Legend

——	River
▒	Wetland
▓	Lake

Restricted Range Plant Species*

● *Diapensia lapponica* (Diapensia)

● *Oxytropis arctica* spp. *bellii* (Bell's crazyweed)

▨ Kiggavik Lease

▨ Sissons Lease

▭ Regional Study Area

* Labelled with observation date.
Plant species of restricted range as defined by Cody 1979; McJannet et al. 1993, 1995

Area of Detail

Nunavut

05/08/2005

05/08/2005

Schultz Lake

Qamanaajuk Lake

29/07/2004

02/08/2005 02/08/2005

Whitehills Lake

Skinny Lake

25/07/2008

Siamese Lake

Long Lake

Aberdeen Lake

Judge Sissons Lake

Thom Lake

Thelon River

Baker Lake

Audra Lake

Baker Lake

Pitz Lake

Princess Mary Lake

Mallery Lake

0 2.5 5 10 15 20
Kilometres

FIGURE 4.2-6
RESTRICTED RANGE PLANT SPECIES
IN THE KIGGAVIK REGIONAL STUDY AREA

KIGGAVIK PROJECT - EIS

Gebauer & Associates
ENVIRONMENTAL CONSULTANTS

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5 Soils

5.1 Methods

5.1.1 Literature Review

Historical studies in the area around the Kiggavik Project, largely investigations initiated by Urangesellschaft, were used to review the state of knowledge for the Project area and were integrated as much as possible in the characterization of baseline soil conditions for the Mine Local Study Area (LSA), road LSAs and Regional Study Area (RSA). Wherever possible, comparable historical data were used to describe baseline conditions. Differences in study area, design and methodologies, as well as incompleteness of some datasets, prevented direct comparisons with baseline data collected from 2007 to 2010. At a minimum, the availability of historical data is discussed prior to presentation of baseline data, to provide additional context. A summary table of historical studies related to vegetation resources is provided in Table 5.1-1 (including current baseline studies).

The recent development and proximity of the Agnico-Eagle Mine (AEM) Meadowbank Project located east of the Kiggavik Project and north of Baker Lake makes it a useful source of regional data. Terrestrial baseline studies were completed at Meadowbank from 1999 to 2005 and long-term monitoring studies have been completed from 2006 to 2010. Wherever possible, this information was used to provide additional regional context (AEM 2009, 2010; Cumberland 2005). Other available literature relevant to soils included several small scale (1:100,000 to 1:1,000,000) maps of surficial geology, soils, and topography (AAFC 1996; ESWG 1995, internet site; Natural Resources Canada NTS Sheets 55M, 56D, 65P, 66A and 66B).

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Table 5.1-1   Summary List of Available Baseline Data on Soil Conditions

Year (reference)	Reconnaissance	Land Classification	Soil (descriptive only)	Soil Survey	Soil Chemistry
1985 (Svobada et al. 1985)	-	-	-	-	Mine LSA RSA
1986 (Beak 1987a)	-	LSA RSA	LSA RSA	-	-
1987 (Beak 1987b)	-	LSA	LSA	-	LSA
1989 (Wickware 1990)	LSA (BL) RSA (old road)	Mine LSA RSA (old road)	Mine LSA	-	-
1990 (Geomatics 1990)	Sissons LSA	-	-	-	-
1991 (Geomatics 1991)	-	-	-	Mine LSA	-
2007	-	Mine LSA RSA	-	-	LSA
2008	LSAs	LSAs RSA	-	-	LSA
2009	LSAs	LSAs RSA	-	LSAs RSA	RSA
NOTES: '-' = type of survey was not included BL = Baker Lake dock facility; LSAs = refers to North and South AWAR, and/or Winter Access Road (North or South) LSAs (note that RSA/LSA pre-2007 boundaries are different than presented herein)					

5.1.2   Field Surveys

5.1.2.1 Soil Survey

During the 2009 field season, soil survey plots were completed as part of the Ecological Land Classification (ELC) field surveys described in Section 4.1.2 (see Figure 4.1-1 for 2009 plot locations). Soil pits were excavated to approximately 50 cm or less where bedrock or permafrost was encountered. Soils were described according to the Canadian System of Soil Classification (CSSC 1998). General site characteristics were assessed in 20 by 20 m plots following the methodology established in the Field Manual for Describing Terrestrial Ecosystems (BC MELP and MoF 1998).

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At each location several attributes were recorded to describe the soil horizon layer, including:

- depth;
- grade (weak, moderate, strong);
- class size;
- kind (i.e., sub-angular blocky, angular-blocky, granular);
- consistency;
- colour;
- coarse fragment;
- mottles;
- roots; and
- texture.

5.1.2.2 Soil Chemistry Sampling

The sampling strategy called for the collection of soil samples from 12 sampling locations around the RSA and Mine LSA for chemical analysis (Figure 5.1-1).

In 2007, six 'near-field' locations were identified as permanent sample plots in the Mine LSA and soil samples were collected from each location (KIG1, KIG2 and KIG3, and SIS1, SIS2 and SIS3; see Figure 5.1-1). Based on analysis of preliminary data, recommendations were made to increase the number of sampling locations both inside and outside the Mine LSA to obtain better representation of pre-Project conditions. Consequently, four additional near-field locations were identified in the Mine LSA (KIG4 and KIG5, and SIS4 and SIS5; see Figure 5.1-1). Soil samples were collected at all 10 of these sampling locations in 2008. In 2009, two 'far-field' locations were identified in the RSA in areas outside of the potential influence of mine facilities, as indicated by air dispersion models. In addition to documenting baseline conditions on terrestrial conditions within both the Mine LSA and the RSA, ongoing monitoring of soil chemistry from near-field and far-field sampling locations will help evaluate

Where field survey data were not available, potential soil subgroups were extrapolated from the terrain, surficial material, and vegetation characteristics for the identified ELC units.

5.1.2.3 Soil Chemistry Sampling

The sampling strategy called for the collection of soil samples from 12 sampling locations around the RSA and Mine LSA for chemical analysis (Figure 5.1-1).

In 2007, six 'near-field' locations were identified as permanent sample plots in the Mine LSA and soil samples were collected from each location (KIG1, KIG2 and KIG3, and SIS1, SIS2 and SIS3; see Figure 5.1-1). Based on analysis of preliminary data, recommendations were made to increase the

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number of sampling locations both inside and outside the Mine LSA to obtain better representation of pre-Project conditions. Consequently, four additional near-field locations were identified in the Mine LSA (KIG4 and KIG5, and SIS4 and SIS5; see Figure 5.1-1). Soil samples were collected at all 10 of these sampling locations in 2008. In 2009, two 'far-field' locations were identified in the RSA in areas outside of the potential influence of mine facilities, as indicated by air dispersion models. In addition to documenting baseline conditions on terrestrial conditions within both the Mine LSA and the RSA, ongoing monitoring of soil chemistry from near-field and far-field sampling locations will help evaluate any observed changes as Project activities proceed. Plant tissue (see Section 4 above), and insect and small mammal/bird tissues were also collected at the same locations.

At each of the sampling locations, five sample sites were selected within a 200 to 300 m radius, with a minimum distance of 150 m between sample sites. Coordinates of sampling sites at each of the 12 sampling locations are provided in Attachment A.

5.1.2.4 Soil Chemistry Sampling

The sampling strategy called for the collection of soil samples from 12 sampling locations around the RSA and Mine LSA for chemical analysis (Figure 5.1-1).

In 2007, six 'near-field' locations were identified as permanent sample plots in the Mine LSA and soil samples were collected from each location (KIG1, KIG2 and KIG3, and SIS1, SIS2 and SIS3; see Figure 5.1-1). Based on analysis of preliminary data, recommendations were made to increase the number of sampling locations both inside and outside the Mine LSA to obtain better representation of pre-Project conditions. Consequently, four additional near-field locations were identified in the Mine LSA (KIG4 and KIG5, and SIS4 and SIS5; see Figure 5.1-1). Soil samples were collected at all 10 of these sampling locations in 2008. In 2009, two 'far-field' locations were identified in the RSA in areas outside of the potential influence of mine facilities, as indicated by air dispersion models. In addition to documenting baseline conditions on terrestrial conditions within both the Mine LSA and the RSA, ongoing monitoring of soil chemistry from near-field and far-field sampling locations will help evaluate

Where field survey data were not available, potential soil subgroups were extrapolated from the terrain, surficial material, and vegetation characteristics for the identified ELC units.

5.1.2.5 Soil Chemistry Sampling

The sampling strategy called for the collection of soil samples from 12 sampling locations around the RSA and Mine LSA for chemical analysis (Figure 5.1-1).

In 2007, six 'near-field' locations were identified as permanent sample plots in the Mine LSA and soil samples were collected from each location (KIG1, KIG2 and KIG3, and SIS1, SIS2 and SIS3; see

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Figure 5.1-1). Based on analysis of preliminary data, recommendations were made to increase the number of sampling locations both inside and outside the Mine LSA to obtain better representation of pre-Project conditions. Consequently, four additional near-field locations were identified in the Mine LSA (KIG4 and KIG5, and SIS4 and SIS5; see Figure 5.1-1). Soil samples were collected at all 10 of these sampling locations in 2008. In 2009, two 'far-field' locations were identified in the RSA in areas outside of the potential influence of mine facilities, as indicated by air dispersion models. In addition to documenting baseline conditions on terrestrial conditions within both the Mine LSA and the RSA, ongoing monitoring of soil chemistry from near-field and far-field sampling locations will help evaluate any observed changes as Project activities proceed. Plant tissue (see Section 4 above), and insect and small mammal/bird tissues were also collected at the same locations.

At each of the sampling locations, five sample sites were selected within a 200 to 300 m radius, with a minimum distance of 150 m between sample sites. Coordinates of sampling sites at each of the 12 sampling locations are provided in Attachment A.

Within each sample site, representative grab samples were collected from five separate test pits per sample site and were composited. Samples were collected from depths of approximately two to four centimeters below ground level, although collection depths varied as surface organic and permafrost depths were not static. Samples targeted the 'A', 'B' and 'C' soil layers between the surface organic layer and permafrost layer. Standard sampling procedures were followed for quality assurance/quality control (QA/QC). Samples were collected using stainless steel trowels and garden shovels. All equipment was sterilized after each use with Liqui-Nox (mixed according to bottle instructions) dispensed from a squeeze bottle. Field staff wore latex gloves. Samples were placed in new Zip-Loc bags, stored in a cooler, and shipped on ice directly to the laboratory.

In 2007, peat and mineral soil were collected and analyzed separately but differences in chemistry were minimal; therefore, only mineral soil samples were collected in 2008 and 2009.

5.1.3   Laboratory Analysis

5.1.3.1 Soil Analysis

Soil samples were sent to Saskatchewan Research Council (SRC) Analytical Laboratories (Saskatoon, SK) and analyzed for pH, total metals, and radionuclides. For the Mine LSA, all 61 discrete samples collected in 2007 and 2008 were analyzed for metals. All 10 discrete samples from the RSA (five from each sampling location) were analyzed for metals and radionuclides.

Samples collected from the Mine LSA for radionuclide analysis included a combination of discrete and composite samples based on quantities collected, but together provided appropriate representation of the near field and far field sampling areas. In 2007, 11 samples (separated for peat and mineral soil) were analyzed for radionuclides (one sample of mineral soil collected at each of the

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six sampling locations, and one sample of peat collected at all locations except SIS3). In 2008, 20 discrete samples (two from each sampling location) and 11 composite samples were analyzed for radionuclides. These composite samples included one composite from each sampling location, plus an extra sample from KIG4.

Details on analytical methods are provided in Attachment B. Parameters analyzed included:

- Elemental analysis by ICP Atomic Emission Spectroscopy (ICP-AES) and Inductively Coupled Plasma Mass Spectrometry (ICP-MS);
- Radium-226, Thorium isotopes and Polonium-210 by Alpha Spectroscopy;
- Lead-210 by Beta Counting of the Bismuth-210 Successor Product;
- Strontium-90 by counting on a low background gas-flow proportional counter; and
- Cesium-137 by Gamma spectroscopy.

5.1.4   Data Analysis

5.1.4.1 Chemistry Data

Basic statistics (i.e., mean, standard deviation, minimum and maximum) were used to analyze chemistry data from the available baseline database. Data were summarized separately for the Mine LSA and RSA sampling locations. Statistical calculations used a value equivalent to half of the detection limit value for results below detection limit, considered to be a conservative estimate. Using these summary statistics, comparisons could be made between different areas, such as stations within the Mine LSA and RSA, and different years (i.e., more recent data from 2007 to 2009 compared to historical data, where available).

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