Kiggavik Project

Environmental Impact Statement

Tier 2 Volume 4

Atmospheric Environment

Part A – Air Quality

December 2011

FOREWORD

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

The EIS submission consists of a number of documents, as shown in the attached road map. These documents have been categorized into tiers, as follows:

- Tier 1 document (Volume 1) provides a plain language summary of the Environmental Impact Statement.

- Tier 2 documents (Volumes 2 to 10) contain technical information and provide the details of the assessments of potential Project environmental effects for each environmental compartment.

- The Tier 2 documents each have a number of technical appendices, which comprise the Tier 3 supporting documents. These include the environmental baseline reports, design reports, modelling reports and details of other studies undertaken to support the assessments of environmental effects.

ROAD MAP TO THE ENVIRONMENTAL IMPACT STATEMENT

Volume 1
Main Document

Volume 2
Project Description

- Governance and Regulatory Oversight
- Project Description
- Assessment Basis

- **2A** Alternatives Assessment
- **2B** Drilling and Blasting Design
- **2C** Explosives Management Plan
- **2D** Design of Ore and Mine Rock Pads and Ponds
- **2E** Water Diversion and Collection Design
- **2F** Design of Andrew Lake Dewatering Structure
- **2G** Kiggavik-Sissons Access Road Report
- **2H** Ore Storage Management Plan
- **2I** Water Management Plan
- **2J** Marine Transportation
- **2K** Winter Road Report
- **2L** All-season Road Report
- **2M** Roads Management Plan
- **2N** Borrow Pits and Quarry Management Plan
- **2O** Airstrip Design Report
- **2P** Occupational Health and Safety Plan
- **2Q** Radiation Protection Plan
- **2R** Preliminary Decommissioning Plan
- **2S** Waste Management Plan
- **2T** Environmental Management Plan
- **2U** Hazardous Materials Management Plan

Volume 3
Public Engagement & Inuit Qaujimajatuqangit

- Public Engagement
- Inuit Qaujimajatuqangit

- **3A** Public Engagement Documentation
- **3B** Inuit Qaujimajatuqngit Documentation
- **3C** Community Involvement Plan

Volume 4
Atmospheric Environment

- Air Quality and Climate Change
- Noise and Vibration

- **4A** Climate Baseline
- **4B** Air Quality
- **4C** Air Quality Monitoring Plan
- **4D** Long-term Climate Change
- **4E** Noise and Vibration
- **4F** Noise Abatement Plan

Volume 5
Aquatic Environment

- Surface Hydrology
- Hydrogeology
- Water and Sediment Quality
- Aquatic Organisms
- Fish and Fish Habitat

- **5A** Hydrology Baseline
- **5B** Geology and Hydrogeology Baseline
- **5C** Aquatics Baseline
- **5D** Groundwater Flow Model
- **5E** Prediction of Mine Inflows
- **5F** Mine Rock Characterization and Management
- **5G** Thermal and Water Transport Modelling
- **5H** Mine Rock Water Balance
- **5I** Hydrology of Waste Rock Piles in Cold Climates
- **5J** Tailings Characterization and Management
- **5K** Historical and Climate Change Water Balance
- **5L** Conceptual Fish Habitat Compensation Plan
- **5M** Aquatics Effects Monitoring Plan
- **5N** Hydrology Assessments

Volume 6
Terrestrial Environment

- Terrain
- Soils
- Vegetation
- Terrestrial Wildlife

- **6A** Surficial Geology and Terrain Baseline
- **6B** Vegetation and Soils Baseline
- **6C** Wildlife Baseline
- **6D** Wildlife Mitigation and Monitoring Plan

Volume 7
Marine Environment

- Marine Water and Sediment Quality
- Marine Mammals
- Marine Fish

- **7A** Marine Environment Baseline
- **7B** Underwater Acoustic Modelling

Volume 8
Human Health

- Occupational Dose Assessments
- Human Health Risk Assessment

- **8A** Ecological and Human Health Risk Assessment
- **8B** Radiation Protection Support Document

Volume 9
Socio-economics & Community

- Archaeology
- Socio-economics

- **9A** Socio-economic Baseline
- **9B** Archaeology Baseline
- **9C** Human Resources Plan
- **9D** Archaeological Mitigation Plan

Volume 10
Accidents and Malfunctions

- Risk Assessments
- Effects of the Environment on the Project

- **10A** Transportation Risk Assessment
- **10B** Spill Contingency Plan
- **10C** Emergency Response Plan

KEY:

- **Tier 2 Document** — **Environmental Effects Assessment Report**
- **Tier 3 Documents** — **List of Technical Appendices**

EXECUTIVE SUMMARY – AIR QUALITY

As per the guidelines issued by the Nunavut Impact Review Board (NIRB 2011), AREVA has prepared an Environmental Impact Statement (EIS) which includes the assessment of the potential effects to air quality and climate change associated with the Kiggavik Project (Project).

Scope of the Assessment

The Nunavut Impact Review Board (NIRB) developed the scope of the assessment for the Project based on input from Inuit, government, and other interested stakeholders. Issues related to air quality and climate change were identified through this consultation, as well as through engagement activities undertaken directly by AREVA. Identified issues include concerns about contaminated dust, uranium and radioactive emissions leading to contamination of the environment. The air quality assessment addresses emissions to air and the resulting predicted air concentrations and/or deposition rates of constituents of potential concern (COPCs) during construction, operation, decommissioning and reclamation processes, in addition to the release of greenhouse gases (GHG) which have the potential to influence climate change.

Regulatory considerations pertaining to air quality include regulatory standards and guidelines for maximum permissible air concentrations of COPCs under the Nunavut *Environmental Protection Act*, the *Canadian Environmental Protection Act* (CEPA 1999) as well as other provincial and territorial Acts and Regulations.

Existing Environment

Air quality monitoring programs were carried out at the proposed Project site during summer field seasons to measure air concentrations of particulate matter, metals and radionuclides. Total Suspended Particulate (TSP) concentrations ranged from 2 to 6 $\mu g/m^3$, which is comparable to background levels reported in Environmental Impact Statements for other projects located in Nunavut. The findings also suggest that measured baseline concentrations of particulate, metals, and radionuclides are generally low compared to more developed or urbanised areas in Canada, particularly in the southern regions. Measurements at such low levels could be considered to be at the lower sensitivity range of the sampling equipment. This is not unreasonable given the remote nature of the Project site and the relatively undisturbed environment of the area. As such, the current atmospheric environment was characterized as pristine.

The baseline level of GHG emissions in Nunavut were considered to be 552 kt of CO_2-equivalent based on Environment Canada's most recent 2008 National Inventory Report (Environment Canada, 2010), and includes an additional 191 kt of CO_2-equivalent representing emissions from the Meadowbank Gold Mine not captured by the 2008 inventory report. This mine is currently and may be in operation when the Project is commissioned and was therefore included as part of the baseline.

Air Quality

Effects of Project-Related Activities on Air Concentrations of COPCs

During each Project phase (construction, operation, final closure and post-closure), activities will occur which have the potential to increase ambient air concentrations of COPCs within the local and regional environments, including dust (i.e., particulate matter), metals, gaseous compounds and radionuclides. A summary of Project activities which may result in effects to air quality is provided below.

Construction Activities:

- land clearing, excavating (i.e., earth moving), quarrying, material handling and fuel combustion.

Operation Activities:

- drilling and blasting, ore and mine rock handling, stockpile and road maintenance, wind erosion of stockpiles, vehicle travel, fuel combustion and milling operations.

Final Closure Activities:

- backfilling mine rock into the Tailings Management Facilities (TMFs), closure of TMFs and fuel combustion.

Post-Closure Activities:

- passive radon emissions from permanent mine rock stockpiles and closed TMFs.

Mitigation and Project Design

Design aspects, operational and other mitigation measures have been incorporated into the current Project plans to minimize Project-associated COPC emissions and/or the potential effect of emissions to air quality. Design-based mitigation includes several focused air dispersion modelling studies that were conducted to examine the potential effect(s) of alternate locations of various Project facilities such as the acid plant, power plant, storage piles and accommodation complex. These locations were utilized in the final dispersion assessment.

In general, the Project will employ standard operating procedures for equipment/machinery and ensure that regular maintenance is performed in accordance with good engineering practices or as recommended by suppliers such that the equipment is kept in good operating condition. As well, the Project proponent will adhere to conditions outlined in all permits, authorizations and/or approvals. Procedures will also be developed to address community complaints.

More specifically, fuel combustion emissions from heavy equipment, vehicles and marine vessels will be mitigated through the use of appropriate exhaust emissions controls such as catalytic converters and diesel particulate filters. Emissions of sulphur dioxide will also be minimized by using fuels with low sulphur content. Additionally, the number of equipment/vehicle movements and travel distances will be optimized. Lowering vehicle speeds on unpaved roads (including pit ramps), applying water or other dust suppressants as well as implementing road maintenance practices will minimize the potential for dust emissions.

Lastly, emissions from process sources will be minimized through installing appropriate air pollution controls on exhaust stacks of the mill complex and acid plant (e.g., wet scrubbers, dust collectors). Tailings will be chemically treated and released to the TMFs sub-aqueously to minimize the release of dust and radon. Permanent mine rock stockpiles will be covered with a layer of compacted clean rock and overburden to encourage growth of vegetation and suppress the release of dust emissions over the long term.

Residual Project Effects to Air Quality

Air concentrations of COPCs were predicted for various scenarios using the CALPUFF/CALMET air dispersion modelling package to capture potential effects of the Project over its lifetime. Emission inventories and subsequent modelling was completed for construction (quarrying), operations, final closure and post-closure phases. Four operational phases were used to assess long-term effects (i.e., annual) and a maximum operations (i.e., worst-case bounding) scenario was used to assess short-term effects (i.e., 1- and 24-hour). The phased modelling results were also used as inputs for the pathways modelling completed in support of the Human Health and Environmental Risk Assessment (HHERA). A summary of the model predicted results is provided below. For the purposes of this assessment, a residual effect is defined as any predicted COPC concentration that is in excess of a chosen residual effects criterion, also known as the Indicator Threshold (or Threshold).

Construction (Quarrying)

- The overall maximum TSP concentration predicted from quarrying activities at a distance of 500 m from a quarry is 14.6 $\mu g/m^3$. Measureable changes in concentration were found to be limited to a distance of less than 1 km from a quarry.

Operations

Dust (TSP, PM_{10} and $PM_{2.5}$)

- Model predicted maximum 24-hour concentrations for all three size fractions of dust (TSP, PM_{10}, $PM_{2.5}$) exceed their respective Indicator Thresholds extending into a limited area of the LAA at both the Kiggavik and Sissons mine sites. Exceedances can be attributed to emissions of dust from open pit mining activities, in particular unpaved road dust generated on the in-pit ramps.
  - There are no more than 10 days of exceedances per year beyond the Project Footprint for TSP, 15 days for PM_{10} and 1 day for $PM_{2.5}$.
  - AREVA commits to initiating a Dust Management Program in advance of Final EIS submission. The initial phase of this program is intended to identify appropriate chemical dust suppressants that may be applied as a control measure, in addition to further developing operational strategies that will assist in dust control.
- During phased operations, the predicted annual average TSP concentrations are below the Indicator Threshold at receptor locations within the LAA and RAA.

- Average annual and total annual dust deposition rates are below their respective Indicator Thresholds at all receptor locations beyond the Project Footprint.

Uranium and Metals

- The maximum predicted 24-hour uranium concentrations are above the Indicator Threshold beyond the Project Footprint, into the LAA. However, the number of exceedances is limited to a single day within approximately 1 km and 500 m of the Kiggavik and Sissons mine sites, respectively.
- The maximum predicted 24-hour concentrations of all metals are below the Indicator Thresholds within the Project Footprint and at all LAA and RAA receptor locations.
- There are no exceedances of the annual average Indicator Thresholds for either uranium or any of the metals within the LAA and RAA.

Gaseous COPCs

- The maximum predicted 1-hour and 24-hour concentrations of SO_2 are well within the limits of the Indicator Thresholds at all receptor locations in the LAA and RAA.
- The maximum predicted 1- and 24-hour NO_2 concentrations exceed their Indicator Thresholds both within the Project Footprint, extending into the LAA. Exceedances can be attributed to large emissions of NO_x from open pit mining activities including diesel-powered mining equipment and blasting.
  - There are no more than 11 days of exceedances of the 24-hour NO_2 Threshold (or 3%) and no more than 140 hours (1.6%) when the 1-hour NO_2 Threshold was exceeded. In addition, exceedances of the 24-hour threshold are limited to the area within 500 m from Sissons mine site and 900 m from the Kiggavik mine site. Similarly, exceedances of the 1-hour threshold extend no more than 1.4 km from Kiggavik mine site and 1.5 km from the Sissons mine site.
- The highest predicted annual NO_2 and SO_2 concentrations are below their applicable Indicator Thresholds for all off-site locations in the LAA, RAA as well as at the Accommodation Complex.
- PAI values did not exceed either the 0.5 keq/ha/yr or 1.0 keq/ha/year levels in the LAA or RAA. However there were exceedances of the Indicator Threshold at the Kiggavik site; these are limited to within approximately 1 km of the Project Footprint.

Radionuclides

- The highest predicted annual radionuclide concentrations are well below their respective Indicator Thresholds at all off-site receptor locations in the LAA, RAA and at the Accommodation Complex.

Baker Lake – Kiggavik Access Road

- The overall maximum predicted concentrations of TSP, PM_{10}, $PM_{2.5}$, NO_2 and SO_2 along the Winter Road are predicted to be well below their applicable Indicator Thresholds.

Baker Lake Dock and Storage Facility

- Incremental concentrations for all contaminants but NO_2 were predicted to be well below all applicable Indicator Thresholds.
- Maximum predicted 1- and 24-hour concentrations of NO_2 exceeded applicable Thresholds, extending to a distance of about 1 km southwest of the dock.

Final Closure

- During the Final Closure phase, all COPCs were predicted to be well below applicable Indicator Thresholds.

Post-Closure

- Predicted incremental radon concentrations are well below the annual Indicator Threshold of 60 Bq/m³ within the LAA and RAA.

Overall, all predicted residual effects resulting from the Project are predicted not to be significant since the effects are expected not to extend more than 2 km beyond the LAA and only occur a few times per year.

Residual Cumulative Effects

A list of Future projects that may overlap with the proposed Project was screened for potential cumulative effects with the identified residual Project effects. None of the Future projects on the list are located within close enough proximity to interact spatially with the effects from the Kiggavik Project site. The only cumulative effect that was assessed includes the potential increase in ambient NO_2 concentrations resulting from dock and storage facility operations serving the Project and the Meadowbank Gold Mine.

The preferred dock option and storage area for the Project will be located approximately 1 km southeast of the Meadowbank Gold Project's dock and storage facilities. The facilities will both receive fuel and other supplies via barge or tug-barge during the ice-free shipping season from mid-July to early October. As a result, barge (or tug-barge) traffic will likely be present in each dock area at the same time, releasing NO_x emissions simultaneously from the idling engines. In addition, other sources of NO_x, including heavy-duty equipment such as cranes, may also operate simultaneously.

Identical operations and emissions were assumed to be occurring simultaneously at both the Project dock and the Meadowbank dock location and were simulated using the CALPUFF dispersion model. The maximum predicted incremental 1- and 24-hour NO_2 concentrations at the receptor representing the Community of Baker Lake were below applicable Indicator Thresholds, but exceed them in the area immediately surrounding both facilities. However, exceedances were limited to within 2 km from the Project Footprint, and occurred infrequently. As a result, with proposed mitigation and environmental protection measures, the cumulative residual effect of increased ambient NO_2 concentrations from the Project and Meadowbank dock operations is considered to be not significant.

Mitigation Measures

Mitigation measures to reduce potential cumulative environmental effects to ambient NO_2 are recommended to be adopted by both project proponents to reduce NO_x emissions from their dock and storage facility operations and reduce the effect on overall air quality in the vicinity of their operations. These measures include use of appropriate exhaust emissions controls, optimization of the number of heavy equipment movements, and overall minimization of travel distances, the number of barge shipments and offloading activities, as well as the extent and duration of barge or tug-barge engine idling at each dock (i.e., limit idling to a single tug-barge at each dock, if possible).

Recommended Air Quality Monitoring and Follow-Up

It is recommended that ambient air monitoring programs be developed for the operations phase of the Project for verification or compliance purposes, and should include TSP, PM_{10}, $PM_{2.5}$, NO_2, SO_2 and radionuclides. In addition, short-term local monitoring should be undertaken at Baker Lake for NO_2 during one shipping season to confirm the model predictions. Potential effects to air quality from the Kiggavik-Baker Lake access road and other phases such as construction, final closure and post-closure should be monitored using a complaints/community concerns response procedure since there are no predicted residual effects.

Climate Change

Effects of Project-Related Activities on Emissions of Greenhouse Gases

During the construction, operation and final closure phases of the Project, activities will occur which have the potential to generate greenhouse gas emissions (GHGs) and therefore also have the potential to affect climate change. Activities that could result in increased concentrations of GHGs include fuel combustion sources such as heavy-duty equipment operation at the Mine and at the Baker Lake dock and storage facility and well as vehicle travel, power generation, and marine vessels.

Mitigation and Project Design

Design aspects, operational or other mitigation measures have been incorporated into the current Project plans which will minimize Project-associated GHG emissions. These include incorporating energy efficient and emissions minimization features into the building design as well as in the operation of any equipment and ancillary facilities. In general, the use of standard operating procedures for equipment and machinery and ensuring that regular maintenance is performed to help keep equipment in good operating condition will also minimize GHG emissions. In addition, the number of equipment/vehicle movements and travel distances will also be optimized to reduce fuel consumption, and consequently GHG emissions.

Residual Project Effects to Climate Change

Since the assessment of potential effects to climate change is subjective (i.e., there are no specific thresholds or criteria that define whether an effect is expected to occur), potential effects to climate change were assessed quantitatively through comparison of Project-related emissions of GHGs to total federal and provincial/territorial GHG emission levels. The estimated maximum annual GHG emissions based on the peak level of fuel consumption is 181 kilotonnes of CO_2-equivalent. This represents a 25% increase in the baseline GHG emissions for Nunavut and a 0.02% increase in the baseline GHG emissions for Canada. However, it is also expected that other proposed projects will become operational after the Project operations commence, therefore, the contribution to Nunavut GHG emissions will likely be a smaller fraction relative to the total emissions than predicted here.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1 INTRODUCTION

1.1 BACKGROUND

The Kiggavik Project (Project) is a proposed uranium ore mining and milling operation located in the Kivalliq region of Nunavut approximately 80 km west of the community of Baker Lake (Figure 1.1-1). The Project is operated by AREVA Resources Canada Inc. (AREVA), in joint venture partnership with JCU (Canada) Exploration Co., Ltd. and Daewoo International Corp.

Within the Kiggavik Project there are two general site areas referred to herein as the Kiggavik site and the Sissons site. The two sites are located approximately 17 km apart. Three uranium ore deposits will be mined at the Kiggavik site: East Zone, Centre Zone and Main Zone. A uranium mill, related facilities, main accommodations, and landing strip will also be located at the Kiggavik site. The Sissons site has two uranium ore deposits to be mined: Andrew Lake and End Grid. Open pit mining will be used to extract the ore from the three Kiggavik deposits as well as the Andrew Lake deposit. Mining of End Grid ore will require underground methods.

All ore extracted from the mine sites will be processed through the Kiggavik mill. Mined out pits at the Kiggavik site will sequentially be used as tailings management facilities (TMFs) with East Zone being the initial TMF. The uranium product will be packaged and transported via aircraft to southern transportation networks. Initially, mill reagents, fuel and other supplies will be transported by barge to Baker Lake and then by truck to the mine site over a winter access road. An all-season road between Baker Lake and the Kiggavik Site is carried as a secondary option proposed as a contingency in case the winter road cannot adequately support the Project over its life-span.

Decommissioning of the Project will include demolition of site facilities, clean up and reclamation of any disturbed areas, closure of the TMFs and reclamation of mine rock piles to promote vegetative growth and to provide wildlife access.

The Kiggavik Project is subject to the environmental review and related licensing and permitting processes established by the Nunavut Land Claims Agreement (NLCA) (NIRB 2011), and to the licensing requirements of the Canadian Nuclear Safety Commission (CNSC). The Minister of Indian and Northern Affairs Canada referred the Kiggavik Project to the Nunavut Impact Review Board (NIRB) for a Review under Part 5 of Article 12 of the NLCA in March of 2010. Pursuant to Section 12.5.2 of the Nunavut Land Claims Agreement (NLCA):

“When a project proposal has been referred to NIRB by the Minister for review, NIRB shall, upon soliciting any advice it considers appropriate, issue guidelines to the Proponent for the preparation of an impact statement. It is the responsibility of the Proponent to prepare an impact statement in accordance with any guidelines issued by NIRB...” (NIRB 2011)

The final NIRB “Guidelines for the Preparation of an Environmental Impact Statement for AREVA Resources Canada Inc.’s Kiggavik Project (NIRB File No. 09MN003)” (NIRB 2011) were issued in May of 2011.

1.2 NUNAVUT IMPACT REVIEW BOARD GUIDELINES FOR THE ENVIRONMENTAL IMPACT STATEMENT

This volume is intended to address Section 8.1.1 and 8.1.2 of the NIRB “Guidelines for the Preparation of an Environmental Impact Statement for AREVA Resources Canada Inc.’s Kiggavik Project (NIRB File No. 09MN003)” (NIRB 2011) whereby the following requirements are outlined:

Air Quality Baseline Information requirements:

- Background air quality data and data related to atmospheric conditions collected in the LAA and RAA including where relevant radon-222, airborne dust (total suspended particulates (TSP), PM_{10} and $PM_{2.5}$, radioactive constituents, and/or metals), GHG emissions, hydrochloric acid (HCl), and standard air constituents such as sulphur dioxide (SO_2), nitrogen oxides (NO_x), carbon monoxide (CO), hydrocarbons, ozone (O_3), etc.;
- Current sources of potential activities which may contribute acidic precipitation; and
- Current sources of emissions and seasonal variations or climatic conditions associated with variations in air quality.

Air Quality Impact Assessment requirements:

- Discussion of the standards, guidelines and regulations that the Proponent will incorporate to minimize and mitigate effects to air quality;
- Predictions of principle pollution emission sources and emission rates of both radiological and non-radiological emissions from the Project at various stages, including:
  - Gaseous emissions from the fuel consumption of mobile equipment such as vehicles, marine vessels, aircrafts, and stationary equipment such as diesel generators and other combustion sources;
  - Fugitive dust and gaseous (i.e., radon) emissions from extraction and ore processing, handling, tailings, waste rock and ore stockpiling, quarries and other Project components and works;
  - Fugitive dust emissions from ground transportation and wind erosion at various Project components including the all-weather road, access roads and mine hauling roads
- Assessment of dispersion of Project emissions using a LAA and RAA, using appropriate modelling, and discussion of related impacts and mitigation strategies;

- Discussion of Project components and activities which may contribute to the potential for acidic precipitation, and an evaluation of associated effects;
- Assessment of effects on air quality from Project emissions during various Project stages; including radon-222, airborne dust [total suspended particulates (TSP), PM_{10} and $PM_{2.5}$, radioactive constituents, and/or metals], GHG emissions, HCl, and standard air constituents such as SO_2, NO_x, CO, hydrocarbons, O_3, etc.;
- Assessment of the Project's GHG contributions to both Nunavut and Canada; and
- A discussion of the potential effects of changes in air quality on human health (see Volume 8 – Human Health).

Climate (including climate change) and Meteorology Baseline Information requirements:

- A description of the baseline meteorological and climatic conditions at the LAA and RAA, including methods of determination including a discussion of how data from outside the project area may have been utilized and uncertainties encountered;
- Meteorological data including but not limited to: air temperature, precipitation, evaporation and sublimation rates, wind directions and velocity, and prevailing wind directions at areas of project components and along proposed shipping route(s);
- Annual, seasonal, monthly and daily average/mean values of above noted meteorological parameters; seasonal and yearly fluctuations and variability; and extreme climate events over the same period of time in which the data, including site-specific data are collected in the RSA of the Project; and
- Prevalent trends related to VECs in the Project area and any resulting implications to the Project.

Climate (including climate change) and Meteorology Impact Assessment requirements:

- Discussion of the relationship between climate change and GHG emissions from the Project; and
- Discussion on the climate parameters that may change due to emissions (GHG, HCl, and standard air constituents such as SO_2, NO_x, CO, hydrocarbons, O_3, etc.) from the Project.

The location of information related to each individual guideline is noted in the EIS Conformity Table. Note that not all requirements have been addressed in this volume, but reference has been made above to the appropriate volume containing the relevant information.

1.3 PURPOSE AND SCOPE

The EIS has been prepared in fulfillment of the requirements of the NIRB Guidelines.

The purpose of this document is to describe the Project components and activities that have the potential to interact with the atmospheric environment and result in a potential environmental effect to air quality and climate change. The overall objective of the Air Quality and Climate Change Environmental Effects Assessment is to identify the potential residual environmental effects to air quality and climate change resulting from the Project and to determine the significance of such effects.

1.4 REPORT CONTENT

In addition to this introduction, this volume consists of the following sections:

- Section 2: An overview of the Project and associated assessment basis
- Section 3: A description of the environmental assessment approach and methodology used to assess potential effects of the Project
- Section 4: A description of the scope of assessment and the methodology used for the Air Quality and Climate Change Environmental Effects Assessment
- Section 5: A summary of the existing atmospheric environment
- Section 6: An assessment of Project effects and cumulative effects to air quality
- Section 7: An assessment of Project effects and cumulative effects to climate change

Tier 3 documents are appended to this Volume to provide further details and supporting information. The Technical Appendices pertaining to this volume are as follows:

- Technical Appendix 4A – Climate Baseline
- Technical Appendix 4B – Air Dispersion Assessment
- Technical Appendix 4C – Air Quality Monitoring Plan
- Technical Appendix 4D – Baker Lake Long Term Climate Scenario

2 OVERVIEW

2.1 PROJECT FACT SHEET

Location	• Kivalliq Region of Nunavut, approximately 80 km west of Baker Lake. • The Project includes two sites: Kiggavik and Sissons (collectively called the Kiggavik Project). • The Kiggavik site is located at approximately 64°26'36.14"N and 97°38'16.27"W. • The Sissons site is located approximately 17 km southwest of Kiggavik at 64°20'17.61"N and 97°53'14.03"W. • The Kiggavik and Sissons sites are composed of 37 mineral leases, covering 45,639 acres.
Resources	• The total quantity of resources is currently estimated at approximately 51,000 tonnes uranium (133 million lbs U_3O_8) at an average grade of 0.46% uranium.
Life of Mine	• Approximately 12 years of operation, based on studies to date. It is anticipated that pre-operational construction will require 3 years while remaining post-operational decommissioning activities will require 5 years. • Under favourable market conditions, construction of the Project could begin as early as 2017.
Mining	• There are five individual mines proposed for the Project: East Zone, Center Zone and Main Zone at the Kiggavik site; End Grid and Andrew Lake at the Sissons site. • The three Kiggavik deposits and the Andrew Lake deposit will be mined by truck-shovel open pit, while End Grid will be an underground mine.
Mine Rock	• Mine rock will be segregated into material suitable for use in construction (Type 1), non-acid generating (Type 2), and potentially problematic material (Type 3). • Type 2 and Type 3 rock will be managed in surface stockpiles during operation. • Upon completion of mining, Type 3 mine rock will be backfilled into mined-out pits.
Mill	• The ore will be processed in a mill at the Kiggavik site to produce approximately 3,800 tonnes uranium (9.9 million lbs U3O8) per year as a uranium concentrate, commonly referred to as yellowcake.
Tailings	• The mill tailings will be managed at in-pit tailings management facilities constructed using the mined-out East Zone, Centre Zone and Main Zone open pits at the Kiggavik site. • Administrative and action levels will be used to control and optimize tailings preparation performance for key parameters.
Water Management	• A purpose-built-pit will be constructed at the Kiggavik site to optimize water management, storage, and recycling. • All mill effluent, tailings reclaim, and site drainage will be treated prior to discharge to meet the Metals Mining Effluent Regulations and site-specific

	derived effluent release targets. • Administrative and action levels will be used to control and optimize water treatment plant performance for key elements.
Site Infrastructure	• Power will be supplied by on-site diesel generators. • The operation will be fly-in/fly-out on a 7 to 14 day schedule with on-site employees housed in a permanent accommodations complex.
Access	• Access to the site will be provided by either a winter or all-season road between Baker Lake and Kiggavik. Supplies will be shipped to a dock facility at Baker Lake during the summer barge season and trucked to Kiggavik via the road. • An airstrip will be constructed and operated at site for transportation of personnel and yellowcake.
Environment	• Site-specific environmental studies have been on-going since 2007 • Public engagement and collection of Inuit Qaujimajatuqangit has been on-going since 2006; this information is integrated into the environmental effects assessment reports • AREVA's approach has been to integrate environmental assessment and decommissioning requirements into the Project design cycle to enhance mitigation of effects by design and to support the development of management, mitigation, and contingency plans to protect the environment
Benefits	• AREVA is negotiating an Inuit Impact Benefit Agreement with the Kivalliq Inuit Association • The total taxes and royalties to be paid on the Kiggavik project would be approximately $1 billion, payable to Nunavut Tunngavik Inc., Government of Nunavut, and Government of Canada. • The Project is expected to employ up to 750 people during construction and 400-600 people during operation.

2.2 ASSESSMENT BASIS

The purpose of the assessment basis section is to define how the expected average design parameters detailed in the Project Description (Volume 2) have been bounded to ensure the effects assessments are adequately conservative.

The assessment basis is summarized in Table 2.2-1. For biophysical and some socio-economic effects, the range value with the greatest potential to result in an adverse effect is used. In the case of socio-economic benefits, the range value resulting in the lowest benefit is used.

Table 2.2-1 Project Assessment Basis

Project Activities/Physical Works	Parameter	Units	Parameter / Assumption Values	
			Base Case (PD)	Assessment Case
Overall	Production Rate	Tonnes U per year	3,200 – 3,800	3,200 - 4,000
	Mill Feed Rate	Kilotonnes per year	69 – 946	1,000
	Project Operating Life	Years	14	25
	Project Footprint	ha	938	1,021
Milling	Flowsheet	N/A	No SX	SX Possibly calciner
	Final Product	N/A	Non-calcined	Calcined and non-calcined
Tailings Management	Containment volume	Mm^3	28.4	30.0
	Total tailings volume (un-consolidated)	Mm3	21	30.0
	Design		Natural surround, no drain	Various design contingencies
Water Management	Freshwater requirements – no permeate or site drainage recycle	m^3/day	7,910	8,000
	Freshwater requirements – permeate and site drainage recycle	m^3/day	2,000	8,000
	Freshwater requirements - Sissons	m^3/day	500	600
	Treated effluent discharge at base quality – Kiggavik	m^3/day	2,707	3,000
	Treated effluent discharge – Sissons	m^3/day	1,700	1,700

Project Activities/Physical Works	Parameter	Units	Parameter / Assumption Values	
			Base Case (PD)	Assessment Case
Power Generation	Kiggavik peak load	MW	12.5	12.5 – 16.6
	Sissons peak load	MW	4.1	0 – 4.1
Logistics & Transportation	Number of barge trips – 5000t & 270 containers	Barge trips / year	9 - 31	31
	Number of barge trips – 7500t & 370 containers	Barge trips / year	7 - 22	22
	Number of truck trips – 50,000L & 48t	Truck trips / year	328 - 3233	3300
	Number of truck trips – 76,000L & 60t	Truck trips / year	243 - 2405	2500
	Number of yellowcake flights	Flights / year	310 - 350	355
	Road Route	N/A	Winter road S	Winter road S Winter road N All-season road N with cable ferry
	Dock location		Site 1	Sites 1, 2,3,4
Decommissioning	Period	Years	10	10

3 ASSESSMENT METHODOLOGY

3.1 INTRODUCTION

This section describes the methods used in the assessment of environmental and socio-economic effects associated with the Kiggavik Project. The methods meet the applicable regulatory requirements while focusing the assessment on the matters of greatest environmental, social, cultural, economic and scientific importance. The methodological approach also recognizes the iterative nature of project-level environmental assessment, considering the integration of engineering design and mitigation and monitoring programs into comprehensive environmental management planning for the life of the Project.

The environmental effects assessment method is based on a structured approach that:

- considers the factors that are required under Nunavut Land Claim Agreement;
- focuses on issues of greatest concern;
- affords consideration of all territorial and federal regulatory requirements for the assessment of environmental effects;
- considers issues raised by the Inuit, regulators, government agencies and public stakeholders; and
- integrates Project design and programs for mitigation and monitoring into a comprehensive environmental planning.

The environmental assessment focuses on specific environmental components called Valued Environmental Components (VECs) or Valued Socio-economic Components (VSECs) that are of particular value or interest to Inuit, regulators, government agencies and stakeholders. The term Valued Components (VCs) refers collectively to VECs and VSECs. Valued Components are selected based on regulatory issues and guidelines, consultation with Inuit, regulators, government agencies and stakeholders, field studies, and professional judgment of the study team. Where a VC has various sub-components that may interact in different manners with the Project, the environmental assessment may consider the environmental effects on individual Key Indicators (KIs).

The term “environmental effect” is used throughout the Application and broadly refers to the response of the biophysical or human system or a component of these systems to a disturbance from a Project action or activity or other regional actions (i.e., projects and activities).

The environmental assessment methods address Project-related and cumulative environmental effects. Project-related environmental effects are changes to the biophysical or socio-economic environment that are caused by the Project or activity arising solely because of the proposed principal works and activities, as defined by the Scope of the Project. This includes consideration of the environmental effects of malfunctions or accidents that may occur in connection with the Project. Cumulative environmental effects are changes to the biophysical or socio-economic environment that are caused by an action of the Project in combination with other past, present and future projects and activities.

In this assessment, Project-related environmental effects and cumulative environmental effects are assessed sequentially. The mechanisms through which a Project-specific environmental effect may occur are discussed first, taking into account Project design measures and mitigation that help to reduce or avoid environmental effects. The residual environmental effect is then characterized taking into account planned mitigation. At a minimum, all Project environmental effects are characterized using specific criteria (e.g., magnitude, geographic extent, duration) that are defined for each VC.

A cumulative environmental effects screening is then conducted to determine if there is potential for the Project residual environmental effect to act in a cumulative manner with similar environmental effects from other projects and activities. If there is potential for the Kiggavik Project to contribute to cumulative environmental effects, the environmental effect is assessed to determine if it has the potential to shift a component of the natural or socio-economic environment to an unacceptable state.

The environmental effects assessment approach used in this assessment involves the following steps:

- ***Scoping***: Scoping of the overall assessment, which includes: issues identification; selection of VCs (and KIs, if required); description of measurable parameters; description of temporal, spatial, administrative and technical boundaries; definition of the parameters that will be used to characterize the Project-related environmental effects and cumulative environmental effects; and identification of the standards or thresholds that will be used to determine the significance of environmental effects.

- ***Assessment of Project-related environmental effects***: The assessment of Project-related environmental effects, which includes: description of the mechanism(s) by which an environmental effect will occur; mitigation and environmental protection measures to reduce or eliminate the environmental effect; and evaluation and characterization of the residual environmental effects (i.e., environmental effects remaining after application of mitigation measures) of the Project on the biophysical and socio-economic environment for each development phase.

- ***Evaluation of cumulative environmental effects:*** The evaluation of cumulative environmental effects, which involves two tasks: screening for potential cumulative environmental effects and, if there is potential for cumulative environmental effects, assessment of cumulative environmental effects. Where an assessment of potential cumulative environmental effects is required, the residual cumulative environmental effects of the Project are evaluated in combination with other past, present and future projects and activities.

- ***Determination of significance***: The significance of Project-related and cumulative residual environmental effects is determined using standards or thresholds that are defined for each VC.

- ***Monitoring***: Several different types of monitoring may be required to confirm compliance with mitigation measures or Project design features, address uncertainties or verify environmental effects predictions and/or assess the effectiveness of mitigation measures.

- ***Summary***: The last step of the assessment of environmental effects on a VC is the development of summaries on Project and cumulative environmental effects (including combined Project environmental effects and combined cumulative environmental effects), mitigation measures and Project design features, and monitoring.

3.2 SCOPE OF THE ASSESSMENT

3.2.1 Valued Components, Indicators and Measurable Parameters

Valued Components are defined as broad components of the biophysical and socio-economic environments, which if altered by the Project, would be of concern to regulators, Inuit, resource managers, scientists, and public stakeholders.

VECs for the biophysical environment typically represent major components or aspects of the physical and biological environment that might be altered by the Project, and are widely recognized as important for ecological reasons.

Criteria for selection of VCs include:

- Do they represent a broad environmental, ecological or human environment component that may be altered by the Project?

- Are they vulnerable to the environmental effects of the Project and other activities in the region?

- Have they been identified as important issues of concerns of Inuit or stakeholders, or in other assessments in the region?

- Were they identified by the Nunavut Impact Review Board (NIRB), Inuit organizations or departments within the territorial or federal government?

Key indicators (KIs) are species, species groups, resources or ecosystem functions that represent components of the broader VCs. They are selected using the same criteria as described above for VCs. For practical reasons, KIs are often selected where sufficient information is available to assess the potential Project residual environmental effects and cumulative environmental effects.

For each VC or KI, one or more measurable parameters are selected to quantitatively or qualitatively measure the Project environmental effects and cumulative environmental effects. Measurable parameters provide the means of determining the level or amount of change to a VC or KI. The degree of change in the measurable parameter is used to characterize project-related and cumulative environmental effects, and evaluate the significance of these effects. Thresholds or standards are identified for each measurable parameter, where possible, to assist in determining significance of the residual environmental effect.

3.2.2 Key Issues

Issues identification focuses the assessment on matters of greatest importance related to the Project, and assists in determining which factors and the scope of those factors that will be considered in the assessment.

Issues and concern about the possible biophysical or socio-economic effects of the Project have been identified from a variety of sources, including:

- the regulatory requirements applicable to the Project,
- discussions with technical experts from various territorial and federal government agencies,
- input from Inuit and public stakeholders during engagement activities in relation to the Project,
- existing regional information and documentation regarding environmental components found near the Project,
- baseline and assessment studies conducted in the area of the Project, and
- professional judgment of the assessment team, based on experience with similar projects elsewhere and other mining project and activities in Nunavut.

Key Project-related issues are summarized in the scoping section for each discipline considered in the assessment.

3.2.3 Project – Environment Interactions and Environmental Effects

Key Project-related activities that are likely to result in environmental effects are considered for each VC. A matrix of Project activities and environmental components is provided in the scoping section for each discipline to identify where interactions are likely to occur based on the spatial and temporal overlap between Project activities and the VC. Each interaction is ranked according to the potential for an activity to cause an environmental effect. The interactions are ranked according to the following:

- If there is no interaction or no potential for substantive interaction between a Project activity and the VC to cause a potential environmental effect, an assessment of that environmental effect is not required. These interactions are categorized as 0, and are not considered further in the EA. The environmental effects of these activities are thus, by definition, rated not significant.

- If there is likely to be a potential interaction between a Project activity and a VC but not likely to be substantive in light of planned mitigation, the interaction is categorized as 1. Such interactions are well understood and are subject to prescribed mitigation or codified practices. These interactions are subject to a less detailed environmental effects assessment and are rated as not significant. Justification is provided and the mitigation is described for such categorizations. Such interactions can be mitigated with a high degree of certainty with proven technology and practices.

- If a potential interaction between a Project activity and a VC could result in more substantive environmental effects despite the planned mitigation, if there is less certainty regarding the effectiveness of mitigation, or if there is high concern from regulatory agencies, Inuit or stakeholders, the interaction is categorized as 2. These potential interactions are subject to a more detailed analysis and consideration in the environmental assessment in order to predict, mitigate and evaluate the potential environmental effects.

The ranking takes a precautionary approach, whereby interactions with a meaningful degree of uncertainty are assigned a rank of 2 to ensure that a detailed analysis of the potential environmental effect is undertaken.

Justification for ranking the Project-environmental interactions considered for each VC is provided in the scoping section for each discipline.

3.2.4 Assessment Boundaries

Boundaries of the assessment are defined for each VC to allow for a meaningful analysis of the significance of environmental effects. The assessment boundaries are described in terms of temporal, spatial and administrative and technical boundaries.

3.2.4.1 Spatial Boundaries

Spatial boundaries are established for assessing the potential Project-related environmental effects and cumulative environmental effects on each VC. The primary consideration in establishing these boundaries is the probable geographical extent of the environmental effects (i.e., the zone of influence) on the VC.

Spatial boundaries represent the geographic extent of the VC, as they pertain to potential Project-environment interactions. Spatial boundaries are selected for each VC to reflect the geographic extent over which Project activities will or are likely to occur, and as such, they may be different from one VC to another depending on the characteristics of the VC. For this assessment, the spatial boundaries are referred to as 'assessment areas' to differentiate the areas from the local and regional study areas referred to in many baseline studies.

Three assessment areas are defined for each VC.

The ***Project Footprint*** is the most immediate area of the Project. The Project Footprint includes the area of direct physical disturbance associated with the construction or operation of the Project.

The ***Local Assessment Area*** (LAA) is the maximum area within which Project-related environmental effects can be predicted or measured with a reasonable degree of accuracy and confidence. The LAA includes the Project Footprint and any adjacent areas where Project-related environmental effects may be reasonably expected to occur.

The **Regional Assessment Area** (RAA) is a broader area within which cumulative environmental effects on the VC may potentially occur. This will depend on physical and biological conditions (e.g., air sheds, watersheds, seasonal range of movements, population unit), and the type and location of other past, present or reasonably foreseeable projects or activities. For the socio-economic environment, the RAA may be much broader (planning areas, regions, territories etc.) based on the potential geographic extent over which socio-economic effects are likely to occur. It is also the area where, depending on conditions (e.g., seasonal conditions, habitat use, more intermittent and dispersed Project activities), Project environmental effects may be more wide reaching.

3.2.4.2 Temporal Boundaries

The temporal boundaries for the assessment are defined based on the timing and duration of Project activities and the nature of the interactions with each VC. Temporal boundaries encompass those periods during which the VCs and KIs are likely to be affected by Project activities.

For the Kiggavik Project, temporal boundaries include the following Project phases.

- construction
- operations
- final closure
- post closure

The operations phase includes consideration of maintenance, planned exploration and temporary closure (care & maintenance) of the Project. The final closure phase considers decommissioning and reclamation, and post-closure phase includes management of restored sites.

In some cases, temporal boundaries are refined to a specific period of time beyond simply limiting them to a specific phase of the Project. This is carried out as necessary within each environmental effects analysis section. Temporal boundaries for the assessment may reflect seasonal variations or life cycle requirements of biological VCs, long-term population cycles for some biological VECs, or forecasted trends for socio-economic VSECs.

3.2.4.3 Administrative and Technical Boundaries

Administrative and technical boundaries are identified and justified for each VC or KI, as appropriate. Administrative boundaries include specific aspects of provincial, territorial and federal regulatory requirements, standards, objectives, or guidelines, as well as regional planning initiatives that are relevant to the assessment of the Project's environmental effects on the VC. Administrative boundaries may be selected to establish spatial boundaries.

Technical boundaries reflect technical limitations in evaluating potential environmental effects of the Project, and may include limitations in scientific and social information, data analyses, and data interpretation.

3.2.5 Environmental Effects Criteria

Where possible, the following characteristics are described quantitatively for each VC to assist in the assessment of residual environmental effects. Where these residual environmental effects cannot be defined quantitatively, they are described using qualitative terms. If qualitative descriptions are used, definitions are provided for each VC or KI, as appropriate, in the scoping section of the environmental assessment for that VC or KI.

- ***Direction:*** the ultimate long-term trend of the environmental effect (e.g., positive, neutral or adverse)
- ***Magnitude:*** the amount of change in a measurable parameter or variable relative to the baseline case (i.e., low, moderate, high)
- ***Geographical Extent:*** the geographic area within which an environmental effect of a defined magnitude occurs (site-specific, local, regional, territorial, national, international)
- ***Frequency:*** the number of times during the Project or a specific Project phase that an environmental effect may occur (i.e., once, sporadically, regular, continuous)
- ***Duration:*** this is typically defined in terms of the period of time that is required until the VC returns to its baseline condition or the environmental effect can no longer be

measured or otherwise perceived (i.e., short term, medium term, long term, permanent)

- ***Reversibility:*** the likelihood that a measurable parameter for the VC will recover from an environmental effect (i.e., reversible, irreversible)
- ***Ecological or socio-economic context:*** the general characteristics of the area in which the Kiggavik Project is located (i.e., undisturbed, disturbed, urban setting)

3.2.6 Standards or Thresholds for Determining Significance

Where possible, threshold criteria or standards for determining the significance of environmental effects are defined for each VC or KI to represent that limit beyond which a residual environmental effect would be considered significant. In some cases, standards or thresholds are also defined for specific environmental effects on a VC or KI.

Standards are recognized federal and territorial regulatory requirements or industry objectives that are applicable to the VC, and that reflect the limits of an acceptable state for that component. Where standards, guidelines or regulatory requirements do not specifically exist, thresholds are defined for the measurable parameters for an environmental effect on a VC based on resource management objectives, community standards, scientific literature, or ecological processes (e.g., desired states for fish or wildlife habitats or populations).

Potential changes in a measurable parameter or VC resulting from residual Project or cumulative environmental effects are evaluated against these standards or thresholds. Environmental effects are rated as either *significant* or *not significant*.

3.2.7 Influence of Engagement on the Assessment

Engagement undertaken to date with regulators, Inuit and public stakeholders in relation to the Project is described in Volume 3. Issues raised during these engagement activities and Inuit Qaujimajatuqangit (IQ) sessions were documented, and were reviewed for consideration in each discipline-specific assessment, including scoping of baseline data collection, selection of VC and KIs, use of TEK and IQ in the environmental effects assessment, mitigation and monitoring.

3.3 ASSESSMENT OF PROJECT ENVIRONMENTAL EFFECTS

3.3.1 Existing Conditions

The existing conditions for each VC are described according to the status and characteristics of the VC within its defined spatial and temporal assessment boundaries. This is based on a variety of sources, including:

- information from past research conducted in the region;

- Inuit Qaujimajatuqangit (IQ); and
- knowledge gained from the collection of baseline data through literature review, qualitative and quantitative analyses, and field programs carried out as part of the environmental assessment.

In general, the description of existing conditions is limited to information directly relevant to the potential VC interactions with the Project to support the environmental effects analysis.

3.3.2 Project Effect Linkages

The mechanisms or linkages through which the Project components and activities could result in an environmental effect on a VC, and the spatial and temporal extent of this interaction is described based on the existing conditions of the VC. Because the assessment focuses on residual environmental effects, effects prior to mitigation are not characterized or quantified and the significance of the effect is not determined.

3.3.3 Mitigation Measures and Project Design

Where Project activities are likely to cause an environmental effect on a VC, mitigation measures are identified to minimize or avoid environmental effects of the Project. This includes measures or strategies that are technically and economically feasible and that would reduce the extent, duration or magnitude of the environmental effect.

Mitigation includes Project design features to change the spatial or temporal aspect of the Project, specialized mitigation, environmental protection measures and protocols, and compensation (habitat compensation, replacement or financial compensation).

Where mitigation is identified, a brief discussion of how the measure(s) will help to minimize the residual environmental effect on the VC is provided. Where possible, this includes a description of how effective the measure is expected to be in minimizing the change in the measurable parameters for the environmental effect.

3.3.4 Residual Project Effects Assessment

Taking into account the mitigation and expected effectiveness of the measure(s), the residual environmental effects of the Project are described according to their probable magnitude, geographic scope, duration, frequency, reversibility and ecological context, where appropriate. The residual effect is characterized in the context of the existing condition for the measureable parameter(s) and how it is likely to change as a result of the Project environmental effect. For some residual environmental effects, the change in the measurable parameter is described relative to each Project phase.

Where possible, the magnitude, geographic extent and duration of the residual environmental effect are quantified. If a residual effect cannot be quantified, qualitative terms are used to describe the attributes of the effect.

3.3.5 Significance of Residual Project Environmental Effects

Significance of a residual Project environmental effect is determined based on standards or thresholds that are specific to the VEC, KI and/or the measurable parameters used to assess the environmental effect. Determination of whether a residual environmental effect is considered to be significant or not significant is based on a comparison of the predicted change in the VC or measurable parameter to the defined threshold or standard. This includes an indication of the likelihood that a residual environmental effect on a VC will occur based on probability of occurrence (i.e., based on past experience) and level of scientific uncertainty.

Determination of significance also includes a discussion of the confidence of the prediction with respect to:

- the characterization of environmental effects, and
- the success of Project design features, mitigation measures, and environmental protection measures in effectively reducing the environmental effect.

Prediction confidence for the environmental effect and the success of mitigation measures is ranked as low, moderate or high.

3.3.6 Monitoring of Residual Project Environmental Effects

Based on analysis of the residual Project environmental effect, it may be necessary to conduct a monitoring program. Monitoring is recommended in cases where there is a need to address Project-related issues of public concern, test the accuracy of the assessment predictions, verify the success of the mitigation measures, or gain additional scientific knowledge related to prediction of the Project environmental effect.

Two types of monitoring are considered: compliance and follow-up environmental monitoring.

Compliance monitoring is undertaken to confirm that Project design features, mitigation measures, environmental protection measures, or benefit agreements are being effectively implemented.

Biophysical and socio-economic monitoring programs are used to:

- verify predictions of environmental effects;
- determine the effectiveness of mitigation measures, environmental protection measures or benefits agreements in order to modify or implement new measures where required;

- support the implementation of adaptive management measures to address previously unanticipated adverse environmental effects; and
- support environmental management systems used to manage the environmental effects of projects.

Where a monitoring program for a specific VC or KI is identified, the following aspects of the program are defined:

- parameters to be measured,
- methods and equipment to be used,
- location and timing of surveys, and
- how the results of the monitoring will be applied, including consideration of an adaptive management approach.

3.4 ASSESSMENT OF CUMULATIVE ENVIRONMENTAL EFFECTS

3.4.1 Screening for Potential Cumulative Effects

Cumulative environmental effects are only assessed if the following criteria are met for the residual Project effect under consideration:

- The Project will result in a measurable, demonstrable or reasonably-expected residual environmental effect on a component of the biophysical or socio-economic environment,
- The Project-specific residual environmental effect on the component will likely act in a cumulative fashion with the environmental effects of other past or future projects or activities that are likely to occur (i.e., Is there overlap of environmental effects?), and
- There is a reasonable expectation that the Project's contribution to cumulative environmental effects will be substantive, measurable or discernible such as that it will affect the viability or sustainability of the resource.

If, based on these criteria, there is potential for cumulative environmental effects, the effect is assessed further to determine if it is likely to shift the component to an unacceptable state. Where there is no potential for the environmental effect of the Project to spatially or temporally overlap with similar effects of other project and activities, justification for not carrying these environmental effects forward to the assessment of cumulative environmental effects is provided.

3.4.2 Project Inclusion List

The project inclusion list includes all past, present and reasonable foreseeable projects, activities and actions in the region of the Kiggavik Project. Only projects and activities that overlap with the Project residual environmental effects both spatially and temporally are considered in the assessment of potential cumulative environmental effects.

The specific projects, activities and action considered for each environmental effect are described in the assessment for the VC or KI.

3.4.3 Description of Cumulative Environmental Effects

The first step in the assessment of cumulative environmental effects involves describing the environmental effect, the mechanisms by which the Project environmental effect may interact cumulatively with other projects and activities in the RAA (from the Project Inclusion List), and the geographic and temporal scope of the cumulative environmental effect.

For this assessment, cumulative environmental effects are described for four cases. A more detailed description of the assessment cases is provided within the Project Inclusion List (Volume 1, Appendix 2).

- ***Base Case***: the current status of the measurable parameters for the environmental effects at baseline (i.e., prior to the Project). Baseline includes all past and present projects and activities in the RAA that may result in similar environmental effects to the Project environmental effect, including ongoing mineral exploration. Existing projects include projects that have received environmental approval and are in some form of planning, construction and/or commissioning.
- ***Project Case:*** the status of the measurable parameters for the environmental effect with the Project in place, over and above the Base Case. This is usually assessed using the peak environmental effect of the Project or maximum active footprint for the Project.
- ***Future Case:*** the status of the measurable parameters for the environmental effect because of the Project Case, in combination with all reasonable foreseeable projects, activities and actions. Reasonably foreseeable projects are defined as future projects, activities and actions that will occur with certainty, including projects that are in some form of regulatory approval or have made a public announcement to seek regulatory approval.

  For this assessment, future projects include proposed mines that are currently under NIRB review:

  - Meadowbank
  - Doris North 1
  - Doris North 2

- Meliadine
- Mary River
- Hackett River
- Back River
- Hackett River
- High Lake

The combination of the Project Case with the Future Case allows determination of the Project's contribution to cumulative effects of all past, present and reasonably-foreseeable projects and activities.

- ***Far Future Case:*** the status of the measurable parameters for the environmental effect because of the Future Case, in combination with possible far future developments in the Kiggavik region.

  It is recognized that exploration activities will continue in the vicinity of the Kiggavik Project, and that there is the potential for additional resources to be discovered during the life of the Project. To address such a possibility, a potential far future development scenario was developed. This scenario assumes additional deposits within a 200 km radius of the Kiggavik site, and the development of a non-uranium operation located within the Kiggavik RSA. The Meadowbank gold operation is used as the model for this. It assumes additional resources are found in the Meadowbank area, and that operation of Meadowbank continues. The following projects and activities are included in the development scenario.

Component	**Locations**
Uranium mines	3 mines within 200 km of Kiggavik
Uranium mills	Kiggavik mill
Gold mines	1 mine within Kiggavik RSA Meadowbank region
Gold mills	Meadowbank region Additional mill within Kiggavik RSA
Access Roads	Meadowbank region Additional mill within Kiggavik RSA
Exploration	Induced exploration near the access road(s) and in the Kiggavik area

Due to the lack of information regarding the specific details of potential future developments (i.e., footprint of projects and activities), the assessment of cumulative environmental effects under this Case is by definition qualitative and is limited to a description of how these projects, activities and actions could affect the magnitude, duration and extent of cumulative environmental effects.

3.4.4 Mitigation of Cumulative Environmental Effects

Mitigation measures that would reduce the Project's environmental effects are described for cumulative environmental effects, with emphasis on measures that should limit the interaction of environmental effects of the Project with similar environmental effects from other projects. Three types of mitigation measures are considered, where appropriate:

- measures that can be implemented solely by AREVA;
- measures that can be implemented by AREVA, in cooperation with other project proponents, government, Aboriginal organizations and/or public stakeholders; and
- measures that can be implemented independently by other project proponents, government, Aboriginal Organizations and/or public stakeholders.

For the latter two types of mitigation, the degree to which AREVA can or cannot influence the implementation of these measures is noted.

Mitigation measures that could assist in reducing potential cumulative environmental effects are identified for each environmental effect, including a discussion of how these measures may potentially modify the characteristics of an environmental effect.

3.4.5 Residual Cumulative Environmental Effects Assessment

Residual cumulative environmental effects are described, taking into account how the mitigation will change the environmental effect. Where possible, cumulative environmental effects are characterized quantitatively or qualitatively in terms of the direction, magnitude, duration, geographic extent, frequency and reversibility. This includes characterization of:

- the total residual cumulative environmental effects based on the Future Case (i.e., the environmental effects of all past, present and reasonably foreseeable project and activities), in combination with the environmental effects of the Project, and
- the contribution of the Project to the total residual cumulative effects (i.e., how much of the total residual cumulative effects can be attributed to the Project).

3.4.6 Significance of Residual Cumulative Environmental Effects

The significance of cumulative environmental effects is determined using standards or thresholds that are specific to the VC, KI and/or measurable parameters used to assess the Project environmental effect. Determinations of significance are made for:

- the significance of the total residual cumulative environmental effect; and

- the significance of the contribution of the Project to the total residual cumulative environmental effect.

The determination of residual cumulative environmental effects includes a discussion of the confidence of the prediction based on scientific certainty relative to:

- quantifying or estimating the environmental effect (i.e., quality and/or quantity of data, understanding of the effects mechanisms), and

- the effectiveness of the proposed mitigation measures.

As for residual Project environmental effects, prediction confidence for the cumulative environmental effect and the success of mitigation measures is ranked as low, moderate or high.

3.4.7 Monitoring of Cumulative Environmental Effects

Based on the evaluation of residual cumulative environmental effects, it may be necessary to conduct monitoring programs. Monitoring programs are designed to:

- confirm the effectiveness of a broad range of approved mitigation techniques;
- determine whether different or an increased level of mitigation is required to achieve the mitigation or reclamation goals; and
- identify and address any cumulative effects that occur but were not predicted.

Two types of monitoring are considered:

- Compliance Monitoring: to confirm that Project design features, mitigation measures, environmental protection measures, or benefit agreements are being effectively implemented.
- Biophysical or Socio-economic Monitoring: to confirm the environmental effect prediction and/or effectiveness of a Project design feature, mitigation measure, environmental protection measure, or benefit agreement.

3.5 SUMMARY OF RESIDUAL ENVIRONMENTAL EFFECTS

Residual Project and cumulative environmental effects are briefly summarized for each VC. This includes a discussion of the overall combined environmental effect of the Project on the VC and its significance, as well as a discussion of the overall combined effect of all cumulative effects on the VC and its significance. For biophysical VECs, this relates to the sustainability of the resource or populations being considered. For socio-economic VSECs, this relates to the ability of the community, the Kivalliq region and/or Nunavut to adapt to or manage the environmental effect. A discussion of the Project's contribution to the combined cumulative effect is also provided.

In addition, this summary section presents an assessment of the effects of climate change on residual Project and cumulative effects. Where possible, the effects are described quantitatively, and include a description of how likely climate changes in the region will likely influence Project and cumulative residual effects.

3.6 ASSESSMENT OF TRANSBOUNDARY EFFECTS

As required by the NIRB EIS Guidelines, the assessment includes consideration of transboundary effects, where residual environmental effects are likely to extend beyond the Nunavut into federal waters and/or other provincial or territorial jurisdictions. As this is based largely on the cumulative effects assessment, the transboundary effects are characterized qualitatively or semi-quantitatively.

3.7 SUMMARY OF MITIGATION

A detailed description of the mitigation measures proposed to minimize or avoid project-related and cumulative effects on VCs is provided based on the scoping and effects analyses. This includes:

- relevant Project design features to reduce environmental effects,
- Project policies (e.g., Inuit hiring policy),
- specialized mitigation measures to minimize environmental effects on VECs,
- social or community programs to minimize environmental effects on VSECs,
- Environmental Protection plans,
- broader agreements (e.g., benefits agreements), and
- compensation.

3.8 SUMMARY OF MONITORING

Monitoring programs to address uncertainties associated with the environmental effects predictions and environmental design features and mitigation proposed for residual Project effects and cumulative effects are described in detail. This includes all compliance monitoring and environmental monitoring that may be applied during the life of the Project, and that will form the:

- Compliance Monitoring Program Framework,
- Environmental Monitoring Program Framework,

- Socio-Economic Monitoring Program Framework,
- Post-Project Analysis Program Framework, and
- Follow-up Monitoring Programs.

4 SCOPE OF THE ASSESSMENT

This section describes the scope of the assessment for potential effects to air quality and climate change. Resource exploration, extraction, processing and transportation activities associated with the Kiggavik Project have the potential to affect ambient air quality and generate emissions of greenhouse gases (GHGs). Increased emissions of GHGs have the potential to affect climate.

The various Project phases, including construction, operation, final closure and post-closure will result in atmospheric emissions of Constituents of Potential Concern (COPCs) and GHGs and as a result, the discussion(s) presented herein focus on the potential effects of the Project as they relate to changes in ambient COPC concentrations or changes in GHG emissions. Other disciplines evaluate the potential effects of air quality on the terrestrial and aquatic environments, as well as the potential effects of changes in air quality to human health. Refer to Volume 5: Aquatic Environment, Volume 6: Terrestrial Environment, and Volume 8: Human Health, for these assessments.

4.1 ISSUES AND CONCERNS IDENTIFIED DURING INUIT, GOVERNMENT AND STAKEHOLDER ENGAGEMENT

The Nunavut Impact Review Board (NIRB) "Guidelines for the Preparation of an Environmental Impact Statement for AREVA Resources Canada Inc.'s Kiggavik Project (NIRB File No. 09MN003)" (NIRB 2011) incorporated advice from the public and interested parties on the proposed scope of assessment for the atmospheric environment, including identification of Valued Environmental Components (VECs) and issues that should be considered in the Environmental Impact Statement (EIS). Specifically, the guidelines require an analysis of the environmental effects of the following activities:

- open-pit and underground mining and their associated activities, including drilling, blasting, transportation, and stockpiling activities;
- mill operations, including crushing, screening, yellowcake processing, and power generation;
- dock and storage facility operations; and
- ground transportation, including mine traffic along the Kiggavik-Sissons access road and the Kiggavik-Baker Lake access roads.

These effects, as identified by NIRB, were analyzed in the assessment of environmental effects to air quality and climate change.

Project-specific issues and concerns identified during Inuit, government and stakeholder engagement broadly include:

- The impacts of fugitive dust from construction and operations;
- The impacts of emissions of uranium from the Project; and
- Impacts of the Project on climate change and the permafrost.

These items have been included and will be addressed in the assessment.

4.2 REGULATORY SETTING FOR THE ATMOSPHERIC ENVIRONMENT

The design, construction and operational phases of the Project are subject to regulatory approvals by different jurisdictions having regulatory authority relating to air quality. The regulatory approvals applicable to the Project are discussed in the following sections.

4.2.1 Nunavut Environmental Protection Act

The *Nunavut Environmental Protection Act* (Government of Nunavut 1988) is a piece of territorial legislation established to regulate contaminant discharges into the environment, including emissions to air. The Nunavut Department of Environment (Environmental Protection Service) regulates activities that have the potential to affect air quality (via the *Act*), and has set guidelines related to ambient air concentrations for a limited number COPCs that were included in the assessment.

Since air quality is a provincial/territorial jurisdiction, air quality objectives, guidelines, standards or criteria enacted under the Nunavut Environmental Protection Act will be given precedence over federal objectives, guidelines, standards or criteria. However, federal objectives and standards are discussed below for completeness.

4.2.2 Canadian Environmental Protection Act

Regulatory jurisdiction for air quality (i.e., the act of setting and enforcing standards) generally rests with the provincial and territorial governments in Canada. However, Environment Canada has also set National Ambient Air Quality Objectives (NAAQOs) to use as a benchmark to assess the effect of anthropogenic activities on air quality in Canada. These air quality objectives are set by the federal government based on recommendations from a National Advisory Committee and Working Group on Air Quality Objectives and Guidelines under the authority of the *Canadian Environmental Protection Act* (CEPA) (Government of Canada 1999), and are based on recognized scientific principles that include risk assessment and risk management. The NAAQOs are based on a two-tiered approach which identifies the different ranges of air concentrations having specific levels of effects to air quality: maximum desirable and maximum acceptable levels. Provincial and territorial governments have the option of adopting these levels either as objectives or as enforceable standards according to their legislation.

In addition, the Canadian Council of Ministers of the Environment (CCME) has also established Canada-Wide air quality standards (CWS) with the objective to protect human health (CCME 2000). Like NAAQOs, provincial and territorial governments have the option of adopting the CCME standards either as objectives or as enforceable standards according to their legislation.

4.2.3 Other Provincial Regulations

Other Canadian provinces also have acts and regulations that govern allowable emissions to air and/or set standards for predicted COPC concentrations. For example, Ontario Regulation 419/05: Air Pollution – Local Air Quality (Government of Ontario 2005) uses a mixture of regulatory standards and guidelines to govern allowable off-property concentrations for a large number of COPCs. Similarly, regulations in Newfoundland, Alberta and British Columbia have regulatory standards for a number of COPCs. These will be used as Project-specific guidelines for COPCs in the absence of applicable Nunavut regulatory standards or federal objectives and standards.

In the event that no other objectives, guidelines, standards or criteria exist, World Health Organization (WHO) guidelines will be used.

4.3 PROJECT – ENVIRONMENT INTERACTIONS AND EFFECTS: AIR QUALITY AND CLIMATE CHANGE

Project activities and physical works have the potential to interact with and affect the surrounding environment. This section identifies such interactions and the potential environmental effects to air quality and climate change. Interactions are expected to occur between the atmospheric environment and Project-related activities during construction, operation and final closure phases. These are ranked according to the potential for an activity to interact with one or more components of the atmospheric environment. Ranking of each interaction was assigned as described in Section 3.2.3 of this report.

Tables 4.3-1 through 4.3-3 present the rankings of interactions between the Project and the atmospheric environment (i.e., air quality and climate change) for the construction, operations and final closure phases of the Project as well as the rationale for each of the chosen rankings. Interactions are ranked according to the potential for a Project activity to interact with the atmospheric environment to cause an environmental effect to air quality and climate.

4.3.1 Construction

Activities associated with the construction of the Mine Development Area, including land preparation, construction of infrastructure (e.g., the mill complex, accommodation complex, etc.)

as well as the access roads, have the potential to affect air quality. The primary sources of air emissions during this phase are fugitive emissions resulting from earthworks, material movement and vehicle travel, in addition to exhaust emissions from heavy equipment. All Project-environmental effects interactions for construction are outlined in Table 4.3-1.

The following types of activities have been ranked as 2, and therefore included in the assessment: topsoil removal and site clearing; pad construction, construction of foundations and buildings; and exhaust emissions resulting from the operation of heavy equipment. In contrast, emissions of COPCs due to in-water construction activities are minor in relation to emissions from other construction activities since majority of the work is done in wet conditions which will naturally suppress dust. Therefore, these activities have been ranked as 1.

Additionally, with the exception of quarrying activities for access road construction, COPC emissions from construction activities related to the Dock and Storage Facility are of short duration and likely to be minor in comparison to the operations phase. As a result, these activities have been ranked as 1 and have not been carried forward in the assessment.

Finally, emissions of greenhouse gases from construction activities will result from fuel combustion in heavy equipment. However, the construction phase is short in comparison to the operations phase, and has a lower overall fuel consumption. As a result, all construction activities have been ranked as 1 for Climate Change, and therefore not carried forward in the assessment.

Table 4.3-1 Identification of Project-Environmental Effects Interaction – Construction

	Activities	Study Area	Component	Air Quality	Climate Change
Economic Activities	Construction Workforce Management (hiring and training) Contracts and Taxes Advance Training of Operations Workforce			0	0
In-Water Construction	Construct freshwater diversions and site drainage containment systems (dykes, berms, collection ponds)	Site Access	Freshwater diversions	1	1
		Mine Site	Freshwater diversions Site containment dykes and berms Andrew Lake dyke Site runoff ponds Purpose built pit	1	1
	Construct in-water / shoreline structures	Site Access	Wharf construction Thelon bridge Ferry crossing Water crossings (culverts and clear span bridges)	1	1
		Mine Site	Water crossings (culverts and clear span bridges) Intake pipelines Effluent pipelines and diffusers	1	1
	Water transfers and discharge	Site Access	Domestic wastewater	1	1
		Mine Site	Andrew Lake dewatering Minor ponds/standing water dewatering Domestic wastewater	1	1
	Freshwater withdrawal	Site Access	Ice flooding winter road	1	1
		Mine Site	Kiggavik site freshwater Sissons site freshwater Ice flooding temporary airstrip	1	1

Activities		Study Area	Component	Air Quality	Climate Change
On-Land Construction	Site clearing and pad construction (blasting, earth-moving, loading, hauling, dumping, crushing) Site clearing and pad construction (blasting, earth-moving, loading, hauling, dumping, crushing)	Site Access	Baker Lake port Winter road All weather road Quarry development	1 1 1 2	1 1 1 1
		Mine Site	Kiggavik, including pit stripping	2	1
			Sissons, including pit stripping Airstrip	2	1
			Quarry development	2	1
			Haul road and site roads	2	1
	Construct foundations	Site Access	Baker Lake fuel tank farm	1	1
		Mine Site	Mill and powerhouse, tank farms Accommodation complex	2	1
	Construct buildings	Site Access	Emergency shelters Warehouse	1	1
		Mine Site	Mill, powerhouse, mine shops, water treatment plants Accommodation complex and temporary camps Backfill Plant Airstrip shelter	2	1
	Install equipment	Site Access	Generators Dock and Storage Facility Port crane and fuel off-loading	1	1
		Mine Site	Temporary generators Mill, backfill and water treatment equipment Powerhouse Utility distribution Maintenance Incinerator Communications systems	1	1
	Install and commission fuel tanks	Site Access	Baker Lake tank farm	1	1
		Mine Site	Kiggavik site tank farm	1	1

Activities		Study Area	Component	Air Quality	Climate Change
			Sissons fuel tanks Airstrip jet fuel tanks		
	Mill dry commissioning (water only)	Mine Site		1	1
Supporting Activities	Transport fuel and construction materials	Site Access	Transfers, barging, trucking	1	1
		Mine Site	Transfers	1	1
	Air transport of personnel and supplies	Mine Site		1	1
	Hazardous materials storage and use	Site Access	Baker Lake storage facility	1	1
		Mine Site	Kiggavik and Sissons	1	1
	Explosives storage and use	Site Access		1	1
		Mine Site		1	1
	Waste incineration and disposal	Site Access		1	1
		Mine Site		1	1
	Industrial machinery operation	Site Access		1	1
		Mine Site		2	1
	Power generation	Site Access	Baker Lake storage facility	1	1
		Mine Site	Temporary generators	1	1

4.3.2 Operations

Activities associated with the operation of the Project and its related facilities (i.e., the mill complex and ancillary works such as the accommodation complex) have the potential to affect air quality. The primary sources of air emissions during this phase are point source emissions from power generation, milling and acid production, in addition to fugitive emissions resulting from mining activities (drilling, blasting, excavating) and vehicle travel, in addition to exhaust emissions from heavy equipment. All Project environmental effects interactions for operations are outlined in Table 4.3-2.

Activities related to mine dewatering, freshwater withdrawal and placement or consolidation of tailings slurry are all wet activities and are not expected to generate emissions of COPCs. Therefore, these have been assigned a rating of 0.

Fugitive and tailpipe emissions of COPCs from waste management activities, including disposal and/or management of industrial, domestic, hazardous waste and sewage sludge are minor in comparison to the emissions from the mining and milling operations. As such, these sources have been ranked as a 1 and not assessed further in this Volume. It should be noted however that incineration of food/organic wastes was rated as 2 and was included in the assessment.

General site operations and maintenance services, such as the operation of the accommodation complex, etc., are expected to have minimal releases of COPCs relative to mining and milling operations. In addition, maintenance services are often short-lived and only occur on an as needed basis. As such these activities are rated as 1 and not carried forward.

Air transportation of personnel and yellowcake, as well as general air transportation support are considered to be minor, short-lived sources of COPCs in relation to the other sources on site since emissions will typically last over a 5 to 10 minute period during take-off, landing or taxiing of aircraft for a maximum of 4 to 5 times per day. Similarly, ground transportation of site personnel or controlled public traffic on the access roads were also considered to be intermittent sources which are minor in nature compared to the mining truck traffic. These sources have therefore all been rated as 1 and were not carried forward in the assessment.

During the operational phase of the Project, greenhouse gases are expected to be emitted as a result of the combustion of fossil fuels. The primary sources of fossil fuel combustion are power generation and the operation of heavy equipment (loaders, excavators, haul trucks, etc.). While there are other sources of fossil fuel combustion (e.g., air transportation of yellowcake or personnel and miscellaneous industrial equipment [e.g., pumps]), these are minor in comparison to the primary emissions sources and occur over a short-term or intermittent basis. Also, all equipment that operates on electrical power has been rated as 0 (e.g., process equipment in the mill) since the greenhouse gas emissions have been accounted for in the assessment of power generation.

Finally, ongoing exploration activities are also expected to be transient in nature and will only occur for limited periods of time. As such these activities are rated as 1 and are not carried forward.

Table 4.3-2 Identification of Project-Environmental Effects Interaction – Operations

Activities		Study Area	Component	Air Quality	Climate Change
Economic Activities	Workforce Management (hiring and training)			0	0
	Employment Contracts and Taxes				
Mining	Mining ore (blasting, loading, hauling)	Mine Site	East Zone, Centre Zone, Main Zone, Andrew Lake open pits	2	2
			End Grid Underground Haul Road		
	Ore stockpiling	Mine Site	Kiggavik ore stockpile	2	2
			Sissons ore stockpile		
	Mining special waste (blasting, loading, hauling)	Mine Site	East Zone, Centre Zone, Main Zone, Andrew Lake open pits	2	2
			End Grid Underground		
	Special waste stockpiling		Kiggavik special waste stockpile	2	2
			Sissons special waste stockpile		
	Mining clean waste (blasting, loading, hauling)		East Zone, Centre Zone, Main Zone, Andrew Lake open pits	2	2
			End Grid Underground		
	Clean rock stockpiling	Mine Site	Kiggavik clean rock stockpile	2	2
			Sissons clean rock stockpile		
	Mine dewatering	Mine Site	East Zone, Centre Zone, Main Zone, Andrew Lake open pits	0	0
			End Grid Underground		
	Underground ventilation	Mine Site	End Grid Underground	2	2
	Backfill production and underground placement	Mine Site	End Grid Underground	2	2
Milling	Transfer ore to mill	Mine Site		2	2
	Crushing and grinding	Mine Site		2	0
	Leaching and U Recovery	Mine Site		2	0
	U Purification	Mine Site		2	0
	Yellowcake drying and packaging	Mine Site		2	0
	Tailings neutralization	Mine Site		2	0
	Reagents Preparation and Use	Mine Site		2	0

Activities		Study Area	Component	Air Quality	Climate Change
Tailings Management	Pumping and placement of tailings slurry	Mine Site	East Zone, Centre Zone, Main Zone TMFs; pipelines	0	0
	Consolidation of tailings	Mine Site	East Zone, Centre Zone, Main Zone TMFs	0	0
	Pumping of TMF supernatant	Mine Site	East Zone, Centre Zone, Main Zone TMFs; pipelines	0	0
	Create and maintain water levels	Mine Site	East Zone, Centre Zone, Main Zone TMFs	0	0
Water Management	Freshwater withdrawal	Site Access	Ice flooding winter road	0	0
		Mine Site	Kiggavik site, potable and industrial use		
			Sissons site, potable and industrial use		
	Potable water treatment	Mine Site	Kiggavik	0	
			Sissons		
	Collection of site and stockpile drainage	Mine Site	Site runoff ditches and ponds	0	0
			Purpose built pit		
			Snow fencing and clearing		
			Stockpile drainage collection		
	Water and sewage treatment	Mine Site	Kiggavik water treatment plant	0	0
			Sissons water treatment plant		
	Discharge of treated effluents (including grey water)	Site Access	Domestic wastewater	0	0
		Mine Site	Kiggavik treated effluent		
			Sissons treated effluent		
			Clean waste stockpile excess runoff		
Waste Management	Disposal industrial waste	Mine Site	Kiggavik and Sissons	1	1
	Management of hazardous waste	Mine Site	Kiggavik and Sissons	1	1
	Management of radiologically contaminated waste	Mine Site	Kiggavik and Sissons	1	1
	Disposal of domestic waste	Mine Site	Kiggavik and Sissons	1	1
	Incineration and handling of burnables	Mine Site	Kiggavik incinerator	2	1
	Disposal of sewage sludge	Mine Site	Kiggavik and Sissons	1	1
General Services	Generation of power	Site Access	Dock and Storage Facility generator	2	2
		Mine Site	Kiggavik powerhouse		
			Sissons powerhouse		

Activities		Study Area	Component	Air Quality	Climate Change
			Power transmission lines	0	0
	Operate accommodations complex	Mine Site	Cafeteria, recreation areas, quarters	1	1
	Recreational activities (fishing?)	Mine Site		0	0
	Maintain vehicles and equipment	Mine Site	Shops and wash bays	1	1
	Maintain infrastructure	Site Access	Roads, bridges, culverts, cable ferry, Dock and Storage Facility	1	1
		Mine Site	Site pads, roads, bridges, culverts, airstrip, buildings		
	Operate airstrip	Mine Site	Arrivals, departures, transfer materials, planes + helicopters	1	1
	Hazardous materials storage and handling (reagents, fuel and hydrocarbons)	Site Access	Baker Lake storage	1	1
		Mine Site	Kiggavik and Sissons		
	Explosives storage and handling	Site Access	Baker Lake storage	0	0
		Mine Site	Kiggavik and Sissons		
Transportation	Marine transportation	Site Access	Loading barges, barging, off-loading; fuel, reagents and supplies; Baker Lake and Churchill); back-haul	2	2
	Truck transportation	Site Access	Fuel, reagents and supplies; winter road and/or all-weather road; cable ferry operation	2	2
	General traffic (project-related)	Site Access		1	2
		Mine Site		2	2
	Controlled public traffic	Site Access		1	1
	Air transportation of personnel, goods and supplies	Mine Site		1	1
	Air transportation of yellowcake	Mine Site	Handling and transport of yellowcake to Points North	1	1
	General air transportation support	Mine Site	Airplanes + helicopters; medivac, inspections, exploration, monitoring	1	1
On-going Exploration	Aerial surveys	Mine Site		1	1
	Ground surveys	Mine Site		1	1
	Drilling	Mine Site		1	1

4.3.3 Final Closure

Activities associated with the closure and decommissioning of the Project and all related facilities (mill complex, access roads and accommodation complex) have the potential to affect air quality. The primary sources of air emissions during this phase are fugitive emissions resulting from earthworks, material movement and vehicle travel, in addition to exhaust emissions from heavy equipment. All Project-environmental effects interactions for final-closure are outlined in Table 4.3-3.

Emissions of COPCs from all remaining on-land decommissioning activities such as the removal of foundations, buildings, equipment, fuel tanks, etc., are minor in comparison to the primary fugitive sources and thus have not been assessed further.

Emissions of COPCs from in-water closure and decommissioning activities including the removal of freshwater diversions, surface drainage containment, shoreline structures, etc., are minor in relation to the emissions from other decommissioning operations, as a majority of the work is done in wet conditions which will naturally suppress dust. Therefore, these activities have been rated as 1, and are not carried forward in the assessment.

Emissions of greenhouse gases from final closure and decommissioning activities will result from fuel combustion in heavy equipment. However, this phase has a lower overall fuel consumption and thus lower emissions in comparison to the operations phase. As a result, all closure and decommissioning activities have been ranked as 1 for Climate Change and therefore, not carried forward in the assessment.

4.3.4 Post-Closure

Once all of the final closure and decommissioning activities have been completed there will be one remaining Project related interaction with the atmospheric environment. Although the clean rock (Type II) stockpiles will have been contoured and re-vegetated, they will be a continuous source of passive radon emissions. The potential effect of this interaction has been ranked as a 2, and was therefore assessed in more detail.

Table 4.3-3 Identification of Project-Environmental Effects Interaction – Final Closure

	Activities	Study Area	Component	Air Quality	Climate Change
General	Decommissioning Workforce Management (hiring and training)			0	0
	Contracts and Taxes				
	Hazardous materials storage	Site Access	Storage at Baker Lake port	1	1
		Mine Site			
	Industrial machinery operation	Site Access		2	2
		Mine Site			
In-Water Decommissioning	Remove freshwater diversions; re-establish natural drainage	Mine Site	Headwater stream channel	1	1
			Centre Zone		
			Andrew Lake berm		
	Remove surface drainage containment	Site Access	Site runoff pond Baker Lake port	1	1
		Mine Site	Site containment dykes and berms		
			Monitoring ponds		
			Site runoff pond, Kiggavik, Sissons		
	Remove in-water/shoreline structures	Site Access	Wharf removal	1	1
			Thelon bridge		
			Cable ferry		
			Water crossings (culverts		
			Clear span bridges		
		Mine Site	Freshwater pipelines		
			Effluent pipeline		
			Intakes		
			Diffusers		
	Water transfers and discharge	Site Access	Domestic wastewater	1	1
		Mine Site	Andrew Lake flooding		
			PBP flooding Domestic wastewater		
	Construct fish habitat	Mine Site	In-pit	1	1

	Activities	Study Area	Component	Air Quality	Climate Change
On-Land Decommissioning	Remove site pads (blasting, earth-moving, loading, hauling, dumping)	Site Access	Baker Lake port Winter road Site roads AWR	1	1
		Mine Site	Kiggavik, including pits and stockpiles Sissons, including mines and stockpiles Airstrip Quarry development Haul road	2	1
	Backfilling	Mine Site	Special waste into TMFs and pits Underground mine stabilization	2	1
	Contouring	Site Access	Quarries	1	1
		Mine Site	Clean mine rock piles	2	1
	Covering	Mine Site	TMFs Landfills	2	1
	Revegetation	Site Access	Baker Lake port Thelon crossing Quarries	1	1
		Mine Site	Kiggavik site pad Sissons site pad Clean mine rock piles TMFs Airstrip		
	Remove foundations	Site Access	Baker Lake fuel tank farm	1	1
		Mine Site	Mill and powerhouse buildings, Kiggavik fuel tanks Sissons fuel tanks and WTP Accommodation complex		
	Remove buildings	Site Access	Emergency shelters Warehouse	1	1

Activities		Study Area	Component	Air Quality	Climate Change
		Mine Site	Backfill Plant Kiggavik structures Sissons structures Airstrip shelter Accommodation complex and potable WTP		
	Remove equipment	Site Access	Temporary generators - Baker Lake Port crane and fuel off-loading	1	1
		Mine Site	Mill equipment Power house equipment Utility distribution Incinerator		
	Remove fuel tanks	Site Access	Baker Lake tank farm	1	1
		Mine Site	Kiggavik site tank farm Sissons fuel tanks Airstrip jet fuel tanks		

4.4 VALUED COMPONENTS, INDICATORS AND MEASURABLE PARAMETERS

The Nunavut Impact Review Board selected the Valued Environmental Components (VECs) for the assessment of the Project, based on the following criteria:

- Do they represent a broad human environment component that may be affected by the Project?
- Are they vulnerable to the environmental effects of the Project and other activities in the region?
- Have they been identified as important issues or concerns during Inuit, government and stakeholder engagement or in other effects assessments in the region?

Based on the NIRB "Guidelines for the Preparation of an Environmental Impact Statement for AREVA Resources Canada Inc.'s Kiggavik Project (NIRB File No. 09MN003)" (NIRB 2011) [NIRB Guidelines], two VECs were selected for the atmospheric assessment, as follows:

- VEC 1 – Ambient Air Quality
- VEC 2 – Climate Change

4.4.1 VEC 1 - Ambient Air Quality

Ambient air quality is described by measurable air concentrations of Constituents of Potential Concern (COPCs). For the Project, the following compounds have been identified as COPCs:

- Total Suspended Particulate Matter (TSP)
- Particulate matter less than 10 microns (μm) in diameter (PM_{10})
- Particulate matter less than 2.5 microns (μm) in diameter ($PM_{2.5}$)
- Radioactive and non-radioactive constituents in TSP, including:
    - Uranium-238
    - Arsenic (As)
    - Cadmium (Cd)
    - Chromium (Cr)
    - Cobalt (Co)
    - Copper (Cu)
    - Molybdenum (Mo)
    - Lead (Pb)
    - Nickel (Ni)

    - Selenium (Se)
    - Zinc (Zn)
- Nitrogen Oxides (specifically, NO_2)
- Sulphur Dioxide (SO_2)
- Radionuclides, including:
    - Radon (Rn-222)
    - Lead-210 (Pb-210)
    - Polonium-210 (Po-210)

It should be noted that although hydrogen chloride (HCl) was identified in the NIRB Guidelines as a potential COPC for the Project, incineration of food and other organic wastes has been identified as the single source of emissions of this COPC. However, the incinerator to be located at the Kiggavik and potentially the Sissons site will operate on an intermittent basis as necessary, and will be a very minor contributor to overall emissions of COPCs. In addition, due to the nature of the waste stream (primarily food wastes), emissions of HCl will be negligible. As a result, HCl was not carried forward as a COPC in the assessment.

Ozone (O_3) was similarly identified as a potential COPC in the NIRB Guidelines. As none of the sources at the site emit ozone directly, only ground level ozone formation could be included in the assessment. Ozone is formed in the atmosphere as a result of chemical reactions between nitrogen oxides (NO_x) and reactive organic gases (ROGs) and/or volatile organic compounds (VOCs) in the presence of sunlight. While the Project emits nitrogen oxides and ROG/VOCs, optimal conditions for ground level ozone formation include strong solar radiation, high ambient temperatures and low wind speeds. However, these conditions rarely occur within the RAA as the mean and maximum summertime temperatures are 11.4°C and 16.7°C, respectively (Environment Canada 2011a). This limits the potential for ground level ozone formation to occur. As a result, significant ground level ozone formation is not expected to occur, and O_3 was not carried forward as a COPC in the assessment.

In addition to the COPCs identified above, particulate-based compounds and gaseous compounds such as nitrogen oxides and sulphur dioxide can deposit on surfaces at far distances from the original source. Deposited particles have the potential to become a nuisance (i.e., dusting of surfaces) or a cause a potential environmental effect to the terrestrial or aquatic environments, depending on the dust composition. Additionally, NO_x and SO_2 have the potential to acidify the environment. However, the incremental change in the deposition rates of these compounds are not considered to be a measure of the potential effect of the Project on air quality or climate change. Instead, changes in deposition rates of dust and acidifying COPCs were assessed as measures of the potential Project effects to the aquatic and the terrestrial environments, which are assessed in Volumes 5 and 6, respectively. Nonetheless, the results used by these other volumes are presented in this report for completeness.

Table 4.4-1 presents the measurable parameters studied to assess the Project effects on ambient air quality.

Table 4.4-1 Measureable Parameters for Ambient Air Quality

Environmental Effect	Measurable Parameter(s)	Rationale for Selection
Change in ambient air quality	change in ambient air concentrations of COPCs	• potential to affect ecological and human health • community, government, stakeholder engagement • regulatory drivers

4.4.2 VEC 2 - Climate Change

Project-related activities which require the combustion of fossil fuels (i.e., diesel) will result in the emission greenhouse gases (GHGs), including carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). Increased emissions of GHGs are known to contribute to the greenhouse effect, therefore, any changes to GHG levels resulting from Project-related activities have the potential to lead to changes in the regional climate in the long term. Because of the possible linkage to climate change, managing Project GHG emissions is an important issue for regulators and stakeholders. Table 4.4-2 presents the measurable parameters studied to assess the project effects on climate change.

Table 4.4-2 Measureable Parameters for Climate Change

Environmental Effect	Measurable Parameter(s)	Rationale for Selection
Potential to affect climate change	change in emissions of carbon dioxide equivalent (CO_2-eq)	• community, government, stakeholder engagement • regulatory drivers

4.5 SPATIAL BOUNDARIES

The assessment of potential effects of the Project focus largely on an area referred to as the Local Assessment Area (LAA). The cumulative effects assessment uses a broader spatial boundary referred to as the Regional Assessment Area (RAA).

4.5.1 Project Footprint

The Project Footprint consists of three components: the Kiggavik and Sissons mine sites and interconnecting Kiggavik-Sissons access road (collectively referred to as the Mine Development Area), the Baker Lake Dock and Storage Facility, and the access road between Baker Lake and the Mine Development Area (Kiggavik-Baker Lake access road). For the purpose of this assessment, the preferred alternative for the Kiggavik-Baker Lake access road is the South

Winter Road. However, the North All-Season Road and North Winter Road options have also been considered in the assessment.

The Kiggavik mine site, located approximately 80 kilometres (km) west of the community of Baker Lake, includes three open pit mines (East Zone Pit, Center Zone Pit and Main Zone Pit), mine rock and ore stockpiles, and ore processing and auxiliary facilities. The Sissons mine site, located approximately 17 km southwest of the Kiggavik mine site, includes one open pit mine (Andrew Lake Pit), one underground mine (End Grid Ore Zone), mine rock and ore stockpiles, and auxiliary facilities. The Kiggavik and Sissons mine sites are connected by a 20 km Kiggavik-Sissons access road used to transport ore from the Sissons mine site to the Kiggavik mine site for ore processing or to transport personnel to and from the Sissons Mine Site.

The Dock and Storage Facility, located approximately two and a half kilometres southeast of the community of Baker Lake, will act as a transfer station between the marine and road transportation routes. The preferred option for the transportation route between the Mine Development Area and Dock and Storage Facility is the 100 km South Winter Road. The Project footprint is illustrated in Figure 4.5-1.

4.5.2 Local Assessment Area

The Local Assessment Area (LAA) is defined as an area which is represented by approximately a 25 km by 25 km area centered over the Project Footprint of the Mine Development Area and a 5 km by 5 km area centered over the Dock and Storage Facility where measureable effects from Project specific activities are most likely to occur. The LAA is illustrated in Figure 4.5-2.

4.5.3 Regional Assessment Area

The Regional Assessment Area (RAA) extends beyond the LAA to encompass a 117 km by 65 km area that extends from Samarook Lake to just east of Whitehills Lake, and includes the Mine Development Area, the Kiggavik-Sissons access road, the Kiggavik-Baker Lake access road, as well as the community of Baker Lake. This is done to capture the full extent of potential emissions from the entire Project Footprint through all development phases. The RAA is illustrated in Figure 4.5-2

4.6 TEMPORAL BOUNDARIES

The temporal boundaries for the assessment are defined based on the timing and duration of potential effects from activities associated with the Project. The assessment covers the period of all major Project phases including construction, operation, final closure and post-closure. Since the level of activity from each of the Project phases differs, the extent of any related potential effects will also differ. For this reason, the assessment of potential effects of the Project on air quality and climate change has been considered as follows:

- **Maximum Construction** – The construction scenario considers land preparation and construction of the Kiggavik mine site and Sissons mine site infrastructure, and quarry operations for the construction of the Kiggavik-Baker Lake access road. Activities for these scenarios include, but are not limited to, land clearing, site grading, excavation, concrete production and pouring, rock crushing and screening, power generation and building construction. It should be noted that the simultaneous construction of both the Kiggavik and Sissons mine sites is not likely; however, it was considered as the most conservative bounding assumption possible for this scenario. In addition, the quarrying assessment was based on the assumption that activities (and emissions of COPCs) will be the same for each quarry, regardless of the location. Therefore, any differences in the potential effects to air quality will occur as a result of localized effects of meteorology and terrain. As a result, three separate quarry locations were chosen for assessment to demonstrate possible localized effects of terrain and meteorology. The expected duration of the construction phase is approximately 4 years.
- **Maximum Operation** – Project-related effects were also considered for a maximum emissions bounding scenario, which is an artificial scenario that represents the maximum operational period assuming that each Project activity occurs simultaneously. This is unlikely to occur in reality, but this scenario was simulated to assess the maximum envelope of operations. This assessment provides an upper bound estimate of mining activity air emissions and the predicted atmospheric concentrations are used to assess the largest potential short-term (i.e., 1- or 24-hour) effects of site activities on ambient air quality. Should the current production schedule change, this assessment will provide the necessary flexibility such that a new mining schedule will be within the bounds of this maximum emissions scenario.
- **Phased Operation** – Project-related effects are considered for operational scenarios that are representative of planned mining and milling activities over the lifetime of the Project. In air dispersion modelling it is generally not practical to model every year of scheduled production due to the excessive amount of computational time involved in carrying out the model runs and in processing the output data. Hence, it is common practice to select certain years for modelling purposes that are considered to be representative of activities at the site over consecutive periods spanning the operating life of the Project. The years chosen for modelling are generally selected on the basis that they are expected to yield the highest amount of emissions during each of the chosen periods. Long-term (i.e., monthly, annual) potential effects to air quality were assessed for four (4) phased operation scenarios associated with the scheduled activities of the Project over its lifetime. Predicted concentrations are also assessed through an exposure pathways analysis in Volume 6 – Terrestrial Environment and Volume 8 – Human Health. The scenarios assessed include:
    - Scenario 1 - Year 0 and 1, includes the following activities:
        - construction of the Purpose Built Pit;
        - open pit mining of East Zone Pit and Centre Zone Pit mine rock and ore;
        - open pit mining of mine rock from Main Zone East Pit; and,

        - stockpiling East Zone and Centre Zone Pit ores.
    - Scenario 2 - Year 2 to 5, includes the following activities:
        - simultaneous open pit mining of ore and mine rock from Main Zone West Pit;
        - open pit mining of mine rock from Andrew Lake Pit;
        - extraction of mine rock from End Grid Underground Mine
        - milling of ores from East Zone, Centre Zone and Main Zone pits;
        - mine rock management; and,
        - tailings management.
    - Scenario 3 – Years 6 to 13, includes the following activities:
        - open pit mining of ore and mine rock from Andrew Lake Pit;
        - extraction of ore from End Grid Underground Mine
        - milling of ores from Andrew Lake Pit and End Grid Underground mine;
        - mine rock management; and,
        - tailings management.
    - Scenario 4 – Year 14
        - milling of any remaining ore; and,
        - tailings management.

With respect to GHG emissions, the year with the highest anticipated fuel consumption was selected for the assessment of potential effects to climate change from the Project.

For the purpose of this assessment, the total duration of Project operations was considered to be 15 years (Year 0 up to and including 14). However, based on the capacity of the TMFs, the operational life of the Project may be extended to 25 years. Since the potential Project-related effects to air quality have already been captured in the outlined operational scenarios, no additional assessments were required to evaluate an extended operational life.

- **Final Closure** – For this assessment it was assumed that beginning in Year 15, closure activities will begin to restore the Mine Development Area back to a near undisturbed state. The first phase of closure will take approximately 2 years to complete and will involve the progressive rehabilitation of the mine sites. Activities will include backfilling Type III mine rock (special waste) at Kiggavik and Sissons mine sites into Main Zone pit and Andrew Lake pit, respectively and charging (or covering) Centre Zone TMF with a layer of Type II mine rock (clean waste) from the north Type II mine rock stockpile.
- **Post-Closure** – At this stage of the Project, all final closure operations are assumed to have been completed, and only passive emissions of radon from the permanent Type II

mine rock stockpiles and fully charged and covered TMFs (East Zone, Centre Zone and Main Zone TMFs) are expected to occur.

4.7 ADMINISTRATIVE AND TECHNICAL BOUNDARIES

The air quality and climate change assessments are subject to some technical limitations due to a lack of scientific information with which to form effects predictions or mitigations. These technical limitations have been considered in the assessment and pertain to the following:

- Many of the emissions estimates of COPCs from mining operations are based on U.S. EPA AP-42 emission factors (US EPA 1995) (e.g., drilling, blasting, material handling, and unpaved road dust) and site-specific mineral/metal assay data. Most of these emission factors require further site-specific or activity-specific data that was not available . For example, parameters such as roadway silt content, material moisture content, daily vehicle counts, daily material quantities handled, among others parameters, were not available. In these cases, professional judgment and information available from similar mining assessments was used in place of the site specific data.
- Site specific information pertaining to emissions of COPCs from milling equipment, including the acid plant was unavailable. As a result, estimates of COPC emissions from milling operations and acid production were based on stack testing data available from AREVA`s McClean Lake operation which has similar mill processing to what has been planned for the Project.
- Specific emissions data for each piece of equipment that would be operating, including heavy equipment, were not available. COPC emissions for heavy equipment were derived from calculations using the power rating of the equipment in combination with the US EPA emission factors published in "Exhaust and Crankcase Emission Factors for Nonroad Engine Modelling – Compression-Ignition" (US EPA 2010). For some types of equipment, the make and model was available, and manufacturers' brochures were consulted to determine the power rating of the equipment. Where equipment make and model were not available, equipment information available from similar mining assessments was used.

These technical limitations were overcome by using conservative estimation techniques and professional judgment in a manner that likely results in an overestimate of potential effects to air quality and climate change. Technical Appendix 4B (Air Dispersion Assessment) provides further details on all assumptions that have been used in the assessment.

4.8 ENVIRONMENTAL EFFECTS CRITERIA

Project environmental effects on air quality are typically assessed in quantitative terms through comparison of atmospheric concentrations to ambient air quality criteria, objectives or guidelines. Conversely, the assessment of potential effects to climate change is subjective as there are no specific thresholds or criteria that define whether an effect is expected to occur. Instead, potential effects on climate change are typically assessed quantitatively through comparison of Project-related emissions of greenhouse gases to total federal and provincial/territorial GHG emission levels.

Project effects criteria for air quality are defined by the regulatory/guidance criteria presented in Table 4.8-1. Predicted concentrations from air dispersion modelling are compared to the criteria shown in Table 4.8-1 to determine the potential for a residual effect to occur due to changes in ambient air concentrations of COPCs. These criteria have been used as Indicator Thresholds to identify potential residual effects. In general, no residual effects to the atmospheric environment are considered to occur if the predicted concentrations of COPCs are below the applicable Indicator Threshold.

Furthermore, the Indicator Thresholds outlined below are not generally applicable to on-site locations, as different criteria or standards are generally applied to assess potential effects to workers. As a result, on-site exceedances of the selected Indicator Thresholds are not considered to be residual effects. It should also be noted that potential effects to other VECs (i.e., the aquatic environment, the terrestrial environment, and human health) resulting from changes in air quality likely use different effects criteria than those presented here. The potential effects on these VECs due to changes in ambient COPC concentrations have been assessed in Volumes 5, Volume 6 and Volume 8.

Although changes in dustfall deposition levels and Potential Acid Input (PAI) are not used to assess Project effects on air quality or climate change, selected criteria are used to provide context for the air dispersion results presented later in this report. The applicable criteria are presented in Table 4.8-2 and Table 4.8-3.

Table 4.8-1 Summary of Ambient Air Quality Effects Criteria and Selected Indicator Thresholds

COPC	Averaging Period	Canada Wide Standards ($\mu g/m^3$)	NWT Standards ($\mu g/m^3$)	Nunavut Guidelines ($\mu g/m^3$)	Other Relevant Criteria ($\mu g/m^3$)	National Air Quality Objectives		Indicator Threshold ($\mu g/m^3$)
						Maximum Desirable Level ($\mu g/m^3$)	Maximum Acceptable Level ($\mu g/m^3$)	
TSP	Annual 24-hour		60 120	60 120		60 (1)	70 (1) 120	60 120
PM_{10}	Annual 24-hour				50(4)(5)			50
$PM_{2.5}$	Annual 24-hour	 30(3)	 30					 30
SO_2	Annual 24 hour 1 hour			30 150 450		30 (2) 150 450	60 (2) 300 900	30 150 450
NO_2	Annual 24 hour 1 hour				 200(5) 400(5)	60 (2)	100 (2) 400	60 200 400
Uranium	24 hour Annual				0.03 (6) 0.3 (6)			0.03 0.3
Arsenic	24 hour Annual				0.3 (7) 0.06 (8)			0.3 0.06
Cadmium	24 hour Annual				0.025 (7) 0.005 (7)			0.025 0.005
Chromium	24 hour Annual				0.5 (7) 0.1 (8)			0.5 0.1
Cobalt	24 hour Annual				0.1 (7) 0.02 (8)			0.1 0.02
Copper	24 hour Annual				50 (7) 9.6 (8)			50 9.6
Lead	24 hour Annual				0.5 (7) 0.1 (8)			0.5 0.1
Molybdenum	24 hour Annual				120 (7) 23 (8)			120 23
Nickel	24 hour Annual				0.2 (9) 0.04 (9)			0.2 0.04
Selenium	24 hour Annual				10 (7) 1.9 (8)			10 1.9
Zinc	24 hour Annual				120 (7) 23 (8)			120 23
Radon	Annual				60 (Bq/m^3) (10)			60 (Bq/m^3)
Lead-210	Annual				0.021 (Bq/m^3) (11)			0.021 (Bq/m^3)
Polonium-210	Annual				0.028 (Bq/m^3) (11)			0.028 (Bq/m^3)

Notes:

(1) Calculated as geometric mean (CCME 1999)

(2) Calculated as arithmetic mean (CCME 1999)

(3) Compliance based on 98th percentile value averaged over 3 years (CCME 2000).

(4) Ontario Interim guideline (MOE 2008)

(5) Guideline in Ontario (MOE 2008) Newfoundland (Government of Newfoundland and Labrador 2004) and British Columbia (BC MOE 2009)

(6) Uranium AQ criteria adopted from the Ontario Ministry of Environment's new AAQC under Regulation 419/05 accepted June 22, 2011. EBR No. 010-7190. (MOE 2011a)

(7) 24-hour criteria provided in Ontario's Ambient Air Quality Criteria, Ontario Ministry of Environment Standards and Development Branch, 2008. (MOE 2008)

(8) Annual values were derived for use in the current assessment from 24-hour values based on the following equation: $C_{long}/C_{short} = (t_{long}/t_{short})^{0.28}$ (MOE 2009)

9) Nickel AQ criteria adopted from the Ontario Ministry of Environment's new standard under Regulation 419/05 accepted June 22, 2011. EBR No. 010-7190. (MOE 2011b)

(10) Radiation Protection Regulations of the Canadian Nuclear Safety Commission (CNSC 2000)

(11) See Appendix 4B – Air Dispersion Assessment.

Table 4.8-2 identifies dust deposition criteria for Alberta and Ontario. These criteria are nuisance based. For the purpose of this assessment, the Ontario Ambient Air Quality Criteria were selected as the applicable Indicator Thresholds.

Table 4.8-2 Dust Deposition Criteria and Selected Indicator Thresholds

Averaging Time	Alberta Residential and Recreational Areas	Alberta Commercial and Industrial Areas	Ontario Ambient Air Quality Criteria	Indicator Threshold
Monthly	5.3 g/m²/30 days	15.8 g/m²/30 days	7 g/m²/30 days	7 g/m²/30 days
Annual Average	-	-	4.6 g/m²/30 days	4.6 g/m²/30 days
Annual Loading	-	-	55 g/m²/year	55 g/m²/year

Sources: Alberta Environment (2011) and Ontario Ministry of Environment (MOE 2008)

Table 4.8-3 presents the suggested loading thresholds for Potential Acid Input based on the sensitivity of the receiving environment. For the purpose of this assessment, the critical loading level for sensitive environments was selected as the Indicator Threshold.

Table 4.8-3 Thresholds for Potential Acid Input

Sensitivity of Environment	Deposition Load	Parameter	Indicator Threshold
Sensitive	Monitoring	0.17 keq/ha/yr	0.25 keq/ha/yr
	Target	0.22 keq/ha/yr	
	Critical	0.25 keq/ha/yr	
Moderately Sensitive	Critical	0.50 keq/ha/yr	
Low Sensitivity	Critical	1.00 keq/ha/yr	

Source: CASA and Alberta Environment (1999)

4.8.1 Descriptors for Residual Effects of the Project on Ambient Air Quality

Residual effects are those that remain when all mitigation options have been incorporated into the Project design and operation. The criteria identified earlier in Table 4.8-1 were used to determine whether a residual effect is expected to occur as a result of the Project. Table 4.8-4 presents the descriptors used for describing the residual effects of the Project on air quality. Professional judgment was used to develop these descriptors based on the consideration of the magnitude of the effect in relation to the effects criteria, in addition to the geographic extent, duration, and frequency of the effect. As noted previously there are no effects criteria for climate change.

Table 4.8-4 Definitions of Criteria Used in the Description of Residual Effects to Air Quality

Direction	Magnitude	Geographic Extent	Duration	Reversibility	Frequency	Likelihood	Context
							Socio-Economic
P Positive: an improvement in air quality due to a reduction in concentrations of COPCs in air A Adverse: a deterioration in air quality due to an increase in concentrations of air COPCs N Neutral: No notable change in concentrations of air COPCs	L Low: The predicted COPC concentrations are less than 25% greater than the Indicator Threshold criterion. M Moderate: The predicted COPC concentrations are less than 100% greater than the Indicator Threshold. H High: The predicted COPC concentrations are more than 100% greater than the Indicator Threshold.	F Footprint: Effect confined to the project footprint F* Footprint: Effect confined to 2km from the project footprint L Local: Effect confined to the LAA R Regional: Effect extends beyond the LAA but within the RAA	ST Short term: Less than one year (growing season) MT Medium term: More than one year, but not beyond the end of project decommissioning LT Long term: Beyond the life of the project P Permanent	R Reversible: the VEC will recover from an environmental effect I Irreversible: the VEC will not recover from an environmental effect	Infrequent – Less than 1% of the time (i.e., the effect occurs no more than four days per year or 88 hours per year)) Sporadic – Less than 3.5% of the time (i.e., the effect occurs no more than 12 days per year or 305 hours per year) Regular - Less than15% of the time (i.e., the effect occurs no more than 55 days per year or approximately 1300 hours per year) Continuous – The effect occurs more than 15% of the time	L Low probability of occurrence M Medium probability of occurrence H High probability of occurrence	Negligible: No implications to human health, well-being or quality of life Level I: No implications to human health, well-being or quality of life but some changes in annoyance / disturbance levels; potential effects on individuals within populations Level II: Implications to human health, well-being or quality of life; potential population level effects

4.9 ASSESSMENT OF SIGNIFICANCE

Under the NIRB "Guidelines for the Preparation of an Environmental Impact Statement for AREVA Resources Canada Inc.'s Kiggavik Project (NIRB File No. 09MN003)" (NIRB 2011), the environmental assessment must include a determination of the significance of environmental effects. Significance criteria were developed for the Air Quality VEC based on the measurable parameters (i.e., COPC concentrations) beyond which a residual environmental effect would be considered significant.

The potential effect to climate change was assessed through changes to emissions of greenhouse gases and the relative contribution of the Project to overall greenhouse gas emissions in Nunavut and Canada. The direct effect to climate change that could occur as a result of changes in GHGs is unknown at present. As a result, it is not possible to assess the significance of changes to greenhouse gas emissions. However, Project-related greenhouse gas emissions will be put into context by comparison to greenhouse gas emissions from other existing and proposed projects in Nunavut and total GHG emissions in Canada.

4.9.1 Ambient Air Quality

Exceedances of the Indicator Thresholds indicate the presence of a residual effect. However, a predicted COPC concentration in air that is greater than the relevant Threshold is not necessarily considered to be a significant environmental effect since infrequent, low magnitude exceedances of criteria typically do not represent degradation to overall air quality. Also, there is generally an inherent amount of conservatism built into the emission estimates and model results.

Significance criteria for residual effects to air quality have been developed using professional judgement, based on the combined magnitude, frequency and geographic extent of the residual effects. As an example, residual effects to air quality are considered to be not significant if they occur infrequently and are localized to within 2 km of the Project Footprint boundary, regardless of the magnitude of the effect.

Table 4.9-1 presents the combinations of magnitude, geographic extent and frequency of residual effects, and the associated significance ratings. See Table 4.8-4 for the definitions of the effects criteria descriptors.

Table 4.9-1 Significance Criteria for Residual Effects to Air Quality

Magnitude	Geographic Extent	Frequency	Significant?
Negligible	Any	Any	NS
Low (<25%)	F*	Any	NS
	LAA	I, S, R	NS
		C	S
	RAA	I,S	NS
		R, C	S
Moderate (<100%)	F*	I, S, R	NS
		C	S
	LAA	I, S	NS
		R, C	S
	RAA	I	NS
		S, R, C	S
High (>100%)	F*	I, S	NS
		R, C	S
	LAA	I	NS
		S, R, C	S
	RAA	Any	S

The determination of significance of potential Project-related effects on biophysical VECs due to changes in air quality focuses on the specific environmental endpoints selected for analysis of each VEC. Environmental receptors for this Project include:

- soils and terrain;
- vegetation;
- wildlife;
- aquatic resources; and
- human health

Individual disciplines (e.g., surface water quality [Volume 5 – Aquatic Environment], vegetation, wildlife, terrain and soils [Volume 6 – Terrestrial Environment] and human health [Volume 8] consider the results developed for this volume, where relevant, to assess the potential effects of the Project on specific VECs due to changes in predicted COPC concentrations.

4.10 INFLUENCE OF INUIT AND STAKEHOLDER ENGAGEMENT ON THE ASSESSMENT

As part of the consultation process for the Kiggavik Project, AREVA has conducted a community tour and held public open houses in order identify Project-specific issues and concerns and to gain a better understanding of the value associated with specific VECs. Project-specific issues and concerns identified during Inuit, government and stakeholder engagement broadly include:

- dust blowing during storms;
- dust complaints from workers at other local mining operations;
- dust during crushing, very fine particles and possibility of dispersion;
- the effects of dust from mining, and dispersion (travel) distance from the mine;
- dust and uranium depositing on the ground and on lichens, and contamination of animals and people;
- Uranium and contaminated dust produced during mining, and effect of deposition onto land to wildlife and human health;
- dust control from open pit mining and blasting (including use of hazardous chemicals and effect on community (possible concern with dust suppressants);
- Uranium emissions from blasting;
- radiation from ore after crushing, and effect on the environment;
- the effect of prevailing winds and windy conditions in Nunavut on dust emissions and dispersion (other sites in Saskatchewan are not comparable because they have trees, whereas there are a lack of trees at Kiggavik); and
- the effect of road dust from mine hauling on roadside grass and caribou feeding.

Where appropriate, these concerns were considered in the air quality and climate change assessments, or by other disciplines which assess the potential effects of changes in air quality to the environment and human health.

4.11 INFLUENCE OF INUIT QAUJIMAJATUQANGIT ON THE ASSESSMENT

In order to learn more about important values and concerns to help identify valued environmental and socioeconomic components for the Kiggavik Project, AREVA conducted a community tour at several communities in the Kivalliq region during spring 2009. During this exercise, an interactive display was set up for participants to identify broad ecological areas they valued highly and/or had concerns about in relation to the Kiggavik Project. Each participant was given four stickers that they used to select areas components. This exercise was used to confirm high-level components of concern and provide opportunities for participants to share more specific concerns with an AREVA representative. A total of 7% of respondents identified air quality as one of the components of concern.

In addition, AREVA organized a series of open houses in late fall 2010 to gather additional information from these communities. The results of surveys and feedback from these public open houses (from VEC interactive posters at the November 2010 Open House Tour) indicate that air quality is an important VEC to residents in the Kivalliq region. Community responses have primarily categorized air quality as "*peaceful*", important for "*health*", as well as something that commands "*respect*".

The AREVA Kiggavik Project website (www.kiggavik.ca) contains a forum for the public to ask questions about the Project. From November 2010 until May 2011, a survey was available on the website asking for opinions on why VECs hold a particular value to the survey participant. The comments received on why certain air quality is valued are as follows:

"We need clean air and environment because most of our time as Inuit is spent out on the land"

This illustrates that Air Quality is of key importance to the local community.

5 SUMMARY OF EXISTING ENVIRONMENT

5.1 AIR QUALITY

Air quality in the vicinity of the Kiggavik site and within the Kivalliq Region in general, can be characterized as typical of the rural north in that the air is relatively pristine, with very low baseline concentrations of the COPCs of interest. However, baseline air concentrations of some COPCs can be expected to be slightly higher in and adjacent to hamlets such as Baker Lake due to increased emissions from human activities such as fuel consumption for heating and transportation.

Baseline concentrations should capture emissions from existing operations or emissions sources located within the vicinity of Project. As a result, emissions from nearby operations such as the Agnico-Eagle dock servicing the Meadowbank Gold Mine should be included as part of baseline COPC concentrations. However, monitoring data in the Baker Lake area was not available. In addition, emissions data from this source was also not available. As a result, the Agnico-Eagle dock was instead included as part of the cumulative effects assessment provided in Section 6.2 in order to capture the potential effects of this nearby source.

Baseline concentrations used in this assessment were obtained through a combination of on-site measurements and existing data and from literature reviews of EIS documents from other projects in Nunavut and are summarized below following a discussion of existing sources of COPCs.

5.1.1 Current Emission Sources of COPCs

Current sources of COPCs, including GHGs, within the local and regional assessment areas defined in Section 4.5 primarily include anthropogenic emissions from inhabited areas such as the hamlet of Baker Lake or the Meadowbank dock. Specific emission sources include fuel combustion for the purpose of heating or transportation (ground, air and marine). Drilling and exploration activities would also be existing sources of COPCs; however, emissions would be short-lived.

Emissions within the study areas would tend to be higher during the winter months due to increased heating requirements, for example. Lack of daylight during the winter would also impact the formation of secondary COPCs that only react in the presence of daylight. Furthermore, concentrations of COPCs, particularly gaseous COPCs, are typically higher during the colder months because of a decrease in the depth of the mixing height. A lower mixing height means that COPCs are confined to a shallower layer of the atmosphere and cannot disperse as easily, which leads to higher concentrations near the surface.

5.1.2 Local Air Quality

A series of high volume air samplers (Hi-vols) were used to collect on-site measurements of metals and radionuclides during the 2010 summer field season (June to August) at the Kiggavik mine site. High volume samplers were deployed on June 29 (Campaign 1) and July 20 (Campaign 2) and ran continuously for 20 and 28 days, respectively. This approach was used to collect a sufficient amount of sample for analysis, which was expected to contain very low levels of the target COPCs. Table 5.1-1 presents the highest measured concentration for each of the target COPCs which shows low baseline levels of TSP and all metals constituents.

During Campaign 1 the concentrations of metals ranged from a low of 1.28E-05 μg/m^3 (uranium) and a high of 1.65E-01 μg/m^3 (boron) averaged over the sampling period as mentioned above. Metal concentrations during Campaign 2 were slightly lower ranging from a low of 6.86E-06 μg/m^3 (cobalt) and a high of 1.15E-02 μg/m^3 (copper). In regard to radionuclides, lead-210 had the highest overall concentration at 1.37E-04 μg/m^3 during Campaign 1 and 1.67E-04 μg/m^3 during Campaign 2. Polonium-210, radium-226, thorium-230 and thorium-232 were all less than 3.60E-05 μg/m^3 in Campaign 1 and 2. Overall concentrations of metals and radionuclides were low considering the extended sampling period used in each Campaign.

An additional ambient air quality program was carried out at the site using low volume air samplers (PQ-100s) to collect samples for analysis of TSP, PM10 and PM2.5 approximately every three days throughout July 2010. The results are presented in Table 5.1-2. As can be seen in the table, the baseline particulate concentrations are all very low, which is expected due to the nature of the area. However, a number of unforeseen challenges were experienced with the equipment, which compromised the reliability of the data that was collected. As a result, additional monitoring was undertaken during the 2011 and 2012 monitoring season. This data was not available at the time of preparation of the draft EIS, but will be presented in the final EIS. The addition of this data is not likely to impact the outcome of the assessment.

Table 5.1-1 Measured Metals and Radionuclides at Kiggavik in July and August, 2010

Metal	Concentration (μg/m³)
Aluminum	5.24E-02
Antimony	1.28E-04
Arsenic	4.11E-05
Barium	3.34E-03
Beryllium	1.28E-05
Boron	1.64E-01
Cadmium	3.34E-05
Chromium	2.57E-04
Cobalt	1.28E-05
Copper	1.49E-02
Iron	2.80E-02
Lead	2.47E-03
Manganese	1.03E-03
Molybdenum	2.57E-05
Nickel	1.77E-04
Selenium	4.37E-05
Silver	3.85E-05
Strontium	1.59E-03
Thallium	1.28E-05
Tin	3.60E-04
Titanium	6.42E-04
Uranium	1.28E-05
Vanadium	1.80E-05
Zinc	5.65E-03
Lead-210	1.67E-04 *
Polonium-210	3.60E-05 *
Radium-226	2.57E-06 *
Thorium-230	5.14E-06 *
Thorium-232	5.14E-06 *

Notes: *Concentrations in Bq/m³

Table 5.1-2 TSP, PM_{10} and $PM_{2.5}$ Measurements at Kiggavik in July, 2010

Sampling Date	Particulate Concentration (μg/m³)		
	TSP	PM_{10}	$PM_{2.5}$
09-Jul-10	2	-	2
12-Jul-10	3	3	-
15-Jul-10	6	-	5
18-Jul-10	*4*		-

Additional sampling was also carried out to measure baseline levels of radon during the summer months of 2008, 2009 and 2010. Three dosimeters (located in Baker Lake, at the Kiggavik site and at the Sissons site), were used to measure alpha emissions of short life daughter products of radon-222 (Rn-222). Measured potential alpha energies (nJ/m³) of Rn-222 were converted to an activity or concentration (Bq/m³) of radon gas. The results of this sampling program are summarized in Table 5.1-3. As can be seen in the table, average radon concentrations are in the range of 1.4 to 2.4 Bq/m³. Overall, the baseline concentration of radon is considered to be low.

Table 5.1-3 Measured Potential Alpha Energies of Radon-222 and Resulting Activity (Bq/m³)

Parameter	Location	Jun 2008	Jul 2008	Sept 2008	Jun 2009	Jul 2009	Aug 2009	Jul 2010	Aug 2010	Average
Rn-222 PAE (nJ/m³)	Baker Lake	3	5	5	3	5	6	bdl	NA	4.5
	Kiggavik	bdl	8	bdl	5	8	6	9	8	7.3
	Sissons	bdl	7	bdl	5	7	7	13	10	8.2
Rn-222 Activity (Bq/m³)	Baker Lake	0.90	1.50	1.50	0.90	1.50	1.80	bdl	NA	1.3
	Kiggavik	bdl	2.40	bdl	1.50	2.40	1.80	2.70	2.40	2.2
	Sissons	bdl	2.10	bdl	1.50	2.10	2.10	3.90	3.00	2.4

Notes:
PAE = potential alpha energy
bdl = below detection limit
NA = not available

5.1.3 Regional Air Quality

There were no regional monitoring sites located in close proximity to the Project site that would allow for the characterization of regional air quality. As a result, data from air quality studies submitted to NIRB as part of other EIS documents were used to assist in the characterization.

5.1.3.1 Literature Review

A review of EIS documents previously submitted to the Nunavut Impact Review Board for other regional projects was completed to identify ambient levels of target COPCs in similar environments. The following projects were identified:

Project	Proponent	Year Submitted
Meadowbank Gold	Cumberland Resources Ltd	2005
Doris North	Miramar Hope Bay Ltd	2005
Mary River	Baffinland Iron Mines Corporation	2010

Air quality monitoring data in the Meadowbank Gold Project Air Quality Impact Assessment (Cumberland Resources Ltd. 2005) noted that existing PM_{10} concentrations reported by the Environment Protection Service of the Government of NWT were less than 10 µg/m^3 for a 24-hour period for undisturbed areas of Northwest Territories. Concentrations of SO_2, NO_x, and CO, were expected to be very low.

The Doris North Lake Atmospheric Environment, Technical Report (Golder Associates 2005) indicated that a baseline particulate (TSP) monitoring program was conducted at the site using a high volume air sampler. However, a very limited dataset was collected (3 samples). The measured TSP values ranged from 3.9 μg/m³ to 5.5 μg/m³ for a 24-hour period. Concentrations in this range are consistent with those expected in an undisturbed remote environment, and are consistent with those measured at the Kiggavik site.

An ambient air monitoring program was also conducted as part of the Baffinland Mary River project, where measurements of TSP and PM_{10} were completed over 24-hour periods. SO_2, NO_2 and dust deposition (including metal constituents) were also completed (Knight Piésold Consulting 2010). The average 24-hour concentration of TSP and PM_{10} were 7.0 and 3.8 μg/m^3, respectively (Table 5.1-4). This data is also consistent with that from the measurements at the Kiggavik site. Table 5.1-4 also shows that over a 30-day period, the SO_2 and NO_2 concentrations were 0.26 and 0.19 μg/m^3, respectively. The total dustfall was 0.40 mg/100cm^2/30-day (Table 5.1-5). The measured 30-day metal deposition rates ranged from a low of 0.3 to a high 30.6 (mg/100cm^2/30-day).

Table 5.1-4 Measured Baseline Concentrations at Mary River

Constituent	Averaging Period	Concentration(μg/m^3)
TSP	24-hour	7.0
PM_{10}	24-hour	3.8
SO_2	30-day	0.26
NO_2	30-day	0.19

Source: Knight Piésold Consulting (2010)

Table 5.1-5 Baseline Dustfall and Metals Deposition Rates at Mary River

Constituent	Concentration (mg/100 cm^2/30-day)
Total Dustfall	0.40
Al	25.9
Co	0.5
Cr	0.3
Fe	30.6
Mg	23.9
Mn	1.7

Source: Knight Piésold Consulting (2010)

Similar to the findings of the previous studies, the measured baseline concentrations and metal deposition rates are generally low compared to those from more urbanised and disturbed areas in southern regions.

5.1.4 Selected Baseline COPC Concentrations

Overall, very little long-term information is available on the ambient air concentrations of COPCs in the RAA. Available short-term measured data suggests that concentrations of COPC are very low. Measurements at such low levels could be considered to be at the lower sensitivity range of the sampling equipment. This is not unexpected given the remote nature of the Project site and the relatively pristine environment of the area.

As such, it was assumed that annual and 1- and 24-hour baseline concentrations of the various COPCs considered in this assessment would have a minimal contribution relative to the predicted COPC concentrations from the Project and thus were not added to model predicted concentrations.

5.2 POTENTIAL ACID INPUT (PAI)

Background levels of Potential Acid Input in the RAA were calculated based on data from the National Atmospheric Chemistry Precipitation Database (NAtChem) (Environment Canada 2008). Current sources of acidic precipitation would include sources which emit precursors to acidic precipitation; primarily NO_x and SO_2. Such sources would include fuel combustion which was previously discussed in Section 5.1.1. The annual average background PAI was calculated to be 0.093 keq/ha/yr. As per the PAI calculation methodology, this background component was added to the Project related contribution to PAI. Additional details are provided in Technical Appendix 4B – Air Dispersion Assessment.

5.3 GREENHOUSE GASES

As of 2010, Canadian facilities that emit more than 25,000 tonnes of CO_2-equivalent must report their emissions to Environment Canada's Greenhouse Gas Inventory. In previous reporting years, the threshold was 50,000 tonnes of CO_2-equivalent. According to the Inventory, the total amount of facility-reported greenhouse gases emissions in Canada in 2009 (the most recent available year) was 250,454 kilotonnes (kt) of CO_2-equivalent (Environment Canada 2009). There were no facility-reported GHG emissions in Nunavut (NU) in 2009., In the Northwest Territories, however, facility-reported GHG emissions totalled 519 kt of CO_2-equivalent in 2009 (Environment Canada 2009).

Environment Canada also generates a National Inventory Report which is submitted to the UN Framework Convention on Climate Change (Environment Canada 2010). This report provides a summary of both national and provincial/territorial estimates of GHG emissions and includes sources which did not necessarily meet the reporting threshold for the GHG Inventory. According to the latest submission, Canada-wide GHG emissions were calculated to be 734,000 kt of CO_2-equivalent in 2008. For the same year, GHG emissions in Nunavut were 361 kt of CO_2-equivalent, of which about 10 kt were attributable to Mining & Oil and Gas Extraction. Therefore, GHG emissions in the Nunavut were approximately 0.05% of the 2008 total for Canada.

The Meadowbank Gold Mine is currently operating, and may continue to be in operation when the Kiggavik Project is commissioned. As a result, GHG emissions from this project should be included as part of the baseline GHG levels in Nunavut. Since the Meadowbank Gold Mine was not yet commissioned in 2008, the Nunavut level as reported by Environment Canada (2010) did not include emissions from this facility. Therefore, the GHG emissions estimate of 191 kt of CO_2-equivalent as provided in the Meadowbank Gold Mine Environmental Assessment

(Cumberland Resources Ltd. 2005), was added to the reported 2008 GHG emissions in Nunavut. Therefore, the baseline level of GHG emissions in Nunavut was considered to be 552 kt of CO_2-equivalent which will be used as a measure of comparison to Project-related emissions of CO_2-equivalent.

5.4 CLIMATE

A description of the existing climate within the LAA and RAA is outlined in the Baseline Climate report provided in Technical Appendix 4A.

6 EFFECTS ASSESSMENT FOR AIR QUALITY

The effect of the Project on air quality is measured by increased ambient levels of COPCs in the atmosphere that could result in exceedances of the Indicator Thresholds presented earlier in Table 4.8-1. Effects on air quality that could result in changes in human and/or environmental health have been assessed separately in Volume 5 (Aquatic Environment), Volume 6 (Terrestrial Environment) and Volume 8 (Human Health).

6.1 ASSESSMENT OF CHANGES IN AMBIENT AIR QUALITY

6.1.1 Analytical Methods

Air quality assessment requires the use of a variety of different analytical methods (e.g., computer models, manual calculations, professional judgement). The specific methods employed in this assessment are briefly described below. Further details about the methods used are provided in Technical Appendix 4B – Air Dispersion Assessment.

Emissions inventories for 17 COPCs were developed for several Project phases, namely: construction; operations (phased and maximum operations); final closure; and post-closure. These were developed primarily using US EPA AP-42 emission factors (US EPA 1995). Specifically, AP-42 emission factors were used to estimate emissions for the following activities:

- Drilling, bulldozing, grading, ore and mine rock handling, vehicle movement and general construction activities.

Where AP-42 emission factors were not available, alternative emission factors were used. For example, blasting emissions were estimated using an emission factor developed by the Colorado Department of Health (CDOH) (Tistinic 1981). In addition, data from AREVA's McClean Lake operation was also utilized to estimate emissions from sources such as the mill and the acid plant.

Emissions of radionuclides were estimated assuming that radon generated through decay of uranium in ore or mine rock is at equilibrium within the void spaces of the rock.

The CALPUFF/CALMET modelling package was used to predict Project-related incremental ambient air concentrations of 17 COPCs at a network of receptor locations within the local and regional assessment areas. The CALPUFF model was also used to assess atmospheric deposition of selected COPCs (e.g., particulate matter, NO_2, SO_2) in addition to the potential acidifying effect of NO_2 and SO_2 deposition, also known as Potential Acid Input (PAI).

CALMET was used to simulate meteorological conditions in the local and regional assessment areas for a one year period (August 15, 2009 to August 14, 2010). In order to assess whether there were any potential effects from the Project, model predicted incremental COPC concentrations were compared to the Indicator Thresholds presented in Table 4.8-1. Where residual effects were predicted, the significance criteria outlined in Table 4.9-1 were used to assess whether the effect was significant or not.

The Indicator Thresholds presented in Table 4.8-1 for the assessment effects to air quality were applied at several sensitive points of reception (PORs) within the LAA and RAA, including three sensitive PORs. A total of three receptors were identified as being representative of the most sensitive PORs in the vicinity of the Project and are outlined in Table 6.1-1. These receptors were of particular interest to the Human Health assessment completed as part of Volume 8.

Table 6.1-1 Summary of Sensitive Points of Reception

Receptor ID	Description	Location (Coordinates)	
		UTM-Easting (m)	UTM-Northing (m)
R1	Kiggavik Accommodation Complex	564900	7148433
R2	Community of Baker Lake	644179	7135840
R3	Judge Sissons Lake Cabin (Residence)	566550	7137729

6.1.2 Effects Mechanisms and Linkages

The Project-environment interactions and effects described above in Section 4.3 and ranked as a “2” in Tables 4.3-1 through 4.3-3 for the construction, operation and final closure Project phases, form the basis for the air quality assessment effects mechanisms and linkages. Air quality effects resulting from the Project relate to emissions of COPCs from construction activities, mining and milling activities, general supporting activities as well as vehicle transportation. Such emissions may lead to potential exceedances of selected Indicator Thresholds within the Project Footprint, the LAA, and to a more limited extent, the RAA and the Community of Baker Lake.

The activities outlined below for each of the Project phases have the potential to release emissions of COPCs to air, including dust (and its radioactive and non-radioactive constituents), gaseous compounds and radionuclides. The effects on air quality associated with any specific activity depend on the type of activity, the type of equipment being used, the production rate, the length or duration of the activity, the material being handled (ore vs. mine rock), the distance between the activity and sensitive receptors, and any controls used to mitigate or reduce the amount of emissions that are generated by the activity (e.g., watering roads).

Complete details about the emission sources of COPCs and all assumptions used in the air quality assessments are provided in Technical Appendix 4B – Air Dispersion Assessment.

6.1.2.1 Construction

The potential environmental effects associated with on-land construction and supporting activities that could result in increased concentrations of ambient COPCs include:

- Dust emissions produced by the site preparation of the Kiggavik and Sissons sites. Dust generating activities can include land clearing (bulldozing, grading), excavating (i.e., earth moving), material handling and the construction of infrastructure such as the mill, the accommodation complex, the power plant, etc.
- Dust emissions produced by the development of the access roads which includes quarrying to supply road bed materials.
- Gaseous emissions generated by heavy-duty diesel-powered construction equipment used for site preparation, construction of infrastructure and quarrying.

6.1.2.2 Operations

The potential environmental effects associated with open pit and underground mining, milling operations, waste management, general/supporting services, and transportation that could result in increased concentrations of ambient COPCs include:

- Dust emissions (and its radioactive and non-radioactive constituents) and/or radionuclides (i.e., radon) generated by open pit and underground mining activities, including:
  - Drilling;
  - Blasting;
  - Ore and mine rock handling;
  - Stockpile and road maintenance (i.e., dozing and grading);
  - Wind erosion of stockpiles;
  - Vehicle movement; and,
  - Supporting activities such as the underground mine backfill plant.
- Emissions of fuel combustion products (i.e., NO_x, SO_2 and fine particulate matter) from the power plant and from the operation of diesel-powered equipment and vehicles both at the Mine Development Area and at the Dock and Storage Facility, including heavy-duty mining equipment, trucks and marine vessels.
- Emissions of dust and gaseous COPCs generated by truck traffic along the Kiggavik-Baker Lake access road.
- Emissions of COPCs (primarily radionuclides) from milling, including ore handling, ore crushing and grinding, in-process agitated storage, yellowcake drying and packing as well as SO_2 generated by the production of acid.

- Emissions of radon from tailings management facilities (TMFs).

6.1.2.3 Final Closure

During final closure, activities will take place to restore the Kiggavik Project site back to a near undisturbed state. The first closure phase will take approximately two years to complete. The potential environmental effects associated with closure activities that could result in increased concentrations of ambient COPCs include:

- Dust (and its radioactive and nonradioactive constituents) and radionuclide emissions generated by backfilling Type III mine rock at Kiggavik and Sissons into Main Zone TMF and Andrew Lake pit, respectively and charging (covering) Centre Zone TMF with a layer of Type II mine rock (i.e., material handling).
- Emissions of radon from tailings management facilities (TMFs).
- Emissions of fuel combustion products (i.e., NO_x, SO_2 and fine particulate matter) from diesel powered equipment and vehicles.

6.1.2.4 Post-Closure

The potential environmental effects associated with the post-closure phase of the Project that could result in increased concentrations of ambient COPCs include:

- Continuous radon emissions from the remaining permanent clean mine rock stockpiles and covered TMFs.

6.1.2.5 Emission Source Summary for the Kiggavik and Sissons Mine Sites

Table 6.1-2 provides a summary of the active emission sources at the Kiggavik and Sissons mine sites during the operation, final closure and post closure phase of the Project. As discussed in Section 4.6, mine operations (i.e., operations at the Kiggavik and Sissons mine sites) have been assessed using two different approaches. The first approach is an assessment of phased operations which is representative of planned mining activities over the lifetime of the Project (specific scenarios and the operational time periods assessed were presented in Section 4.6). The second approach assesses an artificial maximum emission scenario, whereby the highest potential emission rates from all mine site activities have been assessed. It conservatively assumes that all mining operations occur concurrently; however, it is unlikely that all of the activities will occur together at the rate that was assessed. Such a scenario was assessed to permit flexibility and allow modifications to the proposed mining schedule in the event that such changes result in higher emissions than those assessed in each of the operational phases.

Table 6.1-2 Source Activity Summary at the Kiggavik and Sissons Mine Sites by Project Phase

Source Location	Source Description	Mine Site Operations					Mine Site Closure	Mine Site Post-Closure
		Maximum	Scenario 1	Scenario 2	Scenario 3	Scenario 4		
Kiggavik Mine Site	Main Zone East Pit/TMF	A	A	A*	A*	A	A	A
	Main Zone West Pit/TMF	A	I	A	A*	A	A	A
	Centre Zone Pit/TMF	A*	A	A*	A*	A	A	A
	East Zone Pit/TMF	A*	A	A*	A*	A	A*	A
	Purpose Built Pit	I	A	I	I	I	I	A
	Kiggavik Type III Mine Rock Stockpile	A	A	A	A	A*	A	I
	Kiggavik Type II Mine Rock Stockpile – North	A	I	A	A*	A*	A	A
	Kiggavik Type II Mine Rock Stockpile – South	A	A	A	A	A*	A*	A
	Kiggavik Overburden Stockpile	A	A	A	A*	A*	I	I
	Kiggavik Ore Stockpile	A	A	A	A	A	I	I
	Mill Complex	A	A	A	A	A	I	I
	Power Plant	A	A	A	A	A	A	I
	Acid Plant	A	A	A	A	A	I	I
	Backfill Plant	A	I	A	A	I	I	I
	Incinerator	A	A	A	A	A	A	I
	Haulage routes between pits and mill and/or stockpiles	A	A	A	A	A	A	I
Sissons Mine Site	Andrew Lake Pit	A	I	A	A	A*	A	I
	End Grid Underground Mine Exhaust	A	I	A	A	I	I	I
	Andrew Lake Type III Mine Rock Stockpile	A	I	I	A	A	A	I
	Andrew Lake Type II Mine Rock Stockpile	A	I	A	A	A	A*	A
	Andrew Lake Overburden Pile	A	I	A	A	A*	I	I
	Andrew Lake Ore Pile	A	I	I	A	I	I	I
	End Grid Type III Mine Rock Stockpile	A	I	A	A	I	I	I
	End Grid Type II Mine Rock Stockpile	A	I	A	A	I	I	I
	End Grid Special Ore Stockpile	A	I	I	A	I	I	I
	Power Plant	A	I	A	A	I	I	I
	Incinerator	A	I	A	A	I	I	I
	Haulage routes between pits and mill or stockpiles	A	A	A	A	A	A	I
Haul Roads	Haul road between Kiggavik and Sissons	A	I	A	A	I	I	I
	Access Road to Baker Lake (1 km segment modelled)	A	A	A	A	A	I	I
	Road to Airstrip	A	A	A	A	A	I	I

Notes:
A = Active emission source
A* = Active emission source; radon only
I = Inactive emission source

6.1.3 Mitigation Measures and Project Design for Changes in Air COPCs

Design aspects, operational measures and other mitigation measures have been incorporated into the current Project plans which will minimize Project-associated emissions and/or the potential effect of Project-related emissions (i.e., increased ambient concentrations of COPCs). Mitigation measures that will be applied to reduce changes to ambient air quality are divided into three categories: Design-Based Mitigation; General Mitigation; and Activity-Specific Mitigation Measures. Each category is outlined below.

Design-Based Mitigation

- Several focussed dispersion modelling studies were conducted during the Project design phase to examine the potential effects of alternate locations of several of the Project facilities within the Project Footprint. These are as follows:
    - Acid Plant
    - Power Plant
    - Storage Piles
    - Accommodation Complex
- The locations utilized in this assessment reflect the outcome of these studies where the potential impacts to air quality have been minimized.

General Mitigation Measures

- Employ standard operating procedures for use of equipment and machinery
- Initiate a Dust Management Program in advance of Final EIS submission. The initial phase of this program is intended to identify appropriate chemical dust suppressants that may be applied as a control measure, in addition to further developing operational strategies that will assist in dust control.
- Perform regular maintenance of equipment and machinery in accordance with good engineering practices or as recommended by equipment suppliers such that the equipment is kept in good operating condition (e.g., effective fuel combustion)
- Develop community complaint/response procedure(s)
- Adhere to all permits, authorizations and/or approvals

Activity-Specific Mitigation Measures

- Heavy Equipment Operation, Vehicles and Marine Vessels
    - Where available, use diesel-powered heavy equipment equipped with appropriate exhaust emissions controls like catalytic converters and diesel particulate filters

- Optimize the number of heavy equipment movements and minimize travel distances, where possible
- Minimize the number of barge shipments and container off-loading activities
- Diesel fuel will meet the Canada-wide Diesel Sulphur Content standard of 15 ppm for off-road engines and marine vessels were assumed to have a sulphur fuel content of 1000 ppm

- Unpaved Road Transportation
  - Minimize or reduce vehicle speed on unpaved mine site roads (including pit ramps) and the Kiggavik-Sissons access road and enforce speed limits, where possible
  - Apply water or another approved dust suppressant to the surfaces of unpaved mine site roads (including pit ramps) and the Kiggavik-Sissons access road, when possible
  - Maintain all unpaved road surfaces via grading or other maintenance practices to minimize the amount of silt (i.e., fine particles) present in the roadbed material
- Blasting
  - Minimize the number of charges per day to reduce NO_x and particulate matter emissions
  - Optimize/minimize the use of ANFO to reduce emissions of NO_x
- Milling and Tailings Management
  - Appropriate air pollution controls will be installed on the exhaust stacks of the mill complex and acid plant (e.g., wet scrubbers, dust collectors)
  - Tailings will be released to the TMFs as a slurry below a water surface to avoid tailings dust emissions
  - Tailings will be treated to minimize the release of radon
- Post-closure
  - Where possible, permanent mine rock stockpiles will stabilized to minimize the release of long-term dust emissions. For example, pile could be compacted and/or re-vegetated to suppress emissions of dust.
- Installation of incinerator that complies with the Canada-wide Standards

6.1.4 Residual Effects Assessment for Change in Ambient Air Quality – Preferred Options

The analytical methods described in Section 6.1.1 above were applied to the construction, operation, final closure and post-closure phases of the Project to quantify how the Project, with mitigation, might result in changes to ambient air quality.

The following sections outline the potential effects of the Project for the preferred options for each project phase. Where applicable, the results from the CALPUFF air dispersion modelling have been presented in both graphical format showing the results in the LAA and RAA, and tabular format at specific receptor locations. Complete results are provided in Technical Appendix 4B – Air Dispersion Assessment.

Note that the predicted concentrations of COPCs presented and discussed herein are incremental concentrations above and beyond existing baseline air quality conditions. As discussed in Section 5.1.4, it was assumed that annual and 1- and 24-hour baseline concentrations of the various COPCs considered in this assessment would have a minimal contribution to the total predicted COPC concentrations from the Project and were not added to model predicted concentrations.

6.1.4.1 Construction

Construction of the Mine Development Area

The potential effects from construction of the Mine Development Area (i.e., the Kiggavik and Sissons mine sites) were evaluated through an emissions burden analysis, which is an accounting of the total emissions of key COPCs. Since construction emissions are generated within the same footprint as site operation emissions (i.e., the Mine Development Area), the emission rates for construction can be compared to the emissions for the maximum operation assessment to determine the potential effect of construction relative to maximum operations. If the emissions from construction are less than or equal to the maximum operation emissions, it can be inferred that the potential change in ambient air concentrations will also be the same or less.

The particulate matter emissions estimates from mine site construction are based on AP-42 emission factors for general construction activities. Table 6.1-3 presents a summary of the estimated emission rates for the mine construction scenario and the maximum operations assessment scenario. As can be seen in the table, emissions from construction of the Mine Development Area are less than those calculated for the maximum operation assessment. Thus, the potential effects during construction will likely be less than during maximum operations. As a result, the mine construction scenario was not carried forward to the dispersion modelling assessment. The effects of the maximum operation assessment are discussed in Section 6.1.4.2.

Table 6.1-3 Emissions Burden Analysis Results for Mine Construction

Assessment	Location	Emission Rate (g/s)					
		TSP	PM_{10}	$PM_{2.5}$	NO_x	SO_2	CO
Mine Development Area Construction	Kiggavik Mine Site	12.50	12.50	12.50*	14.40	0.08	3.06
	Sissons Mine Site	21.20	21.20*	21.20*	14.40	0.08	3.06
	Total	33.70	17.19	5.06	28.80	0.16	6.12
Maximum Operation Scenario	Kiggavik Mine Site	102.94	30.30	6.15	81.48	1.32	33.94
	Sissons Mine Site	127.56	27.21	6.3	43.36	1.10	36.80
	Total	230.50	67.51	12.45	124.84	2.42	70.74

Notes:

***Conservatively assumes all PM_{10} and $PM_{2.5}$ is the same as TSP emissions.**

Quarrying

Quarries will be used to supply aggregate for the construction of the mine sites and access roads. The potential effects to air quality from quarrying were quantified using separate air dispersion model runs for three possible (3) quarry locations. The quarries assessed were Q2, Q10 and Q18 whose locations are shown in Figure 6.1-1. Since the same activities are expected to occur at each quarry site, COPC emission rates were assumed to be the same from each quarry. Therefore, differences observed in the model predicted concentrations arise from the effects of terrain and air dispersion meteorology. Note that only short-term maximum effects were assessed since the lifespan of each quarry operation will be limited by the proximity of the construction activities to each quarry and by the amount of material available.

Table 6.1-4 presents the overall maximum predicted incremental concentration for each of the COPCs assessed. The results from the three selected quarries reflect the potential maximum local effects of any of the individual quarry sites. As can be seen in the table, all COPCs are well below their respective Indicator Thresholds. Figure 6.1-2 presents the maximum predicted 24-hour TSP concentrations in the vicinity of each of the quarries included in the dispersion modelling assessment. The figure shows that the TSP concentrations drop rapidly with distance away from each quarry, with measurable changes in concentration limited to less than 1 km from the edge of each quarry.

Table 6.1-4 Maximum Predicted COPC Concentrations at 500 m Distance from Selected Quarries

Quarry	UTM Coordinates (m)		Maximum Incremental Concentration (μg/m³) at a distance of 500 m from the Quarry						
	Easting	Northing	TSP	PM_{10}	$PM_{2.5}$	NO_2		SO_2	
			24-hour Maximum	24-hour Maximum	24-hour Maximum	1-hour Maximum	24-hour Maximum	1-hour Maximum	24-hour Maximum
Q2	573460	7152497	14.6	7.9	6.0	38.6	10.6	0.8	0.2
Q10	615476	7150167	9.5	5.6	4.3	37.2	7.5	0.7	0.1
Q18	642133	7138389	9.9	5.4	4.1	34.1	7.2	0.7	0.1
Indicator Threshold (μg/m³)			**120**	**50**	**-**	**400**	**200**	**450**	**150**

Notes:
TSP and SO_2 Thresholds based on Nunavut Department of Sustainable Development Environmental Guideline for Air Quality - Sulphur Dioxide & Suspended Particulates, 2002.
PM_{10} Threshold adopted from Ontario's Ambient Air Quality Criteria, Ontario Ministry of Environment Standards and Development Branch, 2008.
NO_2 Thresholds adopted from the NWT Department of Environment and Natural Resources Guideline for Ambient Air Quality Standards in the Northwest Territories, January 2011.

6.1.4.2 Operation

Mine Development Area

As described in Section 4.6, various operational phases were assessed for the Project in addition to a maximum emissions bounding scenario. Various operational phases (all but the maximum assessment) were assessed for the purpose of generating inputs for pathways exposure analysis, so it was important to capture these potential effects over longer averaging periods (i.e., annual averages). In contrast, the maximum emissions bounding scenario was designed to capture the highest potential short-term effects (i.e., 1-hour and 24-hour averages).

As a result, model-predicted ambient COPC concentrations from the phased operations assessments were used to evaluate long term effects, whereas the maximum bounding assessment was used to evaluate short-term effects.

Tables 6.1-5 and 6.1-6 provide the maximum predicted 1- and 24-hour incremental concentrations of the COPCs including particulate matter, uranium, NO_2, SO_2, and metals resulting from the maximum emissions bounding scenario at three sensitive POR locations. Table 6.1-7 and Table 6.1-8 provide model predicted annual average concentrations for operations phases 1 to 4 (see Section 4.6) at the same PORs. Contour plots are also provided to illustrate these concentrations graphically throughout the LAA and RAA. It should be noted that these figures do not represent a snapshot in time since the maximum concentrations at each receptor typically occur during different meteorological conditions (i.e., different hours and/or days) and thus do not occur simultaneously. These plots represent the highest predicted COPC concentrations at each location in the area. Complete model results from all assessment scenarios can be found in Technical Appendix 4B – Air Dispersion Assessment.

The predicted changes in ambient air concentrations due to operations for each of the COPCs or COPC groups assessed are discussed in more detail below.

Dust (TSP, PM_{10} and $PM_{2.5}$)

The maximum incremental 24-hour average concentrations of TSP, PM_{10} and $PM_{2.5}$ predicted for the maximum emissions bounding scenario are presented as graphically in Figure 6.1-3, Figure 6.1-4 and 6.1-5, respectively. As seen in the figures, the concentrations of TSP, PM_{10} and $PM_{2.5}$ exceed their respective Indicator Thresholds beyond the Project Footprint into a limited area of the LAA.

The frequency of exceedances beyond the Project Footprint were determined and are presented in Figures 6.1-6, 6.1-7 and 6.1-8 for TSP, PM_{10} and $PM_{2.5}$, respectively. As the figures demonstrate, there are very few exceedances of the criteria for TSP, PM_{10} and $PM_{2.5}$ beyond the Project Footprint. In particular, there are no more than 10 days of exceedances per year off-site for TSP, 15 days for PM_{10} and 1 day for $PM_{2.5}$. The figures also show that exceedances of the Indicator Thresholds occur up to about 3 to 4 km beyond the Project Footprint in the LAA for TSP, 2 to 3 km for PM_{10} and about 400 to 500 m for $PM_{2.5}$.

In addition, Table 6.1-5 shows that the maximum predicted incremental 24-hour concentrations of TSP and PM_{10} are above the Indicator Thresholds at the Accommodation Complex. The frequency of these exceedances is also shown in the table. In contrast, the $PM_{2.5}$ Indicator Threshold is not exceeded at the Accommodation Complex. As discussed earlier in Section 4.8, even though there are on-site exceedances of the Indicator Thresholds, this is not considered to be a residual effect.

Figures 6.1-9 through 6.1-12 present the annual average TSP concentrations for operations phases 1 to 4. Annual plots for PM_{10} and $PM_{2.5}$ are provided in Technical Appendix 4B – Air Dispersion Assessment. On an annual basis, the predicted average TSP concentrations are below the Indicator Threshold of 60 µg/m³ at receptor locations within the LAA and RAA as well as at sensitive PORs as indicated in Table 6.1-7.

Uranium and Metals

Table 6.1-5 shows that the maximum incremental 24-hour uranium concentration predicted for the maximum emission bounding scenario at the Accommodation Complex is 0.31 µg/m³, which is slightly above the applicable Indicator Threshold of 0.3 µg/m³. The number of exceedances is also indicated in the table. However, as discussed previously, exceedances of the Indicator Thresholds within the Project Footprint are not a measure of potential changes to air quality in the LAA and RAA. The potential effects to human health resulting from changes in air concentrations of uranium and other COPCs at the Accommodation Complex have been assessed in Volume 8.

The maximum predicted 24-hour average concentration of uranium is also presented graphically in Figure 6.1-13 for the maximum bounding scenario. The figure illustrates that the maximum predicted uranium concentrations are above the Indicator Threshold beyond the Project Footprint, into the LAA, which is considered to be a residual effect. The frequency of exceedances within the LAA is presented graphically in Figure 6.1-14. This figure shows that the number of exceedances within approximately 1 km of the Kiggavik mine site is limited to a single day. Similarly, within about 500 m or less of the Sissons mine site, exceedances are also limited to one day.

Maximum predicted 24-hour concentrations of metals are presented in Table 6.1-6 at the sensitive POR locations for the maximum bounding scenario. As can be seen in the table, all predicted concentrations are well within their applicable 24-hour Indicator Thresholds at these locations. Since uranium and metals were calculated as a fraction of TSP, the contour plots for each of the metals assessed tend to follow a similar pattern to the uranium contour plot (Figure 6.1-13). Additionally, the maximum predicted 24-hour concentrations for all metals are below the Indicator Thresholds within the Project Footprint as well as at all LAA and RAA receptor locations. As such, the plots are not presented here, but can be found in Technical Appendix 4B – Air Dispersion Assessment.

Incremental annual concentrations of uranium for operation phases 1 to 4 are provided in Table 6.1-7 and in Table 6.1-8 for metals, respectively. As can be seen in the tables, during each phase, all of the predicted incremental concentrations are well below their respective Indicator Thresholds at the Accommodation Complex. There are also no exceedances of either the uranium or metal Indicator Thresholds at any off-site receptor locations within the LAA and RAA. Annual uranium and metal contour plots follow similar patterns to annual TSP contour plots and are provided in Technical Appendix 4B – Air Dispersion Assessment.

Gaseous COPCs

Table 6.1-5 shows that the maximum predicted 1- and 24-hour concentrations of NO_2 and SO_2 are below their respective Indicator Thresholds at all three sensitive PORs for the maximum bounding emissions scenario. The results are also presented graphically in the following figures: Figure 6.1-15 (1-hour NO_2), Figure 6.1-16 (24-hour NO_2), Figure 6.1-17 (1-hour SO_2) and Figure 6.1-18 (24-hour SO_2).

As shown in Figures 6.1-17 and 6.1-18, 1- and 24-hour maximum concentrations of SO_2 are well within the limits of the Indicator Thresholds at all receptor locations in the LAA and RAA. In contrast, the 1- and 24-hour NO_2 concentrations exceed their Indicator Thresholds both within the Project Footprint, extending into the LAA. These exceedances can be attributed large emissions of NO_x from open pit mining activities, including diesel-powered mining equipment and blasting, and are considered to be a residual effect.

Figure 6.1-19 and Figure 6.1-20 present the frequency analysis for 1- and 24-hour NO_2 concentrations, respectively. As the figures demonstrate, there are very few exceedances of the NO_2 Indicator Thresholds beyond the Project Footprint. In particular, there are no more than 11 days of exceedances of the 24-hour Threshold (or 3%) and no more than 140 hours (1.6%) when the 1-hour Indicator Threshold was exceeded. In addition, exceedances of the 24-hour Threshold are limited to an area within 500 m of the Sissons mine site and 900 m of the Kiggavik mine site. Similarly, exceedances of the 1-hour Threshold extend no more than 1.4 km from the Kiggavik mine site and 1.5 km from the Sissons mine site.

With respect to NO_2 concentrations, however, it should be noted that the model conservatively assumed that emissions from regular mining activities and blasting occurred concurrently for each hour over 24 hours a day when in reality, blasting emissions are intermittent and tend to last only minutes. As a result, the tabular results and contours presented here are overestimates of 1-hour NO_2 concentrations. Further discussion is provided in Technical Appendix 4B – Air Dispersion Assessment.

Annual concentrations of NO_2 and SO_2 for each operational phase assessed are shown in Table 6.1-7 at the sensitive PORs. The highest annual NO_2 and SO_2 concentrations at the Accommodation Complex occur during Period 1, having concentrations of 13.65 μg/m³ and 1.31 μg/m³, respectively, which are below their applicable Indicator Thresholds. Similar to the trends seen in the annual average TSP concentrations, the spatial variability in annual average concentrations of gaseous COPCs reflect the dependence of emissions on specific mining activities. Annual contour plots for NO_2 and SO_2 can be found in the Technical Appendix 4B – Air Dispersion Assessment.

Radionuclides

Table 6.1-7 shows that the highest annual incremental concentrations of radionuclides at the Accommodation Complex are 12.45 Bq/m³ for radon, and 2.10E-04 Bq/m³ for both Pb-210 and Po-210, depending on the phase assessed. The predicted radionuclide concentrations during operations phases 1 and 2 reflect the influence of both mining activities and mill operations at the Kiggavik mine site. During phases 3 and 4, the predicted radionuclide concentrations are primarily a result of mill emissions, including the ore pile. Since radionuclides only have applicable Indicator Thresholds with an annual averaging period, the annual radionuclide concentrations for the maximum emissions scenario are not presented. As discussed previously, annual emissions are overestimated in the maximum emissions scenario, which is only representative for COPCs having 1- and 24-hour Indicator Thresholds.

The annual average radon concentrations are also provided graphically in Figure 6.1-21 through 6.1-24 and Figures 6.1-25 through 6.1-28 for Pb-210 (and Po-210) to demonstrate the spatial and temporal variability of annual radionuclide concentrations across the lifetime of the Project. As both the figures and Table 6.1-7 show, predicted annual radionuclide concentrations are well below their respective Indicator Thresholds at all receptor locations in the LAA and RAA and at the sensitive PORs.

Table 6.1-5 Maximum Incremental 1- and 24-hour Concentrations of COPCs

Discrete Receptor	UTM Coordinates (m)		Maximum Incremental Concentration (µg/m³)								
			TSP	PM_{10}	$PM_{2.5}$		Uranium	NO_2		SO_2	
	Easting	Northing	24-hour	24-hour	24-hr 98th Percentile	24-hour	24-hour	1-hour	24-hour	1-hour	24-hour
Accommodation Complex	564900	7148433	**283.20 (8 days)**	**115.20 (12 days)**	14.13	22.50	**0.31 (1 day)**	380.70	171.90	41.00	15.40
Community of Baker Lake	644179	7135840	0.70	0.60	0.06	0.20	0.00	3.80	1.00	0.16	0.04
Judge Sissons Lake Cabin	566550	7137729	12.80	11.10	0.88	2.00	0.02	36.50	12.90	2.70	0.80
Indicator Threshold (µg/m³)			**120**	**50**	**30***	-	**0.3**	**400**	**200**	**450**	**150**

Notes:
Red text indicates that a value is greater than the air quality criteria. Number of exceedances indicated in brackets.
Concentrations predicted as a result of all sources, including blasting.
TSP and SO_2 Thresholds based on Nunavut Department of Sustainable Development Environmental Guideline for Air Quality - Sulphur Dioxide & Suspended Particulates, 2002.
PM_{10} Threshold adopted from Ontario's Ambient Air Quality Criteria, Ontario Ministry of Environment Standards and Development Branch, 2008.
* Canada-Wide Standard for PM2.5 based on the average 98th percentile over 3 consecutive years. Note that modelling only occurred over 1 year.
NO_2 Thresholds adopted from the NWT Department of Environment and Natural Resources Guideline for Ambient Air Quality Standards in the Northwest Territories, January 2011.
Uranium Threshold adopted from the Ontario Ministry of Environment's new AAQC under Regulation 419/05 accepted June 22, 2011. EBR No. 010-7190

Table 6.1-6 Maximum Incremental 24-hour Metal Concentrations

Receptor Name	UTM Coordinates (m)		24-hour Maximum Incremental Concentration (µg/m³)									
	Easting	Northing	As	Cd	Cr	Co	Cu	Pb	Mo	Ni	Se	Zn
Accommodation Complex	564900	7148433	8.10E-04	5.30E-05	2.60E-02	3.60E-03	6.10E-03	1.80E-02	7.60E-03	1.10E-02	4.90E-04	1.10E-02
Community of Baker Lake	644179	7135840	8.30E-06	2.70E-07	1.60E-04	1.50E-05	2.80E-05	5.60E-05	1.80E-05	6.00E-05	2.90E-06	4.60E-05
Judge Sissons Lake Cabin	566550	7137729	1.60E-04	5.70E-06	4.60E-03	2.40E-04	5.00E-04	9.70E-04	3.70E-04	1.30E-03	6.00E-05	7.10E-04
Indicator Threshold (µg/m³)			**0.3**	**0.025**	**0.5**	**0.1**	**50**	**0.5**	**120**	**0.2***	**10**	**120**

Notes:
24-hour Thresholds provided in Ontario's Ambient Air Quality Criteria, Ontario Ministry of Environment Standards and Development Branch, 2008.
*Nickel Threshold adopted from the Ontario Ministry of Environment's new standard under Regulation 419/05 accepted June 22, 2011. EBR No. 010-7190.

Table 6.1-7 Annual Incremental COPC Concentrations for Operation Period 1 to 4

Discrete Receptor	UTM Coordinates (m)		Operation Period	Annual Incremental Concentration (µg/m³)								
	Easting	Northing		TSP	PM_{10}	$PM_{2.5}$	Uranium	NO_2	SO_2	Radon (Bq/m³)	Pb-210	Po-210
Accommodation Complex	564900	7148433	Period 1 (Year 0-1)	19.58	8.68	1.97	0.01	13.65	1.31	7.72	1.50E-04	1.50E-04
			Period 2 (Year 2-5)	14.32	6.97	1.81	0.02	10.39	0.63	12.45	2.10E-04	2.10E-04
			Period 3 (Year 6-13)	4.82	2.99	1.12	0.01	6.22	0.36	10.88	1.30E-04	1.30E-04
			Period 4 (Year 14)	1.42	1.02	0.56	0.01	6.56	0.13	9.09	8.20E-05	8.20E-05
			Maximum	19.58	8.68	1.97	0.02	13.65	1.31	12.45	2.10E-04	2.10E-04
Community of Baker Lake	644179	7135840	Period 1 (Year 0-1)	0.01	0.01	0.00	0.00	0.03	0.00	0.01	1.40E-07	1.40E-07
			Period 2 (Year 2-5)	0.02	0.01	0.00	0.00	0.04	0.00	0.01	2.10E-07	2.10E-07
			Period 3 (Year 6-13)	0.01	0.01	0.00	0.00	0.04	0.00	0.01	2.00E-07	2.00E-07
			Period 4 (Year 14)	0.00	0.00	0.00	0.00	0.02	0.00	0.01	3.00E-08	3.00E-08
			Maximum	0.02	0.01	0.00	0.00	0.04	0.00	0.01	2.10E-07	2.10E-07
Judge Sissons Lake Cabin	566550	7137729	Period 1 (Year 0-1)	0.53	0.34	0.08	0.00	0.78	0.06	0.19	5.30E-06	5.30E-06
			Period 2 (Year 2-5)	0.77	0.47	0.11	0.00	0.80	0.03	0.29	7.80E-06	7.80E-06
			Period 3 (Year 6-13)	0.41	0.29	0.08	0.00	0.59	0.02	0.24	5.10E-06	5.10E-06
			Period 4 (Year 14)	0.05	0.04	0.03	0.00	0.40	0.00	0.20	1.00E-06	1.00E-06
			Maximum	0.77	0.47	0.11	0.00	0.80	0.06	0.29	7.80E-06	7.80E-06
Indicator Threshold (µg/m³)				**60**	**-**	**-**	**0.03**	**60**	**30**	**60 (Bq/m³)**	**0.21 (Bq/m³)**	**0.028 (Bq/m³)**

Notes:
NO_2 concentrations predicted as a result of all sources, including blasting.
TSP and SO_2 Thresholds based on Nunavut Department of Sustainable Development Environmental Guideline for Air Quality - Sulphur Dioxide & Suspended Particulates, 2002.
PM_{10} Threshold adopted from Ontario's Ambient Air Quality Criteria, Ontario Ministry of Environment Standards and Development Branch, 2008.
NO_2 AQ Thresholds from the NWT Department of Environment and Natural Resources Guideline for Ambient Air Quality Standards in the Northwest Territories, January 2011.
Uranium Threshold adopted from the Ontario Ministry of Environment's new AAQC under Regulation 419/05 accepted June 22, 2011. EBR No. 010-7190

Table 6.1-8 Annual Incremental Metals Concentrations for Operation Period 1 to 4

Discrete Receptor	UTM Coordinates (m)		Operation Period	Annual Concentration (µg/m³)									
	Easting	Northing		As	Cd	Cr	Co	Cu	Pb	Mo	Ni	Se	Zn
Accommodation Complex	564900	7148433	Period 1 (Year 0-1)	8.30E-04	3.70E-06	1.50E-03	2.80E-04	4.80E-04	1.00E-03	3.20E-04	7.90E-04	3.10E-05	9.00E-04
			Period 2 (Year 2-5)	4.20E-04	3.10E-06	1.00E-03	1.80E-04	3.00E-04	1.20E-03	6.00E-04	5.30E-04	2.30E-05	5.30E-04
			Period 3 (Year 6-13)	6.10E-04	1.60E-06	9.80E-04	3.00E-05	9.90E-05	4.20E-04	8.50E-05	1.60E-04	5.60E-06	9.00E-05
			Period 4 (Year 14)	4.50E-04	1.00E-06	6.20E-04	1.20E-05	4.80E-05	2.80E-04	5.50E-05	8.20E-05	2.30E-06	3.60E-05
			Maximum	8.30E-04	3.70E-06	1.50E-03	2.80E-04	4.80E-04	1.20E-03	6.00E-04	7.90E-04	3.10E-05	9.00E-04
Community of Baker Lake	644179	7135840	Period 1 (Year 0-1)	1.50E-06	3.10E-09	1.50E-06	3.00E-07	4.60E-07	9.10E-07	3.00E-07	8.30E-07	3.40E-08	9.40E-07
			Period 2 (Year 2-5)	2.30E-06	4.50E-09	2.50E-06	3.40E-07	5.30E-07	1.10E-06	4.50E-07	1.20E-06	5.30E-08	1.00E-06
			Period 3 (Year 6-13)	3.80E-06	5.00E-09	3.40E-06	1.60E-07	3.70E-07	8.20E-07	1.60E-07	9.90E-07	4.60E-08	5.20E-07
			Period 4 (Year 14)	3.10E-07	4.70E-10	3.20E-07	9.80E-09	2.60E-08	1.00E-07	1.80E-08	6.80E-08	2.70E-09	3.20E-08
			Maximum	3.80E-06	5.00E-09	3.40E-06	3.40E-07	5.30E-07	1.10E-06	4.50E-07	1.20E-06	5.30E-08	1.00E-06
Judge Sissons Lake Cabin	566550	7137729	Period 1 (Year 0-1)	4.20E-05	1.20E-07	5.70E-05	1.10E-05	1.70E-05	3.60E-05	1.30E-05	3.00E-05	1.30E-06	3.40E-05
			Period 2 (Year 2-5)	3.90E-05	1.60E-07	8.80E-05	1.30E-05	2.00E-05	4.40E-05	1.80E-05	4.20E-05	1.90E-06	4.00E-05
			Period 3 (Year 6-13)	1.30E-04	1.30E-07	9.70E-05	4.80E-06	1.20E-05	2.30E-05	4.60E-06	2.80E-05	1.30E-06	1.50E-05
			Period 4 (Year 14)	7.60E-06	1.50E-08	9.60E-06	2.70E-07	8.10E-07	3.50E-06	6.70E-07	1.80E-06	6.70E-08	8.40E-07
			Maximum	1.30E-04	1.60E-07	9.70E-05	1.30E-05	2.00E-05	4.40E-05	1.80E-05	4.20E-05	1.90E-06	4.00E-05
Indicator Threshold (µg/m³)				0.06	0.005	0.3	0.02	9.6	0.1	23	0.4	1.9	23

Notes:
Annual Indicator Thresholds developed from in Ontario's Ambient Air Quality Criteria, Ontario Ministry of Environment Standards and Development Branch, 2008.
*Nickel Threshold adopted from the Ontario Ministry of Environment's new standard under Regulation 419/05 accepted June 22, 2011. EBR No. 010-7190.

Dust Deposition and Potential Acid Input

Table 6.1-9 presents the predicted average annual and total annual dust deposition levels at the sensitive POR locations for Year 2-5 (operation period 2). Total annual dust deposition is also presented graphically in Figure 6.1-29. As can be seen in the figure, exceedances of the total annual Indicator Threshold were only predicted to occur over a small area within the Project Footprint.

Table 6.1-9 Incremental Annual Average and Total Annual TSP Deposition for Operation Period 2

Receptor Name	UTM Coordinates (m)		TSP Deposition	
	Easting	Northing	Average Annual (g/m^2/30 days)	Total Annual (g/m^2/year)
Camp	564900	7148433	5.20E-01	6.32E+00
Baker Lake	644179	7135840	1.78E-04	2.17E-03
Judge Sissons Lake	566550	7137729	3.21E-02	3.91E-01
		Indicator Threshold	**4.6 g/m^2/30 days**	**55 g/m^2/year**

Table 6.1-10 provides the estimated annual Potential Acid Input (PAI) values in the local assessment area (LAA). As is shown in the table, PAI values did not exceed either the 0.5 keq/ha/yr or 1.0 keq/ha/year thresholds. However there were exceedances of the 0.25 keq/ha/year Threshold to within approximately 1 km of the Project Footprint at the Kiggavik site. The potential environmental effects of these PAI values are further evaluated in Volume 6 of the EIS.

Table 6.1-10 Estimated Annual Potential Acid Input based on Period 2 (Year 2-5) NO_2 and SO_2 Emissions

Parameter	Background PAI (keq/ha/yr)	Total PAI (keq/ha/yr)		Mine Contribution to PAI (%)
		Kiggavik	Sissons	
Max. Annual Average Deposition	0.093	0.294	0.172	68%
Area above 0.17 keq/ha/yr (ha)	0	2200	0	100%
Area above 0.22 keq/ha/yr (ha)	0	730	0	100%
Area above 0.25 keq/ha/yr (ha)	0	225	0	100%
Area above 0.50 keq/ha/yr (ha)	0	0	0	n/a
Area above 1.00 keq/ha/yr (ha)	0	0	0	n/a

Notes:
Mine contribution refers to both mine sites, Kiggavik and Sissons.

Preferred South Winter Road

Separate model runs were completed to assess the effects of the preferred Access Road Option (i.e., the south winter road) for connecting the Mine Development Area to the Dock and Storage Facility. Table 6.1-11 shows the overall maximum predicted concentrations of TSP, PM_{10}, $PM_{2.5}$, NO_2 and SO_2 which are all well below their applicable Indicator Thresholds. More specifically, the predicted overall maximum 24-hour concentration of TSP is 44.95 µg/m³ which is 37% of the Indicator Threshold of 120 µg/m³. The TSP results are also presented graphically in Figure 6.1-31. NO_2 and SO_2 concentrations are both less than 0.2% of their 1-hour, 24-hour and annual Thresholds.

Additional plots for PM_{10}, $PM_{2.5}$, NO_2 and SO_2 are provided in Technical Appendix 4B – Air Dispersion Assessment.

Dock and Storage Facility

A separate model run was also completed to assess the effects of day-to-day operations at the Dock and Storage Facility. The predicted incremental concentrations of particulate (TSP, PM_{10} and $PM_{2.5}$) and gaseous compounds (NO_2 and SO_2) at the receptor representing the community of Baker Lake are provided in Table 6.1-12. At this receptor location, incremental concentrations for all constituents are well below all applicable Indicator Thresholds.

Contour plots showing the incremental concentrations of TSP, NO_2 and SO_2 over short-term averaging periods in and around the Dock and Storage Facility are provided in Figures 6.1-32 through 6.1-36. PM_{10} and $PM_{2.5}$ contour plots are similar to TSP and provided in Technical Appendix 4B – Air Dispersion Assessment. Since the Facility will likely operate over a short period annually (i.e., from late July to September), predicted annual concentrations are relatively low (less than 10% of applicable criteria) and are therefore only presented in Technical Appendix 4B – Air Dispersion Assessment.

As indicated by Figures 6.1-32, 6.1-35 and 6.1-36, incremental TSP and SO_2 concentrations are well below their applicable Thresholds surrounding the Dock and Storage Facility. In contrast, 1- and 24-hour NO_2 Indicator Thresholds are exceeded in the area surrounding the Facility, extending to about 1 km southwest of the Dock and Storage Facility over the water, which is considered to be a residual effect. Frequency plots are provided in Figure 6.1-37 (1-hour NO_2) and Figure 3.1-38 (24-hour NO_2).

6.1.4.3 Final Closure

The predicted incremental annual concentrations of various COPCs for the final closure phase of the Project are presented in Table 6.1-13. Contour plots for TSP, uranium and radon are also presented in Figures 6.1-39 through Figure 6.1-41. Incremental annual concentrations for metals are shown in Table 6.1-14. Contour plots for the remaining COPCs are provided in Technical Appendix 4B – Air Dispersion Assessment.

As can be seen in both the tables and figures, all COPCs were well below applicable criteria during the final closure phase. Compared to the operational phases, incremental TSP and uranium concentrations are much lower during closure; however, the radon concentration predicted at the Accommodation Complex during closure is of the same order of magnitude as radon during the operational phase of the project.

6.1.4.4 Post-Closure

The only COPC assessed for post-closure was radon, since all closure activities were assumed to have been completed, and all TMFs charged and covered. The incremental annual radon concentrations predicted at discrete receptor locations during post-closure are presented in Table 6.1-15 and the contour plot is provided in Figure 6.1-42 As can been seen in both table and figure, the predicted incremental radon concentrations are well below the annual Threshold of 60 Bq/m^3 within the LAA and RAA.

Table 6.1-11 Overall Maximum Incremental Dust and Gaseous COPC Concentrations Predicted for the Preferred Access Road Option

Access Road Option	Overall Maximum Incremental Concentration											
	TSP (μg/m^3)		PM_{10} (μg/m^3)		$PM_{2.5}$ (μg/m^3)		NO_2 (μg/m^3)			SO_2 (μg/m^3)		
	24-hr Maximum	Annual	24-hr Maximum	Annual	24-hr Maximum	Annual	1-hr Maximum	24-hr Maximum	Annual	1-hr Maximum	24-hr Maximum	Annual
South Winter Road	44.95	1.83	13.10	0.51	1.37	0.05	6.5E-01	4.3E-01	1.7E-02	5.6E-02	3.7E-02	1.4E-03
Indicator Threshold (μg/m^3)	**120**	**60**	**50**	-	-	-	**400**	**200**	**100**	**450**	**150**	**30**

Notes:
TSP and SO_2 Thresholds based on Nunavut Department of Sustainable Development Environmental Guideline for Air Quality - Sulphur Dioxide & Suspended Particulates, 2002.
PM_{10} Threshold adopted from Ontario's Ambient Air Quality Criteria, Ontario Ministry of Environment Standards and Development Branch, 2008.
NO_2 Thresholds adopted from the NWT Department of Environment and Natural Resources Guideline for Ambient Air Quality Standards in the Northwest Territories, January 2011.

Table 6.1-12 Dock and Storage Facility Incremental Dust and Gaseous Concentrations Predicted at the Community of Baker Lake

Receptor	UTM Coordinates (m)		Incremental Concentration									
			TSP (μg/m^3)		PM_{10} (μg/m^3)	PM2.5 (μg/m^3)	NO_2 (μg/m^3)			SO_2 (μg/m^3)		
	Easting	Northing	24-hour Maximum	Annual	24-hour Maximum	24-hour Maximum	1-hour Maximum	24-hour Maximum	Annual	1-hour Maximum	24-hour Maximum	Annual
Community of Baker Lake	644179	7135840	8.8E-01	7.7E-05	8.7E-01	8.0E-01	59.86	11.70	0.19	5.51	1.11	0.02
Indicator Threshold (μg/m^3)			**120**	**60**	**50**	**-**	**400**	**200**	**100**	**450**	**150**	**30**

Notes:
TSP and SO_2 Thresholds based on Nunavut Department of Sustainable Development Environmental Guideline for Air Quality - Sulphur Dioxide & Suspended Particulates, 2002.
PM_{10} Threshold adopted from Ontario's Ambient Air Quality Criteria, Ontario Ministry of Environment Standards and Development Branch, 2008.
NO_2 Thresholds adopted from the NWT Department of Environment and Natural Resources Guideline for Ambient Air Quality Standards in the Northwest Territories, January 2011.

Table 6.1-13 Incremental Annual COPC Concentrations during Final Closure

Receptor Name	UTM Coordinates (m)		Incremental Annual Concentration (µg/m³)								
	Easting	Northing	TSP	PM_{10}	$PM_{2.5}$	Uranium	NO_2	SO_2	Radon (Bq/m^3)	Pb-210 (Bq/m^3)	Po-210 (Bq/m^3)
Accommodation Complex	564900	7148433	1.10	0.69	0.42	0.00	6.40	0.03	6.40	8.2E-06	8.2E-06
Community of Baker Lake	644179	7135840	0.00	0.00	0.00	0.00	0.01	0.00	0.01	1.3E-08	1.3E-08
Judge Sissons Lake Cabin	566550	7137729	0.05	0.04	0.03	0.00	0.43	0.00	0.43	4.8E-07	4.8E-07
Indicator Threshold (µg/m³)			**60**	**-**	**-**	**0.03**	**100**	**30**	**60 (Bq/m^3)**	**0.21 (Bq/m^3)**	**0.028 (Bq/m^3)**

Notes:
TSP and SO_2 Thresholds based on Nunavut Department of Sustainable Development Environmental Guideline for Air Quality - Sulphur Dioxide & Suspended Particulates, 2002.
PM_{10} Threshold adopted from Ontario's Ambient Air Quality Criteria, Ontario Ministry of Environment Standards and Development Branch, 2008.
NO_2 Thresholds adopted from the NWT Department of Environment and Natural Resources Guideline for Ambient Air Quality Standards in the Northwest Territories, January 2011.
Uranium Threshold adopted from the Ontario Ministry of Environment's new AAQC under Regulation 419/05 accepted June 22, 2011. EBR No. 010-7190

Table 6.1-14 Predicted Incremental Annual Metal Concentrations during Final Closure

Receptor Name	UTM Coordinates (m)		Incremental Annual Concentration ($\mu g/m^3$)									
	Easting	Northing	As	Cd	Cr	Co	Cu	Pb	Mo	Ni	Se	Zn
Accommodation Complex	564900	7148433	1.3E-06	6.1E-08	5.6E-05	1.1E-05	3.5E-05	2.5E-05	1.1E-05	2.7E-05	1.5E-06	3.5E-05
Community of Baker Lake	644179	7135840	3.6E-09	1.5E-10	1.3E-07	1.5E-08	4.0E-08	3.5E-08	1.1E-08	5.3E-08	2.7E-09	4.8E-08
Judge Sissons Lake Cabin	566550	7137729	1.3E-07	5.1E-09	4.5E-06	5.3E-07	1.6E-06	1.3E-06	4.5E-07	1.8E-06	9.6E-08	1.8E-06
Indicator Threshold ($\mu g/m^3$)			0.06	0.005	0.3	0.02	9.6	0.10	23	0.4	1.9	23

Notes:
Annual Indicator Thresholds developed from in Ontario's Ambient Air Quality Criteria, Ontario Ministry of Environment Standards and Development Branch, 2008.
*Nickel AQ criteria adopted from the Ontario Ministry of Environment's new standard under Regulation 419/05 accepted June 22, 2011. EBR No. 010-7190.

Table 6.1-15 Predicted Incremental Annual Radon Concentrations during Post-Closure

Receptor Name	UTM Coordinates (m)		Radon (Bq/m^3)
	Easting	Northing	Annual Concentration
Accommodation Complex	564900	7148433	1.1E+00
Community of Baker Lake	644179	7135840	3.1E-03
Judge Sissons Lake Cabin	566550	7137729	8.4E-02
		Indicator Threshold (Bq/m^3)	**60**

6.1.5 Residual Effects Assessment for Change in Ambient Air Quality – Other Options

6.1.5.1 Access Road Options

An access road will be required for transporting mill reagents, fuel and other supplies to the Kiggavik Project site from Baker Lake. Currently there are two proposed options: a winter access road and an all-season road; there are presently two potential routes for the winter road, a south route and a north route. All options were assessed.

Two potential routes for a winter road were assessed with the South Winter Road being the Preferred Option (Section 6.1.4.2). Most of the North Winter Road will utilize ice surfaces provided by existing lakes and estuaries, whereas approximately 50% of the south route will cross over land. Over-land crossings will require the construction of either a snow/ice pad over frozen subgrade or a thin pad of granular fill over frozen subgrade. It is estimated that eventually 50% of over-land crossings will consist of granular fill and was taken into account as such.

As an alternative to the winter road options, the All-Season Road option was also assessed. This road will be constructed using granular fill excavated from bedrock quarries located at various locations along the route.

Comparison of Other Options – North All-Season Road / North Winter Road

The overall maximum TSP, NO_2 and SO_2 concentrations predicted for the North Winter Road operation scenario and North All-Season Road are provided in Table 6.1-16 and compared to the South Winter Road option. For all scenarios, predicted COPC concentrations were all below their respective Indicator Thresholds. Comparing all three options, short-term (24-hour) and long-term (annual) concentrations of particulate-based COPCs (TSP, PM_{10} and $PM_{2.5}$) were highest for the North All-Season Road. Since this roadway will be completely constructed with granular fill, dust emissions are greater than the winter road options in which only sections of the roadway are constructed with granular fill over a frozen subgrade. In contrast, gaseous compounds have higher 1- and 24-hour concentrations predicted for the Winter Access Road Options. This a result of higher traffic counts compared to the All-Season Road; daily traffic volumes are higher for both of the Winter Road Options because of a narrower operating window of 90 days.

Table 6.1-16 Overall Maximum Incremental TSP, NO_2 and SO_2 Concentrations predicted for each Access Road Option

Access Road Option	Overall Maximum Incremental Concentration							
	TSP (µg/m³)		NO_2 (µg/m³)			SO_2 (µg/m³)		
	24-hr Maximum	Annual	1-hr Maximum	24-hr Maximum	Annual	1-hr Maximum	24-hr Maximum	Annual
North All-Season Road	54.92	5.11	1.40E-01	7.00E-02	8.80E-03	1.00E-02	5.40E-03	6.70E-04
North Winter Road	52.76	3.25	8.40E-01	4.80E-01	2.80E-02	7.30E-02	4.10E-02	2.40E-03
South Winter Road	44.95	1.83	6.50E-01	4.30E-01	1.70E-02	5.60E-02	3.70E-02	1.40E-03
Indicator Threshold (µg/m³)	**120**	**60**	**400**	**200**	**100**	**450**	**150**	**30**

Notes:
TSP and SO_2 Thresholds based on Nunavut Department of Sustainable Development Environmental Guideline for Air Quality - Sulphur Dioxide & Suspended Particulates, 2002.
NO_2 Thresholds adopted from the NWT Department of Environment and Natural Resources Guideline for Ambient Air Quality Standards in the Northwest Territories, January 2011.

6.1.5.2 Dock and Storage Facility Options

The Dock and Storage Facility options (North Shore Site 2 and 3) are greater than 6 km from the closest receptor in Baker Lake whereas the preferred Dock and Storage Facility (North Shore Site 1) is approximately 2.5 km away. As such, it is expected that the predicted ambient air concentrations would be lower than those presented previously for the Preferred Option at the Community of Baker Lake receptor (Table 6.1-12). Within the localized area surrounding the either North Shore Site 2 or 3, the ambient concentrations would be the same magnitude as those predicted for the Preferred Option.

6.1.5.3 Power Plant Options

Two options have been considered for power generation at the Mine Development Area; central power generation (power generation at the Kiggavik mine site with transmission lines to the Sissons mine site) and de-central power generation (power generation at both the Kiggavik and Sissons mine sites). The de-central power generation option is the preferred option and includes five (one standby, one maintenance) 4,190 kW generators at the Kiggavik mine site and five (one standby, one maintenance) 1,450 kW generators at the Sissons mine site. The central power generation option includes five (one standby, one maintenance) 5,570 kW generators at the Kiggavik mine site.

For the purpose of this assessment, the maximum power plant output and maximum overall equipment configuration were used for each mine site (i.e., four 4,190 kW generators operating at the Kiggavik mine site and one 4,190 kW generators operating at the Sissons mine site) in the maximum bounding scenario. This scenario was considered to conservatively bound all power plant options and thus no additional modelling was undertaken.

6.1.6 Summary of Residual Effects to Air Quality

Operations of the Project facilities are predicted to result in increased ambient concentrations of dust, uranium, and NO_2 relative to baseline beyond their respective Indicator Thresholds. It is therefore concluded that there will be residual Project effects to air quality. Identified residual effects are summarized in Table 6.1-17.

As noted in Section 4.4.1, dust deposition and PAI are considered not to be indicative of air quality, but rather have been calculated for use in assessing the potential environmental effects to other VECs including the aquatic environment, terrestrial environment and human health. Although the results were summarized in Section 6.1.2.2 and compared to selected Indicator Thresholds, residual effects have not been identified.

Table 6.1-17 Summary of Identified Residual Effects to Air Quality

Project Phase	Assessment Area	COPC(s) Assessed	Averaging Period	Residual Effect (Y/N?)
Construction	Quarries	Dust & gaseous COPCs	All	N
	Mine Development Area	Dust & gaseous COPCs	All	N
Operations	Mine Development Area	NO_2	1-hour	Y
		NO_2, TSP, PM_{10}, $PM_{2.5}$, uranium	24-hour	Y
		Metals, radionuclides & remaining gaseous COPCs	All	N
	Dock and Storage Facility	NO_2	1- and 24-hour	Y
	Access Roads	Dust & gaseous COPCs	All	N
Final Closure	Mine Development Area	All COPCs	All	N
Post-Closure	Mine Development Area	Radionuclides	Annual	N

6.1.7 Determination of Significance of Residual Effects to Air Quality

As discussed in Section 4.8, a residual effect is predicted when modelled concentrations are above relevant Indicator Thresholds beyond the Project Footprint as outlined in Table 4.8-1. If a predicted concentration is greater than the relevant Indicator Threshold, the magnitude, geographic extent and frequency of exceedances of the Threshold were evaluated using the significance criteria in Table 4.9-1 to determine whether a residual effect is considered significant.

The residual environmental effect of operations at the Project Mine Development Area on ambient TSP, PM_{10}, $PM_{2.5}$, uranium and NO_2 concentrations is predicted to be moderate to high in magnitude. However, exceedances of Indicator thresholds will not extend beyond 2 km from the Project Footprint and will be sporadic or infrequent. Similarly, the residual environmental effect of operations at the Project Dock and Storage Facility on ambient NO_2 concentrations is predicted to be moderate to high in magnitude, but exceedances of the Indicator Thresholds will not occur beyond 2 km of the Project Footprint and will be infrequent.

With implementation of the proposed mitigation and environmental protection measures, the residual Project environmental effects of increased ambient concentrations 24-hour TSP, PM_{10}, $PM_{2.5}$ and uranium from the Mine Development Area as well as the 1-hour and 24-hour concentrations of NO_2 from both the Mine Development Area and Baker Lake Dock operations are predicted to be not significant (Table 6.1-18). Residual Project effects to air quality in the vicinity of the Mine Development Area and Baker Lake facilities will be localized, and occur infrequently during the period of time when mining, milling and shipping operations are occurring. Residual Project effects on air quality will be reversible once the Project ceases operations at both locations.

Table 6.1-18 Significance Assessment of Residual Effects to Air Quality

Project Phase	Constituent of Potential Concern	Averaging Period	Description of Residual Effects: Magnitude	Description of Residual Effects: Geographic Extent	Description of Residual Effects: Frequency	Significance
Change in Air Quality – Preferred Option						
Construction – Quarries	All	All	No residual effects			
Construction – Mine Development Area	All	All	No residual effects			
Operations - Mine Development Area	TSP	24-hr	M	LAA	I	NS
			H	F*	I	NS
	PM_{10}	24-hr	M	F*	S	NS
			H	LAA	I	NS
	$PM_{2.5}$	24-hr	H	F*	I	NS
	Uranium	24-hr	H	F*	I	NS
	NO_2	24-hr	H	F*	I	NS
		1-hr	H	F*	S	NS
	Other COPCs	All	No residual effects			
Operations - South Winter Road	All	All	No residual effects			
Operations - Dock and Storage Facility	NO_2	24-hr	M	F*	I	NS
		1-hr	H	F*	I	NS
Final Closure	All	All	No residual effects			
Post-Closure	Radon	Annual	No residual effects			
Change in Air Quality – Other Options						
Operations - North Winter Road	TSP, PM_{10}, $PM_{2.5}$, NO_2, SO_2	All	No residual effects			
Operations - All-Season Road	TSP, PM_{10}, $PM_{2.5}$, NO_2, SO_2	All	No residual effects			

6.1.8 Compliance and Environmental Monitoring for Changes in Air COPCs

Recommended follow-up and environmental monitoring for each Project phase having a predicted residual effect is outlined below. Any of these recommendations are considered to be above and beyond the mitigation measures outline in Section 6.1.3. Details regarding any recommended monitoring have been outlined in the Air Quality Monitoring Plan – Technical Appendix 4C.

Operations – Mine Development Area

- Implement a dust management follow-up monitoring plan, which will include sampling of total suspended particulate to verify the modelling results as well as any mitigation and or design features that have been implemented by the Project. Details are provided in Technical Appendix 4C.
- Implement an ambient air monitoring program for NO_2 monitoring to verify both the modelling results and compliance with air quality criteria. Details are provided in Technical Appendix 4C.
- Implement a radionuclide monitoring program to verify the results of the modelling assessment at sensitive POR locations. Details are provided in Technical Appendix 4C.

Operations – Baker Lake Dock and Storage Facility

- Implement an ambient air monitoring program for NO_2 monitoring to verify compliance with air quality criteria. This monitoring program would use similar methods and equipment as those recommended for use at the Mine Development Area (see Technical Appendix 4C).

For any Project phases or COPCs where monitoring requirements have not been recommended, it is suggested that monitoring be considered/implemented on a complaints basis.

6.2 CUMULATIVE ENVIRONMENTAL EFFECTS TO AIR QUALITY

6.2.1 Screening for Cumulative Environmental Effects

A cumulative environmental effects assessment was conducted for those Project residual environmental effects that have the potential to overlap with other projects and/or activities that may currently or will be carried out in the future within the LAA or RAA.

Future projects and activities that may overlap with the proposed Project are identified in the Project Inclusion List. This list includes both approved and proposed projects that have been planned for the future and far future within the LAA or RAA.

A screening assessment for cumulative environmental effects was completed to determine if there is potential for a Project residual effect on air quality to interact with similar effects of other past, present and future projects and activities. The screening was based on the following criteria:

- Is there a residual effect from the Project;
- Does the Project-related environmental effect overlap with those of other past, present and future projects or activities that have been or will be carried out;
- Is the Project contribution to cumulative environmental effects substantive and measurable or discernible such that there is some potential for substantive cumulative environmental effects that are attributable to the Project

If it was determined that there is potential for a cumulative environmental effect, the potential effect was assessed to determine if it has the potential to shift a component of the atmospheric environment to an unacceptable state. Only those projects and activities that overlap with the Project residual environmental effects both spatially and temporally were included in the assessment of potential cumulative environmental effects.

An interaction table was developed to identify where Project residual effects could interact with the effects of other projects (or project types) or activities to cause a potential cumulative environmental effect on air quality (Table 6.2-1). For each project or type of activity, the likelihood of a cumulative effect occurring was evaluated and each interaction was assigned a rating of 0, 1 or 2. Justification for each of the rankings is provided following the table.

Table 6.2-1 Potential Cumulative Environmental Effects to Air Quality

Other Projects and Activities with Potential for Cumulative Environmental Effects	Potential Cumulative Environmental Effects[a]				
	Increase in TSP Concentration	Increase in PM_{10} Concentration	Increase in $PM_{2.5}$ Concentration	Increase in Uranium Concentration	Increase in NO_2 Concentration
Present & Future Mining Drilling & Exploration Projects[b]	0	0	0	0	0
Present Mines					
Meadowbank Gold Mine – Mine Site Operations	0	0	0	0	0
Meadowbank Gold Mine – Dock and Storage Facility	0	0	0	0	2
Future Mines[c]					
Doris North Projects 1 and 2	0	0	0	0	0
Meliadine Project	0	0	0	0	0
Mary River Project	0	0	0	0	0
Hackett River Project	0	0	0	0	0
Back River Project	0	0	0	0	0
High Lake Project	0	0	0	0	0

Notes:

(a) Only residual Project effects were considered as possible cumulative environmental effects

(b) Includes current projects as well as proposed projects that have been awarded leases, but not exploration permits

(c) Includes projects that are currently undergoing regulatory review or have publicly announced the intent to seek regulatory approval

0 = Project environmental effects do not act cumulatively with those of other projects and activities.

1 = Project environmental effects act cumulatively with those of other projects and activities, but the resulting cumulative effects are unlikely to exceed acceptable levels with the application of best management or codified practices.

2 = Project environmental effects act cumulatively with those of other projects and activities and the resulting cumulative effects may exceed acceptable levels without implementation of project-specific or regional mitigation. Further assessment is warranted.

Based on the Project Inclusion List, there are no current or proposed drilling and exploration activities that could spatially and temporally overlap with any of the Project phases. Many of the exploration projects, particularly in the LAA, will have already undertaken their field programs or have the intention to complete planned exploration activities prior to construction of the proposed Project. Furthermore, many exploration activities are planned for locations at least 5 km away from the Project Footprint and therefore would not result in effects to air quality that would spatially overlap with Project residual effects to air quality. For these reasons, the potential for cumulative environmental effects was assigned a value of 0.

Potential interactions between the Project and mining projects that are currently under regulatory review or have announced the intent to seek regulatory approval were also assigned a 0, as none of these are in close enough proximity (i.e., within 5 km) to interact spatially with Project residual effects on air quality. While temporal overlap may occur between Project residual effects and the effects of future projects and the Meadowbank Gold mine (A cumulative environmental effects assessment was conducted for those Project residual environmental effects that have the potential to overlap with other projects and/or activities that may currently or will be carried out in the future within the LAA or RAA.

Future projects and activities that may overlap with the proposed Project are identified in the Project Inclusion List. This list includes both approved and proposed projects that have been planned for the future and far future within the LAA or RAA.

A screening assessment for cumulative environmental effects was completed to determine if there is potential for a Project residual effect on air quality to interact with similar effects of other past, present and future projects and activities. The screening was based on the following criteria:

- Is there a residual effect from the Project;
- Does the Project-related environmental effect overlap with those of other past, present and future projects or activities that have been or will be carried out;
- Is the Project contribution to cumulative environmental effects substantive and measurable or discernible such that there is some potential for substantive cumulative environmental effects that are attributable to the Project

If it was determined that there is potential for a cumulative environmental effect, the potential effect was assessed to determine if it has the potential to shift a component of the atmospheric environment to an unacceptable state. Only those projects and activities that overlap with the Project residual environmental effects both spatially and temporally were included in the assessment of potential cumulative environmental effects.

An interaction table was developed to identify where Project residual effects could interact with the effects of other projects (or project types) or activities to cause a potential cumulative environmental effect on air quality (Table 6.2-1). For each project or type of activity, the likelihood of a cumulative effect occurring was evaluated and each interaction was assigned a rating of 0, 1 or 2. Justification for each of the rankings is provided following the table.

Table 6.2-1), these projects will be located hundreds of kilometres away from the Project and therefore will not interact spatially. Therefore, air quality effects of mine site operations at the Meadowbank Gold Project are unlikely to act cumulatively with Project residual effects and therefore were assigned values of 0.

The Meadowbank Gold Mine will also operate a dock and storage facility located approximately 1 km west of the Project's proposed Dock Option 1, as well as an access road linking the Meadowbank mine site to its Baker Lake facilities. Although the access roads for the Project and Meadowbank mines will likely be used at the same time, there were no predicted residual effects resulting from the operation of the Project's access road options. As a result, the potential for cumulative effects on ambient dust concentrations from the access roads were assigned a value of 0.

Both construction and operations of the Project's dock and storage facility will occur while the Meadowbank dock is operating. Since no residual effects from construction of the Project's dock were anticipated (Section 6.1.6), cumulative effects were not considered. In contrast, the Meadowbank dock will operate concurrently with the Project's dock operations, and due to its proximity, the potential for a cumulative effect to occur is likely. Specifically, there is potential for a cumulative effect on ambient NO_2 concentrations to occur as a residual Project effect for NO_2 was identified within the vicinity of the Project's dock operations (Table 6.1-18). This potential cumulative effect was assigned a value of 2 because it is likely that the combination of activities occurring at the two dock sites will result in a potential cumulative environmental effect on air quality.

6.2.2 Cumulative Environmental Effects to Ambient NO_2 Concentrations

6.2.2.1 Interactions for Cumulative Environmental Effects to Ambient NO_2 Concentrations

6.2.2.1.1 Base Case

The Meadowbank Gold Project, which commenced operations in July 2010, includes operation of a barge landing site located approximately 2 km east of the community of Baker Lake. In addition to a barge landing facility, Meadowbank's Baker Lake facilities also consist of a storage compound, which includes an open storage area, a cold storage building and a fuel storage and distribution complex (AMEC 2005). The facility receives fuel and other supplies during the shipping season from late July until early October (AMEC 2005). These supplies are then shipped to the mine site using conventional tractor trailer via a 102 km all-season access road.

Base air emissions from Meadowbank's Baker Lake facilities consist mostly of NO_x from idling barges and other fuel combustion sources. Dust and exhaust emissions of NO_x are also generated by traffic activity along the access road. According to the Air Quality Assessment for the Meadowbank Gold Project (Cumberland Resources Ltd. 2005), no measurable effects on air quality were anticipated from operations within the barge landing area. Although barge traffic emissions were predicted to lead to a low frequency of pollution events, this effect was not predicted to cause a significant effect on air quality. Similarly, measureable effects from access road traffic were predicted to be not significant.

6.2.2.1.2 Project Case

The preferred dock option and storage area for the proposed Project will be located approximately 1 km southeast of the Meadowbank Gold Project's Baker Lake dock and storage facilities. Both facilities will receive fuel and other supplies via barge or tug-barge during the ice-free shipping season from late-July to early October. As a result, there is the possibility that barge traffic will be present in each dock area at the same time, releasing NO_x emissions simultaneously from the idling barge (or tug-barge) engines. Additional sources of NO_x, including cargo handling equipment such as cranes, may also operate simultaneously.

Vehicle activity in and around the dock and storage areas may or may not overlap temporally depending on the transportation schedule of each project, but due to the relative size and number of vehicles in comparison to that of the tug-barges, cranes and other on-site equipment, vehicles are expected to contribute negligible quantities of NO_2 to the overall concentrations. In addition, the air quality assessment for the Meadowbank Gold Project also showed that effects of the access road were not significant. As a result, only the barge traffic and heavy duty equipment were carried through to the cumulative effects assessment.

6.2.2.1.3 Future Case

Based on the Project Inclusion List, there are no future projects or activities that could act cumulatively with the Project to cause a cumulative effect on ambient NO_2 concentrations.

6.2.2.1.4 Future Potential Case

Based on the Project Inclusion List, there are no far future projects or activities that could act cumulatively with the Project to cause a cumulative effect on ambient NO_2 concentrations.

6.2.2.2 Mitigation of Cumulative Environmental Effects to Ambient NO_2 Concentrations

It is recommended that AREVA and Agnico-Eagle Mines work collaboratively to implement mitigation measures to reduce potential cumulative environmental effects on ambient NO_2 concentrations in the vicinity of their dock and storage facilities. The following general and activity-specific measures can be implemented to reduce cumulative effects on air quality.

General Mitigation Measures

- Employ standard operating procedures for use of equipment and machinery

- Perform regular maintenance of equipment and machinery in accordance with good engineering practices or as recommended by equipment suppliers such that the equipment is kept in good operating condition (e.g., effective fuel combustion)
- Develop community complaint/response procedure(s)
- Adhere to all permits, authorizations and/or approvals

Activity-Specific Mitigation Measures

- Marine Vessels and Heavy Equipment Operation
  - o Where available, use diesel-powered heavy equipment equipped with appropriate exhaust emissions controls such that US EPA Tier 4 emissions standards are met
  - o Optimize the number of heavy equipment movements and minimize travel distances, where possible
  - o Minimize number of barge shipments and offloading activities
  - o Minimize the amount of barge or tug-barge engine idling at each dock (i.e., where possible, limit idling emissions to a single tug-barge at each dock)

6.2.2.3 Characterization of Residual Cumulative Environmental Effects on Air Quality

Air emission modeling was completed to assess the potential cumulative effects of operations at the Project's dock facility in combination with operations at the Meadowbank dock and storage facility. For the purposes of modeling, operations and emissions were assumed to be occurring simultaneously at the Kiggavik and Meadowbank docks. The predicted incremental concentration of NO_2 at the receptor (representing the community of Baker Lake) is provided in Table 6.2-2. At this receptor location, the incremental concentrations of NO_2 for all averaging periods are below the applicable Indicator Thresholds. Based on a comparison of the cumulative annual NO_2 concentration and the predicted annual concentration for the Project Case (Table 6.1-12), the relative contribution of the Project at this sensitive POR is lower than that of the operations at the Meadowbank dock (i.e., Project contribution is 37%). This is due to the fact that the Meadowbank dock and storage facility is located closer to the community of Baker Lake.

Table 6.2-2 Predicted Incremental Concentrations of NO_2 resulting from the simultaneous operation of the Project and Meadowbank Dock and Storage Facilities

Sensitive POR	UTM Coordinates (m)		Incremental Concentration of NO_2 ($\mu g/m^3$)		
	Easting	Northing	1-hour Maximum	24-hour Maximum	Annual
Community of Baker Lake	644179	7135840	155.3	29.1	0.5
Air Quality Criteria ($\mu g/m^3$)			**400**	**200**	**100**

Contour plots of 1-hour and 24-hour incremental NO_2 concentrations are provided in Figure 6.3-1 and Figure 6.3-2, respectively. Both the 1-hour and 24-hour NO_2 Indicator Thresholds are exceeded in the area surrounding the two facilities. To determine the nature of the exceedances, a frequency analysis was completed and frequency plots are developed for 1-hour NO_2 (Figures 6.3-3) and 24-hour NO_2 (Figure 6.3-4). The results predict that there will be no more than 61 exceedances of the 1-hour Indicator Threshold (about 1% of the time) and no more than 4 exceedances of the 24-hour Indicator Threshold (or 1% of the time).

The Project's contribution to the total predicted residual cumulative environmental effect on ambient 1-hour and 24-hour NO_2 concentrations will depend on the receptor location of interest. The isopleths presented in Figures 6.3-1 and 6.3-2 represent the overall maximum concentration at each receptor location, meaning that the maximum concentration shown at each receptor does not necessarily occur during the same hour or day. Depending on the location of the receptor, the concentration may be a result of either the Project alone, the Meadowbank dock operations alone, or a combination of the two dock operations. The concentration at each receptor is determined by its location relative to the operations and the wind direction. For example, when the wind is blowing from the northwest, receptors located downwind the Project dock (i.e., to the southeast) would be influenced mostly by the Project, but there would be some contribution from the Meadowbank dock. Conversely, when the wind is blowing from the southeast, receptors located downwind the Meadowbank dock (i.e., to the northwest) would be influenced mostly by the Meadowbank operations, with some contribution from the Project dock. To demonstrate this concept, two receptors, one northwest of the Meadowbank dock and one southeast of the Project dock were selected and the contribution of the Project to the maximum predicted 1- and 24-hour concentrations were determined. This exercise was also completed for a receptor located between the two sites.

Table 6.2-3 and

Table 6.2-4 show the relative contribution of Project dock and storage facility operations to the maximum predicted 1- and 24-hr NO_2 concentrations for three receptor locations. The results are also shown graphically in Figure 6.3-5. For a receptor located to the northwest of the Meadowbank dock (Receptor 3), the Project's contribution to the maximum 1-hour concentration is predicted to be less than 1%. At a location southeast of the Project dock (Receptor 1), the contribution of the Project is predicted to be 99%. At a receptor located between the sites (Receptor 2), the Project will be the main contributor (93%) of ambient $NO_{2.}$

Table 6.2-3 Relative Contribution of the Project to Maximum 1-hour NO_2 Concentrations at Three Receptor Locations

Receptor	UTM Coordinates (m)		Maximum 1-hour NO_2 Concentration	Year	Julian Day	Hour	Project Contribution (%)
	Easting	Northing					

1	648015	7133374	959.89	2009	266	0900	99.1%
2	647515	7133874	821.81	2009	264	1100	93.3%
3	647015	7134374	1091.6	2009	265	900	0.55%

Table 6.2-4 Relative Contribution of the Project to Maximum 24-hour NO_2 Concentrations at Three Receptor Locations

Receptor	UTM Coordinates (m)		Maximum 24-hour NO_2 Concentration	Year	Julian Day	Project Contribution (%)
	Easting	Northing				
1	648015	7133374	469.41	2009	237	99.4%
2	647515	7133874	212.01	2010	218	95.8%
3	647015	7134374	428.57	2009	264	1.29%

6.2.3 Summary of Residual Cumulative Environmental Effects on Air Quality

Simultaneous operations of the Project and Meadowbank dock facilities are predicted to result in increased ambient 1-hour and 24-hour NO_2 concentrations relative to the operation of the Project dock facility alone (Section 6.1.4.2). It is therefore concluded that there will be residual cumulative effects on air quality.

The residual cumulative environmental effect of operation of the Project and Meadowbank dock facilities on ambient NO_2 concentrations is predicted to be moderate to high in magnitude. However, exceedance of Indicator thresholds will not extend beyond 2 km from the combined Project Footprints and will be infrequent.

6.2.4 Determination of Significance of Cumulative Environmental Effects

With implementation of the proposed mitigation and environmental protection measures, the residual cumulative environmental effect of increased ambient NO_2 concentrations from the Meadowbank dock and storage facility operations, in combination with the Project dock and storage facility operations, is predicted to be not significant (Table 6.2-5). Residual cumulative effects on air quality in the vicinity of the dock facilities will be localized, and occur infrequently during the period of time when both the Project and Meadowbank docks are operating simultaneously. Residual cumulative effects on air quality will be reversible once one or both of these projects cease operations.

Table 6.2-5 Summary of Residual Cumulative Environmental Effects on Air Quality

Cumulative Environmental Effect	Case	Other Projects, Activities and Actions	Mitigation and Compensation Measures	Description of Residual Effects				Significance
				Magnitude	Geographic Extent	Frequency	Reversibility	
Change in Air Quality – Preferred Option								
Ambient 1-hour NO_2 Concentration	Cumulative Effect with Project (Project Case)	Meadowbank	General and activity-specific measures – Section 0	H	F*	I	R	NS
Ambient 24-hour NO_2 Concentration	Cumulative Effect with Project (Project Case)	Meadowbank	General and activity-specific measures – Section 0	M	F*	I	R	NS

Summary of Project Residual Environmental Effects: Air Quality

KEY		
Magnitude: L Low: The predicted COPC concentrations are less than 25% greater than the Indicator Threshold criterion. M Moderate: The predicted COPC concentrations are less than 100% greater than the Indicator Threshold. H High: The predicted COPC concentrations are more than 100% greater than the Indicator Threshold. ***Geographic Extent:*** F Footprint: Effect confined to the project footprint F* Footprint: Effect confined to 2km from the project footprint L Local: Effect confined to the LAA R Regional: Effect extends beyond the LAA but within the RAA	***Duration:*** ST Short term: Less than one year (growing season) MT Medium term: More than one year, but not beyond the end of project decommissioning LT Long term: Beyond the life of the project P Permanent ***Frequency:*** I Infrequent: occurs less than 1% of the time (no more than 4 days per year or 88 hours per year) S Sporadic: Occurs less than 3.5% of the time (no more than 12 days per year or 305 hours per year) R Regular: Occurs less than 15% of the time (no more than 55 days per year or 1300 hours per year) C Continuous: the effect occurs more than 15% of the time. ***Reversibility:*** R Reversible I Irreversible	***Significance:*** S Significant N Not Significant ***Likelihood:*** Based on professional judgment L Low probability of occurrence M Medium probability of occurrence H High probability of occurrence ***Prediction Confidence:*** Based on scientific information and statistical analysis, professional judgment and effectiveness of mitigation L Low level of confidence M Moderate level of confidence H High level of confidence **N/A** Not Applicable

6.3 SUMMARY OF RESIDUAL EFFECTS ON AIR QUALITY

6.3.1 Project Effects

An overall summary of residual Project effects to air quality related to the various Project phases are presented in Table 6.3-1 along with a summary of recommended follow-up and monitoring. All predicted residual effects to air quality resulting from Project-environment interactions are predicted not to be significant. Based on the air dispersion modelling results, all identified residual effects to air quality are expected not to extend beyond the local assessment area (LAA) boundary and any exceedances of applicable Indicator Thresholds are limited to a few times per year.

6.3.2 Cumulative Effects

An overall summary of residual cumulative effects to air quality related to the various Project phases are presented in Table 6.3-2 along with a summary of recommended follow-up and monitoring. All predicted residual cumulative effects to air quality resulting from Project-environment interactions are predicted not to be significant. Based on the air dispersion modelling results, all identified residual effects to air quality are expected not to extend beyond the local assessment area (LAA) boundary and any exceedances of applicable Indicator Thresholds are limited to a few times per year.

6.3.3 Effects of Climate Change on Project and Cumulative Effects to Air Quality

Changes in the local or regional climate during the lifetime of the Project would likely affect meteorological parameters governing air dispersion, and consequently, ambient air concentrations of COPCs. Rainfall is expected to increase by 10 to 25% between 2020 and 2080. Summer rainfall is expected to change the least, while winter would change the most. This would potentially necessitate additional capacity for higher runoff levels. However, an increased frequency of precipitation would likely result in reduced ambient dust and COPC concentrations, since snow and rainfall help to “wash” the COPCs from the air. In addition, changes in precipitation would affect dust dry deposition rates.

Technical Appendix 4D also notes that a general increase in Canadian annual temperatures of between 2 and 5 degrees Centigrade is predicted for various seasons. Winter is expected to experience the greatest increase and summer the least. The annual average temperatures in northern Canada and Baker Lake are expected to increase by 5 degrees over the next 100 years from -7 to -2 degrees, with shorter winters, more rain and more extreme weather. Higher temperatures generally lead to increased evapotranspiration and therefore less natural moisture in the soils. This typically results in an increased frequency of application of water for mitigation of dust, etc. Additionally, changes to the average surface temperatures may affect the wind profile and/or mixing height, which in turn would affect the level of dispersion of COPCs emitted from the Project.

Table 6.3-1 Summary of Project Residual Environmental Effects to Air Quality

Project Phase	Mitigation / Compensation Measures	Residual Environmental Effects Characteristics					Significance	Likelihood	Prediction Confidence	Recommended Follow-up and Monitoring
		Direction	Magnitude	Geographic Extent	Frequency	Reversibility				
Change in Ambient Air Concentrations of Constituents of Potential Concern - Preferred Option										
Construction – Quarries	General mitigation measures – Section 6.1.3	No residual effects					n/a			Complaints response procedure and monitoring, if complaints history warrants action.
Construction – Mine Development Area	General mitigation measures – Section 6.1.3	No residual effects					n/a			Complaints response procedure and monitoring, if complaints history warrants action.
Operation – Mine Development Area										
24-hr TSP	General and activity-specific measures – Section 6.1.3	A	M	L	I	R	NS	n/a	n/a	Implement dust management plan and ambient air monitoring program as required. See Appendix 4C.
			H	F*	I	R	NS	n/a	n/a	
24-hr PM_{10}	General and activity-specific measures – Section 6.1.3	A	M	F*	S	R	NS	n/a	n/a	
			H	L	I	R	NS	n/a	n/a	
24-hr $PM_{2.5}$	General and activity-specific measures – Section 6.1.3	A	H	F*	I	R	NS	n/a	n/a	
24-hr Uranium	Design, general and activity-specific measures – Section 6.1.3	A	H	F*	I	R	NS	n/a	n/a	
1-hr NO_2	Design, general and activity-specific measures – Section 6.1.3	A	H	F*	S	R	NS	n/a	n/a	Implement ambient air monitoring program as required. See Appendix 4C.
24-hr NO_2	Design, general and activity-specific measures – Section 6.1.3	A	H	F*	I	R	NS	n/a	n/a	
Other COPCs	Design, general and activity-specific measures – Section 6.1.3	No residual effects					n/a			Implement ambient air monitoring program as required. See Appendix 4C.
Operation - South Winter Road	Design, general and activity-specific measures – Section 6.1.3	No residual effects					n/a			Complaints response procedure and monitoring, if complaints history warrants action.
Operation - Baker Lake Dock and Storage Facility										
1-hr NO_2	Design, general and activity-specific measures – Section 6.1.3	A	H	F*	I	R	NS	n/a	n/a	Implement ambient air monitoring program as required. See Appendix 4C.
24-hr NO_2	Design, general and activity-specific measures – Section 6.1.3	A	M	F*	I	R	NS	n/a	n/a	Implement ambient air monitoring program as required. See Appendix 4C.
Final Closure	Design, general and activity-specific measures – Section 6.1.3	No residual effects					n/a			Complaints response procedure and monitoring, if complaints history warrants action.
Post-Closure	Design, general and activity-specific measures – Section 6.1.3	No residual effects					n/a			Complaints response procedure and monitoring, if complaints history warrants action.
Change in Ambient Air Concentrations of Constituents of Potential Concern - Other Options										
Operation - North Winter Road	General mitigation measures – Section 6.1.3	No residual effects					n/a			Complaints response procedure and monitoring, if complaints history warrants action.
Operation - All-Season Road	General mitigation measures – Section 6.1.3	No residual effects					n/a			Complaints response procedure and monitoring, if complaints history warrants action.

KEY ***Magnitude:*** L Low: The predicted COPC concentrations are less than 25% greater than the Indicator Threshold criterion. M Moderate: The predicted COPC concentrations are less than 100% greater than the Indicator Threshold. H High: The predicted COPC concentrations are more than 100% greater than the Indicator Threshold. ***Geographic Extent:*** F Footprint: Effect confined to the project footprint F* Footprint: Effect confined to 2km from the project footprint L Local: Effect confined to the LAA R Regional: Effect extends beyond the LAA but within the RAA	***Duration:*** ST Short term: Less than one year (growing season) MT Medium term: More than one year, but not beyond the end of project decommissioning LT Long term: Beyond the life of the project P Permanent ***Frequency:*** I Infrequent: occurs less than 1% of the time (no more than 4 days per year or 88 hours per year) S Sporadic: Occurs less than 3.5% of the time (no more than 12 days per year or 305 hours per year) R Regular: Occurs less than 15% of the time (no more than 55 days per year or 1300 hours per year) C Continuous: the effect occurs more than 15% of the time. ***Reversibility:*** R Reversible I Irreversible	***Significance:*** S Significant N Not Significant ***Likelihood:*** Based on professional judgment L Low probability of occurrence M Medium probability of occurrence H High probability of occurrence ***Prediction Confidence:*** Based on scientific information and statistical analysis, professional judgment and effectiveness of mitigation L Low level of confidence M Moderate level of confidence H High level of confidence **N/A** Not Applicable

Table 6.3-2 Summary of Cumulative Residual Environmental Effects to Air Quality

Cumulative Environmental Effect	Case	Other Projects, Activities and Actions	Mitigation and Compensation Measures	Description of Residual Effects				Significance	Likelihood	Prediction Confidence	Proposed Follow-up and Monitoring Programs
				Magnitude	Geographic Extent	Frequency	Reversibility				
Change in Air Quality – Preferred Option											
Ambient 1-hour NO_2 Concentration	Cumulative Effect with Project (Project Case)	Meadowbank	General and activity-specific measures – Section 6.2.2.2	H	F*	I	R	NS	n/a	n/a	Implement ambient air monitoring program as required. See Appendix 4C.
Ambient 24-hour NO_2 Concentration	Cumulative Effect with Project (Project Case)	Meadowbank	General and activity-specific measures – Section 6.2.2.2	M	F*	I	V	NS	n/a	n/a	Implement ambient air monitoring program as required. See Appendix 4C.

6.4 SUMMARY OF MITIGATION MEASURES FOR AIR QUALITY

Potential effects on air quality can be mitigated through the direct reduction or prevention of emissions from the Project related emission sources. Reasonable mitigation measures have already been proposed and considered in the assessment. A complete list of mitigation measures was provided Section 6.1.3. An abbreviated list is as follows:

- Develop and implement a Dust Management Plan;
- Install of end of pipe (exhaust) air pollution controls for milling processes, acid production and power generation;
- Treatment and sub-aqueous discharge of tailings;
- Ensure proper equipment operation and regular maintenance;
- Develop and implement community complaints/response procedures; and
- Adhere to all permits, authorizations and approvals.

These measures are generally regarded as Best Practices for the reduction of COPCs from the Project, and represent the most commonly applied mitigation for similar operations. Administrative controls, such as limiting activities in certain conditions (i.e., high winds) could be implemented to provide additional mitigation, if necessary.

6.5 SUMMARY OF COMPLIANCE AND ENVIRONMENTAL MONITORING FOR AIR QUALITY

It is anticipated that an air quality monitoring program will be implemented to demonstrate that the environmental effects are equivalent to or lower than those predicted herein. This will likely include monitoring for the following COPCs:

- Particulate
  - Selected Metals in particulate
- Sulphur dioxide
- Radon

For example, predicted residual effects for TSP, PM_{10} and $PM_{2.5}$ can generally be attributed to emissions from unpaved roads at the mine site, including in-pit ramps. Since reasonable mitigation measures such as watering and low vehicle speeds have already been considered in this assessment. It is recommended that monitoring of PM_{10} or $PM_{2.5}$ take place at the Accommodation Complex and other locations proximate to the sites to verify model results. If exceedances are observed, enhanced dust controls such as the application of chemical dust suppressants should be considered at that time.

7 EFFECTS ASSESSMENT FOR CLIMATE CHANGE

7.1 BACKGROUND INFORMATION

7.1.1 Relationship between Greenhouse Gases and Climate Change

Greenhouse gases (GHGs) are gases present in the atmosphere that trap outgoing terrestrial radiation which would otherwise escape to space. This natural phenomenon causes a warming of the Earth's surface and is known as the "Greenhouse Effect". Greenhouse gases collectively include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulphur hexafluoride (SF_6), water vapour, ozone (O_3), and a group of chemical compounds known as chlorofluorocarbons (CFCs). Each greenhouse gas has a different radiative forcing or Global Warming Potential (GWP) which is simply a measure of its effectiveness to trap heat in the atmosphere. CO_2 has a GWP of 1, whereas CH_4 is 25 and N_2O is 298, for example.

Currently, there is much concern that the rapid increase in anthropogenic sources of GHGs is leading to an enhanced warming of the Earth, otherwise known as "Global Warming". Simple theory shows that an increase in GHGs, particularly CO_2, will lead to a warming of the Earth's average temperature; however, scepticism still surrounds the link between the observed warming of the Earth and increases in GHGs. The link between GHGs and other climatic parameters like precipitation is even less certain. In fact, there are many other forcing and amplification mechanisms which drive climatic change besides GHGs such as solar variability, resulting in a complex topic that is under much scientific scrutiny (see Technical Appendix 4D for further discussions).

7.1.2 Climate Change and the Project

As discussed previously, Project-related activities which require the combustion of fossil fuels will result in emissions greenhouse gases. Because of the possible linkage between increased emissions of GHGs and Global Warming, there is a potential for the Project to contribute to changes in climate in the long term, although, the nature and magnitude of these changes is highly speculative. Also, it should be noted that climate change is largely a global phenomenon and therefore, any emissions from the Project will act collectively with other regional and even global anthropogenic emissions of GHGs from various sources. In all, the direct impact and in particular, the Project's contribution to climate change is very difficult to assess. As a result, only a comparison to current Canada-wide and global GHG emissions can be made as a means to quantify the Project's possible contribution to climate change. Such comparisons are made in the following sections. Alternatively, a discussion about how future changes to climate may impact the Project are discussed in Technical Appendix 4D.

7.2 EFFECTS ASSESSMENT ANALYTICAL METHODS

As described above as well as in Section 4.8, the effect of the Project on the VEC - Climate Change can be assessed by quantifying the increase in greenhouse gas emissions due to Project activities. This effect is assessed in the following sections.

A mass balance approach was used to estimate emissions of CO_2-equivalent from all project related activities which require the use of diesel fuel. Emission factors adapted from Environment Canada (2011) were used to estimate emissions of greenhouse gases, including carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) resulting from the operation of the power plant (diesel generators), heavy equipment and vehicles.

Current estimates of diesel fuel usage for the Project were multiplied by the emission factors to estimate emissions of greenhouse gases. Further details about the methods employed are provided in Technical Appendix 4B – Air Dispersion Assessment.

7.3 EFFECTS MECHANISMS AND LINKAGES FOR INCREASES IN GREENHOUSE GASES

The Project-environment interactions and effects described above in Section 4.3 and listed in Tables 4.3-1 through 4.3-3 for the construction, operation and closure Project phases, form the basis for the climate change assessment effects mechanisms and linkages. The Project climate change effects relate to emissions of greenhouse gases (GHGs) including CO_2, CH_4 and N_2O from construction activities, open pit and underground mining and supporting activities, power generation and vehicle transportation which may have to potential to cause effects to climate change within the LAA and RAA.

Project activities that could result in increased concentrations of greenhouse gases include:

- Greenhouse gas emissions from the combustion of sources/activities using diesel fuel, including:
  - Heavy-duty equipment operation at both the Mine site and at the Dock and Storage Facility
  - Vehicular transport along on-site roads, haul roads and access road
  - Power generation at the Mine site
  - Marine vessels

7.4 MITIGATION MEASURES AND PROJECT DESIGN FOR INCREASES IN GREENHOUSE GASES

Design aspects, operational measures and other mitigation measures have been incorporated into the current Project plans which will minimize project-associated emissions and/or the potential effect of project-related emissions (i.e., increased GHG emissions). Mitigation measures that will be applied to reduce emissions of GHGs are divided into two (2) categories, General and Activity-Specific Mitigation Measures; each one is outlined below.

General Mitigation Measures

- Incorporate energy efficient and emission minimization features in building design and operation of equipment and facilities.
- Employ standard operating procedures for use of equipment and machinery
- Perform regular maintenance of equipment and machinery in accordance with good engineering practices or as recommended by equipment suppliers such that the equipment is kept in good operating condition (e.g., effective fuel combustion)

Activity-Specific Mitigation Measures

- Heavy Equipment Operation, Vehicles and Marine Vessels
  - Where available, use diesel-powered heavy that meet US EPA Tier 4 emissions standards
  - Optimize the number of heavy equipment movements and minimize travel distances, where possible
  - Minimize number of barge shipments and offloading activities

7.5 RESIDUAL EFFECTS FOR INCREASES IN GREENHOUSE GASES

As discussed previously, the assessment of potential residual effects to climate change is subjective as there are no specific thresholds or criteria that define whether an effect is expected to occur. Instead, potential effects to climate change are typically assessed quantitatively through comparison of Project-related emissions of greenhouse gases to total federal and provincial/territorial GHG emission levels. Since climate change is a global issue, the Project's potential contribution to global GHG emission levels is also examined.

The analytical methods described in Section 7.2 above were applied to the Project to quantify how the Project, with mitigation, could change ambient levels of greenhouse gases. The results of the analysis are discussed in the follow paragraphs.

Table 7.5-1 shows the associated emission factors adapted from Environment Canada (Environment Canada 2011b) and estimated GHG emissions from the Project. During peak consumption, annual GHG emissions were calculated to be 181 kilotonnes (kt) of CO_2 equivalent per year.

The project related GHG emissions were compared to the baseline levels outlined in Section 5.3. This comparison is presented in Table 7.5-2 below. The Project represents a maximum annual increase in GHG emissions of 181 kt CO_2 equivalanet. This would represent a 25% increase in the baseline GHG emissions for Nunavut and a 0.02% increase in the baseline GHG emissions for Canada. In general, it is expected that the Project will noticeably contribute to Nunavut's overall GHG emissions total. It is also expected that other proposed projects will be operational when the Project commences operations, therefore, the contribution to Nunavut GHG emissions will likely be a smaller fraction relative to the total emissions. Further details are discussed in Section 7.6.

Table 7.5-1 Project-Related Greenhouse Gas Emissions during the Peak Production Year

Greenhouse Gas	Emission Factor[a]	GWP[b]	Estimated GHG Emissions (kt CO_2 eq)
CO_2	2,663	1	173
CH_4	0.133	25	0.22
N_2O	0.4	298	7.7
Total	-	-	**181**

Notes:
[a] Emission factors from Environment Canada's GHG Emissions Quantification Guidance available at www.ec.gc.ca/ges-ghg/
[b] GWP = global warming potential. As per values indicated in the IPCC's 4th Assessment Report, 2007 (Solomon et al. 2007)

Table 7.5-2 Project Contribution to National and Northwest Territories Greenhouse Gas Emissions

Region[a]	Baseline GHG Emissions (kt CO_2 eq)	Total GHG Emissions[b] (kt CO_2 eq)	Contribution of Project to GHG Emissions
Canada[a]	734,191	734,372	0.02%
Nunavut	552	733	25%

Notes:
[a] Includes 2008 Environment Canada reported GHG emissions and Meadowbank Gold Mine GHG emissions estimate of 191 kt of CO_2-equivalent
[b] Baseline GHG emissions + peak annual emissions from the Project

In addition, according to the International Energy Agency (IEA), the 2009 estimate of global GHG emissions from the energy sector is 30.6 Gigatonnes (Gt) (IEA 2011). As a result, the annual contribution of the Project to global CO_2 emissions is 0.0006 %. As can be seen, the Project will make up only a small fraction of global emissions.

7.6 CUMULATIVE EFFECTS ANALYSIS FOR CLIMATE CHANGE

Climate change resulting from increased emissions of greenhouse gases (GHG) is a global phenomenon driven by global emissions of GHG. Emissions of GHG from the Project will act cumulatively with GHG emissions from other local or regional projects, such as the Meadowbank project, in addition to other future projects which will be major contributions to the total provincial GHG inventory for Nunavut. As such, the potential cumulative increases in the total emissions were considered.

As discussed previously, the potential effects of emissions of GHG and other COPCs on climate change is subjective as there are no specific thresholds or criteria that define whether an effect is expected to occur. Instead, potential effects to climate change are typically assessed quantitatively through comparison of Project-related emissions of greenhouse gases to total federal and provincial/territorial GHG emission levels. Where possible, Project-related emissions of GHGs have been compared to the emissions estimated from each of the projects identified earlier in Section 3.4.3 which provides perspective on the relative contributions of each of the other projects. However, due to a lack of the necessary scientific information, these will not be compared to any specific Indicator Thresholds to assess the presence of a residual effect or the significance thereof.

7.6.1 Assessment of Cumulative Effects: Increases in Greenhouse Gases

As outlined above, Table 7.6-1, presents the estimated annual greenhouse gas emissions from those projects listed in the PIL where information was available. As can be seen in the table, the estimated annual GHG emissions for the High Lake and Doris North project are both approximately 78 kt of CO_2-equivalent whereas emissions from the Mary River Project are closer to 350 kt. Collectively, emissions from the Kiggavik Project and other projects within the RAA make up 0.09% of the Canada-wide total of CO_2-equivalent emissions or 55% of the Nunavut total. As discussed previously, the direct implications of such increases are unclear as much speculation revolves around the issue of climate change.

Table 7.6-1 Greenhouse Gas Emissions from other Projects within the Regional Assessment Area

Project Name	Estimated Annual GHG Production[1] (kt CO_2-equivalent)	Reference
High Lake Project	76.47	High Lake EIS, Volume 4, Section 2
Doris North Project	77.45	Doris North Project EIS, Chapter 10
Mary River Project	344	Mary River Project EIS, Appendix 5B

Notes:
[1]Unless otherwise indicated, GHG emissions are based on annual estimates of diesel fuel consumption during operations

7.7 SUMMARY OF MITIGATION MEASURES FOR CLIMATE CHANGE

In summary, mitigation measures will be employed to reduce emissions of greenhouse gases from fuel combustion sources used by the Project. Such mitigation includes incorporating practices which promote and maintain efficient fuel combustion and which minimizes fossil fuel consumption by optimizing the amount of movement of vehicles and heavy equipment.

7.8 SUMMARY OF COMPLIANCE AND ENVIRONMENTAL MONITORING FOR CLIMATE CHANGE

In general, annual records and verification of fuel use for the Project and other local and regional sources, if available, will be maintained and estimates of GHG emissions will be completed on an annual basis using appropriate emission factors. If necessary, a greenhouse gas reduction strategy could be considered in the future.

8 REFERENCES

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FIGURES

Projection: NAD 1983 UTM Zone 14N
Creator: CDC
Date: 09/01/2011 Scale: 1:16,000,000
File:
Data Sources: *Natural Resources Canada, Geobase®, Nation Topographic Database, Geological Survey of Canada, AREVA Resources Canada Inc.*

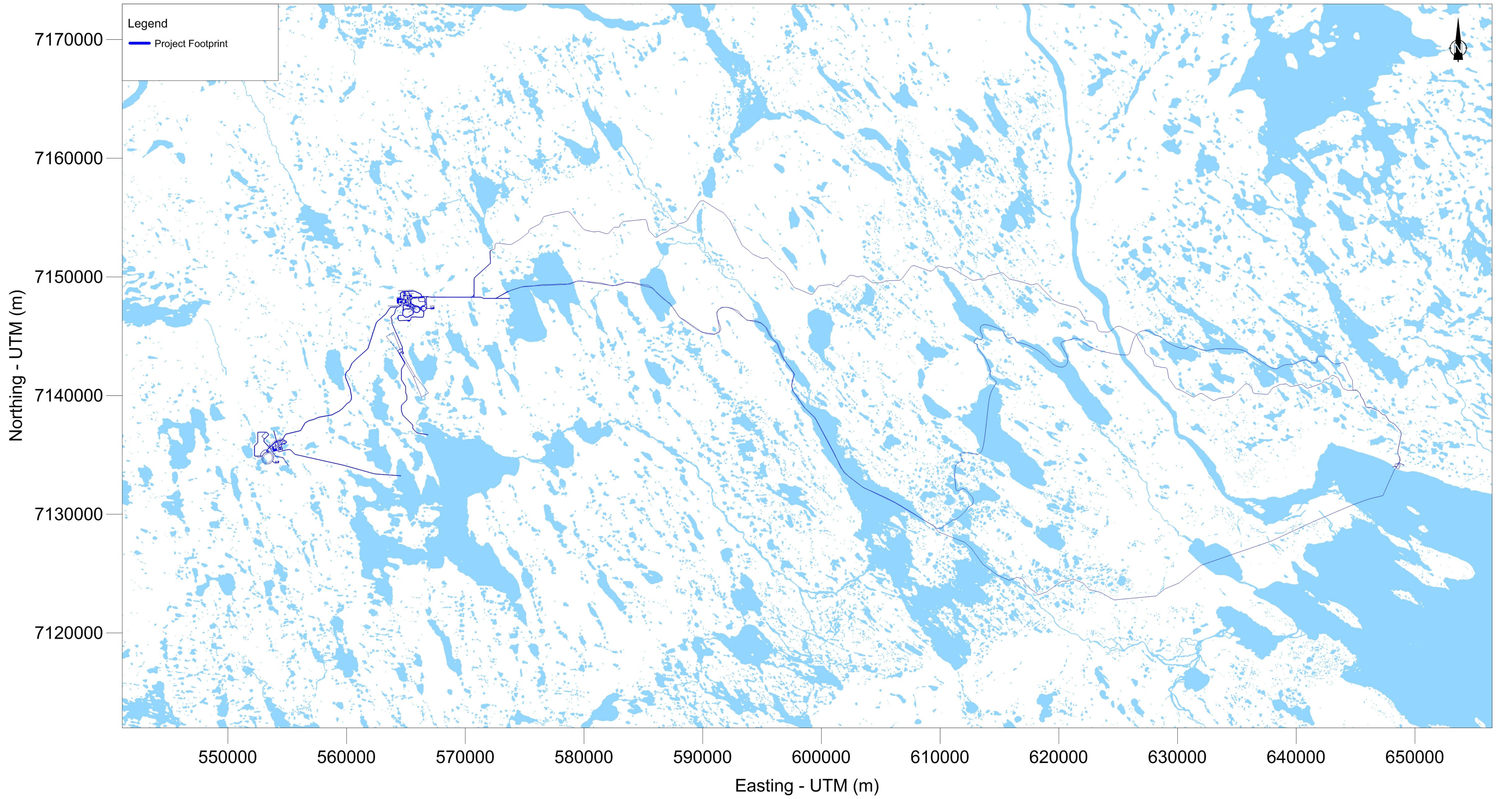
FIGURE 1.1-1
GENERAL LOCATION OF PROPOSED KIGGAVIK PROJECT IN CANADA

ENVIRONMENTAL IMPACT STATEMENT TIER 2 VOLUME

Kiggavik Project

AREVA

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



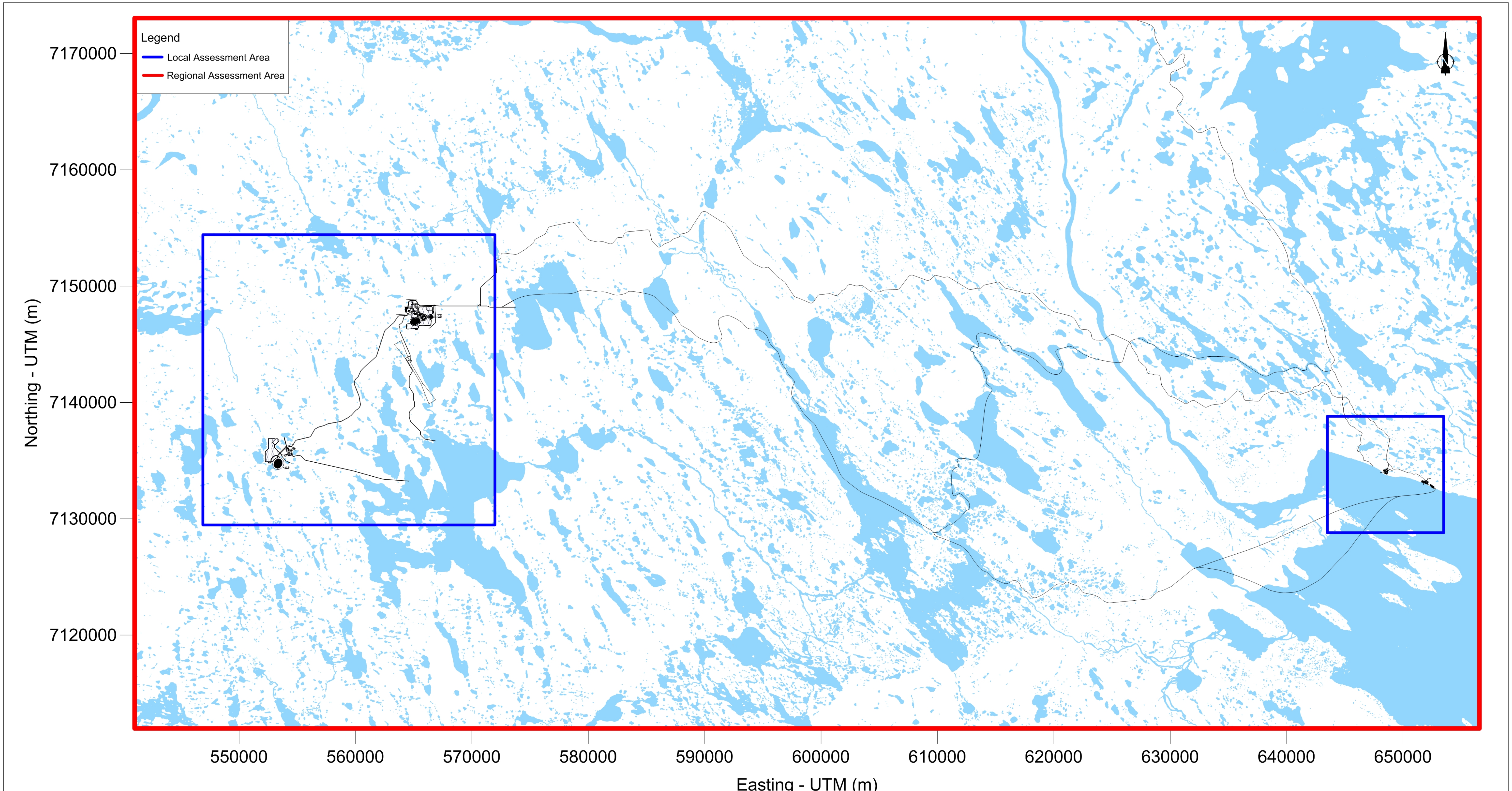
Projection: NAD 1983 UTM Zone 14N
Creator: SENES Consultants Limited
Date: 26/09/2011 Scale:
File: n/a
Data Sources:

FIGURE 4.5-1
Air Quality Project Footprint

ENVIRONMENTAL IMPACT STATEMENT
VOLUME 4: Part A

Kiggavik Project
AREVA

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



Projection: NAD 1983 UTM Zone 14N
Creator: SENES Consultants Limited
Date: 26/09/2011 Scale:
File: n/a
Data Sources:

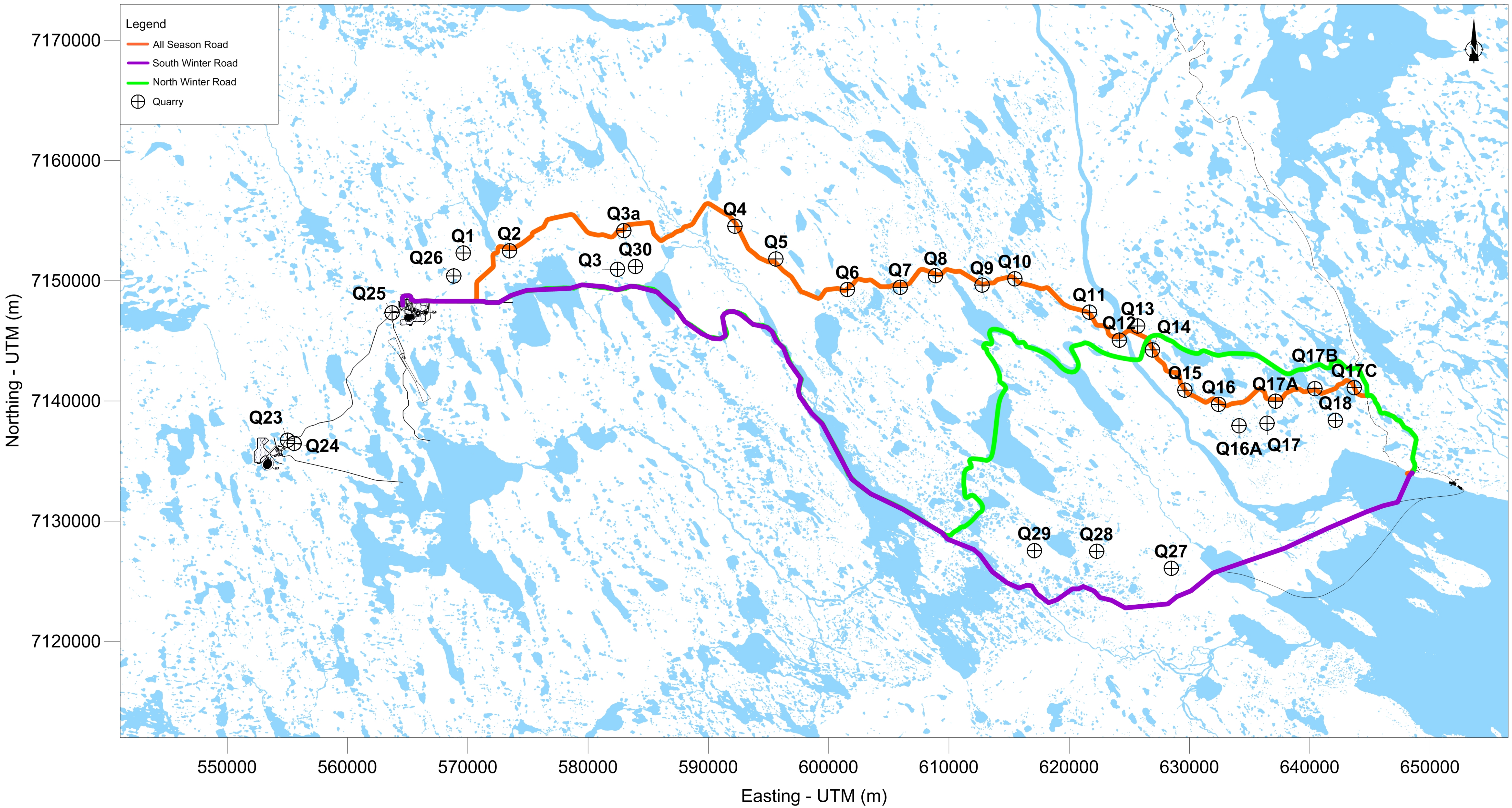
FIGURE 4.5-2
Air Quality
Local and Regional Assessment Areas

ENVIRONMENTAL IMPACT STATEMENT
VOLUME 4: Part A

Kiggavik Project

AREVA

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



Projection: NAD 1983 UTM Zone 14N

Creator: SENES Consultants Limited

Date: 26/09/2011 Scale:

File: n/a

Data Sources:

FIGURE 6.1-1

Quarry Locations

ENVIRONMENTAL IMPACT STATEMENT
VOLUME 4: Part A

Kiggavik Project

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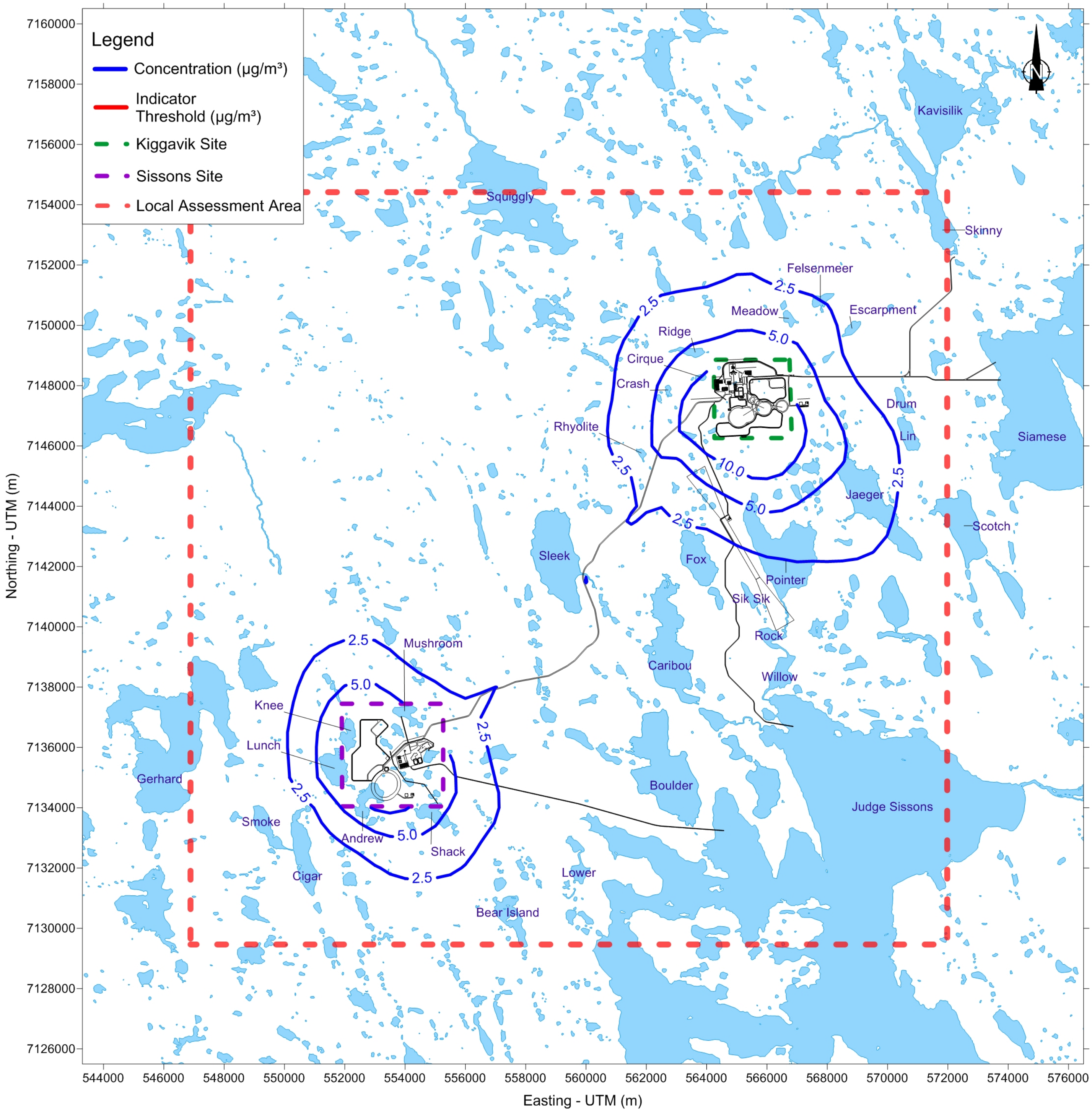

Projection: NAD 1983 UTM Zone 14N
Creator: SENES Consultants Limited
Date: 26/09/2011 Scale:
File: n/a
Data Sources: CALPUFF Air Dispersion Modelling

FIGURE 6.1-10
Operation Assessment - Phase 2
Incremental Annual TSP Concentration (µg/m³)

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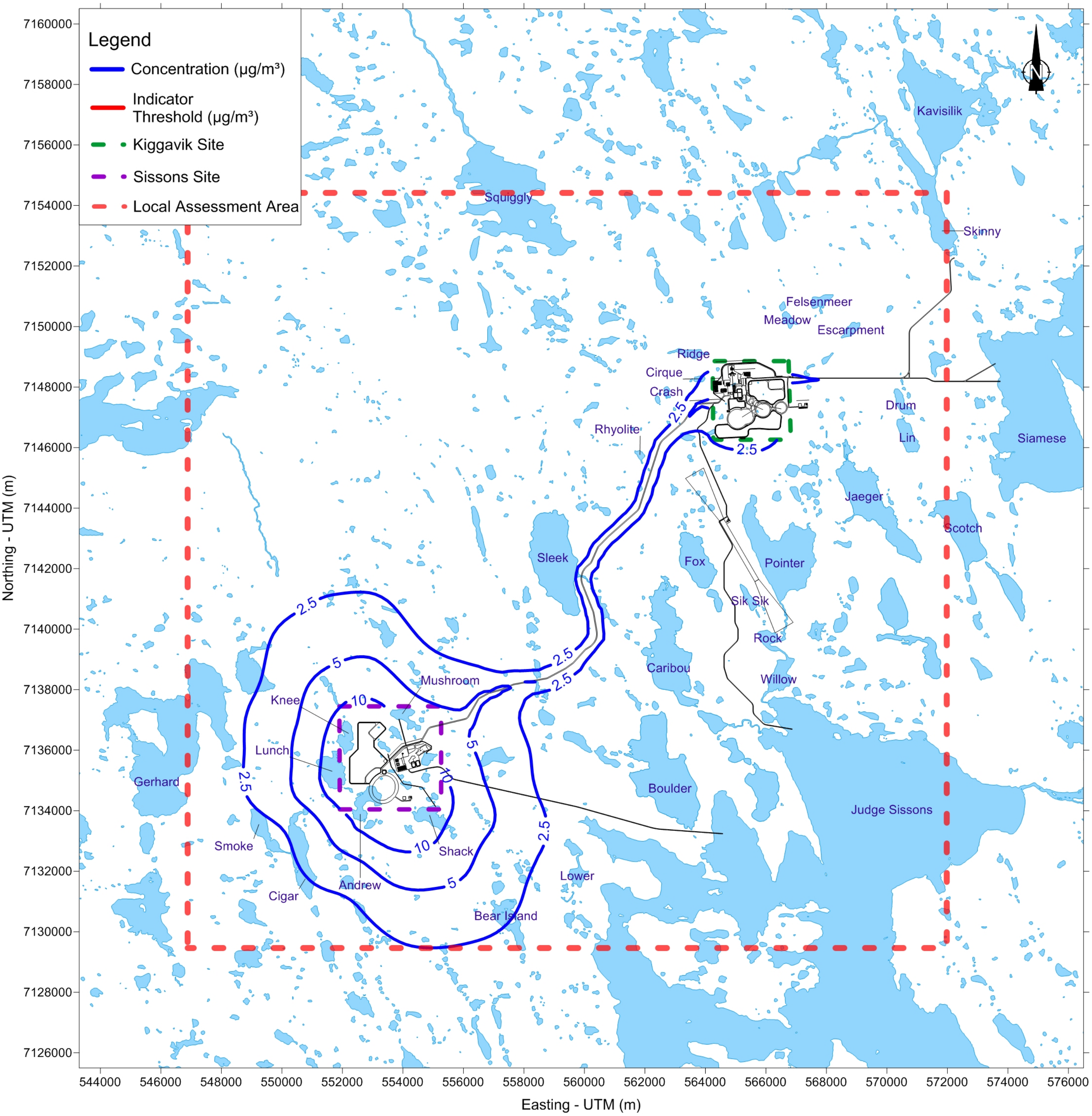

Projection: NAD 1983 UTM Zone 14N

Creator: SENES Consultants Limited

Date: 26/09/2011 Scale:

File: n/a

Data Sources: CALPUFF Air Dispersion Modelling

FIGURE 6.1-11

Operation Assessment - Phase 3
Incremental Annual TSP Concentration (µg/m³)

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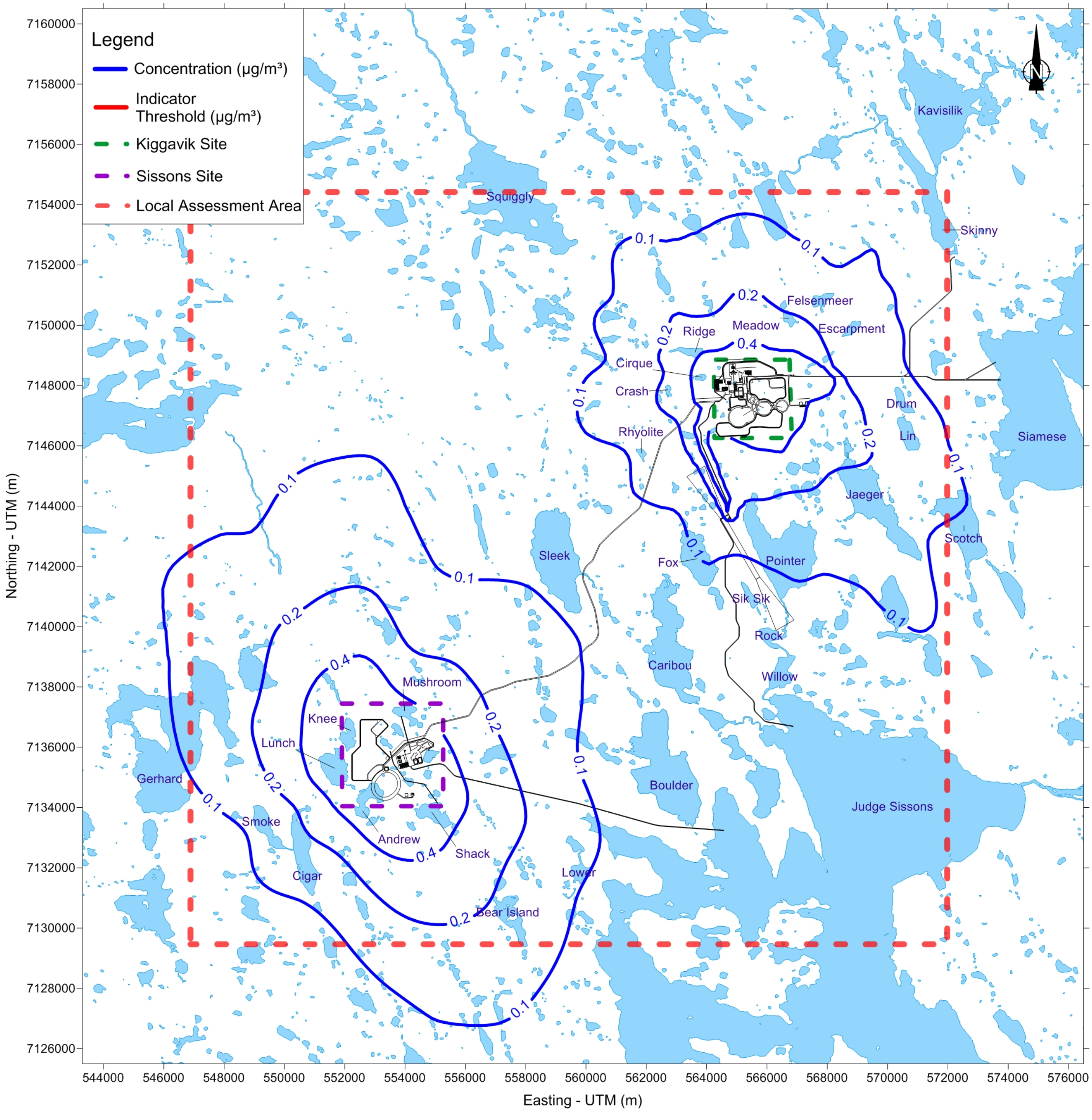

Projection: NAD 1983 UTM Zone 14N

Creator: SENES Consultants Limited

Date: 26/09/2011 Scale:

File: n/a

Data Sources: CALPUFF Air Dispersion Modelling

FIGURE 6.1-12

Operation Assessment - Phase 4

Incremental Annual TSP Concentration (µg/m³)

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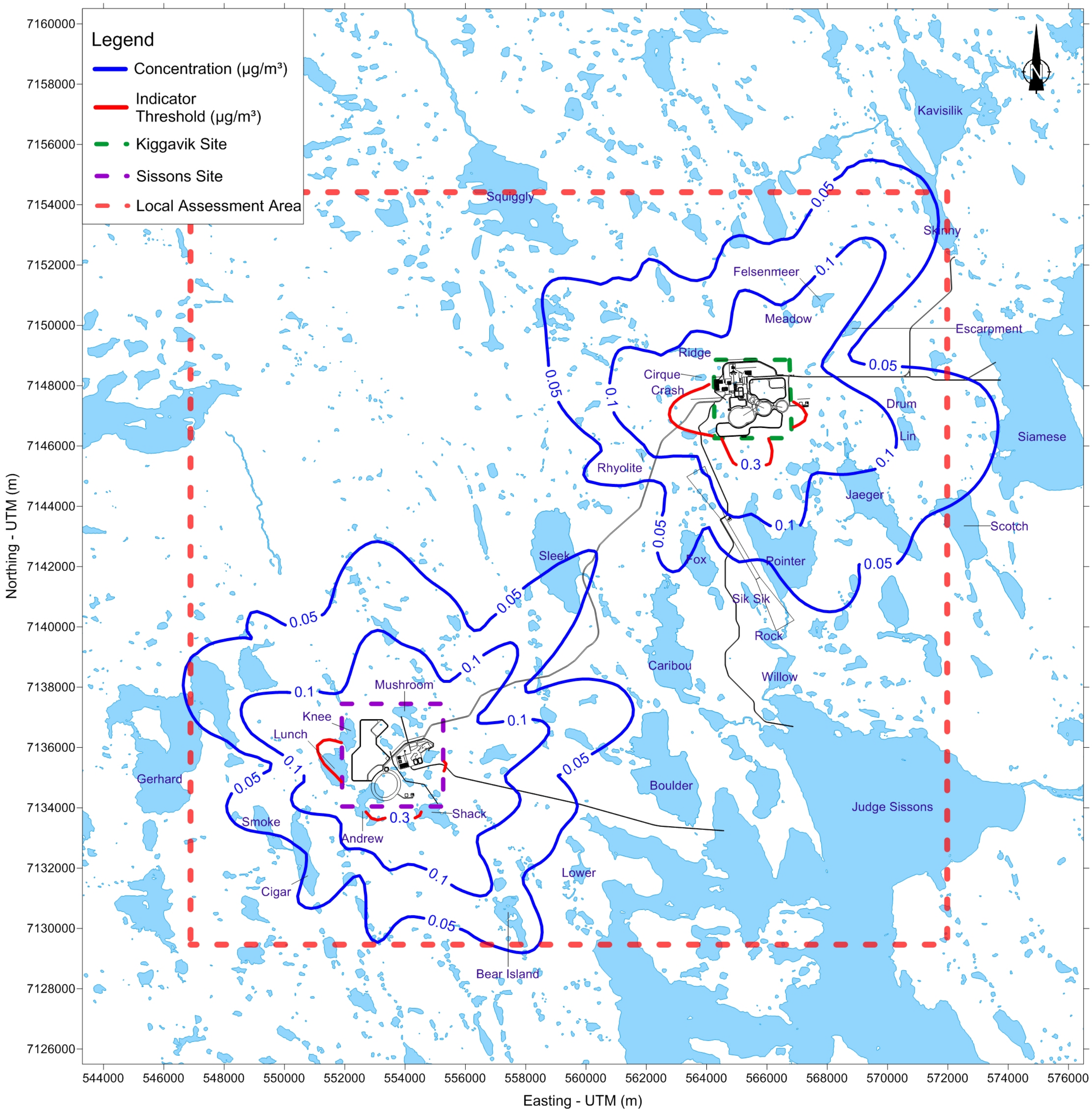

Projection: NAD 1983 UTM Zone 14N
Creator: SENES Consultants Limited
Date: 26/09/2011 Scale:
File: n/a
Data Sources: CALPUFF Air Dispersion Modelling

FIGURE 6.1-13
Maximum Operation Assessment
Incremental Maximum 24-hr Uranium Concentration (µg/m³)

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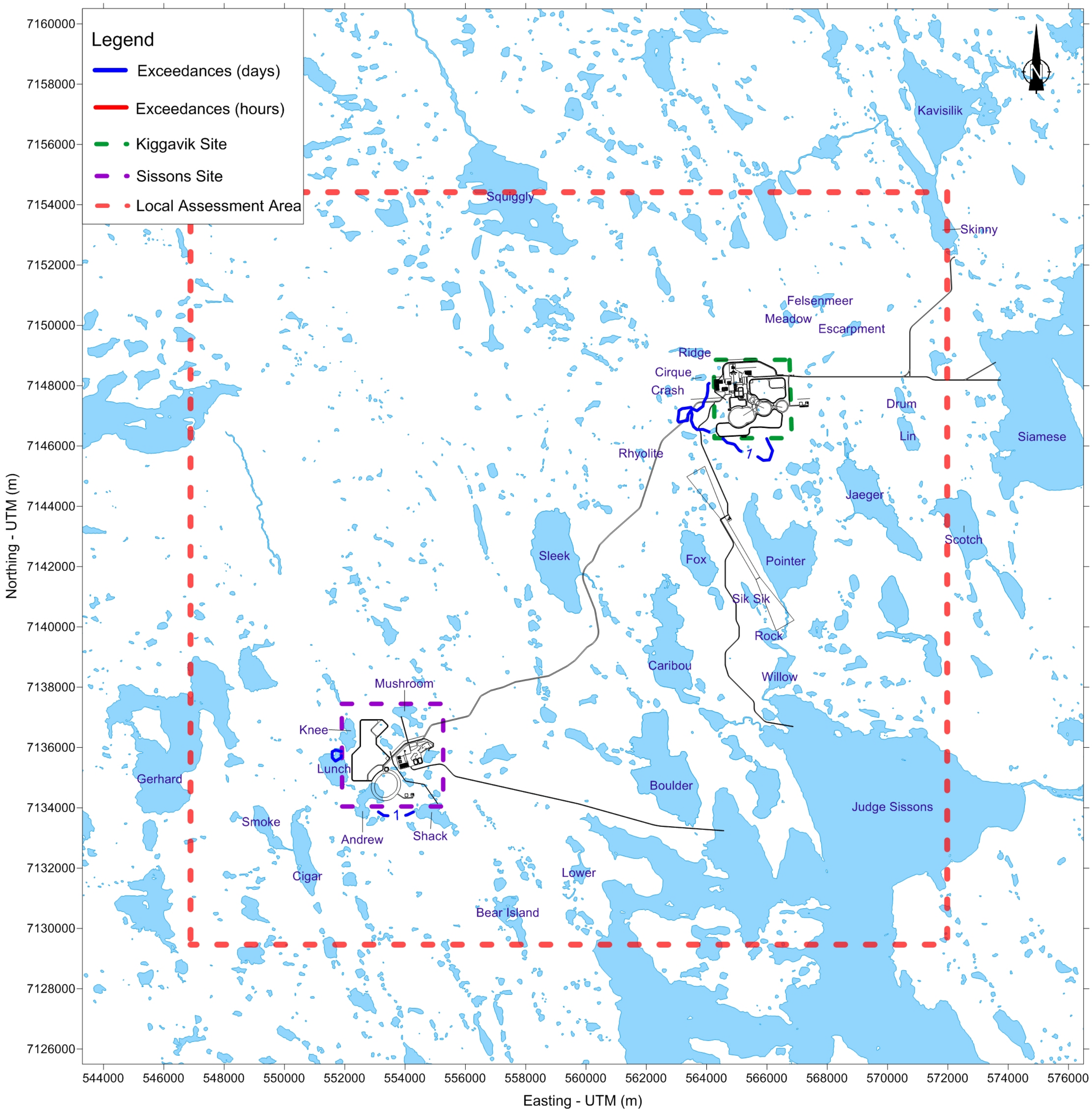

Projection: NAD 1983 UTM Zone 14N

Creator: SENES Consultants Limited

Date: 26/09/2011 Scale:

File: n/a

Data Sources: CALPUFF Air Dispersion Modelling

FIGURE 6.1-14

Maximum Operation Assessment
Exceedances of 24-hr Uranium Indicator Threshold (days)

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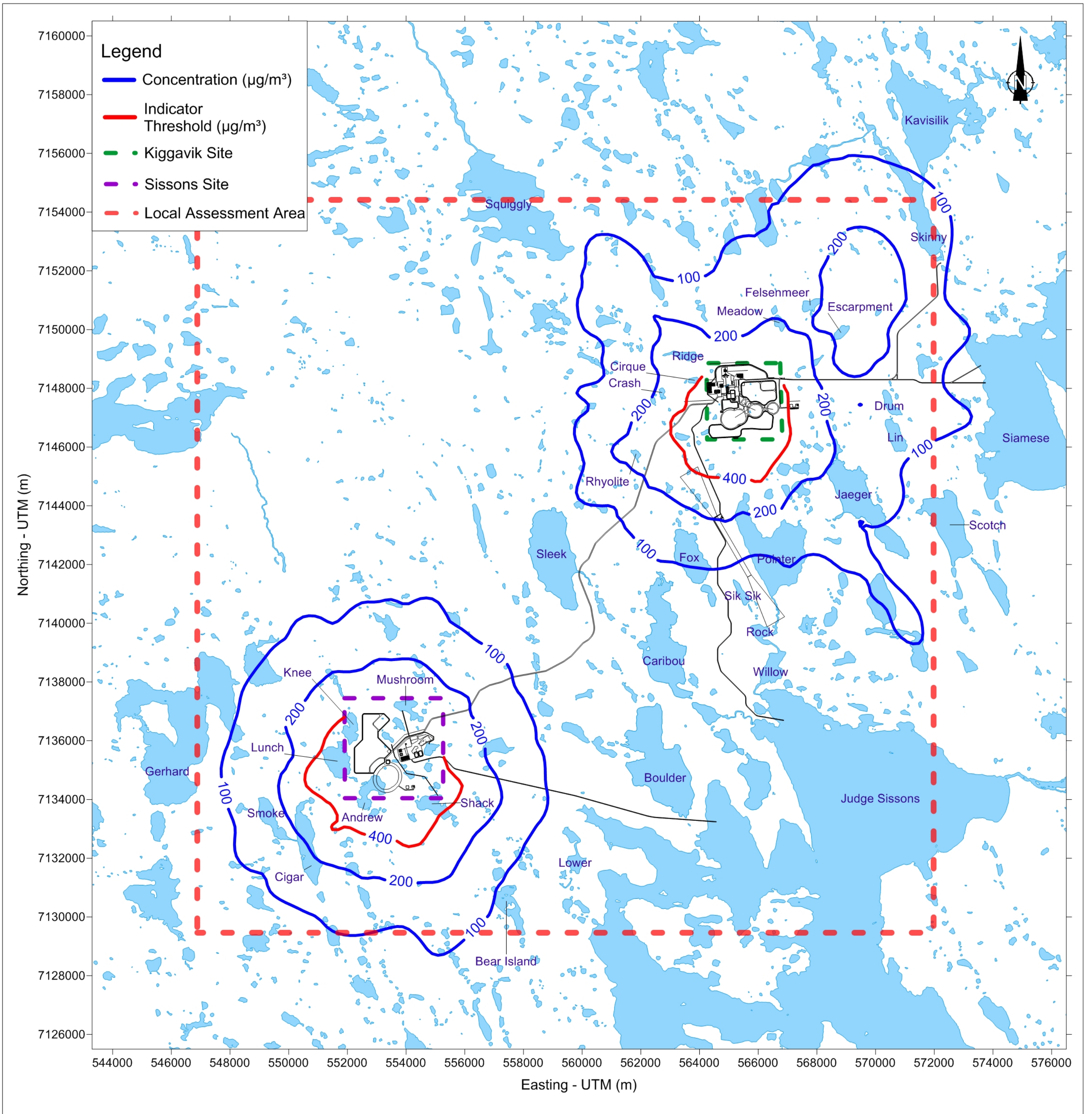

Projection: NAD 1983 UTM Zone 14N

Creator: SENES Consultants Limited

Date: 26/09/2011 Scale:

File: n/a

Data Sources: CALPUFF Air Dispersion Modelling

FIGURE 6.1-15

Maximum Operation Assessment
Incremental Maximum 1-hr NO_2 Concentration (µg/m³)

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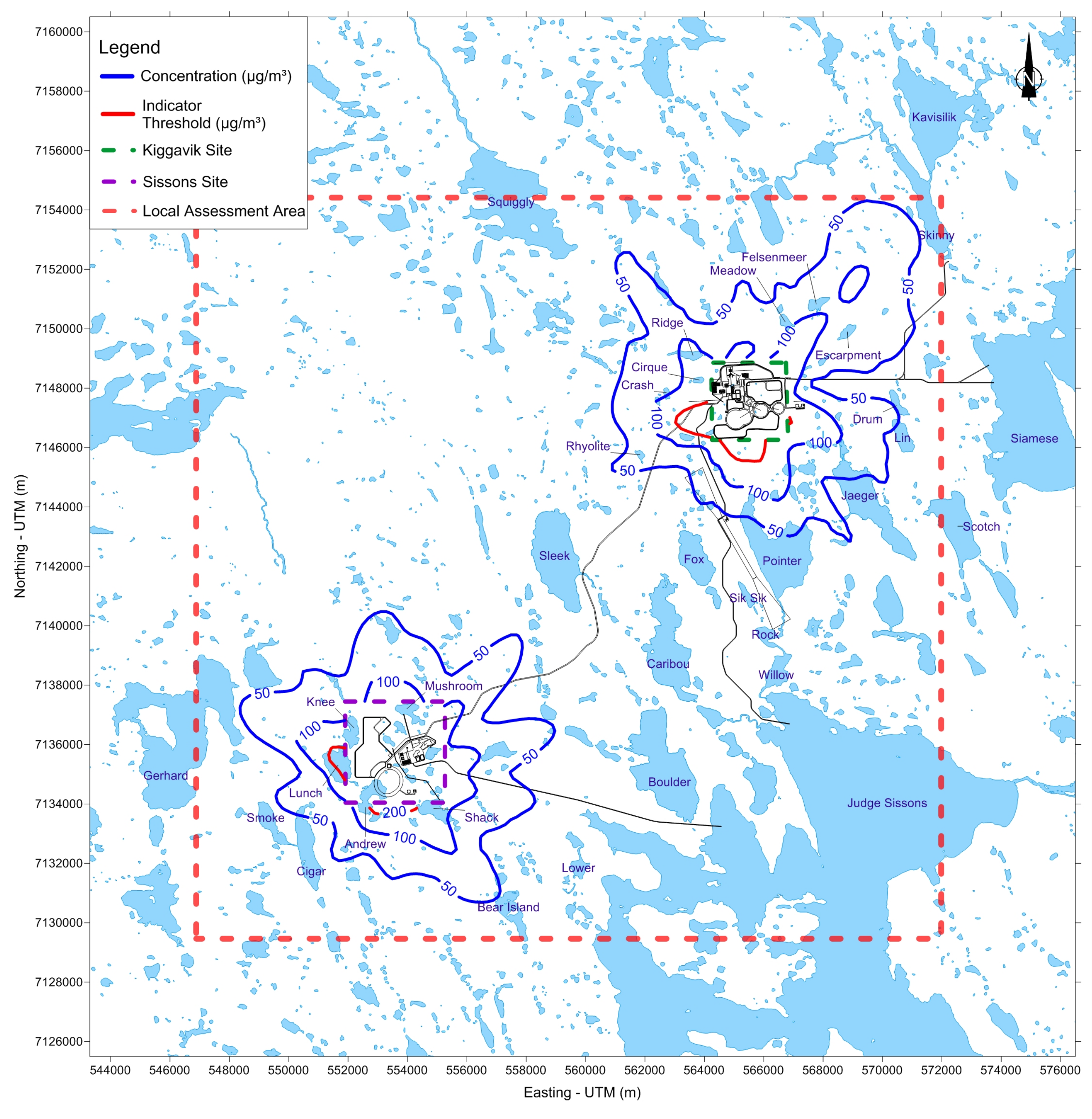

Projection: NAD 1983 UTM Zone 14N
Creator: SENES Consultants Limited
Date: 26/09/2011 Scale:
File: n/a
Data Sources: CALPUFF Air Dispersion Modelling

FIGURE 6.1-16
Maximum Operation Assessment
Incremental Maximum 24-hr NO_2 Concentration (µg/m³)

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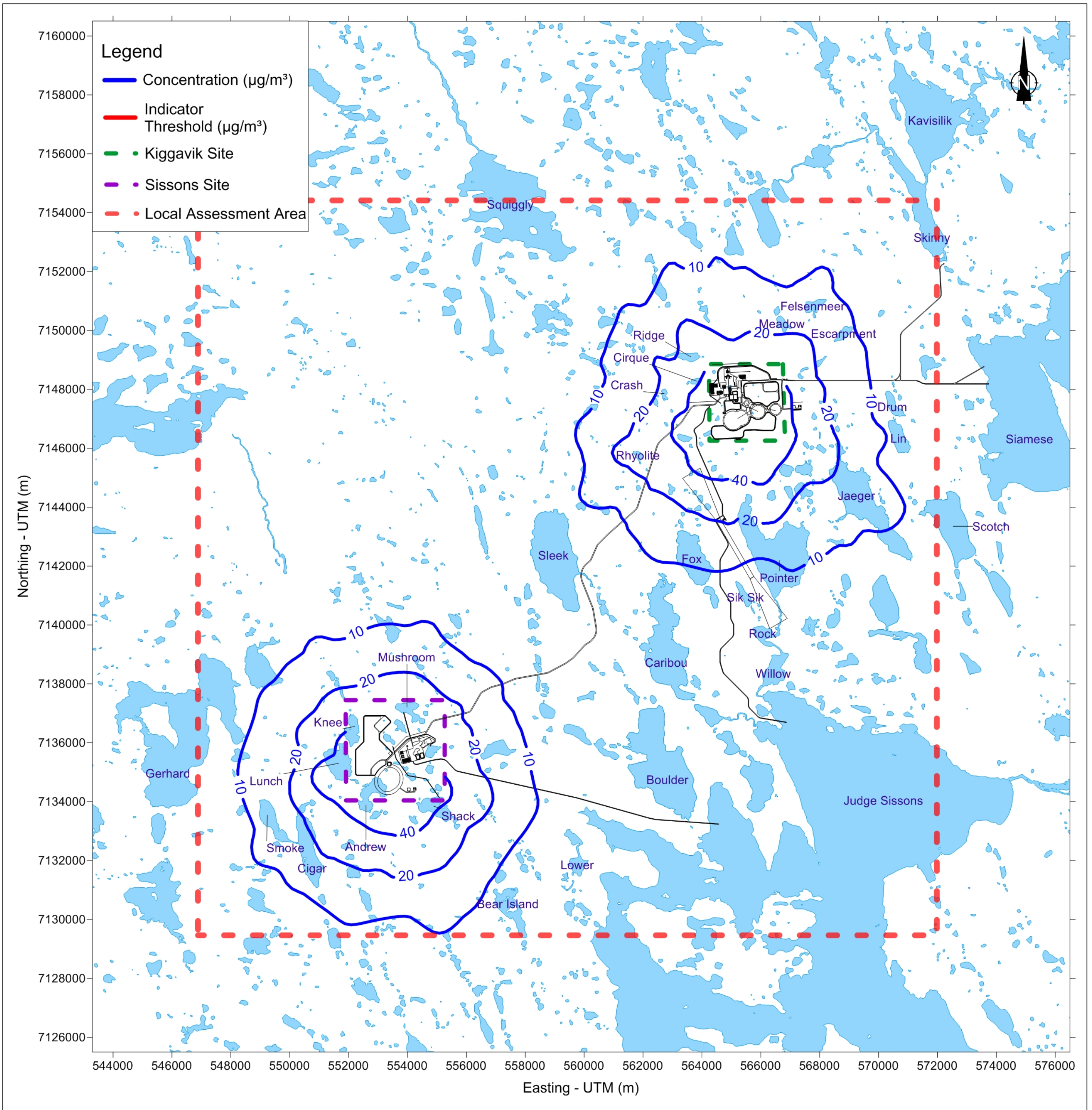

Projection: NAD 1983 UTM Zone 14N
Creator: SENES Consultants Limited
Date: 26/09/2011 Scale:
File: n/a
Data Sources: CALPUFF Air Dispersion Modelling

FIGURE 6.1-17
Maximum Operation Assessment
Incremental Maximum 1-hr SO_2 Concentration (µg/m³)

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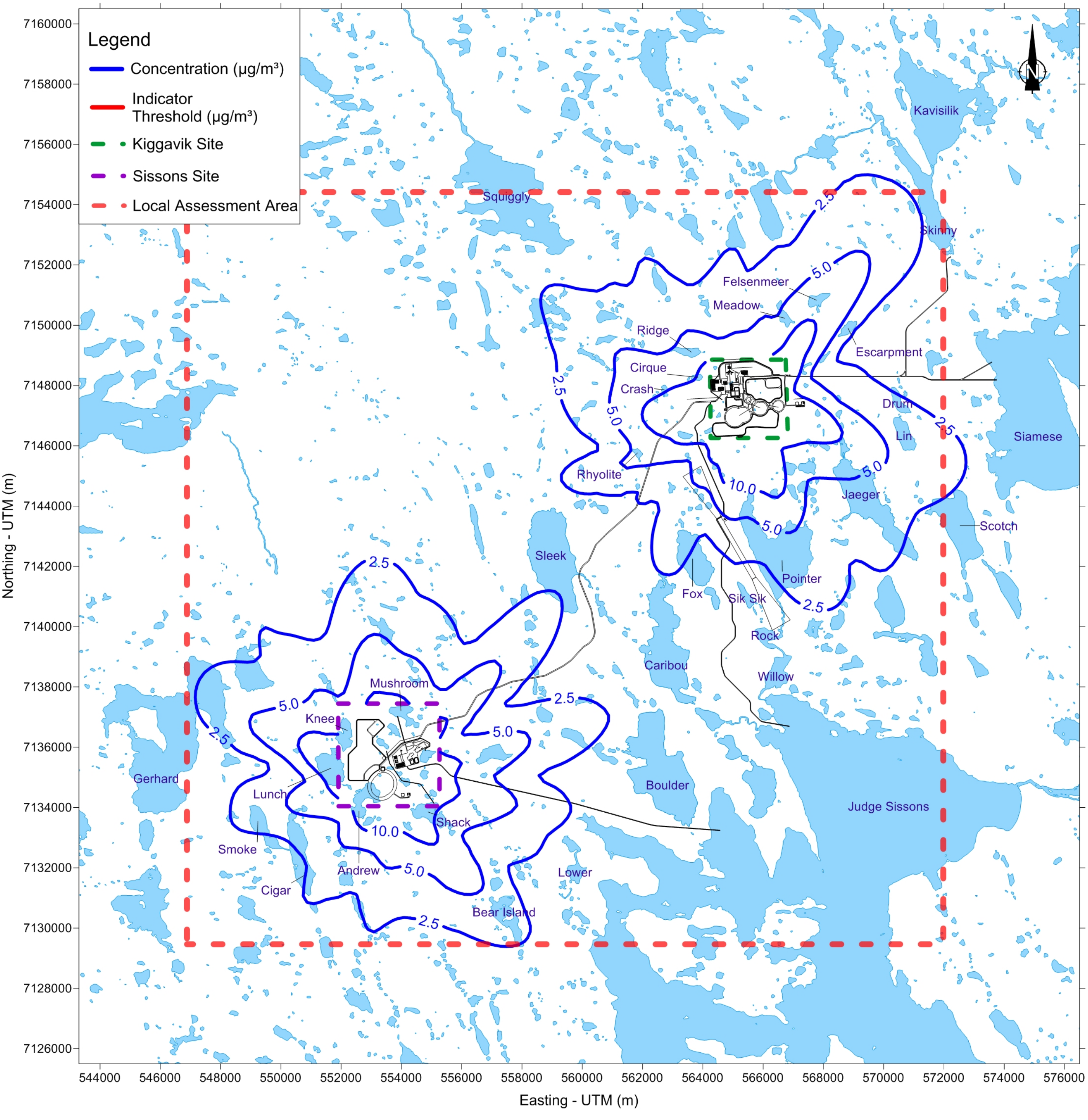

Projection: NAD 1983 UTM Zone 14N
Creator: SENES Consultants Limited
Date: 26/09/2011 Scale:
File: n/a
Data Sources: CALPUFF Air Dispersion Modelling

FIGURE 6.1-18
Maximum Operation Assessment
Incremental Maximum 24-hr SO_2 Concentration (µg/m³)

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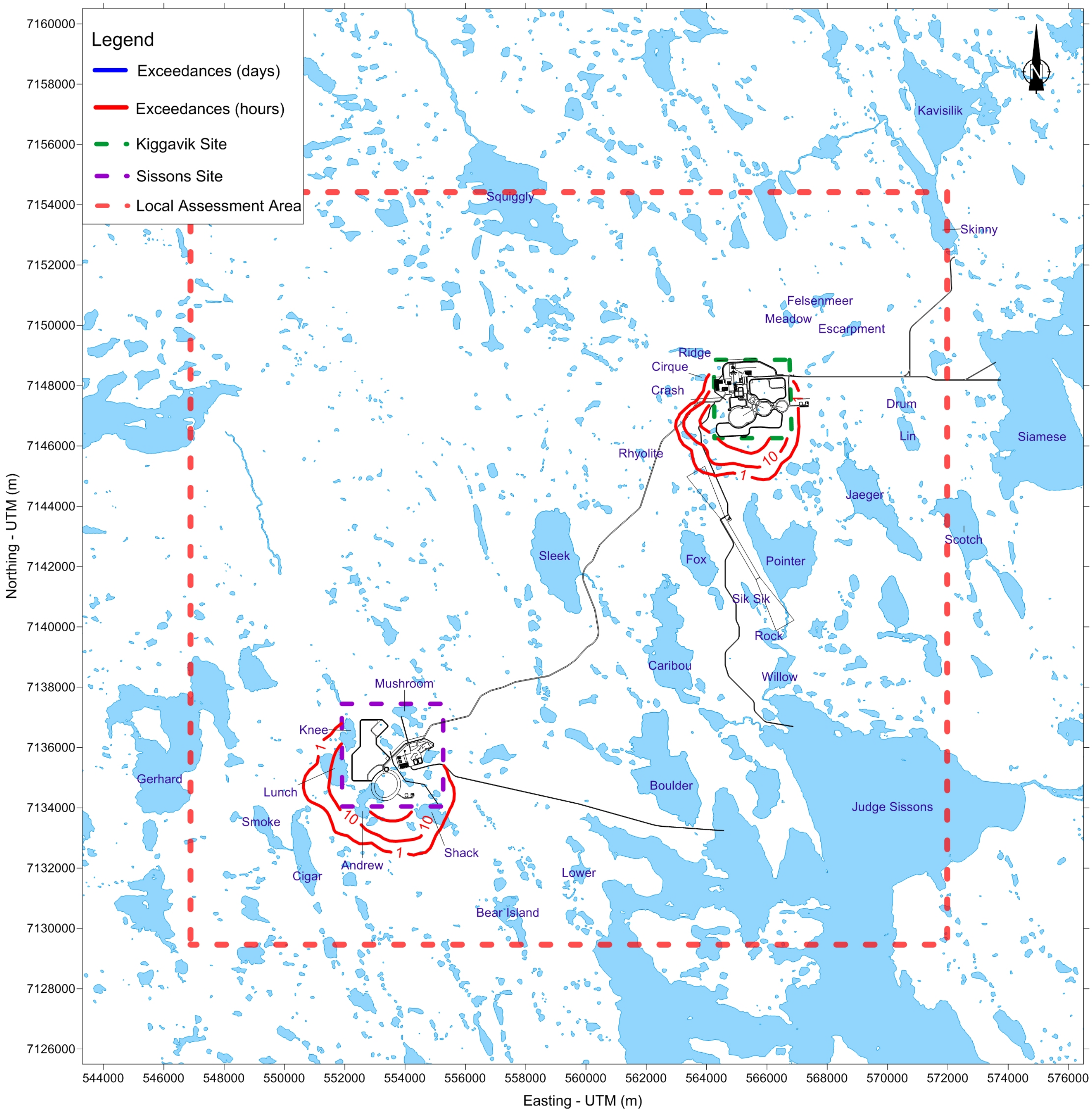

Projection: NAD 1983 UTM Zone 14N

Creator: SENES Consultants Limited

Date: 26/09/2011 Scale:

File: n/a

Data Sources: CALPUFF Air Dispersion Modelling

FIGURE 6.1-19

Maximum Operation Assessment

Exceedances of 1-hr NO_2 Indicator Threshold (hours)

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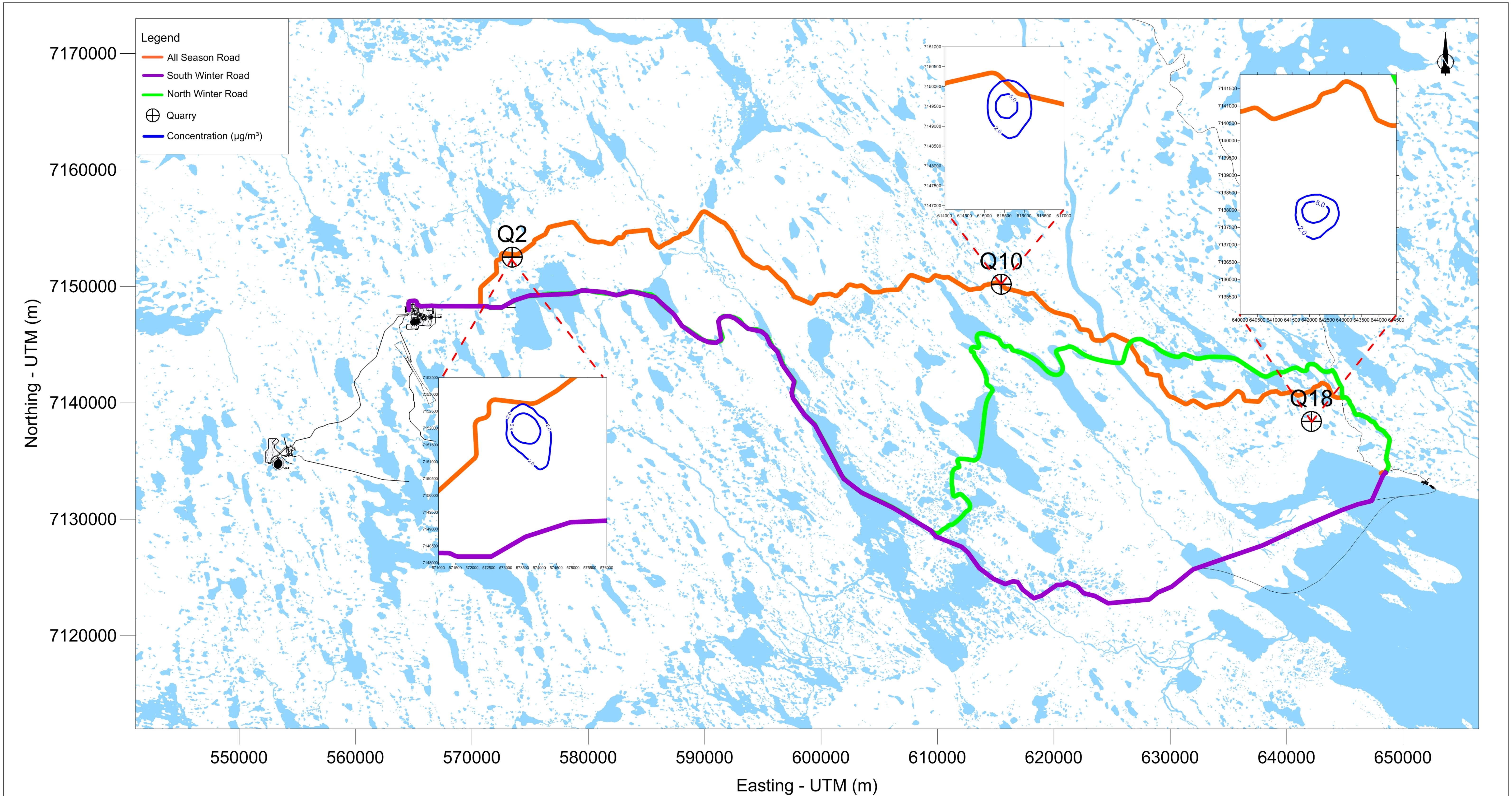

Projection: NAD 1983 UTM Zone 14N
Creator: SENES Consultants Limited
Date: 26/09/2011 Scale:
File: n/a
Data Sources: CALPUFF Air Dispersion Modelling

FIGURE 6.1-2
Quarry Assessment
Incremental Maximum 24-hr TSP Concentration (μg/m³)

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VOLUME 4: Part A

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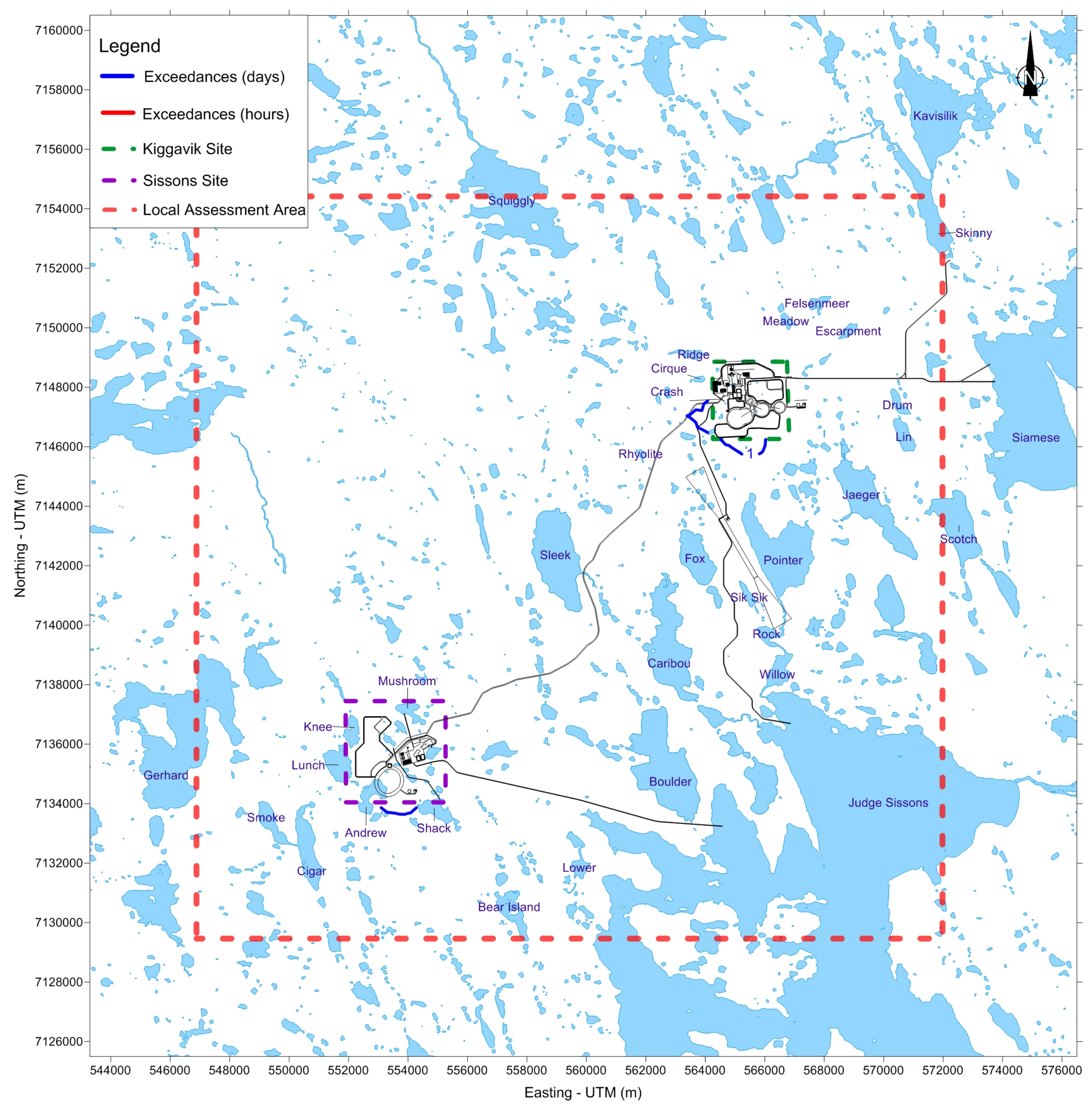

Projection: NAD 1983 UTM Zone 14N
Creator: SENES Consultants Limited
Date: 26/09/2011 Scale:
File: n/a
Data Sources: CALPUFF Air Dispersion Modelling

FIGURE 6.1-20
Maximum Operation Assessment
Exceedances of 24-hr NO_2 Indicator Threshold (days)

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VOLUME 4

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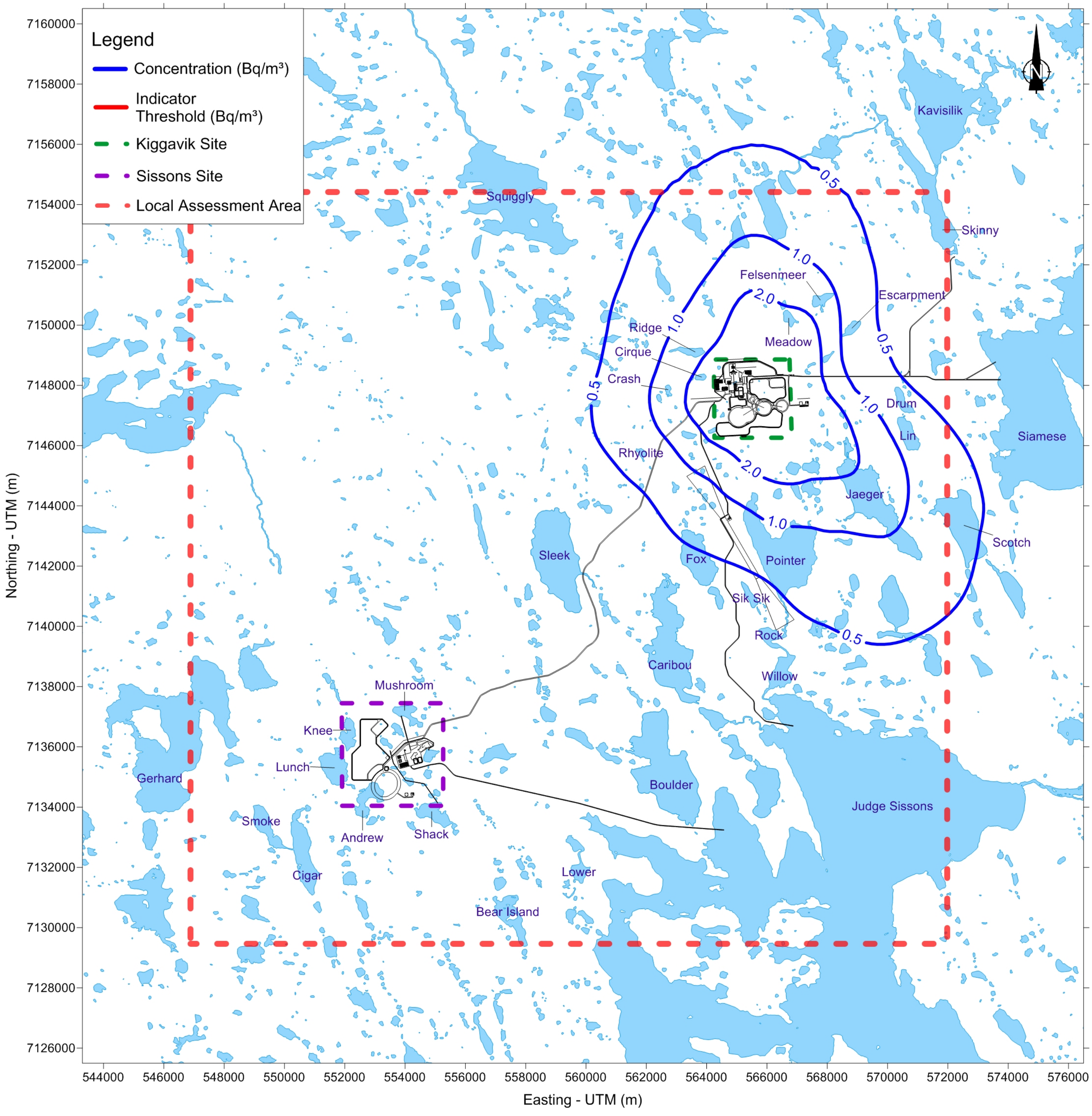

Projection: NAD 1983 UTM Zone 14N

Creator: SENES Consultants Limited

Date: 26/09/2011 Scale:

File: n/a

Data Sources: CALPUFF Air Dispersion Modelling

FIGURE 6.1-21

Operation Assessment - Phase 1
Incremental Annual Radon Concentration (Bq/m³)

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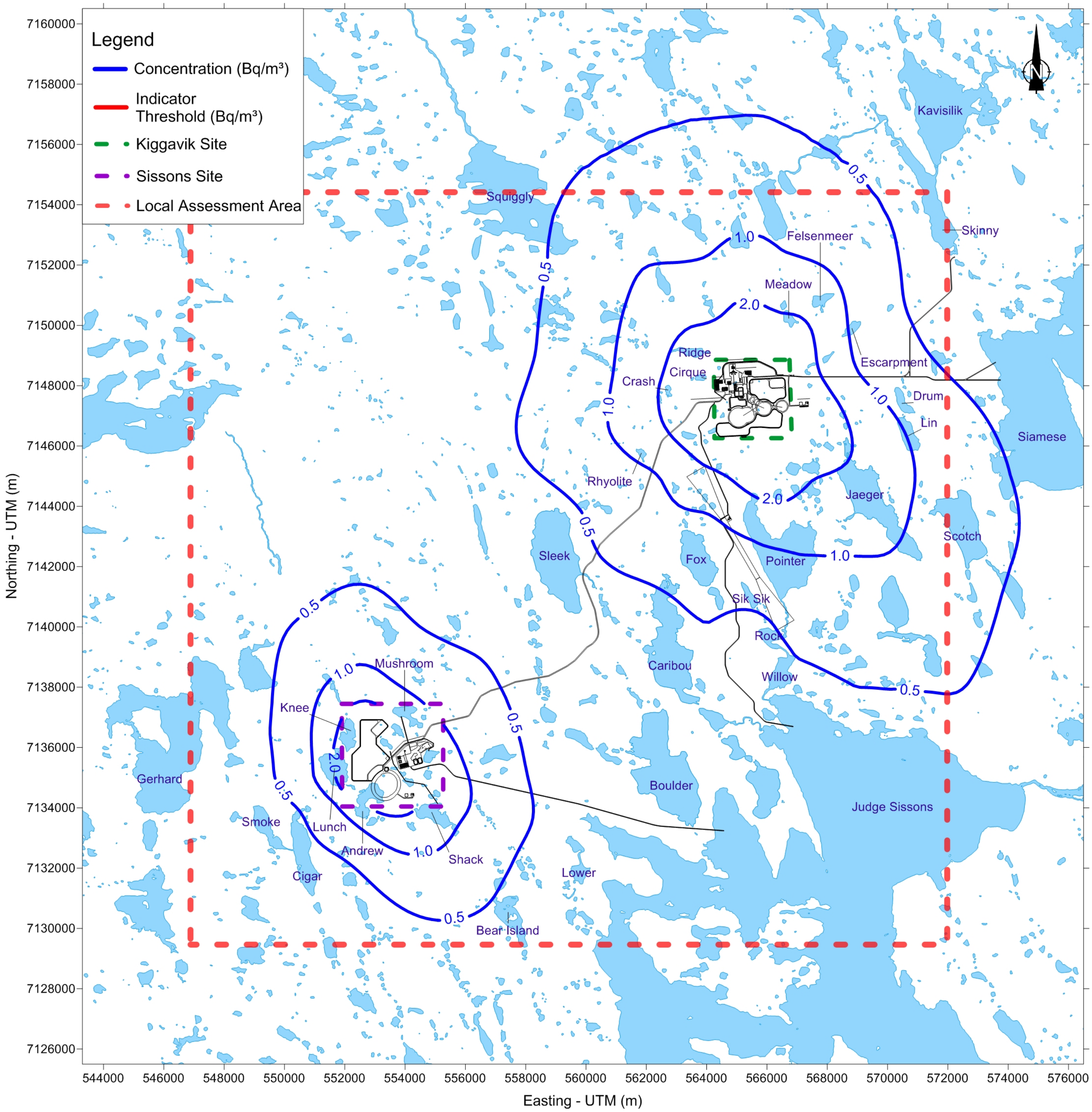

Projection: NAD 1983 UTM Zone 14N

Creator: SENES Consultants Limited

Date: 26/09/2011 Scale:

File: n/a

Data Sources: CALPUFF Air Dispersion Modelling

FIGURE 6.1-22

Operation Assessment - Phase 2
Incremental Annual Radon Concentration (Bq/m³)

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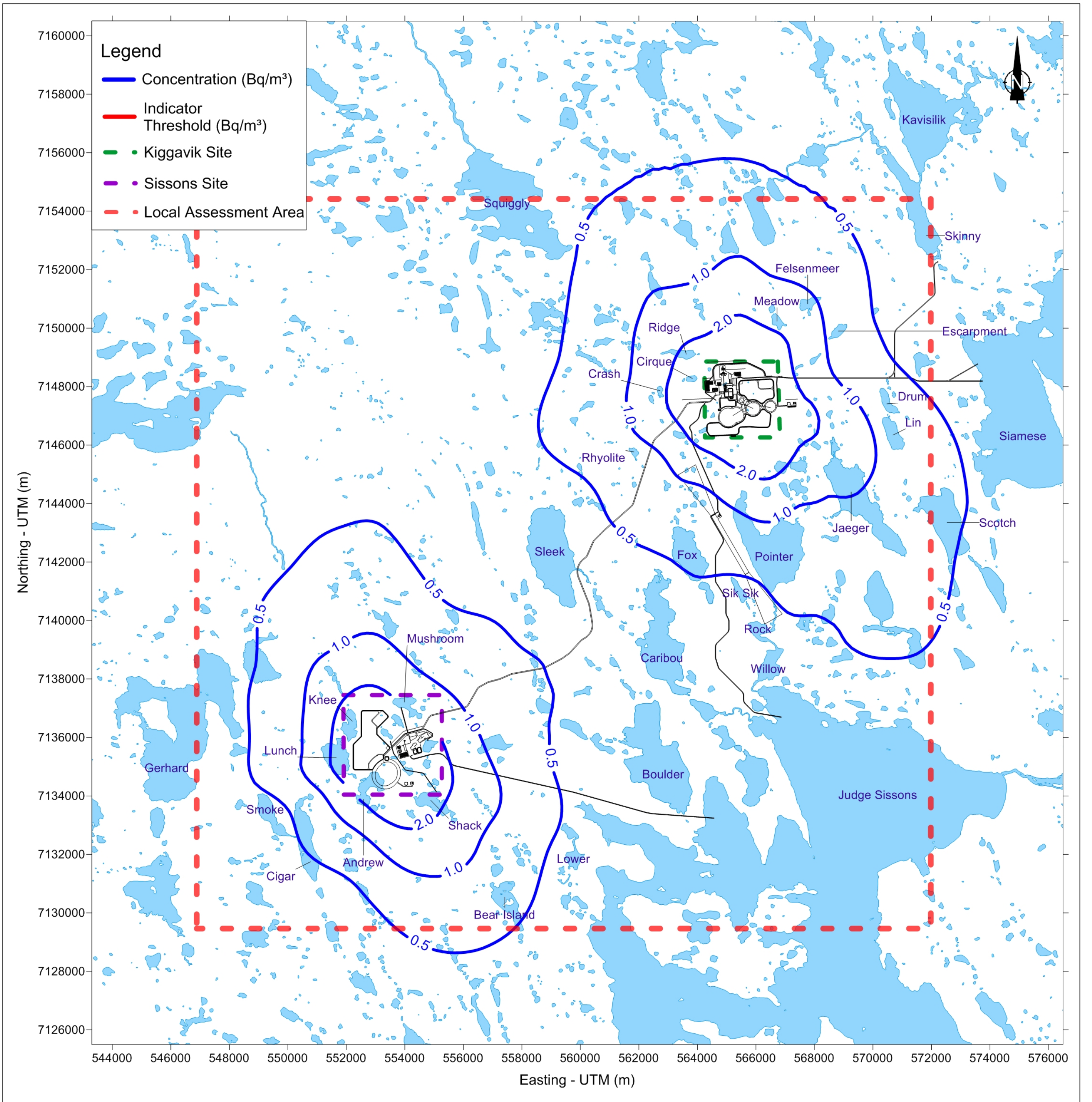

Projection: NAD 1983 UTM Zone 14N

Creator: SENES Consultants Limited

Date: 26/09/2011 Scale:

File: n/a

Data Sources: CALPUFF Air Dispersion Modelling

FIGURE 6.1-23

Operation Assessment - Phase 3
Incremental Annual Radon Concentration (Bq/m³)

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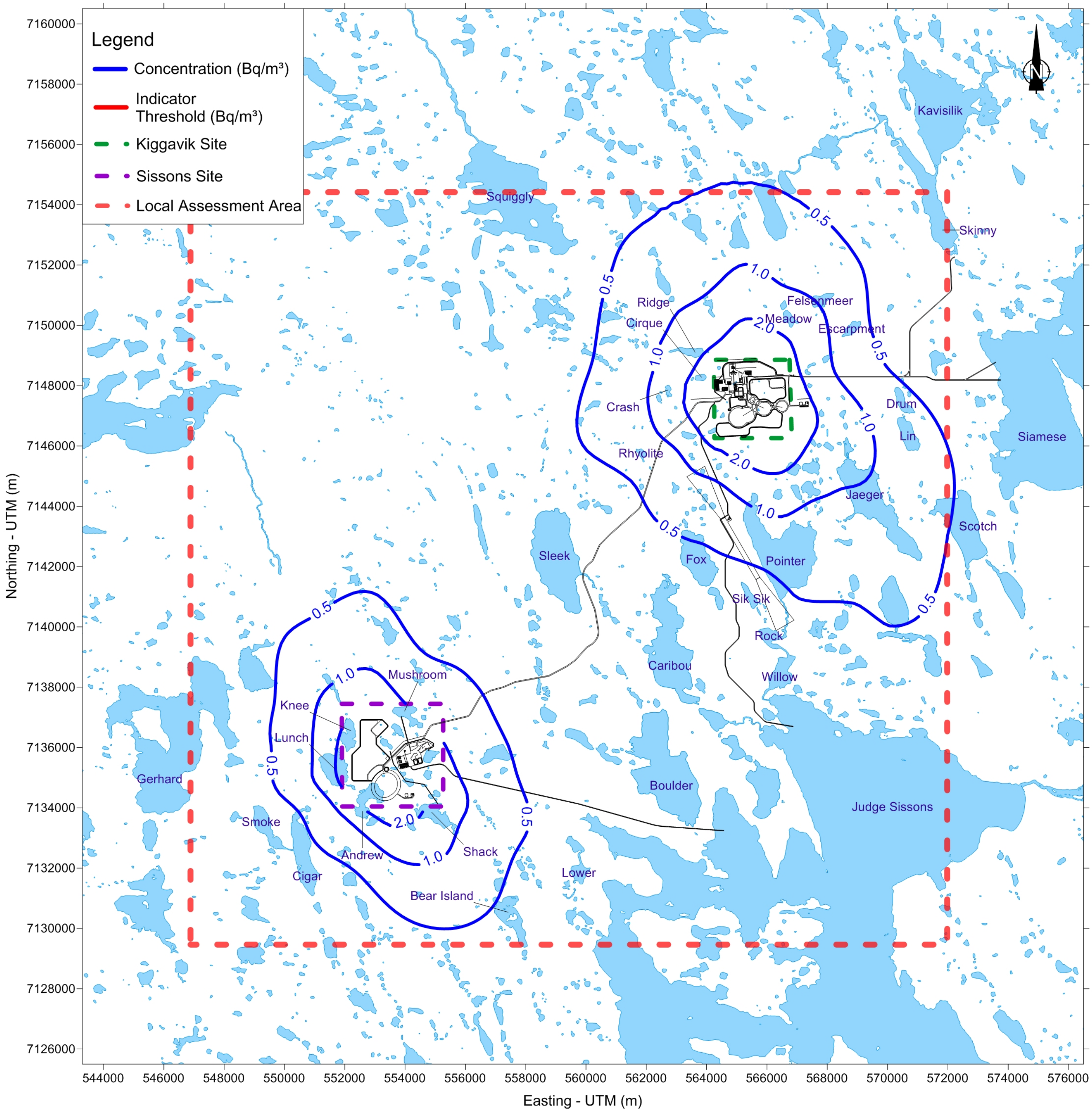

Projection: NAD 1983 UTM Zone 14N

Creator: SENES Consultants Limited

Date: 26/09/2011 Scale:

File: n/a

Data Sources: CALPUFF Air Dispersion Modelling

FIGURE 6.1-24

Operation Assessment - Phase 3

Incremental Annual Radon Concentration (Bq/m³)

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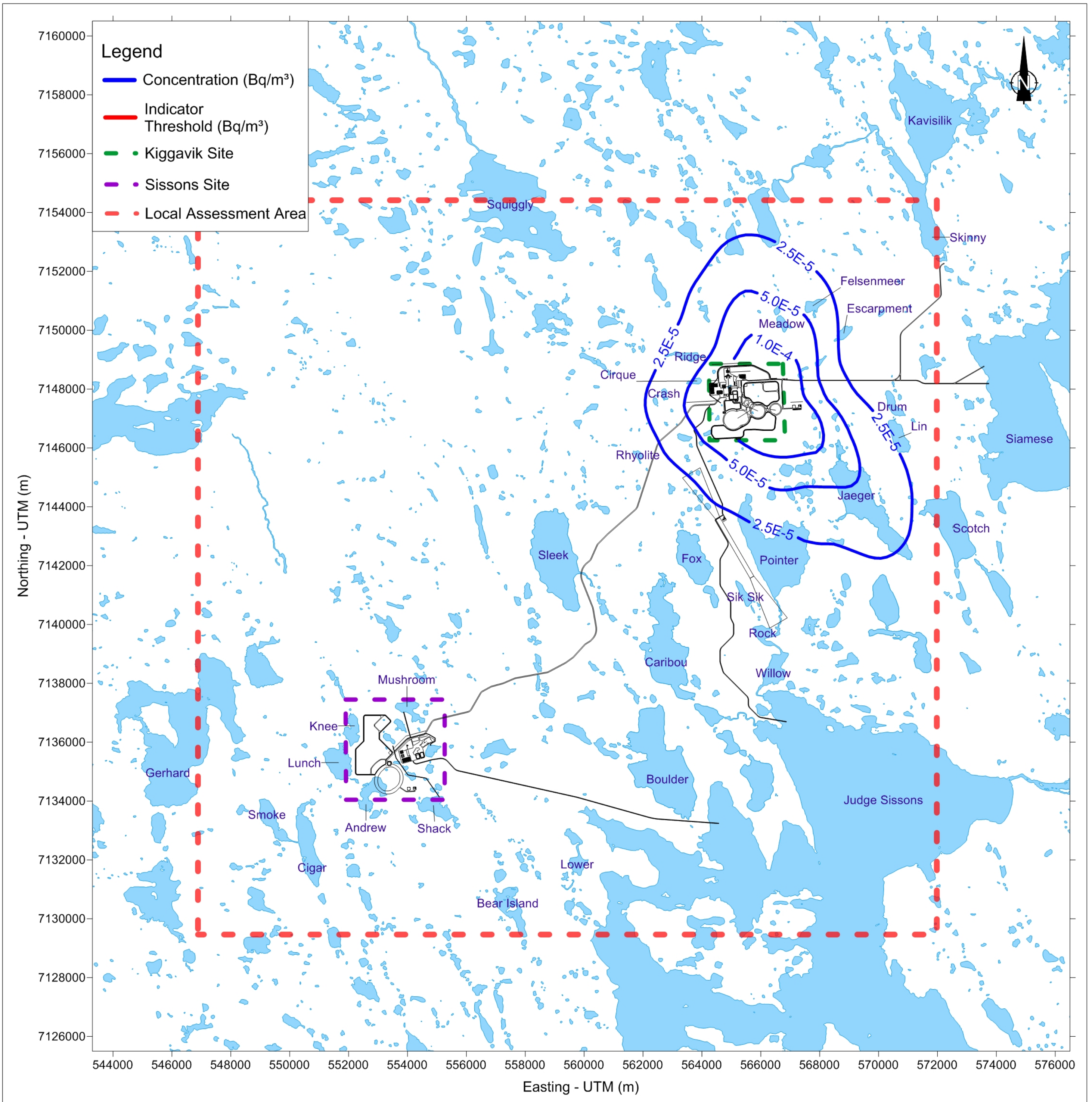

Projection: NAD 1983 UTM Zone 14N
Creator: SENES Consultants Limited
Date: 26/09/2011 Scale:
File: n/a
Data Sources: CALPUFF Air Dispersion Modelling

FIGURE 6.1-25
Operation Assessment - Phase 1
Incremental Annual Pb-210 or Po-210 Concentration (Bq/m³)

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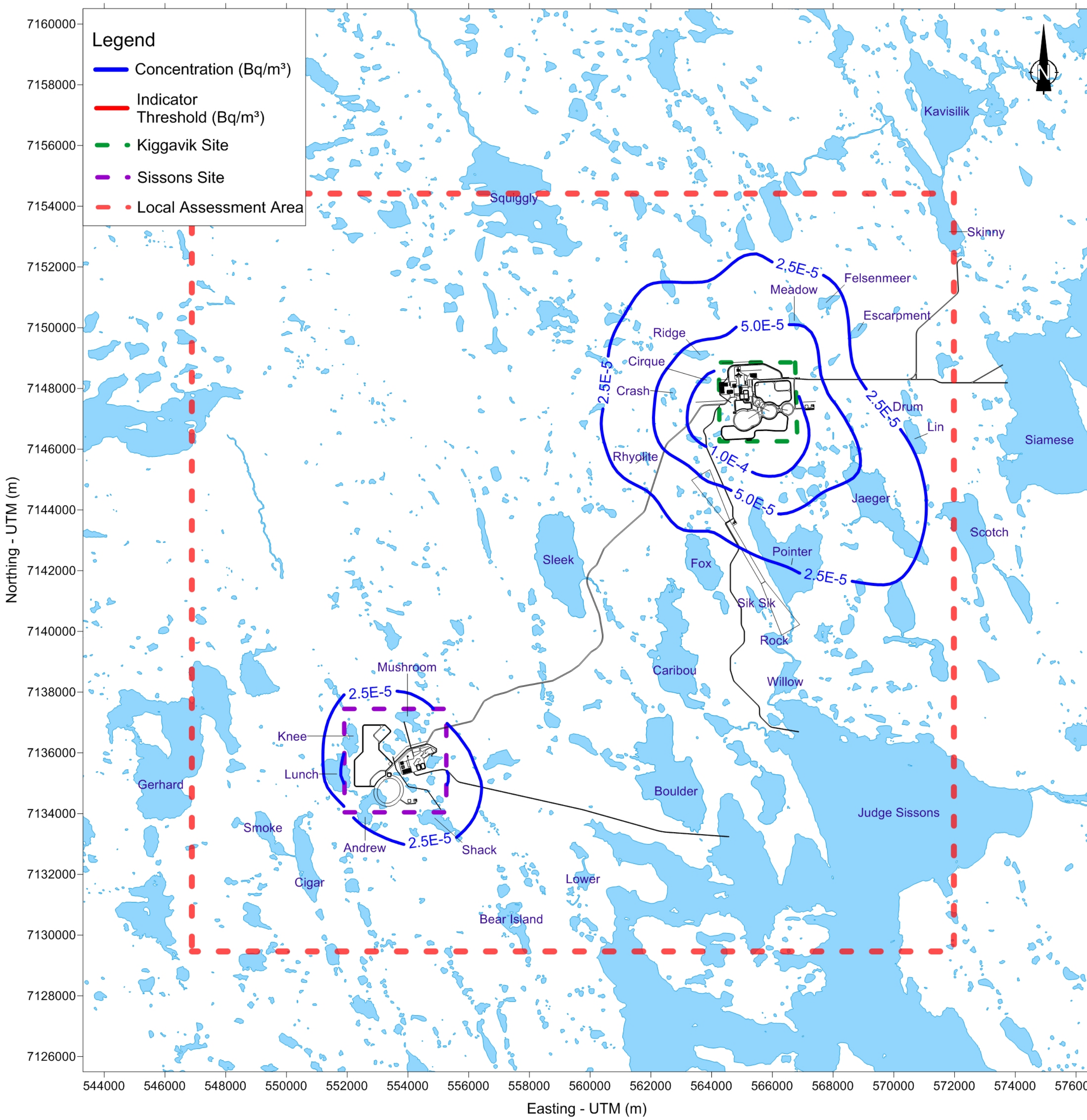

Projection: NAD 1983 UTM Zone 14N
Creator: SENES Consultants Limited
Date: 26/09/2011 Scale:
File: n/a
Data Sources: CALPUFF Air Dispersion Modelling

FIGURE 6.1-26
Operation Assessment - Phase 2
Incremental Annual Pb-210 or Po-210 Concentration (Bq/m³)

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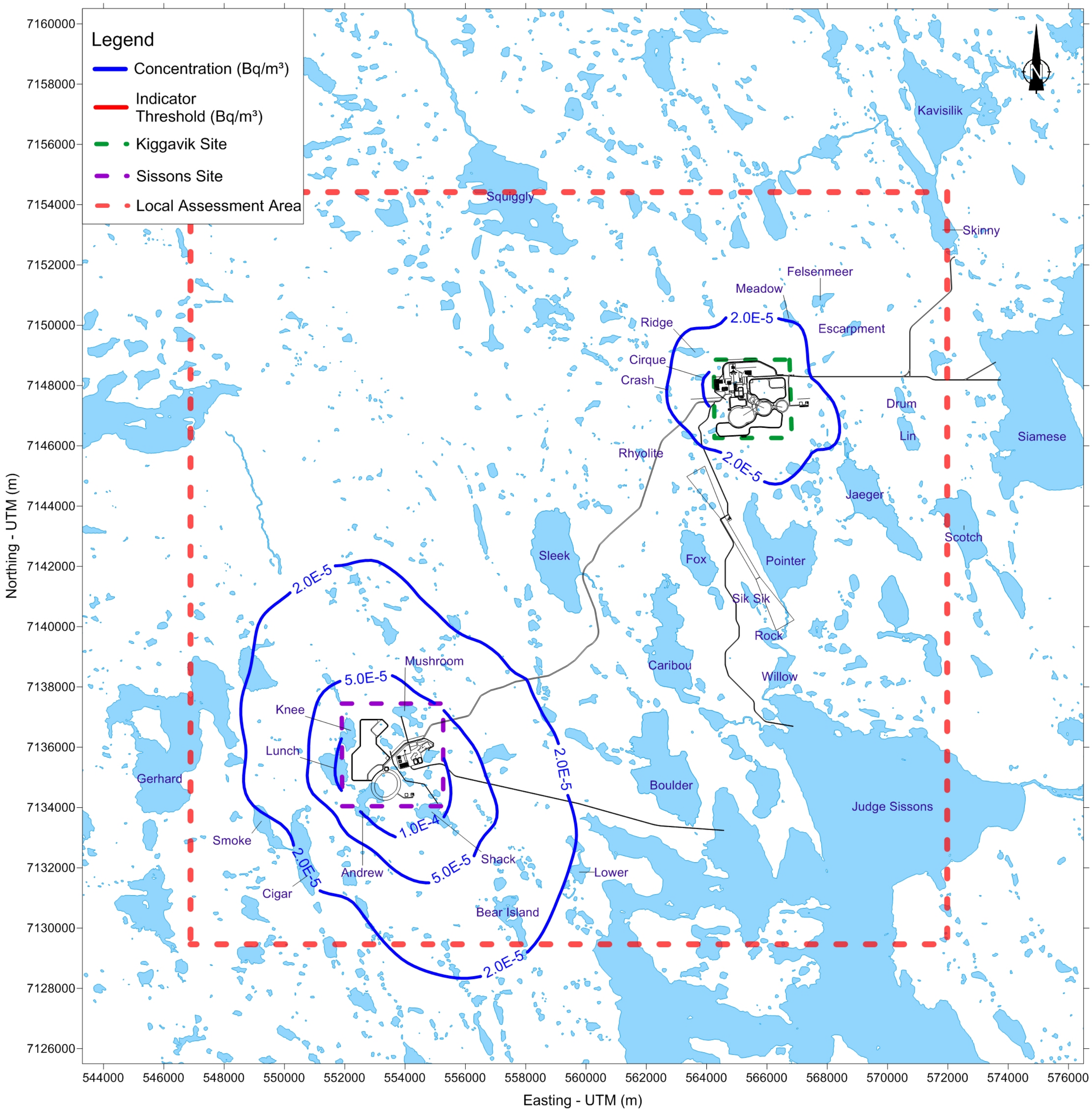

Projection: NAD 1983 UTM Zone 14N

Creator: SENES Consultants Limited

Date: 26/09/2011 Scale:

File: n/a

Data Sources: CALPUFF Air Dispersion Modelling

FIGURE 6.1-27

Operation Assessment - Phase 3

Incremental Annual Pb-210 or Po-210 Concentration (Bq/m³)

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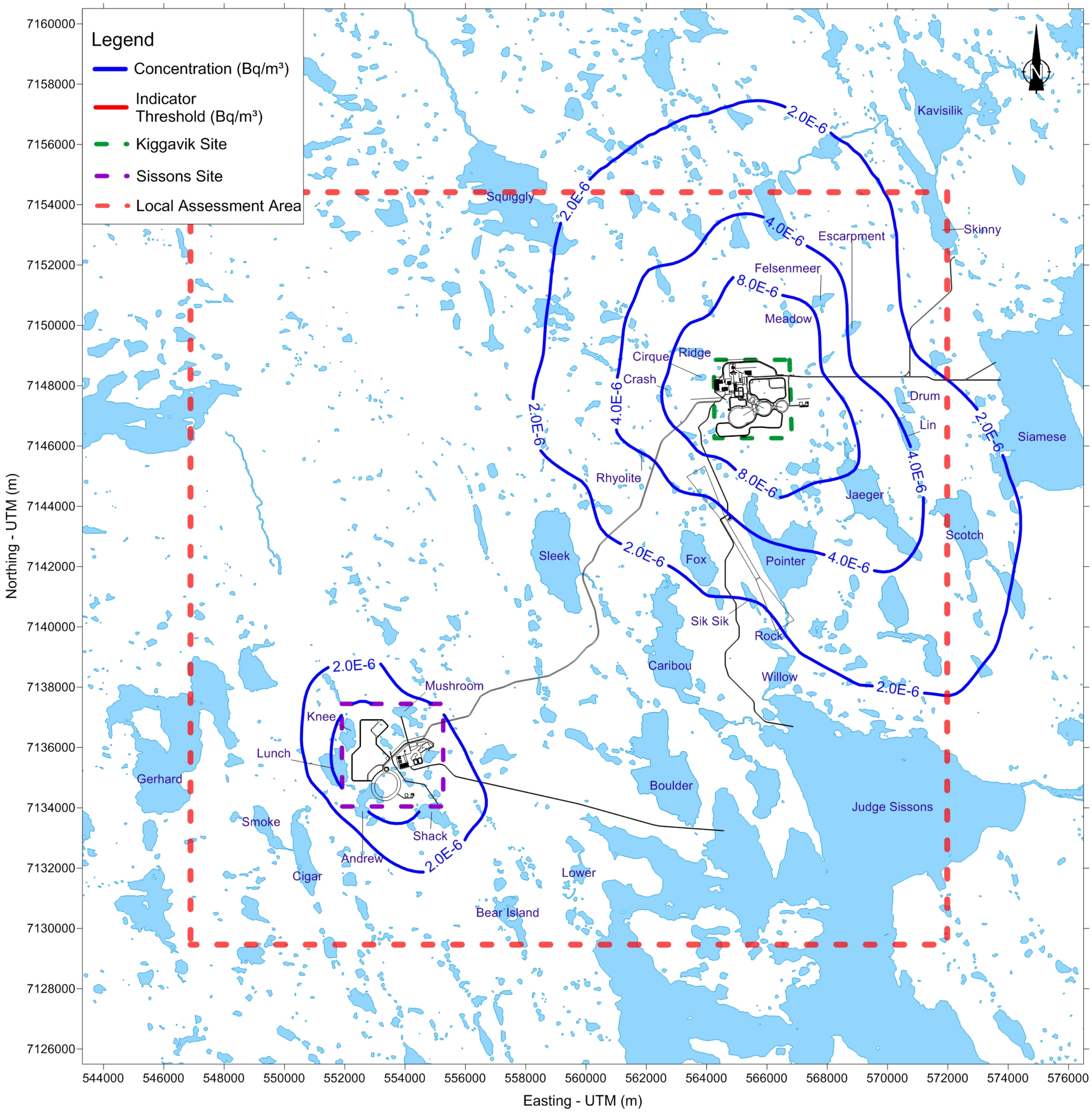

Projection: NAD 1983 UTM Zone 14N

Creator: SENES Consultants Limited

Date: 26/09/2011 Scale:

File: n/a

Data Sources: CALPUFF Air Dispersion Modelling

FIGURE 6.1-28

Operation Assessment - Phase 4

Incremental Annual Pb-210 or Po-210 Concentration (Bq/m³)

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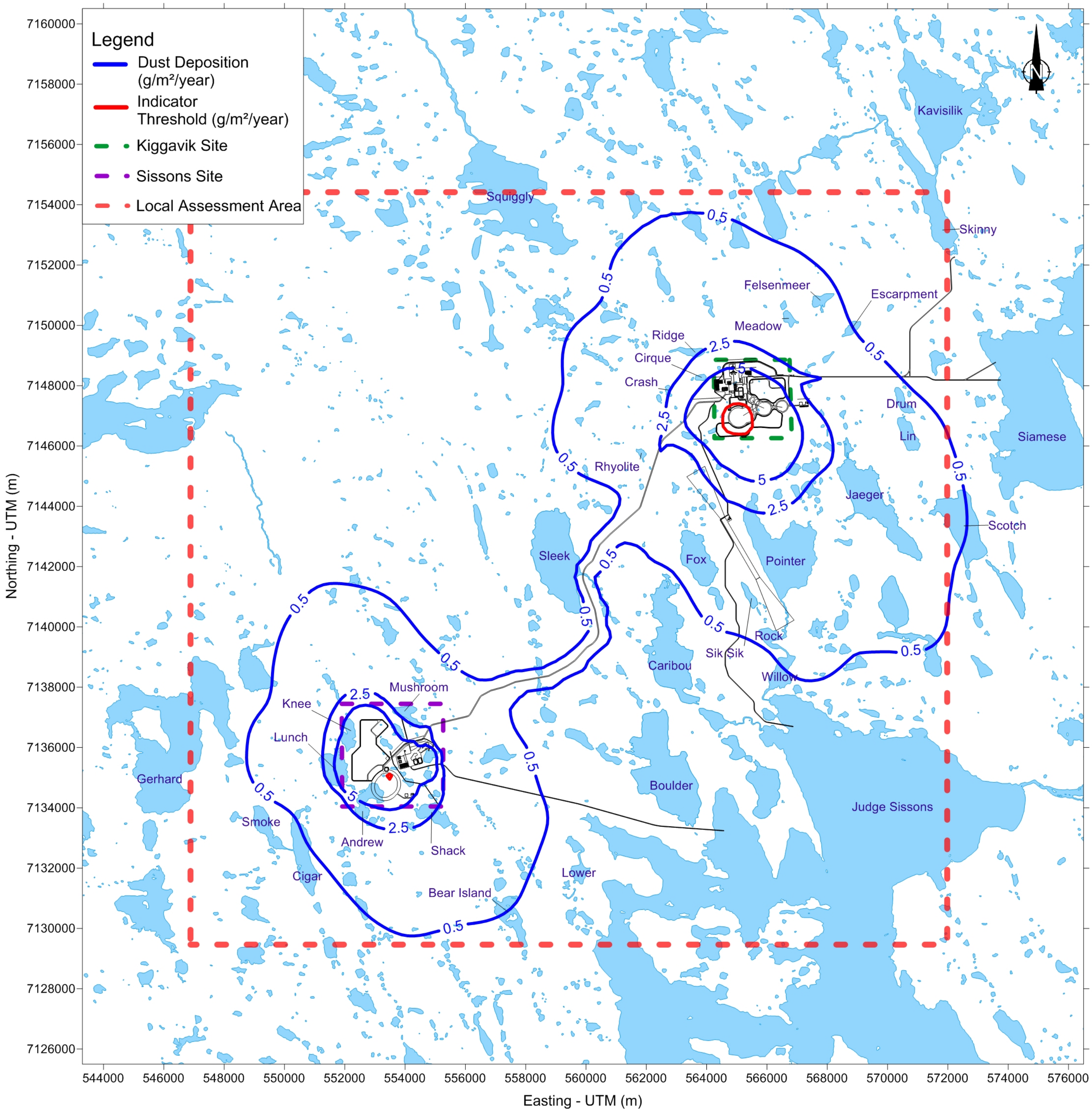

Projection: NAD 1983 UTM Zone 14N
Creator: SENES Consultants Limited
Date: 26/09/2011 Scale:
File: n/a
Data Sources: CALPUFF Air Dispersion Modelling

FIGURE 6.1-29
Operation Assessment - Phase 2
Incremental Total Annual Dust Deposition (g/m²/year)

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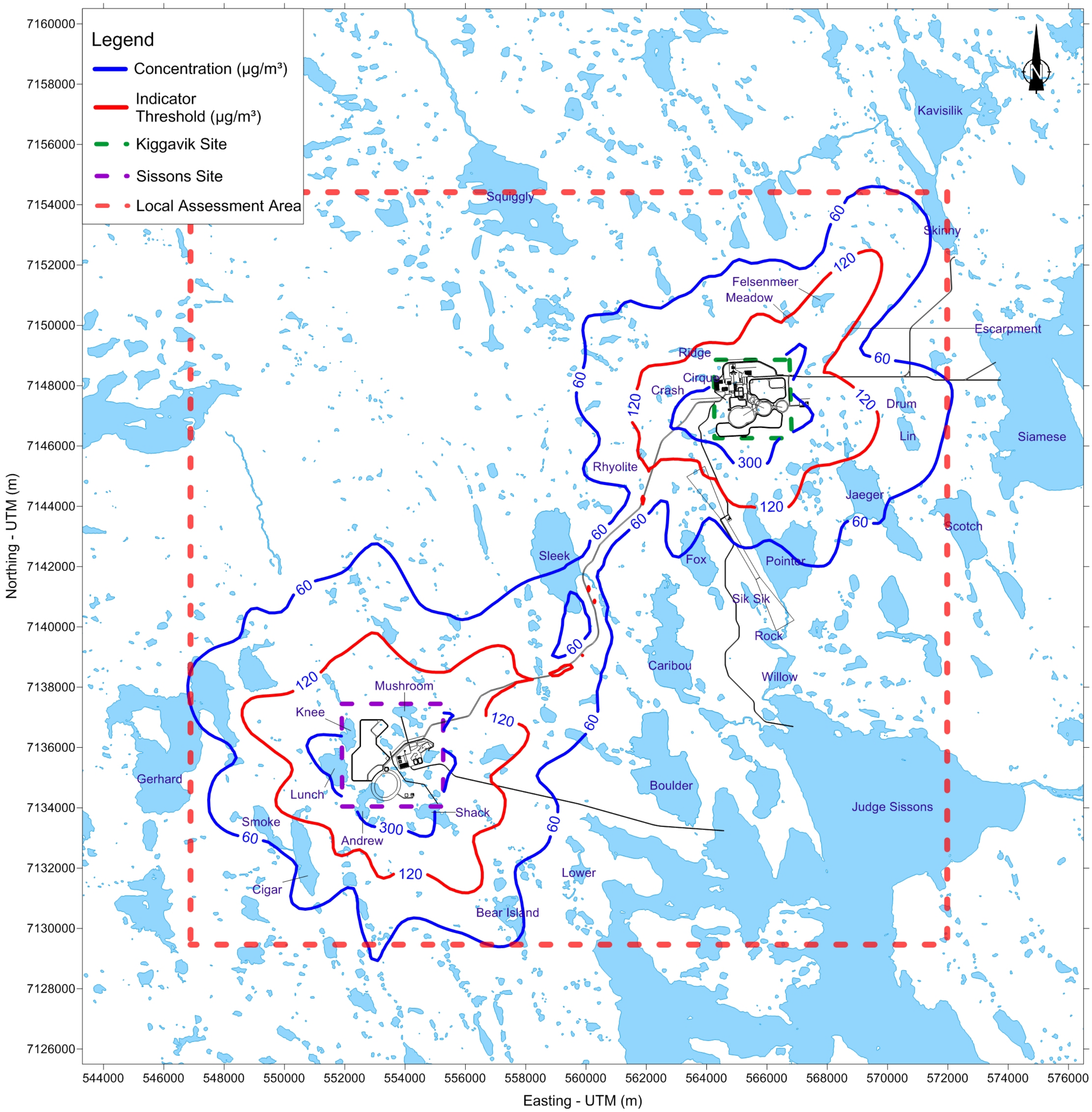

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Date: 26/09/2011 Scale:

File: n/a

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FIGURE 6.1-3

Maximum Operation Assessment

Incremental Maximum 24-hr TSP Concentration (µg/m³)

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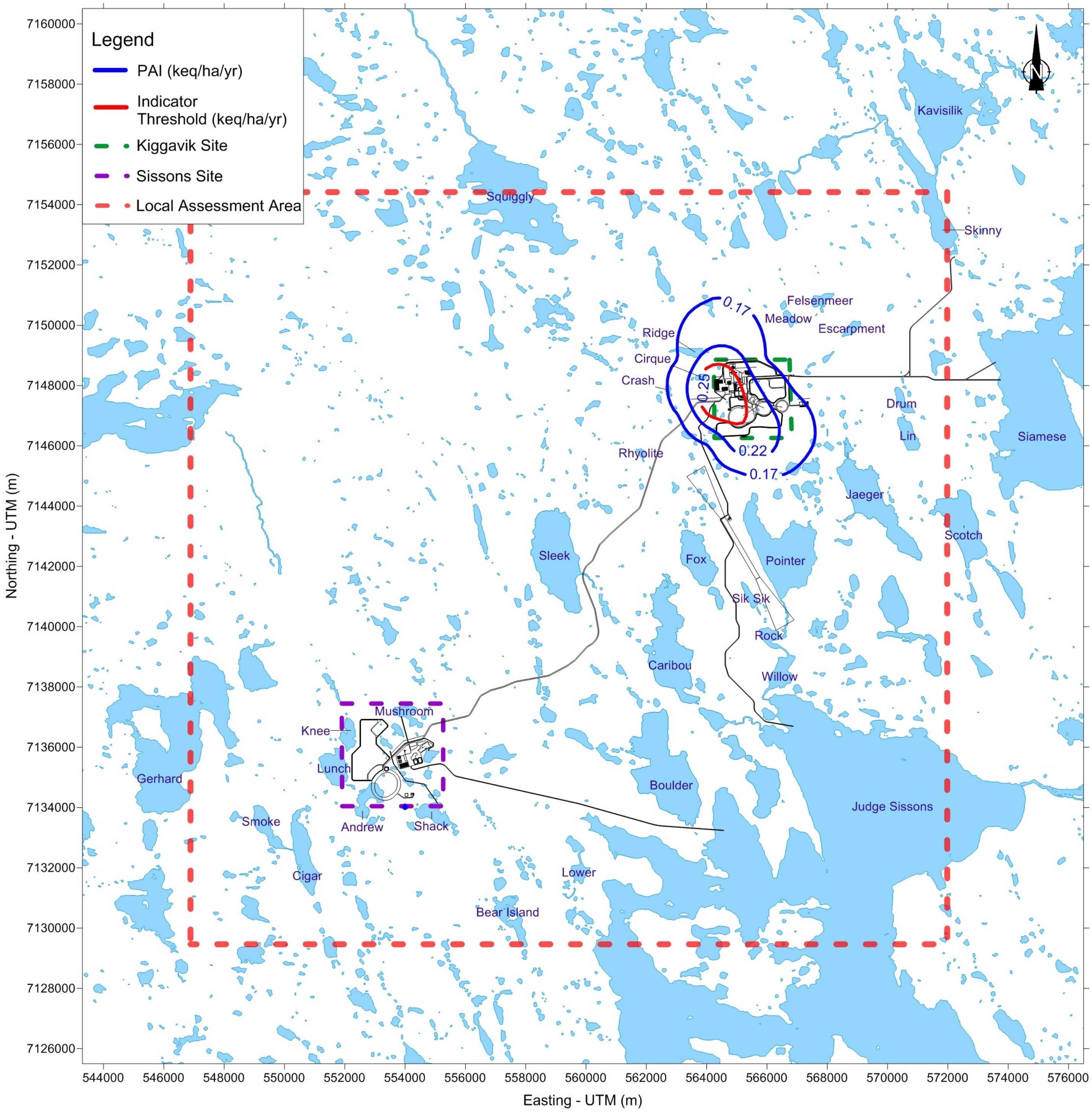

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Creator: SENES Consultants Limited
Date: 26/09/2011 Scale:
File: n/a
Data Sources: CALPUFF Air Dispersion Modelling

FIGURE 6.3-30
Operation Assessment
Potential Acid Input (keq/ha/yr)

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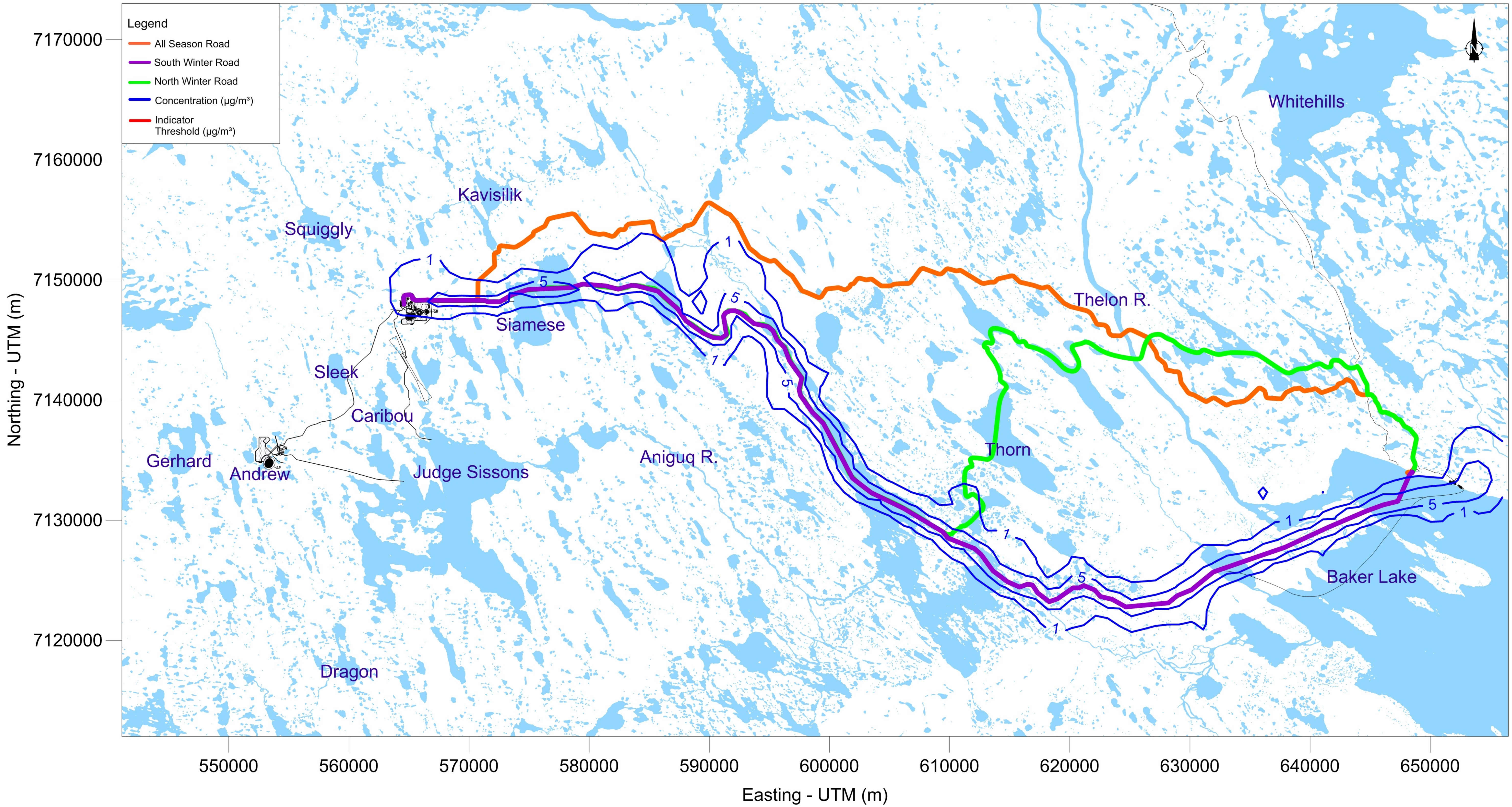

Projection: NAD 1983 UTM Zone 14N
Creator: SENES Consultants Limited
Date: 26/09/2011 Scale:
File: n/a
Data Sources: CALPUFF Air Dispersion Modelling

FIGURE 6.1-31
Operation Assessment - South Winter Access Road
Incremental Maximum 24-hr TSP Concentration (µg/m³)

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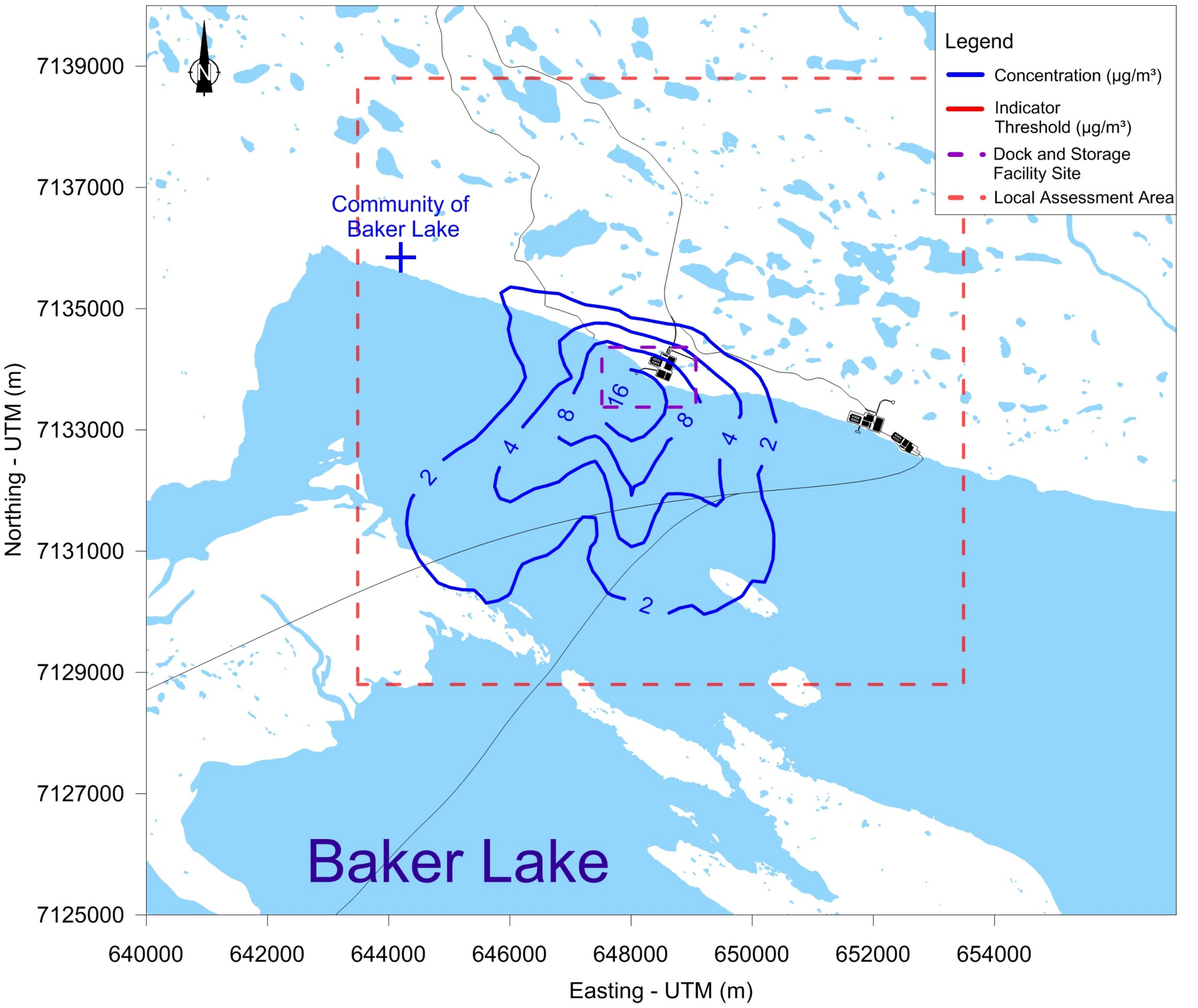

Projection: NAD 1983 UTM Zone 14N
Creator: SENES Consultants Limited
Date: 26/09/2011 Scale:
File: n/a
Data Sources: CALPUFF Air Dispersion Modelling

FIGURE 6.1-32
Operation Assessment - Baker Lake Dock and Storage Facility
Incremental Maximum 24-hr TSP Concentration (µg/m³)

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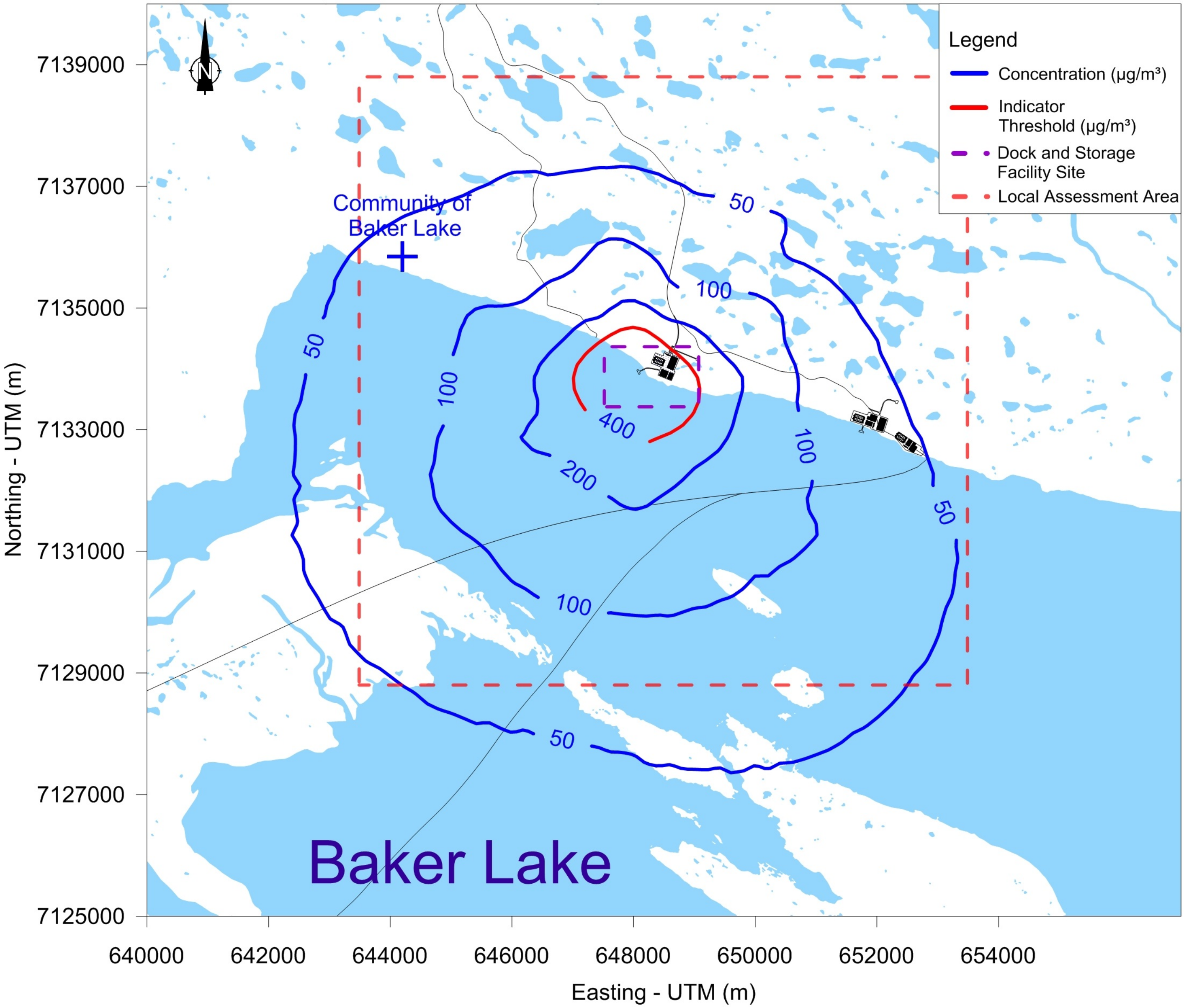

Projection: NAD 1983 UTM Zone 14N
Creator: SENES Consultants Limited
Date: 26/09/2011 Scale:
File: n/a
Data Sources: CALPUFF Air Dispersion Modelling

FIGURE 6.1-33
Operation Assessment - Baker Lake Dock and Storage Facility Incremental Maximum 1-hr NO_2 Concentration (µg/m³)

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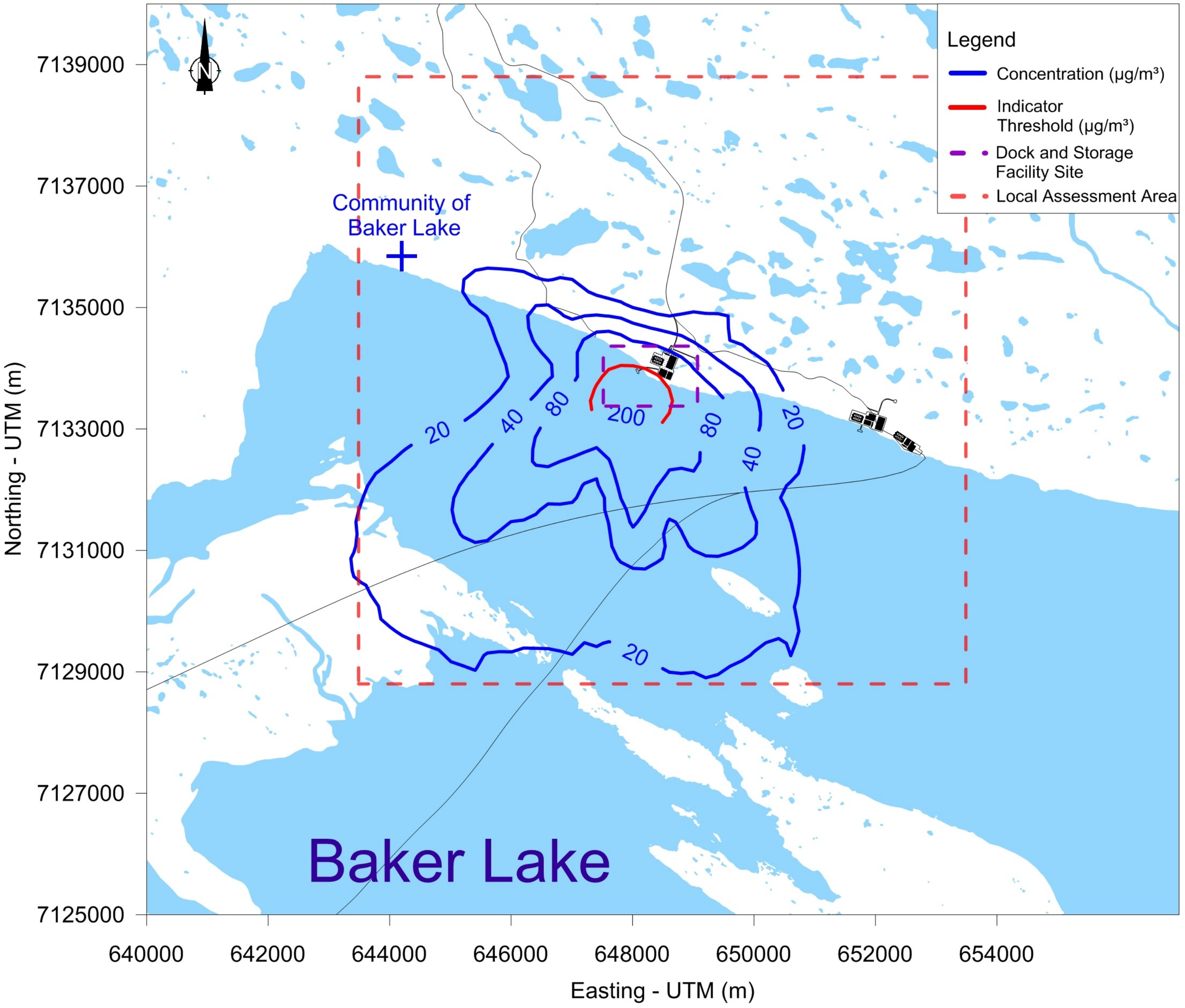

Projection: NAD 1983 UTM Zone 14N

Creator: SENES Consultants Limited

Date: 26/09/2011 Scale:

File: n/a

Data Sources: CALPUFF Air Dispersion Modelling

FIGURE 6.1-34

Operation Assessment - Baker Lake Dock and Storage Facility
Incremental Maximum 24-hr NO_2 Concentration (µg/m³)

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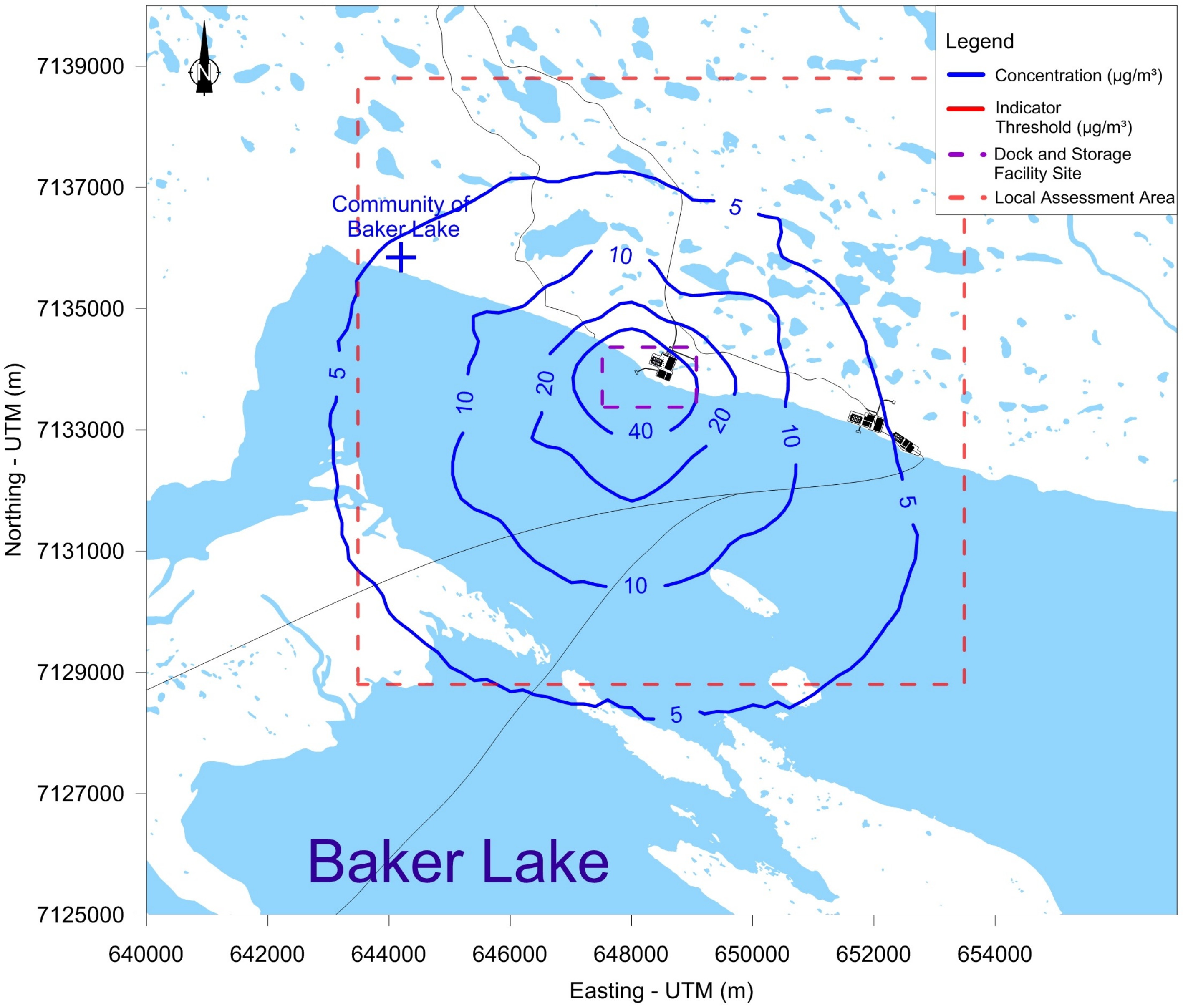

Projection: NAD 1983 UTM Zone 14N
Creator: SENES Consultants Limited
Date: 26/09/2011 Scale:
File: n/a
Data Sources: CALPUFF Air Dispersion Modelling

FIGURE 6.1-35
Operation Assessment - Baker Lake Dock and Storage Facility Incremental Maximum 1-hr SO_2 Concentration (µg/m³)

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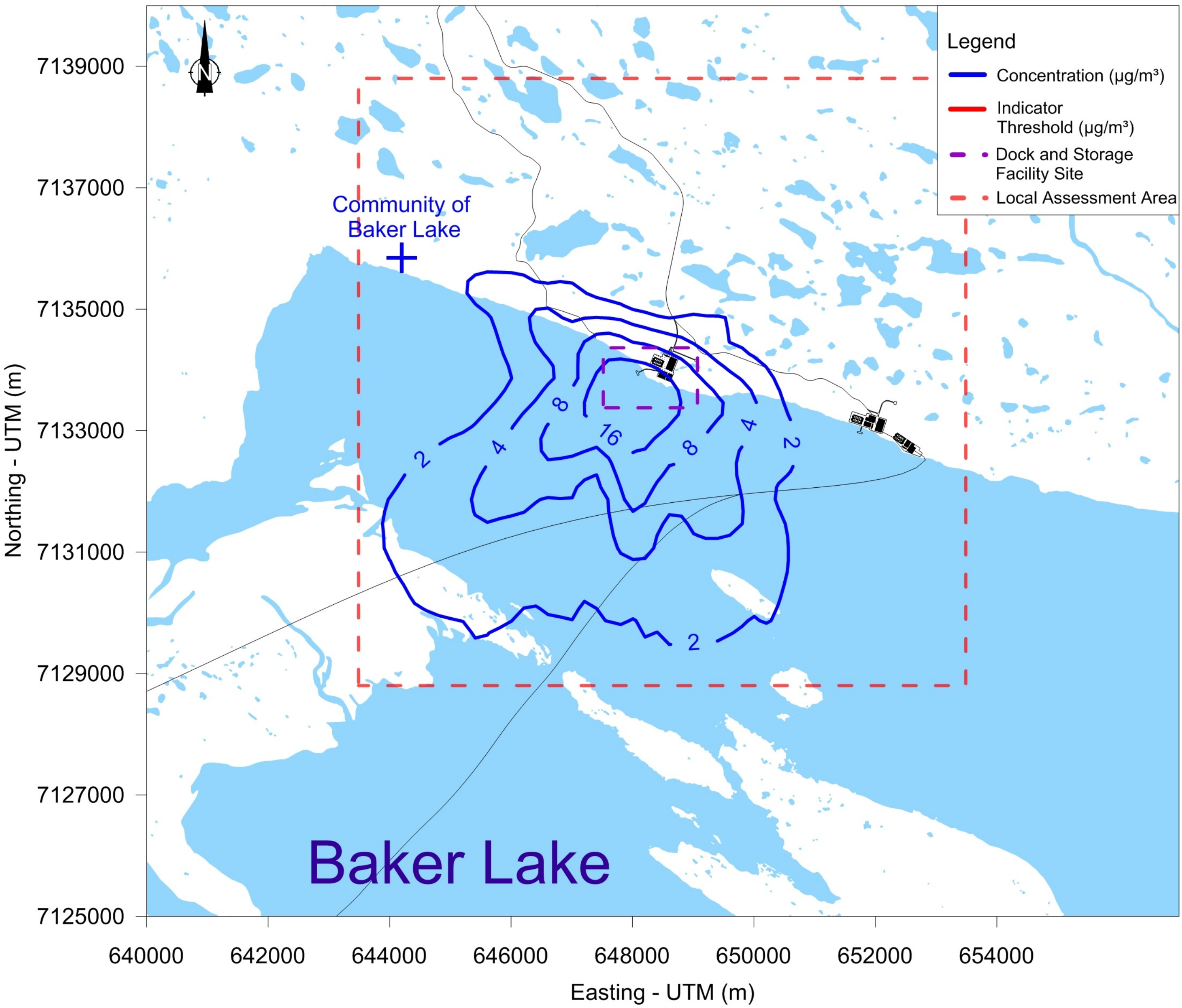

Projection: NAD 1983 UTM Zone 14N

Creator: SENES Consultants Limited

Date: 26/09/2011 Scale:

File: n/a

Data Sources: CALPUFF Air Dispersion Modelling

FIGURE 6.1-36

Operation Assessment - Baker Lake Dock and Storage Facility Incremental Maximum 24-hr SO_2 Concentration (µg/m³)

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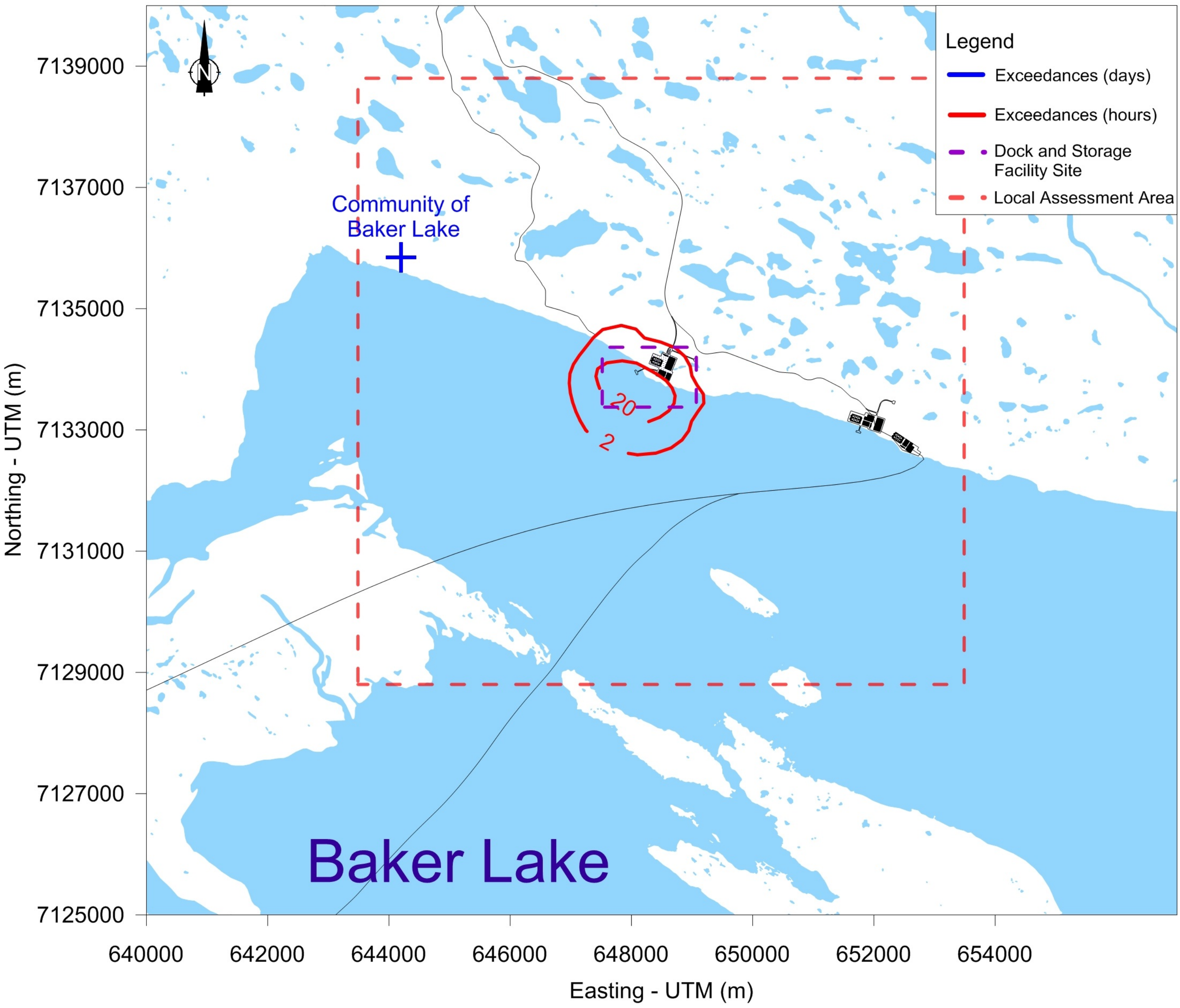

Projection: NAD 1983 UTM Zone 14N
Creator: SENES Consultants Limited
Date: 26/09/2011 Scale:
File: n/a
Data Sources: CALPUFF Air Dispersion Modelling

FIGURE 6.1-37
Operation Assessment - Baker Lake Dock and Storage Facility
Frequency of Exceedances of the 1-hr NO_2 Indicator Threshold (hours)

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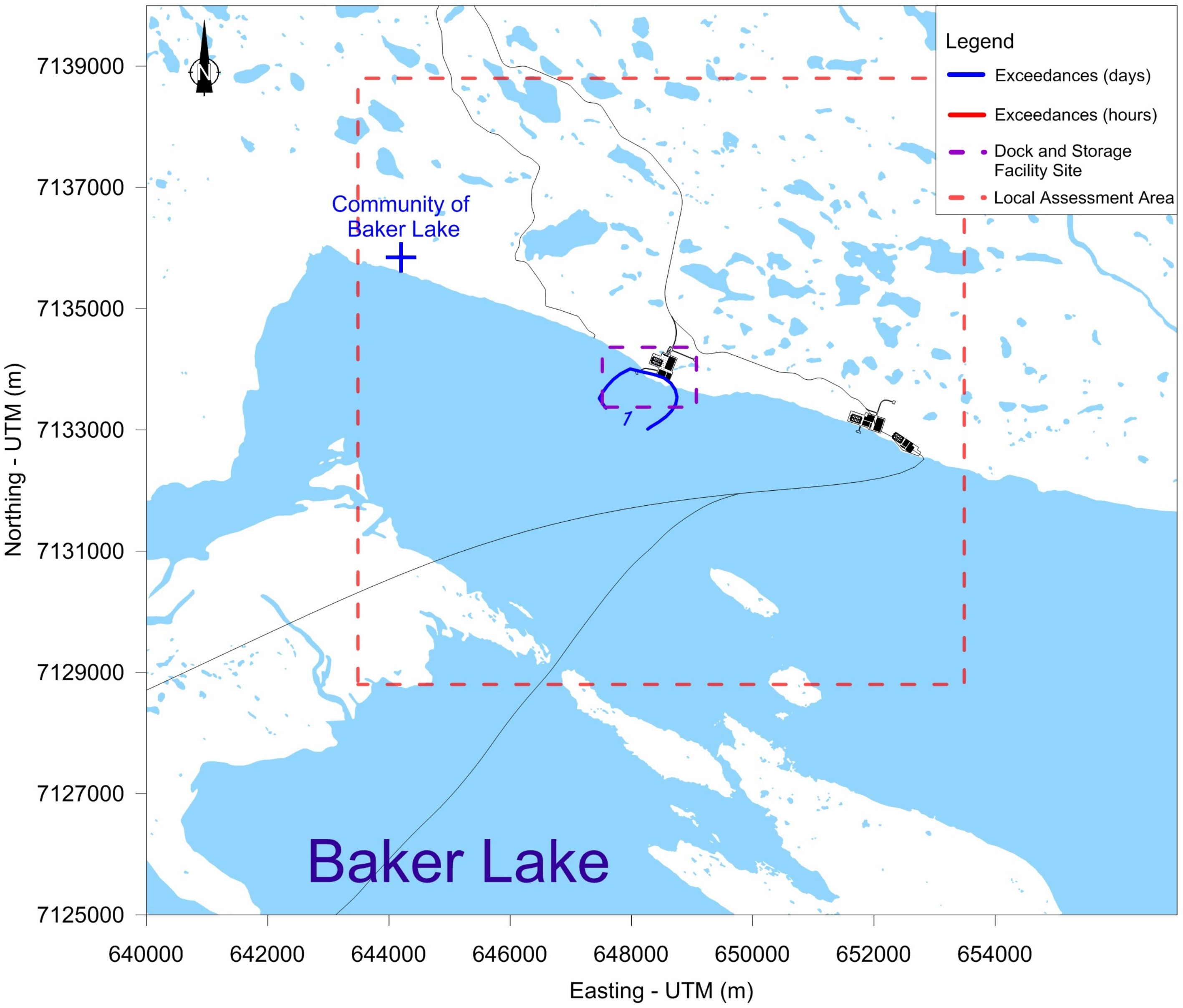

Projection: NAD 1983 UTM Zone 14N
Creator: SENES Consultants Limited
Date: 26/09/2011 Scale:
File: n/a
Data Sources: CALPUFF Air Dispersion Modelling

FIGURE 6.1-38
Operation Assessment - Baker Lake Dock and Storage Facility
Frequency of Exceedances of the 24-hr NO_2 Indicator Threshold (days)

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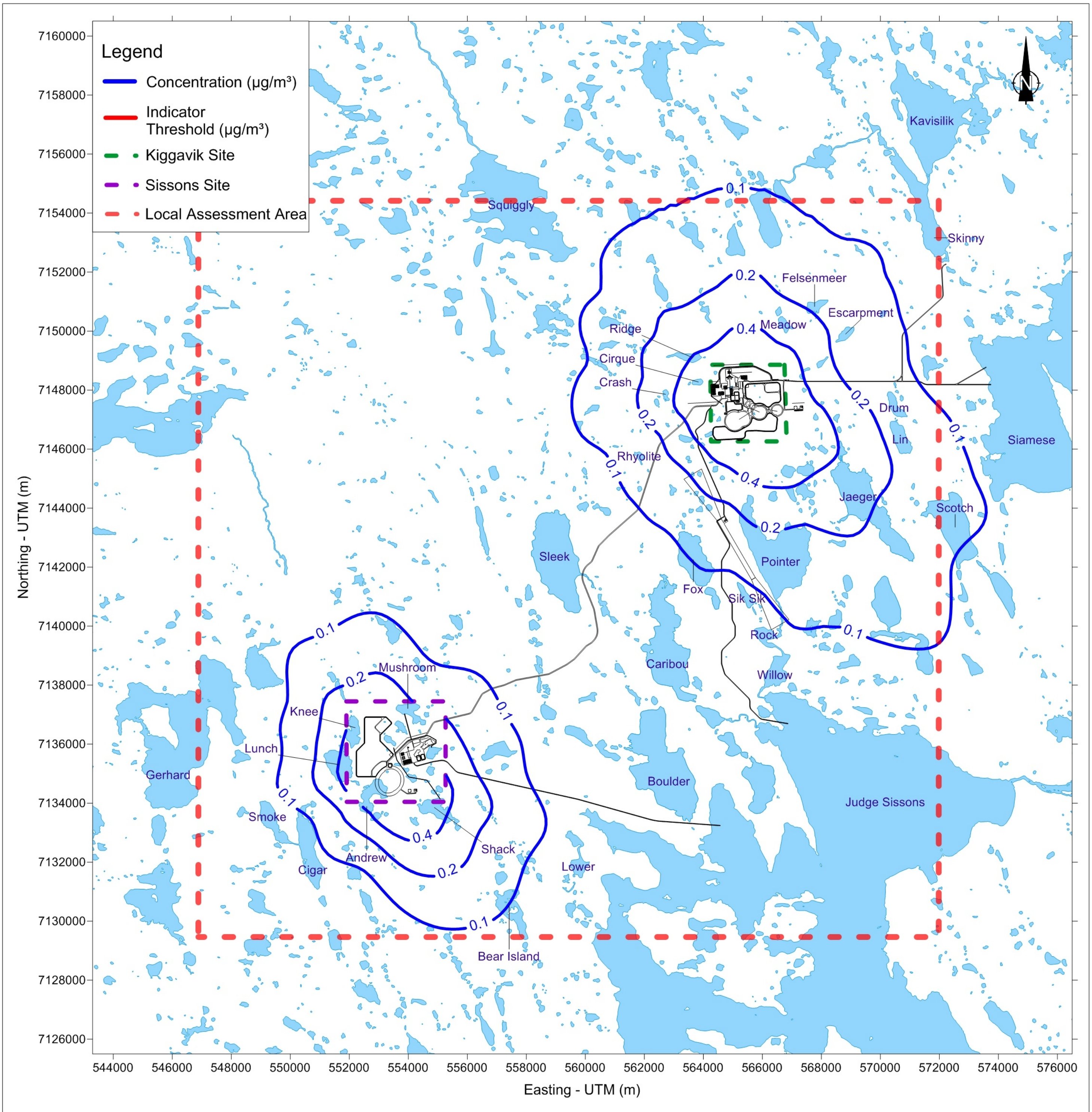

Projection: NAD 1983 UTM Zone 14N
Creator: SENES Consultants Limited
Date: 26/09/2011 Scale:
File: n/a
Data Sources: CALPUFF Air Dispersion Modelling

FIGURE 6.1-39
Final Closure Assessment
Incremental Annual TSP Concentration (µg/m³)

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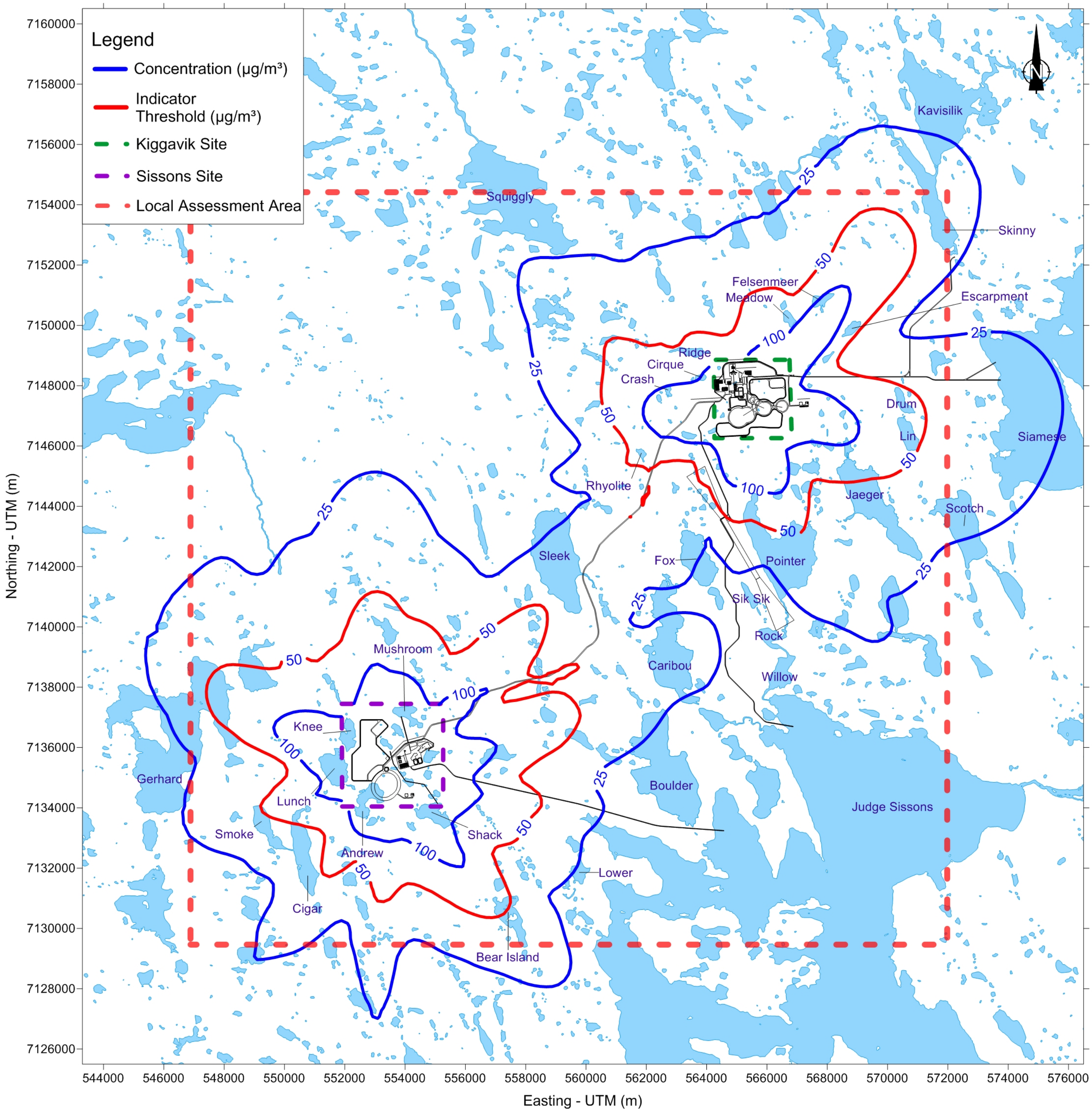

Projection: NAD 1983 UTM Zone 14N
Creator: SENES Consultants Limited
Date: 26/09/2011 Scale:
File: n/a
Data Sources: CALPUFF Air Dispersion Modelling

FIGURE 6.1-4
Maximum Operation Assessment
Incremental Maximum 24-hr PM_{10} Concentration (µg/m³)

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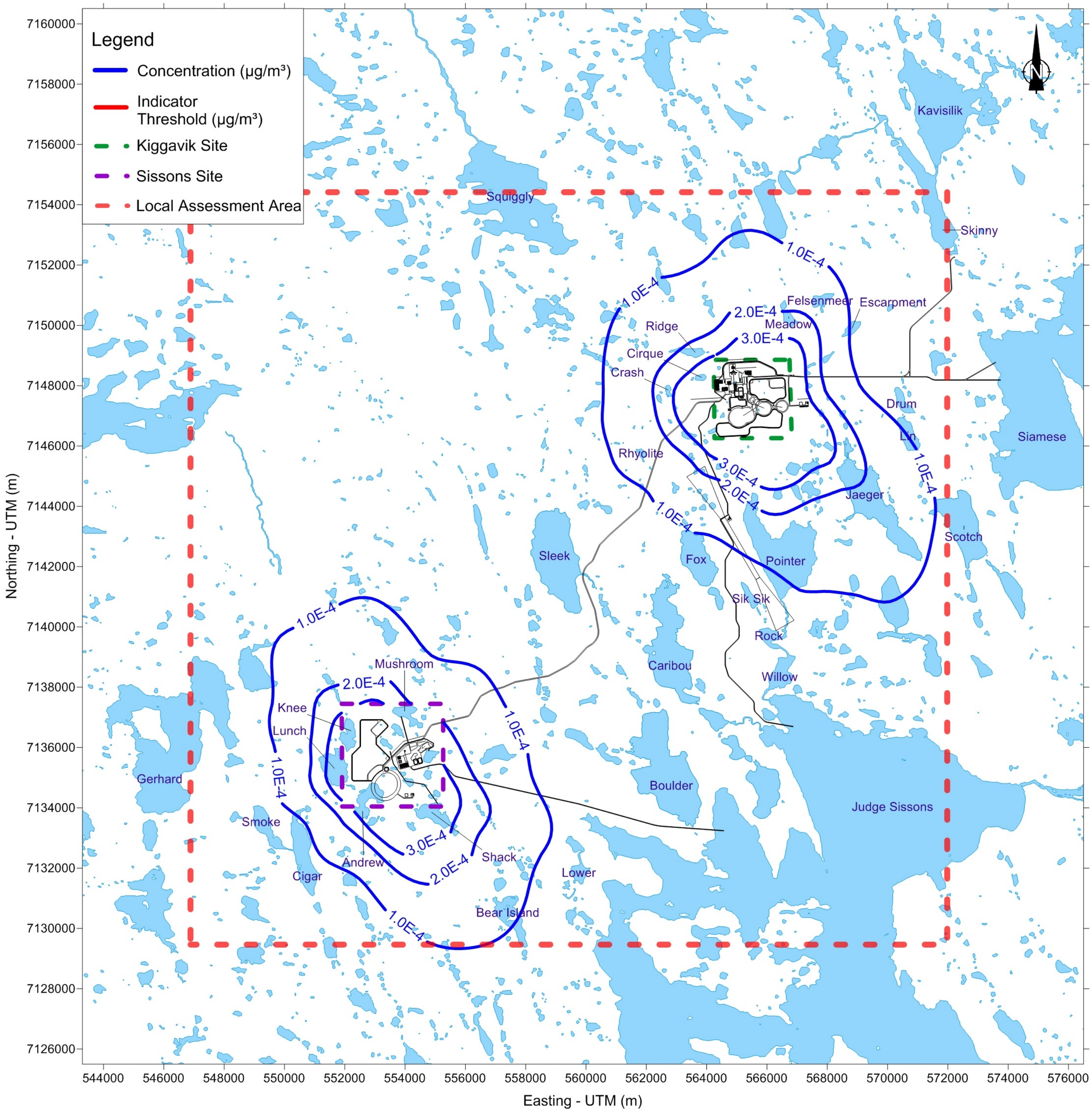

Projection: NAD 1983 UTM Zone 14N

Creator: SENES Consultants Limited

Date: 26/09/2011 Scale:

File: n/a

Data Sources: CALPUFF Air Dispersion Modelling

FIGURE 6.1-40

Final Closure Assessment

Incremental Annual Uranium Concentration (µg/m³)

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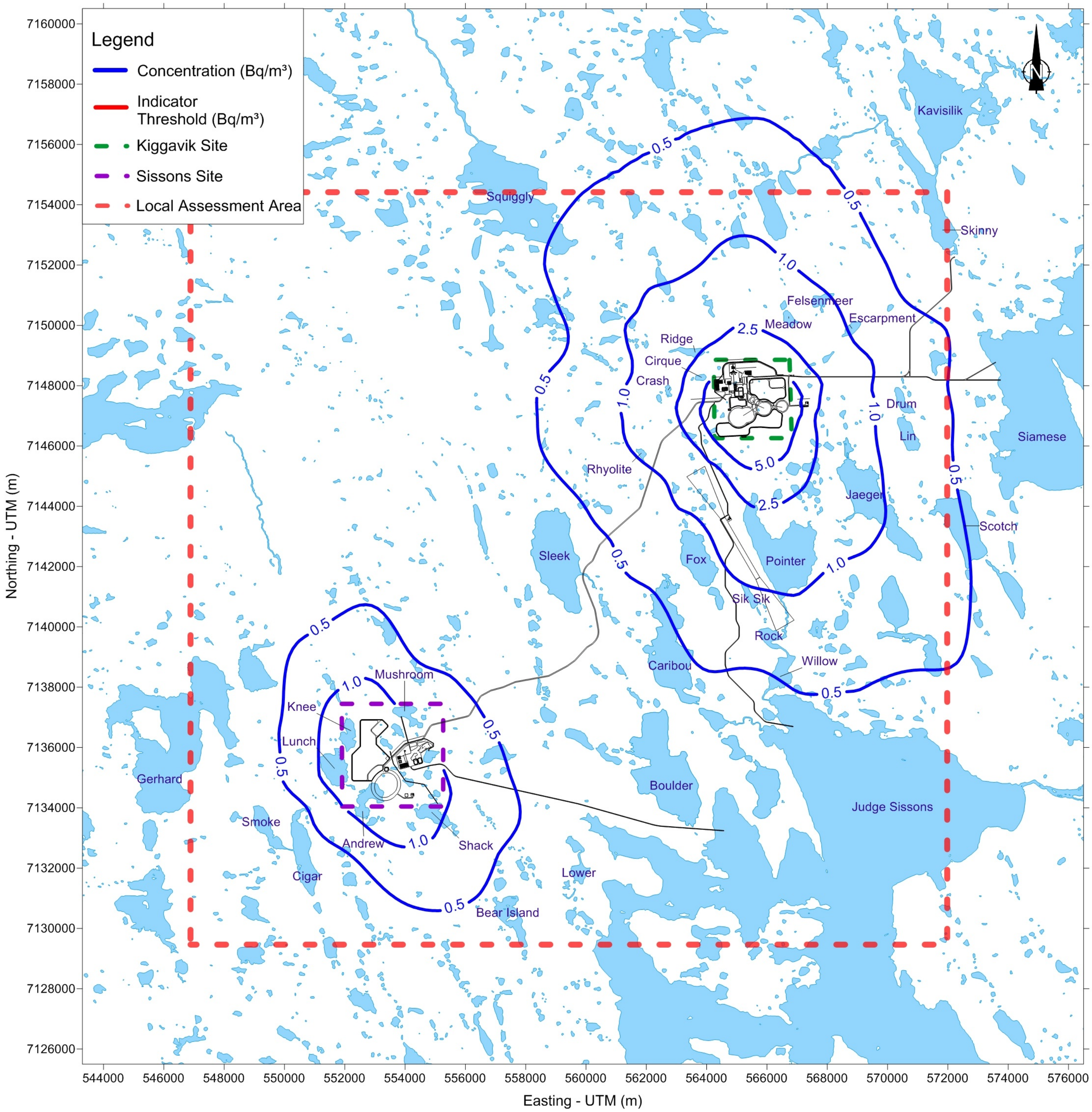

Projection: NAD 1983 UTM Zone 14N

Creator: SENES Consultants Limited

Date: 26/09/2011 Scale:

File: n/a

Data Sources: CALPUFF Air Dispersion Modelling

FIGURE 6.1-41

Final Closure Assessment

Incremental Annual Radon Concentration (Bq/m³)

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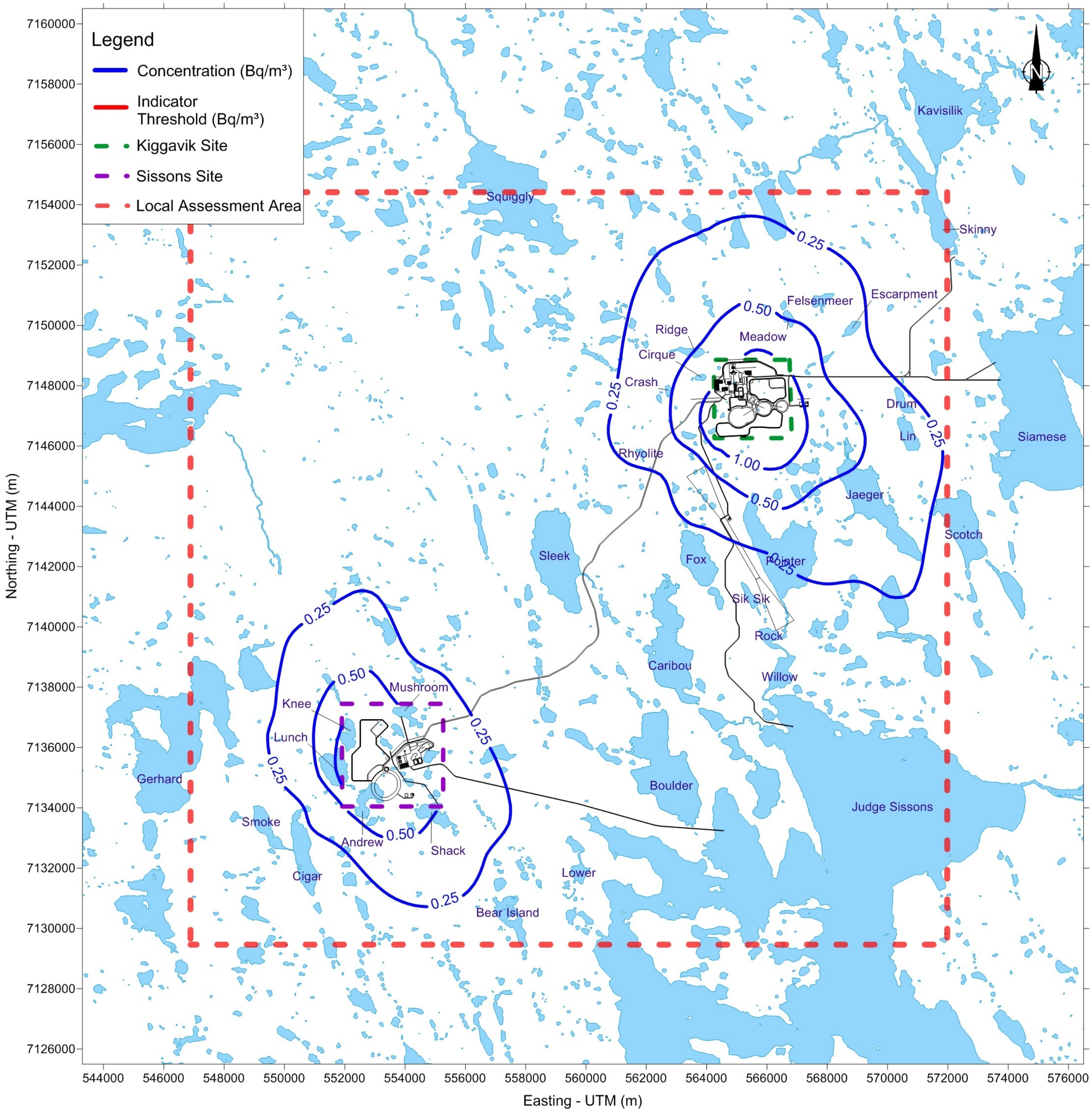

Projection: NAD 1983 UTM Zone 14N
Creator: SENES Consultants Limited
Date: 26/09/2011 Scale:
File: n/a
Data Sources: CALPUFF Air Dispersion Modelling

FIGURE 6.1-42
Post-Closure Assessment
Incremental Annual Radon Concentration (Bq/m³)

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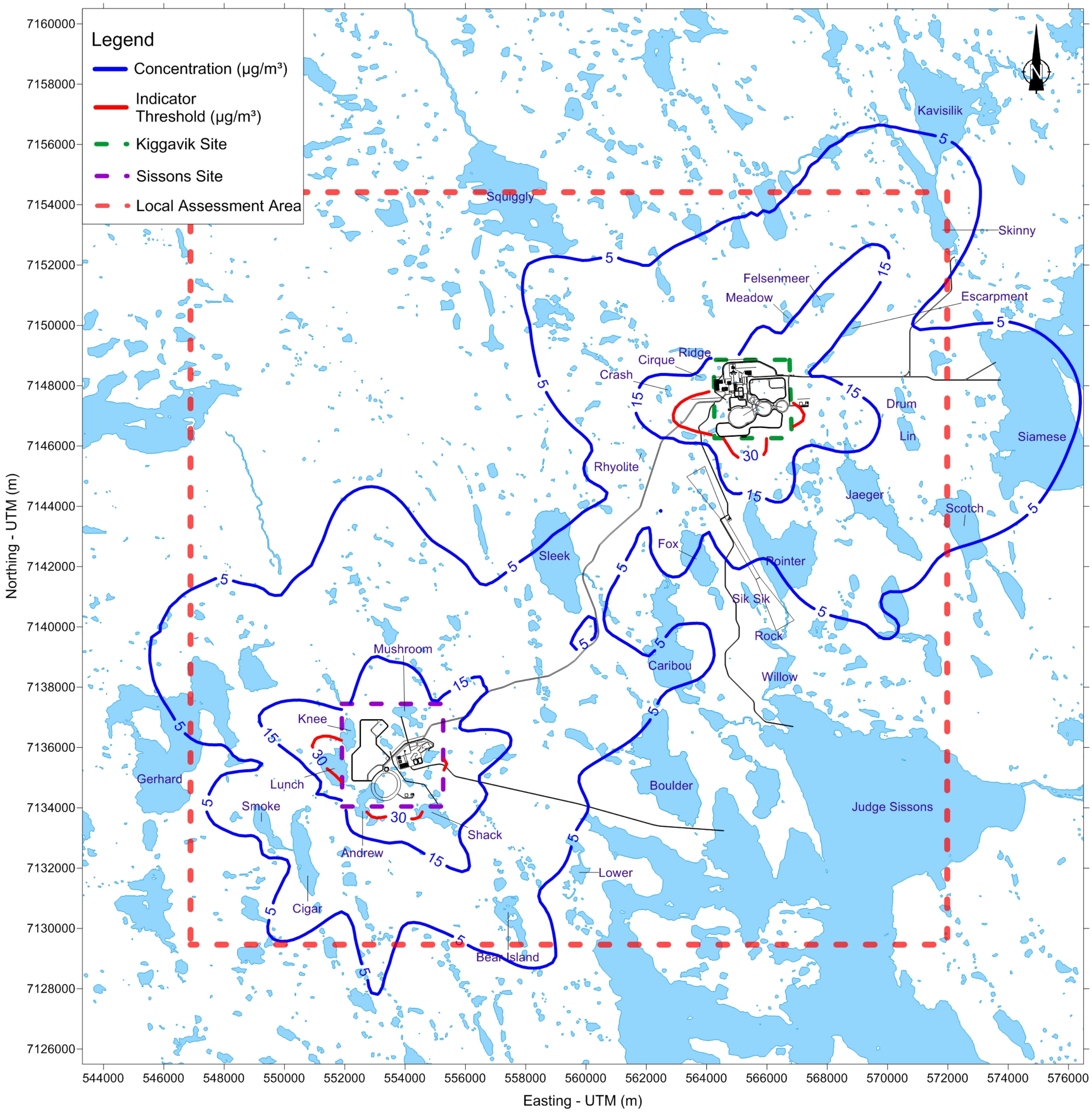

Projection: NAD 1983 UTM Zone 14N

Creator: SENES Consultants Limited

Date: 26/09/2011 Scale:

File: n/a

Data Sources: CALPUFF Air Dispersion Modelling

FIGURE 6.1-5

Maximum Operation Assessment
Incremental Maximum 24-hr $PM_{2.5}$ Concentration (µg/m³)

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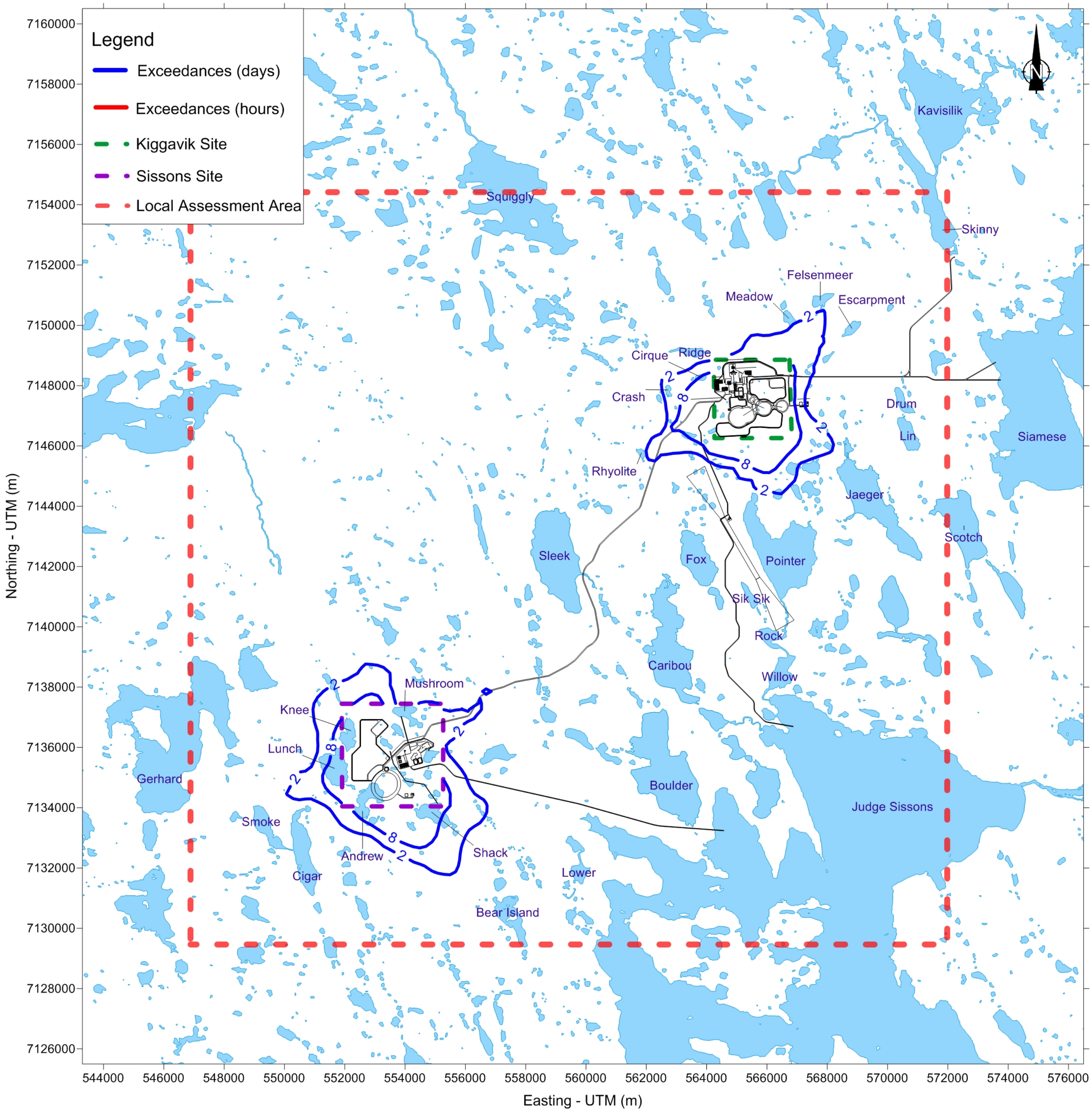

Projection: NAD 1983 UTM Zone 14N

Creator: SENES Consultants Limited

Date: 26/09/2011 Scale:

File: n/a

Data Sources: CALPUFF Air Dispersion Modelling

FIGURE 6.1-6

Maximum Operation Assessment
Exceedances of 24-hr TSP Indicator Threshold (days)

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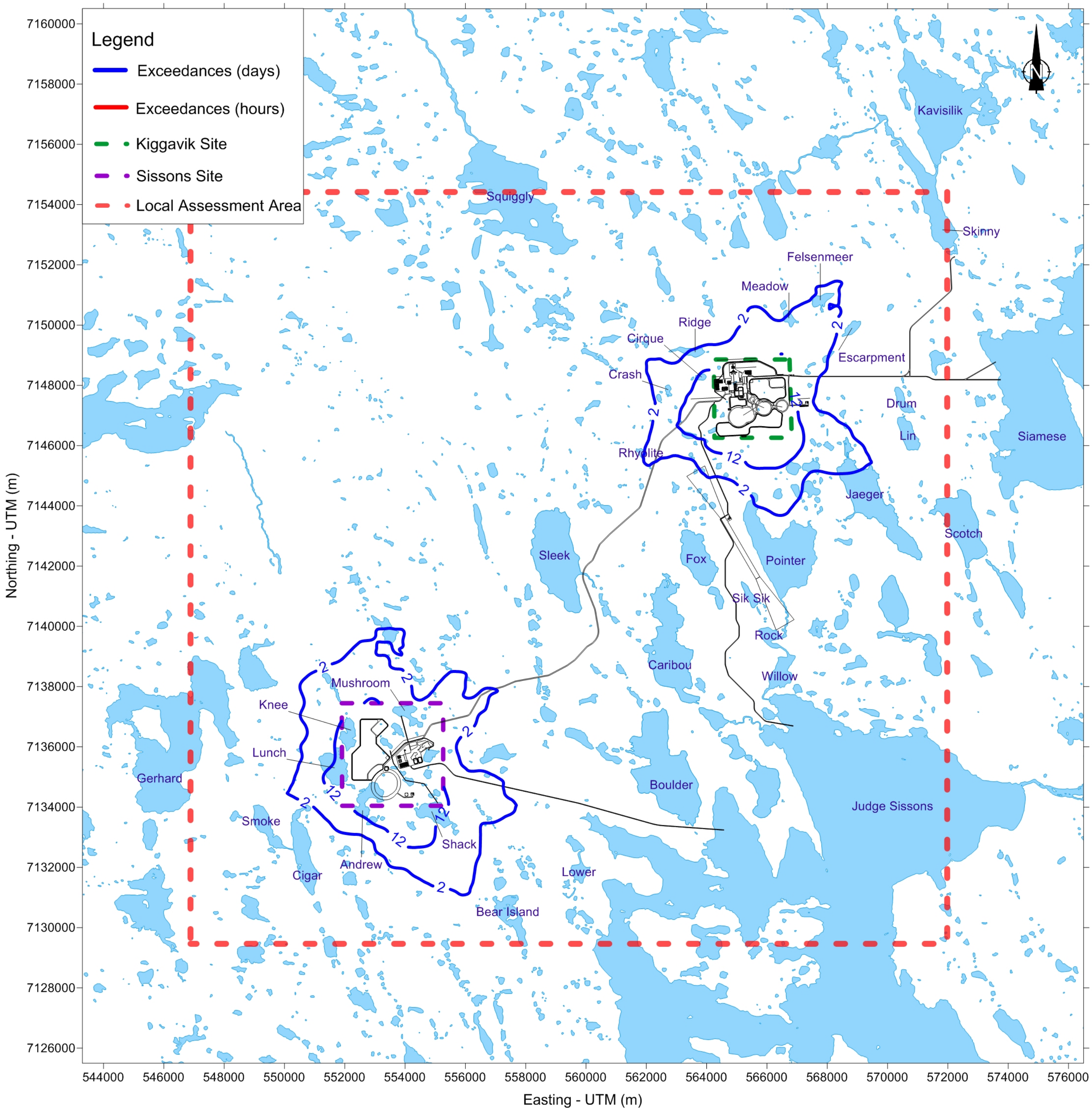

Projection: NAD 1983 UTM Zone 14N

Creator: SENES Consultants Limited

Date: 26/09/2011 Scale:

File: n/a

Data Sources: CALPUFF Air Dispersion Modelling

FIGURE 6.1-7

Maximum Operation Assessment
Exceedances of 24-hr PM_{10} Indicator Threshold (days)

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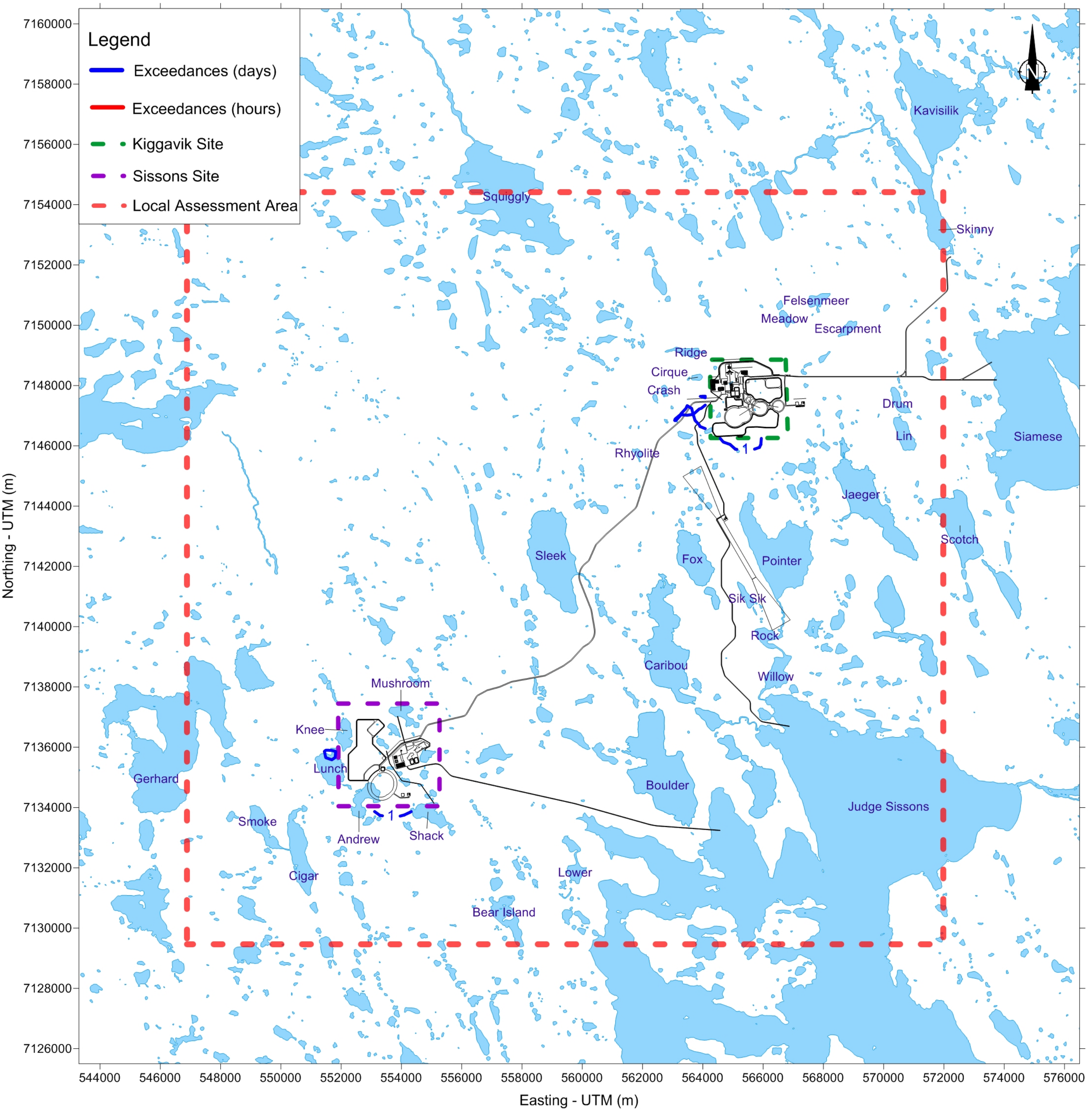

Projection: NAD 1983 UTM Zone 14N

Creator: SENES Consultants Limited

Date: 26/09/2011 Scale:

File: n/a

Data Sources: CALPUFF Air Dispersion Modelling

FIGURE 6.1-8

Maximum Operation Assessment

Exceedances of 24-hr $PM_{2.5}$ Indicator Threshold (days)

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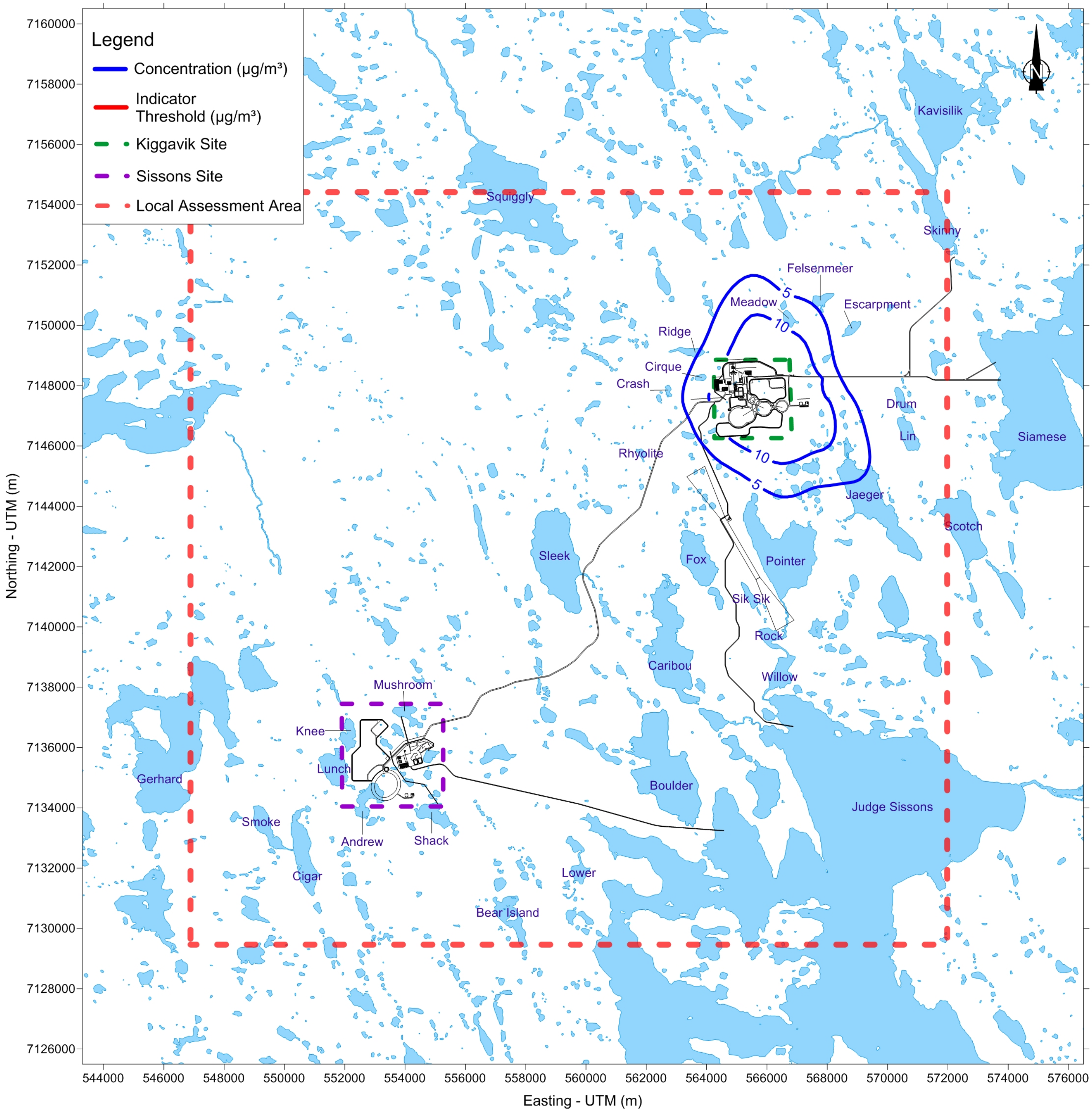

Projection: NAD 1983 UTM Zone 14N
Creator: SENES Consultants Limited
Date: 26/09/2011 Scale:
File: n/a
Data Sources: CALPUFF Air Dispersion Modelling

FIGURE 6.1-9
Operation Assessment - Phase 1
Incremental Annual TSP Concentration (µg/m³)

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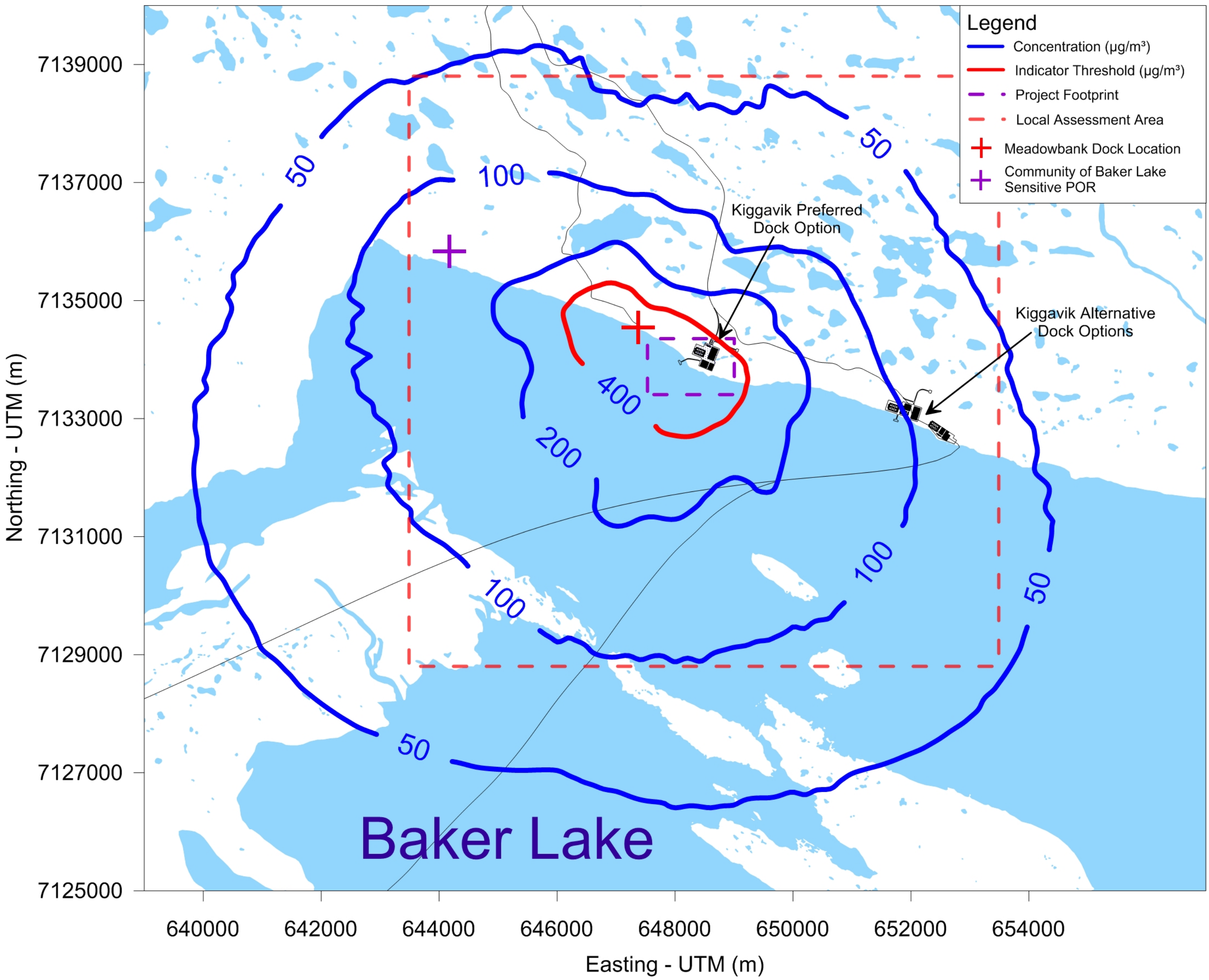

Projection: NAD 1983 UTM Zone 14N
Creator: SENES Consultants Limited
Date: 26/09/2011 Scale:
File: n/a
Data Sources: CALPUFF Air Dispersion Modelling

FIGURE 6.3-1
Baker Lake Facility Cumulative Effects Assessment
Incremental Maximum 1-hr NO_2 Concentration (µg/m³)

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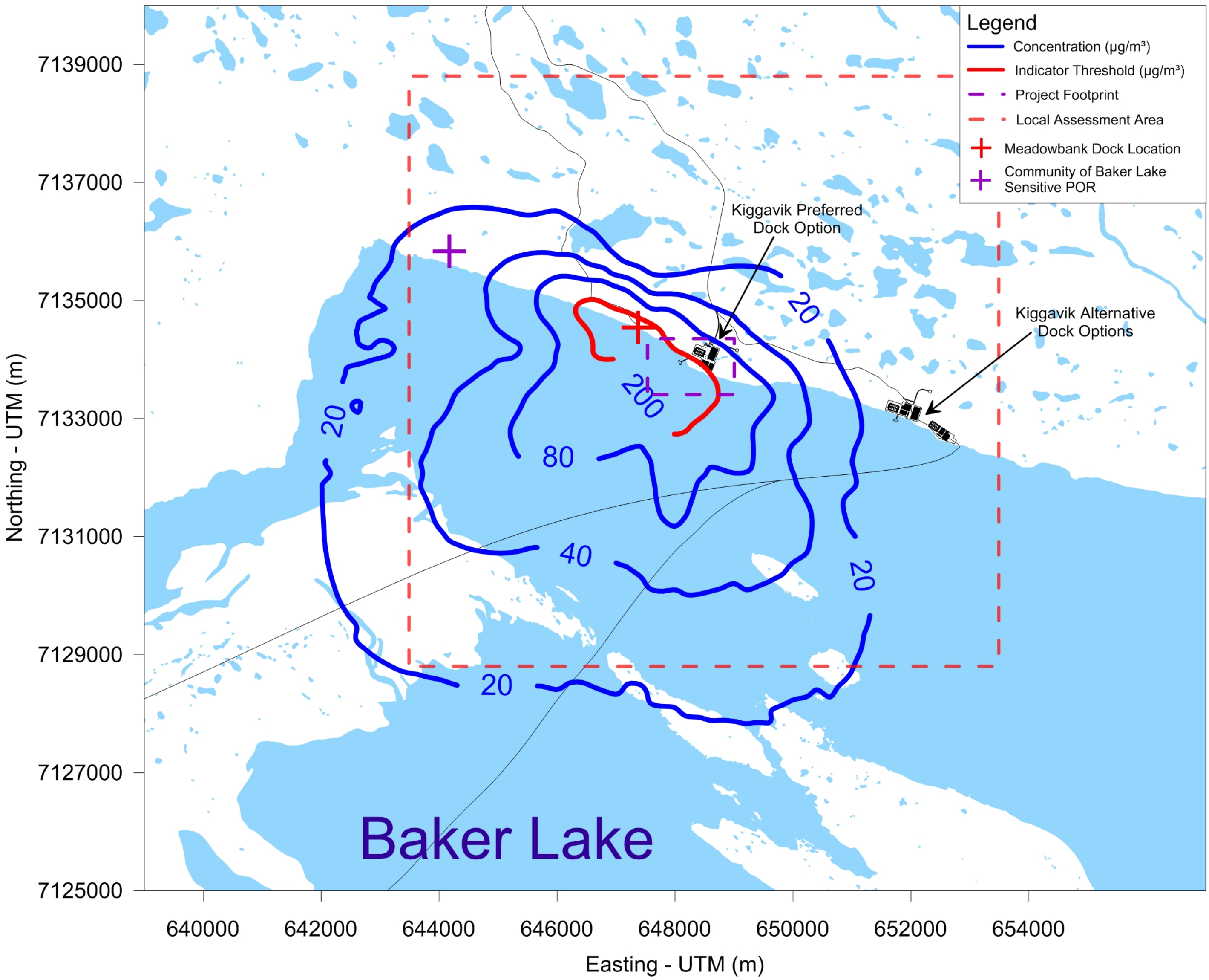

Projection: NAD 1983 UTM Zone 14N
Creator: SENES Consultants Limited
Date: 26/09/2011 Scale:
File: n/a
Data Sources: CALPUFF Air Dispersion Modelling

FIGURE 6.3-2
Baker Lake Facility Cumulative Effects Assessment
Incremental Maximum 24-hr NO_2 Concentration (µg/m³)

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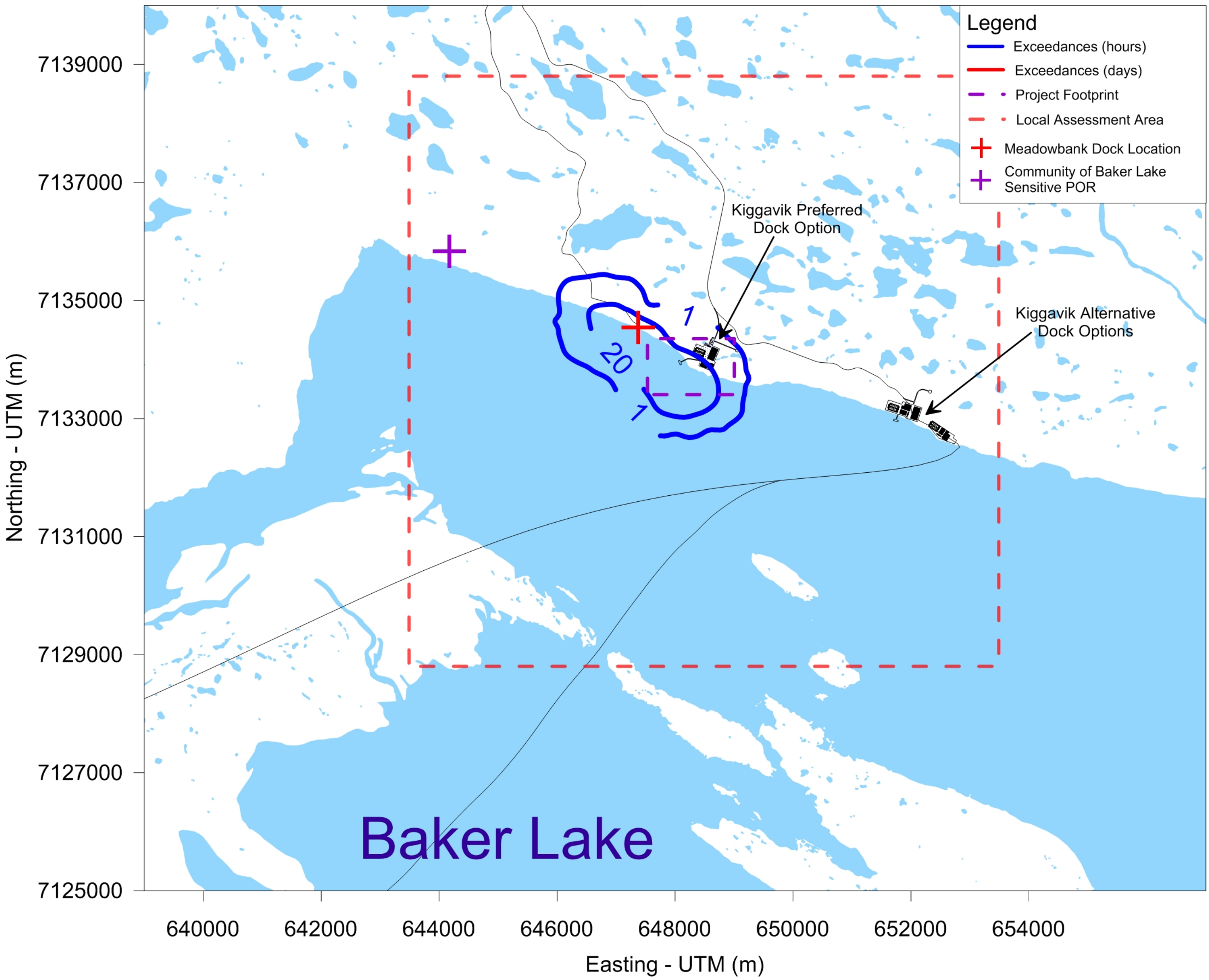

Projection: NAD 1983 UTM Zone 14N
Creator: SENES Consultants Limited
Date: 26/09/2011 Scale:
File: n/a
Data Sources: CALPUFF Air Dispersion Modelling

FIGURE 6.3-3
Baker Lake Facility Cumulative Effects Assessment
Exceedances of the1-hr NO_2 Indicator Threshold (hours)

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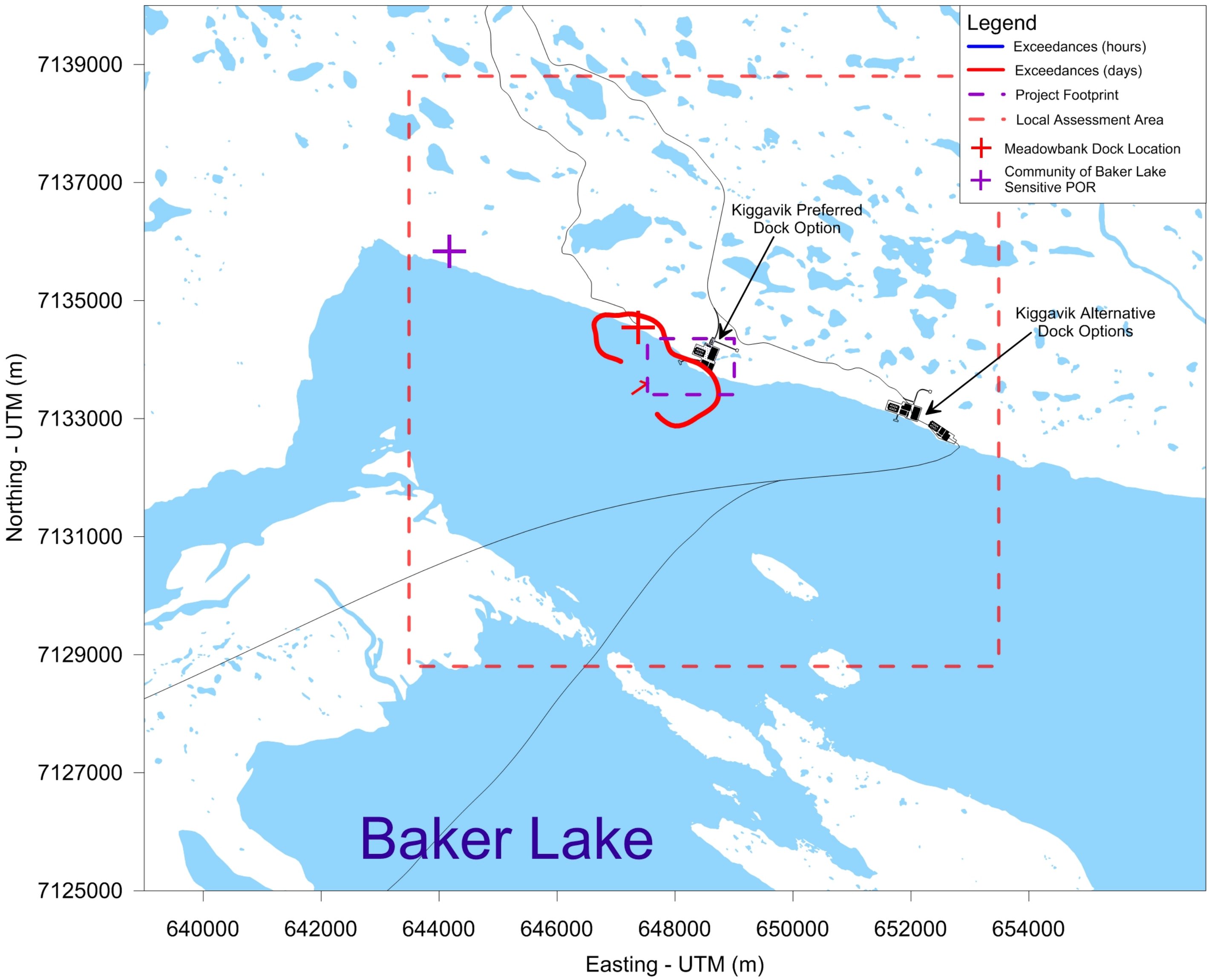

Projection: NAD 1983 UTM Zone 14N
Creator: SENES Consultants Limited
Date: 26/09/2011 Scale:
File: n/a
Data Sources: CALPUFF Air Dispersion Modelling

FIGURE 6.3-4
Baker Lake Facility Cumulative Effects Assessment
Exceedances of the24-hr NO_2 Indicator Threshold (days)

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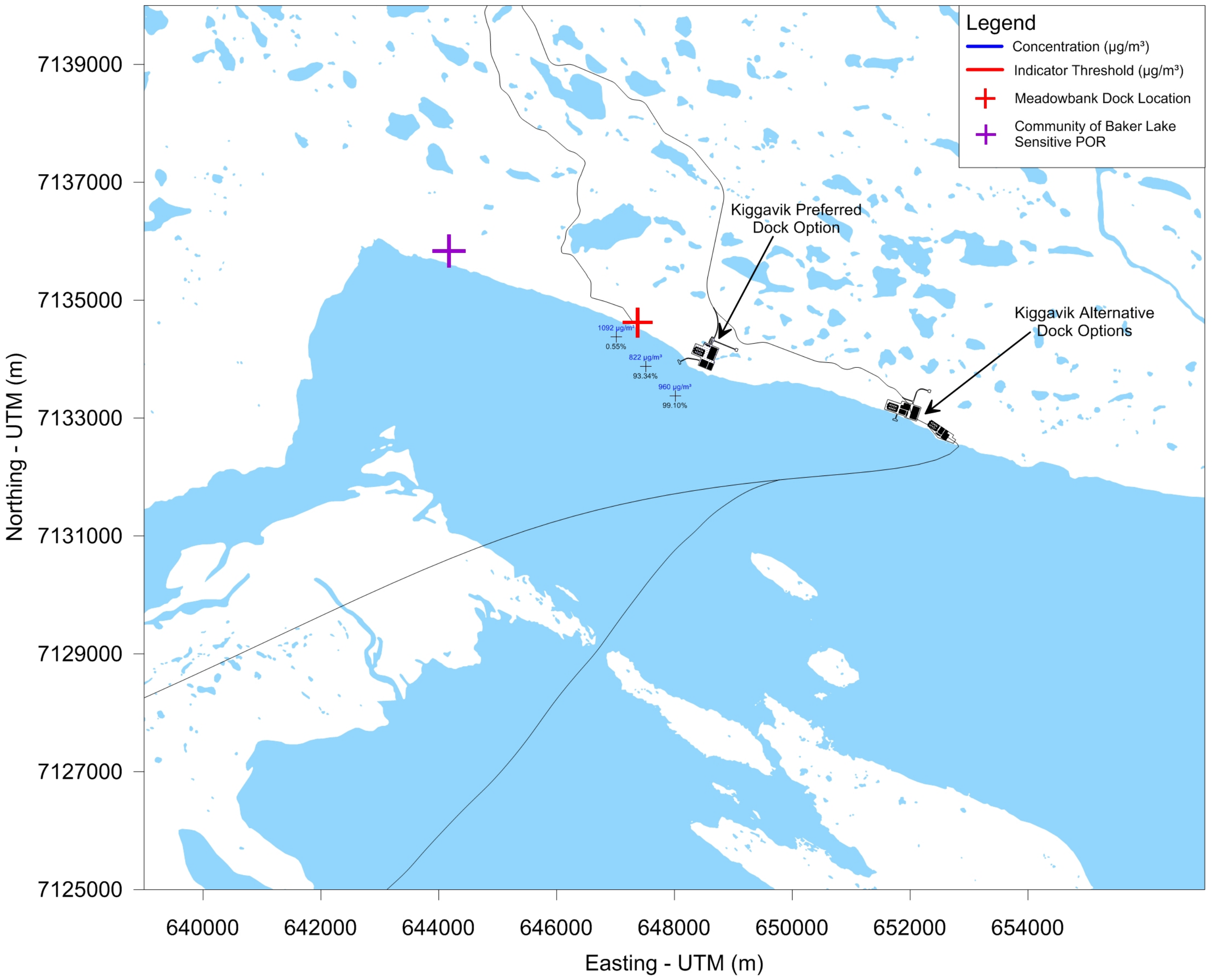

Projection: NAD 1983 UTM Zone 14N
Creator: SENES Consultants Limited
Date: 26/09/2011 Scale:
File: n/a
Data Sources: CALPUFF Air Dispersion Modelling

FIGURE 6.3-5
Baker Lake Facility Cumulative Effects Assessment
Project Contribution to 1-hour NO_2 at 3 Receptor Locations

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