Kiggavik Project

Final Environmental Impact Statement

Tier 3 Technical Appendix 2I: Water Management 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.*

Table of Contents

List of Tables

List of Figures

1 Introduction

1.1 Overview

The AREVA Resources Canada Inc. (AREVA) Water Management Plan (Plan) will be in effect for the duration of the Kiggavik Project. The Plan is intended to apply to the Kiggavik Project located approximately 80 km west of Baker Lake and all points located between the site and Baker Lake.

The enclosed document forms part of the Kiggavik Project Environmental Impact Statement (EIS) submission. The submission has been prepared for the Nunavut Impact Review Board by AREVA Resources Canada Inc. to fulfill the requirements of the “Guidelines for the Preparation of an Environmental Impact Statement for AREVA Resources Canada Inc.’s Kiggavik Project (NIRB File No. 09MN003)”.

1.2 Purpose and Scope

The purpose of the Plan is to provide consolidated information on water management strategies for intercepting, collecting, containing, and monitoring potentially contaminated water from the Project sites. The Plan has been written to address Section 9.4.3 of the Nunavut Impact Review Board’s “*Guidelines for the Preparation of an Environmental Impact Statement For AREVA Resources Canada Inc.’s Kiggavik Project”, May 2011*.

1.3 Mitigation by Design, and by Management

As outlined in 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. Mitigation measures can generally be classified as mitigation by design, and mitigation by management, as outlined below.

1.3.1 Mitigation by Design

Many facility design features have been adopted to mitigate potential environmental and health effects and ensure worker safety. The main water management mitigation measures by design outlined in this plan include:

- Freshwater diversion channels to intercept and divert clean runoff away from facility operational areas. The incorporation of a purpose built water storage facility at the Kiggavik site to manage spring freshet and facilitate water recycling at the mill. At Sissons, sedimentation ponds are designed to manage spring freshet and allow recycling of runoff.
- At both sites, water treatment facilities have been designed to meet discharge quality objectives selected to minimize potential environmental effects associated with the release of treated effluent.
- Water bodies for fresh water withdrawal and effluent discharge were selected to minimize environmental effects.

1.3.2 Mitigation by Management

Many management practises mitigate potential environmental and health effects and promote safety. This often includes the development, use, enforcement, and revision of codes of practise, procedures and work instructions, and staff training and auditing. The main mitigation measures by management outlined in this water management plan include:

- All treated effluent will comply with applicable regulations.
- All contact water will be treated prior to release to the environment.
- During operations, water will be recycled as much as practical to reduce fresh water consumption.
- Andrew Lake will be dewatered in a manner to minimize environmental effects.
- 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 ice-covered season.

1.3.3 Monitoring

Results from the monitoring of facilities, and operations will be evaluated against predicted performance, a process to identify design and management improvement opportunities, and adaptive management needs. The main monitoring activities outlined in this plan include:

- All water treated at the Kiggavik and Sissons water treatment plants will be sampled and analyzed prior to discharge to ensure compliance with discharge criteria.
- Effluent discharge pipelines will be subject to preventative maintenance and monitored to minimize the potential for leakage.
- Effects to the downstream aquatic environment due to effluent discharge will be monitored as outlined in the Aquatic Effects Monitoring Plan (Technical Appendix 5M).

1.4 Related Documents

This document presents the management and treatment of water for all phases of the project under normal operating conditions. Although contingency measures to prevent the unanticipated release of waters from the Project are presented herein, mitigation measures to address spills and other water management malfunctions are addressed in Volume 10 and related technical appendices.

2 Water Management Concept

The overall objectives of the water management strategy are to minimize the intake of fresh water from lakes, to minimize the release of treated effluents to surface water receptors, and to ensure containment of potentially contaminated waters. Project design, water recycling, and management practices will be the key factors used to achieve this objective. Conservative assumptions have been used at this stage of design; continuous improvement will be used during operation to further reduce water consumption and discharge.

For the purpose of the water management, contact water is defined as any water that may have been physically or chemically affected by site activities. Consistent with the philosophy to divert clean surface drainage prior to contact with the site, this definition does not include freshwater diversion around site infrastructure which will be accomplished using freshwater diversion channels. Contact water includes:

- surface runoff from the mill terrace and mining areas,
- surface runoff from lined ore stockpiles,
- surface runoff from lined Type 3 mine rock stockpiles,
- surface runoff from Type 2 mine rock stockpiles,
- water expulsed during tailings consolidation,
- water inflows into mines, and
- tailings thickener overflow.

All contact water will be intercepted, contained, analyzed and treated, when required. All water released to the environment will meet discharge quality criteria, which have been selected to ensure no significant environmental effects are associated with the release of contact water.

The monitoring locations, methods, volumes, parameters tested, QA/QC, and statistical rationale for monitoring contact water upstream of the water treatment plants will be determined by the project metallurgy department to ensure monitoring program requirements meet the objectives established for process control at each site. At each Final Point of Discharge, the monitoring methods, volumes, parameters tested, and QA/QC will meet the requirements of the Metal Mining Effluent Regulations.

Non-contact water includes runoff originating from areas unaffected by site activities and will not come into contact with mining and milling areas. Non-contact water will be diverted from the site activities to the surrounding surface water system.

The overall water management strategy is based on the following concepts:

- Minimize contact water by diverting local drainage prior to contact with the site and use snow fences to minimize on-site drifts,
- Contain all contact drainage and provide contingency storage ,
- Contain all mine water, and
- Maximize recycling of on-site contact water.

At the Kiggavik site, the milling process is the primary consumer of fresh water and determines the type of effluent treatment required. The other key components of the water balance are surface runoff and water expulsed as a result of tailings consolidation in the Tailings Management Facilities (TMFs).

At the Sissons site, the underground mining and wash bay are the primary consumer of water and determines the type of effluent treatment required. The other key components of the water balance are surface runoff and mine water inflows.

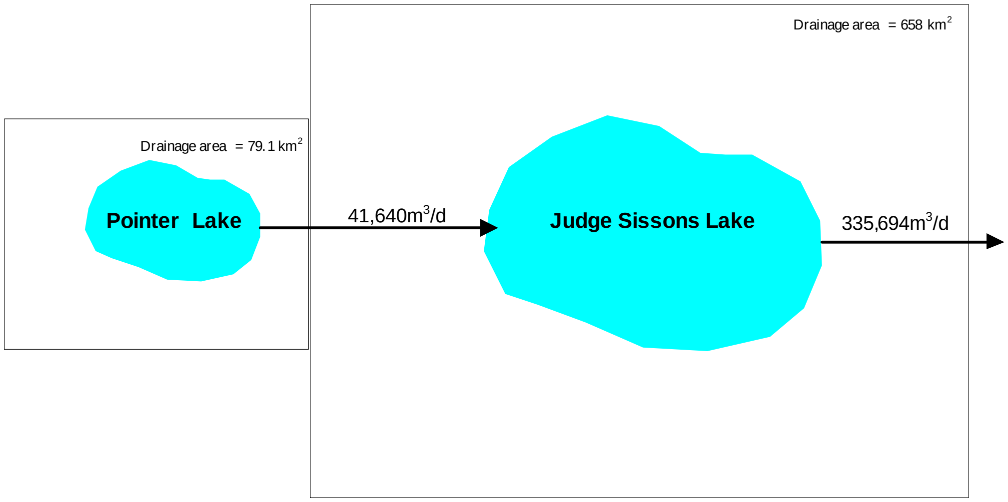
3 General Management Practices

3.1 Baseline Water Flows

As part of the EIS baseline studies, baseline water flows were measured for both the Kiggavik and Sissons sites. Details are provided in Technical Appendix 5C. Baseline water flows are shown in Figure 3.1-1 and Figure 3.1-2 for the Kiggavik and Sissons sites respectively. The effects of climate change on the baseline water balance are presented in Section 7.1

With water diversion and fresh water withdrawal, alterations to the baseline flows are expected as shown in Figure 3.1-3 and Figure 3.1-4 for the Kiggavik and Sissons sites respectively. The changes are based on the conservative treated effluent discharge volumes outlined in the assessment basis (Tier 2, Volume 2, Table 20-1), which are greater than the anticipated average treated effluent discharge volumes for the Kiggavik and Sissons sites. As illustrated, the changes expected to the baseline drainage during project operation are relatively small. During construction, the changes in flows will trend toward the operational values. During decommissioning, the changes in flows will trend toward the baseline state.

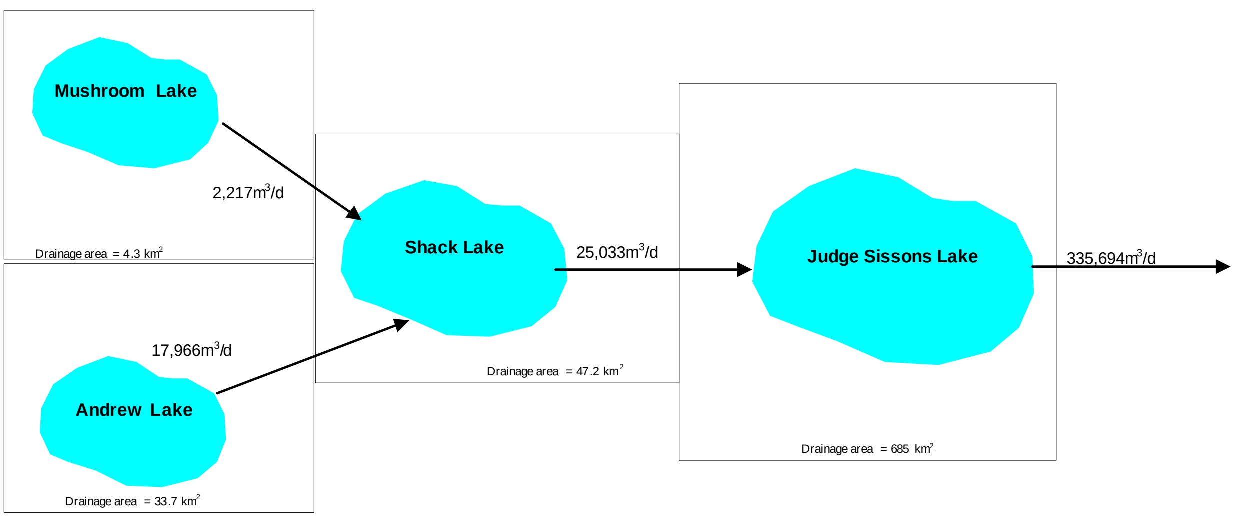
Kiggavik



Note 1: All discharges based on regionally derived runoff equation
Note 2: Siamese Lake part of separate drainage area (not shown)
Note 3: Not to scale

Figure 3.1-1

Sissons



Note 1:Not to scale

Figure 3.1-2

Projection: NA
Compiled:TL
Date: 7/21/2014
Data Sources:

Drawn: LB
Scale:

FIGURE 3.1-1/3.1-2
KIGGAVIK & SISSONS SITE BASELINE WATER FLOWS

ENVIRONMENTAL IMPACT STATEMENT
APPENDIX 2I - WATER MANAGEMENT PLAN

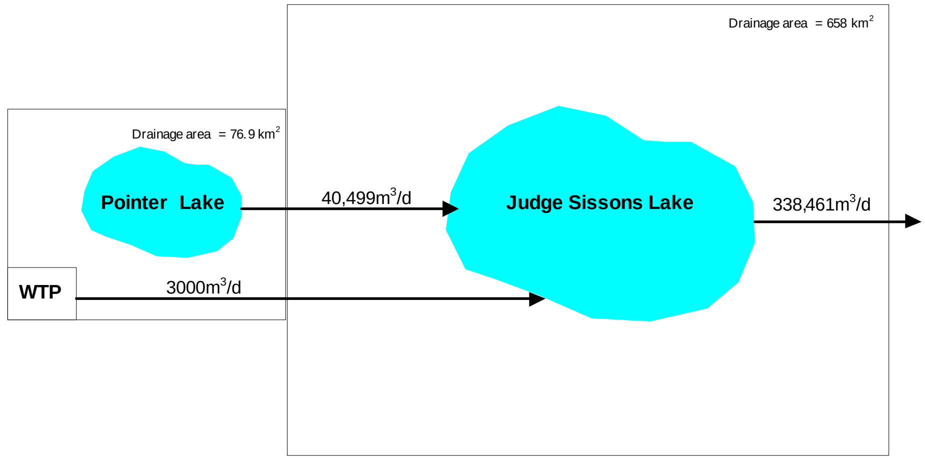
KIGGAVIK PROJECT

AREVA

File: Q:\SHEQ\GIS\KIGGAVIK\2014\EIS\Volume 2 - Project Description\Volume 2 - Tier 3\Appendix 2I - Water Management Plan\Maps\MXD\Figure 3.1-1 & 3.1-2 Water_Management_Sissons_Kiggavik_Baseline.mxd

AREVA Resources Canada Inc - P.O. Box 9204 - 817 - 45th Street West - Saskatoon, SK - S7K 3X5

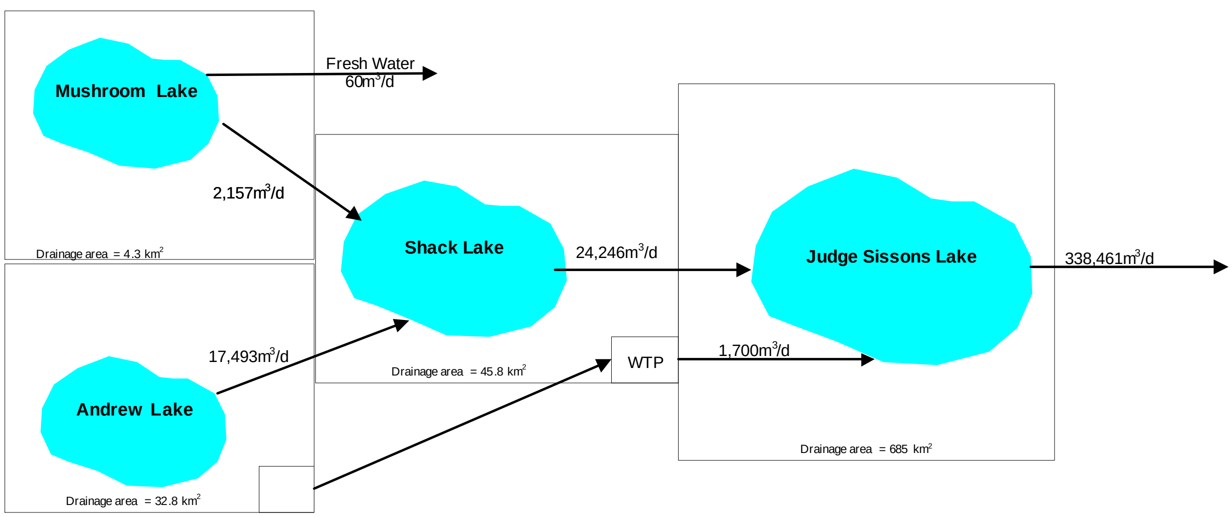
Kiggavik



Note 1: Pointer Lake drainage area reduced by 2.2 km² due to water diverted to WTP
Note 2: Runoff from 1.5km² (clean waste rock) will be collected but returned to receiving environment following passive treatment in sedimentation ponds (not shown)
Note 3: Not to scale

Figure 3.1-3

Sissons



Note 1:Not to Scale

Figure 3.1-4

Projection: NA
Compiled:TL Drawn: LB
Date: 7/21/2014 Scale:
Data Sources:

FIGURE 3.1-3/3.1-4
KIGGAVIK & SISSONS SITE CHANGES TO
BASELINE WATER BALANCE DURING OPERATIONS

ENVIRONMENTAL IMPACT STATEMENT
APPENDIX 2I - WATER MANAGEMENT PLAN

KIGGAVIK PROJECT

AREVA

File: Q:\SHEQ\GIS\KIGGAVIK\2014\EIS\Volume 2 - Project Description\Volume 2 - Tier 3\Appendix 2I - Water Management Plan\Maps\MXD\Figure 3.1-3 & 3.1-4 Kiggavik Sissons Site Changes to Baseline Water Balance During Operations.mxd

AREVA Resources Canada Inc - P.O. Box 9204 - 817 - 45th Street West - Saskatoon, SK - S7K 3X5

3.2 Freshwater Withdrawal

Freshwater will be required at both the Kiggavik and Sissons sites. Siamese Lake will be used for Kiggavik site fresh water while Mushroom Lake will be used for Sissons site freshwater. Water will be drawn from a depth of at least 3 m below surface and pumped to the site through a heat-traced line. The amount of water, which can be withdrawn from Mushroom Lake, is limited by the size of the Lake. If required, supplemental fresh water will be trucked from Kiggavik.

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.

Recycling strategies will be used to minimize the volume of fresh water required at both sites. Site drainage and mine water will be used for industrial purposes wherever possible. The inclusion of substantial water storage capacity at both sites will facilitate recycling efforts.

3.3 Freshwater Diversion

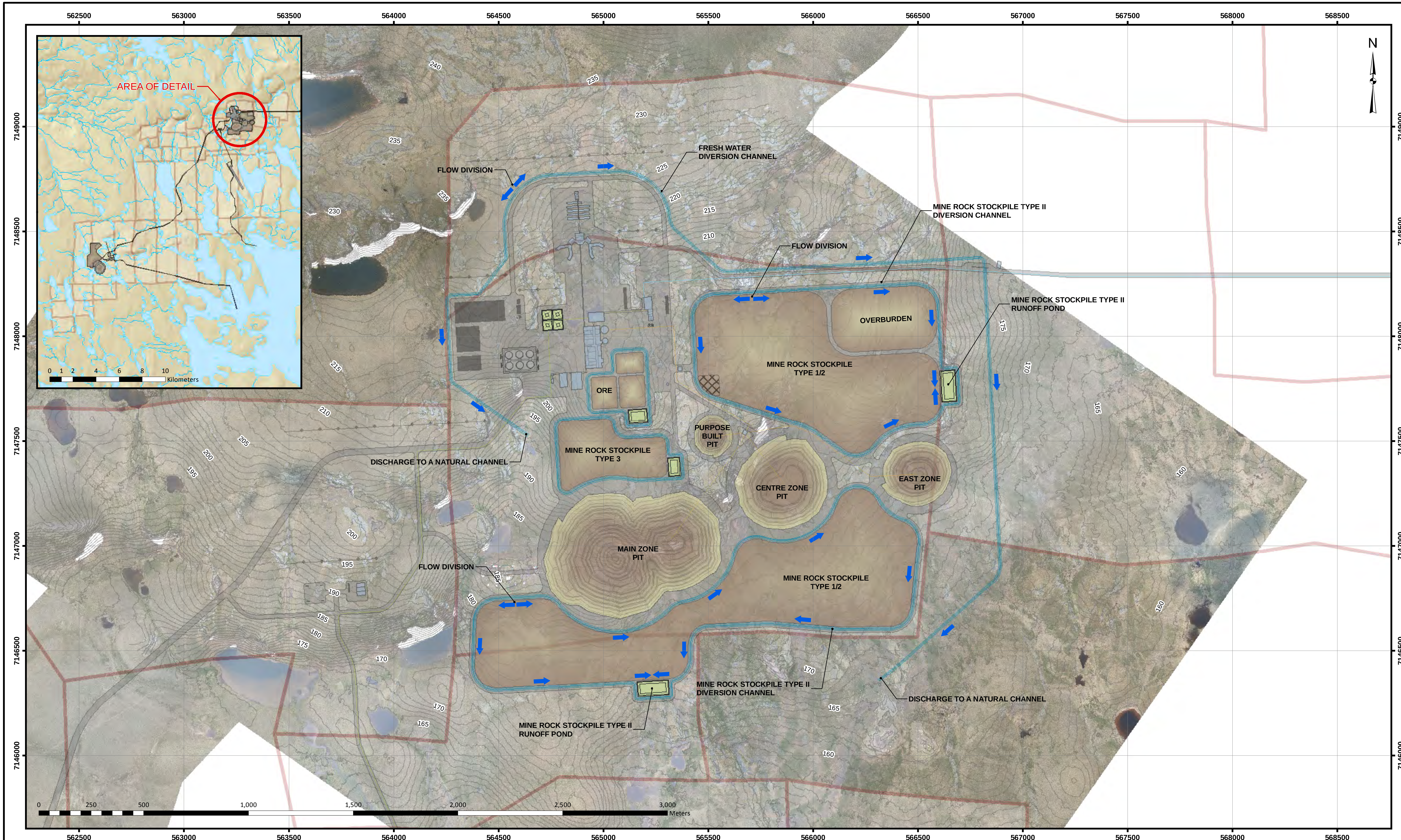
Two methods are used to divert freshwater from the site and thereby minimize the volume of contact water:

- Freshwater diversion channels; and
- Snow fences.

Freshwater diversion channels have been designed to isolate clean runoff, which drains toward site facilities (see Technical Appendix 2E). The runoff would be intercepted and directed around the core facilities area and returned to the channels, which carried the flow from these areas prior to development. The channels are designed to carry runoff from a Probable Maximum Precipitation (PMP), which has been calculated for the Kiggavik area at 184 mm in 24 hours (Technical Appendix 4A). The PMP is very conservative and the proposed designs will be more than adequate for managing heavy rainfall and maximum snowmelt runoff. These designs will be optimized at the time of licensing application.

The design strategy is to minimize excavation depths and use berms to control flow where possible. A minimum channel invert gradient of 0.2% has been adopted to facilitate drainage and reduce channel cross-sectional areas. Channels oriented perpendicular to runoff slopes will be shallow cut on the upslope side and bermed on the downslope side. Channel sideslopes will be 3H:1V and riprap protection will be implemented for longitudinal gradients greater that 2%. Channel base widths will vary with longitudinal gradient, and with distance downstream as increasingly larger conveyance capacity is required. Construction approaches for the diversion channels are provided in Section 12.

There is potential for some sediment transport where runoff from adjacent disturbed areas could report to the channel. However, Best Management Practices for erosion and sediment control will be implemented with the intention of trapping sediment close to the source (i.e., silt fences, check dams in flow pathways, revegetation, etc.) during construction and operations where required. Erosion and Sediment Control measures are outlined in Technical Appendix 5O. Where flow velocities exceed the erosion resistance, armouring in the diversion channels using riprap and geotextile will be implemented where required will reduce the potential for erosion and sediment transport within the channels. Freshwater Diversion Channels for the Kiggavik and Sissons Sites are shown in Figure 3.3-1 and Figure 3.3-2 respectively.



Projection: NAD 1983 UTM Zone 14N
Creator: CDC Revised:TL
Date: 09/02/2014 Scale: 1:16,546
File:
Data Sources: *Natural Resources Canada, Geobase®, Nation Topographic Database, AREVA Resources Canada Inc.*

FIGURE 3.3-1
KIGGAVIK WATER DIVERSION CHANNELS

ENVIRONMENTAL IMPACT STATEMENT
APPENDIX 2I - WATER MANAGEMENT PLAN

Kiggavik Project
AREVA

AREVA Resources Canada Inc - P.O. Box 9204 - 817 - 45th Street West - Saskatoon, SK - S7K 3X5

Projection: NAD 1983 UTM Zone 14N
Creator: CDC Revised:TL
Date: 09/02/2014 Scale: 1:15,000
File:
Data Sources: *Natural Resources Canada, Geobase®, Nation Topographic Database, AREVA Resources Canada Inc.*

FIGURE 3.3-2
SISSONS WATER DIVERSION CHANNELS

ENVIRONMENTAL IMPACT STATEMENT
APPENDIX 2I - WATER MANAGEMENT PLAN

Kiggavik Project
AREVA

AREVA Resources Canada Inc - P.O. Box 9204 - 817 - 45th Street West - Saskatoon, SK - S7K 3X5

Snow fences will be installed at the Kiggavik and Sissons sites to limit snow accumulation on site and reduce water runoff from snow melt within the site. The snow fences will be located north of site infrastructure to reduce wind speeds from the prevailing winds. The reduction of wind speed will shorten the distance travelled by snow into site.

3.4 Sewage Management

Sewage at the Kiggavik and Sissons sites will be treated in vendor packaged plants. The sewage treatment plants will be housed in either modular units or standard 20ft or 40ft containers. It is estimated that at peak manpower levels the volume of sewage requiring treatment at the Kiggavik site will be 200 m^3/d, while at the Sissons site the volume of sewage requiring treatment will be 60 m^3/d. A biological treatment plant is envisioned. The exact type of biological treatment plant will be selected at the detailed design stage. The biological processes commonly employed in sewage treatment include oxidation of carbonaceous BOD and conversion of ammonia to nitrates. Membranes or other separation technologies may be applied to separate the sewage solids from the treated sewage liquids. The sewage treatment plant will be designed to meet the criteria outlined in Table 3.4-1.

Table 3.4-1 Sewage Discharge Criteria

Parameter	Quality
BOD_5	≤ 15 mg/L
TSS	≤ 15 mg/L
NH3-N	≤ 1.25 mg/L
Chlorine	<0.02 mg/L
Phosphorus	≤ 1 mg/L
Faecal Coliform	≤ 100counts / 100mL

Sewage effluent will meet the DFO Regulations. Nunavut Public Health Regulations and any requirements stipulated by the Nunavut Water Board and the CCME Municipal Effluent Guidelines. Treated sewage effluent will be combined with the water treatment plant discharge (after monitoring) and discharged to Judge Sissons Lake. Sewage solids from Sissons will be transported periodically to the Kiggavik site for disposal. Throughout operations, the preferred disposal method for solid sewage is to dispose of it on site in a dedicated sewage disposal area; the composted material would later be used in selected areas as a soil amendment for site re-vegetation. However, as sewage sludge may have the potential of attracting wildlife, AREVA may consider burying the sewage sludge under mine rock or incinerating the sewage sludge and bury the ashes as is practice at several mines.

Sewage effluent that does not meet the discharge criteria will be recycled to the front-end of the sewage treatment plant.

The minimal amounts of sewage expected at the Baker Lake dock site will be collected in either a portable unit (port-a-potty) or an aboveground sewage tank. The sewage will be trucked as needed to the Baker Lake community sewage lagoon.

3.5 Drainage from Hazardous Material Storage and Handling Areas

Drainage from fuel storage areas, fuel transfer stations, and hazardous materials storage areas will be contained within lined, bermed areas. Any contaminated water from the Kiggavik and Sissons sites would be recovered using a vacuum truck and delivered to the water treatment plant. Runoff from within the berms at the dock site will be sampled prior to discharge and may be passed through a passive filter to remove any organics or other contaminants.

3.6 Exploration Water Management

Exploration activities are expected to continue through the construction and operational phases of the Project. These future activities will be similar to those conducted on the Project site since 2007. These activities are expected to take place within the Kiggavik and St. Tropez lease areas currently held by AREVA (Volume 2, Section 2).

Anticipated exploration activities include:

- Mapping
- Ground geophysical surveys
- Aerial surveys
- Exploration drilling
- Delineation drilling and hydrogeological testing
- Sampling of mineralized and non-mineralized core
- Geotechnical drilling
- Environmental baseline studies to support any future mine development proposals

Future exploration will continue to comply with licence conditions and the Fisheries and Oceans Canada (DFO) operational statement for mineral exploration activities (DFO, 2009). AREVA remains committed to the appropriate DFO timing windows and water withdrawal guidelines. Current and future exploration activities ensure water pump intakes prevent streambed disturbance and fish mortality by following the DFO Freshwater Intake End-of-Pipe Fish Screen Guideline (DFO, 1995).

AREVA will not conduct drilling within 30 m of the ordinary high water mark unless approved by licence amendment, there is sufficient ground stability, and the timeline is outside the spring and fall spawning periods for known fish species. To avoid impact to fish or fish habitat, drilling water will be withdrawn from non-fish bearing water bodies when feasible, or from larger water bodies capable of supporting drilling water requirements. Sumps and fuel caches will be a minimum of 30 m from the ordinary high water mark and will be inspected on a regular basis. Spill kits at the drill site will provide response capabilities to manage and minimize unanticipated events. Drill cuttings will be pumped to a natural low-lying depression to prevent erosion, sedimentation, or release into aquatic habitat. Drill holes will be plugged and permanently sealed upon completion, which will also prevent any possible artesian flow from entering water bodies. Drill holes will be sealed by cementing/grouting the upper 30 m of bedrock or the entire depth of the hole, whichever is less or otherwise approved of by the Nunavut Water Board (NWB).

3.7 Water Management and Construction Activities

Appropriate construction mitigation measures will be employed during construction to ensure that potential environmental effects will be limited and managed. Erosion and sediment control measures are detailed in Technical Appendix 5O. Mitigation measures will include:

- avoiding construction activities near fish bearing waters during spring and fall fish spawning or migration periods;
- scheduling in-stream work, where possible, during a low flow period to minimize erosion;
- applying erosion and sediment control measures to prevent discharge of sediments into fish bearing streams (e.g., erosion control blankets, silt fences);

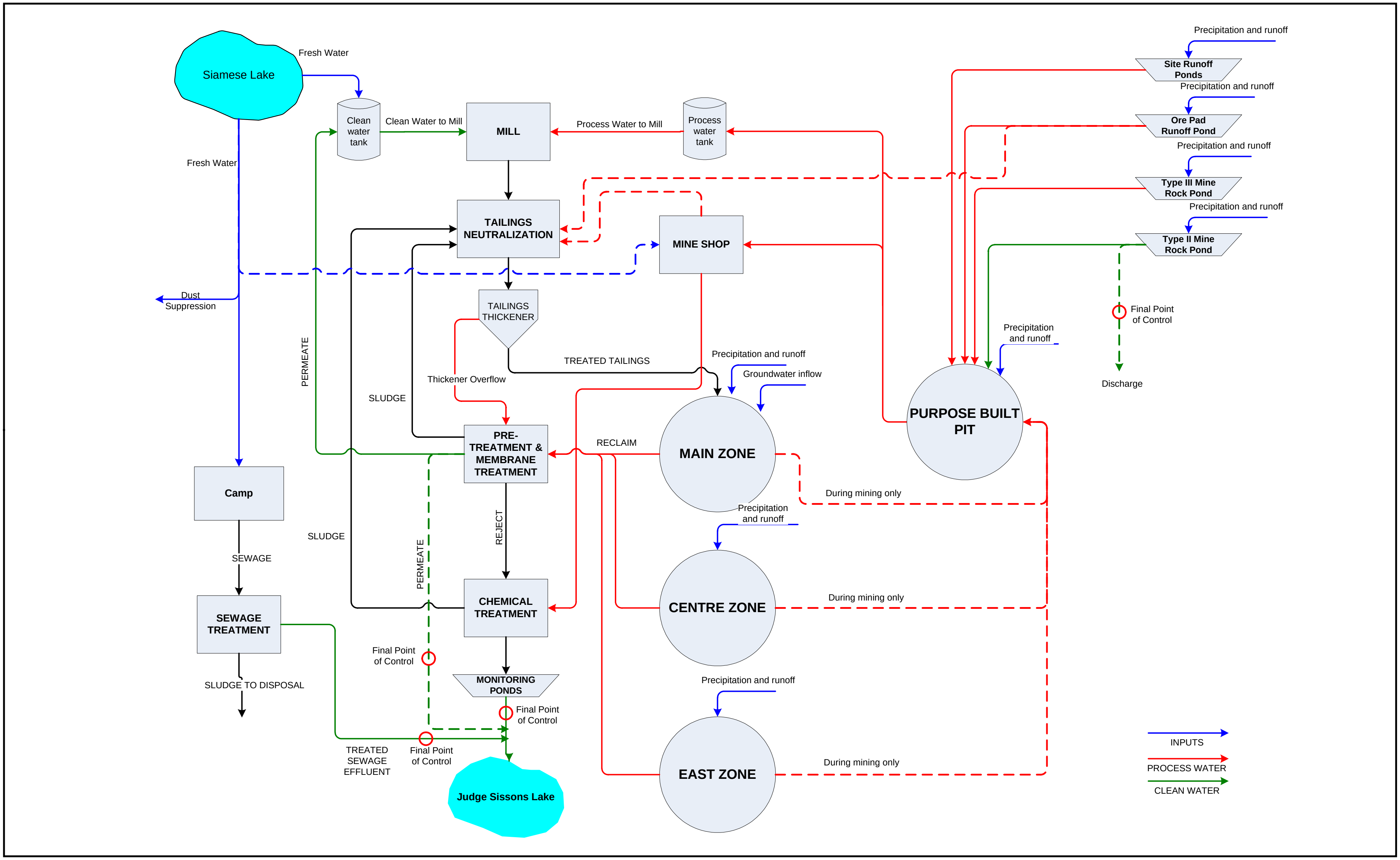
4 Kiggavik Site Water Management

4.1 Facilities and Infrastructure

The Kiggavik site will include the water management facilities and infrastructure listed in Table 4.1-1 and summarized in Figure 4.1-1.

Table 4.1-1 Summary of Kiggavik Site Infrastructure

Facility	Containment		Key Features
	Yes	No	
Fresh Water Pipe and Service Road		✓	• To Siamese Lake
Water Treatment Plant	✓		• 5,560 m^3/day capacity
Monitoring Ponds	✓		• Lined ponds
Treated Effluents Discharge Pipe and Service Road	✓		• Discharge to Judge Sissons Lake
Purpose Built Pit	✓		• Storage of site drainage
Site Drainage Ponds	✓		• Collection of ore pad, mine rock and general site drainage • Unlined pond for clean waste rock pile runoff • Lined ponds for all other runoff
Water Diversion Structures		✓	• Fresh water diversion
Snow Fences		✓	



Projection: NA
Compiled: TL
Date: 7/21/2014
Data Sources: *NA*
Drawn: LB
Scale:

FIGURE 4.1-1
KIGGAVIK SITE WATER RECYCLING STRATEGY

ENVIRONMENTAL IMPACT STATEMENT
APPENDIX 2I - WATER MANAGEMENT PLAN

KIGGAVIK PROJECT

AREVA

AREVA Resources Canada Inc - P.O. Box 9204 - 817 - 45th Street West - Saskatoon, SK - S7K 3X5

File:Q:\SHEQ\GIS\KIGGAVIK\2014\EIS\Volume 2 - Project Description\Volume 2 - Tier 3\Appendix 2I - Water Management Plan\Maps\MXD\Figure 4.1-1 Kiggavik Site Water Recycling Strategy.mxd

4.2 Kiggavik Site Water Balance

4.2.1 Overview

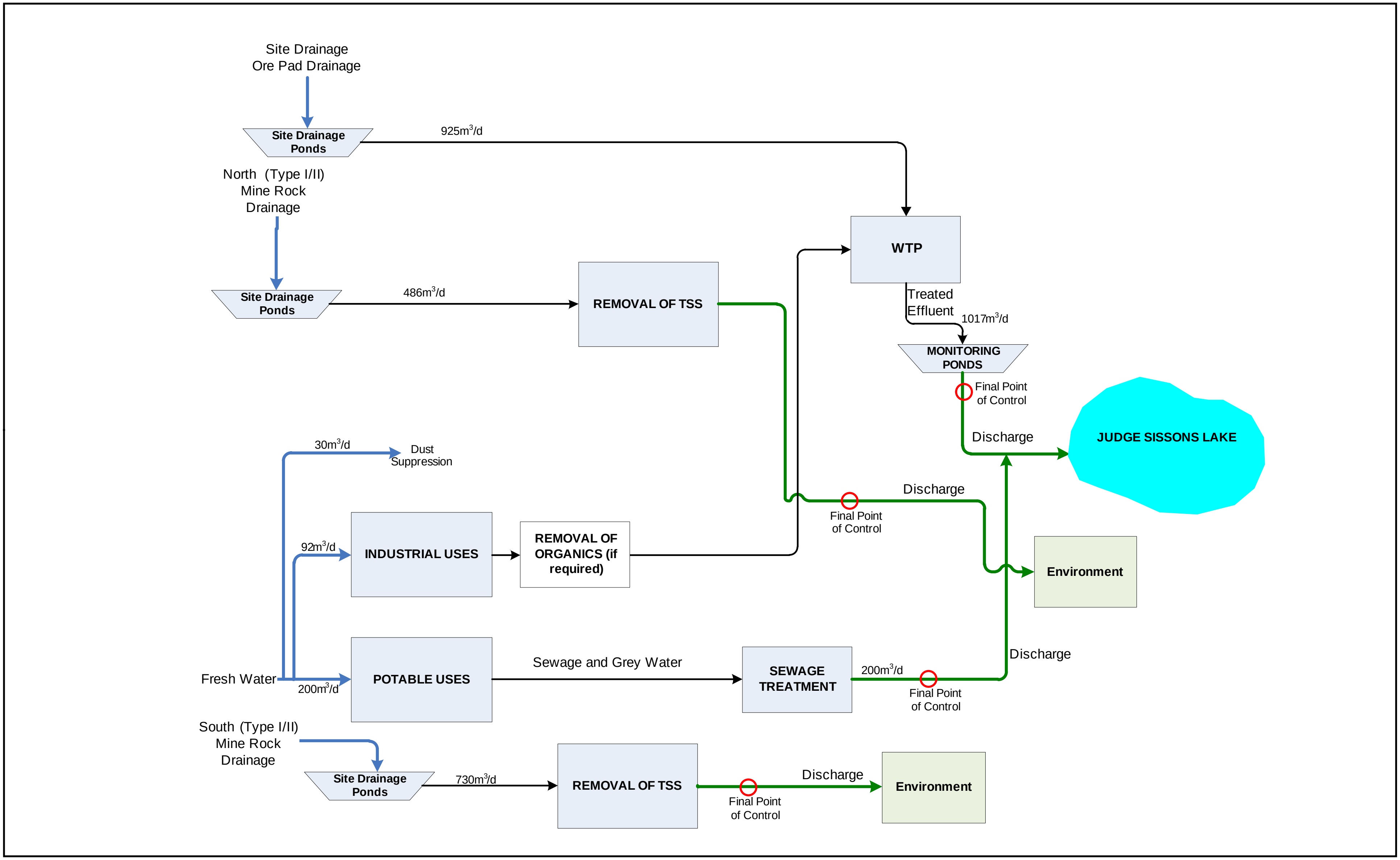
Key site water inputs include:

- Fresh water for the mill process, general industrial use, potable use, and dust suppression
- Contaminated site drainage
- Plant and mine site drainage
- Ore pad drainage
- Type III mine rock stockpile drainage
- Type I & II mine rock stockpile drainage
- Pit inflows due to direct precipitation into Main Zone, Centre Zone, East Zone and the Purpose-built Pit
- Minor groundwater inflows to Main Zone during mine development

All of the water inputs shown above, with the exception of fresh water intake, are considered contact water.

The water balance is summarized for an average year for construction, operation, and decommissioning in Table 4.2-1 below. Water balance figures for construction, operation, and decommissioning are shown in Figures 4.2-1, 4.2-2 and 4.2-3. The change in the baseline water balance during operations is presented in Figure 3.1-3.

The contaminated runoff volume for construction and decommissioning presented represent the maximum runoff values expected during these phases. As construction proceeds, runoff requiring treatment will gradually increase as infrastructure is built. Conversely, during infrastucture decommissioning runoff requiring treatment will decrease. Type I and II runoff will gradually increase during the mining phase of operation. During decommissioning, the waste rock pile will be recontoured and an appreciable change in runoff volume is not expected.



Projection: NA
Compiled: TL
Drawn: LB
Date: 7/21/2014
Scale:
Data Sources: *NA*

FIGURE 4.2-1
KIGGAVIK WATER MANAGEMENT - CONSTRUCTION

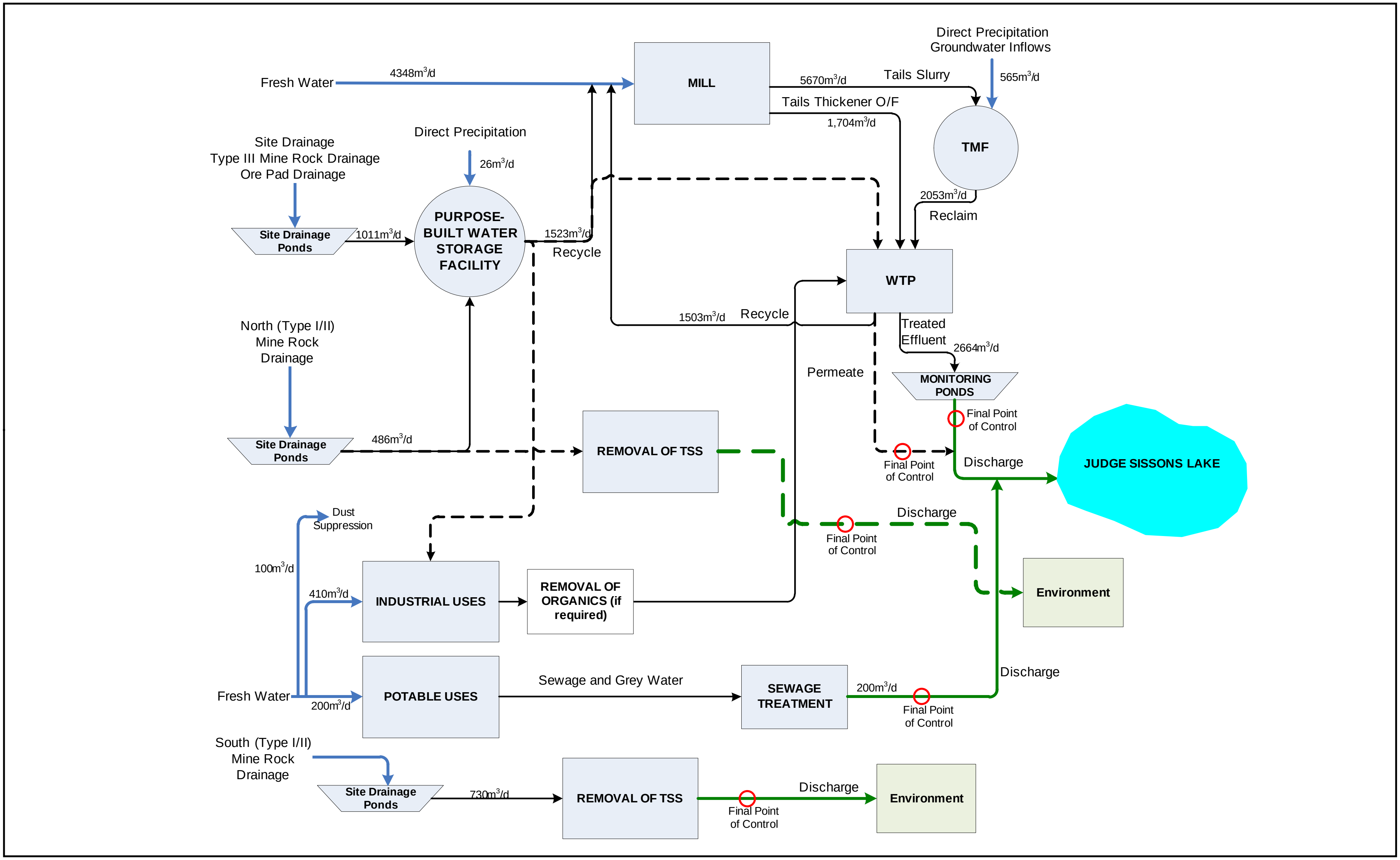
ENVIRONMENTAL IMPACT STATEMENT
APPENDIX 2I - WATER MANAGEMENT PLAN

KIGGAVIK PROJECT

AREVA

AREVA Resources Canada Inc - P.O. Box 9204 - 817 - 45th Street West - Saskatoon, SK - S7K 3X5

File:Q:\SHEQ\GIS\KIGGAVIK\2014\EIS\Volume 2 - Project Description\Volume 2 - Tier 3\Appendix 2I - Water Management Plan\Maps\MXD\Figure 4.2-1 Kiggavik Water Management Construction.mxd



Projection: NA
Compiled: TL
Drawn: LB
Date: 7/21/2014
Scale:
Data Sources: *NA*

FIGURE 4.2-2

KIGGAVIK WATER MANAGEMENT - OPERATIONS

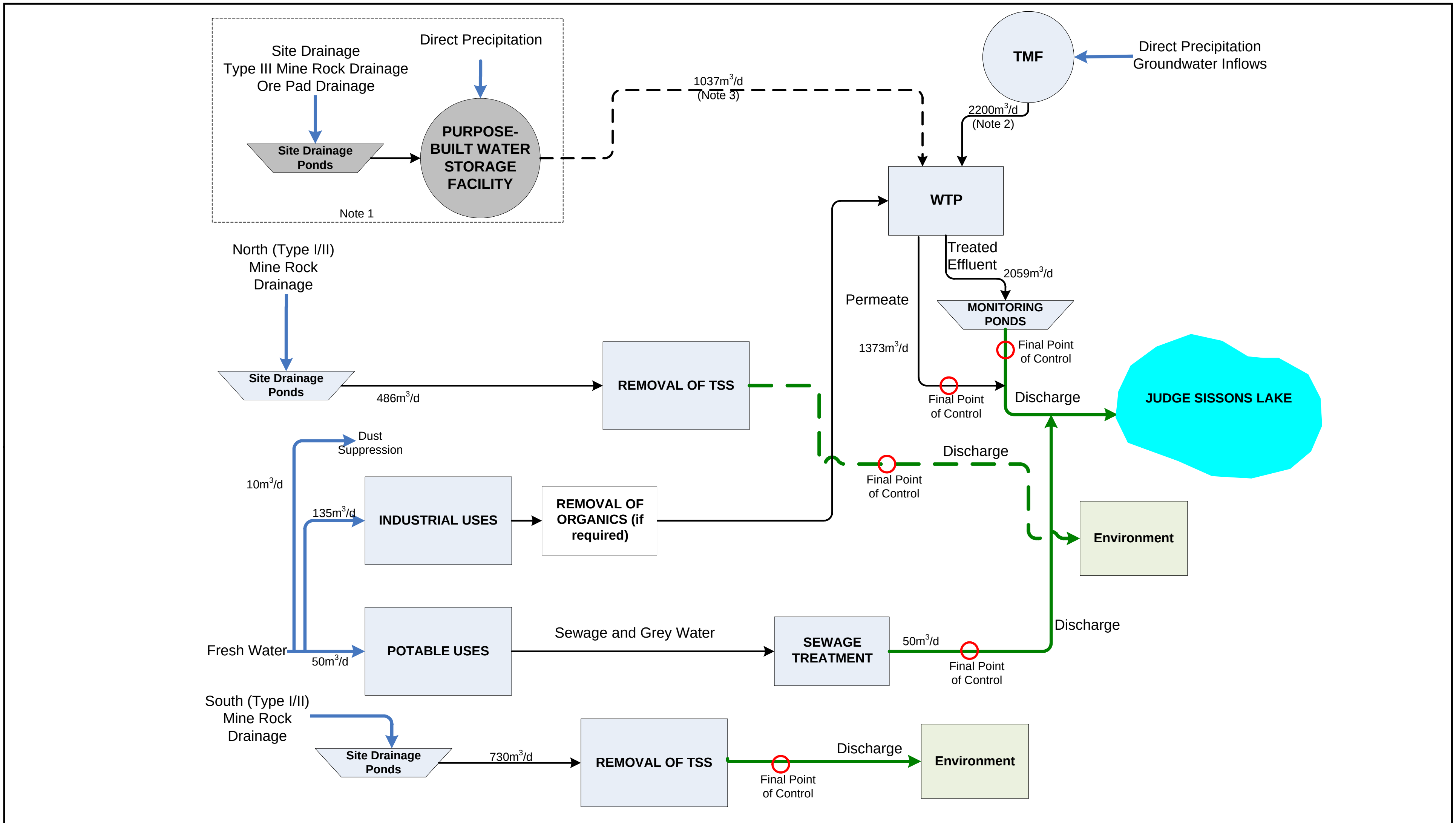
ENVIRONMENTAL IMPACT STATEMENT
APPENDIX 2I - WATER MANAGEMENT PLAN

KIGGAVIK PROJECT

AREVA

File: Q:\SHEQ\GIS\KIGGAVIK\2014\EIS\Volume 2 - Project Description\Volume 2 - Tier 3\Appendix 2I - Water Management Plan\Maps\MXD\Figure 4.2-2 Kiggavik Water Management Operations.mxd

AREVA Resources Canada Inc - P.O. Box 9204 - 817 - 45th Street West - Saskatoon, SK - S7K 3X5



Note 1: Facilities inside box are anticipated to be decommissioned early during the decommissioning phase
Note 2: Flows include removal of tailings porewater expulsed during consolidations and are expected to decrease over time
Note 3: Flows are expected to decrease over time as areas are decommissioned

Projection: NA
Compiled: TL
Drawn: LB
Date: 8/20/2014
Scale:
Data Sources: *NA*

FIGURE 4.2-3
KIGGAVIK WATER MANAGEMENT - DECOMMISSIONING

ENVIRONMENTAL IMPACT STATEMENT
APPENDIX 2I - WATER MANAGEMENT PLAN

KIGGAVIK PROJECT

AREVA

AREVA Resources Canada Inc - P.O. Box 9204 - 817 - 45th Street West - Saskatoon, SK - S7K 3X5

File:Q:\SHEQ\GIS\KIGGAVIK\2014\EIS\Volume 2 - Project Description\Volume 2 - Tier 3\Appendix 2I - Water Management Plan\Maps\MXD\Figure 4.2-3 Kiggavik Water Management Decommissioning.mxd

Table 4.2-1 Summary of Kiggavik Site Water Inputs

Component	Water Expected (m^3/year)		
	Construction	Operation	Decommissioning
Contaminated Site Drainage[1]	378,505	378,505	378,505
Pit Water (Precipitation and Groundwater)	0	206,225	206,225
North Waste Stockpile (Type II) Runoff	177,390	177,390	177,390
Potable Water	73,000	73,000	18,250
Mine Shop And Wash Bay Water	18,250	149,650	18,250
Water for Dust Suppression (Pits, Roads)	10,950	36,500	3,650
Mill and WTP Water Requirements	15,330	2,691,510	31,025
Net Fresh Water Input with No Recycle	117,530	2,950,660	71,175
Net Fresh Water Input with Drainage Recycle	83,950	2,394,765	N/A [3]
Net Freshwater Input with Drainage and Permeate Recycle	68,620	1,846,170	21,900
South Waste Stockpile (Type II) Runoff [2]	266,450	266,450	266,450

NOTE:

[1] Includes purpose-built pit water

[2] Discharged to the environment

[3] No recycle anticipated during decommissioning

4.2.2 Site Drainage

Key components of Kiggavik site drainage management include:

- Containment of all drainage that has contacted the site
- Treatment of drainage as required
- Storage and recycling of drainage to mill processes where practicable
- Contingency storage through site design

Site drainage will include runoff that contacts the mill terrace, ore pad, Type 3 mine rock pad, and other facilities including the contaminated landfill and explosives storage area. The drainage around infrastructure will be managed to reduce pools of water at the surface. Site drainage will be contained using lined pads and ditches and collected in lined sedimentation ponds. Where practicable, this water will be pumped to the purpose-built pit for storage and use in the mill. Any non-recyclable water will be pumped to the WTP for treatment prior to discharge.

Consistent with SERM (2000), the ore pad will be double-lined with HDPE or LLDPE. The Type 3 mine rock pad will be single-lined. All sedimentation ponds will be double-lined and sized to safely contain drainage during 24-hour PMP event (detailed in Technical Appendix 4A). A leakage detection system will be included to monitor the ore pad and pond system. Final design and construction of the pads and ponds must take into account the potential for thaw induced differential settlement. Design of the pads and ponds is further detailed in Technical Appendix 2D.

4.2.3 Type 2 Mine Rock Drainage

Part of the runoff management strategy within the site boundary consists of the construction of drainage channels around the mine rock piles to collect runoff water for passive treatment in unlined sediment ponds to reduce potential suspended sediment loads prior to releasing flow to the natural receiving drainages. The Type 2 waste rock piles are operational areas as defined by the federal Metal Mining Effluent Regulations; therefore, the monitoring methods, volumes, parameters tested, and QA/QC will meet the requirements of the Metal Mining Effluent Regulations. A contingency for discharge that does not meet MMER requirements would be to curtail discharge, and direct the Type 2 waste rock pile runoff to the site water treatment plant.

Runoff conveyance channels have been designed to manage the PMP, and lesser precipitation events, using the same methods as the freshwater diversion channels. In most cases the pile exterior will form one side of the channel while a berm will constrain the flow within the desired alignments. Where topography dictates, channels may need to be excavated over some sections. These channels will drain according to topographic controls and discharge to unlined sedimentation ponds. Outflow from the sedimentation ponds will be to natural channel flow pathways or existing channels, with the exception of the north pile at the Kiggavik site, which will drain to the east freshwater diversion channel. Where channels encounter roadways, culverts will be used to facilitate cross-drainage.

4.2.4 Mine Water

In general, the mines proposed for the Kiggavik site will be excavated in competent low permeability bedrock and therefore significant issues relating to dewatering and groundwater quality and quantity management are not expected. Furthermore the mines will be excavated entirely (East Zone and Centre Zone) or partially (Main Zone) in permafrost, where the frozen ground conditions are expected to further reduce the permeability of the rock mass. For the open pits snowmelt in early summer months is expected to be the dominant source of water inflow.

At the Kiggavik site, mine water will consist of direct precipitation and some groundwater entering the East Zone, Centre Zone and Main Zone open pits. During mining and TMF preparation, this water will be collected in pit sumps and pumped either to the WTP for treatment or to the water storage pit for recycling to the mill. Once the pit has been transformed to a tailings management facility, this water will contribute to the total volume of tailings reclaim water, which is pumped to the WTP.

The groundwater flow model developed for the Kiggavik Project area (Technical Appendix 5D) was used to simulate the dewatering of the Kiggavik mines (Technical Appendix 5E). Transient simulations presented in Technical Appendix 5E suggest that the groundwater inflow to the proposed open pits will be low due to the low hydraulic conductivity of the rock mass in which the pits will be excavated. In addition, mining of the Main Zone pit is expected to take place over several years. During most of this time, the pits will be excavated in permafrost and groundwater inflows are expected to be negligible. In the final years of mining the pits are expected to extend below the bottom of permafrost; the results of the model simulations predict that groundwater inflow to Main Zone pit will be lower than 25 m^3/d for the ultimate pit depth.

Water balance estimates for the open pits suggest that the snowmelt in early summer months will be the dominant source of water inflow to the pits. A peak rate of 745 m^3/day is predicted for Main Zone. Inflow rates are much smaller for Centre Zone and East Zones pits. There is no groundwater inflow component for these open pits and the total inflows are predicted to be less than 500 m^3/day.

For design purposes a total inflow of 2,400 m^3/day was considered for Main Zone pit. This design flow is expected to include a snowmelt component of 1600 m^3/day and a groundwater flow component of 800 m^3/day through depressurization wells. The expected design flow for Centre Zone and East Zone is 500 m^3/day.

Given the development schedule of the Kiggavik and Andrew Lake pits it is proposed to use two pumps (each with a backup) to handle the dewatering of the open pits. One pump will be sized to pump the expected flow from the bottom of the fully developed Main Zone ultimate pit and the other, smaller pump will be used to pump water from the bottom of the fully developed East Zone and Centre Zone pits. The larger pump used to pump water from the Main Zone pit will eventually be moved over to the Andrew Lake pit, once the depth in Andrew Lake pit warrants having a larger pump. The smaller pump will be used to pump water from East Zone pit, then in Centre Zone pit, and then in the shallower Andrew Lake starter pit, while the development of Andrew Lake and Main Zone pits overlap.

The pumps are sized based on the expected frictional head losses and static head in each dewatering pipeline. In each case, calculations are based on using Standard Steel pipe from the bottom of each pit, running straight up the side of the pit and emptying to atmosphere at the diversion ditch on the catch-berm near the top of the pit.

The proposed pumps are submersible vertical turbine style pumps which discharge straight up from the pump column and can be lowered into a sump for operation.

4.2.5 Designing for PMP

The Probable Maximum Precipitation (PMP) represents what is meteorologically possible for the area where the pits are located. The likelihood of a PMP event occurring is extremely low. The PMP estimate for Kiggavik project is approximately 185 mm in 24 hours. Information on the PMP event is detailed in Technical Appendix 4A. This would translate to an inflow ranging from 27,000 m^3 in 24 hr for East Zone pit to 142,000 m^3 in 24 hr for Andrew Lake pit. It is not practical to design for such an event. However, to ensure the pumping system would remain running in the unlikely event of a PMP rainfall the electrical works for the pumping system should be located high enough off the pit floor to stay dry. This way the pumping system could remove excess water accumulated over a longer period of time.

4.2.6 Water Storage Pit

Construction and operation of a water storage pit is proposed as a means of managing spring freshet. This pit will be located to reduce pumping distances to the mill, to take advantage of gradients and to provide contingency containment in case of failure of the primary site containment structures. This pit will be the first pit mined at Kiggavik to allow freshet to be managed during the later stages of construction. During normal operation, recyclable water will be diverted to this pit for storage prior to use in the mill. Contingency uses include storage of TMF reclaim solution.

Water from the north Type 2 mine rock pile may be diverted directly to this pit using diversion channels. All other sources will be pumped to the pit as needed. The design storage volume of the pit is 350,000 m^3. Preparation of the pit includes placement of a pump and access. The level of the water will be maintained 5m below the pit crest.

4.3 Water Treatment and Discharge

Water to be treated at Kiggavik includes:

- Open pit mine water
- Site drainage
- Reclaim water from the tailings management facilities
- Tailings thickener overflow
- Sewage

Contact water and sewage will be treated to meet or exceed required standards prior to release to the environment. The effluent discharge pipeline and monitoring ponds will be constructed during the initial phase of construction to allow the water to be managed effectively during the construction phase of the project.

4.3.1 Water Treatment during Construction

If required, a temporary water treatment plant suitable for treating contaminated water generated from the construction phase will be constructed prior to construction of the permanent water treatment plant. The temporary water treatment plant would be housed in 20ft or 40ft shipping containers to minimize the construction required. Alternatively, the construction of the Kiggavik water treatment plant may be staged to construct the chemical treatment portion of the water treatment plant prior to construction of the RO and its associated pre-treatment.

4.3.2 Water Treatment during Operations

The proposed water treatment process for the Kiggavik site has been selected to allow recycling of some effluent to the mill, and meet MMER and site-specific effluent criteria and to maintain the annual contaminant load discharge to Judge Sissons Lake below a potential threshold of concern based on aquatic life criteria. The preferred option for the water treatment plant is a combination of Reverse Osmosis (RO) technology and a three-stage chemical water treatment plant. The plant will have a capacity of 5,560m^3/d and is designed to remove metals and radionuclides. The RO feed is pre-treated, and is expected to operate at a recovery of 40%. The RO permeate will be recycled to the mill. The RO reject will be sent to the chemical water treatment plant. Each stage of the chemical water treatment plant water treatment consists of chemical addition in reaction tanks followed by clarification for removal of solids.

4.3.3 Water Treatment during Decommissioning

During decommissioning, it is recognized that the feed flow to the water treatment plant will decrease over time. During the initial stages of decommissioning, the entire water treatment plant will be used to treat the water. Initially, the tailings neutralization circuit, or a portion of it, will remain in place to treat the water treatment plant sludges on an as needed basis. Over time, the water treatment plant feed is expected to decrease, as facilities are decommissioned. Once the flow has reduced to below the chemical water treatment plant capacity, the RO portion of the water treatment plant will be decommissioned, and all the feed water will be treated using the chemical treatment portion of the water treatment plant. During the late stages of decommissioning, the tailings neutralization circuit will no longer be available and water treatment plant sludges will be pumped directly to the TMF for disposal. Based on site requirements, the water treatment plant may be operated intermittently during the decommissioning period.

4.3.4 Treated Effluent Discharge

The water treatment plant effluent from both the temporary and permanent water treatment plant will be monitored using three lined monitoring ponds to ensure the effluent meets regulatory requirements. The water will be sampled as it is being discharged to the monitoring ponds and the assay results will be documented and used to confirm that the sample is suitable for discharge. Should the effluent quality of the monitoring pond not meet discharge criteria, the effluent will be recycled to the water treatment plant or TMF, and the cause of the upset condition will be investigated to ensure subsequent treated effluent meets discharge criteria.

Water will be discharged to Judge Sissons Lake via a single-walled pipeline. The pipeline design includes a berm and containment ponds located at low points along the corridor. The berm will be designed such that the pipeline can be crossed by wildlife. An autosampler will collect a sample of the monitoring pond discharge for confirmation of the initial analysis that the effluent meets specifications. The pipeline will be monitored on a regular basis to ensure that there are no leaks.

Effluent will also be tested for both acute and sublethal toxicity as per MMER requirements. Administrative and action levels will be incorporated into the management of treated effluent discharge to ensure ecological risk assessment objectives are achieved. These administrative and action levels will be incorporated into an Environmental Code of Practice. Details on the Environmental Code of Practice can be found in Technical Appendix 2T.

4.3.5 Sewage Treatment and Discharge

All sewage generated at the Kiggavik site will be treated in a dedicated sewage treatment plant. The sewage treatment plant will be built in 20ft or 40ft shipping container modules to minimize construction time and to provide flexibility in the size of the sewage treatment plant. The effluent from the sewage treatment plant will be combined with the effluent from the water treatment plant for discharge to Judge Sissons Lake. The Waste Water Systems Effluent Regulations will be used as guidance to establish the monitoring program for treated sewage. Prior to construction of the discharge pipeline, treated sewage will be stored in a temporary holding facility until the discharge pipeline is completed. It is anticipated that one of the waste rock sedimentation ponds will be used as a temporary holding facility. The pond will then be re-purposed for use as a sedimentation pond. As a contingency, treated sewage could also be stored in the purpose built pit once constructed. The water would then be subject to additional treatment prior to discharge.

4.4 Contingency Measures

Preliminary contingency measures for discharge during upset conditions have been developed. Table 4.4-1 shows the upset condition and the contingency measures to be taken.

Table 4.4-1 Contingency Measures for Discharge

Upset Condition	Contingency Measures
Liner break in monitoring pond	• Operate with 2 of 3 monitoring ponds • Reduce feed flow rate if required
Operator unable to monitor pipeline due to poor weather conditions	• Temporarily suspend discharge of effluent • Suspend operation of water treatment plant • If mill running, temporarily pump tailings thickener O/F to TMF
Major leak in pipeline	• Temporarily suspend discharge of effluent • Temporarily divert treated effluent to TMF
Monitoring pond does not meet discharge criteria	• Recycle pond contents to front-end of water treatment plant or empty pond contents to TMF
Sewage does not meet discharge criteria	• Recycle to front-end of sewage treatment plant
Water treatment plant not operating and sewage requires discharging	• Storage of treated sewage effluent, followed by intermittent batch discharge.

5 Sissons Site Water Management

5.1 Facilities and Infrastructure

The Sissons site will include the water management facilities and infrastructure listed in Table 5.1-1 and summarized in Figure 5.1-1.

Table 5.1-1 Summary of Sissons Site Infrastructure

Facility	Containment Yes	Containment No	Key Features
Fresh Water Pipe and Service Road		✓	• To Mushroom Lake
Water Treatment Plant	✓		• Chemical treatment • 1,700 m3/d nominal capacity
Monitoring Ponds	✓		• Lined ponds
Water Diversion Structures		✓	• Fresh water diversion
Snow Fences		✓	
Treated Effluents Discharge Pipe and Service Road	✓		• Discharge to Judge Sissons Lake
Sedimentation Ponds	✓		• Storage of mine water and site runoff for WTP flow equalization • Lined ponds

5.2 Sissons Site Water Balance

5.2.1 Overview

Key site water inputs include:

- Fresh water for potable use, and dust suppression
- Contaminated site drainage
- Mine site drainage
- Andrew Lake and End Grid ore pad drainage
- Type III mine rock stockpile drainage
- Type I & II mine rock stockpile drainage

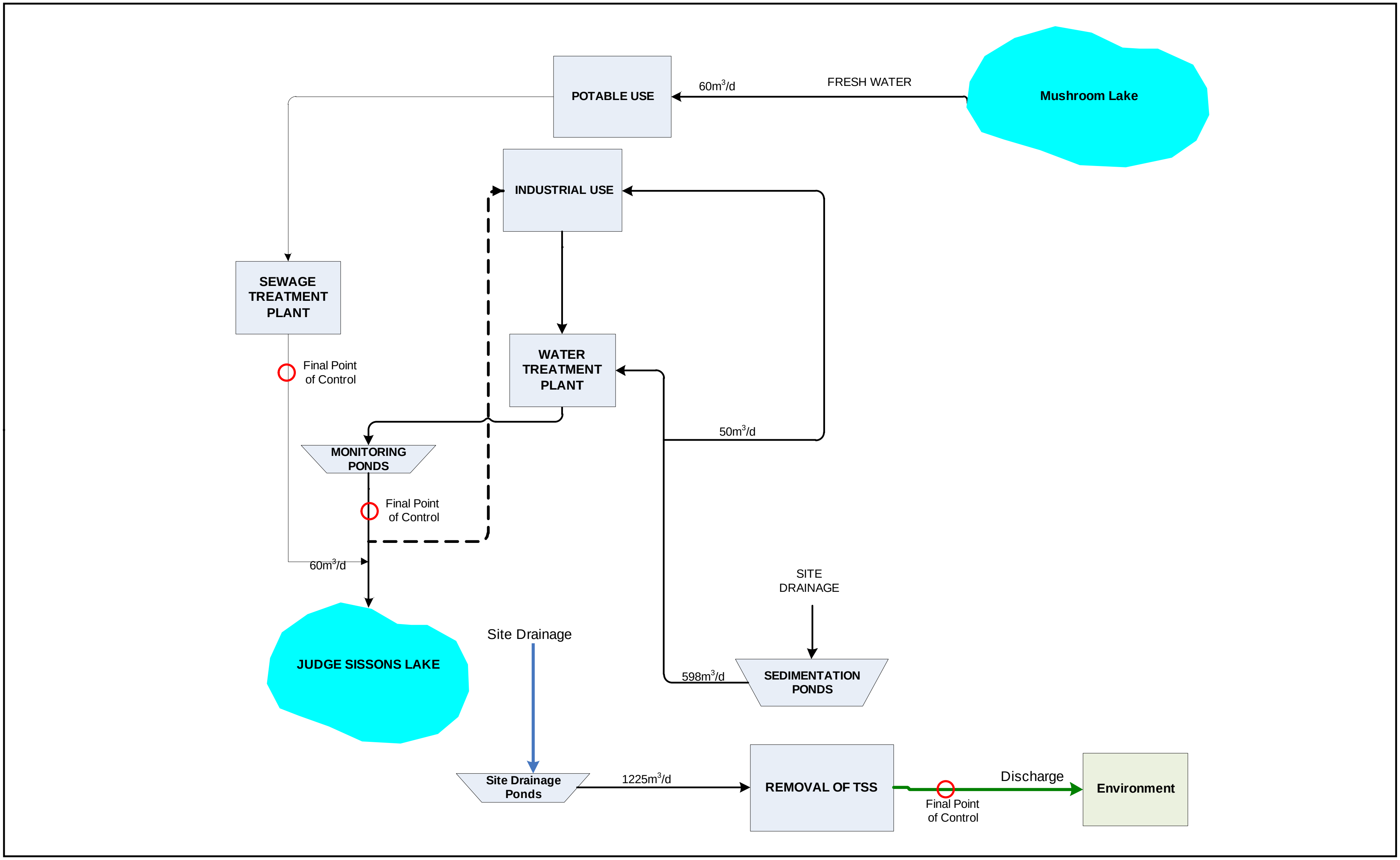
- Pit inflows due to direct precipitation
- Minor groundwater inflows to Andrew Lake pit and End Grid underground during mine development
- Water used in underground mining processes (technical water)

All of the water inputs shown above, with the exception of fresh water intake, are considered contact water

The water balance is summarized for an average year during construction, operation, and decommissioning in Table 5.2-1 below and Figures 5.2-1, 5.2-2 and 5.2-3. The change in the baseline water balance during operations is presented in Figure 3.1-4.

Table 5.2-1 Sissons Site Water Balance

Component	Water Expected (m^3/year)		
	Construction	Operation	Decommissioning
Andrew Lake Open Pit (groundwater and precipitation))	-	159,870	-
End Grid U/G Mine Technical Water	-	74,825	-
End Grid U/G Mine Groundwater	-	58,400	-
Contaminated Site Runoff	218,270	218,270	218,270
Clean Site Runoff	447,125	447,125	447,125
Potable Water	21,900	21,900	7,300
Mine Shop and Wash Bays	18,250	73,000	18,250
Batch Plant	-	7,300	-
Dust Suppression (pits, roads)	10,950	18,250	3,650
Andrew Lake Pit Flooding	-	-	6,300,000
Net Freshwater Input with Drainage Recycle	21,900	21,900	12,775



Projection: NA
Compiled: TL
Date: 7/21/2014
Data Sources: *NA*
Drawn: LB
Scale:

FIGURE 5.2-1
SISSONS SITE WATER MANAGEMENT - CONSTRUCTION

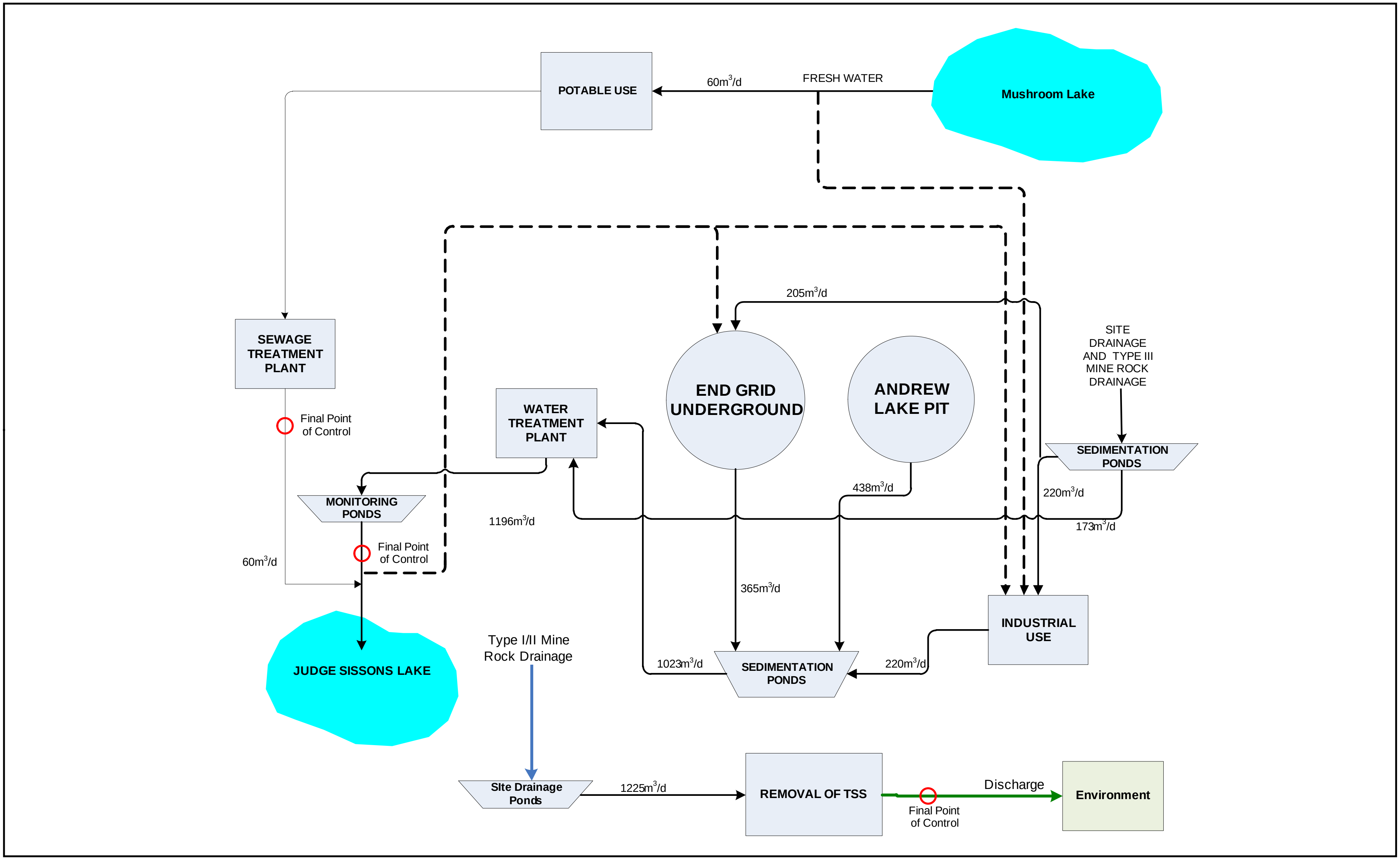
ENVIRONMENTAL IMPACT STATEMENT
APPENDIX 2I - WATER MANAGEMENT PLAN

KIGGAVIK PROJECT

AREVA

File:Q:\SHEQ\GIS\KIGGAVIK\2014\EIS\Volume 2 - Project Description\Volume 2 - Tier 3\Appendix 2I - Water Management Plan\Maps\MXD\Figure 5.2-1 Sissons Site Water Management - Construction.mxd

AREVA Resources Canada Inc - P.O. Box 9204 - 817 - 45th Street West - Saskatoon, SK - S7K 3X5



Projection: NA
Compiled: TL
Drawn: LB
Date: 7/21/2014
Scale:
Data Sources: *NA*

FIGURE 5.2-2

SISSONS SITE WATER MANAGEMENT - OPERATIONS

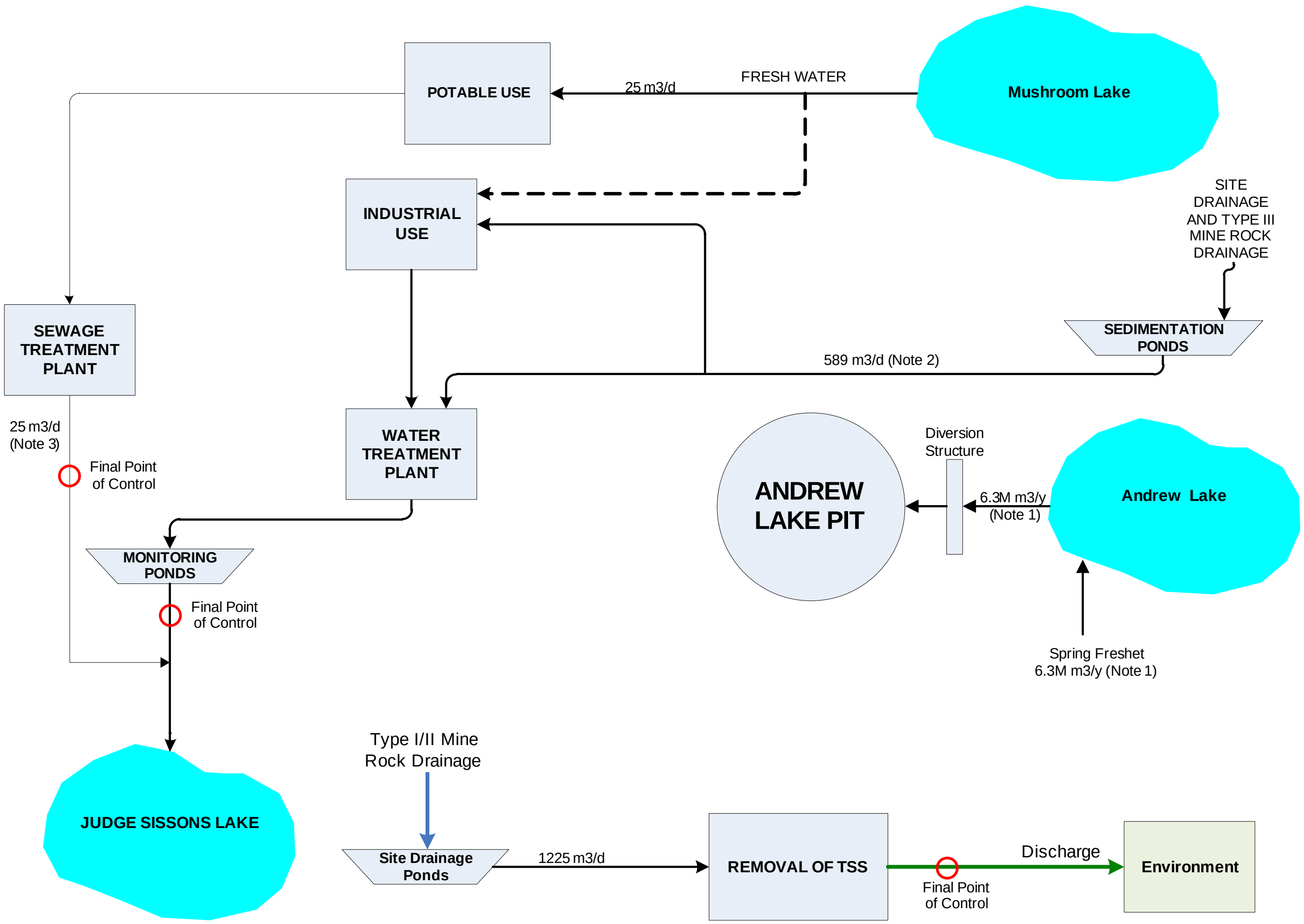
ENVIRONMENTAL IMPACT STATEMENT
APPENDIX 2I - WATER MANAGEMENT PLAN

KIGGAVIK PROJECT

AREVA

File:Q:\SHEQ\GIS\KIGGAVIK\2014\EIS\Volume 2 - Project Description\Volume 2 - Tier 3\Appendix 2I - Water Management Plan\Maps\MXD\Figure 5.2-2 Sissons Site Water Management Operation.mxd

AREVA Resources Canada Inc - P.O. Box 9204 - 817 - 45th Street West - Saskatoon, SK - S7K 3X5



Note 1: Refilling of Andrew Lake pit anticipated to occur over a 6 year period
Note 2: Flow expected to decrease over time as areas are reclaimed
Note 3: Sewage may be trucked to Kiggavik for treatment during decommissioning

Projection: NA
Compiled: TL
Drawn: LB
Date: 7/21/2014
Scale:
Data Sources: *NA*

FIGURE 5.2-3
SISSONS SITE WATER MANAGEMENT - DECOMMISSIONING

ENVIRONMENTAL IMPACT STATEMENT
APPENDIX 2I - WATER MANAGEMENT PLAN

KIGGAVIK PROJECT

AREVA

AREVA Resources Canada Inc - P.O. Box 9204 - 817 - 45th Street West - Saskatoon, SK - S7K 3X5

File: Q:\SHEQ\GIS\KIGGAVIK\2014\EIS\Volume 2 - Project Description\Volume 2 - Tier 3\Appendix 2I - Water Management Plan\Maps\MXD\Figure 5.2-3 Sissons Site Water Management Decommissioning.mxd

At the Sissons site, fresh water is required primarily for potable use and for dust suppression in Andrew Lake pit and on site roads. Surface drainage and recycled water will be used for most other purposes. The other key components of the water balance are surface runoff and mine water.

The contaminated runoff volume for construction and decommissioning presented above represent the maximum runoff values expected during these phases. As construction proceeds, runoff requiring management will gradually increase as site infrastructure is developed. Conversely, during decommissioning, as the waste piles and other facilities are decommissioned, runoff requiring management will decrease. Type I and II runoff will gradually increase during the mining phase of operation. During decommissioning, the waste rock pile will be recontoured and an appreciable change in runoff volume is not expected. The flooding of the Andrew Lake pit is anticipated to take 6 years at a flooding rate of 6.3Mm^3/year, based on partial diversion of the spring freshet. Information on Andrew Lake pit flooding can be found in Attachment I of the Preliminary Decommissioning Plan (Technical Appendix 2R). Once flooding of the pit is complete, the diversion structure will be removed and the berm breached for permanent connection of Andrew Lake and pit waters.

To minimize the use of fresh water, mine process water will use recycled water as much as possible. For underground drilling, an inventory of water will be kept underground for use in drilling processes. Sand filters may be used to reduce the total suspended solids of the drilling water. The mine water inflow is insufficient to meet the technical water requirements. Site runoff water could be used for technical water. Sufficient inventory will need to be maintained in the site runoff sedimentation ponds to ensure adequate supply of technical water. In the event that sufficient site runoff is not available, treated effluent could be used to supplement the technical water needs.

Water used in the wash bay and mine shop for cleaning heavy equipment will come from recycled water. Site drainage will be used as the primary source of recycled water for the mine shop. As a contingency, in the event that sufficient runoff is not available, treated effluent could be used in the wash bay for cleaning heavy equipment.

At the Sissons site, fresh water is required primarily for potable use and for dust suppression in Andrew Lake pit and on site roads. Surface drainage and recycled water will be used for most other purposes. The other key components of the water balance are surface runoff and mine water.

5.2.2 Mine Water

At the Sissons site, mine water will consist of direct precipitation, groundwater entering the Andrew Lake open pit, and surface water inflows, groundwater inflows and technical water from the End Grid underground mine. During mining, this water will be collected in pit sumps and pumped to a sedimentation pond for temporary storage. The site runoff pond, which supplies technical water and water treatment plant feed, will be designed to hold a volume of approximately 105,000 m^3. This provides sufficient buffer capacity to store spring freshet and provide technical water and water for the mine shop on a year-round basis. In the event that sufficient runoff is not available, the treated effluent volumes will provide sufficient backup to meet the recycled water requirements. Water from the site runoff pond, which is not used for recycled water, will be pumped to the WTP for treatment.

The mines proposed for the Kiggavik Project will be excavated in competent low permeability bedrock and therefore significant issues relating to dewatering and groundwater quality and quantity management are not expected. Furthermore the mines will be excavated partially (Andrew Lake and End Grid) in permafrost, where the frozen ground conditions are expected to further reduce the permeability of the rock mass. For the open pits snowmelt in early summer months is expected to be the dominant source of water inflow.

5.2.3 Andrew Lake Open Pit

In the final years of mining the pit is expected to extend below the bottom of permafrost; the results of the model simulations predict that groundwater inflow to the Andrew Lake pit will be lower than 20 m^3/d for the ultimate pit depth.

Water balance estimates suggest that the snowmelt in early summer months will be the dominant source of water inflow to the pits. A peak rate of 1050 m^3/day in July is predicted for the Andrew Lake open pit. For design purposes a total inflow of 2,400 m^3/day was considered for Andrew Lake pit. This design flow is expected to include a snowmelt component of 1600 m^3/day and a groundwater flow component of 800 m^3/day through depressurization wells.

5.2.4 End Grid Underground Mine

For the underground mine End Grid mine water will include groundwater inflows to the mine, technical water (i.e., drilling, wall and mine equipment washing, dust suppression, backfill, combustion) and surface water entering the mine. The sum of these three components is not expected to exceed 1,000 m^3/day for the final mine configuration and during the peak production phases of the operation.

Although End Grid extends into the groundwater regime beneath the permafrost, groundwater inflows into the mine openings are expected to be small due to the low hydraulic conductivity of the rock mass. Model results (see Technical Appendix 5E) suggest that inflow to the End Grid underground mine may slightly increase as development progresses below the permafrost horizon. Predicted groundwater flow to the End Grid underground mine is approximately 160 m^3/day for the ultimate configuration of the mine. Most of this flow originates from the enhanced permeability zones assumed to be associated with the sub-vertical faults passing through the mine. If these faults are either not present or have a lower hydraulic conductivity than assumed then inflow to the mine would be lower than 100 m^3/day.

During the development of the decline in permafrost, pressure heads beneath the permafrost will not be reduced; therefore, if prior depressurization is not undertaken, pressure heads will initially be initially be 250 m or more when the mine first penetrates beneath the permafrost. If these pressures are determined to be high, based on stability concerns, or the inflow volumes are considered to be difficult to manage, then a depressurization program will need to be implemented. An effective depressurization system would likely consist of vertical or sub-vertical boreholes drilled from a development excavation. The boreholes could either be allowed to flow under artesian conditions, or pumps could be installed (if larger diameter holes are drilled) to provide additional lowering of water levels. The water would then be pumped to surface for treatment.

5.2.5 Site Drainage

Key components of Sissons site drainage management include:

- Containment of all drainage that has contacted the site
- Treatment of drainage as required
- Storage and recycling of drainage to underground mine processes where practicable
- Contingency storage through site design

Site drainage will include runoff that contacts the mine site infrastructure, ore pad, and special waste pad. This water will be contained using lined pads and ditches and collected in a lined sedimentation pond. Where practicable, this water will be used for technical water in mining operations and for wash bay water. Any water that is not recycled will be pumped to the WTP for treatment prior to discharge.

Consistent with SERM (2000), the ore pad will be double-lined with HDPE or LLDPE. The special waste pad will be single-lined. All sedimentation ponds will be double-lined and sized to safely contain drainage during 24-hour PMP event. Information on the PMP event is detailed in Technical Appendix 4A. A leakage detection system will be included to monitor the ore pad and pond system. Final design and construction of the pads and ponds must take into account the potential for thaw induced differential settlement. Design of the pads and ponds is further detailed in Technical Appendix 2D.

The Sissons site includes a fresh water diversion channel that intercepts flow from natural channels draining from the north. Drainage basins to the south and west drain away from the site. Figure 3.2-2 indicates the proposed freshwater diversion channel, and mine rock channel alignments and flow directions for the site.

The freshwater diversion channel has three main sections, one flowing eastward around the core facilities area and reporting to End Grid Lake, the second flowing initially south along the Mushroom Lake access road, and then west to discharge to the third section that flows southward through a series of small ponds. The east channel section carries outflow from Mushroom Lake to Grid Lake which is the natural receiving waterbody. The lower portion of the east channel will be deeply incised through bedrock at the same gradient as the existing channel. This was done to allow the same opportunity for fish movement as was available in the natural channel. Both diversion channels converge at a small waterbody which drains Shack Lake. Shack Lake received runoff from these same drainages prior to development.

The mine rock pile area is located at the west side of the site and will have a sedimentation pond on the south end. Outflow from the sedimentation pond will drain to Andrews Lake.

5.2.6 Industrial Water

The main consumers of industrial water is the backfill plant for the end grid underground mine and water for the mine shop/wash bay. The industrial water requirements are estimated at approximately $230m^3/d$. The industrial water requirements can be met by using site runoff water (preferred) or by using treated effluent. Any waste water produced from industrial sources will be pumped to the runoff sedimentation pond for treatment in the water treatment plant.

5.3 Water Treatment and Discharge

A water treatment plant will be constructed at Sissons to treat all contaminated wastewater prior to discharge. Wastewater and sewage will be treated to meet or exceed required standards prior to release to the environment. The water treatment plant, monitoring ponds and discharge pipe will be constructed prior to preparation of the runoff stockpiles and site infrastructure, so that water treatment facilities will be available to treat any contaminated water generated during the construction phase. Sedimentation ponds will be constructed for temporary storage of contaminated water prior to treatment. The ponds will be sized to contain spring freshet and allow for flow equalization for the WTP feed.

The proposed water treatment process for the Sissons site has been selected to meet MMER and site-specific effluent criteria and, also, to maintain the annual contaminant mass load of discharges to Judge Sissons Lake below a potential threshold of concern based on aquatic life criteria.

5.3.1 Water Treatment during Operations

The water treatment plant will be a three stage chemical treatment plant with a capacity of 1,700m3/d and is designed to remove metals and radionuclides to environmentally acceptable levels. Each stage of water treatment consists of chemical addition in reaction tanks followed by multimedia filtration for removal of suspended solids. Each stage has two tanks, each with a 40 minute retention time. Reagents are added to the first tank, designed for rapid mixing to promote the precipitation reactions. Flocculant is added to the second tank, which is a slow mix tank, to promote flocculation. .

5.3.2 Water Treatment during Decommissioning

During decommissioning the feed to the water treatment plant will decrease over time. During the initial stages of decommissioning, the operating philosophy of the water treatment plant will not change. As the flow decreases, the water treatment plant may only require intermittent operation. The feed and effluent water quantity and quality will be monitored. A portion of the water treatment plant may be decommissioned if the effluent discharge quality can be met under a reduced operating scenario.

5.3.3 Treated Effluent Discharge

The water treatment plant effluent will be monitored using three lined monitoring ponds to ensure the effluent meets regulatory requirements. The water will be sampled as it is being discharged to the monitoring ponds and the assay results will be documented and used to confirm that the sample is suitable for discharge. Should the effluent quality of the monitoring pond not meet discharge criteria, the effluent will be recycled to the water treatment plant or sedimentation ponds, and the cause of the upset condition will be investigated to ensure subsequent treated effluent meets discharge criteria.

Water will be discharged to Judge Sissons Lake via a single-walled pipeline. The pipeline design includes a berm and containment ponds located at low points along the corridor. The berm will be designed such that the pipeline can be crossed by wildlife. An autosampler will collect a sample of the monitoring pond discharge for confirmation of the initial analysis that the effluent meets specifications. The pipeline will be monitored on a regular basis to ensure that there are no leaks.

Effluent will also be tested for both acute and sublethal toxicity as per MMER requirements. Administrative and action levels will be incorporated into the management of treated effluent discharge to ensure ecological risk assessment objectives are achieved. These administrative and action levels will be incorporated into an Environmental Code of Practice. Details on the Environmental Code of Practice can be found in Technical Appendix 2T.

5.3.4 Sewage Treatment and Discharge

All sewage generated at the Sissons site will be treated in a dedicated sewage treatment plant. The sewage treatment plant will be built in 20ft or 40ft shipping container modules to minimize construction time and to provide flexibility in the size of the sewage treatment plant. The effluent from the sewage treatment plant will be combined with the effluent from the water treatment plant for discharge to Judge Sissons Lake. The Waste Water Systems Effluent Regulations will be used as guidance to establish the monitoring program for treated sewage. Prior to construction of the discharge pipeline, sewage from the Sissons sites will be stored in a temporary holding tank and be periodically trucked to the Kiggavik site for treatment in the Kiggavik sewage treatment plant.

5.4 Contingency Measures

Preliminary contingency measures for discharge during upset conditions have been developed. Table 5.4-1 shows the upset condition and the contingency measures to be taken.

Table 5.4-1 Contingency Measures for Discharge

Upset Condition	Contingency Measures
Liner break in monitoring pond	• Operate with 2 of 3 monitoring ponds • Reduce feed flow rate if required
Operator unable to monitor pipeline due to poor weather conditions	• Temporarily suspend discharge of effluent • Suspend operation of water treatment plant
Major leak in pipeline	• Temporarily suspend operation of WTP and discharge of effluent
Monitoring pond does not meet discharge criteria	• Recycle pond contents to run-off sedimentation pond for re-treatment in WTP
Sewage does not meet discharge criteria	• Recycle to front-end of sewage treatment plant
Water treatment plant not operating and sewage requires discharging	• Storage of treated sewage effluent, followed by intermittent batch discharge.

5.5 Andrew Lake Dewatering

At the Sissons site, the south west portion of the Andrew Lake open pit extends into Andrew Lake and a structure is required to allow this end of the lake to be dewatered for the proposed pit development. Andrew Lake pit will be dewatered at a rate to minimize the potential for serious harm to fish, and water and sediment quality. Dewatering will occur after spring freshet and spring spawning season and prior to freeze-up. Similarly, at decommissioning, Andrew Lake pit will be flooded at a rate that will minimize the potential serious harm to fish, surface hydrology, and water quality.

Although Andrew Lake is a shallow lake, with an average depth of 1 m, aquatics studies have indicated that small fish frequent the lake and, therefore, the dyked area will be fished-out prior to dewatering. The fish-out will be done in consultation with the local communities and regulators. Approximately 135,000 m2 of lake area, containing approximately 30,000 m3 of water, will require dewatering.

The general design basis for this dewatering structure includes:

- Maintaining a suitable setback between the open pit limit and the dewatering structure;
- Meeting or exceeding the required safety factors for stability and hydrotechnical design criteria according to the consequence classification as set out by the Canadian Dam Association 2007; and,
- Managing seepage into the open pit.

Turbidity curtains will be installed prior to berm construction and Andrew Lake dewatering. In-water construction will follow standard protocols and best management practices as outlined in Technical Appendix 5O.

The construction of the dewatering structure is summarized in Volume 2, Section 12 and the design is described in detail in Technical Appendix 2F (Conceptual Design for Andrew Lake Pit Dewatering Structure).

6 Site Access Water Management

It is expected that any contact waters associated with the Baker Lake dock site, the access road(s), and quarries, will generally not require treatment. Where sediment transport is identified as a potential concern, sedimentation ponds or other means of removing total suspended solids (TSS) from runoff, such as silt fences, will be installed.

6.1 Baker Lake Dock Facility and Storage Area

The Baker Lake storage area and associated infrastructure will be located on an upland area near to the temporary dock. General drainage will be diverted around the site.

General drainage from within the site footprint is not expected to require treatment. Berms or silt fences may be utilized to control any excess runoff and potential sediment transport from the site.

Fuel and hazardous materials will be stored within secondary containment berms. Runoff from within the berms may be passed through a passive filter prior to discharge to remove any organics or other contaminants.

6.2 Quarry Sites

A number of potential aggregate source quarries have been identified along the access road routes. Water from within quarries will be managed to prevent effects on the aquatic environment. To reduce ponding and resulting permafrost degradation, drainage ditches or channels will be constructed, where required, to divert water from entering the quarry. Where water erosion may cause slope destabilization or sediment transport, side slopes will be maintained below 1H:1V to 2H:1V where possible, and erosion control measures will be available (e.g., geotextiles, rip-rap, straw blankets) as outlined in Technical Appendix 5O. Berms and silt fences may be utilized to control any excess runoff from the quarry.

Drainage from within the quarry will be collected in a sump, and if required, will undergo testing prior to release. Material characterization indicates that the majority of excavated rock would not have significant acid rock drainage (ARD) or metals leaching (ML) potential (Technical Appendix 5F). The aggregate rock materials are not likely to leach constituents of potential concern.

6.3 Baker Lake – Kiggavik Access Roads

The two access road options proposed for the Project are a winter access road and the all-season access road.

6.3.1 Winter Access Road

Water for preparation of the winter access road will be withdrawn from lakes of substantial volume along the route. Withdrawal rates will follow all applicable Fisheries and Oceans Canada (DFO) guidelines for protection of fish habitat. Specifically, no more than 10% of the under-ice volume will be withdrawn from a lake during one ice covered season. Approaches along shorelines will be built up using ice ramps to reduce the potential for erosion or sediment transport.

As the winter access road will operate only during periods of ice cover, it is not anticipated that any collection or treatment of water will be necessary.

6.3.2 All-Season Access Road

The all-season road, if constructed, will cross the Thelon River and a number of other streams. The Thelon River crossing will consist of a cable ferry during the ice-free season and an ice-bridge during the ice-covered season. The reminder of the crossing will consist of either clear span bridges or culverts.

The road will be constructed from fill drawn from the quarries. Only clean fill that does not have potential for ARD or ML will be used for construction purposes. Therefore drainage from the road bed is not expected to require collection or treatment.

Construction best-practices will be used when constructing crossings to ensure that potential aquatics effects due to sediment transport or shoreline erosion are mitigated. Erosion and sediment control measures are detailed in Technical Appendix 5O.

7 Climate Change Considerations

Considerations for climate change have been incorporated in the development of water management strategies and facilities primarily through conservatism in both design and in the environmental assessment basis. This is considered the best approach since changes in regional climate have the potential to either decrease or increase the volume of contact water. The assessments of environmental effects have been based on conservative values (refer to Tier 2 Volume 2 Project Description and Assessment Basis) wherein freshwater withdrawal rates are assumed to be consistently at the high end of the range (in case of lower volumes of recyclable site drainage) and treated effluent discharge is assumed to be consistently at the maximum capacity of the water treatment plants.

During the construction and operational phase, additional data will be gathered on hydrological conditions in the site areas (see Technical Appendix 5A for existing baseline). This data, in addition to site-specific operating experience, are considered to provide opportunities for continuous improvement in water management and optimization of storage, such that the Project will adapt to future fluctuations in climate within the context of the current Environmental Impact Statement.

7.1 Climate Change Water Balance

The operating water balance for Kiggavik and Sissons drainage systems, incorporating climate change are shown in Figure 7.1-1 and 7.1-2. The climate change water balance is detailed in Technical Appendix 5K, Climate Change Water Balance.

Based on the average outcome of the climate change scenarios evaluated, run-off and flow through both the Kiggavik and Sissons drainage systems are expected to increase. Table 7.1-1 below provides a comparison of the baseline water balance flows with and without accounting for potential impacts due to Climate change.

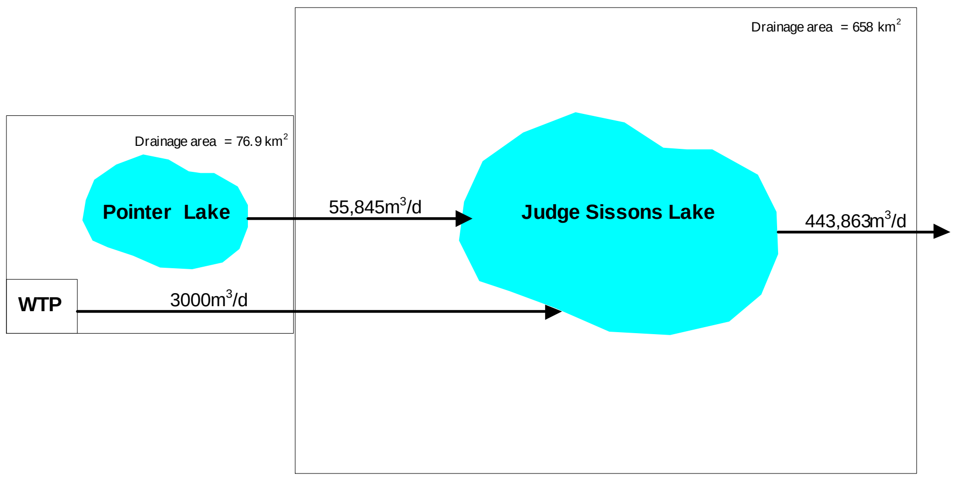
Table 7.1-1 Comparison of Baseline Water Balance With and Without Climate

	Baseline Flow without Climate Change (m^3/d)	Baseline Flow With Climate Change (m^3/d)
Kiggavik Drainage System		
Pointer Lake Outflow	41,640	61,922
Judge Sissons Lake Outflow*	335,694	557,634
Sissons Drainage System		
Mushroom Lake Outflow	2,217	3,560
Andrew Lake Outflow	17,966	29,823
Shack Lake Outflow	25,033	41,555

* Judge Sissons Lake Outflow is part of Kiggavik and Sissons drainage systems

Design measures to account for potential changes in water flows include sizing of channels and ponds for a 24-hour Probable Maximum Precipitation (PMP) event (Technical Appendix 4A), over-sizing the water treatment plant, and providing contingency containment with on-site pits and ponds. The design mitigation measures in place will provide sufficient mitigation for the potential effects due to climate change.

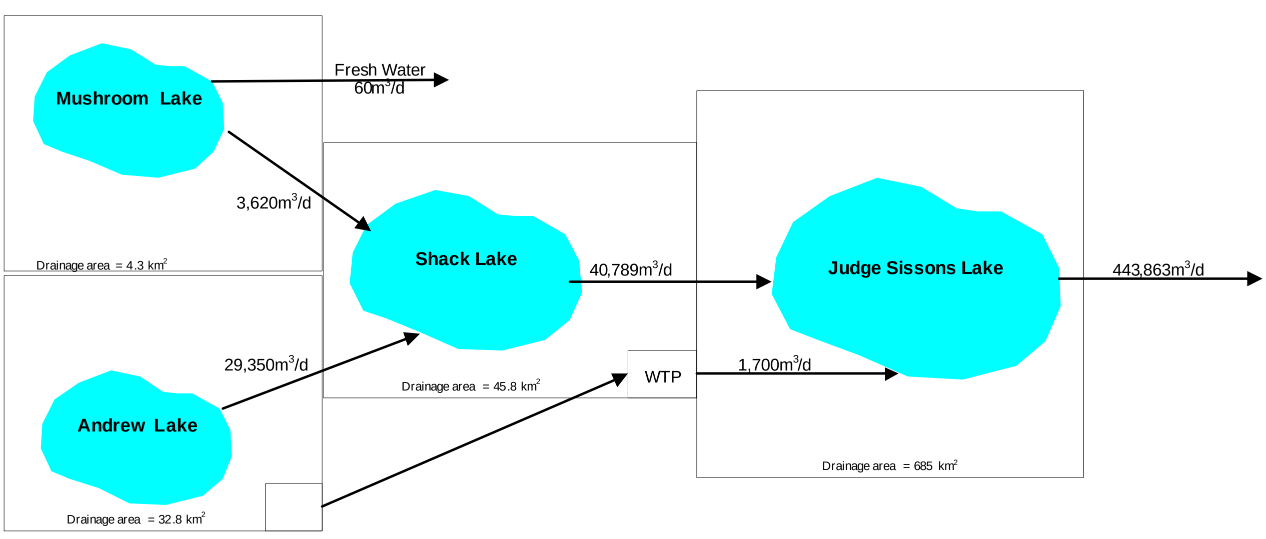
Kiggavik



Note 1: With climate change , baseline flows increase by a factor of 1.66
Note 2: Climate change water balance located in Appendix 5K
Note 3: Not to scale

Figure 7.1-1

Sissons



Note 1: Not to scale
Note 2: With climate change , baseline flows increase by a factor of 1.66
Note 3: Climate change water balance located in Appendix 5K

Figure 7.1-2

Projection: NA
Compiled:TL
Date: 7/21/2014
Data Sources:
Drawn: LB
Scale:

FIGURE 7.1-1/7.1-2
KIGGAVIK & SISSONS SITE DRAINAGE WATER BALANCE - CLIMATE CHANGE AND OPERATIONS

ENVIRONMENTAL IMPACT STATEMENT
APPENDIX 2I - WATER MANAGEMENT PLAN

KIGGAVIK PROJECT

AREVA

File: Q:\SHEQ\GIS\KIGGAVIK\2014\EIS\Volume 2 - Project Description\Volume 2 - Tier 3\Appendix 2I - Water Management Plan\Maps\MXD\Figure 7.1-1 & 7.1-2 Kiggavik Sissons site drainage water balance climate change and observations.mxd

AREVA Resources Canada Inc - P.O. Box 9204 - 817 - 45th Street West - Saskatoon, SK - S7K 3X5

8 References

AREVA Resources Canada (2014). Kiggavik Environmental Impact Statement – Tier 2 Volume 2 – Project Description and Assessment Basis, September 2014

AREVA Resources Canada (2014). Kiggavik Environmental Impact Statement – Tier 2 Volume 10 – Accidents and Malfunctions, September 2014

AREVA Resources Canada (2014). Kiggavik Environmental Impact Statement – Tier 3 Technical Appendix 2D- Conceptual Design for Ore and Special Waste Pads and Ponds, September 2014

AREVA Resources Canada (2014). Kiggavik Environmental Impact Statement – Tier 3 Technical Appendix 2E – Conceptual Freshwater Diversions and Wasterock Collections Channels, September 2014

AREVA Resources Canada (2014). Kiggavik Environmental Impact Statement – Tier 3 Technical Appendix 2F – Conceptual Design for Andrew Lake Pit Dewatering Structure, September 2014

AREVA Resources Canada (2014). Kiggavik Environmental Impact Statement – Tier 3 Technical Appendix 2R – Preliminary Decommissioning Plan, September 2014

AREVA Resources Canada (2014). Kiggavik Environmental Impact Statement – Tier 3 Technical Appendix 2T – Environmental Management Plan, September 2014

AREVA Resources Canada (2014). Kiggavik Environmental Impact Statement – Tier 3 Technical Appendix 4A –Climate Baseline, September 2014

AREVA Resources Canada (2014). Kiggavik Environmental Impact Statement – Tier 3 Technical Appendix 5A – Hydrology Baseline, September 2014

AREVA Resources Canada (2014). Kiggavik Environmental Impact Statement – Tier 3 Technical Appendix 5C – Aquatics Baseline, September 2014

AREVA Resources Canada (2014). Kiggavik Environmental Impact Statement – Tier 3 Technical Appendix 5D –Groundwater Flow Model, September 2014

AREVA Resources Canada (2014). Kiggavik Environmental Impact Statement – Tier 3 Technical Appendix 5E – Prediction of Water Inflows to Kiggavik Project Mines, September 2014

AREVA Resources Canada (2014). Kiggavik Environmental Impact Statement – Tier 3 Technical Appendix 5F –Mine Rock Characterization, and Management, September 2014

AREVA Resources Canada (2014). Kiggavik Environmental Impact Statement – Tier 3 Technical Appendix 5K-Climate Change Water Balance, September 2014

AREVA Resources Canada (2014). Kiggavik Environmental Impact Statement – Tier 3 Technical Appendix 5M-Aquatic Effects Monitoring Plan, September 2014

AREVA Resources Canada (2014). Kiggavik Environmental Impact Statement – Tier 3 Technical Appendix 5O-Erosion and Sediment Control Plan, September 2014