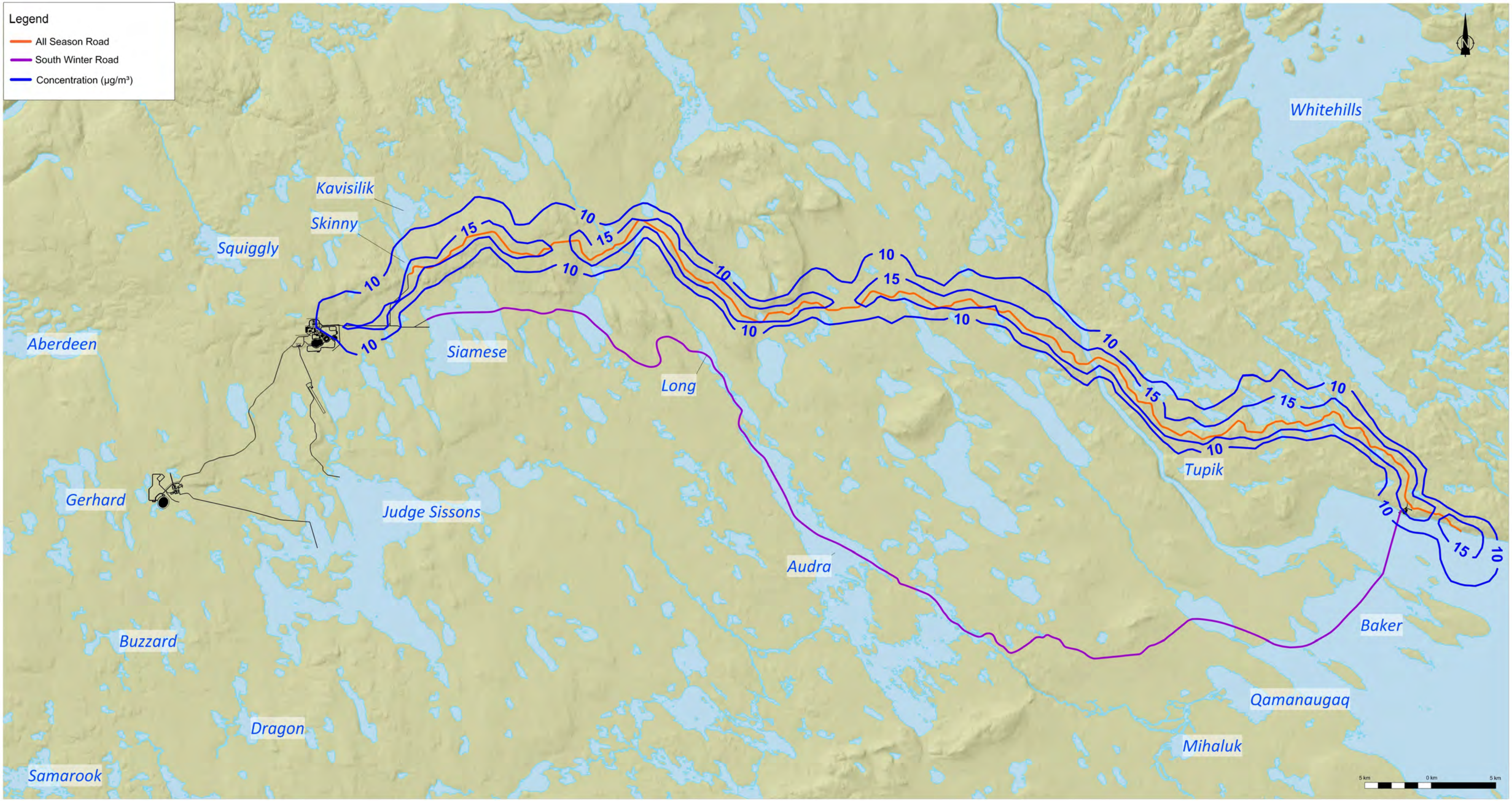

Projection: NAD 1983 UTM Zone 14N

Compiled: SENES Consultant

Date: 05/05/2014

Data Sources: Natural Resources Canada, Geobase®, Nation Topographic Database, AREVA Resources Canada Inc.

FIGURE 46

All Season Road Option Assessment
Maximum 24-hour TSP Concentration (µg/m³)

ENVIRONMENTAL IMPACT STATEMENT
VOLUME 4: ATMOSPHERIC ENVIRONMENT
TECHNICAL APPENDIX 4B: AIR QUALITY AND CLIMATE

KIGGAVIK PROJECT

AREVA

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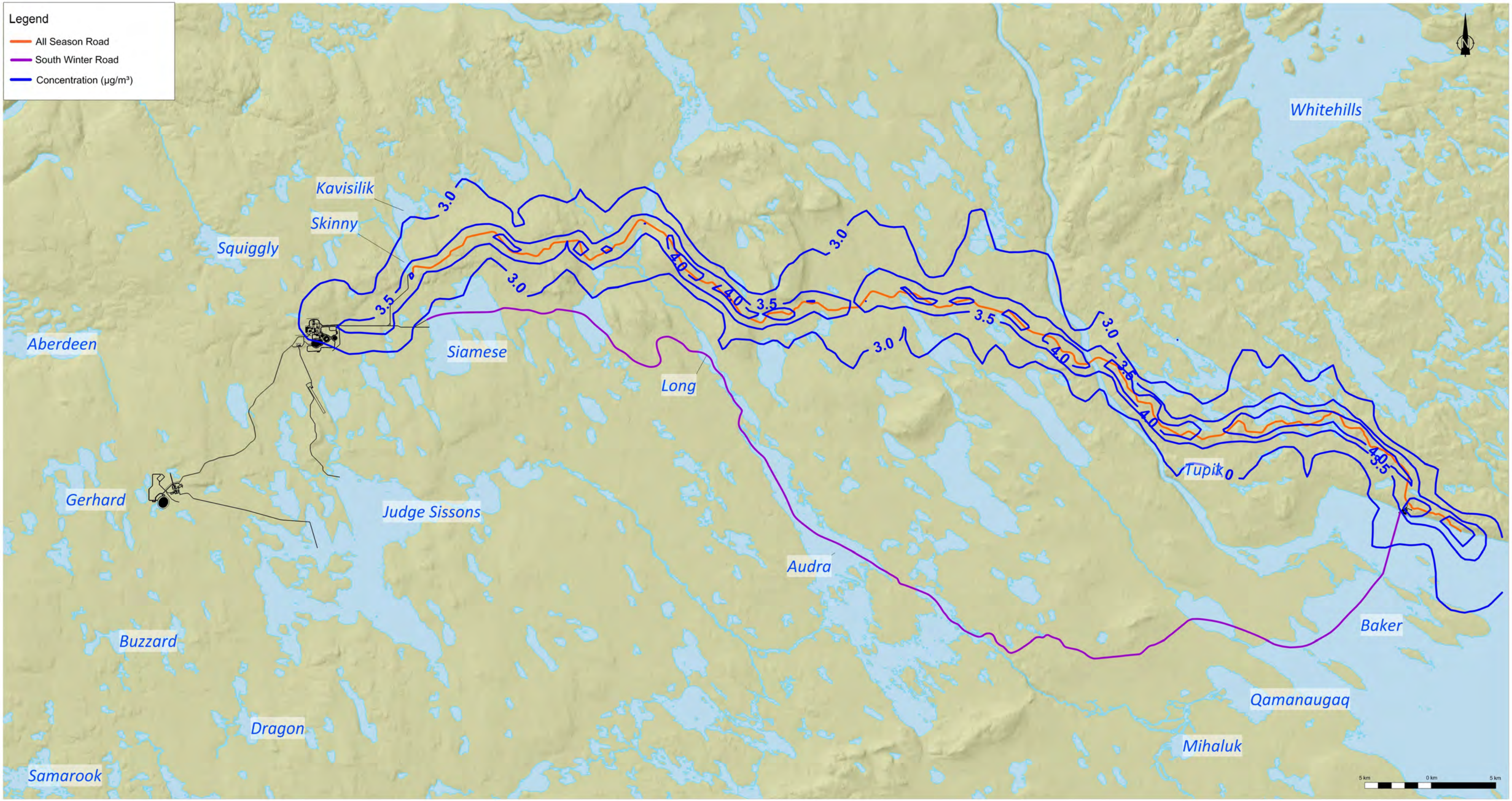

Projection: NAD 1983 UTM Zone 14N

Compiled: SENES Consultant

Date: 05/05/2014

Data Sources: Natural Resources Canada, Geobase®, Nation Topographic Database, AREVA Resources Canada Inc.

FIGURE 47

All Season Road Option Assessment
Annual TSP Concentration (µg/m³)

ENVIRONMENTAL IMPACT STATEMENT
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TECHNICAL APPENDIX 4B: AIR QUALITY AND CLIMATE

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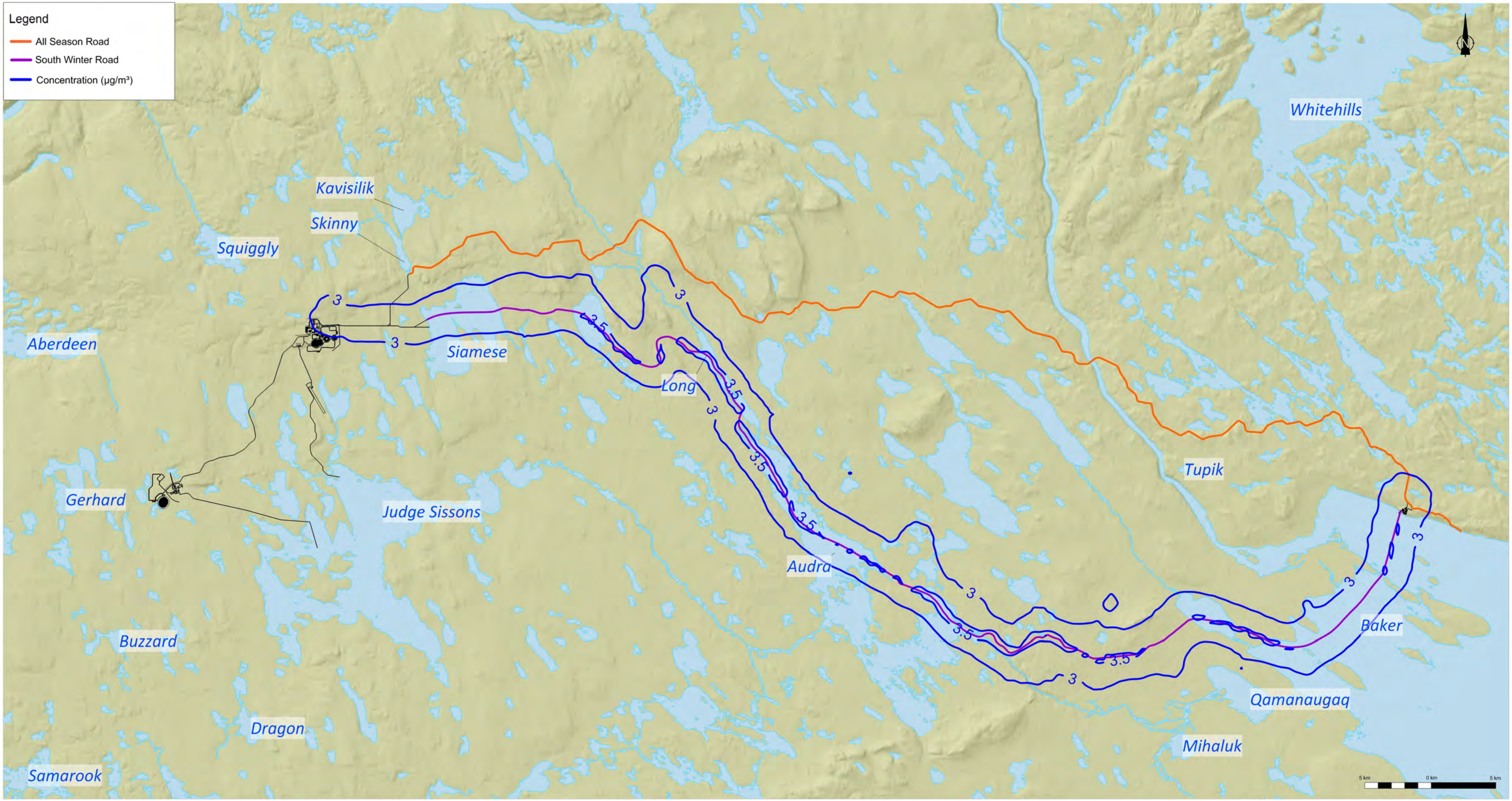
AREVA Resources Canada Inc - P.O. Box 9204 - 817 - 45th Street West - Saskatoon, SK - S7K 3X5



Projection: NAD 1983 UTM Zone 14N

Compiled: SENES Consultant

Date: 05/05/2014

Data Sources: Natural Resources Canada, Geobase®, Nation Topographic Database, AREVA Resources Canada Inc.

FIGURE 48

Winter Road Option Assessment
Annual TSP Concentration (µg/m³)

ENVIRONMENTAL IMPACT STATEMENT
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TECHNICAL APPENDIX 4B: AIR QUALITY AND CLIMATE

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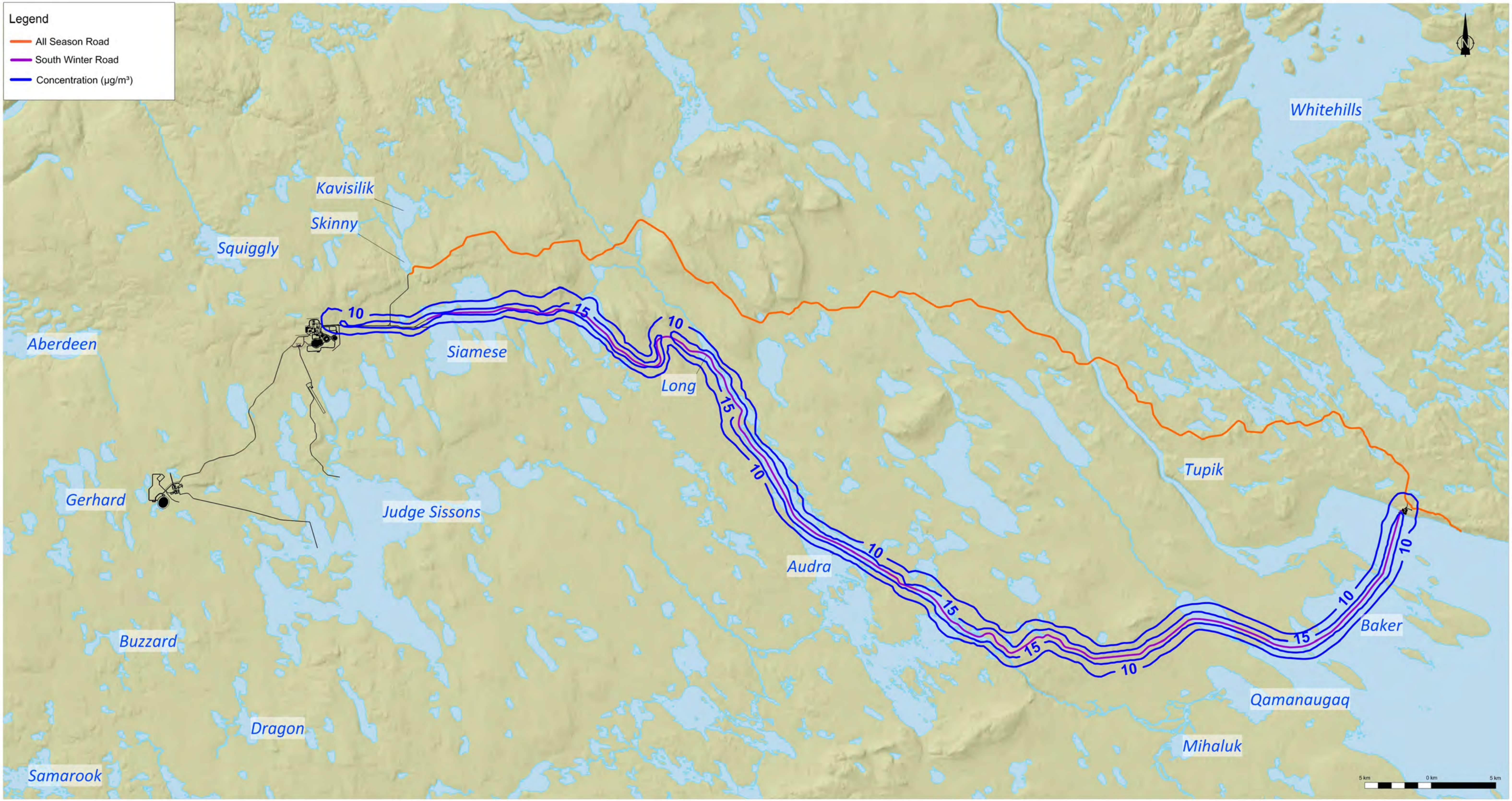

Projection: NAD 1983 UTM Zone 14N

Compiled: SENES Consultant

Date: 05/05/2014

Data Sources: Natural Resources Canada, Geobase®, Nation Topographic Database, AREVA Resources Canada Inc.

FIGURE 49

Winter Road Option Assessment
Maximum 24-hour TSP Concentration (µg/m³)

ENVIRONMENTAL IMPACT STATEMENT
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TECHNICAL APPENDIX 4B: AIR QUALITY AND CLIMATE

KIGGAVIK PROJECT

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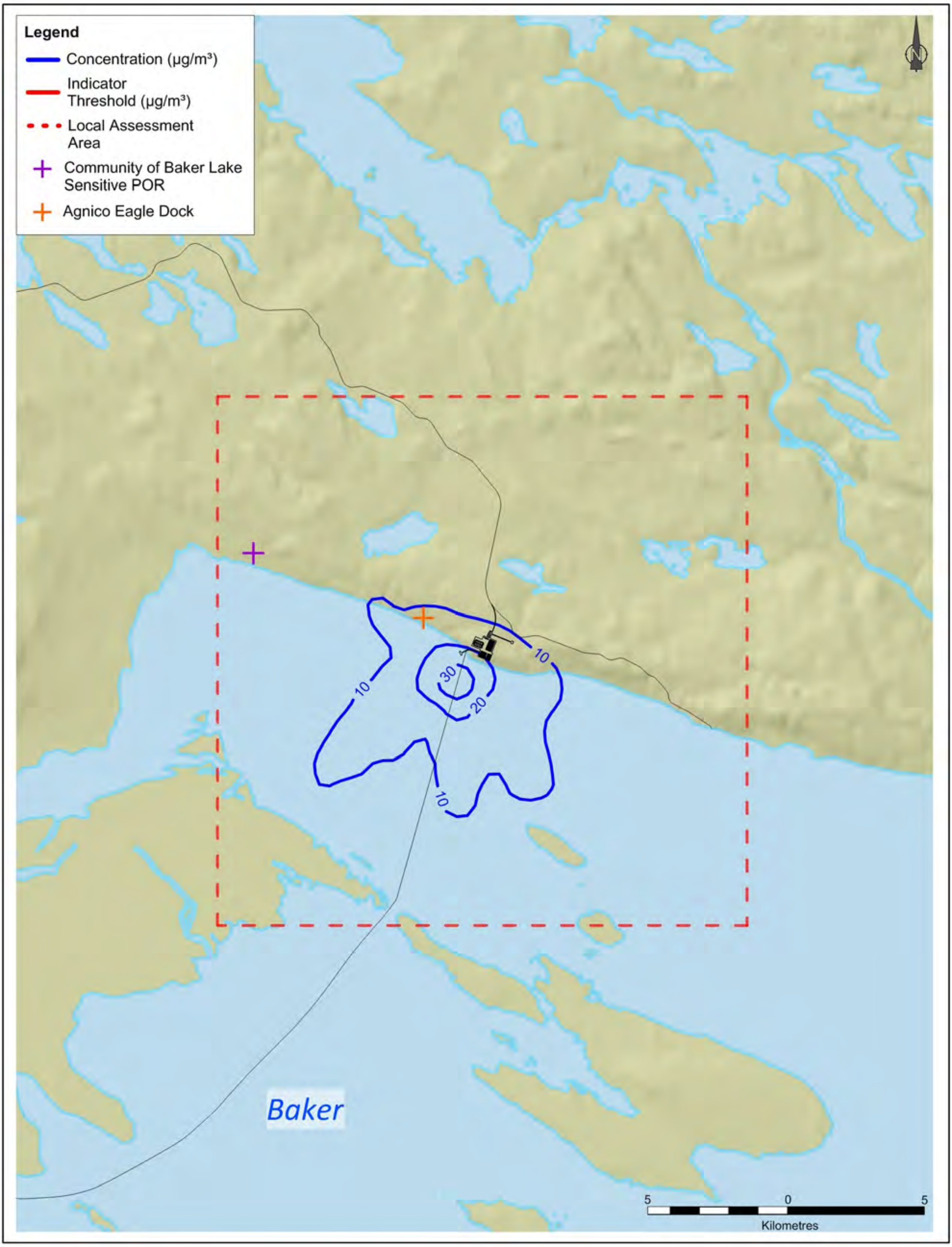


Projection: NAD 1983 UTM Zone 14N
Compiled: SENES Consultants
Date: 05/05/2014
Data Sources: *Natural Resources Canada, Geobase®, Nation Topographic Database, AREVA Resources Canada Inc.*

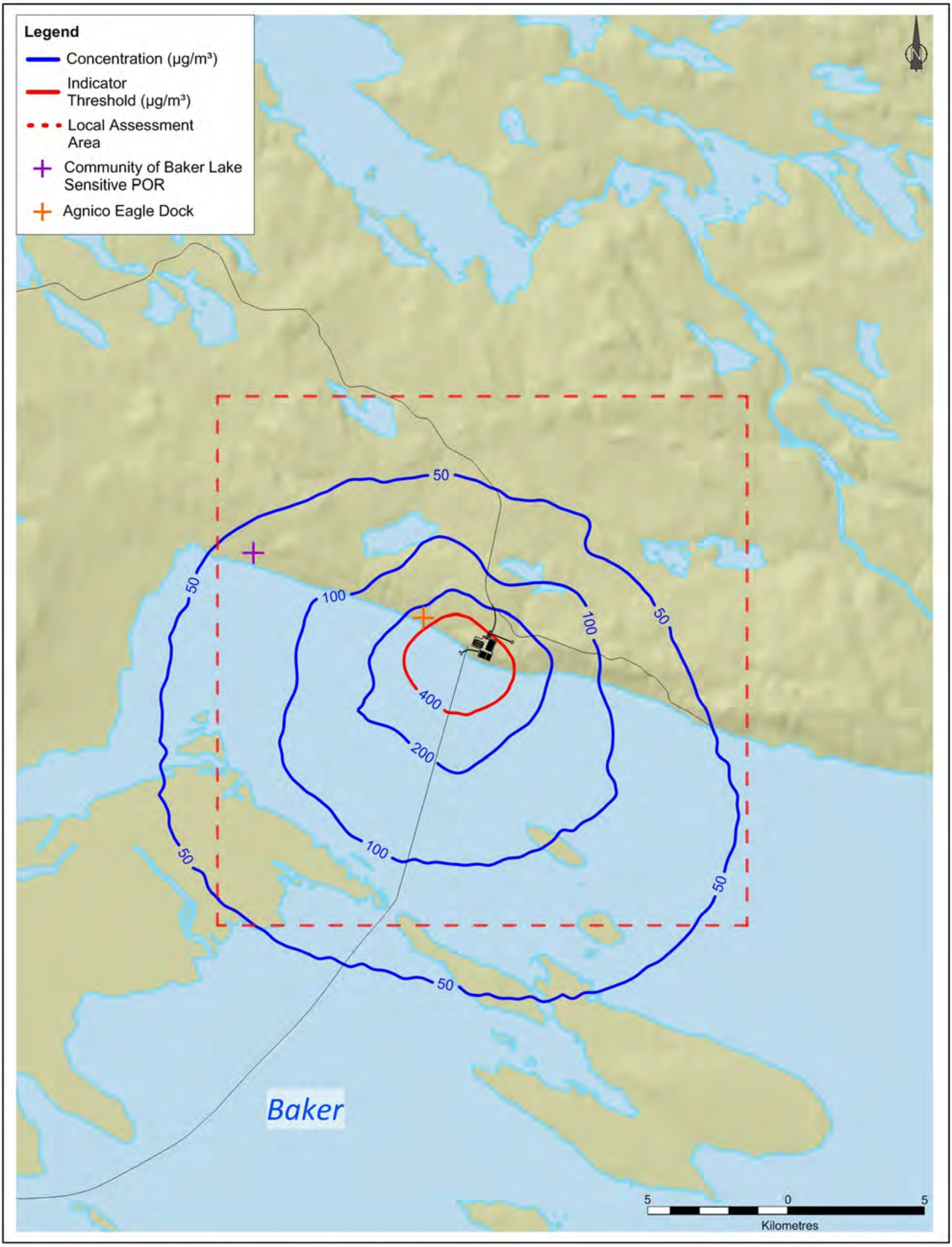
FIGURE 50

Operation Assessment - Baker Lake Dock and Storage Facility
24-hour TSP Concentration (µg/m³)

ENVIRONMENTAL IMPACT STATEMENT
VOLUME 4: ATMOSPHERIC ENVIRONMENT
Technical Appendix 4B: AIR QUALITY AND CLIMATE

KIGGAVIK OPERATION

AREVA



Projection: NAD 1983 UTM Zone 14N
Compiled: SENES Consultants
Date: 05/05/2014
Data Sources: *Natural Resources Canada, Geobase®, Nation Topographic Database, AREVA Resources Canada Inc.*

FIGURE 51
Operation Assessment - Baker Lake Dock and Storage Facility
1-hour NO_2 Concentration (µg/m³)

ENVIRONMENTAL IMPACT STATEMENT
VOLUME 4: ATMOSPHERIC ENVIRONMENT
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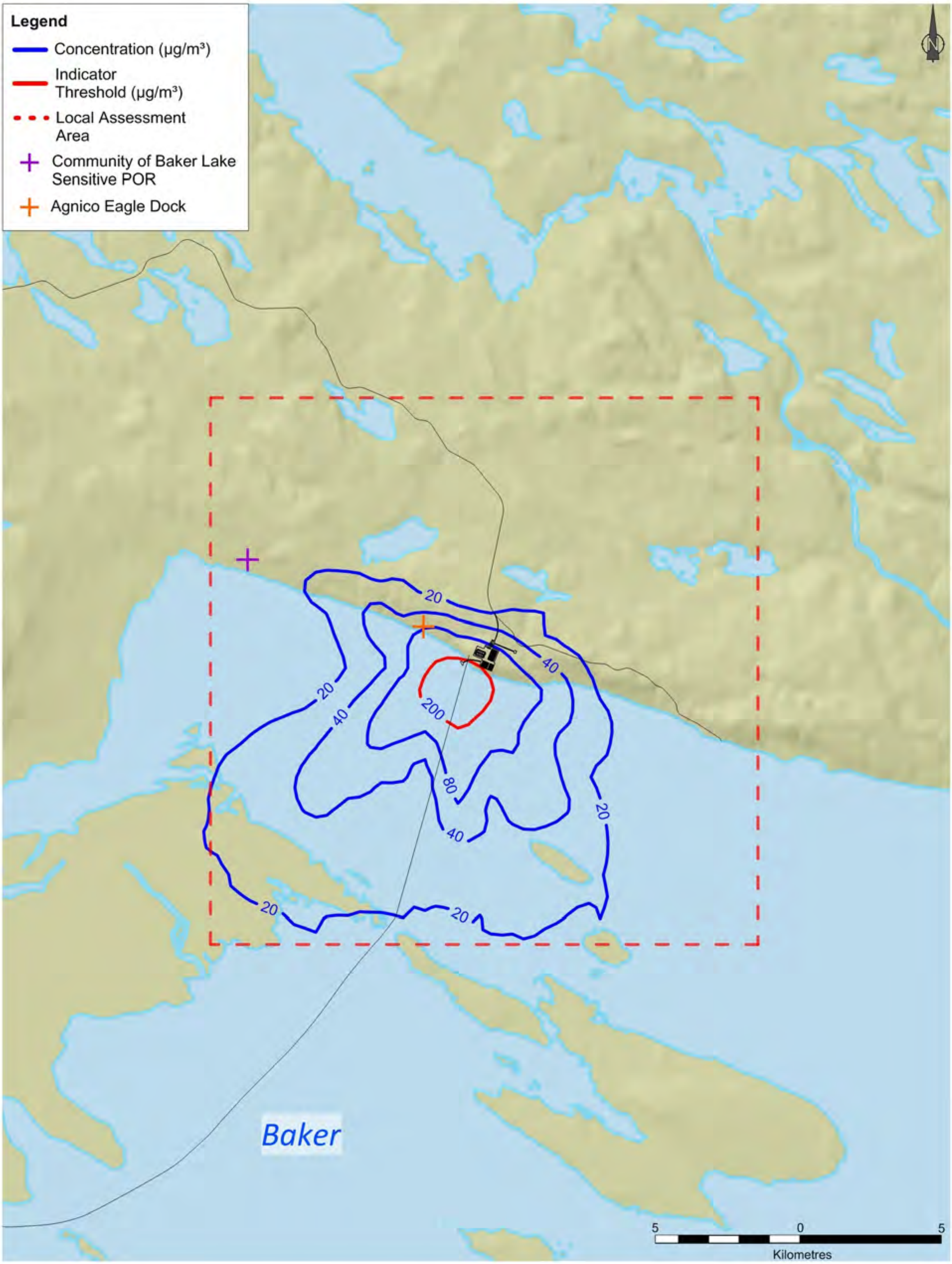
KIGGAVIK OPERATION

AREVA



Projection: NAD 1983 UTM Zone 14N
Compiled: SENES Consultants
Date: 05/05/2014
Data Sources: *Natural Resources Canada, Geobase®, Nation Topographic Database, AREVA Resources Canada Inc.*

FIGURE 52

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

ENVIRONMENTAL IMPACT STATEMENT
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KIGGAVIK OPERATION

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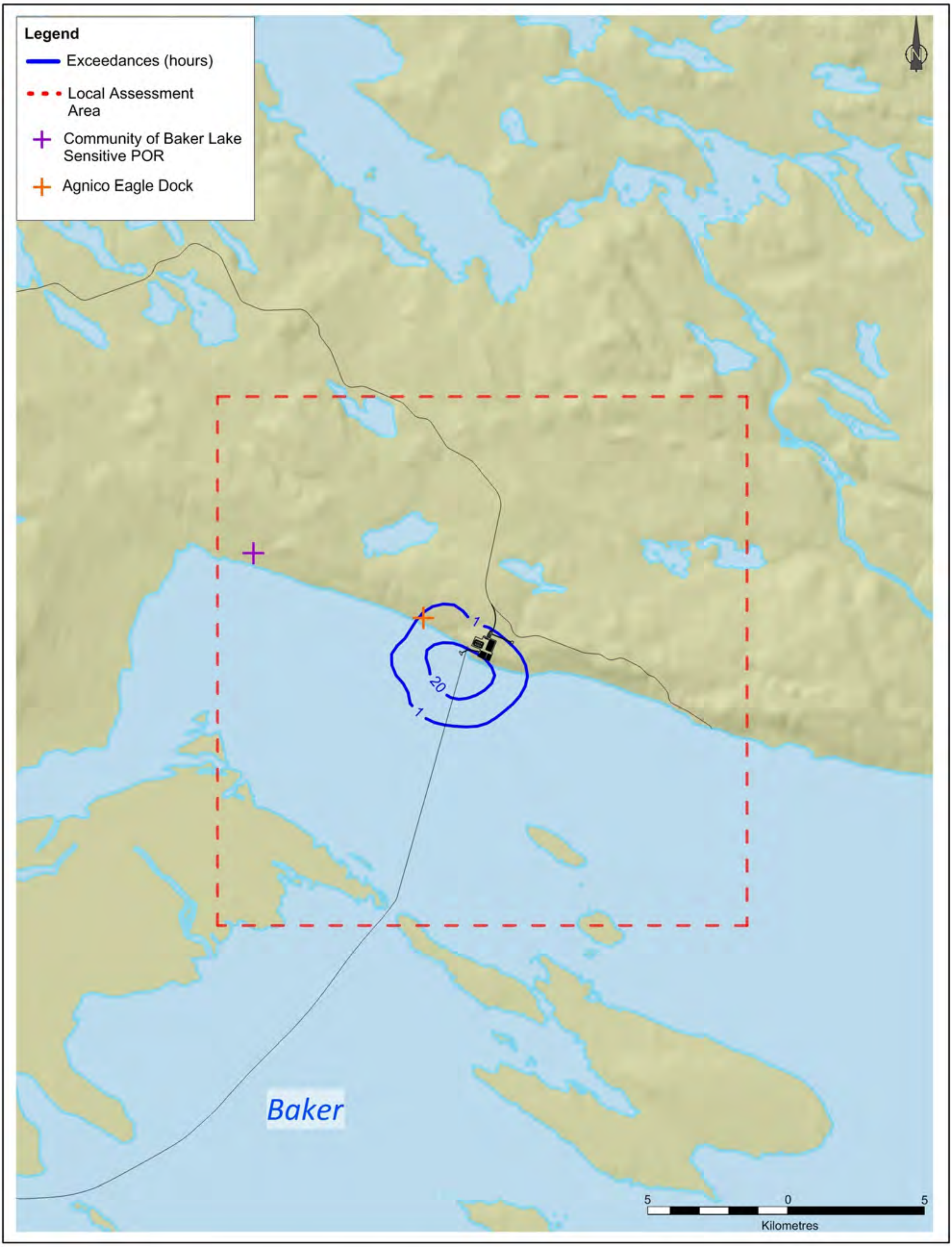

Projection: NAD 1983 UTM Zone 14N
Compiled: SENES Consultants
Date: 05/05/2014
Data Sources: Natural Resources Canada, Geobase®, Nation Topographic Database, AREVA Resources Canada Inc.

FIGURE 53
Operation Assessment - Baker Lake Dock and Storage Facility Exceedances of 1-hour NO_2 Indicator Threshold (hours)

ENVIRONMENTAL IMPACT STATEMENT
VOLUME 4: ATMOSPHERIC ENVIRONMENT
Technical Appendix 4B: AIR QUALITY AND CLIMATE

KIGGAVIK OPERATION

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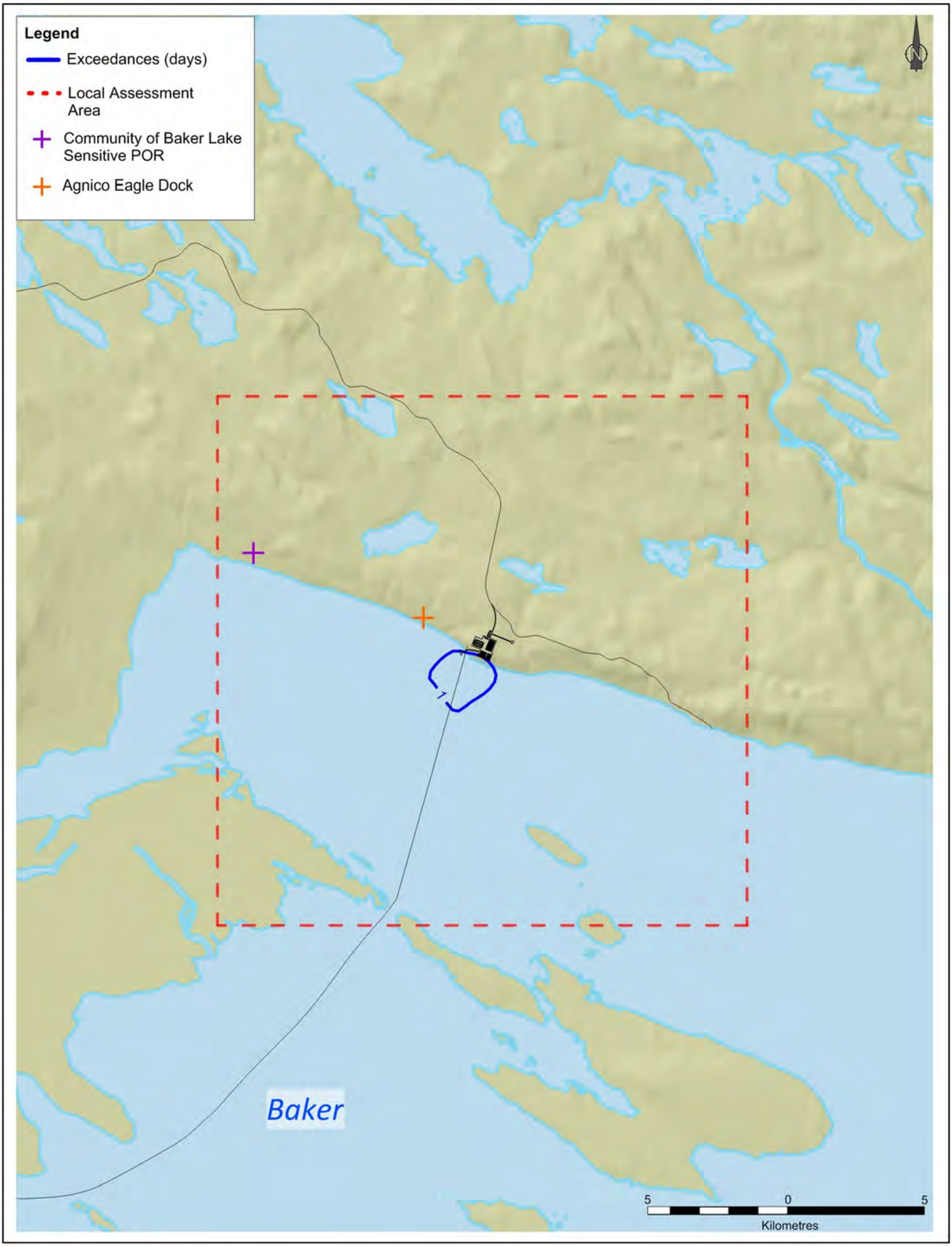


Projection: NAD 1983 UTM Zone 14N
Compiled: SENES Consultants
Date: 05/05/2014
Data Sources: *Natural Resources Canada, Geobase®, Nation Topographic Database, AREVA Resources Canada Inc.*

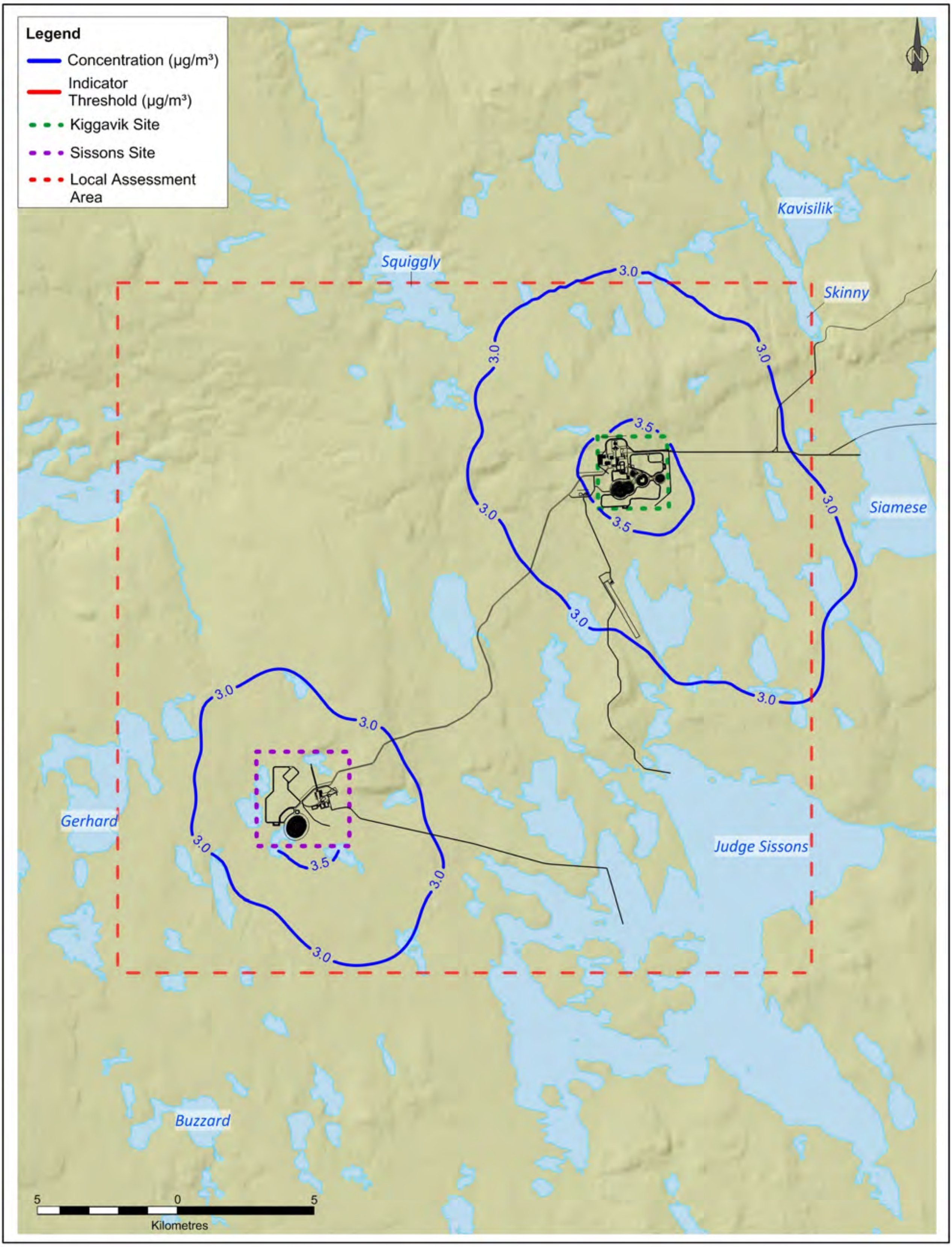
FIGURE 54

Operation Assessment - Baker Lake Dock and Storage Facility Exceedances of 24-hour NO_2 Indicator Threshold (days)

ENVIRONMENTAL IMPACT STATEMENT
VOLUME 4: ATMOSPHERIC ENVIRONMENT
Technical Appendix 4B: AIR QUALITY AND CLIMATE

KIGGAVIK OPERATION

AREVA



Projection: NAD 1983 UTM Zone 14N
Compiled: SENES Consultants
Date: 05/05/2014
Data Sources: *Natural Resources Canada, Geobase®, Nation Topographic Database, AREVA Resources Canada Inc.*

FIGURE 55
Final Closure Assessment
Annual TSP Concentration (µg/m³)

ENVIRONMENTAL IMPACT STATEMENT
VOLUME 4: ATMOSPHERIC ENVIRONMENT
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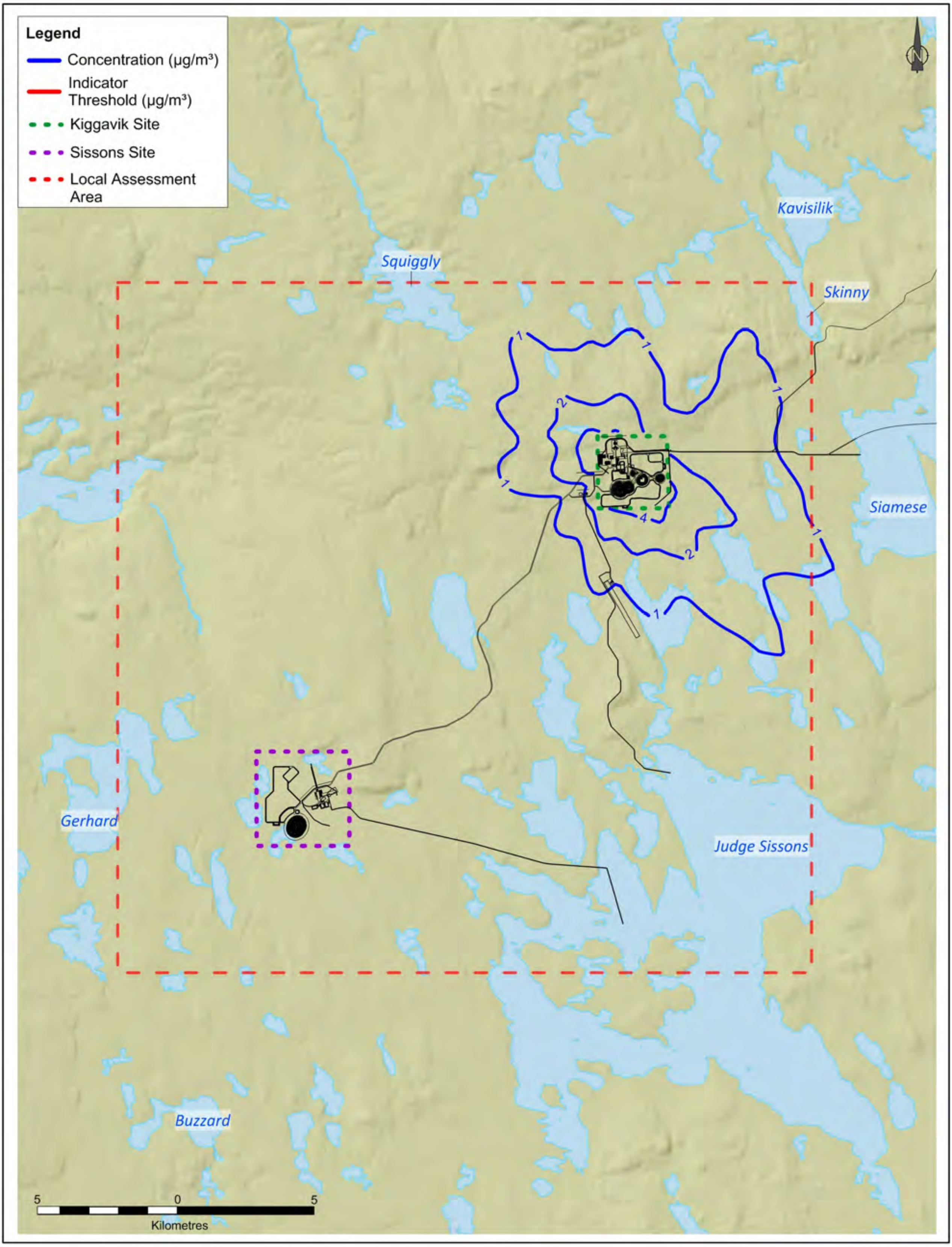
KIGGAVIK OPERATION

AREVA



Projection: NAD 1983 UTM Zone 14N
Compiled: SENES Consultants
Date: 05/05/2014
Data Sources: *Natural Resources Canada, Geobase®, Nation Topographic Database, AREVA Resources Canada Inc.*

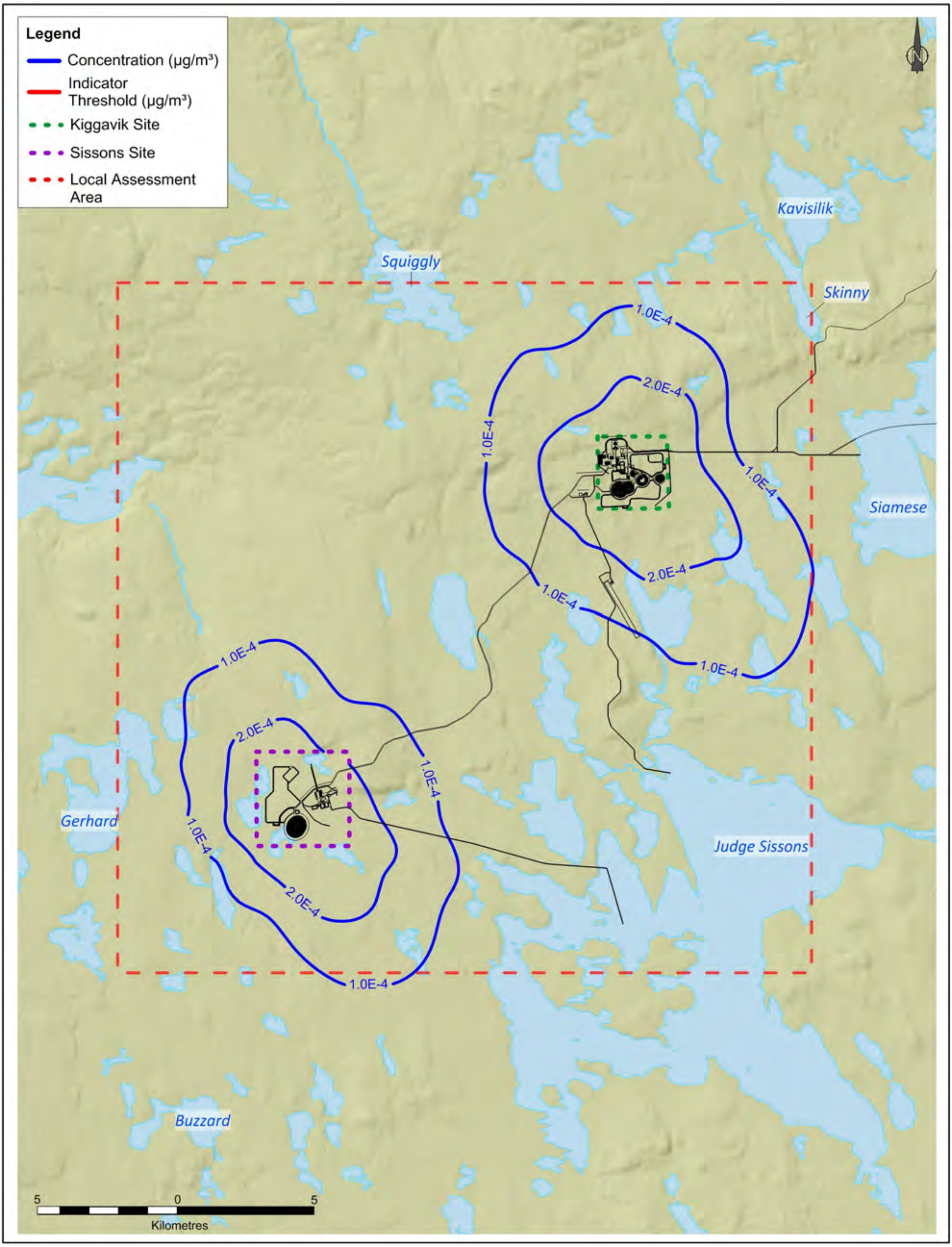
FIGURE 56

Final Closure Assessment
Incremental NO_2 Concentration (μg/m³)

ENVIRONMENTAL IMPACT STATEMENT
VOLUME 4: ATMOSPHERIC ENVIRONMENT
Part 4B: AIR QUALITY AND CLIMATE

KIGGAVIK OPERATION

AREVA



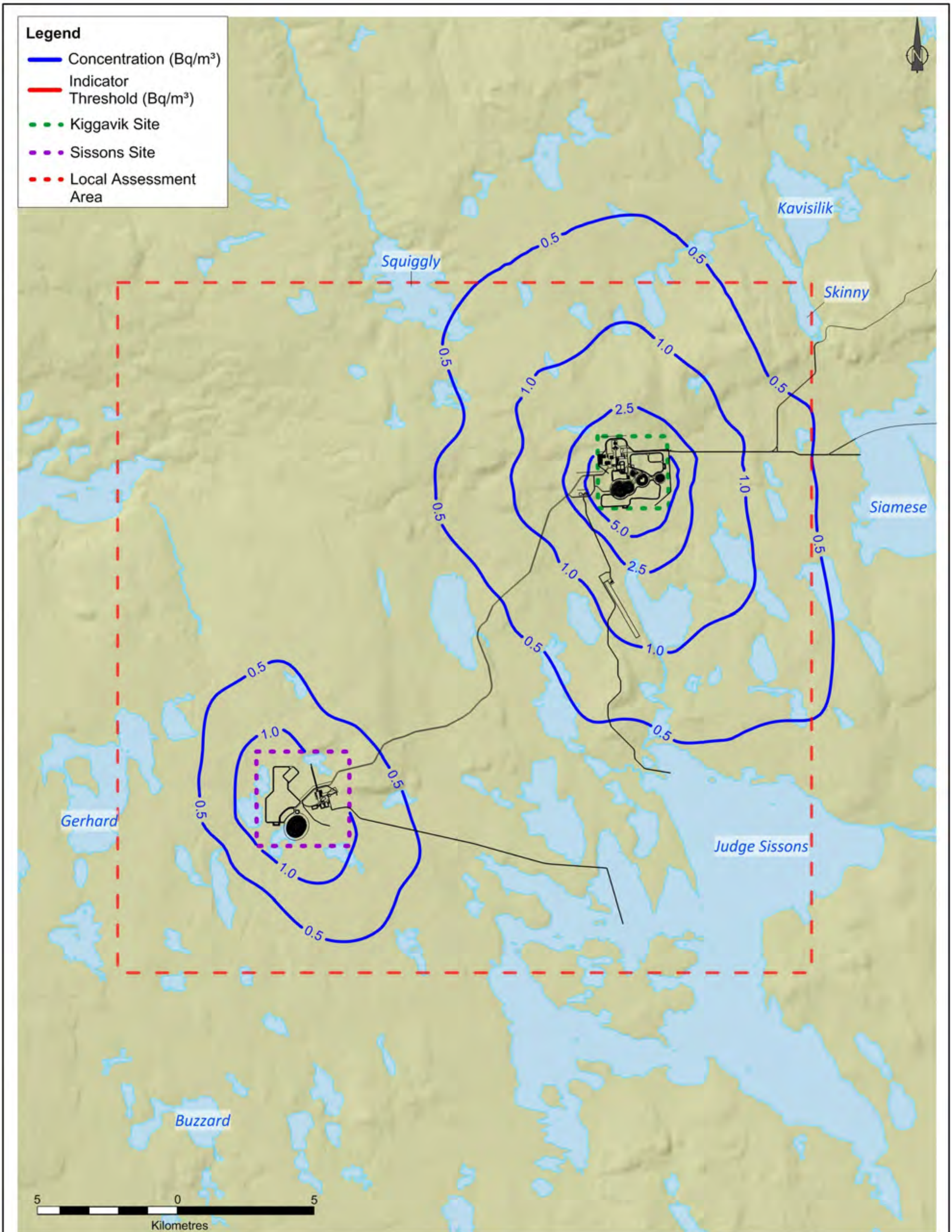
Projection: NAD 1983 UTM Zone 14N
Compiled: SENES Consultants
Date: 05/05/2014
Data Sources: *Natural Resources Canada, Geobase®, Nation Topographic Database, AREVA Resources Canada Inc.*

FIGURE 57
Final Closure Assessment
Annual Uranium (U) Concentration (µg/m³)

ENVIRONMENTAL IMPACT STATEMENT
VOLUME 4: ATMOSPHERIC ENVIRONMENT
Part 4B: AIR QUALITY AND CLIMATE

KIGGAVIK OPERATION

AREVA



Projection: NAD 1983 UTM Zone 14N
Compiled: SENES Consultants
Date: 05/05/2014
Data Sources: Natural Resources Canada, Geobase®, Nation Topographic Database, AREVA Resources Canada Inc.

FIGURE 58
Final Closure Assessment
Incremental Annual Radon Concentration (Bq/m³)

ENVIRONMENTAL IMPACT STATEMENT
VOLUME 4: ATMOSPHERIC ENVIRONMENT
Part 4B: AIR QUALITY AND CLIMATE

KIGGAVIK OPERATION

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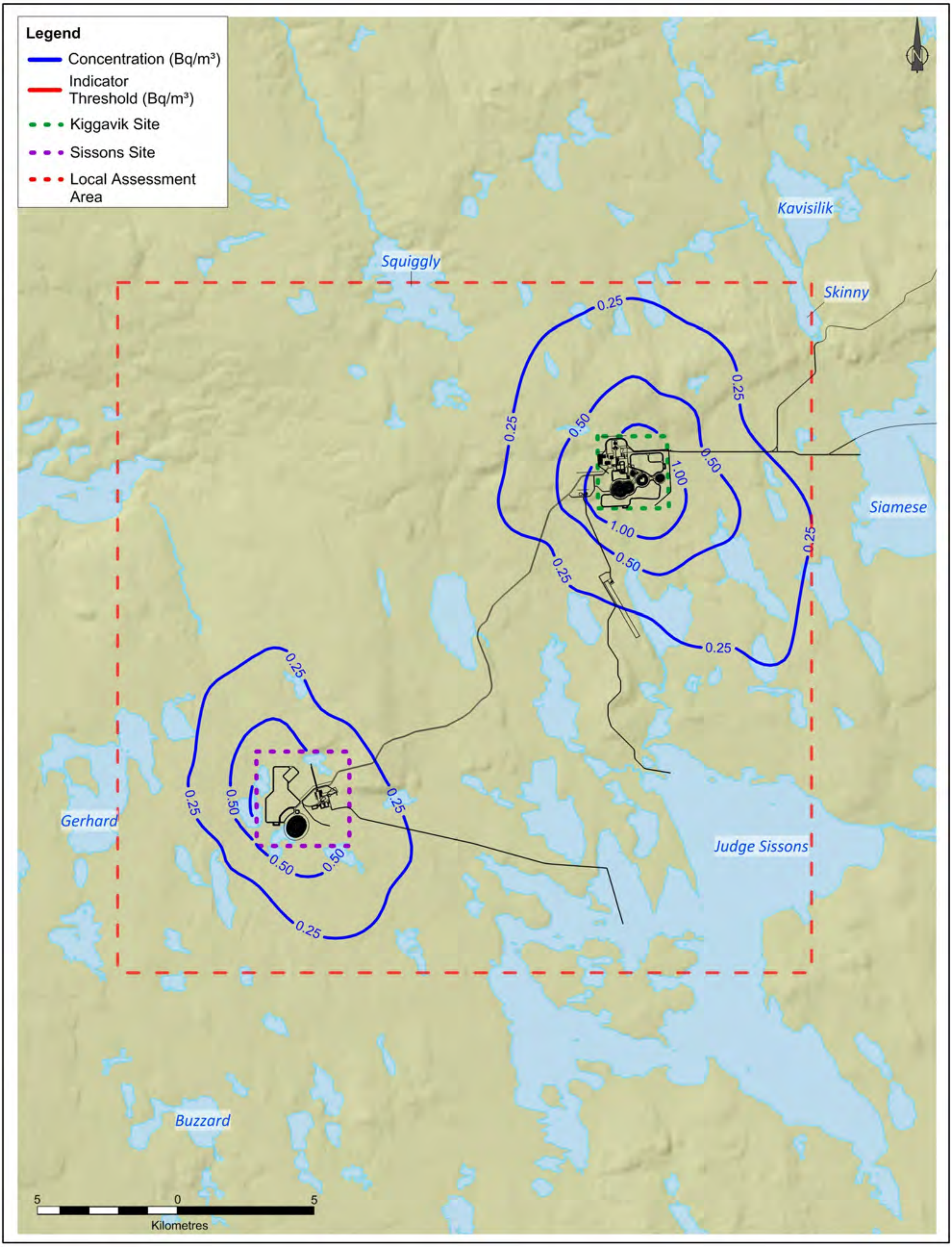

Projection: NAD 1983 UTM Zone 14N
Compiled: SENES Consultants
Date: 05/05/2014
Data Sources: *Natural Resources Canada, Geobase®, Nation Topographic Database, AREVA Resources Canada Inc.*

FIGURE 59
Post-Closure Assessment
Incremental Annual Radon Concentration (Bq/m³)

ENVIRONMENTAL IMPACT STATEMENT
VOLUME 4: ATMOSPHERIC ENVIRONMENT
Part 4B: AIR QUALITY AND CLIMATE

KIGGAVIK OPERATION

AREVA

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Attachment A Air Emissions Calculation Methods

Attachment A.1 On-site Operations

Attachment A.2 Final Closure and Post-Closure

Attachment A.3 Access Roads

Attachment A.4 Baker Lake Facility

Attachment A.5 Construction

Attachment A.6 Potential Acid Input

A.1 Air Emissions Calculation Methods: On-Site Operations

The following sections discuss the methods used to calculate air emissions from on-site operations of the Kiggavik Project and highlight the variables and assumptions that went into each of the emissions calculations. On-site operations refers to all mining, milling and supporting activities taking place at the Kiggavik site, the Sissons site and along the haul road connecting the two mine sites. At the end of this section, excerpts from the calculation spreadsheets for each of the on-site operations scenarios are provided. For each scenario, all variables and assumptions are provided, however, only the individual calculation spreadsheets for the maximum bounding scenario are provided as examples for each type of air emissions calculation.

Drilling

Emissions of dust from drilling were estimated using the US EPA AP-42 emission factor for Western Surface Coal Mining (US EPA 1998):

TSP = 0.59 kg per hole

For this assessment, it was assumed that an average of 150 holes will be drilled per day in each actively mined open pit. This value was estimated based on the amount of ANFO used per week in each open pit (see Blasting section below) and the maximum charge weight per hole as outlined in the report by Golder Associates (2011). Personal communications with AREVA staff (AREVA 2011) indicated that 60 to 70 holes will be drilled per day in the underground mine. T total of 70 was used as a conservative measure.

Blasting

For this assessment, it was assumed that ammonium nitrate-fuel oil (ANFO) would be the preferred explosive type, having a powder factor of 0.25 kg ANFO per tonne of rock for the open pit mines and a powder factor of 2.5 kg ANFO per tonne of rock for the underground mine. US EPA AP-42 emission factors for explosives detonation were used to estimate emissions of SO_2 and CO from blasting (US EPA 1980). For NO_x, often a significant constituent from blasting, a more up-to-date emission factor was used. The National Institute for Occupational Health and Safety (NIOSH) also has a published emission factor which is considered suitable for maintaining a healthy level of exposure of NO_x to workers (NIOSH 1997). It was assumed that the Kiggavik Project will take the necessary steps to limit the exposure of its workers to NO_x and the NIOSH emission factor was considered appropriate as a result.

To estimate emissions of particulate from blasting, the emission factor published by the Colorado Department of Health (Tistinic 1981) was used. This factor has been used in many other mining assessments and is considered conservative as it does not consider the amount of material being blasted, but only the number of blasts per day.

According to the Project Description (Volume 2), a 200,000 to 300,000 tonne blast will occur on average 2 to 3 times per week in the open pit mines. For this assessment, the higher end of both ranges was used and was applied to each active pit. Using the open pit powder factor from above, the total amount of ANFO required per blast is 75 tonnes.

To estimate the blast size and frequency for the underground mine, information from both the Project Description (AREVA 2011) and the Drilling and Blasting Design Report (Golder 2011) was used. Each blast was estimated to be 200 m^3 in size.

As mentioned in Section 4.1.1.1 of the main report, blasting emissions, in general, only last about 15 minutes. Since monthly variable emissions were applied to each model run, blasting could not be scaled in a way that captured this short-term release of emissions (only one type of variable emissions can be applied to each modelled source). As a result, a separate model run was completed to estimate the impact from blasting over shorter averaging periods (i.e., 1 and 24-hour). For this model run it was assumed that 1) blasting occurs independently of all other open pit mining activities and 2) blasting occurs once per day between noon and 1 pm. All other open pit activities (e.g., material loading) were turned off, but supporting activities such as power generation were included. Instead of re-modelling blasting using the entire meteorological dataset, the day with the highest predicted 24-hour NO_x concentration from the maximum bounding scenario model run was used.

Material Handling

Material handling includes activities such as loading haul trucks with ore and mine rock and unloading these materials to designated ore and mine rock stockpiles. The US EPA AP-42 emission factor for Aggregate Handling was used to the estimate emissions of dust from such activities (US EPA 2006a). Material handling depends on the average wind speed as well as the moisture content of the material being handled. For the purpose of this assessment, an estimate of 5% was used for the silt content and the average wind speed was varied on a monthly basis . A typical indoor wind speed of 1 m/s was used in the case of underground mining.

Dozing and Grading

For this assessment, it was assumed that bulldozers will be used for maintenance of the mine rock stockpiles and the US EPA emission factor was used to estimate dust emissions from this activity (US EPA 1998). Dust emissions from bulldozing depend on the silt and moisture content of the material. For this assessment it was assumed that the silt content of the mine rock is 5% and the moisture content 3%. These values are similar to what has been used in other northern mining assessments.

To maintain the on-site roads between the open pit mines, the ore and mine rock stockpiles, and the haul road, graders were assumed to be used during the summer months. The US EPA AP-42 emission factor was used to estimate dust emissions from this activity (US EPA 1998). Dust emissions from grading depend on the speed of the vehicle. For this assessment it was assumed that the graders would travel at an average speed of 8 km/hr.

Diesel Engines

Emissions from non-road mining equipment exhaust were estimated based on horsepower ratings and US EPA steady-state emission factors for non-road diesel engines (US EPA 2010). The emission factors were established to account for the effect of federal emission standards on non-road engines. For this assessment, it was assumed that all mining equipment would meet Tier 4 standards. To estimate emissions of SO_2, the 2010 Canada-Wide sulphur standard for diesel fuel of 15 ppm was used.

Equipment considered in this assessment is outlined in Table A-1.

For on-road vehicles such as supply trucks travelling along the haul roads and access road, vehicle tailpipe emissions were estimated using MOBILE6C model emission factors for heavy duty vehicles for the year 2010 (the ‘C’ denotes the adjustment for the average Canadian fleet by Environment Canada).

Unpaved Road Dust

Unpaved road dust was estimated using the US EPA AP-42 emission factor equation for unpaved industrial roads (US EPA 2006). The silt content of all unpaved roads was assumed to be 5%. For each in-pit ramp or haul route (including the haul road between Kiggavik and Sissons), the weighted average of the vehicle fleet was determined and the total number of vehicle kilometres travelled was calculated using daily production rates and the ore haul truck capacity (90 tonnes) and/or waste truck capacity (140 tonnes).

The generation of dust from unpaved roads can be controlled through operational practices such as watering, applying chemical dust suppressants or driving at lower speeds. For this assessment it was assumed that vehicle speeds along the open pit ramps and along the on-site haul routes will be kept below 25 km/h. This controls dust emissions by about 44% as suggested by the WRAP Fugitive Dust Handbook (WRAP 2006). An additional 50% control was applied during the winter (October to May) to account for dust suppression because of snow covered or frozen surfaces. During the summer months (June to September), it was assumed that watering (or an equivalent control method) will take place on an as needed basis on all haul routes, including in-pit ramps, so that dust emissions are controlled by an additional 75% at all times.

Wind Erosion

Wind erosion emissions were estimated using the emission factor equation for storage pile wind erosion published by the Air and Waste Management Association (AWMA 1992). This equation depends on both the silt content and the frequency or percentage of time that wind speeds exceed 5.4 m/s. According to the AMWA, below 5.4 m/s, wind erosion emissions are negligible. For each operational scenario assessed, the average frequency was varied by month.

There is a finite amount of erodible material within a stockpile. If left undisturbed, eventually all of the fines will get blown away. In reality, all of the fine particulate is likely to be removed by wind erosion within less than a year of a pile being undisturbed; however, as a conservative measure, mine rock stockpiles were considered to be a negligible source of emissions only if the pile was considered to be undisturbed for at least three years.

Emissions of dust from wind erosion inherently depend on the total area exposed to the wind. For this assessment, it was assumed that a typical daily working area within an open pit is 100 m by 100 m (1 ha). For large temporary or permanent stockpiles, it was assumed that 10% of the surface area is exposed to the wind at any given time. From experience with other assessments, this is a reasonable assumption. However, to be conservative, if 10% of the stockpile surface area worked out to be less than 1 ha, an active area of 1 ha was used.

Mill Operations

As described previously, ore crushing and grinding, calcining or drying, and yellowcake packaging are the main sources of dust and uranium emissions from the mill. Dust and uranium emissions arising from these activities were scaled based on 2008 stack monitoring data for AREVA's McClean Lake Operation. Emissions from crushing and grinding were scaled on the basis of proposed mill feed rates at Kiggavik relative to McCLean, whereas emissions from calcining or drying and yellowcake packaging were scaled based on yellowcake production.

Emissions of SO_2 from the acid plant were estimated using an emission factor of 75 g SO_2 per tonne of acid produced (AREVA 2011). However, NO_x and CO emissions were estimated using stack test data from McClean Lake which operates an acid plant similar to that proposed for the Kiggavik Project. Emissions were scaled based on the production of sulphuric acid relative to that at the McClean Lake Operation at the time of stack testing.

Power Generation

Power plant emissions of NO_x and CO were estimated according to manufacturer's specifications and the power output of each generator set. For this assessment, it was assumed that four (4) 4,186 kW Caterpillar 12CM32 diesel generator sets were used at the Kiggavik site. At the Sissons site, it was assumed that only one (1) 4,186 kW 12CM32 generator was used. The emission rate of particulate provided in the manufacturer's brochure was dependent on the flow rate, which could not be estimated due to limited availability of data. Instead, the AP-42 TSP emission factor for Large Stationary Diesel Engines was used (US EPA 1996).

Since the emission rate of SO_2 is highly dependent on fuel sulphur content, a mass balance calculation approach was used to estimate SO_2 emissions using anticipated power requirements supplied by AREVA. At the Kiggavik site, peak power generation is estimated to be 155 GWh per year and at the Sissons site, 23 GWh per year. It was also assumed that the diesel fuel used by the generator sets will meet the 2010 Canada-Wide sulphur standard for diesel fuel of 15 ppm.

Waste Incineration

An incinerator will be used at both the Kiggavik and Sissons sites; however, it was assumed that the Sissons incinerator will have a capacity that is 50% of the Kiggavik incinerator. For present purposes, a model similar to Eco Waste Solutions Model No. ECO 1.75TN MS 60L was used. Emissions from the incinerators were estimated using manufacturer's specifications and engineering estimates for the exhaust flow rate.

Underground Mining Exhaust

The preferred mining method for End Grid mine is the underhand drift-and-fill method. This involves removing ore in horizontal slices using a top down approach and replacing it with backfill. Sources of emissions from the underground mining are similar to open pit mining and include drilling, blasting, handling ore and mine rock, diesel engine emissions, etc. All emissions generated below the surface exhaust through one mine ventilation exhaust having a flow rate of 285 m^3/s, a diameter of 5 m and an exit temperature of 2 degrees Celsius. The portal will be used as a fresh air intake.

End Grid Backfill Plant

Cemented rock fill is proposed as the End Grid mine backfill material. Crushed mine rock (primarily from the Kiggavik site) will be mixed with cement to produce the backfill in a concrete batching plant located near the underground mine. Emissions of dust were estimated using AP-42 emission factors for Concrete Batching (US EPA 2006c). Backfill aggregate and cement quantities required for each production year were given in the proposed schedule provided to SENES by AREVA. The maximum hourly production rate of 60 tonnes of backfill per hour was used as per discussions with AREVA staff (AREVA 2011).

Uranium and Metals in Dust

Uranium and metal emission rates were calculated based on the composition of the parent material from which TSP is emitted (i.e., metal (%) x TSP (g/s)). The uranium grade and metal content of ore and mine rock for the Kiggavik Project were derived using either data supplied by AREVA or sampling data from EcoMetrix (EcoMetrix Inc. 2010, memorandum). The compositions of the ore and mine rock are provided below.

Uranium Grade and Metal Content of Ore

The expected grade of uranium (U%) for each ore deposit was provided by AREVA in the most recently proposed production schedule. To be conservative, a weighted average of U% for each ore deposit was calculated for each of the phased operational scenarios using those years having relatively high uranium grades. The selected year(s) for each of the periods assessed is shown in the Table A-2. Similarly, a weighted average of mill feed U% was calculated for each period based on information provided in AREVA's proposed production schedule. The overall maximum U% out of all production years was used for the maximum bounding scenario. The resulting weighted averages of ore and mill feed U% used in this assessment are provided in Table A-3.

The metal content for each of the ore deposits were provided to SENES by AREVA and are presented in Table A-4. For the mill ore feed, a weighted average of each metal grade was calculated assuming a combination of ores depending upon the period being assessed. For example, for Period 1 it was assumed that mill feed would be made up of ores from Centre Zone and East Zone open pits.

Table A-5 shows the calculated mill feed uranium grade for each scenario assessed.

Uranium Grade and Metal Content of Mine rock

There are three types of mine rock as defined in the Project Description (AREVA 2011):

- Type I Mine Rock: U% ≤ 40 ppm
- Type II or Clean Mine Rock: 40 ppm ≥ U% ≤ 250 ppm
- Type III or Special Mine Rock: 250 ppm ≥ U% ≤ 900 ppm (open pit) or 2100 ppm (End Grid)

As a conservative measure, the cut-off uranium concentrations were used for Type III mine rock (900 or 2100 ppm); however, the uranium concentrations for Type I and Type II mine rock were developed using EcoMetrix sampling data (EcoMetrix Inc. 2010, memorandum). The geometric standard deviation of U% was calculated for each mine area as well as for all samples combined. The final uranium concentrations used in this assessment are summarized in Table A-6.

The metal content of the different types of mine rock were obtained from AREVA (AREVA 2011) which was developed from the EcoMetrix data . This table is reproduced below simply as a reference (Table A-7).

Table A-8 outlines how the uranium and metal content of the various types of mine rock were applied to on-site sources of dust including mine rock stockpiles and on-site roads. For instance, it was assumed that all open pit ramps consist of Type II (clean rock) and that all on-site roads have been constructed with Type I rock.

Table A-1 Equipment List for Open Pit and Underground Mining

Equipment	Manufacturer	Model	Number of Units	Power Rating (hp)
Open Pit Mining				
Blasthole Drill Rig -D80SP-150MM	Sandvik	D245S	4	630
Waste 18 m^3 Hydraulic Shovel	Terex / O&K	RH 170	3	2032
10 m^3 Ore Backhoe	Hitachi	EX1900	1	1025
Ore Haul Truck	Caterpillar	777 (777F)	2	1016
Waste Haul Truck	Caterpillar	785C	11	1450
18.5 m^3 Large Dozer - D10	Caterpillar	D10T	2	580
13.5 m^3 Medium Dozer - D9	Caterpillar	D9T	1	410
12 m^3 930G Wheel Loader w/ Forks	Caterpillar	930H	2	149
22 m^3 Wheel Loader 992HL	Caterpillar	992K	2	801
Grader 16H	Caterpillar	16H	1	299
Underground Mining				
Blasthole Drill Rig -D80SP-150MM	Sandvik	D245S	4	630
Waste 18 m^3 Hydraulic Shovel	Terex / O&K	RH 170	3	2032
10 m^3 Ore Backhoe	Hitachi	EX1900	1	1025
Ore Haul Truck	Caterpillar	777 (777F)	0	1016

Table A-1 Equipment List for Open Pit and Underground Mining

Equipment	Manufacturer	Model	Number of Units	Power Rating (hp)
Waste Haul Truck	Caterpillar	785C	0	1450
18.5 m^3 Large Dozer - D10	Caterpillar	D10T	0	580
13.5 m^3 Medium Dozer - D9	Caterpillar	D9T	0	410
12 m^3 930G Wheel Loader w/ Forks	Caterpillar	930H	0	149
22 m^3 Wheel Loader 992HL	Caterpillar	992K	0	801
Grader 16H	Caterpillar	16H	0	299
Production loader (6 m^3)	n/a	n/a	2	705
Development loader (6 m^3)	n/a	n/a	1	353
Rammer-Jammer CRF loader (6 m^3)	n/a	n/a	1	353
Production haulage truck (45 tonne)	n/a	n/a	2	1173
Development haulage truck (45 tonne)	n/a	n/a	1	586
Backfill truck (45 tonne)	n/a	n/a	1	586
Production Drill Jumbo (2-boom)	n/a	n/a	2	294
Development Drill Jumbo (2-boom)	n/a	n/a	1	148
Blasters truck	n/a	n/a	1	148
Production bolter	n/a	n/a	2	294
Development bolter	n/a	n/a	1	148
Grader	n/a	n/a	1	165
Shotcrete carrier	n/a	n/a	2	294
Scissorlifts	n/a	n/a	3	231
Fuel truck	n/a	n/a	1	148
Boom truck	n/a	n/a	1	50
Jeeps	n/a	n/a	8	359
Surveyor jeep (with scissorlift)	n/a	n/a	1	90
Mechanics truck	n/a	n/a	1	148
Electrician truck	n/a	n/a	1	148
Personnel carrier	n/a	n/a	1	148

Table A-2 Uranium Ore Grade over the Project Lifetime and Selected Years for Assessment

Period	Year	East Zone Ore		Centre Zone Ore		Main Zone Ore		Andrew Lake Ore		End Grid Ore		Mill Ore Feed	
		Kt	U%	Kt	U%	Kt	U%	Kt	U%	Kt	U%	Kt	U%
1	0	-	-	-	-	-	-	-	-	-	-	-	-
	1	84	***0.258%***	824	***0.476%***	5	-	-	-	-	-	69	***0.460%***
2	2	-	-	0	-	388	***0.512%***	-	-	-	-	752	***0.454%***
	3	-	-	0	-	405	***0.681%***	0	-	-	-	668	***0.524%***
	4	-	-	-	-	1122	0.350%	0	-	0	-	906	0.367%
	5	-	-	-	-	830	0.346%	0	-	170	***0.345%***	946	0.358%
3	6	-	-	-	-	0	-	134	***0.511%***	308	0.309%	920	0.346%
	7	-	-	-	-	0	-	616	***0.632%***	328	0.303%	738	***0.514%***
	8	-	-	-	-	0	-	506	***0.536%***	326	0.288%	842	***0.442%***
	9	-	-	-	-	0	-	567	***0.546%***	336	0.320%	823	***0.448%***
	10	-	-	-	-	-	-	741	***0.516%***	317	0.335%	741	***0.498%***
	11	-	-	-	-	-	-	534	0.332%	223	***0.416%***	957	0.358%
	12	-	-	-	-	-	-	570	0.436%	50	***0.501%***	937	0.374%
4	13	-	-	-	-	-	-	0	-	0	-	81	***0.667%***

NOTES:

Years selected to calculate the weighted average of U% for each of the periods are in ***bold italics.***

Table A-3 Calculated Weighted Average of U% by Scenario

Ore Source	Ore Uranium Grade (%)				
	Maximum	Period 1	Period 2	Period 3	Period 4
Main Zone East Open Pit	-	-	0.598	-	-
Main Zone West Open Pit	0.681	-	0.598	-	-
Centre Zone Open Pit	-	0.476	-	-	-
East Zone Open Pit	-	0.258	-	-	-
Purpose Built Open Pit	-	-	-	-	-
Andrew Lake Open Pit	0.682	-	-	0.554	-
End Grid Underground Mine	0.501	-	0.345	0.432	-
Mill Feed	0.667	0.460	0.487	0.474	0.667

Table A-4 Metal Content of Ore Deposits

Mine	Arsenic (%)	Cobalt (%)	Copper (%)	Lead (%)	Molybdenum (%)	Nickel (%)	Selenium (%)	Zinc (%)	Cadmium (%)	Chromium (%)
Main Zone East Open Pit	5.70E-04	1.70E-03	3.10E-03	5.03E-02	2.87E-02	6.60E-03	2.00E-04	3.90E-03	1.20E-04	1.54E-02
Main Zone West Open Pit	5.70E-04	1.70E-03	3.10E-03	5.03E-02	2.87E-02	6.60E-03	2.00E-04	3.90E-03	1.20E-04	1.54E-02
Centre Zone Open Pit	2.52E-03	1.87E-03	7.32E-03	2.83E-02	3.10E-03	7.81E-03	2.00E-05	9.78E-03	1.40E-04	1.78E-02
East Zone Open Pit	2.52E-03	1.87E-03	7.32E-03	2.83E-02	3.10E-03	7.81E-03	2.00E-05	9.78E-03	1.40E-04	1.78E-02
Purpose Built Open Pit	8.00E-05	9.50E-04	9.40E-04	2.58E-03	1.20E-03	2.11E-03	2.00E-05	2.73E-03	5.00E-06	5.60E-03
Andrew Lake Open Pit	1.66E-03	8.30E-04	5.05E-03	3.55E-02	5.57E-03	9.54E-03	5.00E-05	3.41E-03	1.10E-04	9.61E-02
End Grid Underground Mine	5.49E-03	2.08E-03	4.67E-03	2.08E-02	6.46E-03	6.60E-03	5.50E-04	4.05E-03	1.20E-04	1.13E-02
SOURCE: Data provided to SENES by AREVA on July 20, 2010. See file: 340680-001 Client Supplied Materials\KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls										

Table A-5 Metal Content of Mill Ore Feed by Scenario

Scenario	Sources of Ore	Arsenic (%)	Cobalt (%)	Copper (%)	Lead (%)	Molybdenum (%)	Nickel (%)	Selenium (%)	Zinc (%)	Cadmium (%)	Chromium (%)
Maximum	n/a	1.69E-03	1.47E-03	4.00E-03	4.08E-02	1.75E-02	7.59E-03	2.03E-04	3.76E-03	1.17E-04	4.20E-02
Period 1	EZ + CZ + MZEST	2.51E-03	1.87E-03	7.30E-03	2.84E-02	3.23E-03	7.80E-03	2.09E-05	9.75E-03	1.40E-04	1.78E-02
Period 2	MZWEST + End Grid	8.57E-04	1.72E-03	3.19E-03	4.86E-02	2.74E-02	6.60E-03	2.20E-04	3.91E-03	1.20E-04	1.52E-02
Period 3	AL+ End Grid	2.96E-03	1.25E-03	4.92E-03	3.05E-02	5.87E-03	8.54E-03	2.20E-04	3.63E-03	1.13E-04	6.73E-02
Period 4	Remaining ore	5.49E-03	2.08E-03	4.67E-03	2.08E-02	6.46E-03	6.60E-03	5.50E-04	4.05E-03	1.20E-04	1.13E-02

NOTES:
n/a – not applicable
EZ = East Zone Open Pit
CZ = Centre Zone Open Pit
MZEST = Main Zone East Open Pit
MZWEST = Main Zone West Open Pit
AL = Andrew Lake Open Pit

Table A-6 Uranium Grades of Type I, Type II and Type III Mine Rock

Parameter	Type I Mine rock	Andrew Lake		End Grid		Main Zone		Centre Zone		East Zone	
		Type II	Type III	Type II	Type III	Type II	Type III	Type II	Type III	Type II	Type III
# of Samples	114	7	5	0	1	10	5	2	1	0	0
Uranium (ppm)	10	200	900	250	2100	200	900	60	900	250	900

NOTES:
Type II Mine rock: where no samples were available, the cut-off of 250 ppm was assumed.
Type III Mine rock: the cut-off for ore was used (900 ppm for open pits and 2100 ppm for the underground mine).

Table A-7 Metal Content of Type I, Type II and Type III Mine Rock

Metal	Units	Type I Mine Rock		Type II Mine Rock		Type III Mine Rock	
		Kiggavik	Andrew Lake	Kiggavik	Andrew Lake	Kiggavik	Andrew Lake
As	ppm	0.80	3.69	0.92	3.28	0.73	1.92
Co	ppm	11.17	3.76	9.63	3.73	10.86	2.63
Cu	ppm	13.52	7.40	11.96	6.72	45.09	5.64
Pb	ppm	10.06	7.63	12.41	8.70	30.17	14.12
Mo	ppm	1.90	0.67	1.91	0.69	14.65	0.84
Ni	ppm	26.97	27.05	26.16	28.04	22.19	27.90
Se	ppm	1.13	1.33	1.14	1.28	1.43	1.10
Zn	ppm	35.50	13.57	30.14	13.43	35.24	9.95
Cd	ppm	0.05	0.08	0.04	0.09	0.05	0.11
Cr	ppm	46.28	86.59	45.77	84.50	42.14	77.05

SOURCE: (AREVA 2011)

Table A-8 Uranium Grade and Metal Content of Stockpiled Material and Roads

Source	Uranium (%)	Arsenic (%)	Cobalt (%)	Copper (%)	Lead (%)	Molybdenum (%)	Nickel (%)	Selenium (%)	Zinc (%)	Cadmium (%)	Chromium (%)
Main Zone Open Pit Ramp	2.00E-02	9.20E-05	9.63E-04	1.20E-03	1.24E-03	1.91E-04	2.62E-03	1.14E-04	3.01E-03	4.00E-06	4.58E-03
East Zone Open Pit Ramp	2.50E-01	9.20E-05	9.63E-04	1.20E-03	1.24E-03	1.91E-04	2.62E-03	1.14E-04	3.01E-03	4.00E-06	4.58E-03
Centre Zone Open Pit Ramp	6.00E-03	9.20E-05	9.63E-04	1.20E-03	1.24E-03	1.91E-04	2.62E-03	1.14E-04	3.01E-03	4.00E-06	4.58E-03
Andrew Lake Open Pit Ramp	2.00E-02	3.28E-04	3.73E-04	6.72E-04	8.70E-04	6.90E-05	2.80E-03	1.28E-04	1.34E-03	9.00E-06	8.45E-03
Kiggavik Special Waste Pile	9.00E-02	7.30E-05	1.09E-03	4.51E-03	3.02E-03	1.47E-03	2.22E-03	1.43E-04	3.52E-03	5.00E-06	4.21E-03
Kiggavik Clean Rock Pile - North	1.55E-02	9.20E-05	9.63E-04	1.20E-03	1.24E-03	1.91E-04	2.62E-03	1.14E-04	3.01E-03	4.00E-06	4.58E-03
Kiggavik Clean Rock Pile - South	2.00E-02	9.20E-05	9.63E-04	1.20E-03	1.24E-03	1.91E-04	2.62E-03	1.14E-04	3.01E-03	4.00E-06	4.58E-03
Kiggavik Overburden Pile	1.00E-03	8.00E-05	1.12E-03	1.35E-03	1.01E-03	1.90E-04	2.70E-03	1.13E-04	3.55E-03	5.00E-06	4.63E-03
Andrew Lake Ore Pile	6.32E-01	1.66E-03	8.30E-04	5.05E-03	3.55E-02	5.57E-03	9.54E-03	5.00E-05	3.41E-03	1.10E-04	9.61E-02
Sissons Special Waste Pile	9.00E-02	1.92E-04	2.63E-04	5.64E-04	1.41E-03	8.40E-05	2.79E-03	1.10E-04	9.95E-04	1.10E-05	7.71E-03
Sissons Clean Rock Pile	2.00E-02	3.28E-04	3.73E-04	6.72E-04	8.70E-04	6.90E-05	2.80E-03	1.28E-04	1.34E-03	9.00E-06	8.45E-03
Sissons Overburden Pile	1.00E-03	3.69E-04	3.76E-04	7.40E-04	7.63E-04	6.70E-05	2.71E-03	1.33E-04	1.36E-03	8.00E-06	8.66E-03
End Grid Special Waste Pile	2.10E-01	1.00E-04	1.30E-03	2.00E-04	3.80E-03	1.00E-04	3.70E-03	9.00E-05	3.80E-03	1.00E-04	1.00E-02
End Grid Clean Waste Pile	2.50E-02	3.28E-04	3.73E-04	6.72E-04	8.70E-04	6.90E-05	2.80E-03	1.28E-04	1.34E-03	9.00E-06	8.45E-03
End Grid Ore Pile	5.01E-01	5.49E-03	2.08E-03	4.67E-03	2.08E-02	6.46E-03	6.60E-03	5.50E-04	4.05E-03	1.20E-04	1.13E-02
Kiggavik On-site Roads	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
Sissons On-site Roads	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
Haul Road between Kiggavik and Sissons	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
Road to Baker Lake (1 km)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Road to Airstrip	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03

NOTES:

Pit ramps: assumed to be Type II mine rock (i.e., Clean Waste).

- Uranium values were calculated using EcoMetrix data (EcoMetrix 2010, memorandum)
- Values for metals were obtained from , AREVA, 2011). Kiggavik samples were applied to Main Zone, Centre Zone and East Zone.

Clean waste piles: U% developed using EcoMetrix data (EcoMetrix 2010, memorandum). Value varied by pit. Where no data existed, the cut-off for clean waste (250 ppm) was used. For metals, values were obtained from AREVA. Values differ between Kiggavik and Andrew Lake.

End Grid clean waste pile: data unavailable for Type II waste, therefore, used the same values as the Andrew Lake clean waste pile.

Special waste piles: For U%, used the cut-off value for open pits (900 ppm) and for the underground mine (2100 ppm). Values differ between Kiggavik and Andrew Lake.

Overburden piles: assumed to be the same as Type I Rock.

- U developed using EcoMetrix data (EcoMetrix 2010, memorandum). U% calculated to be approximately 10 ppm using all Type I samples.
- Values for Type I metals were obtained from AREVA. Values differ between Kiggavik and Andrew Lake.

On-site roads, haul road and road to airstrip: assumed to be constructed with Type I Rock.

- U and metals developed using EcoMetrix data (EcoMetrix 2010, memorandum). U% calculated to be approximately 10 ppm. It is unknown where the material will go, so the geometric mean was calculated using all Type I samples from Andrew Lake, Main Zone and Centre Zone.

Access road to Baker Lake is assumed to not contain any uranium or metals as the road will be constructed with borrowed materials.

Radon Emissions

Sources of Radon Gas

Radon gas (radon-222 or Rn-222) is created when its precursor or parent, radium-226 (Ra-226), decays. This decay process is continuous, resulting in the ongoing release of radon into the pores and fissures of the radium bearing material. For this assessment, it was assumed that radium-226 is present in equilibrium with its parent, uranium-238 (U-238); that is, for each Becquerel (Bq) of U-238 there is one Bq of Ra-226.

Potential sources of radon from the open pit mines, the underground mine and ore and mine rock stockpiles include:

- **Exposed surfaces of rock containing U-238.** Rn-222 is continuously released from exposed surfaces of U-238 (and subsequently Ra-226) bearing materials and is a function of the uranium grade and size of the exposed surface area. Sources in this assessment include open pit mines (walls and floors), exposed surfaces in the underground mine and surfaces of ore and mine rock stockpiles. Rn-222 is emitted from the surface of the pit or stockpile and from the underground mine ventilation exhaust.
- **Rock breaking.** Rn-222 released when a mass of ore or mine rock is broken and removed from an open pit or underground mine. The emission rate is a function of the uranium grade and the amount of ore and mine rock that is mined and/or removed per day.
- **Rock handling after storage.** Similar to rock breaking, if a material containing U-238/Ra-226 is stored in a pile for more than a few days it will have a “fresh” inventory or build-up of radon gas that is available for release upon handling the material once again.
- **Water inflow into open pits and underground mine.** Rn-222 is somewhat soluble in water under pressure, but when water enters into a mine which is depressurized it is released upon contact with air. In general terms, as groundwater migrates through rock, some radon will be transferred from the mineralized rock matrix to the groundwater. As a result, water flowing out of the pore spaces of ore and mine rock containing U-238 is also a source of radon gas in this assessment. It is assumed that the mine water flows through rock slowly enough to reach a near equilibrium state, therefore, radon released from mine water must be considered where there is inflow. Water inflow occurs in both the underground mine and to a lesser extent in Main Zone and Andrew Lake open pits during later production years.

Similarly, sources of radon from milling operations include:

- **Ore handling after storage.** If the ore is stockpiled for more than a few days before it is loaded into the mill it will have a "fresh" inventory of radon gas that is emitted upon re-handling the material. This term is only considered once during entry into the mill circuit although there are three possible points of release: 1) picking up the ore; 2) dropping the ore into the crusher; and 3) crushing the ore. Insufficient time is available for in-growth between each of these steps, therefore, only a single release of radon was considered.
- **Ore processing.** As the ore is processed through the remainder of the mill, additional radon gas will form through the decay of Ra-226 during agitated storage of the crushed ore slurry. Depending on the exact milling process, this is typically considered a continuous source of emission with radon being released from agitation as it is produced through decay. Radon gas emitted from all storage tanks in the mill is collected and vented directly to the atmosphere outside of the mill building.
- **Tailings management.** Tailings produced by the mill will be treated and discharged below water to a tailings management facility (TMF). Experience with similar mining projects has shown that Rn-222 emissions from similar types of TMFs are negligible. However, for conservatism, emissions were considered in this assessment. Emissions of radon gas depend on the concentration of Ra-226 in the TMF (i.e., Bq/L), the depth of the mixing layer in contact with air, and finally, the surface area of the TMF.

Radon Gas Calculations

The base assumption of most radon calculations is that every gram of uranium in ore or mine rock will generate an equivalent equilibrium radon activity level of 1.22×10^4 Bq. This will be used in almost all of the subsequent calculations; however, some facilities report uranium as U (or U-natural) and others as U_3O_8 which is about 85% U-natural.

Useful Conversion Factors

- U-natural to Ra-226 = 1.22×10^4 Bq Ra-226/g U-natural
- Radon Generation Rate = 2.1×10^{-6} Bq/s Rn-222 per Bq Ra-226

Radon Emissions from Exposed Surfaces

An Australian report for mine rock and a Nuclear Regulatory Commission guide for tailings provide a radon emission rate of 0.5 $Bq/m^2 \cdot s$ per Bq/g Ra-226. Alternatively a nominal (generic) value of 1 $Bq/m^2 \cdot s$ per Bq/g Ra-226 can be referenced as a universal and somewhat conservative value. A value of 0.5 $Bq/m^2 \cdot s/g$ Ra-226 was used in this assessment. The complete equation used to estimate radon emissions from exposed surfaces is:

$$\text{Rn-222 (Bq/s)} = 0.5\ \text{Bq/m}^2 \cdot \text{s/g Ra-226} \times \text{area m}^2 \times 1.22 \times 10^4\ \text{Bq Ra-226/g U} \times \text{U \%} \div 100$$

The exposed surface area in each open pit was calculated using general geometry (i.e., the surface area of a cone) and information obtained from the site drawings and project description provided by AREVA. Since there will be exposed surfaces of both ore and mine rock, it was assumed that the exposed surface areas will be a function of the daily amount of material removed from the pit and the uranium grade of each rock type.

In order to calculate radon emissions from End Grid underground mine, SENES required information on the extent of exposed ore surfaces in the mine. AREVA requested this information from Golder Associates, which was provided in a memorandum to SENES dated January 31, 2011. The memorandum outlined that each drift will be approximately 5 m x 5 m and 100 m in length in ore, with an estimated 6 drifts in production at any given time. It was further assumed that three (3) sides of each drift will be exposed to ore and one (1) side of each drift will be exposed to a combination (50% each) of Type II (clean) and Type III (special) mine rock. This was used to calculate the total expected exposed surface area of 9,000 m^2 of ore and 3,000 m^2 of mine rock.

An example calculation for surface emissions of radon from Andrew Lake open pit is provided below. It assumes that Andrew Lake is completely developed (i.e., the maximum surface area is exposed).

Sample Calculation – Andrew Lake

Ore U-238 = 0.63%
Mine rock U-238 = 0.09%
Clean Rock U-238 = 0.02%
Exposed Surface Area = 615,000 m^2 (3% ore, 1% mine rock, 96% clean rock)
Weighted Average U-238 = 0.63 x 0.03 + 0.09 x 0.01 + 0.02 x 0.96 = 0.039%

Therefore,

$E_{Rn\text{-}222}$ = 0.5 Bq/m^2·s per Bq/g Ra-226 x 615,000 m^2 x 1.22 x 10^4 Bq Ra-226/g U x 0.039% ÷ 100 = 1.47 x 10^6 Bq/s

Radon Emissions from Rock Breaking and Handling

To calculate the amount of radon gas emitted from rock breaking or handling activities, the total mass of rock handled and uranium content must be known. Note that radon from handling is only considered if the rock has been stockpiled/stored for more than a week after breaking, as all of the radon was assumed to have exited the exposed pores upon breaking, with insufficient time for new in-growth if handled within one week. The equation used to estimate radon emissions from rock breaking or handling is:

Rn-222 (Bq/s) = g rock per day x 1.22 x 10^4 Bq Ra-226/g U x U% ÷ 100 x Emanation Factor

The Emanation Factor represents the fraction of generated radon that escapes from the pore spaces of the rock and is discussed in more detail below. Typically a value of 0.02 was used. A sample calculation for Andrew Lake Pit is provided below.

Sample calculation – Andrew Lake

Ore U-238 = 0.63%
Mine rock U-238 = 0.09%
Clean Rock U-238 = 0.02%
Handling rate = 1,030 t ore + 403 t special waste + 33,091 t clean waste = 34,524 t
Average U-238 = (0.63 x 1,030 + 0.09 x 403 + 0.02 x 33,091) ÷ 34,524 = 0.039%

Therefore,

Rn-222 = 34,254 t/day x 10^6 g/t x 1.22 x10^4 Bq Ra-226/g U x 0.039% ÷ 100 x Emanation Factor (0.02)
= 3.3 x 10^9 Bq/day ÷ 24 hr/day ÷ 3600 s/hr
= 3.8 x 10^4 Bq/s

Radon Emissions from Mine Water Inflow

In order to calculate the amount of radon released from water that flows into open pits or mines, the water inflow rate must be known as well as the uranium content of the rock. In addition, the density and porosity of the rock must be known or assumed. The equation used to estimate radon emissions from water inflow is:

Rn-222 (Bq/s) = W x U x D x Rn / P x F x Emanation Factor

Where,

W = water inflow rate in m^3 per day
U = uranium concentration = U% ÷ 100 x 10^6 g/tonne
D = in situ rock density in tonnes per m^3
P = porosity in m^3 water per m^3 of rock
Rn = radon generation rate = 1.22 x 10^4 Bq Ra-226/g U

Conservative estimates of the mine water inflow rates were used to calculate emissions for the Main Zone open pit, Andrew Lake open pit and End Grid underground mine. The maximum water inflow rates that were used in this assessment are:

- Main Zone Open Pit: 1.4 m^3 per day, applicable to Period 2 and the Maximum Bounding Scenario
- Andrew Lake Open Pit: 100 m^3 per day, applicable to Period 3 and the Maximum Bounding Scenario
- End Grid Underground Mine: 200 m^3 per day, applicable to Period 3 and the Maximum Bounding Scenario

The porosity of the rock is another important factor in determining the amount of radon in mine water. An effective porosity of 1% was assumed for this assessment. A sample calculation for Andrew Lake mine water inflow is provided below.

Sample Calculation – Andrew Lake

Average Daily Water Inflow Rate = 100 m^3/day
Ore U-238 = 0.63%
Mine rock U-238 = 0.09%
Clean Rock U-238 = 0.02%

Density of ore = 2.35 tonnes/m^3
Density of mine rock = 2.7 tonnes/m^3

Handling rate = 1,030 t ore + 403 t special waste + 33,091 t clean waste = 34,524 t
Average U-238 = (0.63 x 1,030 + 0.09 x 403 + 0.02 x 33,091) ÷ 34,524 = 0.039%
Average in-situ density = (2.35 x 1,030 +2.7 x 403 t + 2.7 x 33,091 t) ÷ 34,524 = 2.8 tonnes/m^3

Rn-222 (Bq/s) = 100 m^3 water/day x 0.039% ÷ 100 x 10^6 g/t x 1.22x10^4 Bq Ra-226/g U x 2.8 t/m^3 rock x 1 m^3 rock/ 0.1 m^3 water x Emanation Factor (0.02)
= 2.7 x 10^8 Bq/day ÷ 24 hr/day ÷ 3600 s/hr
= 7.6 x 10^6 Bq/s

Radon Emanation Factor

The Radon Emanation Factor, which represents the fraction of radon that escapes from the rock matrix into the pore spaces of ore and mine rock, is an important factor which is affected by both the rock type as well as frozen and unfrozen conditions. Based on measurements of emanation factors for ore and mine rock from several northern Saskatchewan mines, which are primarily comprised of sandstone deposits, an emanation factor of 0.2 is a reasonably conservative value. However, it is understood that the ore deposits at the Kiggavik Project site are more similar to ores that were mined in Elliot Lake Ontario. Data provided in the *US Bureau of Mines Report 8264* (Austin and Droullard 1978) suggests that the emanation of radon from Elliot Lake ores (a dense quartz-pebble conglomerate) are relatively low; about 1% of the emanation rate for US sandstone ores. This is consistent with direct in-situ measurements of radon emanation in Elliot Lake mines as reported by Thompkins and Chen (1969), for example.

While there is no direct comparison for the emanation factor for Kiggavik, based on the differences between the rock characteristics at Kiggavik and other mines it is reasonable to assume that the emanation fraction would, on average, be substantially lower than emanation factors reported for northern Saskatchewan ores. As a result, for present purposes, a 10-fold reduction in emanation to 0.02 for both ore and mine rock was assumed. This may still be somewhat conservative, but given natural variability and limited data specific to the Kiggavik Project, it is considered a reasonable assumption.

With respect to radon emanation during frozen conditions, a further 10-fold reduction in the “effective” emanation of radon for a frozen core relative to unfrozen core was assumed. This assumption was based on measurements of radon emanation performed on frozen Cigar Lake cores (SENES and CEA 1987).

In summary, the following emanation factors were applied in this assessment:

- an emanation factor of 0.002 for mining in fully frozen areas; and
- an emanation fraction of 0.02 otherwise.

The frozen condition emanation factor was applied to rock extracted from open pits at depths located within the permafrost and during the early operational years at End Grid mine. The unfrozen emanation factor was applied to rock extracted from depths below the permafrost and to all ore and mine rock handled outside of the mines.

Radon Emissions from Tailings Management Facilities

To calculate the emissions of radon gas from active tailings management facilities, the concentration on radon in the TMF (i.e., Bq/L) and the depth of the mixing layer in contact with air have to be known or assumed. The equation used to estimate the radon generation rate from active TMFs is:

$$\text{Rn-222 (Bq/s)} = \text{TMF surface area } (m^2) \times \text{Bq Ra-226/L} \times \text{mixing depth (m)} \times 1000\ \text{L/m}^3 \times 2.1 \times 10^{-6}\ \text{Bq/s Rn-222 per Bq Ra-226}$$

From experience with similar mining projects, the concentration of radon in the TMF water is in the range of 1 to 3 Bq/L and the mixing layer is between 0.1 and 1 metre. As a conservative measure, 3 Bq/L and 1 metre were used.

Once a TMF is full to capacity, the tailings are consolidated and subsequently covered with a layer of mine rock and overburden/soil. Main Zone TMF will first be covered with a layer of special waste, followed by clean waste, whereas East Zone and Centre Zone TMFs will be covered with clean waste. Emissions from decommissioned TMFs are discussed in Section A.2.

Excerpts from Calculation Spreadsheets

Period 1 (Year 0 -1) Variables and Assumptions Spreadsheet

Summary of Variables Used for Emission Estimates on Worksheets			340680 Kiggavik
Month	December		Note: enter full name of month
"Daily" or "Annual" Multiplier Used?	Daily		
Material Handling	Calculation Method: Drop Equation AP-42 13.2.4, November 2006		
Variable	**Assumed Value**	**Units**	**Comments**
Operation days per month - January to March	12	days per month	KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, Basic
Operation days per month - April to December	30	days per month	KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, Basic
Operation days per year	306	days per year	Calculated
Operation hours per day	24	hours per day	Assumption
Conversion factor bcm to tonnes - waste rock	2.7	tonnes/bcm	KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, SenesRequest3
Conversion factor bcm to tonnes - overburden	1.65	tonnes/bcm	Midpoint of dry bulk density as outlined in the IFS rounded to 1.65
Conversion factor bcm to tonnes - ore - East Zone	2.36	tonnes/bcm	KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, SenesRequest3
Conversion factor bcm to tonnes - ore - Centre Zone	2.36	tonnes/bcm	KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, SenesRequest3
Conversion factor bcm to tonnes - ore - Main Zone	2.40	tonnes/bcm	KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, SenesRequest3
Conversion factor bcm to tonnes - ore - Andrew Lake	2.35	tonnes/bcm	KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, SenesRequest3
Conversion factor bcm to tonnes - ore - End Grid	2.40	tonnes/bcm	KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, SenesRequest3
Variable	**Assumed Value**	**Units**	**Comments**
Maximum Excavated per Day - bcm - Scenario 1			from "AnnualSched_Apr2011" tab
East Zone - Total	2,686,000	bcm per year	Note: rock types will not add up to total due to rounding
PB Pit - Total	350,000	bcm per year	
Centre Zone - Total	6,854,000	bcm per year	
Main Zone - Total	2,064,000	bcm per year	
Andrew Lake - Total	0	bcm per year	
End Grid - Total	0	bcm per year	
East Zone - Ore	90	kt per year	
PB Pit - Ore	0	kt per year	
Centre Zone - Ore	900	kt per year	
Main Zone - Ore	5	kt per year	
Andrew Lake - Ore	0	kt per year	
End Grid - Ore	0	kt per year	
East Zone - WR Type III	59,000	bcm per year	Special waste
PB Pit - WR Type III	0	bcm per year	
Centre Zone - WR Type III	121,000	bcm per year	
Main Zone - WR Type III	300	bcm per year	
Andrew Lake - WR Type III	0	bcm per year	
End Grid - WR Type III	0	kt per year	
East Zone - WR Type II	2,010,000	bcm per year	Clean waste
PB Pit - WR Type II	350,000	bcm per year	Assume all of PB is clean
Centre Zone - WR Type II	4,570,000	bcm per year	
Main Zone - WR Type II	0	bcm per year	
Andrew Lake - WR Type II	0	bcm per year	
End Grid - WR Type II	0	kt per year	
East Zone - OV	593,000	bcm per year	Overburden
PB Pit - OV	0	bcm per year	
Centre Zone - OV	1,820,000	bcm per year	
Main Zone - OV	2,070,000	bcm per year	
Andrew Lake - OV	0	bcm per year	
End Grid - OV	0	kt per year	
Maximum Excavated per Day - tonnes - Scenario 1			Note: values have been rounded up to either nearest 10, 100 or 1000 as applicable
East Zone - Total	22,000	tonnes/day	
PB Pit - Total	3,100	tonnes/day	
Centre Zone - Total	54,000	tonnes/day	
Main Zone - Total	11,000	tonnes/day	
Andrew Lake - Total	0	tonnes/day	
End Grid - Total	0	tonnes/day	
East Zone - Ore	294	tonnes/day	
PB Pit - Ore	0	tonnes/day	
Centre Zone - Ore	2,941	tonnes/day	
Main Zone - Ore	16	tonnes/day	
Andrew Lake - Ore	0	tonnes/day	
End Grid - Ore	0	tonnes/day	
East Zone - WR Type III	521	tonnes/day	Special waste
PB Pit - WR Type III	0	tonnes/day	
Centre Zone - WR Type III	1,068	tonnes/day	
Main Zone - WR Type III	3	tonnes/day	
Andrew Lake - WR Type III	0	tonnes/day	
End Grid - WR Type III	0	tonnes/day	
East Zone - WR Type II	17,735	tonnes/day	Clean waste
PB Pit - WR Type II	3,088	tonnes/day	
Centre Zone - WR Type II	40,324	tonnes/day	
Main Zone - WR Type II	0	tonnes/day	
Andrew Lake - WR Type II	0	tonnes/day	
End Grid - WR Type II	0	tonnes/day	
East Zone - OV	3,198	tonnes/day	Overburden
PB Pit - OV	0	tonnes/day	
Centre Zone - OV	9,814	tonnes/day	
Main Zone - OV	11,162	tonnes/day	
Andrew Lake - OV	0	tonnes/day	
End Grid - OV	0	tonnes/day	
Moisture Content of extracted material	3%	%	Assumption: 2.5% was used for Red Dog in Alaska; 3% was used for Mid-west in North
Moisture Content of clean fill	-	%	
Wind Speed		m/s	Average wind speeds at the Kiggavik site from CALMET
January	4.94	m/s	
February	3.45	m/s	
March	4.43	m/s	
April	4.23	m/s	
May	4.14	m/s	
June	3.50	m/s	
July	3.37	m/s	
August	3.44	m/s	
September	4.85	m/s	
October	3.99	m/s	
November	4.24	m/s	
December	5.10	m/s	
Control Efficiency	0%	%	Assumed no control for dumping of excavated material
On-site Truck Characteristics			
Variable	**Assumed Value**	**Units**	**Comments**
Waste Truck Capacity	140	tonnes	IFS, Section 6.2.1.2, Figure 6.2-3 April 2011
Ore Truck Capacity	90	tonnes	IFS, Section 6.2.1.2, Figure 6.2-3 April 2011
Ore Trailer Capacity	140	tonnes	IFS Section 6.6, April 2011. Based on CAT 785C type trucks.
Empty average waste truck vehicle weight	100	tonnes	CAT785C (equipment provided in KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, Basic
Loaded weight of waste truck	240	tonnes	Calculated
Loaded / Empty average waste truck vehicle weight on haul road	170	tonnes	Based on 100 tonnes empty and 250 tonnes when loaded (100+250)/2=175
Empty average ore truck vehicle weight	70	tonnes	CAT777F (equipment provided in KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, Basic
Loaded weight of ore truck	160	tonnes	Calculated
Loaded / Empty average ore truck vehicle weight on haul road	115	tonnes	Average of loaded and empty weight
Ore-trailers used between Kiggavik and Sissons			
Empty average vehicle weight	110	tonnes	Calculated
Loaded weight of vehicle	250	tonnes	IFS Section 6.6, April 2011. Based on CAT 785C type trucks.
Loaded / Empty average vehicle weight on haul road	180	tonnes	Average of loaded and empty weight
Standard tractor-trailers used on access road (from Baker Lake to Kiggavik)			
Empty average vehicle weight	20	tonnes	From Kiggavik Screening Level Assessment (SENES 2008)
Loaded weight of vehicle	60	tonnes	Information provided by AREVA October 21, 2010
Loaded / Empty average vehicle weight	40	tonnes	Average of loaded and empty weight
Underground Trucks Hauling Ore from End Grid			
Underground Trucks Capacity	45	tonnes	CAT AD45B (45-tonne underground truck)
Empty average vehicle weight	40	tonnes	CAT AD45B (45-tonne underground truck)
Loaded weight of vehicle	85	tonnes	CAT AD45B (45-tonne underground truck)
Loaded / Empty average vehicle weight on haul road	63	tonnes	Average of loaded and empty weight
Explosive trucks			
Empty average vehicle weight	13	tonnes	Peterbilt 367 (equipment provided in AREVA memo October 21, 2010)
Loaded weight of vehicle	26	tonnes	Assumed
Loaded / Empty average vehicle weight	20	tonnes	Average of loaded and empty weight
Number of trips for explosives	6	trips per day	Calculated
Yellowcake transport trucks			Aassumed same as tractor-trailers from Baker Lake to Kiggavik
Loaded / Empty average vehicle weight	60	tonnes	Information provided by AREVA October 21, 2010
Number of trips	1	trip per day	Assumed: according to 34680-2, the total annual trips required for yellowcake are 96 trips per year; also AREVA memo dated October 21, 2010 stated frequency of yellowcake transportation flights of 336 flights/year; therefore 1 trip/day should be conservative.
Vehicle Speed	70	kph	Assumed same as tractor-trailers from Baker Lake to Kiggavik
Water truck			
Loaded / Empty average vehicle weight	24	tonnes	Assumed: based on GVW 35,000 lbs for Peterbilt 348, http://www.peterbilt.com/voc348.1.aspx
Number of trips	1	trip per day	Assumed - 1 water truck; 1 trip per day
In-pit truck trips per day (one way)			
East Zone			Calculated based on quantities excavated and truck capacities above
Ore	3	trips per day	
Special Waste	4	trips per day	
Clean Waste	127	trips per day	
Overburden	23	trips per day	
Centre Zone			
Ore	33	trips per day	
Special Waste	8	trips per day	
Clean Waste	288	trips per day	
Overburden	70	trips per day	
Purpose-built Pit			
Ore	0	trips per day	
Special Waste	0	trips per day	
Clean Waste	22	trips per day	
Overburden	0	trips per day	
Main Zone			
Ore	0	trips per day	
Special Waste	0	trips per day	
Clean Waste	0	trips per day	
Overburden	80	trips per day	
Andrew Lake			
Ore	0	trips per day	
Special Waste	0	trips per day	
Clean Waste	0	trips per day	
Overburden	0	trips per day	
End Grid			
Ore	0	trips per day	
Special Waste	0	trips per day	
Clean Waste	0	trips per day	
Overburden	0	trips per day	

Period 1 (Year 0 -1) Variables and Assumptions Spreadsheet, continued

Access Road and Haul Road			
Access Road from Baker Lake to Kiggavik			
Length of road to be included in modelling	1	km	Only 1km stretch is included in the assessment of impact of access road on Kiggavik site.
Vehicle speed - All Weather Road	70	km/h	IFS Section 12.5.3.1, April 2011
Vehicle speed - Winter Road	25	km/h	IFS Section 12.5.2.6, April 2011
Traffic volume - All Weather Road	10	trips/day	IFS Section 12.5.3.1, April 2011 - All weather road must be capable of handling 3625 vehicles (plue return trips) per year
Traffic volume - Winter Road	43	trips/day	Project Description (AREVA 2008)
Access Road Modelled Scenario			
Length of road	1	km	Only modelling 1 km stretch for Scenarios and worst case.
Traffic volume	11	trips per day	IFS Section 12.5.2.6, April 2011 - the total annual trips are 3920 per year which equals an average of 11 trips per day, including fuel and dry goods, etc.
Worst Case Scenario - Vehicle speed	70	km/h	Assume the same speed as the All Weather Road
Haul Road between Kiggavik and Sissons			
Length of road	19.6	km	IFS Section 6.6, April 2011
Vehicle speed	60	km/h	IFS Section 6.6, April 2011
Traffic volume from AL ore	0	trips per day	Calculated based on total quantities of ore from Andrew Lake and capacity of ore trailers
Traffic volume from EG ore	0	trips per day	Calculated based on total quantities of ore from End Grid and capacity of ore trailers

On-Road Vehicles Tailpipe	Calculation Method: Mobile 6C		
Variable	**Assumed Value**	**Units**	**Comments**
Trucks - g/VKT	various	g PM/VKT	Based on Mobile 6C EF's for Haul Trucks - HDDV8b Emission factors were used

Unpaved Road Emissions	Calculation Method: Unpaved Road Emissions, AP-42 5th Edition, 13.2.2, 1/95		
Variable	**Assumed Value**	**Units**	**Comments**
On-site haul trucks (gravel roads) - Silt %	5	(%)	Assumption: used in the Kiggavik Screening Level Assessment (SENES 2008); average for Red
On-site haul trucks - vehicle speed	20	kph	Assumption
Control Efficiency for On-site Vehicles with Speed < 40 kph	44%	(%)	WRAP Fugitive Dust Handbook, September 2006, control efficiency due to speed limit of 25
On-site haul trucks - Control Efficiency - Summer	75%	(%)	Assumed 75% control for watering road in summer when necessary
On-site haul trucks - Control Efficiency - Winter	50%	(%)	Assumed 50% control in winter due to frozen surface
number of days in a year with at least 0.254 mm of precipitation	111	(days)	From: Canadian Climate Normals Mean number of days with 0.254 mm (0.01 inch) or more of precipitation in Baker Lake

Drilling	Calculation Method: AP-42 Table 11.9-4, October 1998		
Variable	**Assumed Value**	**Units**	**Comments**
Est. Number of Holes per Day - Open Pits	150	holes per day	Calculated based on amt. of ANFO used per week ÷ max charge weight per hole
Max Number of Holes per Day - End Grid	70	holes per blast	IFS, Section 6.4.8 Drilling and Blasting, April 2011
Volume of blasted material - End Grid	100	m^3 per blast	Based on 5 m by 5 m blast face with holes about 4 m deep and Golder drilling and blasting report (Golder Associates 2011)

Rock Blasting Volume Calc's	Calculation Method: AP-42 Table 13.3-1, February 1980		
Variable	**Assumed Value**	**Units**	**Comments**
Blasting Material	Emulsion/ANFO	-	Will use either a 70/30 Emulsion/ANFO blend or 100% ANFO. No emission factors available for ANFO.
Duration of Emissions	15	minutes	Assumed contaminants from explosives detonation are emitted to atmosphere over 15 min
Open Pits			
Max Number of Blasts per Week	3	#	IFS, Section 6.2.1.4, April 2011
Max charge weight per hole	215	kg	Table 15 of Golder drilling and blasting report (Golder Associates 2011)
ANFO Explosives Powder Factor - Open Pits	0.25	kg ANFO/tonne of rock	IFS, Section 6.2.1.4, April 2011
Max amount of rock to be blasted - Open Pits	300,000	tonnes per blast	IFS, Section 6.2.1.4, April 2011
Total Amount of ANFO required per blast - Open Pits	75	tonnes per blast	Calculated
End Grid Underground Mine			
ANFO Explosives Powder Factor - End Grid	2.5	kg rock/tonne ANFO	IFS, Section 6.2.1.4, April 2011
Max amount of rock to be blasted - End Grid	255	tonnes per blast	Calculated. Used average denisty of waste rock and ore.
Total Amount of ANFO required per blast - End Grid	110	tonnes per blast	Calculated
Average number of blasts per day	0	#	Calculated
Control - End Grid	50%	%	Assumed that 50% of dust will be retained in the mine due to deposition

NonRoad Equipment Tailpipe Emissions	Calculation Method: US EPA Nonroad (Excavators & Loaders)		
Variable	**Assumed Value**	**Units**	**Comments**
Equipment hp ratings	various	hp	Actual horsepower ratings from equipment brochures, etc.
Excavators and Loaders - g/hp-hr	various	g/hp-hr	US EPA Crankcase Emission Factors for Nonroad Engine Modeling - Compression-
Episodic (local) Diesel Fuel Sulphur Content	15	ppm	Canada-wide diesel fuel sulphur content as of 2010
Episodic (local) Diesel Fuel Sulphur Content	0.0015	%	Calculated

Grading and Dozing	Calculation Method: Western Surface Coal Mining - Bulldozing AP-42 Table 11.9-2, October 1998		
Variable	**Assumed Value**	**Units**	**Comments**
Material Moisture Content (%)	3%	%	Assumption: 2.5% was used for Red Dog in Alaska; 3% was used for Mid West in northern
Material Silt Content (%)	5%	%	Assumption: used in the Kiggavik Screening Level Assessment (SENES 2008); average for Red
Dozer Operating Hours per Day	20	hours per day	Assumption: Red Dog used 20 hours per day
Bulldozer Operating Frequency	40%	%	Assumption: same as Red Dog, % of time dozer operates for each operating hour
Control Efficiency based on watering	0%	%	Assumption: watering is unlikely
Mean vehicle speed for Graders	8.0	kph	Assumption: used in the Kiggavik Screening Level Assessment (SENES 2008)
Number of trips per day - Graders	1	trips per day	Assumption

Wind Erosion	Calculation Method: AWMA Air Pollution Engineering Manual, 1992, page 137		
Variable	**Assumed Value**	**Units**	**Comments**
Maximum Height of Permanent Clean Rock Stockpiles	50	m	AREVA e-mail dated June 30, 2010. Based on total amount of material put into stockpiles.
Maximum Height of Ore and Temporary Waste Rock Stockpiles	10	m	AREVA e-mail dated June 30, 2010. Based on total amount of material put into stockpiles.
Material Silt Content (%)	5%	%	Assumption: used in the Kiggavik Screening Level Assessment (SENES 2008)

End grid Underground Mine	Calculation Method: Engineering Calculations		
Variable	**Assumed Value**	**Units**	**Comments**
Total Air Requirement/Exhaust Flow Rate	285	m^3/s	IFS, Section 6.4.10, April 2011
Air Exhaust Diameter	5	m	IFS, Section 6.4.10, April 2011
Air Exhaust Exit Velocity	14.5	m/s	Calculated
Air Exhaust Exit Temperature	2.0	degrees C	IFS, Section 6.4.10, April 2011

Incinerator	Calculation Method: Refuse Combustion - AP-42 Chapter 2.1, October 1996		
Variable	**Assumed Value**	**Units**	**Comments**
Quantity incinerated	109	kg/h	Based on charge rate of 1750 kg/cycle and a total cycle time of 10-hour burn plus 6-hour cool down. (Eco Waste Solutions Incinerator Model No. ECO 1.75TN 1P MS 60L Technical Specification sheet, provided as part of AREVA memo dated October 21, 2010.)
Capacity of Incinerator at Sissons vs. Kiggavik	50%	%	Assumed: the Sissons incinerator will be significantly smaller than the Kiggavik incinerator (AREVA 2010, memorandum)
Type of control equipment	none	-	

Backfill Plant	Calculation Method: Engineering Calculations		
Variable	**Assumed Value**	**Units**	**Comments**
Backfill Aggregate Quantity	0	tonnes per year	from "AnnualSched_Apr2011" tab
Backfill Aggregate Quantity	0	tonnes per day	Calculated
Backfill Aggregate Transfer - Number of Trips from Kiggavik	0	trips per day	Assuming aggregate is preferentially transferred from Kiggavik using ore trailer trucks as per
Backfill Aggregate Transfer - Number of Trips from End Grid	0	trips per day	According to IFS, Section 6.4.6, End Grid only provides a fraction of aggregate, therefore, it was assumed that main sources is Kiggavik clean rock.
Backfill Cement Quantity	0	tonnes per year	from "AnnualSched_Apr2011" tab
Backfill Cement Quantity	0	tonnes per day	Calculated
Max plant capacity	60	tonnes per hour	IFS, Section 6.4.6, April 2011

Ore Crushing and Grinding	Calculation Method: MOE Procedure Document Table C-2, Approximating Particulate Emissions from Baghouses		
Variable	**Assumed Value**	**Units**	**Comments**
			Assumed a similar design to McClean - use stack testing to scale emissions based on U

Acid Plant	Calculation Method: Engineering Calculations		
Variable	**Assumed Value**	**Units**	**Comments**
Maximum Daily Production	350	tonnes H_2SO_4 per day	IFS, Section 8.4.11.1, April 2011. Peak daily production capacity is 310t/day, but used 350 t per day to be conservative.
SO_2 Emission Factor	75	g per tonne of H_2SO_4	IFS, Section 8.4.11.1, April 2011. Based on acid plant design.

Mill	Calculation Method: Engineering Calculations		
Variable	**Assumed Value**	**Units**	**Comments**
Mill feed	70	kt ore per year	from "AnnualSched_Apr2011" tab
U Grade	0.460%	%	from "AnnualSched_Apr2011" tab
Plant availability	85%	%	from KiggavikProject_HLDC_June30_ToSENES_RevAug11.xls
Mill feed per day	230	tonnes ore per day	Calculated based on plant availability and operating 365 days per year
Ore Stockpile	900	Kt ore	from "AnnualSched_Apr2011" tab
Tonnes U produced	320	T U per year	from "AnnualSched_Apr2011" tab
Max theoretical U production	4,000	T U per year	Calculated based on plant availability and operating 24 hours per day
Hourly Uranium Production	43	kg U/hour	AREVA e-mail dated May 20, 2011
Max Hourly Uranium Production	537	kg U/hour	Calculated based on plant availability and operating 24 hours per day

Power Plant	Calculation Method: Engineering Calculations		
Variable	**Assumed Value**	**Units**	**Comments**
Kiggavik			
Max number of generators operating simultaneously	4	#	IFS, Section 11.1.1, Table 11.1-1, April 2011
Unit Capacity	4190	kW	IFS, Section 11.1.1, Table 11.1-1, April 2011
Annual power consumption	155,000,000	kWh/year	SupplementalData_Kissavik&SissonsLayouts_ToSenes_Nov3.pdf page 3
Sissons			
Max number of generators operating simultaneously	1	#	According to the IFS Section 11.1.1, there will be 3 small 1450 kW units at Sissons; however,
Unit Capacity	4190	kW	one large 4190 kW unit was considered to simplify modelling.
Annual Power consumption at Sissons	23,000,000	kWh/year	SupplementalData_Kissavik&SissonsLayouts_ToSenes_Nov3.pdf page 3
Episodic (local) Diesel Fuel Sulphur Content	15	ppm	Assume using same diesel fuel for power plant as vehicles. Canada-wide diesel fuel sulphur content as of 2010
Episodic (local) Diesel Fuel Sulphur Content	0.0015	%	Calculated
Diesel High Heating Value	19,300	Btu/lb	AP-42 Chapter 3.3 - Gasoline and Diesel Industrial Engines (10/96), Table 3.3-1

Period 2 (Year 2 - 5) Variables and Assumptions Spreadsheet

Summary of Variables Used for Emission Estimates on Worksheets			**340680 Kiggavik**
Month	**December**	**Note:** enter full name of month	
"Daily" or "Annual" Multiplier Used?	**Daily**		
Material Handling	Calculation Method: Drop Equation AP-42 13.2.4, November 2006		
Variable	**Assumed Value**	**Units**	**Comments**
Operation days per month - January to March	12	days per month	KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, Basic
Operation days per month - April to December	30	days per month	KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, Basic
Operation days per year	306	days per year	Calculated
Operation hours per day	24	hours per day	Assumption
Conversion factor bcm to tonnes - waste rock	2.7	tonnes/bcm	KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, SenesRequest3
Conversion factor bcm to tonnes - overburden	1.65	tonnes/bcm	Midpoint of dry bulk density as outlined in the IFS rounded to 1.65
Conversion factor bcm to tonnes - ore - East Zone	2.36	tonnes/bcm	KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, SenesRequest3
Conversion factor bcm to tonnes - ore - Centre Zone	2.36	tonnes/bcm	KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, SenesRequest3
Conversion factor bcm to tonnes - ore - Main Zone	2.40	tonnes/bcm	KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, SenesRequest3
Conversion factor bcm to tonnes - ore - Andrew Lake	2.35	tonnes/bcm	KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, SenesRequest3
Conversion factor bcm to tonnes - ore - End Grid	2.40	tonnes/bcm	KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, SenesRequest3
Variable	**Assumed Value**	**Units**	**Comments**
Maximum Excavated per Year - Scenario 2			from "AnnualSched_Apr2011" tab
East Zone - Total	0	bcm per year	Note: rock types will not add up to total due to rounding
PB Pit - Total	0	bcm per year	
Centre Zone - Total	0	bcm per year	
Main Zone - Total	8,894,000	bcm per year	
Andrew Lake - Total	6,474,000	bcm per year	
End Grid - Total	144,000	bcm per year	
East Zone - Ore	0	kt per year	
PB Pit - Ore	0	kt per year	
Centre Zone - Ore	0	kt per year	
Main Zone - Ore	2,000	kt per year	
Andrew Lake - Ore	0	kt per year	
End Grid - Ore	200	kt per year	
East Zone - WR Type III	0	bcm per year	Special waste
PB Pit - WR Type III	0	bcm per year	
Centre Zone - WR Type III	0	bcm per year	
Main Zone - WR Type III	143,000	bcm per year	
Andrew Lake - WR Type III	0	bcm per year	
End Grid - WR Type III	10	kt per year	
East Zone - WR Type II	0	bcm per year	Clean waste
PB Pit - WR Type II	0	bcm per year	Assume all of PB is clean
Centre Zone - WR Type II	0	bcm per year	
Main Zone - WR Type II	8,266,000	bcm per year	
Andrew Lake - WR Type II	6,474,000	bcm per year	
End Grid - WR Type II	200	kt per year	
East Zone - OV	0	bcm per year	Overburden
PB Pit - OV	0	bcm per year	
Centre Zone - OV	0	bcm per year	
Main Zone - OV	0	bcm per year	
Andrew Lake - OV	0	bcm per year	
End Grid - OV	0	kt per year	
Maximum Excavated per Day - tonnes - Scenario 2			Note: values have been rounded up to either nearest 10, 100 or 1000 as applicable
East Zone - Total	0	tonnes/day	
PB Pit - Total	0	tonnes/day	
Centre Zone - Total	0	tonnes/day	
Main Zone - Total	80,733	tonnes/day	
Andrew Lake - Total	57,124	tonnes/day	
End Grid - Total	1,339	tonnes/day	
East Zone - Ore	0	tonnes/day	
PB Pit - Ore	0	tonnes/day	
Centre Zone - Ore	0	tonnes/day	
Main Zone - Ore	6,536	tonnes/day	
Andrew Lake - Ore	0	tonnes/day	
End Grid - Ore	654	tonnes/day	
East Zone - WR Type III	0	tonnes/day	Special waste
PB Pit - WR Type III	0	tonnes/day	
Centre Zone - WR Type III	0	tonnes/day	
Main Zone - WR Type III	1,262	tonnes/day	
Andrew Lake - WR Type III	0	tonnes/day	
End Grid - WR Type III	31	tonnes/day	
East Zone - WR Type II	0	tonnes/day	Clean waste
PB Pit - WR Type II	0	tonnes/day	
Centre Zone - WR Type II	0	tonnes/day	
Main Zone - WR Type II	72,935	tonnes/day	
Andrew Lake - WR Type II	57,124	tonnes/day	
End Grid - WR Type II	654	tonnes/day	
East Zone - OV	0	tonnes/day	Overburden
PB Pit - OV	0	tonnes/day	
Centre Zone - OV	0	tonnes/day	
Main Zone - OV	0	tonnes/day	
Andrew Lake - OV	0	tonnes/day	
End Grid - OV	0	tonnes/day	
Moisture Content of extracted material	3%	%	Assumption: 2.5% was used for Red Dog in Alaska; 3% was used for Mid-west in North Saskatchewan.
Moisture Content of clean fill	-	%	
Wind Speed		m/s	Average wind speeds at the Kiggavik site from CALMET
January	4.94	m/s	
February	3.45	m/s	
March	4.43	m/s	
April	4.23	m/s	
May	4.14	m/s	
June	3.50	m/s	
July	3.37	m/s	
August	3.44	m/s	
September	4.85	m/s	
October	3.99	m/s	
November	4.24	m/s	
December	5.10	m/s	
Control Efficiency	0%	%	Assumed no control for dumping of excavated material

On-site Truck Characteristics			
Variable	**Assumed Value**	**Units**	**Comments**
Waste Truck Capacity	140	tonnes	IFS, Section 6.2.1.2, Figure 6.2-3 April 2011
Ore Truck Capacity	90	tonnes	IFS, Section 6.2.1.2, Figure 6.2-3 April 2011
Ore Trailer Capacity	140	tonnes	IFS Section 6.6, April 2011. Based on CAT 785C type trucks.
Empty average waste truck vehicle weight	100	tonnes	CAT785C (equipment provided in KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, Basic)
Loaded weight of waste truck	240	tonnes	Calculated
Loaded / Empty average waste truck vehicle weight on haul road	170	tonnes	Based on 100 tonnes empty and 250 tonnes when loaded (100+250)/2=175
Empty average ore truck vehicle weight	70	tonnes	CAT777F (equipment provided in KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, Basic)
Loaded weight of ore truck	160	tonnes	Calculated
Loaded / Empty average ore truck vehicle weight on haul road	115	tonnes	Average of loaded and empty weight
Ore-trailers used between Kiggavik and Sissons			
Empty average vehicle weight	110	tonnes	Calculated
Loaded weight of vehicle	250	tonnes	IFS Section 6.6, April 2011. Based on CAT 785C type trucks.
Loaded / Empty average vehicle weight on haul road	180	tonnes	Average of loaded and empty weight
Standard tractor-trailers used on access road (from Baker Lake to Kiggavik)			
Empty average vehicle weight	20	tonnes	From Kiggavik Screening Level Assessment (SENES 2008)
Loaded weight of vehicle	60	tonnes	Information provided by AREVA October 21, 2010
Loaded / Empty average vehicle weight	40	tonnes	Average of loaded and empty weight
Underground Trucks Hauling Ore from End Grid			
Underground Trucks Capacity	45	tonnes	CAT AD45B (45-tonne underground truck)
Empty average vehicle weight	40	tonnes	CAT AD45B (45-tonne underground truck)
Loaded weight of vehicle	85	tonnes	CAT AD45B (45-tonne underground truck)
Loaded / Empty average vehicle weight on haul road	63	tonnes	Average of loaded and empty weight
Explosive trucks			
Empty average vehicle weight	13	tonnes	Peterbilt 367 (equipment provided in AREVA memo October 21, 2010)
Loaded weight of vehicle	26	tonnes	Assumed
Loaded / Empty average vehicle weight	20	tonnes	Average of loaded and empty weight
Number of trips for explosives	6	trips per day	Calculated
Yellowcake transport trucks			Aassumed same as tractor-trailers from Baker Lake to Kiggavik
Loaded / Empty average vehicle weight	60	tonnes	Information provided by AREVA October 21, 2010
Number of trips	1	trip per day	Assumed: according to 34680-2, the total annual trips required for yellowcake are 96 trips per year; also AREVA memo dated October 21, 2010 stated frequency of yellowcake transportation flights of 336 flights/year; therefore 1 trip/day should be conservative.
Vehicle Speed	70	kph	Assumed same as tractor-trailers from Baker Lake to Kiggavik
Water truck			
Loaded / Empty average vehicle weight	24	tonnes	Assumed: based on GVW 35,000 lbs for Peterbilt 348, http://www.peterbilt.com/voc348.1.aspx
Number of trips	1	trip per day	Assumed - 1 water truck; 1 trip per day

In-pit truck trips per day (one way)			
East Zone			Calculated based on quantities excavated and truck capacities above
Ore	0	trips per day	
Special Waste	0	trips per day	
Clean Waste	0	trips per day	
Overburden	0	trips per day	
Centre Zone			
Ore	0	trips per day	
Special Waste	0	trips per day	
Clean Waste	0	trips per day	
Overburden	0	trips per day	
Purpose-built Pit			
Ore	0	trips per day	
Special Waste	0	trips per day	
Clean Waste	0	trips per day	
Overburden	0	trips per day	
Main Zone			
Ore	73	trips per day	
Special Waste	9	trips per day	
Clean Waste	521	trips per day	
Overburden	0	trips per day	
Andrew Lake			
Ore	0	trips per day	
Special Waste	0	trips per day	
Clean Waste	408	trips per day	
Overburden	0	trips per day	
End Grid			
Ore	7	trips per day	
Special Waste	0	trips per day	
Clean Waste	5	trips per day	
Overburden	0	trips per day	

Period 2 (Year 2 - 5) Variables and Assumptions Spreadsheet, continued

Access Road and Haul Road

Access Road from Baker Lake to Kiggavik			
Length of road to be included in modelling	1	km	Only 1km stretch is included in the assessment of impact of access road on Kiggavik site.
Vehicle speed - All Weather Road	70	km/h	IFS Section 12.5.3.1, April 2011
Vehicle speed - Winter Road	25	km/h	IFS Section 12.5.2.6, April 2011
Traffic volume - All Weather Road	10	trips/day	IFS Section 12.5.3.1, April 2011 - All weather road must be capable of handling 3625 vehicles (plue return trips) per year
Traffic volume - Winter Road	43	trips/day	Project Description (AREVA 2008)
Access Road Modelled Scenario			
Length of road	1	km	Only modelling 1 km stretch for Scenarios and worst case.
Traffic volume	11	trips per day	IFS Section 12.5.2.6, April 2011 - the total annual trips are 3920 per year which equals an average of 11 trips per day, including fuel and dry goods, etc.
Worst Case Scenario - Vehicle speed	70	km/h	Assume the same speed as the All Weather Road
Haul Road between Kiggavik and Sissons			
Length of road	19.6	km	IFS Section 6.6, April 2011
Vehicle speed	60	km/h	IFS Section 6.6, April 2011
Traffic volume from AL ore	0	trips per day	Calculated based on total quantities of ore from Andrew Lake and capacity of ore trailers
Traffic volume from EG ore	5	trips per day	Calculated based on total quantities of ore from End Grid and capacity of ore trailers

On-Road Vehicles Tailpipe

Calculation Method: Mobile 6C

Variable	Assumed Value	Units	Comments
Trucks - g/VKT	various	g PM/VKT	Based on Mobile 6C EF's for Haul Trucks - HDDV8b Emission factors were used

Unpaved Road Emissions

Calculation Method: Unpaved Road Emissions, AP-42 5th Edition, 13.2.2, 1/95

Variable	Assumed Value	Units	Comments
On-site haul trucks (gravel roads) - Silt %	5	(%)	Assumption: used in the Kiggavik Screening Level Assessment (SENES 2008); average for Red Dog EIS was 4.61%; average for Mid West EIS was 5%
On-site haul trucks - vehicle speed	20	kph	Assumption
Control Efficiency for On-site Vehicles with Speed < 40 kph	44%	(%)	WRAP Fugitive Dust Handbook, September 2006, control efficiency due to speed limit of 25 mph which equals 40 kph
On-site haul trucks - Control Efficiency - Summer	75%	(%)	Assumed 75% control for watering road in summer when necessary
On-site haul trucks - Control Efficiency - Winter	50%	(%)	Assumed 50% control in winter due to frozen surface
number of days in a year with at least 0.254 mm of precipitation	111	(days)	From: Canadian Climate Normals Mean number of days with 0.254 mm (0.01 inch) or more of precipitation in Baker Lake

Drilling

Calculation Method: AP-42 Table 11.9-4, October 1998

Variable	Assumed Value	Units	Comments
Est. Number of Holes per Day - Open Pits	150	holes per day	Calculated based on amt. of ANFO used per week ÷ max charge weight per hole
Max Number of Holes per blast - End Grid	70	holes per blast	IFS, Section 6.4.8 Drilling and Blasting, April 2011
Amount of blasted material per day - End Grid	200	tonnes per blast	Based on 5 m by 5 m blast face with holes about 4 m deep and Golder drilling and blasting report (Golder Associates 2011)

Rock Blasting Volume Calc's

Calculation Method: AP-42 Table 13.3-1, February 1980

Variable	Assumed Value	Units	Comments
Blasting Material	Emulsion/ANFO	-	Will use either a 70/30 Emulsion/ANFO blend or 100% ANFO. No emission factors available for ANFO.
Duration of Emissions	15	minutes	Assumed contaminants from explosives detonation are emitted to atmosphere over 15 min
Open Pits			
Max Number of Blasts per Week	3	#	IFS, Section 6.2.1.4, April 2011
Max charge weight per hole	215	kg	Table 15 of Golder drilling and blasting report (Golder Associates 2011)
ANFO Explosives Powder Factor - Open Pits	0.25	kg ANFO/tonne of rock	IFS, Section 6.2.1.4, April 2011
Max amount of rock to be blasted - Open Pits	300,000	tonnes per blast	IFS, Section 6.2.1.4, April 2011
Total Amount of ANFO required per blast - Open Pits	75	tonnes per blast	Calculated
End Grid Underground Mine			
ANFO Explosives Powder Factor - End Grid	2.5	kg ANFO/tonne of rock	IFS, Section 6.2.1.4, April 2011
Amount of rock to be blasted per day - End Grid	1	tonnes per day	Calculated. Used average denisty of waste rock and ore.
Total Amount of ANFO required per blast - End Grid	0.5	tonnes per blast	Calculated
Average number of blasts per day	0	#	Calculated
Control - End Grid	50%	%	Assumed that 50% of dust will be retained in the mine due to deposition

NonRoad Equipment Tailpipe Emissions

Calculation Method: US EPA Nonroad (Excavators & Loaders)

Variable	Assumed Value	Units	Comments
Equipment hp ratings	various	hp	Actual horsepower ratings from equipment brochures, etc.
Emission Factors	various	g/hp-hr	US EPA Crankcase Emission Factors for Nonroad Engine Modeling - Compression-Ignition,EPA420-P-04-009, July 2010
Episodic (local) Diesel Fuel Sulphur Content	15	ppm	Canada-wide diesel fuel sulphur content as of 2010
Episodic (local) Diesel Fuel Sulphur Content	0.0015	%	Calculated

Grading and Dozing

Calculation Method: Western Surface Coal Mining - Bulldozing AP-42 Table 11.9-2, October 1998

Variable	Assumed Value	Units	Comments
Material Moisture Content (%)	3%	%	Assumption: 2.5% was used for Red Dog in Alaska; 3% was used for Mid West in northern Saskatchewan
Material Silt Content (%)	5%	%	Assumption: used in the Kiggavik Screening Level Assessment (SENES 2008); average for Red Dog EIS was 4.61%; average for Mid West EIS was 5%
Dozer Operating Hours per Day	20	hours per day	Assumption: Red Dog used 20 hours per day
Bulldozer Operating Frequency	40%	%	Assumption: same as Red Dog, % of time dozer operates for each operating hour
Control Efficiency based on watering	0%	%	Assumption: watering is unlikely
Mean vehicle speed for Graders	8.0	kph	Assumption: used in the Kiggavik Screening Level Assessment (SENES 2008)
Number of trips per day - Graders	1	trips per day	Assumption

Wind Erosion

Calculation Method: AWMA Air Pollution Engineering Manual, 1992, page 137

Variable	Assumed Value	Units	Comments
Maximum Height of Permanent Clean Rock Stockpiles	50	m	AREVA e-mail dated June 30, 2010. Based on total amount of material put into stockpiles.
Maximum Height of Ore and Temporary Waste Rock Stockpiles	10	m	AREVA e-mail dated June 30, 2010. Based on total amount of material put into stockpiles.
Material Silt Content (%)	5%	%	Assumption: used in the Kiggavik Screening Level Assessment (SENES 2008)

End grid Underground Mine

Calculation Method: Engineering Calculations

Variable	Assumed Value	Units	Comments
Total Air Requirement/Exhaust Flow Rate	285	m^3/s	IFS, Section 6.4.10, April 2011
Air Exhaust Diameter	5	m	IFS, Section 6.4.10, April 2011
Air Exhaust Exit Velocity	14.5	m/s	Calculated
Air Exhaust Exit Temperature	2.0	degrees C	IFS, Section 6.4.10, April 2011

Incinerator

Calculation Method: Refuse Combustion - AP-42 Chapter 2.1, October 1996

Variable	Assumed Value	Units	Comments
Quantity incinerated	109	kg/h	Based on charge rate of 1750 kg/cycle and a total cycle time of 10-hour burn plus 6-hour cool down. (Eco Waste Solutions Incinerator Model No. ECO 1.75TN 1P MS 60L Technical Specification sheet, provided as part of AREVA memo dated October 21, 2010.)
Capacity of Incinerator at Sissons vs. Kiggavik	50%	%	Assumed: the Sissons incinerator will be significantly smaller than the Kiggavik incinerator (AREVA 2010, memorandum)
Type of control equipment	none	-	

Backfill Plant

Calculation Method: Engineering Calculations

Variable	Assumed Value	Units	Comments
Backfill Aggregate Quantity	122,000	tonnes per year	from "AnnualSched_Apr2011" tab
Backfill Aggregate Quantity	399	tonnes per day	Calculated
Backfill Aggregate Transfer - Number of Trips from Kiggavik	3	trips per day	Assuming aggregate is preferentially transferred from Kiggavik using ore trailer trucks as per Section 6.4.6 of the IFS, April 2011
Backfill Aggregate Transfer - Number of Trips from End Grid	0	trips per day	According to IFS, Section 6.4.6, End Grid only provides a fraction of aggregate, therefore, it was assumed that main sources is Kiggavik clean rock.
Backfill Cement Quantity	4,300	tonnes per year	from "AnnualSched_Apr2011" tab
Backfill Cement Quantity	14	tonnes per day	Calculated
Max plant capacity	60	tonnes per hour	IFS, Section 6.4.6, April 2011

Ore Crushing and Grinding

Calculation Method: MOE Procedure Document Table C-2, Approximating Particulate Emissions from Baghouses

Variable	Assumed Value	Units	Comments
	-		Assumed a similar design to McClean - use stack testing to scale emissions based on U

Acid Plant

Calculation Method: Engineering Calculations

Variable	Assumed Value	Units	Comments
Maximum Daily Production	350	tonnes H_2SO_4 per day	IFS, Section 8.4.11.1, April 2011. Peak daily production capacity is 310t/day, but used 350 t per day to be conservative.
SO_2 Emission Factor	75	g per tonne of H_2SO_4	IFS, Section 8.4.11.1, April 2011. Based on acid plant design.

Mill

Calculation Method: Engineering Calculations

Variable	Assumed Value	Units	Comments
Mill feed	1,000	kt ore per year	from "AnnualSched_Apr2011" tab
U Grade	48.734%	%	from "AnnualSched_Apr2011" tab
Plant availability	85%	%	from KiggavikProject_HLDC_June30_ToSENES_RevAug11.xls
Mill feed per day	3223	tonnes ore per day	Calculated based on plant availability and operating 365 days per year
Ore Stockpile	500	Kt ore	from "AnnualSched_Apr2011" tab
Tonnes U produced	3,400	T U per year	from "AnnualSched_Apr2011" tab
Hourly Uranium Production	457	kg U/hour	Calculated based on plant availability and operating 24 hours per day
Max theoretical U production	4,000	T U per year	AREVA e-mail dated May 20, 2011
Max Hourly Uranium Production	537	kg U/hour	Calculated based on plant availability and operating 24 hours per day

Power Plant

Calculation Method: Engineering Calculations

Variable	Assumed Value	Units	Comments
Kiggavik			
Max number of generators operating simultaneously	4	#	IFS, Section 11.1.1, Table 11.1-1, April 2011
Unit Capacity	4190	kW	IFS, Section 11.1.1, Table 11.1-1, April 2011
Annual power consumption	155,000,000	kWh/year	SupplementalData_Kissavik&SissonsLayouts_ToSenes_Nov3.pdf page 3
Sissons			
Max number of generators operating simultaneously	1	#	According to the IFS Section 11.1.1, there will be 3 small 1450 kW units at Sissons; however, one large 4190 kW unit was considered to simplify modelling.
Unit Capacity	4190	kW	
Annual Power consumption at Sissons	23,000,000	kWh/year	SupplementalData_Kissavik&SissonsLayouts_ToSenes_Nov3.pdf page 3
Episodic (local) Diesel Fuel Sulphur Content	15	ppm	Assume using same diesel fuel for power plant as vehicles. Canada-wide diesel fuel sulphur content as of 2010
Episodic (local) Diesel Fuel Sulphur Content	0.0015	%	Calculated
Diesel High Heating Value	19,300	Btu/lb	AP-42 Chapter 3.3 - Gasoline and Diesel Industrial Engines (10/96), Table 3.3-1

Period 3 (Year 6 - 13) Variables and Assumptions Spreadsheet

Summary of Variables Used for Emission Estimates on Worksheets			340680 Kiggavik
Month	December	Note: enter full name of month	
"Daily" or "Annual" Multiplier Used?	Daily		
Material Handling	Calculation Method: Drop Equation AP-42 13.2.4, November 2006		
Variable	**Assumed Value**	**Units**	**Comments**
Operation days per month - January to March	12	days per month	KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, Basic
Operation days per month - April to December	30	days per month	KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, Basic
Operation days per year	306	days per year	Calculated
Operation hours per day	24	hours per day	Assumption
Conversion factor bcm to tonnes - waste rock	2.7	tonnes/bcm	KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, SenesRequest3
Conversion factor bcm to tonnes - overburden	1.65	tonnes/bcm	Midpoint of dry bulk density as outlined in the IFS rounded to 1.65
Conversion factor bcm to tonnes - ore - East Zone	2.36	tonnes/bcm	KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, SenesRequest3
Conversion factor bcm to tonnes - ore - Centre Zone	2.36	tonnes/bcm	KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, SenesRequest3
Conversion factor bcm to tonnes - ore - Main Zone	2.40	tonnes/bcm	KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, SenesRequest3
Conversion factor bcm to tonnes - ore - Andrew Lake	2.35	tonnes/bcm	KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, SenesRequest3
Conversion factor bcm to tonnes - ore - End Grid	2.40	tonnes/bcm	KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, SenesRequest3
Variable	**Assumed Value**	**Units**	**Comments**
Maximum Excavated per Year - Scenario 3			from "AnnualSched_Apr2011" tab
East Zone - Total	0	bcm per year	Note: rock types will not add up to total due to rounding
PB Pit - Total	0	bcm per year	
Centre Zone - Total	0	bcm per year	
Main Zone - Total	0	bcm per year	
Andrew Lake - Total	10,212,000	bcm per year	
End Grid - Total	164,000	bcm per year	
East Zone - Ore	0	kt per year	
PB Pit - Ore	0	kt per year	
Centre Zone - Ore	0	kt per year	
Main Zone - Ore	0	kt per year	
Andrew Lake - Ore	200	kt per year	
End Grid - Ore	400	kt per year	
East Zone - WR Type III	0	bcm per year	Special waste
PB Pit - WR Type III	0	bcm per year	
Centre Zone - WR Type III	0	bcm per year	
Main Zone - WR Type III	0	bcm per year	
Andrew Lake - WR Type III	28,200	bcm per year	
End Grid - WR Type III	20	kt per year	
East Zone - WR Type II	0	bcm per year	Clean waste
PB Pit - WR Type II	0	bcm per year	Assume all of PB is clean
Centre Zone - WR Type II	0	bcm per year	
Main Zone - WR Type II	0	bcm per year	
Andrew Lake - WR Type II	10,126,000	bcm per year	
End Grid - WR Type II	40	kt per year	
East Zone - OV	0	bcm per year	Overburden
PB Pit - OV	0	bcm per year	
Centre Zone - OV	0	bcm per year	
Main Zone - OV	0	bcm per year	
Andrew Lake - OV	0	bcm per year	
End Grid - OV	0	kt per year	
Maximum Excavated per Day - tonnes - Scenario 3			Note: values have been rounded up to either nearest 10, 100 or 1000 as applicable
East Zone - Total	0	tonnes/day	
PB Pit - Total	0	tonnes/day	
Centre Zone - Total	0	tonnes/day	
Main Zone - Total	0	tonnes/day	
Andrew Lake - Total	90,249	tonnes/day	
End Grid - Total	1,503	tonnes/day	
East Zone - Ore	0	tonnes/day	
PB Pit - Ore	0	tonnes/day	
Centre Zone - Ore	0	tonnes/day	
Main Zone - Ore	0	tonnes/day	
Andrew Lake - Ore	654	tonnes/day	
End Grid - Ore	1,307	tonnes/day	
East Zone - WR Type III	0	tonnes/day	Special waste
PB Pit - WR Type III	0	tonnes/day	
Centre Zone - WR Type III	0	tonnes/day	
Main Zone - WR Type III	0	tonnes/day	
Andrew Lake - WR Type III	249	tonnes/day	
End Grid - WR Type III	65	tonnes/day	
East Zone - WR Type II	0	tonnes/day	Clean waste
PB Pit - WR Type II	0	tonnes/day	
Centre Zone - WR Type II	0	tonnes/day	
Main Zone - WR Type II	0	tonnes/day	
Andrew Lake - WR Type II	89,347	tonnes/day	
End Grid - WR Type II	131	tonnes/day	
East Zone - OV	0	tonnes/day	Overburden
PB Pit - OV	0	tonnes/day	
Centre Zone - OV	0	tonnes/day	
Main Zone - OV	0	tonnes/day	
Andrew Lake - OV	0	tonnes/day	
End Grid - OV	0	tonnes/day	
Moisture Content of extracted material	3%	%	Assumption: 2.5% was used for Red Dog in Alaska; 3% was used for Mid-west in North
Moisture Content of clean fill	-	%	
Wind Speed		m/s	Average wind speeds at the Kiggavik site from CALMET
January	4.94	m/s	
February	3.45	m/s	
March	4.43	m/s	
April	4.23	m/s	
May	4.14	m/s	
June	3.50	m/s	
July	3.37	m/s	
August	3.44	m/s	
September	4.85	m/s	
October	3.99	m/s	
November	4.24	m/s	
December	5.10	m/s	
Control Efficiency	0%	%	Assumed no control for dumping of excavated material

On-site Truck Characteristics			
Variable	**Assumed Value**	**Units**	**Comments**
Waste Truck Capacity	140	tonnes	IFS, Section 6.2.1.2, Figure 6.2-3 April 2011
Ore Truck Capacity	90	tonnes	IFS, Section 6.2.1.2, Figure 6.2-3 April 2011
Ore Trailer Capacity	140	tonnes	IFS Section 6.6, April 2011. Based on CAT 785C type trucks.
Empty average waste truck vehicle weight	100	tonnes	CAT785C (equipment provided in KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, Basic
Loaded weight of waste truck	240	tonnes	Calculated
Loaded / Empty average waste truck vehicle weight on haul road	170	tonnes	Based on 100 tonnes empty and 250 tonnes when loaded (100+250)/2=175
Empty average ore truck vehicle weight	70	tonnes	CAT777F (equipment provided in KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, Basic
Loaded weight of ore truck	160	tonnes	Calculated
Loaded / Empty average ore truck vehicle weight on haul road	115	tonnes	Average of loaded and empty weight
Ore-trailers used between Kiggavik and Sissons			
Empty average vehicle weight	110	tonnes	Calculated
Loaded weight of vehicle	250	tonnes	IFS Section 6.6, April 2011. Based on CAT 785C type trucks.
Loaded / Empty average vehicle weight on haul road	180	tonnes	Average of loaded and empty weight
Standard tractor-trailers used on access road (from Baker Lake to Kiggavik)			
Empty average vehicle weight	20	tonnes	From Kiggavik Screening Level Assessment (SENES 2008)
Loaded weight of vehicle	60	tonnes	Information provided by AREVA October 21, 2010
Loaded / Empty average vehicle weight	40	tonnes	Average of loaded and empty weight
Underground Trucks Hauling Ore from End Grid			
Underground Trucks Capacity	45	tonnes	CAT AD45B (45-tonne underground truck)
Empty average vehicle weight	40	tonnes	CAT AD45B (45-tonne underground truck)
Loaded weight of vehicle	85	tonnes	CAT AD45B (45-tonne underground truck)
Loaded / Empty average vehicle weight on haul road	63	tonnes	Average of loaded and empty weight
Explosive trucks			
Empty average vehicle weight	13	tonnes	Peterbilt 367 (equipment provided in AREVA memo October 21, 2010)
Loaded weight of vehicle	26	tonnes	Assumed
Loaded / Empty average vehicle weight	20	tonnes	Average of loaded and empty weight
Number of trips for explosives	6	trips per day	Calculated
Yellowcake transport trucks			Aassumed same as tractor-trailers from Baker Lake to Kiggavik
Loaded / Empty average vehicle weight	60	tonnes	Information provided by AREVA October 21, 2010
Number of trips	1	trip per day	Assumed: according to 34680-2, the total annual trips required for yellowcake are 96 trips per year; also AREVA memo dated October 21, 2010 stated frequency of yellowcake transportation flights of 336 flights/year; therefore 1 trip/day should be conservative.
Vehicle Speed	70	kph	Assumed same as tractor-trailers from Baker Lake to Kiggavik
Water truck			
Loaded / Empty average vehicle weight	24	tonnes	Assumed: based on GVW 35,000 lbs for Peterbilt 348, http://www.peterbilt.com/voc348.1.aspx
Number of trips	1	trip per day	Assumed - 1 water truck; 1 trip per day

In-pit truck trips per day (one way)			
East Zone			Calculated based on quantities excavated and truck capacities above
Ore	0	trips per day	
Special Waste	0	trips per day	
Clean Waste	0	trips per day	
Overburden	0	trips per day	
Centre Zone			
Ore	0	trips per day	
Special Waste	0	trips per day	
Clean Waste	0	trips per day	
Overburden	0	trips per day	
Purpose-built Pit			
Ore	0	trips per day	
Special Waste	0	trips per day	
Clean Waste	0	trips per day	
Overburden	0	trips per day	
Main Zone			
Ore	0	trips per day	
Special Waste	0	trips per day	
Clean Waste	0	trips per day	
Overburden	0	trips per day	
Andrew Lake			
Ore	7	trips per day	
Special Waste	2	trips per day	
Clean Waste	638	trips per day	
Overburden	0	trips per day	
End Grid			
Ore	15	trips per day	
Special Waste	0	trips per day	
Clean Waste	1	trips per day	
Overburden	0	trips per day	

Period 3 (Year 6 - 13) Variables and Assumptions Spreadsheet, continued

Access Road and Haul Road

Access Road from Baker Lake to Kiggavik			
Length of road to be included in modelling	1	km	Only 1km stretch is included in the assessment of impact of access road on Kiggavik site.
Vehicle speed - All Weather Road	70	km/h	IFS Section 12.5.3.1, April 2011
Vehicle speed - Winter Road	25	km/h	IFS Section 12.5.2.6, April 2011
Traffic volume - All Weather Road	10	trips/day	IFS Section 12.5.3.1, April 2011 - All weather road must be capable of handling 3625 vehicles (plue return trips) per year
Traffic volume - Winter Road	43	trips/day	Project Description (AREVA 2008)
Access Road Modelled Scenario			
Length of road	1	km	Only modelling 1 km stretch for Scenarios and worst case.
Traffic volume	11	trips per day	IFS Section 12.5.2.6, April 2011 - the total annual trips are 3920 per year which equals an average of 11 trips per day, including fuel and dry goods, etc.
Worst Case Scenario - Vehicle speed	70	km/h	Assume the same speed as the All Weather Road
Haul Road between Kiggavik and Sissons			
Length of road	19.6	km	IFS Section 6.6, April 2011
Vehicle speed	60	km/h	IFS Section 6.6, April 2011
Traffic volume from AL ore	5	trips per day	Calculated based on total quantities of ore from Andrew Lake and capacity of ore trailers
Traffic volume from EG ore	9	trips per day	Calculated based on total quantities of ore from End Grid and capacity of ore trailers

On-Road Vehicles Tailpipe — Calculation Method: Mobile 6C

Variable	Assumed Value	Units	Comments
Trucks - g/VKT	various	g PM/VKT	Based on Mobile 6C EF's for Haul Trucks - HDDV8b Emission factors were used

Unpaved Road Emissions — Calculation Method: Unpaved Road Emissions, AP-42 5th Edition, 13.2.2, 1/95

Variable	Assumed Value	Units	Comments
On-site haul trucks (gravel roads) - Silt %	5	(%)	Assumption: used in the Kiggavik Screening Level Assessment (SENES 2008); average for Red
On-site haul trucks - vehicle speed	20	kph	Assumption
Control Efficiency for On-site Vehicles with Speed < 40 kph	44%	(%)	WRAP Fugitive Dust Handbook, September 2006, control efficiency due to speed limit of 25
On-site haul trucks - Control Efficiency - Summer	75%	(%)	Assumed 75% control for watering road in summer when necessary
On-site haul trucks - Control Efficiency - Winter	50%	(%)	Assumed 50% control in winter due to frozen surface
number of days in a year with at least 0.254 mm of precipitation	111	(days)	From: Canadian Climate Normals Mean number of days with 0.254 mm (0.01 inch) or more of precipitation in Baker Lake

Drilling — Calculation Method: AP-42 Table 11.9-4, October 1998

Variable	Assumed Value	Units	Comments
Est. Number of Holes per Day - Open Pits	150	holes per day	Calculated based on amt. of ANFO used per week ÷ max charge weight per hole
Max Number of Holes per blast - End Grid	70	holes per blast	IFS, Section 6.4.8 Drilling and Blasting, April 2011
Amount of blasted material per day - End Grid	200	tonnes per blast	Based on 5 m by 5 m blast face with holes about 4 m deep and Golder drilling and blasting report (Golder Associates 2011)

Rock Blasting Volume Calc's — Calculation Method: AP-42 Table 13.3-1, February 1980

Variable	Assumed Value	Units	Comments
Blasting Material	Emulsion/ANFO	-	Will use either a 70/30 Emulsion/ANFO blend or 100% ANFO. No emission factors available for ANFO.
Duration of Emissions	15	minutes	Assumed contaminants from explosives detonation are emitted to atmosphere over 15 min
Open Pits			
Max Number of Blasts per Week	3	#	IFS, Section 6.2.1.4, April 2011
Max charge weight per hole	215	kg	Table 15 of Golder drilling and blasting report (Golder Associates 2011)
ANFO Explosives Powder Factor - Open Pits	0.25	kg ANFO/tonne of rock	IFS, Section 6.2.1.4, April 2011
Max amount of rock to be blasted - Open Pits	300,000	tonnes per blast	IFS, Section 6.2.1.4, April 2011
Total Amount of ANFO required per blast - Open Pits	75	tonnes per blast	Calculated
End Grid Underground Mine			
ANFO Explosives Powder Factor - End Grid	2.5	kg ANFO/tonne of rock	IFS, Section 6.2.1.4, April 2011
Amount of rock to be blasted per day - End Grid	1,503	tonnes per day	Calculated. Used average denisty of waste rock and ore.
Total Amount of ANFO required per blast - End Grid	0.5	tonnes per blast	Calculated
Average number of blasts per day	8	#	Calculated
Control - End Grid	50%	%	Assumed that 50% of dust will be retained in the mine due to deposition

NonRoad Equipment Tailpipe Emissions — Calculation Method: US EPA Nonroad (Excavators & Loaders)

Variable	Assumed Value	Units	Comments
Equipment hp ratings	various	hp	Actual horsepower ratings from equipment brochures, etc.
Excavators and Loaders - g/hp-hr	various	g/hp-hr	US EPA Crankcase Emission Factors for Nonroad Engine Modeling - Compression-
Episodic (local) Diesel Fuel Sulphur Content	15	ppm	Canada-wide diesel fuel sulphur content as of 2010
Episodic (local) Diesel Fuel Sulphur Content	0.0015	%	Calculated

Grading and Dozing — Calculation Method: Western Surface Coal Mining - Bulldozing AP-42 Table 11.9-2, October 1998

Variable	Assumed Value	Units	Comments
Material Moisture Content (%)	3%	%	Assumption: 2.5% was used for Red Dog in Alaska; 3% was used for Mid West in northern
Material Silt Content (%)	5%	%	Assumption: used in the Kiggavik Screening Level Assessment (SENES 2008); average for Red
Dozer Operating Hours per Day	20	hours per day	Assumption: Red Dog used 20 hours per day
Bulldozer Operating Frequency	40%	%	Assumption: same as Red Dog, % of time dozer operates for each operating hour
Control Efficiency based on watering	0%	%	Assumption: watering is unlikely
Mean vehicle speed for Graders	8.0	kph	Assumption: used in the Kiggavik Screening Level Assessment (SENES 2008)
Number of trips per day - Graders	1	trips per day	Assumption

Wind Erosion — Calculation Method: AWMA Air Pollution Engineering Manual, 1992, page 137

Variable	Assumed Value	Units	Comments
Maximum Height of Permanent Clean Rock Stockpiles	50	m	AREVA e-mail dated June 30, 2010. Based on total amount of material put into stockpiles.
Maximum Height of Ore and Temporary Waste Rock Stockpiles	10	m	AREVA e-mail dated June 30, 2010. Based on total amount of material put into stockpiles.
Material Silt Content (%)	5%	%	Assumption: used in the Kiggavik Screening Level Assessment (SENES 2008)

End grid Underground Mine — Calculation Method: Engineering Calculations

Variable	Assumed Value	Units	Comments
Total Air Requirement/Exhaust Flow Rate	285	m^3/s	IFS, Section 6.4.10, April 2011
Air Exhaust Diameter	5	m	IFS, Section 6.4.10, April 2011
Air Exhaust Exit Velocity	14.5	m/s	Calculated
Air Exhaust Exit Temperature	2.0	degrees C	IFS, Section 6.4.10, April 2011

Incinerator — Calculation Method: Refuse Combustion - AP-42 Chapter 2.1, October 1996

Variable	Assumed Value	Units	Comments
Quantity incinerated	109	kg/h	Based on charge rate of 1750 kg/cycle and a total cycle time of 10-hour burn plus 6-hour cool down. (Eco Waste Solutions Incinerator Model No. ECO 1.75TN 1P MS 60L Technical Specification sheet, provided as part of AREVA memo dated October 21, 2010.)
Capacity of Incinerator at Sissons vs. Kiggavik	50%	%	Assumed: the Sissons incinerator will be significantly smaller than the Kiggavik incinerator (AREVA 2010, memorandum)
Type of control equipment	none	-	

Backfill Plant — Calculation Method: Engineering Calculations

Variable	Assumed Value	Units	Comments
Backfill Aggregate Quantity	241,000	tonnes per year	from "AnnualSched_Apr2011" tab
Backfill Aggregate Quantity	788	tonnes per day	Calculated
Backfill Aggregate Transfer - Number of Trips from Kiggavik	6	trips per day	Assuming aggregate is preferentially transferred from Kiggavik using ore trailer trucks as per
Backfill Aggregate Transfer - Number of Trips from End Grid	0	trips per day	According to IFS, Section 6.4.6, End Grid only provides a fraction of aggregate, therefore, it was assumed that main sources is Kiggavik clean rock.
Backfill Cement Quantity	8,500	tonnes per year	from "AnnualSched_Apr2011" tab
Backfill Cement Quantity	28	tonnes per day	Calculated
Max plant capacity	60	tonnes per hour	IFS, Section 6.4.6, April 2011

Ore Crushing and Grinding — Calculation Method: MOE Procedure Document Table C-2, Approximating Particulate Emissions from Baghouses

Variable	Assumed Value	Units	Comments
	-		Assumed a similar design to McClean - use stack testing to scale emissions based on U

Acid Plant — Calculation Method: Engineering Calculations

Variable	Assumed Value	Units	Comments
Maximum Daily Production	350	tonnes H_2SO_4 per day	IFS, Section 8.4.11.1, April 2011. Peak daily production capacity is 310t/day, but used 350 t per day to be conservative.
SO_2 Emission Factor	75	g per tonne of H_2SO_4	IFS, Section 8.4.11.1, April 2011. Based on acid plant design.

Mill — Calculation Method: Engineering Calculations

Variable	Assumed Value	Units	Comments
Mill feed	900	kt ore per year	from "AnnualSched_Apr2011" tab
U Grade	0.474%	%	from "AnnualSched_Apr2011" tab
Plant availability	85%	%	from KiggavikProject_HLDC_June30_ToSENES_RevAug11.xls
Mill feed per day	2901	tonnes ore per day	Calculated based on plant availability and operating 365 days per year
Ore Stockpile	600	Kt ore	from "AnnualSched_Apr2011" tab
Tonnes U produced	3,800	T U per year	from "AnnualSched_Apr2011" tab
Hourly Uranium Production	510	kg U/hour	Calculated based on plant availability and operating 24 hours per day
Max theoretical U production	4,000	T U per year	AREVA e-mail dated May 20, 2011
Max Hourly Uranium Production	537	kg U/hour	Calculated based on plant availability and operating 24 hours per day

Power Plant — Calculation Method: Engineering Calculations

Variable	Assumed Value	Units	Comments
Kiggavik			
Max number of generators operating simultaneously	4	#	IFS, Section 11.1.1, Table 11.1-1, April 2011
Unit Capacity	4190	kW	IFS, Section 11.1.1, Table 11.1-1, April 2011
Annual power consumption	155,000,000	kWh/year	SupplementalData_Kissavik&SissonsLayouts_ToSenes_Nov3.pdf page 3
Sissons			
Max number of generators operating simultaneously	1	#	According to the IFS Section 11.1.1, there will be 3 small 1450 kW units at Sissons; however, one large 4190 kW unit was considered to simplify modelling.
Unit Capacity	4190	kW	
Annual Power consumption at Sissons	23,000,000	kWh/year	SupplementalData_Kissavik&SissonsLayouts_ToSenes_Nov3.pdf page 3
Episodic (local) Diesel Fuel Sulphur Content	15	ppm	Assume using same diesel fuel for power plant as vehicles. Canada-wide diesel fuel sulphur content as of 2010
Episodic (local) Diesel Fuel Sulphur Content	0.0015	%	Calculated
Diesel High Heating Value	19,300	Btu/lb	AP-42 Chapter 3.3 - Gasoline and Diesel Industrial Engines (10/96), Table 3.3-1

Period 4 (Year 14) Variables and Assumptions Spreadsheet

Summary of Variables Used for Emission Estimates on Worksheets			340680 Kiggavik
Month	December	Note: enter full name of month	
"Daily" or "Annual" Multiplier Used?	Daily		
Material Handling	Calculation Method: Drop Equation AP-42 13.2.4, November 2006		
Variable	**Assumed Value**	**Units**	**Comments**
Operation days per month - January to March	12	days per month	KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, Basic
Operation days per month - April to December	30	days per month	KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, Basic
Operation days per year	306	days per year	Calculated
Operation hours per day	24	hours per day	Assumption
Conversion factor bcm to tonnes - waste rock	2.7	tonnes/bcm	KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, SenesRequest3
Conversion factor bcm to tonnes - overburden	1.65	tonnes/bcm	Midpoint of dry bulk density as outlined in the IFS rounded to 1.65
Conversion factor bcm to tonnes - ore - East Zone	2.36	tonnes/bcm	KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, SenesRequest3
Conversion factor bcm to tonnes - ore - Centre Zone	2.36	tonnes/bcm	KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, SenesRequest3
Conversion factor bcm to tonnes - ore - Main Zone	2.40	tonnes/bcm	KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, SenesRequest3
Conversion factor bcm to tonnes - ore - Andrew Lake	2.35	tonnes/bcm	KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, SenesRequest3
Conversion factor bcm to tonnes - ore - End Grid	2.40	tonnes/bcm	KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, SenesRequest3
Variable	**Assumed Value**	**Units**	**Comments**
Maximum Excavated per Year - Scenario 4			from "AnnualSched_Apr2011" tab
East Zone - Total	0	bcm per year	Note: rock types will not add up to total due to rounding
PB Pit - Total	0	bcm per year	
Centre Zone - Total	0	bcm per year	
Main Zone - Total	0	bcm per year	
Andrew Lake - Total	0	bcm per year	
End Grid - Total	0	bcm per year	
East Zone - Ore	0	kt per year	
PB Pit - Ore	0	kt per year	
Centre Zone - Ore	0	kt per year	
Main Zone - Ore	0	kt per year	
Andrew Lake - Ore	0	kt per year	
End Grid - Ore	0	kt per year	
East Zone - WR Type III	0	bcm per year	Special waste
PB Pit - WR Type III	0	bcm per year	
Centre Zone - WR Type III	0	bcm per year	
Main Zone - WR Type III	0	bcm per year	
Andrew Lake - WR Type III	0	bcm per year	
End Grid - WR Type III	0	kt per year	
East Zone - WR Type II	0	bcm per year	Clean waste
PB Pit - WR Type II	0	bcm per year	Assume all of PB is clean
Centre Zone - WR Type II	0	bcm per year	
Main Zone - WR Type II	0	bcm per year	
Andrew Lake - WR Type II	0	bcm per year	
End Grid - WR Type II	0	kt per year	
East Zone - OV	0	bcm per year	Overburden
PB Pit - OV	0	bcm per year	
Centre Zone - OV	0	bcm per year	
Main Zone - OV	0	bcm per year	
Andrew Lake - OV	0	bcm per year	
End Grid - OV	0	kt per year	
Maximum Excavated per Day - tonnes - Scenario 4			Note: values have been rounded up to either nearest 10, 100 or 1000 as applicable
East Zone - Total	0	tonnes/day	
PB Pit - Total	0	tonnes/day	
Centre Zone - Total	0	tonnes/day	
Main Zone - Total	0	tonnes/day	
Andrew Lake - Total	0	tonnes/day	
End Grid - Total	0	tonnes/day	
East Zone - Ore	0	tonnes/day	
PB Pit - Ore	0	tonnes/day	
Centre Zone - Ore	0	tonnes/day	
Main Zone - Ore	0	tonnes/day	
Andrew Lake - Ore	0	tonnes/day	
End Grid - Ore	0	tonnes/day	
East Zone - WR Type III	0	tonnes/day	Special waste
PB Pit - WR Type III	0	tonnes/day	
Centre Zone - WR Type III	0	tonnes/day	
Main Zone - WR Type III	0	tonnes/day	
Andrew Lake - WR Type III	0	tonnes/day	
End Grid - WR Type III	0	tonnes/day	
East Zone - WR Type II	0	tonnes/day	Clean waste
PB Pit - WR Type II	0	tonnes/day	
Centre Zone - WR Type II	0	tonnes/day	
Main Zone - WR Type II	0	tonnes/day	
Andrew Lake - WR Type II	0	tonnes/day	
End Grid - WR Type II	0	tonnes/day	
East Zone - OV	0	tonnes/day	Overburden
PB Pit - OV	0	tonnes/day	
Centre Zone - OV	0	tonnes/day	
Main Zone - OV	0	tonnes/day	
Andrew Lake - OV	0	tonnes/day	
End Grid - OV	0	tonnes/day	
Moisture Content of extracted material	3%	%	Assumption: 2.5% was used for Red Dog in Alaska; 3% was used for Mid-west in North
Moisture Content of clean fill	-	%	
Wind Speed		m/s	Average wind speeds at the Kiggavik site from CALMET
January	4.94	m/s	
February	3.45	m/s	
March	4.43	m/s	
April	4.23	m/s	
May	4.14	m/s	
June	3.50	m/s	
July	3.37	m/s	
August	3.44	m/s	
September	4.85	m/s	
October	3.99	m/s	
November	4.24	m/s	
December	5.10	m/s	
Control Efficiency	0%	%	Assumed no control for dumping of excavated material
On-site Truck Characteristics			
Variable	**Assumed Value**	**Units**	**Comments**
Waste Truck Capacity	140	tonnes	IFS, Section 6.2.1.2, Figure 6.2-3 April 2011
Ore Truck Capacity	90	tonnes	IFS, Section 6.2.1.2, Figure 6.2-3 April 2011
Ore Trailer Capacity	140	tonnes	IFS Section 6.6, April 2011. Based on CAT 785C type trucks.
Empty average waste truck vehicle weight	100	tonnes	CAT785C (equipment provided in KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, Basic
Loaded weight of waste truck	240	tonnes	Calculated
Loaded / Empty average waste truck vehicle weight on haul road	170	tonnes	Based on 100 tonnes empty and 250 tonnes when loaded (100+250)/2=175
Empty average ore truck vehicle weight	70	tonnes	CAT777F (equipment provided in KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, Basic
Loaded weight of ore truck	160	tonnes	Calculated
Loaded / Empty average ore truck vehicle weight on haul road	115	tonnes	Average of loaded and empty weight
Ore-trailers used between Kiggavik and Sissons			
Empty average vehicle weight	110	tonnes	Calculated
Loaded weight of vehicle	250	tonnes	IFS Section 6.6, April 2011. Based on CAT 785C type trucks.
Loaded / Empty average vehicle weight on haul road	180	tonnes	Average of loaded and empty weight
Standard tractor-trailers used on access road (from Baker Lake to Kiggavik)			
Empty average vehicle weight	20	tonnes	From Kiggavik Screening Level Assessment (SENES 2008)
Loaded weight of vehicle	60	tonnes	Information provided by AREVA October 21, 2010
Loaded / Empty average vehicle weight	40	tonnes	Average of loaded and empty weight
Underground Trucks Hauling Ore from End Grid			
Underground Trucks Capacity	45	tonnes	CAT AD45B (45-tonne underground truck)
Empty average vehicle weight	40	tonnes	CAT AD45B (45-tonne underground truck)
Loaded weight of vehicle	85	tonnes	CAT AD45B (45-tonne underground truck)
Loaded / Empty average vehicle weight on haul road	63	tonnes	Average of loaded and empty weight
Explosive trucks			
Empty average vehicle weight	13	tonnes	Peterbilt 367 (equipment provided in AREVA memo October 21, 2010)
Loaded weight of vehicle	26	tonnes	Assumed
Loaded / Empty average vehicle weight	20	tonnes	Average of loaded and empty weight
Number of trips for explosives	6	trips per day	Calculated
Yellowcake transport trucks			Aassumed same as tractor-trailers from Baker Lake to Kiggavik
Loaded / Empty average vehicle weight	60	tonnes	Information provided by AREVA October 21, 2010
Number of trips	1	trip per day	Assumed: according to 34680-2, the total annual trips required for yellowcake are 96 trips per year; also AREVA memo dated October 21, 2010 stated frequency of yellowcake transportation flights of 336 flights/year; therefore 1 trip/day should be conservative.
Vehicle Speed	70	kph	Assumed same as tractor-trailers from Baker Lake to Kiggavik
Water truck			
Loaded / Empty average vehicle weight	24	tonnes	Assumed: based on GVW 35,000 lbs for Peterbilt 348, http://www.peterbilt.com/voc348.1.aspx
Number of trips	1	trip per day	Assumed - 1 water truck; 1 trip per day
In-pit truck trips per day (one way)			
East Zone			Calculated based on quantities excavated and truck capacities above
Ore	0	trips per day	
Special Waste	0	trips per day	
Clean Waste	0	trips per day	
Overburden	0	trips per day	
Centre Zone			
Ore	0	trips per day	
Special Waste	0	trips per day	
Clean Waste	0	trips per day	
Overburden	0	trips per day	
Purpose-built Pit			
Ore	0	trips per day	
Special Waste	0	trips per day	
Clean Waste	0	trips per day	
Overburden	0	trips per day	
Main Zone			
Ore	0	trips per day	
Special Waste	0	trips per day	
Clean Waste	0	trips per day	
Overburden	0	trips per day	
Andrew Lake			
Ore	0	trips per day	
Special Waste	0	trips per day	
Clean Waste	0	trips per day	
Overburden	0	trips per day	
End Grid			
Ore	0	trips per day	
Special Waste	0	trips per day	
Clean Waste	0	trips per day	
Overburden	0	trips per day	

Period 4 (Year 14) Variables and Assumptions Spreadsheet, continued

Access Road and Haul Road

Variable	Assumed Value	Units	Comments
Access Road from Baker Lake to Kiggavik			
Length of road to be included in modelling	1	km	Only 1km stretch is included in the assessment of impact of access road on Kiggavik site.
Vehicle speed - All Weather Road	70	km/h	IFS Section 12.5.3.1, April 2011
Vehicle speed - Winter Road	25	km/h	IFS Section 12.5.2.6, April 2011
Traffic volume - All Weather Road	10	trips/day	IFS Section 12.5.3.1, April 2011 - All weather road must be capable of handling 3625 vehicles (plue return trips) per year
Traffic volume - Winter Road	43	trips/day	Project Description (AREVA 2008)
Access Road Modelled Scenario			
Length of road	1	km	Only modelling 1 km stretch for Scenarios and worst case.
Traffic volume	11	trips per day	IFS Section 12.5.2.6, April 2011 - the total annual trips are 3920 per year which equals an average of 11 trips per day, including fuel and dry goods, etc.
Worst Case Scenario - Vehicle speed	70	km/h	Assume the same speed as the All Weather Road
Haul Road between Kiggavik and Sissons			
Length of road	19.6	km	IFS Section 6.6, April 2011
Vehicle speed	60	km/h	IFS Section 6.6, April 2011
Traffic volume from AL ore	0	trips per day	Calculated based on total quantities of ore from Andrew Lake and capacity of ore trailers
Traffic volume from EG ore	0	trips per day	Calculated based on total quantities of ore from End Grid and capacity of ore trailers

On-Road Vehicles Tailpipe — Calculation Method: Mobile 6C

Variable	Assumed Value	Units	Comments
Trucks - g/VKT	various	g PM/VKT	Based on Mobile 6C EF's for Haul Trucks - HDDV8b Emission factors were used

Unpaved Road Emissions — Calculation Method: Unpaved Road Emissions, AP-42 5th Edition, 13.2.2, 1/95

Variable	Assumed Value	Units	Comments
On-site haul trucks (gravel roads) - Silt %	5	(%)	Assumption: used in the Kiggavik Screening Level Assessment (SENES 2008); average for Red
On-site haul trucks - vehicle speed	20	kph	Assumption
Control Efficiency for On-site Vehicles with Speed < 40 kph	44%	(%)	WRAP Fugitive Dust Handbook, September 2006, control efficiency due to speed limit of 25
On-site haul trucks - Control Efficiency - Summer	75%	(%)	Assumed 75% control for watering road in summer when necessary
On-site haul trucks - Control Efficiency - Winter	50%	(%)	Assumed 50% control in winter due to frozen surface
number of days in a year with at least 0.254 mm of precipitation	111	(days)	From: Canadian Climate Normals Mean number of days with 0.254 mm (0.01 inch) or more of precipitation in Baker Lake

Drilling — Calculation Method: AP-42 Table 11.9-4, October 1998

Variable	Assumed Value	Units	Comments
Est. Number of Holes per Day - Open Pits	150	holes per day	Calculated based on amt. of ANFO used per week ÷ max charge weight per hole
Max Number of Holes per blast - End Grid	70	holes per blast	IFS, Section 6.4.8 Drilling and Blasting, April 2011
Amount of blasted material per day - End Grid	200	tonnes per blast	Based on 5 m by 5 m blast face with holes about 4 m deep and Golder drilling and blasting report (Golder Associates 2011)

Rock Blasting Volume Calc's — Calculation Method: AP-42 Table 13.3-1, February 1980

Variable	Assumed Value	Units	Comments
Blasting Material	Emulsion/ANFO	-	Will use either a 70/30 Emulsion/ANFO blend or 100% ANFO. No emission factors available for ANFO.
Duration of Emissions	15	minutes	Assumed contaminants from explosives detonation are emitted to atmosphere over 15 min
Open Pits			
Max Number of Blasts per Week	3	#	IFS, Section 6.2.1.4, April 2011
Max charge weight per hole	215	kg	Table 15 of Golder drilling and blasting report (Golder Associates 2011)
ANFO Explosives Powder Factor - Open Pits	0.25	kg ANFO/tonne of rock	IFS, Section 6.2.1.4, April 2011
Max amount of rock to be blasted - Open Pits	300,000	tonnes per blast	IFS, Section 6.2.1.4, April 2011
Total Amount of ANFO required per blast - Open Pits	75	tonnes per blast	Calculated
End Grid Underground Mine			
ANFO Explosives Powder Factor - End Grid	2.5	kg ANFO/tonne of rock	IFS, Section 6.2.1.4, April 2011
Amount of rock to be blasted per day - End Grid	0	tonnes per day	Calculated. Used average denisty of waste rock and ore.
Total Amount of ANFO required per blast - End Grid	0.5	tonnes per blast	Calculated
Average number of blasts per day	0	#	Calculated
Control - End Grid	50%	%	Assumed that 50% of dust will be retained in the mine due to deposition

NonRoad Equipment Tailpipe Emissions — Calculation Method: US EPA Nonroad (Excavators & Loaders)

Variable	Assumed Value	Units	Comments
Equipment hp ratings	various	hp	Actual horsepower ratings from equipment brochures, etc.
Excavators and Loaders - g/hp-hr	various	g/hp-hr	US EPA Crankcase Emission Factors for Nonroad Engine Modeling - Compression-
Episodic (local) Diesel Fuel Sulphur Content	15	ppm	Canada-wide diesel fuel sulphur content as of 2010
Episodic (local) Diesel Fuel Sulphur Content	0.0015	%	Calculated

Grading and Dozing — Calculation Method: Western Surface Coal Mining - Bulldozing AP-42 Table 11.9-2, October 1998

Variable	Assumed Value	Units	Comments
Material Moisture Content (%)	3%	%	Assumption: 2.5% was used for Red Dog in Alaska; 3% was used for Mid West in northern
Material Silt Content (%)	5%	%	Assumption: used in the Kiggavik Screening Level Assessment (SENES 2008); average for Red
Dozer Operating Hours per Day	20	hours per day	Assumption: Red Dog used 20 hours per day
Bulldozer Operating Frequency	40%	%	Assumption: same as Red Dog, % of time dozer operates for each operating hour
Control Efficiency based on watering	0%	%	Assumption: watering is unlikely
Mean vehicle speed for Graders	8.0	kph	Assumption: used in the Kiggavik Screening Level Assessment (SENES 2008)
Number of trips per day - Graders	1	trips per day	Assumption

Wind Erosion — Calculation Method: AWMA Air Pollution Engineering Manual, 1992, page 137

Variable	Assumed Value	Units	Comments
Maximum Height of Permanent Clean Rock Stockpiles	50	m	AREVA e-mail dated June 30, 2010. Based on total amount of material put into stockpiles.
Maximum Height of Ore and Temporary Waste Rock Stockpiles	10	m	AREVA e-mail dated June 30, 2010. Based on total amount of material put into stockpiles.
Material Silt Content (%)	5%	%	Assumption: used in the Kiggavik Screening Level Assessment (SENES 2008)

End grid Underground Mine — Calculation Method: Engineering Calculations

Variable	Assumed Value	Units	Comments
Total Air Requirement/Exhaust Flow Rate	285	m^3/s	IFS, Section 6.4.10, April 2011
Air Exhaust Diameter	5	m	IFS, Section 6.4.10, April 2011
Air Exhaust Exit Velocity	14.5	m/s	Calculated
Air Exhaust Exit Temperature	2.0	degrees C	IFS, Section 6.4.10, April 2011

Incinerator — Calculation Method: Refuse Combustion - AP-42 Chapter 2.1, October 1996

Variable	Assumed Value	Units	Comments
Quantity incinerated	109	kg/h	Based on charge rate of 1750 kg/cycle and a total cycle time of 10-hour burn plus 6-hour cool down. (Eco Waste Solutions Incinerator Model No. ECO 1.75TN 1P MS 60L Technical Specification sheet, provided as part of AREVA memo dated October 21, 2010.)
Capacity of Incinerator at Sissons vs. Kiggavik	50%	%	Assumed: the Sissons incinerator will be significantly smaller than the Kiggavik incinerator (AREVA 2010, memorandum)
Type of control equipment	none	-	

Backfill Plant — Calculation Method: Engineering Calculations

Variable	Assumed Value	Units	Comments
Backfill Aggregate Quantity	0	tonnes per year	from "AnnualSched_Apr2011" tab
Backfill Aggregate Quantity	0	tonnes per day	Calculated
Backfill Aggregate Transfer - Number of Trips from Kiggavik	0	trips per day	Assuming aggregate is preferentially transferred from Kiggavik using ore trailer trucks as per
Backfill Aggregate Transfer - Number of Trips from End Grid	0	trips per day	According to IFS, Section 6.4.6, End Grid only provides a fraction of aggregate, therefore, it was assumed that main sources is Kiggavik clean rock.
Backfill Cement Quantity	0	tonnes per year	from "AnnualSched_Apr2011" tab
Backfill Cement Quantity	0	tonnes per day	Calculated
Max plant capacity	60	tonnes per hour	IFS, Section 6.4.6, April 2011

Ore Crushing and Grinding — Calculation Method: MOE Procedure Document Table C-2, Approximating Particulate Emissions from Baghouses

Variable	Assumed Value	Units	Comments
	-		Assumed a similar design to McClean - use stack testing to scale emissions based on U

Acid Plant — Calculation Method: Engineering Calculations

Variable	Assumed Value	Units	Comments
Maximum Daily Production	350	tonnes H_2SO_4 per day	IFS, Section 8.4.11.1, April 2011. Peak daily production capacity is 310t/day, but used 350 t per day to be conservative.
SO_2 Emission Factor	75	g per tonne of H_2SO_4	IFS, Section 8.4.11.1, April 2011. Based on acid plant design.

Mill — Calculation Method: Engineering Calculations

Variable	Assumed Value	Units	Comments
Mill feed	90	kt ore per year	from "AnnualSched_Apr2011" tab
U Grade	0.667%	%	from "AnnualSched_Apr2011" tab
Plant availability	85%	%	from KiggavikProject_HLDC_June30_ToSENES_RevAug11.xls
Mill feed per day	290	tonnes ore per day	Calculated based on plant availability and operating 365 days per year
Ore Stockpile	90	Kt ore	from "AnnualSched_Apr2011" tab
Tonnes U produced	550	T U per year	from "AnnualSched_Apr2011" tab
Hourly Uranium Production	74	kg U/hour	Calculated based on plant availability and operating 24 hours per day
Max theoretical U production	4,000	T U per year	AREVA e-mail dated May 20, 2011
Max Hourly Uranium Production	537	kg U/hour	Calculated based on plant availability and operating 24 hours per day

Power Plant — Calculation Method: Engineering Calculations

Variable	Assumed Value	Units	Comments
Kiggavik			
Max number of generators operating simultaneously	4	#	IFS, Section 11.1.1, Table 11.1-1, April 2011
Unit Capacity	4190	kW	IFS, Section 11.1.1, Table 11.1-1, April 2011
Annual power consumption	155,000,000	kWh/year	SupplementalData_Kissavik&SissonsLayouts_ToSenes_Nov3.pdf page 3
Sissons			
Max number of generators operating simultaneously	1	#	According to the IFS Section 11.1.1, there will be 3 small 1450 kW units at Sissons; however, one large 4190 kW unit was considered to simplify modelling.
Unit Capacity	4190	kW	
Annual Power consumption at Sissons	23,000,000	kWh/year	SupplementalData_Kissavik&SissonsLayouts_ToSenes_Nov3.pdf page 3
Episodic (local) Diesel Fuel Sulphur Content	15	ppm	Assume using same diesel fuel for power plant as vehicles. Canada-wide diesel fuel sulphur content as of 2010
Episodic (local) Diesel Fuel Sulphur Content	0.0015	%	Calculated
Diesel High Heating Value	19,300	Btu/lb	AP-42 Chapter 3.3 - Gasoline and Diesel Industrial Engines (10/96), Table 3.3-1

Maximum Bounding Emissions Scenario Variables and Assumptions Spreadsheet

Summary of Variables Used for Emission Estimates on Worksheets			340680 Kiggavik
Month	**December**		**Note:** enter full name of month
"Daily" or "Annual" Multiplier Used?	**Daily**		
Material Handling	Calculation Method: Drop Equation AP-42 13.2.4, November 2006		
Variable	**Assumed Value**	**Units**	**Comments**
Operation days per month - January to March	12	days per month	KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, Basic
Operation days per month - April to December	30	days per month	KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, Basic
Operation days per year	306	days per year	Calculated
Operation hours per day	24	hours per day	Assumption
Conversion factor bcm to tonnes - waste rock	2.7	tonnes/bcm	KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, SenesRequest3
Conversion factor bcm to tonnes - overburden	1.65	tonnes/bcm	Midpoint of dry bulk density as outlined in the IFS rounded to 1.65
Conversion factor bcm to tonnes - ore - East Zone	2.36	tonnes/bcm	KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, SenesRequest3
Conversion factor bcm to tonnes - ore - Centre Zone	2.36	tonnes/bcm	KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, SenesRequest3
Conversion factor bcm to tonnes - ore - Main Zone	2.40	tonnes/bcm	KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, SenesRequest3
Conversion factor bcm to tonnes - ore - Andrew Lake	2.35	tonnes/bcm	KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, SenesRequest3
Conversion factor bcm to tonnes - ore - End Grid	2.40	tonnes/bcm	KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, SenesRequest3
Variable	**Assumed Value**	**Units**	**Comments**
Maximum Excavated per Year - Worst-Case			from "AnnualSched_Apr2011" tab
East Zone - Total	0	bcm per year	Note: rock types will not add up to total due to rounding
PB Pit - Total	0	bcm per year	
Centre Zone - Total	0	bcm per year	
Main Zone - Total	9,066,125	bcm per year	
Andrew Lake - Total	10,211,045	bcm per year	
End Grid - Total	165,949	bcm per year	
East Zone - Ore	0	kt per year	
PB Pit - Ore	0	kt per year	
Centre Zone - Ore	0	kt per year	
Main Zone - Ore	1,122	kt per year	
Andrew Lake - Ore	741	kt per year	
End Grid - Ore	336	kt per year	
East Zone - WR Type III	0	bcm per year	Special waste
PB Pit - WR Type III	0	bcm per year	
Centre Zone - WR Type III	0	bcm per year	
Main Zone - WR Type III	142,417	bcm per year	
Andrew Lake - WR Type III	123,383	bcm per year	
End Grid - WR Type III	33	kt per year	
East Zone - WR Type II	0	bcm per year	Clean waste
PB Pit - WR Type II	0	bcm per year	Assume all of PB is clean
Centre Zone - WR Type II	0	bcm per year	
Main Zone - WR Type II	8,265,521	bcm per year	
Andrew Lake - WR Type II	10,125,844	bcm per year	
End Grid - WR Type II	184	kt per year	
East Zone - OV	0	bcm per year	Overburden
PB Pit - OV	0	bcm per year	
Centre Zone - OV	0	bcm per year	
Main Zone - OV	3,124,334	bcm per year	
Andrew Lake - OV	1,989,514	bcm per year	
End Grid - OV	0	kt per year	
Maximum Excavated per Day - tonnes - Worst-Case			Note: values have been rounded up to either nearest 10, 100 or 1000 as applicable
East Zone - Total	0	tonnes/day	
PB Pit - Total	0	tonnes/day	
Centre Zone - Total	0	tonnes/day	
Main Zone - Total	94,900	tonnes/day	
Andrew Lake - Total	103,800	tonnes/day	
End Grid - Total	2,000	tonnes/day	
East Zone - Ore	0	tonnes/day	
PB Pit - Ore	0	tonnes/day	
Centre Zone - Ore	0	tonnes/day	
Main Zone - Ore	3,700	tonnes/day	
Andrew Lake - Ore	2,500	tonnes/day	
End Grid - Ore	1,100	tonnes/day	
East Zone - WR Type III	0	tonnes/day	Special waste
PB Pit - WR Type III	0	tonnes/day	
Centre Zone - WR Type III	0	tonnes/day	
Main Zone - WR Type III	1,300	tonnes/day	
Andrew Lake - WR Type III	1,100	tonnes/day	
End Grid - WR Type III	200	tonnes/day	
East Zone - WR Type II	0	tonnes/day	Clean waste
PB Pit - WR Type II	0	tonnes/day	
Centre Zone - WR Type II	0	tonnes/day	
Main Zone - WR Type II	73,000	tonnes/day	
Andrew Lake - WR Type II	89,400	tonnes/day	
End Grid - WR Type II	700	tonnes/day	
East Zone - OV	0	tonnes/day	Overburden
PB Pit - OV	0	tonnes/day	
Centre Zone - OV	0	tonnes/day	
Main Zone - OV	16,900	tonnes/day	
Andrew Lake - OV	10,800	tonnes/day	
End Grid - OV	0	tonnes/day	
Moisture Content of extracted material	3%	%	Assumption: 2.5% was used for Red Dog in Alaska; 3% was used for Mid-west in North
Moisture Content of clean fill	-	%	
Wind Speed		m/s	Average wind speeds at the Kiggavik site from CALMET
January	4.94	m/s	
February	3.45	m/s	
March	4.43	m/s	
April	4.23	m/s	
May	4.14	m/s	
June	3.50	m/s	
July	3.37	m/s	
August	3.44	m/s	
September	4.85	m/s	
October	3.99	m/s	
November	4.24	m/s	
December	5.10	m/s	
Control Efficiency	0%	%	Assumed no control for dumping of excavated material
On-site Truck Characteristics			
Variable	**Assumed Value**	**Units**	**Comments**
Waste Truck Capacity	140	tonnes	IFS, Section 6.2.1.2, Figure 6.2-3 April 2011
Ore Truck Capacity	90	tonnes	IFS, Section 6.2.1.2, Figure 6.2-3 April 2011
Ore Trailer Capacity	140	tonnes	IFS Section 6.6, April 2011. Based on CAT 785C type trucks.
Empty average waste truck vehicle weight	100	tonnes	CAT785C (equipment provided in KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, Basic
Loaded weight of waste truck	240	tonnes	Calculated
Loaded / Empty average waste truck vehicle weight on haul road	170	tonnes	Based on 100 tonnes empty and 250 tonnes when loaded (100+250)/2=175
Empty average ore truck vehicle weight	70	tonnes	CAT777F (equipment provided in KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, Basic
Loaded weight of ore truck	160	tonnes	Calculated
Loaded / Empty average ore truck vehicle weight on haul road	115	tonnes	Average of loaded and empty weight
Ore-trailers used between Kiggavik and Sissons			
Empty average vehicle weight	110	tonnes	Calculated
Loaded weight of vehicle	250	tonnes	IFS Section 6.6, April 2011. Based on CAT 785C type trucks.
Loaded / Empty average vehicle weight on haul road	180	tonnes	Average of loaded and empty weight
Standard tractor-trailers used on access road (from Baker Lake to Kiggavik)			
Empty average vehicle weight	20	tonnes	From Kiggavik Screening Level Assessment (SENES 2008)
Loaded weight of vehicle	60	tonnes	Information provided by AREVA October 21, 2010
Loaded / Empty average vehicle weight	40	tonnes	Average of loaded and empty weight
Underground Trucks Hauling Ore from End Grid			
Underground Trucks Capacity	45	tonnes	CAT AD45B (45-tonne underground truck)
Empty average vehicle weight	40	tonnes	CAT AD45B (45-tonne underground truck)
Loaded weight of vehicle	85	tonnes	CAT AD45B (45-tonne underground truck)
Loaded / Empty average vehicle weight on haul road	63	tonnes	Average of loaded and empty weight
Explosive trucks			
Empty average vehicle weight	13	tonnes	Peterbilt 367 (equipment provided in AREVA memo October 21, 2010)
Loaded weight of vehicle	26	tonnes	Assumed
Loaded / Empty average vehicle weight	20	tonnes	Average of loaded and empty weight
Number of trips for explosives	6	trips per day	Calculated
Yellowcake transport trucks			Aassumed same as tractor-trailers from Baker Lake to Kiggavik
Loaded / Empty average vehicle weight	60	tonnes	Information provided by AREVA October 21, 2010
Number of trips	1	trip per day	Assumed: according to 34680-2, the total annual trips required for yellowcake are 96 trips per year; also AREVA memo dated October 21, 2010 stated frequency of yellowcake transportation flights of 336 flights/year; therefore 1 trip/day should be conservative.
Vehicle Speed	70	kph	Assumed same as tractor-trailers from Baker Lake to Kiggavik
Water truck			
Loaded / Empty average vehicle weight	24	tonnes	Assumed: based on GVW 35,000 lbs for Peterbilt 348, http://www.peterbilt.com/voc348.1.aspx
Number of trips	1	trip per day	Assumed - 1 water truck; 1 trip per day
In-pit truck trips per day (one way)			
East Zone			Calculated based on quantities excavated and truck capacities above
Ore	0	trips per day	
Special Waste	0	trips per day	
Clean Waste	0	trips per day	
Overburden	0	trips per day	
Centre Zone			
Ore	0	trips per day	
Special Waste	0	trips per day	
Clean Waste	0	trips per day	
Overburden	0	trips per day	
Purpose-built Pit			
Ore	0	trips per day	
Special Waste	0	trips per day	
Clean Waste	0	trips per day	
Overburden	0	trips per day	
Main Zone			
Ore	41	trips per day	
Special Waste	9	trips per day	
Clean Waste	521	trips per day	
Overburden	121	trips per day	
Andrew Lake			
Ore	28	trips per day	
Special Waste	8	trips per day	
Clean Waste	639	trips per day	
Overburden	77	trips per day	
End Grid			
Ore	12	trips per day	
Special Waste	1	trips per day	
Clean Waste	5	trips per day	
Overburden	0	trips per day	

Maximum Bounding Emissions Scenario Variables and Assumptions Spreadsheet, continued

Access Road and Haul Road			
Access Road from Baker Lake to Kiggavik			
Length of road to be included in modelling	1	km	Only 1km stretch is included in the assessment of impact of access road on Kiggavik site.
Vehicle speed - All Weather Road	70	km/h	IFS Section 12.5.3.1, April 2011
Vehicle speed - Winter Road	25	km/h	IFS Section 12.5.2.6, April 2011
Traffic volume - All Weather Road	10	trips/day	IFS Section 12.5.3.1, April 2011 - All weather road must be capable of handling 3625 vehicles (plue return trips) per year
Traffic volume - Winter Road	43	trips/day	Project Description (AREVA 2008)
Access Road Modelled Scenario			
Length of road	1	km	Only modelling 1 km stretch for Scenarios and worst case.
Traffic volume	11	trips per day	IFS Section 12.5.2.6, April 2011 - the total annual trips are 3920 per year which equals an average of 11 trips per day, including fuel and dry goods, etc.
Worst Case Scenario - Vehicle speed	70	km/h	Assume the same speed as the All Weather Road
Haul Road between Kiggavik and Sissons			
Length of road	19.6	km	IFS Section 6.6, April 2011
Vehicle speed	60	km/h	IFS Section 6.6, April 2011
Traffic volume from AL ore	18	trips per day	Calculated based on total quantities of ore from Andrew Lake and capacity of ore trailers
Traffic volume from EG ore	8	trips per day	Calculated based on total quantities of ore from End Grid and capacity of ore trailers
On-Road Vehicles Tailpipe	Calculation Method: Mobile 6C		
Variable	**Assumed Value**	**Units**	**Comments**
Trucks - g/VKT	various	g PM/VKT	Based on Mobile 6C EF's for Haul Trucks - HDDV8b Emission factors were used
Unpaved Road Emissions	Calculation Method: Unpaved Road Emissions, AP-42 5th Edition, 13.2.2, 1/95		
Variable	**Assumed Value**	**Units**	**Comments**
On-site haul trucks (gravel roads) - Silt %	5	(%)	Assumption: used in the Kiggavik Screening Level Assessment (SENES 2008); average for Red
On-site haul trucks - vehicle speed	20	kph	Assumption
Control Efficiency for On-site Vehicles with Speed < 40 kph	44%	(%)	WRAP Fugitive Dust Handbook, September 2006, control efficiency due to speed limit of 25
On-site haul trucks - Control Efficiency - Summer	75%	(%)	Assumed 75% control for watering road in summer when necessary
On-site haul trucks - Control Efficiency - Winter	50%	(%)	Assumed 50% control in winter due to frozen surface
number of days in a year with at least 0.254 mm of precipitation	111	(days)	From: Canadian Climate Normals Mean number of days with 0.254 mm (0.01 inch) or more of precipitation in Baker Lake
Drilling	Calculation Method: AP-42 Table 11.9-4, October 1998		
Variable	**Assumed Value**	**Units**	**Comments**
Est. Number of Holes per Day - Open Pits	150	holes per day	Calculated based on amt. of ANFO used per week ÷ max charge weight per hole
Max Number of Holes per blast - End Grid	70	holes per blast	IFS, Section 6.4.8 Drilling and Blasting, April 2011
Amount of blasted material per blast - End Grid	200	tonnes per blast	Based on 5 m by 5 m blast face with holes about 4 m deep and Golder drilling and blasting report (Golder Associates 2011)
Rock Blasting Volume Calc's	Calculation Method: AP-42 Table 13.3-1, February 1980		
Variable	**Assumed Value**	**Units**	**Comments**
Blasting Material	Emulsion/ANFO	-	Will use either a 70/30 Emulsion/ANFO blend or 100% ANFO. No emission factors available for ANFO.
Duration of Emissions	15	minutes	Assumed contaminants from explosives detonation are emitted to atmosphere over 15 min
Open Pits			
Max Number of Blasts per Day	1	#	IFS, Section 6.2.1.4, April 2011
Max charge weight per hole	215	kg	Table 15 of Golder drilling and blasting report (Golder Associates 2011)
ANFO Explosives Powder Factor - Open Pits	0.25	kg ANFO/tonne of rock	IFS, Section 6.2.1.4, April 2011
Max amount of rock to be blasted - Open Pits	300,000	tonnes per blast	IFS, Section 6.2.1.4, April 2011
Total Amount of ANFO required per blast - Open Pits	75	tonnes per blast	Calculated
End Grid Underground Mine			
ANFO Explosives Powder Factor - End Grid	2.5	kg ANFO/tonne of rock	IFS, Section 6.2.1.4, April 2011
Amount of rock to be blasted per day - End Grid	1,808	tonnes per day	Calculated. Used average denisty of waste rock and ore.
Total Amount of ANFO required per blast - End Grid	0.5	tonnes per blast	Calculated
Average number of blasts per day	9	#	Calculated
Control - End Grid	50%	%	Assumed that 50% of dust will be retained in the mine due to deposition
NonRoad Equipment Tailpipe Emissions	Calculation Method: US EPA Nonroad (Excavators & Loaders)		
Variable	**Assumed Value**	**Units**	**Comments**
Equipment hp ratings	various	hp	Actual horsepower ratings from equipment brochures, etc.
Excavators and Loaders - g/hp-hr	various	g/hp-hr	US EPA Crankcase Emission Factors for Nonroad Engine Modeling - Compression-
Episodic (local) Diesel Fuel Sulphur Content	15	ppm	Canada-wide diesel fuel sulphur content as of 2010
Episodic (local) Diesel Fuel Sulphur Content	0.0015	%	Calculated
Grading and Dozing	Calculation Method: Western Surface Coal Mining - Bulldozing AP-42 Table 11.9-2, October 1998		
Variable	**Assumed Value**	**Units**	**Comments**
Material Moisture Content (%)	3%	%	Assumption: 2.5% was used for Red Dog in Alaska; 3% was used for Mid West in northern Saskatchewan
Material Silt Content (%)	5%	%	Assumption: used in the Kiggavik Screening Level Assessment (SENES 2008); average for Red Dog EIS was 4.61%; average for Mid West EIS was 5%
Dozer Operating Hours per Day	20	hours per day	Assumption: Red Dog used 20 hours per day
Bulldozer Operating Frequency	40%	%	Assumption: same as Red Dog, % of time dozer operates for each operating hour
Control Efficiency based on watering	0%	%	Assumption: watering is unlikely
Mean vehicle speed for Graders	8.0	kph	Assumption: used in the Kiggavik Screening Level Assessment (SENES 2008)
Number of trips per day - Graders	1	trips per day	Assumption
Wind Erosion	Calculation Method: AWMA Air Pollution Engineering Manual, 1992, page 137		
Variable	**Assumed Value**	**Units**	**Comments**
Maximum Height of Permanent Clean Rock Stockpiles	50	m	AREVA e-mail dated June 30, 2010. Based on total amount of material put into stockpiles.
Maximum Height of Temporary Waste Rock Stockpiles	10	m	AREVA e-mail dated June 30, 2010. Based on total amount of material put into stockpiles.
Material Silt Content (%)	5%	%	Assumption: used in the Kiggavik Screening Level Assessment (SENES 2008)
End grid Underground Mine	Calculation Method: Engineering Calculations		
Variable	**Assumed Value**	**Units**	**Comments**
Total Air Requirement/Exhaust Flow Rate	285	m^3/s	IFS, Section 6.4.10, April 2011
Air Exhaust Diameter	5	m	IFS, Section 6.4.10, April 2011
Air Exhaust Exit Velocity	14.5	m/s	Calculated
Air Exhaust Exit Temperature	2.0	degrees C	IFS, Section 6.4.10, April 2011
Incinerator	Calculation Method: Refuse Combustion - AP-42 Chapter 2.1, October 1996		
Variable	**Assumed Value**	**Units**	**Comments**
Quantity incinerated	109	kg/h	Based on charge rate of 1750 kg/cycle and a total cycle time of 10-hour burn plus 6-hour cool down. (Eco Waste Solutions Incinerator Model No. ECO 1.75TN 1P MS 60L Technical Specification sheet, provided as part of AREVA memo dated October 21, 2010.)
Capacity of Incinerator at Sissons vs. Kiggavik	50%	%	Assumed: the Sissons incinerator will be significantly smaller than the Kiggavik incinerator (AREVA 2010, memorandum)
Type of control equipment	none	-	
Backfill Plant	Calculation Method: Engineering Calculations		
Variable	**Assumed Value**	**Units**	**Comments**
Backfill Aggregate Quantity	241,000	tonnes per year	from "AnnualSched_Apr2011" tab
Backfill Aggregate Quantity	788	tonnes per day	Calculated
Backfill Aggregate Transfer - Number of Trips from Kiggavik	6	trips per day	Assuming aggregate is preferentially transferred from Kiggavik using ore trailer trucks as per
Backfill Aggregate Transfer - Number of Trips from End Grid	0	trips per day	According to IFS, Section 6.4.6, End Grid only provides a fraction of aggregate, therefore, it was assumed that main sources is Kiggavik clean rock.
Backfill Cement Quantity	8,500	tonnes per year	from "AnnualSched_Apr2011" tab
Backfill Cement Quantity	28	tonnes per day	Calculated
Max plant capacity	60	tonnes per hour	IFS, Section 6.4.6, April 2011
Ore Crushing and Grinding	Calculation Method: MOE Procedure Document Table C-2, Approximating Particulate Emissions from Baghouses		
Variable	**Assumed Value**	**Units**	**Comments**
	-		Assumed a similar design to McClean - use stack testing to scale emissions based on U
Acid Plant	Calculation Method: Engineering Calculations		
Variable	**Assumed Value**	**Units**	**Comments**
Maximum Daily Production	350	tonnes H_2SO_4 per day	IFS, Section 8.4.11.1, April 2011. Peak daily production capacity is 310t/day, but used 350 t per day to be conservative.
SO_2 Emission Factor	75	g per tonne of H_2SO_4	IFS, Section 8.4.11.1, April 2011. Based on acid plant design.
Mill	Calculation Method: Engineering Calculations		
Variable	**Assumed Value**	**Units**	**Comments**
Ore Stockpile	900	Kt ore	from "AnnualSched_Apr2011" tab
Tonnes U produced	4,000	T U per year	from "AnnualSched_Apr2011" tab
Hourly Uranium Production	537	kg U/hour	Calculated based on plant availability and operating 24 hours per day @ 85% availability
Max theoretical U production	4,000	T U per year	AREVA e-mail dated May 20, 2011
Max Hourly Uranium Production	537	kg U/hour	Calculated based on plant availability and operating 24 hours per day @ 85% availability
Average U Grade	0.4%	%	AREVA e-mail dated May 20, 2011
Recovery rate	96%	%	from KiggavikProject_HLDC_June30_ToSENES_RevAug11.xls
Mill feed	1,042	kt ore per year	Calculated based on recovery rate and % U
Plant availability	85%	%	from KiggavikProject_HLDC_June30_ToSENES_RevAug11.xls
Mill feed per day	3358	tonnes ore per day	Calculated based on plant availability and operating 365 days per year
Power Plant	Calculation Method: Engineering Calculations		
Variable	**Assumed Value**	**Units**	**Comments**
Kiggavik			
Max number of generators operating simultaneously	4	#	IFS, Section 11.1.1, Table 11.1-1, April 2011
Unit Capacity	4190	kW	IFS, Section 11.1.1, Table 11.1-1, April 2011
Annual power consumption	155,000,000	kWh/year	SupplementalData_Kissavik&SissonsLayouts_ToSenes_Nov3.pdf page 3
Sissons			
Max number of generators operating simultaneously	1	#	According to the IFS Section 11.1.1, there will be 3 small 1450 kW units at Sissons; however,
Unit Capacity	4190	kW	one large 4190 kW unit was considered to simplify modelling.
Annual Power consumption at Sissons	23,000,000	kWh/year	SupplementalData_Kissavik&SissonsLayouts_ToSenes_Nov3.pdf page 3
Episodic (local) Diesel Fuel Sulphur Content	15	ppm	Assume using same diesel fuel for power plant as vehicles. Canada-wide diesel fuel sulphur content as of 2010
Episodic (local) Diesel Fuel Sulphur Content	0.0015	%	Calculated
Diesel High Heating Value	19,300	Btu/lb	AP-42 Chapter 3.3 - Gasoline and Diesel Industrial Engines (10/96), Table 3.3-1

Maximum Bounding Emissions Scenario Material Handling Calculation Spreadsheet

Source ID	Source Description	Material Handling Activity	k SPM	k PM_{10}	k $PM_{2.5}$	M (%)	U (m/s)	Emission Factor in kg/tonne SPM	Emission Factor in kg/tonne PM_{10}	Emission Factor in kg/tonne $PM_{2.5}$	Maximum Tonnes Handled per Hour	Uncontrolled (g/s) SPM	Uncontrolled (g/s) PM_{10}	Uncontrolled (g/s) $PM_{2.5}$	Assumed Control Efficiency (%)
MZWEST	Main Zone East Pit - Ore	Drop to Mine Trucks (Dumping)	0.74	0.35	0.053	3%	5.10	0.00200	0.00095	0.00014	154	8.57E-02	4.05E-02	6.14E-03	0%
MZWEST	Main Zone East Pit - SW	Drop to Mine Trucks (Dumping)	0.74	0.35	0.053	3%	5.10	0.00200	0.00095	0.00014	54	3.01E-02	1.42E-02	2.16E-03	0%
MZWEST	Main Zone East Pit - CW	Drop to Mine Trucks (Dumping)	0.74	0.35	0.053	3%	5.10	0.00200	0.00095	0.00014	3042	1.69E+00	8.00E-01	1.21E-01	0%
MZWEST	Main Zone East Pit - OVB	Drop to Mine Trucks (Dumping)	0.74	0.35	0.053	3%	5.10	0.00200	0.00095	0.00014	704	3.92E-01	1.85E-01	2.80E-02	0%
MZEST	Main Zone West Pit - Ore	Drop to Mine Trucks (Dumping)	0.74	0.35	0.053	3%	5.10	0.00200	0.00095	0.00014	0	0.00E+00	0.00E+00	0.00E+00	0%
MZEST	Main Zone West Pit - SW	Drop to Mine Trucks (Dumping)	0.74	0.35	0.053	3%	5.10	0.00200	0.00095	0.00014	0	0.00E+00	0.00E+00	0.00E+00	0%
MZEST	Main Zone West Pit - CW	Drop to Mine Trucks (Dumping)	0.74	0.35	0.053	3%	5.10	0.00200	0.00095	0.00014	0	0.00E+00	0.00E+00	0.00E+00	0%
MZEST	Main Zone West Pit - OVB	Drop to Mine Trucks (Dumping)	0.74	0.35	0.053	3%	5.10	0.00200	0.00095	0.00014	0	0.00E+00	0.00E+00	0.00E+00	0%
CZ	Centre Zone Pit - Ore	Drop to Mine Trucks (Dumping)	0.74	0.35	0.053	3%	5.10	0.00200	0.00095	0.00014	0	0.00E+00	0.00E+00	0.00E+00	0%
CZ	Centre Zone Pit - SW	Drop to Mine Trucks (Dumping)	0.74	0.35	0.053	3%	5.10	0.00200	0.00095	0.00014	0	0.00E+00	0.00E+00	0.00E+00	0%
CZ	Centre Zone Pit - CW	Drop to Mine Trucks (Dumping)	0.74	0.35	0.053	3%	5.10	0.00200	0.00095	0.00014	0	0.00E+00	0.00E+00	0.00E+00	0%
CZ	Centre Zone Pit - OVB	Drop to Mine Trucks (Dumping)	0.74	0.35	0.053	3%	5.10	0.00200	0.00095	0.00014	0	0.00E+00	0.00E+00	0.00E+00	0%
EZ	East Zone Pit - Ore	Drop to Mine Trucks (Dumping)	0.74	0.35	0.053	3%	5.10	0.00200	0.00095	0.00014	0	0.00E+00	0.00E+00	0.00E+00	0%
EZ	East Zone Pit - SW	Drop to Mine Trucks (Dumping)	0.74	0.35	0.053	3%	5.10	0.00200	0.00095	0.00014	0	0.00E+00	0.00E+00	0.00E+00	0%
EZ	East Zone Pit - CW	Drop to Mine Trucks (Dumping)	0.74	0.35	0.053	3%	5.10	0.00200	0.00095	0.00014	0	0.00E+00	0.00E+00	0.00E+00	0%
EZ	East Zone Pit - OVB	Drop to Mine Trucks (Dumping)	0.74	0.35	0.053	3%	5.10	0.00200	0.00095	0.00014	0	0.00E+00	0.00E+00	0.00E+00	0%
PB	Purpose built Pit	Drop to Mine Trucks (Dumping)	0.74	0.35	0.053	3%	5.10	0.00200	0.00095	0.00014	0	0.00E+00	0.00E+00	0.00E+00	0%
AL	Andrew Lake Pit - Ore	Drop to Mine Trucks (Dumping)	0.74	0.35	0.053	3%	5.10	0.00200	0.00095	0.00014	104	5.79E-02	2.74E-02	4.15E-03	0%
AL	Andrew Lake Pit - SW	Drop to Mine Trucks (Dumping)	0.74	0.35	0.053	3%	5.10	0.00200	0.00095	0.00014	46	2.55E-02	1.21E-02	1.83E-03	0%
AL	Andrew Lake Pit - CW	Drop to Mine Trucks (Dumping)	0.74	0.35	0.053	3%	5.10	0.00200	0.00095	0.00014	3725	2.07E+00	9.80E-01	1.48E-01	0%
AL	Andrew Lake Pit - OVB	Drop to Mine Trucks (Dumping)	0.74	0.35	0.053	3%	5.10	0.00200	0.00095	0.00014	450	2.50E-01	1.18E-01	1.79E-02	0%
OREK	Kiggavik Ore Pile	Truck Unloading to Pile	0.74	0.35	0.053	3%	5.10	0.00200	0.00095	0.00014	304	1.69E-01	8.00E-02	1.21E-02	0%
OREK	Kiggavik Ore Pile	Front end loader	0.74	0.35	0.053	3%	5.10	0.00200	0.00095	0.00014	140	7.78E-02	3.68E-02	5.57E-03	0%
SWK	Kiggavik Special Waste Pile	Truck Unloading to Pile	0.74	0.35	0.053	3%	5.10	0.00200	0.00095	0.00014	54	3.01E-02	1.42E-02	2.16E-03	0%
CWNK	Kiggavik Clean Rock Pile - North	Truck Unloading to Pile	0.74	0.35	0.053	3%	5.10	0.00200	0.00095	0.00014	0	0.00E+00	0.00E+00	0.00E+00	0%
CWK	Kiggavik Clean Rock Pile - South	Truck Unloading to Pile	0.74	0.35	0.053	3%	5.10	0.00200	0.00095	0.00014	3042	1.69E+00	8.00E-01	1.21E-01	0%
KOVB	Kiggavik Overburden Pile	Truck Unloading to Pile	0.74	0.35	0.053	3%	5.10	0.00200	0.00095	0.00014	704	3.92E-01	1.85E-01	2.80E-02	0%
ORES	Andrew Lake Ore Pad	Truck Unloading to Pile	0.74	0.35	0.053	3%	5.10	0.00200	0.00095	0.00014	104	5.79E-02	2.74E-02	4.15E-03	0%
SWS	Andrew Lake Special Waste Pile	Truck Unloading to Pile	0.74	0.35	0.053	3%	5.10	0.00200	0.00095	0.00014	46	2.55E-02	1.21E-02	1.83E-03	0%
CWS	Andrew Lake Clean Rock Pile	Truck Unloading to Pile	0.74	0.35	0.053	3%	5.10	0.00200	0.00095	0.00014	3725	2.07E+00	9.80E-01	1.48E-01	0%
SOVB	Andrew Lake Overburden Pile	Truck Unloading to Pile	0.74	0.35	0.053	3%	5.10	0.00200	0.00095	0.00014	450	2.50E-01	1.18E-01	1.79E-02	0%
CWEG	End Grid (Backfill) Clean Waste	Truck Unloading to Pile	0.74	0.35	0.053	3%	5.10	0.00200	0.00095	0.00014	29	1.62E-02	7.67E-03	1.16E-03	0%
SWEG	End Grid Special Waste Pile	Truck Unloading to Pile	0.74	0.35	0.053	3%	5.10	0.00200	0.00095	0.00014	8	4.63E-03	2.19E-03	3.32E-04	0%
EGORE	End Grid Ore Pad	Truck Unloading to Pile	0.74	0.35	0.053	3%	5.10	0.00200	0.00095	0.00014	46	2.55E-02	1.21E-02	1.83E-03	0%
	End Grid	Handling of Ore	0.74	0.35	0.053	3%	1.00	0.00024	0.00011	0.00002	46	3.07E-03	1.45E-03	2.20E-04	0%
	End Grid	Handling of SW	0.74	0.35	0.053	3%	1.00	0.00024	0.00011	0.00002	8	5.57E-04	2.64E-04	3.99E-05	0%
	End Grid	Handling of CW	0.74	0.35	0.053	3%	1.00	0.00024	0.00011	0.00002	29	1.95E-03	9.23E-04	1.40E-04	0%
	Total														

Source ID	Material Handling Activity	Metal Fraction (%) Uranium	As	Co	Cu	Pb	Mo	Ni	Se	Zn	Cd	Cr
MZWEST	Drop to Mine Trucks (Dumping)	6.81E-01	5.70E-04	1.70E-03	3.10E-03	5.03E-02	2.87E-02	6.60E-03	2.00E-04	3.90E-03	1.20E-04	1.54E-02
MZWEST	Drop to Mine Trucks (Dumping)	9.00E-02	7.30E-05	1.09E-03	4.51E-03	3.02E-03	1.47E-03	2.22E-03	1.43E-04	3.52E-03	5.00E-06	4.21E-03
MZWEST	Drop to Mine Trucks (Dumping)	2.00E-02	9.20E-05	9.63E-04	1.20E-03	1.24E-03	1.91E-04	2.62E-03	1.14E-04	3.01E-03	4.00E-06	4.58E-03
MZWEST	Drop to Mine Trucks (Dumping)	1.00E-03	8.00E-05	1.12E-03	1.35E-03	1.01E-03	1.90E-04	2.70E-03	1.13E-04	3.55E-03	5.00E-06	4.63E-03
MZEST	Drop to Mine Trucks (Dumping)	0.00E+00	5.70E-04	1.70E-03	3.10E-03	5.03E-02	2.87E-02	6.60E-03	2.00E-04	3.90E-03	1.20E-04	1.54E-02
MZEST	Drop to Mine Trucks (Dumping)	9.00E-02	7.30E-05	1.09E-03	4.51E-03	3.02E-03	1.47E-03	2.22E-03	1.43E-04	3.52E-03	5.00E-06	4.21E-03
MZEST	Drop to Mine Trucks (Dumping)	2.00E-02	9.20E-05	9.63E-04	1.20E-03	1.24E-03	1.91E-04	2.62E-03	1.14E-04	3.01E-03	4.00E-06	4.58E-03
MZEST	Drop to Mine Trucks (Dumping)	1.00E-03	8.00E-05	1.12E-03	1.35E-03	1.01E-03	1.90E-04	2.70E-03	1.13E-04	3.55E-03	5.00E-06	4.63E-03
CZ	Drop to Mine Trucks (Dumping)	0.00E+00	2.52E-03	1.87E-03	7.32E-03	2.83E-02	3.10E-03	7.81E-03	2.00E-05	9.78E-03	1.40E-04	1.78E-02
CZ	Drop to Mine Trucks (Dumping)	9.00E-02	7.30E-05	1.09E-03	4.51E-03	3.02E-03	1.47E-03	2.22E-03	1.43E-04	3.52E-03	5.00E-06	4.21E-03
CZ	Drop to Mine Trucks (Dumping)	6.00E-03	9.20E-05	9.63E-04	1.20E-03	1.24E-03	1.91E-04	2.62E-03	1.14E-04	3.01E-03	4.00E-06	4.58E-03
CZ	Drop to Mine Trucks (Dumping)	1.00E-03	8.00E-05	1.12E-03	1.35E-03	1.01E-03	1.90E-04	2.70E-03	1.13E-04	3.55E-03	5.00E-06	4.63E-03
EZ	Drop to Mine Trucks (Dumping)	0.00E+00	2.52E-03	1.87E-03	7.32E-03	2.83E-02	3.10E-03	7.81E-03	2.00E-05	9.78E-03	1.40E-04	1.78E-02
EZ	Drop to Mine Trucks (Dumping)	9.00E-02	7.30E-05	1.09E-03	4.51E-03	3.02E-03	1.47E-03	2.22E-03	1.43E-04	3.52E-03	5.00E-06	4.21E-03
EZ	Drop to Mine Trucks (Dumping)	2.50E-02	9.20E-05	9.63E-04	1.20E-03	1.24E-03	1.91E-04	2.62E-03	1.14E-04	3.01E-03	4.00E-06	4.58E-03
EZ	Drop to Mine Trucks (Dumping)	1.00E-03	8.00E-05	1.12E-03	1.35E-03	1.01E-03	1.90E-04	2.70E-03	1.13E-04	3.55E-03	5.00E-06	4.63E-03
PB	Drop to Mine Trucks (Dumping)	2.50E-02	8.00E-05	9.50E-04	9.40E-04	2.58E-03	1.20E-03	2.11E-03	2.00E-05	2.73E-03	5.00E-06	5.60E-03
AL	Drop to Mine Trucks (Dumping)	6.32E-01	1.66E-03	8.30E-04	5.05E-03	3.55E-02	5.57E-03	9.54E-03	5.00E-05	3.41E-03	1.10E-04	9.61E-02
AL	Drop to Mine Trucks (Dumping)	9.00E-02	1.92E-04	2.63E-04	5.64E-04	1.41E-03	8.40E-05	2.79E-03	1.10E-04	9.95E-04	1.10E-05	7.71E-03
AL	Drop to Mine Trucks (Dumping)	2.00E-02	3.28E-04	3.73E-04	6.72E-04	8.70E-04	6.90E-05	2.80E-03	1.28E-04	1.34E-03	9.00E-06	8.45E-03
AL	Drop to Mine Trucks (Dumping)	1.00E-03	3.69E-04	3.76E-04	7.40E-04	7.63E-04	6.70E-05	2.71E-03	1.33E-04	1.36E-03	8.00E-06	8.66E-03
OREK	Truck Unloading to Pile	6.67E-01	1.69E-03	1.47E-03	4.00E-03	4.08E-02	1.75E-02	7.59E-03	2.03E-04	3.76E-03	1.17E-04	4.20E-02
OREK	Front end loader	6.67E-01	1.69E-03	1.47E-03	4.00E-03	4.08E-02	1.75E-02	7.59E-03	2.03E-04	3.76E-03	1.17E-04	4.20E-02
SWK	Truck Unloading to Pile	9.00E-02	7.30E-05	1.09E-03	4.51E-03	3.02E-03	1.47E-03	2.22E-03	1.43E-04	3.52E-03	5.00E-06	4.21E-03
CWNK	Truck Unloading to Pile	1.55E-02	9.20E-05	9.63E-04	1.20E-03	1.24E-03	1.91E-04	2.62E-03	1.14E-04	3.01E-03	4.00E-06	4.58E-03
CWK	Truck Unloading to Pile	2.00E-02	9.20E-05	9.63E-04	1.20E-03	1.24E-03	1.91E-04	2.62E-03	1.14E-04	3.01E-03	4.00E-06	4.58E-03
KOVB	Truck Unloading to Pile	1.00E-03	8.00E-05	1.12E-03	1.35E-03	1.01E-03	1.90E-04	2.70E-03	1.13E-04	3.55E-03	5.00E-06	4.63E-03
ORES	Truck Unloading to Pile	6.32E-01	1.66E-03	8.30E-04	5.05E-03	3.55E-02	5.57E-03	9.54E-03	5.00E-05	3.41E-03	1.10E-04	9.61E-02
SWS	Truck Unloading to Pile	9.00E-02	1.92E-04	2.63E-04	5.64E-04	1.41E-03	8.40E-05	2.79E-03	1.10E-04	9.95E-04	1.10E-05	7.71E-03
CWS	Truck Unloading to Pile	2.00E-02	3.28E-04	3.73E-04	6.72E-04	8.70E-04	6.90E-05	2.80E-03	1.28E-04	1.34E-03	9.00E-06	8.45E-03
SOVB	Truck Unloading to Pile	1.00E-03	3.69E-04	3.76E-04	7.40E-04	7.63E-04	6.70E-05	2.71E-03	1.33E-04	1.36E-03	8.00E-06	8.66E-03
CWEG	Truck Unloading to Pile	2.50E-02	3.28E-04	3.73E-04	6.72E-04	8.70E-04	6.90E-05	2.80E-03	1.28E-04	1.34E-03	9.00E-06	8.45E-03
SWEG	Truck Unloading to Pile	2.10E-01	1.00E-04	1.30E-03	2.00E-04	3.80E-03	1.00E-04	3.70E-03	9.00E-05	3.80E-03	1.00E-04	1.00E-02
EGORE	Truck Unloading to Pile	5.01E-01	5.49E-03	2.08E-03	4.67E-03	2.08E-02	6.46E-03	6.60E-03	5.50E-04	4.05E-03	1.20E-04	1.13E-02
	Handling of Ore	5.01E-01	5.49E-03	2.08E-03	4.67E-03	2.08E-02	6.46E-03	6.60E-03	5.50E-04	4.05E-03	1.20E-04	1.13E-02
	Handling of SW	2.10E-01	1.00E-04	1.30E-03	2.00E-04	3.80E-03	1.00E-04	3.70E-03	9.00E-05	3.80E-03	1.00E-04	1.00E-02
	Handling of CW	2.50E-02	3.28E-04	3.73E-04	6.72E-04	8.70E-04	6.90E-05	2.80E-03	1.28E-04	1.34E-03	9.00E-06	8.45E-03
	Total											

Source ID	Material Handling Activity	Controlled (g/s) SPM	PM_{10}	$PM_{2.5}$	Uranium	As	Co	Cu	Pb	Mo	Ni	Se	Zn	Cd	Cr
MZWEST	Drop to Mine Trucks (Dumping)	8.57E-02	4.05E-02	6.14E-03	5.84E-04	4.89E-07	1.46E-06	2.66E-06	4.31E-05	2.46E-05	5.66E-06	1.71E-07	3.34E-06	1.03E-07	1.32E-05
MZWEST	Drop to Mine Trucks (Dumping)	3.01E-02	1.42E-02	2.16E-03	2.71E-05	2.20E-08	3.27E-07	1.36E-06	9.09E-07	4.41E-07	6.68E-07	4.31E-08	1.06E-06	1.51E-09	1.27E-06
MZWEST	Drop to Mine Trucks (Dumping)	1.69E+00	8.00E-01	1.21E-01	3.38E-04	1.56E-06	1.63E-05	2.02E-05	2.10E-05	3.23E-06	4.42E-05	1.93E-06	5.10E-05	6.76E-08	7.74E-05
MZWEST	Drop to Mine Trucks (Dumping)	3.92E-01	1.85E-01	2.80E-02	3.92E-06	3.13E-07	4.37E-06	5.29E-06	3.94E-06	7.44E-07	1.06E-05	4.42E-07	1.39E-05	1.96E-08	1.81E-05
MZEST	Drop to Mine Trucks (Dumping)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MZEST	Drop to Mine Trucks (Dumping)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MZEST	Drop to Mine Trucks (Dumping)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MZEST	Drop to Mine Trucks (Dumping)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CZ	Drop to Mine Trucks (Dumping)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CZ	Drop to Mine Trucks (Dumping)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CZ	Drop to Mine Trucks (Dumping)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CZ	Drop to Mine Trucks (Dumping)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EZ	Drop to Mine Trucks (Dumping)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EZ	Drop to Mine Trucks (Dumping)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EZ	Drop to Mine Trucks (Dumping)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EZ	Drop to Mine Trucks (Dumping)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PB	Drop to Mine Trucks (Dumping)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
AL	Drop to Mine Trucks (Dumping)	5.79E-02	2.74E-02	4.15E-03	3.66E-04	9.61E-07	4.81E-07	2.92E-06	2.06E-05	3.23E-06	5.53E-06	2.90E-08	1.98E-06	6.37E-08	5.57E-05
AL	Drop to Mine Trucks (Dumping)	2.55E-02	1.21E-02	1.83E-03	2.29E-05	4.89E-08	6.70E-08	1.44E-07	3.60E-07	2.14E-08	7.11E-07	2.80E-08	2.54E-07	2.80E-09	1.96E-06
AL	Drop to Mine Trucks (Dumping)	2.07E+00	9.80E-01	1.48E-01	4.14E-04	6.79E-06	7.73E-06	1.39E-05	1.80E-05	1.43E-06	5.81E-05	2.65E-06	2.78E-05	1.86E-07	1.75E-04
AL	Drop to Mine Trucks (Dumping)	2.50E-01	1.18E-01	1.79E-02	2.50E-06	9.23E-07	9.41E-07	1.85E-06	1.91E-06	1.68E-07	6.77E-06	3.33E-07	3.40E-06	2.00E-08	2.17E-05
OREK	Truck Unloading to Pile	1.69E-01	8.00E-02	1.21E-02	1.13E-03	2.86E-06	2.48E-06	6.76E-06	6.90E-05	2.96E-05	1.28E-05	3.43E-07	6.36E-06	1.97E-07	7.09E-05
OREK	Front end loader	7.78E-02	3.68E-02	5.57E-03	5.19E-04	1.31E-06	1.14E-06	3.11E-06	3.17E-05	1.36E-05	5.90E-06	1.58E-07	2.92E-06	9.07E-08	3.26E-05
SWK	Truck Unloading to Pile	3.01E-02	1.42E-02	2.16E-03	2.71E-05	2.20E-08	3.27E-07	1.36E-06	9.09E-07	4.41E-07	6.68E-07	4.31E-08	1.06E-06	1.51E-09	1.27E-06
CWNK	Truck Unloading to Pile	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CWK	Truck Unloading to Pile	1.69E+00	8.00E-01	1.21E-01	3.38E-04	1.56E-06	1.63E-05	2.02E-05	2.10E-05	3.23E-06	4.42E-05	1.93E-06	5.10E-05	6.76E-08	7.74E-05
KOVB	Truck Unloading to Pile	3.92E-01	1.85E-01	2.80E-02	3.92E-06	3.13E-07	4.37E-06	5.29E-06	3.94E-06	7.44E-07	1.06E-05	4.42E-07	1.39E-05	1.96E-08	1.81E-05
ORES	Truck Unloading to Pile	5.79E-02	2.74E-02	4.15E-03	3.66E-04	9.61E-07	4.81E-07	2.92E-06	2.06E-05	3.23E-06	5.53E-06	2.90E-08	1.98E-06	6.37E-08	5.57E-05
SWS	Truck Unloading to Pile	2.55E-02	1.21E-02	1.83E-03	2.29E-05	4.89E-08	6.70E-08	1.44E-07	3.60E-07	2.14E-08	7.11E-07	2.80E-08	2.54E-07	2.80E-09	1.96E-06
CWS	Truck Unloading to Pile	2.07E+00	9.80E-01	1.48E-01	4.14E-04	6.79E-06	7.73E-06	1.39E-05	1.80E-05	1.43E-06	5.81E-05	2.65E-06	2.78E-05	1.86E-07	1.75E-04
SOVB	Truck Unloading to Pile	2.50E-01	1.18E-01	1.79E-02	2.50E-06	9.23E-07	9.41E-07	1.85E-06	1.91E-06	1.68E-07	6.77E-06	3.33E-07	3.40E-06	2.00E-08	2.17E-05
CWEG	Truck Unloading to Pile	1.62E-02	7.67E-03	1.16E-03	4.05E-06	5.32E-08	6.05E-08	1.09E-07	1.41E-07	1.12E-08	4.55E-07	2.08E-08	2.18E-07	1.46E-09	1.37E-06
SWEG	Truck Unloading to Pile	4.63E-03	2.19E-03	3.32E-04	9.73E-06	4.63E-09	6.02E-08	9.27E-09	1.76E-07	4.63E-09	1.71E-07	4.17E-09	1.76E-07	4.63E-09	4.63E-07
EGORE	Truck Unloading to Pile	2.55E-02	1.21E-02	1.83E-03	1.28E-04	1.40E-06	5.30E-07	1.19E-06	5.29E-06	1.65E-06	1.68E-06	1.40E-07	1.03E-06	3.06E-08	2.88E-06
	Handling of Ore	3.07E-03	1.45E-03	2.20E-04	1.54E-05	1.68E-07	6.38E-08	1.43E-07	6.37E-07	1.98E-07	2.02E-07	1.69E-08	1.24E-07	3.68E-09	3.46E-07
	Handling of SW	5.57E-04	2.64E-04	3.99E-05	1.17E-06	5.57E-10	7.25E-09	1.11E-09	2.12E-08	5.57E-10	2.06E-08	5.02E-10	2.12E-08	5.57E-10	5.57E-08
	Handling of CW	1.95E-03	9.23E-04	1.40E-04	4.88E-07	6.40E-09	7.28E-09	1.31E-08	1.70E-08	1.35E-09	5.47E-08	2.50E-09	2.62E-08	1.76E-10	1.65E-07
	Total	5.57E-03	2.64E-03	3.99E-04	1.70E-05	1.75E-07	7.83E-08	1.57E-07	6.75E-07	2.00E-07	2.78E-07	1.99E-08	1.72E-07	4.41E-09	5.67E-07

[1] According to AREVA schedule (Aug 11, 2010), no clean waste or special waste from End Grid are brought up to surface.

Emission Factor Equation	Reference
$E = k \times (0.0016) \times (U/2.2)^{1.3} / (M/2)^{1.4}$	AP-42 13.2.4 November 2006

Parameter	SPM	PM_{10}	$PM_{2.5}$
k	0.74	0.35	0.053

E = emission factor in kg/megagram
k = particle size multiplier for particulate size range and units of interest
U = mean wind speed (m/s)
M = material moisture content (%)

Maximum Bounding Emissions Scenario Pit Ramps and Unpaved Road Inputs Spreadsheet

Source ID	Pit Ramps and Unpaved Roads	s (%)	One-way Trips per Day - OR	One-way Trips per Day - SW	One-way Trips per Day - CW	One-way Trips per Day - OVB	One-way Trips per Day - Other	One-way Trips per Day - Water Truck	Total # of One-way Trips per day	Average Weight - Ore Truck (tonnes)	Average Weight - Waste Trucks (tonnes)	Average Weight - Water Trucks (tonnes)	Average Weight - Other (tonnes)	Weighted Average W (tonnes)	Road length[1] (km)	Vehicle Speed (km/h)	Control Efficiency - Summer (%) (Watering)	Control Efficiency - Winter (%) (Frozen Surface)	Control Efficiency for Speed <40 km/h	Notes
EZ	East Zone Pit ramp	5.0	0	0	0	0	0	0	0	115	170	24	0	0	0.50	7.5	75%	50%	44%	
EZ	East Zone Pit floor	5.0	0	0	0	0	0	0	0	115	170	24	0	0	0.05	7.5	75%	50%	44%	Length travelled on pit floor assumed to be 50 m
PB	Purpose Built Pit ramp	5.0	0	0	0	0	0	0	0	115	170	24	0	0	0.3	7.5	75%	50%	44%	
PB	Purpose Built Pit floor	5.0	0	0	0	0	0	0	0	115	170	24	0	0	0.02	7.5	75%	50%	44%	Length travelled on pit floor assumed to be 20 m
CZ	Centre Zone Pit ramp	5.0	0	0	0	0	0	0	0	115	170	24	0	0	0.85	7.5	75%	50%	44%	
CZ	Centre Zone Pit floor	5.0	0	0	0	0	0	0	0	115	170	24	0	0	0.05	7.5	75%	50%	44%	Length travelled on pit floor assumed to be 50 m
MZEST	Main Zone East Pit ramp	5.0	0	0	0	0	0	0	0	115	170	24	0	0	0.40	7.5	75%	50%	44%	
MZEST	Main Zone East Pit floor	5.0	0	0	0	0	0	0	0	115	170	24	0	0	0.10	7.5	75%	50%	44%	Length travelled on pit floor approx. 70 m (Frederic Guerin e-mail dated May 27, 2011). Assumed 100 to be conservative.
MZWEST	Main Zone West Pit ramp	5.0	41	9	521	121	0	0	693	115	170	24	0	167	1.75	7.5	75%	50%	44%	
MZWEST	Main Zone West Pit floor	5.0	41	9	521	121	0	0	693	115	170	24	0	167	0.10	7.5	75%	50%	44%	Length travelled on pit floor approx. 70 m (Frederic Guerin e-mail dated May 27, 2011). Assumed 100 to be conservative.
AL	Andrew Lake Pit ramp	5.0	28	8	639	77	0	0	751	115	170	24	0	168	2.60	7.5	75%	50%	44%	
AL	Andrew Lake Pit floor	5.0	28	8	639	77	0	0	751	115	170	24	0	168	0.10	7.5	75%	50%	44%	Length travelled on pit floor approx. 70 m (Frederic Guerin e-mail dated May 27, 2011). Assumed 100 to be conservative.
R1	segment off of main zone west ramp	5.0	41	9	0	121	0	0	171	115	170	24	0	157	0.078	20	75%	50%	44%	OR, SW & OVB from WZWEST
R2	segment off of main zone west ramp to main zone east ramp	5.0	41	0	0	121	0	0	162	115	170	24	0	156	0.436	20	75%	50%	44%	OR & OVB from MZWEST
R3	segment off of main zone east ramp	5.0	41	0	0	121	0	0	162	115	170	24	0	156	0.152	20	75%	50%	44%	OR & OVB from MZWEST + OR SW, CW & OVB from MZEST
R4	segment off of main zone west ramp to CW pile (south)	5.0	0	0	521	0	0	0	521	115	170	24	0	170	0.431	20	75%	50%	44%	CW from MZWEST
R5	segment off of main zone west ramp to west of SW pile	5.0	0	9	0	0	0	0	9	115	170	24	0	170	0.244	20	75%	50%	44%	SW from MZWEST
R6	road north from main zone east to east of SW pile	5.0	41	0	0	0	0	0	41	115	170	24	0	115	0.211	20	75%	50%	44%	OR from MZWEST + OR & SW from MZEST
R7	road north from east of SW pile to scanner	5.0	41	0	0	0	0	0	41	115	170	24	0	115	0.309	20	75%	50%	44%	OR from MZWEST + OR from MZEST + SW from CZ + SW from EZ
R8	road from main zone east ramp to CW pile (south)	5.0	0	0	0	121	0	0	121	115	170	24	0	170	0.229	20	75%	50%	44%	OVB from MZWEST + CW & OVB from MZEST
R9	road from main zone east ramp to CW pile (south)	5.0	0	0	0	0	0	0	0	115	170	24	0	0	0.139	20	75%	50%	44%	CW from MZEST
R10	overburden from main zone to CW pile (north)	5.0	0	0	0	121	0	0	121	115	170	24	0	170	0.499	20	75%	50%	44%	OVB from MZWEST + OVB from MZEST
R11	road from east zone pit to CW pile (north)	5.0	0	0	0	0	0	0	0	115	170	24	0	0	0.209	20	75%	50%	44%	OR, SW, CW & OVB from EZ
R12	road from east zone pit to Centre Zone	5.0	0	0	0	121	0	0	121	115	170	24	0	170	0.253	20	75%	50%	44%	OR & SW from EZ + CW & OVB from CZ + CW from PB + OVB from MZEST + OVB from MZWEST
R13	road from east zone pit to Centre Zone ramp	5.0	0	0	0	121	0	0	121	115	170	24	0	170	0.112	20	75%	50%	44%	OR & SW from EZ + OR & SW from CZ + CW from PB + OVB from MZEST + OVB from MZWEST
R14	road from Centre Zone to R15	5.0	0	0	0	121	0	0	121	115	170	24	0	170	0.118	20	75%	50%	44%	OR & SW from EZ + OR & SW from CZ + CW from PB + OVB from MZEST + OVB from MZWEST
R15	road from Centre Zone pit to Purpose Built	5.0	0	0	0	0	0	0	0	115	170	24	0	0	0.251	20	75%	50%	44%	CW from PB + OR & SW from EZ + OR & SW from CZ
R16	road from Purpose Built to scanner	5.0	0	0	0	0	0	0	0	115	170	24	0	0	0.242	20	75%	50%	44%	OR & SW from EZ + OR & SW from CZ
R17	road from scanner to ore pile	5.0	41	0	0	0	0	0	41	115	170	24	0	115	0.111	20	75%	50%	44%	OR from EZ, CZ, MZEST & MZWEST
R18	road off of purpose built	5.0	0	0	0	0	0	0	0	115	170	24	0	0	0.349	20	75%	50%	44%	CW from PB
R19	site entrance road from Baker Lake (links to R31)	5.0	0	0	0	0	11	0	11	115	170	24	40	40	1.671	20	75%	50%	44%	Supply and fuel trucks
R20	road off of Andrew Lake to Sissons scanner	5.0	28	8	639	77	0	0	751	115	170	24	0	168	0.387	20	75%	50%	44%	OR, SW, CW & OVB from AL
R21	road from Sissons scanner to SW pile	5.0	0	8	0	0	0	0	8	115	170	24	0	170	0.261	20	75%	50%	44%	SW from AL
R22	road from Sissons scanner to ore pile	5.0	28	0	639	77	0	0	743	115	170	24	0	168	0.092	20	75%	50%	44%	OR, CW & OVB from AL
R23	road past Sissons scanner to CW pile	5.0	0	0	639	77	18	0	734	115	170	24	180	170	0.123	20	75%	50%	44%	CW & OVB from AL + Ore trailers to Kiggavik (from AL)
R24	road past Sissons scanner to End Grid road	5.0	0	0	0	0	18	0	18	115	170	24	180	180	0.328	20	75%	50%	44%	Ore trailers to Kiggavik (from AL)
R25	road past Sissons scanner to Haul Road	5.0	0	0	0	0	26	0	26	115	170	24	180	180	0.787	20	75%	50%	44%	Ore trailers to Kiggavik (from AL and End Grid)
R26	road from decline to End Grid CW pile	5.0	12	1	5	0	0	0	19	115	170	24	0	134	0.241	20	75%	50%	44%	OR, SW & CW from End Grid
R27	road from decline to End Grid SW pile	5.0	12	1	0	0	0	0	14	115	170	24	0	121	0.326	20	75%	50%	44%	OR & SW from End Grid
R28	road from decline to End Grid ore pile	5.0	12	0	0	0	0	0	12	115	170	24	0	115	0.125	20	75%	50%	44%	OR from End Grid
R29	road from End Grid ore pile to R25	5.0	0	0	0	0	8	0	8	115	170	24	180	180	0.673	20	75%	50%	44%	Ore trailers to Kiggavik (from End Grid) + Ore trailers carrying aggregate
R30	Haul road b/n Kiggavik and Sissons	5.0	0	0	0	0	31	0	31	115	170	24	180	180	19.6	60	75%	50%	0%	Ore trailers to Kiggavik (from AL and End Grid) + Ore trailers carrying aggregate
R31	Road to Baker Lake (1 km segment modelled)	5.0	0	0	0	0	11	0	11	115	170	24	40	40	1.0	70	75%	50%	0%	Supply and fuel trucks
R32	Road to Airstrip	5.0	0	0	0	0	1	0	1	115	170	24	60	60	4.1	60	75%	50%	0%	Yellowcake transport to airstrip
CWNK	Clean waste pile north - Kiggavik (CW trucks only)	5.0	0	0	0	0	0	0	0	115	170	24	0	0	0.300	7.5	0%	50%	44%	Length taken as 1/2 width of the pile. Obtained from digitizing Site_Layout_revB
CWNK	Clean waste pile north - Kiggavik (OVB trucks only)	5.0	0	0	0	121	0	0	121	115	170	24	0	170	1.545	7.5	0%	50%	44%	Length obtained from digitizing a route to the OVB pile using Site_Layout_RevB
CWK	Clean waste pile south - Kiggavik	5.0	0	0	521	0	0	0	521	115	170	24	0	170	0.528	7.5	0%	50%	44%	Length taken as 1/2 width of the pile
KOVB	Overburden pile - Kiggavik	5.0	0	0	0	121	0	0	121	115	170	24	0	170	0.415	7.5	0%	50%	44%	Length taken as 1/2 width of the pile
SWK	Special waste pile - Kiggavik	5.0	0	9	0	0	0	0	9	115	170	24	0	170	0.264	7.5	0%	50%	44%	Length taken as 1/2 width of the pile
OREK	Ore pile - Kiggavik	5.0	0	0	0	0	0	0	0	115	170	24	0	0	0.264	7.5	0%	50%	44%	Length taken as 1/2 width of the pile
CWS	Clean waste pile - Sissons (CW trucks only)	5.0	0	0	639	0	0	0	639	115	170	24	0	170	0.572	7.5	0%	50%	44%	Length taken as 1/2 width of the pile. Obtained from digitizing Site_Layout_revB
CWS	Clean waste pile - Sissons (OVB trucks only)	5.0	0	0	0	77	0	0	77	115	170	24	0	170	1.193	7.5	0%	50%	44%	Length obtained from digitizing a route to the OVB pile using Site_Layout_RevB
SWS	Special waste pile - Sissons	5.0	0	8	0	0	0	0	8	115	170	24	0	170	0.099	7.5	0%	50%	44%	Length taken as 1/2 width of the pile
SOVB	Overburden pile - Sissons	5.0	0	0	0	77	0	0	77	115	170	24	0	170	0.341	7.5	0%	50%	44%	Length taken as 1/2 width of the pile

Always zero. Do not change.

Notes:

[1] Road lengths can be found in the following Excel file: ..\..\340680-1 IFS Revised site layout April2011\340680-1 Road Links_Site roads_RevB 31May2011.xlsx

Water trucks assumed to pass over any road or pit ramp/floor during the summer months only. Water trucks will not pass over piles or pit floors.

Ore at Sissons is assumed to be first dumped to piles and then hauled to Kiggavik in ore tractor trailers.

Maximum Bounding Emissions Scenario On-Road Tailpipe Calculation Spreadsheet

Source ID	Unpaved Road	One-way road length (km)	One-way Trips per day	Vehicle Speed (km/h)	SPM (g/s)	PM_{10} (g/s)	$PM_{2.5}$ (g/s)	Uranium (g/s)	As (g/s)	Co (g/s)	Cu (g/s)	Pb (g/s)	Mo (g/s)	Ni (g/s)	Se (g/s)	Zn (g/s)	Cd (g/s)	Cr (g/s)	NOx (g/s)	SO_2 (g/s)	CO (g/s)
R19	site entrance road from Baker Lake (links to R31)	1.7	11	20	5.05E-05	5.05E-05	4.09E-05	0	0	0	0	0	0	0	0	0	0	0	1.57E-03	8.58E-05	4.82E-04
R23	road past Sissons scanner to CW pile	0.1	18	20	6.03E-06	6.03E-06	4.88E-06	0	0	0	0	0	0	0	0	0	0	0	1.88E-04	1.02E-05	5.75E-05
R24	road past Sissons scanner to End Grid road	0.3	18	20	1.61E-05	1.61E-05	1.30E-05	0	0	0	0	0	0	0	0	0	0	0	5.01E-04	2.73E-05	1.54E-04
R25	road past Sissons scanner to Haul Road	0.8	26	20	5.56E-05	5.56E-05	4.50E-05	0	0	0	0	0	0	0	0	0	0	0	1.73E-03	9.45E-05	5.31E-04
R29	road from End Grid ore pile to R25	0.7	8	20	1.45E-05	1.45E-05	1.18E-05	0	0	0	0	0	0	0	0	0	0	0	4.52E-04	2.47E-05	1.39E-04
R30	Haul road b/n Kiggavik and Sissons	19.6	31	60	1.69E-03	1.69E-03	1.37E-03	0	0	0	0	0	0	0	0	0	0	0	5.05E-02	2.87E-03	1.10E-02
R31	Road to Baker Lake (1 km segment modelled)	1.0	11	70	3.03E-05	3.03E-05	2.45E-05	0	0	0	0	0	0	0	0	0	0	0	9.57E-04	5.14E-05	1.79E-04
R32	Road to Airstrip	4.1	1	60	1.14E-05	1.14E-05	9.23E-06	0	0	0	0	0	0	0	0	0	0	0	3.41E-04	1.94E-05	7.40E-05

Note:

Cells highlighed gray indicates that emissions of a contaminant are zero.

Mobile 6C Emission Factors - Year 2009 - Units g/VKT

Vehicle Type	SPM	PM_{10}	$PM_{2.5}$	NO_x	SO_2*	CO
HD Diesel 40 km/hr	0.119	0.119	0.096	3.699	0.202	1.133
HD Diesel 50 km/hr	0.119	0.119	0.096	3.530	0.202	0.902
HD Diesel 60 km/hr	0.119	0.119	0.096	3.551	0.202	0.771
HD Diesel 70 km/hr	0.119	0.119	0.096	3.757	0.202	0.705
HD Diesel 80 km/hr	0.119	0.119	0.096	4.176	0.202	0.689

Notes:

Emission Factors obtained from the Mobile6C model for the Toronto Metropolitan area, for calendar year 2009, except for SO_2* which are for 2006.

..\Supplemental Info for Calcs\Mobile6C EF Results from Markham Bypass.xls

Maximum Bounding Emissions Scenario Unpaved Roads (winter) Calculation Spreadsheet

Source ID	Unpaved Road	s (%)	S - mean vehicle speed (kph)	W (tonnes)	Annual EF SPM	Emission Factor in g/VKT SPM	Emission Factor in g/VKT PM_{10}	Emission Factor in g/VKT $PM_{2.5}$	Total # of One-way Trips per day	One way length (km)	Roundtrip VKT per day	Uncontrolled Emissions (g/s) Annual SPM	Uncontrolled Emissions (g/s) SPM	Uncontrolled Emissions (g/s) PM_{10}	Uncontrolled Emissions (g/s) $PM_{2.5}$	Control Efficiency (%)	Control Efficiency (%) (Speed Limit)
EZ	East Zone Pit ramp	5.0	8	0	0	0	0	0	0	0.50	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	50%	44%
EZ	East Zone Pit floor	5.0	8	0	0	0	0	0	0	0.05	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	50%	44%
PB	Purpose Built Pit ramp	5.0	8	0	0	0	0	0	0	0.30	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	50%	44%
PB	Purpose Built Pit floor	5.0	8	0	0	0	0	0	0	0.02	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	50%	44%
CZ	Centre Zone Pit ramp	5.0	8	0	0	0	0	0	0	0.85	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	50%	44%
CZ	Centre Zone Pit floor	5.0	8	0	0	0	0	0	0	0.05	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	50%	44%
MZEST	Main Zone East Pit ramp	5.0	8	0	0	0	0	0	0	0.40	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	50%	44%
MZEST	Main Zone East Pit floor	5.0	8	0	0	0	0	0	0	0.10	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	50%	44%
MZWEST	Main Zone West Pit ramp	5.0	8	167	3319	4769	1225	123	693	1.75	2424	9.31E+01	1.34E+02	3.44E+01	3.44E+00	50%	44%
MZWEST	Main Zone West Pit floor	5.0	8	167	3319	4769	1225	123	693	0.10	139	5.32E+00	7.65E+00	1.96E+00	1.96E-01	50%	44%
AL	Andrew Lake Pit ramp	5.0	8	168	3330	4785	1229	123	751	2.60	3907	1.51E+02	2.16E+02	5.56E+01	5.56E+00	50%	44%
AL	Andrew Lake Pit floor	5.0	8	168	3330	4785	1229	123	751	0.10	150	5.79E+00	8.32E+00	2.14E+00	2.14E-01	50%	44%
R1	segment off of main zone west ramp	5.0	20	157	3228	4639	1192	119	171	0.08	27	1.00E+00	1.44E+00	3.70E-01	3.70E-02	50%	44%
R2	segment off of main zone west ramp to main zone east ramp	5.0	20	156	3221	4629	1189	119	162	0.44	141	5.26E+00	7.57E+00	1.94E+00	1.94E-01	50%	44%
R3	segment off of main zone east ramp	5.0	20	156	3221	4629	1189	119	162	0.15	49	1.83E+00	2.63E+00	6.76E-01	6.76E-02	50%	44%
R4	segment off of main zone west ramp to CW pile (south)	5.0	20	170	3348	4811	1236	124	521	0.43	450	1.74E+01	2.51E+01	6.44E+00	6.44E-01	50%	44%
R5	segment off of main zone west ramp to west of SW pile	5.0	20	170	3348	4811	1236	124	9	0.24	5	1.76E-01	2.52E-01	6.49E-02	6.49E-03	50%	44%
R6	road north from main zone east to east of SW pile	5.0	20	115	2808	4035	1037	104	41	0.21	17	5.64E-01	8.11E-01	2.08E-01	2.08E-02	50%	44%
R7	road north from east of SW pile to scanner	5.0	20	115	2808	4035	1037	104	41	0.31	25	8.27E-01	1.19E+00	3.05E-01	3.05E-02	50%	44%
R8	road from main zone east ramp to CW pile (south)	5.0	20	170	3348	4811	1236	124	121	0.23	55	2.14E+00	3.08E+00	7.91E-01	7.91E-02	50%	44%
R9	road from main zone east ramp to CW pile (south)	5.0	20	0	0	0	0	0	0	0.14	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	50%	44%
R10	overburden from main zone to CW pile (north)	5.0	20	170	3348	4811	1236	124	121	0.50	120	4.67E+00	6.71E+00	1.72E+00	1.72E-01	50%	44%
R11	road from east zone pit to CW pile (north)	5.0	20	0	0	0	0	0	0	0.21	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	50%	44%
R12	road from east zone pit to Centre Zone	5.0	20	170	3348	4811	1236	124	121	0.25	61	2.37E+00	3.41E+00	8.75E-01	8.75E-02	50%	44%
R13	road from east zone pit to Centre Zone ramp	5.0	20	170	3348	4811	1236	124	121	0.11	27	1.04E+00	1.50E+00	3.86E-01	3.86E-02	50%	44%
R14	road from Centre Zone to R15	5.0	20	170	3348	4811	1236	124	121	0.12	28	1.10E+00	1.59E+00	4.07E-01	4.07E-02	50%	44%
R15	road from Centre Zone pit to Purpose Built	5.0	20	0	0	0	0	0	0	0.25	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	50%	44%
R16	road from Purpose Built to scanner	5.0	20	0	0	0	0	0	0	0.24	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	50%	44%
R17	road from scanner to ore pile	5.0	20	115	2808	4035	1037	104	41	0.11	9	2.97E-01	4.27E-01	1.10E-01	1.10E-02	50%	44%
R18	road off of purpose built	5.0	20	0	0	0	0	0	0	0.35	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	50%	44%
R19	site entrance road from Baker Lake (links to R31)	5.0	20	40	1746	2509	645	64	11	1.67	37	7.43E-01	1.07E+00	2.74E-01	2.74E-02	50%	44%
R20	road off of Andrew Lake to Sissons scanner	5.0	20	168	3330	4785	1229	123	751	0.39	582	2.24E+01	3.22E+01	8.28E+00	8.28E-01	50%	44%
R21	road from Sissons scanner to SW pile	5.0	20	170	3348	4811	1236	124	8	0.26	4	1.59E-01	2.28E-01	5.86E-02	5.86E-03	50%	44%
R22	road from Sissons scanner to ore pile	5.0	20	168	3330	4785	1229	123	743	0.09	137	5.29E+00	7.60E+00	1.95E+00	1.95E-01	50%	44%
R23	road past Sissons scanner to CW pile	5.0	20	170	3350	4814	1237	124	734	0.12	180	6.99E+00	1.00E+01	2.58E+00	2.58E-01	50%	44%
R24	road past Sissons scanner to End Grid road	5.0	20	180	3435	4936	1268	127	18	0.33	12	4.66E-01	6.69E-01	1.72E-01	1.72E-02	50%	44%
R25	road past Sissons scanner to Haul Road	5.0	20	180	3435	4936	1268	127	26	0.79	40	1.61E+00	2.31E+00	5.94E-01	5.94E-02	50%	44%
R26	road from decline to End Grid CW pile	5.0	20	134	3007	4322	1110	111	19	0.24	9	3.13E-01	4.50E-01	1.16E-01	1.16E-02	50%	44%
R27	road from decline to End Grid SW pile	5.0	20	121	2870	4125	1060	106	14	0.33	9	2.96E-01	4.25E-01	1.09E-01	1.09E-02	50%	44%
R28	road from decline to End Grid ore pile	5.0	20	115	2808	4035	1037	104	12	0.12	3	9.90E-02	1.42E-01	3.66E-02	3.66E-03	50%	44%
R29	road from End Grid ore pile to R25	5.0	20	180	3435	4936	1268	127	8	0.67	11	4.20E-01	6.04E-01	1.55E-01	1.55E-02	50%	44%
R30	Haul road b/n Kiggavik and Sissons	5.0	60	180	3435	4936	1268	127	31	19.6	1229	4.88E+01	7.02E+01	1.80E+01	1.80E+00	50%	0%
R31	Road to Baker Lake (1 km segment modelled)	5.0	70	40	1746	2509	645	64	11	1.00	22	4.45E-01	6.39E-01	1.64E-01	1.64E-02	50%	0%
R32	Road to Airstrip	5.0	60	60	2095	3011	774	77	1	4.15	8	2.01E-01	2.89E-01	7.43E-02	7.43E-03	50%	0%
CWNK	Clean waste pile north - Kiggavik (CW trucks only)	5.0	8	0	0	0	0	0	0	0.30	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	50%	44%
CWNK	Clean waste pile north - Kiggavik (OVB trucks only)	5.0	8	170	3348	4811	1236	124	121	1.55	373	1.45E+01	2.08E+01	5.34E+00	5.34E-01	50%	44%
CWK	Clean waste pile south - Kiggavik	5.0	8	170	3348	4811	1236	124	521	0.53	551	2.13E+01	3.07E+01	7.88E+00	7.88E-01	50%	44%
KOVB	Overburden pile - Kiggavik	5.0	8	170	3348	4811	1236	124	121	0.42	100	3.88E+00	5.58E+00	1.43E+00	1.43E-01	50%	44%
SWK	Special waste pile - Kiggavik	5.0	8	170	3348	4811	1236	124	9	0.26	5	1.90E-01	2.73E-01	7.02E-02	7.02E-03	50%	44%
OREK	Ore pile - Kiggavik	5.0	8	0	0	0	0	0	0	0.26	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	50%	44%
CWS	Clean waste pile - Sissons (CW trucks only)	5.0	8	170	3348	4811	1236	124	639	0.57	731	2.83E+01	4.07E+01	1.05E+01	1.05E+00	50%	44%
CWS	Clean waste pile - Sissons (OVB trucks only)	5.0	8	170	3348	4811	1236	124	77	1.19	184	7.13E+00	1.03E+01	2.63E+00	2.63E-01	50%	44%
SWS	Special waste pile - Sissons	5.0	8	170	3348	4811	1236	124	8	0.10	2	6.05E-02	8.70E-02	2.24E-02	2.24E-03	50%	44%
SOVB	Overburden pile - Sissons	5.0	8	170	3348	4811	1236	124	77	0.34	53	2.04E+00	2.93E+00	7.53E-01	7.53E-02	50%	44%

Source ID	Unpaved Road	Metal Fraction (%) Uranium	As	Co	Cu	Pb	Mo	Ni	Se	Zn	Cd	Cr
EZ	East Zone Pit ramp	2.50E-02	9.20E-05	9.63E-04	1.20E-03	1.24E-03	1.91E-04	2.62E-03	1.14E-04	3.01E-03	4.00E-06	4.58E-03
EZ	East Zone Pit floor	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PB	Purpose Built Pit ramp	2.50E-02	9.20E-05	9.63E-04	1.20E-03	1.24E-03	1.91E-04	2.62E-03	1.14E-04	3.01E-03	4.00E-06	4.58E-03
PB	Purpose Built Pit floor	2.50E-02	8.00E-05	9.50E-04	9.40E-04	2.58E-03	1.20E-03	2.11E-03	2.00E-05	2.73E-03	5.00E-06	5.60E-03
CZ	Centre Zone Pit ramp	6.00E-03	9.20E-05	9.63E-04	1.20E-03	1.24E-03	1.91E-04	2.62E-03	1.14E-04	3.01E-03	4.00E-06	4.58E-03
CZ	Centre Zone Pit floor	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MZEST	Main Zone East Pit ramp	2.00E-02	9.20E-05	9.63E-04	1.20E-03	1.24E-03	1.91E-04	2.62E-03	1.14E-04	3.01E-03	4.00E-06	4.58E-03
MZEST	Main Zone East Pit floor	0.00E+00	5.70E-04	1.70E-03	3.10E-03	5.03E-02	2.87E-02	6.60E-03	2.00E-04	3.90E-03	1.20E-04	1.54E-02
MZWEST	Main Zone West Pit ramp	2.00E-02	9.20E-05	9.63E-04	1.20E-03	1.24E-03	1.91E-04	2.62E-03	1.14E-04	3.01E-03	4.00E-06	4.58E-03
MZWEST	Main Zone West Pit floor	6.81E-01	5.70E-04	1.70E-03	3.10E-03	5.03E-02	2.87E-02	6.60E-03	2.00E-04	3.90E-03	1.20E-04	1.54E-02
AL	Andrew Lake Pit ramp	2.00E-02	3.28E-04	3.73E-04	6.72E-04	8.70E-04	6.90E-05	2.80E-03	1.28E-04	1.34E-03	9.00E-06	8.45E-03
AL	Andrew Lake Pit floor	6.32E-01	1.66E-03	8.30E-04	5.05E-03	3.55E-02	5.57E-03	9.54E-03	5.00E-05	3.41E-03	1.10E-04	9.61E-02
R1	segment off of main zone west ramp	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R2	segment off of main zone west ramp to main zone east ramp	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R3	segment off of main zone east ramp	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R4	segment off of main zone west ramp to CW pile (south)	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R5	segment off of main zone west ramp to west of SW pile	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R6	road north from main zone east to east of SW pile	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R7	road north from east of SW pile to scanner	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R8	road from main zone east ramp to CW pile (south)	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R9	road from main zone east ramp to CW pile (south)	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R10	overburden from main zone to CW pile (north)	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R11	road from east zone pit to CW pile (north)	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R12	road from east zone pit to Centre Zone	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R13	road from east zone pit to Centre Zone ramp	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R14	road from Centre Zone to R15	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R15	road from Centre Zone pit to Purpose Built	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R16	road from Purpose Built to scanner	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R17	road from scanner to ore pile	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R18	road off of purpose built	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R19	site entrance road from Baker Lake (links to R31)	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R20	road off of Andrew Lake to Sissons scanner	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R21	road from Sissons scanner to SW pile	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R22	road from Sissons scanner to ore pile	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R23	road past Sissons scanner to CW pile	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R24	road past Sissons scanner to End Grid road	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R25	road past Sissons scanner to Haul Road	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R26	road from decline to End Grid CW pile	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R27	road from decline to End Grid SW pile	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R28	road from decline to End Grid ore pile	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R29	road from End Grid ore pile to R25	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R30	Haul road b/n Kiggavik and Sissons	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R31	Road to Baker Lake (1 km segment modelled)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
R32	Road to Airstrip	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
CWNK	Clean waste pile north - Kiggavik (CW trucks only)	1.55E-02	9.20E-05	9.63E-04	1.20E-03	1.24E-03	1.91E-04	2.62E-03	1.14E-04	3.01E-03	4.00E-06	4.58E-03
CWNK	Clean waste pile north - Kiggavik (OVB trucks only)	1.55E-02	9.20E-05	9.63E-04	1.20E-03	1.24E-03	1.91E-04	2.62E-03	1.14E-04	3.01E-03	4.00E-06	4.58E-03
CWK	Clean waste pile south - Kiggavik	2.00E-02	9.20E-05	9.63E-04	1.20E-03	1.24E-03	1.91E-04	2.62E-03	1.14E-04	3.01E-03	4.00E-06	4.58E-03
KOVB	Overburden pile - Kiggavik	1.00E-03	8.00E-05	1.12E-03	1.35E-03	1.01E-03	1.90E-04	2.70E-03	1.13E-04	3.55E-03	5.00E-06	4.63E-03
SWK	Special waste pile - Kiggavik	9.00E-02	7.30E-05	1.09E-03	4.51E-03	3.02E-03	1.47E-03	2.22E-03	1.43E-04	3.52E-03	5.00E-06	4.21E-03
OREK	Ore pile - Kiggavik	6.67E-01	1.69E-03	1.47E-03	4.00E-03	4.08E-02	1.75E-02	7.59E-03	2.03E-04	3.76E-03	1.17E-04	4.20E-02
CWS	Clean waste pile - Sissons (CW trucks only)	2.00E-02	3.28E-04	3.73E-04	6.72E-04	8.70E-04	6.90E-05	2.80E-03	1.28E-04	1.34E-03	9.00E-06	8.45E-03
CWS	Clean waste pile - Sissons (OVB trucks only)	2.00E-02	3.28E-04	3.73E-04	6.72E-04	8.70E-04	6.90E-05	2.80E-03	1.28E-04	1.34E-03	9.00E-06	8.45E-03
SWS	Special waste pile - Sissons	9.00E-02	1.92E-04	2.63E-04	5.64E-04	1.41E-03	8.40E-05	2.79E-03	1.10E-04	9.95E-04	1.10E-05	7.71E-03
SOVB	Overburden pile - Sissons	1.00E-03	3.69E-04	3.76E-04	7.40E-04	7.63E-04	6.70E-05	2.71E-03	1.33E-04	1.36E-03	8.00E-06	8.66E-03

Source ID	Unpaved Road	Controlled Emissions (g/s) Annual SPM	SPM	PM_{10}	$PM_{2.5}$	Uranium	As	Co	Cu	Pb	Mo	Ni	Se	Zn	Cd	Cr
EZ	East Zone Pit ramp	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EZ	East Zone Pit floor	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PB	Purpose Built Pit ramp	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PB	Purpose Built Pit floor	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CZ	Centre Zone Pit ramp	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CZ	Centre Zone Pit floor	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MZEST	Main Zone East Pit ramp	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MZEST	Main Zone East Pit floor	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MZWEST	Main Zone West Pit ramp	2.61E+01	3.75E+01	9.63E+00	9.63E-01	7.49E-03	3.45E-05	3.61E-04	4.48E-04	4.65E-04	7.16E-05	9.80E-04	4.27E-05	1.13E-03	1.50E-06	1.71E-03
MZWEST	Main Zone West Pit floor	1.49E+00	2.14E+00	5.50E-01	5.50E-02	1.46E-02	1.22E-05	3.64E-05	6.64E-05	1.08E-03	6.14E-04	1.41E-04	4.28E-06	8.35E-05	2.57E-06	3.30E-04
AL	Andrew Lake Pit ramp	4.22E+01	6.06E+01	1.56E+01	1.56E+00	1.21E-02	1.99E-04	2.26E-04	4.07E-04	5.27E-04	4.18E-05	1.70E-03	7.75E-05	8.14E-04	5.45E-06	5.12E-03
AL	Andrew Lake Pit floor	1.62E+00	2.33E+00	5.99E-01	5.99E-02	1.47E-02	3.87E-05	1.93E-05	1.18E-04	8.27E-04	1.30E-04	2.22E-04	1.17E-06	7.95E-05	2.56E-06	2.24E-03
R1	segment off of main zone west ramp	2.81E-01	4.04E-01	1.04E-01	1.04E-02	4.04E-06	8.07E-07	3.23E-06	1.01E-05	6.46E-06	3.23E-06	1.01E-05	8.07E-07	8.48E-06	4.04E-08	2.42E-05
R2	segment off of main zone west ramp to main zone east ramp	1.47E+00	2.12E+00	5.44E-01	5.44E-02	2.12E-05	4.24E-06	1.69E-05	5.30E-05	3.39E-05	1.69E-05	5.30E-05	4.24E-06	4.45E-05	2.12E-07	1.27E-04
R3	segment off of main zone east ramp	5.13E-01	7.37E-01	1.89E-01	1.89E-02	7.37E-06	1.47E-06	5.89E-06	1.84E-05	1.18E-05	5.89E-06	1.84E-05	1.47E-06	1.55E-05	7.37E-08	4.42E-05
R4	segment off of main zone west ramp to CW pile (south)	4.88E+00	7.02E+00	1.80E+00	1.80E-01	7.02E-05	1.40E-05	5.61E-05	1.75E-04	1.12E-04	5.61E-05	1.75E-04	1.40E-05	1.47E-04	7.02E-07	4.21E-04
R5	segment off of main zone west ramp to west of SW pile	4.92E-02	7.07E-02	1.82E-02	1.82E-03	7.07E-07	1.41E-07	5.65E-07	1.77E-06	1.13E-06	5.65E-07	1.77E-06	1.41E-07	1.48E-06	7.07E-09	4.24E-06
R6	road north from main zone east to east of SW pile	1.58E-01	2.27E-01	5.83E-02	5.83E-03	2.27E-06	4.54E-07	1.82E-06	5.67E-06	3.63E-06	1.82E-06	5.67E-06	4.54E-07	4.77E-06	2.27E-08	1.36E-05
R7	road north from east of SW pile to scanner	2.32E-01	3.33E-01	8.55E-02	8.55E-03	3.33E-06	6.65E-07	2.66E-06	8.32E-06	5.32E-06	2.66E-06	8.32E-06	6.65E-07	6.99E-06	3.33E-08	2.00E-05
R8	road from main zone east ramp to CW pile (south)	5.99E-01	8.61E-01	2.21E-01	2.21E-02	8.61E-06	1.72E-06	6.89E-06	2.15E-05	1.38E-05	6.89E-06	2.15E-05	1.72E-06	1.81E-05	8.61E-08	5.17E-05
R9	road from main zone east ramp to CW pile (south)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
R10	overburden from main zone to CW pile (north)	1.31E+00	1.88E+00	4.83E-01	4.83E-02	1.88E-05	3.76E-06	1.50E-05	4.70E-05	3.01E-05	1.50E-05	4.70E-05	3.76E-06	3.94E-05	1.88E-07	1.13E-04
R11	road from east zone pit to CW pile (north)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
R12	road from east zone pit to Centre Zone	6.64E-01	9.54E-01	2.45E-01	2.45E-02	9.54E-06	1.91E-06	7.63E-06	2.38E-05	1.53E-05	7.63E-06	2.38E-05	1.91E-06	2.00E-05	9.54E-08	5.72E-05
R13	road from east zone pit to Centre Zone ramp	2.93E-01	4.20E-01	1.08E-01	1.08E-02	4.20E-06	8.41E-07	3.36E-06	1.05E-05	6.73E-06	3.36E-06	1.05E-05	8.41E-07	8.83E-06	4.20E-08	2.52E-05
R14	road from Centre Zone to R15	3.09E-01	4.44E-01	1.14E-01	1.14E-02	4.44E-06	8.88E-07	3.55E-06	1.11E-05	7.10E-06	3.55E-06	1.11E-05	8.88E-07	9.32E-06	4.44E-08	2.66E-05
R15	road from Centre Zone pit to Purpose Built	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
R16	road from Purpose Built to scanner	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
R17	road from scanner to ore pile	8.32E-02	1.19E-01	3.07E-02	3.07E-03	1.19E-06	2.39E-07	9.56E-07	2.99E-06	1.91E-06	9.56E-07	2.99E-06	2.39E-07	2.51E-06	1.19E-08	7.17E-06
R18	road off of purpose built	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
R19	site entrance road from Baker Lake (links to R31)	2.08E-01	2.99E-01	7.68E-02	7.68E-03	2.99E-06	5.98E-07	2.39E-06	7.47E-06	4.78E-06	2.39E-06	7.47E-06	5.98E-07	6.27E-06	2.99E-08	1.79E-05
R20	road off of Andrew Lake to Sissons scanner	6.28E+00	9.02E+00	2.32E+00	2.32E-01	9.02E-05	1.80E-05	7.21E-05	2.25E-04	1.44E-04	7.21E-05	2.25E-04	1.80E-05	1.89E-04	9.02E-07	5.41E-04
R21	road from Sissons scanner to SW pile	4.44E-02	6.39E-02	1.64E-02	1.64E-03	6.39E-07	1.28E-07	5.11E-07	1.60E-06	1.02E-06	5.11E-07	1.60E-06	1.28E-07	1.34E-06	6.39E-09	3.83E-06
R22	road from Sissons scanner to ore pile	1.48E+00	2.13E+00	5.47E-01	5.47E-02	2.13E-05	4.26E-06	1.70E-05	5.32E-05	3.40E-05	1.70E-05	5.32E-05	4.26E-06	4.47E-05	2.13E-07	1.28E-04
R23	road past Sissons scanner to CW pile	1.96E+00	2.81E+00	7.22E-01	7.22E-02	2.81E-05	5.62E-06	2.25E-05	7.03E-05	4.50E-05	2.25E-05	7.03E-05	5.62E-06	5.90E-05	2.81E-07	1.69E-04
R24	road past Sissons scanner to End Grid road	1.30E-01	1.87E-01	4.81E-02	4.81E-03	1.87E-06	3.75E-07	1.50E-06	4.68E-06	3.00E-06	1.50E-06	4.68E-06	3.75E-07	3.93E-06	1.87E-08	1.12E-05
R25	road past Sissons scanner to Haul Road	4.50E-01	6.47E-01	1.66E-01	1.66E-02	6.47E-06	1.29E-06	5.18E-06	1.62E-05	1.04E-05	5.18E-06	1.62E-05	1.29E-06	1.36E-05	6.47E-08	3.88E-05
R26	road from decline to End Grid CW pile	8.76E-02	1.26E-01	3.24E-02	3.24E-03	1.26E-06	2.52E-07	1.01E-06	3.15E-06	2.01E-06	1.01E-06	3.15E-06	2.52E-07	2.64E-06	1.26E-08	7.56E-06
R27	road from decline to End Grid SW pile	8.28E-02	1.19E-01	3.06E-02	3.06E-03	1.19E-06	2.38E-07	9.52E-07	2.98E-06	1.90E-06	9.52E-07	2.98E-06	2.38E-07	2.50E-06	1.19E-08	7.14E-06
R28	road from decline to End Grid ore pile	2.77E-02	3.98E-02	1.02E-02	1.02E-03	3.98E-07	7.97E-08	3.19E-07	9.96E-07	6.37E-07	3.19E-07	9.96E-07	7.97E-08	8.37E-07	3.98E-09	2.39E-06
R29	road from End Grid ore pile to R25	1.18E-01	1.69E-01	4.34E-02	4.34E-03	1.69E-06	3.38E-07	1.35E-06	4.23E-06	2.70E-06	1.35E-06	4.23E-06	3.38E-07	3.55E-06	1.69E-08	1.01E-05
R30	Haul road b/n Kiggavik and Sissons	2.44E+01	3.51E+01	9.02E+00	9.02E-01	3.51E-04	7.02E-05	2.81E-04	8.77E-04	5.61E-04	2.81E-04	8.77E-04	7.02E-05	7.37E-04	3.51E-06	2.11E-03
R31	Road to Baker Lake (1 km segment modelled)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
R32	Road to Airstrip	1.01E-01	1.45E-01	3.71E-02	3.71E-03	1.45E-06	2.89E-07	1.16E-06	3.61E-06	2.31E-06	1.16E-06	3.61E-06	2.89E-07	3.03E-06	1.45E-08	8.67E-06
CWNK	Clean waste pile north - Kiggavik (CW trucks only)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CWNK	Clean waste pile north - Kiggavik (OVB trucks only)	4.05E+00	5.82E+00	1.49E+00	1.49E-01	9.04E-04	5.35E-06	5.60E-05	6.96E-05	7.22E-05	1.11E-05	1.52E-04	6.63E-06	1.75E-04	2.33E-07	2.66E-04
CWK	Clean waste pile south - Kiggavik	5.98E+00	8.59E+00	2.21E+00	2.21E-01	1.72E-03	7.90E-06	8.27E-05	1.03E-04	1.07E-04	1.64E-05	2.25E-04	9.79E-06	2.59E-04	3.44E-07	3.93E-04
KOVB	Overburden pile - Kiggavik	1.09E+00	1.56E+00	4.01E-01	4.01E-02	1.56E-05	1.25E-06	1.74E-05	2.11E-05	1.57E-05	2.97E-06	4.21E-05	1.77E-06	5.55E-05	7.81E-08	7.23E-05
SWK	Special waste pile - Kiggavik	5.32E-02	7.65E-02	1.97E-02	1.97E-03	6.88E-05	5.58E-08	8.31E-07	3.45E-06	2.31E-06	1.12E-06	1.70E-06	1.09E-07	2.70E-06	3.82E-09	3.22E-06
OREK	Ore pile - Kiggavik	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CWS	Clean waste pile - Sissons (CW trucks only)	7.93E+00	1.14E+01	2.93E+00	2.93E-01	2.28E-03	3.74E-05	4.25E-05	7.66E-05	9.91E-05	7.86E-06	3.19E-04	1.46E-05	1.53E-04	1.03E-06	9.63E-04
CWS	Clean waste pile - Sissons (OVB trucks only)	2.00E+00	2.87E+00	7.37E-01	7.37E-02	5.74E-04	9.41E-06	1.07E-05	1.93E-05	2.50E-05	1.98E-06	8.05E-05	3.67E-06	3.85E-05	2.58E-07	2.43E-04
SWS	Special waste pile - Sissons	1.70E-02	2.44E-02	6.26E-03	6.26E-04	2.19E-05	4.68E-08	6.41E-08	1.37E-07	3.44E-07	2.05E-08	6.80E-07	2.68E-08	2.42E-07	2.68E-09	1.88E-06
SOVB	Overburden pile - Sissons	5.71E-01	8.21E-01	2.11E-01	2.11E-02	8.21E-06	3.03E-06	3.09E-06	6.07E-06	6.26E-06	5.50E-07	2.22E-05	1.09E-06	1.11E-05	6.57E-08	7.11E-05

Emission Factor Equation	Reference
$E_{unpaved} = k \times (s/12)^a \times (W/3)^b$	AP-42 13.2.2-4, November 2006

Constant	Industrial Roads SPM	Industrial Roads PM_{10}	Industrial Roads $PM_{2.5}$
k	4.9	1.5	0.15
a	0.7	0.9	0.9
b	0.45	0.45	0.45

E = size speific emission factor (lb/VMT)
s = surface materal silt content (%) - equation based on range from 1.8 - 25.2%
W = mean vehicle weight (tons) where 1 tonne = 1.1 tons
1 lb/VMT = 281.9 g/VKT

SILT CONTENT (%)	Location	Low	High	Average
construction sites	scraper routes	0.6	23.0	8.5
sand and gravel processing	plant road	4.1	6.0	4.8
western surface coal mining	plant road	4.9	5.3	5.1
western surface coal mining	haul road to/from pit	2.8	18.0	8.4

Maximum Bounding Emissions Scenario Non-Road Mining Equipment Calculation Spreadsheet - Mines

Equipment	Manufacturer	Model	Number of Units	Power Rating (hp)	Steady-State Emission Factor (g/hp-hr): PM EF_{ss}	NOx EF_{ss}	CO EF_{ss}	HC EF_{ss}	Transient Adjustment Factor (TAF): PM TAF	NOx TAF	CO TAF	HC TAF	BSFC	PM Adj g/hp.hr	% of Maximum Operating Capacity[1]	% Daily Operation[1]
Blasthole Drill Rig -D80SP-150MM	Sandvik	D245S	4	630	0.0092	2.50	0.1330	0.1314	1	1	1	1	0.367	1.1484	80%	100%
Waste 18 m^3 Hydraulic Shovel	Terex / O&K	RH 170	3	2032	0.0690	2.3920	0.7642	0.2815	1	1	1	1	0.367	1.1484	55%	100%
10 m^3 Ore Backhoe	Hitachi	EX1900	1	1025	0.0690	2.3920	0.7642	0.2815	1	1	1	1	0.367	1.1484	57%	100%
Ore Haul Truck	Caterpillar	777 (777F)	0	1016	0.0690	2.3920	0.7642	0.2815	1	1	1	1	0.367	1.1484	50%	100%
Waste Haul Truck	Caterpillar	785C	0	1450	0.0690	2.3920	0.7642	0.2815	1	1	1	1	0.367	1.1484	50%	100%
18.5 m^3 Large Dozer - D10	Caterpillar	D10T	0	580	0.0092	2.50	0.084	0.1314	1	1	1	1	0.367	1.1484	40%	83%
13.5 m^3 Medium Dozer - D9	Caterpillar	D9T	0	410	0.0092	2.50	0.084	0.1314	1	1	1	1	0.367	1.1484	40%	83%
12 m^3 930G Wheel Loader w/ Forks	Caterpillar	930H	0	149	0.0092	2.5	0.087	0.1314	1	1	1	1	0.367	1.1484	59%	100%
22 m^3 Wheel Loader 992HL	Caterpillar	992K	0	801	0.0690	2.3920	0.7642	0.2815	1	1	1	1	0.367	1.1484	59%	100%
Grader 16H	Caterpillar	16H	0	299	0.0092	2.5	0.075	0.1314	1	1	1	1	0.367	1.1484	61%	25%
Blasthole Drill Rig -D80SP-150MM	Sandvik	D245S	4	630	0.0092	2.50	0.1330	0.1314	1	1	1	1	0.367	1.1484	80%	100%
Waste 18 m^3 Hydraulic Shovel	Terex / O&K	RH 170	3	2032	0.0690	2.3920	0.7642	0.2815	1	1	1	1	0.367	1.1484	55%	100%
10 m^3 Ore Backhoe	Hitachi	EX1900	1	1025	0.0690	2.3920	0.7642	0.2815	1	1	1	1	0.367	1.1484	57%	100%
Ore Haul Truck	Caterpillar	777 (777F)	0	1016	0.0690	2.3920	0.7642	0.2815	1	1	1	1	0.367	1.1484	50%	100%
Waste Haul Truck	Caterpillar	785C	0	1450	0.0690	2.3920	0.7642	0.2815	1	1	1	1	0.367	1.1484	50%	100%
18.5 m^3 Large Dozer - D10	Caterpillar	D10T	0	580	0.0092	2.50	0.084	0.1314	1	1	1	1	0.367	1.1484	40%	83%
13.5 m^3 Medium Dozer - D9	Caterpillar	D9T	0	410	0.0092	2.50	0.084	0.1314	1	1	1	1	0.367	1.1484	40%	83%
12 m^3 930G Wheel Loader w/ Forks	Caterpillar	930H	0	149	0.0092	2.5	0.087	0.1314	1	1	1	1	0.367	1.1484	59%	100%
22 m^3 Wheel Loader 992HL	Caterpillar	992K	0	801	0.0690	2.3920	0.7642	0.2815	1	1	1	1	0.367	1.1484	59%	100%
Grader 16H	Caterpillar	16H	0	299	0.0092	2.5	0.075	0.1314	1	1	1	1	0.367	1.1484	61%	25%
Production loader (6 m^3)	n/a	n/a	2	705	0.0092	2.5	0.133	0.1314	1	1	1	1	0.3670	1.1484	85%	85%
Development loader (6 m^3)	n/a	n/a	1	353	0.0092	2.5	0.084	0.1314	1	1	1	1	0.3670	1.1484	85%	85%
Rammer-Jammer CRF loader (6 m^3)	n/a	n/a	1	353	0.0092	2.5	0.084	0.1314	1	1	1	1	0.3670	1.1484	85%	85%
Production haulage truck (45 tonne)	n/a	n/a	2	1173	0.0690	2.3920	0.764	0.2815	1	1	1	1	0.3670	1.1484	85%	85%
Development haulage truck (45 tonne)	n/a	n/a	1	586	0.0092	2.50	0.084	0.1314	1	1	1	1	0.3670	1.1484	85%	85%
Backfill truck (45 tonne)	n/a	n/a	1	586	0.0092	2.50	0.084	0.1314	1	1	1	1	0.3670	1.1484	85%	85%
Production Drill Jumbo (2-boom)	n/a	n/a	2	294	0.0092	2.5	0.075	0.1314	1	1	1	1	0.3670	1.1484	85%	85%
Development Drill Jumbo (2-boom)	n/a	n/a	1	148	0.0092	2.5	0.087	0.1314	1	1	1	1	0.3670	1.1484	85%	85%
Blasters truck	n/a	n/a	1	148	0.0092	2.5	0.087	0.1314	1	1	1	1	0.3670	1.1484	85%	85%
Production bolter	n/a	n/a	2	294	0.0092	2.5	0.075	0.1314	1	1	1	1	0.3670	1.1484	85%	85%
Development bolter	n/a	n/a	1	148	0.0092	2.5	0.087	0.1314	1	1	1	1	0.3670	1.1484	85%	85%
Grader	n/a	n/a	1	165	0.0092	2.5	0.087	0.1314	1	1	1	1	0.3670	1.1484	85%	85%
Shotcrete carrier	n/a	n/a	2	294	0.0092	2.5	0.075	0.1314	1	1	1	1	0.3670	1.1484	85%	85%
Scissorlifts	n/a	n/a	3	231	0.0092	2.5	0.075	0.1314	1	1	1	1	0.3670	1.1484	85%	85%
Fuel truck	n/a	n/a	1	148	0.0092	2.5	0.087	0.1314	1	1	1	1	0.3670	1.1484	85%	85%
Boom truck	n/a	n/a	1	50	0.2	3	2.366	0.1836	1	1	1	1	0.4080	1.2767	85%	85%
Jeeps	n/a	n/a	8	359	0.0092	2.50	0.084	0.1314	1	1	1	1	0.3670	1.1484	85%	85%
Surveyor jeep (w scissorlift)	n/a	n/a	1	90	0.0092	3	0.2370	0.1314	1	1	1	1	0.4080	1.2767	85%	85%
Mehcanics truck	n/a	n/a	1	148	0.0092	2.5	0.09	0.13	1	1	1	1	0.3670	1.1484	85%	85%
Electrician truck	n/a	n/a	1	148	0.0092	2.5	0.09	0.13	1	1	1	1	0.3670	1.1484	85%	85%
Personnel carrier	n/a	n/a	1	148	0.0092	2.5	0.09	0.13	1	1	1	1	0.3670	1.1484	85%	85%
Underground total																

Equipment	Uncontrolled (g/s): TSP	PM_{10}	$PM_{2.5}$	Uranium	As	Co	Cu	Pb	Mo	Ni	Se	Zn	Cd	Cr	NOx	SO_2	CO
Blasthole Drill Rig -D80SP-150MM	0.0052	0.0052	0.0050	0	0	0	0	0	0	0	0	0	0	0	1.4000	0.003	0.0745
Waste 18 m^3 Hydraulic Shovel	0.0643	0.0643	0.0623	0	0	0	0	0	0	0	0	0	0	0	2.2277	0.003	0.7117
10 m^3 Ore Backhoe	0.0112	0.0112	0.0109	0	0	0	0	0	0	0	0	0	0	0	0.3882	0.003	0.1240
Ore Haul Truck	0.0000	0.0000	0.0000	0	0	0	0	0	0	0	0	0	0	0	0.0000	0.003	0.0000
Waste Haul Truck	0.0000	0.0000	0.0000	0	0	0	0	0	0	0	0	0	0	0	0.0000	0.003	0.0000
18.5 m^3 Large Dozer - D10	0.0000	0.0000	0.0000	0	0	0	0	0	0	0	0	0	0	0	0.0000	0.003	0.0000
13.5 m^3 Medium Dozer - D9	0.0000	0.0000	0.0000	0	0	0	0	0	0	0	0	0	0	0	0.0000	0.003	0.0000
12 m^3 930G Wheel Loader w/ Forks	0.0000	0.0000	0.0000	0	0	0	0	0	0	0	0	0	0	0	0.0000	0.003	0.0000
22 m^3 Wheel Loader 992HL	0.0000	0.0000	0.0000	0	0	0	0	0	0	0	0	0	0	0	0.0000	0.003	0.0000
Grader 16H	0.0000	0.0000	0.0000	0	0	0	0	0	0	0	0	0	0	0	0.0000	0.003	0.0000
Blasthole Drill Rig -D80SP-150MM	0.0052	0.0052	0.0050	0	0	0	0	0	0	0	0	0	0	0	1.4000	0.003	0.0745
Waste 18 m^3 Hydraulic Shovel	0.0643	0.0643	0.0623	0	0	0	0	0	0	0	0	0	0	0	2.2277	0.003	0.7117
10 m^3 Ore Backhoe	0.0112	0.0112	0.0109	0	0	0	0	0	0	0	0	0	0	0	0.3882	0.003	0.1240
Ore Haul Truck	0.0000	0.0000	0.0000	0	0	0	0	0	0	0	0	0	0	0	0.0000	0.003	0.0000
Waste Haul Truck	0.0000	0.0000	0.0000	0	0	0	0	0	0	0	0	0	0	0	0.0000	0.003	0.0000
18.5 m^3 Large Dozer - D10	0.0000	0.0000	0.0000	0	0	0	0	0	0	0	0	0	0	0	0.0000	0.003	0.0000
13.5 m^3 Medium Dozer - D9	0.0000	0.0000	0.0000	0	0	0	0	0	0	0	0	0	0	0	0.0000	0.003	0.0000
12 m^3 930G Wheel Loader w/ Forks	0.0000	0.0000	0.0000	0	0	0	0	0	0	0	0	0	0	0	0.0000	0.003	0.0000
22 m^3 Wheel Loader 992HL	0.0000	0.0000	0.0000	0	0	0	0	0	0	0	0	0	0	0	0.0000	0.003	0.0000
Grader 16H	0.0000	0.0000	0.0000	0	0	0	0	0	0	0	0	0	0	0	0.0000	0.003	0.0000
Production loader (6 m^3)	0.0026	0.0026	0.0025	0	0	0	0	0	0	0	0	0	0	0	0.7078	0.003	0.0377
Development loader (6 m^3)	0.0007	0.0007	0.0006	0	0	0	0	0	0	0	0	0	0	0	0.1770	0.003	0.0059
Rammer-Jammer CRF loader (6 m^3)	0.0007	0.0007	0.0006	0	0	0	0	0	0	0	0	0	0	0	0.1770	0.003	0.0059
Production haulage truck (45 tonne)	0.0325	0.0325	0.0315	0	0	0	0	0	0	0	0	0	0	0	1.1266	0.003	0.3599
Development haulage truck (45 tonne)	0.0011	0.0011	0.0010	0	0	0	0	0	0	0	0	0	0	0	0.2940	0.003	0.0099
Backfill truck (45 tonne)	0.0011	0.0011	0.0010	0	0	0	0	0	0	0	0	0	0	0	0.2940	0.003	0.0099
Production Drill Jumbo (2-boom)	0.0011	0.0011	0.0011	0	0	0	0	0	0	0	0	0	0	0	0.2947	0.003	0.0088
Development Drill Jumbo (2-boom)	0.0003	0.0003	0.0003	0	0	0	0	0	0	0	0	0	0	0	0.0740	0.003	0.0026
Blasters truck	0.0003	0.0003	0.0003	0	0	0	0	0	0	0	0	0	0	0	0.0740	0.003	0.0026
Production bolter	0.0011	0.0011	0.0011	0	0	0	0	0	0	0	0	0	0	0	0.2947	0.003	0.0088
Development bolter	0.0003	0.0003	0.0003	0	0	0	0	0	0	0	0	0	0	0	0.0740	0.003	0.0026
Grader	0.0003	0.0003	0.0003	0	0	0	0	0	0	0	0	0	0	0	0.0828	0.003	0.0029
Shotcrete carrier	0.0011	0.0011	0.0011	0	0	0	0	0	0	0	0	0	0	0	0.2947	0.003	0.0088
Scissorlifts	0.0013	0.0013	0.0012	0	0	0	0	0	0	0	0	0	0	0	0.3472	0.003	0.0104
Fuel truck	0.0003	0.0003	0.0003	0	0	0	0	0	0	0	0	0	0	0	0.0740	0.003	0.0026
Boom truck	0.0020	0.0020	0.0019	0	0	0	0	0	0	0	0	0	0	0	0.0299	0.004	0.0236
Jeeps	0.0053	0.0053	0.0051	0	0	0	0	0	0	0	0	0	0	0	1.4425	0.003	0.0485
Surveyor jeep (w scissorlift)	0.0002	0.0002	0.0002	0	0	0	0	0	0	0	0	0	0	0	0.0541	0.004	0.0043
Mehcanics truck	0.0003	0.0003	0.0003	0	0	0	0	0	0	0	0	0	0	0	0.0740	0.003	0.0026
Electrician truck	0.0003	0.0003	0.0003	0	0	0	0	0	0	0	0	0	0	0	0.0740	0.003	0.0026
Personnel carrier	0.0003	0.0003	0.0003	0	0	0	0	0	0	0	0	0	0	0	0.0740	0.003	0.0026
Underground total	5.28E-02	5.28E-02	5.12E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.13E+00	7.41E-02	5.63E-01

Notes:

Cells highlighed gray indicates that emissions of a contaminant are zero.

Emission factors were obtained from the USEPA document *Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling - Compression Ignition* dated July 2010, EPA-420-R-10-018.

- see Table A4. *Zero Steady-State Emission Factors for Nonroad CI Engines*
- assumed Tier 4 (Tier 4A or just Tier 4), which are applicable to model years 2011 to 2014. No adjustments (i.e., TAF or sulphur content) needed to Tier 4 Efs.
- TAF is 1 for Tier 4 models. Also, PM not adjusted for sulphur content (resulted in a negative value)
- SO2 calculated using the following equation:

$$SO2 = (BSFC \times 453.6 \times (1 - soxcnv) - HC) \times 0.01 \times soxdsl \times 2$$

where:

soxcnv is the fraction of fuel sulphur converted to direct PM (0.3 for Tier 4)

soxdsl is the episodic weight % of sulphur in nonroad diesel fuel

[1] % of maximum operating capacity for open ptis based on manufacturer's brochure or assumption from URBEMIS2007 Model Appendix G for each piece of Equipment (equipment not listed in Appendix G assumed to be "Other General Industrial Equipment").

% daily operation in open pits based on the same document or assumed 100%.

Size Fraction	% in Range	Reference
PM <30 µm	100%	EPA420-R-10-018, July 2010
PM <10 µm	100%	EPA420-R-10-018, July 2010
PM <2.5 µm	97%	EPA420-R-10-018, July 2010

Allocation of Emissions to Active Pits

Source	BCM Excavated per Year - Total	% of Toal Excavated per Year	BCM Excavated per Year - Waste	% of Toal Excavated per Year	kt Excavated per Year - Ore	% of Toal Excavated per Year	Uncontrolled (g/s): TSP	PM_{10}	$PM_{2.5}$	Uranium	As	Co	Cu	Pb	Mo	Ni	Se	Zn	Cd	Cr	NOx	SO_2	CO
East Zone Pit	0	0%	0	0%	0	0%	0.0000	0.0000	0.0000	0	0	0	0	0	0	0	0	0	0	0	0.0000	0.0000	0.0000
Purpose Built Pit	0	0%	0	0%	0	0%	0.0000	0.0000	0.0000	0	0	0	0	0	0	0	0	0	0	0	0.0000	0.0000	0.0000
Centre Zone Pit	0	0%	0	0%	0	0%	0.0000	0.0000	0.0000	0	0	0	0	0	0	0	0	0	0	0	0.0000	0.0000	0.0000
Main Zone West Pit	9,066,125	100%	11,532,273	100%	1,122	100%	0.0806	0.0806	0.0782	0	0	0	0	0	0	0	0	0	0	0	4.0160	0.0349	0.9102
Main Zone East Pit	0	0%	0	0%	0	0%	0.0000	0.0000	0.0000	0	0	0	0	0	0	0	0	0	0	0	0.0000	0.0000	0.0000
Andrew Lake Pit	10,211,045	100%	12,238,741	100%	741	100%	0.0806	0.0806	0.0782	0	0	0	0	0	0	0	0	0	0	0	4.0160	0.0349	0.9102

Notes:

Cells highlighed gray indicates that emissions of a contaminant are zero.

Maximum Bounding Emissions Scenario Non-Road Mining Equipment Calculation Spreadsheet – Stockpiles

Equipment	Manufacturer	Model	Number of Units	Power Rating (hp)	Steady-State Emission Factor (g/hp-hr): PM EF_{ss}	NOx EF_{ss}	CO EF_{ss}	HC EF_{ss}	Transient Adjustment Factor (TAF): PM TAF	NOx TAF	CO TAF	HC TAF	BSFC	PM Adj g/hp.hr	% of Maximum Operating Capacity[1]	% Daily Operation[1]
Blasthole Drill Rig -D80SP-150MM	Sandvik	D245S	0	630	0.0092	2.50	0.1330	0.1314	1	1	1	1	0.367	1.1484	80%	100%
Waste 18 m^3 Hydraulic Shovel	Terex / O&K	RH 170	0	2032	0.0690	2.3920	0.7642	0.2815	1	1	1	1	0.367	1.1484	55%	100%
10 m^3 Ore Backhoe	Hitachi	EX1900	0	1025	0.0690	2.3920	0.7642	0.2815	1	1	1	1	0.367	1.1484	57%	100%
Ore Haul Truck	Caterpillar	777 (777F)	0	1016	0.0690	2.3920	0.7642	0.2815	1	1	1	1	0.367	1.1484	50%	100%
Waste Haul Truck	Caterpillar	785C	0	1450	0.0690	2.3920	0.7642	0.2815	1	1	1	1	0.367	1.1484	50%	100%
18.5 m^3 Large Dozer - D10	Caterpillar	D10T	2	580	0.0092	2.50	0.084	0.1314	1	1	1	1	0.367	1.1484	40%	83%
13.5 m^3 Medium Dozer - D9	Caterpillar	D9T	1	410	0.0092	2.50	0.084	0.1314	1	1	1	1	0.367	1.1484	40%	83%
12 m^3 930G Wheel Loader w/ Forks	Caterpillar	930H	2	149	0.0092	2.5	0.087	0.1314	1	1	1	1	0.367	1.1484	59%	100%
22 m^3 Wheel Loader 992HL	Caterpillar	992K	2	801	0.0690	2.3920	0.7642	0.2815	1	1	1	1	0.367	1.1484	59%	100%
Grader 16H	Caterpillar	16H	0	299	0.0092	2.5	0.075	0.1314	1	1	1	1	0.367	1.1484	61%	25%
Blasthole Drill Rig -D80SP-150MM	Sandvik	D245S	0	630	0.0092	2.50	0.1330	0.1314	1	1	1	1	0.367	1.1484	80%	100%
Waste 18 m^3 Hydraulic Shovel	Terex / O&K	RH 170	0	2032	0.0690	2.3920	0.7642	0.2815	1	1	1	1	0.367	1.1484	55%	100%
10 m^3 Ore Backhoe	Hitachi	EX1900	0	1025	0.0690	2.3920	0.7642	0.2815	1	1	1	1	0.367	1.1484	57%	100%
Ore Haul Truck	Caterpillar	777 (777F)	0	1016	0.0690	2.3920	0.7642	0.2815	1	1	1	1	0.367	1.1484	50%	100%
Waste Haul Truck	Caterpillar	785C	0	1450	0.0690	2.3920	0.7642	0.2815	1	1	1	1	0.367	1.1484	50%	100%
18.5 m^3 Large Dozer - D10	Caterpillar	D10T	2	580	0.0092	2.50	0.084	0.1314	1	1	1	1	0.367	1.1484	40%	83%
13.5 m^3 Medium Dozer - D9	Caterpillar	D9T	1	410	0.0092	2.50	0.084	0.1314	1	1	1	1	0.367	1.1484	40%	83%
12 m^3 930G Wheel Loader w/ Forks	Caterpillar	930H	2	149	0.0092	2.5	0.087	0.1314	1	1	1	1	0.367	1.1484	59%	100%
22 m^3 Wheel Loader 992HL	Caterpillar	992K	2	801	0.0690	2.3920	0.7642	0.2815	1	1	1	1	0.367	1.1484	59%	100%
Grader 16H	Caterpillar	16H	0	299	0.0092	2.5	0.075	0.1314	1	1	1	1	0.367	1.1484	61%	25%

Equipment	Uncontrolled (g/s): TSP	PM_{10}	$PM_{2.5}$	Uranium	As	Co	Cu	Pb	Mo	Ni	Se	Zn	Cd	Cr	NOx	SO_2	CO	CO_2	CH_4
Blasthole Drill Rig -D80SP-150MM	0.0000	0.0000	0.0000	0	0	0	0	0	0	0	0	0	0	0	0.0000	0.003	0.0000	0	0
Waste 18 m^3 Hydraulic Shovel	0.0000	0.0000	0.0000	0	0	0	0	0	0	0	0	0	0	0	0.0000	0.003	0.0000	0	0
10 m^3 Ore Backhoe	0.0000	0.0000	0.0000	0	0	0	0	0	0	0	0	0	0	0	0.0000	0.003	0.0000	0	0
Ore Haul Truck	0.0000	0.0000	0.0000	0	0	0	0	0	0	0	0	0	0	0	0.0000	0.003	0.0000	0	0
Waste Haul Truck	0.0000	0.0000	0.0000	0	0	0	0	0	0	0	0	0	0	0	0.0000	0.003	0.0000	0	0
18.5 m^3 Large Dozer - D10	0.0010	0.0010	0.0010	0	0	0	0	0	0	0	0	0	0	0	0.2685	0.003	0.0090	0	0
13.5 m^3 Medium Dozer - D9	0.0003	0.0003	0.0003	0	0	0	0	0	0	0	0	0	0	0	0.0949	0.003	0.0032	0	0
12 m^3 930G Wheel Loader w/ Forks	0.0004	0.0004	0.0004	0	0	0	0	0	0	0	0	0	0	0	0.1221	0.003	0.0042	0	0
22 m^3 Wheel Loader 992HL	0.0181	0.0181	0.0176	0	0	0	0	0	0	0	0	0	0	0	0.6280	0.003	0.2006	0	0
Grader 16H	0.0000	0.0000	0.0000	0	0	0	0	0	0	0	0	0	0	0	0.0000	0.003	0.0000	0	0
Blasthole Drill Rig -D80SP-150MM	0.0000	0.0000	0.0000	0	0	0	0	0	0	0	0	0	0	0	0.0000	0.003	0.0000	0	0
Waste 18 m^3 Hydraulic Shovel	0.0000	0.0000	0.0000	0	0	0	0	0	0	0	0	0	0	0	0.0000	0.003	0.0000	0	0
10 m^3 Ore Backhoe	0.0000	0.0000	0.0000	0	0	0	0	0	0	0	0	0	0	0	0.0000	0.003	0.0000	0	0
Ore Haul Truck	0.0000	0.0000	0.0000	0	0	0	0	0	0	0	0	0	0	0	0.0000	0.003	0.0000	0	0
Waste Haul Truck	0.0000	0.0000	0.0000	0	0	0	0	0	0	0	0	0	0	0	0.0000	0.003	0.0000	0	0
18.5 m^3 Large Dozer - D10	0.0010	0.0010	0.0010	0	0	0	0	0	0	0	0	0	0	0	0.2685	0.003	0.0090	0	0
13.5 m^3 Medium Dozer - D9	0.0003	0.0003	0.0003	0	0	0	0	0	0	0	0	0	0	0	0.0949	0.003	0.0032	0	0
12 m^3 930G Wheel Loader w/ Forks	0.0004	0.0004	0.0004	0	0	0	0	0	0	0	0	0	0	0	0.1221	0.003	0.0042	0	0
22 m^3 Wheel Loader 992HL	0.0181	0.0181	0.0176	0	0	0	0	0	0	0	0	0	0	0	0.6280	0.003	0.2006	0	0
Grader 16H	0.0000	0.0000	0.0000	0	0	0	0	0	0	0	0	0	0	0	0.0000	0.003	0.0000	0	0

Notes:

Emission factors were obtained from the USEPA document *Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling - Compression Ignition* dated July 2010, EPA-420-R-10-018.

Cells highlighed gray indicates that emissions of a contaminant are zero.

- see Table A4. *Zero Steady-State Emission Factors for Nonroad CI Engines*
- assumed Tier 4 (Tier 4A or just Tier 4), which are applicable to model years 2011 to 2014. No adjustments (i.e., TAF or sulphur content) needed to Tier 4 Efs.
- TAF is 1 for Tier 4 models. Also, PM not adjusted for sulphur content (resulted in a negative value)
- SO2 calculated using the following equation:

$$SO2=(BSFC \times 453.6 \times (1-soxcnv)-HC) \times 0.01 \times soxdsl \times 2$$

where:

soxcnv is the fraction of fuel sulphur converted to direct PM (0.3 for Tier 4)

soxdsl is the episodic weight % of sulphur in nonroad diesel fuel

[1] % of maximum operating capacity for open ptis based on manufacturer's brochure or assumption from URBEMIS2007 Model Appendix G for each piece of Equipment (equipment not listed in Appendix G assumed to be "Other General Industrial Equipment").

% daily operation in open pits based on the same document or assumed 100%.

Size Fraction	% in Range	Reference
PM <30 µm	100%	EPA420-R-10-018, July 2010
PM <10 µm	100%	EPA420-R-10-018, July 2010
PM <2.5 µm	97%	EPA420-R-10-018, July 2010

Allocation of Emissions to Active Piles

Source	BCM Material per Year - Total	% of Total Material per Year	BCM Material per Year - Waste	% of Toal Material per Year	BCM Material per Year - Ore	% of Toal Material per Year	Uncontrolled (g/s): TSP	PM_{10}	$PM_{2.5}$	Uranium	As	Co	Cu	Pb	Mo	Ni	Se	Zn	Cd	Cr	NOx	SO_2	CO	CO_2	CH_4
Kiggavik Ore Pile	470,729	4%	0	0%	470,729	100%	0.0007	0.0007	0.0007	0	0	0	0	0	0	0	0	0	0	0	0.0294	0.0075	0.0080	0.0000	0.0000
Kiggavik Waste Rock Pile	142,417	1%	142,417	1%	0	0%	0.0002	0.0002	0.0002	0	0	0	0	0	0	0	0	0	0	0	0.0134	0.0003	0.0026	0.0000	0.0000
Kiggavik Clean Rock Pile North	0	0%	0	0%	0	0%	0.0000	0.0000	0.0000	0	0	0	0	0	0	0	0	0	0	0	0.0000	0.0000	0.0000	0.0000	0.0000
Kiggavik Clean Rock Pile South	8,265,521	69%	8,265,521	72%	0	0%	0.0137	0.0137	0.0133	0	0	0	0	0	0	0	0	0	0	0	0.7770	0.0196	0.1498	0.0000	0.0000
Kiggavik Overburden Pile	3,124,334	26%	3,124,334	27%	0	0%	0.0052	0.0052	0.0050	0	0	0	0	0	0	0	0	0	0	0	0.2937	0.0074	0.0566	0.0000	0.0000
Andrew Lake Ore Pad	0	0%	0	0%	0	0%	0.0000	0.0000	0.0000	0	0	0	0	0	0	0	0	0	0	0	0.0000	0.0000	0.0000	0.0000	0.0000
Andrew Lake Waste Rock Pile	123,383	1%	123,383	1%	0	0%	0.0002	0.0002	0.0002	0	0	0	0	0	0	0	0	0	0	0	0.0112	0.0003	0.0022	0.0000	0.0000
Andrew Lake Clean Rock Pile	10,125,844	83%	10,125,844	83%	0	0%	0.0165	0.0165	0.0160	0	0	0	0	0	0	0	0	0	0	0	0.9213	0.0231	0.1796	0.0000	0.0000
Andrew Lake Overburden Pile	1,989,514	16%	1,989,514	16%	0	0%	0.0032	0.0032	0.0031	0	0	0	0	0	0	0	0	0	0	0	0.1810	0.0045	0.0353	0.0000	0.0000

Note: Since End Grid Piles and ORES are small and temporary, equipment will primarily be used on larger piles, therefore, they were not included.

Cells highlighed gray indicates that emissions of a contaminant are zero.

Maximum Bounding Emissions Scenario Non-Road Mining Equipment Calculation Spreadsheet – Mine Roads

Equipment	Manufacturer	Model	Steady-State Emission Factor (g/hp-hr)				Transient Adjustment Factor (TAF)				BSFC	PM Adj	Emission Factor per Unit in g/hp-hr							
			PM EF_{ss}	NOx EF_{ss}	CO EF_{ss}	HC EF_{ss}	PM TAF	NOx TAF	CO TAF	HC TAF		g/hp.hr	SPM	PM_{10}	$PM_{2.5}$	NOx	SO_2	CO	CO_2	CH_4
Ore Haul Truck	Caterpillar	777 (777F)	0.0690	2.3920	0.7642	0.2815	1	1	1	1	0.367	1.1484	0.069	0.069	0.067	2.392	0.003	0.764	0	0
Waste Haul Truck	Caterpillar	785C	0.0690	2.3920	0.7642	0.2815	1	1	1	1	0.367	1.1484	0.069	0.069	0.067	2.392	0.003	0.764	0	0
Water Truck	Peterbilt	348	0.0092	2.50	0.084	0.1314	1	1	1	1	0.367	1.1484	0.009	0.009	0.009	2.500	0.003	0.084	0	0
Grader 16H	Caterpillar	16H	0.0092	2.50	0.075	0.1314	1	1	1	1	0.367	1.1484	0.009	0.009	0.009	2.500	0.003	0.075	0	0

Notes:

Emission factors were obtained from the USEPA document *Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling - Compression Ignition* dated July 2010, EPA-420-R-10-018.

- see Table A4. *Zero Steady-State Emission Factors for Nonroad CI Engines*
- assumed Tier 4 (Tier 4A or just Tier 4), which are applicable to model years 2011 to 2014. No adjustments (i.e., TAF or sulphur content) needed to Tier 4 Efs.
- TAF is 1 for Tier 4 models. Also, PM not adjusted for sulphur content (resulted in a negative value)
- SO2 calculated using the following equation:

$$SO2=(BSFC\times453.6\times(1-soxcnv)-\mathrm{HC})\times0.01\times\mathrm{soxdsl}\times2$$

where:
soxcnv is the fraction of fuel sulphur converted to direct PM (0.3 for Tier 4)
soxdsl is the episodic weight % of sulphur in nonroad diesel fuel

Size Fraction	% in Range	Reference
PM <30 µm	100%	EPA420-R-10-018, July 2010
PM <10 µm	100%	EPA420-R-10-018, July 2010
PM <2.5 µm	97%	EPA420-R-10-018, July 2010

Equipment	Manufacturer	Model	Power Rating (hp)	Average Speed (km/hr)	Emission Factor per Unit in g/VKT							
					SPM	PM_{10}	$PM_{2.5}$	NOx	SO_2	CO	CO_2	CH_4*
Ore Truck	Caterpillar	777 (777F)	1016	20	3.51	3.51	3.40	121.51	0.18	38.82	0.00	0.00
Waste Haul Truck	Caterpillar	785C	1450	20	5.00	5.00	4.85	173.42	0.25	55.40	0.00	0.00
Water Truck	Peterbilt	348	330	20	0.15	0.15	0.15	41.25	0.06	1.39	0.00	0.00
Grader 16H	Caterpillar	16H	299	8	0.34	0.34	0.33	93.44	0.13	2.80	0.00	0.00

On-Site Roads Tailpipe

Summer — Note: Enter **Summer** for June, July, August September, otherwise, enter **Winter**

Unpaved Road	One way length (km)	One-way Trips per Day - Ore	One-way Trips per Day - Waste	One-way Trips per Day - Water Truck	One-way Trips per Day - Grader	VKT per day - Ore	VKT per day - Waste	VKT per day - Water	VKT per day - Grader	Uncontrolled Emissions (g/s)								Control Efficiency (%)
										SPM	PM_{10}	$PM_{2.5}$	NOx	SO_2	CO	CO_2	CH_4*	
East Zone Pit ramp	0.50	0	0	0	0	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0%
East Zone Pit floor	0.05	0	0	0	0	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0%
Purpose Built Pit ramp	0.30	0	0	0	0	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0%
Purpose Built Pit floor	0.02	0	0	0	0	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0%
Centre Zone Pit ramp	0.85	0	0	0	0	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0%
Centre Zone Pit floor	0.05	0	0	0	0	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0%
Main Zone East Pit ramp	0.40	0	0	0	0	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0%
Main Zone East Pit floor	0.10	0	0	0	0	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0%
Main Zone West Pit ramp	1.75	41	651	0	1	143.89	2280.00	0.00	3.50	1.38E-01	1.38E-01	1.34E-01	4.78E+00	6.97E-03	1.53E+00	0.00E+00	0.00E+00	0%
Main Zone West Pit floor	0.10	41	651	0	1	8.22	130.29	0.00	0.20	7.88E-03	7.88E-03	7.64E-03	2.73E-01	3.98E-04	8.72E-02	0.00E+00	0.00E+00	0%
Andrew Lake Pit ramp	2.60	28	724	0	1	144.44	3762.57	0.00	5.20	2.24E-01	2.24E-01	2.17E-01	7.76E+00	1.13E-02	2.48E+00	0.00E+00	0.00E+00	0%
Andrew Lake Pit floor	0.10	28	724	0	1	5.56	144.71	0.00	0.20	8.61E-03	8.61E-03	8.35E-03	2.98E-01	4.35E-04	9.53E-02	0.00E+00	0.00E+00	0%
segment off of main zone west ramp	0.08	41	130	0	1	6.45	20.40	0.00	0.16	1.44E-03	1.44E-03	1.40E-03	5.02E-02	7.32E-05	1.60E-02	0.00E+00	0.00E+00	0%
segment off of main zone west ramp to main zone east ramp	0.44	41	121	0	1	35.88	105.35	0.00	0.87	7.56E-03	7.56E-03	7.33E-03	2.63E-01	3.83E-04	8.37E-02	0.00E+00	0.00E+00	0%
segment off of main zone east ramp	0.15	41	121	0	1	12.47	36.63	0.00	0.30	2.63E-03	2.63E-03	2.55E-03	9.14E-02	1.33E-04	2.91E-02	0.00E+00	0.00E+00	0%
segment off of main zone west ramp to CW pile (south)	0.43	0	521	0	1	0.00	449.96	0.00	0.86	2.61E-02	2.61E-02	2.53E-02	9.04E-01	1.32E-03	2.89E-01	0.00E+00	0.00E+00	0%
segment off of main zone west ramp to west of SW pile	0.24	0	9	0	1	0.00	4.53	0.00	0.49	2.64E-04	2.64E-04	2.56E-04	9.63E-03	1.40E-05	2.92E-03	0.00E+00	0.00E+00	0%
road north from main zone east to east of SW pile	0.21	41	0	0	1	17.36	0.00	0.00	0.42	7.06E-04	7.06E-04	6.85E-04	2.49E-02	3.62E-05	7.81E-03	0.00E+00	0.00E+00	0%
road north from east of SW pile to scanner	0.31	41	0	0	1	25.45	0.00	0.00	0.62	1.03E-03	1.03E-03	1.00E-03	3.65E-02	5.31E-05	1.15E-02	0.00E+00	0.00E+00	0%
road from main zone east ramp to CW pile (south)	0.23	0	121	0	1	0.00	55.25	0.00	0.46	3.20E-03	3.20E-03	3.10E-03	1.11E-01	1.62E-04	3.54E-02	0.00E+00	0.00E+00	0%
road from main zone east ramp to CW pile (south)	0.14	0	0	0	0	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0%
overburden from main zone to CW pile (north)	0.50	0	121	0	1	0.00	120.47	0.00	1.00	6.98E-03	6.98E-03	6.77E-03	2.43E-01	3.54E-04	7.73E-02	0.00E+00	0.00E+00	0%
road from east zone pit to CW pile (north)	0.21	0	0	0	0	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0%
road from east zone pit to Centre Zone	0.25	0	121	0	1	0.00	61.18	0.00	0.51	3.54E-03	3.54E-03	3.44E-03	1.23E-01	1.80E-04	3.92E-02	0.00E+00	0.00E+00	0%
road from east zone pit to Centre Zone ramp	0.11	0	121	0	1	0.00	26.97	0.00	0.22	1.56E-03	1.56E-03	1.52E-03	5.44E-02	7.93E-05	1.73E-02	0.00E+00	0.00E+00	0%
road from Centre Zone to R15	0.12	0	121	0	1	0.00	28.47	0.00	0.24	1.65E-03	1.65E-03	1.60E-03	5.74E-02	8.37E-05	1.83E-02	0.00E+00	0.00E+00	0%
road from Centre Zone pit to Purpose Built	0.25	0	0	0	0	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0%
road from Purpose Built to scanner	0.24	0	0	0	0	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0%
road from scanner to ore pile	0.11	41	0	0	1	9.14	0.00	0.00	0.22	3.72E-04	3.72E-04	3.60E-04	1.31E-02	1.91E-05	4.11E-03	0.00E+00	0.00E+00	0%
road off of purpose built	0.35	0	0	0	0	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0%
site entrance road from Baker Lake (links to R31)	1.67	0	0	0	0	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0%
road off of Andrew Lake to Sissons scanner	0.39	28	724	0	1	21.50	560.10	0.00	0.77	3.33E-02	3.33E-02	3.23E-02	1.16E+00	1.68E-03	3.69E-01	0.00E+00	0.00E+00	0%
road from Sissons scanner to SW pile	0.26	0	8	0	1	0.00	4.10	0.00	0.52	2.39E-04	2.39E-04	2.32E-04	8.78E-03	1.28E-05	2.64E-03	0.00E+00	0.00E+00	0%
road from Sissons scanner to ore pile	0.09	28	716	0	1	5.13	132.12	0.00	0.18	7.86E-03	7.86E-03	7.62E-03	2.73E-01	3.97E-04	8.70E-02	0.00E+00	0.00E+00	0%
road past Sissons scanner to CW pile	0.12	0	716	0	1	0.00	175.80	0.00	0.25	1.02E-02	1.02E-02	9.87E-03	3.53E-01	5.15E-04	1.13E-01	0.00E+00	0.00E+00	0%
road past Sissons scanner to End Grid road	0.33	0	0	0	0	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0%
road past Sissons scanner to Haul Road	0.79	0	0	0	0	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0%
road from decline to End Grid CW pile	0.24	12	6	0	1	5.89	3.10	0.00	0.48	4.20E-04	4.20E-04	4.08E-04	1.50E-02	2.19E-05	4.65E-03	0.00E+00	0.00E+00	0%
road from decline to End Grid SW pile	0.33	12	1	0	1	7.97	0.93	0.00	0.65	3.80E-04	3.80E-04	3.69E-04	1.38E-02	2.01E-05	4.20E-03	0.00E+00	0.00E+00	0%
road from decline to End Grid ore pile	0.12	12	0	0	1	3.05	0.00	0.00	0.25	1.25E-04	1.25E-04	1.21E-04	4.55E-03	6.62E-06	1.38E-03	0.00E+00	0.00E+00	0%
road from End Grid ore pile to R25	0.67	0	0	0	0	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0%
Haul road b/n Kiggavik and Sissons	19.60	0	0	0	0	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0%
Road to Baker Lake (1 km segment modelled)	1.00	0	0	0	0	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0%
Road to Airstrip	4.15	0	0	0	0	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0%
Clean waste pile north - Kiggavik (CW trucks only)	0.30	0	0	0	0	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0%
Clean waste pile north - Kiggavik (OVB trucks only)	1.55	0	121	0	0	0.00	373.03	0.00	0.00	2.16E-02	2.16E-02	2.10E-02	7.49E-01	1.09E-03	2.39E-01	0.00E+00	0.00E+00	0%
Clean waste pile south - Kiggavik	0.53	0	521	0	0	0.00	550.95	0.00	0.00	3.19E-02	3.19E-02	3.09E-02	1.11E+00	1.61E-03	3.53E-01	0.00E+00	0.00E+00	0%
Overburden pile - Kiggavik	0.42	0	121	0	0	0.00	100.19	0.00	0.00	5.80E-03	5.80E-03	5.63E-03	2.01E-01	2.93E-04	6.42E-02	0.00E+00	0.00E+00	0%
Special waste pile - Kiggavik	0.26	0	9	0	0	0.00	4.91	0.00	0.00	2.84E-04	2.84E-04	2.76E-04	9.85E-03	1.44E-05	3.15E-03	0.00E+00	0.00E+00	0%
Ore pile - Kiggavik	0.26	0	0	0	0	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0%
Clean waste pile - Sissons (CW trucks only)	0.57	0	639	0	0	0.00	730.81	0.00	0.00	4.23E-02	4.23E-02	4.10E-02	1.47E+00	2.14E-03	4.69E-01	0.00E+00	0.00E+00	0%
Clean waste pile - Sissons (OVB trucks only)	1.19	0	77	0	0	0.00	184.09	0.00	0.00	1.07E-02	1.07E-02	1.03E-02	3.69E-01	5.39E-04	1.18E-01	0.00E+00	0.00E+00	0%
Special waste pile - Sissons	0.10	0	8	0	0	0.00	1.56	0.00	0.00	9.05E-05	9.05E-05	8.77E-05	3.14E-03	4.57E-06	1.00E-03	0.00E+00	0.00E+00	0%
Overburden pile - Sissons	0.34	0	77	0	0	0.00	52.64	0.00	0.00	3.05E-03	3.05E-03	2.96E-03	1.06E-01	1.54E-04	3.38E-02	0.00E+00	0.00E+00	0%

Unpaved Road	Controlled Emissions (g/s)																		
	SPM	PM_{10}	$PM_{2.5}$	Uranium	As	Co	Cu	Pb	Mo	Ni	Se	Zn	Cd	Cr	NOx	SO_2	CO	CO_2	CH_4*
East Zone Pit ramp	0.00E+00	0.00E+00	0.00E+00	0	0	0	0	0	0	0	0	0	0	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
East Zone Pit floor	0.00E+00	0.00E+00	0.00E+00	0	0	0	0	0	0	0	0	0	0	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Purpose Built Pit ramp	0.00E+00	0.00E+00	0.00E+00	0	0	0	0	0	0	0	0	0	0	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Purpose Built Pit floor	0.00E+00	0.00E+00	0.00E+00	0	0	0	0	0	0	0	0	0	0	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Centre Zone Pit ramp	0.00E+00	0.00E+00	0.00E+00	0	0	0	0	0	0	0	0	0	0	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Centre Zone Pit floor	0.00E+00	0.00E+00	0.00E+00	0	0	0	0	0	0	0	0	0	0	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Main Zone East Pit ramp	0.00E+00	0.00E+00	0.00E+00	0	0	0	0	0	0	0	0	0	0	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Main Zone East Pit floor	0.00E+00	0.00E+00	0.00E+00	0	0	0	0	0	0	0	0	0	0	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Main Zone West Pit ramp	1.38E-01	1.38E-01	1.34E-01	0	0	0	0	0	0	0	0	0	0	0	4.78E+00	6.97E-03	1.53E+00	0.00E+00	0.00E+00
Main Zone West Pit floor	7.88E-03	7.88E-03	7.64E-03	0	0	0	0	0	0	0	0	0	0	0	2.73E-01	3.98E-04	8.72E-02	0.00E+00	0.00E+00
Andrew Lake Pit ramp	2.24E-01	2.24E-01	2.17E-01	0	0	0	0	0	0	0	0	0	0	0	7.76E+00	1.13E-02	2.48E+00	0.00E+00	0.00E+00
Andrew Lake Pit floor	8.61E-03	8.61E-03	8.35E-03	0	0	0	0	0	0	0	0	0	0	0	2.98E-01	4.35E-04	9.53E-02	0.00E+00	0.00E+00
segment off of main zone west ramp	1.44E-03	1.44E-03	1.40E-03	0	0	0	0	0	0	0	0	0	0	0	5.02E-02	7.32E-05	1.60E-02	0.00E+00	0.00E+00
segment off of main zone west ramp to main zone east ramp	7.56E-03	7.56E-03	7.33E-03	0	0	0	0	0	0	0	0	0	0	0	2.63E-01	3.83E-04	8.37E-02	0.00E+00	0.00E+00
segment off of main zone east ramp	2.63E-03	2.63E-03	2.55E-03	0	0	0	0	0	0	0	0	0	0	0	9.14E-02	1.33E-04	2.91E-02	0.00E+00	0.00E+00
segment off of main zone west ramp to CW pile (south)	2.61E-02	2.61E-02	2.53E-02	0	0	0	0	0	0	0	0	0	0	0	9.04E-01	1.32E-03	2.89E-01	0.00E+00	0.00E+00
segment off of main zone west ramp to west of SW pile	2.64E-04	2.64E-04	2.56E-04	0	0	0	0	0	0	0	0	0	0	0	9.63E-03	1.40E-05	2.92E-03	0.00E+00	0.00E+00
road north from main zone east to east of SW pile	7.06E-04	7.06E-04	6.85E-04	0	0	0	0	0	0	0	0	0	0	0	2.49E-02	3.62E-05	7.81E-03	0.00E+00	0.00E+00
road north from east of SW pile to scanner	1.03E-03	1.03E-03	1.00E-03	0	0	0	0	0	0	0	0	0	0	0	3.65E-02	5.31E-05	1.15E-02	0.00E+00	0.00E+00
road from main zone east ramp to CW pile (south)	3.20E-03	3.20E-03	3.10E-03	0	0	0	0	0	0	0	0	0	0	0	1.11E-01	1.62E-04	3.54E-02	0.00E+00	0.00E+00
road from main zone east ramp to CW pile (south)	0.00E+00	0.00E+00	0.00E+00	0	0	0	0	0	0	0	0	0	0	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
overburden from main zone to CW pile (north)	6.98E-03	6.98E-03	6.77E-03	0	0	0	0	0	0	0	0	0	0	0	2.43E-01	3.54E-04	7.73E-02	0.00E+00	0.00E+00
road from east zone pit to CW pile (north)	0.00E+00	0.00E+00	0.00E+00	0	0	0	0	0	0	0	0	0	0	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
road from east zone pit to Centre Zone	3.54E-03	3.54E-03	3.44E-03	0	0	0	0	0	0	0	0	0	0	0	1.23E-01	1.80E-04	3.92E-02	0.00E+00	0.00E+00
road from east zone pit to Centre Zone ramp	1.56E-03	1.56E-03	1.52E-03	0	0	0	0	0	0	0	0	0	0	0	5.44E-02	7.93E-05	1.73E-02	0.00E+00	0.00E+00
road from Centre Zone to R15	1.65E-03	1.65E-03	1.60E-03	0	0	0	0	0	0	0	0	0	0	0	5.74E-02	8.37E-05	1.83E-02	0.00E+00	0.00E+00
road from Centre Zone pit to Purpose Built	0.00E+00	0.00E+00	0.00E+00	0	0	0	0	0	0	0	0	0	0	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
road from Purpose Built to scanner	0.00E+00	0.00E+00	0.00E+00	0	0	0	0	0	0	0	0	0	0	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
road from scanner to ore pile	3.72E-04	3.72E-04	3.60E-04	0	0	0	0	0	0	0	0	0	0	0	1.31E-02	1.91E-05	4.11E-03	0.00E+00	0.00E+00
road off of purpose built	0.00E+00	0.00E+00	0.00E+00	0	0	0	0	0	0	0	0	0	0	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
site entrance road from Baker Lake (links to R31)	0.00E+00	0.00E+00	0.00E+00	0	0	0	0	0	0	0	0	0	0	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
road off of Andrew Lake to Sissons scanner	3.33E-02	3.33E-02	3.23E-02	0	0	0	0	0	0	0	0	0	0	0	1.16E+00	1.68E-03	3.69E-01	0.00E+00	0.00E+00
road from Sissons scanner to SW pile	2.39E-04	2.39E-04	2.32E-04	0	0	0	0	0	0	0	0	0	0	0	8.78E-03	1.28E-05	2.64E-03	0.00E+00	0.00E+00
road from Sissons scanner to ore pile	7.86E-03	7.86E-03	7.62E-03	0	0	0	0	0	0	0	0	0	0	0	2.73E-01	3.97E-04	8.70E-02	0.00E+00	0.00E+00
road past Sissons scanner to CW pile	1.02E-02	1.02E-02	9.87E-03	0	0	0	0	0	0	0	0	0	0	0	3.53E-01	5.15E-04	1.13E-01	0.00E+00	0.00E+00
road past Sissons scanner to End Grid road	0.00E+00	0.00E+00	0.00E+00	0	0	0	0	0	0	0	0	0	0	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
road past Sissons scanner to Haul Road	0.00E+00	0.00E+00	0.00E+00	0	0	0	0	0	0	0	0	0	0	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
road from decline to End Grid CW pile	4.20E-04	4.20E-04	4.08E-04	0	0	0	0	0	0	0	0	0	0	0	1.50E-02	2.19E-05	4.65E-03	0.00E+00	0.00E+00
road from decline to End Grid SW pile	3.80E-04	3.80E-04	3.69E-04	0	0	0	0	0	0	0	0	0	0	0	1.38E-02	2.01E-05	4.20E-03	0.00E+00	0.00E+00
road from decline to End Grid ore pile	1.25E-04	1.25E-04	1.21E-04	0	0	0	0	0	0	0	0	0	0	0	4.55E-03	6.62E-06	1.38E-03	0.00E+00	0.00E+00
road from End Grid ore pile to R25	0.00E+00	0.00E+00	0.00E+00	0	0	0	0	0	0	0	0	0	0	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Haul road b/n Kiggavik and Sissons	0.00E+00	0.00E+00	0.00E+00	0	0	0	0	0	0	0	0	0	0	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Road to Baker Lake (1 km segment modelled)	0.00E+00	0.00E+00	0.00E+00	0	0	0	0	0	0	0	0	0	0	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Road to Airstrip	0.00E+00	0.00E+00	0.00E+00	0	0	0	0	0	0	0	0	0	0	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Clean waste pile north - Kiggavik (CW trucks only)	0.00E+00	0.00E+00	0.00E+00	0	0	0	0	0	0	0	0	0	0	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Clean waste pile north - Kiggavik (OVB trucks only)	2.16E-02	2.16E-02	2.10E-02	0	0	0	0	0	0	0	0	0	0	0	7.49E-01	1.09E-03	2.39E-01	0.00E+00	0.00E+00
Clean waste pile south - Kiggavik	3.19E-02	3.19E-02	3.09E-02	0	0	0	0	0	0	0	0	0	0	0	1.11E+00	1.61E-03	3.53E-01	0.00E+00	0.00E+00
Overburden pile - Kiggavik	5.80E-03	5.80E-03	5.63E-03	0	0	0	0	0	0	0	0	0	0	0	2.01E-01	2.93E-04	6.42E-02	0.00E+00	0.00E+00
Special waste pile - Kiggavik	2.84E-04	2.84E-04	2.76E-04	0	0	0	0	0	0	0	0	0	0	0	9.85E-03	1.44E-05	3.15E-03	0.00E+00	0.00E+00
Ore pile - Kiggavik	0.00E+00	0.00E+00	0.00E+00	0	0	0	0	0	0	0	0	0	0	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Clean waste pile - Sissons (CW trucks only)	4.23E-02	4.23E-02	4.10E-02	0	0	0	0	0	0	0	0	0	0	0	1.47E+00	2.14E-03	4.69E-01	0.00E+00	0.00E+00
Clean waste pile - Sissons (OVB trucks only)	1.07E-02	1.07E-02	1.03E-02	0	0	0	0	0	0	0	0	0	0	0	3.69E-01	5.39E-04	1.18E-01	0.00E+00	0.00E+00
Special waste pile - Sissons	9.05E-05	9.05E-05	8.77E-05	0	0	0	0	0	0	0	0	0	0	0	3.14E-03	4.57E-06	1.00E-03	0.00E+00	0.00E+00
Overburden pile - Sissons	3.05E-03	3.05E-03	2.96E-03	0	0	0	0	0	0	0	0	0	0	0	1.06E-01	1.54E-04	3.38E-02	0.00E+00	0.00E+00

Notes:
Assuming pits, stockpiles and ore pads are not graded.
Assume roads are not graded during the winter months.
Assume grader or water truck only passes over roads with traffic
Cells highlighed gray indicates that emissions of a contaminant are zero.
Do not change these cells.

Maximum Bounding Emissions Scenario Grading Calculation Spreadsheet

Source ID	Unpaved Road	Description	Mean Vehicle Speed (kph)	Emission Factor in kg/VKT SPM	Emission Factor in kg/VKT PM_{10}	Emission Factor in kg/VKT $PM_{2.5}$	One-way Length (km)	One-wayTrips per Day	Uncontrolled Emission Rate (g/s) SPM	Uncontrolled Emission Rate (g/s) PM_{10}	Uncontrolled Emission Rate (g/s) $PM_{2.5}$	Control (%)
EZ	East Zone Pit ramp	Grading CAT 16H	8.0	0.615	0.215	0.019	0.50	0	0.0000	0.0000	0.0000	0%
EZ	East Zone Pit floor	Grading CAT 16H	8.0	0.615	0.215	0.019	0.05	0	0.0000	0.0000	0.0000	0%
PB	Purpose Built Pit ramp	Grading CAT 16H	8.0	0.615	0.215	0.019	0.30	0	0.0000	0.0000	0.0000	0%
PB	Purpose Built Pit floor	Grading CAT 16H	8.0	0.615	0.215	0.019	0.02	0	0.0000	0.0000	0.0000	0%
CZ	Centre Zone Pit ramp	Grading CAT 16H	8.0	0.615	0.215	0.019	0.85	0	0.0000	0.0000	0.0000	0%
CZ	Centre Zone Pit floor	Grading CAT 16H	8.0	0.615	0.215	0.019	0.05	0	0.0000	0.0000	0.0000	0%
MZEST	Main Zone East Pit ramp	Grading CAT 16H	8.0	0.615	0.215	0.019	0.40	0	0.0000	0.0000	0.0000	0%
MZEST	Main Zone East Pit floor	Grading CAT 16H	8.0	0.615	0.215	0.019	0.10	0	0.0000	0.0000	0.0000	0%
MZWEST	Main Zone West Pit ramp	Grading CAT 16H	8.0	0.615	0.215	0.019	1.75	1	0.0249	0.0087	0.0008	0%
MZWEST	Main Zone West Pit floor	Grading CAT 16H	8.0	0.615	0.215	0.019	0.10	1	0.0014	0.0005	0.0000	0%
AL	Andrew Lake Pit ramp	Grading CAT 16H	8.0	0.615	0.215	0.019	2.60	1	0.0370	0.0129	0.0011	0%
AL	Andrew Lake Pit floor	Grading CAT 16H	8.0	0.615	0.215	0.019	0.10	1	0.0014	0.0005	0.0000	0%
R1	segment off of main zone west ramp	Grading CAT 16H	8.0	0.615	0.215	0.019	0.08	1	0.0011	0.0004	0.0000	0%
R2	segment off of main zone west ramp to main zone east ramp	Grading CAT 16H	8.0	0.615	0.215	0.019	0.44	1	0.0062	0.0022	0.0002	0%
R3	segment off of main zone east ramp	Grading CAT 16H	8.0	0.615	0.215	0.019	0.15	1	0.0022	0.0008	0.0001	0%
R4	segment off of main zone west ramp to CW pile (south)	Grading CAT 16H	8.0	0.615	0.215	0.019	0.43	1	0.0061	0.0021	0.0002	0%
R5	segment off of main zone west ramp to west of SW pile	Grading CAT 16H	8.0	0.615	0.215	0.019	0.24	1	0.0035	0.0012	0.0001	0%
R6	road north from main zone east to east of SW pile	Grading CAT 16H	8.0	0.615	0.215	0.019	0.21	1	0.0030	0.0011	0.0001	0%
R7	road north from east of SW pile to scanner	Grading CAT 16H	8.0	0.615	0.215	0.019	0.31	1	0.0044	0.0015	0.0001	0%
R8	road from main zone east ramp to CW pile (south)	Grading CAT 16H	8.0	0.615	0.215	0.019	0.23	1	0.0033	0.0011	0.0001	0%
R9	road from main zone east ramp to CW pile (south)	Grading CAT 16H	8.0	0.615	0.215	0.019	0.14	0	0.0000	0.0000	0.0000	0%
R10	overburden from main zone to CW pile (north)	Grading CAT 16H	8.0	0.615	0.215	0.019	0.50	1	0.0071	0.0025	0.0002	0%
R11	road from east zone pit to CW pile (north)	Grading CAT 16H	8.0	0.615	0.215	0.019	0.21	0	0.0000	0.0000	0.0000	0%
R12	road from east zone pit to Centre Zone	Grading CAT 16H	8.0	0.615	0.215	0.019	0.25	1	0.0036	0.0013	0.0001	0%
R13	road from east zone pit to Centre Zone ramp	Grading CAT 16H	8.0	0.615	0.215	0.019	0.11	1	0.0016	0.0006	0.0000	0%
R14	road from Centre Zone to R15	Grading CAT 16H	8.0	0.615	0.215	0.019	0.12	1	0.0017	0.0006	0.0001	0%
R15	road from Centre Zone pit to Purpose Built	Grading CAT 16H	8.0	0.615	0.215	0.019	0.25	0	0.0000	0.0000	0.0000	0%
R16	road from Purpose Built to scanner	Grading CAT 16H	8.0	0.615	0.215	0.019	0.24	0	0.0000	0.0000	0.0000	0%
R17	road from scanner to ore pile	Grading CAT 16H	8.0	0.615	0.215	0.019	0.11	1	0.0016	0.0006	0.0000	0%
R18	road off of purpose built	Grading CAT 16H	8.0	0.615	0.215	0.019	0.35	0	0.0000	0.0000	0.0000	0%
R19	site entrance road from Baker Lake (links to R31)	Grading CAT 16H	8.0	0.615	0.215	0.019	1.67	0	0.0000	0.0000	0.0000	0%
R20	road off of Andrew Lake to Sissons scanner	Grading CAT 16H	8.0	0.615	0.215	0.019	0.39	1	0.0055	0.0019	0.0002	0%
R21	road from Sissons scanner to SW pile	Grading CAT 16H	8.0	0.615	0.215	0.019	0.26	1	0.0037	0.0013	0.0001	0%
R22	road from Sissons scanner to ore pile	Grading CAT 16H	8.0	0.615	0.215	0.019	0.09	1	0.0013	0.0005	0.0000	0%
R23	road past Sissons scanner to CW pile	Grading CAT 16H	8.0	0.615	0.215	0.019	0.12	1	0.0017	0.0006	0.0001	0%
R24	road past Sissons scanner to End Grid road	Grading CAT 16H	8.0	0.615	0.215	0.019	0.33	0	0.0000	0.0000	0.0000	0%
R25	road past Sissons scanner to Haul Road	Grading CAT 16H	8.0	0.615	0.215	0.019	0.79	0	0.0000	0.0000	0.0000	0%
R26	road from decline to End Grid CW pile	Grading CAT 16H	8.0	0.615	0.215	0.019	0.24	1	0.0034	0.0012	0.0001	0%
R27	road from decline to End Grid SW pile	Grading CAT 16H	8.0	0.615	0.215	0.019	0.33	1	0.0046	0.0016	0.0001	0%
R28	road from decline to End Grid ore pile	Grading CAT 16H	8.0	0.615	0.215	0.019	0.12	1	0.0018	0.0006	0.0001	0%
R29	road from End Grid ore pile to R25	Grading CAT 16H	8.0	0.615	0.215	0.019	0.67	0	0.0000	0.0000	0.0000	0%
R30	Haul road b/n Kiggavik and Sissons	Grading CAT 16H	8.0	0.615	0.215	0.019	19.60	0	0.0000	0.0000	0.0000	0%
R31	Road to Baker Lake (1 km segment modelled)	Grading CAT 16H	8.0	0.615	0.215	0.019	1.00	0	0.0000	0.0000	0.0000	0%
R32	Road to Airstrip	Grading CAT 16H	8.0	0.615	0.215	0.019	4.15	0	0.0000	0.0000	0.0000	0%
CWNK	Clean waste pile north - Kiggavik (CW trucks only)	Grading CAT 16H	8.0	0.615	0.215	0.019	0.30	0	0.0000	0.0000	0.0000	0%
CWNK	Clean waste pile north - Kiggavik (OVB trucks only)	Grading CAT 16H	8.0	0.615	0.215	0.019	1.55	0	0.0000	0.0000	0.0000	0%
CWK	Clean waste pile south - Kiggavik	Grading CAT 16H	8.0	0.615	0.215	0.019	0.53	0	0.0000	0.0000	0.0000	0%
KOVB	Overburden pile - Kiggavik	Grading CAT 16H	8.0	0.615	0.215	0.019	0.42	0	0.0000	0.0000	0.0000	0%
SWK	Special waste pile - Kiggavik	Grading CAT 16H	8.0	0.615	0.215	0.019	0.26	0	0.0000	0.0000	0.0000	0%
OREK	Ore pile - Kiggavik	Grading CAT 16H	8.0	0.615	0.215	0.019	0.26	0	0.0000	0.0000	0.0000	0%
CWS	Clean waste pile - Sissons (CW trucks only)	Grading CAT 16H	8.0	0.615	0.215	0.019	0.57	0	0.0000	0.0000	0.0000	0%
CWS	Clean waste pile - Sissons (OVB trucks only)	Grading CAT 16H	8.0	0.615	0.215	0.019	1.19	0	0.0000	0.0000	0.0000	0%
SWS	Special waste pile - Sissons	Grading CAT 16H	8.0	0.615	0.215	0.019	0.10	0	0.0000	0.0000	0.0000	0%
SOVB	Overburden pile - Sissons	Grading CAT 16H	8.0	0.615	0.215	0.019	0.34	0	0.0000	0.0000	0.0000	0%

Source ID	Unpaved Road	Metal Fraction (%) Uranium	As	Co	Cu	Pb	Mo	Ni	Se	Zn	Cd	Cr
EZ	East Zone Pit ramp	2.50E-02	9.20E-05	9.63E-04	1.20E-03	1.24E-03	1.91E-04	2.62E-03	1.14E-04	3.01E-03	4.00E-06	4.58E-03
EZ	East Zone Pit floor	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PB	Purpose Built Pit ramp	2.50E-02	9.20E-05	9.63E-04	1.20E-03	1.24E-03	1.91E-04	2.62E-03	1.14E-04	3.01E-03	4.00E-06	4.58E-03
PB	Purpose Built Pit floor	2.50E-02	8.00E-05	9.50E-04	9.40E-04	2.58E-03	1.20E-03	2.11E-03	2.00E-05	2.73E-03	5.00E-06	5.60E-03
CZ	Centre Zone Pit ramp	6.00E-03	9.20E-05	9.63E-04	1.20E-03	1.24E-03	1.91E-04	2.62E-03	1.14E-04	3.01E-03	4.00E-06	4.58E-03
CZ	Centre Zone Pit floor	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MZEST	Main Zone East Pit ramp	2.00E-02	9.20E-05	9.63E-04	1.20E-03	1.24E-03	1.91E-04	2.62E-03	1.14E-04	3.01E-03	4.00E-06	4.58E-03
MZEST	Main Zone East Pit floor	0.00E+00	5.70E-04	1.70E-03	3.10E-03	5.03E-02	2.87E-02	6.60E-03	2.00E-04	3.90E-03	1.20E-04	1.54E-02
MZWEST	Main Zone West Pit ramp	2.00E-02	9.20E-05	9.63E-04	1.20E-03	1.24E-03	1.91E-04	2.62E-03	1.14E-04	3.01E-03	4.00E-06	4.58E-03
MZWEST	Main Zone West Pit floor	6.81E-01	5.70E-04	1.70E-03	3.10E-03	5.03E-02	2.87E-02	6.60E-03	2.00E-04	3.90E-03	1.20E-04	1.54E-02
AL	Andrew Lake Pit ramp	2.00E-02	3.28E-04	3.73E-04	6.72E-04	8.70E-04	6.90E-05	2.80E-03	1.28E-04	1.34E-03	9.00E-06	8.45E-03
AL	Andrew Lake Pit floor	6.32E-01	1.66E-03	8.30E-04	5.05E-03	3.55E-02	5.57E-03	9.54E-03	5.00E-05	3.41E-03	1.10E-04	9.61E-02
R1	segment off of main zone west ramp	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R2	segment off of main zone west ramp to main zone east ramp	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R3	segment off of main zone east ramp	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R4	segment off of main zone west ramp to CW pile (south)	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R5	segment off of main zone west ramp to west of SW pile	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R6	road north from main zone east to east of SW pile	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R7	road north from east of SW pile to scanner	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R8	road from main zone east ramp to CW pile (south)	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R9	road from main zone east ramp to CW pile (south)	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R10	overburden from main zone to CW pile (north)	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R11	road from east zone pit to CW pile (north)	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R12	road from east zone pit to Centre Zone	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R13	road from east zone pit to Centre Zone ramp	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R14	road from Centre Zone to R15	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R15	road from Centre Zone pit to Purpose Built	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R16	road from Purpose Built to scanner	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R17	road from scanner to ore pile	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R18	road off of purpose built	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R19	site entrance road from Baker Lake (links to R31)	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R20	road off of Andrew Lake to Sissons scanner	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R21	road from Sissons scanner to SW pile	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R22	road from Sissons scanner to ore pile	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R23	road past Sissons scanner to CW pile	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R24	road past Sissons scanner to End Grid road	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R25	road past Sissons scanner to Haul Road	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R26	road from decline to End Grid CW pile	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R27	road from decline to End Grid SW pile	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R28	road from decline to End Grid ore pile	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R29	road from End Grid ore pile to R25	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R30	Haul road b/n Kiggavik and Sissons	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
R31	Road to Baker Lake (1 km segment modelled)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
R32	Road to Airstrip	1.00E-03	2.00E-04	8.00E-04	2.50E-03	1.60E-03	8.00E-04	2.50E-03	2.00E-04	2.10E-03	1.00E-05	6.00E-03
CWNK	Clean waste pile north - Kiggavik (CW trucks only)	1.55E-02	9.20E-05	9.63E-04	1.20E-03	1.24E-03	1.91E-04	2.62E-03	1.14E-04	3.01E-03	4.00E-06	4.58E-03
CWNK	Clean waste pile north - Kiggavik (OVB trucks only)	1.55E-02	9.20E-05	9.63E-04	1.20E-03	1.24E-03	1.91E-04	2.62E-03	1.14E-04	3.01E-03	4.00E-06	4.58E-03
CWK	Clean waste pile south - Kiggavik	2.00E-02	9.20E-05	9.63E-04	1.20E-03	1.24E-03	1.91E-04	2.62E-03	1.14E-04	3.01E-03	4.00E-06	4.58E-03
KOVB	Overburden pile - Kiggavik	1.00E-03	8.00E-05	1.12E-03	1.35E-03	1.01E-03	1.90E-04	2.70E-03	1.13E-04	3.55E-03	5.00E-06	4.63E-03
SWK	Special waste pile - Kiggavik	9.00E-02	7.30E-05	1.09E-03	4.51E-03	3.02E-03	1.47E-03	2.22E-03	1.43E-04	3.52E-03	5.00E-06	4.21E-03
OREK	Ore pile - Kiggavik	6.67E-01	1.69E-03	1.47E-03	4.00E-03	4.08E-02	1.75E-02	7.59E-03	2.03E-04	3.76E-03	1.17E-04	4.20E-02
CWS	Clean waste pile - Sissons (CW trucks only)	2.00E-02	3.28E-04	3.73E-04	6.72E-04	8.70E-04	6.90E-05	2.80E-03	1.28E-04	1.34E-03	9.00E-06	8.45E-03
CWS	Clean waste pile - Sissons (OVB trucks only)	2.00E-02	3.28E-04	3.73E-04	6.72E-04	8.70E-04	6.90E-05	2.80E-03	1.28E-04	1.34E-03	9.00E-06	8.45E-03
SWS	Special waste pile - Sissons	9.00E-02	1.92E-04	2.63E-04	5.64E-04	1.41E-03	8.40E-05	2.79E-03	1.10E-04	9.95E-04	1.10E-05	7.71E-03
SOVB	Overburden pile - Sissons	1.00E-03	3.69E-04	3.76E-04	7.40E-04	7.63E-04	6.70E-05	2.71E-03	1.33E-04	1.36E-03	8.00E-06	8.66E-03

Source ID	Unpaved Road	Controlled Emission Rate (g/s) SPM	PM_{10}	$PM_{2.5}$	Uranium	As	Co	Cu	Pb	Mo	Ni	Se	Zn	Cd	Cr
EZ	East Zone Pit ramp	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EZ	East Zone Pit floor	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PB	Purpose Built Pit ramp	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PB	Purpose Built Pit floor	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CZ	Centre Zone Pit ramp	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CZ	Centre Zone Pit floor	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MZEST	Main Zone East Pit ramp	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MZEST	Main Zone East Pit floor	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MZWEST	Main Zone West Pit ramp	2.49E-02	8.71E-03	7.73E-04	4.99E-06	2.29E-08	2.40E-07	2.98E-07	3.09E-07	4.76E-08	6.52E-07	2.84E-08	7.51E-07	9.97E-10	1.14E-06
MZWEST	Main Zone West Pit floor	1.42E-03	4.98E-04	4.42E-05	9.70E-06	8.12E-09	2.42E-08	4.42E-08	7.17E-07	4.09E-07	9.40E-08	2.85E-09	5.56E-08	1.71E-09	2.19E-07
AL	Andrew Lake Pit ramp	3.70E-02	1.29E-02	1.15E-03	7.41E-06	1.21E-07	1.38E-07	2.49E-07	3.22E-07	2.56E-08	1.04E-06	4.74E-08	4.97E-07	3.33E-09	3.13E-06
AL	Andrew Lake Pit floor	1.42E-03	4.98E-04	4.42E-05	9.00E-06	2.36E-08	1.18E-08	7.19E-08	5.06E-07	7.94E-08	1.36E-07	7.12E-10	4.86E-08	1.57E-09	1.37E-06
R1	segment off of main zone west ramp	1.12E-03	3.91E-04	3.46E-05	1.12E-08	2.24E-09	8.94E-09	2.79E-08	1.79E-08	8.94E-09	2.79E-08	2.24E-09	2.35E-08	1.12E-10	6.71E-08
R2	segment off of main zone west ramp to main zone east ramp	6.22E-03	2.17E-03	1.93E-04	6.22E-08	1.24E-08	4.97E-08	1.55E-07	9.95E-08	4.97E-08	1.55E-07	1.24E-08	1.31E-07	6.22E-10	3.73E-07
R3	segment off of main zone east ramp	2.16E-03	7.55E-04	6.70E-05	2.16E-08	4.32E-09	1.73E-08	5.40E-08	3.46E-08	1.73E-08	5.40E-08	4.32E-09	4.54E-08	2.16E-10	1.30E-07
R4	segment off of main zone west ramp to CW pile (south)	6.15E-03	2.15E-03	1.91E-04	6.15E-08	1.23E-08	4.92E-08	1.54E-07	9.84E-08	4.92E-08	1.54E-07	1.23E-08	1.29E-07	6.15E-10	3.69E-07
R5	segment off of main zone west ramp to west of SW pile	3.48E-03	1.22E-03	1.08E-04	3.48E-08	6.96E-09	2.78E-08	8.69E-08	5.56E-08	2.78E-08	8.69E-08	6.96E-09	7.30E-08	3.48E-10	2.09E-07
R6	road north from main zone east to east of SW pile	3.01E-03	1.05E-03	9.32E-05	3.01E-08	6.01E-09	2.41E-08	7.52E-08	4.81E-08	2.41E-08	7.52E-08	6.01E-09	6.32E-08	3.01E-10	1.80E-07
R7	road north from east of SW pile to scanner	4.41E-03	1.54E-03	1.37E-04	4.41E-08	8.82E-09	3.53E-08	1.10E-07	7.05E-08	3.53E-08	1.10E-07	8.82E-09	9.26E-08	4.41E-10	2.65E-07
R8	road from main zone east ramp to CW pile (south)	3.26E-03	1.14E-03	1.01E-04	3.26E-08	6.52E-09	2.61E-08	8.15E-08	5.22E-08	2.61E-08	8.15E-08	6.52E-09	6.85E-08	3.26E-10	1.96E-07
R9	road from main zone east ramp to CW pile (south)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
R10	overburden from main zone to CW pile (north)	7.11E-03	2.48E-03	2.20E-04	7.11E-08	1.42E-08	5.69E-08	1.78E-07	1.14E-07	5.69E-08	1.78E-07	1.42E-08	1.49E-07	7.11E-10	4.27E-07
R11	road from east zone pit to CW pile (north)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
R12	road from east zone pit to Centre Zone	3.61E-03	1.26E-03	1.12E-04	3.61E-08	7.22E-09	2.89E-08	9.03E-08	5.78E-08	2.89E-08	9.03E-08	7.22E-09	7.58E-08	3.61E-10	2.17E-07
R13	road from east zone pit to Centre Zone ramp	1.59E-03	5.56E-04	4.93E-05	1.59E-08	3.18E-09	1.27E-08	3.98E-08	2.55E-08	1.27E-08	3.98E-08	3.18E-09	3.34E-08	1.59E-10	9.55E-08
R14	road from Centre Zone to R15	1.68E-03	5.87E-04	5.21E-05	1.68E-08	3.36E-09	1.34E-08	4.20E-08	2.69E-08	1.34E-08	4.20E-08	3.36E-09	3.53E-08	1.68E-10	1.01E-07
R15	road from Centre Zone pit to Purpose Built	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
R16	road from Purpose Built to scanner	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
R17	road from scanner to ore pile	1.58E-03	5.53E-04	4.91E-05	1.58E-08	3.17E-09	1.27E-08	3.96E-08	2.53E-08	1.27E-08	3.96E-08	3.17E-09	3.33E-08	1.58E-10	9.50E-08
R18	road off of purpose built	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
R19	site entrance road from Baker Lake (links to R31)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
R20	road off of Andrew Lake to Sissons scanner	5.51E-03	1.93E-03	1.71E-04	5.51E-08	1.10E-08	4.41E-08	1.38E-07	8.82E-08	4.41E-08	1.38E-07	1.10E-08	1.16E-07	5.51E-10	3.31E-07
R21	road from Sissons scanner to SW pile	3.71E-03	1.30E-03	1.15E-04	3.71E-08	7.43E-09	2.97E-08	9.28E-08	5.94E-08	2.97E-08	9.28E-08	7.43E-09	7.80E-08	3.71E-10	2.23E-07
R22	road from Sissons scanner to ore pile	1.31E-03	4.59E-04	4.08E-05	1.31E-08	2.63E-09	1.05E-08	3.29E-08	2.10E-08	1.05E-08	3.29E-08	2.63E-09	2.76E-08	1.31E-10	7.89E-08
R23	road past Sissons scanner to CW pile	1.75E-03	6.11E-04	5.42E-05	1.75E-08	3.50E-09	1.40E-08	4.37E-08	2.80E-08	1.40E-08	4.37E-08	3.50E-09	3.67E-08	1.75E-10	1.05E-07
R24	road past Sissons scanner to End Grid road	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
R25	road past Sissons scanner to Haul Road	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
R26	road from decline to End Grid CW pile	3.43E-03	1.20E-03	1.06E-04	3.43E-08	6.87E-09	2.75E-08	8.59E-08	5.49E-08	2.75E-08	8.59E-08	6.87E-09	7.21E-08	3.43E-10	2.06E-07
R27	road from decline to End Grid SW pile	4.65E-03	1.62E-03	1.44E-04	4.65E-08	9.29E-09	3.72E-08	1.16E-07	7.44E-08	3.72E-08	1.16E-07	9.29E-09	9.76E-08	4.65E-10	2.79E-07
R28	road from decline to End Grid ore pile	1.78E-03	6.20E-04	5.50E-05	1.78E-08	3.55E-09	1.42E-08	4.44E-08	2.84E-08	1.42E-08	4.44E-08	3.55E-09	3.73E-08	1.78E-10	1.07E-07
R29	road from End Grid ore pile to R25	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
R30	Haul road b/n Kiggavik and Sissons	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
R31	Road to Baker Lake (1 km segment modelled)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
R32	Road to Airstrip	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CWNK	Clean waste pile north - Kiggavik (CW trucks only)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CWNK	Clean waste pile north - Kiggavik (OVB trucks only)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CWK	Clean waste pile south - Kiggavik	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
KOVB	Overburden pile - Kiggavik	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SWK	Special waste pile - Kiggavik	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
OREK	Ore pile - Kiggavik	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CWS	Clean waste pile - Sissons (CW trucks only)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CWS	Clean waste pile - Sissons (OVB trucks only)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SWS	Special waste pile - Sissons	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SOVB	Overburden pile - Sissons	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Notes:
Assume stockpiles and pit floors are not graded.
Assume roads are not graded during the winter months.

Size Fraction	Emission Factor Equation	Reference
SPM <30 µm	$E = 0.0034 \times (S)^{2.5}$	AP-42 Table 11.9-2, October 1998
PM <10 µm	$E = 0.60 \times 0.0056 \times (S)^{2.0}$	AP-42 Table 11.9-2, October 1998
PM <2.5 µm	$E = 0.031 \times 0.0034 \times (S)^{2.5}$	AP-42 Table 11.9-2, October 1998

E = emission factor in kg/VKT
S = mean vehicle speed (kph)

Maximum Bounding Emissions Scenario Bulldozing Calculation Spreadsheet

Source ID	Source Location	Silt (%)	Moisture (%)	Emission Factor in kg/hr			Operating Hours per Day	Operating Frequency	Uncontrolled Emission Rate (g/s)			Control Based on Watering (%)
				SPM	PM_{10}	$PM_{2.5}$			SPM	PM_{10}	$PM_{2.5}$	
OREK	Kiggavik Ore Pile	5.0	3.0	4.300	0.811	0.452	0	40%	0.0000	0.0000	0.0000	0%
SWK	Kiggavik Special Waste Pile	5.0	3.0	4.300	0.811	0.452	20	40%	0.3982	0.0750	0.0418	0%
CWNK	Kiggavik Clean Rock Pile North	5.0	3.0	4.300	0.811	0.452	0	40%	0.0000	0.0000	0.0000	0%
CWK	Kiggavik Clean Rock Pile South	5.0	3.0	4.300	0.811	0.452	20	40%	0.3982	0.0750	0.0418	0%
KOVB	Kiggavik Overburden Pile	5.0	3.0	4.300	0.811	0.452	20	40%	0.3982	0.0750	0.0418	0%
ORES	Andrew Lake Ore Pile	5.0	3.0	4.300	0.811	0.452	0	40%	0.0000	0.0000	0.0000	0%
SWS	Andrew Lake Special Waste Pile	5.0	3.0	4.300	0.811	0.452	20	40%	0.3982	0.0750	0.0418	0%
CWS	Andrew Lake Clean Rock Pile	5.0	3.0	4.300	0.811	0.452	20	40%	0.3982	0.0750	0.0418	0%
SOVB	Andrew Lake Overburden Pile	5.0	3.0	4.300	0.811	0.452	20	40%	0.3982	0.0750	0.0418	0%
CWEG	End Grid Clean Waste Pile	5.0	3.0	4.300	0.811	0.452	0	40%	0.0000	0.0000	0.0000	0%
SWEG	End Grid Special Waste Pile	5.0	3.0	4.300	0.811	0.452	0	40%	0.0000	0.0000	0.0000	0%
EGORE	End Grid Ore Pile	5.0	3.0	4.300	0.811	0.452	0	40%	0.0000	0.0000	0.0000	0%

Source ID	Metal %										
	Uranium	As	Co	Cu	Pb	Mo	Ni	Se	Zn	Cd	Cr
OREK	6.67E-01	1.69E-03	1.47E-03	4.00E-03	4.08E-02	1.75E-02	7.59E-03	2.03E-04	3.76E-03	1.17E-04	4.20E-02
SWK	9.00E-02	7.30E-05	1.09E-03	4.51E-03	3.02E-03	1.47E-03	2.22E-03	1.43E-04	3.52E-03	5.00E-06	4.21E-03
CWNK	1.55E-02	9.20E-05	9.63E-04	1.20E-03	1.24E-03	1.91E-04	2.62E-03	1.14E-04	3.01E-03	4.00E-06	4.58E-03
CWK	2.00E-02	9.20E-05	9.63E-04	1.20E-03	1.24E-03	1.91E-04	2.62E-03	1.14E-04	3.01E-03	4.00E-06	4.58E-03
KOVB	1.00E-03	8.00E-05	1.12E-03	1.35E-03	1.01E-03	1.90E-04	2.70E-03	1.13E-04	3.55E-03	5.00E-06	4.63E-03
ORES	6.32E-01	1.66E-03	8.30E-04	5.05E-03	3.55E-02	5.57E-03	9.54E-03	5.00E-05	3.41E-03	1.10E-04	9.61E-02
SWS	9.00E-02	1.92E-04	2.63E-04	5.64E-04	1.41E-03	8.40E-05	2.79E-03	1.10E-04	9.95E-04	1.10E-05	7.71E-03
CWS	2.00E-02	3.28E-04	3.73E-04	6.72E-04	8.70E-04	6.90E-05	2.80E-03	1.28E-04	1.34E-03	9.00E-06	8.45E-03
SOVB	1.00E-03	3.69E-04	3.76E-04	7.40E-04	7.63E-04	6.70E-05	2.71E-03	1.33E-04	1.36E-03	8.00E-06	8.66E-03
CWEG	2.50E-02	3.28E-04	3.73E-04	6.72E-04	8.70E-04	6.90E-05	2.80E-03	1.28E-04	1.34E-03	9.00E-06	8.45E-03
SWEG	2.10E-01	1.00E-04	1.30E-03	2.00E-04	3.80E-03	1.00E-04	3.70E-03	9.00E-05	3.80E-03	1.00E-04	1.00E-02
EGORE	5.01E-01	5.49E-03	2.08E-03	4.67E-03	2.08E-02	6.46E-03	6.60E-03	5.50E-04	4.05E-03	1.20E-04	1.13E-02

Source ID	Controlled Emission Rate (g/s)													
	SPM	PM_{10}	$PM_{2.5}$	Uranium	As	Co	Cu	Pb	Mo	Ni	Se	Zn	Cd	Cr
OREK	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SWK	3.98E-01	7.50E-02	4.18E-02	3.58E-04	2.91E-07	4.32E-06	1.80E-05	1.20E-05	5.83E-06	8.84E-06	5.69E-07	1.40E-05	1.99E-08	1.68E-05
CWNK	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CWK	3.98E-01	7.50E-02	4.18E-02	7.96E-05	3.66E-07	3.83E-06	4.76E-06	4.94E-06	7.60E-07	1.04E-05	4.54E-07	1.20E-05	1.59E-08	1.82E-05
KOVB	3.98E-01	7.50E-02	4.18E-02	3.98E-06	3.19E-07	4.45E-06	5.38E-06	4.01E-06	7.57E-07	1.07E-05	4.50E-07	1.41E-05	1.99E-08	1.84E-05
ORES	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SWS	3.98E-01	7.50E-02	4.18E-02	3.58E-04	7.64E-07	1.05E-06	2.25E-06	5.62E-06	3.34E-07	1.11E-05	4.38E-07	3.96E-06	4.38E-08	3.07E-05
CWS	3.98E-01	7.50E-02	4.18E-02	7.96E-05	1.31E-06	1.49E-06	2.68E-06	3.46E-06	2.75E-07	1.12E-05	5.10E-07	5.35E-06	3.58E-08	3.36E-05
SOVB	3.98E-01	7.50E-02	4.18E-02	3.98E-06	1.47E-06	1.50E-06	2.95E-06	3.04E-06	2.67E-07	1.08E-05	5.30E-07	5.40E-06	3.19E-08	3.45E-05
CWEG	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SWEG	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EGORE	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Notes:
As per the IFS, bulldozers will primarily be used for maintenance of stockpiles. Secondary functions include maintenance of road berms and assisting with loading ore and waste in pits. For simplicity, it was assumed that bulldozers will only be used on stockpiles.
Since End Grid Piles and ORES are small and temporary, equipment will primarily be used on larger piles, therefore, they were not included.

Size Fraction	Emission Factor Equation	Reference
SPM <30 µm	$E = 2.6 \times (s)^{1.2} \times (M)^{-1.3}$	AP-42 Table 11.9-2, October 1998
PM <10 µm	$E = 0.75 \times 0.45 \times (s)^{1.5} \times (M)^{-1.4}$	AP-42 Table 11.9-2, October 1998
PM <2.5 µm	$E = 0.105 \times 2.6 \times (s)^{1.2} \times (M)^{-1.3}$	AP-42 Table 11.9-2, October 1998

E = emission factor in kg/hour
s = silt content (%)
M = material moisture content (%)

Maximum Bounding Emissions Scenario Drilling Calculation Spreadsheet

Source ID	Source Location	Description	Emission Factor in kg/hole			Number of Holes Drilled per Day	Uncontrolled Emission Rate (g/s)			Control Based on Watering (%)
			SPM	PM_{10}	$PM_{2.5}$		SPM	PM_{10}	$PM_{2.5}$	
EZ	East Zone Pit	Drilling	0.590	0.301	0.089	0	0.0000	0.0000	0.0000	0%
PB	Purpose Built Pit	Drilling	0.590	0.301	0.089	0	0.0000	0.0000	0.0000	0%
CZ	Centre Zone Pit	Drilling	0.590	0.301	0.089	0	0.0000	0.0000	0.0000	0%
MZWEST	Main Zone East Pit	Drilling	0.590	0.301	0.089	150	1.0209	0.5207	0.1531	0%
MZEST	Main Zone West Pit	Drilling	1.590	0.811	0.239	0	0.0000	0.0000	0.0000	0%
AL	Andrew Lake Pit	Drilling	0.590	0.301	0.089	150	1.0209	0.5207	0.1531	0%
	End Grid Underground Mine	Drilling	0.590	0.301	0.089	633	4.3211	2.2038	0.6482	0%

Source ID	Source Location	Metal %										
		Uranium	As	Co	Cu	Pb	Mo	Ni	Se	Zn	Cd	Cr
EZ	East Zone Pit	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PB	Purpose Built Pit	2.50E-02	8.00E-05	9.50E-04	9.40E-04	2.58E-03	1.20E-03	2.11E-03	2.00E-05	2.73E-03	5.00E-06	5.60E-03
CZ	Centre Zone Pit	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MZWEST	Main Zone East Pit	5.59E-02	1.17E-04	1.00E-03	1.35E-03	3.85E-03	1.71E-03	2.82E-03	1.19E-04	3.07E-03	1.01E-05	5.14E-03
MZEST	Main Zone West Pit	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
AL	Andrew Lake Pit	3.91E-02	3.66E-04	3.85E-04	8.01E-04	1.91E-03	2.33E-04	3.00E-03	1.25E-04	1.40E-03	1.20E-05	1.11E-02
	End Grid Underground Mine	3.25E-01	3.45E-03	1.47E-03	3.08E-03	1.31E-02	3.96E-03	5.17E-03	3.82E-04	3.14E-03	8.19E-05	1.03E-02

Source ID	Source Location	Controlled Emission Rate (g/s)													
		SPM	PM_{10}	$PM_{2.5}$	Uranium	As	Co	Cu	Pb	Mo	Ni	Se	Zn	Cd	Cr
EZ	East Zone Pit	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PB	Purpose Built Pit	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CZ	Centre Zone Pit	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MZWEST	Main Zone East Pit	1.02E+00	5.21E-01	1.53E-01	5.71E-04	1.19E-06	1.02E-05	1.38E-05	3.93E-05	1.75E-05	2.88E-05	1.21E-06	3.13E-05	1.03E-07	5.25E-05
MZEST	Main Zone West Pit	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
AL	Andrew Lake Pit	1.02E+00	5.21E-01	1.53E-01	3.99E-04	3.74E-06	3.93E-06	8.18E-06	1.95E-05	2.38E-06	3.07E-05	1.28E-06	1.43E-05	1.23E-07	1.13E-04
	End Grid Underground Mine	4.32E+00	2.20E+00	6.48E-01	1.41E-02	1.49E-04	6.34E-05	1.33E-04	5.68E-04	1.71E-04	2.23E-04	1.65E-05	1.35E-04	3.54E-06	4.44E-04

Size Fraction	Emission Factor Equatio	Reference
SPM <30 µm	E = 0.59 kg/hole	AP-42 Table 11.9-4, October 1998
PM <10 µm	E = 51% of TSP	AP-42 Table B.2.2, Category 3 - Aggregate, Unprocessed Ores, January 1995
PM <2.5 µm	E = 15% of TSP	AP-42 Table B.2.2, Category 3 - Aggregate, Unprocessed Ores, January 1995

Maximum Bounding Emissions Scenario Blasting Calculation Spreadsheet

Source ID	Source Location	Description	Emission Factor						Number of Blasts per Day	ANFO Required per Blast	Uncontrolled Emission Rate (g/s)						Control Based on Watering (%)
			SPM (kg/blast)	PM_{10} (kg/blast)	$PM_{2.5}$ (kg/blast)	NOx (kg/Mg)	SO_2 (kg/Mg)	CO (kg/Mg)		(tonnes)	SPM	PM_{10}	$PM_{2.5}$	NO_x	SO_2	CO	
EZ	East Zone Pit	Explosive Blasting	38.7	19.737	5.805	5	1	34	0	0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0%
PB	Purpose Built Pit	Explosive Blasting	38.7	19.737	5.805	5	1	34	0	0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0%
CZ	Centre Zone Pit	Explosive Blasting	38.7	19.737	5.805	5	1	34	0	0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0%
MZWEST	Main Zone West Pit	Explosive Blasting	38.7	19.737	5.805	5	1	34	1	75	0.4479	0.2284	0.0672	4.3404	0.8681	29.5139	0%
MZEST	Main Zone East Pit	Explosive Blasting	38.7	19.737	5.805	5	1	34	0	0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0%
AL	Andrew Lake Pit	Explosive Blasting	38.7	19.737	5.805	5	1	34	1	75	0.4479	0.2284	0.0672	4.3404	0.8681	29.5139	0%
	End Grid Underground Mine	Explosive Blasting	38.7	19.737	5.805	5	1	34	9	0.5	2.0246	1.0325	0.3037	0.2616	0.0523	1.7787	0%

Source ID	Source Location	Metal %										
		Uranium	As	Co	Cu	Pb	Mo	Ni	Se	Zn	Cd	Cr
EZ	East Zone Pit	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PB	Purpose Built Pit	2.50E-02	8.00E-05	9.50E-04	9.40E-04	2.58E-03	1.20E-03	2.11E-03	2.00E-05	2.73E-03	5.00E-06	5.60E-03
CZ	Centre Zone Pit	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MZWEST	Main Zone West Pit	5.59E-02	1.17E-04	1.00E-03	1.35E-03	3.85E-03	1.71E-03	2.82E-03	1.19E-04	3.07E-03	1.01E-05	5.14E-03
MZEST	Main Zone East Pit	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
AL	Andrew Lake Pit	3.91E-02	3.66E-04	3.85E-04	8.01E-04	1.91E-03	2.33E-04	3.00E-03	1.25E-04	1.40E-03	1.20E-05	1.11E-02
	End Grid Underground Mine	3.25E-01	3.45E-03	1.47E-03	3.08E-03	1.31E-02	3.96E-03	5.17E-03	3.82E-04	3.14E-03	8.19E-05	1.03E-02

Source ID	Source Location	Controlled Emission Rate (g/s)																
		SPM	PM_{10}	$PM_{2.5}$	Uranium	As	Co	Cu	Pb	Mo	Ni	Se	Zn	Cd	Cr	NO_x	SO_2	CO
EZ	East Zone Pit	0.0000	0.0000	0.0000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.0000	0.0000	0.0000
PB	Purpose Built Pit	0.0000	0.0000	0.0000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.0000	0.0000	0.0000
CZ	Centre Zone Pit	0.0000	0.0000	0.0000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.0000	0.0000	0.0000
MZWEST	Main Zone West Pit	0.4479	0.2284	0.0672	2.51E-04	5.23E-07	4.50E-06	6.04E-06	1.73E-05	7.67E-06	1.26E-05	5.33E-07	1.37E-05	4.54E-08	2.30E-05	4.3404	0.8681	29.5139
MZEST	Main Zone East Pit	0.0000	0.0000	0.0000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.0000	0.0000	0.0000
AL	Andrew Lake Pit	0.4479	0.2284	0.0672	1.75E-04	1.64E-06	1.73E-06	3.59E-06	8.55E-06	1.04E-06	1.35E-05	5.62E-07	6.27E-06	5.39E-08	4.95E-05	4.3404	0.8681	29.5139
	End Grid Underground Mine	2.0246	1.0325	0.3037	6.59E-03	6.99E-05	2.97E-05	6.23E-05	2.66E-04	8.01E-05	1.05E-04	7.74E-06	6.35E-05	1.66E-06	2.08E-04	0.2616	0.0523	1.7787

Notes:
Emission factors for PM are taken from Colorado Department of Health (1981).
Emission factors for SO_2 and CO are taken from AP-42 Table 13.3-1 for detonation of ANFO. Kiggavik uses 100% emulsion or emulsion + ANFO. However at present time no emission factor for the detonation of emulsion is available.
Emission factor for NO_x is 10 lb/ton ANFO used, taken from NIOSH publication TIC-2 No. 20025380, A Technique for Measuring Toxic Gases Produced by Blasting Agents, January 1997.

Size Fraction	Emission Factor Equatio	Reference
SPM <30 µm	E = 38.7 kg/blast	CDOH 1981
PM <10 µm	E = 51% of TSP	AP-42 Table B.2.2, Category 3 - Aggregate, Unprocessed Ores, January 1995
PM <2.5 µm	E = 15% of TSP	AP-42 Table B.2.2, Category 3 - Aggregate, Unprocessed Ores, January 1995

Maximum Bounding Emissions Scenario Wind Erosion Calculation Spreadsheet

Source ID	Wind Erosion Source	Active or Inactive?	s %	Base Length (m)	Base Width (m)	Height of Pile (m)	Occupied Area (ha)	Surface Area (ha)	Active Surface Area (ha)[1]	E (kg/ha/day) TSP	E (kg/ha/day) PM_{10}	E (kg/ha/day) $PM_{2.5}$	Uncontrolled (g/s) TSP	Uncontrolled (g/s) PM_{10}	Uncontrolled (g/s) $PM_{2.5}$	Assumed Control Efficiency (%)
EZ	East Zone Pit Active Area	Inactive	5	N/A	N/A	N/A	6.6	6.6	0.0	19.749	9.875	3.950	0.00000	0.00000	0.00000	0%
PB	Purpose Built Pit Active Area	Inactive	5	N/A	N/A	N/A	2.8	2.8	0.0	19.749	9.875	3.950	0.00000	0.00000	0.00000	0%
CZ	Centre Zone Pit Active Area	Inactive	5	N/A	N/A	N/A	14.3	14.3	0.0	19.749	9.875	3.950	0.00000	0.00000	0.00000	0%
MZEST	Main Zone East Pit Active Area	Inactive	5	N/A	N/A	N/A	16.2	16.2	0.0	19.749	9.875	3.950	0.00000	0.00000	0.00000	0%
MZWEST	Main Zone West Pit Active Area	Active	5	N/A	N/A	N/A	25.9	25.9	1.0	19.749	9.875	3.950	0.22858	0.11429	0.04572	0%
AL	Andrew Lake Pit Active Area	Active	5	N/A	N/A	N/A	46.9	46.9	1.0	19.749	9.875	3.950	0.22858	0.11429	0.04572	0%
OREK	Kiggavik Ore Pile - large	Active	5	255	145	7	5.2	4.2	1.0	19.749	9.875	3.950	0.22858	0.11429	0.04572	0%
OREK	Kiggavik Ore Pile - small	Active	5	135	95	7	n/a	1.6	1.0	19.749	9.875	3.950	0.22858	0.11429	0.04572	0%
SWK	Kiggavik Special Waste Pile	Active	5	520	237	10	12.3	13.8	1.4	19.749	9.875	3.950	0.31588	0.15794	0.06318	0%
CWNK	Kiggavik Clean Rock Pile North	Active	5	1150	478	50	54.9	71.2	7.1	19.749	9.875	3.950	1.62782	0.81391	0.32556	0%
CWK	Kiggavik Clean Rock Pile South	Active	5	2060	377	50	77.6	102.0	10.2	19.749	9.875	3.950	2.33089	1.16545	0.46618	0%
KOVB	Kiggavik Overburden Pile	Active	5	500	300	50	14.0	23.0	2.3	19.749	9.875	3.950	0.52573	0.26286	0.10515	0%
ORES	Andrew Lake Ore Pad	Active	5	95	95	10	0.9	1.3	1.0	19.749	9.875	3.950	0.22858	0.11429	0.04572	0%
SWS	Andrew Lake Special Waste Pile	Active	5	600	200	10	12.0	13.6	1.4	19.749	9.875	3.950	0.31102	0.15551	0.06220	0%
CWS	Andrew Lake Clean Rock Pile	Active	5	2000	683	50	136.7	163.5	16.4	19.749	9.875	3.950	3.73788	1.86894	0.74758	0%
SOVB	Andrew Lake Overburden Pile	Active	5	500	280	50	14.7	21.8	2.2	19.749	9.875	3.950	0.49830	0.24915	0.09966	0%
CWEG	End Grid (Backfill) Clean Waste Pile	Active	5	150	100	10	1.5	2.0	1.0	19.749	9.875	3.950	0.22858	0.11429	0.04572	0%
SWEG	End Grid Special Waste Pile	Active	5	150	100	10	1.5	2.0	1.0	19.749	9.875	3.950	0.22858	0.11429	0.04572	0%
EGORE	End Grid Ore Pile	Active	5	50	50	10	0.2	0.5	1.0	19.749	9.875	3.950	0.22858	0.11429	0.04572	0%

Source ID	Metal % Uranium	As	Co	Cu	Pb	Mo	Ni	Se	Zn	Cd	Cr
EZ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PB	2.50E-02	8.00E-05	9.50E-04	9.40E-04	2.58E-03	1.20E-03	2.11E-03	2.00E-05	2.73E-03	5.00E-06	5.60E-03
CZ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MZEST	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MZWEST	5.59E-02	1.17E-04	1.00E-03	1.35E-03	3.85E-03	1.71E-03	2.82E-03	1.19E-04	3.07E-03	1.01E-05	5.14E-03
AL	3.91E-02	3.66E-04	3.85E-04	8.01E-04	1.91E-03	2.33E-04	3.00E-03	1.25E-04	1.40E-03	1.20E-05	1.11E-02
OREK	6.67E-01	1.69E-03	1.47E-03	4.00E-03	4.08E-02	1.75E-02	7.59E-03	2.03E-04	3.76E-03	1.17E-04	4.20E-02
OREK	6.67E-01	1.69E-03	1.47E-03	4.00E-03	4.08E-02	1.75E-02	7.59E-03	2.03E-04	3.76E-03	1.17E-04	4.20E-02
SWK	9.00E-02	7.30E-05	1.09E-03	4.51E-03	3.02E-03	1.47E-03	2.22E-03	1.43E-04	3.52E-03	5.00E-06	4.21E-03
CWNK	1.55E-02	9.20E-05	9.63E-04	1.20E-03	1.24E-03	1.91E-04	2.62E-03	1.14E-04	3.01E-03	4.00E-06	4.58E-03
CWK	2.00E-02	9.20E-05	9.63E-04	1.20E-03	1.24E-03	1.91E-04	2.62E-03	1.14E-04	3.01E-03	4.00E-06	4.58E-03
KOVB	1.00E-03	8.00E-05	1.12E-03	1.35E-03	1.01E-03	1.90E-04	2.70E-03	1.13E-04	3.55E-03	5.00E-06	4.63E-03
ORES	6.32E-01	1.66E-03	8.30E-04	5.05E-03	3.55E-02	5.57E-03	9.54E-03	5.00E-05	3.41E-03	1.10E-04	9.61E-02
SWS	9.00E-02	1.92E-04	2.63E-04	5.64E-04	1.41E-03	8.40E-05	2.79E-03	1.10E-04	9.95E-04	1.10E-05	7.71E-03
CWS	2.00E-02	3.28E-04	3.73E-04	6.72E-04	8.70E-04	6.90E-05	2.80E-03	1.28E-04	1.34E-03	9.00E-06	8.45E-03
SOVB	1.00E-03	3.69E-04	3.76E-04	7.40E-04	7.63E-04	6.70E-05	2.71E-03	1.33E-04	1.36E-03	8.00E-06	8.66E-03
CWEG	2.50E-02	3.28E-04	3.73E-04	6.72E-04	8.70E-04	6.90E-05	2.80E-03	1.28E-04	1.34E-03	9.00E-06	8.45E-03
SWEG	2.10E-01	1.00E-04	1.30E-03	2.00E-04	3.80E-03	1.00E-04	3.70E-03	9.00E-05	3.80E-03	1.00E-04	1.00E-02
EGORE	5.01E-01	5.49E-03	2.08E-03	4.67E-03	2.08E-02	6.46E-03	6.60E-03	5.50E-04	4.05E-03	1.20E-04	1.13E-02

Source ID	Controlled Emission Rate (g/s) TSP	PM_{10}	$PM_{2.5}$	Uranium	As	Co	Cu	Pb	Mo	Ni	Se	Zn	Cd	Cr
EZ	0.00000	0.00000	0.00000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PB	0.00000	0.00000	0.00000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CZ	0.00000	0.00000	0.00000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MZEST	0.00000	0.00000	0.00000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MZWEST	0.22858	0.11429	0.04572	1.28E-04	2.67E-07	2.29E-06	3.08E-06	8.81E-06	3.92E-06	6.44E-06	2.72E-07	7.01E-06	2.31E-08	1.18E-05
AL	0.22858	0.11429	0.04572	8.93E-05	8.37E-07	8.81E-07	1.83E-06	4.36E-06	5.33E-07	6.87E-06	2.87E-07	3.20E-06	2.75E-08	2.53E-05
OREK	0.22858	0.11429	0.04572	1.52E-03	3.86E-06	3.35E-06	9.14E-06	9.33E-05	4.00E-05	1.73E-05	4.64E-07	8.59E-06	2.67E-07	9.59E-05
OREK	0.22858	0.11429	0.04572	1.52E-03	3.86E-06	3.35E-06	9.14E-06	9.33E-05	4.00E-05	1.73E-05	4.64E-07	8.59E-06	2.67E-07	9.59E-05
SWK	0.31588	0.15794	0.06318	2.84E-04	2.31E-07	3.43E-06	1.42E-05	9.53E-06	4.63E-06	7.01E-06	4.52E-07	1.11E-05	1.58E-08	1.33E-05
CWNK	1.62782	0.81391	0.32556	2.53E-04	1.50E-06	1.57E-05	1.95E-05	2.02E-05	3.11E-06	4.26E-05	1.86E-06	4.91E-05	6.51E-08	7.45E-05
CWK	2.33089	1.16545	0.46618	4.66E-04	2.14E-06	2.24E-05	2.79E-05	2.89E-05	4.45E-06	6.10E-05	2.66E-06	7.03E-05	9.32E-08	1.07E-04
KOVB	0.52573	0.26286	0.10515	5.26E-06	4.21E-07	5.87E-06	7.11E-06	5.29E-06	9.99E-07	1.42E-05	5.94E-07	1.87E-05	2.63E-08	2.43E-05
ORES	0.22858	0.11429	0.04572	1.44E-03	3.79E-06	1.90E-06	1.15E-05	8.11E-05	1.27E-05	2.18E-05	1.14E-07	7.79E-06	2.51E-07	2.20E-04
SWS	0.31102	0.15551	0.06220	2.80E-04	5.97E-07	8.18E-07	1.75E-06	4.39E-06	2.61E-07	8.68E-06	3.42E-07	3.09E-06	3.42E-08	2.40E-05
CWS	3.73788	1.86894	0.74758	7.48E-04	1.23E-05	1.39E-05	2.51E-05	3.25E-05	2.58E-06	1.05E-04	4.78E-06	5.02E-05	3.36E-07	3.16E-04
SOVB	0.49830	0.24915	0.09966	4.98E-06	1.84E-06	1.87E-06	3.69E-06	3.80E-06	3.34E-07	1.35E-05	6.63E-07	6.76E-06	3.99E-08	4.31E-05
CWEG	0.22858	0.11429	0.04572	5.71E-05	7.50E-07	8.53E-07	1.54E-06	1.99E-06	1.58E-07	6.41E-06	2.93E-07	3.07E-06	2.06E-08	1.93E-05
SWEG	0.22858	0.11429	0.04572	4.80E-04	2.29E-07	2.97E-06	4.57E-07	8.69E-06	2.29E-07	8.46E-06	2.06E-07	8.69E-06	2.29E-07	2.29E-05
EGORE	0.22858	0.11429	0.04572	1.14E-03	1.25E-05	4.75E-06	1.07E-05	4.75E-05	1.48E-05	1.51E-05	1.26E-06	9.26E-06	2.74E-07	2.58E-05

[1] Active area for pits was assumed to be 100 metres by 100 meters. Active area for stock piles was assumed to be 10% of total area or 100 metres by 100 metres, whichever is larger.

Equation	Reference
E = k*1.9 *(s/1.5) * f/15	AWMA - Air Pollution Engineering Manual, 1992, page 137

E = emission factor (kg/ha/day)
k = particle size multilier for particulate size range of interest
s = Silt Content in %
f = % of time that the unobstructed wind speed exceeds 5.4 m/s at mean pile height

Parameter	TSP	PM_{10}	$PM_{2.5}$	Reference
k	1.0	0.5	0.2	AWMA - Air Pollution Engineering Manual, 1992, page 137
f	see wind frequency table below - Updated from CALMET runs May 2011.			

Stockpile surface area sample calculation:

Conservatively assume stockpiles acting as a rectangular prism, then
SA = B + Ph = (lw) + 2(l+w)(h)

Where,
B = Base area
P = Perimeter
h = Height of pile

Month	f
January	39
February	20
March	33
April	31
May	22
June	13
July	8
August	21
September	35
October	21
November	34
December	47

Maximum Bounding Emissions Scenario Mill Calculation Spreadsheet

McClean Stack Testing Results

Source	Stack Test Data					Calculated				
	Particulate (kg/h)	Uranium (kg/h)	NO_x (kg/h)	SO_2 (kg/h)	CO (kg/h)	Particulate (g/s)	Uranium (g/s)	NO_x (g/s)	SO_2 (g/s)	CO (g/s)
Crushing & Grinding Stack	0.01	0.0	0.0	0.0	0.0	3.61E-03	-	0.00	0.00	0.00
Yellowcake Calciner Stack	6.0	6.90E-03	0.76	0.02	0.39	1.67	1.92E-03	0.21	0.01	0.11
Yellowcake Packaging Area Stack	0.1	2.60E-03	0.0	0.0	0.0	0.03	7.22E-04	0.00	0.00	0.00
Total for Calcining and Packaging	6.1	0.0	0.8	0.0	0.4	1.69	2.64E-03	0.21	0.01	0.11

Note: stack test report for yellowcake packaging area includes NOx, SO_2 and CO; however, it is likely that these are a result of heating equipment that shares a stack with the packaging area.

McClean Mill Production:

Ore Feed	t/day	677
Prod'n during Calcining test	kg U/h	832
Prod'n during Packaging test	kg U/h	2255
Grade	%U (2008)	0.81%

Note: Grade U% from McClean Report 34918 "McCLEAN LAKE OPERATONS ATMOSPHERIC AND WATERSHED DISPERSION MODELLING", May 2009, page 12.

Kiggavik

Ore Feed	t/day	3358
Yellowcake Prod'n	kg U/h	537
Grade	%U	0.400%

Source ID	Description	Emission Rate (g/s)																
		TSP	PM_{10}	$PM_{2.5}$	Uranium	As	Co	Cu	Pb	Mo	Ni	Se	Zn	Cd	Cr	NO_x	SO_2	CO
MILL	Crushing & Grinding	1.79E-02	9.13E-03	2.69E-03	1.19E-04	3.03E-07	2.62E-07	7.16E-07	7.31E-06	3.14E-06	1.36E-06	3.64E-08	6.73E-07	2.09E-08	7.51E-06	0.00E+00	0.00E+00	0.00E+00
MILL	Calcining	1.08E+00	5.49E-01	1.61E-01	1.24E-03	0	0	0	0	0	0	0	0	0	0	1.36E-01	3.59E-03	6.99E-02
MILL	Packaging	5.96E-03	3.04E-03	8.93E-04	1.72E-04	0	0	0	0	0	0	0	0	0	0	0.00E+00	0.00E+00	0.00E+00
		1.10E+00																

Size Fraction	Emission Factor	Reference
PM <10 µm	E = 51% of TSP	AP-42 Table B.2.2, Category 3 - Aggregate, Unprocessed Ores, January 1995
PM <2.5 µm	E = 15% of TSP	AP-42 Table B.2.2, Category 3 - Aggregate, Unprocessed Ores, January 1995

Notes:

Cells highlighed gray indicate that emissions of a contaminant are insignificant. Assumed that most metals/minerals have been removed during the milling process.

Maximum Bounding Emissions Scenario Underground Mine Calculation Spreadsheet

Source ID	Source	TSP Emission Rate (g/s)	PM_{10} Emission Rate (g/s)	$PM_{2.5}$ Emission Rate (g/s)	Uranium Emission Rate (g/s)	As Emission Rate (g/s)	Co Emission Rate (g/s)	Cu Emission Rate (g/s)	Pb Emission Rate (g/s)	Mo Emission Rate (g/s)	Ni Emission Rate (g/s)	Se Emission Rate (g/s)	Zn Emission Rate (g/s)	Cd Emission Rate (g/s)	Cr Emission Rate (g/s)	NO_X Emission Rate (g/s)	SO_2 Emission Rate (g/s)	CO Emission Rate (g/s)
End Grid	NonRoad Equipment Tailpipe Emissions	0.0528	0.0528	0.0512	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	6.1350	0.0741	0.5634
	Material Handling Emissions	0.0056	0.0026	0.0004	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-	-	-
	Drilling Emissions	4.3211	2.2038	0.6482	0.0141	0.0001	0.0001	0.0001	0.0006	0.0002	0.0002	0.0000	0.0001	0.0000	0.0004	-	-	-
	Blasting Emissions	2.0246	1.0325	0.3037	0.0066	0.0001	0.0000	0.0001	0.0003	0.0001	0.0001	0.0000	0.0001	0.0000	0.0002	0.2616	0.0523	1.7787
EXHAUST	Total Emissions from Underground Mine	**6.404**	**3.292**	**1.003**	**0.021**	**0.000**	**0.000**	**0.000**	**0.001**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.001**	**6.397**	**0.126**	**2.342**

Maximum Bounding Emissions Scenario Power Generation Calculation Spreadsheet

Diesel Generator Sets

CAT model 12CM32 diesel generator set was selected (AREVA memo dated January 3, 2011).

Number of generators operating - Kiggavik	4		
Number of generators operating - Sissons	1		
Full Load Power	4186	eKW	(Caterpillar Engine Performance Report January 17, 2011)
	5611	hp	$hp = \frac{kw}{0.746 \times Efficiency}$
	5760	bKW	

ENGINE POWER	4186	eKW
	5611	hp
Contaminant	EF[1]	ER (g/s)
PM (lb/hp-hr)	7.0E-04	0.49
NOx (g/KWh)	13.60	15.81
CO (g/KWh)	0.06	0.07

Notes:

1. EF for PM from AP-42 Ch. 3.4 - Large Stationary Diesel and all Stationary Dual-fuel Engines, Table 3.4-1

EF for Nox and CO obtained from CATERPILLAR Engine Performance Report Model 9CM32 C provided January 17, 2011

Sulphur Dioxide emissions calculations

Sulphur fuel content	0.0015	%
Power generation at Kiggavik	155,000,000	kWh/year
Power generation at Kiggavik	23,000,000	kWh/year
Heating value	19,676	Btu/lb
Convert kWh to Btu	3412.142	Btu/kWh
Convert lb to g	453.5924	g/lb
Operating hours per year	8760	hours
SO2 @ Kiggavik total	0.0058	g/s
SO2 @ Sissons total	0.0009	g/s

Kiggavik

Source ID	Emission Rate (g/s)															
	TSP	PM_{10}	$PM_{2.5}$	Uranium	As	Co	Cu	Pb	Mo	Ni	Se	Zn	Cd	Cr	NOx	SO_x	CO
STK	1.98E+00	1.90E+00	1.78E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	63.3	0.0058	0.3

Size Fraction	Emission Factor Equation	Reference
PM <10 µm	E = 96% of TSP	AP-42 Table B.2.2, Category 1 - Gasoline and Diesel Fueled Stationary IC Engines, January 1995
PM <2.5 µm	E = 90% of TSP	AP-42 Table B.2.2, Category 1 - Gasoline and Diesel Fueled Stationary IC Engines, January 1996

Sissons

7Jan11: Assumed 1 generator set at Sissons.

Power requirement for Sissons is significantly less than Kiggavik, at 23,000,000 kWh in comparison to 155,000,000 kWh at Kiggavik. The ratio is approximately 15%, which is equivalent to 1 out of 6 generator running.

Therefore, it was assumed the power plant at Sissons consists of 1 CAT 3616 4.4 MW generator.

Source ID	Emission Rate (g/s)															
	TSP	PM_{10}	$PM_{2.5}$	Uranium	As	Co	Cu	Pb	Mo	Ni	Se	Zn	Cd	Cr	NOx	SO_x	CO
SPPL	4.95E-01	4.75E-01	4.45E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	15.81	0.0009	0.07

Maximum Bounding Emissions Scenario Incineration Calculation Spreadsheet

Source ID	Source Description	Exhaust Gas Flow Rate (m^3/s)	Tested Emission Rate (mg/m^3): TSP	PM_{10}	$PM_{2.5}$	Uranium	As	Co	Cu	Pb	Mo	Ni	Se	Zn	Cd	Cr	NO_x	SO_2	CO	CO_2	CH_4	Hg	HCl	CDD/CDF
KINC	Multi-chamber Incinerator at Kiggavik	7.2	3.112	2.458	1.400	0	0	0	0	0	0	0	0	0	0	0	14.64	7.78	1.09	0	0	0	0	1.24E-11
SINC	Multi-chamber Incinerator at Sissons	3.6	3.112	2.458	1.400	0	0	0	0	0	0	0	0	0	0	0	14.64	7.78	1.09	0	0	0	0	1.24E-11

Source ID	Uncontrolled Emission Rate (g/s): TSP	PM_{10}	$PM_{2.5}$	Uranium	As	Co	Cu	Pb	Mo	Ni	Se	Zn	Cd	Cr	NO_x	SO_2	CO	CO_2	CH_4	Hg	HCl	CDD/CDF
KINC	2.23E-02	1.76E-02	1.00E-02	0	0	0	0	0	0	0	0	0	0	0	1.05E-01	5.58E-02	7.81E-03	0	0	0	0	8.93E-14
SINC	1.12E-02	8.81E-03	5.02E-03	0	0	0	0	0	0	0	0	0	0	0	5.25E-02	2.79E-02	3.91E-03	0	0	0	0	4.46E-14

Notes:

Emission factor data from Eco Waste Solutions Incinerator Model No. ECO 1.75TN 1P MS 60L Technical Specification sheet, provided as part of AREVA memo dated October 21, 2010.

0.033

Cells highlighed gray indicate that emissions of a contaminant are zero.

Emission Factor (mg/m^3)	Tested Emission Rate (mg/m^3): TSP	PM_{10}	$PM_{2.5}$	Uranium	As	Co	Cu	Pb	Mo	Ni	Se	Zn	Cd	Cr	NO_x	SO_2	CO	CO_2	CH_4	Hg	HCl	CDD/CDF
@ 25 C, 11% O2	20	-	-	0	0	0	0	0	0	0	0	0	0	0	94	50	7	0	0	0	0	8.00E-11
@ 1000 C, 6% O2	3.1	-	-	0	0	0	0	0	0	0	0	0	0	0	14.6	7.8	1.1	0	0	0	0	1.24E-11

Source: Emission data in Eco Waste Solutions Incinerator Model No. ECO 1.75TN 1P MS 60L Technical Specification sheet, provided as part of AREVA memo dated October 21, 2010.

Calculating Exhaust Gas Volumetric Flow Rate Based on Mass Flow Rate:

Flue Gas Temperature (°C)	1000	from Eco Waste Solutions Technical Specification sheet
Flue Gas Flow Rate (kg/s) (max)	1.996	from Eco Waste Solutions Technical Specification sheet
Density of air at STP	1.189	Assumed flue gas has similar composition to air
Actual Flue Gas Volumetric Flow Rate (m^3/s)	7.2	at 1000 C and 6% O2

Maximum Bounding Emissions Scenario Backfill Plant Calculation Spreadsheet

Source ID	Source Description	Process Rate (t/day) or (t/hr)	Controlled Emission Factor (kg/Mg): TSP	PM_{10}	$PM_{2.5}$	Uranium	As	Co	Cu	Pb	Mo	Ni	Se	Zn	Cd	Cr	NO_x	SO_2	CO	CO2	CH4	Hg	HCl	CDD/CDF
BATCH PLANT	Cement Unloading (to Silo)	28	0.0005	1.70E-04	1.70E-04	0	8.38E-07	0	0	3.68E-07	0	8.83E-06	0	0	1.17E-07	1.26E-07	0	0	0	0	0	0	0	0
BATCH PLANT	Uncontrolled Aggregate Transfer	788	0.0035	1.70E-03	0.000257	5.44E-07	3.22E-09	3.37E-08	4.19E-08	4.34E-08	6.69E-09	9.16E-08	3.99E-09	1.05E-07	1.40E-10	1.60E-07	0	0	0	0	0	0	0	0
BATCH PLANT	Unloading to continuous CRF mixer	60	0.0092	2.80E-03	0.000646	0	4.19E-06	0	0	1.91E-07	0	1.64E-06	0	0	5.29E-09	7.11E-07	0	0	0	0	0	0	0	0

Source ID	Source Description	Controlled Emission Rate (g/s): TSP	PM_{10}	$PM_{2.5}$	Uranium	As	Co	Cu	Pb	Mo	Ni	Se	Zn	Cd	Cr	NO_x	SO_2	CO	CO2	CH4	Hg	HCl	CDD/CDF
BATCH PLANT	Cement Unloading (to Silo)	1.61E-04	5.47E-05	5.47E-05	0.0	2.69E-07	0.0	0.0	1.18E-07	0.0	2.84E-06	0.0	0.0	3.76E-08	4.05E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BATCH PLANT	Uncontrolled Aggregate Transfer	3.19E-02	1.55E-02	2.35E-03	4.96E-06	2.94E-08	3.07E-07	3.82E-07	3.96E-07	6.09E-08	8.35E-07	3.64E-08	9.62E-07	1.28E-09	1.46E-06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BATCH PLANT	Unloading to continuous CRF mixer	1.53E-01	4.67E-02	1.08E-02	0.0	6.98E-05	0.0	0.0	3.18E-06	0.0	2.73E-05	0.0	0.0	8.82E-08	1.19E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Notes:

Road dust emissions due to the transfer of aggregate have been considered in the haul road emissions calculation Unpaved Road Dust

According to the IFS, Section 6.4.3, cemented rock fill typically has enough strength to support adjacent mining 7-10 days after placement. Therefore, it is unlikely that the batch plant will operate simultaneously with underground mining.

Emission factor source: AP-42 Chapter 11.12 Concrete Batching, June 2006. Assumed $PM_{2.5}$ size fraction for Central Mix is 23% of PM_{10} (based on constants used in Equation 11.12-1 - see table below).

Constant	AP-42 Table 11.12-4 Central Mix: SPM	PM_{10}	$PM_{2.5}$
k	0.19	0.13	0.03
a	0.95	0.45	0.45
b	0.9	0.9	0.9
c	0.001	0.001	0.0002

Maximum Bounding Emissions Scenario Acid Plant Calculation Spreadsheet

Emissions scaled based on McClean emissions (stack test for Acid Plant)

	Acid Plant	Stack Emission Rate			Calculated Emission Rate		
		SO_2 (kg/h)	NO_X (kg/h)	CO (kg/h)	SO_2 (g/s)	NO_X (g/s)	CO (g/s)
McClean		5.52	0.05	0.08	1.53	0.0139	0.02

Source: Source Testing of AREVA Resources Canada Inc. McClean Lake, Yellowcake Calciner, Yellowcake Packaging Area, Grinding, Crystallizer and Acid Plant Stacks, SRC Publication No. 10448-29C08, June 2008.
Note: SO_2 emission rate not used. Emission from IFS used instead.

Production of H_2SO_4

McClean	100.1	tonnes/day	1323.477
Kiggavik	350	tonnes/day	
SO_2 EF	75	g/tonne H_2SO_4	

Source ID	Emission Rate (g/s)															
	TSP	PM_{10}	$PM_{2.5}$	Uranium	As	Co	Cu	Pb	Mo	Ni	Se	Zn	Cd	Cr	NO_x	SO_2	CO
ACID	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4.86E-02	3.04E-01	7.77E-02

Notes:
Cells highlighed gray indicates that emissions of a contaminant are zero.

A.2 Air Emissions Calculation Methods: Final Closure and Post-Closure

Final Closure

For the purpose of this assessment, decommissioning or final closure activities assessed included backfilling all special waste at Kiggavik and Sissons into the Main Zone TMF and mined-out Andrew Lake pit, respectively. It was conservatively assumed that all material will be a backfilled over a two year period. Therefore, the average amount of special waste moved over a one year period is about 603,500 tonnes at Kiggavik and about 764,400 tonnes at Sissons.

Activities for charging or covering Centre Zone pit with a layer of Type II mine rock were also considered in this assessment. It is anticipated that by the time final-closure gets underway, Centre Zone TMF will have begun to be charged. For present purposes, it was assumed that half of Centre Zone TMF had already been charged and that the remainder was completed concurrently with backfilling of special waste. The mine rock cover was assumed to originate from the north Type II mine rock pile.

Sources of dust emissions from backfilling special waste and charging Centre Zone TMF include:

- material handling at the stockpiles and at Main Zone TMF, Centre Zone TMF and Andrew Lake open pit;
- unpaved road dust;
- diesel-powered engines;
- dozing within Main Zone TMF, Centre Zone TMF and Andrew Lake; and
- wind erosion of the special waste stockpiles and active working areas within Main Zone, Centre Zone and Andrew Lake.

Emissions from each of the listed activities were calculated used the same methods outlined in Attachment A.1 – On-Site Operations. To backfill special waste into Andrew Lake pit, it was assumed that haul trucks travelled all the way to the bottom of the pit to dump its load rather than dumping it over the edge of the pit.

Radon emissions were also considered during this assessment. Radon was considered to be generated from the following sources:

- handling of Type II and Type II mine rock;
- surface area emissions from permanent clean rock stockpiles;

- surface area emissions from charged TMFs (East Zone and part of Centre Zone); and
- surface area emissions from backfilled Type III mine rock in Main Zone TMF and Andrew Lake pit.

Again, the same methods as outlined in Attachment A.1 were used to calculate radon emissions.

Post-Closure

During the post-closure period, air emissions are assumed to consist of only radon gas released from the surfaces of the Type II (clean) mine rock stockpiles and decommissioned TMFs which are covered with a layer of clean rock and overburden. Since the piles will be well compacted, remain largely undisturbed, and the TMFs re-vegetated, dust emissions were not considered. The size of the clean rock piles were reduced to reflect that material had been taken away to cover decommissioned TMFs.

Surface area emissions of radon from the permanent Type II mine rock piles were estimated using the methods outlined in Attachment A.1. The model used to calculated radon emissions from decommissioned TMFs was based on the methodology recommended by the IAEA Technical Reports Series No. 474 (2013), with additional guidance from U.S. NRC Regulatory Guide 3.46 (1989) and IAEA Technical Reports Series No. 333 (1992). The parameter values were based on default values recommended by IAEA or the NRC guideline, and site-specific values where available. The parameters and their values, as well as equations used in the estimation are listed in Table A-9. Based on this calculation for 0.42% uranium in ore, the long-term radon flux from tailings covered by 2 m of sand was estimated to be 0.66 Bq/m²/s.

Table A-9 Final Closure Scenario Variables and Assumptions Spreadsheet

Description	Parameter	Unit	Value	Source	Equation
Percent U in ore	%Uo		0.42	DEIS Vol 2 - Table 5.3-1	
Activity of U-238 in ore	Bq/kg		51660		=%Uo/100*12300*1000
Ra-226 activity in tailings	R	Bq/kg	51660	equilibrium with U-238 in ore	
Bulk density	rb	kg/m^3	1925	Estimated	
Emanation coefficient	Et	-	0.2	Verifiable for Canada	
Specific gravity of tailings	Gt	-	2.75	NRC	
Mass density of water	rw	kg/m^3	1000	NRC	

Table A-9 Final Closure Scenario Variables and Assumptions Spreadsheet

Description	Parameter	Unit	Value	Source	Equation
Porosity of tailings	nt		0.30	Consolidated tailings have a solids content of 70% (DEIS Vol 2, Sec 8.3.1)	nt=1- rb/ Gt.rw
Long-term average moisture content of tailings	Wt	dry wt. percent	15	Although water cover removed tailings will be wet - set to half of porosity	
Moisture Saturation fraction of tailings	mt		0.96		mt= 0.01 rb. Wt/ nt. rw
Diffusion coefficient for radon in the total pore space of the tailings	Dt	cm^2/s	7.74E-05		D= 0.07 exp [-4(m-m.n2 + m5)]
Radon diffusion coefficient of the residue material	Dr	m^2/s	7.74E-09	units conversion	
Radon decay constant	l	s^{-1}	2.10E-06	NRC	
Radon flux density	frinf	$Bq/m^2/s$	2.54E+00		=RrbE(lDr)^0.5
Thickness of tailings	zr	m	90		
Diffusion length	Lr	m	1.00E+00	for Rn-222 (p. 61)	
Diffusion length	L	m	6.07E-02	calculated	=(D/l)^0.5
Flux from a residue surface, no cover	fr	$Bq/m^2/s$	2.54		=frinf tanh(zr/Lr)
Dry bulk mass density of soil cover	rc	g/cm^3	1.6	assumed sand	
Specific gravity of soil cover	Gc	-	2.65	sand	
Long-term average moisture content of soil cover	Wc	dry wt. percent	3	sand	
Porosity of cover soil	nc		0.40		nc=1- rc/ Gc.rw
Moisture Saturation fraction of cover soil	mc		0.121		mc= 0.01 rc. Wc/ nc. rw
Diffusion coefficient for radon in the total pore space of the tailings	Dc	cm^2/s	0.047		D= 0.07 exp [-4(m-m.n2 + m5)]
Radon diffusion coefficient of the cover	Dc	m^2/s	4.65E-06	units conversion	

Table A-9 Final Closure Scenario Variables and Assumptions Spreadsheet

Description	Parameter	Unit	Value	Source	Equation
Cover thickness	zc	m	2	2-m layer of sand fill will be placed directly on tailings (no accounting for additional rock and soil cover)	
Radon diffusion length in cover material	Lc	m	1.49		=(Dc/l)^0.5
Flux from a residue surface covered with soil of thickness zc	fcr	$Bq/m^2/s$	0.66		=fr exp(-zc/Lc)

Final Closure Scenario Variables and Assumptions Spreadsheet

Summary of Variables Used for Emission Estimates on Worksheets			340680 Kiggavik
Month	**December**	**Note:** enter full name of month	
"Daily" or "Annual" Multiplier Used?	**Daily**		
Material Handling	Calculation Method: Drop Equation AP-42 13.2.4, November 2006		
Variable	**Assumed Value**	**Units**	**Comments**
Operation days per month - January to March	12	days per month	KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, Basic
Operation days per month - April to December	30	days per month	KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, Basic
Operation days per year	365	days per year	Calculated
Operation hours per day	24	hours per day	Assumption
Conversion factor bcm to tonnes - waste rock	2.7	tonnes/bcm	KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, SenesRequest3
Conversion factor bcm to tonnes - overburden	1.65	tonnes/bcm	Midpoint of dry bulk density as outlined in the IFS rounded to 1.65
Conversion factor bcm to tonnes - ore - East Zone	2.36	tonnes/bcm	KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, SenesRequest3
Conversion factor bcm to tonnes - ore - Centre Zone	2.36	tonnes/bcm	KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, SenesRequest3
Conversion factor bcm to tonnes - ore - Main Zone	2.40	tonnes/bcm	KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, SenesRequest3
Conversion factor bcm to tonnes - ore - Andrew Lake	2.35	tonnes/bcm	KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, SenesRequest3
Conversion factor bcm to tonnes - ore - End Grid	2.40	tonnes/bcm	KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, SenesRequest3
Variable	**Assumed Value**	**Units**	**Comments**
Maximum Excavated per Year - Decomm.			from "AnnualSched_Apr2011" tab
East Zone - Total	0	bcm per year	Note: rock types will not add up to total due to rounding
PB Pit - Total	0	bcm per year	
Centre Zone - Total	0	bcm per year	
Main Zone - Total	0	bcm per year	
Andrew Lake - Total	0	bcm per year	
End Grid - Total	0	bcm per year	
East Zone - Ore	0	kt per year	
PB Pit - Ore	0	kt per year	
Centre Zone - Ore	0	kt per year	
Main Zone - Ore	0	kt per year	
Andrew Lake - Ore	0	kt per year	
End Grid - Ore	0	kt per year	
East Zone - WR Type III	29,500	bcm per year	Special waste
PB Pit - WR Type III	0	bcm per year	
Centre Zone - WR Type III	60,500	bcm per year	
Main Zone - WR Type III	133,500	bcm per year	
Andrew Lake - WR Type III	255,500	bcm per year	
End Grid - WR Type III	75	kt per year	
East Zone - WR Type II	0	bcm per year	Clean waste
PB Pit - WR Type II	0	bcm per year	Assume all of PB is clean
Centre Zone - WR Type II	264,500	bcm per year	
Main Zone - WR Type II	0	bcm per year	
Andrew Lake - WR Type II	0	bcm per year	
End Grid - WR Type II	0	kt per year	
East Zone - OV	0	bcm per year	Overburden
PB Pit - OV	0	bcm per year	
Centre Zone - OV	0	bcm per year	
Main Zone - OV	0	bcm per year	
Andrew Lake - OV	0	bcm per year	
End Grid - OV	0	kt per year	
Maximum Excavated per Day - tonnes - Decomm.			Note: values have been rounded up to either nearest 10, 100 or 1000 as applicable
East Zone - Total	218	tonnes/day	
PB Pit - Total	0	tonnes/day	
Centre Zone - Total	2,404	tonnes/day	
Main Zone - Total	988	tonnes/day	
Andrew Lake - Total	1,890	tonnes/day	
End Grid - Total	204	tonnes/day	
East Zone - Ore	0	tonnes/day	
PB Pit - Ore	0	tonnes/day	
Centre Zone - Ore	0	tonnes/day	
Main Zone - Ore	0	tonnes/day	
Andrew Lake - Ore	0	tonnes/day	
End Grid - Ore	0	tonnes/day	
East Zone - WR Type III	218	tonnes/day	Special waste
PB Pit - WR Type III	0	tonnes/day	
Centre Zone - WR Type III	448	tonnes/day	
Main Zone - WR Type III	988	tonnes/day	
Andrew Lake - WR Type III	1,890	tonnes/day	
End Grid - WR Type III	204	tonnes/day	
East Zone - WR Type II	0	tonnes/day	Clean waste
PB Pit - WR Type II	0	tonnes/day	
Centre Zone - WR Type II	1,957	tonnes/day	
Main Zone - WR Type II	0	tonnes/day	
Andrew Lake - WR Type II	0	tonnes/day	
End Grid - WR Type II	0	tonnes/day	
East Zone - OV	0	tonnes/day	Overburden
PB Pit - OV	0	tonnes/day	
Centre Zone - OV	0	tonnes/day	
Main Zone - OV	0	tonnes/day	
Andrew Lake - OV	0	tonnes/day	
End Grid - OV	0	tonnes/day	
Moisture Content of extracted material	3%	%	Assumption: 2.5% was used for Red Dog in Alaska; 3% was used for Mid-west in North
Moisture Content of clean fill	-	%	
Wind Speed		m/s	Average wind speeds at the Kiggavik site from CALMET
January	4.94	m/s	
February	3.45	m/s	
March	4.43	m/s	
April	4.23	m/s	
May	4.14	m/s	
June	3.50	m/s	
July	3.37	m/s	
August	3.44	m/s	
September	4.85	m/s	
October	3.99	m/s	
November	4.24	m/s	
December	5.10	m/s	
Control Efficiency	0%	%	Assumed no control for dumping of excavated material
On-site Truck Characteristics			
Variable	**Assumed Value**	**Units**	**Comments**
Waste Truck Capacity	140	tonnes	IFS, Section 6.2.1.2, Figure 6.2-3 April 2011
Ore Truck Capacity	90	tonnes	IFS, Section 6.2.1.2, Figure 6.2-3 April 2011
Ore Trailer Capacity	140	tonnes	IFS Section 6.6, April 2011. Based on CAT 785C type trucks.
Empty average waste truck vehicle weight	100	tonnes	CAT785C (equipment provided in KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, Basic
Loaded weight of waste truck	240	tonnes	Calculated
Loaded / Empty average waste truck vehicle weight on haul road	170	tonnes	Based on 100 tonnes empty and 250 tonnes when loaded (100+250)/2=175
Empty average ore truck vehicle weight	70	tonnes	CAT777F (equipment provided in KiggavikProject_HLDC_June30_ToSenes_RevAug11.xls, Basic
Loaded weight of ore truck	160	tonnes	Calculated
Loaded / Empty average ore truck vehicle weight on haul road	115	tonnes	Average of loaded and empty weight
Ore-trailers used between Kiggavik and Sissons			
Empty average vehicle weight	110	tonnes	Calculated
Loaded weight of vehicle	250	tonnes	IFS Section 6.6, April 2011. Based on CAT 785C type trucks.
Loaded / Empty average vehicle weight on haul road	180	tonnes	Average of loaded and empty weight
Standard tractor-trailers used on access road (from Baker Lake to Kiggavik)			
Empty average vehicle weight	20	tonnes	From Kiggavik Screening Level Assessment (SENES 2008)
Loaded weight of vehicle	60	tonnes	Information provided by AREVA October 21, 2010
Loaded / Empty average vehicle weight	40	tonnes	Average of loaded and empty weight
Underground Trucks Hauling Ore from End Grid			
Underground Trucks Capacity	45	tonnes	CAT AD45B (45-tonne underground truck)
Empty average vehicle weight	40	tonnes	CAT AD45B (45-tonne underground truck)
Loaded weight of vehicle	85	tonnes	CAT AD45B (45-tonne underground truck)
Loaded / Empty average vehicle weight on haul road	63	tonnes	Average of loaded and empty weight
Explosive trucks			
Empty average vehicle weight	13	tonnes	Peterbilt 367 (equipment provided in AREVA memo October 21, 2010)
Loaded weight of vehicle	26	tonnes	Assumed
Loaded / Empty average vehicle weight	20	tonnes	Average of loaded and empty weight
Number of trips for explosives	6	trips per day	Calculated
Yellowcake transport trucks			Aassumed same as tractor-trailers from Baker Lake to Kiggavik
Loaded / Empty average vehicle weight	60	tonnes	Information provided by AREVA October 21, 2010
Number of trips	1	trip per day	Assumed: according to 34680-2, the total annual trips required for yellowcake are 96 trips per year; also AREVA memo dated October 21, 2010 stated frequency of yellowcake transportation flights of 336 flights/year; therefore 1 trip/day should be conservative.
Vehicle Speed	70	kph	Assumed same as tractor-trailers from Baker Lake to Kiggavik
Water truck			
Loaded / Empty average vehicle weight	24	tonnes	Assumed: based on GVW 35,000 lbs for Peterbilt 348, http://www.peterbilt.com/voc348.1.aspx
Number of trips	1	trip per day	Assumed - 1 water truck; 1 trip per day
In-pit truck trips per day (one way)			
East Zone			Calculated based on quantities excavated and truck capacities above
Ore	0	trips per day	
Special Waste	2	trips per day	
Clean Waste	0	trips per day	
Overburden	0	trips per day	
Centre Zone			
Ore	0	trips per day	
Special Waste	3	trips per day	
Clean Waste	14	trips per day	
Overburden	0	trips per day	
Purpose-built Pit			
Ore	0	trips per day	
Special Waste	0	trips per day	
Clean Waste	0	trips per day	
Overburden	0	trips per day	
Main Zone			
Ore	0	trips per day	
Special Waste	7	trips per day	
Clean Waste	0	trips per day	
Overburden	0	trips per day	
Andrew Lake			
Ore	0	trips per day	
Special Waste	14	trips per day	
Clean Waste	0	trips per day	
Overburden	0	trips per day	
End Grid			
Ore	0	trips per day	
Special Waste	1	trips per day	
Clean Waste	0	trips per day	
Overburden	0	trips per day	

Final Closure Scenario Variables and Assumptions Spreadsheet, continued

Variable	Assumed Value	Units	Comments
Access Road and Haul Road			
Access Road from Baker Lake to Kiggavik			
Length of road to be included in modelling	1	km	Only 1km stretch is included in the assessment of impact of access road on Kiggavik site.
Vehicle speed - All Weather Road	70	km/h	IFS Section 12.5.3.1, April 2011
Vehicle speed - Winter Road	25	km/h	IFS Section 12.5.2.6, April 2011
Traffic volume - All Weather Road	10	trips/day	IFS Section 12.5.3.1, April 2011 - All weather road must be capable of handling 3625 vehicles (plue return trips) per year
Traffic volume - Winter Road	43	trips/day	Project Description (AREVA 2008)
Access Road Modelled Scenario			
Length of road	1	km	Only modelling 1 km stretch for Scenarios and worst case.
Traffic volume	11	trips per day	IFS Section 12.5.2.6, April 2011 - the total annual trips are 3920 per year which equals an average of 11 trips per day, including fuel and dry goods, etc.
Worst Case Scenario - Vehicle speed	70	km/h	Assume the same speed as the All Weather Road
Haul Road between Kiggavik and Sissons			
Length of road	19.6	km	IFS Section 6.6, April 2011
Vehicle speed	60	km/h	IFS Section 6.6, April 2011
Traffic volume from AL ore	0	trips per day	Calculated based on total quantities of ore from Andrew Lake and capacity of ore trailers
Traffic volume from EG ore	0	trips per day	Calculated based on total quantities of ore from End Grid and capacity of ore trailers
On-Road Vehicles Tailpipe	Calculation Method: Mobile 6C		
Variable	**Assumed Value**	**Units**	**Comments**
Trucks - g/VKT	various	g PM/VKT	Based on Mobile 6C EF's for Haul Trucks - HDDV8b Emission factors were used
Unpaved Road Emissions	Calculation Method: Unpaved Road Emissions, AP-42 5th Edition, 13.2.2, 1/95		
Variable	**Assumed Value**	**Units**	**Comments**
On-site haul trucks (gravel roads) - Silt %	5	(%)	Assumption: used in the Kiggavik Screening Level Assessment (SENES 2008); average for Red
On-site haul trucks - vehicle speed	20	kph	Assumption
Control Efficiency for On-site Vehicles with Speed < 40 kph	44%	(%)	WRAP Fugitive Dust Handbook, September 2006, control efficiency due to speed limit of 25
On-site haul trucks - Control Efficiency - Summer	75%	(%)	Assumed 75% control for watering road in summer when necessary
On-site haul trucks - Control Efficiency - Winter	50%	(%)	Assumed 50% control in winter due to frozen surface
number of days in a year with at least 0.254 mm of precipitation	111	(days)	From: Canadian Climate Normals Mean number of days with 0.254 mm (0.01 inch) or more of precipitation in Baker Lake
Drilling	Calculation Method: AP-42 Table 11.9-4, October 1998		
Variable	**Assumed Value**	**Units**	**Comments**
Est. Number of Holes per Day - Open Pits	150	holes per day	Calculated based on amt. of ANFO used per week ÷ max charge weight per hole
Max Number of Holes per blast - End Grid	70	holes per blast	IFS, Section 6.4.8 Drilling and Blasting, April 2011
Amount of blasted material per day - End Grid	200	tonnes per blast	Based on 5 m by 5 m blast face with holes about 4 m deep and Golder drilling and blasting report (Golder Associates 2011)
Rock Blasting Volume Calc's	Calculation Method: AP-42 Table 13.3-1, February 1980		
Variable	**Assumed Value**	**Units**	**Comments**
Blasting Material	Emulsion/ANFO	-	Will use either a 70/30 Emulsion/ANFO blend or 100% ANFO. No emission factors available for ANFO.
Duration of Emissions	15	minutes	Assumed contaminants from explosives detonation are emitted to atmosphere over 15 min
Open Pits			
Max Number of Blasts per Week	3	#	IFS, Section 6.2.1.4, April 2011
Max charge weight per hole	215	kg	Table 15 of Golder drilling and blasting report (Golder Associates 2011)
ANFO Explosives Powder Factor - Open Pits	0.25	kg ANFO/tonne of rock	IFS, Section 6.2.1.4, April 2011
Max amount of rock to be blasted - Open Pits	300,000	tonnes per blast	IFS, Section 6.2.1.4, April 2011
Total Amount of ANFO required per blast - Open Pits	75	tonnes per blast	Calculated
End Grid Underground Mine			
ANFO Explosives Powder Factor - End Grid	2.5	kg ANFO/tonne of rock	IFS, Section 6.2.1.4, April 2011
Amount of rock to be blasted per day - End Grid	0	tonnes per day	Calculated. Used average denisty of waste rock and ore.
Total Amount of ANFO required per blast - End Grid	0.5	tonnes per blast	Calculated
Average number of blasts per day	0.0000	#	Calculated
Control - End Grid	50%	%	Assumed that 50% of dust will be retained in the mine due to deposition
NonRoad Equipment Tailpipe Emissions	Calculation Method: US EPA Nonroad (Excavators & Loaders)		
Variable	**Assumed Value**	**Units**	**Comments**
Equipment hp ratings	various	hp	Actual horsepower ratings from equipment brochures, etc.
Excavators and Loaders - g/hp-hr	various	g/hp-hr	US EPA Crankcase Emission Factors for Nonroad Engine Modeling - Compression-
Episodic (local) Diesel Fuel Sulphur Content	15	ppm	Canada-wide diesel fuel sulphur content as of 2010
Episodic (local) Diesel Fuel Sulphur Content	0.0015	%	Calculated
Grading and Dozing	Calculation Method: Western Surface Coal Mining - Bulldozing AP-42 Table 11.9-2, October 1998		
Variable	**Assumed Value**	**Units**	**Comments**
Material Moisture Content (%)	3%	%	Assumption: 2.5% was used for Red Dog in Alaska; 3% was used for Mid West in northern
Material Silt Content (%)	5%	%	Assumption: used in the Kiggavik Screening Level Assessment (SENES 2008); average for Red
Dozer Operating Hours per Day	20	hours per day	Assumption: Red Dog used 20 hours per day
Bulldozer Operating Frequency	40%	%	Assumption: same as Red Dog, % of time dozer operates for each operating hour
Control Efficiency based on watering	0%	%	Assumption: watering is unlikely
Mean vehicle speed for Graders	8.0	kph	Assumption: used in the Kiggavik Screening Level Assessment (SENES 2008)
Number of trips per day - Graders	1	trips per day	Assumption
Wind Erosion	Calculation Method: AWMA Air Pollution Engineering Manual, 1992, page 137		
Variable	**Assumed Value**	**Units**	**Comments**
Maximum Height of Permanent Clean Rock Stockpiles	50	m	AREVA e-mail dated June 30, 2010. Based on total amount of material put into stockpiles.
Maximum Height of Ore and Temporary Waste Rock Stockpiles	10	m	AREVA e-mail dated June 30, 2010. Based on total amount of material put into stockpiles.
Material Silt Content (%)	5%	%	Assumption: used in the Kiggavik Screening Level Assessment (SENES 2008)
End grid Underground Mine	Calculation Method: Engineering Calculations		
Variable	**Assumed Value**	**Units**	**Comments**
Total Air Requirement/Exhaust Flow Rate	285	m^3/s	IFS, Section 6.4.10, April 2011
Air Exhaust Diameter	5	m	IFS, Section 6.4.10, April 2011
Air Exhaust Exit Velocity	14.5	m/s	Calculated
Air Exhaust Exit Temperature	2.0	degrees C	IFS, Section 6.4.10, April 2011
Incinerator	Calculation Method: Refuse Combustion - AP-42 Chapter 2.1, October 1996		
Variable	**Assumed Value**	**Units**	**Comments**
Quantity incinerated	109	kg/h	Based on charge rate of 1750 kg/cycle and a total cycle time of 10-hour burn plus 6-hour cool down. (Eco Waste Solutions Incinerator Model No. ECO 1.75TN 1P MS 60L Technical Specification sheet, provided as part of AREVA memo dated October 21, 2010.)
Capacity of Incinerator at Sissons vs. Kiggavik	50%	%	Assumed: the Sissons incinerator will be significantly smaller than the Kiggavik incinerator (AREVA 2010, memorandum)
Type of control equipment	none	-	
Backfill Plant	Calculation Method: Engineering Calculations		
Variable	**Assumed Value**	**Units**	**Comments**
Backfill Aggregate Quantity	0	tonnes per year	from "AnnualSched_Apr2011" tab
Backfill Aggregate Quantity	0	tonnes per day	Calculated
Backfill Aggregate Transfer - Number of Trips from Kiggavik	0	trips per day	Assuming aggregate is preferentially transferred from Kiggavik using ore trailer trucks as per
Backfill Aggregate Transfer - Number of Trips from End Grid	0	trips per day	According to IFS, Section 6.4.6, End Grid only provides a fraction of aggregate, therefore, it was assumed that main sources is Kiggavik clean rock.
Backfill Cement Quantity	0	tonnes per year	from "AnnualSched_Apr2011" tab
Backfill Cement Quantity	0	tonnes per day	Calculated
Max plant capacity	60	tonnes per hour	IFS, Section 6.4.6, April 2011
Ore Crushing and Grinding	Calculation Method: MOE Procedure Document Table C-2, Approximating Particulate Emissions from Baghouses		
Variable	**Assumed Value**	**Units**	**Comments**
	-		Assumed a similar design to McClean - use stack testing to scale emissions based on U
Acid Plant	Calculation Method: Engineering Calculations		
Variable	**Assumed Value**	**Units**	**Comments**
Maximum Daily Production	350	tonnes H_2SO_4 per day	IFS, Section 8.4.11.1, April 2011. Peak daily production capacity is 310t/day, but used 350 t per day to be conservative.
SO_2 Emission Factor	75	g per tonne of H_2SO_4	IFS, Section 8.4.11.1, April 2011. Based on acid plant design.
Mill	Calculation Method: Engineering Calculations		
Variable	**Assumed Value**	**Units**	**Comments**
Mill feed	0	kt ore per year	from "AnnualSched_Apr2011" tab
U Grade	0.000%	%	from "AnnualSched_Apr2011" tab
Plant availability	85%	%	from KiggavikProject_HLDC_June30_ToSENES_RevAug11.xls
Mill feed per day	0	tonnes ore per day	Calculated based on plant availability and operating 365 days per year
Ore Stockpile	0	Kt ore	from "AnnualSched_Apr2011" tab
Tonnes U produced	0	T U per year	from "AnnualSched_Apr2011" tab
Hourly Uranium Production	0	kg U/hour	Calculated based on plant availability and operating 24 hours per day
Max theoretical U production	4,000	T U per year	AREVA e-mail dated May 20, 2011
Max Hourly Uranium Production	537	kg U/hour	Calculated based on plant availability and operating 24 hours per day
Power Plant	Calculation Method: Engineering Calculations		
Variable	**Assumed Value**	**Units**	**Comments**
Kiggavik			
Max number of generators operating simultaneously	4	#	IFS, Section 11.1.1, Table 11.1-1, April 2011
Unit Capacity	4190	kW	IFS, Section 11.1.1, Table 11.1-1, April 2011
Annual power consumption	155,000,000	kWh/year	SupplementalData_Kissavik&SissonsLayouts_ToSenes_Nov3.pdf page 3
Sissons			
Max number of generators operating simultaneously	1	#	According to the IFS Section 11.1.1, there will be 3 small 1450 kW units at Sissons; however,
Unit Capacity	4190	kW	one large 4190 kW unit was considered to simplify modelling.
Annual Power consumption at Sissons	23,000,000	kWh/year	SupplementalData_Kissavik&SissonsLayouts_ToSenes_Nov3.pdf page 3
Episodic (local) Diesel Fuel Sulphur Content	15	ppm	Assume using same diesel fuel for power plant as vehicles. Canada-wide diesel fuel sulphur content as of 2010
Episodic (local) Diesel Fuel Sulphur Content	0.0015	%	Calculated
Diesel High Heating Value	19,300	Btu/lb	AP-42 Chapter 3.3 - Gasoline and Diesel Industrial Engines (10/96), Table 3.3-1

A.3 Air Emissions Calculation Methods: Access Roads

Like the mine site roads and haul road between Kiggavik and Sissons, air emissions from the Access Roads include vehicle exhaust (i.e., NO_x, SO_2 and CO) and re-suspended road dust; however, road dust is only generated from sections of roadway constructed with quarried granular fill. As a result, dust emissions were only calculated for the All-Season Access Road and the portions of the Winter Access Road that are constructed with fill. For this assessment, it was assumed that 50% of the Winter Road over-land crossings were constructed with granular fill. A 50% reduction for frozen conditions during the winter months was also applied.

Since the access roads are not travelled often, there is sufficient time between the passing of vehicles to allow wind erosion to occur. For a roadway with higher traffic volumes, such as the mine site roads, emissions are predominately generated by the vehicles themselves. Since this is not the case for access roads, wind erosion emissions were considered in this assessment. Again, wind erosion is only applicable to road sections constructed with granular fill. It was also assumed that frozen conditions would prevent any wind erosion during the winter months (October to May).

Additional parameters and assumptions used for assessing the access road options are provided below. Excerpts from the emissions calculation spreadsheets are also provided at the end of this section. Note that total emissions were averaged over the entire length of the roadway.

Preferred Option: Winter Road

As inferred by the name, the Winter Access Road option would be used to transport fuel and other supplies during the winter months when frozen water bodies and ice pads can be utilized. The operating window for the Kiggavik Project is 110 days; however, 90 days was used as a conservative measure (i.e. use of a shorter operating window results in higher daily traffic volumes and higher daily emission rates). Other parameters used for the winter road options are presented in Table A-10 below. Information was obtained from the Project Description (Volume 2) and refined for the specific options with information from AREVA (AREVA 2011).

Table A-10 Winter Access Road Parameters

Parameter	Units	Winter Road
Length of road	km	100
Over-land crossing[(a)]	km	50
Speed	km/h	25
Operating window	days	90
Loads (one-way)	loads per year	3,920
Traffic (one-way)	vehicles per day	43
Daily operation	hours	24
NOTES: Assumes that 50% of over-land crossings are constructed using granular fill.		

All-Season Access Road

As an alternative to the Winter Road option, an All-Season Road option presented by AREVA was also assessed. This road will be constructed using granular fill excavated from bedrock quarries located along the route. Table A-11 summarizes the parameters and/or assumptions used in assessing the All-Season Road option.

Table A-11 All Season Access Road Parameters

Parameter	Units	All-Season Road
Length of road	km	114
Speed	km/h	80
Operating window	days	310
Loads (one-way)	load per year	3,625
Traffic (one-way)	vehicles per day	11
Daily operation	hours	24

Access Roads Assessment Inputs Spreadsheet

Source ID	Pit Ramps and Unpaved Roads	s (%)	One-way Trips per Day - OR	One-way Trips per Day - SW	One-way Trips per Day - CW	One-way Trips per Day - OVB	One-way Trips per Day - Other	One-way Trips per Day - Water Truck	Total # of One-way Trips per day	Average Weight - Ore Truck (tonnes)	Average Weight - Waste Trucks (tonnes)	Average Weight - Water Trucks (tonnes)	Average Weight - Other (tonnes)	Weighted Average W (tonnes)	Road length[1] (km)	Vehicle Speed (km/h)	Control Efficiency - Summer (%) (Watering)	Control Efficiency - Winter (%) (Frozen Surface)	Control Efficiency for Speed <40 km/h
ASR	All Season Access Road - 100% granular fill	5.0	0	0	0	0	10	0	10	115	170	24	40	40	112.1	80	0%	50%	0%
WR	Winter Road Option - over land 50% fill	5.0	0	0	0	0	43	0	43	115	170	24	40	40	27.3	25	0%	50%	44%
WR	Winter Road Option - over land no fill	2.5	0	0	0	0	43	0	43	115	170	24	40	40	27.3	25	0%	50%	44%
WR	Winter Road Option - over ice	0.0	0	0	0	0	43	0	43	115	170	24	40	40	50.1	25	0%	0%	44%

Always zero. Do not change.

Notes:

[1] Road lengths can be found in the following Excel file: ..\..\340680-1 IFS Revised site layout April2011\340680-1 Road Links_Site roads_RevB 31May2011.xlsx

Water trucks assumed to pass over any road or pit ramp/floor during the summer months only. Water trucks will not pass over piles or pit floors.

Ore at Sissons is assumed to be first dumped to piles and then hauled to Kiggavik in ore tractor trailers.

Access Roads Assessment On-Road Tailpipe Calculation Spreadsheet

Unpaved Road	One-way road length (km)	One-way Trips per day	Vehicle Speed (km/h)	SPM (g/s)	PM_{10} (g/s)	$PM_{2.5}$ (g/s)	Uranium (g/s)	As (g/s)	Co (g/s)	Cu (g/s)	Pb (g/s)	Mo (g/s)	Ni (g/s)	Se (g/s)	Zn (g/s)	Cd (g/s)	Cr (g/s)	NOx (g/s)	SO_2 (g/s)	CO (g/s)
All Season Access Road - 100% granular fill	112.1	10	80	3.08E-03	3.08E-03	2.50E-03	0	0	0	0	0	0	0	0	0	0	0	1.08E-01	5.23E-03	1.79E-02
Winter Road Option - over land 50% fill	27.3	43	25	3.23E-03	3.23E-03	2.62E-03	0	0	0	0	0	0	0	0	0	0	0	1.01E-01	5.49E-03	3.08E-02
Winter Road Option - over land no fill	27.3	43	25	3.23E-03	3.23E-03	2.62E-03	0	0	0	0	0	0	0	0	0	0	0	1.01E-01	5.49E-03	3.08E-02
Winter Road Option - over ice	50.1	43	25	5.93E-03	5.93E-03	4.80E-03	0	0	0	0	0	0	0	0	0	0	0	1.85E-01	1.01E-02	5.65E-02

Note:

Cells highlighed gray indicates that emissions of a contaminant are zero.

Mobile 6C Emission Factors - Year 2009 - Units g/VKT						
Vehicle Type	SPM	PM_{10}	$PM_{2.5}$	NO_x	SO_2^*	CO
HD Diesel 40 km/hr	0.119	0.119	0.096	3.699	0.202	1.133
HD Diesel 50 km/hr	0.119	0.119	0.096	3.530	0.202	0.902
HD Diesel 60 km/hr	0.119	0.119	0.096	3.551	0.202	0.771
HD Diesel 70 km/hr	0.119	0.119	0.096	3.757	0.202	0.705
HD Diesel 80 km/hr	0.119	0.119	0.096	4.176	0.202	0.689

Notes:

Emission Factors obtained from the Mobile6C model for the Toronto Metropolitan area, for calendar year 2009, except for SO_2^* which are for 2006.

Access Roads Assessment Unpaved Road Dust (Winter) Calculation Spreadsheet

Unpaved Road	s (%)	S - mean vehicle speed (kph)	W (tonnes)	Annual EF	Emission Factor in g/VKT			Total # of One-way Trips per day	One way length (km)	Roundtrip VKT per day	Uncontrolled Emissions (g/s)				Control Efficiency (%)	Control Efficiency (%) (Speed Limit)
				SPM	SPM	PM_{10}	$PM_{2.5}$				Annual SPM	SPM	PM_{10}	$PM_{2.5}$		
All Season Access Road - 100% granular fill	5.0	80	40	1746	2509	645	64	10	112.12	2242	4.53E+01	6.51E+01	1.67E+01	1.67E+00	50%	0%
Winter Road Option - over land 50% fill	5.0	25	40	1746	2509	645	64	43	27.34	2351	4.75E+01	6.83E+01	1.75E+01	1.75E+00	50%	44%
Winter Road Option - over land no fill	2.5	25	40	1075	1544	345	35	43	27.34	2351	2.92E+01	4.20E+01	9.40E+00	9.40E-01	50%	44%
Winter Road Option - over ice	0.0	25	40	0	0	0	0	43	50.11	4310	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0%	44%

Unpaved Road	Controlled Emissions (g/s)													
	SPM	PM_{10}	$PM_{2.5}$	Uranium	As	Co	Cu	Pb	Mo	Ni	Se	Zn	Cd	Cr
All Season Access Road - 100% granular fill	3.26E+01	8.36E+00	8.36E-01	2.73E-05	4.30E-05	1.88E-04	3.97E-04	3.05E-04	1.17E-05	3.39E-04	4.92E-05	9.83E-04	1.30E-06	0.00E+00
Winter Road Option - over land 50% fill	1.91E+01	4.91E+00	4.91E-01	1.61E-05	2.52E-05	1.11E-04	2.33E-04	1.79E-04	6.88E-06	1.99E-04	2.89E-05	5.77E-04	7.65E-07	0.00E+00
Winter Road Option - over land no fill	1.18E+01	2.63E+00	2.63E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Winter Road Option - over ice	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Emission Factor Equation	Reference
$E_{unpaved} = k \times (s/12)^a \times (W/3)^b$	AP-42 13.2.2-4, November 2006

E = size speific emission factor (lb/VMT)
s = surface materal silt content (%) - equation based on range from 1.8 - 25.2%
W = mean vehicle weight (tons) where 1 tonne = 1.1 tons
1 lb/VMT = 281.9 g/VKT

Constant	Industrial Roads		
	SPM	PM_{10}	$PM_{2.5}$
k	4.9	1.5	0.15
a	0.7	0.9	0.9
b	0.45	0.45	0.45

SILT CONTENT (%)	Location	Low	High	Average
construction sites	scraper routes	0.6	23.0	8.5
sand and gravel processing	plant road	4.1	6.0	4.8
western surface coal mining	plant road	4.9	5.3	5.1
western surface coal mining	haul road to/from pit	2.8	18.0	8.4

Access Roads Assessment Wind Erosion (Summer) Calculation Spreadsheet

Wind Erosion Source	Active or Inactive?	s %	Base Length (m)	Base Width (m)	Height of Pile (m)	Occupied Area (ha)	Surface Area (ha)	Active Surface Area (ha)[1]	E (kg/ha/day)			Uncontrolled (g/s)			Assumed Control Efficiency (%)[2]
									TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$	
All Season Access Road	Active	5	n/a	n/a	n/a	112	112	112	3.462	1.731	0.692	4.49	2.25	0.90	0%

Wind Erosion Source	Controlled Emission Rate (g/s)													
	TSP	PM_{10}	$PM_{2.5}$	Uranium	As	Co	Cu	Pb	Mo	Ni	Se	Zn	Cd	Cr
All Season Access Road	4.49229	2.24614	0.89846	3.77E-06	5.93E-06	2.60E-05	5.48E-05	4.20E-05	1.62E-06	4.67E-05	6.78E-06	1.36E-04	1.80E-07	0.00E+00

[1] Active area for pits was assumed to be 100 metres by 100 meters. Active area for stock piles was assumed to be 10% of total area or 100 metres by 100 metres, whichever is larger.
[2] Assume wind erosion only occurs from All Season Road during the summer months (JJAS)

Equation	Reference
E = k*1.9 *(s/1.5) * f/15	AWMA - Air Pollution Engineering Manual, 1992, page 137

E = emission factor (kg/ha/day)
k = particle size multilier for particulate size range of interest
s = Silt Content in %
f = % of time that the unobstructed wind speed exceeds 5.4 m/s at mean pile height

Parameter	TSP	PM_{10}	$PM_{2.5}$	Reference
k	1.0	0.5	0.2	AWMA - Air Pollution Engineering Manual, 1992, page 137
f	see wind frequency table below - Updated from CALMET runs May 2011.			

Stockpile surface area sample calculation:

Conservatively assume stockpiles acting as a rectangular prism, then
SA = B + Ph = (lw) + 2(l+w)(h)

Where,
B = Base area
P = Perimeter
h = Height of pile

Month	f
January	39
February	20
March	33
April	31
May	22
June	13
July	8
August	21
September	35
October	21
November	34
December	47

A.4 Air Emissions Calculation Methods: Baker Lake Dock

Air emissions were calculated for typical operations at the Baker Lake Dock and Storage Facility which consists primarily of unloading and transferring of sea-containers from barges to the shipping yard. Emissions from diesel-powered equipment at the Baker Lake Dock were considered and a list of equipment considered is provided in Table A-12 below.

Table A-12 Baker Lake Facility Equipment List

Equipment	Manufacturer	Model	Number of Units	Power Rating (hp)
Mobile Crane	Zoomlion	QUY200	1	343
Shunt / Rigging Truck	Kalmar	Ottawa 4x2	1	160
Container Handler	Kalmar	DCD200-250	1	264
Heavy Lift Truck	Kalmar	DC F280-330	1	260
Reach Stacker	Kamlar	DRF	1	422

Emissions from two (2) manoeuvring 4,500 horsepower tug-barges near the dock were also considered in this assessment. Emissions factors were obtained from the Environment Canada's National Emission Inventory Tool for the Commercial Marine Sector V2.5 which is a database that was used in the baseline assessments for the SENES study "*Canadian Arctic Marine Assessment 2002-2050"* (SENES 2010). The emission factors are summarized in Table A-13 below. Note that a load factor of 10% was applied as per the database tool to represent manoeuvring tug-barges. The sulphur fuel content of marine diesel was assumed to be 1% which is consistent with proposed regulations for 2015.

Table A-13 Tug-Barge Emission Factors

Engine	Fuel Type	Fuel Origin	NO_x	SO_2	TSP	PM_{10}	$PM_{2.5}$
M2	MDO	Dom	18.1	0.297	0.868	0.833	0.767
M4	MDO	Dom	13.9	0.297	0.868	0.833	0.767

SOURCE: National Emission Inventory Tool for the Commercial Marine Sector V2.5, prepared for Environment Canada by Levelton Consultants Ltd., March 2008.

NOTES:

M2 = propulsion 2-stroke engine
M4 = propulsion 4-stroke engine
MDO = marine diesel fuel
Dom = domestic fuel source

In general, it was conservatively assumed that all equipment including the tug-barges operate simultaneously over a 24 hour period. Excerpts from the emissions calculations spreadsheets are provided at the end of this section.

Baker Lake Dock Assessment Variables and Assumptions Spreadsheet

NonRoad Equipment Tailpipe Emissions	Calculation Method: US EPA Nonroad Equipment		
Variable	**Assumed Value**	**Units**	**Comments**
Equipment hp ratings			
Mobile Crane	343	hp	Zoomlion QUY200
Shunt / Rigging Truck	160	hp	Kalmar Ottawa 4x2
Container Handler	264	hp	Kalmar DCD200-250
Heavy Lift Truck	260	hp	Kalmar DC F280-330
Reach Stacker	422	hp	Kamlar DRF
Idling Tug-Barge	4500	hp	HP rating from IFS Section 12.3.3 - Tug-Barge Fleet
Episodic (local) Diesel Fuel Sulphur Content	15	ppm	Canada-wide off-road diesel fuel sulphur for content as of 2010
	0.0015	%	Calculated
Marine Vessel Diesel Fuel Sulphur Content	1000	ppm	Arctic Marine diesel fuel sulphur for content effective 2015 - personal communication with D. Hrebenyk
	0.1	%	

Baker Lake Facility Assessment Non-Road Equipment Emissions Calculation Spreadsheet

Equipment	Manufacturer	Model	Number of Units	Power Rating (hp)	Steady-State Emission Factor (g/hp-hr)				Load Factor % [1]	% Daily Operation [1]	Uncontrolled (g/s)					
					PM EF_{ss}	NOx EF_{ss}	CO EF_{ss}	HC EF_{ss}			TSP	PM_{10}	$PM_{2.5}$	NOx	SO_2	CO
Mobile Crane	Zoomlion	QUY200	1	343	0.0092	2.50	0.084	0.1314	10%	100%	0.0001	0.0001	0.0001	0.0238	0.003	0.0008
Shunt / Rigging Truck	Kalmar	Ottawa 4x2	1	160	0.0092	2.50	0.087	0.1314	10%	100%	0.0000	0.0000	0.0000	0.0111	0.003	0.0004
Container Handler	Kalmar	DCD200-250	1	264	0.0092	2.50	0.075	0.1314	10%	100%	0.0001	0.0001	0.0001	0.0183	0.003	0.0006
Heavy Lift Truck	Kalmar	DC F280-330	1	260	0.0092	2.50	0.075	0.1314	10%	100%	0.0001	0.0001	0.0001	0.0181	0.003	0.0005
Reach Stacker	Kamlar	DRF	1	422	0.0092	2.50	0.075	0.1314	10%	100%	0.0001	0.0001	0.0001	0.0293	0.003	0.0009
Total											0.0004	0.0004	0.0004	0.1007	0.0175	0.0032

Notes:

[1] load factor assumed to be 80% and daily operating capacity conservatively assumed to be 100%

Emission factors for non road equipmentwere obtained from the USEPA document *Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling - Compression Ignition* dated July 2010, EPA-420-R-10-018.

- see Table A4. *Zero Steady-State Emission Factors for Nonroad CI Engines*
- assumed Tier 4 (Tier 4A or just Tier 4), which are applicable to model years 2011 to 2014. No adjustments (i.e., TAF or sulphur content) needed to Tier 4 Efs.
- TAF is 1 for Tier 4 models. Also, PM not adjusted for sulphur content (resulted in a negative value)
- SO2 calculated using the following equation:

$$SO2=(BSFC \times 453.6 \times (1\text{-}soxcnv)\text{-}\ HC) \times 0.01 \times soxdsl \times 2$$

where:

soxcnv is the fraction of fuel sulphur converted to direct PM (0.3 for Tier 4)

soxdsl is the episodic weight % of sulphur in nonroad diesel fuel

Size Fraction	% in Range	Reference
PM <30 µm	100%	EPA420-R-10-018, July 2010
PM <10 µm	100%	EPA420-R-10-018, July 2010
PM <2.5 µm	97%	EPA420-R-10-018, July 2010

Baker Lake Dock Assessment Marine Vessel Emissions Calculation Spreadsheet

Equipment	Number of Units	Power Rating (kW)	Emission Factor (g/kw-hr)						Load Factor % [1]	% Daily Operation[1]	Uncontrolled (g/s)					
			TSP	PM_{10}	$PM_{2.5}$	NO_x	CO	SO_2			TSP	PM_{10}	$PM_{2.5}$	NOx	SO_2	CO
Idling Tug-Barge	2	3356	0.87	0.83	0.77	18.1	1.1	0.297	10%	100%	0.16	0.16	0.14	3.37	0.21	0.06

Notes:

[1] load factor from Marine Tool Databse v2.5 for tugs at maneuvering speeds. Daily operating capacity conservatively assumed to be 100%

SO2 calculated using the following equation used in the *Canadian Arctic Marine Assessment 2002-2050* (SENES 2010)

$$SO2 = 0.4653(S) + 0.25$$

where:

S = sulphur content of fuel in %

A.5 Air Emissions Calculation Methods: Construction

On-Site Construction

Dust emissions from construction of the each of the mine sites, Kiggavik and Sissons, were estimated using the general US EPA AP-42 TSP emission factor for heavy construction and the WRAP Fugitive Dust Handbook PM_{10} (Countess Environmental 2006) emission factor for heavy construction:

TSP = 2.69 x 106 g per ha per month
PM10 = 0.94 x 106 g per ha per month

The total occupied area of the mine development area (1,102 ha) was obtained from the Project Description (Tier 2, Volume 2, Section 20.1.3). It was also assumed that it would take approximately two (2) years to complete construction such that the average monthly construction rate would be 46 ha.

Emissions from diesel-powered construction equipment were also estimated using US EPA emission factors for non-road equipment (US EPA 2010). A list of equipment considered is provided in Table A-13. In general, it was assumed that all equipment operates simultaneously at a load of 80% over the entire construction shift. A typical construction shift will be 10 hours per day (AREVA 2011). Excerpts from the emissions calculations spreadsheets are provided at the end of this section.

During the construction phase of the mine, the Baker Lake Dock and Storage Facility and the Winter Access Road will be utilized for receiving and shipping construction supplies to the mine development area. The number of anticipated loads during construction will be 2,100 loads per year whereas the number of loads assessed during mine operations is 3,920 per year. Emissions from the Winter Access Road and Dock and Storage Facility during construction of the mine sites were therefore estimated by applying a ratio of 0.54 (i.e., 2,100 ÷ 3,920) to the emission rates for these sources during mine operations. Emissions from the Winter Access Road and Dock and Storage Facility during mine operations were discussed in Sections A.3 and A.4, respectively.

Access Road Construction: Quarrying

The All-Season Access Road and sections of the Winter Access Road will be constructed with granular fill. Fill will be extracted from bedrock quarries located along the length of each of the options. Each quarry will be developed sequentially as construction progresses and equipment will be moved from one quarry to the next. Assuming similar production rates, emissions from each quarry will be the same; however, in order to capture the effect of terrain on resulting concentrations, three (3) quarries along the All-Season Road option were selected for assessment: Q2, Q10 and

Q18. Quarry Q18 is also the closest to the community of Baker Lake. The location of each of the quarries was provided in Figure 8 in the main report.

Details about quarrying activities were limited, therefore, typical sources of dust from AP-42 Chapter 11.19.2 *Crushed Stone Processing and Pulverized Mineral Processing* (US EPA 2004) were assumed including:

- truck loading of extracted aggregate material;
- unloading of aggregate to the primary crusher;
- primary crushing;
- screening;
- conveyor transfer to a secondary crusher; and
- secondary crushing.

The AP-42 material handling emission factor was used to estimate dust from loading/unloading and conveyor drops. A moisture content of 3% was assumed and the average annual wind speed of 4.1 m/s obtained from CALMET was used. Uncontrolled emission factors for crushing and screening were obtained from AP-42 Table 11.19.2-1 (US EPA 2004). A conservative production rate of 300 tonnes per hour was assumed to occur over a 10 hour working day.

As with all other diesel-powered equipment, exhaust emissions from quarrying machinery, including the crushing and screening plant, were estimated using US EPA non-road emission factors (US EPA 2010). The equipment considered in the quarrying assessment is provided in Table A-15. Further calculation details are provided in spreadsheet excerpts at the end of this section.

Baker Lake Dock Construction

For construction of the Baker Lake Dock and Storage Facility, it was assumed that grading/earth moving will be the main source of particulate matter emissions since minimal infrastructure is required at the dock and storage facility. Dust emissions from grading depend on the speed of the vehicle. For this assessment it was assumed that the graders would travel at an average speed of 8 km/hr. It was also assumed that all grading/earth moving activities would occur over a two week period and a 100 m by 100 m working area at any given time.

Gaseous emissions from diesel-powered equipment were also calculated. The equipment considered in the quarrying assessment is provided in Table A-16. Further calculation details are provided in spreadsheet excerpts at the end of this section.

Table A-14 Mine Site Construction Equipment List

Equipment Type	Number of Units	Power Rating([1]) (hp)
1604 Crusher Jaw	1	300
1604 Cone Plant	1	300
1604 Screen Plant	1	110
1604 Power Tower	1	200
1604 Stacking Conveyor	1	48
Feeder and Bin wall Conveyor	1	48
Rock truck	6	1450
Art truck	2	1450
Loader 988	1	705
Loader 980	1	705
Loader 966	1	705
Skid Steer 262	1	149
Dozer D8R	2	580
Dozer D6R	1	580
Grader 14	1	299
Excavator 345	2	801
Crane 65t	1	330
Pick up F350 Ambulance	1	359
F350 Crew cab	6	359
Bus 48 passenger	2	359
winch truck	1	586
Scissor deck	1	231
Fuel trailer	1	148
Water truck	1	330
Lub fuel truck	1	148
Fuel truck	1	148
Flat deck truck F550	1	359
RO/RO Truck	1	148
Vac Truck	2	148
Mechanical truck	2	148
Weld Truck	2	148
Tire truck	1	148

NOTES:

(1) Power ratings based on either similar equipment that will be used during mining operations or typical equipment used for other mining assessments

Table A-15 Quarry Equipment List

Equipment Type	Quantity	Model	Power Rating[(1)] (hp)
1604 Crusher Jaw	1	-	300
1604 Cone Plant	1	-	300
1604 Screen Plant	1	-	110
1604 Power Tower (Generator)	1	-	200
1604 Stacking Conveyor	1	-	48
Feeder and Bin wall Conveyor	1	-	48
Waste haul truck	1	Cat 785D	1348
Small wheel loader	2	Cat 992K	801
Excavator 345	1	Terex RH170	2000

NOTES:

(1) Power ratings based on either similar equipment that will be used during mining operations or typical equipment used for other mining assessments

Table A-16 Baker Lake Dock and Storage Facility Construction Equipment List

Equipment Type	Quantity	Model	Power Rating([1]) (hp)
Waste Hydraulic Excavator	1	Terex RH170	2032
Large Wheel Loader	1	Cat 993K	801
Motor Grader	1	Cat 16M	299
Large Dozer	1	Cat 834H-	580
Mechanical Truck	1	-	148

NOTES:

(1) Power ratings based on either similar equipment that will be used during mining operations or typical equipment used for other mining assessments

Mine Site Construction Assessment Dust Calculation Spreadsheet

Description	Emission Factor in Mg/ha/month of activity			Total Occupied Area (ha)	Working Area (ha per month)	Working Hours per day	Uncontrolled Emissions (g/s)			Control Efficiency (%)	Controlled Emissions (g/s)		
	SPM	PM_{10}	$PM_{2.5}$				SPM	PM_{10}	$PM_{2.5}$		SPM	PM_{10}	$PM_{2.5}$
Construction Area Mine Development Area	2.69	0.94	0.94	1,102	46	10	1.99E+01	6.95E+00	6.95E+00	0%	1.99E+01	6.95E+00	6.95E+00

Notes:

Total occupied area from revised project description (Volume 2, Section 20.1.3)

Emissions only occur over a 10 hour working day

Emission Factor Equation	Reference
TSP =1.2 tons/acre/month (worst-case)[a] TSP = 0.31 (average)[b]	AP-42 13.2.3, January 1995
PM10 = 0.42 tons/acre/month (worst-case)[a] PM10 = 0.11 tons/acre/month (average)	WRAP Fugitive Dust Handbook, 2006
PM2.5 = PM10	Assumed to be equal to PM10

Notes:

a) wost-case refers to sites with large scale earth moving activities (WRAP, 2006). This is assumed to be applicable to the mine site.

b) average emisison factor for TSP developed based on the TSP/PM10 ratio under worst-case conditions (1.2 / 0.42 = 2.9)

Mine Site Construction Assessment Non-Road Equipment Emissions Calculation Spreadsheet

Equipment	Manufacturer	Model	Number of Units	Power Rating (hp)	Steady-State Emission Factor (g/hp-hr)				% of Maximum Operating Capacity[1]	% Daily Operation[1]	Uncontrolled (g/s)					
					PM EF_{ss}	NOx EF_{ss}	CO EF_{ss}	HC EF_{ss}			TSP	PM_{10}	$PM_{2.5}$	NOx	SO_2	CO
1604 Crusher Jaw	n/a	n/a	1	300	0.0092	2.5	0.084	0.1314	100%	100%	7.67E-04	7.67E-04	7.44E-04	0.2083	0.003	0.0070
1604 Cone Plant	n/a	n/a	1	300	0.0092	2.5	0.084	0.1314	100%	100%	7.67E-04	7.67E-04	7.44E-04	0.2083	0.003	0.0070
1604 Screen Plant	n/a	n/a	1	110	0.0092	2.5	0.087	0.1314	100%	100%	2.81E-04	2.81E-04	2.73E-04	0.0764	0.003	0.0027
On-site																
1604 Power Tower	n/a	n/a	1	200	0.0092	2.5	0.075	0.1314	100%	100%	5.11E-04	5.11E-04	4.96E-04	0.1389	0.003	0.0042
1604 Stacking Conveyor	n/a	n/a	1	48	0.2	4.7279	1.5323	0.2789	100%	100%	2.67E-03	2.67E-03	2.59E-03	0.0630	0.004	0.0204
Feeder and Bin wall Conveyor	n/a	n/a	1	48	0.2	4.7279	1.5323	0.2789	100%	100%	2.67E-03	2.67E-03	2.59E-03	0.0630	0.004	0.0204
Rock truck	n/a	n/a	6	1450	0.0690	2.3920	0.7642	0.2815	100%	100%	1.67E-01	1.67E-01	1.62E-01	5.7807	0.003	1.8468
Art truck	n/a	n/a	2	1450	0.0690	2.3920	0.7642	0.2815	100%	100%	5.56E-02	5.56E-02	5.39E-02	1.9269	0.003	0.6156
Loader 988	n/a	n/a	1	705	0.0092	2.5	0.133	0.1314	100%	100%	1.80E-03	1.80E-03	1.75E-03	0.4898	0.003	0.0261
Loader 980	n/a	n/a	1	705	0.0092	2.5	0.133	0.1314	100%	100%	1.80E-03	1.80E-03	1.75E-03	0.4898	0.003	0.0261
Loader 966	n/a	n/a	1	705	0.0092	2.5	0.133	0.1314	100%	100%	1.80E-03	1.80E-03	1.75E-03	0.4898	0.003	0.0261
Skid Steer 262	n/a	n/a	1	149	0.0092	2.5	0.087	0.1314	100%	100%	3.81E-04	3.81E-04	3.69E-04	0.1035	0.003	0.0036
dozer D8R	n/a	n/a	2	580	0.0092	2.50	0.084	0.1314	100%	100%	2.96E-03	2.96E-03	2.88E-03	0.8056	0.003	0.0271
dozer D6R	n/a	n/a	1	580	0.0092	2.50	0.084	0.1314	100%	100%	1.48E-03	1.48E-03	1.44E-03	0.4028	0.003	0.0135
Grader 14	n/a	n/a	1	299	0.0092	2.5	0.075	0.1314	100%	100%	7.64E-04	7.64E-04	7.41E-04	0.2076	0.003	0.0062
Excavator 345	n/a	n/a	2	801	0.0690	2.3920	0.7642	0.2815	100%	100%	3.07E-02	3.07E-02	2.98E-02	1.0644	0.003	0.3401
Crane 65t	n/a	n/a	1	330	0.0092	2.50	0.084	0.1314	100%	100%	8.43E-04	8.43E-04	8.18E-04	0.2292	0.003	0.0077
Pick up F350 Ambulance	n/a	n/a	1	359	0.0092	2.5	0.084	0.1314	100%	100%	9.18E-04	9.18E-04	8.91E-04	0.2496	0.003	0.0084
F350 Crew cab	n/a	n/a	6	359	0.0092	2.5	0.084	0.1314	80%	42%	1.85E-03	1.85E-03	1.80E-03	0.5031	0.001	0.0169
Bus 48 passenger	n/a	n/a	2	359	0.0092	2.5	0.084	0.1314	80%	42%	6.17E-04	6.17E-04	5.99E-04	0.1677	0.001	0.0056
winch truck	n/a	n/a	1	586	0.0092	2.5	0.084	0.1314	80%	42%	5.03E-04	5.03E-04	4.88E-04	0.1367	0.001	0.0046
Scissor deck	n/a	n/a	1	231	0.0092	2.5	0.075	0.1314	80%	42%	1.98E-04	1.98E-04	1.92E-04	0.0538	0.001	0.0016
fuel trailer	n/a	n/a	1	148	0.0092	2.5	0.087	0.1314	80%	42%	1.27E-04	1.27E-04	1.23E-04	0.0344	0.001	0.0012
water truck	n/a	n/a	1	330	0.0092	2.50	0.084	0.1314	80%	42%	2.83E-04	2.83E-04	2.75E-04	0.0770	0.001	0.0026
lub fuel truck	n/a	n/a	1	148	0.0092	2.5	0.087	0.1314	80%	42%	1.27E-04	1.27E-04	1.23E-04	0.0344	0.001	0.0012
fuel truck	n/a	n/a	1	148	0.0092	2.5	0.087	0.1314	80%	42%	1.27E-04	1.27E-04	1.23E-04	0.0344	0.001	0.0012
Flat deck truck F550	n/a	n/a	1	359	0.0092	2.5	0.084	0.1314	80%	42%	3.09E-04	3.09E-04	2.99E-04	0.0839	0.001	0.0028
RO/RO Truck	n/a	n/a	1	148	0.0092	2.5	0.087	0.1314	80%	42%	1.27E-04	1.27E-04	1.23E-04	0.0344	0.001	0.0012
Vac Truck	n/a	n/a	2	148	0.0092	2.5	0.087	0.1314	80%	42%	2.53E-04	2.53E-04	2.46E-04	0.0688	0.001	0.0024
Mech truck	n/a	n/a	2	148	0.0092	2.5	0.087	0.1314	80%	42%	2.53E-04	2.53E-04	2.46E-04	0.0688	0.001	0.0024
Weld Truck	n/a	n/a	2	148	0.0092	2.5	0.087	0.1314	80%	42%	2.53E-04	2.53E-04	2.46E-04	0.0688	0.001	0.0024
Tire truck	n/a	n/a	1	148	0.0092	2.5	0.087	0.1314	80%	42%	1.27E-04	1.27E-04	1.23E-04	0.0344	0.001	0.0012
										Total	0.279	0.279	0.270	1.44E+01	8.00E-02	3.06E+00
Baker Lake Dock																
Waste Hydraulic Excavator	Terex / O&K	RH 170	1	2032	0.0690	2.392	0.7642	0.2815	80%	42%	1.31E-02	1.31E-02	1.27E-02	0.4537	0.003	0.1449
Large Wheel Loader	Caterpillar	993K	1	801	0.0690	2.392	0.7642	0.2815	80%	42%	5.16E-03	5.16E-03	5.00E-03	0.1788	0.003	0.0571
Motor Grader	Caterpillar	16M	1	299	0.0092	2.50	0.0750	0.1314	80%	42%	2.57E-04	2.57E-04	2.49E-04	0.0698	0.003	0.0021
Large Dozer	Caterpillar	834H	1	580	0.0092	2.50	0.0840	0.1314	80%	42%	4.98E-04	4.98E-04	4.83E-04	0.1353	0.003	0.0045
Mech truck	2.0000	147.5100	1	148	0.0092	2.50	0.0870	0.1314	80%	42%	1.27E-04	1.27E-04	1.23E-04	0.0344	0.003	0.0012
										Total	0.019	0.019126	0.019	8.72E-01	1.75E-02	2.10E-01

Notes:

Cells highlighed gray indicates that emissions of a contaminant are zero.

Emission factors were obtained from the USEPA document *Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling - Compression Ignition* dated July 2010, EPA-420-R-10-018.

- see Table A4. *Zero Steady-State Emission Factors for Nonroad CI Engines*
- assumed Tier 4 (Tier 4A or just Tier 4), which are applicable to model years 2011 to 2014. No adjustments (i.e., TAF or sulphur content) needed to Tier 4 Efs.
- TAF is 1 for Tier 4 models. Also, PM not adjusted for sulphur content (resulted in a negative value)
- SO2 calculated using the following equation:

$$SO2=(BSFC\times 453.6\times(1\text{-}soxcnv)\text{-}HC)\times 0.01\times soxdsl\times 2$$

where:

soxcnv is the fraction of fuel sulphur converted to direct PM (0.3 for Tier 4)

soxdsl is the episodic weight % of sulphur in nonroad diesel fuel

[1] % of maximum operating capacity for open ptis based on manufacturer's brochure or assumption from URBEMIS2007 Model Appendix G for each piece of Equipment (equipment not listed in Appendix G assumed to be "Other General Industrial Equipment").

% daily operation in open pits based on the same document or assumed 100%.

Size Fraction	% in Range	Reference
PM <30 µm	100%	EPA420-R-10-018, July 2010
PM <10 µm	100%	EPA420-R-10-018, July 2010
PM <2.5 µm	97%	EPA420-R-10-018, July 2010

Quarry Assessment Material Handling Calculation Spreadsheet

Source ID	Source Description	Material Handling Activity	k			M (%)	U (m/s)	Emission Factor in kg/tonne			Maximum Tonnes Handled per Hour	Uncontrolled (g/s)			Assumed Control Efficiency (%)	Controlled (g/s)		
			SPM	PM_{10}	$PM_{2.5}$			SPM	PM_{10}	$PM_{2.5}$		SPM	PM_{10}	$PM_{2.5}$		SPM	PM_{10}	$PM_{2.5}$
Q2	Quarry 2	Truck loading	0.74	0.35	0.053	3%	4.1	0.00151	0.00071	0.00011	300	1.26E-01	5.94E-02	9.00E-03	0%	1.26E-01	5.94E-02	9.00E-03
Q2	Quarry 2	Truck unloading to primary crushing plant	0.74	0.35	0.053	3%	4.1	0.00151	0.00071	0.00011	300	1.26E-01	5.94E-02	9.00E-03	0%	1.26E-01	5.94E-02	9.00E-03
Q2	Quarry 2	Conveyor transfer point to screen plant	0.74	0.35	0.053	2%	4.1	0.00266	0.00126	0.00019	300	2.22E-01	1.05E-01	1.59E-02	0%	2.22E-01	1.05E-01	1.59E-02
Q2	Quarry 2	Conveyor transfer point to secondary crusher	0.74	0.35	0.053	2%	4.1	0.00266	0.00126	0.00019	150	1.11E-01	5.24E-02	7.94E-03	0%	1.11E-01	5.24E-02	7.94E-03
Q2	Quarry 2	Conveyor drop to product truck	0.74	0.35	0.053	2%	4.1	0.00266	0.00126	0.00019	150	1.11E-01	5.24E-02	7.94E-03	0%	1.11E-01	5.24E-02	7.94E-03
Q10	Quarry 10	Truck loading	0.74	0.35	0.053	3%	4.1	0.00151	0.00071	0.00011	300	1.26E-01	5.94E-02	9.00E-03	0%	1.26E-01	5.94E-02	9.00E-03
Q10	Quarry 10	Truck unloading to primary crushing plant	0.74	0.35	0.053	3%	4.1	0.00151	0.00071	0.00011	300	1.26E-01	5.94E-02	9.00E-03	0%	1.26E-01	5.94E-02	9.00E-03
Q10	Quarry 10	Conveyor transfer point to screen plant	0.74	0.35	0.053	2%	4.1	0.00266	0.00126	0.00019	300	2.22E-01	1.05E-01	1.59E-02	0%	2.22E-01	1.05E-01	1.59E-02
Q10	Quarry 10	Conveyor transfer point to secondary	0.74	0.35	0.053	2%	4.1	0.00266	0.00126	0.00019	150	1.11E-01	5.24E-02	7.94E-03	0%	1.11E-01	5.24E-02	7.94E-03
Q10	Quarry 10	Conveyor drop to product truck	0.74	0.35	0.053	2%	4.1	0.00266	0.00126	0.00019	150	1.11E-01	5.24E-02	7.94E-03	0%	1.11E-01	5.24E-02	7.94E-03
Q18	Quarry 18	Truck loading	0.74	0.35	0.053	3%	4.1	0.00151	0.00071	0.00011	300	1.26E-01	5.94E-02	9.00E-03	0%	1.26E-01	5.94E-02	9.00E-03
Q18	Quarry 18	Truck unloading to primary crushing plant	0.74	0.35	0.053	3%	4.1	0.00151	0.00071	0.00011	300	1.26E-01	5.94E-02	9.00E-03	0%	1.26E-01	5.94E-02	9.00E-03
Q18	Quarry 18	Conveyor transfer point to screen plant	0.74	0.35	0.053	2%	4.1	0.00266	0.00126	0.00019	300	2.22E-01	1.05E-01	1.59E-02	0%	2.22E-01	1.05E-01	1.59E-02
Q18	Quarry 18	Conveyor transfer point to secondary	0.74	0.35	0.053	2%	4.1	0.00266	0.00126	0.00019	150	1.11E-01	5.24E-02	7.94E-03	0%	1.11E-01	5.24E-02	7.94E-03
Q18	Quarry 18	Conveyor drop to product truck	0.74	0.35	0.053	2%	4.1	0.00266	0.00126	0.00019	150	1.11E-01	5.24E-02	7.94E-03	0%	1.11E-01	5.24E-02	7.94E-03

Emission Factor Equation	Reference
$E = k \times (0.0016) \times (U/2.2)^{1.3} / (M/2)^{1.4}$	AP-42 13.2.4 November 2006

Parameter	SPM	PM_{10}	$PM_{2.5}$
k	0.74	0.35	0.053

E = emission factor in kg/megagram
k = particle size multiplier for particulate size range and units of interest
U = mean wind speed (m/s)
M = material moisture content (%)

Quarry Assessment Crushing and Screening Calculation Spreadsheet

Source ID	Source Type	Description	Emission Factor (kg/Mg)[1]			Processing Rate (tonnes/hr)[2]	Emission Rate (g/s)		
			PM	PM_{10}	$PM_{2.5}$*		PM	PM_{10}	$PM_{2.5}$*
Q2	Jaw Crusher	Primary Crushing (Uncontrolled)	0.0027	0.0012	0.0012	300	2.25E-01	1.00E-01	1.00E-01
Q2	Sceen Plant	Screening (Uncontrolled)	0.0125	0.0043	0.0043	300	1.04E+00	3.58E-01	3.58E-01
Q2	Cone Crusher	Secondary Crushing (Uncontrolled)	0.0195	0.0075	0.0075	150	8.13E-01	3.13E-01	3.13E-01
Q10	Jaw Crusher	Primary Crushing (Uncontrolled)	0.0027	0.0012	0.0012	300	2.25E-01	1.00E-01	1.00E-01
Q10	Sceen Plant	Screening (Uncontrolled)	0.0125	0.0043	0.0043	300	1.04E+00	3.58E-01	3.58E-01
Q10	Cone Crusher	Secondary Crushing (Uncontrolled)	0.0195	0.0075	0.0075	150	8.13E-01	3.13E-01	3.13E-01
Q18	Jaw Crusher	Primary Crushing (Uncontrolled)	0.0027	0.0012	0.0012	300	2.25E-01	1.00E-01	1.00E-01
Q18	Sceen Plant	Screening (Uncontrolled)	0.0125	0.0043	0.0043	300	1.04E+00	3.58E-01	3.58E-01
Q18	Cone Crusher	Secondary Crushing (Uncontrolled)	0.0195	0.0075	0.0075	150	8.13E-01	3.13E-01	3.13E-01

Notes:

[1] Primary and secondary crushing assumed to be the same as tertiary crushing

[2] Assumed that 50% of material needs to be crushed again in the cone crusher plant

*Where data is unavailable, $PM_{2.5}$ assumed to be equal to PM_{10}

Reference
AP-42 11.19.2 Crushed Stone Processing and Pulverized Mineral Processing
Table 11.19.2-1, August 2004

Quarry Assessment Wind Erosion Calculation Spreadsheet

Source ID	Wind Erosion Source	s %	f	E (kg/ha/day)			Active Surface Area (ha)[1]	Uncontrolled (g/s)			Assumed Control Efficiency (%)	Controlled Emission Rate (g/s)		
				TSP	PM_{10}	$PM_{2.5}$		TSP	PM_{10}	$PM_{2.5}$		TSP	PM_{10}	$PM_{2.5}$
Q2	East Zone Pit Active Area	5	27	11.396	5.698	2.279	0.25	0.03297	0.01649	0.00659	0%	0.03297	0.01649	0.00659
Q10	Purpose Built Pit Active Area	5	27	11.396	5.698	2.279	0.25	0.03297	0.01649	0.00659	0%	0.03297	0.01649	0.00659
Q18	Centre Zone Pit Active Area	5	27	11.396	5.698	2.279	0.25	0.03297	0.01649	0.00659	0%	0.03297	0.01649	0.00659

[1] Active area for pits was assumed to be 50 metres by 50 meters.

Equation	Reference
E = k*1.9 *(s/1.5) * f/15	AWMA - Air Pollution Engineering Manual, 1992, page 137

E = emission factor (kg/ha/day)
k = particle size multilier for particulate size range of interest
s = Silt Content in %
f = % of time that the unobstructed wind speed exceeds 5.4 m/s at mean pile height

Parameter	TSP	PM_{10}	$PM_{2.5}$	Reference
k	1.0	0.5	0.2	AWMA - Air Pollution Engineering Manual, 1992, page 137
f	average frequency obtained from CALMET data			

Quarry Assessment Wind Erosion Calculation Spreadsheet

Equipment	Manufacturer	Model	Number of Units	Power Rating (hp)	Steady-State Emission Factor (g/hp-hr)				% of Maximum Operating Capacity	% Daily Operation	Uncontrolled (g/s)					
					PM EF_{ss}	NOx EF_{ss}	CO EF_{ss}	HC EF_{ss}			TSP	PM_{10}	$PM_{2.5}$	NOx	SO_2	CO
1604 Crusher Jaw	n/a	n/a	1	300	0.0092	2.5	0.084	0.1314	80%	80%	4.91E-04	4.91E-04	4.76E-04	0.133	0.003	0.004
1604 Cone Plant	n/a	n/a	1	300	0.0092	2.5	0.084	0.1314	80%	80%	4.91E-04	4.91E-04	4.76E-04	0.133	0.003	0.004
1604 Screen Plant	n/a	n/a	1	110	0.0092	2.5	0.087	0.1314	80%	80%	1.80E-04	1.80E-04	1.75E-04	0.049	0.003	0.002
1604 Power Tower	n/a	n/a	1	200	0.0092	2.5	0.075	0.1314	80%	80%	3.27E-04	3.27E-04	3.17E-04	0.089	0.003	0.003
1604 Stacking Conveyor	n/a	n/a	1	48	0.2	4.7279	1.5323	0.2789	80%	80%	1.71E-03	1.71E-03	1.66E-03	0.040	0.004	0.013
Feeder and Bin wall Conveyor	n/a	n/a	1	48	0.2	4.7279	1.5323	0.2789	80%	80%	1.71E-03	1.71E-03	1.66E-03	0.040	0.004	0.013
Waste haul truck	Caterpillar	785D	1	1348	0.0690	2.3920	0.7642	0.2815	80%	80%	1.65E-02	1.65E-02	1.60E-02	0.573	0.003	0.183
Small wheel loader	Caterpillar	992K	2	801	0.0690	2.3920	0.7642	0.2815	80%	80%	1.97E-02	1.97E-02	1.91E-02	0.681	0.003	0.218
Excavator 345	Terex	RH170	1	2000	0.0690	2.3920	0.7642	0.2815	80%	80%	2.45E-02	2.45E-02	2.38E-02	0.850	0.003	0.272
										Total	0.066	0.066	0.064	2.59	0.03	0.71

Notes:

Cells highlighed gray indicates that emissions of a contaminant are zero.

Emission factors were obtained from the USEPA document *Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling - Compression Ignition* dated July 2010, EPA-420-R-10-018.

- see Table A4. *Zero Steady-State Emission Factors for Nonroad CI Engines*
- assumed Tier 4 (Tier 4A or just Tier 4), which are applicable to model years 2011 to 2014. No adjustments (i.e., TAF or sulphur content) needed to Tier 4 Efs.
- TAF is 1 for Tier 4 models. Also, PM not adjusted for sulphur content (resulted in a negative value)
- SO2 calculated using the following equation:

$$SO2=(BSFC\times 453.6\times (1\text{-}soxcnv)\text{-}HC)\times 0.01\times soxdsl\times 2$$

where:

soxcnv is the fraction of fuel sulphur converted to direct PM (0.3 for Tier 4)

soxdsl is the episodic weight % of sulphur in nonroad diesel fuel

% operating capacity and % daily operation assumed to be 80%

Size Fraction	% in Range	Reference
PM <30 µm	100%	EPA420-R-10-018, July 2010
PM <10 µm	100%	EPA420-R-10-018, July 2010
PM <2.5 µm	97%	EPA420-R-10-018, July 2010

Baker Lake Dock and Storage Facility Construction Assessment Dust Calculation Spreadsheet

Description	Mean Vehicle Speed (kph)	Emission Factor in kg/VKT			One-way Length[1] (km)	One-wayTrips per Day[1]	Working Hours per day	Uncontrolled Emission Rate (g/s)			Control (%)	Controlled Emission Rate (g/s)		
		SPM	PM_{10}	$PM_{2.5}$				SPM	PM_{10}	$PM_{2.5}$		SPM	PM_{10}	$PM_{2.5}$
Construction Area of Baker Lake	8.0	0.615	0.215	0.019	0.1	40	10	0.1368	0.0199	0.0018	0%	1.37E-01	1.99E-02	1.77E-03

Notes: Assume a 100 m by 100 m working area a day. Also assume grader works in 2.5 m wide strips (width of blade). Therefore, it makes 40 passes, 100 m in length in a work day.

Size Fraction	Emission Factor Equation	Reference
SPM <30 µm	$E = 0.0034 \times (S)^{2.5}$	AP-42 Table 11.9-2, October 1998
PM <10 µm	$E = 0.60 \times 0.0056 \times (S)^{2.0}$	AP-42 Table 11.9-2, October 1998
PM <2.5 µm	$E = 0.031 \times 0.0034 \times (S)^{2.5}$	AP-42 Table 11.9-2, October 1998

E = emission factor in kg/VKT
S = mean vehicle speed (kph)

A.6 Air Emissions Calculation Methods: Potential Acid Input

To calculate Potential Acid Input (PAI), two (2) main steps are required:

$$\boldsymbol{PAI}_{\boldsymbol{sulphur}} = \frac{([SO_2]_{dep,wet} + [SO_2]_{dep,dry}) \times 2}{64} + \frac{([SO_4^{2-}]_{dep,wet} + [SO_4^{2-}]_{dep,dry}) \times 2}{96}$$

1. PAI resulting from sulphur species is calculated from annual sulphur deposition rates expressed in kg/ha/yr.These are subsequently converted to keq/ha/yr using the following equation:

   Where:

   $[SO_2]_{dep,wet}$ = wet deposition of sulphur dioxide in kg/ha/yr

   $[SO_2]_{dep,dry}$ = dry deposition of sulphur dioxide in kg/ha/yr

   $[SO_4^{2-}]_{dep,wet}$ = wet deposition of sulphate in kg/ha/yr

   $[SO_4^{2-}]_{dep,dry}$ = dry deposition of sulphate in kg/ha/yr

2. PAI resulting from nitrogen species is calculated from the annual nitrogen deposition rates expressed as kg/ha/yr. Since there is more than one chemical species considered, these fluxes are converted to kiloequivalents per hectare per year (keq/ha/yr) by dividing the predicted deposition rate by the molecular weight and multiplying by the hydrogen ion equivalents as follows:

$$\boldsymbol{PAI}_{\text{nitrogen}} = \frac{([NO]_{\boldsymbol{dep,wet}} + [NO]_{\boldsymbol{dep},dry})}{30} + \frac{([NO_2]_{\boldsymbol{dep,wet}} + [NO_2]_{\boldsymbol{dep},dry})}{46} + \frac{([HNO_3]_{\boldsymbol{dep,wet}} + [HNO_3]_{\boldsymbol{dep},dry})}{63} + \frac{([NO_3^-]_{\boldsymbol{dep,wet}} + [NO_3^-]_{\boldsymbol{dep},dry})}{62}$$

   Where:

   $[NO]_{dep,wet}$ = wet deposition of nitrogen oxide in kg/ha/yr

   $[NO]_{dep,dry}$ = dry deposition of nitrogen oxide in kg/ha/yr

   $[NO_2]_{dep,wet}$ = wet deposition of nitrogen dioxide in kg/ha/yr

   $[NO_2]_{dep,dry}$ = dry deposition of nitrogen dioxide in kg/ha/yr

   $[HNO_3]_{dep,wet}$ = wet deposition of nitric acid in kg/ha/yr

   $[HNO_3]_{dep,dry}$ = dry deposition of nitric acid in kg/ha/yr

   $[NO_3^-]_{dep,wet}$ = wet deposition of nitrate in kg/ha/yr

   $[NO_3^-]_{dep,dry}$ = dry deposition of nitrate in kg/ha/yr

Here 'keq' refers to hydrogen ion equivalents (1 keq = 1 kmol H^+). The total PAI is calculated as the sum of the sulphur and nitrogen deposition rates from sources within the study area together with the background PAI for the region.

$$PAI = PAI_{sulphur} + PAI_{nitrogen} + PAI_{background}$$

In this equation, the PAI background accounts for background sulphur, nitrogen, Cl^-, NH_4^+ and base cations. Background PAI levels for the modelling domain were determined using the National Atmospheric Chemistry Precipitation Database (NAtChem) for Snare Rapids, NT (NAtChem 2008). Snare Rapids is the only location in the NT for which NAtChem precipitation data is available and therefore it was used to determine the background PAI for the assessment. NAtChem data provides wet deposition values for sulphur, nitrogen, Cl^-, NH_4^+ and base cations. The NAtChem data is provided in Table A-17.

The following equations demonstrate the background PAI calculation:

$$PAI_{background} = PAI_{acidifying\ substances} + PAI_{base\ cations}$$

The PAI from acidifying substances can be expressed as:

$$PAI_{acidifying\ substances} = \frac{\left([SO_4^{2-}]_{dep,wet} + [SO_4^{2-}]_{dep,dry}\right) \times 2}{96} + \frac{[NO_3^-]_{dep,wet} + [NO_3^-]_{dep,dry}}{62} + \frac{[NH_4^+]_{dep,wet}}{18} + \frac{[Cl^-]_{dep,wet}}{35.5}$$

Where:

$[SO_4^{2-}]_{dep,wet}$ = wet deposition of sulphate in keq/ha/yr

$[SO_4^{2-}]_{dep,dry}$ = dry deposition of sulphate in keq/ha/yr

$[NO_3^-]_{dep,wet}$ = wet deposition of nitrate in keq/ha/yr

$[NO_3^-]_{dep,dry}$ = dry deposition of nitrate in keq/ha/yr

$[NH_4^+]_{dep,wet}$ = wet deposition of ammoinium in keq/ha/yr

$[Cl^-]_{dep,wet}$ = wet deposition of chlorine in keq/ha/yr

NAtChem data only provides wet deposition values. In order to determine the background dry deposition values for the modelling domain, the average ratio of dry deposition to wet deposition for nitrogen and sulphur in predicted in the LAA was applied to NAtChem wet nitrogen and sulphur deposition values to determine the background dry nitrogen and sulphur deposition values for the modelling domain.

$$PAI_{base\ cation} = -\left(\frac{[Ca^{2+}]_{dep,back} \times 2}{40} + \frac{[Mg^{2+}]_{dep,back} \times 2}{24} + \frac{[K^{+}]_{dep,back}}{39} + \frac{[Na^{+}]_{dep,back}}{23}\right)$$

The base cations PAI are calculated according to the following equation:

Where:

$[Ca^{2+}]_{dep,back}$ = background deposition of calcium in keq/ha/yr

$[Mg^{2+}]_{dep,back}$ = background deposition of magnesium in keq/ha/yr

$[K^{+}]_{dep,back}$ = background deposition of potassium in keq/ha/yr

$[Na^{+}]_{dep,back}$ = background deposition of sodium in keq/ha/yr

An average annual background PAI value of 0.093 keq/ha/yr was calculated.

Table A-17 NAtCHEM Database 2008 Annual Summary Statistics of Precipitation Chemistry Data for Snare Rapids, NT Monitoring Station

Constituent	Wet Deposition (kg/ha/yr)
SO_4=	0.988
NO_3^-	1.111
Cl^-	0.276
NH_4^+	0.899
Na^+	0.23
Ca^{++}	0.251
Mg^{++}	0.051
K^+	0.159

Attachment B Detailed Air Emissions Summaries

B.1 Air Emissions: Phased Operations

Table B-1 Period 1 (Year 0 and 1) Maximum Air Emissions Rate Summary

Location	Source Description	Emission Rates (g/s)																	
		Radon (Bq/s)	TSP	PM_{10}	$PM_{2.5}$	U	As	Co	Cu	Pb	Mo	Ni	Se	Zn	Cd	Cr	SO_2	NO_x	CO
Kiggavik Site	Main Zone East Open Pit	2.3E+05	1.5E+00	6.0E-01	1.5E-01	1.9E-04	4.9E-06	2.0E-05	3.5E-05	3.9E-04	2.2E-04	6.8E-05	2.3E-06	5.2E-05	9.3E-07	1.5E-04	3.8E-01	2.7E+00	1.3E+01
	Main Zone West Open Pit	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Centre Zone Open Pit	4.2E+05	6.9E+00	2.1E+00	3.4E-01	2.3E-03	1.6E-05	7.0E-05	1.1E-04	1.9E-04	2.5E-05	2.0E-04	7.5E-06	2.3E-04	8.1E-07	3.7E-04	4.0E-01	5.7E+00	1.4E+01
	East Zone Open Pit	1.7E+06	2.3E+00	8.4E-01	1.8E-01	5.7E-03	5.4E-06	2.4E-05	3.7E-05	6.6E-05	8.7E-06	6.7E-05	2.5E-06	7.9E-05	2.8E-07	1.2E-04	3.8E-01	3.1E+00	1.3E+01
	Purpose Built Open Pit	3.1E+04	8.7E-01	4.1E-01	1.2E-01	2.2E-04	7.1E-07	8.2E-06	8.4E-06	2.1E-05	9.4E-06	1.9E-05	2.7E-07	2.4E-05	4.2E-08	4.7E-05	3.7E-01	2.0E+00	1.3E+01
	Kiggavik Clean Rock Pile - South	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Kiggavik Clean Rock Pile - North	7.0E+05	2.8E+01	7.7E+00	1.0E+00	4.3E-03	2.5E-05	2.7E-04	3.3E-04	3.4E-04	5.3E-05	7.2E-04	3.1E-05	8.3E-04	1.1E-06	1.3E-03	1.0E-02	2.0E+00	6.3E-01
	Kiggavik Overburden Pile	1.2E+04	5.7E+00	1.7E+00	2.8E-01	5.7E-05	4.6E-06	6.4E-05	7.7E-05	5.8E-05	1.1E-05	1.5E-04	6.5E-06	2.0E-04	2.9E-07	2.6E-04	5.6E-03	5.7E-01	1.7E-01
	Kiggavik Ore Pile	1.3E+06	5.4E-01	2.7E-01	9.8E-02	2.5E-03	1.3E-05	1.0E-05	3.9E-05	1.5E-04	1.7E-05	4.2E-05	1.1E-07	5.2E-05	7.5E-07	9.6E-05	7.5E-03	2.6E-02	7.2E-03
	Kiggavik Mine Rock Pile	7.1E+05	8.4E-01	2.7E-01	1.1E-01	7.6E-04	6.1E-07	9.1E-06	3.8E-05	2.5E-05	1.2E-05	1.9E-05	1.2E-06	3.0E-05	4.2E-08	3.5E-05	1.4E-02	3.9E-01	1.9E-02
	Mill	8.4E+04	8.8E-02	4.5E-02	1.3E-02	1.2E-04	3.1E-08	2.3E-08	9.0E-08	3.5E-07	4.0E-08	9.6E-08	2.6E-10	1.2E-07	1.7E-09	2.2E-07	2.9E-04	1.1E-02	5.6E-03
	Acid Plant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.4E-02	3.9E-03	6.2E-03
	Power Plant at Kiggavik	-	2.0E+00	1.9E+00	1.8E+00	-	-	-	-	-	-	-	-	-	-	-	5.8E-03	6.3E+01	2.8E-01
	Incinerator at Kiggavik	-	2.2E-02	1.8E-02	1.0E-02	-	-	-	-	-	-	-	-	-	-	-	5.6E-02	1.0E-01	7.8E-03
	Power Plant at Sissons	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sissons Site	Incinerator at Sissons	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	On-Site Roads at Kiggavik	-	9.2E+00	2.4E+00	2.7E-01	9.2E-05	1.8E-05	7.4E-05	2.3E-04	1.5E-04	7.4E-05	2.3E-04	1.8E-05	1.9E-04	9.2E-07	5.5E-04	1.7E-03	1.2E+00	3.7E-01
	Andrew Lake Open Pit	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Andrew Lake Mine Rock Pile	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Andrew Lake Ore Pile	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Andrew Lake Overburden Pile	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Andrew Lake Clean Rock Pile	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	End Grid Special Waste Pile	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	End Grid Clean Rock Pile	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	End Grid Special Ore Pile	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Backfill Plant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	End Grid Underground Mine Exhaust	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	On-Site Roads at Sissons	-	3.0E-01	7.7E-02	7.7E-03	3.0E-06	6.0E-07	2.4E-06	7.5E-06	4.8E-06	2.4E-06	7.5E-06	6.0E-07	6.3E-06	3.0E-08	1.8E-05	1.0E-04	6.9E-03	6.9E-04
Roads	Haul road between Kiggavik and Sissons	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Road to Baker Lake (1 km segment modelled)	-	3.2E-01	8.2E-02	8.2E-03	-	-	-	-	-	-	-	-	-	-	-	6.0E-05	4.2E-03	2.9E-04
	Road to Airstrip	-	1.8E-01	5.2E-02	5.1E-03	1.8E-06	3.6E-07	1.5E-06	4.6E-06	2.9E-06	1.5E-06	4.6E-06	3.6E-07	3.8E-06	1.8E-08	1.1E-05	5.7E-05	1.4E-02	5.5E-04
Maximum Monthly Total Emission Rate		5.2E+06	5.0E+01	1.6E+01	4.1E+00	1.4E-02	7.8E-05	4.7E-04	7.4E-04	1.2E-03	4.0E-04	1.3E-03	5.8E-05	1.5E-03	4.6E-06	2.4E-03	8.1E+01	1.7E+00	5.4E+01

Table B-2 Period 2 (Year 2 – 5) Maximum Air Emissions Rate Summary

Location	Source Description	Emission Rates (g/s)																	
		Radon (Bq/s)	TSP	PM_{10}	$PM_{2.5}$	U	As	Co	Cu	Pb	Mo	Ni	Se	Zn	Cd	Cr	SO_2	NO_x	CO
Kiggavik Site	Main Zone East Open Pit	3.0E+02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
	Main Zone West Open Pit	1.4E+06	1.9E+01	5.3E+00	7.0E-01	9.8E-03	2.2E-05	1.9E-04	2.4E-04	7.4E-04	3.3E-04	5.3E-04	2.2E-05	5.7E-04	2.0E-06	9.7E-04	4.0E-01	8.6E+00	1.5E+01
	Centre Zone Open Pit	9.0E+02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
	East Zone Open Pit	4.2E+02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
	Purpose Built Open Pit	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
	Kiggavik Clean Rock Pile - South	1.3E+06	2.1E+01	6.1E+00	9.8E-01	4.2E-03	1.9E-05	2.0E-04	2.5E-04	2.6E-04	4.0E-05	5.5E-04	2.4E-05	6.3E-04	8.4E-07	9.6E-04	7.3E-03	1.4E+00	4.4E-01
	Kiggavik Clean Rock Pile - North	6.7E+05	1.6E+00	8.1E-01	3.3E-01	2.5E-04	1.5E-06	1.6E-05	1.9E-05	2.0E-05	3.1E-06	4.3E-05	1.9E-06	4.9E-05	6.5E-08	7.5E-05	-	-	0.0E+00
	Kiggavik Overburden Pile	1.4E+04	5.3E-01	2.6E-01	1.1E-01	5.3E-06	4.2E-07	5.9E-06	7.1E-06	5.3E-06	1.0E-06	1.4E-05	5.9E-07	1.9E-05	2.6E-08	2.4E-05	-	-	0.0E+00
	Kiggavik Ore Pile	1.8E+06	7.0E-01	3.5E-01	1.1E-01	3.4E-03	6.0E-06	1.2E-05	2.2E-05	3.4E-04	1.9E-04	4.6E-05	1.5E-06	2.7E-05	8.4E-07	1.1E-04	1.1E-02	2.0E-01	5.4E-02
	Kiggavik Mine Rock Pile	7.6E+05	8.2E-01	2.7E-01	1.1E-01	7.4E-04	6.0E-07	8.9E-06	3.7E-05	2.5E-05	1.2E-05	1.8E-05	1.2E-06	2.9E-05	4.1E-08	3.4E-05	1.4E-02	3.8E-01	1.7E-02
	Mill	1.2E+06	9.4E-01	4.8E-01	1.4E-01	1.3E-03	1.5E-07	3.0E-07	5.5E-07	8.4E-06	4.7E-06	1.1E-06	3.8E-08	6.7E-07	2.1E-08	2.6E-06	3.0E-03	1.2E-01	5.9E-02
	Acid Plant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.6E-01	4.1E-02	6.6E-02
	Power Plant at Kiggavik	-	2.0E+00	1.9E+00	1.8E+00	-	-	-	-	-	-	-	-	-	-	-	5.8E-03	6.3E+01	2.8E-01
	Incinerator at Kiggavik	-	2.2E-02	1.8E-02	1.0E-02	-	-	-	-	-	-	-	-	-	-	-	5.6E-02	1.0E-01	7.8E-03
	Power Plant at Sissons	-	4.9E-01	4.8E-01	4.5E-01	-	-	-	-	-	-	-	-	-	-	-	8.6E-04	1.6E+01	7.0E-02
Sissons Site	Incinerator at Sissons	-	1.1E-02	8.8E-03	5.0E-03	-	-	-	-	-	-	-	-	-	-	-	2.8E-02	5.2E-02	3.9E-03
	On-Site Roads at Kiggavik	-	9.6E+00	2.5E+00	2.8E-01	9.6E-05	1.9E-05	7.7E-05	2.4E-04	1.5E-04	7.7E-05	2.4E-04	1.9E-05	2.0E-04	9.6E-07	5.7E-04	1.7E-03	1.2E+00	3.8E-01
	Andrew Lake Open Pit	5.9E+05	4.6E+00	1.5E+00	2.7E-01	9.1E-04	1.5E-05	1.7E-05	3.1E-05	4.0E-05	3.2E-06	1.3E-04	5.8E-06	6.1E-05	4.1E-07	3.9E-04	3.9E-01	4.2E+00	1.3E+01
	Andrew Lake Mine Rock Pile	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
	Andrew Lake Ore Pile	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
	Andrew Lake Overburden Pile	1.3E+04	5.0E-01	2.5E-01	1.0E-01	5.0E-06	1.8E-06	1.9E-06	3.7E-06	3.8E-06	3.3E-07	1.3E-05	6.6E-07	6.8E-06	4.0E-08	4.3E-05	-	-	0.0E+00
	Andrew Lake Clean Rock Pile	1.8E+06	1.9E+01	5.7E+00	1.0E+00	3.7E-03	6.1E-05	7.0E-05	1.3E-04	1.6E-04	1.3E-05	5.3E-04	2.4E-05	2.5E-04	1.7E-06	1.6E-03	5.8E-03	1.2E+00	3.7E-01
	End Grid Special Waste Pile	2.0E+05	6.3E-01	1.9E-01	8.8E-02	1.3E-03	6.3E-07	8.2E-06	1.3E-06	2.4E-05	6.3E-07	2.3E-05	5.6E-07	2.4E-05	6.3E-07	6.3E-05	-	-	0.0E+00
	End Grid Clean Rock Pile	3.1E+04	6.4E-01	2.0E-01	8.9E-02	1.6E-04	2.1E-06	2.4E-06	4.3E-06	5.6E-06	4.4E-07	1.8E-05	8.2E-07	8.6E-06	5.8E-08	5.4E-05	-	-	0.0E+00
	End Grid Special Ore Pile	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
	Backfill Plant	-	1.7E-01	5.5E-02	1.2E-02	2.5E-06	7.0E-05	1.6E-07	1.9E-07	3.4E-06	3.1E-08	2.9E-05	1.8E-08	4.9E-07	1.1E-07	1.3E-05	-	-	0.0E+00
	End Grid Underground Mine Exhaust	1.4E+05	2.0E+00	1.0E+00	3.4E-01	2.2E-03	3.3E-05	1.6E-05	3.4E-05	1.2E-04	3.5E-05	7.4E-05	4.6E-06	4.1E-05	7.8E-07	1.8E-04	9.0E-02	6.2E+00	1.1E+00
	On-Site Roads at Sissons	2.2E+06	3.1E+01	9.6E+00	1.9E+00	7.5E-03	1.9E-04	1.7E-04	3.8E-04	4.6E-04	1.2E-04	8.9E-04	4.7E-05	5.1E-04	4.1E-06	2.4E-03	9.7E-02	8.4E+00	1.8E+00
Roads	Haul road between Kiggavik and Sissons	-	4.9E+00	1.3E+00	1.3E-01	4.9E-05	9.8E-06	3.9E-05	1.2E-04	7.8E-05	3.9E-05	1.2E-04	9.8E-06	1.0E-04	4.9E-07	2.9E-04	4.8E-04	6.8E-02	3.4E-03
	Road to Baker Lake (1 km segment modelled)	-	3.2E-01	8.2E-02	8.2E-03	-	-	-	-	-	-	-	-	-	-	-	6.0E-05	4.2E-03	2.9E-04
	Road to Airstrip	-	1.8E-01	5.2E-02	5.1E-03	1.8E-06	3.6E-07	1.5E-06	4.6E-06	2.9E-06	1.5E-06	4.6E-06	3.6E-07	3.8E-06	1.8E-08	1.1E-05	5.7E-05	1.4E-02	5.5E-04
Maximum Monthly Total Emission Rate		1.2E+07	8.1E+01	2.7E+01	6.9E+00	2.3E-02	2.2E-04	6.2E-04	1.2E-03	1.9E-03	7.7E-04	2.1E-03	1.1E-04	1.8E-03	8.1E-06	4.8E-03	1.3E+00	1.0E+02	3.0E+01

Table B-3 Period 3 (Year 6 – 13) Maximum Air Emissions Rate Summary

Location	Source Description	Emission Rates (g/s)																	
		Radon (Bq/s)	TSP	PM_{10}	$PM_{2.5}$	U	As	Co	Cu	Pb	Mo	Ni	Se	Zn	Cd	Cr	SO_2	NO_x	CO
Kiggavik Site	Main Zone East Open Pit	1.0E+03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
	Main Zone West Open Pit	1.6E+03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
	Centre Zone Open Pit	9.0E+02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
	East Zone Open Pit	4.2E+02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
	Purpose Built Open Pit	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
	Kiggavik Clean Rock Pile - South	1.2E+06	2.3E+00	1.2E+00	4.7E-01	4.7E-04	2.1E-06	2.2E-05	2.8E-05	2.9E-05	4.5E-06	6.1E-05	2.7E-06	7.0E-05	9.3E-08	1.1E-04	-	-	0.0E+00
	Kiggavik Clean Rock Pile - North	6.7E+05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
	Kiggavik Overburden Pile	1.4E+04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
	Kiggavik Ore Pile	1.7E+06	5.7E-01	2.8E-01	1.0E-01	2.7E-03	1.7E-05	7.1E-06	2.8E-05	1.7E-04	3.3E-05	4.9E-05	1.3E-06	2.1E-05	6.5E-07	3.8E-04	7.3E-03	9.1E-03	2.5E-03
	Kiggavik Mine Rock Pile	7.6E+05	3.2E-01	1.6E-01	6.3E-02	2.8E-04	2.3E-07	3.4E-06	1.4E-05	9.5E-06	4.6E-06	7.0E-06	4.5E-07	1.1E-05	1.6E-08	1.3E-05	-	-	0.0E+00
	Mill	1.1E+06	1.0E+00	5.3E-01	1.6E-01	1.4E-03	4.6E-07	1.9E-07	7.6E-07	4.7E-06	9.1E-07	1.3E-06	3.4E-08	5.6E-07	1.8E-08	1.0E-05	3.4E-03	1.3E-01	6.6E-02
	Acid Plant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.9E-01	4.6E-02	7.4E-02
	Power Plant at Kiggavik	-	2.0E+00	1.9E+00	1.8E+00	-	-	-	-	-	-	-	-	-	-	-	5.8E-03	6.3E+01	2.8E-01
	Incinerator at Kiggavik	-	2.2E-02	1.8E-02	1.0E-02	-	-	-	-	-	-	-	-	-	-	-	5.6E-02	1.0E-01	7.8E-03
	Power Plant at Sissons	-	4.9E-01	4.8E-01	4.5E-01	-	-	-	-	-	-	-	-	-	-	-	8.6E-04	1.6E+01	7.0E-02
Sissons Site	Incinerator at Sissons	-	1.1E-02	8.8E-03	5.0E-03	-	-	-	-	-	-	-	-	-	-	-	2.8E-02	5.2E-02	3.9E-03
	On-Site Roads at Kiggavik	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
	Andrew Lake Open Pit	9.9E+05	2.9E+01	8.0E+00	1.0E+00	1.2E-02	1.1E-04	1.1E-04	2.4E-04	6.2E-04	7.9E-05	8.8E-04	3.6E-05	4.1E-04	3.7E-06	3.4E-03	4.2E-01	1.1E+01	1.5E+01
	Andrew Lake Mine Rock Pile	7.4E+05	7.2E-01	2.3E-01	1.1E-01	6.5E-04	1.4E-06	1.9E-06	4.1E-06	1.0E-05	6.0E-07	2.0E-05	7.9E-07	7.2E-06	7.9E-08	5.5E-05	1.4E-02	2.3E-01	8.2E-03
	Andrew Lake Ore Pile	4.4E+05	2.4E-01	1.2E-01	4.7E-02	1.4E-03	4.0E-06	2.0E-06	1.2E-05	8.7E-05	1.4E-05	2.3E-05	1.2E-07	8.3E-06	2.7E-07	2.3E-04	-	-	0.0E+00
	Andrew Lake Overburden Pile	1.3E+04	5.0E-01	2.5E-01	1.0E-01	5.0E-06	1.8E-06	1.9E-06	3.7E-06	3.8E-06	3.3E-07	1.3E-05	6.6E-07	6.8E-06	4.0E-08	4.3E-05	-	-	0.0E+00
	Andrew Lake Clean Rock Pile	2.0E+06	2.8E+01	8.3E+00	1.4E+00	5.6E-03	9.2E-05	1.0E-04	1.9E-04	2.4E-04	1.9E-05	7.8E-04	3.6E-05	3.7E-04	2.5E-06	2.4E-03	1.6E-02	1.8E+00	5.7E-01
	End Grid Special Waste Pile	2.6E+05	2.3E-01	1.2E-01	4.6E-02	4.8E-04	2.3E-07	3.0E-06	4.6E-07	8.7E-06	2.3E-07	8.5E-06	2.1E-07	8.7E-06	2.3E-07	2.3E-05	-	-	0.0E+00
	End Grid Clean Rock Pile	3.1E+04	2.3E-01	1.2E-01	4.6E-02	5.8E-05	7.6E-07	8.6E-07	1.6E-06	2.0E-06	1.6E-07	6.5E-06	3.0E-07	3.1E-06	2.1E-08	2.0E-05	-	-	0.0E+00
	End Grid Special Ore Pile	1.3E+05	2.6E-01	1.3E-01	4.8E-02	1.1E-03	1.4E-05	5.4E-06	1.2E-05	5.4E-05	1.7E-05	1.7E-05	1.4E-06	1.0E-05	3.1E-07	2.9E-05	-	-	0.0E+00
	Backfill Plant	-	1.9E-01	6.2E-02	1.3E-02	5.0E-06	7.0E-05	3.1E-07	3.8E-07	3.7E-06	6.1E-08	3.1E-05	3.6E-08	9.6E-07	1.3E-07	1.3E-05	-	-	0.0E+00
	End Grid Underground Mine Exhaust	3.5E+05	2.2E+00	1.1E+00	3.7E-01	7.9E-03	9.7E-05	3.9E-05	8.4E-05	3.7E-04	1.1E-04	1.3E-04	1.0E-05	7.9E-05	2.3E-06	2.3E-04	9.2E-02	6.2E+00	1.2E+00
	On-Site Roads at Sissons	2.8E+06	4.5E+01	1.4E+01	2.4E+00	1.5E-02	3.0E-04	2.6E-04	6.3E-04	9.0E-04	2.6E-04	1.3E-03	7.5E-05	7.7E-04	6.8E-06	3.5E-03	1.1E-01	9.7E+00	2.2E+00
Roads	Haul road between Kiggavik and Sissons	-	1.3E+01	3.3E+00	3.3E-01	1.3E-04	2.5E-05	1.0E-04	3.2E-04	2.0E-04	1.0E-04	3.2E-04	2.5E-05	2.7E-04	1.3E-06	7.6E-04	1.0E-03	7.8E-02	5.5E-03
	Road to Baker Lake (1 km segment modelled)	-	3.2E-01	8.2E-02	8.2E-03	-	-	-	-	-	-	-	-	-	-	-	6.0E-05	4.2E-03	2.9E-04
	Road to Airstrip	-	1.8E-01	5.2E-02	5.1E-03	1.8E-06	3.6E-07	1.5E-06	4.6E-06	2.9E-06	1.5E-06	4.6E-06	3.6E-07	3.8E-06	1.8E-08	1.1E-05	5.7E-05	1.4E-02	5.5E-04
Maximum Monthly Total Emission Rate		1.3E+07	8.3E+01	2.6E+01	6.5E+00	2.4E-02	3.3E-04	4.4E-04	1.1E-03	1.6E-03	3.8E-04	2.3E-03	1.2E-04	1.3E-03	9.8E-06	7.4E-03	9.2E-01	1.0E+02	1.7E+01

Table B-4 Period 4 (Year 14) Maximum Air Emissions Rate Summary

Location	Source Description	Emission Rates (g/s)																	
		Radon (Bq/s)	TSP	PM_{10}	$PM_{2.5}$	U	As	Co	Cu	Pb	Mo	Ni	Se	Zn	Cd	Cr	SO_2	NO_x	CO
Kiggavik Site	Main Zone East Open Pit	1.0E+03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
	Main Zone West Open Pit	1.6E+03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
	Centre Zone Open Pit	9.0E+02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
	East Zone Open Pit	4.2E+02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
	Purpose Built Open Pit	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
	Kiggavik Clean Rock Pile - South	1.2E+06	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
	Kiggavik Clean Rock Pile - North	6.7E+05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
	Kiggavik Overburden Pile	1.4E+04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
	Kiggavik Ore Pile	2.1E+06	4.7E-01	2.4E-01	1.0E-01	3.1E-03	1.4E-05	5.8E-06	2.3E-05	1.4E-04	2.7E-05	4.0E-05	1.0E-06	1.7E-05	5.3E-07	3.1E-04	3.8E-01	2.1E-02	1.0E-01
	Kiggavik Mine Rock Pile	7.6E+05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
	Mill	1.5E+05	1.5E-01	7.7E-02	2.3E-02	2.0E-04	4.6E-08	1.9E-08	7.6E-08	4.7E-07	9.1E-08	1.3E-07	3.4E-09	5.6E-08	1.8E-09	1.0E-06	1.9E-02	4.9E-04	9.6E-03
	Acid Plant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.7E-03	4.2E-02	1.1E-02
	Power Plant at Kiggavik	-	2.0E+00	1.9E+00	1.8E+00	-	-	-	-	-	-	-	-	-	-	-	6.3E+01	5.8E-03	2.8E-01
	Incinerator at Kiggavik	-	2.2E-02	1.8E-02	1.0E-02	-	-	-	-	-	-	-	-	-	-	-	1.0E-01	5.6E-02	7.8E-03
	Power Plant at Sissons	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
Sissons Site	Incinerator at Sissons	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
	On-Site Roads at Kiggavik	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
	Andrew Lake Open Pit	7.5E+05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
	Andrew Lake Mine Rock Pile	7.4E+05	3.1E-01	1.5E-01	6.2E-02	2.8E-04	5.9E-07	8.1E-07	1.7E-06	4.4E-06	2.6E-07	8.6E-06	3.4E-07	3.1E-06	3.4E-08	2.4E-05	-	-	0.0E+00
	Andrew Lake Ore Pile	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
	Andrew Lake Overburden Pile	1.3E+04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
	Andrew Lake Clean Rock Pile	2.0E+06	3.7E+00	1.9E+00	7.5E-01	7.5E-04	1.2E-05	1.4E-05	2.5E-05	3.3E-05	2.6E-06	1.0E-04	4.8E-06	5.0E-05	3.4E-07	3.2E-04	-	-	0.0E+00
	End Grid Special Waste Pile	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
	End Grid Clean Rock Pile	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
	End Grid Special Ore Pile	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
	Backfill Plant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
	End Grid Underground Mine Exhaust	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
	On-Site Roads at Sissons	-	3.0E-01	7.7E-02	7.7E-03	3.0E-06	6.0E-07	2.4E-06	7.5E-06	4.8E-06	2.4E-06	7.5E-06	6.0E-07	6.3E-06	3.0E-08	1.8E-05	6.9E-03	1.0E-04	6.9E-04
Roads	Haul road between Kiggavik and Sissons	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
	Road to Baker Lake (1 km segment modelled)	-	3.2E-01	8.2E-02	8.2E-03	-	-	-	-	-	-	-	-	-	-	-	4.2E-03	6.0E-05	2.9E-04
	Road to Airstrip	-	1.8E-01	5.2E-02	5.1E-03	1.8E-06	3.6E-07	1.5E-06	4.6E-06	2.9E-06	1.5E-06	4.6E-06	3.6E-07	3.8E-06	1.8E-08	1.1E-05	1.4E-02	5.7E-05	5.5E-04
Maximum Monthly Total Emission Rate		8.4E+06	7.8E+00	4.5E+00	2.7E+00	4.3E-03	2.8E-05	2.4E-05	6.1E-05	1.9E-04	3.4E-05	1.6E-04	7.0E-06	7.9E-05	9.4E-07	6.8E-04	6.4E+01	1.3E-01	4.1E-01

B.2 Air Emissions: Maximum Bounding Scenario

Table B-5 Maximum Bounding Scenario Maximum Air Emissions Rates Summary

Location	Source Description	Emission Rates (g/s)																	
		Radon (Bq/s)	TSP	PM_{10}	$PM_{2.5}$	U	As	Co	Cu	Pb	Mo	Ni	Se	Zn	Cd	Cr	SO_2	NO_x	CO
Kiggavik Site	Main Zone East Open Pit	1.0E+03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
	Main Zone West Open Pit	1.1E+06	2.2E+01	6.2E+00	8.3E-01	1.2E-02	2.6E-05	2.2E-04	2.8E-04	8.4E-04	3.7E-04	6.2E-04	2.6E-05	6.7E-04	2.2E-06	1.1E-03	9.1E-01	1.3E+01	3.2E+01
	Centre Zone Open Pit	9.0E+02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
	East Zone Open Pit	4.2E+02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
	Purpose Built Open Pit	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
	Kiggavik Clean Rock Pile - South	1.3E+06	2.1E+01	6.2E+00	9.9E-01	4.2E-03	1.9E-05	2.0E-04	2.5E-04	2.6E-04	4.0E-05	5.5E-04	2.4E-05	6.3E-04	8.4E-07	9.6E-04	2.1E-02	1.9E+00	5.0E-01
	Kiggavik Clean Rock Pile - North	6.7E+05	1.3E+01	3.6E+00	5.7E-01	2.0E-03	1.2E-05	1.2E-04	1.5E-04	1.6E-04	2.5E-05	3.4E-04	1.5E-05	3.9E-04	5.2E-07	5.9E-04	1.1E-03	7.5E-01	2.4E-01
	Kiggavik Overburden Pile	1.5E+04	4.3E+00	1.3E+00	2.4E-01	4.3E-05	3.4E-06	4.8E-05	5.8E-05	4.3E-05	8.1E-06	1.2E-04	4.8E-06	1.5E-04	2.1E-07	2.0E-04	7.7E-03	4.9E-01	1.2E-01
	Kiggavik Ore Pile	2.5E+06	7.0E-01	3.5E-01	1.1E-01	4.7E-03	1.2E-05	1.0E-05	2.8E-05	2.9E-04	1.2E-04	5.3E-05	1.4E-06	2.6E-05	8.2E-07	3.0E-04	7.5E-03	2.9E-02	8.0E-03
	Kiggavik Mine Rock Pile	7.6E+05	8.2E-01	2.7E-01	1.1E-01	7.4E-04	6.0E-07	8.9E-06	3.7E-05	2.5E-05	1.2E-05	1.8E-05	1.2E-06	2.9E-05	4.1E-08	3.5E-05	3.5E-04	2.3E-02	5.7E-03
	Mill	1.8E+06	1.1E+00	5.6E-01	1.6E-01	1.5E-03	3.0E-07	2.6E-07	7.2E-07	7.3E-06	3.1E-06	1.4E-06	3.6E-08	6.7E-07	2.1E-08	7.5E-06	3.6E-03	1.4E-01	7.0E-02
	Acid Plant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.0E-01	4.9E-02	7.8E-02
	Power Plant at Kiggavik	-	2.0E+00	1.9E+00	1.8E+00	-	-	-	-	-	-	-	-	-	-	-	5.8E-03	6.3E+01	2.8E-01
	Incinerator at Kiggavik	-	2.2E-02	1.8E-02	1.0E-02	-	-	-	-	-	-	-	-	-	-	-	5.6E-02	1.0E-01	7.8E-03
	Power Plant at Sissons	-	4.9E-01	4.8E-01	4.5E-01	-	-	-	-	-	-	-	-	-	-	-	8.6E-04	1.6E+01	7.0E-02
Sissons Site	Incinerator at Sissons	-	1.1E-02	8.8E-03	5.0E-03	-	-	-	-	-	-	-	-	-	-	-	2.8E-02	5.2E-02	3.9E-03
	On-Site Roads at Kiggavik	-	1.6E+01	4.1E+00	4.6E-01	1.6E-04	3.1E-05	1.2E-04	3.9E-04	2.5E-04	1.2E-04	3.9E-04	3.1E-05	3.3E-04	1.6E-06	9.3E-04	2.9E-03	2.0E+00	6.3E-01
	Andrew Lake Open Pit	1.6E+06	3.4E+01	9.2E+00	1.2E+00	1.4E-02	1.3E-04	1.3E-04	2.8E-04	7.1E-04	9.0E-05	1.0E-03	4.2E-05	4.8E-04	4.2E-06	3.9E-03	9.1E-01	1.6E+01	3.3E+01
	Andrew Lake Mine Rock Pile	7.5E+05	7.6E-01	2.5E-01	1.1E-01	6.8E-04	1.5E-06	2.0E-06	4.3E-06	1.1E-05	6.4E-07	2.1E-05	8.3E-07	7.6E-06	8.3E-08	5.8E-05	2.9E-04	1.4E-02	3.2E-03
	Andrew Lake Ore Pile	5.4E+05	2.9E-01	1.4E-01	5.0E-02	1.8E-03	4.8E-06	2.4E-06	1.4E-05	1.0E-04	1.6E-05	2.7E-05	1.4E-07	9.8E-06	3.2E-07	2.8E-04	-	-	0.0E+00
	Andrew Lake Overburden Pile	1.4E+04	2.7E+00	8.0E-01	1.9E-01	2.6E-05	9.8E-06	1.0E-05	2.0E-05	2.0E-05	1.8E-06	7.2E-05	3.5E-06	3.6E-05	2.1E-07	2.3E-04	4.7E-03	2.9E-01	6.9E-02
	Andrew Lake Clean Rock Pile	2.0E+06	3.4E+01	9.8E+00	1.5E+00	6.7E-03	1.1E-04	1.3E-04	2.3E-04	2.9E-04	2.3E-05	9.5E-04	4.3E-05	4.5E-04	3.0E-06	2.8E-03	2.6E-02	2.8E+00	7.7E-01
	End Grid Special Waste Pile	2.6E+05	2.3E-01	1.2E-01	4.6E-02	4.9E-04	2.3E-07	3.0E-06	4.7E-07	8.9E-06	2.3E-07	8.6E-06	2.1E-07	8.9E-06	2.3E-07	2.3E-05	-	-	0.0E+00
	End Grid Clean Rock Pile	3.1E+04	2.4E-01	1.2E-01	4.7E-02	6.1E-05	8.0E-07	9.1E-07	1.6E-06	2.1E-06	1.7E-07	6.9E-06	3.1E-07	3.3E-06	2.2E-08	2.1E-05	-	-	0.0E+00
	End Grid Special Ore Pile	1.5E+05	2.5E-01	1.3E-01	4.8E-02	1.3E-03	1.4E-05	5.3E-06	1.2E-05	5.3E-05	1.6E-05	1.7E-05	1.4E-06	1.0E-05	3.0E-07	2.9E-05	-	-	0.0E+00
	Backfill Plant	-	1.9E-01	6.2E-02	1.3E-02	5.0E-06	7.0E-05	3.1E-07	3.8E-07	3.7E-06	6.1E-08	3.1E-05	3.6E-08	9.6E-07	1.3E-07	1.3E-05	-	-	0.0E+00
	End Grid Underground Mine Exhaust	2.8E+05	6.4E+00	3.3E+00	1.0E+00	2.1E-02	2.2E-04	9.3E-05	2.0E-04	8.3E-04	2.5E-04	3.3E-04	2.4E-05	2.0E-04	5.2E-06	6.5E-04	1.3E-01	6.4E+00	2.3E+00
	On-Site Roads at Sissons	-	1.6E+01	4.1E+00	4.5E-01	1.6E-04	3.1E-05	1.2E-04	3.9E-04	2.5E-04	1.2E-04	3.9E-04	3.1E-05	3.3E-04	1.6E-06	9.4E-04	2.9E-03	1.8E+00	5.8E-01
Roads	Haul road between Kiggavik and Sissons	-	3.5E+01	9.0E+00	9.0E-01	3.5E-04	7.0E-05	2.8E-04	8.8E-04	5.6E-04	2.8E-04	8.8E-04	7.0E-05	7.4E-04	3.5E-06	2.1E-03	3.0E-03	1.1E-01	1.3E-02
	Road to Baker Lake (1 km segment modelled)	-	3.2E-01	8.2E-02	8.2E-03	-	-	-	-	-	-	-	-	-	-	-	5.6E-05	4.1E-03	2.8E-04
	Road to Airstrip	-	1.8E-01	5.2E-02	5.0E-03	1.8E-06	3.6E-07	1.5E-06	4.6E-06	2.9E-06	1.5E-06	4.6E-06	3.6E-07	3.8E-06	1.8E-08	1.1E-05	3.7E-05	1.3E-02	4.8E-04
Maximum Monthly Total Emission Rate		1.4E+07	1.8E+02	5.5E+01	1.1E+01	6.7E-02	7.0E-04	1.3E-03	3.0E-03	4.4E-03	1.5E-03	5.1E-03	2.9E-04	3.9E-03	2.3E-05	1.3E-02	2.4E+00	1.3E+02	7.1E+01

B.3 Air Emissions: Final Closure

Table B-6 Final Closure Maximum Air Emissions Rates Summary

Location	Source Description	Emission Rates (g/s)																	
		Radon (Bq/s)	TSP	PM_{10}	$PM_{2.5}$	U	As	Co	Cu	Pb	Mo	Ni	Se	Zn	Cd	Cr	SO_2	NO_x	CO
Kiggavik Site	Main Zone East Open Pit	8.9E+05	8.0E-01	2.4E-01	9.0E-02	7.2E-04	5.8E-07	8.7E-06	3.6E-05	2.4E-05	1.2E-05	1.8E-05	1.1E-06	2.8E-05	4.0E-08	3.4E-05	4.1E-03	2.9E-01	1.8E-02
	Main Zone West Open Pit	1.4E+06	1.4E+00	3.9E-01	1.5E-01	1.3E-03	1.1E-06	1.6E-05	6.5E-05	4.4E-05	2.1E-05	3.2E-05	2.1E-06	5.1E-05	7.2E-08	6.1E-05	8.2E-03	5.9E-01	3.6E-02
	Centre Zone Open Pit	6.8E+04	3.9E-01	1.2E-01	4.7E-02	7.0E-05	8.3E-07	2.6E-06	3.7E-06	4.1E-06	5.1E-07	1.1E-05	4.8E-07	8.5E-06	2.6E-08	2.6E-05	2.4E-03	1.7E-01	8.9E-03
	East Zone Open Pit	6.2E+04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
	Purpose Built Open Pit	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
	Kiggavik Clean Rock Pile - South	1.2E+06	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
	Kiggavik Clean Rock Pile - North	6.6E+05	4.8E-01	1.8E-01	5.9E-02	7.4E-05	4.4E-07	4.6E-06	5.7E-06	5.9E-06	9.1E-07	1.2E-05	5.4E-07	1.4E-05	1.9E-08	2.2E-05	2.4E-03	2.7E-01	7.6E-02
	Kiggavik Overburden Pile	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
	Kiggavik Ore Pile	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
	Kiggavik Mine Rock Pile	7.6E+05	3.6E-01	1.8E-01	7.1E-02	3.2E-04	2.6E-07	3.8E-06	1.6E-05	1.1E-05	5.2E-06	7.9E-06	5.1E-07	1.2E-05	1.8E-08	1.5E-05	2.0E-03	2.2E-01	5.9E-02
	Mill	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
	Acid Plant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
	Power Plant at Kiggavik	-	2.0E+00	1.9E+00	1.8E+00	-	-	-	-	-	-	-	-	-	-	-	5.8E-03	6.3E+01	2.8E-01
	Incinerator at Kiggavik	-	2.2E-02	1.8E-02	1.0E-02	-	-	-	-	-	-	-	-	-	-	-	5.6E-02	1.0E-01	7.8E-03
	Power Plant at Sissons	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
Sissons Site	Incinerator at Sissons	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
	On-Site Roads at Kiggavik	-	2.8E-01	7.2E-02	8.1E-03	2.8E-06	5.6E-07	2.2E-06	6.9E-06	4.4E-06	2.2E-06	6.9E-06	5.6E-07	5.8E-06	2.8E-08	1.7E-05	5.3E-05	3.6E-02	1.1E-02
	Andrew Lake Open Pit	1.8E+05	9.7E-01	2.7E-01	6.4E-02	4.5E-04	2.7E-06	3.2E-06	6.1E-06	1.0E-05	7.2E-07	2.7E-05	1.2E-06	1.2E-05	9.4E-08	7.9E-05	2.8E-03	3.3E-01	5.7E-02
	Andrew Lake Mine Rock Pile	7.5E+05	3.7E-01	1.9E-01	7.2E-02	3.2E-04	6.9E-07	9.5E-07	2.0E-06	5.1E-06	3.0E-07	1.0E-05	4.0E-07	3.6E-06	4.0E-08	2.8E-05	2.6E-03	2.8E-01	7.5E-02
	Andrew Lake Ore Pile	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
	Andrew Lake Overburden Pile	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
	Andrew Lake Clean Rock Pile	2.0E+06	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
	End Grid Special Waste Pile	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
	End Grid Clean Rock Pile	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
	End Grid Special Ore Pile	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
	Backfill Plant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
	End Grid Underground Mine Exhaust	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
	On-Site Roads at Sissons	-	3.0E-01	7.9E-02	8.9E-03	3.0E-06	6.0E-07	2.4E-06	7.6E-06	4.8E-06	2.4E-06	7.6E-06	6.0E-07	6.3E-06	3.0E-08	1.8E-05	5.8E-05	4.0E-02	1.2E-02
Roads	Haul road between Kiggavik and Sissons	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
	Road to Baker Lake (1 km segment modelled)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
	Road to Airstrip	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0E+00
Maximum Monthly Total Emission Rate		8.0E+06	5.5E+00	3.1E+00	2.2E+00	1.6E-03	6.3E-06	2.3E-05	6.4E-05	5.6E-05	1.8E-05	8.9E-05	4.7E-06	7.4E-05	2.7E-07	2.2E-04	6.5E+01	7.6E-02	6.0E-01

Attachment C Air Dispersion Modelling

Attachment C.1 CALMET Meteorology

Attachment C.2 CALPUFF Model SETUP

C.1 CALMET Meteorology

Meteorological Stations

Data from several meteorological stations was used in this assessment. One of the meteorological stations is located within the Local Assessment Area near the proposed Pointer Lake Airstrip, about 3 km south of the Accommodation Complex. It was installed in August 2009 and since then it has been recording surface temperature, relative humidity, wind speed and direction and atmospheric pressure data. Hourly surface wind speed and direction data from this station was used to develop the one year meteorological data set for air dispersion modelling. The meteorological dataset used in this assessment is for the period August 15, 2009 to August 14, 2010.

The nearest Environment Canada (EC) surface station is located at the Baker Lake Airport, approximately 80 km east of the Kiggavik Project site. It records hourly data including air temperature, precipitation, atmospheric pressure, wind speed and direction, relative humidity, cloud ceiling and sky cover. Upon examining the Baker Lake Airport station data, it was found that about 1,730 hours had recorded wind speeds less 0.5 m/s in the one year period chosen for this assessment (i.e., 19.8% calms). As a result, another station was considered. EC also operates a climate station located in Baker Lake which records hourly observations of air temperature, wind speed and direction, atmospheric pressure and relative humidity. Approximately 40% of the wind data needed for the assessment period was missing from the climate station dataset beginning on March 23, 2010 up until August 14, 2010. Therefore, the final Baker Lake wind data set that was used for modelling was created by filling in the gaps of missing hourly wind observations at the Baker Lake climate station with data from the Baker Lake Airport station. The result is a dataset having a complete record of hourly wind data for the period considered in this assessment, with 8% calms.

CALMET Model

The CALMET meteorological model was used to simulate meteorological conditions in the assessment areas (LAA and RAA) for a one year period (August 15, 2009 to August 14, 2010). The CALMET simulation was initialized with gridded three dimensional wind field data from the Nonhydrostatic Mesoscale Model (NMM) analysis data obtained from the National Centre for Environmental Prediction (NCEP). The NMM initialization fields were available for a grid having a spatial resolution of 32 km and temporal resolution of 6 hours. The grid points that were selected from the NMM analysis are presented in Figure C-1. The red line represents the Regional Assessment Area and the blue line the Local Assessment Area. The use of mesoscale analysis facilitates the generation of three dimensional profiles for the proper simulation of the wind fields at upper levels in the atmosphere and allows for a better definition of the boundary layer heights (i.e., mixing heights) and thus an improved simulation of plume dispersion. The initial wind fields from the NMM analysis were modified with the surface observations from the Kiggavik meteorological station and the combined dataset from the Baker Lake stations in order to better represent the local characteristics within the local and regional assessment areas.

In order to model wet deposition (which was required for the assessment of PAI), CALMET also requires precipitation data. Daily total precipitation from the Baker Lake Airport station was used and divided evenly over the hours in each day when there was precipitation.

The CALMET model was run for a large modelling domain measuring 117 km in an east-west direction and 65 km in a north-south direction, with a grid spacing of 1 km. The CALMET model domain was defined to include the South Winter Road Option between Baker Lake and the mine site.

To properly simulate the transport and dispersion of COPCs in CALPUFF, it is important to be able to accurately simulate the typical log-linear vertical profile of wind speed, temperature, turbulence intensity, and wind direction within the atmospheric boundary layer (i.e., within about 2,000 m above the Earth's surface). In order to capture this vertical structure, a total of ten vertical layers were selected. Within CALMET, vertical layers are defined as the midpoint between two layer interfaces. (i.e., eleven interfaces = ten layers, with the lowest layer interface always being ground level or zero). The vertical interfaces used in this study are: 0, 20, 40, 80, 160, 300, and 600, 1000, 1500, 2200 and 3000 m.

CALMET requires geophysical data in order to prepare the wind fields and other meteorological parameters. The geophysical data include:

- terrain elevation data;
- land use data;
- surface roughness length;
- albedo;
- Bowen Ratio;
- soil heat flux parameter;
- vegetation leaf area index; and
- anthropogenic heat flux.

These parameters are discussed in more detail below.

Terrain Elevation Data

Gridded terrain elevations for the modelling domain were derived from 30 arc-second Digital Elevation Models (DEM) produced by the United States Geological Survey (USGS). The spacing of the elevations is approximately 1 km. The raw terrain data was processed in each gridded cell (1 km x 1 km) within the CALMET modelling domain and the resulting terrain elevations are presented in Figure C-2. This terrain field effectively resolves major land features within the modelled area.

Land Use Data

Land use and land cover (LULC) data were processed for each CALMET grid cell to produce a 1 km resolution field of fractional land use categories and weighted land use values of surface and vegetation properties. Surface properties, such as albedo, Bowen Ratio, roughness length, soil heat flux and leaf area index are computed proportionately to the fractional land use category within each grid cell. The CALMET default values for land use categories and the land use related parameters are listed in Table C-1. These are based on the US Geological Survey and Land Use Classification System as shown in Table C-2. The generated land use categories for each CALMET grid cell are shown in Figure C-3.

To better represent local climate conditions during the winter months (October through May), the land use dataset was revised to reflect a completely snow covered/frozen landscape. In short, land use category 90 – Perennial Snow or Ice was applied to each CALMET grid cell.

Stability Classes and Mixing Heights

Meteorological mechanisms govern the dispersion, transformation and eventual removal of COPCs from the atmosphere. Dispersion comprises vertical and horizontal components of motion. The stability of the atmosphere and the depth of the surface-mixing layer define the vertical component and horizontal dispersion in the boundary layer as primarily a function of the wind field. The generation of mechanical turbulence is similarly a function of the wind speed, but in combination with the surface roughness. The variability in wind direction determines the general path pollutants will follow. To adequately characterize the dispersion meteorology, information is needed on the prevailing wind regime, mixing depth and atmospheric stability.

Atmospheric stability refers to the tendency of the atmosphere to resist or enhance vertical motion. The Pasquill-Gifford-Turner assignment scheme identifies six Stability Classes, “A” to “F”, to categorize the degree of atmospheric stability (Pasquill 1962; Turner 1969). These classes indicate the characteristics of the prevailing meteorological conditions.

The stability classes are summarized in the table below. Stability Class “A” represents highly unstable conditions that are typically found during summer, categorized by strong winds and convective conditions. Conversely, Stability Class “F” relates to highly stable conditions, typically associated with clear skies, light winds and the presence of a temperature inversion. Classes “B” through to “E” represent conditions intermediate to these extremes.

Atmospheric Stability Class Category Description

Atmospheric Stability Class	Category	Description
A	Very unstable	Low wind, clear skies, hot daytime conditions
B	Unstable	Clear skies, daytime conditions
C	Moderately Unstable	Moderate wind, slightly overcast daytime conditions
D	Neutral	High winds or cloudy days and nights
E	Stable	Moderate wind, slightly overcast night-time conditions
F	Very Stable	Low winds, clear skies, cold night-time conditions

The frequency of occurrence for each stability class for the modelling period August 15, 2009 to August 14, 2010 as predicted by CALMET is presented in Figure C-4. The results indicate the most typical conditions are neutral stability class “D”. The second highest frequency is stability class “F” which is indicative of highly stable conditions, which is conducive to moderate to low dispersion due to a lack of mechanical mixing.

Diurnal variations in average mixing depths predicted by CALMET are illustrated Figure C-5. It can be seen that an increase in the mixing depth begins during the morning hours due to the onset of vertical mixing following sunrise and that maximum mixing heights occur in the mid to late afternoon due to the dissipation of ground-based temperature inversions and the growth of convective mixing layer.

Wind

A summary of the average annual wind behaviour simulated by CALMET for the period August 15, 2009 to August 14, 2010 is presented in Figure C-6 and compared to the on-site (Pointer Lake) meteorological observations. The figure was generated using CALMET wind data interpolated at the grid point closest to the Pointer Lake station so that modelled and observed data can be compared.

As can be seen in Figure C-6, on-site winds derived from CALMET are predominately from the northwest (11.5% frequency) to north-northwest (9.8% frequency) at an average speed of 5.0 m/s and 5.3 m/s, respectively. The overall average annual wind speed is 4.1 m/s. Calm wind conditions (i.e., wind speeds less than 0.5 m/s) were predicted to occur 1.7% of the time. Observations at the on-site or Pointer Lake station show that the wind blows predominately from the west-northwest (10.4% frequency) at an average speed of 5.3 m/s and from the northwest (10.0 % frequency) at an average speed of 6.0 m/s. The average annual wind speed at the Pointer Lake station is 4.7 m/s. The observation dataset indicates calm conditions at the site occur 5.7% of the time. In all, the CALMET interpolated wind data compares well with on-site observations, indicating that CALMET meteorological wind data is sufficiently representative for air dispersion modelling purposes.

Table C-1 Default CALMET Land Use Categories and Associated Geophysical Parameters

Land Use Type	Description	Surface Roughness (m)	Albedo	Bowen Ratio	Soil Heat Flux Parameter	Anthropogenic Heat Flux (W/m ²)	Leaf Area Index
10	Urban or Built-up Land	1	0.18	1.5	0.25	0	0.2
20	Agricultural Land – UnIrrigated	0.25	0.15	1	0.15	0	3
-20*	Agricultural Land – Irrigated	0.25	0.15	0.5	0.15	0	3
30	Rangeland	0.05	0.25	1	0.15	0	0.5
40	Forest Land	1	0.1	1	0.15	0	7
50	Water	0.001	0.1	0	1	0	0
54	Small Water Body	0.001	0.1	0	1	0	0
55	Large Water Body	0.001	0.1	0	1	0	0
60	Wetland	1	0.1	0.5	0.25	0	2
61	Forested Wetland	1	0.1	0.5	0.25	0	2
62	Nonforested Wetland	0.2	0.1	0.1	0.25	0	1
70	Barren Land	0.05	0.3	1	0.15	0	0.05
80	Tundra	0.2	0.3	0.5	0.15	0	0
90	Perennial Snow or Ice	0.05	0.7	0.5	0.15	0	0

NOTES:

Land use categories and geophysical parameters are based on the 14-cateorgy system of the US Geological Survey Land Use Classification System (Table C-2).

SOURCE: Scire et al 2000a

Table C-2 US Geological Survey Land Use and Land Cover Classification System

Level I		Level II	
10	Urban or Built-up Land	11	Residential
		12	Commercial and Services
		13	Industrial
		14	Transportation, Communications and Utilities
		15	Industrial and Commercial Complexes
		16	Mixed Urban or Built-up Land
		17	Other Urban or Built-up Land
20	Agricultural Land	21	Cropland
		22	Orchards, Groves, Vineyards, Nurseries, and Ornamental Horticultural Areas
		23	Confined Feeding Operations
		24	Other Agricultural Land
30	Rangeland	31	Herbaceous Rangeland
		32	Shrub and Brush Rangeland
		33	Mixed Rangeland
40	Forest Land	41	Deciduous Forest Land
		42	Evergreen Forest Land
		43	Mixed Forest Land
50	Water	51	Streams and Canals
		52	Lakes
		53	Reservoirs
		54	Bays and Estuaries
		55	Oceans and Seas
60	Wetland	61	Forested Wetland
		62	Nonforested Wetland

Table C-2 US Geological Survey Land Use and Land Cover Classification System

Level I		Level II	
70	Barren Land	71	Dry Salt Flats
		72	Beaches
		73	Sandy Areas Other than Beaches
		74	Bare Exposed Rock
		75	Strip Mines, Quarries, and Gravel Pits
		76	Transitional Areas
		77	Mixed Barren Land
80	Tundra	81	Shrub and Brush Tundra
		82	Herbaceous Tundra
		83	Bare Ground
		84	Wet Tundra
		85	Mixed Tundra
90	Perennial Snow/Ice	91	Perennial Snowfields
		92	Glaciers
SOURCE: Scire et al 2000a			

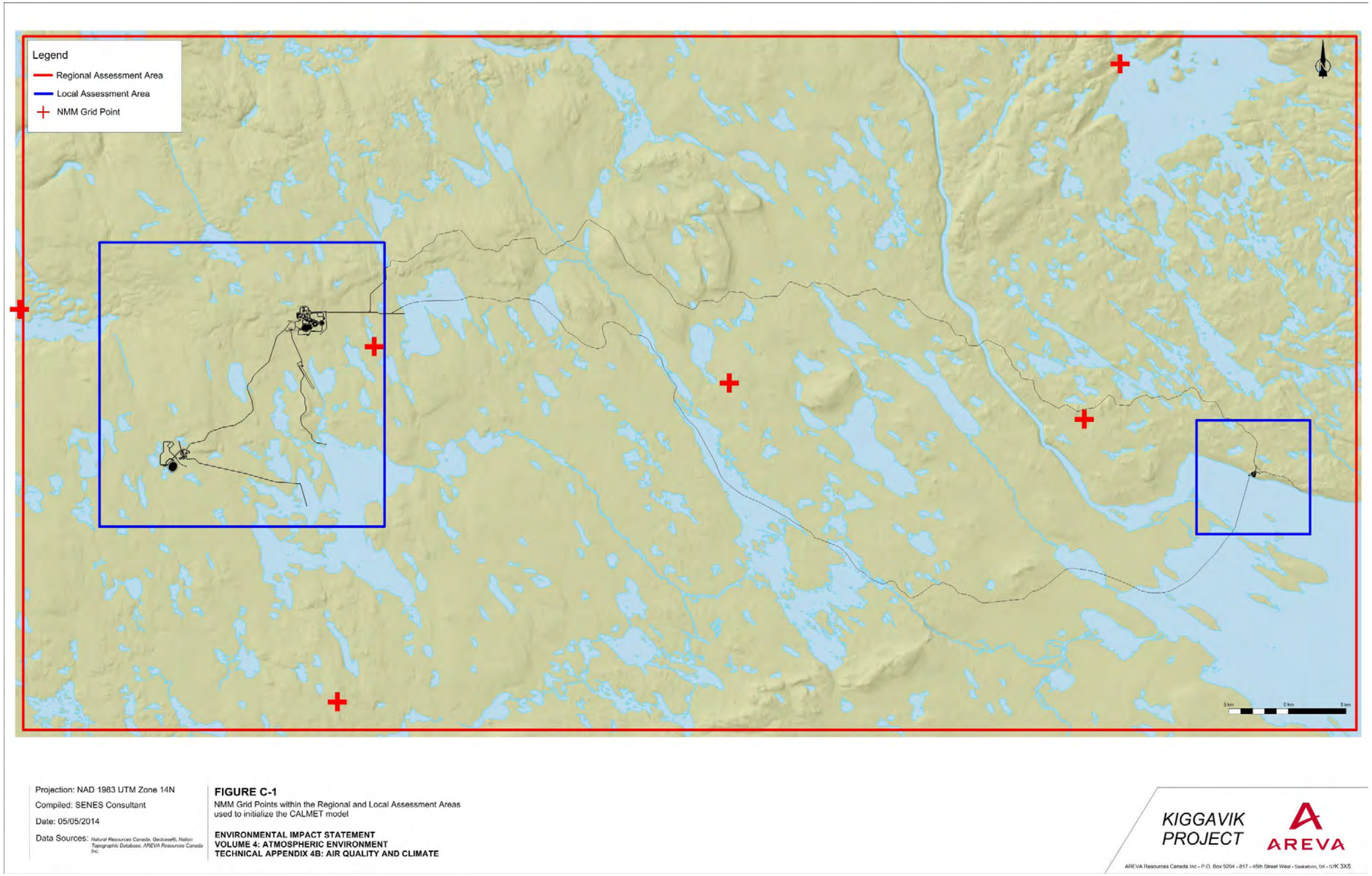


Figure C-1 NMM Grid Points within the Regional and Local Study Areas used to initialize the CALMET Model

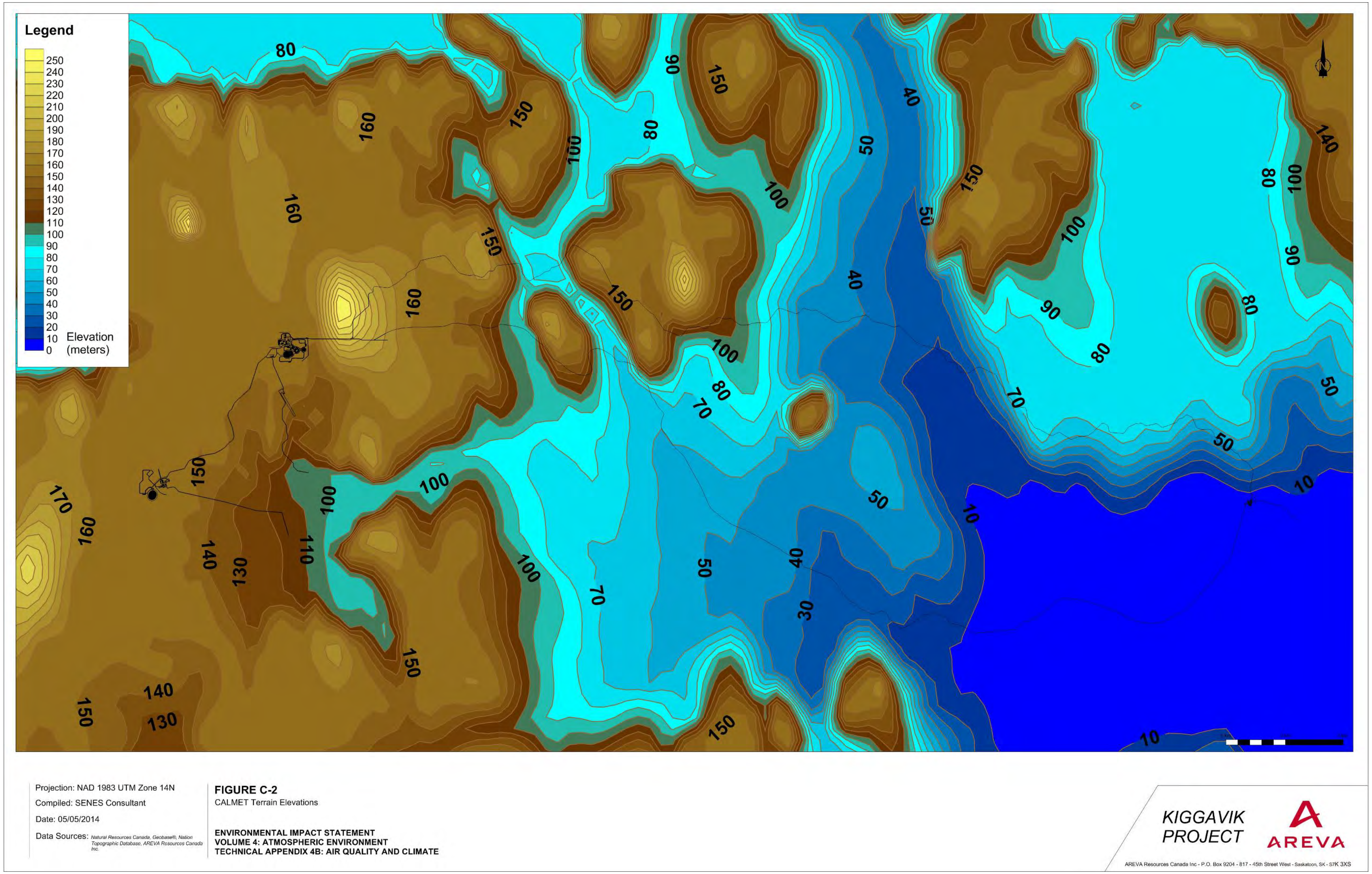


Figure C-2 CALMET Terrain Elevations

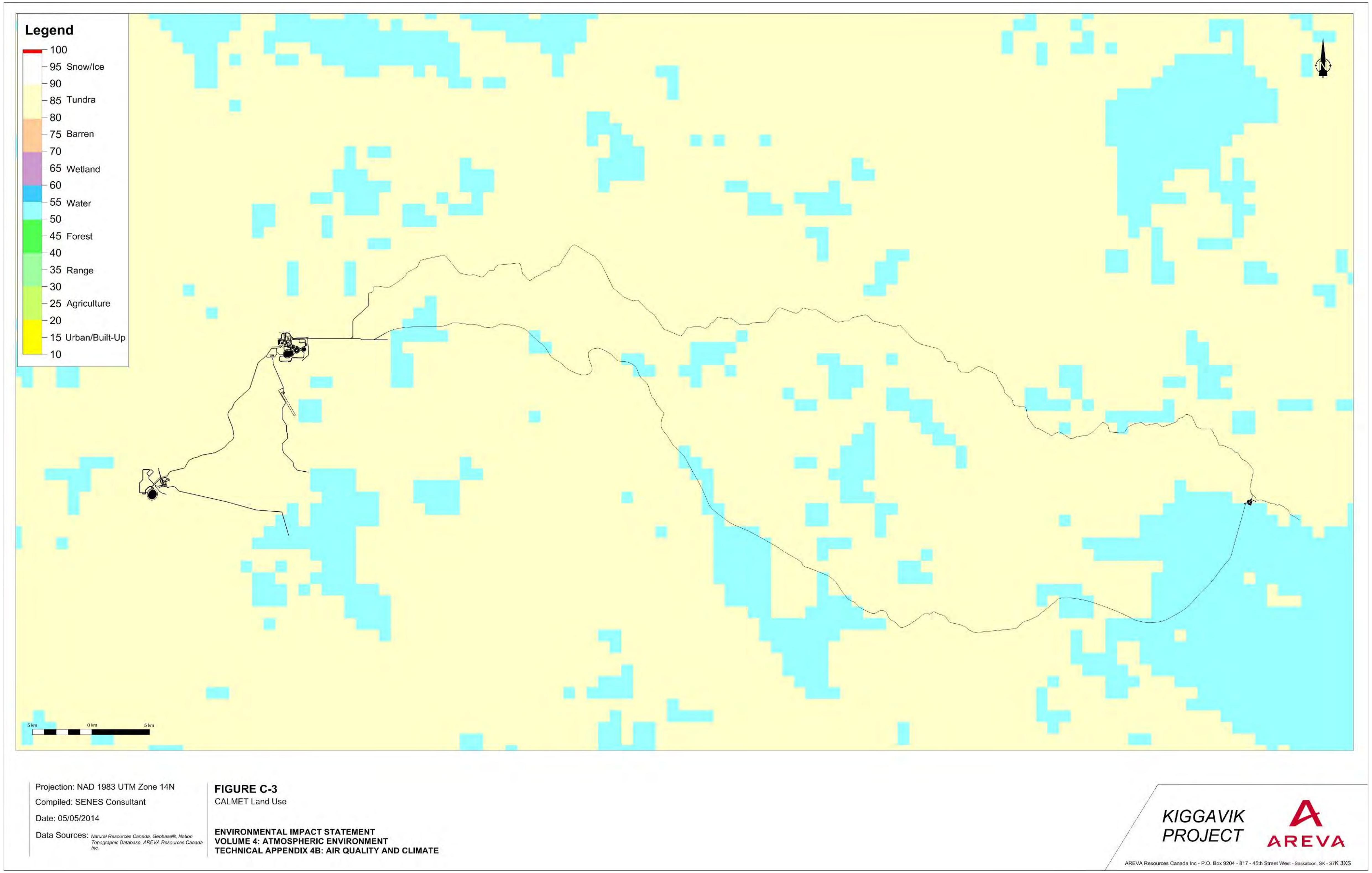


Figure C-3 CALMET Land Use

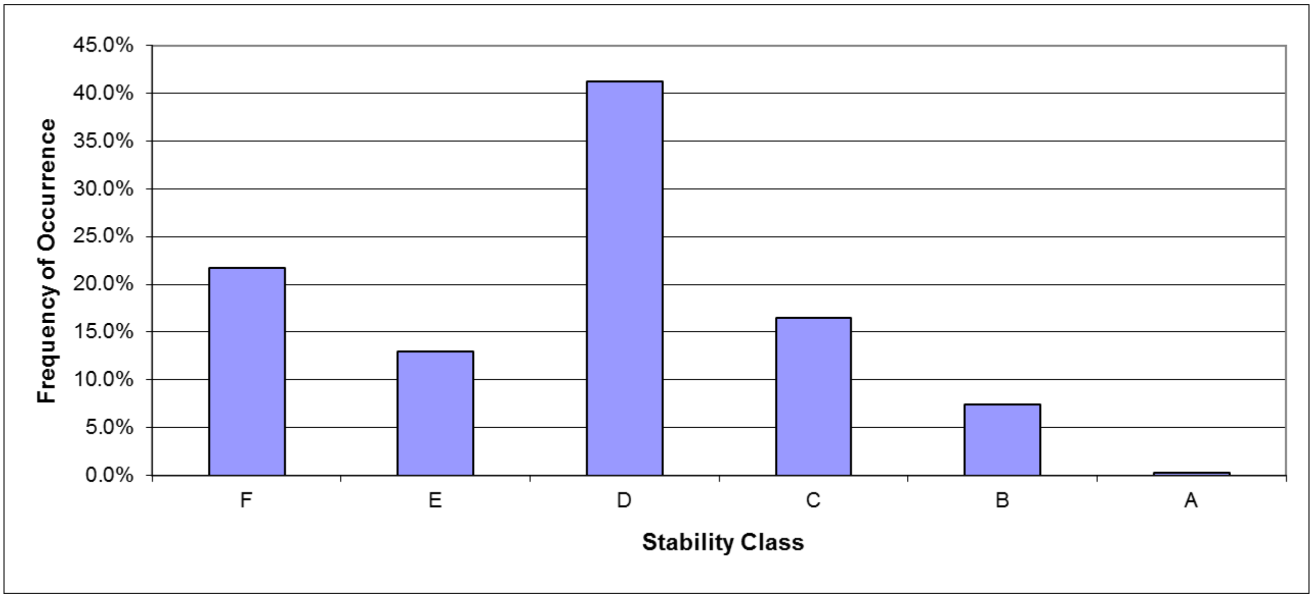


Figure C-4 **CALMET Stability Class Frequency for the period August 15, 2009 to August 14, 2010**

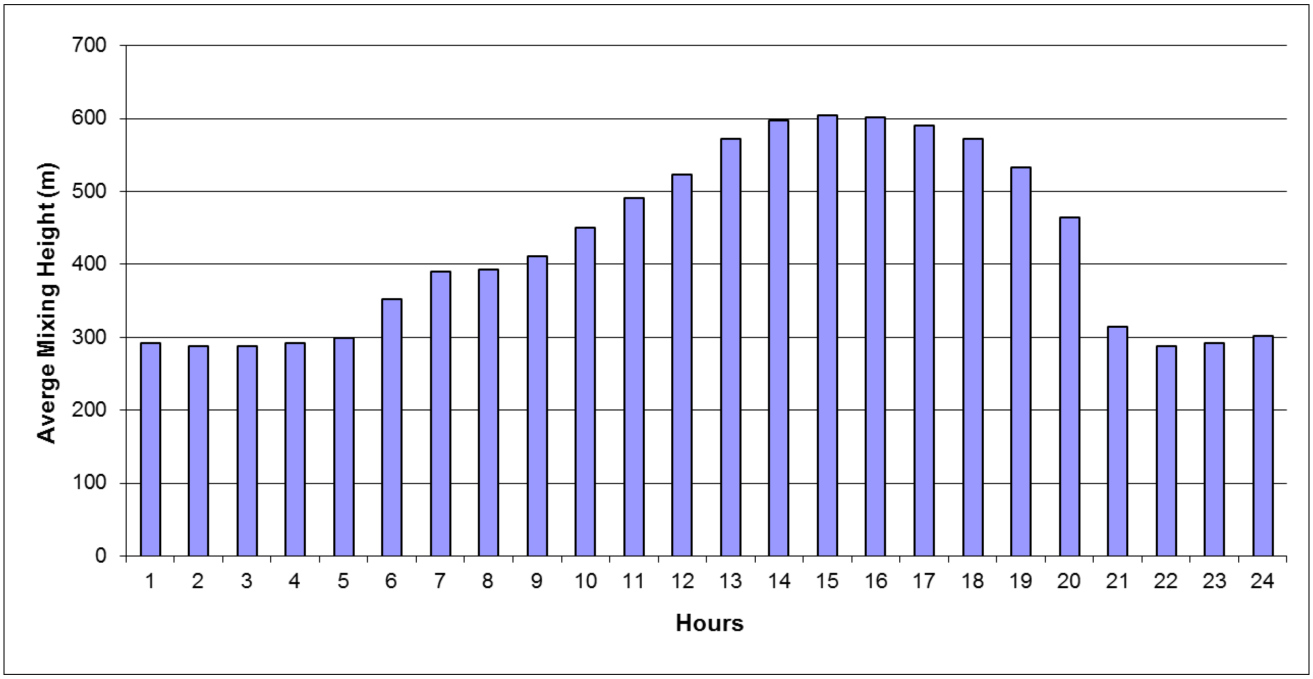
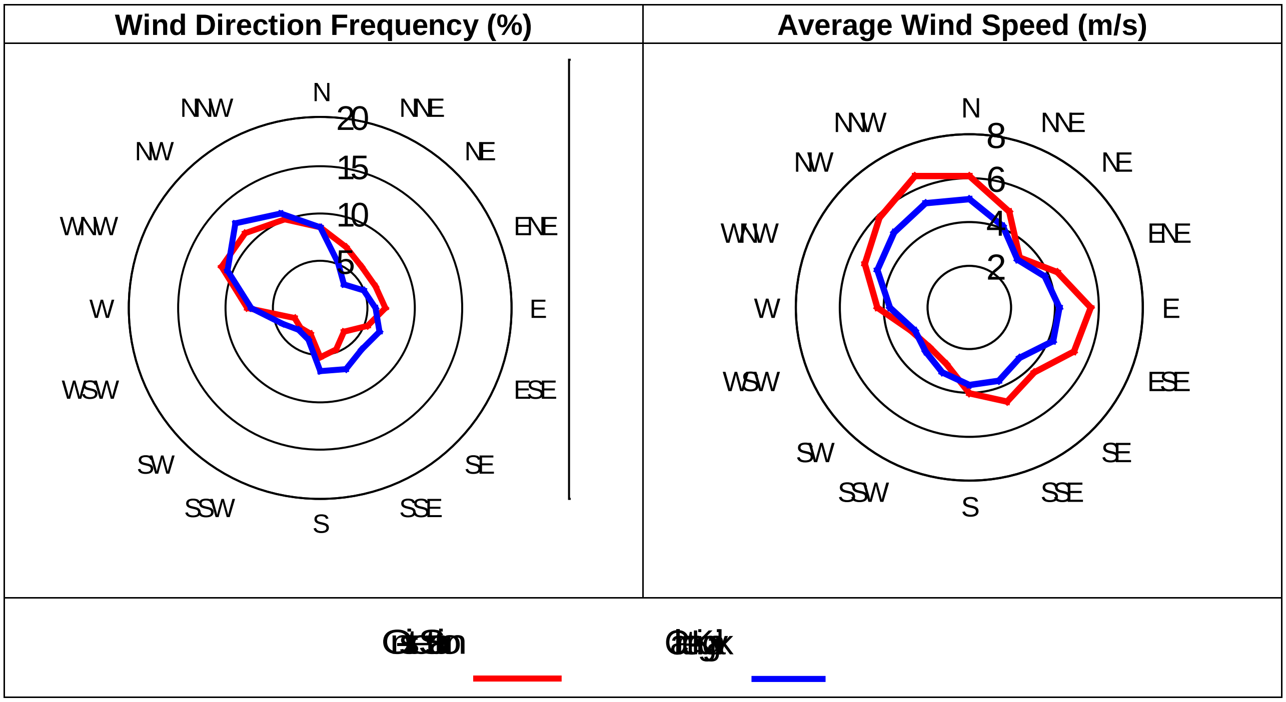


Figure C-5 **Diurnal Variation in Average CALMET Mixing Heights for the period August 15, 2009 to August 14, 2010**



NOTES:

Percentage of Calms for the On-site Station: 5.4%

Percentage of Calms for CALMET-Kiggavik: 1.7%

Figure C-6 **Wind Rose Comparison of CALMET-Kiggavik Meteorological Dataset to On-Site Station Observations for the period August 15, 2009 to August 14, 2010**

C.2 CALPUFF Model Setup

Table C-3 Kiggavik and Sissons Mine Sites Area Source Parameters

Emission Source	Source Type	UTM Coordinates (m)		Area (m^2)	Total Area (m^2)
		East	North		
Main Zone Pit	Area	565193	7147001	86,002	421,406
		565228	7147000	76,004	
		565000	7147003	41,296	
		565003	7146996	103,708	
		565004	7146998	70,299	
		564999	7147255	44,097	
Andrew Lake Pit	Area	553115	7135006	63,908	468,802
		552999	7134424	404,894	
Central Zone Pit	Area	565650	7147120	122,768	142,820
		566004	7147104	20,052	
East Zone Pit	Area	566346	7147234	65,894	65,894
Purpose Build Pit	Area	565416	7147477	28,007	28,007

Table C-4 Kiggavik and Sissons Mine Sites Volume Source Parameters

Emission Source	Source Type	Number of Volume Sources	Maximum Source Height (m)
Kiggavik Ore Pile	Volume	3	10
Kiggavik Type II Mine Rock Pile - North	Volume	6	50
Kiggavik Type II Mine Rock Pile - South	Volume	13	50
Kiggavik Type III Mine Rock Pile	Volume	2	10
Kiggavik Overburden Pile	Volume	2	10
Mill	Volume	3	22
Andrew Lake Type II Mine Rock Pile	Volume	6	50
Andrew Lake Type III Mine Rock Pile	Volume	6	10
Andrew Lake Ore Pile	Volume	1	10
Andrew Lake Overburden Pile	Volume	1	10
End Grid Clean Rock Pile	Volume	1	10
End Grid Special Waste Rock Pile	Volume	1	10
End Grid Ore Pile	Volume	1	10

Table C-5 Kiggavik and Sissons Mine Sites Point Source Parameters

Emission Source	Source Type	UTM Coordinates (m)		Stack Parameters			
		East	North	Height (m)	Diameter (m)	Exit Velocity (m/s)	Exit Temperature (Deg. C)
Kiggavik Power Plant	Point	564776	7147770	30	0.9	20	330
		564779	7147770	30	0.9	20	330
		564778	7147770	30	0.9	20	330
		564778	7147770	30	0.9	20	330
Sissons Power Plant	Point	554087	7135764	30	0.9	20	330
Kiggavik Incinerator	Point	565365	7147847	11.8	0.97	9.85	1000
Sissons Incinerator	Point	554094	7135826	11.8	0.97	9.85	1000
Acid Plant	Point	564854	7147754	30	1.2	8.5	82
Underground Mine Exhaust	Point	554724	7135969	1	5	14.5	2
Backfill Plant	Point	554238	7135635	15	0.5	15	5

Table C-6 CALPUFF Model Parameters: Dry Deposition for Particles

Species	Geometric mass mean diameter (μm)	Geometric standard deviation (μm)	NINT
TSP	20	1.24	5
PM_{10}	5	1.24	5
PM25	1.25	1.24	5
U	2.0	2.0	5
As	2.0	2.0	5
Cb	2.0	2.0	5
Cu	2.0	2.0	5
Pb	2.0	2.0	5
Mo	2.0	2.0	5
Ni	2.0	2.0	5
Se	2.0	2.0	5
Zn	2.0	2.0	5
Cd	2.0	2.0	5
Cr	2.0	2.0	5
SO_4	0.48	2.0	5
NO_3	0.48	2.0	5

Table C-7 CALPUFF Model Parameters: Dry Deposition for Particles

Species	Diffusivity (cm^2/s)	Alpha Star	Reactivity	Mesophyll Resistance (s/cm)	Henry's Law Coefficient (dimensionless)
RAD	0.1656	1.	8.	0	3.5
NOx	0.1656	1.	8.	0	3.5
SO2	0.509	1000.	8.	0	0.04
CO	0.509	1000.	8.	0	0.04
CDF	0.509	1000.	8.	0	0.04
HNO3	0.1628	1.	18.	0	0.0000001

Table C-8 CALPUFF Model Parameters: Wet Deposition

Species	Scavenging Coefficient for liquid precipitation (s^{-1})	Scavenging Coefficient for frozen precipitation (s^{-1})
SO_2	3.0E-05	0.0E00
SO_4	1.0E-04	3.0E-05
NO_x	1.0E-04	3.0E-05
HNO_3	6.0E-05	0.0E00
NO_3	1.0E-04	3.0E-05

Attachment D Air Dispersion Modelling Results

Attachment D.1 Model Results: Tabular

Attachment D.2 Model Results: Graphical

D.1 Model Results: Tabular

Table D-1 Quarry Assessment – Maximum Predicted COPC Concentrations at 500 m Distance from Selected Quarries

Quarry Assessment – Maximum Predicted COPC Concentrations at 500 m Distance from Selected Quarries									
Quarry	UTM Coordinates (m)		Maximum Concentration (µg/m³) at a distance of 500 m from the Quarry						
			TSP	PM_{10}	$PM_{2.5}$	NO_2		SO_2	
	Easting	Northing	24-hour Maximum	24-hour Maximum	24-hour Maximum	1-hour Maximum	24-hour Maximum	1-hour Maximum	24-hour Maximum
Q2	573460	7152497	21.4	11.3	7.7	38.6	10.6	0.8	0.2
Q10	615476	7150167	16.3	9.0	6.0	37.2	7.5	0.7	0.1
Q18	642133	7138389	16.7	8.8	5.8	34.1	7.2	0.7	0.1
Background Concentration (µg/m³)			6.8	3.4	1.7	-	-	-	-
Air Quality Criteria (µg/m3)			120	50	27	400	200	450	150

NOTES:
Concentrations of TSP, PM_{10} and $PM_{2.5}$ include background concentrations.

Table D-2 Maximum Bounding Scenario – Maximum 1- and 24-hour Concentrations of COPCs

Discrete Receptor	UTM Coordinates (m)		Maximum Concentration (µg/m³)								
			TSP	PM_{10}	$PM_{2.5}$		Uranium	NO_2		SO_2	
	Easting	Northing	24-hour	24-hour	24-hour 98th Percentile	24-hour	24-hour	1-hour	24-hour	1-hour	24-hour
Accommodation Complex	564900	7148433	290.0 (11 days)	118.6 (15 days)	15.8	24.2	0.31 (1 day)	380.7	171.9	41.0	15.4
Community of Baker Lake	644179	7135840	7.5	4.0	1.8	1.9	2.4E-05	3.8	1.0	0.16	0.04
Judge Sissons Lake Cabin	566550	7137729	19.6	14.5	2.6	3.7	2.0E-02	36.5	12.9	2.7	0.8
Background Concentration (µg/m³)			6.8	3.4	1.7	1.7	2.4E-05	-	-	-	-
Air Quality Criteria (µg/m³)			120	50	27		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.
Concentrations of TSP, PM_{10} and $PM_{2.5}$ include background concentrations.

Table D-3 Maximum Bounding Scenario – Maximum 24-hour Metal Concentrations

Receptor Name	UTM Coordinates (m)		24-hour Maximum Concentration($\mu g/m^3$) (including background)									
	Easting	Northing	As	Cd	Cr	Co	Cu	Pb	Mo	Ni	Se	Zn
Accommodation Complex	564900	7148433	1.1E-03	1.9E-04	2.7E-02	3.7E-03	4.1E-02	2.1E-02	8.2E-03	1.1E-02	9.4E-04	2.2E-02
Community of Baker Lake	644179	7135840	2.9E-04	1.4E-04	6.7E-04	1.1E-04	3.5E-02	2.7E-03	6.0E-04	4.0E-04	4.5E-04	1.1E-02
Judge Sissons Lake Cabin	566550	7137729	4.4E-04	1.4E-04	5.1E-03	3.3E-04	3.6E-02	3.6E-03	9.5E-04	1.6E-03	5.1E-04	1.2E-02
Background Concentration ($\mu g/m^3$)			2.8E-04	1.4E-04	5.1E-04	9.1E-05	3.5E-02	2.6E-03	5.8E-04	3.4E-04	4.5E-04	1.1E-02
Air Quality Criteria ($\mu g/m^3$)			0.3	0.025	0.5	0.1	50	0.5	120	0.2*	10	120

Table D-4 Annual COPC Concentrations for Phased Operations Period 1 to 4

Discrete Receptor	UTM Coordinates (m)		Operation Period	Annual Concentration ($\mu g/m^3$)								
	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	Period 1 (Year 0-1)	22.5	10.2	2.7	1.0E-02	13.7	1.3	7.7	2.8E-04	2.0E-04
			Period 2 (Year 2-5)	17.2	8.5	2.5	2.0E-02	10.4	0.6	12.5	3.4E-04	2.6E-04
			Period 3 (Year 6-13)	7.7	4.5	1.8	1.0E-02	6.2	0.4	10.9	2.6E-04	1.8E-04
			Period 4 (Year 14)	4.3	2.5	1.3	1.0E-02	6.6	0.1	9.1	2.1E-04	1.4E-04
			Maximum	22.5	10.2	2.7	2.0E-02	13.7	1.3	12.5	3.4E-04	2.6E-04
Community of Baker Lake	644179	7135840	Period 1 (Year 0-1)	2.9	1.5	0.7	9.9E-06	0.0	0.0	0.0	1.3E-04	5.4E-05
			Period 2 (Year 2-5)	2.9	1.5	0.7	9.9E-06	0.0	0.0	0.0	1.3E-04	5.4E-05
			Period 3 (Year 6-13)	2.9	1.5	0.7	9.9E-06	0.0	0.0	0.0	1.3E-04	5.4E-05
			Period 4 (Year 14)	2.9	1.5	0.7	9.9E-06	0.0	0.0	0.0	1.3E-04	5.4E-05
			Maximum	2.9	1.5	0.7	9.9E-06	0.0	0.0	0.0	1.3E-04	5.4E-05
Judge Sissons Lake Cabin	566550	7137729	Period 1 (Year 0-1)	3.4	1.8	0.8	9.9E-06	0.8	0.1	0.2	1.3E-04	5.9E-05
			Period 2 (Year 2-5)	3.7	2.0	0.8	9.9E-06	0.8	0.0	0.3	1.4E-04	6.2E-05
			Period 3 (Year 6-13)	3.3	1.8	0.8	9.9E-06	0.6	0.0	0.2	1.3E-04	5.9E-05
			Period 4 (Year 14)	3.0	1.5	0.7	9.9E-06	0.4	0.0	0.2	1.3E-04	5.5E-05
			Maximum	3.7	2.0	0.8	9.9E-06	0.8	0.1	0.3	1.4E-04	6.2E-05
Background Concentration ($\mu g/m^3$)				2.9	1.5	0.7	9.9E-06	-	-	-	1.3E-04	5.4E-05
Air Quality Criteria ($\mu g/m3$)				60	-	8.8	0.03	60	30	60 (Bq/m^3)	0.0021 (Bq/m^3)	0.0028 (Bq/m^3)

NOTES:

NO_2 concentrations predicted as a result of all sources, including blasting.

Concentrations of TSP, PM_{10}, $PM_{2.5}$, Uranium, Pb-210 and Po-210 include background concentrations.

Table D-5 Annual Metal Concentrations for Phased Operations Period 1 to 4

Discrete Receptor	UTM Coordinates (m)		Operation Period	Annual Concentration ($\mu g/m^3$) (including background)									
	Easting	Northing		As	Cd	Cr	Co	Cu	Pb	Mo	Ni	Se	Zn
Accommodation Complex	564900	7148433	Period 1 (Year 0-1)	9.5E-04	6.3E-05	1.7E-03	3.2E-04	1.6E-02	2.1E-03	5.6E-04	9.4E-04	2.3E-04	5.4E-03
			Period 2 (Year 2-5)	5.4E-04	6.3E-05	1.2E-03	2.2E-04	1.5E-02	2.3E-03	8.4E-04	6.8E-04	2.2E-04	5.1E-03
			Period 3 (Year 6-13)	7.3E-04	6.1E-05	1.2E-03	7.0E-05	1.5E-02	1.5E-03	3.2E-04	3.1E-04	2.0E-04	4.6E-03
			Period 4 (Year 14)	5.7E-04	6.1E-05	8.4E-04	5.2E-05	1.5E-02	1.4E-03	2.9E-04	2.3E-04	2.0E-04	4.6E-03
			Maximum	9.5E-04	6.3E-05	1.7E-03	3.2E-04	1.6E-02	2.3E-03	8.4E-04	9.4E-04	2.3E-04	5.4E-03
Community of Baker Lake	644179	7135840	Period 1 (Year 0-1)	1.2E-04	6.0E-05	2.2E-04	4.1E-05	1.5E-02	1.1E-03	2.4E-04	1.5E-04	2.0E-04	4.5E-03
			Period 2 (Year 2-5)	1.3E-04	6.0E-05	2.2E-04	4.1E-05	1.5E-02	1.1E-03	2.4E-04	1.5E-04	2.0E-04	4.5E-03
			Period 3 (Year 6-13)	1.3E-04	6.0E-05	2.2E-04	4.0E-05	1.5E-02	1.1E-03	2.4E-04	1.5E-04	2.0E-04	4.5E-03
			Period 4 (Year 14)	1.2E-04	6.0E-05	2.2E-04	4.0E-05	1.5E-02	1.1E-03	2.4E-04	1.5E-04	2.0E-04	4.5E-03
			Maximum	1.3E-04	6.0E-05	2.2E-04	4.1E-05	1.5E-02	1.1E-03	2.4E-04	1.5E-04	2.0E-04	4.5E-03
Judge Sissons Lake Cabin	566550	7137729	Period 1 (Year 0-1)	1.7E-04	6.0E-05	2.8E-04	5.1E-05	1.5E-02	1.2E-03	2.5E-04	1.8E-04	2.0E-04	4.6E-03
			Period 2 (Year 2-5)	1.6E-04	6.0E-05	3.1E-04	5.3E-05	1.5E-02	1.2E-03	2.5E-04	1.9E-04	2.0E-04	4.6E-03
			Period 3 (Year 6-13)	2.5E-04	6.0E-05	3.2E-04	4.5E-05	1.5E-02	1.1E-03	2.4E-04	1.7E-04	2.0E-04	4.6E-03
			Period 4 (Year 14)	1.3E-04	6.0E-05	2.3E-04	4.1E-05	1.5E-02	1.1E-03	2.4E-04	1.5E-04	2.0E-04	4.5E-03
			Maximum	2.5E-04	6.0E-05	3.2E-04	5.3E-05	1.5E-02	1.2E-03	2.5E-04	1.9E-04	2.0E-04	4.6E-03
Background Concentration ($\mu g/m^3$)				1.2E-04	6.0E-05	2.2E-04	4.0E-05	1.5E-02	1.1E-03	2.4E-04	1.5E-04	2.0E-04	4.5E-03
Air Quality Criteria (µg/m3)				0.06	0.005	0.3	0.02	9.6	0.1	23	0.4	1.9	23

Table D-6 Maximum Monthly, Annual Average and Total Annual Dust Deposition for the Maximum Operation Assessment

Receptor Name	UTM Coordinates (m)		TSP Deposition (including background)		
	Easting	Northing	Maximum Monthly ($g/m^2/30$ days)	Average Annual ($g/m^2/30$ days)	Total Annual ($g/m^2/year$)
Camp	564900	7148433	2.3	1.3	15.8
Baker Lake	644179	7135840	0.04	0.04	0.5
Judge Sissons Lake	566550	7137729	0.2	0.1	1.6
Background Dustfall			0.04 $g/m^2/30$ days	0.04 $g/m^2/30$ days	0.48 $g/m^2/30$ year
Air Quality Criteria			7 $g/m^2/30$ days	4.6 $g/m^2/30$ days	55 $g/m^2/year$

Table D-7 Estimated Annual Potential Acid Input based on Phased Operations Period 2 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.
Total PAI includes background PAI.

Table D-8 Overall Maximum TSP, NO_2 and SO_2 Concentrations predicted for each Baker Lake-Kiggavik Access Road Option

Access Road Option	Overall Maximum Concentration ($\mu g/m^3$)											
	TSP		PM_{10}		$PM_{2.5}$		NO_2			SO_2		
	24-hour	Annual	24-hour	Annual	24-hour	Annual	1-hour	24-hour	Annual	1-hour	24-hour	Annual
All-Season Road	61.7	8.0	23.6	3.1	6.1	1.0	1.4E-01	7.0E-02	8.8E-03	1.0E-02	5.4E-03	6.7E-04
Winter Road	29.7	4.3	8.1	1.9	0.9	0.7	3.5E-01	2.6E-01	1.5E-02	3.0E-02	2.3E-02	1.3E-03
Background Concentration (µg/m3)	6.8	2.9	3.4	1.5	1.7	0.7	-	-	-	-	-	-
Air Quality Criteria (µg/m3)	120	60	50	-	27	8.8	400	200	100	450	150	30

NOTES:
Concentrations of TSP, PM_{10} and $PM_{2.5}$ include background concentrations.

Table D-9　Dock and Storage Facility Dust and Gaseous Concentrations Predicted at the Community of Baker Lake

Sensitive Point of Reception	UTM Coordinates (m)		Maximum Concentration (µg/m³)										
			TSP		PM_{10}	$PM_{2.5}$		NO_2			SO_2		
	Easting	Northing	24-hour	Annual	24-hour	Annual	24-hour	Annual	1-hour	24-hour	Annual	1-hour	24-hour
Community of Baker Lake	644179	7135840	7.7	2.9	4.3	2.5	60.6	59.9	11.7	0.2	5.5	1.1	0.02
Background Concentration (µg/m3)			6.8	2.9	3.4	1.7	0.7	-	-	-	-	-	-
Air Quality Criteria (µg/m3)			120	60	50	27	8.8	400	200	100	450	150	30

NOTES:
Concentrations of TSP, PM_{10} and $PM_{2.5}$ include background concentrations.

Table D-10　Annual COPC Concentrations during Final Closure

Receptor Name	UTM Coordinates (m)		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	4.00	2.19	1.12	9.9E-06	6.4	3.0E-02	6.4	8.2E-06	8.2E-06
Community of Baker Lake	644179	7135840	2.90	1.50	0.70	9.9E-06	0.01	0.0E+00	0.01	1.3E-08	1.3E-08
Judge Sissons Lake Cabin	566550	7137729	2.95	1.54	0.73	9.9E-06	0.4	0.0E+00	0.4	4.8E-07	4.8E-07
Background Concentration (µg/m³)											
Air Quality Criteria (µg/m³)			60	-	8.8	0.03	100	30	60 (Bq/m3)	0.0021 (Bq/m3)	0.0028 (Bq/m3)

NOTES:
Concentrations of TSP, PM_{10}, $PM_{2.5}$, Uranium, Pb-210 and Po-210 include background concentrations.

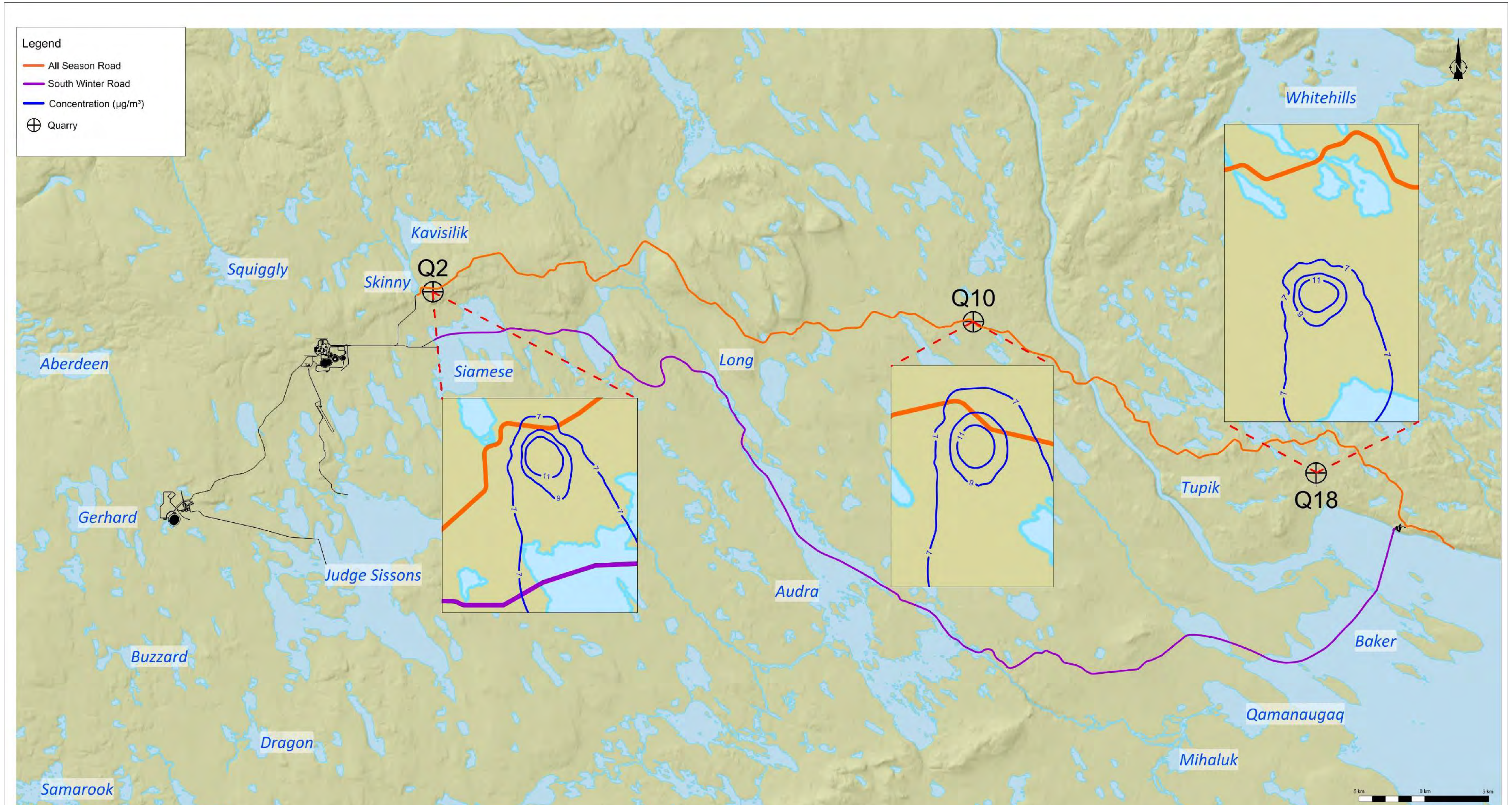
Table D-11 Predicted Annual Metal Concentrations during Final Closure

Receptor Name	UTM Coordinates (m)		Annual Concentration (µg/m³) (including background)									
	Easting	Northing	As	Cd	Cr	Co	Cu	Pb	Mo	Ni	Se	Zn
Accommodation Complex	564900	7148433	1.2E-04	6.0E-05	2.7E-04	5.1E-05	1.5E-02	1.1E-03	2.5E-04	1.7E-04	2.0E-04	4.6E-03
Community of Baker Lake	644179	7135840	1.2E-04	6.0E-05	2.2E-04	4.0E-05	1.5E-02	1.1E-03	2.4E-04	1.5E-04	2.0E-04	4.5E-03
Judge Sissons Lake Cabin	566550	7137729	1.2E-04	6.0E-05	2.2E-04	4.1E-05	1.5E-02	1.1E-03	2.4E-04	1.5E-04	2.0E-04	4.5E-03
Background Concentration (µg/m³)			1.2E-04	6.0E-05	2.2E-04	4.0E-05	1.5E-02	1.1E-03	2.4E-04	1.5E-04	2.0E-04	4.5E-03
Air Quality Criteria (µg/m3)			0.06	0.005	0.3	0.02	9.6	0.10	23	0.4	1.9	23

Table D-12 Predicted Incremental Annual Radon Concentrations during Post-Closure

Receptor Name	UTM Coordinates (m)		Radon (Bq/m³)
	Easting	Northing	Annual Concentration
Accommodation Complex	564900	7148433	1.1E+00
Community of Baker Lake	644179	7135840	3.2E-03
Judge Sissons Lake Cabin	566550	7137729	8.7E-02
Air Quality Criteria (Bq/m3)			60

D.2 Model Results: Graphical



Projection: NAD 1983 UTM Zone 14N
Compiled: SENES Consultant
Date: 05/05/2014
Data Sources: Natural Resources Canada, Geobase®, Nation Topographic Database, AREVA Resources Canada Inc.

FIGURE D-1
Quarry Assessment
Maximum 24-hour TSP Concentration (µg/m³)

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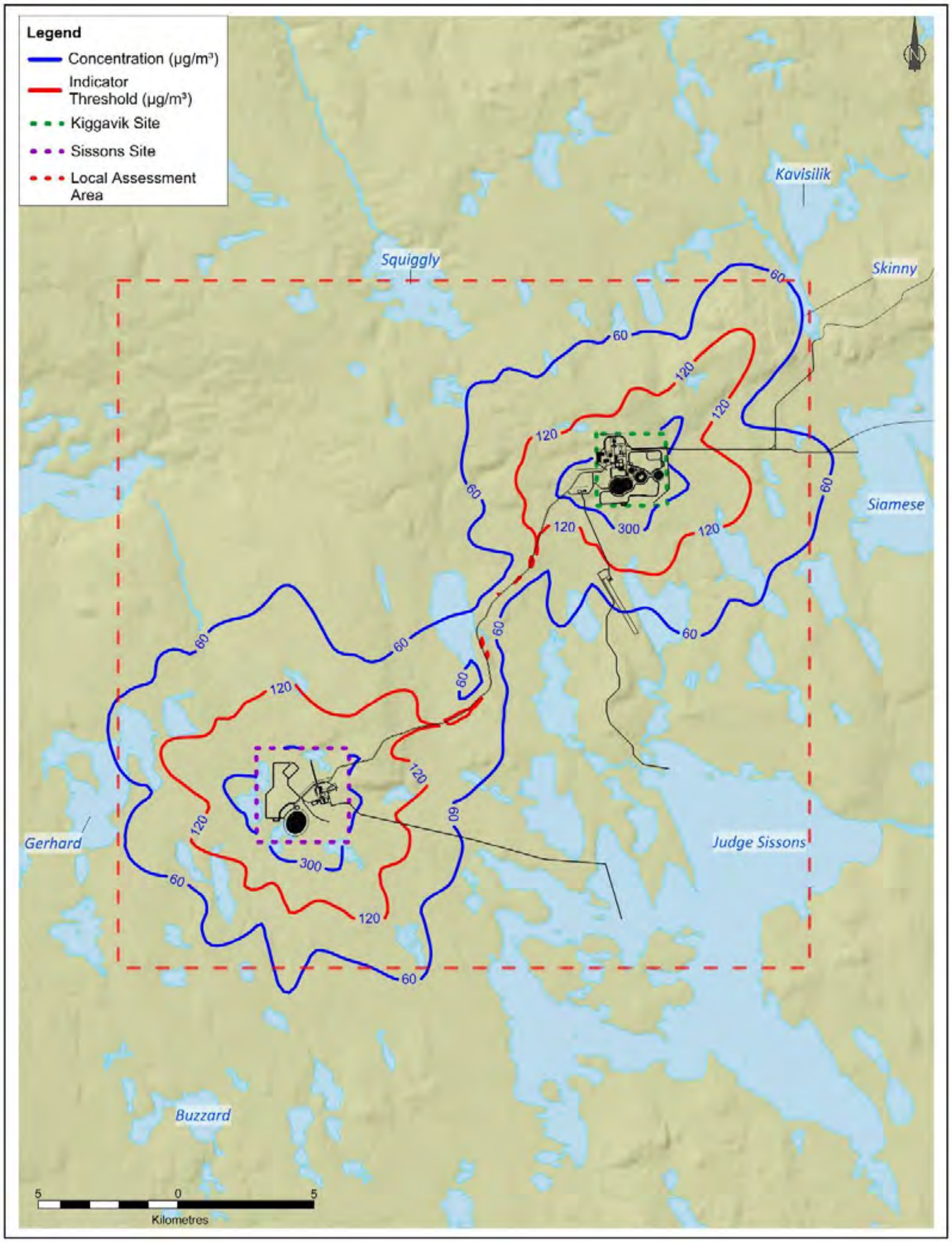

Projection: NAD 1983 UTM Zone 14N
Compiled: SENES Consultants
Date: 05/05/2014
Data Sources: *Natural Resources Canada, Geobase®, Nation Topographic Database, AREVA Resources Canada Inc.*

FIGURE D-2
Maximum Operations Assessment
24-hour TSP Concentration (µg/m³)
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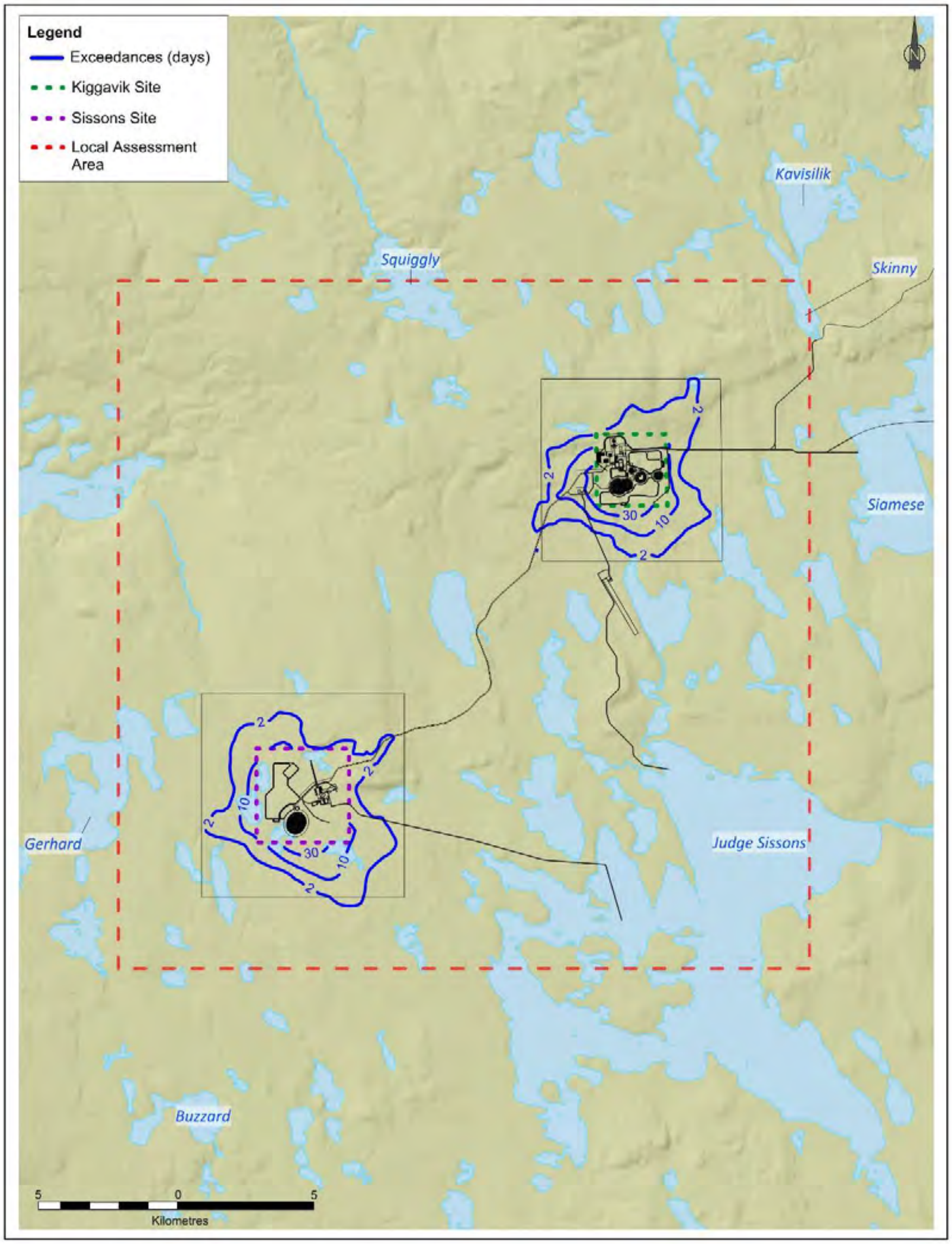

Projection: NAD 1983 UTM Zone 14N
Compiled: SENES Consultants
Date: 05/05/2014
Data Sources: Natural Resources Canada, Geobase®, Nation Topographic Database, AREVA Resources Canada Inc.

FIGURE D-3
Maximum Operations Assessment
Exceedances of 24-hour TSP Indicator Threshold (days)

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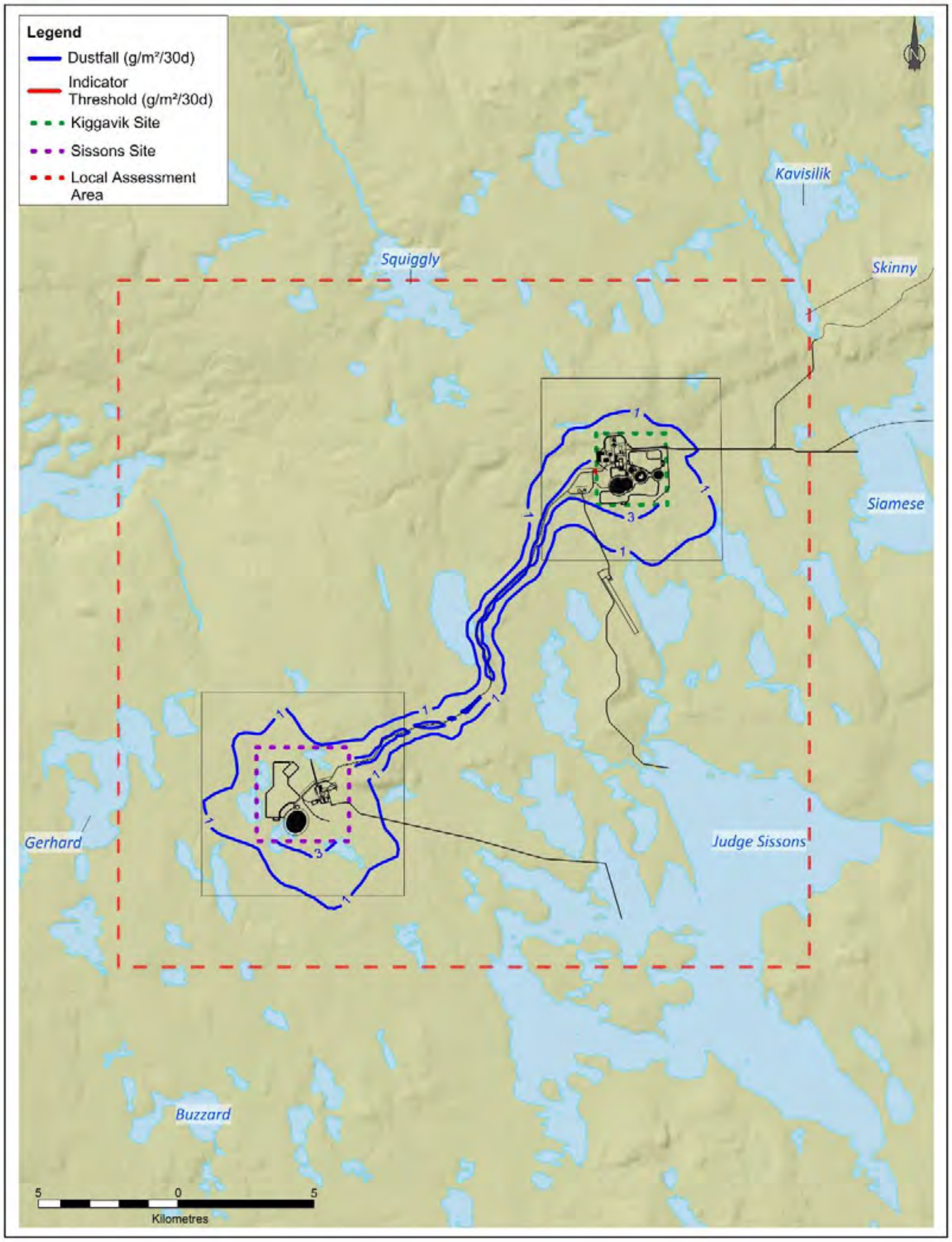

Projection: NAD 1983 UTM Zone 14N
Compiled: SENES Consultants
Date: 05/05/2014
Data Sources: Natural Resources Canada, Geobase®, Nation Topographic Database, AREVA Resources Canada Inc.

FIGURE D-4
Maximum Operations Assessment
Maximum Monthly Dust Deposition Rate (g/m²/30 days)
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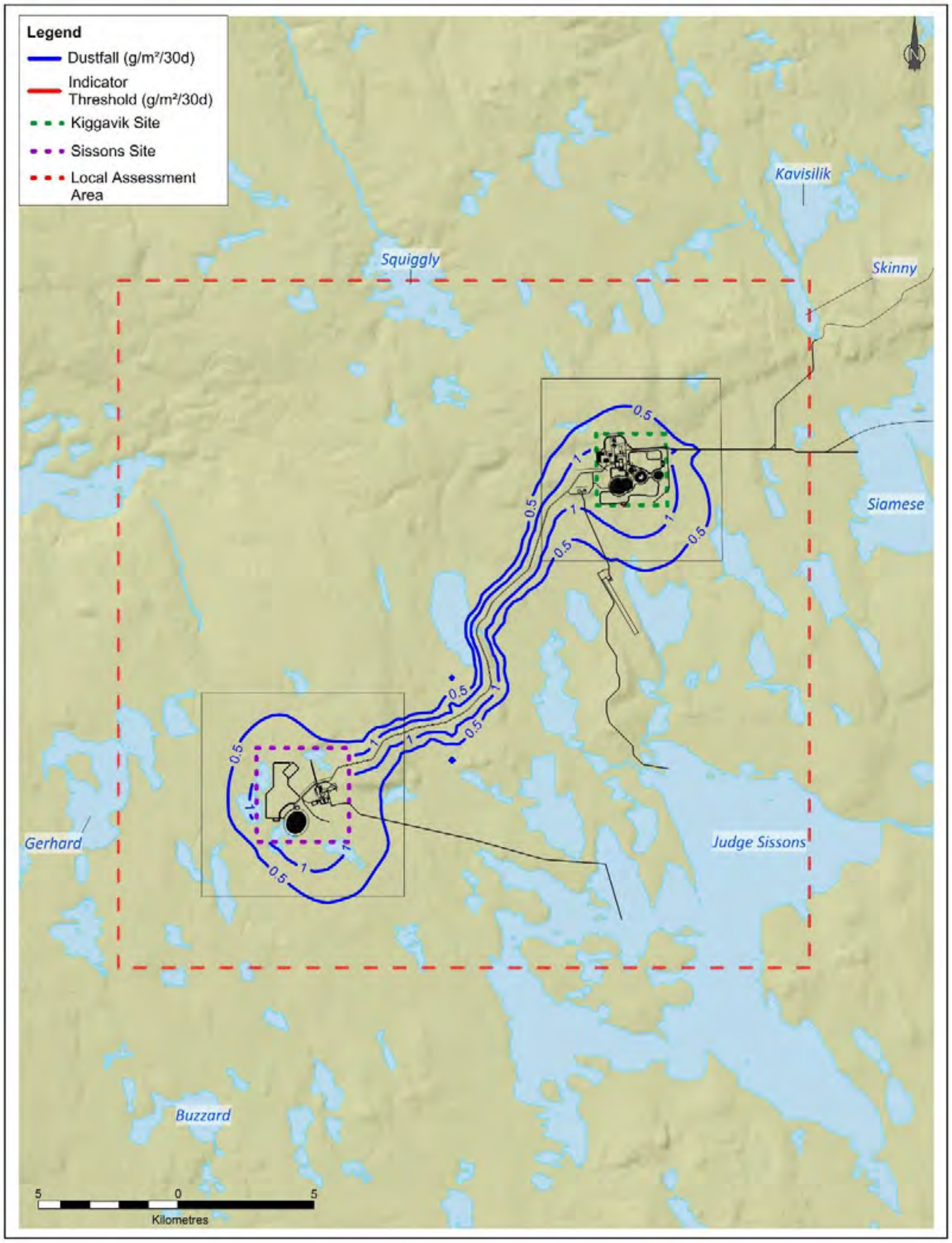

Projection: NAD 1983 UTM Zone 14N
Compiled: SENES Consultants
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Data Sources: Natural Resources Canada, Geobase®, Nation Topographic Database, AREVA Resources Canada Inc.

FIGURE D-5
Maximum Operations Assessment
Average Annual Dust Deposition Rate (g/m²/30 days)

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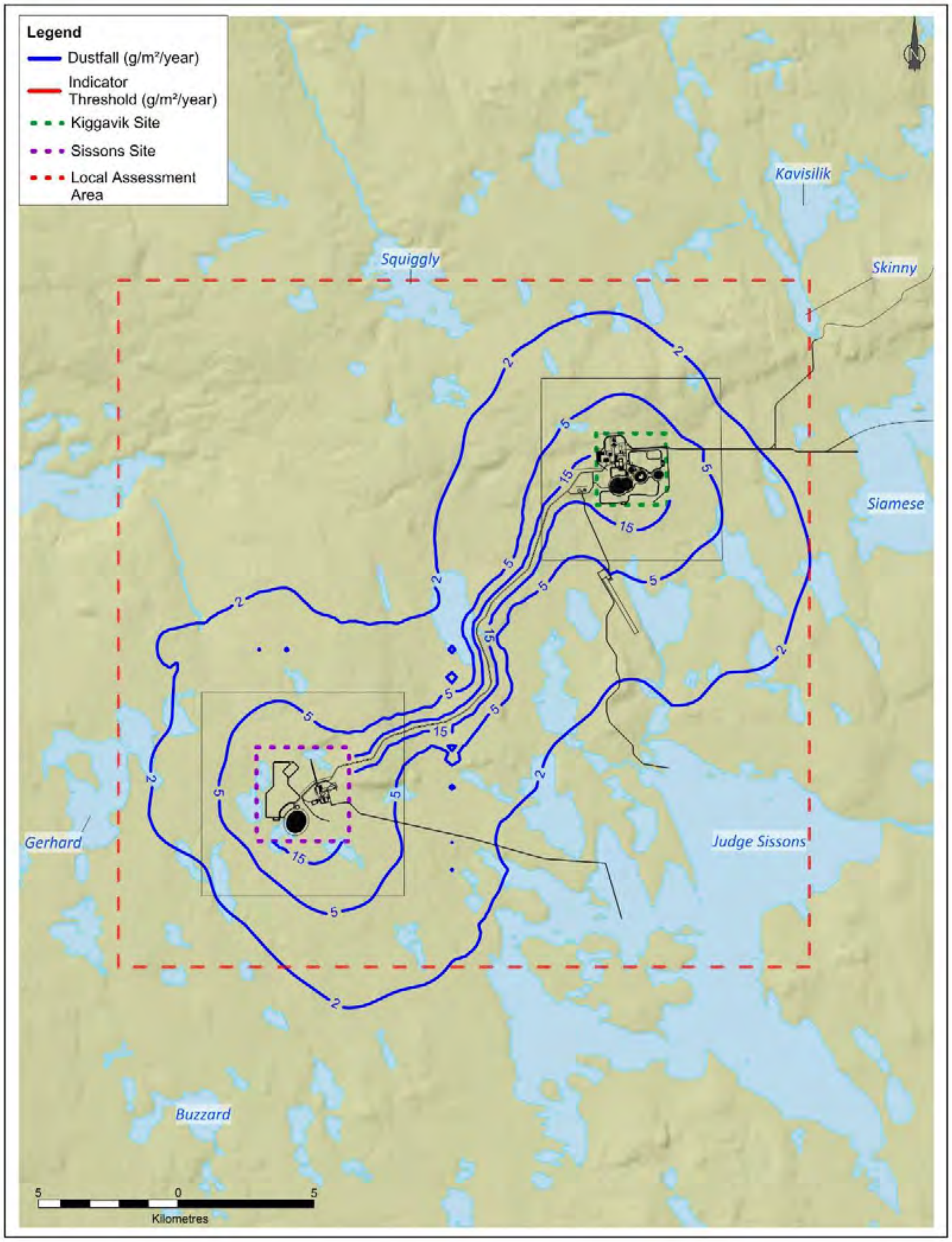

Projection: NAD 1983 UTM Zone 14N
Compiled: SENES Consultants
Date: 05/05/2014
Data Sources: Natural Resources Canada, Geobase®, Nation Topographic Database, AREVA Resources Canada Inc.

FIGURE D-6
Maximum Operations Assessment
Total Annual Dust Deposition (g/m²/year)
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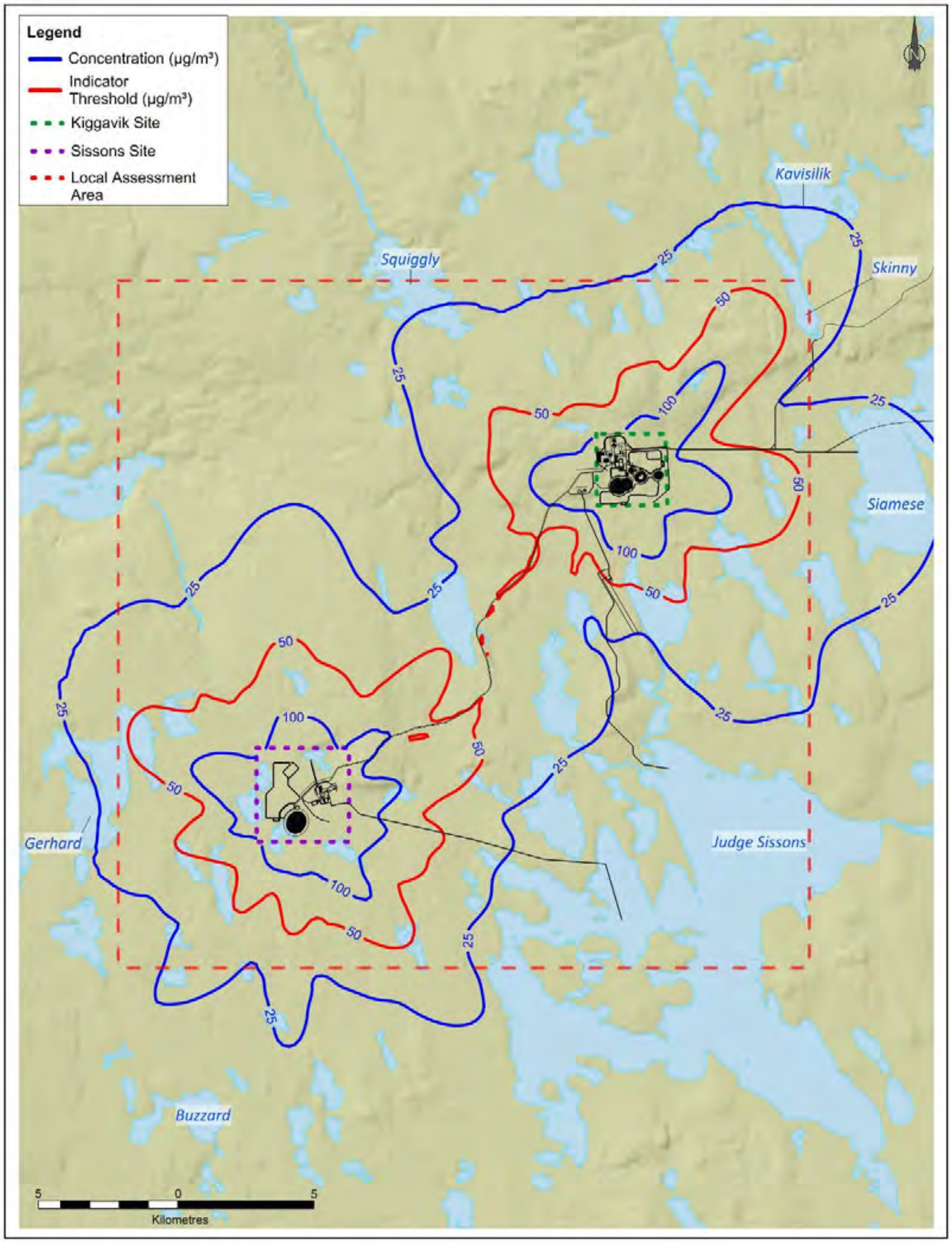

Projection: NAD 1983 UTM Zone 14N
Compiled: SENES Consultants
Date: 05/05/2014
Data Sources: Natural Resources Canada, Geobase®, Nation Topographic Database, AREVA Resources Canada Inc.

FIGURE D-7
Maximum Operations Assessment
24-hour PM_{10} Concentration (µg/m³)
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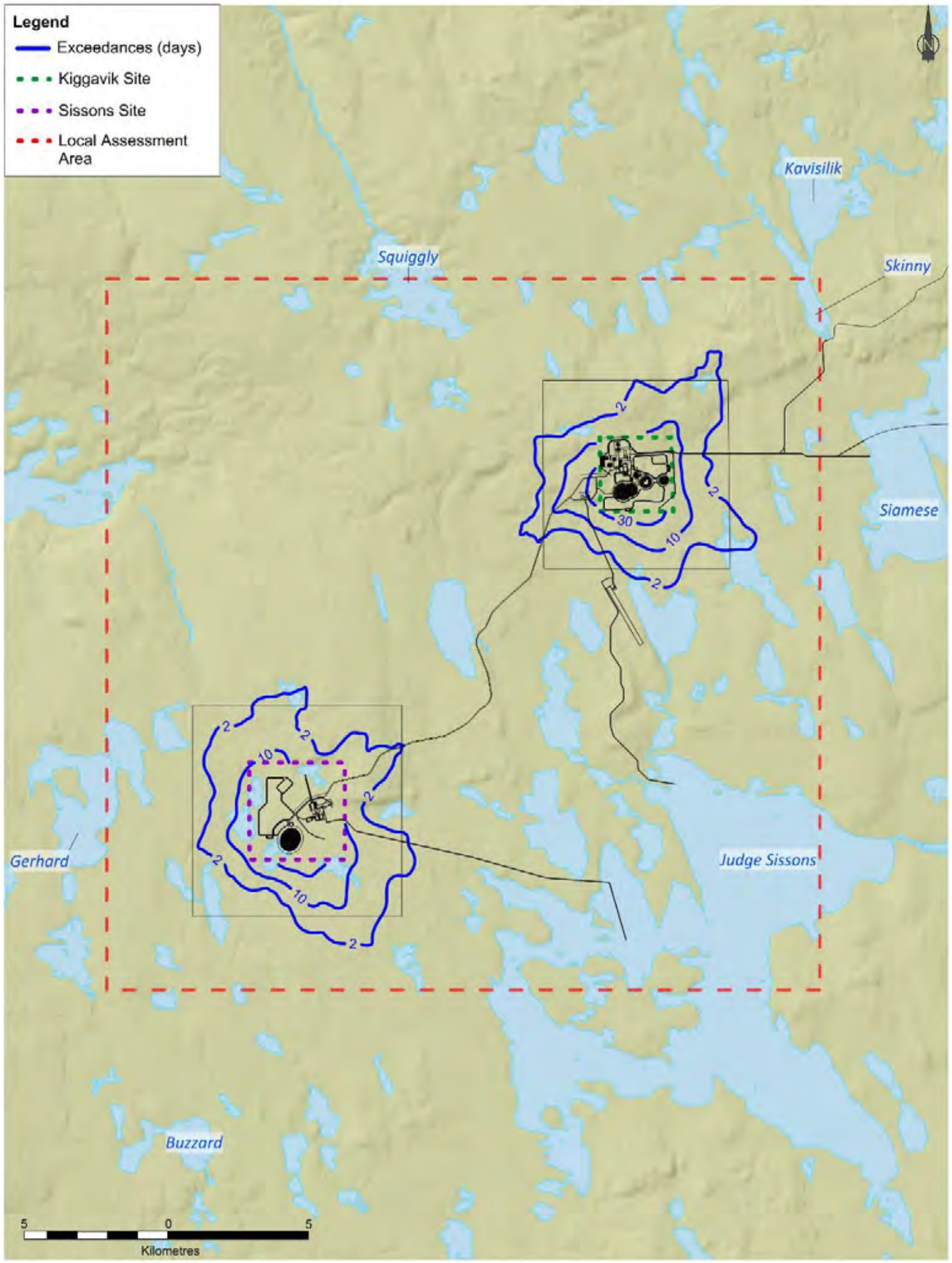

Projection: NAD 1983 UTM Zone 14N
Compiled: SENES Consultants
Date: 05/05/2014
Data Sources: Natural Resources Canada, Geobase®, Nation Topographic Database, AREVA Resources Canada Inc.

FIGURE D-8
Maximum Operations Assessment
Exceedances of 24-hour PM_{10} Indicator Threshold (days)
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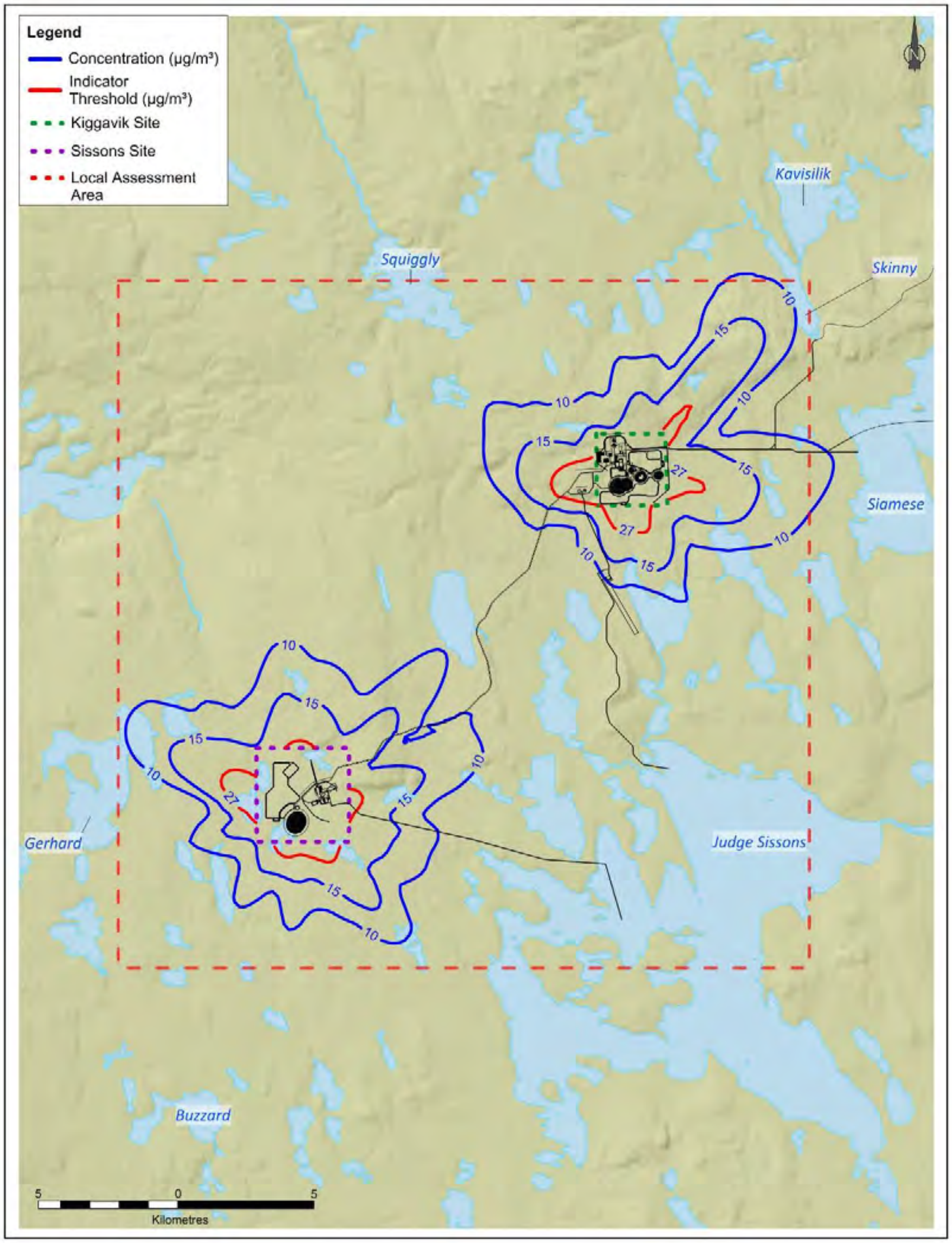

Projection: NAD 1983 UTM Zone 14N
Compiled: SENES Consultants
Date: 05/05/2014
Data Sources: Natural Resources Canada, Geobase®, Nation Topographic Database, AREVA Resources Canada Inc.

FIGURE D-9
Maximum Operations Assessment
24-hour $PM_{2.5}$ Concentration (µg/m³)
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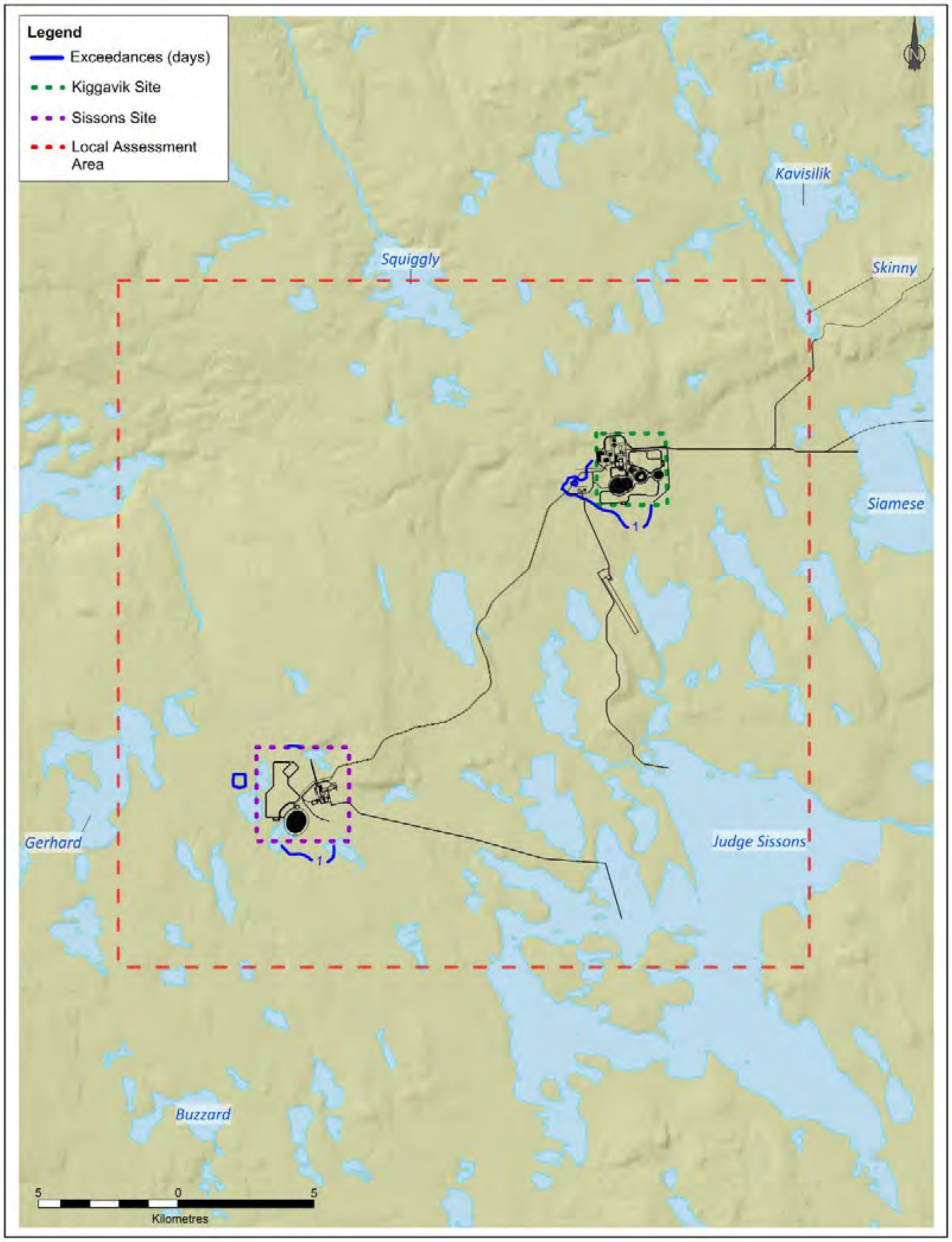

Projection: NAD 1983 UTM Zone 14N
Compiled: SENES Consultants
Date: 05/05/2014
Data Sources: Natural Resources Canada, Geobase®, Nation Topographic Database, AREVA Resources Canada Inc.

FIGURE D-10
Maximum Operations Assessment
Exceedances of 24-hour $PM_{2.5}$ Indicator Threshold (days)
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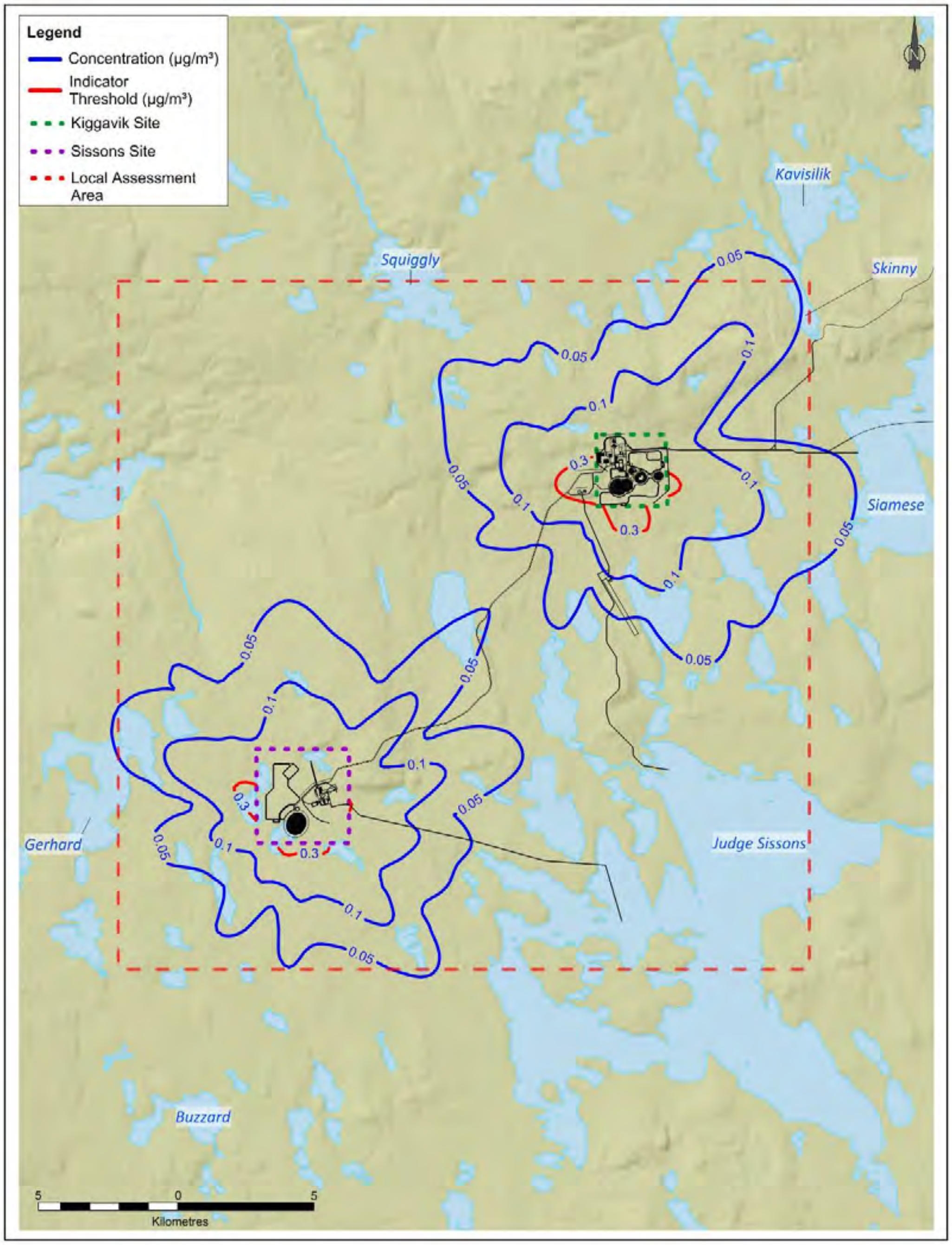

Projection: NAD 1983 UTM Zone 14N
Compiled: SENES Consultants
Date: 05/05/2014
Data Sources: Natural Resources Canada, Geobase®, Nation Topographic Database, AREVA Resources Canada Inc.

FIGURE D-11
Maximum Operations Assessment
24-hour Uranium (U) Concentration (µg/m³)
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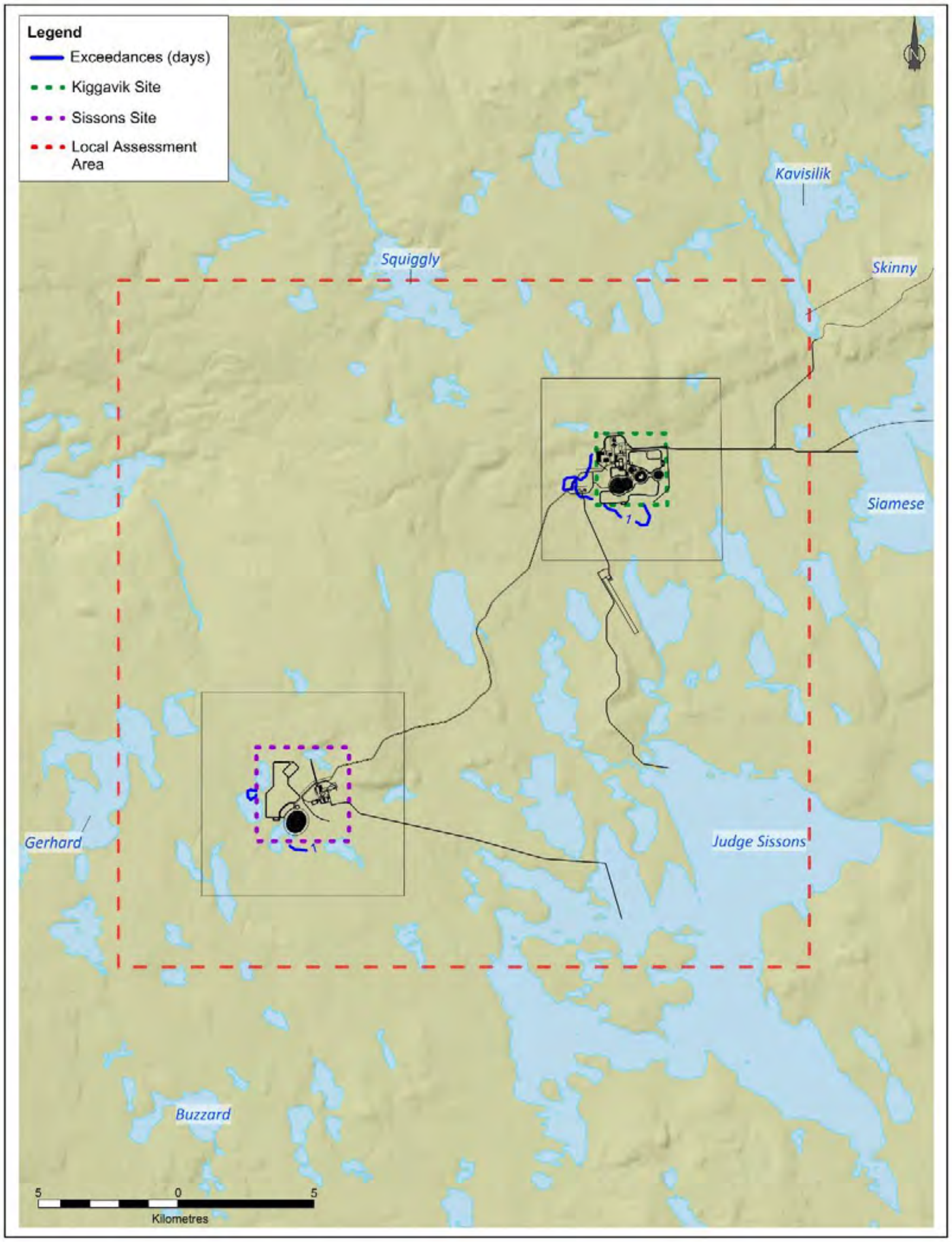

Projection: NAD 1983 UTM Zone 14N
Compiled: SENES Consultants
Date: 05/05/2014
Data Sources: Natural Resources Canada, Geobase®, Nation Topographic Database, AREVA Resources Canada Inc.

FIGURE D-12
Maximum Operations Assessment
Exceedances of 24-hour Uranium Indicator Threshold (days)
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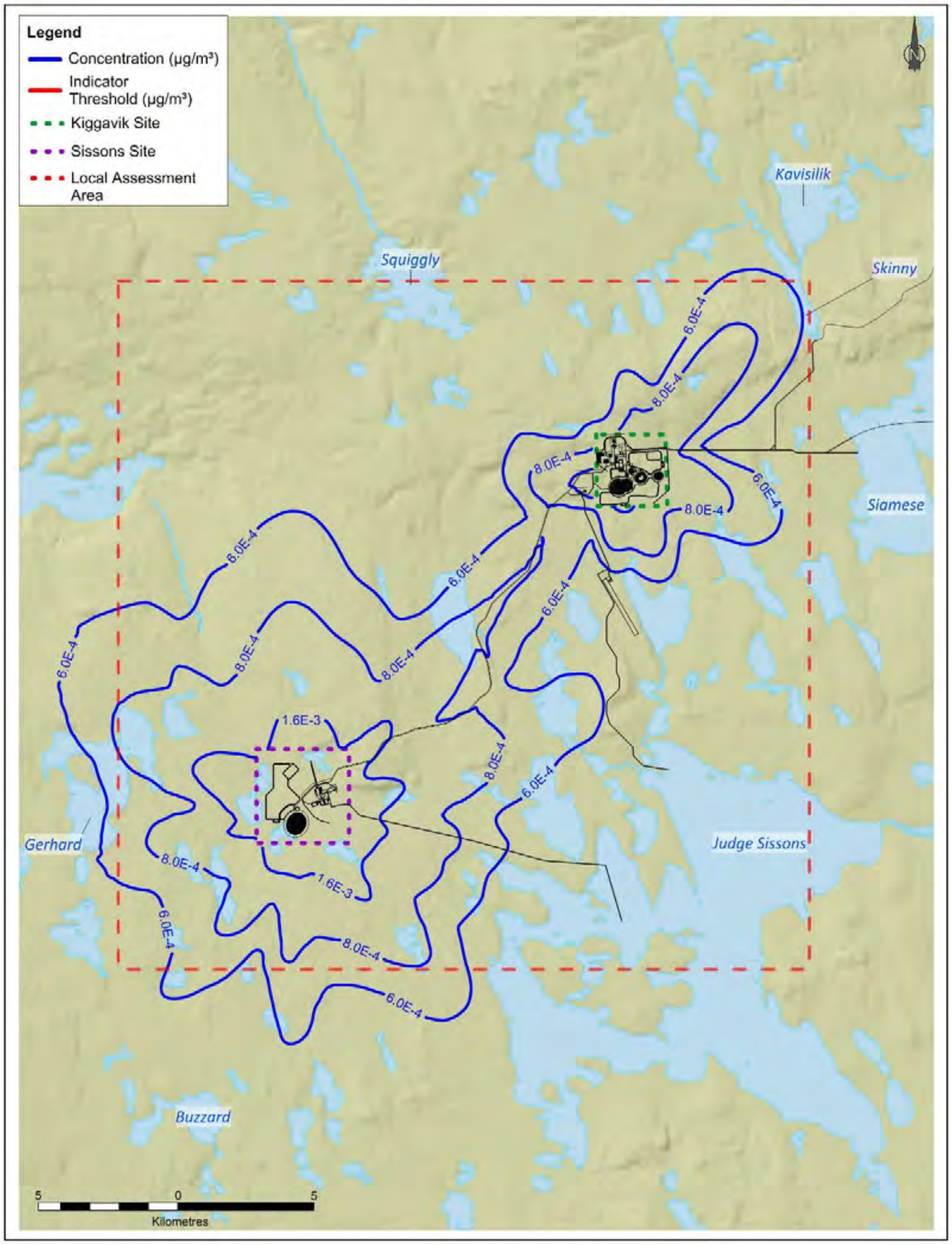

Projection: NAD 1983 UTM Zone 14N
Compiled: SENES Consultants
Date: 05/05/2014
Data Sources: Natural Resources Canada, Geobase®, Nation Topographic Database, AREVA Resources Canada Inc.

FIGURE D-13
Maximum Operations Assessment
24-hour Arsenic (As) Concentration (µg/m³)
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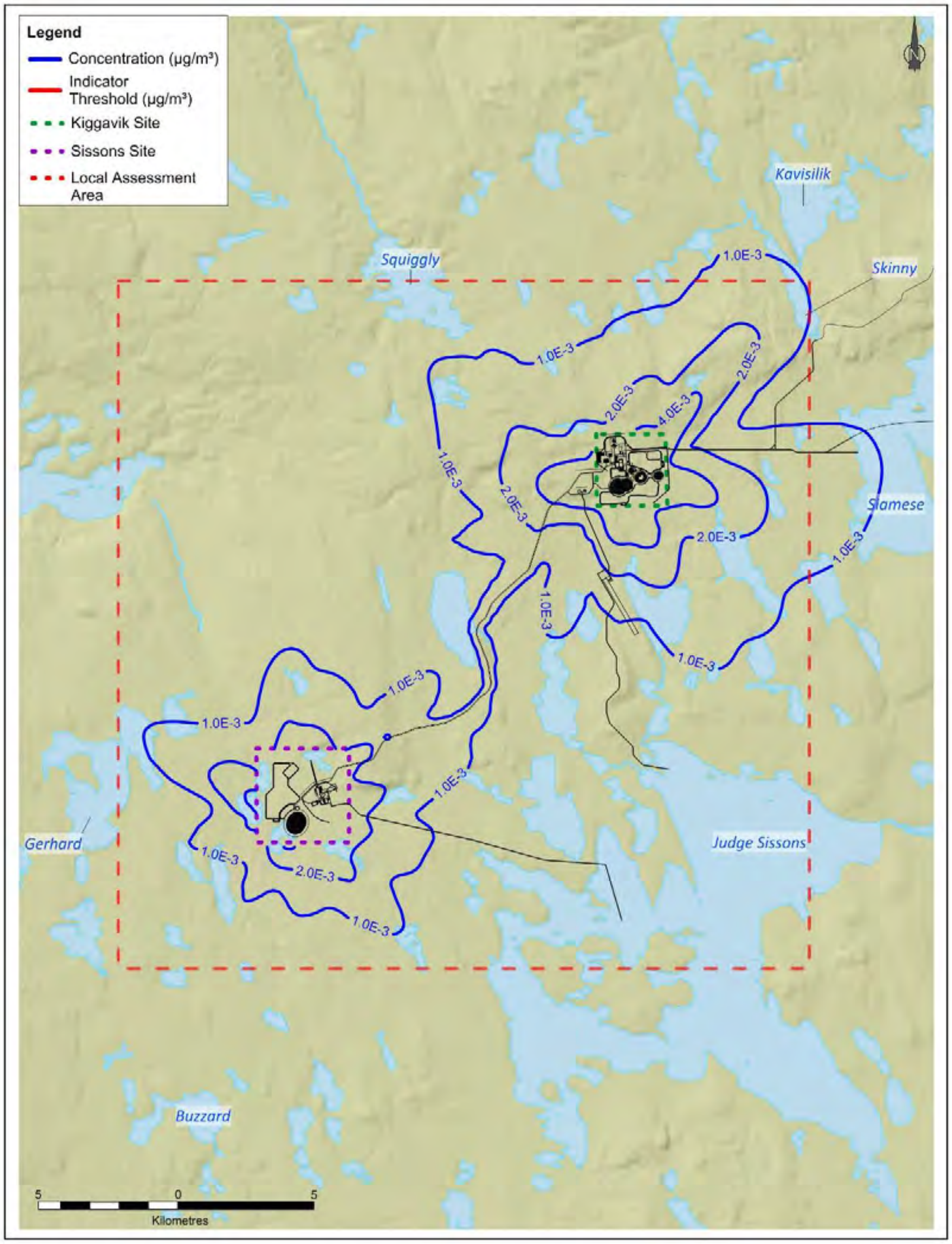

Projection: NAD 1983 UTM Zone 14N
Compiled: SENES Consultants
Date: 05/05/2014
Data Sources: Natural Resources Canada, Geobase®, Nation Topographic Database, AREVA Resources Canada Inc.

FIGURE D-14
Maximum Operations Assessment
24-hour Cobalt (Co) Concentration (µg/m³)
ENVIRONMENTAL IMPACT STATEMENT
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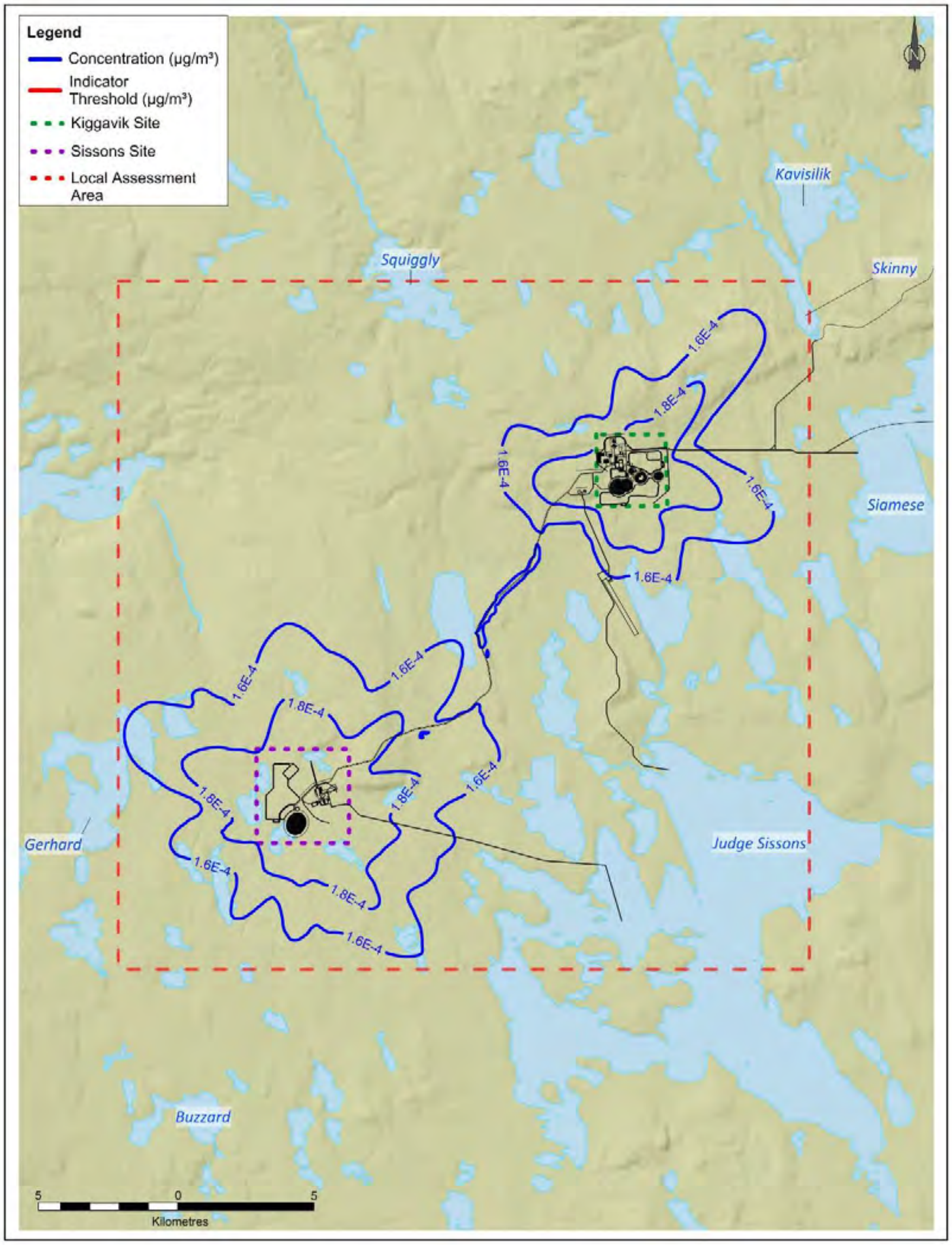

Projection: NAD 1983 UTM Zone 14N
Compiled: SENES Consultants
Date: 05/05/2014
Data Sources: Natural Resources Canada, Geobase®, Nation Topographic Database, AREVA Resources Canada Inc.

FIGURE D-15
Maximum Operations Assessment
24-hour Cadmium (Cd) Concentration (µg/m³)
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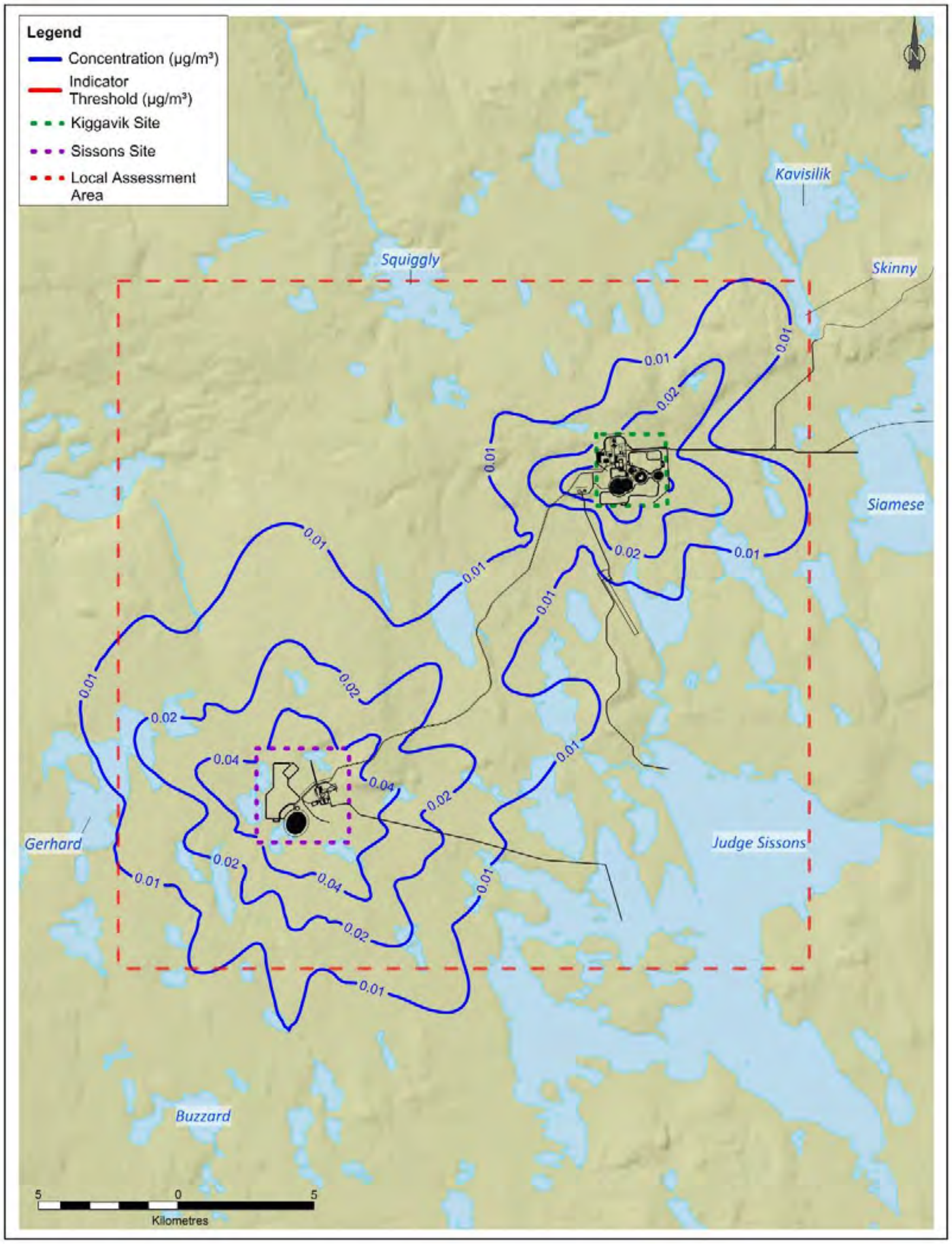

Projection: NAD 1983 UTM Zone 14N
Compiled: SENES Consultants
Date: 05/05/2014
Data Sources: Natural Resources Canada, Geobase®, Nation Topographic Database, AREVA Resources Canada Inc.

FIGURE D-16
Maximum Operations Assessment
24-hour Chromium (Cr) Concentration (µg/m³)
ENVIRONMENTAL IMPACT STATEMENT
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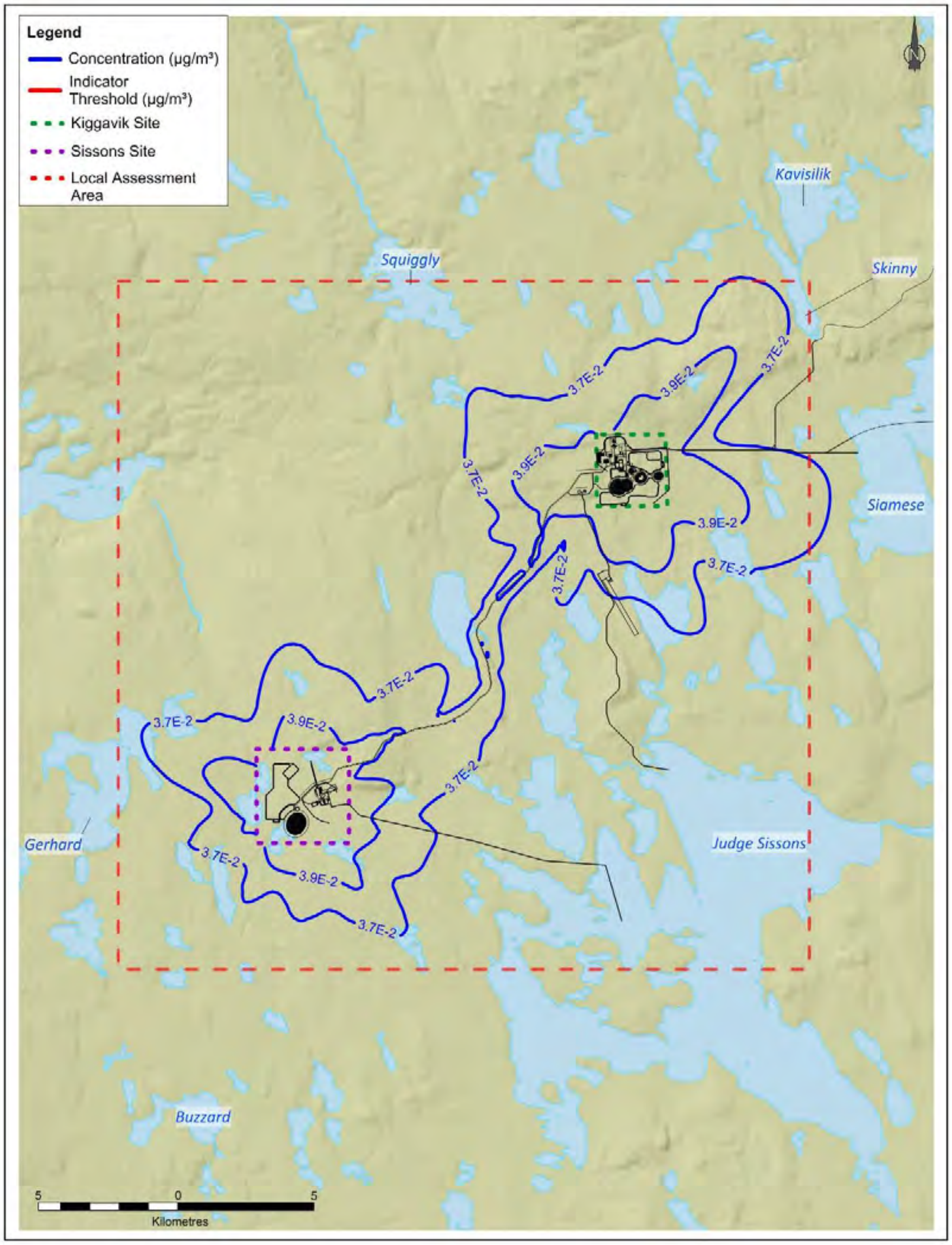

Projection: NAD 1983 UTM Zone 14N
Compiled: SENES Consultants
Date: 05/05/2014
Data Sources: Natural Resources Canada, Geobase®, Nation Topographic Database, AREVA Resources Canada Inc.

FIGURE D-17
Maximum Operations Assessment
24-hour Copper (Cu) Concentration (µg/m³)
ENVIRONMENTAL IMPACT STATEMENT
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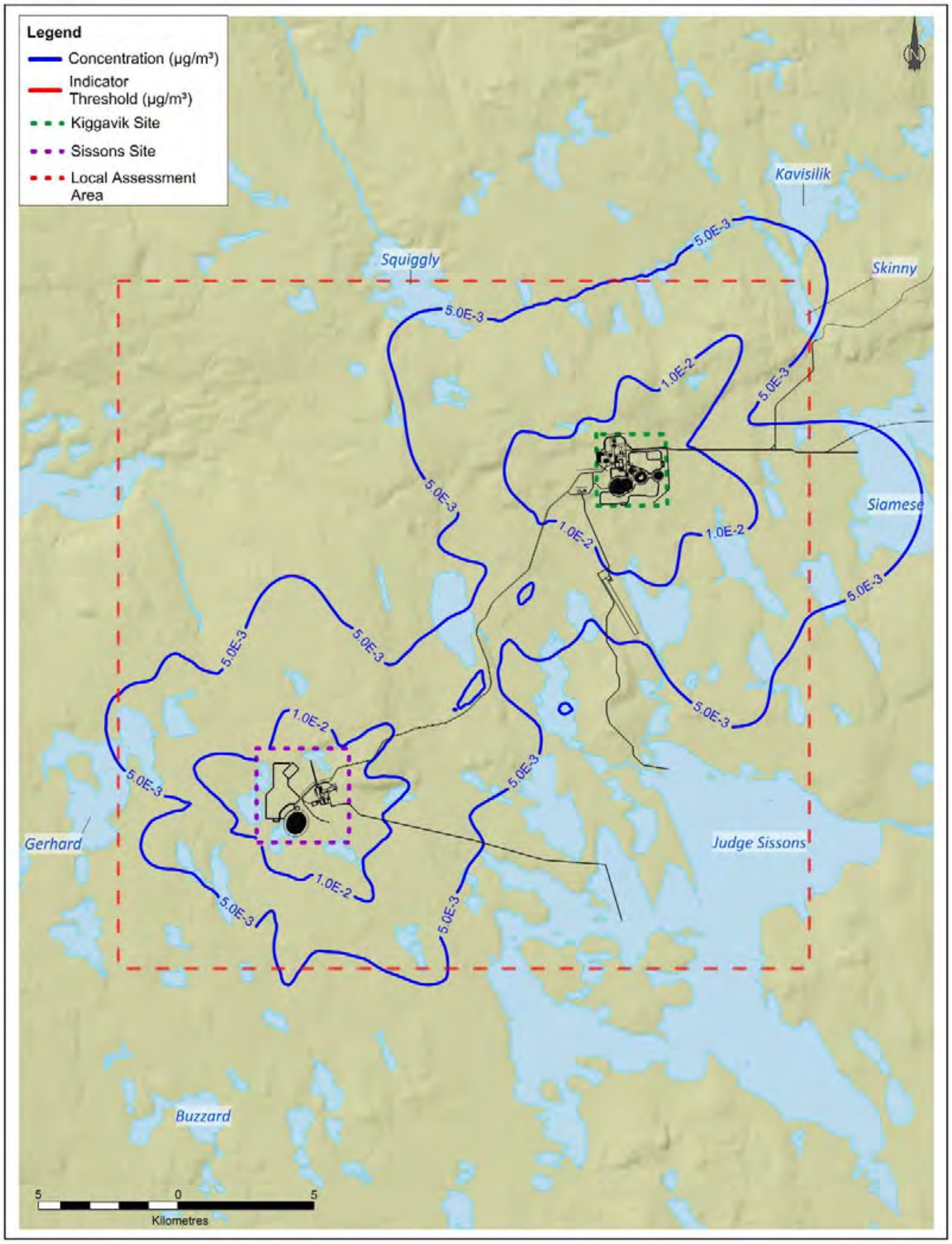

Projection: NAD 1983 UTM Zone 14N
Compiled: SENES Consultants
Date: 05/05/2014
Data Sources: Natural Resources Canada, Geobase®, Nation Topographic Database, AREVA Resources Canada Inc.

FIGURE D-18
Maximum Operations Assessment
24-hour Lead (Pb) Concentration (µg/m³)
ENVIRONMENTAL IMPACT STATEMENT
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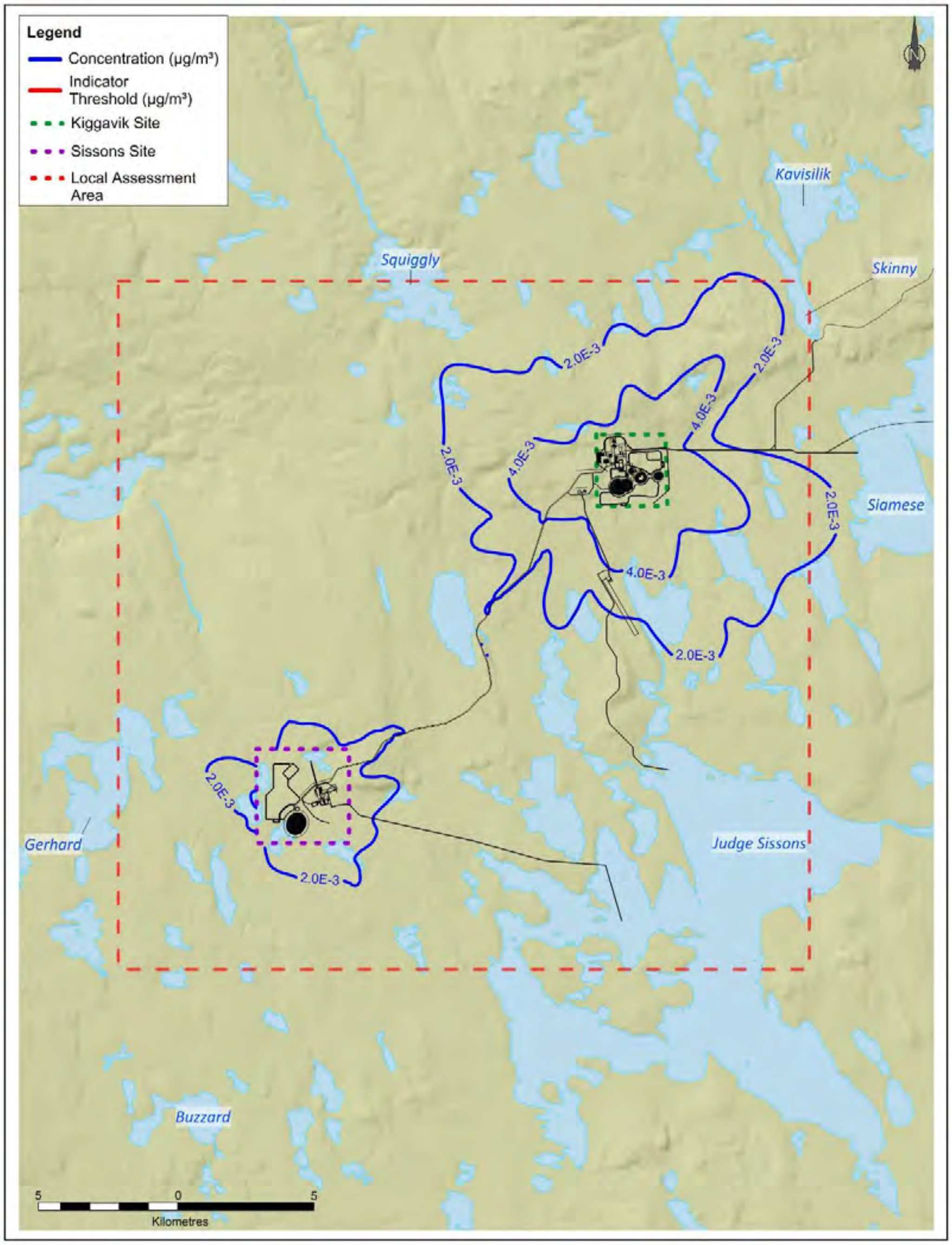

Projection: NAD 1983 UTM Zone 14N
Compiled: SENES Consultants
Date: 05/05/2014
Data Sources: Natural Resources Canada, Geobase®, Nation Topographic Database, AREVA Resources Canada Inc.

FIGURE D-19
Maximum Operations Assessment
24-hour Molybdenum (Mo) Concentration (µg/m³)
ENVIRONMENTAL IMPACT STATEMENT
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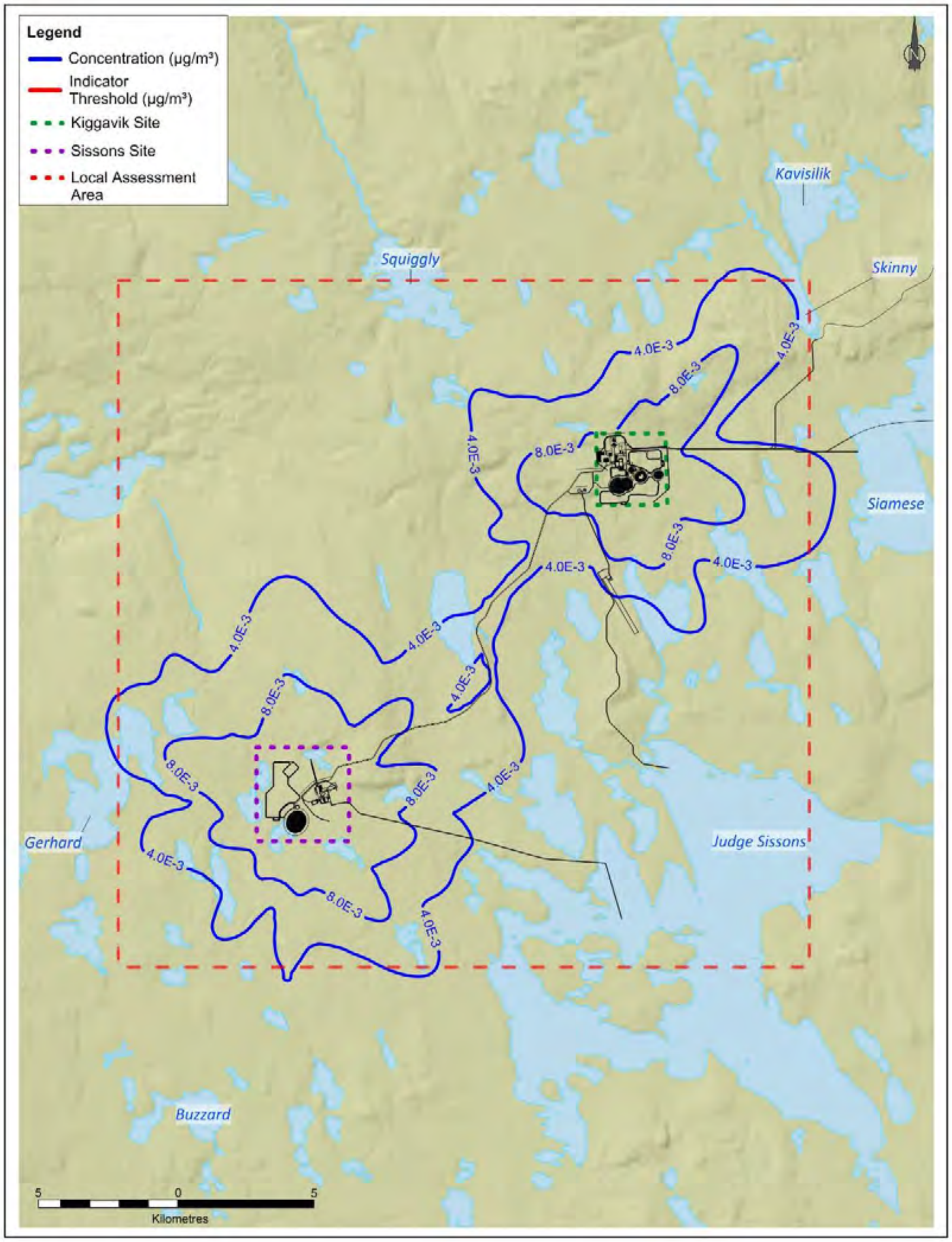

Projection: NAD 1983 UTM Zone 14N
Compiled: SENES Consultants
Date: 05/05/2014
Data Sources: Natural Resources Canada, Geobase®, Nation Topographic Database, AREVA Resources Canada Inc.

FIGURE D-20
Maximum Operations Assessment
24-hour Nickel (Ni) Concentration (µg/m³)
ENVIRONMENTAL IMPACT STATEMENT
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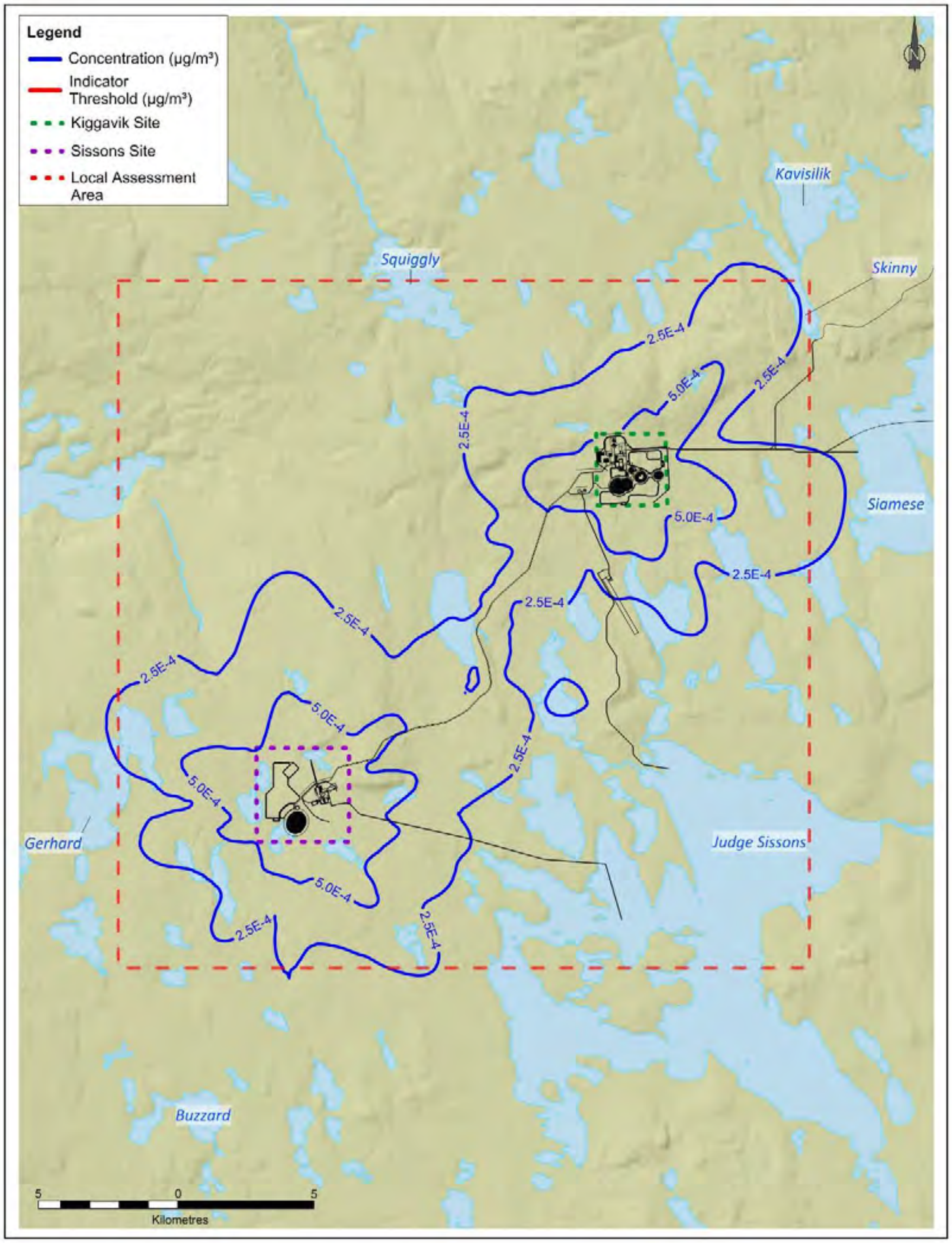

Projection: NAD 1983 UTM Zone 14N
Compiled: SENES Consultants
Date: 05/05/2014
Data Sources: Natural Resources Canada, Geobase®, Nation Topographic Database, AREVA Resources Canada Inc.

FIGURE D-21
Maximum Operations Assessment
24-hour Selenium (Se) Concentration (µg/m³)
ENVIRONMENTAL IMPACT STATEMENT
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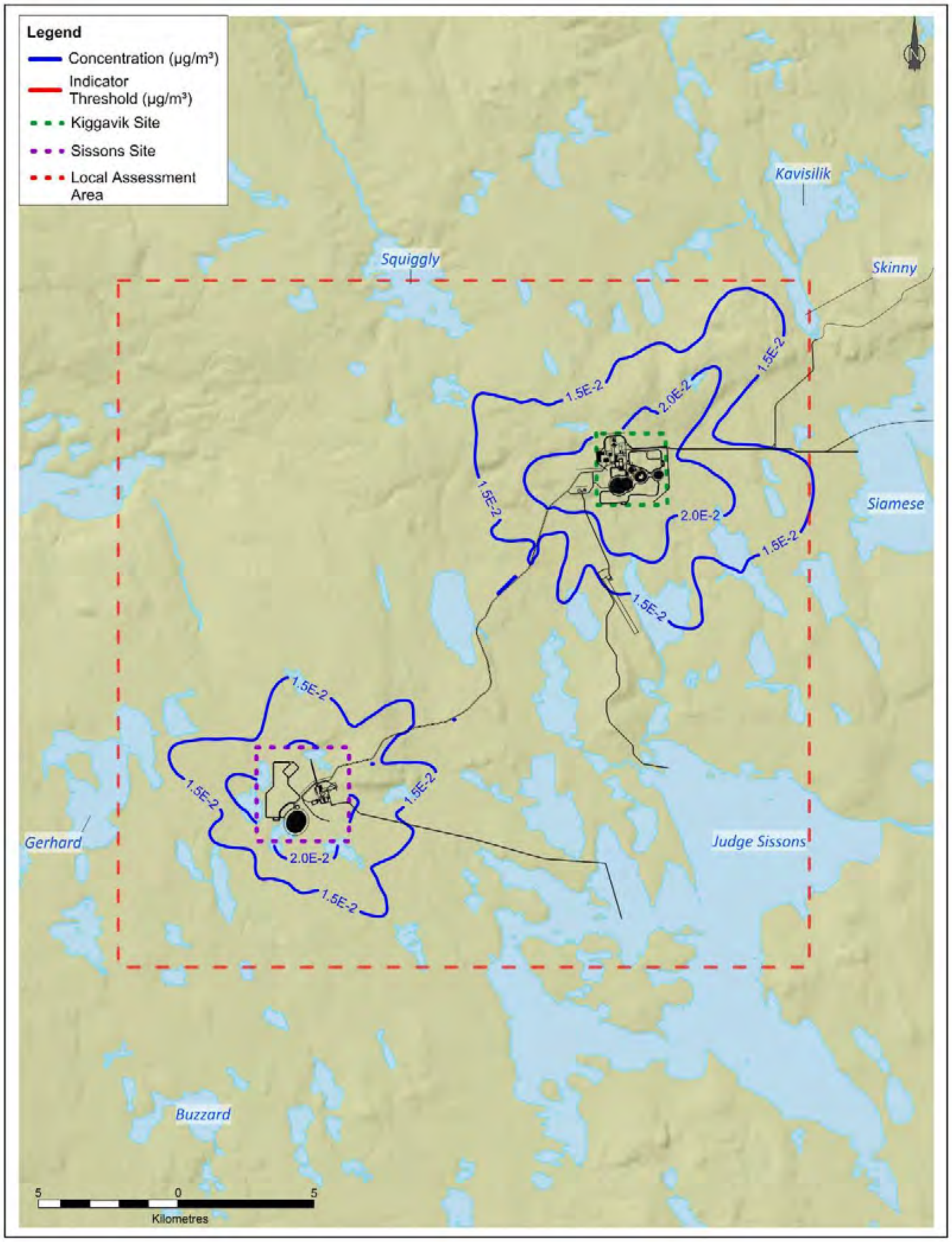

Projection: NAD 1983 UTM Zone 14N
Compiled: SENES Consultants
Date: 05/05/2014
Data Sources: Natural Resources Canada, Geobase®, Nation Topographic Database, AREVA Resources Canada Inc.

FIGURE D-22
Maximum Operations Assessment
24-hour Zinc (Zn) Concentration (µg/m³)
ENVIRONMENTAL IMPACT STATEMENT
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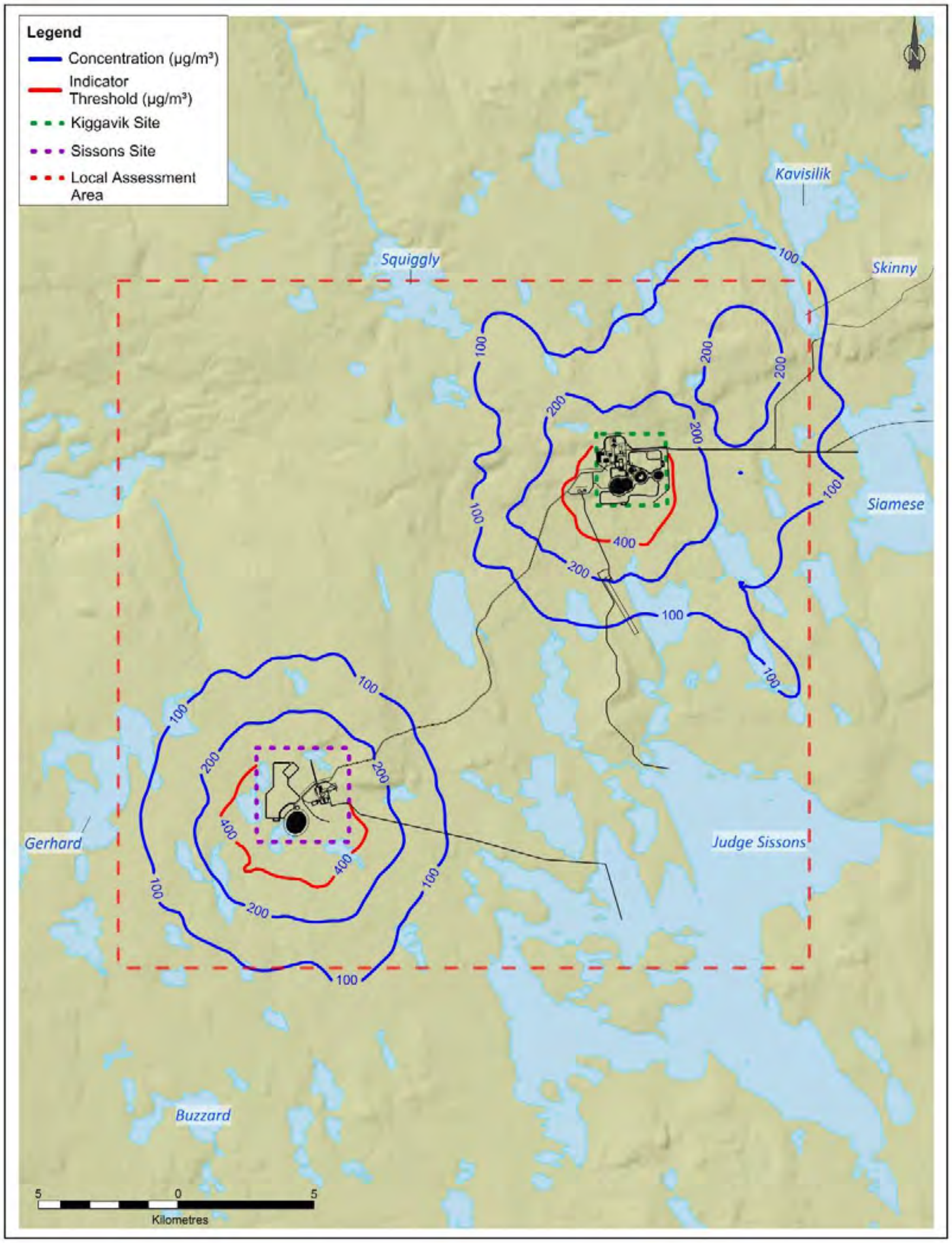

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Compiled: SENES Consultants
Date: 05/05/2014
Data Sources: Natural Resources Canada, Geobase®, Nation Topographic Database, AREVA Resources Canada Inc.

FIGURE D-23
Maximum Operations Assessment
1-hour NO_2 Concentration (µg/m³)
ENVIRONMENTAL IMPACT STATEMENT
VOLUME 4: ATMOSPHERIC ENVIRONMENT
Technical Appendix 4B: AIR QUALITY AND CLIMATE

KIGGAVIK OPERATION

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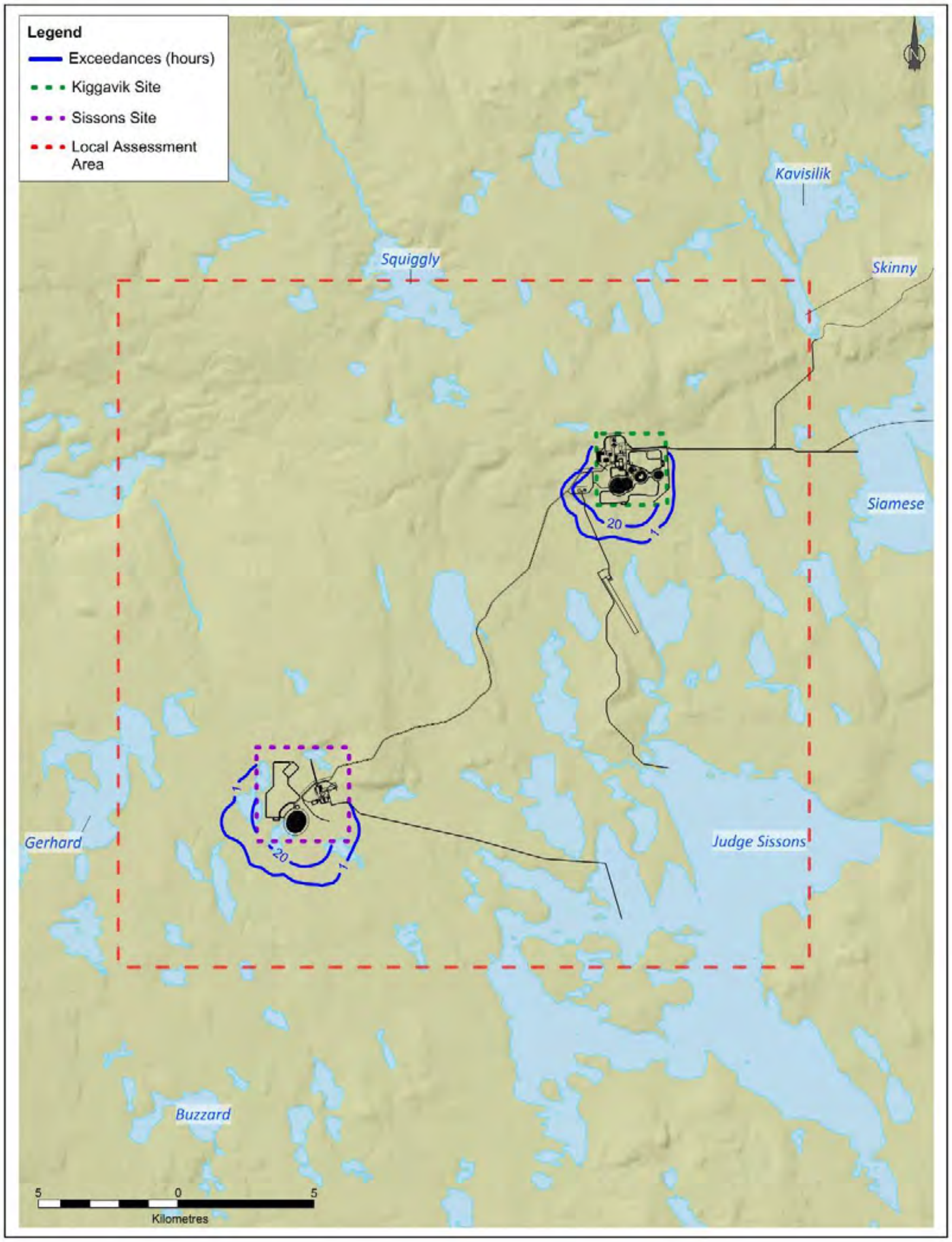

Projection: NAD 1983 UTM Zone 14N
Compiled: SENES Consultants
Date: 05/05/2014
Data Sources: Natural Resources Canada, Geobase®, Nation Topographic Database, AREVA Resources Canada Inc.

FIGURE D-24
Maximum Operations Assessment
Exceedances of 1-hour NO_2 Indicator Threshold (hours)
ENVIRONMENTAL IMPACT STATEMENT
VOLUME 4: ATMOSPHERIC ENVIRONMENT
Technical Appendix 4B: AIR QUALITY AND CLIMATE

KIGGAVIK OPERATION

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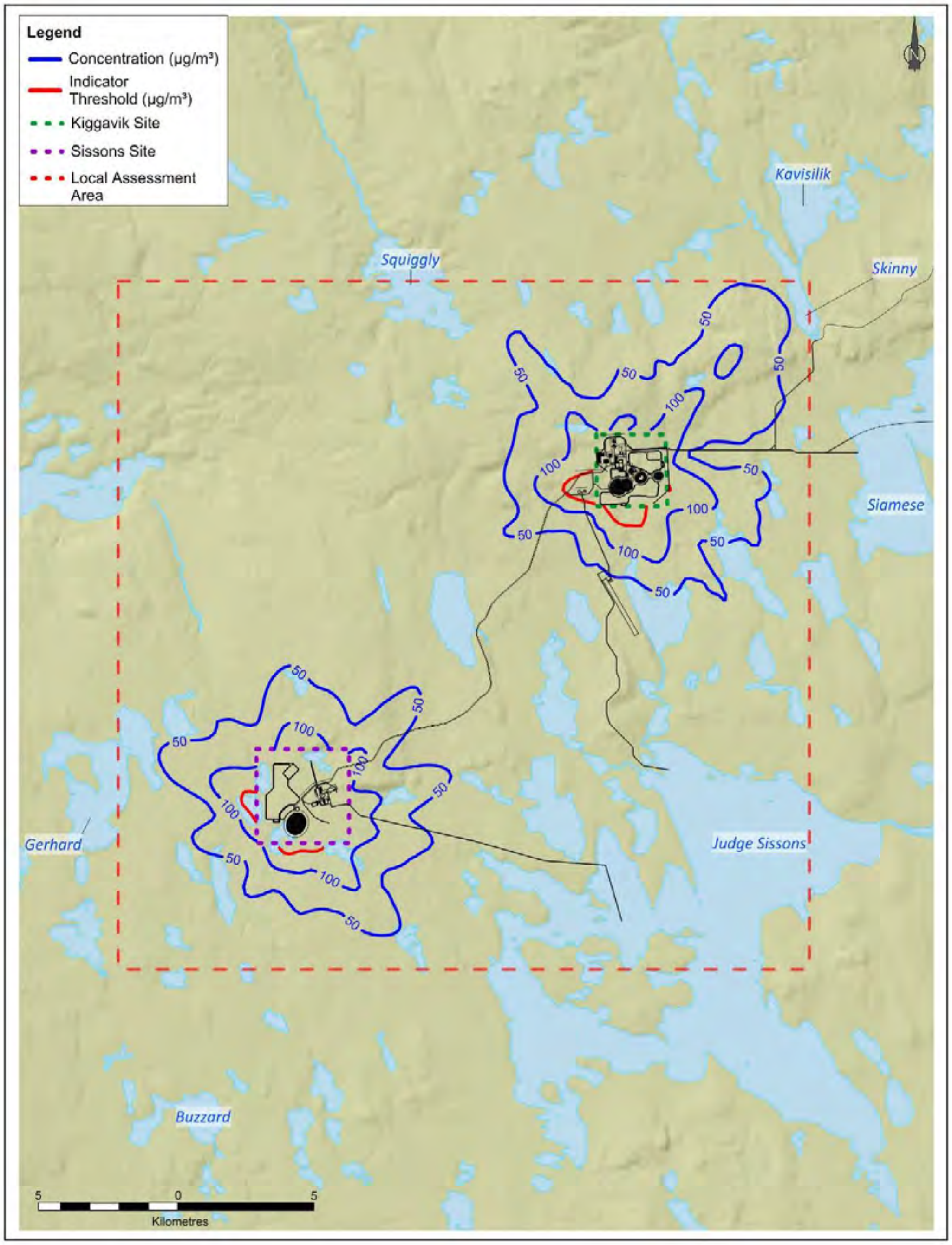

Projection: NAD 1983 UTM Zone 14N
Compiled: SENES Consultants
Date: 05/05/2014
Data Sources: Natural Resources Canada, Geobase®, Nation Topographic Database, AREVA Resources Canada Inc.

FIGURE D-25
Maximum Operations Assessment
24-hour NO_2 Concentration (µg/m³)
ENVIRONMENTAL IMPACT STATEMENT
VOLUME 4: ATMOSPHERIC ENVIRONMENT
Technical Appendix 4B: AIR QUALITY AND CLIMATE

KIGGAVIK OPERATION
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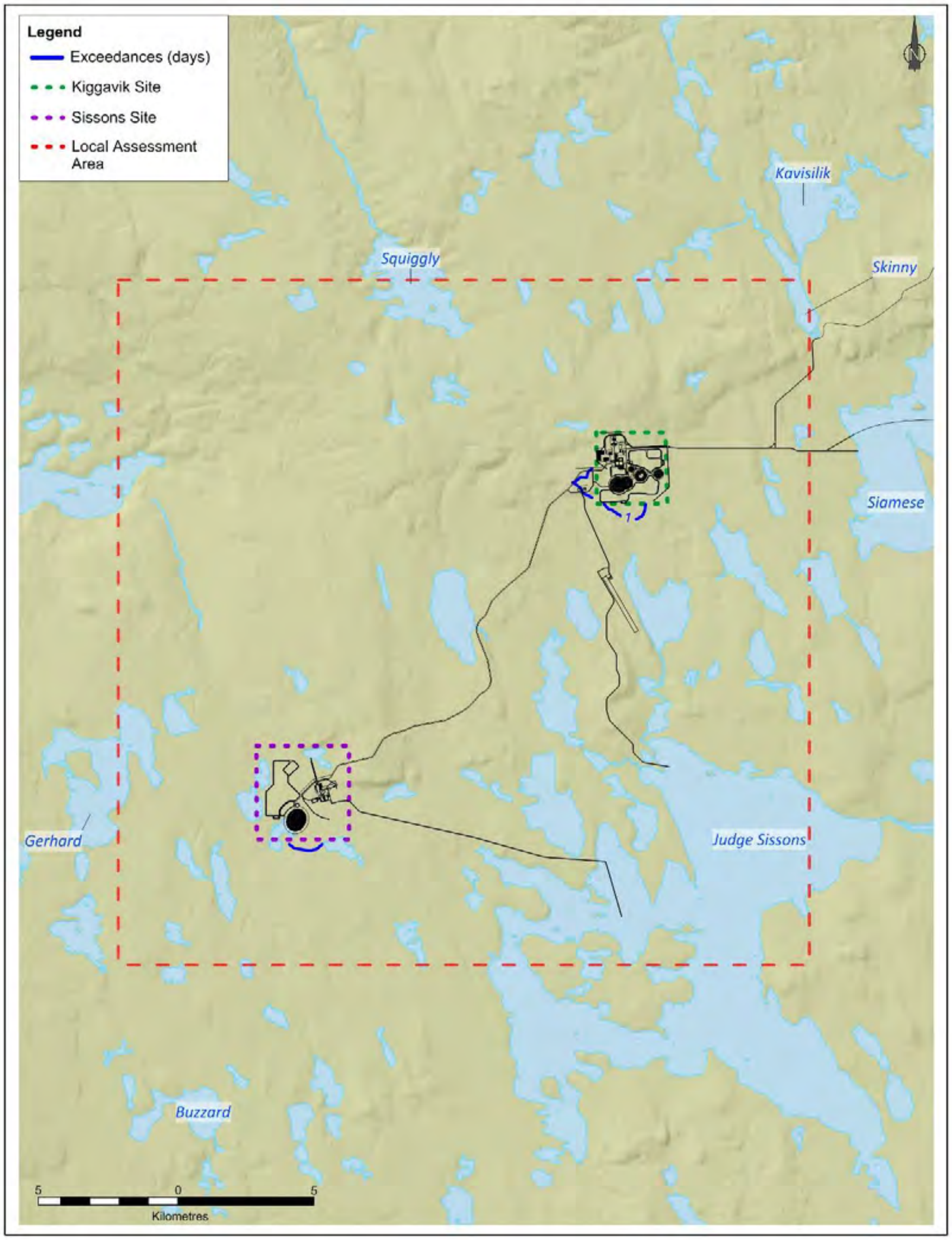

Projection: NAD 1983 UTM Zone 14N
Compiled: SENES Consultants
Date: 05/05/2014
Data Sources: Natural Resources Canada, Geobase®, Nation Topographic Database, AREVA Resources Canada Inc.

FIGURE D-26
Maximum Operations Assessment
Exceedances of 24-hour NO_2 Indicator Threshold (days)

ENVIRONMENTAL IMPACT STATEMENT
VOLUME 4: ATMOSPHERIC ENVIRONMENT
Technical Appendix 4B: AIR QUALITY AND CLIMATE

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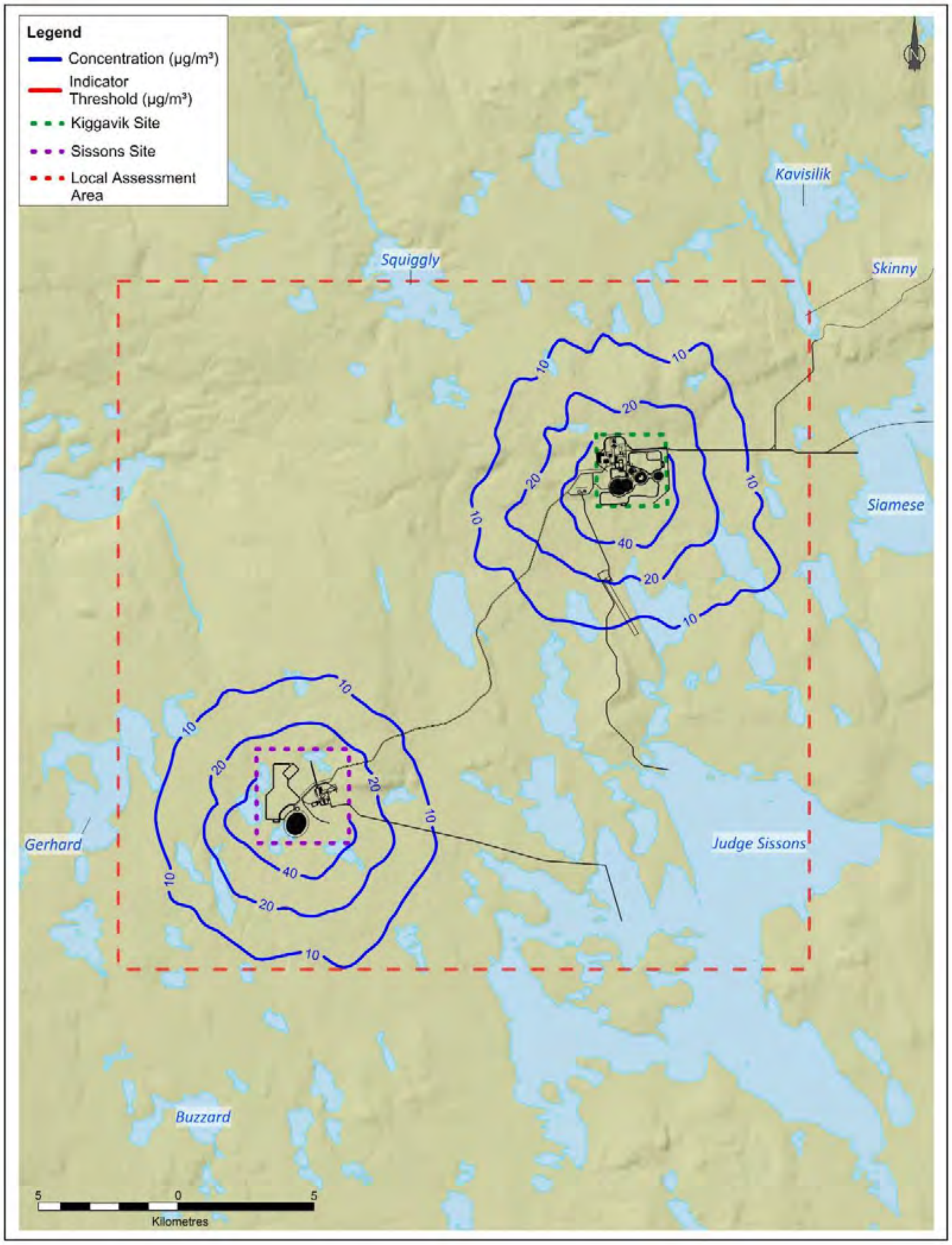

Projection: NAD 1983 UTM Zone 14N
Compiled: SENES Consultants
Date: 05/05/2014
Data Sources: Natural Resources Canada, Geobase®, Nation Topographic Database, AREVA Resources Canada Inc.

FIGURE D-27
Maximum Operations Assessment
1-hour SO_2 Concentration (µg/m³)
ENVIRONMENTAL IMPACT STATEMENT
VOLUME 4: ATMOSPHERIC ENVIRONMENT
Technical Appendix 4B: AIR QUALITY AND CLIMATE

KIGGAVIK OPERATION
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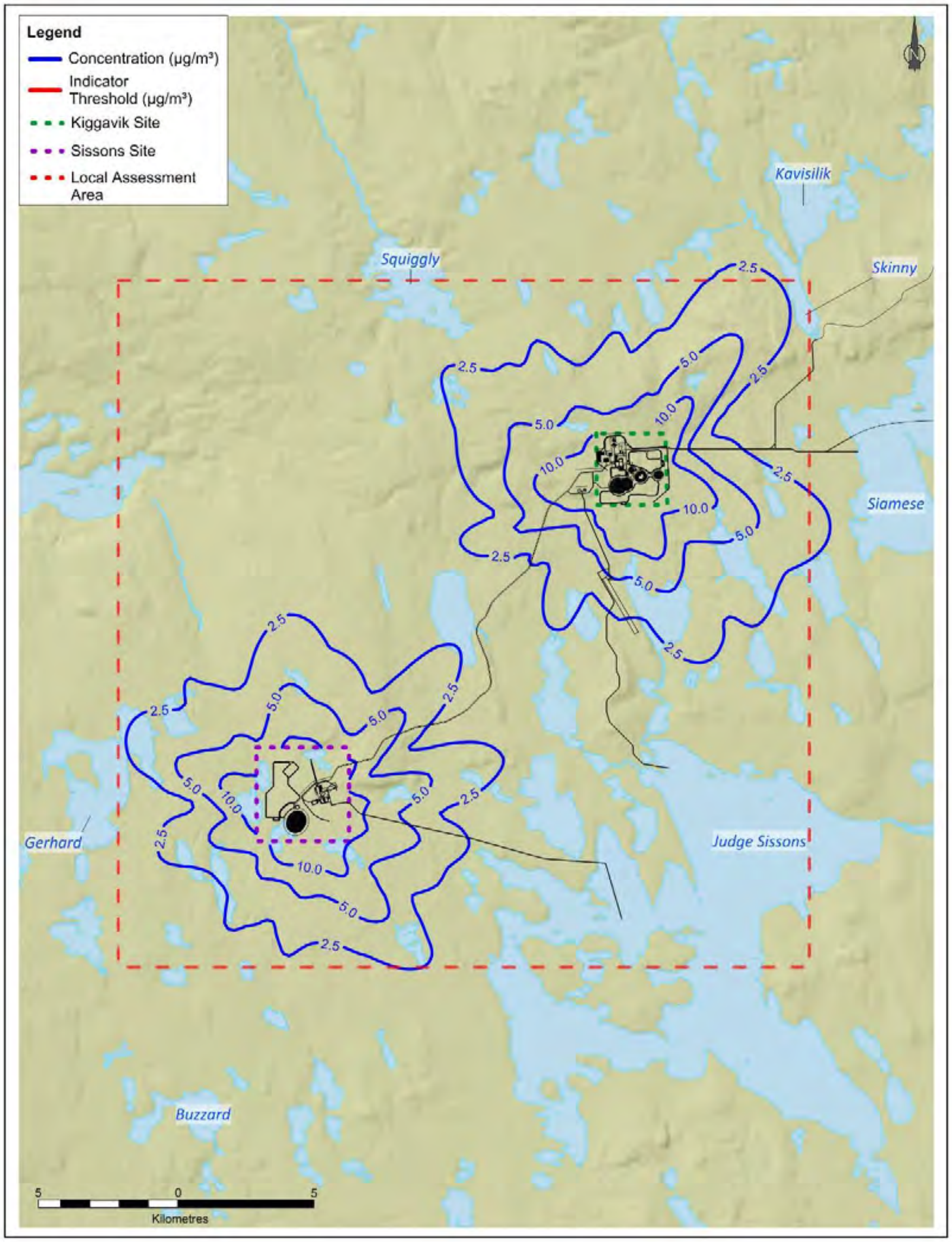

Projection: NAD 1983 UTM Zone 14N
Compiled: SENES Consultants
Date: 05/05/2014
Data Sources: Natural Resources Canada, Geobase®, Nation Topographic Database, AREVA Resources Canada Inc.

FIGURE D-28
Maximum Operations Assessment
24-hour SO_2 Concentration (μg/m³)
ENVIRONMENTAL IMPACT STATEMENT
VOLUME 4: ATMOSPHERIC ENVIRONMENT
Technical Appendix 4B: AIR QUALITY AND CLIMATE

KIGGAVIK OPERATION

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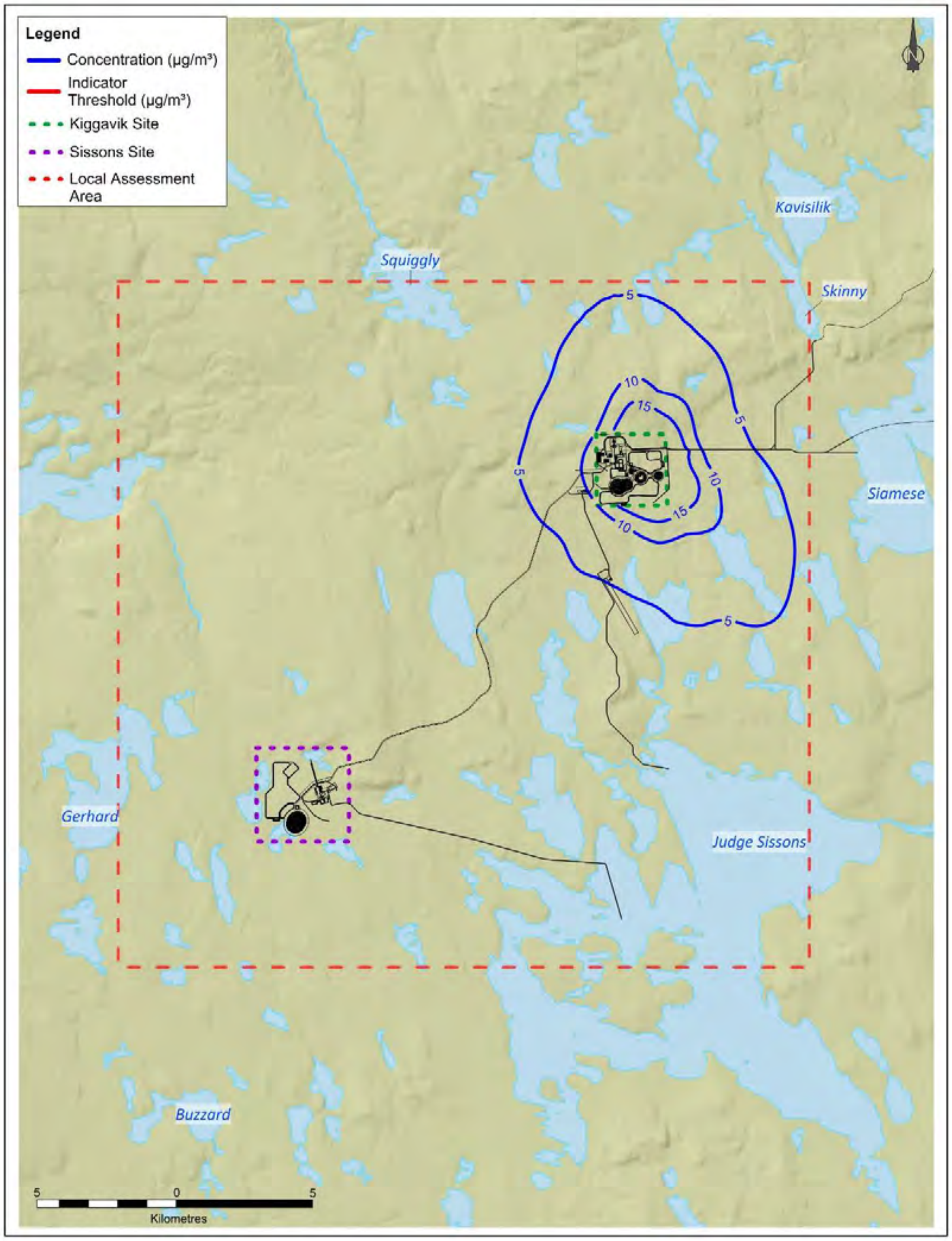

Projection: NAD 1983 UTM Zone 14N
Compiled: SENES Consultants
Date: 05/05/2014
Data Sources: Natural Resources Canada, Geobase®, Nation Topographic Database, AREVA Resources Canada Inc.

FIGURE D-29
Operation Assessment - Phase 1
Annual TSP Concentration (µg/m³)
ENVIRONMENTAL IMPACT STATEMENT
VOLUME 4: ATMOSPHERIC ENVIRONMENT
Technical Appendix 4B: AIR QUALITY AND CLIMATE

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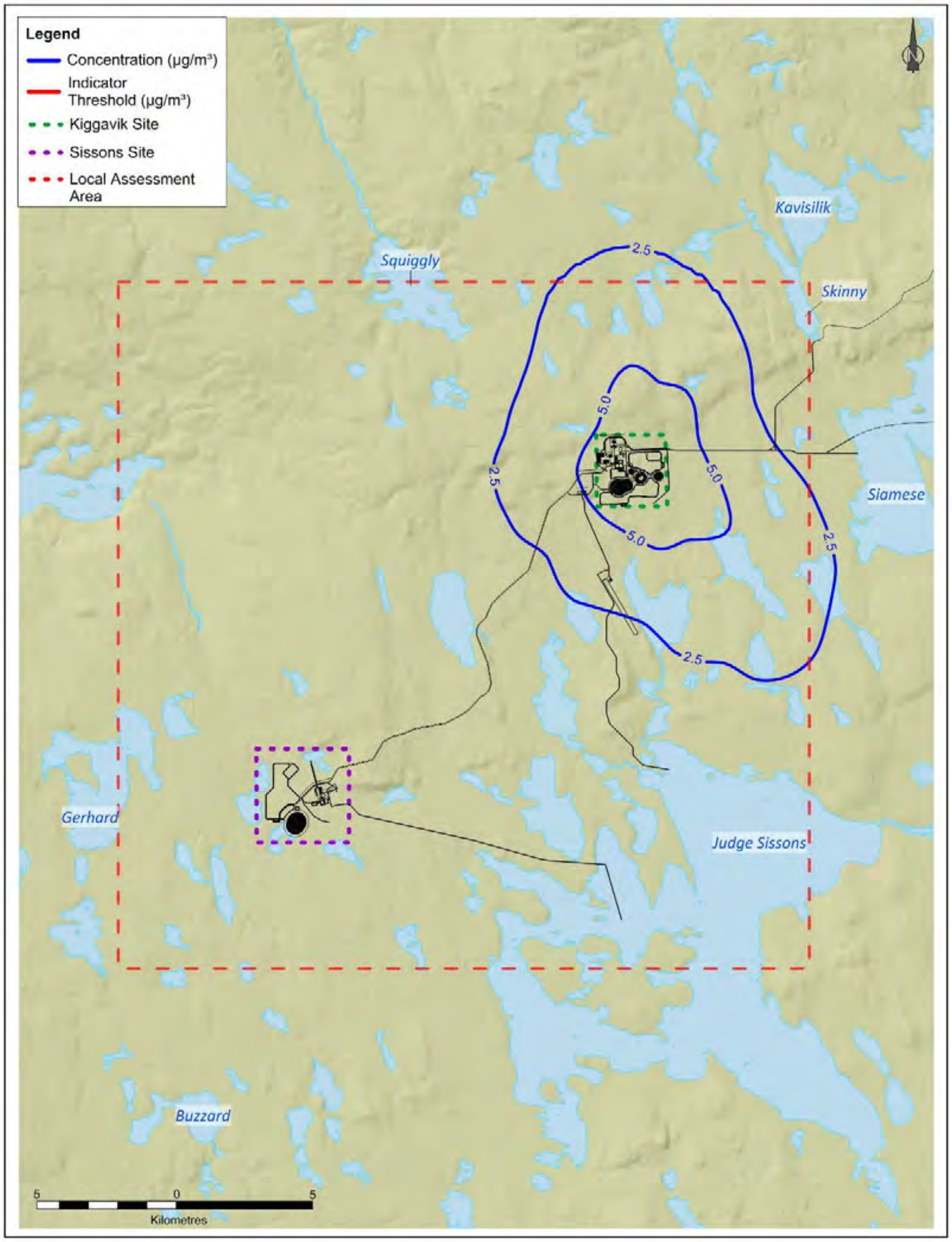

Projection: NAD 1983 UTM Zone 14N
Compiled: SENES Consultants
Date: 05/05/2014
Data Sources: Natural Resources Canada, Geobase®, Nation Topographic Database, AREVA Resources Canada Inc.

FIGURE D-30
Operation Assessment - Phase 1
Annual PM_{10} Concentration (µg/m³)
ENVIRONMENTAL IMPACT STATEMENT
VOLUME 4: ATMOSPHERIC ENVIRONMENT
Technical Appendix 4B: AIR QUALITY AND CLIMATE

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