	Value	Method	Entered DL	Entered Uncertainty
As	1.2			
Ba	0.340			
Cu	0.0019			
Fe	0.100			
Mo	0.0100			
Ni	0.00100			
Pb	0.0025			
Ra226	1.230			
Se	0.0020			
U	250.000			
Zn	0.005			

Child Field	Station: TL-9				
Date: 2016/12/13					
Assigned: SRC Lab					
Parameter	Value	Method	Entered DL	Entered Uncertainty	% Absolute Difference
As	0.9	ICP-MS	0.1	0.2	28.6
Ba	0.320	ICP-MS	0.001	0.030	6.061
Cu	0.0005	ICP-MS	0.0002	0.0003	116.6667
Fe	0.026	ICP-MS	0.001	0.004	117.460
Mo	0.0089	ICP-MS	0.0001	0.0010	11.6402
Ni	0.00040	ICP-MS	0.00010	0.00020	85.71429
Pb	0.0003	ICP-MS	0.0001	0.0001	157.1429
Ra226	1.400	Alpha Septroscopy	0.020	0.200	12.928
Se	0.0019	ICP-MS	0.0001	0.0005	5.1282
U	237.000	ICP-MS	0.100	20.000	5.339
Zn	0.001	ICP-MS	0.001	0.001	157.143

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

APPENDIX H

APPENDIX H

2016 Hydrometric Monitoring near Beaverlodge Mine

Cameco Corporation
February 2017

MISSINIPI WATER SOLUTIONS INC.
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SASKATOON, SK CANADA
S7S 1N8
FILE NUMBER: MWS-16-005

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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 owned by 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 to 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.

An additional station included in this 2016 monitoring report is a water level datalogger deployed in the Fay Shaft. The locations of 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 include 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.

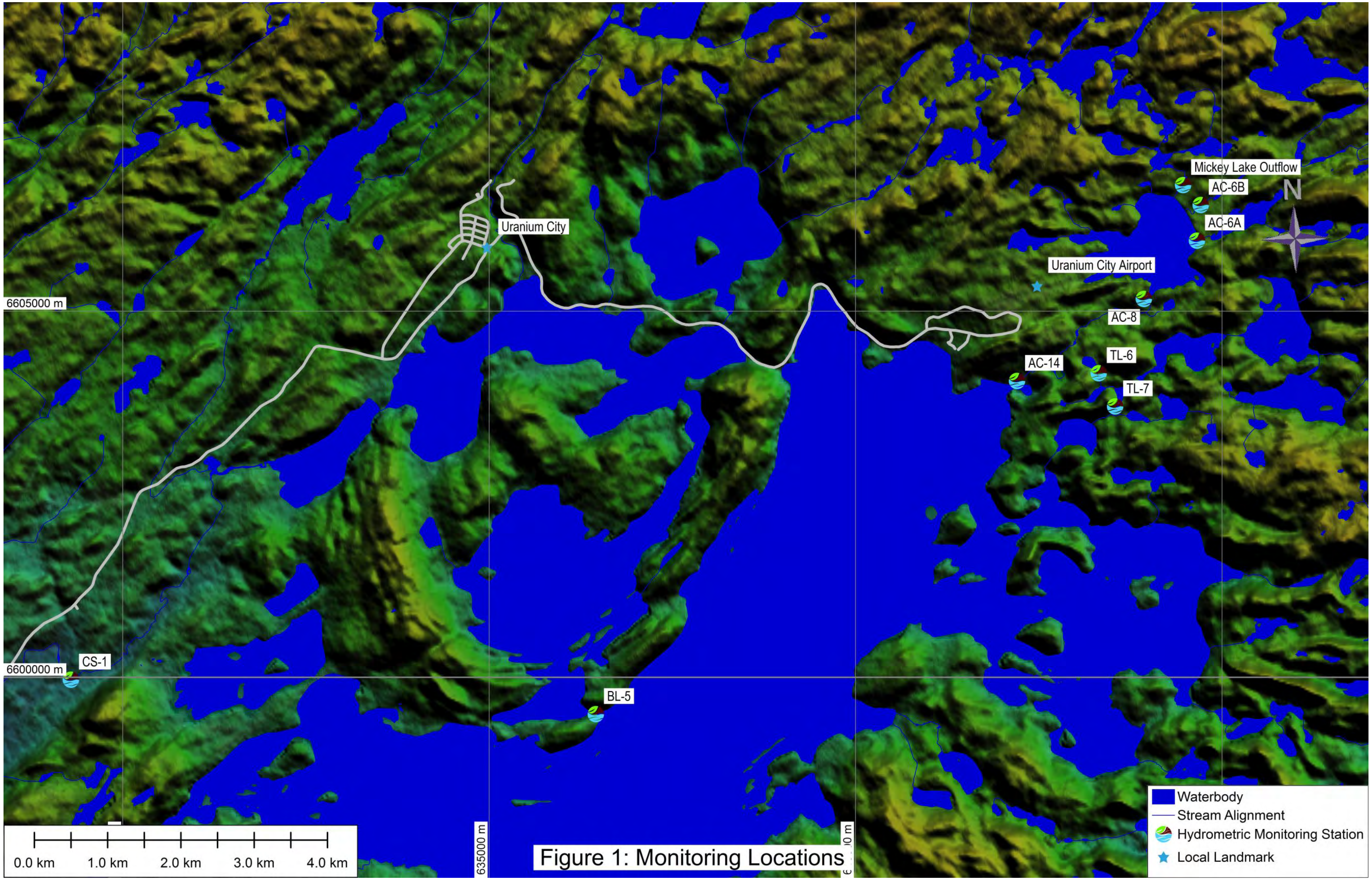

Figure 1: Monitoring Locations

2.0 METHODS

Three field programs were undertaken during 2016. The first occurred between May 1 and May 5 and ran concurrently with other work in the Uranium City area. The second program occurred on August 11. The final field program was undertaken on October 7 and 8.

At each monitoring station discharge was measured either by in-stream velocity measurements or volumetric methods. 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 using a vessel of known volume and a stop watch. All equipment used for measurements are regularly checked for quality data acquisition. Water levels are reported in reference to locally established benchmarks and are not corrected to geodetic elevation.

To calculate the hydrograph at each station, the measurements of stage and discharge are correlated 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 (2016).

Cameco must exercise caution in regards to 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. 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 and, especially during lower flow conditions, a station with good flow records, unimpeded by backwater conditions, can be used to estimate flows at a station where snow, ice and other backwater causing conditions exist.

Winter flow monitoring has not been carried out at any of these sites with the exception of AC-8 in 2006. At that time AC-8 was observed to be flowing unimpeded by ice or snow encroachment on the weir. 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. For these stations the winter hydrographs are estimated based on AC-8 to capture the trends of AC-8 through the winter period.

3.0 CLIMATIC CONDITIONS

Environment Canada operates meteorological stations at Uranium City and Stony Rapids, Saskatchewan. Meteorological data from these sites are intended to provide an indication of climatic conditions through the hydrological monitoring period. The station near Uranium City is automated and has been subject to problems in the past resulting in gaps in the meteorological record. Data presented in Table 1 are total precipitation records for 2016 as available for Uranium City and Stony Rapids.

In 2016 the data record from Uranium City indicated collection of 88% of the year with February having the greatest number of missed days with 12. The data as presented in Table 1 and by MWSI (2016) indicate that winter of 2015/2016 had relatively normal precipitation. MWSI was in the Uranium City area beginning in late April and observed above normal temperatures spanning several days concurrently. These above normal temperatures resulted in a rapid melt of the snowpack and earlier than normal peak discharges from hydrometric stations in the area. Overall, 2016 experienced above normal precipitation (approximately 123% of normal). Approximately 30% of the precipitation for the year came in the month of August. Both the rapid snowmelt and late summer/early fall rainfalls showed responses in the hydrographs in 2016.

The station at Stony Rapids collected fewer days than that at Uranium City but is included in this report as reference. The station at Stony Rapids indicates that 2016 was drier than normal (approximately 65%) but also is missing climate data in August and September when rainfall occurred frequently throughout northern Saskatchewan. MWSI observed elevated water levels near Stony Rapids in the fall of 2016 indicating that rainfalls had increased flow response in the area but may be associated with the missing days of record for that climate station.

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
2016	January	21.3*	19.3	110.4	29/31	8.6	18.1	47.5	31/31
	February	8.3*	15.5	53.5	17/29	0.9*	13.3	6.8	23/29
	March	9.7*	17.8	54.5	27/31	10.1	18.2	55.5	31/31
	April	15.9*	16.9	94.1	29/30	4.3*	18	23.9	29/30
	May	6.6*	17.5	37.7	23/31	8.6*	26.3	32.7	29/31
	June	41.3*	31.3	131.9	28/30	72.8*	44.4	164.0	21/30
	July	82.9	47.1	176.0	31/31	27.1*	56.3	48.1	25/31
	August	120.7*	42.4	284.7	29/31	46.4*	63.9	72.6	19/31
	September	33.7*	33.7	100.0	23/30	32.2*	48.4	66.5	22/30
	October	21.1*	29.1	72.5	27/31	31.2*	30.1	103.7	26/31
	November	25.7*	28	91.8	29/30	7.3*	27.6	26.4	18/30
	December	9.6*	23.6	40.7	30/31	0.0*	18.7	0.0	19/31
Totals		396.8*	322.2	123.2	322/366	249.5*	383.3	65.1	293/366

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 2016. The only datalogger downloaded with a record extending beyond October 2016 is AC-8; any station with a flow record extending beyond this period (AC-6B, BL-5, CS-1 and TL-7) are synthesized from AC-8. Only stations where flow is known to occur year-round (AC-6B, BL-5, CS-1 and TL-7) have had their records extended with the exception of AC-14 which is monitored upstream at AC-8.

4.1 AC-6A – VERNA LAKE TO ACE LAKE

A v-notch weir installed in 2011 is used to monitor discharge at AC-6A. The weir is mounted to an existing culvert through the road which follows the perimeter of Ace Lake. The station monitors discharge from Verna Lake to Ace Lake.

As discussed in further detail in Section 4.4, Ace Lake had elevated water levels which were examined in context of AC-6A. Though it was possible for Ace Lake to create a backwater condition over the v-notch in 2016 it seems that, if this had occurred, the period of time would have been brief spanning from September 2 to September 12. MWSI is of the opinion based on the available data that backwater from Ace Lake did not have an appreciable influence on recorded water level data at AC-6A.

Photo 1 and Photo 2 were taken during the spring and fall field programs, respectively. Measurements throughout 2016 helped to improve the accuracy of the rating curve at this station (Table 2 and Figure 2). Figure 3 presents the 2016 hydrograph for AC-6A and Table 3 provides the discharge data numerically.

Photo 1: AC-6A – May 1, 2016

Photo 2: AC-6A – October 7, 2016

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

Figure 2: AC-6A Rating Curve

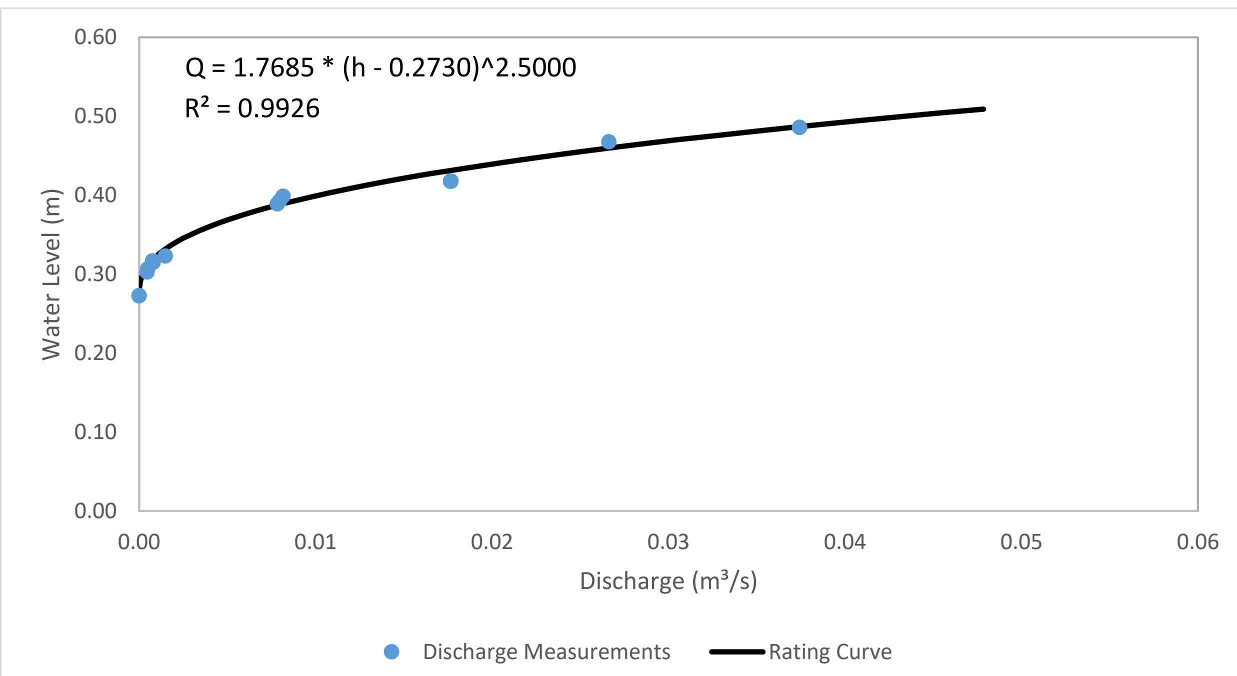

Figure 3: AC-6A 2016 Hydrograph

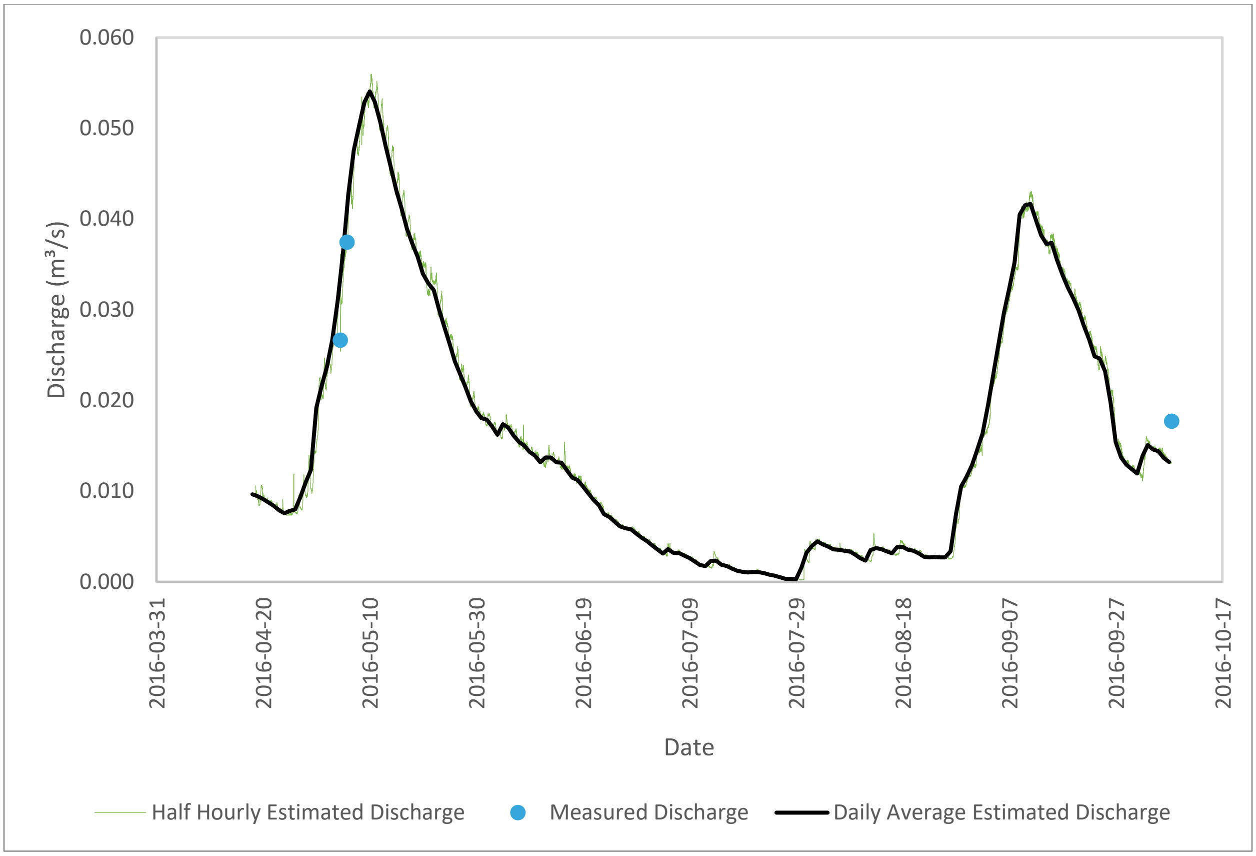

Table 3: AC-6A 2016 Daily Average Discharge (m³/s)

Day	Apr	May	Jun	Jul	Aug	Sep	Oct
1		0.0216	0.0179	0.0045	0.0040	0.0145	0.0120
2		0.0237	0.0171	0.0040	0.0045	0.0164	0.0139
3		0.0267	0.0162	0.0036	0.0041	0.0195	0.0151
4		0.0310	0.0174	0.0031	0.0039	0.0227	0.0146
5		0.0361	0.0170	0.0036	0.0036	0.0262	0.0144
6		0.0427	0.0162	0.0032	0.0035	0.0297	0.0137
7		0.0476	0.0154	0.0032	0.0034	0.0323	0.0132
8		0.0502	0.0150	0.0029	0.0034	0.0352	
9		0.0528	0.0144	0.0026	0.0031	0.0405	
10		0.0541	0.0139	0.0022	0.0026	0.0415	
11		0.0529	0.0132	0.0019	0.0023	0.0417	
12		0.0507	0.0137	0.0017	0.0035	0.0400	
13		0.0480	0.0137	0.0023	0.0037	0.0382	
14		0.0457	0.0132	0.0023	0.0036	0.0373	
15		0.0431	0.0131	0.0019	0.0034	0.0373	
16		0.0411	0.0123	0.0018	0.0031	0.0354	
17		0.0389	0.0115	0.0015	0.0038	0.0338	
18	0.0097	0.0373	0.0112	0.0012	0.0039	0.0325	
19	0.0094	0.0358	0.0105	0.0011	0.0035	0.0313	
20	0.0091	0.0340	0.0097	0.0010	0.0035	0.0299	
21	0.0088	0.0329	0.0091	0.0011	0.0032	0.0283	
22	0.0084	0.0322	0.0085	0.0011	0.0028	0.0267	
23	0.0079	0.0301	0.0075	0.0010	0.0027	0.0249	
24	0.0076	0.0281	0.0071	0.0008	0.0027	0.0246	
25	0.0078	0.0263	0.0066	0.0007	0.0027	0.0232	
26	0.0080	0.0243	0.0061	0.0005	0.0027	0.0198	
27	0.0093	0.0228	0.0059	0.0003	0.0034	0.0154	
28	0.0110	0.0215	0.0058	0.0003	0.0075	0.0137	
29	0.0123	0.0199	0.0053	0.0003	0.0105	0.0129	
30	0.0192	0.0188	0.0049	0.0015	0.0116	0.0124	
31		0.0180		0.0032	0.0129		
Average		0.0351	0.0116	0.0020	0.0043	0.0279	

4.2 AC-6B – ACE CREEK TO ACE LAKE

The gauging station on Ace Creek upstream of Ace Lake is located immediately upstream of a bridge crossing. The station was visited in the spring (Photo 3) and fall (Photo 4) of 2016. Table 4 and Figure 4 present the measured flow data numerically and graphically (rating curve). The 2016 hydrograph is presented as Figure 5 and the daily average flow data are provided in Table 5.

Photo 3: AC-6B – May 5, 2016

Photo 4: AC-6B – October 7, 2016

Table 4: AC-6B Stage and Discharge Measurements

Measurement Date & Time	Water Level (m)	Discharge (m^3/s)
2010-04-27 0:00	98.907	0.7724
2010-07-01 0:00	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 0:00	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

Figure 4: AC-6B Rating Curve

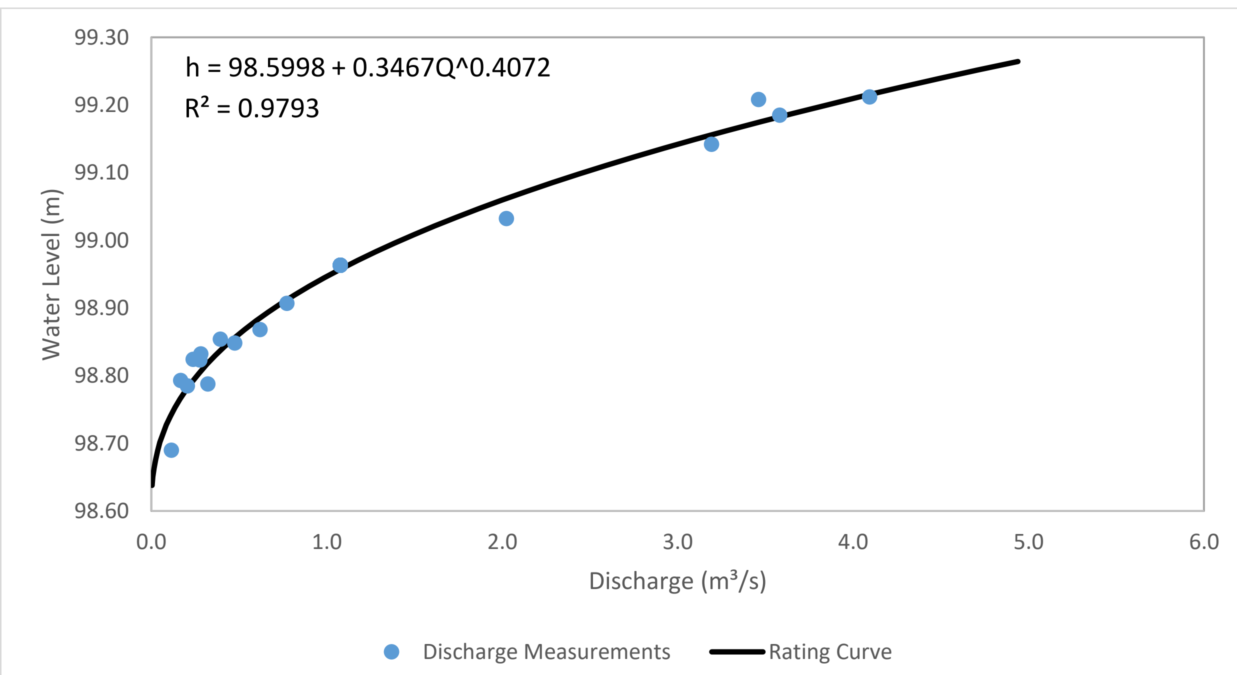

Figure 5: AC-6B 2016 Hydrograph

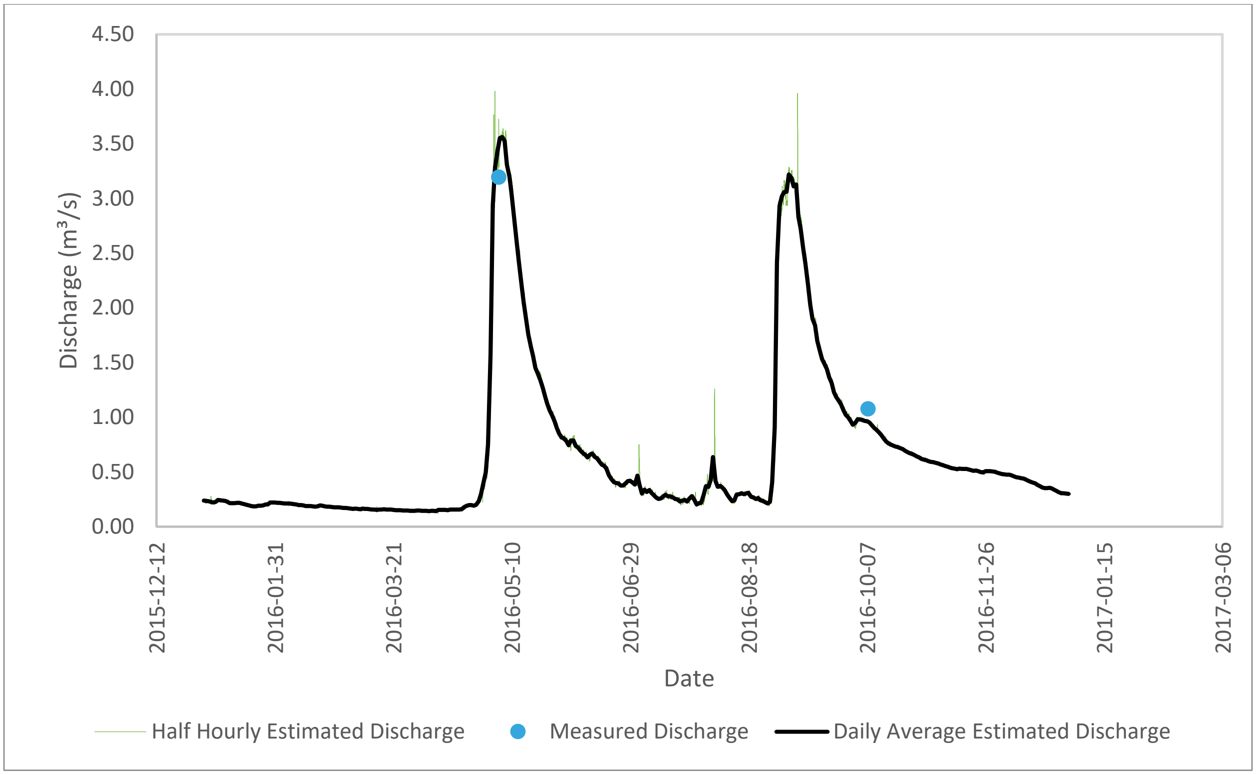

Table 5: AC-6B 2016 Daily Average Discharge (m³/s)

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0.238	0.219	0.170	0.148	1.577	0.808	0.383	0.365	3.018	0.931	0.606	0.493
2	0.236	0.217	0.167	0.146	2.938	0.782	0.466	0.427	3.057	0.948	0.597	0.487
3	0.232	0.215	0.164	0.145	3.283	0.745	0.375	0.635	3.062	0.983	0.591	0.480
4	0.228	0.212	0.164	0.144	3.439	0.787	0.304	0.417	3.220	0.980	0.589	0.477
5	0.220	0.211	0.164	0.142	3.551	0.787	0.339	0.365	3.191	0.976	0.583	0.476
6	0.228	0.211	0.162	0.145	3.562	0.738	0.317	0.374	3.111	0.966	0.577	0.476
7	0.245	0.209	0.160	0.144	3.526	0.721	0.335	0.356	3.128	0.964	0.570	0.470
8	0.241	0.206	0.165	0.142	3.311	0.695	0.308	0.333	2.834	0.951	0.563	0.462
9	0.239	0.202	0.162	0.153	3.200	0.675	0.289	0.290	2.726	0.928	0.555	0.453
10	0.234	0.199	0.162	0.154	3.032	0.657	0.265	0.261	2.544	0.903	0.549	0.448
11	0.225	0.196	0.159	0.153	2.812	0.633	0.253	0.234	2.401	0.884	0.540	0.443
12	0.216	0.193	0.158	0.152	2.618	0.659	0.260	0.240	2.214	0.860	0.534	0.439
13	0.214	0.189	0.158	0.151	2.433	0.669	0.278	0.293	2.029	0.838	0.530	0.433
14	0.215	0.189	0.154	0.155	2.231	0.639	0.291	0.298	1.900	0.809	0.526	0.419
15	0.218	0.188	0.155	0.157	2.060	0.624	0.277	0.305	1.841	0.780	0.530	0.411
16	0.218	0.184	0.156	0.156	1.896	0.596	0.277	0.296	1.698	0.762	0.529	0.403
17	0.213	0.183	0.159	0.155	1.756	0.566	0.269	0.304	1.607	0.750	0.528	0.395
18	0.207	0.187	0.158	0.157	1.646	0.558	0.252	0.307	1.530	0.742	0.528	0.382
19	0.199	0.193	0.156	0.161	1.558	0.531	0.251	0.274	1.489	0.733	0.522	0.369
20	0.193	0.190	0.155	0.179	1.452	0.470	0.231	0.267	1.441	0.727	0.515	0.358
21	0.188	0.187	0.153	0.190	1.397	0.438	0.239	0.254	1.367	0.718	0.512	0.351
22	0.186	0.184	0.152	0.197	1.345	0.408	0.243	0.261	1.311	0.708	0.512	0.352
23	0.186	0.182	0.150	0.196	1.270	0.399	0.230	0.241	1.230	0.695	0.506	0.354
24	0.190	0.179	0.149	0.191	1.196	0.397	0.255	0.234	1.186	0.683	0.500	0.351
25	0.192	0.178	0.148	0.201	1.123	0.376	0.280	0.224	1.151	0.671	0.496	0.338
26	0.193	0.176	0.147	0.234	1.061	0.375	0.249	0.211	1.118	0.665	0.508	0.326
27	0.204	0.176	0.146	0.297	1.019	0.396	0.204	0.227	1.064	0.654	0.507	0.313
28	0.204	0.173	0.145	0.390	0.962	0.417	0.214	0.405	1.024	0.641	0.507	0.307
29	0.220	0.172	0.144	0.495	0.902	0.420	0.217	0.908	1.002	0.633	0.504	0.305
30	0.222		0.144	0.747	0.853	0.402	0.290	2.419	0.967	0.617	0.501	0.302
31	0.221		0.146		0.814		0.369	2.928		0.611		0.299
Average	0.215	0.193	0.156	0.206	2.059	0.579	0.284	0.482	1.982	0.797	0.537	0.399

4.3 MICKEY LAKE OUTFLOW

The outflow from Mickey Lake represents the watershed in which the former Hab Mine is located. The discharge measurement location has been used since 2010 but concerns over the reliability of this location have been raised in the past few years due to the presence of a beaver dam upstream of the station. Reconnaissance of other portions of the watershed have not identified a better location thus the measurements remain at the present location. To date, the rating curve appears to be stable and not drifting appreciably from year to year. Photo 5 was taken during the spring field program and Photo 6 during the fall. Table 6 presents the field measurement data and the rating curve is shown in Figure 6. Figure 7 shows the 2016 hydrograph while daily average discharge data are provided in Table 7.

Photo 5: Mickey Lake Outflow – May 5, 2016

Photo 6: Mickey Lake Outflow - October 7, 2016

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 0:00	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

Figure 6: Mickey Lake Outflow Rating Curve

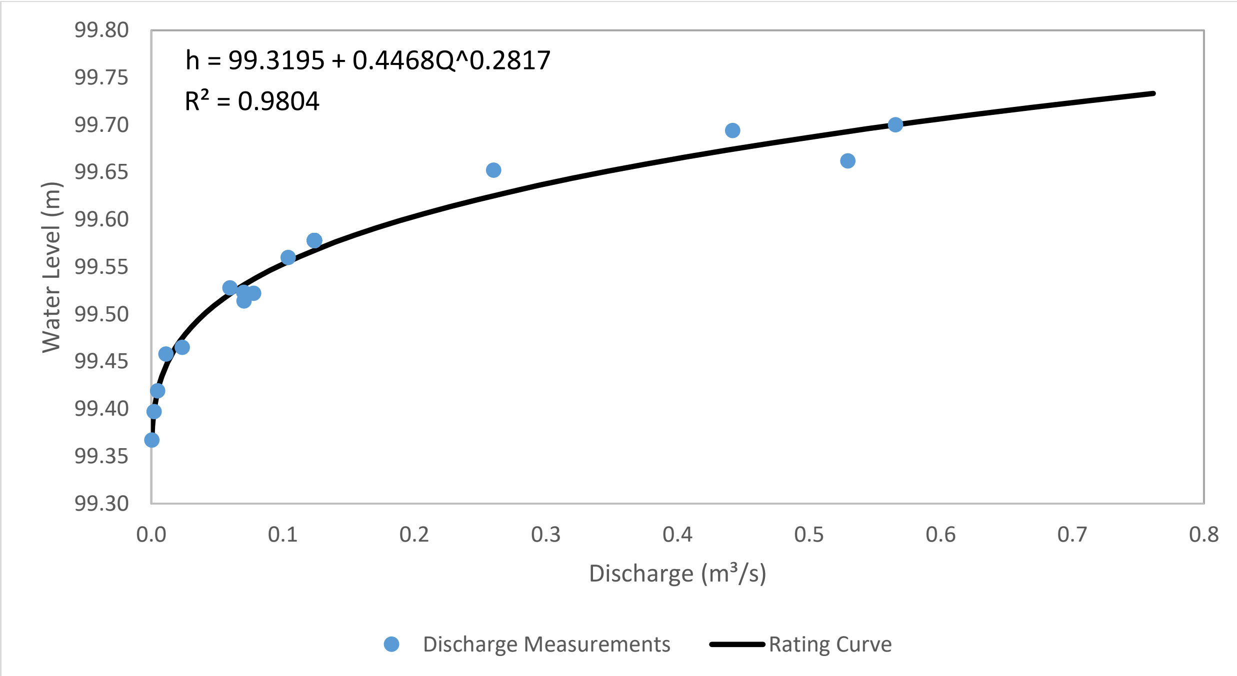

Figure 7: Mickey Lake Outflow 2016 Hydrograph

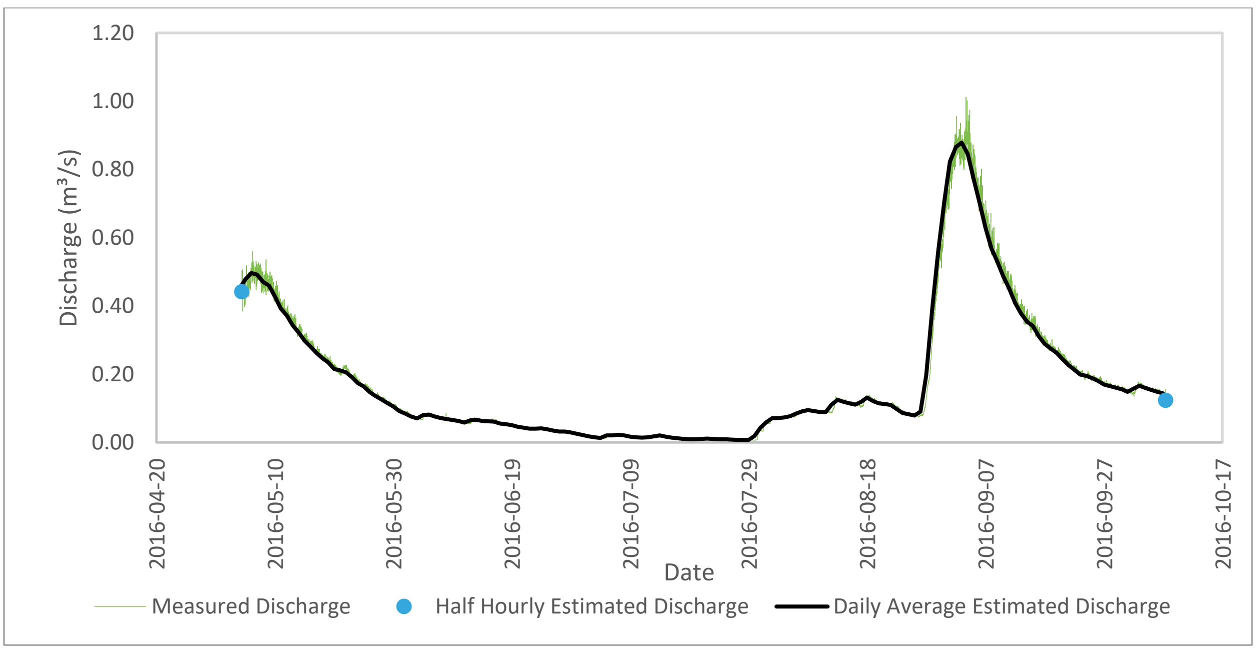

Table 7: Mickey Lake Outflow 2016 Daily Average Discharge (m³/s)

Day	May	Jun	Jul	Aug	Sep	Oct
1		0.085	0.021	0.059	0.823	0.148
2		0.076	0.018	0.072	0.866	0.158
3		0.070	0.015	0.071	0.878	0.166
4	0.451	0.080	0.013	0.073	0.845	0.159
5	0.477	0.082	0.021	0.077	0.772	0.154
6	0.496	0.076	0.020	0.085	0.701	0.148
7	0.492	0.072	0.022	0.091	0.629	0.144
8	0.471	0.068	0.020	0.095	0.568	
9	0.460	0.065	0.017	0.092	0.530	
10	0.427	0.063	0.015	0.090	0.486	
11	0.392	0.059	0.014	0.089	0.452	
12	0.372	0.065	0.015	0.111	0.408	
13	0.344	0.067	0.018	0.125	0.378	
14	0.322	0.063	0.021	0.119	0.354	
15	0.299	0.062	0.017	0.115	0.341	
16	0.280	0.061	0.014	0.110	0.311	
17	0.263	0.056	0.013	0.119	0.289	
18	0.247	0.053	0.010	0.132	0.275	
19	0.235	0.050	0.010	0.121	0.262	
20	0.215	0.046	0.010	0.115	0.244	
21	0.211	0.043	0.011	0.113	0.227	
22	0.206	0.041	0.011	0.110	0.213	
23	0.192	0.040	0.011	0.097	0.199	
24	0.173	0.041	0.010	0.087	0.195	
25	0.164	0.038	0.010	0.083	0.188	
26	0.147	0.034	0.008	0.079	0.180	
27	0.136	0.032	0.008	0.091	0.170	
28	0.126	0.032	0.008	0.197	0.165	
29	0.115	0.029	0.007	0.393	0.160	
30	0.105	0.025	0.019	0.557	0.156	
31	0.092		0.043	0.703		
Average	0.282	0.056	0.015	0.144	0.409	

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), summer (Photo 8) and fall (Photo 9) of 2016. During 2016, an old dock drifted up to the weir thus impeding flow through the outlet. Cameco first made mention of the obstruction on June, 14 though no such blockage was present on May 4. On August 11, the dock was pulled up onto the bank by MWSI and Uranium City Contracting (UCC).

UCC checked on the structure on August 31 and observed that the dock remained on the bank at that time. The piers supporting the former tailings line near the weir were removed on September 12 by UCC and Outside Environmental Consulting Ltd., on behalf of Cameco, at which time the dock was observed to be once again obstructing the weir; the dock was removed at the same time as the piers and the debris hauled away for disposal. The final field visit in 2016 occurred on October 7 by MWSI at which time no debris was observed to be blocking the outlet.

In summary, the dock obstructed flow out of the weir sometime after May 4 and before June 14, was removed on August 11, returned to the weir presumably due to elevated water levels between August 31 and September 12 and was removed permanently on September 12. The presence of the dock obstructing the weir would serve to impede flow out of the weir thus creating an increased water level response on the stage level record. Following discussions with Cameco, MWSI has opted to not attempt to correct the flow record, which results in an overestimation of flow during the above noted timeframes in the data presented below.

The field monitoring data are provided in Table 8 and the rating curve is presented in Figure 8. The hydrograph for 2016 is shown as Figure 9. Daily average discharge data are presented in Table 9 and the long term monthly data are provided in Table 10.

Photo 7: AC-8 – May 4, 2016

Photo 8: AC-8 - August 11, 2016

Photo 9: AC-8 – October 7, 2016

Table 8: 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

Figure 8: AC-8 Rating Curve

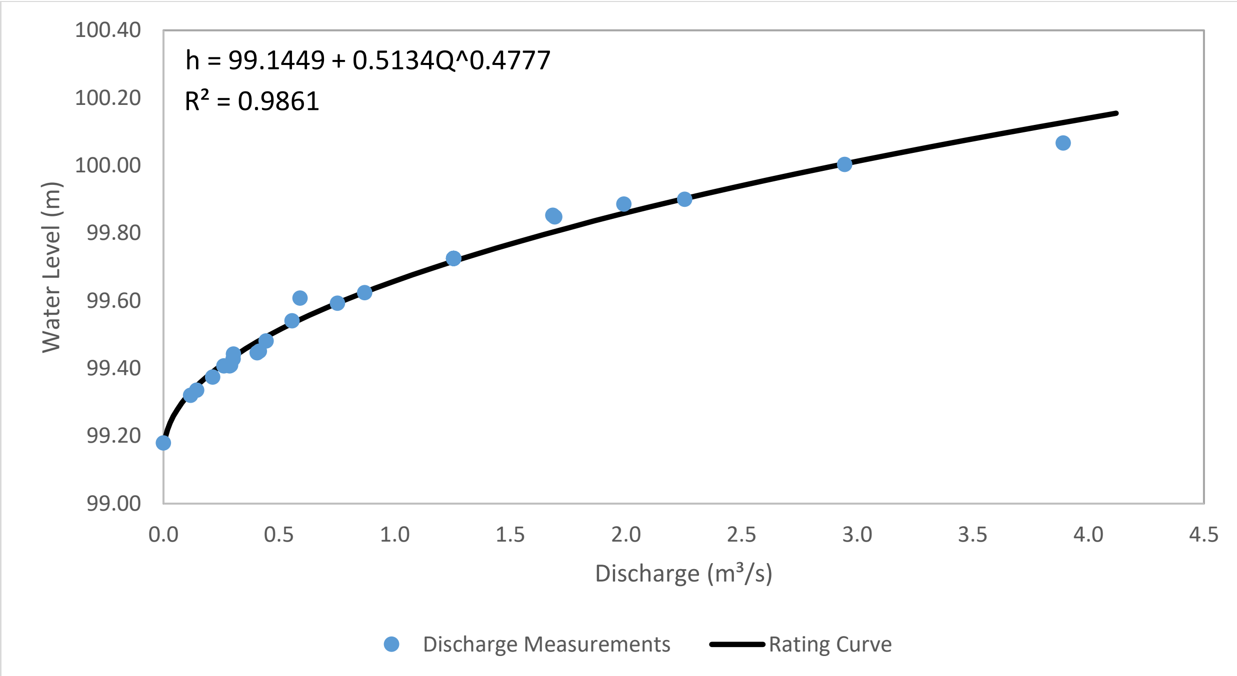

Figure 9: AC-8 2016 Hydrograph

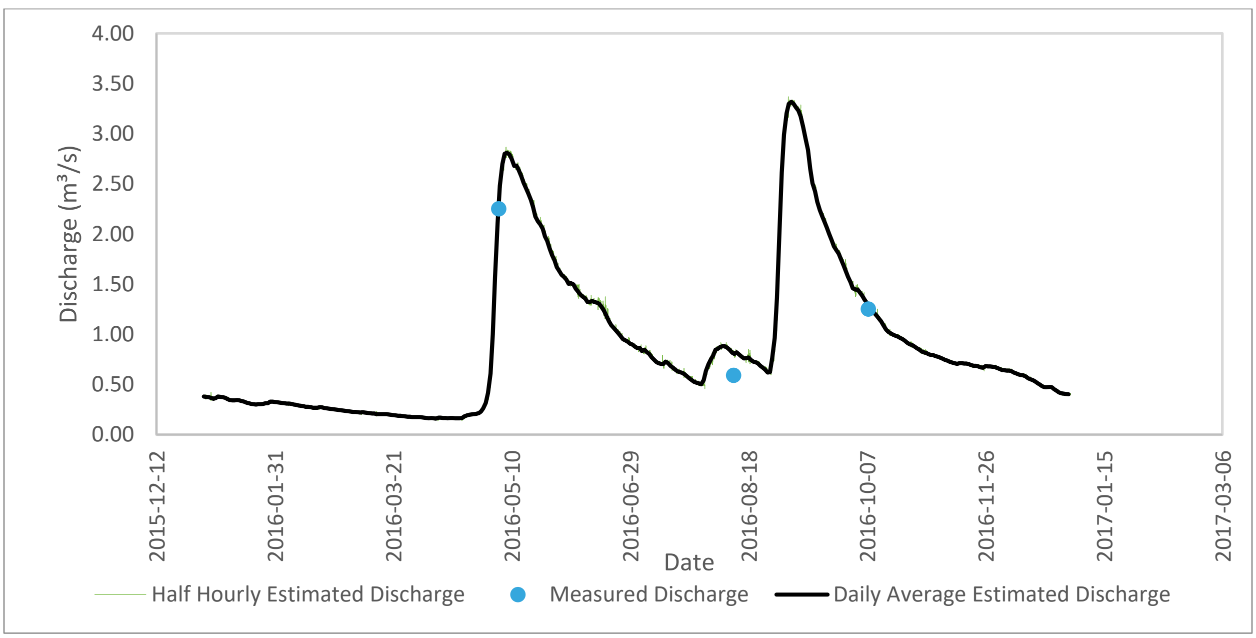

Table 9: AC-8 2016 Daily Average Discharge (m³/s)

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0.381	0.322	0.237	0.175	0.610	1.574	0.877	0.703	2.612	1.460	0.815	0.663
2	0.377	0.320	0.232	0.172	0.998	1.545	0.861	0.748	2.991	1.447	0.802	0.654
3	0.373	0.316	0.229	0.170	1.572	1.504	0.864	0.785	3.203	1.447	0.793	0.645
4	0.367	0.312	0.226	0.167	2.107	1.510	0.834	0.845	3.297	1.417	0.792	0.641
5	0.358	0.310	0.226	0.164	2.481	1.496	0.846	0.856	3.316	1.381	0.783	0.639
6	0.365	0.309	0.222	0.166	2.697	1.456	0.822	0.874	3.298	1.345	0.775	0.639
7	0.381	0.305	0.219	0.164	2.800	1.425	0.805	0.881	3.261	1.310	0.766	0.631
8	0.376	0.300	0.223	0.161	2.810	1.396	0.772	0.881	3.232	1.277	0.756	0.620
9	0.372	0.296	0.219	0.170	2.793	1.376	0.749	0.866	3.173	1.247	0.745	0.609
10	0.366	0.291	0.217	0.170	2.750	1.356	0.726	0.846	3.064	1.213	0.738	0.601
11	0.356	0.287	0.213	0.167	2.680	1.322	0.712	0.818	2.956	1.188	0.726	0.595
12	0.345	0.283	0.210	0.166	2.681	1.325	0.704	0.804	2.838	1.155	0.717	0.590
13	0.342	0.277	0.209	0.163	2.637	1.333	0.705	0.822	2.648	1.125	0.712	0.581
14	0.342	0.276	0.204	0.166	2.578	1.320	0.727	0.799	2.507	1.087	0.706	0.563
15	0.343	0.273	0.204	0.166	2.511	1.315	0.712	0.778	2.426	1.048	0.712	0.551
16	0.342	0.269	0.203	0.164	2.455	1.303	0.687	0.761	2.320	1.023	0.710	0.541
17	0.336	0.266	0.205	0.162	2.405	1.268	0.669	0.763	2.239	1.007	0.709	0.531
18	0.328	0.269	0.203	0.162	2.341	1.232	0.646	0.770	2.181	0.997	0.709	0.513
19	0.320	0.274	0.200	0.165	2.266	1.183	0.633	0.744	2.126	0.985	0.701	0.496
20	0.312	0.270	0.198	0.182	2.174	1.129	0.622	0.726	2.064	0.977	0.691	0.480
21	0.306	0.265	0.194	0.192	2.126	1.093	0.615	0.720	2.001	0.964	0.687	0.472
22	0.302	0.261	0.192	0.198	2.097	1.064	0.601	0.707	1.939	0.951	0.687	0.473
23	0.301	0.257	0.189	0.201	2.051	1.037	0.582	0.686	1.877	0.934	0.680	0.475
24	0.304	0.254	0.187	0.203	1.976	1.012	0.563	0.666	1.842	0.917	0.671	0.471
25	0.304	0.251	0.184	0.206	1.932	0.979	0.543	0.648	1.803	0.902	0.666	0.454
26	0.305	0.248	0.182	0.213	1.852	0.951	0.526	0.621	1.748	0.893	0.682	0.438
27	0.314	0.246	0.180	0.229	1.792	0.939	0.516	0.623	1.690	0.878	0.681	0.421
28	0.313	0.242	0.177	0.261	1.738	0.927	0.510	0.760	1.632	0.861	0.680	0.412
29	0.328	0.240	0.175	0.315	1.671	0.907	0.500	0.963	1.573	0.850	0.677	0.409
30	0.328		0.174	0.414	1.633	0.896	0.542	1.361	1.520	0.829	0.672	0.406
31	0.326		0.175		1.594		0.636	2.038		0.821		0.401
Average	0.339	0.279	0.204	0.192	2.155	1.239	0.681	0.834	2.446	1.095	0.721	0.536

Table 10: AC-8 Monthly Average Discharge (m³/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
Mean	0.250	0.212	0.188	0.213	1.216	0.988	0.572	0.478	0.535	0.457	0.427	0.334	0.489

4.5 AC-14 – ACE CREEK UPSTREAM OF BEAVERLODGE LAKE

Ace Creek is monitored approximately 250 m upstream of Beaverlodge Lake at the station known as AC-14. The site was visited twice in 2016 during the spring and fall field programs (Photo 10 and Photo 11). Field measurement data are summarized in Table 11 and the rating curve is presented as Figure 10. The 2016 hydrograph is shown in Figure 11 with daily average discharge data presented in Table 12.

Photo 10: AC-14 – May 5, 2016

Photo 11: AC-14 - October 7, 2016

Table 11: 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

Figure 10: AC-14 Rating Curve

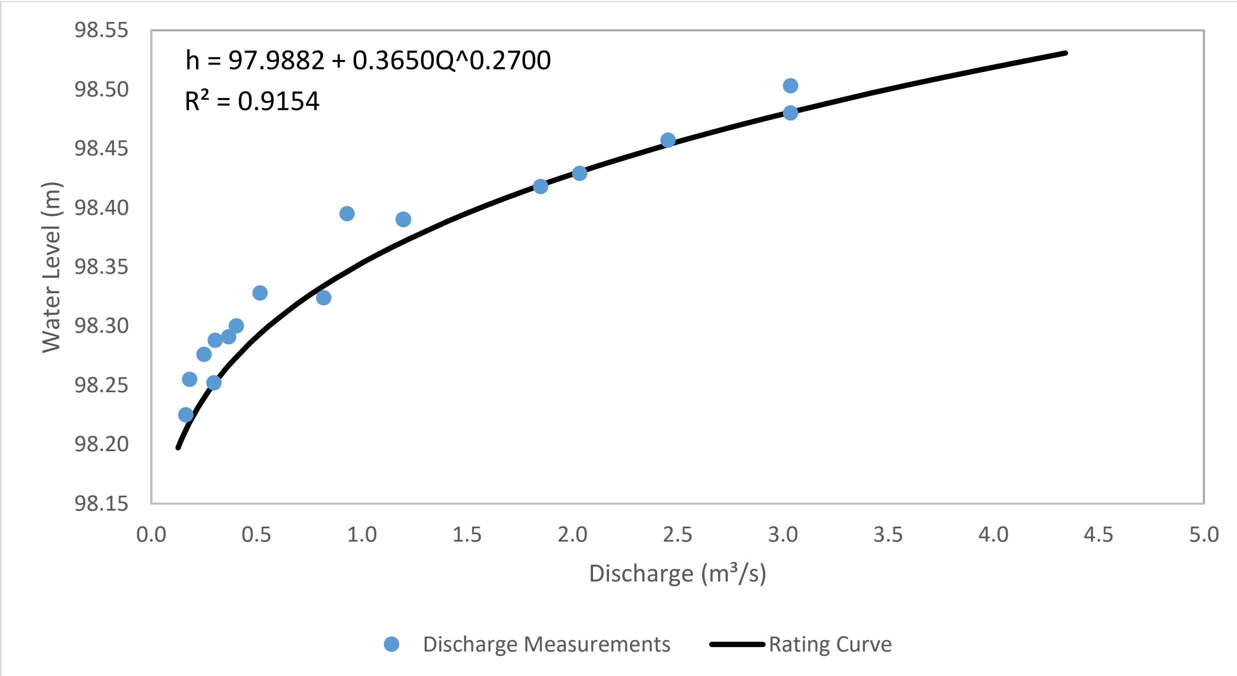

Figure 11: AC-14 2016 Hydrograph

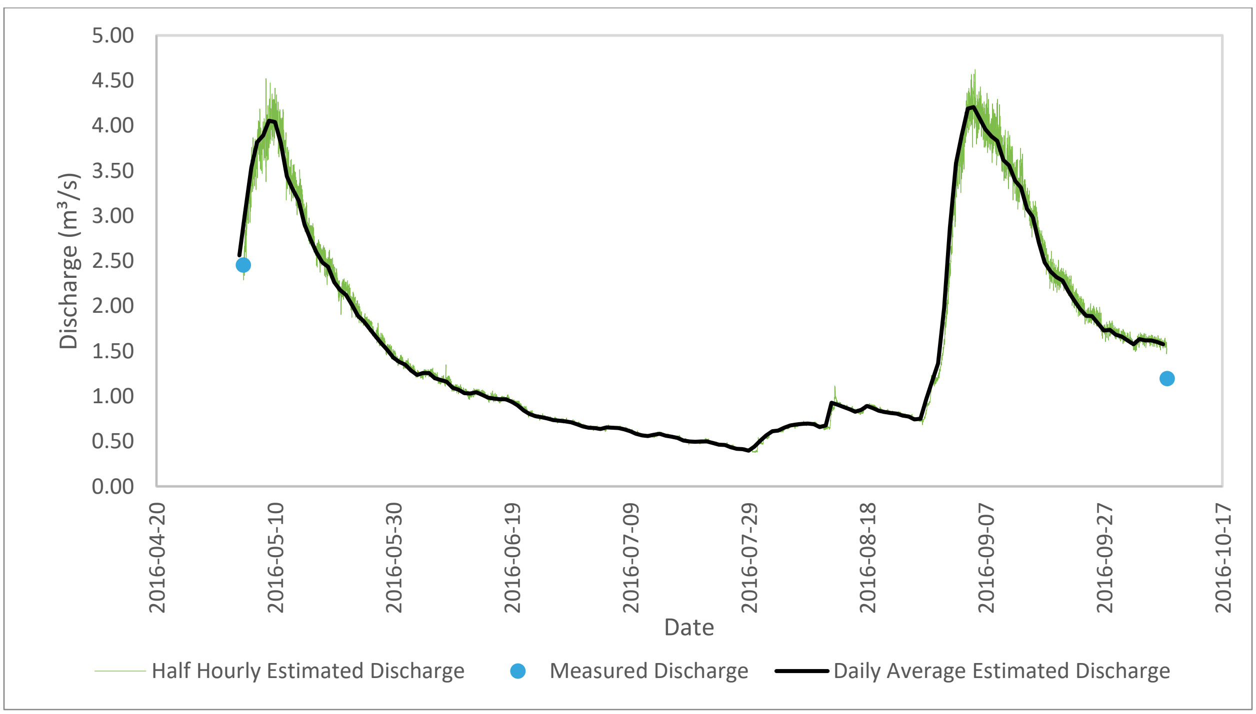

Table 12: AC-14 2016 Daily Average Discharge (m^3/s)

Day	May	Jun	Jul	Aug	Sep	Oct
1		1.348	0.666	0.567	2.869	1.618
2		1.285	0.650	0.612	3.581	1.577
3		1.237	0.649	0.618	3.895	1.632
4	2.561	1.258	0.637	0.651	4.188	1.618
5	3.050	1.255	0.653	0.674	4.206	1.619
6	3.536	1.201	0.650	0.686	4.080	1.601
7	3.818	1.177	0.648	0.694	3.960	1.575
8	3.892	1.161	0.633	0.696	3.879	
9	4.056	1.093	0.611	0.689	3.832	
10	4.041	1.072	0.585	0.658	3.620	
11	3.809	1.035	0.566	0.676	3.560	
12	3.439	1.031	0.557	0.927	3.389	
13	3.295	1.044	0.574	0.908	3.314	
14	3.167	1.018	0.582	0.880	3.076	
15	2.906	0.984	0.562	0.855	2.988	
16	2.738	0.973	0.550	0.828	2.703	
17	2.597	0.968	0.538	0.850	2.484	
18	2.483	0.965	0.509	0.891	2.380	
19	2.435	0.939	0.497	0.869	2.320	
20	2.263	0.900	0.493	0.840	2.283	
21	2.181	0.841	0.499	0.825	2.165	
22	2.122	0.804	0.497	0.813	2.060	
23	2.016	0.777	0.482	0.808	1.967	
24	1.893	0.768	0.461	0.785	1.891	
25	1.830	0.753	0.460	0.773	1.888	
26	1.748	0.738	0.435	0.745	1.806	
27	1.663	0.727	0.418	0.750	1.730	
28	1.582	0.723	0.415	0.967	1.735	
29	1.512	0.712	0.396	1.173	1.682	
30	1.428	0.690	0.442	1.364	1.662	
31	1.382		0.509	1.979		
Average	2.623	0.983	0.543	0.840	2.840	

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 12 is from the spring field program of 2016 while Photo 13 was taken during the fall. Stage and discharge monitoring data are compiled in Table 13 and the rating curve is presented in Figure 12. The 2016 hydrograph is provided in Figure 13 with the daily average discharge data presented in Table 14.

Photo 12: TL-6– May 1, 2016

Photo 13: TL-6 – October 8, 2016

Table 13: 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	Not Measured
2016-05-04 14:17	0.412	0.00611
2016-10-08 11:00	0.341	0.00127

Figure 12: TL-6 Rating Curve

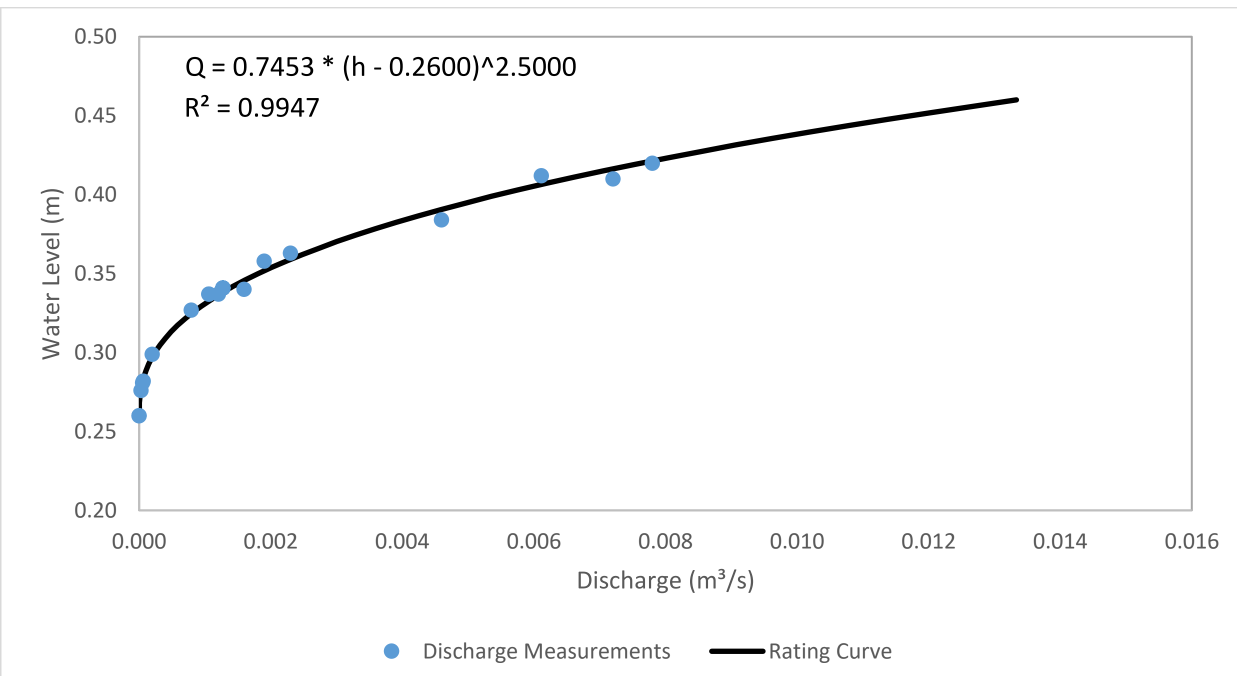

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Figure 13: TL-6 2016 Hydrograph

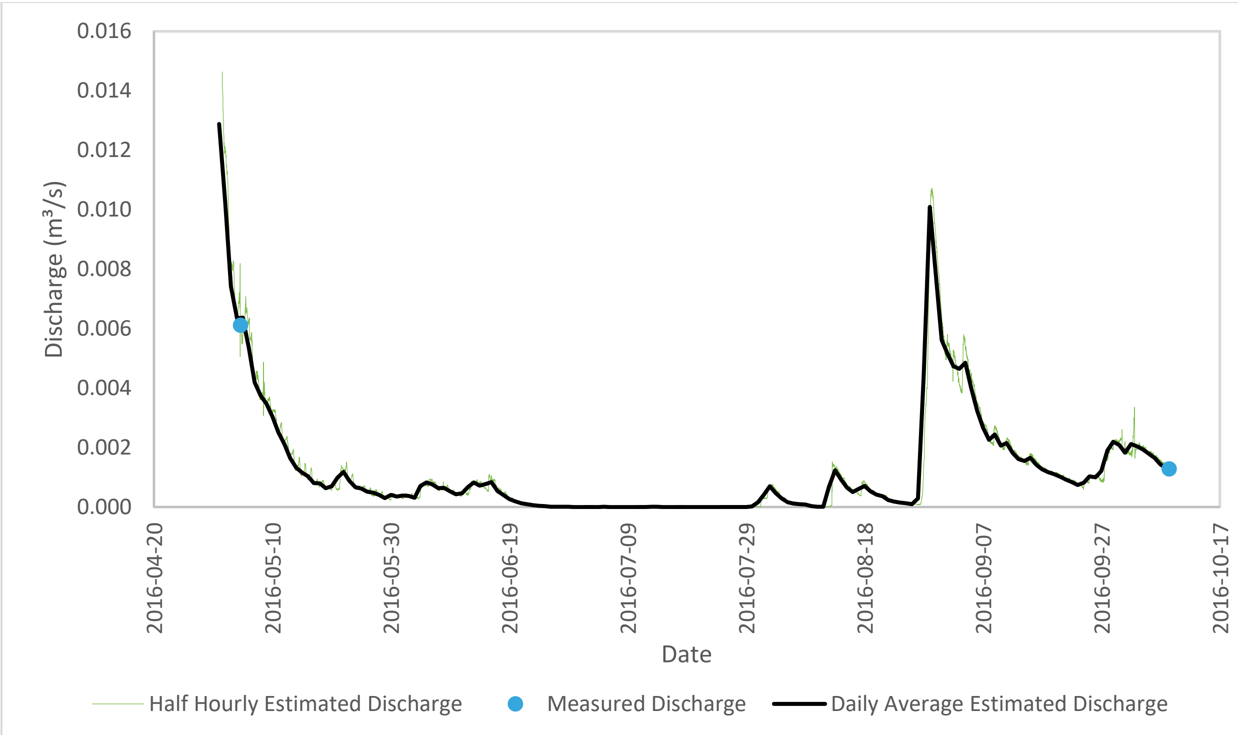


Table 14: TL-6 2016 Daily Average Discharge (m³/s)

Day	May	Jun	Jul	Aug	Sep	Oct
1	0.0129	0.0004	0.0000	0.0004	0.0052	0.0018
2	0.0103	0.0004	0.0000	0.0007	0.0047	0.0021
3	0.0074	0.0003	0.0000	0.0005	0.0046	0.0020
4	0.0063	0.0007	0.0000	0.0003	0.0049	0.0019
5	0.0064	0.0008	0.0000	0.0002	0.0040	0.0018
6	0.0053	0.0008	0.0000	0.0001	0.0032	0.0016
7	0.0042	0.0006	0.0000	0.0001	0.0027	0.0014
8	0.0037	0.0006	0.0000	0.0001	0.0023	0.0013
9	0.0035	0.0005	0.0000	0.0000	0.0024	
10	0.0030	0.0004	0.0000	0.0000	0.0021	
11	0.0025	0.0005	0.0000	0.0000	0.0022	
12	0.0021	0.0007	0.0000	0.0007	0.0018	
13	0.0016	0.0008	0.0000	0.0012	0.0016	
14	0.0013	0.0007	0.0000	0.0009	0.0015	
15	0.0012	0.0008	0.0000	0.0007	0.0017	
16	0.0010	0.0008	0.0000	0.0005	0.0014	
17	0.0008	0.0005	0.0000	0.0006	0.0013	
18	0.0008	0.0004	0.0000	0.0007	0.0012	
19	0.0006	0.0003	0.0000	0.0005	0.0011	
20	0.0007	0.0002	0.0000	0.0004	0.0010	
21	0.0010	0.0001	0.0000	0.0004	0.0009	
22	0.0012	0.0001	0.0000	0.0002	0.0008	
23	0.0009	0.0001	0.0000	0.0002	0.0007	
24	0.0007	0.0000	0.0000	0.0001	0.0008	
25	0.0006	0.0000	0.0000	0.0001	0.0010	
26	0.0005	0.0000	0.0000	0.0001	0.0010	
27	0.0005	0.0000	0.0000	0.0003	0.0012	
28	0.0004	0.0000	0.0000	0.0045	0.0019	
29	0.0003	0.0000	0.0000	0.0101	0.0022	
30	0.0004	0.0000	0.0000	0.0079	0.0021	
31	0.0003		0.0002	0.0056		
Average	0.0027	0.0004	0.0000	0.0012	0.0021	

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 standing 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); however, in 2016, the weir was open during the spring field program and the datalogger was installed during that site visit (Photo 14). At that time, it was not possible to measure the flow rate. The fall field program successfully measured the highest flow rate observed during an ice free condition (Photo 15) and assisted greatly in developing the rating curve (Table 15 and Figure 14).

Flow data for TL-7 are required by Cameco for the entire year of record. 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 15 presents the 2016 hydrograph for TL-7 while Table 16 and Table 17 present the 2016 daily average discharge data and the long term monthly average discharge data, respectively.

Photo 14: TL-7– May 4, 2016

Photo 15: TL-7 – October 8, 2016

Table 15: TL-7 Stage and Discharge Measurements

Measurement Date & Time	Water Level (m)	Discharge (m³/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		0.0815
2013-05-16 11:50		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

Figure 14: TL-7 Rating Curve

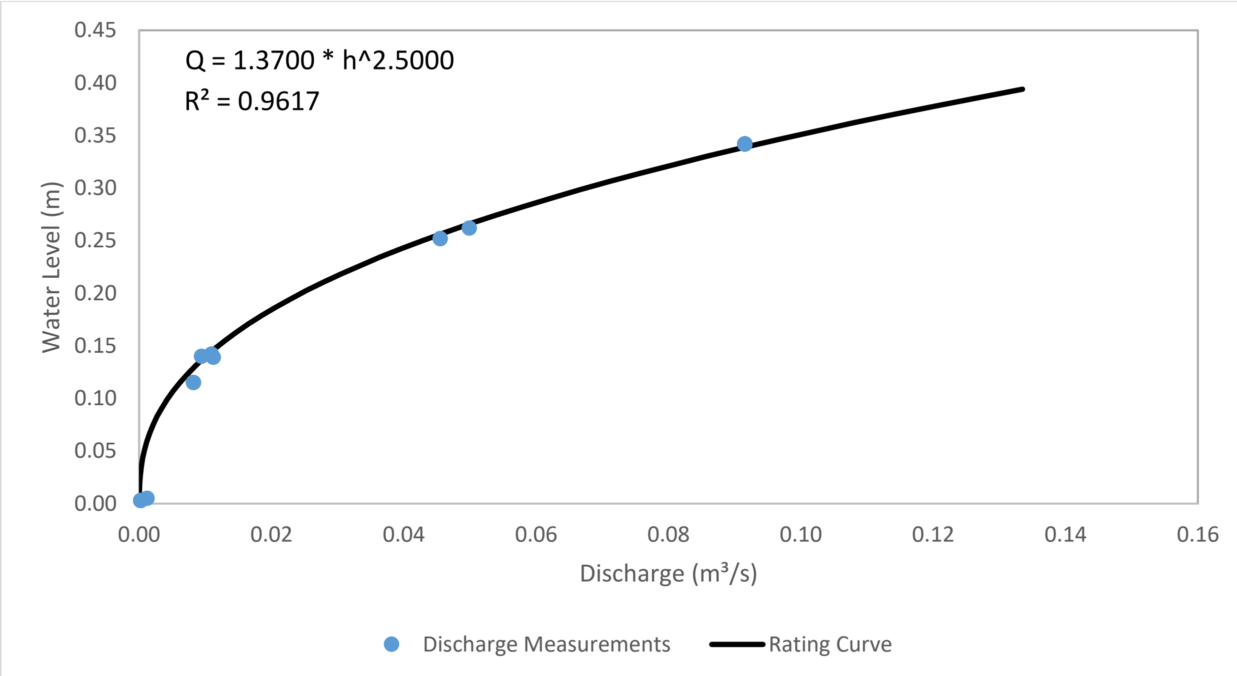


Figure 15: TL-7 2016 Hydrograph

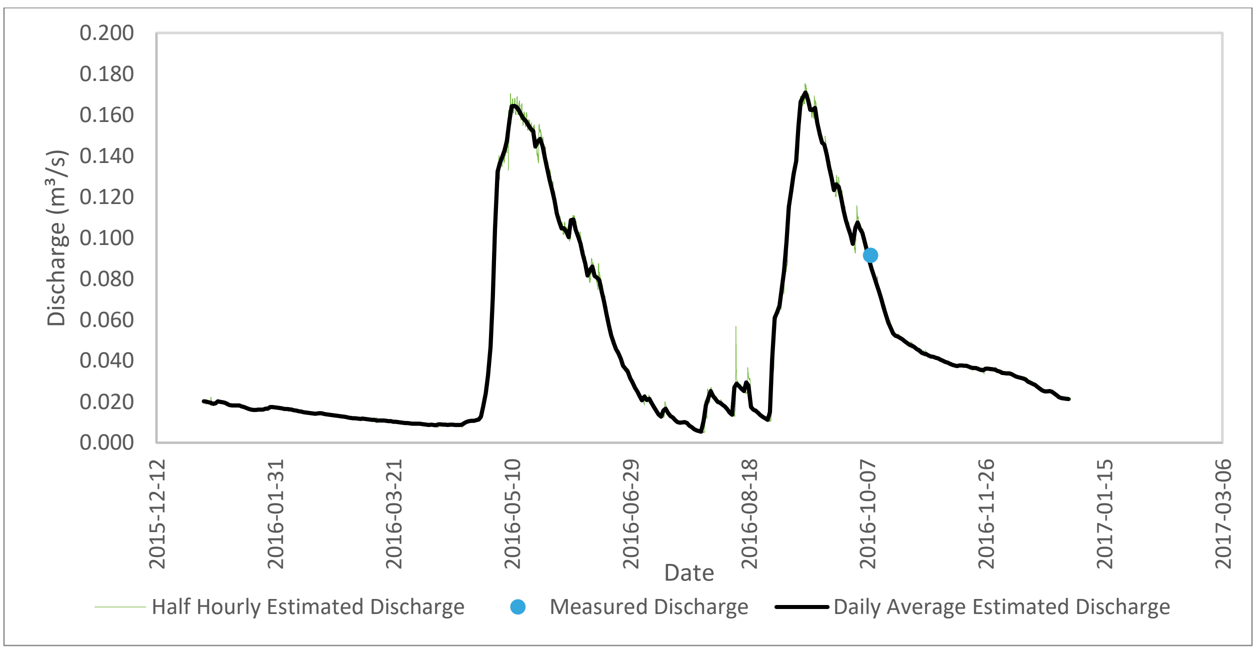


Table 16: TL-7 2016 Daily Average Discharge (m^3/s)

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0.0202	0.0171	0.0125	0.0093	0.0467	0.1048	0.0270	0.0222	0.0751	0.0971	0.0432	0.0351
2	0.0200	0.0169	0.0123	0.0091	0.0708	0.1030	0.0249	0.0252	0.0834	0.1048	0.0425	0.0347
3	0.0198	0.0168	0.0121	0.0090	0.1047	0.1003	0.0227	0.0229	0.0983	0.1075	0.0421	0.0342
4	0.0194	0.0165	0.0120	0.0088	0.1324	0.1085	0.0206	0.0214	0.1150	0.1046	0.0420	0.0339
5	0.0190	0.0164	0.0120	0.0087	0.1365	0.1090	0.0225	0.0199	0.1233	0.1023	0.0415	0.0339
6	0.0193	0.0164	0.0118	0.0088	0.1397	0.1039	0.0209	0.0195	0.1311	0.0982	0.0411	0.0339
7	0.0202	0.0162	0.0116	0.0087	0.1428	0.1005	0.0214	0.0185	0.1373	0.0932	0.0406	0.0335
8	0.0199	0.0159	0.0118	0.0085	0.1473	0.0972	0.0194	0.0177	0.1540	0.0886	0.0401	0.0329
9	0.0197	0.0157	0.0116	0.0090	0.1571	0.0921	0.0176	0.0163	0.1664	0.0847	0.0395	0.0323
10	0.0194	0.0154	0.0115	0.0090	0.1642	0.0873	0.0155	0.0147	0.1689	0.0809	0.0391	0.0319
11	0.0188	0.0152	0.0113	0.0089	0.1643	0.0816	0.0138	0.0136	0.1710	0.0776	0.0385	0.0315
12	0.0183	0.0150	0.0112	0.0088	0.1639	0.0844	0.0127	0.0272	0.1673	0.0738	0.0380	0.0313
13	0.0181	0.0147	0.0111	0.0086	0.1623	0.0859	0.0157	0.0288	0.1625	0.0702	0.0378	0.0308
14	0.0181	0.0146	0.0108	0.0088	0.1600	0.0814	0.0166	0.0275	0.1624	0.0661	0.0374	0.0298
15	0.0182	0.0145	0.0108	0.0088	0.1582	0.0805	0.0144	0.0262	0.1634	0.0620	0.0378	0.0292
16	0.0181	0.0142	0.0108	0.0087	0.1568	0.0793	0.0130	0.0252	0.1561	0.0587	0.0377	0.0287
17	0.0178	0.0141	0.0109	0.0086	0.1550	0.0733	0.0122	0.0294	0.1504	0.0558	0.0376	0.0281
18	0.0174	0.0142	0.0107	0.0086	0.1532	0.0687	0.0110	0.0278	0.1464	0.0533	0.0376	0.0272
19	0.0169	0.0145	0.0106	0.0088	0.1522	0.0629	0.0101	0.0173	0.1454	0.0522	0.0372	0.0263
20	0.0165	0.0143	0.0105	0.0096	0.1445	0.0571	0.0097	0.0161	0.1403	0.0518	0.0366	0.0255
21	0.0162	0.0140	0.0103	0.0102	0.1472	0.0524	0.0100	0.0156	0.1345	0.0511	0.0364	0.0250
22	0.0160	0.0138	0.0102	0.0105	0.1482	0.0486	0.0101	0.0146	0.1291	0.0504	0.0364	0.0251
23	0.0160	0.0136	0.0100	0.0107	0.1446	0.0457	0.0095	0.0135	0.1232	0.0495	0.0360	0.0252
24	0.0161	0.0134	0.0099	0.0107	0.1389	0.0439	0.0083	0.0126	0.1261	0.0486	0.0356	0.0250
25	0.0161	0.0133	0.0098	0.0109	0.1338	0.0410	0.0075	0.0119	0.1248	0.0478	0.0353	0.0241
26	0.0161	0.0132	0.0097	0.0113	0.1280	0.0375	0.0066	0.0112	0.1199	0.0473	0.0362	0.0232
27	0.0166	0.0130	0.0095	0.0128	0.1236	0.0361	0.0060	0.0149	0.1135	0.0465	0.0361	0.0223
28	0.0166	0.0128	0.0094	0.0177	0.1181	0.0346	0.0058	0.0408	0.1088	0.0456	0.0361	0.0219
29	0.0174	0.0127	0.0093	0.0241	0.1119	0.0317	0.0054	0.0609	0.1051	0.0450	0.0359	0.0217
30	0.0174		0.0092	0.0328	0.1082	0.0293	0.0109	0.0635	0.1014	0.0440	0.0356	0.0215
31	0.0173		0.0093		0.1045		0.0184	0.0669		0.0435		0.0213
Average	0.0180	0.0148	0.0108	0.0110	0.1361	0.0721	0.0142	0.0246	0.1335	0.0678	0.0382	0.0284

Table 17: 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
Mean	0.0067	0.0055	0.0048	0.0057	0.0544	0.0385	0.0210	0.0173	0.0212	0.0178	0.0170	0.0099	0.0183

4.8 BL-5 – BEAVERLODGE LAKE OUTFLOW

The station BL-5 monitors discharge at the outlet of Beaverlodge Lake. The station was not visited until August, 2016 due to spring ice conditions. Summer and fall field program photos are shown as Photo 16 and Photo 17, respectively. 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. The 2016 reporting year again experienced a shift in the rating curve requiring re-assessment of the rating curve for estimation of the hydrograph. For 2016, the water level data in the rating curve are referenced from the location of the datalogger rather than the measurement cross-section. The summary data are presented in Table 18 and the rating curve presented in Figure 16. The 2016 hydrograph is shown in Figure 17 and the daily average discharge data are provided in Table 19.

It is MWSI's understanding that at this location, the stream alignment between Beaverlodge and Martin Lakes, was historically used to transport infrastructure and potentially personal from Uranium City to the mine site prior to construction of the road. There is some evidence that part of the infrastructure between the two lakes may be partially responsible for the shifts in the rating curve as it degrades over time. It may be worth considering removal of some of this infrastructure during the 2017 field season in an attempt to restore the hydraulic geometry at this cross-section to a more stable condition.

Photo 16: BL-5 – August 11, 2016

Photo 17: BL-5 – October 7, 2016

Table 18: 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

Figure 16: BL-5 Rating Curve

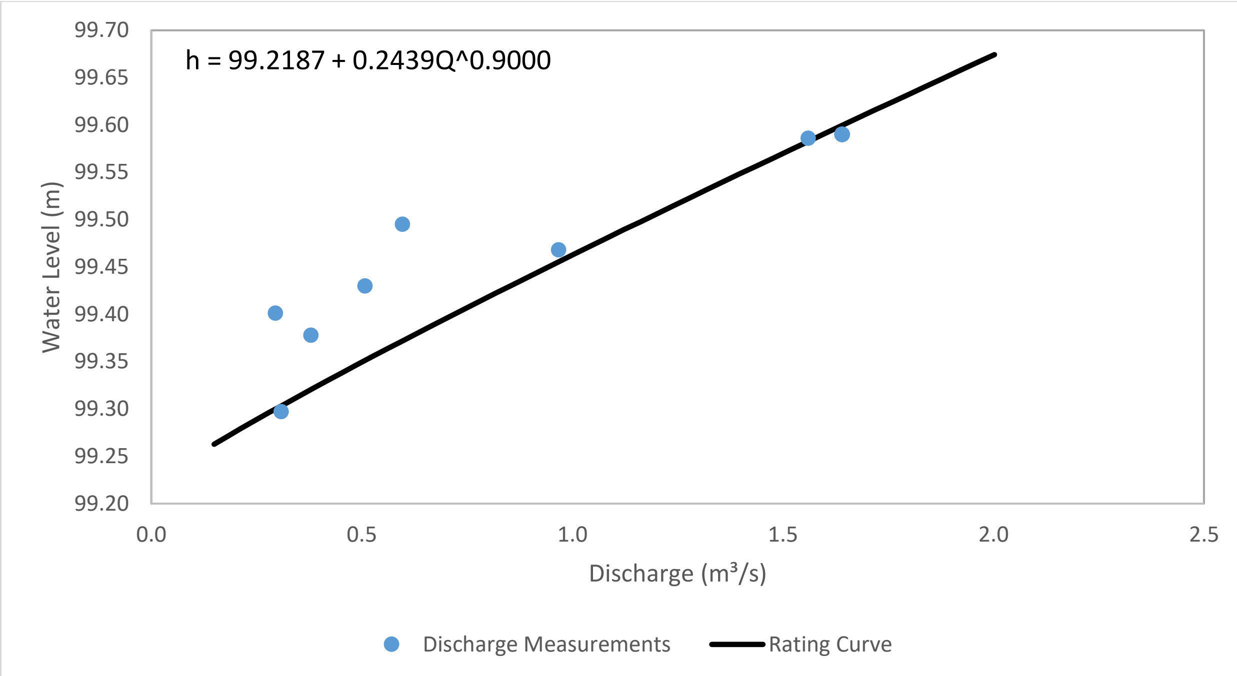


Figure 17: BL-5 2016 Hydrograph

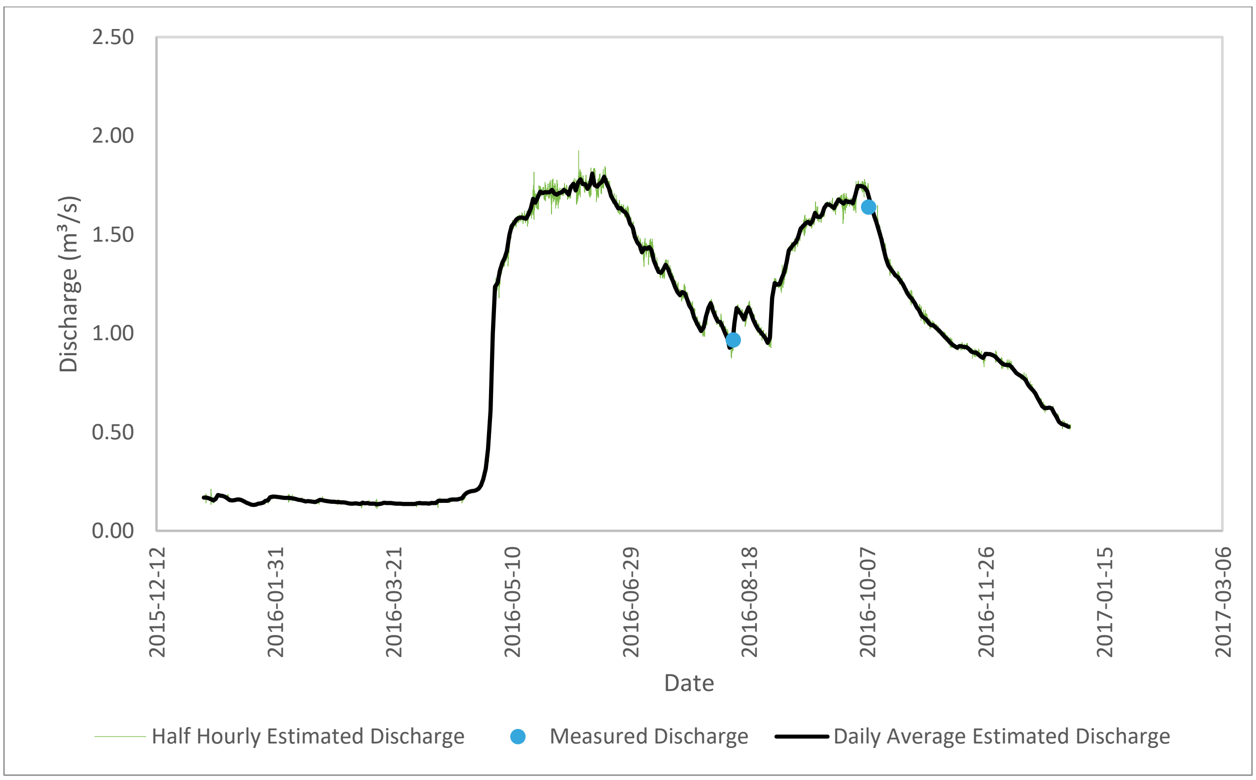


Table 19: BL-5 2016 Daily Average Discharge (m³/s)

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0.169	0.171	0.142	0.141	0.610	1.727	1.488	1.129	1.279	1.659	1.070	0.871
2	0.168	0.171	0.140	0.140	0.996	1.716	1.459	1.152	1.307	1.701	1.053	0.860
3	0.165	0.169	0.138	0.139	1.236	1.702	1.445	1.115	1.359	1.746	1.043	0.847
4	0.161	0.167	0.138	0.139	1.255	1.742	1.411	1.082	1.420	1.747	1.040	0.842
5	0.154	0.166	0.139	0.138	1.316	1.758	1.433	1.061	1.435	1.744	1.029	0.840
6	0.163	0.167	0.138	0.142	1.359	1.723	1.428	1.056	1.450	1.737	1.018	0.839
7	0.181	0.165	0.137	0.141	1.382	1.764	1.437	1.033	1.464	1.720	1.006	0.830
8	0.178	0.163	0.142	0.140	1.417	1.780	1.421	1.006	1.492	1.679	0.993	0.815
9	0.176	0.160	0.140	0.152	1.499	1.755	1.369	0.975	1.531	1.638	0.979	0.800
10	0.172	0.157	0.140	0.153	1.544	1.756	1.337	0.927	1.543	1.593	0.970	0.790
11	0.163	0.156	0.138	0.153	1.559	1.732	1.312	0.936	1.556	1.561	0.954	0.782
12	0.155	0.153	0.137	0.153	1.577	1.754	1.306	1.051	1.565	1.518	0.943	0.775
13	0.154	0.149	0.138	0.152	1.585	1.809	1.325	1.128	1.553	1.479	0.936	0.763
14	0.156	0.150	0.135	0.157	1.587	1.750	1.348	1.109	1.570	1.428	0.928	0.739
15	0.159	0.150	0.137	0.159	1.584	1.742	1.325	1.096	1.610	1.377	0.936	0.725
16	0.159	0.147	0.138	0.159	1.580	1.757	1.293	1.069	1.590	1.344	0.934	0.711
17	0.155	0.146	0.142	0.159	1.601	1.768	1.265	1.103	1.588	1.324	0.931	0.697
18	0.149	0.151	0.141	0.161	1.635	1.793	1.234	1.132	1.602	1.310	0.931	0.674
19	0.143	0.158	0.140	0.165	1.681	1.762	1.209	1.101	1.635	1.294	0.921	0.652
20	0.137	0.156	0.140	0.182	1.661	1.735	1.193	1.069	1.654	1.283	0.908	0.631
21	0.133	0.153	0.138	0.192	1.692	1.694	1.209	1.041	1.652	1.267	0.903	0.620
22	0.132	0.150	0.138	0.198	1.718	1.671	1.202	1.022	1.643	1.249	0.903	0.622
23	0.133	0.149	0.137	0.201	1.710	1.653	1.173	1.008	1.635	1.227	0.893	0.625
24	0.137	0.147	0.137	0.203	1.715	1.632	1.140	0.993	1.657	1.205	0.882	0.619
25	0.139	0.147	0.136	0.206	1.714	1.634	1.120	0.977	1.679	1.185	0.875	0.597
26	0.142	0.146	0.136	0.213	1.716	1.619	1.082	0.951	1.667	1.174	0.897	0.575
27	0.153	0.146	0.136	0.229	1.727	1.611	1.053	0.978	1.657	1.154	0.895	0.553
28	0.154	0.144	0.135	0.261	1.706	1.593	1.033	1.180	1.672	1.131	0.894	0.542
29	0.171	0.144	0.135	0.315	1.702	1.555	1.011	1.255	1.665	1.117	0.890	0.538
30	0.173		0.136	0.414	1.710	1.537	1.029	1.246	1.666	1.090	0.883	0.533
31	0.173		0.139		1.713		1.085	1.249		1.079		0.527
Average	0.157	0.155	0.138	0.182	1.532	1.707	1.264	1.072	1.560	1.412	0.948	0.704

4.9 CS-1 CRACKINGSTONE RIVER

The Crackingstone River is located downstream of Cinch Lake which receives discharge from Beaverlodge 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 18) and fall (Photo 19) of 2016. The measurement data for CS-1 are presented in Table 20 and the rating curve is shown in Figure 18. Figure 19 depicts the hydrograph for 2016. The daily average discharge data are presented in Table 21.

Photo 18: CS-1 – May 5, 2016

Photo 19: CS-1 – October 8, 2016

Table 20: 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
2013-10-12 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

Figure 18: CS-1 Rating Curve

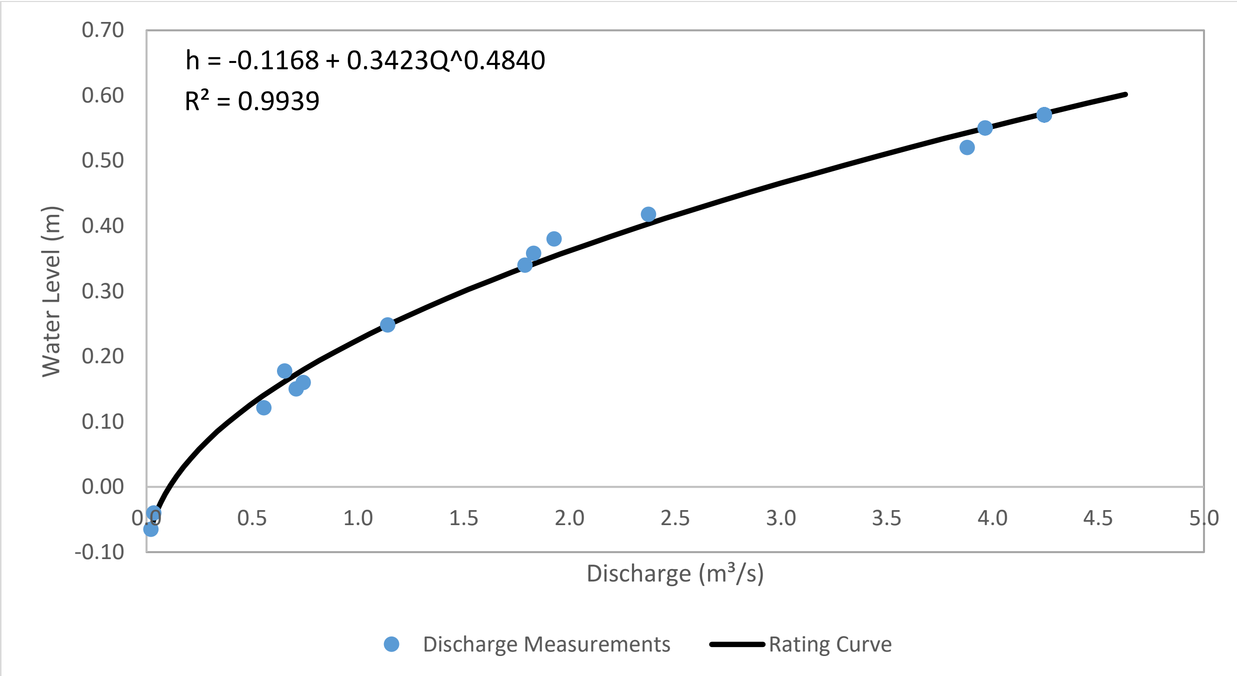


Figure 19: CS-1 2016 Hydrograph

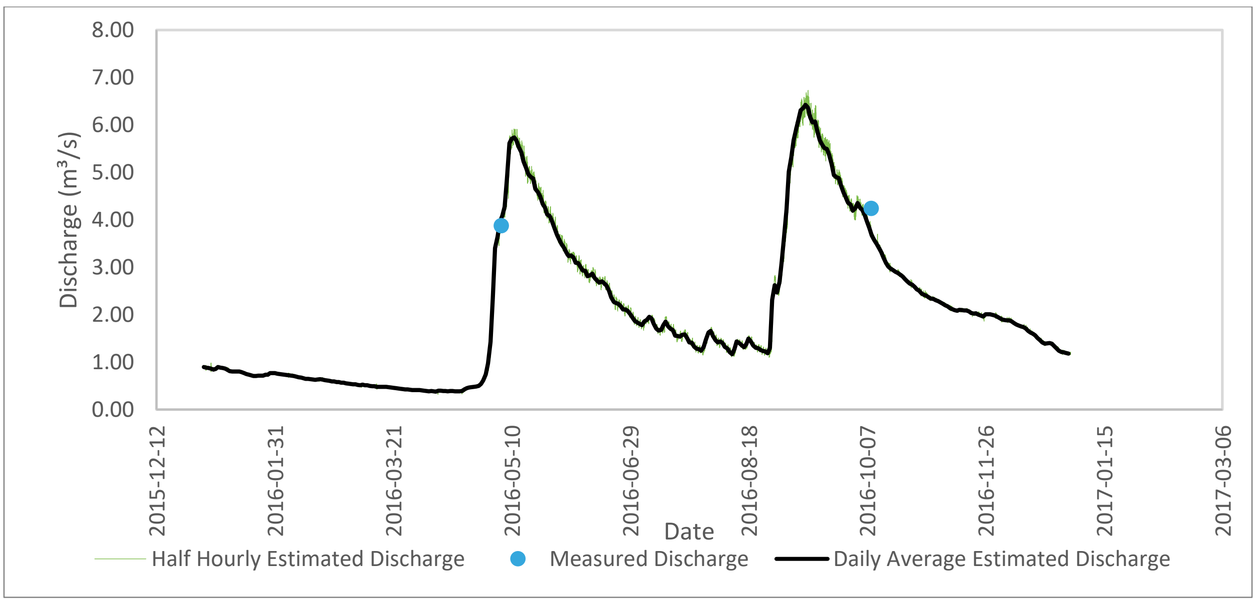


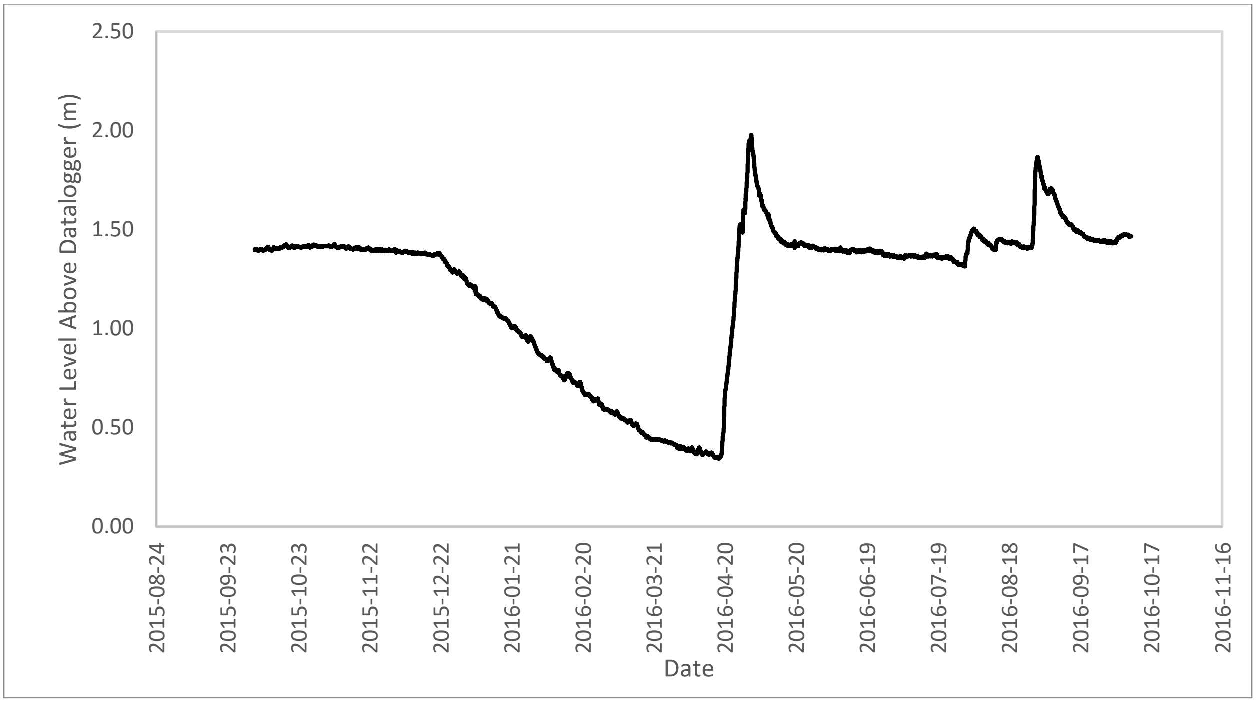
Table 21: CS-1 2016 Daily Average Discharge (m³/s)

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0.894	0.757	0.555	0.412	1.431	3.420	1.870	1.627	3.125	4.191	2.401	1.953
2	0.886	0.751	0.545	0.404	2.342	3.310	1.830	1.655	3.627	4.247	2.363	1.928
3	0.875	0.742	0.536	0.398	3.401	3.233	1.810	1.547	4.229	4.352	2.339	1.900
4	0.861	0.732	0.531	0.392	3.646	3.246	1.782	1.466	5.017	4.260	2.333	1.888
5	0.840	0.727	0.530	0.385	3.951	3.211	1.862	1.413	5.327	4.203	2.308	1.884
6	0.856	0.724	0.522	0.390	4.090	3.091	1.886	1.433	5.674	4.107	2.284	1.883
7	0.894	0.716	0.515	0.385	4.270	3.085	1.951	1.401	5.913	3.949	2.257	1.861
8	0.882	0.705	0.523	0.377	4.855	3.003	1.923	1.319	6.108	3.820	2.228	1.829
9	0.873	0.694	0.514	0.399	5.615	2.932	1.808	1.286	6.308	3.675	2.196	1.794
10	0.859	0.683	0.510	0.398	5.710	2.926	1.706	1.216	6.356	3.574	2.175	1.773
11	0.835	0.674	0.500	0.393	5.738	2.811	1.666	1.167	6.424	3.501	2.139	1.754
12	0.811	0.663	0.494	0.389	5.665	2.831	1.680	1.271	6.365	3.405	2.115	1.739
13	0.803	0.650	0.491	0.383	5.532	2.868	1.776	1.435	6.162	3.316	2.099	1.712
14	0.803	0.648	0.479	0.389	5.425	2.774	1.851	1.402	6.054	3.204	2.081	1.658
15	0.805	0.642	0.479	0.390	5.229	2.714	1.754	1.360	6.076	3.088	2.100	1.625
16	0.802	0.631	0.478	0.384	5.097	2.675	1.708	1.315	5.870	3.016	2.094	1.596
17	0.788	0.625	0.481	0.381	4.960	2.701	1.674	1.376	5.676	2.969	2.089	1.564
18	0.770	0.631	0.476	0.381	4.900	2.665	1.555	1.494	5.586	2.938	2.089	1.511
19	0.750	0.643	0.469	0.388	4.876	2.615	1.550	1.428	5.516	2.903	2.066	1.463
20	0.733	0.633	0.464	0.427	4.647	2.506	1.534	1.349	5.494	2.878	2.038	1.416
21	0.718	0.622	0.456	0.451	4.584	2.367	1.580	1.299	5.370	2.842	2.025	1.391
22	0.710	0.612	0.450	0.464	4.496	2.271	1.587	1.294	5.171	2.803	2.026	1.395
23	0.707	0.604	0.443	0.473	4.334	2.244	1.509	1.263	4.943	2.752	2.003	1.401
24	0.714	0.595	0.438	0.476	4.257	2.229	1.417	1.231	4.902	2.702	1.979	1.388
25	0.714	0.590	0.432	0.485	4.109	2.174	1.406	1.225	4.878	2.657	1.963	1.338
26	0.715	0.583	0.427	0.501	4.076	2.113	1.328	1.189	4.721	2.632	2.011	1.290
27	0.737	0.578	0.423	0.538	3.973	2.108	1.280	1.299	4.579	2.588	2.007	1.240
28	0.735	0.569	0.416	0.612	3.819	2.074	1.276	2.313	4.474	2.537	2.005	1.215
29	0.769	0.564	0.412	0.740	3.692	2.013	1.241	2.621	4.360	2.505	1.997	1.207
30	0.769		0.409	0.971	3.589	1.936	1.323	2.466	4.318	2.444	1.982	1.196
31	0.766		0.411		3.485		1.473	2.690		2.421		1.182
Average	0.796	0.655	0.478	0.452	4.380	2.671	1.632	1.511	5.287	3.241	2.126	1.580

4.10 FAY SHAFT

The Fay Shaft was the main vertical access to the underground workings at the Site. The shaft and underground workings are presently flooded and a stage datalogger has been installed in the shaft for several years suspended from the top of the cap. On October 8, 2016 at 3:30 pm the water level was approximately 24.3 m below the top of the cap. Figure 20 shows the fluctuation of the water level in the shaft presented as "water level above the sensor" which shows response to snowmelt runoff and rainfall events through 2016.

Figure 20: Fay Shaft Recorded Water Level



5.0 BOREHOLE SURVEY

During the spring and fall field programs various known boreholes were observed either for leakage from the seals or if they have begun to discharge. As in previous years, BH-007 was noted to have a very small unmeasurable seepage. The remaining boreholes were dry at the time of observation.

6.0 SEEP DISCHARGE MONITORING AND TIME LAPSE CAMERAS

At Cameco's request, MWSI deployed time lapse cameras at Seeps 2, 3 and 4/5 to assist with determining the rainfall response of the seeps. The video sequences collected from each of the cameras have been provided to Cameco electronically at the time of issuance of this document in its Final version.

During the spring field program the Seeps were not measured for discharge. On October 8, 2016, the seeps were observed for discharge as follows:

- Seep 1 was flowing but unmeasurable (very low discharge);
- Seep 2 was flowing but unmeasurable (very low discharge);
- Seep 3 was estimated to be flowing between 0.05 to 0.10 L/s;
- Seep 4 was measured at approximately 0.28 L/s; and,
- Seep 5 had negligible flow (very low discharge).

No attempt has been made to correlate flow relationships to the photographic record at each station. The Seeps do show a visual response to rainfall events.

7.0 RECOMMENDATIONS

Through discussion with the manufacturer of the dataloggers (Solinst Canada) MWSI understands that on older Leveloggers the battery life indicator may be faulty. The datalogger at AC-8 and the barometric pressure datalogger are both of this older style. Cameco should consider either purchasing an additional Levelogger (and Barologger) for deployment at AC-8. Alternatively, one datalogger could be moved from a different station to this location; however, a new Barologger would still be required.

MWSI believes that the drifting rating curve at BL-5 is a function of the debris jams located immediately downstream of the measurement cross-section and their degrading states. It may be possible to improve the hydraulics of the channel by removing some of this debris. The level of effort required to complete this task can be assessed upon request and incorporated into field work in 2017.

8.0 SUMMARY AND CLOSURE

Cameco has retained MWSI for monitoring and reporting of discharges in the vicinity of the former mine near Beaverlodge Lake. This reporting consists of the monitoring data and other pertinent observations recorded during the field programs.

Climate records for Uranium City indicate that 2016 was above normal based on annual totals but with large rainfalls in August and somewhat dry early summer. Flow records developed for each station reflect this observation as the peak flows in 2016 occurred both during snowmelt runoff and following rain events in August and September.

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. If there are 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

9.0 REFERENCES

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