9.6.2 Management of Contact Water

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 mine processes where practicable; and,
- contingency storage through site design.

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 which will be directed to unlined sedimentation ponds prior to reporting to natural drainage pathways. Contact water includes site drainage, Type 1 / 2 mine rock drainage, and mine water. It has been assumed that all site drainage, which includes drainage from the mine terrace, ore pad, and Type 3 mine rock pad, will either be recycled or pumped to the WTP. Mine water will also be either recycled or treated.

Drainage from the Type 2 mine rock pile will be treated passively in unlined sedimentation ponds and released to the environment. 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 1 / 2 waste rock pile runoff to the site water treatment plant.

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*.

9.6.3 Water Treatment During Operations

Water to be treated at Sissons during the operational phase includes:

- mine water from the End Grid underground mine;
- mine water, from the Andrew Lake open pit;
- water from the Sissons wash bay / mine shop;
- sissons site and stockpile drainage; and
- domestic waste water.

9.6.3.1 ***Water Treatment Options Considered***

Water treatment options considered for the Sissons site included the following:

- installation of a membrane treatment plant similar to the Kiggavik WTP;
- piping the contaminated water to Kiggavik and treating the water in the Kiggavik WTP;
- trucking the contaminated water to Kiggavik and treating the water in the Kiggavik WTP;
- installation of a 3-stage chemical WTP in a building; and
- installation of a containerized 3-stage chemical WTP.

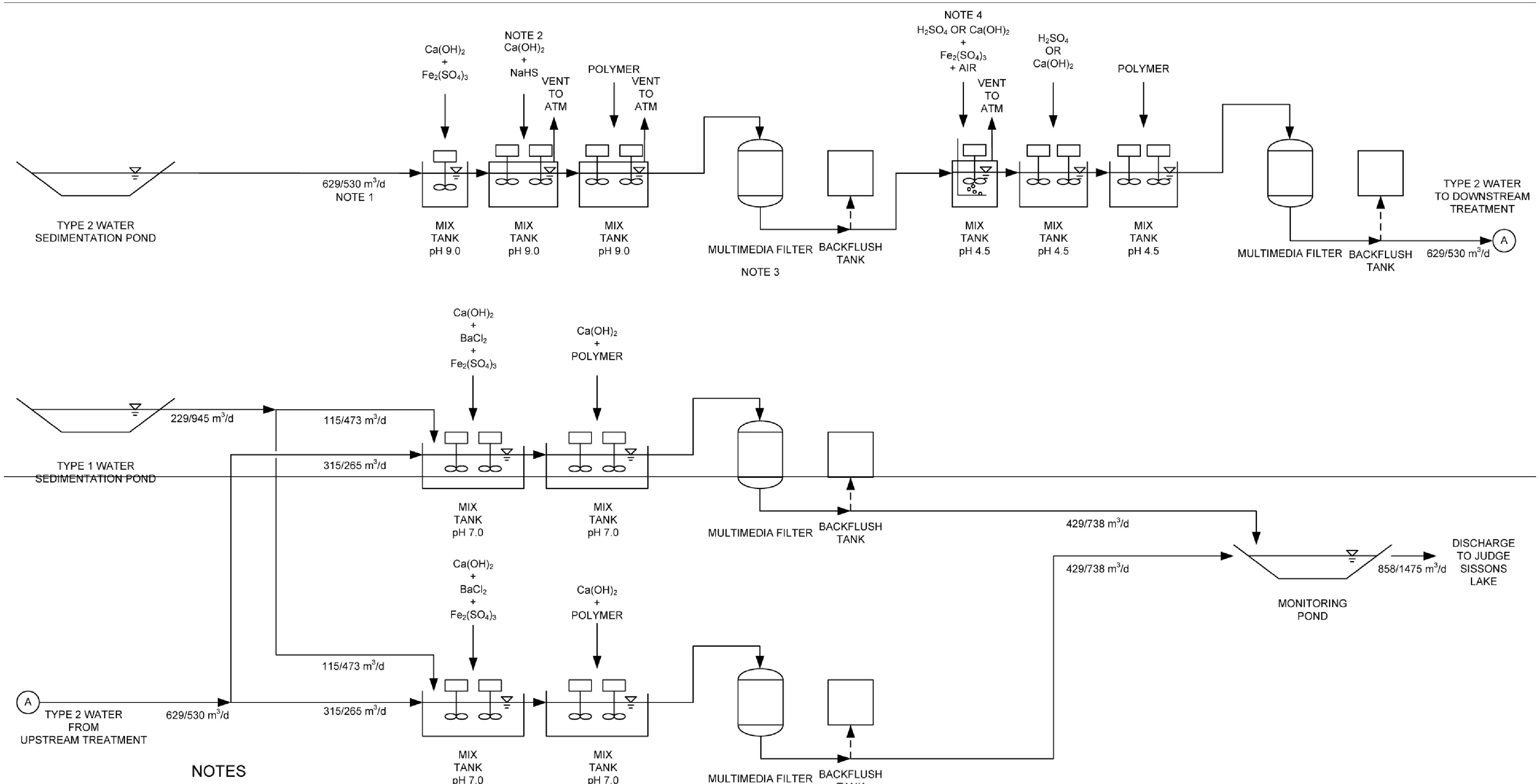
9.6.3.2 ***Water Treatment Process***

This section describes a base case water treatment option meeting the discharge criteria. It is anticipated that this option will be optimized as a result of on-going tests and studies. The design will be updated at the time of licensing application.

The preferred water treatment option for the Sissons WTP is a 3-stage chemical water treatment plant located in a building. A block diagram of the Sissons WTP process is shown in Figure 9.6-2. If additional recycled water is desired at the Kiggavik site, the water may be piped or trucked to Kiggavik and treated in the Kiggavik WTP. If this is done, expansion of the Kiggavik WTP may be required and a water treatment plant at Sissons would not be required.

As discussed in Section 12.9.7, a temporary WTP may be required at the Kiggavik site during construction. Once the permanent Kiggavik WTP is constructed and commissioned, the temporary water treatment plant will be moved to the Sissons site. Most of the equipment used in the temporary water treatment plant will be re-used in the water treatment plant building at Sissons. The main exception is the containerized reaction tanks and their agitators. New agitated reaction tanks will be constructed for the Sissons WTP to provide better mixing as well as improved operator access. If a temporary WTP is not required at the Kiggavik site, this plant will be constructed at Sissons using all new equipment.

Each stage of water treatment at the Sissons site consists of chemical addition in reaction tanks followed by multimedia filtration or clarification 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.



NOTES

1. PEAK FLOWS SHOWN FOR KIGGAVIK/SISSONS.
2. VENTING REQUIREMENTS WILL DEPEND ON RESIDUAL SULFIDE PROCESS CONTROL STRATEGY.
3. BACKWASH STREAMS OMITTED FOR CLARITY. BACKWASH RETURNED TO SEDIMENTATION PONDS.
4. REQUIREMENT FOR SLAKED LIME OR SULFURIC ACID WILL DEPEND ON BUFFERING CAPACITY OF WATER AND FERRIC SULFATE DOSAGE.

Projection: N/A
Creator: CDC
Date: 09/01/2011 Scale:
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Data Sources: *AREVA Resources Canada Inc.*

FIGURE 9.6-2
SISSONS WATER TREATMENT PLANT BLOCK DIAGRAM

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Effluent from the slow mix tank will be pumped to multimedia filters. Several multimedia filters will operate in parallel to remove suspended solids from the water. The quantity of filters will be specified to permit one filter unit to be taken out of service to be backwashed while the other filters continue to operate. Backwash from the filter will be directed to the sedimentation pond.

High pH Treatment Train

Contaminated runoff will be collected in a dedicated sedimentation pond and pumped to the first treatment train consisting of high pH treatment for removal of divalent heavy metals as sulphide precipitates and uranium as a hydroxide precipitate. The reaction train will consist of three stirred reaction tanks in series. Slaked lime and ferric sulphate are dosed to the first tank and mixed rapidly to increase the pH to 9.0, producing ferric hydroxide coagulant. In the second reaction tank, sodium bisulphide (NaHS) solution is dosed to precipitate heavy metal sulphides. Slaked lime will be added for fine tuning to control the pH to a value of 9.0. Polymer flocculant will be added to a third, slowly stirred reaction tank to produce settleable floc before the water is pumped to downstream media filters.

The head space of the latter two reaction tanks will be operated at negative air pressure and vented to the atmosphere. Due to the low design sulphide concentration and alkaline pH, hydrogen sulphide odour is not expected to be an issue during normal operation.

Low pH Treatment Train

The filtered water from the high pH train will be forwarded to a low pH treatment train containing three reaction tanks. The first rapidly mixed tank will be dosed with ferric sulphate to produce ferric hydroxide coagulant. The pH will be controlled to 4.5 using slaked lime and/or sulphuric acid. Bench-scale testing will be required to determine the required addition rate for slaked lime or sulphuric acid. In unbuffered water, the ferric sulphate will consume alkalinity and lime may be required to prevent the pH from dropping below 4.5. Air will also be sparged into the reactor tank to strip any residual sulphide to the atmosphere. A second rapid mix tank provides additional residence time. Polymer flocculant is added in a third, slowly stirred reaction tank to produce settleable floc before the water is pumped to downstream media filters.

Barium Precipitation Treatment Train

Partially treated runoff and mine water from the mine water sedimentation pond will be combined and treated in two parallel trains for removal of radium-226. Each train consists of a reaction tank container followed by a media filtration container. The first reaction tank rapidly mixes the wastewater streams with ferric sulphate, barium chloride and slaked lime. The ferric sulphate produces ferric hydroxide coagulant. The barium precipitates with sulphate in the wastewater to produce $BaSO_4$.

Radium-226 is removed by co-precipitation. Slaked lime neutralizes the wastewater to pH 7 and provides alkalinity for the ferric hydroxide formation. Polymer flocculant is added to a second, slowly stirred reaction tank to produce settleable floc before the water is pumped to downstream media filters.

9.6.3.3 *Treated Effluent Quality and Quantity*

Sissons WTP effluent concentrations were based on modelling software projections. Since the Sissons water treatment process is not easily comparable to existing operations, use of modelling software provides a reasonable estimate of the expected effluent quality.

Sewage is not expected to have significant levels of contamination, and therefore was not considered in the prediction of effluent quality.

Average treated effluent discharge from the Sissons WTP will be approximately 1,475 m^3/day, while maximum flows are estimated at 1,700 m^3/day. The projected discharge concentrations and annual mass loadings from treated effluent discharge from the Sissons water treatment process are shown in Table 9.6-1. This table includes estimated loadings of a wide range of parameters including those required to be monitored under MMER requirements. Cyanide is not used in the uranium milling process and the effluent is not expected to contain any cyanide.

Table 9.6-1 Sissons Treated Effluent Quality and Mass Loadings

Contaminant	Concentration (mg/L)	Mass Loading (kg/y)
Calcium	336.0	180,919
Chloride	846.6	455,796
Magnesium	84.3	45,390
Potassium	8.640	4,652
Sodium	84.2	45,354
Sulfate	166.9	89,893
Nitrate	0.083	45
Aluminum	0.003	1.48
Ammonia (as N)	3.126	1,683
Antimony	0.001	0.46
Arsenic	0.018	10
Barium	0.785	423
Beryllium	6.41E-05	0.034
Boron	0.109	59
Cadmium	0.0001	0.064
Chromium	0.0003	0.172
Cobalt	0.0003	0.151
Copper	0.001	0.801
Iron	0.106	57
Lead	0.0005	0.257
Manganese	1.467	790
Molybdenum	0.085	46
Nickel	0.0012	0.65
Selenium	0.004	1.97
Strontium	6.086	3,277
Uranium	0.034	18
Vanadium	0.001	0.456
Zinc	0.014	7
Fluoride	0.737	397
Radium-226	0.1 Bq/L	53,838 kBq/y

9.6.3.4 *Treated Effluent Monitoring and Discharge*

The treated effluent is pumped to the lined monitoring ponds, which serve as the final treated water quality checkpoint before discharge. A composite sample of the water pumped to the monitoring ponds will be taken using an autosampler for chemical analysis prior to discharge. Should the effluent quality of the monitoring pond not meet discharge criteria, the pond will be recycled to the

TMF or WTP and the cause will be investigated to reduce the likelihood that additional monitoring ponds do not meet the discharge criteria.

The effluent will be discharged to Judge Sissons Lake on a year-round basis. An autosampler will collect a sample of the monitoring pond discharge for confirmation of the initial analysis and that the pond meets specifications.The water will be transported via a 6” insulated, single-walled, heat-traced pipeline approximately 12 km in length. The system will include a berm, containment ponds and a diffuser as described for the Kiggavik WTP discharge line (Section 9.3.4.5).

AREVA has experience operating effluent discharge lines during Canadian winter conditions. AREVA's McClean Lake Operation in Northern Saskatchewan has two effluent discharge pipelines from its Water Treatment Plants. The water treatment plants operate year-round and batch basis and effluent has been piped during all weather conditions, including northern winters. These lines are insulated and heat-traced. The discharge pipelines are approximately 5km and 7km in length. The pipelines have been operated successfully for over 10 to 15 years without any major issues.

Containment ponds will be located at the low points of the pipeline to hold water in the event of a pipeline leakage or breakage, or if the pipeline needs to be drained. The containment ponds will be designed for at least two pipe volumes of the section of pipe that the pond will drain into.

Discharge of treated effluent into Judge Sissons Lake will be accomplished using a diffuser system to promote treated effluent mixing. The diffuser will be located a minimum of 500 m from the shoreline of Judge Sissons Lake. The diffuser will consist of a weeping tile pipe.

The discharge of treated effluents to Judge Sissons Lake on a year-round basis will also necessitate a service road. The road will be 12 km in length and 5.1 m wide. A power line will be constructed alongside the road to provide power to the discharge pipe’s heat trace system.

9.6.3.5 *Contingency Measures for Discharge*

Preliminary contingency measures for discharge during upset conditions have been developed. Table 9.6-2 shows the upset condition and the contingency measures to be taken.

Table 9.6-2 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
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
Water treatment plant not operating and treated sewage effluent requires discharging	Storage of treated sewage effluent, followed by intermittent batch discharge.

10 Project Logistics and Transportation Infrastructure

10.1 Introduction

The logistics and transportation strategy adopted for the Kiggavik Project is similar to the strategies of many mining projects in northern Canada. Broadly, the strategy includes air transportation, and a combination of open water marine transportation, in conjunction with a winter road and/or all-season road access to the Project site.

The majority of the goods required for the Project will be shipped via marine transportation during the open water season to a dock facility along the north shore of Baker Lake. Transportation will then be by winter and/or all-season road to the Kiggavik site. An airstrip will also be constructed at the Kiggavik site for the transportation of yellowcake and the delivery of perishable goods, emergency supplies and personnel. This is a similar transportation strategy as that employed at other northern mine projects and is consistent with input received from the public. The influence of IQ and public engagement on transportation is outlined in Section 4.2.5.

10.2 Shipping Quantities

The annual estimated quantities of supplies for the Project during the operations phase are summarized in Table 10.2-1. The total annual diesel fuel requirement will be approximately 55,300 tonnes (peak) while the dry goods and reagents total approximately 91,000 tonnes (peak). The largest tonnages will be for diesel fuel, cement (for underground mine backfill), lime and sulphur (mill reagents). Lime and sulphur requirements are conservatively forecasted as these reagents are expected to be reduced as a result of on-going tests, optimization studies and operating experience. It is anticipated that all equipment will be operated using arctic grade diesel fuel and other fuel requirements will be limited. The current estimate of site supplies for operations is greater than those required for construction.

A number of the site supplies listed are hazardous goods; these will be shipped in accordance with international, federal, and territorial regulations. Fuel will be shipped in bulk. Hazardous goods will be transported either in product-specific ISO containers or, in the case of smaller volumes, as palletized sealed drums placed in standard sea containers. Additional details are provided in the Hazardous Materials Management Plan (Technical Appendix 2U).

Approximately 4,800 tonnes of packaged uranium concentrate (as U_3O_8) will be transported by air from the Project to the south annually. Proposed packaging and transport of yellowcake is discussed in Section 10.6.1.1.

Perishable goods and Project personnel will be transported by air.

Table 10.2-1 Estimated Annual Supplies

Supplies	Maximum Annual Shipping			TEUs
	Value	Units	Packaging	
Blasting materials	10,000	tonnes	tote bags	556
Cement	15,000	tonnes	tote bags	833
Flocculant	101	tonnes	tote bags	6
Flocculant "B"	3	tonnes	drums	0.1
Lime CaO	33,914	tonnes	tote bags	1,884
SAG Mill Grinding Balls (3" & 4")	300	tonnes	bulk	17
Ball Mill Grinding Balls (2")	400	tonnes	bulk	22
Sulphur	23,451	tonnes	tote bags	1,303
Barium chloride	303	tonnes	tote bags	17
Ferric sulphate	239	tonnes	tote bags	13
NaOH	1,442	tonnes	tote bags	80
Na2(SO4)	632	tonnes	tote bags	35
H2O2 (50%) - U	1,716	tonnes	ISO containers	95
Resins Ambersep 920U - U	1,125	tonnes	tote bags	62
Product drums - U*	256	tonnes	drums	14
RO Chemicals	49	tonnes	Drums	3
Ferrous Sulphate	16	tonnes	Totes	1
Sodium Bisulfide	0.2	tonnes	Totes	0.01
Spare Parts / Consumables	2,000	tonnes	bulk	111
Total Dry Cargo	90,947	tonnes		5,053

Diesel Fuel	55,244	tonnes		

NOTES:

* represents 12,800 drums.

TEU = Twenty-foot container equivalent unit

10.3 Marine Transport

The Hamlet of Baker Lake and the Agnico-Eagle Meadowbank mine currently receive supplies during the annual sealift which takes place in the open water season from August to October. Dry cargo and fuel are loaded on ships or barges in southern ports and are then transported to Chesterfield Inlet. A section of the passage between Chesterfield Inlet and Baker Lake known as Chesterfield Narrows (the Narrows) is relatively shallow, with narrow sections, and is subject to strong currents (IQ-CIHT 2009[102]) which limit the size and timing of vessels passing this area. Most ocean going vessels are too deep drafted to pass the Narrows, therefore cargo is lightered onto barges or smaller shallow draft vessels east of the Narrows for transportation to Baker Lake.

Existing sea based navigational aids are currently limited to manual visual aids. The use of modern electronic positioning verification equipment such as Laser Fan beam and radius electronic targets will be considered to assist with navigation.

Various marine transportation options have been studied for the Kiggavik Project. In accordance with conservative planning, the preferred strategy is similar to that currently in use by Agnico-Eagle and the Hamlet of Baker Lake. However, given the development of the mineral industry in the north, the desire of communities and governments for infrastructure development, and in recognition of seasonal variations in northern transportation logistics, it is anticipated that a number of the following described options may be used within a single shipping season and/or over the life of the Project.

Responsibility for the marine transportation component to the Baker Lake dock site will remain with the marine shipping company. In accordance with ISO 14001 principles, AREVA is committed to selecting contractors that comply with all regulations and employ appropriate quality management systems. AREVA also commits to supporting local communities in developing capacity as marine mammal observers as well as an emergency response capability.

The following sections summarize the various components of marine logistics; further details are available in Technical Appendix 2J.

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[102] IQ-CIHT 2009: *Chesterfield Inlet has narrow places with large currents*

10.3.1 Routes

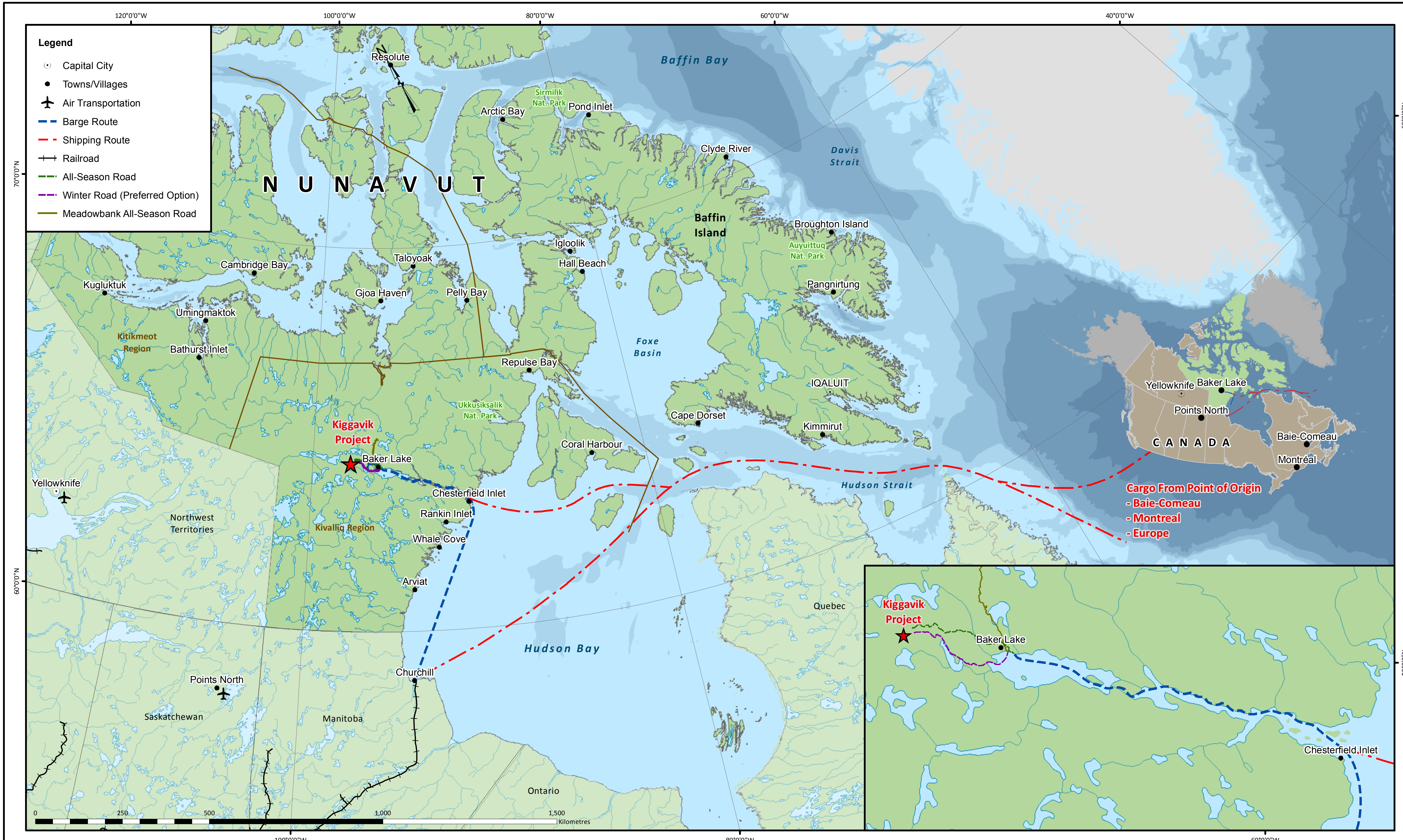
Potential marine routes are shown in Figure 10.3-1. There are a number of primary proposed segments of marine transport to be considered:

Marine shipment of fuel and dry cargo via ocean going vessels through Hudson Strait to Chesterfield Inlet. The cargo would then be lightered into barges in Chesterfield Inlet and delivered to the final destination at Baker Lake.

Marine shipment via ocean going tug/barges from southern ports direct to Baker Lake.

Marine shipment via ocean going vessels through Hudson Strait and Hudson Bay to Churchill. The cargo would be transhipped from Churchill to Baker Lake via tug and barge. A rail link connecting to major southern railways is also available for transporting fuel and dry cargo to Churchill.

All vessels transiting through the Hudson Strait will abide by the Arctic Water Pollution Prevention Act (AWPPA). The Act restricts vessel type and movement with respect to time of year. All vessels will meet or exceed the requirements of the Canada Shipping Act, 2001 (e.g., ballast water management, bilge water management, equipment standards, and safety standards).



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Creator: CDC Revised: TL
Date: 03/28/2012 Scale: 1:10,000,000
File:
Data Sources: *Natural Resources Canada, Geobase®, Nation Topographic Database, AREVA Resources Canada Inc.*

FIGURE 10.3-1
TRANSPORTATION ROUTES

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10.3.2 Shipping Season

Marine transportation is planned around open water operations only. No ice breaking activity is planned.The Marine Shipping Plan (MSP) has been based on a conservative operating season estimate of 60 days, commencing on August 1 and completing on October 1 (Technical Appendix 2J). IQ and the experience of shipping companies working in the area indicates that the operating season may be more accurately predicted as being somewhat longer from mid-July to mid-October (IQ-WCCR 2011[103]). Shipping during the regular season between ice break-up and freeze-up will not affect ice formation (IQ-ARVJ 2011, IQ RIJ 2011). As a precaution, all vessels will have an Ice Class meeting AWPPA regulations for operating mid-July to the end of October in Zones 14, 15 and 16 which includes Hudson Strait, Hudson Bay, Chesterfield Inlet, and Baker Lake. All vessels used for carrying fuel will comply with the Vessel Pollution and Dangerous Chemicals Regulations (2012), including double hull construction.

For conservative planning purposes, the first loaded vessel will arrive at the entrance to Chesterfield Inlet on August 1. The lightering of dry cargo or fuel will commence on arrival and will continue until the cargo has been delivered or October 1. If the season commences earlier, then the first vessel will arrive in Chesterfield Inlet to take advantage of the open water. The purpose of precautionary planning is to provide a contingency for unknown occurrences so that the Kiggavik sealift will be completed well before freeze up.

10.3.3 Vessels

All vessels carrying fuel and/or cargo will comply with the *Canada Shipping Act*, 2001. Various sizes of dry cargo ships, tugs, barges and tankers have been studied and proposed for the Project.. Cargo ships, tankers, tugs and barges will be operated in accordance with Classification requirements of a society belonging to the International Association of Classification Societies (IACS), such as Lloyds Register of Shipping, Det Norske Veritas, Bureau Veritas, American Bureau of Shipping, NK, or others.

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[103]IQ-WCCR 2011: F*reeze-up is later now than in the past but not as much change for break-up*

Ocean-going vessels considered for shipment of fuel include:

- Ice Class 30,000 deadweight tonnage (DWT) double hull tankers
- Ice Class 30,000 DWT Handy size double hull tankers
- Ice Class 18,300 DWT double hull tankers

Ocean-going vessels considered for shipment of dry goods include:

- 660 TEU geared cargo ships
- 1,000 TEU non-geared cargo ships

Various tug – barge arrangements have also been studied. Tugs and barges for the Kiggavik Project will be supplied and operated by a reputable Canadian shipping company yet to be selected. Priority will be given to tug barge arrangements which provide the best maneuverability for safe and efficient operation. Tug barge arrangements must be capable of delivering the entire dry cargo and fuel cargo requirements within a 60 day open water window. The following tug barge arrangements have been studied:

- 4 7,500 DWT double hull Articulating Tug Barges (ATB) and 2 4,500 hp tugs
- 2 7,500 DWT & 2 5,000 DWT ATB double hull barges and 2 4,500 hp tugs
- 4 5,000 DWT ATB double hull barges and 2 3,500 hp tugs
- 4 5,000 DWT Standard double hull barges and 2 3,500 hp tugs

The final selection and design of the types of vessels to be used for the Project will be based on a multitude of factors such as route selection, depth of passage, cargo requirements, seasonal/navigational restrictions, logistics, and operational requirements, among others. A discussion on the viability of operating the proposed tug barge arrangements safely through the Chesterfield Narrows is included in Section 3.5.4 of Technical Appendix 2J. All vessels will conform to and be operated in accordance with the regulations outlined in Technical Appendix 2J.

10.3.4 Navigation

The tug/barges will be highly maneuverable and capable of handling low water levels and changes in current patterns. Navigation in restricted areas will be in daylight hours only with good visibility. Under keel clearance guidelines will be established by the shipping company for all restricted draft areas. Traffic in the Chesterfield Inlet and particularly in the Narrows will be coordinated and managed to enhance safety. For instance, it is proposed that passage at the Narrows be one-way traffic on each high tide, with a maximum of two cargo barges/vessels transiting on each high tide.

AREVA will require all vessel operators to have double redundant radio equipment capable of communicating and coordinating with NORDREG and the Canadian Coast Guard. Tugs will be equipped with the latest generation of navigation aids including electronic charting system (ECDIC) with AIS interface and radar overlay, Differential Global Positioning Systems, Automatic Identification System (AIS), Type X band radar with Automated Radar Plotting Aid (ARPA), and Type S band radar with ARPA. Communications equipment on tugs and other vessels will use the latest satellite based technology. Standard VHF, UHF and SSB communication equipment will also be used.

10.3.5 Transfer Site

To maximize utilization of existing infrastructure, transfer of goods from ocean-going vessel to barge will be performed at either Churchill or via lightering near Chesterfield Inlet. Therefore, no construction of Project-specific infrastructure is anticipated for transferring goods from ocean vessels to barges.

10.3.6 Baker Lake Dock and Associated Facilities

The Baker Lake dock site will be designed and constructed to receive barges, offload goods, and store goods prior to transport by road to the Kiggavik site. Since the preferred road option is a winter road only, the current design considers storage of all goods required for one year of operation.

A number of options for the location and design of the dock facility have been considered. The review of these options are discussed in detail in Technical Appendix 2A. Bathymetric information for the options are included in Technical Appendix 5C.

The preferred location of the dock facility is identified as Site #1 in Figure 10.3-2. This site is preferred due to its potential for synergy with Agnico-Eagle operations, proximity to the community, and location on the north shore. Topography is such that the site is suitable for a dock while storage structures can be placed at sufficient elevation to accommodate changes in water level.

Alternative dock sites included in the assessment are the Agnico-Eagle dock site and dock site #2. Although the Agnico-Eagle dock site was eliminated from the alternatives assessment, it may be a viable alternative if it is no longer required by Agnico-Eagle when the Kiggavik project begins construction. Dock Site #2 remains as an alternative to allow for flexibility in dock site selection at the time of detailed design..

Projection: NAD 1983 UTM Zone 14N
Creator: CDC Revised: TL
Date: 09/01/2011 Scale: 1:175,000
Data Sources: *Natural Resources Canada, Geobase®, Nation Topographic Database, AREVA Resources Canada Inc.*

FIGURE 10.3-2
DOCK SITE OPTIONS

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Consistent with the successful logistics approach used by Agnico-Eagle and applying conservative principles, the dock will consist of a floating spud barge placed from the shore out to sufficient depth to permit barge-docking. No dredging of the lake bottom is anticipated. The dock is constructed by placing minimal clean fill along the shoreline, floating the barge into place and anchoring the barge using steel piles driven into the lake bottom. The barge retains vertical mobility along the steel piles such that changes in water levels and ice formation are accommodated. The spud barge is further secured using steel cabling anchored to the shore. The spud barge can remain in place during winter, be disconnected and shipped south at the end of the shipping season, or be pulled onto shore.

Given that the proposed dock installation would be similar to the current Agnico-Eagle (Meadowbank) dock installation with floating barges, fill required for access to the barges will have a limited footprint on the overall dock site and can be easily monitored, maintained, repaired and decommissioned. This design is anticipated to be relatively unaffected by changing water levels, ice shifting, and spring thaw.

A fuel off-loading system will be constructed to pump fuel from the barges to a 70 million litre (ML) fuel tank farm. The off-loading system will include secondary containment and redundancy as required by the CCME 'Environmental Code of Practice for Aboveground Storage Tank Systems Containing Petroleum and Allied Petroleum Products.' . A preliminary spill contingency plan is included in Technical Appendix 10B.

Sea containers and loose goods will be off-loaded using a crane and mobile equipment for transfer to the storage yard prior to loading trucks for transport to Kiggavik. The storage yard will include a small office area, outdoor laydown area, a cold storage building and possibly a heated storage building.

A section of road to connect the dock facility to the existing road network will be required.

A mobile generator will be installed to provide power to the dock facility. Wireless communications will be used to reduce infrastructure requirements.

Security will include placarding of all hazardous goods storage areas (Technical Appendix 2U). During periods when materials are stored at the site, regular inspections by trained personnel will be conducted to ensure containment. The site will be restricted at all times to authorized personnel with appropriate training. No security fence is anticipated at this time.

The primary use of the dock will be to handle the Kiggavik annual cargo requirements. When the dock is not in use the unloading facilities may be used for other cargo purposes at the discretion of AREVA. Anticipated supplementary uses (other than Porject support) could include off-loading of community re-supply or Agnico-Eagle barges as back-up to the existing off-loading sites.

10.4 Baker Lake – Kiggavik Access Roads

There is currently a winter trail connecting Baker Lake to the Kiggavik site, however construction and maintenance of a more substantial access road will be required to support Project development and operation. The Baker Lake to Kiggavik access road will be used to transport reagents and other supplies to support all phases of the project. As all yellowcake product will be flown directly south from the Kiggavik site there will be no transportation of yellowcake along the Baker Lake to Kiggavik access road.

10.4.1 Truck Configurations

During operations, up to 3,300 truck-trips would be required, approximately, broken down as follows: 1,200 tanker-truck loads of fuel; and, 2,100 truck-loads of dry goods. The trucks which are intended for use are not considered as oversized. The trucks are slightly larger than a standard highway unit, designed to carry a certain load and are not intended to be over loaded creating the potential for spillage. The road geometry is designed to accommodate the design capacity and safe operation of the proposed tractor trailer units.

Truckload estimates are based on 48 tonnes of dry goods per load and Super B configurations of 56,000 litres average loads. It is considered that the number of trips could be decreased by using a truck and trailer combination that could allow for 50 to 60 tonnes dry goods per load and from 68,000 to 70,000 litres fuel per load. With this option, straight fuel haul trailers are fitted with 2 removable fuel tanks, a smaller one on the goose-neck and a larger one towards the rear of the trailer with a combined capacity of up to 38,000 litres per trailer. The space between the fuel tanks is sufficient to fit a 20 foot container and allows a combined load with the allowable weight being topped up with fuel. In the case of 40 foot containers the rear fuel tank would be removed.

With the 60 tonne truck configuration, the truckloads would be, approximately 850 to 1,000 diesel fuel loads; and, 1,350 to 1,650 dry goods loads.

10.4.2 Proposed Options

A number of road alternatives have been developed and assessed, including multiple all-season road and winter road configurations. The road configuration determines, in part, the size of the Baker Lake Storage Facility (Section 10.3.5).

A winter road will be required during the construction phase of the Project. Analysis of alternatives indicates that the operational phase is likely viable with a winter road; however, uncertainty surrounding the potential effects of climate change and materials supply logistics over the life of the mine suggests that it is prudent to include an all-season road option in case the winter road cannot adequately support the Project through to decommissioning and closure.

Therefore, AREVA is proposing and assessing the following two options:

- the preferred winter road option is a winter road from north shore of Baker Lake (Figure 10.4-1):
- all-season road from north shore of Baker Lake; including a cable ferry across the Thelon River

The winter road will be utilized for the first few years and if the materials are being transported reliably to site, AREVA will continue with the winter road. If the materials are not being transported to site on the winter road due to length of season, operational difficulties or high operational costs, the construction of the all-season road will be evaluated. An analysis of possible options including winter road design, transport equipment and procedures and costs of the available alternatives may be part of the decision. Information required for final design and construction including specific siting information, inventory of quarry materials, and updated wildlife survey will be gathered prior to construction of the all-season road.

Projection: NAD 1983 UTM Zone 14N
Compiled:TL
Date:7/4/2014 Scale: 1:300,000
Data Sources: *Natural Resources Canada, Geobase®, Nation Topographic Database, AREVA Resources Canada Inc.*

FIGURE 10.4-1
BAKER LAKE KIGGAVIK WINTER ACCESS ROAD

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File: Q:\SHEQ\GIS\KIGGAVIK\2014\EIS\Volume 2 - Project Description\Maps\MXD\Figure 10.4-1 Baker Lake Kiggavik Winter Access Road.mxd

10.4.3 Preferred Option: Winter Access Road

The potential route for a winter road is shown on Figure 10.4-1. This route should be considered two kilometer wide corridors within which the actual routing will be established. The option shown is considered the best alternative. The route follows a chain of lakes south of the Thelon River and crosses Baker Lake ice outside of the Thelon estuary far enough south-east of the community to maintain a 1 to 2 km buffer.. The final alignment within the corridor will be determined prior to construction, in order to best consider construction and operational needs and environmental protective measures.

The road route utilizes the extensive ice surface provided by Audra Lake and crosses Baker Lake either on or just offshore of the recent deltaic deposits that form the Thelon estuary. The route is about 99 km long with half of the route situated over frozen lakes and half over land. The road would originally travel in a southeasterly direction from the proposed dock site facility across Baker Lake before travelling in a northwesterly direction over land and frozen lakes towards the Kiggavik mine site.

The topography is generally flat with the exception of a large rise of intrusive bedrock west of “20 km Lake” and the large marine deposits just west of Baker Lake. The elevation of the route varies from a low of approximately 2 m above sea level at Baker Lake, climbing steadily to almost 200 m at Kiggavik.

10.4.3.1 *Over-Ice Crossings*

Over-ice crossings consist of either floating ice or ground-fast ice (ice frozen to the lake bottom). Floating ice supports vehicle loads through buoyancy and the flexural strength of the ice. Ground-fast ice has additional bearing capacity due to the sub-grade supporting the overlying ice cover. A stable ice surface is the preferred winter road routing for regions of cold continuous permafrost. The roads can be opened early by effective snow removal, and surface preparation is minimal.

The road will likely need to be built to a minimum 30 m cleared width. Depending on the local conditions, ice road builders and operators recommend the road to be as wide as 48 to 55 meters on the lakes. This width may be necessary to provide a 5 m buffer along the edges separating the vehicle traffic from the thinner ice found under snow banks. It also provides additional lane widths when roads are blown with drifted snow. In high wind locations it may be necessary to initially open the road to widths greater than the normal 30 m. This will provide space for the operational width to narrow throughout the season to a minimum width of 30 m.

10.4.3.2 *Over-Land Crossings*

The natural terrain on the majority of the over-land portions of the route consists of till blankets and some till veneer with isolated portions over alluvial deposits in low areas which are often covered by thin organic layers. Between Long Lake and Audra Lake, large marine deposits and mixed till and marine sediments are dominant while there are aluvial (deltaic) deposits at the mouth of the Thelon River.

There are two options for building over-land crossings that can meet the Project's functional requirements:

- snow/ice pad over frozen subgrade; or
- a thin pad of granular material over frozen subgrade.

The typical practice in NWT is to wait for the active layer to freeze to approximately 0.3 m depth, this will provide sufficient bearing capacity to support haul traffic. A surface course is prepared by spreading and compacting a thin lift of snow or saturating the surface with water to create an ice capped snow road. The required snow surface course can vary significantly depending on the local micro-topography (i.e., presence of boulders and depressions) and sensitivity of the underlying tundra surface.

A granular surface pad is used in areas of rugged microtopography that would normally require levelling. Granular material should be well-drained, cohesion-less soil, such as esker sand or gravel or quarried processed rock material that can be placed in winter. Granular pad thickness can range from a minimum of 100 mm up to 300 mm for levelling purposes.

Over-land roads that handle predominantly one-way traffic can be built to a 4 m width, with provision for the occasional pull-out for vehicles that are waiting for an opening in traffic. For two way traffic a minimum width of 9-10 m is recommended. Depending on the local conditions ice road builders and operators recommend the portages to be as wide as 12 meters.

Portage locations will be selected to minimize the disturbance of the tundra soil and its vegetation and provide grades that are acceptable to traffic. In some locations it may be advantageous to place granular material on the tundra to lessen the effort of maintaining the portage, particularly during the spring period.

Experience from the Tibbitt to Contwoyto Winter Road suggest that over-land portions of the winter road will evolve over several seasons as over-land crossing performance is reviewed. Sections typically start with compacted snow-ice surface but these are replaced with granular pads in areas that have shown to have poor performance in previous years. Eventually up to 50% of the over-land crossings could consist of granular fill pads.

10.4.3.3 *Potential Water Requirements and Water Availability*

The construction, operation and monitoring of winter roads are regulated by issuing Land Use Permits in consultation with the appropriate Regional Land Use Inspector. If there is a requirement to construct ice capped winter roads and portages, there will be a need for water withdrawal from lakes along the winter road routing. The Department of Fisheries and Oceans (DFO) has issued a Protocol, applicable to the Northwest Territories, which outlines guidelines for Winter Water Withdrawal during ice-covered periods. The same protocol is applicable for Nunavut, as stated by DFO, Eastern Arctic Area. For instance the protocol stipulates that in one ice-covered season, total water withdrawal from a single water source is not to exceed 10% of the available volume below the ice, provided the remaining water depth between the bottom of the ice cover and the lake bottom is maintained greater than 1.50 m.

The required quantity of water to be placed on the compacted snow along the road depends on expected traffic loads and density. For the Kiggavik winter road it is considered that adding 10 cm of water on top of the snow would increase the allowable contact pressure by a factor of 4-5, depending on the method of snow stabilization. Therefore assuming a road width of 10 m and that 50% of the winter road will be routed over land, the total quantity of water required with an ice cap of 10 cm would amount to approximately 50,000 m^3. Any one of the five major lakes long the winter road routing (i.e., Qinqug Lake, Audra Lake, Long Lake, “20 km Lake” and Siamese Lake) has a sufficiently large water quantity to meet the DFO requirements of road construction.

10.4.3.4 *Operating Considerations*

Prior to the start of construction activities for the winter road, actual ground temperatures will be monitored from installed ground temperature cables to ensure the ground is adequately frozen and will support construction activities associated with the winter road.

The rate of ice growth on a lake surface in winter and how long it is sustained into spring can be estimated using the “Winter Freezing Index” (WFI). A reasonable correlation was found between the winter air freezing index and available operating window for the Tibitt to Contwoyto Winter Road (TCWR) that is constructed each year from near Yellowknife northeast to Lac de Gras. The total WFI is significantly greater at Baker Lake than at Yellowknife, suggesting that a winter road at Baker Lake could open earlier and close later than the TCWR. The estimated operating period based on the WFI values would be about 110 days at Baker Lake compared to 75 days for the TCWR. However for winter road planning purposes, a more conservative 90-day operating window is considered for the Kiggavik Project to account for factors such as potential climate warming as predicted by modeling work detailed in Technical Appendix 5K, blizzard conditions, high winds and drifting snow management. The weather modeling considered was appropriate for the area and was considered when evaluating and reporting on the operating season of the winter road. Local variations are largely dependent on the amount of snow cover and soil conditions.

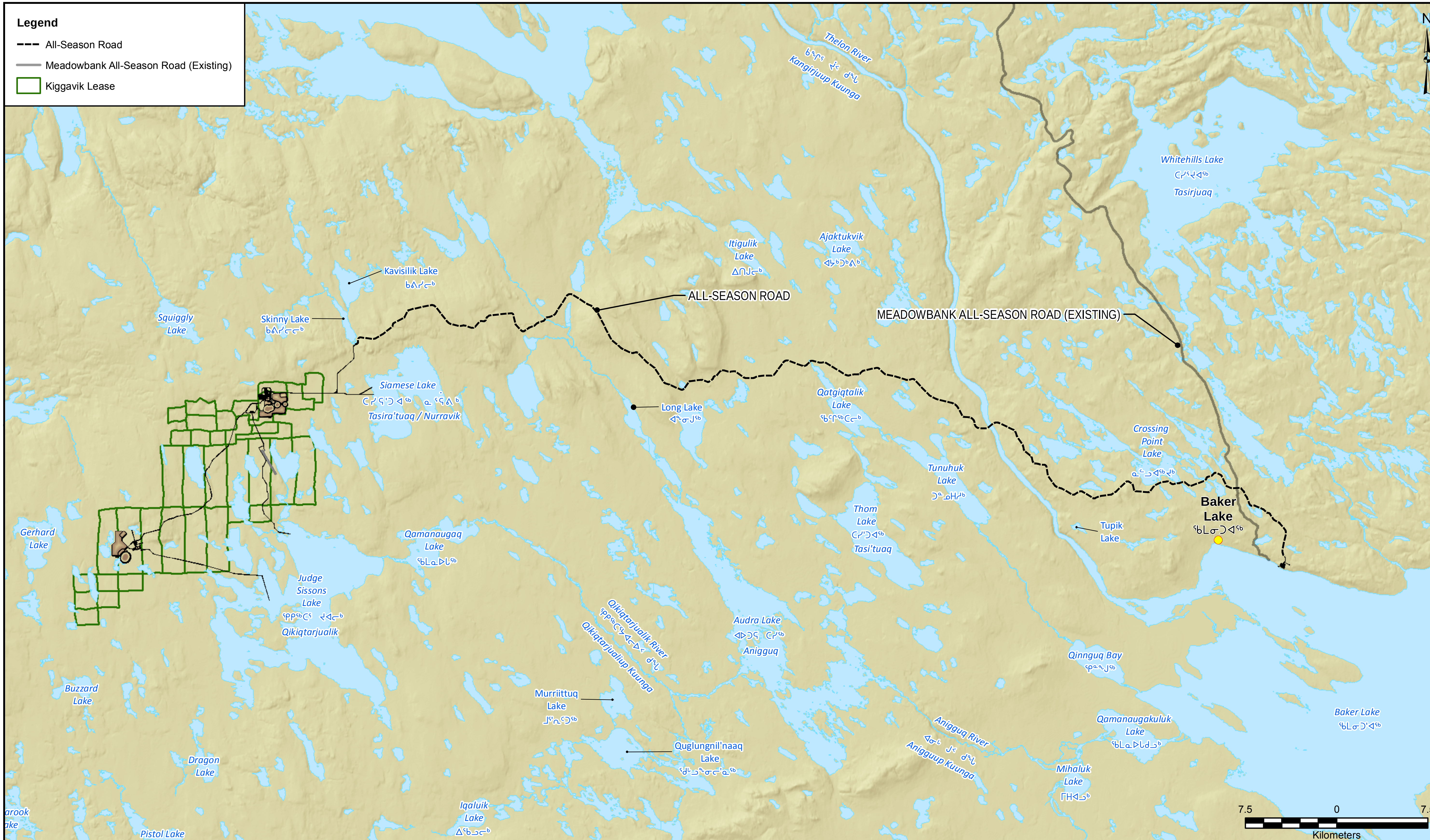
It is considered that the TCWR experience base is an effective tool in estimating operating parameters for the Kiggavik winter road. The average number of loads per day for the Kiggavik winter road is estimated at 37.. This is well within the experience range for the TCWR. The TCWR Joint Venture has found it necessary to dispatch 84 to 174 loads per day because of its shorter operating window and longer route. This means that a smaller fleet of trucks and drivers would be necessary at Kiggavik to accommodate the lower dispatch numbers. Based on an average speed of 25 km/h for a loaded vehicle, the travel time to site is approximately 4 hours. With a 4-hour window for loading and unloading activities, a round trip would take approximately 12 hours. Based on a 24 hour dispatch operation with new drivers every 12 hours, a fleet of 24 trucks operating around the clock could make around 48 trips in a 24 hour period. However for winter road planning purposes, a more conservative 40 trips is considered for the Kiggavik Project to account for downtime due to weather delays, equipment breakdown, or delay due to poor traffic conditions along the winter road.

It is proposed that winter road operations be managed from a central communications facility located at the shipping source (“Dispatch”). Communications of weather delay, closures, operational and emergency situations are Dispatch functions. Documentation will be issued and traffic planning and weight management will be monitored on a load by load basis. All departing load information will be communicated to destination allowing a minimum 4 hours for preparations to be made to turn around the equipment. All equipment will be radio controlled with GPS tracking as an option.

Winter road truck operations will be conducted on a 24 hours, 7 days/week basis. Trucks will travel essentially in pairs giving a heated back-up in case of engine failure. Groups of 3 trucks could also be considered with the lead driver responsible for the party. It is recommended that the trucks be equipped with mini-sleepers as a comfort factor should they become stranded on the road or in the event of a breakdown. The trucks will be spread out to avoid back-ups at the unloading area.

10.4.4 All-Season Access Road Option

Numerous alternatives and variations have been developed and evaluated to arrive at the all-season access road option presented in this section. The proposed All Season Road (Figure 10.4-2) is 114 km in length from the Baker Lake dock site to the Kiggavik site. The road has been sighted to avoid low lying and ice rich areas. The final alignment within the corridor will be determined prior to construction (if the all-season road is required), in order to best consider construction and operational needs and environmental protective measures. There are three bridges (less than 50 meters in length) proposed along the route and one major river crossing (Thelon River). At the Thelon river crossing, it is proposed to use a cable ferry in the summer and ice bridge in the winter to cross the River. The remainder of the water crossings can be accommodated with culverts or rockfills. The road will be 10 meters wide, built with Run-of-Quarry (ROQ) rock embankment (fill). There will be no earth cuts along the alignment, and the only cut sections will be through rock, which will serve as quarry material. Material for the rock embankment and road surfacing will be derived from rock quarries developed along the road.



Projection: NAD 1983 UTM Zone 14N
Compiled:TL
Date:8/22/2014 Scale: 1:300,000
Data Sources: *Natural Resources Canada, Geobase®, Nation Topographic Database, AREVA Resources Canada Inc.*

FIGURE 10.4-2
BAKER LAKE KIGGAVIK ALL-SEASON ACCESS ROAD OPTION

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File: Q:\SHEQ\GIS\KIGGAVIK\2014\EIS\Volume 2 - Project Description\Maps\MXD\Figure 10.4-2 Baker Lake Kiggavik All-Season Access Road Option.mxd

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The route has been located generally on higher ground. The reasons for this are as follows:

- higher areas tend to be less ice-rich, which presents fewer geotechnical issues for constructing the road;
- higher areas tend to have fewer areas of diffuse drainage patterns, which are hard to accommodate in construction;
- higher areas have fewer cross-drainage surface flows;
- higher areas are less prone to snow drifts, which can become a major maintenance issue;
- higher areas tend to have more areas of bedrock which improves the bearing capacity of the road and reduces the embankment fill requirement; and
- suitable quarries tend to be located in higher areas.

Areas of geotechnical instability, environmental and archaeological constraints also guided the route selection.

The criteria for the design of the All Season Road are listed in Table 10.4-1. These criteria are based on the findings and recommendations of previous design work completed on similar projects in the Canadian north, and reflect information gathered from experienced haulers and northern road construction contractors. Since very few roads of the proposed type currently exist in Nunavut, reference has been made to the Government of Northwest Territories (GNWT) Department of Transportation where territorial highways exist in conditions similar to the Kiggavik Project area.

In general, the grades are gentle, in the order of 1 to 3%. There are some sections that reach the maximum end of the design criteria range of 5-6%. However the longest section of this steep gradient is only 500 m in length and the gradient is favourable for loaded vehicles travelling towards the mine.

Slopes along the roads will be suitable for wildlife crossing. Features to facilitate ATV and snowmobile crossings will be included with input from the community of Baker Lake.

Table 10.4-1 All-Season Road Route – Design Criteria

Design Element	Criteria	Comments
Road Surface width	10 m	Width based on the design vehicle in winter conditions. Conforms to Transportation Association of Canada (TAC) table 2.2.13.4 and typical GNWT Department of Transportation Practices.
Design Speed	70 km/h maximum with exceptions	Exceptions are based on topographical considerations and in areas in the vicinity of the Mine site and Baker Lake where conflict with other traffic is more common.
Design Vehicle	Super B-Train	This is the typical haul unit currently used to supply mines in NWT.
Min. Horizontal Radius	190 m	This radius was selected to maintain a 10 meter road surface width for adequate width for Super B-train to pass a WB-20. Also conforms to minimum radius for design speed of 70 km/h – TAC table 2.1.2.6. No spirals have been used in the development of the alignment. This is in keeping with ambient design conditions of similar roads in NWT and typical GNWT Department of Transportation Practices.
Min. Crest/Sag Vertical K Value	20 crest 22 sag	Headlight Control assumed. Minimum curve length of 70 m. TAC tables 2.3.3.2 and 2.3.3.4. Midrange of curves to be used for design
Maximum Grade	6%	Based on rural collector maximum grades TAC table 2.3.3.1.
Cross Fall	3%	Follows typical GNWT Department of Transportation Practices for gravel roads.
Maximum Super-elevation	6%	Follows typical GNWT Department of Transportation Practices
Side Slopes	3:1 in fill 0.25: 1 in rock cut	Fill Sideslopes conform to TAC table 2.3.13.4.
Barriers	none	Not considered appropriate for the typical operating conditions of the design vehicle.
Bridges	Canadian Highway Bridge Design Code. S6-2000	
Road Structure	19 mm gravel over rock fill	Variable, depending on subsurface conditions
Traffic	20 year design life	Must be capable of handling 3,300 loaded Super B-Trains and an equal number of return vehicles each year.

10.4.4.1 *Thelon River Crossing*

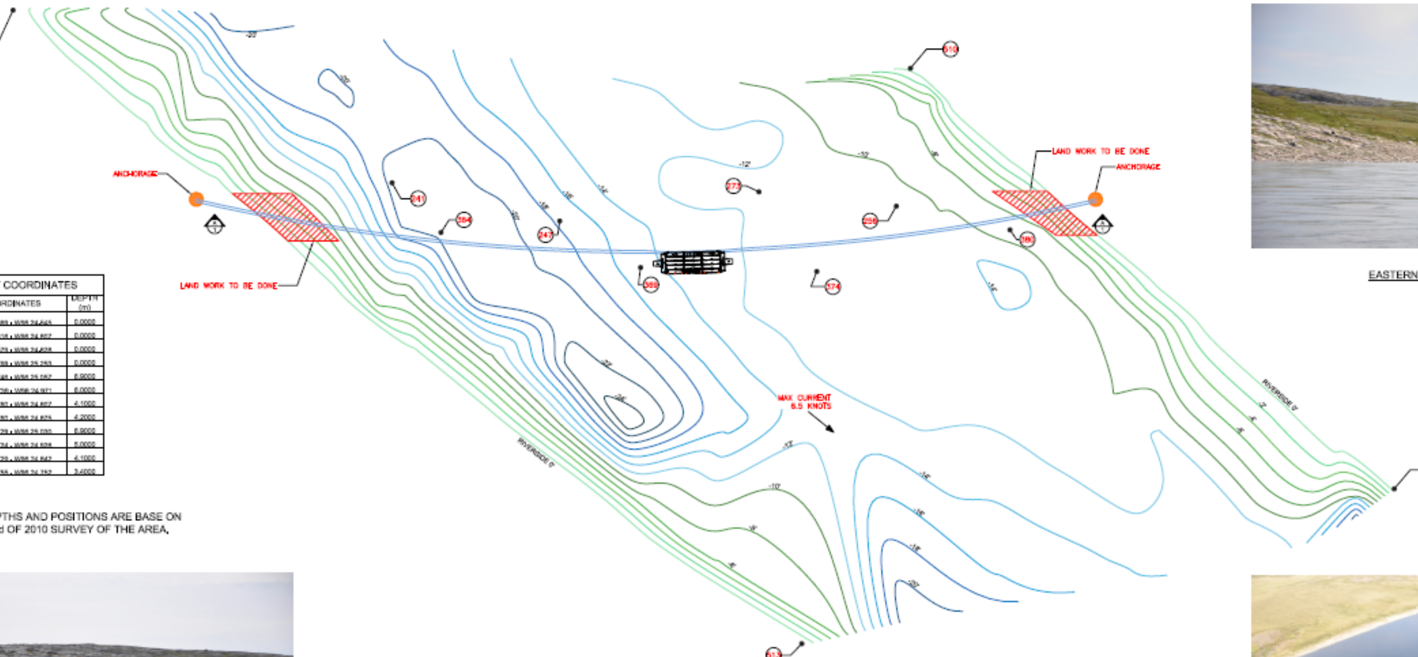
The proposed all-season route generally follows alongside the existing ATV trail north of Baker Lake and crosses the Thelon River. Alternatives analysis has indicated that the most viable method of crossing the Thelon River is the cable-ferry/ice bridge option (Technical Appendix 2A).

The proposed cable ferry crossing the Thelon River will operate in the open water season. The river in this area does not carry any commercial traffic. The cable which operates the ferry lies on the river bottom after the ferry passes therefore small craft will be able to pass the crossing area without interference.

The proposed location for the cable ferry crossing is presented in Figure 10.4-3. The cable ferry will be designed and operated to comply with Transport Canada's Ferry Cable Regulations (Transport Canada, 1986) and the Canada Shipping Act, 2001. The cable ferry will be designed to withstand water current up to 6.5 knots. Lights on the ferry and navigational aids will be installed to promote a safe operation. A minimum of 2 crew members will operate the cable ferry twenty-four hours a day, seven days a week. It is estimated that two shifts of 12 hours each per day will be required on a three phase rotation system, for a total of 6 people.

Operating on a 24 hour basis, the ferry would be capable of transporting a total of four trucks per hour or 96 trucks per day in each direction.

For every operating season a start-up and a winterization of the cable ferry will be required. As the ferry will be removed prior to freeze-up, it is not anticipated that ice will impact the infrastructure. An eight month operating window is anticipated to account for the startup and winterization of cable ferry and the freezing and thawing of the Thelon River.



BATHYMETRY OF THELON RIVER

IN WAY OF FERRY PROPOSAL

TABLE OF COORDINATES		
POINT #	COORDINATES	DEPTH (m)
498	[illegible]	0.0000
510	[illegible]	0.0000
513	[illegible]	0.0000
526	[illegible]	0.0000
241	[illegible]	6.9000
247	[illegible]	6.0000
256	[illegible]	4.1000
273	[illegible]	4.2000
364	[illegible]	6.9000
366	[illegible]	5.0000
374	[illegible]	4.1000
380	[illegible]	3.4000

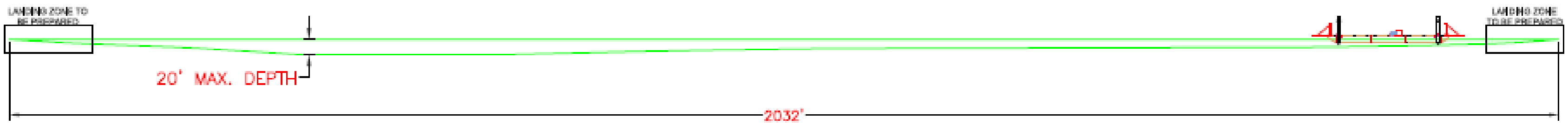
NOTE:

ALL DEPTHS AND POSITIONS ARE BASE ON THE JULY 22nd OF 2010 SURVEY OF THE AREA.

EASTERN SHORE PHOTO

WESTERN SHORE PHOTO

PHOTO OF GENERAL AREA



RIVER BOTTOM CUT VIEW

Projection: NAD 1983 UTM Zone 14N
Creator: CDC
Date: 09/01/2011 Scale:
File:
Data Sources: *Areva Resources Canada Inc.*

FIGURE 10.4-3

LOCATION FOR THELON RIVER CABLE FERRY

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10.4.4.2 ***Other Water Crossings***

The route crosses a number of water courses along its length. During the route selection process the alignment was often moved to higher ground where it could run along local drainage divides. This eliminated many of the smaller crossings, and limited the size and flow that would be encountered in others.

The route crosses many minor diffuse drainage paths, many of which are ephemeral (dry for most of the year). It is proposed to accommodate defined, but still minor stream crossings, using culverts. Larger streams will be spanned with bridges.

The concept for culvert installation is similar to that commonly used in northern Canada. Culverts of appropriate size are laid in place with little disturbance to the existing ground, at locations where drainage paths have been identified in the detailed design. Fill material will be placed and compacted around and over the culverts. In some cases, multiple smaller diameter culverts may be used instead of a single large diameter culvert to avoid having to cut the foundation of the large culvert into the existing ground to maintain the vertical road profile, or to avoid having to create a crest curve or “hump” in the roadway profile where the embankment is constructed over the culvert.

Preliminary stream crossing information for culverts and bridges is presented in Volume 5, Table 5.5-16. Appropriate culvert sizing and location will be confirmed in the detailed design stages of the work and will incorporate considerations for flood frequency and fish passage.

Culverts have been used throughout the Canadian north with varying degrees of success. When installed in areas with permafrost, they tend to require more maintenance and fail more often than culverts installed in more temperate climates, especially in areas with thick organic layers and ice-rich ground conditions. For this reason it is suggested to use permeable rock fills to allow passage of water in wet lowland areas with seasonal channelized flows. Specifically selected coarse single graded rock would be placed to above the waterline to facilitate the cross drainage in this concept.

Further details on crossing design and surveys are included in Technical Appendix 5A.

10.4.5 Road Safety and Management

The safety along the roads and the need for shelters and emergency equipment along the road has been discussed at some of the engagement sessions (EN-BL OH Nov 2013[104], EN-WC OH Nov 2013[105]). Concerns have also been expressed about the operation of the roads during blizzards (EN-CH KIA Feb 2010[106], EN – CH OH Oct 2012[107]). Safety structures will be constructed along the roads at an appropriate distance apart for safety. These structures would include a supply of emergency equipment in the event that someone gets stuck on the road during a blizzard.

The protection of wildlife along the access road has been discussed during several engagement sessions. Residents noted that AREVA should be sensitive to the wildlife during construction as there have been accidents with wildlife with other roads that were constructed in Nunavut (EN-BL EL Oct 2012[108]). It was suggested that roads should be built after nesting. (EN-CH HS Jan 2014[109]) Residents would like wildlife monitors along the road to ensure the wildlife, particularly caribou, are protected (EN-BL OH Oct 2012[110], EN-BL CLC Jan 2011[111]) A hunter suggested that the wildlife monitors would be most useful between June and December (IQ-BLHT 2011[112]). Baker Lake residents stated that caribou travel everywhere and the road slopes should be designed to accommodate caribou crossing (EN-BL OH Oct 2012[113], EN-BL OH Nov 2013[114]).

The roads have been designed to facilitate caribou crossing. Wildlife monitors will be employed with duties that will includeto monitor consideration for wildlife presence on the road.. A roads management plan (Technical Appendix 2M) has been developed to ensure the roads are managed for both environmental protection, including wildlife and safe operation.

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[104] EN-BL OH Nov 2013: *Road management is extremely important for safety and safety shelters too.*

[105] EN-WC OH Nov 2013: *Are there emergency equipment along road?*

[106] EN-CH KIA Feb 2010: *You also need to ask yourself if a truck would be sent out in a blizzard. Common sense would be used.*

[107] EN – CH OH Oct 2012: *Would you operate during blizzards? Would you have safety structures along the road?*

[108] EN-BL EL Oct 2012: *You will probably build a road in the future. Be sensitive to the wildlife. Meadowbank said they would be sensitive but there were accidents with wildlife. Be sensitive during road construction*.

[109] EN-CH HS Jan 2014: *Will there be roads? Roads should be built after nesting*

[110] EN-BL OH Oct 2012: *How strict will we be in protecting caribou? Caribou might stop on the road and not care.*

[111] EN-BL CLC Jan 2011: *If the road goes ahead, there should be at least 4 Wildlife Monitors on the road..*

[112] IQ-BLHT 2011: *A road could potentially provide better access to the caribou, but there would need to be more wildlife monitors in place (3-4). These monitors are most useful between June and December.*

[113] EN-BL OH Oct 2012: *If you are going to taper the road to make it easier for caribou to cross, you have to do that all the way, because caribou travel everywhere.*

[114] EN-BL OH Nov 2013: *Caribou cross all over the Meadowbank road and you should probably talk to AEM about the road slopes that they have and consider what has worked for caribou crossing.*

10.5 Site Roads

10.5.1 Kiggavik-Sissons Haul Road

A 19.6 km long haul road is required to connect mining operations at the End Grid and Andrew Lake area (Sissons) to the main mine/mill site (Kiggavik). The designed principles developed for this road are based on:

- producing a design that is cost-effective with respect to construction costs;
- a design that produces good operating characteristics for the design vehicles;
- minimal maintenance requirements, both on an annual and life-cycle basis; and
- respecting environmental and archaeological constraints.

The primary vehicles that will be using the road are:

- Trailers that can be transported using tractors (highway trucks). The proposed unit would consist of a tri-drive tractor with two B-train trailers. The 12-axle unit would be capable of hauling a payload of 120 tonnes.
- Buses, emergency vehicles and pick-up trucks.
- Occasional mine off-highway trucks and support equipment

The haul road design criteria have been determined using the Mine Health and Safety Act, Northwest Territories and Nunavut. The design is based on the purpose built highway trucks tractor/trailer configuration. The haul road design criteria are as follows:

- design maximum haul truck operating speed: 60 km /h;
- minimum width of travelling surface: 10 m;
- minimum safety berm height if embankment is over 3 m high: 2.2 m;
- maximum grade: 5%;
- minimum horizontal curve radius: 500 m; and
- safety berms.

The general alignment of the proposed road is shown in Figure 10.4-2. The road alignment avoids known archaeological sites. Ten water crossings are identified along the road alignment. Two single-span bridges (less than 50 m in length) will be required along the route. The remainder of the water crossings can be accommodated with culverts and coarse rock fills.

Typical cross-sections for the access road are included in Technical Appendix 2G (Kiggavik-Sissons Haul Road). In non-permafrost areas, it is common for road designs to incorporate both cuts and fills to establish the final grade along the alignment. However, in permafrost areas, disturbing sensitive overburden soils and surface vegetation can result in thaw degradation and the creation of unstable ground. Consequently, the design frequently calls for fill-construction only, wherever the road passes over overburden soils. Minimum depth of embankment fill will be specified for various “terrain types”, and will be designed to be sufficient to construct a stable road embankment and to protect the underlying permafrost. In the current design, cuts have only been incorporated in bedrock.

10.5.2 Other Site Roads

A number of other site roads will be required, including:

- Kiggavik site to Judge Sissons Lake, along the treated effluent pipe alignment. This road passes the airstrip and therefore it includes airstrip access;
- Sissons site to Judge Sissons Lake, along the treated effluent pipe alignment; and,
- Sissons site to Mushroom Lake along the proposed freshwater withdrawal pipe alignment.

Access from Kiggavik site to Siamese Lake is along the final portage along the winter road route.

These roads will be constructed for single vehicle travel. The section of the road connecting Kiggavik site to the Pointer Lake airstrip will use the same design criteria as the all-season access road as it will be used to transport containers (Technical Appendix 2L). All roads will use fill to protect the permafrost and cuts only as needed in rock.

10.6 Air Transportation

10.6.1 Air Transport Activities

Under normal operation, only personnel, perishable goods, drilling equipment and yellowcake will be transported by air. Air transport may also be used to transport emergency construction or operating supplies if unforeseen difficulties are encountered with the marine-road logistics system.

Aircraft that may be used include:

- Lockheed C-130 Hercules
- Lockheed Hercules L382G
- Boeing 737-200
- ATR 42-300
- ATR 72-200
- Beech 1900
- King Air
- Various single-engine helicopters

Aircraft selection will be subject to availability of planes, and the needs of the Project. Aircraft selected will be similar to the aircraft listed above, and will not change the outcome of the assessment. Maintenance schedules will conform to all requirements as outlined for the specific type of aircraft selected and in accordance with the Operating Certificate for the airline. In addition to requiring aircraft providers to comply with regulations, AREVA requires aircraft services to pass periodic audits carried out by third parties. These begin before the service is used and then on a frequency of usually one or two years. Based on AREVA's third party audits, a list of approved carriers is released several times a year. These audits include a review of personnel, licenses, insurance, flight operations, safety program and records, maintenance program and quality assurance program. The maintenance audit includes personnel training and records, publications, parts, facilities, tools and equipment.

Exploration drilling equipment will predominantly be moved using helicopters, as is the current practice at the existing exploration site. It is anticipated that daily helicopter flights to transport personnel and drilling equipment will be required during exploration activities (Section 3).

10.6.1.1 ***Transportation of Uranium Concentrate***

The 2008 project proposal outlined that the transport of uranium concentrate would occur by a combination of air and barging. Concerns have been raised by community members about the storage of uranium concentrate in Baker Lake, transportation of yellowcake through the communities and the barging of uranium concentrate (EN-RI RLC Feb 2009[115,]). Overall, residents preferred that yellowcake be shipped by air (EN-KIV OH Oct 2009[116]). In more recent consultations, Chesterfield Inlet residents, expressed interest in shipping yellowcake by barge, mostly due to a perceived risk of yellowcake exploding in the event of a plane crash (EN-CI OH Nov 2012[117]) Based on the feedback received, transport alternatives were narrowed during the earlier EA review stages and the project description and anticipated licensing approvals now include the transport of uranium concentrate by air only.

---

[115] EN-RI RLC Feb 2009: *Shipping Yellowcake by sea - Idea that if AREVA is building an airstrip then they should use it. Suggestion to not even consider storing YC in Baker (especially not for 9 months) but rather store at Kiggavik and only go in and out of communities as necessary.*

[116] EN-KIV OH Oct 2009: *This yellowcake, it's pretty dangerous and harmful to animals so I would prefer that it be transported by air so there is less harm to the environment.*

[117] EN-CI OH Nov 2012: *I was against shipping yellowcake by airplane because they could blast or the plane crashed. Because they have thick containers, I supported shipping by barge.*

The air transport of uranium concentrate was carried out successfully in the past on an ongoing basis by Eldorado Nuclear, a Cameco Corporation predecessor, for many years. Transfers took place on a daily basis between the Beaverlodge Uranium Mine near Uranium City, Saskatchewan and Saskatoon, with the Eldorado Boeing 737 aircraft.

Air transport in Canada is strictly regulated by Transport Canada – Canadian Aviation Regulations. The packaging and transport of radioactive materials is subject to the following:

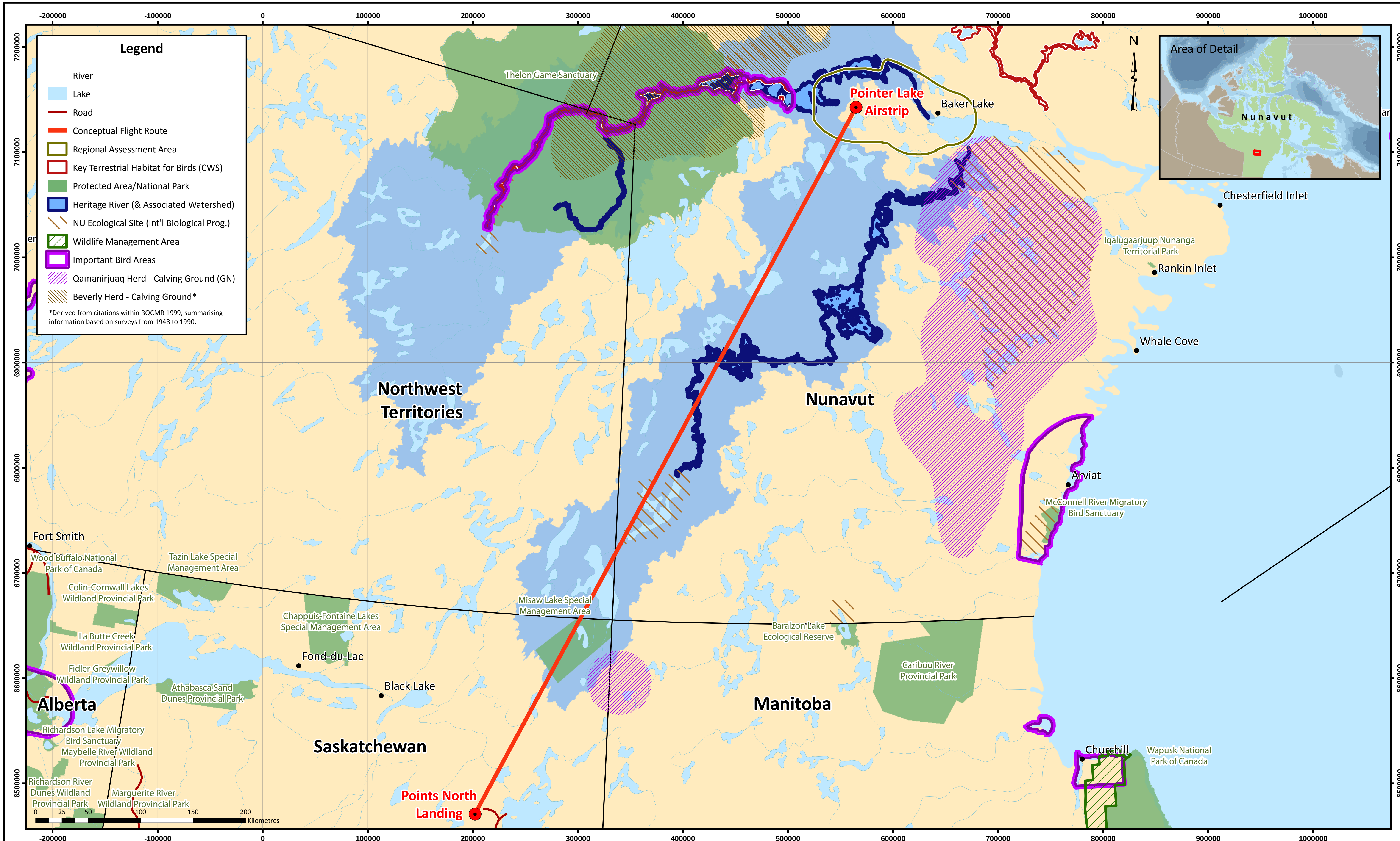
- Transport Canada Transportation of Dangerous Goods Regulations;
- Canadian Nuclear Safety Commission (CNSC) Packaging and Transport of Nuclear Substances Regulations;
- International Civil Aviation Organization Technical Instructions for Safe Transport of Dangerous Goods by Air;
- International Air Transport Association Standards; and,
- International Atomic Energy Agency's TS-R-1, Regulations for the Safe Transport of Radioactive Material.

All transporters of radioactive materials in Canada are required to implement their own Radiation Protection Program.

The use of Hercules Aircraft is presently envisioned to transport uranium concentrate by air. Figure 10.6-1 identifies a conceptual flight route for transport of uranium concentrate by air, originating from the Kiggavik Project's Pointer Lake airstrip to the Points North Landing airstrip in northern Saskatchewan, a distance of 800 kilometres. Alternatives to the Hercules and Points North Landing options, allowing for increased operational flexibility, will be assessed and may be proposed at the time of licensing application.

Approximately 4,000 tonnes of uranium concentrate will be produced each year at the Kiggavik site. The yellowcake will be packaged in steel 55-gallon (206-litre) steel drums and sealed meeting IP-1 industrial package requirements as specified in the *IAEA Regulations for the Safe Transport of Radioactive Material*. Each drum will hold approximately 434 kg of concentrate (e.g., 454 kg gross/drum minus 19.6 kg steel) .

The site will produce between 11,000 and 12,500 drums of uranium concentrate annually, which are washed and tested after filling to remove any residual contamination prior to securely stowing within 20-foot ISO sea freight containers. The drums and containers will be stored in a secure marked location on-site until an aircraft is ready for loading. The containers will remain sealed during transportation from the mine site to the final point of delivery.



Projection: NAD 1983 UTM Zone 14N
Creator: CASLYS CONSULTING LTD.
Date: 10/07/2014 Scale: 1:3,300,000
10.6-1_Conceptual_Flight_Route.mxd
Data Sources: *Natural Resources Canada, GeoBase®, National Topographic Database, AREVA Resources Canada Inc., Gebauer & Associates, Environment Canada - CWS, Government of Nunavut, IBA Canada and Government of Manitoba.*

FIGURE 10.6-1
CONCEPTUAL FLIGHT ROUTE FOR TRANSPORT OF URANIUM CONCENTRATE BY AIR

ENVIRONMENTAL IMPACT STATEMENT
VOLUME 6

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Limitations apply to transportation of radioactive goods, and it is estimated that a maximum of 35 drums may be loaded into a container to maintain a Transportation Index of less than 6.Dangerous Goods Regulations require that the separation between passengers (pilots) and radioactive material (TI index ~6) be at least 1.15 m.

It is expected that between 310 and 355 sea-containers will be shipped to the south annually. Air shipment of all product containers from Kiggavik would require 6 or 7 trips per week (one container per flight). Typically the plane would be mobilized once per week, and it would make 6 or 7 return trips from the site to Points North or an alternative destination, before returning to its point of origin. Alternatively, the plane may mobilize twice a week and reduce to 3 the number of return trips.

On arrival at Points North, uranium concentrate will be transferred from aircraft to truck – trailer. If immediate transfer is not possible, secure temporary storage may be required at Points North. The uranium concentrate would then be transported to a North American refinery or to a Port for shipment to non-North American destinations via routes similar to those currently used during transport of uranium concentrate from the McClean Lake Operation.

Community members have expressed concern about the potential for accidents during the air transportation of yellowcake, and the need for an appropriate response in the event of an incident.(EN-CI OH Nov 2010[118], EN-RB KIA Feb 2010[119], EN-WC OH Nov 2012[120]). Companies shipping uranium concentrate require an approved Emergency Response Assistance Plan (ERAP) The plan is reviewed and approved annually by Transport Canada. The plans specify emergency response responsibilities, procedures, personnel training, response team roles, and available resources. The ERAP is exercised annually and can be limited or multi-agency in scope and include live exercises. The ERAP will be developed in consultation with Transport Canada, the CNSC, local communities, and any other concerned parties.

10.6.1.2 ***Transportation of Personnel***

For the transportation of personnel, the use of three primary aircraft types is envisioned: the ATR 42-300, ATR 72-200, and Lockheed Hercules L382G aircraft. Smaller aircraft will be used within the Kivalliq region when warranted by the number of personnel being transported. Weekly passenger

[118] EN-CI OH Nov 2010: *After mining turns to yellowcake then is ready for transport. What are the potential transportation incidents?*

[119] EN-RB KIA Feb 2010: *Will the water be contaminated if there is an accident with the transport drums?*

[120] EN-WC OH Nov 2012: *What would happen if a plane of uranium crashed?*

traffic of up to 650 passengers is anticipated. In addition, Hercules cargo operations are anticipated during construction and the operating phase of the Project.

Air traffic associated with the Kiggavik Project will adhere to Transport Canada's "Aeronautical Information Manual" (2012). Within this manual, Section 1.14.3 of the Rules of the Air and Air Traffic Services states the following: "Pilots should not fly at an altitude less than 2000 feet AGL when in the vicinity of herds of reindeer or caribou." All aircraft associated with the Kiggavik Project will adhere to this rule of 2000 feet above ground level (i.e., 610 metres), except during take-offs and landings, slinging of equipment by helicopters, or for emergency purposes. The Pointer Lake airstrip aerodrome will have an instrument approach that will specify minimum altitudes at various distances from the airstrip. Wildlife protection measures with requirements for landings and takeoffs will be in effect throughout the life of the Pointer Lake airstrip.

A comprehensive Safety Management System will be developed and subject to approval by Transport Canada. Third party Air Carrier auditing will take place to approve carriers annually to operate to and from the mine site. Ground service including loading and unloading of the passenger aircraft will take place at the apron area. Passengers will be moved to and from the aircraft building by bus or van. Cargo will be moved by pickup truck. Hercules flights will be serviced using a front end loader, tractor trailer lowboy combination, and large forklift.

Moving the flights onto separate days provides for less chance of a weather system affecting workforce availability and provides more options for connecting passengers traveling on other flights.

Personnel arriving from outlying stations such as Yellowknife, Churchill, Winnipeg, and Iqaluit would likely arrive on scheduled airline services to Baker Lake during initial airstrip construction. Prior to completion of the Pointer Lake airstrip, personnel will likely be transported from Baker Lake to the Kiggavik mine site via helicopter. A conceptual conservatively estimated number of helicopter flights for initial personnel transport is provided in Table 10.6-1. Other transportation options will also be investigated during licensing.

Following completion of the Pointer Lake airstrip, personnel and cargo will primarily be flown directly to the Kiggavik mine site on chartered aircraft, many without stopping at Baker Lake. A conceptual breakdown of aircraft used for transporting personnel and cargo, along with the estimated number of flight per week is presented in Table 10.6-1.

It is expected that the commuter transport systems will evolve over time to match efficiencies and aircraft availability with demand.

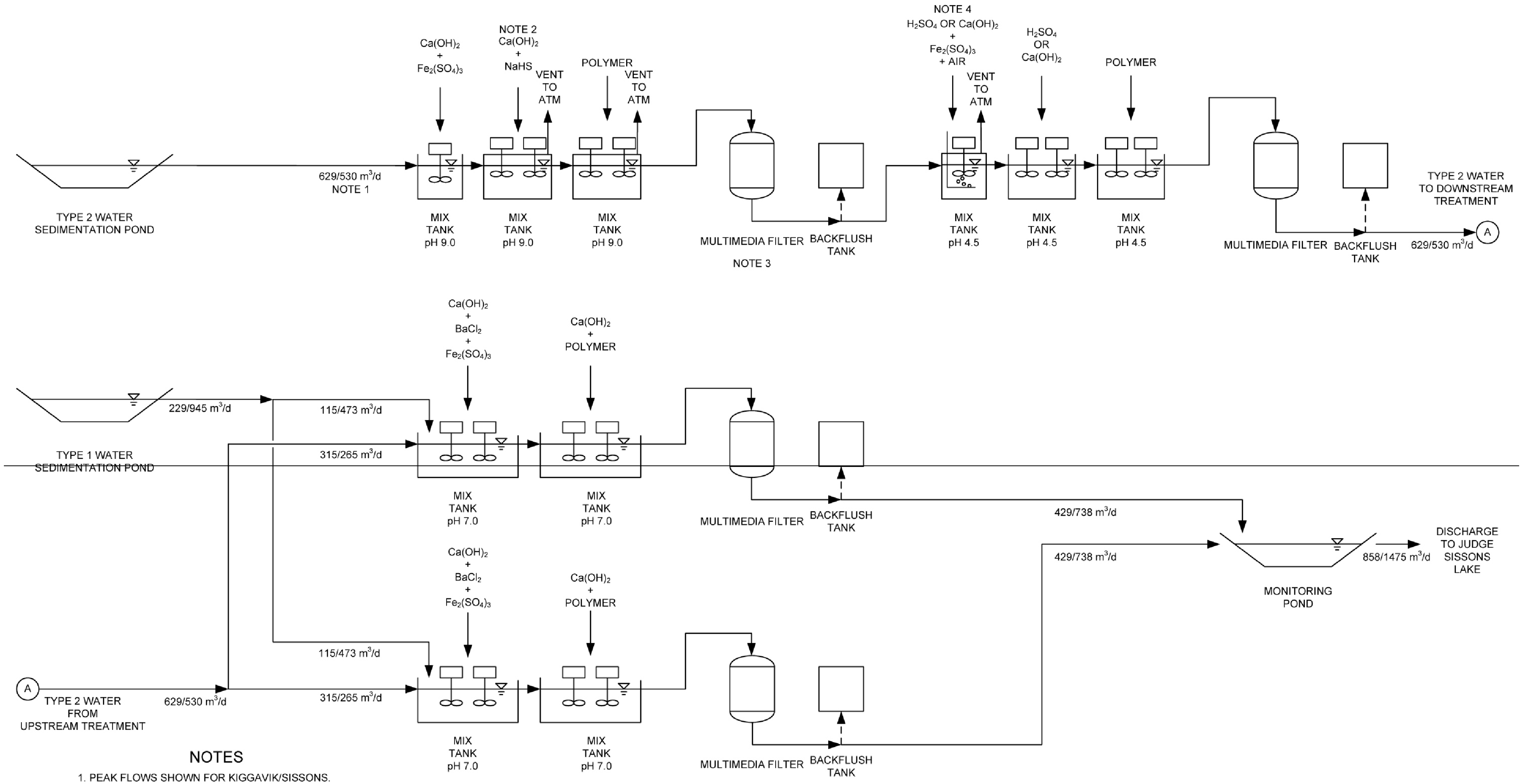
10.6.2 Airstrip Design, Construction and Operation

The upland area west of Pointer Lake was selected as the preferred location for the Kiggavik airstrip (Figure 10.6-2). A weather station was installed at Pointer Lake in August 2009 to confirm key meteorological parameters derived for the Kiggavik area (i.e., prevailing winds, temperatures and weather patterns). Air traffic to and from the Pointer Lake airstrip is anticipated to primarily be from the south and east, depending on atmospheric conditions.

All design parameters used for the proposed airstrip are based on Transport Canada's Aerodrome Standards and Recommended Practices TP312E, 4th Edition. The largest aircraft to be used on a regular basis during construction and operation of the Kiggavik Project is the Hercules (Lockheed C-130 Hercules). However for design purposes, the Boeing 737-200 (Code C Aircraft) was conservatively chosen as the design aircraft. The runway requirements for the 737-200 exceed those for the C-130. The Aerodrome will be constructed to meet Aerodrome standards.

Construction of the Pointer Lake airstrip will be one of the first construction activities started. Airstrip construction is estimated to take between 6 to 12 months to complete. The schedule will be tailored to allow landing of smaller aircrafts on a shorter runway in the early stages of the Project. During mine operations, aviation activity at the Pointer Lake airstrip will include personnel transport to and from the Kiggavik mine site, cargo transport, exploration activities support, and transport of yellowcake. Decommissioning activities will likely require a similar amount of aviation activity related to personnel and cargo transport during the initial phases of decommissioning. However, aviation activity is anticipated to decrease as decommissioning milestones are achieved.

Additional air traffic at the Baker Lake airport related to the Kiggavik Project are conservatively estimated at approximately five flights per week during construction, four flights per week during operations, and one flight per week during decommissioning. Flights during the decommissioning period will likely reduce as decommissioning milestones are achieved. Increased flights to the Baker Lake airport will mostly originate from the Kiggavik site to the west, from Saskatoon, Saskatchewan, or from other Kivalliq communities. Instrument landings currently in place at the Baker Lake aerodrome are as follows: the minimum altitude within 25 miles from Baker Lake is 1900 feet (579 meters), the minimums once on the approach are approximately 1300 feet (396 meters) and then on final approach decrease to approximately 500 feet (152 meters). All altitudes are above sea level and the Baker Lake airport elevation is approximately 60 feet (18 meters).



NOTES

1. PEAK FLOWS SHOWN FOR KIGGAVIK/SISSONS.
2. VENTING REQUIREMENTS WILL DEPEND ON RESIDUAL SULFIDE PROCESS CONTROL STRATEGY.
3. BACKWASH STREAMS OMITTED FOR CLARITY. BACKWASH RETURNED TO SEDIMENTATION PONDS.
4. REQUIREMENT FOR SLAKED LIME OR SULFURIC ACID WILL DEPEND ON BUFFERING CAPACITY OF WATER AND FERRIC SULFATE DOSAGE.

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Data Sources: *AREVA Resources Canada Inc.*

FIGURE 9.6-2
SISSONS WATER TREATMENT PLANT BLOCK DIAGRAM

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Table 10.6-1 Conceptual Breakdown of Aviation Activity Proposed for the Kiggavik Project

Project Phase	Activity	Anticipated Aircraft Type	Flights/Week	Comments
Construction	Personnel Transport from Baker Lake to Kiggavik site prior to completion of Pointer Lake airstrip	single-engine helicopter	10	Conservative estimate. Other options will be investigated during licensing.
	Personnel Transport to Kiggavik site following completion of Pointer Lake airstrip	ATR 42-300, ATR 72-200, Beech 1900, King Air or equivalent	28	Conservative estimate based on the projected maximum number of employees at site at any given time (i.e., 650).
	Cargo Transportation to Kiggavik	Lockheed Hercules or equivalent	4	Alternative aircraft: Lockheed C-130 Hercules.
	Exploration program support	single-engine helicopter	7	Exploration activities for additional resources expected to continue on leases owned by AREVA Resources Canada.
Operations	Transport of yellowcake from Pointer Lake airstrip to Points North Landing, Saskatchewan	Lockheed Hercules or equivalent	6	Alternative aircraft: Lockheed L382G.
	Cargo Transportation to Kiggavik	Lockheed Hercules or equivalent	6	Alternative aircraft: Lockheed C-130 Hercules.
	Personnel Transport to Kiggavik	ATR 42-300, ATR 72-200, Beech 1900, King Air or equivalent	24	Personnel transport expected to evolve over time to match efficiencies and aircraft availability with demand.
	Exploration program support	single-engine helicopter	7	Exploration activities for additional resources expected to continue on leases owned by AREVA Resources Canada.
Decommissioning	Cargo Transportation to Kiggavik	Lockheed L382G	4	Trips will be reduced and eventually phased out as Decommissioning Milestones are achieved.
	Personnel Transport to Kiggavik	ATR 42-300, ATR 72-200, Beech 1900, King Air	24	Trips will be reduced and eventually phased out as Decommissioning milestones are achieved.

The plan and profile of the proposed Pointer Lake airstrip is shown in Figure 10.6-3 and includes the following components and operational considerations:

- A runway 2,000 m in length and 45 m in width
- An aircraft turning D on the south end
- A graded area capable of supporting an aircraft on either side of the runway
- 150 m long Runway End Safety Areas at both ends of the runway
- A 23 m wide taxiway complete with 6 m wide graded shoulders
- An apron for two aircraft, with sufficient space for servicing and independent arrival/departure
- A single storey pre-fabricated Air Terminal Building (ATB) to provide passenger/cargo shelter as well as space for the Field Electrical Centre (FEC). The ATB would have an area for ground vehicle parking associated with it.
- Three-phase electrical power will be provided to the aerodrome site from the Kiggavik site. Electrical controls and regulators would be contained in a separate room from the ATB lighting/heating systems. The ATB would also contain the Aircraft Control of Aerodrome Lighting (ARCAL) antenna, aerodrome beacon, aircraft ground power units and apron flood lighting. The ARCAL will allow pilots to control the aerodrome lighting with no assistance from the aerodrome personnel.
- De-icing of aircraft will be required. Boom truck(s) will be used for de-icing fluid application. De-icing fluid will be delivered in totes or drums and a pumping system to transfer to the boom truck(s) will be required.
- Dust tends to be more prevalent during the summer months and can be problematic if the airport is serviced by jet aircraft. Dust clouds can linger or shift over the surrounding terrain and adjacent lakes. In order to reduce fugitive dust, application of an appropriate approved dust suppressant will be used as needed.
- An emergency supply of aviation fuel will be retained at the airstrip within secondary containment.
- Procedures for detection of animals and birds and prevention of interactions with aircraft and the maneuvering areas will be necessary. This may include pre-landing and pre-take off runway inspections by ground personnel prior to each flight. Security and wildlife fencing has not been included in the design.
- All snow clearing, cargo handling, passenger assistance, baggage handling, fuelling, surface maintenance and electrical maintenance will be provided by either mine site equipment and personnel or contractors. Maintenance of the gravel runway, taxiway and apron surfaces will be required on a regular basis.

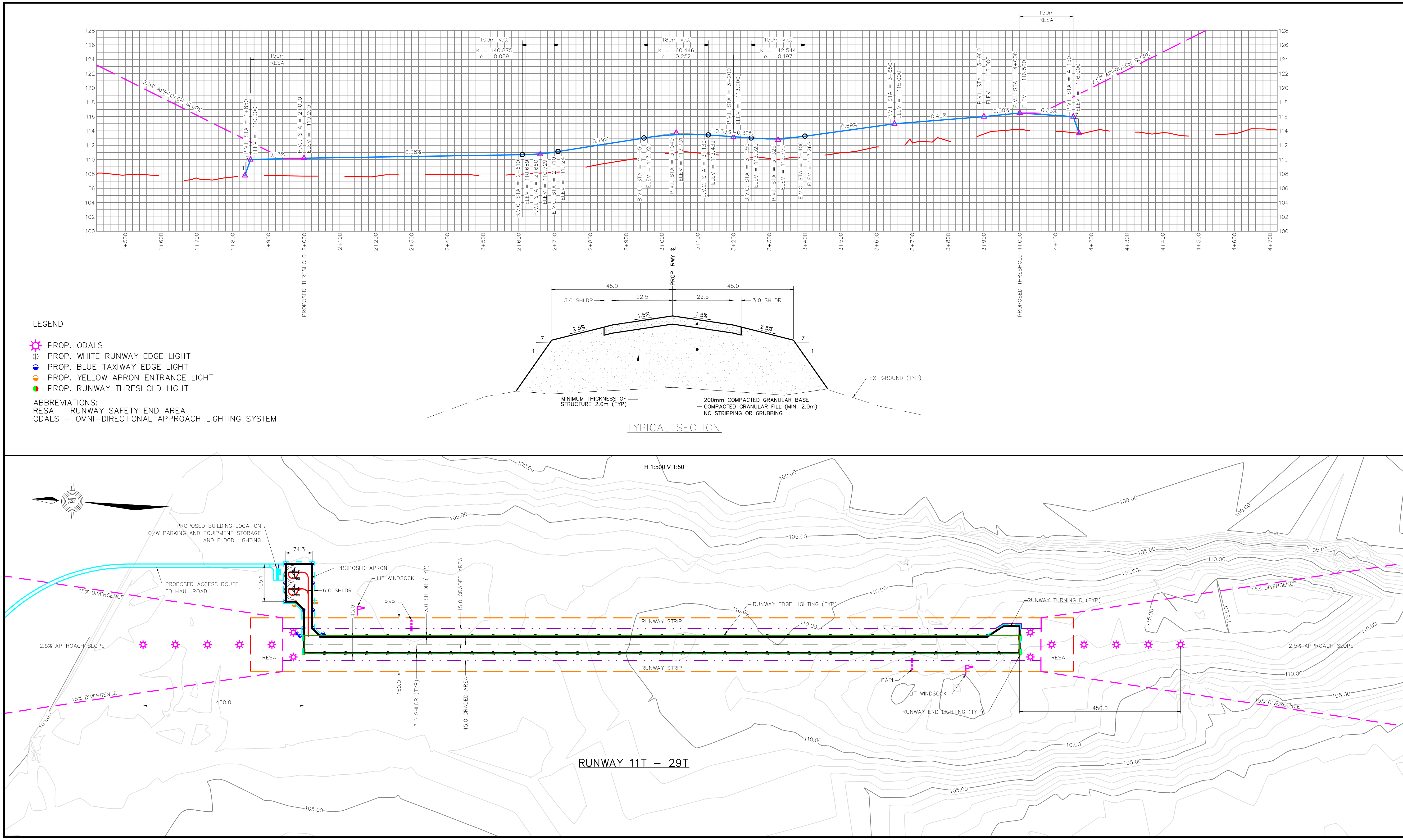

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FIGURE 10.6.3
PROPOSED POINTER LAKE AIRSTRIP
PLAN AND PROFILE

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11 Project Support Infrastructure

11.1 Power Generation and Distribution

Project site power will be generated locally in on-site powerhouses. All equipment on site may be operated using a common arctic grade diesel to eliminate the need for alternate fuels shipping and storage. As a result, the power will be supplied by diesel fuelled generators.

11.1.1 Selection of Design

Power generation options examined include:

- Use of diesel gas turbine engines (GTE) vs. diesel internal combustion engines (ICE) for a combined heat and power (CHP) system;
- Central power generation (Kiggavik powerhouse and transmission line) vs. de-central power generation (independent power generation at Kiggavik and Sissons); and
- Supplementation of diesel power with wind power.

Power generation options initially screened out but could be re-considered closer to project execution include:

- solar energy
- hydropower; and
- geothermal energy.

Additional information on power generation alternatives is found in Tier 2, Volume 2, Technical Appendix 2A.

The sulphuric acid plant can also contribute to site heat generation. An analysis was completed to compare two options for heat recovery in terms of steam and power production:

- Acid plant generates power using a backpressure steam turbine and provides continuous steam to mill processes; or,
- Acid plant generates power using a condensing steam turbine and provides no steam to mill processes.
- It was determined that having the acid plant produce steam and some power consistently resulted in lower fuel and operating costs for all prime movers and central vs. de-central cases.

- The central power generation option involves generating power at the Kiggavik site with a power transmission line to the Sissons site. The de-central power generation option involves generating power at both the Kiggavik and Sissons sites. The de-central option involves less risk to operations at the Sissons site arising from potential outages of the approximately 20 km long transmission line between the two sites.
- Alternatives assessment demonstrates that the preferred option is the use of the internal combustion engines at separate Kiggavik and Sissons powerhouses (Technical Appendix 2A).
- Design and future strategies used for optimization and conservation of power include:
- Recovery of heat generated by the acid plant;
- Air-to-air heat exchange for the key HVAC systems, including the mill and End Grid underground mine;
- Further study of the potential for wind power generation by installation of a tower; and,
- Continuous improvement during operations by monitoring and optimizing key power consumers and minimizing sources of heat loss.

11.1.2 Energy Requirements

The electrical and thermal requirements (loads) of the site over an average year have been estimated. The electrical power requirements will be relatively constant over the year, with only the electric heat trace having significant seasonal variation. Conversely, the thermal load will vary significantly with ambient temperature. The mill will be the largest user of electrical and thermal energy.

Table 11.1-1 shows a schematic summary of the electrical loads. It has been estimated that the Kiggavik peak load will be 13.0 MW and the Sissons peak load will be 3.8 MW; for a total site peak load of 16.8 MW. The sizing of the power plants is based on this peak load. Based on the diversity factor of operating equipment the peak loads will not be reached on a continuous basis, but may be reached during the startup of major equipment.

Table 11.1-2 includes a summary of the thermal loads. Unlike the electrical loads, the thermal loads vary significantly with the ambient temperature. It is assumed that the Kiggavik thermal loads will be met primarily with saturated steam (7 bar). The estimated peak Kiggavik steam requirement is 34,300 kg/hr, while the estimated continuous (year round) steam consumption for Kiggavik is 10,700 kg/hr. Depending on the heat recovery and power plant configuration selected, a portion of the Kiggavik peak steam load could be offset by hot water. Thermal loads at the Sissons site will be met by either a hot water system, and/or indirect fired diesel burners as steam is not specifically required for process.

The largest loads at Sissons occur when the End Grid underground mine is operating; thermal loads at Sissons will be minimal until underground mining begins.

Table 11.1-1 Electrical Load Summary

Area	Component	Electric Load (peak kW)
Kiggavik	Process Equipment	5,345
	Building Services	1,710
	Office/Lab/Administration	35
	Maintenance Shop	50
	Acid Plant	650
	Oxygen Plant	1,140
	Accommodation Complex	500
	Mine Shop	50
	Tailings Management Facilities	205
	Surface Mine	505
	Tank Farm	50
	Container Storage Area	20
	Area Lighting	60
	Water Treatment & Pumping	2,000
	Power House Auxiliary	100
	Heat Tracing	580
	SUB-TOTAL Kiggavik	**13,000**
Sissons	End Grid Underground Mine	2,806
	Andrew Lake Open Pit	467
	Sissons Site (including water treatment plant)	342
	Heat Trace	181
	SUB-TOTAL Sissons	**3,796**
	TOTAL Project	**16,796**

Table 11.1-2 Thermal Load Summary

Area	Component	Thermal Load (MJ/a)
Kiggavik	Process Steam (Acid Plant Generation Not included)	253,854,023
	Mill Ventilation Thermal load	128,368,348
	Mill Heat/Cool Thermal Load	7,683,152
	Camp Thermal Load	20,994,185
	Mine Shop Thermal Load	7,982,106
	SUB-TOTAL Kiggavik	**418,881,800**
Sissons	HVAC Thermal Load (WTP, Camp, Shop)	10,279,089
	Underground Mine Thermal Load	92,822,405
	SUB-TOTAL Sissons	**103,101,500**
	TOTAL Project	**521,983,300**

11.1.3 Kiggavik Site Power Generation

The location of the Kiggavik powerhouse is shown in Figure 4.4-1. The powerhouse will be located south-west of the mill, down-wind of most Project infrastructure.

Mill failsafe systems and independent back-up generators will be in place to safely manage potential power outages.

Depending upon the final selection of generator size, four to six internal combustion diesel engine generators with heat recovery steam generators will be required at the Kiggavik site to produce 13.0 MW.

Heat will be recovered from the diesel engines from 4 locations: exhaust gases, jacket water cooling system, oil lube cooling system, and after cooler system. The after cooler and oil lube systems will produce low grade heat which may be used locally but has not been included in the useful heat output from the powerhouse. Heat from the exhaust gases will be recovered by a heat recovery steam generator. The peak continuous output from the generators is expected to be 4,000 kg/hr. Engine heat will also be recovered from the jacket water cooling system which circulates cooling water around the engines. This jacket water heat is transferred to a high grade heating loop by a plate type heat exchanger for use in the mill.

At peak winter conditions a boiler will be required to provide up to 10,000 kg/hr of additional steam. At peak summer conditions exhaust gases will bypass the steam generator and be vented to atmosphere. The exhaust gases from the engines will be vented to a single exhaust stack located 10 m away from the building.

11.1.4 Sissons Site Power Generation

The total peak load at the Sissons site will be quite small compared to typical installed powerhouses. Also, the electrical load at Sissons will be minimal during construction and open pit mining phases and only grow to the peak value of 3.8 MW when underground mining begins. It is proposed that smaller (1 to 1.5 MW) skid mounted generators be used as primary power for the Sissons site. Using multiple skid mounted units will allow the power supply to be increased in stages as the electrical demand increases. It is also assumed that skid mounted construction power generators would be purchased for use during construction of the Kiggavik site. It is planned to re-use the temporary construction power generating units as the primary power supply at the Sissons site.

Since steam is not specifically required for process use at the Sissons site, all available heat will be recovered in a hot water loop which can be used as preheat for mine air and the Sissons WTP if required.

11.1.5 Wind Power Generation

A preliminary study of the potential for wind power generation at the Kiggavik site has been completed. This study suggests that a small decrease in average annual fuel consumption could be realized through the potential installation of wind turbines.

Recently, the Diavik diamond mine announced construction of a wind farm at the mine site to help off-set the amount of diesel fuel required to meet its energy needs. The proposed wind farm is anticipated to reduce the mine’s total diesel consumption by about 10%. AREVA may consider wind power as an alternative in the future depending on technological advancements in the industry.

11.1.6 Power Distribution

11.1.6.1 *Kiggavik Site*

The generators at Kiggavik powerhouse will feed a 15kV switchgear lineup of 15/16 feeder circuit breakers. These feeders will supply electrical power to all the facilities at Kiggavik site as well as some remote sites such as the Siamese Lake pumphouse.

High voltage and low voltage cable trays will be installed in the mill and arctic corridors. Five 15 kV cables from five circuit breakers will run over these cable trays to three motor-control-centres (MCCs) in the mill. 15 kV cables from the powerhouse will run through arctic corridors to the acid plant, oxygen plant and water treatment plant. Step down transformers at each of these plants will convert 13.8 kV supply to 4,160 V and 600 V and will feed 4,160 V and 600 V MCCs. One 15 kV cable connects the steam turbine generator of the acid plant to the 15 kV switchgear line up in the powerhouse.

The tank farm will be supplied with electricity through buried cable or overhead conduit. Depending upon the location of the tank farm, it may have its own MCC room or it may be supplied from a nearby facility. One 15 kV cable from the powerhouse will run through the arctic corridor to the camp.

A 15 kV feeder will supply three 15 kV overhead transmission lines. One will supply power to surface mines, another will supply power to the Siamese Lake pumphouse and heat tracing, and the third will supply power to the Pointer Lake airstrip and heat tracing of the effluent pipeline to Judge Sissons Lake. Pole mount (13.8 kV/600 V or 13.8 kV/240 V) transformers will be installed every 1,000 m to 1,500 m for heat tracing.

One 15 kV feeder will supply power to an automatic power factor improvement unit (PFI) installed in the powerhouse for remaining loads.

Emergency generators in the Kiggavik mill will supply emergency power to the mill, acid plant, powerhouse, oxygen plant and other nearby facilities. The camp and airport will have their own emergency generator. The emergency generators will be an automatic start-up system in the event of power failure. Part of the lighting, telephone and communication network, control system, computer networks and the necessary process equipment will be on emergency power supply.

11.1.6.2 ***Sissons Site***

Generators at the Sissons site will generate power at 4,160 V and feed a substation. 4,160 V overhead transmission lines will supply power to the underground mine air intake and air exhaust facilities. One overhead 4,160 V line will supply power along the effluent pipe line to Judge Sissons Lake for heat tracing. 600 V overhead or underground cable will supply power to emergency camp, surface mine and mine shop. Step transformers and fused disconnects will be required at mine air intake and exhaust site. Pole mounted transformers will convert the 4.16 kV supply to 600 V or 240 V for heat tracing.

The emergency generators at the Sissons site will be located at the underground mine air intake, air exhaust, underground mine and surface mine. The emergency generators at the mine air intake and exhaust will be sized to satisfy lighting and emergency ventilation requirements. All the emergency generators and power distribution will come with an automatic generator start-up system and automatic power transfer switch.

11.2 Fuel Storage and Distribution

One of the key concerns expressed by the public is the potential for fuel spills, and the potential impacts of a fuel spill to wildlife and the environment (EN-AR NIRB May 2010[121], EN-CH OH Oct 2012[122], EN-CI HTO Nov 2012[123]). Benchmarking against other northern Projects also suggests that the large volumes of fuel required to operate these projects can increase the likelihood that a fuel spill may occur. Accident and incident management and reporting for fuel transport, storage, and use is included in the Hazardous Materials Management Plan (Technical Appendix 2U) and the Spill Contingency Plan (Technical Appendix 10B)..

11.2.1 Required Storage Capacity

Diesel fuel tank farms will be required at Baker Lake, Kiggavik, and Sissons sites. The Kiggavik Project total peak annual fuel consumption has been estimated to be 65 million litres with an average of 49 million litres (ML) over the production period. This total includes all fuel required for:

- heat and power based on the internal combustion engine de-centralized option; and
- mobile equipment and miscellaneous loads.

It is estimated that during the peak consumption year, fuel storage of up to 70 ML may be required at Baker Lake, with 50 ML of fuel storage at Kiggavik site and 20 ML of fuel storage at Sissons site. Therefore up to seven 10 ML tanks at Baker Lake, five 10 ML tanks at the Kiggavik site and two 10 ML tanks at the Sissons site are required. The current design conservatively considers six tanks at Kiggavik and two tanks at Sissons to allow for flexibility in fuel storage at the Kiggavik site.

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[121] EN-AR NIRB May 2010: *Concerned over wildlife and the potential impacts from spills. Would like to know if there are any mitigation plans in place for spills and any chemicals that can be used to clean up the environment (minimize the spill).*

[122] EN-CH OH Oct 2012: *This is a hard environment for spills. How will you look after that?*

[123] EN-CI HTO Nov 2012: *The HTO wants to be involved in planning and conducting and clean up that is necessary. No spill would be good for our animals*

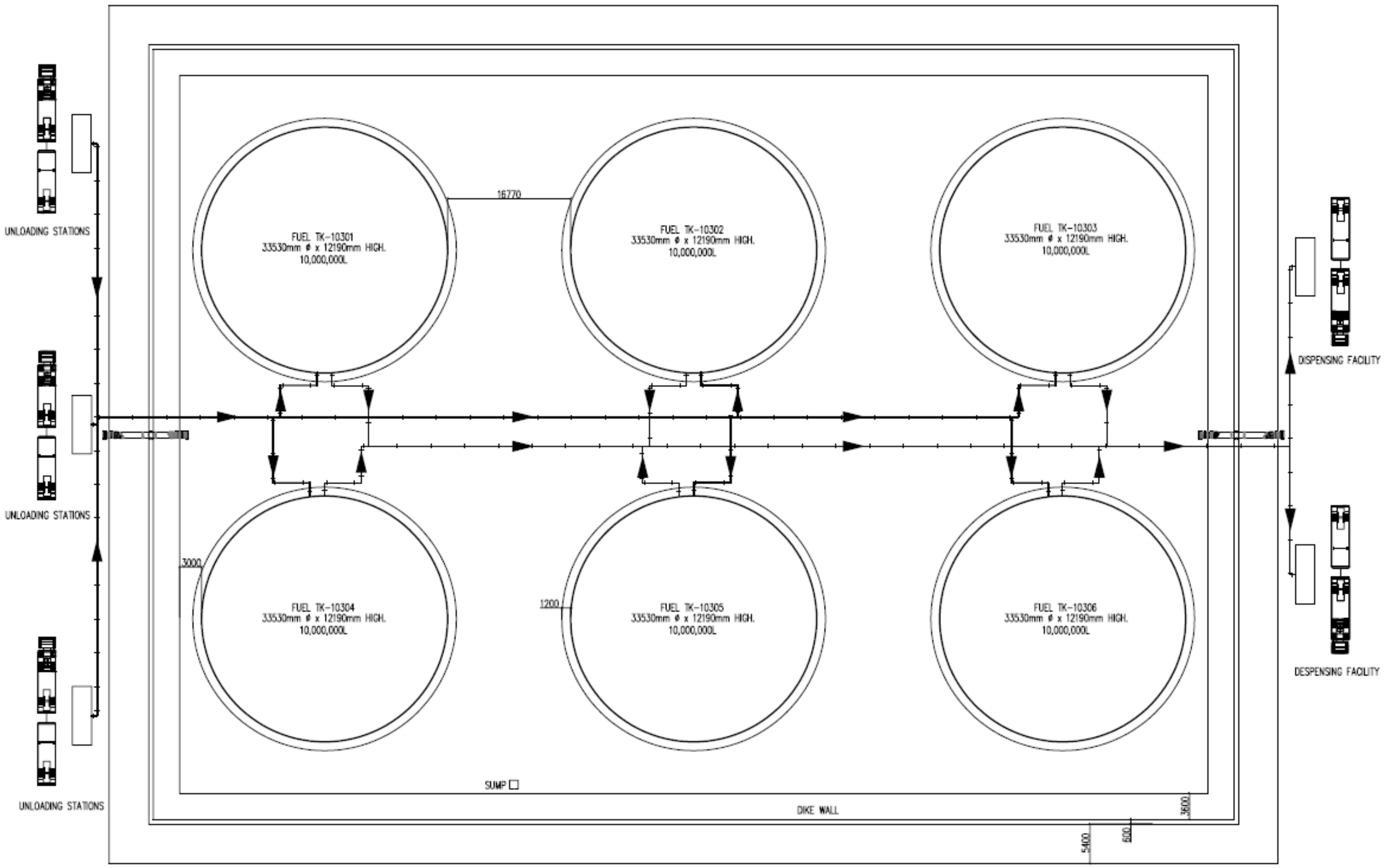
11.2.2 Tank Farm Design

Secondary containment areas required to contain fuel will be designed according to the National Fire Code. Secondary containment volume is the sum of the size of the largest tank (10 ML) and of ten percent of the volume of the remaining tanks. For a tank farm of 6 tanks of 10 ML capacity, the containment volume is 15 ML. An example configuration of the Kiggavik site tank farm is shown in Figure 11.2-1.

A base of coarse gravel of approximately 1,000 mm thickness with a 40 mm thick fine gravel layer will provide a foundation for the dyked area. The truck turn-around area will require a base of approximately 500 mm of coarse gravel and 40 mm of fine gravel.

In order to prevent absorption of fuel by the soil if a tank leaks, a membrane liner will be installed. To prevent puncture of the membrane, 80 mm of sand will be packed on both sides. A geotextile layer and fine gravel will be located above and below the membrane and sand. Along the top of berm walls, an anchoring trench will be used to secure the member and geotextile layers. Under tanks, a thicker layer of fine gravel will be used, with a slope of about 10 to 1 to the floor of the berm. A thin layer of sand will also be used to prevent high stresses to the metal on the underside of the tank.

All piping will be constructed over the berm walls rather than penetrate through it.



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Creator: CDC
Date: 09/01/2011 Scale:
File:
Data Sources: *Areva Resources Canada Inc.*

FIGURE 11.2-1
KIGGAVIK TANK CONFIGURATION

ENVIRONMENTAL IMPACT STATEMENT
VOLUME 2

Kiggavik Project

AREVA

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

11.2.3 Fuel Distribution Facilities

All fuel being loaded from the Baker Lake dock site onto B-train trucks will be done at a reduced pressure, by increasing the pipe diameter.

Based on the design of six 10 ML fuel tanks at Kiggavik, the tank farm will require a minimum of 2 loading and fuelling stations. Two dispensing facilities will also be built at Kiggavik to service the mine shop and mill. Since a large quantity of the site fuel requirements will be consumed at the powerhouse, the placement of the fuel storage facility will allow for simple refuelling operations, by utilidor, between this facility and the powerhouse day tanks.

Fuel will be delivered directly from the Baker Lake dock site to the Sissons tank farm by B-train trucks. There will be a single loading and fuelling station at the tank farm. Offloading and fuelling procedures will be in place to reduce the potential for spills during fuel transfer.

11.3 Permanent Accommodation Camp

A 400-room accommodation complex is envisioned during operations. The proposed complex will be located approximately 300 meters north (predominantly upwind) of the mill site. The mill and the camp buildings will be connected by an arctic corridor. The camp design is summarized as follows:

- 400 single-bed rooms (approximately);
- Floor area: 12,000 to 15,700 m^2;
- Modular residential wings shipped to the site (complex core may be built on site),
- Recreational areas;
- Health Center and ;
- Cafeteria services
-

11.4 Administration

An administration building will be constructed at the north end of the mill complex. This building will house all central administrative support functions, including senior management, human resources, accounting, laboratories and services.

Satellite offices will be included in the mill, mine shops, permanent camp, Sissons site, and the community of Baker Lake.

12 Construction Activities

12.1 Construction Overview

Construction of the Project is expected to be carried out over a 4-year period, from the first barging season to the mechanical completion of the Kiggavik mill. Mining activities will also begin during the construction phase with the excavation of the purpose built pit followed by the excavation of East Zone pit and the conversion of the mined-out pit into an in-pit tailings management facility (TMF).

A number of construction challenges and key parameters have been considered in the planning of the construction phase. These parameters include:

- remoteness of the site;
- long and potentially complex supply chain; including ocean going vessels, barges, winter/ice road, air transport;
- seasonal supply windows; including a short open water season;
- harsh weather conditions; including poor visibility conditions, high winds and cold temperatures;
- snow drifting and construction in permafrost;
- material availability; and
- amount and skill of the available labour force at the time of construction.

The construction schedule for the Kiggavik Project has been divided into the following packages:

- Pre-development;
- Baker Lake preparation work;
- Construction shipping phases;
- Procurement and shipping;
- Construction and commissioning;
- Mine/tailings management facility; and
- Hand over to operations.

12.1.1 Pre-development

This package includes the basic/detailed engineering and licensing stage. Among other deliverables, the detailed engineering phase will produce procurement packages required for the procurement of services and goods for the construction phase of the project.

12.1.2 Baker Lake Preparation Work

This package includes the preparation of the temporary dock site and laydown area at Baker Lake, which will be required prior to receiving the shipments on the barges.

12.1.3 Construction Shipping Phases

This package summarizes the shipping phases available for the construction phase of the project. Three distinct shipping phases are planned, each containing a summer barging shipping season (generally starting at the beginning of August and ending with mid October) and a winter road shipping season (generally starting at the beginning of January and ending with the end of April).

12.1.4 Procurement and Shipping

This package includes the main construction scope items such as temporary and permanent infrastructure, power plant, water management pipelines and water treatment plant.

12.1.5 Construction and Commissioning

This package includes the construction activities on the Kiggavik site, which will end with the mechanical completion of the Kiggavik mill and the turnover of all systems to operations. Table 12.1-1 summarizes the construction activities in each year of construction: It is anticipated that the manpower load during construction will be mainly affected by the following construction activities:

- Phase 1 – Construction work is expected to start with the construction of the site temporary infrastructure and site grading work. Later in the year, work will continue with the construction of the monitoring ponds; then with the concrete/structural work for the Acid Plant and Mill building and the erection of these buildings.
- Phase 2 – Construction work is expected to start on the power plant, freshwater and effluent pipelines, and continue on these items and also on the Mill and Acid Plant buildings. At the same time, mechanical work will start for several mill circuits which will correspond to a peak of construction activities.
- Phase 3 – With the arrival of equipment and materials for the remaining mill circuits and pipelines and mining equipment for the East Zone Pit, construction activities will increase rapidly to a maximum in the summer. In the second part of the year more items will be completed, which will result in a steady decrease of the workforce on site.

A minimal contracting workforce will remain on site along with the operating workforce for the mill commissioning activities.

Table 12.1-1 Summary of Construction Phases

Construction Phase	Activities

Phase 1	• Site temporary construction infrastructure, including construction camp trailers, construction offices, wash and lunch trailers, batch plant, crusher, access road to Pointer Lake and initial air strip.
	• Temporary construction power
	• Site grading work
	• Grading and excavation work for water management system
	• Mill building erection
	  o Grading and excavation
	  o Exterior concrete work
	  o Structural steel work
	  o Exterior architectural work
	  o Building services (start)
	• Acid Plant building erection (concrete, structural and architectural work)

Phase 2	• Site permanent infrastructure
	• Site electrical power distribution system
	• Power plant including tank farm
	• Effluent pipeline to Judge Sissons Lake including power distribution line
	• Freshwater pipeline including power distribution line
	• Mine water treatment plant
	• Main water treatment plant including reclaim and effluent pump houses
	  o Ponds, berms and pipelines
	  o Building excavation
	  o Building foundations (concrete work)
	  o Structural steel work
	  o Building cladding and insulation (architectural work)
	  o Building services work
	• Acid Plant building services
	• Acid Plant – Mechanical and piping work
	• Oxygen Plant – Mechanical and piping work
	• Mill building erection (completion)
	  o Internal concrete work
	  o Internal architectural work
	  o Mill building services (continuation and completion)
	• Crushing – Mechanical, piping, HVAC and E&I work
	• Drying and Packaging – Mechanical, piping and HVAC work
	• Resin Adsorption & Resin Dewatering Wash -Mechanical, piping, HVAC & electrical work
	• Process Water Distribution- Mechanical, piping, HVAC and electrical work
	• Reagents – Mechanical, piping and HVAC work
	• Gypsum Precipitation – Mechanical work
	• Elution and Regeneration – Mechanical work
	• Waste rock storage facility (start in September)

Table 12.1-1 Summary of Construction Phases

Construction Phase	Activities
Phase 3	• Acid Plant – Piping and E&I work • Oxygen Plant – Piping and E&I work • Drying and Packaging – E&I work • Grinding – Mechanical, piping, HVAC and E&I work • Resin Adsorption and Resin Dewatering Wash – E&I work • Process Water Distribution – Piping and E&I work • Gypsum Precipitation – Mechanical, piping, HVAC and E&I work • Elution and Regeneration – Piping and E&I work • Tailings Neutralization – Mechanical, piping, HVAC and E&I work • Utilities – Mechanical, piping, HVAC and E&I work • Reagents – Mechanical, piping, HVAC and E&I work • Uranium Precipitation – Mechanical, piping, HVAC and E&I work • Waste rock storage facility (continuation of work) • Strip overburden for the East Zone pit • Mine East Zone and stockpile ore

12.2 Construction Around Environmentally Sensitive Areas

Appropriate construction mitigation measures will be employed during construction around environmentally sensitive areas, such as stream crossings to ensure that potential environmental effects will be limited and manageable. Mitigation measures will include:

- avoiding construction activities in 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., mulching, erosion control blankets, silt fences); and
- maintaining a minimum required distance from the location of known bird nesting areas during sensitive periods.

12.3 Access Roads

12.3.1 Winter Road

It is proposed to construct the initial winter road from Baker Lake to the Pointer Lake airstrip. This initial road would be 99 km, approximately, half of which is over land. A comparison with the 110 km Tibitt to Contwoyto Winter Road (TCWR) Dome Lake segment, with 28.7 km of land, suggests that it would take 30 days, approximately, to open this road.

The start-up crews would amount to 45 persons, including catering, supervision, emergency medical technicians and safety personnel for double-shift programs. The ice road operation would be separated into two steps dictated by road conditions and cargo type/volume.

The first step, during the construction period, would involve approximately 50 km of overland crossing made up of labour intensive snow pad development. The first phase would be to pad portage crossings with snow and water. The objective would be to make these portage pads 40' wide, approximately, which would leave a substantial polish zone for the snow to blow off. The portages would be pre-set by snow cats pulling steel drags to compact the snow and may require moving snow from the edge of the road or setting up temporary snow fences in areas of poor snow collection.

Once the initial dragging is complete water delivered in heated modules transported on suitable vehicles, such as Deltas or Commanders (large tires), would be placed on the centre line and followed by standard heated water tank trucks. It is proposed to use slide-on-slide-off water tanks transported on tri-axle haul tractors. Low lying areas such as small creeks would be snow ramped with water saturation.

Sections of these portages will collect snow that requires clearing. Two methods of snow clearing are frequently used. One is to use loaders with quick attach self-powered snow blowers to blow the snow clear of the road. The second method is to feather the snow banks back with snow cats which tend to stop the snow from accumulating on the roadway.

Normal widths of the lake lanes are between 48 m and 55 m which tends to blow clear due to tight blading which polishes the ice and limits snow build-up during winds. Most of the barren land lakes have hard packed snow, therefore many passes will be required by graders. Lake ice width permitting, two lanes will be used, one for the loaded trucks going 30 km/hr and one for the empties travelling 65 km/hr.

The second step, resulting from 3 built-up portage crossings, will essentially void the requirement for snow padding and create a reduction in snow clearing.

12.3.2 All-Season Road Option

The proposed all-season road, if built, will extend from the proposed Kiggavik site to the proposed dock site on the north shore of Baker Lake, east of the community, as shown on Figure 10.4-2. The associated construction activities would take place during operation, after milling has started, if the winter road cannot meet the logistical needs of the project.

The proposed All Season Road is approximately 114 km in length from Kiggavik to the proposed dock site. There are up to 14 bridges (less than 50 meters in length) proposed along the route. The other water crossings will be accommodated with culverts. The road has been sighted to avoid low lying and ice rich areas.

The road will be 10 meter wide, built with Run-of-Quarry rock embankment (fill). There will be no earth cuts along the alignment, and the only cut sections will be through rock, which will service as quarry material.

Material to be used for constructing road embankments will be either rock or granular material. However, there is minimal granular material of sufficient quality available along the route to consider using it as a source of fill. Most of the route has exposed bedrock of appropriate quality and quantity close to the alignment. The bedrock outcrops can be developed into suitable quarries for embankment fill material.

The basic road building material used throughout the length of the road will be rock excavated from bedrock quarries situated at various locations along the route. AREVA does not expect prevalent alluvial material. The rock quarry locations are identified in Section 12.7. The surface gravel will likely be 19-25 mm crushed gravel produced from the quarried rock, and will be placed in a layer approximately 300 mm thick.

Based on experience gained during the construction of the Meadowbank access road the 3:1 side slopes are appropriate based on the anticipated site conditions and quarried construction material used for the embankment.

Preliminary estimates of material quantities were developed using the LiDAR information along the road. The quantities were calculated applying typical sections and from extrapolation of representative sections that were carefully designed along the alignment. The volume of embankment materials has been estimated to be in the range of 2.5 million m^3. The volume of road surfacing materials has been estimated to be 375,000 m^3.

The probable approach that a contractor would take in constructing the all season road would consist in dividing the road in distinct sections of construction work. This would include:

- Construction of approximately 40 km of road from the dock site to the Thelon River Cable ferry crossing site. A portion of this alignment crosses and parallels portions of existing ATV trails. Detailed design and community input would determine the exact location of the road with respect to the trails;
- Preparation of the Thelon River crossing area for the cable ferry;
- Construction of approximately 10 km of road from the mill site to just south of Skinny Lake. This work would be based out of the Kiggavik construction camp; and
- Construction of approximately 65 km of road from the Thelon River crossing to meet the segment south of Skinny Lake.

12.3.3 Kiggavik-Sissons Access Road

The Kiggavik-Sissons access road is outlined in this section. However, the associated construction activities would take place during operation, after milling has started.

The road will be built with run-of-quarry embankment material, with safety berms where required. Materials for the rock embankment and road surfacing will be derived from rock quarries developed adjacent to the road and mine rock material obtained from open pit mine operations. Estimated material quantities based on the LiDAR information along the road and typical sections along the alignment are:

- embankment fill; 200 mm minus subgrade rock fill 1,000,000 m^3
- surfacing material; 20 mm minus 125,000 m^3

Potential quarry locations are presented in Section 12.7.

Additional details on the Kiggavik Sissons access road can be found in Technical Appendix 2G.

12.4 Pointer Lake Airstrip

12.4.1 Permanent Airstrip

The Pointer Lake airstrip site will not be required to be stripped or grubbed. The total embankment structure of the airstrip will be a minimum of 2.0 m thick to protect permafrost. The structure will be constructed primarily from quarried rock and gravel mine rock. The sub base will likely be constructed in lifts to ensure proper compaction of each layer. Thicknesses of each lift will depend on the characteristics of the material being placed. The embankment structure will transition down to the existing ground at a slope of 14%, approximately. This should minimize blowing snow drift development.

A 200 mm lift of crushed granular base will form the surface of the runway, shoulders, taxiway, apron, parking and equipment storage. The total quantities for the aerodrome at Pointer Lake have been estimated based on LiDAR topographical data at approximately 650,000 m^3.

The equipment used to construct the embankment will consist of standard road building equipment; including excavators to load and place material, dump trucks (or larger alternatives) for hauling material, dozers or loaders to move material in place and lastly, rollers to provide compaction.

Surface runoff is not expected to be a concern during construction considering the runway will be constructed on high ground adjacent to Pointer Lake. Construction will not require in-fill of any existing waterbodies or watercourses, and erosion control techniques will be adopted to minimize erosion. Spill contingency measures will be in place to mitigate any potential effects to Pointer Lake.

Construction of the airstrip would take between 6 months to one year of on-site construction time, depending on winter conditions and supply logistics. The schedule will be tailored to allow landing of smaller aircrafts on a shorter runway in the early stages of the Project. Some use of borrow source material would be required during this early construction phase.

12.5 Purpose Built Pit

It is proposed to use a construction fleet consisting of off-highway mine trucks and front end loaders to excavate the purpose built pit (PBP). Magazine and package explosives for the excavation will be barged in the summer for the commencement of work. The PBP will consist mainly of Type 1 mine rock that will be used to construct haul roads to the east Pit and to the plant site pad. Along with excavation, ditches and pipelines will be constructed to direct surface water to the treatment plant and discharge to the environment.

It is assumed that an emulsion plant will not be available at the time of excavating the PBP. The contracted explosive supplier will provide storage and packaged explosive product, as well as loading equipment and personnel to load the holes. Magazines for the explosives and detonators will be barged to Baker Lake the summer before excavation and brought to site along the winter road.

12.6 Foundations and Pads

Common engineering practice for work in permafrost environments is to establish heavily loaded and sensitive mine site building foundations on competent bedrock, and to locate at-grade structures on engineered granular backfill. If competent bedrock is too deep to practically locate to, or if building loads are light, then pile systems may be utilized in combination with elevated building designs. Engineered granular fill is acceptable for lighter structures that are at-grade and for traffic areas. Surface pads constructed using locally quarried crushed rock (or natural granular materials) will be used for lay down areas, raising of grade, access roads, etc. and generally, to protect underlying sensitive permafrost soils around all of the permanent infrastructure facilities.

It appears that major structures at the mill/plant site can be located on bedrock; however, outside of the main mill site, the geophysical data indicates that the structures will likely be located on variable foundation conditions – on bedrock, thin overburden, or thick ice-rich overburden soils underlain by bedrock. Therefore, the design of these foundations will be highly location and structure specific. It is expected that footings on bedrock will be the most appropriate foundation type for most of the mill/plant infrastructure components because competent bedrock appears to exist within a reasonable depth below surface (2 to 5 m depth).

At the proposed accommodation complex site, the ground condition consists of exposed rock and bedrock relatively close to the surface, however, the depth to bedrock appears to be quite variable and the geophysical data indicates weathered or fractured bedrock. As a result, the relatively light accommodations building would likely be supported on grouted rock socket steel piles rather than removing overburden for construction of footings on bedrock or placing granular fill.

The following sections review the expected foundation conditions for the Kiggavik site facilities.

12.6.1 Mill Buildings

Relatively good quality bedrock appears to exist close to the ground surface in the area chosen for the mill building. It is therefore appropriate to consider excavation of all the overburden soils and weathered bedrock, and then construction of footings on the surface of the competent bedrock. The excavation will be backfilled around the footings with engineered structural fill that will support floor slabs.

A simplified cross-section showing a typical design for footings on bedrock is shown in Figure 12.6-1.

Minimum footing widths of 600 mm are recommended for both strip and square footings. To ensure that the recommended bearing value for footings founded on bedrock is appropriate, the rock surface will be thoroughly cleaned to provide intimate contact between the rock and concrete foundation. Whenever possible, foundations will be supported by a common foundation type.

Dynamically loaded equipment such as the generators, ball mills, and crushers, etc. will be founded on competent bedrock and will gain the required resistance to dynamic loads either through the weight of a mass concrete block or through the use of post-tensioned rock anchors that can develop the required resistance by effectively developing a resisting mass of rock.