AREVA

Kiggavik Project
Final Environmental Impact Statement

Tier 3 Technical Appendix 5M: Aquatic Effects Monitoring Plan

September 2014

History of Revisions

Revision Number	Date	Details of Revisions
01	December 2011	First Issue with Draft Environmental Impact Statement
02	September 2014	Issued for Final Environmental Impact Statement

A management plan is a living document which is continually reviewed and revised throughout the life of the Project to ensure it meets health, safety, and environmental performance standards. This process of adaptive management and continual improvement (Tier 2, Volume 2, Section 17) is consistent with the Inuit Qaujimajatuqangit (IQ) principles of Qanuqtuurunnarniq *being resourceful and flexible to solve problems* and Pilimmaksarniq *maintaining and improving skills through experience and practice.*

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Abbreviations

e.g. ....example
AEMP……………………………………………………………Aquatic Effects Monitoring Program
AETE…………………………………………………………Aquatic Effects Technology Evaluation
AREVA……………………………………………………………….AREVA Resources Canada Inc.
CANMET………………………………………Canada Centre for Mineral and Energy Technology
CFOP………………………………………………………….… Conceptual Fisheries Offsetting Plan
CNSC…………………………………………………………Canadian Nuclear Safety Commission
CSA………………………………………………………………………Canadian Safety Association
COPC……………………………………………………………..……..Constituents of Potential Concern
DFO……………………………………………………………….. Department of Fisheries and Oceans
EEM………………………………………………………………Environmental Effects Monitoring
EIS………………………………………………………………………Environmental Impact Statement
IMS……………………………………………………………..……..Integrated Management System
LAA…………………………………………………………………………..…..Local Assessment Area
MMER………………………………………………………………..Metal Mining Effluent Regulations
MMLER………………………………………………………... Metal Mining Liquid Effluent Regulations
NIRB……………………………………………………………………Nunavut Impact Review Board
QA/QC………………………………………………………………..quality assurance/quality control
TAP………………………………………………………………………………Technical Advisory Panel
TDS……………………………………………………………………………….Total Dissolved Solids
TMF……………………………………………………………………….....Tailings Management Facility
TSS……………………………………………………………………………...Total Suspended Solids
UMMR……………………………………………………………....Uranium Mines and Mills Regulations
VEC……………………………………………………………..……..Valued Ecosystem Component

1 Introduction

Pursuant to the aquatic effects assessment outlined in the Kiggavik Project Environmental Impact Statement (EIS) Volume 5, AREVA Resources Inc. (AREVA) will design and implement an Aquatic Effects Monitoring Program (AEMP) which takes into account the range of Project activities and potential project-environment interactions identified in the EIS as being of concern for aquatic Valued Ecosystem Components (VECs). As outlined in Volume 2, Tier 3, Technical Appendix 2T, Section 2.2.2, AREVA ‘s integrated approach to environmental protection is based on continual improvement, incorporating the concepts of both a precautionary approach and adaptive management. Performance is continually monitored to confirm acceptability and identify additional mitigation measures where needed and to update predictions of environmental effects. Environmental monitoring and follow-up programs are continually reviewed for improvement opportunities. AREVA’s monitoring programs are included within the larger Integrated Management System (IMS), as described in Appendix 2T, Section 3. The IMS is the equivalent of NIRB’s Environmental Management Plan (EMP). The IMS is established to meet the needs of the Project, regulatory agencies and management system standards. Once the environmental assessment is completed, AREVA will apply for various permits and licences. Each environmental aspect will be reviewed and detailed monitoring plans and designs will be developed/reviewed at each stage of the Project.

The practices and frameworks outlined above, demonstrate AREVA’s compliance to the Guiding Principles of Inuit Qaujimajatuqangit as outlined in the Nunavut Wildlife Act (10:8(b)) in which there is an obligation of guardianship or stewardship that a person may owe in relation to something that does not belong to the person. AREVA’s monitoring programs will ensure that environmental effects remain within those predicted in the EA and that no significant environmental effects will occur as a result of the Project.

When developed, the Kiggavik Project will be a nuclear facility, and will be required to comply with the Nuclear Safety and Control Act, which came into force on May 31, 2000 (see Appendix 2T, Section 2.3). A licence is required from the CNSC, the regulatory agency that oversees all nuclear projects in Canada. The Canadian Safety Association (CSA) has developed risk-based standards for the protection of the environment in conformance with the regulations under the Act which the CNSC has chosen to adopt as part of their licensing requirements. The CSA standards are developed through a consensus standards development process approved by the Standards Council of Canada. This process brings together volunteers representing varied viewpoints and interests to achieve consensus and develop a standard.

Currently, three CSA standards will apply to the Kiggavik Project environmental monitoring program once the Project is licenced beyond exploration activities:

- N288.4-10 Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills
- N288.5-11 Effluent monitoring programs at Class I nuclear facilities and uranium mines
- N288.6-12 Environmental risk assessments at Class I nuclear facilities and uranium mines and mills

During the CNSC licensing process, which occurs only after the environmental assessment has been approved, these three standards will be used to demonstrate that AREVA is a competent operator. Monitoring activities outlined in Appendix 5M, will conform to the CSA standards listed above, when appropriate. The Standards are not a replacement for the requirements contained in the Nuclear Safety and Control Act and its regulations or other legislation, standards or guides.

The purpose of the AEMP will be to monitor components of the aquatic environment and their associated project activities (e.g., effluent release) in order to assess potential ecological risks so that appropriate actions can be taken to mitigate possible adverse effects. In addition, the AEMP will address any mitigation measures to be implemented to protect and minimize effects on the aquatic environment and ensure that mitigation measures are working as predicted.

In addition to the issues identified in the EIS, the AEMP will be designed to incorporate the terms and conditions of a number of permitting and regulatory considerations. These include the guidelines prepared by the Nunavut Impact Review Board (NIRB) in relation to the development of the Kiggavik Project EIS, and the subsequent AEMP; as well as the prospective Class A Water License issued by the Nunavut Water Board (NWB); the Fisheries Authorization that would be issued by the Department of Fisheries and Oceans in relation to DFO's Fisheries Protection Provisions; and the licence(s) and Licence Conditions Handbook (see Appendix 2T, Section 2.3) that would be issued by the CNSC throughout the life of the Project, as well as associated CSA Standards. Additionally, the Project will be required to comply with the Metal Mining Effluent Regulations (MMER) which stipulate discharge limits for deleterious substances, and require routine monitoring of Mine water effluent (MMER; Government of Canada 2012). In association with the MMER, the Project will also be required to conduct Environmental Effects Monitoring as specified in the regulations and guidelines administered by Environment Canada. The AEMP will therefore be designed in consideration of the objectives and requirements set out in the MMER. In addition, the AEMP will incorporate the requirements of Nunavut's Scientists Act.

2 Objectives

The specific objectives of the AEMP as outlined by the NWB will be to determine the short- and long-term effects in the aquatic environment resulting from the Project, evaluate the accuracy of effects assessment predictions, assess the effectiveness of planned mitigation measures, and identify additional mitigation measures to avert or reduce environmental effects. In addition, the primary stated objective of EEM is to evaluate the effects of mining effluent on fish, fish habitat, and the use of fisheries resources (Environment Canada 2002).

The particular focus of the Kiggavik Project Aquatic Effects Monitoring Program will be in relation to the primary VECs identified in the Project EIS for the Aquatic Environment. These include hydrology, hydrogeology, water quality, sediment quality, aquatic organisms, fish populations, and fish habitat. The intent of the AEMP will be to function as an integrated monitoring program which considers a variety of pathways identified as pertinent to the aquatic VECs including:

- the possible effect of water extraction, storage and discharge on the downstream environment;
- alteration of drainage patterns and construction of diversion channels by project infrastructure;
- dewatering of the Andrew Lake Pit; increase in contaminants and radioactive material in groundwater and surface water;
- effects of discharges from Project wastewater treatment plants;
- effects from the deposition of dust and metals; aquatic habitat destruction and/or alteration from Project development activities; and
- effects on fish due to blasting in or near water bodies; and other potential effects described in the EIS.

3 Design Considerations

The aquatic environmental monitoring programs at the Kiggavik and Sissons Mines will be designed to take into account special issues in northern Canada and will be developed in consultation with interested stakeholders. The AEMP will incorporate Inuit Qaujimajatuqangit and the results of Engagement activities and will emphasize issues and concerns that are relevant to sensitive northern ecosystems. The AEMP will also be subject to adaptive management; in other words, it will not be a static document, but rather will be updated as necessary and as new information or findings become available as per the IMS outlined in Volume 2, Tier 3, Technical Appendix 2T, Section 3. Therefore, the scope of the AEMP will change over the life of the Project, as the Project moves from construction into operations then to closure and post-closure. Changes to the AEMP will be done in a consultative manner with key stakeholders and regulatory agencies

Monitoring and sampling techniques, and analytical procedures and data analysis techniques employed in the AEMP will be consistent with those used during the quantitative baseline collection programs, as much as possible. The quantitative aquatic data collected during extensive baseline studies will provide a robust dataset with which to compare monitoring results. Field and laboratory procedures will include quality assurance/quality control measures for all aspects of sampling and analysis including data acquisition; water, sediment, and aquatic biota sampling; and during the data analysis and reporting phases. Components of the AEMP will be developed according to a common, statistically-based study design incorporating regulatory guidance and current scientific principles related to aquatic monitoring. The assessment of data and information collected during future monitoring programs will be compiled into periodic monitoring reports which will be submitted to the appropriate regulatory agencies for review (see Volume 2, Tier 3, Technical Appendix 2T Sections 2.2.2 and 5.1.5).

4 Potential Mitigation Activities

As outlined in Volume 2, Tier 3, Technical Appendix 2T, AREVA's Environmental Protection Framework provides an integrated approach to facility design, mitigation, and environmental assessment, and outlines how the outcomes of these processes are integrated into facility construction, operation and decommissioning. Furthermore, the Environmental Protection Framework outlines how the results of monitoring and follow-up programs are incorporated into evaluation processes which facilitate the identification of continual improvement initiatives and adaptive management requirements, when necessary. The framework also outlines the mechanisms by which these processes and initiatives are communicated to stakeholders.

As part of the environmental assessment process, mitigation measures are incorporated into the Project to avoid and minimize potential adverse environmental effects. Mitigation measures consist of industry best technologies and practices and incorporate the learning-based experiences of other development projects.

A number of mitigation activities are planned in order to reduce the effects of the Project on aquatic VECs. These include a variety of Project environmental design features, specialized mitigation, and environmental protection plans (i.e., sediment and erosion control plans), as well as potential fisheries offsetting plans. These mitigation measures can generally be classified as mitigation by design, and mitigation by management. The information presented below provides a summary of mitigation measures, divided into mitigation by design and management, which will be implemented to limit changes to hydrology, hydrogeology, water quality, sediment quality, aquatic organisms, fish populations, and fish habitat. Because effects to individual VECs are potentially accumulative in response to an alteration of another component of the aquatic environment (i.e., a change to water quality can subsequently affect the health of fish and other aquatic organisms), a single mitigation activity may serve to limit effects to a range of aquatic VECs. Therefore the list of mitigation activities planned for the aquatic environment is described collectively for all aquatic VECs.

4.1 Mitigation by Design

Many facility design features have been adopted to mitigate potential aquatic environmental effects. The main mitigation measures by design include:

- The site footprint for the Kiggavik and Sissons Mine and associated infrastructure will be minimized and situated such that natural drainage areas and watershed boundaries are maintained. This will reduce effects to flow rates and water levels in the aquatic environment.

- The site water system will be designed to recycle water where applicable, and water use will be minimized to limit withdrawal requirements and discharge quantities.
- The design of the Water Treatment Plant (WTP) will focus on the production of effluent that meets or exceeds all appropriate regulations, such as the MMER, as well as site-specific discharge limits. This will reduce potential accumulative effects to sediment quality, and fish and aquatic organism health.
- The proposed tailings management plan has been designed to avoid interaction between tailings and natural water bodies, to maximize the use of mine workings for long-term management of tailings, and to ensure the long-term protection of terrestrial, aquatic, and human environments.
- The tailings treatment system in the mill and the Tailings Management Facilities will be designed to minimize the release of constituents of potential concern (COPC) into the aquatic environment.
- Diversion channels will be designed to intercept freshwater from upslope areas, divert it around development areas, and reintroduce it to natural stream channels further downstream. This will limit effects to flow patterns, downstream flow rates, and minimize potential of erosion.
- During decommissioning, the ground surface will be recontoured and natural flow patterns will be restored to help maintain pre-mining flow patterns and conditions, waterbody characteristics and natural aquatic ecosystems.
- Sedimentation ponds associated with the surface water diversion channels will be designed with a control structure so that evaporative losses can be minimized and sufficient water can be returned to the downstream environment to maintain aquatic ecosystems.
- Scrubbers are being considered for installation on emissions from the sulphuric acid plant, and NOx control systems are being considered for installation on the oil-fired power generators and/or product driers to mitigate the release of acid generating materials to the atmosphere. This will limit the potential for lake acidification and successive effects to aquatic organism health.
- Snow fences will be constructed to limit snow drifting on site and therefore prevent potential elevated flow rates, erosion, and subsequent effects to the aquatic ecosystem during the spring freshet immediately downstream of site.
- In-water construction will follow standard protocols and best management practices.
- Roads constructed in association with the Project will be designed so that natural flow paths intercepted by the route are preserved with adequately designed cross-drainage structures (i.e., culverts). Construction of stream crossings will be completed in such a way that potential effects to fish and fish habitat are mitigated.
- Drilling and blasting activities will be designed to avoid impacts to fish populations (Volume 2, Tier 3, Technical Appendix 2B).

4.2 Mitigation by Management

Many management practices mitigate potential environmental effects. This often includes the development, use, enforcement, and revision of codes of practice, procedures and work instructions, and staff training and auditing, as outlined in Volume 2, Tier 3, Technical Appendix 2T. The main mitigation measures by management include:

- Water will be discharged into large waterbodies to reduce effects on sediment quality, water quantity, and downstream aquatic ecosystems.
- Best management practices have been incorporated into the Project design to control surface water runoff and minimize the potential for erosion and effects to water quality and aquatic ecosystems (Volume 5, Tier 3, Technical Appendix 5O Sediment and Erosion Control Plan).
- Measures will be taken to minimize the amount of dust generated at the two mine sites and along the main haul road between the mine sites. This will reduce the deposition of particulates and metals into local waterbodies.
- Andrew Lake pit will be dewatered during the construction phase and refilled with water during the closure phase at a rate such that effects to water quality and sediment quality are minimized. Only water that meets discharge criteria will be released directly to the environment.
- During project construction, the Andrew Lake Pit area will be dewatered after the spring freshet and spring spawning season and before freeze-up (July/August) to reduce the volume of water that will require pumping and to ensure that Andrew Lake water levels do not exceed the annual peak level.
- DFO procedures for water withdrawal from ice-covered waterbodies in the Northwest Territories and Nunavut will be followed. Specifically, no more than 10% of the under-ice volume will be withdrawn from a lake during one ice covered season.
- In-water construction will follow standard protocols and best management practices.
- Use of a turbidity curtain to separate construction activities from the surrounding lake environment will limit total suspended sediment (TSS) released during the installation of the water intake structures, the effluent diffuser structures, and construction of the Andrew Lake Pit berm.
- Fish salvage will be completed before in-water construction activities associated with the development of the Andrew Lake Pit are initiated in order to minimize the potential for fish mortalities due to stranding. Salvaged fish will be returned to Andrew Lake outside of the construction area.
- An erosion and sediment control plan will be developed in association with Project construction activities taking place in or near waterbodies in order to reduce possible effects to water quality and fish habitat from surface water runoff and associated erosion. This plan will be developed prior to the start-up of construction, and will be followed throughout the duration of the construction. This plan will specify the erosion and sediment control measures that will be put into place by the construction contractors to

prevent the entry of sediment into waterbodies. Potential erosion control measures include minimizing the disturbed area, stabilizing exposed soil, and re-vegetating slopes. Sediment control measures will focus on intercepting sediment-laden runoff that has escaped the erosion control measures. Sediment control measures may include the use of silt fences, turbidity curtains, filter barriers, or control ponds. The selection of the best measures to control erosion and remove sediment will depend on the construction activity, local site conditions, and recommendations made by DFO and other regulatory agencies. The sediment and erosion control plan will be prepared in consultation with the construction contractor, DFO and other interested parties. The control measures will be inspected regularly by the construction contractors or AREVA during the course of construction. Necessary repairs will be made if any damage occurs. A conceptual erosion and sediment control plan is presented in Appendix 5O.

- An explosives management plan (Volume 2, Tier 3, Technical Appendix 2C, Section 4.1.1) for blasting near water will be implemented to protect fish and fish populations.
- A Conceptual Fisheries Offsetting Plan has been developed for the Project which describes both mitigation by design and by management (Appendix 5L). The Plan summarizes the measures that will be implemented to avoid or mitigate serious harm to fish and fish habitat that are part of, or support a commercial, recreational, or Aboriginal fishery. Requirements for offsetting potential effects to CRA fisheries are also described in the Conceptual Fisheries Offsetting Plan.

5 Scope of Potential Monitoring Programs

Three basic types of monitoring are planned following the key issues raised in the EIS; compliance monitoring and inspection, follow-up monitoring, and environmental effects monitoring. Cumulative effects monitoring is not proposed for the aquatic environment because the potential effects of the Project on the receiving environment do not extend beyond the local assessment area and, therefore, do not overlap with other regional projects. Results from the monitoring program will be evaluated against predicted performance, a process to identify design and management improvement opportunities, and adaptive management needs.

5.1 Compliance Monitoring and Inspections

Compliance monitoring and inspections are programs that are designed to confirm that the approved environmental design features and all appropriate construction design standards have been implemented as per the EIS. As each project component is constructed, the component will be inspected to ensure construction issues are managed and that the completed work has met the approved design standards. A check list will also be developed to show that agreed-upon environmental design features are constructed as required. Compliance monitoring and inspections will be primarily focused on the Project Footprint area covered by the Kiggavik and Sissons Mine Sites, as well as any associated Project infrastructure (i.e., utility corridors, roads, water intake and treated water discharge structures, and airstrip). Specifically, effluent monitoring programs will comply with CSA standard *N288.5-11 Effluent monitoring programs at Class I nuclear facilities and uranium mines and mill* and the requirements under the MMER. Compliance monitoring will extend throughout the life of the Project.

5.2 Follow-up Monitoring

Follow-up programs are tailored to verify the accuracy of EA predictions and to determine the effectiveness of mitigation practices. The nature of the information generated by the follow-up program relates to refining and verifying the assumptions of the assessment methodology and thereby both validating the predicted effects and reducing uncertainties in predictions made in future EAs. The feedback from the follow-up program in refining and verifying the assumptions of the assessment methodology also provides the basis for continual improvement in both the facility operation and the monitoring and follow-up programs themselves. Unforeseen or incremental effects beyond those predicted, which indicate the future development of significantly adverse effects, provide the information necessary to implement contingency practices to mitigate the development of these effects. Follow-up monitoring would include fisheries offsetting monitoring to ensure that the productivity of CRA fisheries is maintained or improved, as per DFO's policies, if offsetting is a requirement. .. Similar to compliance monitoring, follow-up monitoring is primarily associated with the Project Footprint area, but will include a number of monitoring activities in downstream waterbodies as well.

5.3 Environmental Effects Monitoring

There are strict requirements and controls at each phase of the Project as per the Uranium Mines and Mills Regulations (UMMR). Volume 2, Tier 3, Technical Appendix 2T Environmental Management Plan outlines the structure of the AREVA IMS and the environmental management, monitoring, mitigation and reporting plans that falls within it, as well as the robust regulatory structure and processes that determine how and when the system is developed and implemented. The UMMR requires AREVA obtain a licence by submitting information relating to the proposed work, programs to identify, assess and mitigate environmental risks to validate the Project efficacy and controls. AREVA will develop detailed environmental monitoring plans as part of its IMS required by CNSC *REG DOC-2.9.1 Environmental Protection: Environmental Protection Policies, Programs and Procedures*. Mitigation measures and monitoring requirements needed for licencing are included in the IMS. Guidance on the structures and function of the IMS and its programs at uranium mines and mills has been provided in the form of regulatory standards and guidance documents from the CNSC, and the nuclear standards developed by the CSA.

AREVA's environmental effects monitoring plan, part of the larger IMS, will be commensurate with the following documents:

- CNSC Regulatory Document REGDOC-2.9.1 Environmental Protection: Environmental Protection, Policies, Programs and Procedures
- CSA Standard N288.6-12 Environmental risk assessments at Class I nuclear facilities and uranium mines and mills (includes human health risk assessment).
- CSA Standard N288.4-10 Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills.

CSA Standard *N288.4-10 Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills*, provides the guidance on monitoring of radioactive and non-radioactive contaminants, physical stressors, potential biological effects, and pathways of effects for both human and non-human biota. The design of the monitoring program is risk informed, with the risk assessment (Volume 8, Tier 3, Technical Appendix 8A Ecological and Human Health Risk Assessment) following another CSA Standard, *N288.6-12 Environmental risk assessments at Class I nuclear facilities and uranium mines and mills* (includes human health risk assessment). Under CSA Standard N288.4-10, an environmental monitoring program consists of a risk-informed set of integrated and documented activities to sample, measure, analyze, interpret, and report. Environmental monitoring programs will be developed to assess the level of potential environmental effects, to demonstrate compliance with limits, to check, independently of effluent monitoring, on the effectiveness of containment and effluent control, and to verify the predictions made by the ecological and human health risk assessments. There may be other project specific objectives as well.

Specific to metal mine projects, as per subsection 36(3) of the *Fisheries Act*, the implementation of an Environmental Effects Monitoring (EEM) program is required of all operating metal mines in Canada. The national EEM program is carried out under the MMER and is administered by Environment Canada. The key components of EEM include effluent characterization and water quality monitoring studies, as well as a biological monitoring component. The EEM study area is comprised of areas anticipated to be influenced by mining related activity (exposure areas) and those areas beyond any mining influence (reference areas).

The effluent and water quality component of EEM requires regular monitoring of effluent quality and water quality in the receiving environment, as well as periodic laboratory testing of effluent for acute and sublethal toxicity to fish and other aquatic organisms. The effluent and water quality component of EEM is intended to support the interpretation of biological data. The biological monitoring studies focus on identifying potential effects of effluent release to fish populations and fish health as well as to fish prey resources (i.e., benthic invertebrate surveys) and the usability of fisheries resources by humans (i.e., fish tissue content studies) (Environment Canada 2012).

Each EEM cycle includes the submission of a study design, field studies (monitoring), and a reporting component. Initiation of the first EEM biological monitoring study occurs 1-2 years after the Mine becomes subject to Section 7 of the MMER. Effluent and water quality monitoring is conducted on an on-going basis (quarterly), while the biological monitoring study is completed periodically (usually every third year). Successive EEM programs are designed to build on the results of earlier studies and require more or less extensive monitoring, depending on effects identified. Preliminary studies attempt to identify possible biological effects in near-field environments (i.e., close to the point of effluent discharge). If biological effects are identified in the near-field, and subsequent studies verify those effects, then an attempt is made to evaluate magnitude and extent, and assess effluent-related causes (Environment Canada 2012).

The Kiggavik Project AEMP will be designed to incorporate the biological and chemical monitoring parameters identified in the EEM guidance documents and will be adapted as required, taking into account the results of respective EEM studies and the guidelines set out in the MMER. After completion of the EEM Study Design and field sampling component, the field data are interpreted and the results submitted to the identified Environment Canada Authorization Officer. Environment Canada will then review and provide feedback on study designs and interpretive reports.

At the time of licensing and permitting, a detailed aquatic effects monitoring plan, compliant with the requirements outlined above, will be finalized and will be applicable to the finale project design (see Volume 2, Tier 3, Technical Appendix 2T Environmental Management Plan). This document provides information on the framework to develop the monitoring program as well as some of the potential monitoring that will be proposed.

6 Potential Monitoring Activities

This section provides an overview of the potential monitoring programs planned in relation to the identified project effects on aquatic VEC as well as any relevant regulatory considerations. This information can be used as a framework for the eventual development of the detailed Kiggavik Project AEMP, as part of the Kiggavik licensing and permitting process. A summary of monitoring activities to be considered for the development of AEMP and consistent with CSA Standards, to be considered at licensing, is provided in Table 6.0-1 for each aquatic VEC to complement the information presented below.

6.1 Hydrology

Key issues identified for surface hydrology included changes to streamflow rates and lake levels and volumes that may affect other components of the aquatic, terrestrial, and socioeconomic environments. Specific activities include the dewatering of ponds and standing water during site clearing and pad construction, dewatering the pit area of Andrew Lake, freshwater withdrawal from lakes, the collection of site and stockpile drainage, and the discharge of treated effluents.

During construction, and through operations and decommissioning, water levels, flow rates and waterbody volumes can be monitored at locations potentially affected by project activities. These include Andrew Lake, Siamese Lake, Mushroom Lake, Judge Sissons Lake, and their outflow channels as a continuation of the baseline hydrology monitoring program.

Staff gauges can be installed on Andrew Lake, Siamese Lake, Mushroom Lake, Judge Sissons Lake, and their outflow discharges. Levels can be recorded on a regular basis during construction and through to decommissioning. Continuous water levels sensors can also be installed in these lakes and streams during the open water season to obtain detailed water level data. These efforts would be a continuation of the existing baseline monitoring program and would provide measurements of changes to water levels at the waterbodies potentially affected by project activities. The monitoring would commence at the start up of the construction phase of the Project. Continuous water level sensors would be installed during the active flow period during all phases of the Project. Staff gauges could be recorded on a monthly basis.

To monitor flow from waterbodies potentially affected by project activities, instantaneous discharge measurements can be taken at Andrew Lake Outflow, Siamese Lake Outflow, Mushroom Lake Outflow, and Judge Sissons Lake Outflow. These flow rates can be used to develop and maintain stage-discharge rating curves so that water level data can be used to estimate continuous discharge. This monitoring would commence at the start up of the construction phase of the Project and would be completed as required to build and maintain stage-discharge rating curves.

Monitoring of water withdrawal rates from Mushroom and Siamese Lakes will be completed on an on-going basis to verify that the volume of water extracted from Mushroom and Siamese Lakes does not exceed the limits specified in the water license. This monitoring will commence when Siamese and Mushroom Lake water intakes begin their operation and will be monitored for the duration that water is being withdrawn from the supply lakes.

Under-ice volumes can be confirmed by annual ice thickness measurements at Siamese Lake, Mushroom Lake, and ice road lakes. This monitoring would provide measurements of waterbody volumes and ice thicknesses of potentially-affected lakes. The monitoring would commence at the start up of the construction phase of the Project and would be completed annually during the month of April when minimum under ice volumes are expected to occur. This monitoring would occur during all phases of the project.

Monitoring of locations prone to ice jamming (i.e., culvert crossings along the Kiggavik-Sissons haul road) and removal of ice jams if necessary can be completed to ensure that the flow paths intercepted by the road are preserved and that stream crossings are not washed out as a result of an ice blockage. This monitoring can be initiated during break up the first spring after culvert installation along the haul road is complete and can be carried out on a weekly basis each spring during ice break-up.

6.2 Hydrogeology

Key issues for hydrogeology identified in the EIS included changes to ground water quality and potentially surface water quality as a result of tailings and mine rock management activities.

Monitoring of water quality in lakes and streams adjacent to and downstream of the Kiggavik and Sissons Mine sites can be completed during the spring freshet each year during the operational life of the Project to confirm that COPC do not increase in area lakes and streams as a result of tailings management or mine rock management activities.

Groundwater monitoring will be carried out in the rock mass surrounding the proposed Tailings Management Facility (TMF) to track chemistry and pressures as the excavation base penetrates the permafrost base and as the pit is filled with tailings material. This will allow changes in ground temperature and pressure gradients (i.e., flow direction) as well as water quality in the deep, sub-permafrost groundwater to be tracked over the construction and use of the TMF. This monitoring would be initiated prior to the TMF development and would be carried out from planning and design through operations, and finally into post closure. It is anticipated that a minimum of nine (9) groundwater monitoring wells will be installed in the Kiggavik site area (i.e., three (3) wells per TMF, one up-gradient and two down-gradient) and six (6) wells in the Sissons site area.

As the monitoring system will be operating in a deep permafrost environment, it will need to operate at temperatures well below 0°C. Pressure monitoring below permafrost will be carried out regularly using electronic transducers that are connected to the surface via an electrical wire. Regarding water sampling it is considered that a viable method will be to use a closed pipe system that can be used with an antifreeze fluid in the permafrost interval.

Investigations into the chemical and physical properties of tailings and mine rock will be continued as part of a Tailings Optimization and Validation Program (TOVP) and a Mine Rock Optimization and Validation Program (MOVP). These programs will provide further insight into the geochemical and physical characteristics of the materials to validate the proposed long-term management plans.

6.3 Water Quality

Key issues for water quality identified as a result of the aquatic effects assessment include changes to surface water chemistry from treated effluent discharge from the Kiggavik and Sissons WTP's, increased dust emissions and subsequent deposition of metals and particulates as a result of mine construction and operation, and acid deposition resulting from increased air emissions. Potential alteration to surface water chemistry from these sources may affect the aquatic organisms residing in local assessment area (LAA) waterbodies.

In order to meet MMER routine compliance responsibilities, effluent discharge rates will be continually documented. Effluent and receiving water quality will likewise be analyzed and documented regularly throughout the duration that the mine operation. Effluent chemistry parameters measured will include the deleterious substances identified under MMER (arsenic, copper, cyanide, lead, nickel, zinc, total suspended solids, radium 226, and pH) as well as other metals, nitrogen compounds, alkalinity, and hardness. This monitoring will be completed according to the schedules set out in the MMER (Government of Canada 2012) and the Metal Mining EEM Guidance Document (Environment Canada 2012) and will extend for the duration that the Mine operation is subject to the MMER. Liquid effluent and water quality monitoring plans will also meet the CSA Standards *N288.5-11 Effluent monitoring programs at Class I nuclear facilities and uranium mines and mill* and *N288.4-10 Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills*.

Sewage will be treated prior to discharge to the receiving environment. The Waste Water Systems Effluent Regulations will be used as guidance to establish the criteria, monitoring methods, volumes, parameters tested, and the quality assurance/quality control (QA/QC) requirements at sewage discharge locations.

Under MMER, the Mine will also be required to conduct routine acute lethality testing of effluent on a freshwater fish species (rainbow trout; *Oncorhynchus mykiss*) and a freshwater invertebrate species (*Daphnia magna*)at least once per month during the time effluent is being discharged to Judge Sissons Lake (MMER; Government of Canada 2012). This monitoring would commence once the

Mine becomes subject to MMER and would be completed according to the protocols described in the regulations and guidelines.

An additional stipulation of EEM requires that sub-lethal toxicity testing of effluent water be completed to identify any potential effects of mine water discharge on aquatic organism health. These tests measure the sublethal effects (i.e., survival, growth, and reproduction effects) of effluents on freshwater organisms under controlled laboratory conditions. Sublethal toxicity testing is conducted using aliquots of effluent collected for effluent characterization. These studies would be implemented according to the guidelines specified in the MMER. Testing typically occurs twice each calendar year for the first three years beginning six months after the Mine operation becomes subject to MMER.

Water quality will be monitored in the receiving environment to compare to effects predictions and as part of the required monitoring under MMER. Water quality in each section of Judge Sissons Lake receiving treated effluent (exposure areas), as well as at the outlet of Judge Sissons Lake, will be monitored in order to compare to effects predictions related to changes in water quality. Water quality parameters will be consistent with those monitored during baseline surveys as well as those used as input variables through the modeling process (including field parameters [i.e., pH, conductivity, dissolved oxygen, temperature], physical parameters [e.g., total suspended solids {TSS}], major ions and total dissolved solids [TDS], total and dissolved metals, total and dissolved nutrients [e.g., total phosphorus, nitrogen compounds, and total organic carbon]). Water quality monitoring will also be conducted in reference areas as per the requirements of MMER and the CSA N288.4 standard. Samples will be collected from the exposure and reference areas. The EEM samples will be collected quarterly as indicated in the Metal Mining EEM Guidance Document. The analytical suite will include the same variables as required for effluent characterization. As discussed in Section 6.5, reference areas may be located within an unexposed area of Judge Sissons Lake or in another waterbody that is not expected to be affected by the Project. EEM water quality monitoring will be completed for the duration that the Mine is subject to the MMER.

Water quality in appropriate lakes and streams will be monitored to measure metals and radionuclide concentrations, TSS and acid deposition, as well as lake acidification to determine if they are within predicted or acceptable levels due to air emissions and the deposition of dust from Project related activities. This monitoring could occur during the spring freshet during the phases of the Project.

Monitoring of locations prone to ice jamming (i.e., culvert crossings along the Kiggavik-Sissons haul road) and removal of ice jams, if necessary, would be completed to ensure that potential ice blockages at stream crossings do not cause the overlying road to wash out. The potential inflow of sediment to the stream system associated with a road washout could potentially alter the chemistry of stream water and have adverse effects on the aquatic ecosystem, especially fish habitat. This monitoring can be initiated during break up the first spring after culvert installation along the haul road is complete, and can be carried out on a weekly basis each spring during ice break-up.

A water quality monitoring program will be completed during in water construction activities (i.e., during the construction of the Andrew Lake Pit berm) to routinely assess the integrity and function of the sediment/turbidity curtain which will be installed to limit increased turbidity. Based on other projects involving in-water excavation and construction, the monitoring program may consist of: daily inspections of turbidity curtain, visual observation of fish in the vicinity of the turbidity curtain, daily (morning and afternoon) collection of water samples for monitoring of turbidity and TSS, and increased frequency of sampling in the event that a breach in the turbidity curtain is detected. Turbidity and TSS will also be monitored in the freshwater diversion channels four times during the open water season for the first year following construction to assess the adequacy of erosion and sediment control measures.

During the closure phase of the project, monitoring of water chemistry parameters of the re-flooded Andrew Lake Pit will be carried out to determine whether or not the dyke separating Andrew Lake from the re-flooded mine pit should be breached and the two waterbodies re-connected. This monitoring would be initiated at decommissioning and would be carried out until water chemistry of the pit reaches a stable equilibrium.

6.4 Sediment Quality

The key issue identified for sediment as a result of the project is the potential for changes to sediment chemistry from the release of treated effluent from the Kiggavik and Sissons Water Treatment Plants and other project effects described in Section 6.3. Effluent discharge can affect water quality in the receiving environment and subsequently affect the sediment through processes such as settling and absorption. Contaminant levels in sediment can have an effect on biota that reside in sediment, as well as wildlife that may incidentally ingest sediment while feeding on other aquatic biota.

Periodic monitoring of sediment quality can be carried out to quantify any measurable changes to sediment quality (i.e., changes to metals, radionuclide concentrations, and lake sedimentation rates) in exposure areas and compare them to predicted levels in lakes used as reference areas. Bottom sediment sampling can be completed at a subset of the water quality sampling stations where fine sediments accumulate to evaluate the effects of the Project on sediment quality. Sediment quality parameters would include particle size distribution, total organic carbon, and concentrations of nutrients and metals. Sediment quality monitoring would occur in the fall prior to freeze-up, during the operational and closure phases of the Project, as well as during the post closure phase. The monitoring would commence at operations start up and would be completed in conjunction with the EEM benthic invertebrate community survey if possible.

While sediment quality is not a regular component of the Environment Canada EEM program, monitoring of sediment may be required by the CNSC, commensurate with the CSA Standard *N288.4-10 Environmental monitoring programs at Class I nuclear facilities and uranium mines and* *mills,* in addition to the usual EEM chemical monitoring parameters. This monitoring would be combined with the EEM benthic monitoring survey which is usually completed every third year.

6.5 Aquatic Organisms and Fish Habitat

Key issues for aquatic organisms and fish habitat identified in the EIS include toxicity effects to aquatic biota from treated effluent discharge; and potential effects resulting from the permanent alteration and/or destruction of fish habitat by Project development activities. In addition, runoff from project construction activities occurring in or near surface waterbodies have the potential to adversely affect water quality and fish habitat in the affected systems.

As part of the process to update the Metal Mining Liquid Effluent Regulations (MMLER), the Canada Centre for Mineral and Energy Technology (CANMET) Aquatic Effects Technology Evaluation (AETE) program was established to review appropriate technologies for assessing the impacts of mine effluent on the aquatic environment. The AETE program concluded that the seasonal and highly variable nature of phytoplankton and zooplankton populations and community compositions limited their use as routine monitoring tools for evaluating environmental performance of a facility (AQUAMIN 1996). Hence, zooplankton monitoring is not proposed as part of the Kiggavik AEMP.

Under MMER, AREVA is required to conduct EEM to determine if effluent release is having an effect on the health of aquatic organisms in the receiving environment. One aspect of the EEM program involves quantifying effects to fish habitat through comparison of benthic invertebrate prey communities collected from areas exposed and unexposed to effluent. This is done by collecting benthic invertebrates in the exposure area and reference area and involves comparison of a number of biological indices (e.g., density, taxa richness, Simpson’s Evenness Index, and Bray-Curtis Index) to determine potential effects of effluent on the benthic invertebrate community. Samples from both the exposure and reference areas would be collected from an ecologically relevant area and season and would be completed as part of the regular EEM cycle as specified under MMER.

Exposure and reference areas will be selected as part of the design of the EEM study. The MMER defines an exposure area as “all fish habitat and waters frequented by fish that are exposed to effluent” (Government of Canada, 2012). Judge Sissons Lake is comprised of three major basins: a northwest basin, a southwest basin, and an east basin. The proposed effluent discharge points are located in the northern portion of the lake in the northwest (Sissons Mine Site discharge) and east basin (Kiggavik Mine Site discharge); therefore, these two areas will likely be defined as exposure areas. A reference area may also be located within Judge Sissons Lake. The MMER defines a reference area as “water frequented by fish that is not exposed to effluent and that has fish habitat that, as far as practicable, is most similar to that of the exposure area” (Government of Canada, 2012). A reference area may be selected within the southwest basin of Judge Sissons Lake given the following:

- Water flows from the south and west portions of Judge Sissons Lake northeast towards the outflow at the Aniguq River (Volume 5, Tier 3, Technical Appendix 5A, Figure 3.2.-2), thus the southwest basin of the lake is unlikely to receive effluent and any potential effect of discharge of treated effluent is likely to be restricted to the northern portion of the lake.
- The three major basins of the lake are connected by shallow channels that are less than one metre (m) deep; given that lake ice development can exceed 2 m in the winter, the channels will likely freeze to the substrate, causing each basin to become a separate waterbody (Volume 5, Tier 3, Technical Appendix 5N), which would further restrict effluent influence to the northern portion of the lake.
- Historical and more recent water quality sampling in Judge Sissons Lake indicates that water quality is generally uniform throughout the lake and between summer and fall, which suggests that the southwest basin would be representative of baseline conditions at the proposed exposure areas.

A second reference area will also be chosen from other suitable lakes in the Local Assessment Area (LAA). The second reference lake will be selected based on similarities in water and sediment quality, benthic invertebrate community structure and composition, and fish and fish habitat characteristics to the exposure areas in Judge Sissons Lake. Potential reference lakes can include Squiggly, Skinny, and Kavisilik lakes, as they are larger lakes located in the LAA that will not be exposed to effluent or otherwise directly affected by the Kiggavik Project. Following approval of the Project, and prior to commencing operations, reconnaissance studies will be conducted to determine the location of suitable reference areas.

The above proposed study design may change in the future as the proposed EEM study design will be reviewed by Environment Canada and the Technical Advisory Panel (TAP). The final EEM study design is dependent on Environment Canada and the TAP's input.

Because effects to aquatic organism health are potentially accumulative in response to changes in water and sediment chemistry, results of the additional monitoring activities described for these components (i.e., monitoring of effluent quantity and quality) can also be considered useful in determining subsequent effects to the health of benthic invertebrate and plankton species.

Monitoring of locations prone to ice jamming (i.e., culvert crossings along the Kiggavik-Sissons haul road) and removal of ice jams if necessary will be completed to monitor and mitigate any potential blockages to the movement of fish to seasonal use habitat areas as a result of ice jams or debris occurring at culvert crossings along the Kiggavik-Sissons haul road. This monitoring can be initiated during break up the first spring after culvert installation along the haul road is complete and can be carried out on a weekly basis each spring during ice break-up. Monitoring of fish passage will focus on crossings of fish bearing streams where culvert installations are proposed. No monitoring of fish passage is planned at watercourses crossed by bridges, as bridges will be built above the ordinary high water mark and are not anticipated to interfere with fish passage. Similarly, no fish passage monitoring is planned at the proposed ferry on the Thelon River (Kilometre 174.8 of the All-Weather Road) because it is not anticipated to interfere with fish passage.

Fish passage will be assessed at crossings that are known or assumed to be fish bearing using visual inspections. Fish passage in larger or deeper streams may also be monitored using fyke nets. Fish passage surveys are anticipated to occur near the peak of spring freshet, and are planned for a two-year period following installation of culverts. Once culvert crossings are confirmed to pass fish effectively, fish passage monitoring will cease. If fish passage is found to be inhibited at a crossing mitigation may be required.

Generally a compliance and effectiveness monitoring program would be carried out to show that fisheries offsetting works implemented in association with identified serious harm to fish resulting from Project development activities have been built as specified and approved. The Conceptual Fisheries Offsetting Plan (CFOP) for the Project specifies in detail the mitigation used to avoid or minimize serious harm to fish (including the permanent alteration and destruction of fish habitat), and provides an assessment of whether offsetting will be required for each of the Project components. If fisheries offsetting is required, a monitoring plan will be developed in collaboration with DFO to confirm that offsetting measures are functioning as designed.

In addition to monitoring requirements under the MMER, monitoring programs will also be implemented to meet CSA Standard *N288.4-10 Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills,* which the CNSC will reference in the licence condition handbook.

6.6 Fish Populations

Key issues for fish populations identified in the EIS include; possible effects from blasting in or near water which can damage the internal organs of fish, kill or injure fish eggs and larvae, and alter fish behaviour; and the potential for toxicity effects to fish from treated effluent discharge from the Kiggavik and Sissons Water Treatment Plants. Monitoring programs will be designed to measure potential effects and meet all regulatory requirements and guidance such as the CSA Standard *N288.4-10 Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills.*

To ensure that blasting activities do not harm fish populations, management plans for blasting near water and use of explosives near water have been developed (Volume 2, Tier 3, Technical Appendix 2B and 2C). Blasting near Andrew Lake will be planned during the frozen water period when Andrew Lake and its inflow and outflow streams do not support fish populations, or during times of year when egg incubation is not occurring. Smaller explosive charges will be used near fish habitats that do not produce, or are not likely to produce, an instantaneous pressure charge (i.e. overpressure) greater than 50kPa in the swimbladder of a fish. This is less than the 100 kPa IPC threshold however DFO has asked a threshold of 50 kPA be used, see DFO letter Volume 2, Tier 3, Technical Appendix 2B Drilling and Blasting Design, Appendix C. The charge sizes to be used near Andrew Lake during the open water season are to reduce the blasting setback distance to less than 50 meters (the width of the dyke). In addition to these measures, a fish exclusion barrier net will be installed annually in Andrew Lake to prevent fish from entering the area of the lake adjacent to Andrew Pit. Although mitigation is being used and the ICP threshold being used is half the regular value, monitoring to calibrate and refine the ground vibration and instantaneous pressure change models developed during the EA process will be completed to ensure blasting activities do not harm fish populations.

Under MMER, AREVA is also required to conduct EEM studies to determine if effluent release is having an effect on fish and fish habitat in the receiving environment. Effects on fish are assessed through comparison of fish exposed to effluent with unexposed fish. The fish survey is conducted to determine if there have been changes in indicators of fish growth, reproduction, condition, and survival as a result of effluent release. According to EEM guidelines, changes in these indicators would be assessed by collecting fish species found in the exposure and reference areas, and comparing (where possible) measurements of length, weight, age, liver weight (an indicator of energy storage), and, if the fish are sexually mature, gonad weight, fecundity (a measure of reproduction), and egg size. Effects of effluent discharge would then be assessed by comparing results for fish collected in the exposure area with those from fish collected in the reference area. Section 6.5 discusses potential exposure and reference areas that could be selected for future EEM programs. This monitoring would be implemented according to the schedule and protocols identified in the EEM guidance documents.

Effects on the use of fisheries resources are assessed by comparing mercury concentrations in edible fish tissue against fish health consumption guidelines. This component is designed to determine if effluent has an effect on fish usability as measured by tissue metal content, with particular attention paid to tissue mercury concentrations.

Table 6.0-1 Summary of Potential Monitoring Activities Planned for Aquatic VECs

Section Number*	Section Name	Monitoring Type: Compliance, Environmental, Follow-up	Description of Monitoring Required	Rationale for Required Monitoring	When Does Monitoring Commence?	Required Duration of Monitoring
6.6	Hydrology	Follow-up	Installation and monitoring of staff gauges and continuous water level sensors in Andrew Lake, Siamese Lake, Mushroom Lake, Judge Sissons Lake, and their outflow channels.	To provide measurements of changes to water levels at the waterbodies potentially affected by project activities	At construction start-up.	Staff gauges will be recorded monthly and sensors will be installed during the active flow period during all phases of the project.
6.6	Hydrology	Follow-up	Measurements of instantaneous discharge at Andrew Lake Outflow, Siamese Lake Outflow, Mushroom Lake Outflow, and Judge Sissons Lake Outflow.	To provide measurements of flow from waterbodies potentially affected by project activities. These flow rates can be used to develop and maintain stage-discharge rating curves so that water level data can be used to estimate continuous discharge.	At construction start-up.	As required to build and maintain stage-discharge rating curves.
6.6	Hydrology	Compliance	Monitoring of water withdrawal rates from Mushroom and Siamese Lakes.	To verify that the water volumes extracted from Mushroom and Siamese Lakes do not exceed the limits specified in the water license.	Once Siamese and Mushroom Lake water intakes begin operation.	For the duration that water is being withdrawn from Siamese and Mushroom Lakes.
6.6	Hydrology	Follow-up	Monitoring of lake under-ice volumes from annual ice thickness measurements at Siamese Lake, Mushroom Lake, and winter ice road lakes.	To confirm that estimated waterbody volumes and ice thicknesses of potentially affected lakes are within the expected range.	At construction start-up.	Annually during the month of April when ice thickness is greatest; throughout all phases of the project.
6.6	Hydrology	Compliance	Monitoring of locations prone to ice jamming (i.e., culvert crossings along the Kiggavik-Sissons haul road) and removal of ice jams if necessary.	To identify and remove any potential ice blockages at stream crossings which could impede the flow of water through culverts.	During break up the first spring after the installation of culverts along the haul road.	Ice break-up will be monitored weekly during spring break up each year
7.7	Hydrogeology	Compliance; Follow-up	Water quality monitoring of lakes and streams adjacent to and downstream of the Mine areas.	To confirm that COPC do not increase as a result of tailings management or mine rock management activities.	At the start-up of the project operations phase.	Annually during spring freshet during the operational life of the project.
7.7	Hydrogeology	Follow-up	Groundwater monitoring in the rock mass surrounding the proposed TMF as the excavation base penetrates the permafrost base, and as the pit is filled with tailings material.	To track changes in ground temperature pressure gradients (flow direction) and water quality in the deep, sub-permafrost, groundwater.	Prior to the project development.	All phases; from planning and design, through operations, and finally into closure.
7.7	Hydrogeology	Follow-up	Monitoring of the chemical and physical properties of tailings and mine rock through the continued development and implementation of the Tailings Optimization and Validation Program (TOVP) and Mine Rock Optimization and Validation Program (MOVP).	To address unforeseen circumstances that could result in a significant increase in the mass flux of solutes to the receptors.	Prior to the project development.	On-going programs during operation with reporting every 5 years.
8.6	Water Quality	Compliance	Monitoring of wastewater/effluent discharge rates.	Routine monitoring of treated effluent quantity for compliance purposes.	Once a licence is issued and effluent is discharged. For MMER purpose, once the mine becomes subject to MMER (i.e., once effluent discharge rates exceed 50 m^3 per day and/or deleterious substances are discharged into Judge Sissons Lake).	As per licensing document. For MMER purposes, monthly as part of MMER compliance monitoring for the duration that the Mine is subject to MMER.

Table 6.0-1 Summary of Potential Monitoring Activities Planned for Aquatic VECs

Section Number*	Section Name	Monitoring Type: Compliance, Environmental, Follow-up	Description of Monitoring Required	Rationale for Required Monitoring	When Does Monitoring Commence?	Required Duration of Monitoring
8.6	Water Quality	Compliance; EEM	Wastewater/effluent discharge quality will be analyzed and documented regularly.	Routine monitoring of treated effluent quality for compliance purposes.	MMER routine effluent water sampling will begin when the Mine becomes subject to MMER; EEM effluent characterization samples must be taken no later than six months after the mine becomes subject to MMER. Effluent discharge quality monitoring will commence when effluent is discharged.	Monthly as part of MMER compliance monitoring, and four times each calendar year for EEM sampling for the duration that the Mine is subject to MMER; Effluent monitoring frequency and duration will be determined during licensing. Discharge quality will be monitored according to Nunavut regulatory requirements.
8.6	Water Quality	Compliance	Routine acute lethality testing of effluent on rainbow trout and *Daphnia magna*.	For compliance purposes to verify that effluent water is not acutely lethal to fish and aquatic organisms.	Upon which time the Mine becomes subject to MMER.	Monthly as part of MMER compliance monitoring during the time that effluent is being discharged to the environment; or immediately if a deposit occurs outside the normal course of events.
8.6	Water Quality	EEM	Sub-lethal toxicity testing of effluent.	To identify any potential effects of mine water discharge on aquatic organism health. These tests measure the sublethal effects (i.e., survival, growth, reproduction effects) of effluents on four freshwater organisms under controlled laboratory conditions and are conducted using aliquots of effluent collected during sampling for effluent characterization.	The first effluent sample will be collected, and sublethal toxicity testing conducted, no later than six months after the mine is subject to MMER.	Twice each calendar year for the first three years to fulfill EEM program requirements
8.6	Water Quality	Follow-up	Water quality monitoring in lakes and streams potentially affected by the Project.	To measure parameters to see if they are within predicted effects of air and dust emissions on water quality (i.e., changes to metals and radionuclide concentrations, TSS and acid deposition levels, and lake pH).	At operations start-up.	During spring freshet following the start of mining operations, and then periodically thereafter during the operational and closure phases of the Project.
8.6	Water Quality	Follow-up	Monitoring of locations prone to ice jamming (i.e., culvert crossings along the Kiggavik-Sissons haul road) and removal of ice jams if necessary.	To identify and remove any potential ice blockages at stream crossings which could cause a culvert to overflow and stream water to wash over the road. The potential inflow of sediment to the stream system associated with a washout could alter water quality of seasonal use aquatic habitats.	During break up the first spring after the installation of culverts along the haul road.	Ice break-up will be monitored weekly during spring break up
8.6	Water Quality	Compliance	Water quality monitoring during in water construction activities.	To confirm that turbidity and total suspended sediments (TSS) levels associated with potential sediment influx from in-water construction activities do not increase such that local fish populations are adversely affected.	At start-up of in-water construction activities.	The duration of monitoring required will be determined in consultation with DFO.
8.6	Water Quality	Compliance	Water quality monitoring in freshwater diversion channels during the first year following construction.	To assess the adequacy of erosion and sediment control measures, turbidity and total suspended solids (TSS) levels will be monitored.	During the first open water season following construction.	Four times during open water season of the first year following construction.

Table 6.0-1 Summary of Potential Monitoring Activities Planned for Aquatic VECs

Section Number*	Section Name	Monitoring Type: Compliance, Environmental, Follow-up	Description of Monitoring Required	Rationale for Required Monitoring	When Does Monitoring Commence?	Required Duration of Monitoring
8.6	Water Quality	Compliance	Monitoring of water chemistry parameters of the re-flooded Andrew Lake Pit.	To determine if and when the dyke separating Andrew Lake from the re-flooded mine pit should be breached and the two waterbodies connected. If water quality is good then the two water bodies could be connected. If water quality is poor or unsuitable for fish use, the waterbodies should remain unconnected.	Upon completion of flooding of the mine pit.	Every one to three years until water quality in the flooded pit stabilizes.
9.6	Sediment Quality	Follow-up	Sediment quality monitoring in lakes potentially affected by effluent discharge.	To monitor potential changes in sediment quality and compare to predicted effects (i.e., changes to metals and radionuclide concentrations..	At operations start-up.	In the fall prior to freeze up during the operational,decomissioning, closure and post closure phases of the Project.
9.7	Sediment Quality	EEM	Monitoring of sediment quality in Judge Sissons Lake.	To identify potential effects of effluent discharge on sediment quality in the receiving environment in Judge Sissons Lake and to support the interpretation of the EEM benthic invertebrate survey data.	Initiation of the first EEM biological monitoring study will occur 12 or 24 months after the day the Mine becomes subject to MMER.	EEM sediment sampling will be completed during the biological monitoring component of the EEM program (usually every third year) and will be collected concurrently with benthic invertebrate community survey data collection.
10.6	Aquatic Organisms and Fish Habitat	EEM	Monitoring of benthic invertebrate communities in exposure areas of Judge Sissons Lake and in reference area(s).	To identify potential effects of effluent release effects on fish habitat through comparison of benthic invertebrate prey communities collected from areas exposed and unexposed to effluent.	Initiation of the first EEM biological monitoring study will occur 12 or 24 months after the day the Mine becomes subject to MMER.	Every 3 years once the Mine is subject to MMER.
10.6	Aquatic Organisms and Fish Habitat	Follow-up	Monitoring of locations prone to ice jamming (i.e., culvert crossings along the Kiggavik-Sissons haul road) or debris and removal of ice jams or debris if necessary.	To identify and remove any potential blockages to the movement of fish to seasonal use habitat areas as a result of ice jams or debris occurring at culvert crossings along the Kiggavik-Sissons haul road.	During break up the first spring after the installation of culverts along the haul road.	Ice break-up will be monitored weekly during spring break up to ensure that seasonal use aquatic habitat areas remain accessible to fish.
10.6	Aquatic Organisms and Fish Habitat	Follow-up	Monitoring of culvert crossings to confirm effective fish passage.	To confirm that culvert crossings can pass fish effectively.	Near the peak of spring freshet.	For a two-year period following installation of the culverts.
11.6	Fish Populations	Follow-up	Monitoring to calibrate and refine the ground vibration and instantaneous pressure change models developed during the EA process at locations away from fish-bearing waterbodies.	To provide mine site-tested ground vibration and IPC setback distance thresholds near fish sensitive waterbodies	Prior to the blasting programs commencing in the Andrew Lake and main zone pits.	Prior to blasting activities near fish bearing water bodies.
11.6	Fish Populations	Environmental Effects Monitoring	Monitoring of fish growth, reproduction, condition, and survival in exposure areas of Judge Sissons Lake as well as in reference areas.	To identify potential effects of effluent release on fish populations and fish health.	Initiation of the first EEM biological monitoring study will occur 12 or 24 months after the day the Mine becomes subject to MMER.	Every 3 years once the Mine is subject to MMER.
11.6	Fish Populations	Follow-up; Environmental Effects Monitoring	Monitoring of mercury concentrations and other COPCs in fish tissues in exposure areas of Judge Sissons Lake as well as in reference areas.	To identify potential effects of effluent release on the usability of fish resources by humans and verify predictions of no adverse effects to human health through consumption of fish.	Initiation of the first EEM biological monitoring study will occur 12 or 24 months after the day the Mine becomes subject to MMER.	Every 3 years once the Mine is subject to MMER.

NOTES:

(a) = Section number refers to AREVA Kiggavik Project Environmental Impact Statement Tier 2, Volume 5 Aquatic Environment

7 References

AQUAMIN. 1996. Assessment of the Aquatic Effects of Mining in Canada: AQUAMIN Final Report. April 30, 1996. Environment Canada, Ottawa, ON.

Environment Canada. 2012. Metal Mining Technical Guidance for Environmental Effects Monitoring. Environment Canada, Ottawa, ON.

Government of Canada. 2012. Fisheries Act R.S.C., 2012, c. F-14. Canadian Standard Association (2010) N288.4-10 Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills.

Canadian Standard Association (2011) N288.5-11 Effluent monitoring programs at Class I nuclear facilities and uranium mines.

Canadian Standard Association (2012) N288.6-12 Environmental risk assessments at Class I nuclear facilities and uranium mines and mills.