DE BEERS

CANADA

GAHCHO KUÉ PROJECT

# Environmental Monitoring & Management Framework

**May 2012**

# TABLE OF CONTENTS

**SECTION** **PAGE**

## LIST OF FIGURES



## LIST OF APPENDICES

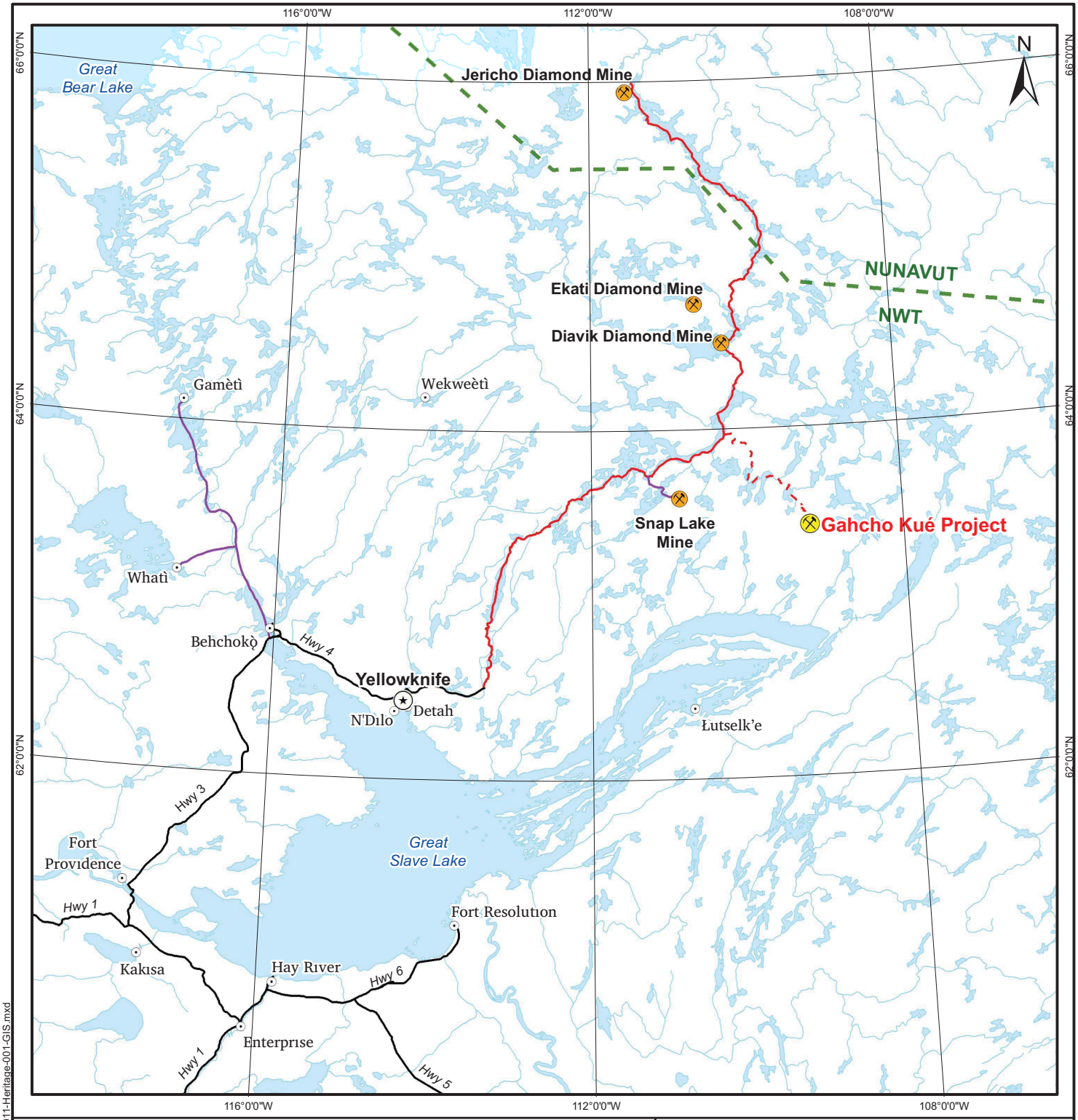
# 1 PROJECT OVERVIEW

The Gahcho Kué Project (Project) as proposed by De Beers Canada Inc. (De Beers) consists of an open pit mine located at Kennady Lake. The Project is located approximately 80 km southeast of the Snap Lake Project, approximately 140 km northeast of the nearest community, Łutselk'e, and 280 km northeast of Yellowknife (Figure 1 in De Beers 2010). Kennady Lake is an 870 ha lake that lies in the headwaters of the Lockhart River system, which eventually flows into Great Slave Lake located approximately 340 km downstream.

The Project is expected to begin in Year 1, with two years of construction during Years -2 and -1. Kimberlite will be mined from three open pits and processed during an eleven-year (Year 1 to 11) operational period. Progressive reclamation will occur during operations, with closure anticipated in Year 13. Further Project details can be found in Section 3 of the 2012 Environmental Impact Statement (EIS) Supplement (De Beer 2012).

In December 2010, De Beers submitted the Gahcho Kué Environmental Impact Statement (EIS; De Beers 2010) to the Gahcho Kué Panel for review, which described the potential effects of the Project on the environment. A number of updates were made to the document in 2011 and 2012, including the July 2011 EIS Conformity Response (De Beers 2011) and the 2012 EIS Supplement (De Beers 2012) submitted to the Panel in April 2012. High level discussions of monitoring programs, as required in the Project Terms of Reference (TOR; Gahcho Kué Panel 2007), were included throughout the EIS.

This document aims to demonstrate De Beers' commitment to proactively develop monitoring programs with consideration of adaptive management, input from regulators and communities, and with due consideration of available Traditional Knowledge (TK). This integration of information has been initiated with the creation of the present document, the Environmental Monitoring and Management Framework (EMMF).




## LEGEND

- Gahcho Kué Project
- Existing Mine
- Territorial Capital
- Populated Place
- Highway
- Existing Winter Road
- Tibbitt-to-Contwoyto Winter Road
- Winter Access Road
- Watercourse
- Waterbody
- Territorial/Provincial Boundary

NOTES
Source: Figure 1.1-1 in De Beers 2010
Base data source: The Atlas of Canada

# GAHCHO KUÉ PROJECT

## Location of the Gahcho Kué Project

| | | |
|---|---|---|
| PROJECTION: Canadian Lambert Conf. Conic | DATUM: NAD83 | |
| Scale: 1:3,500,000 (50 25 0 50 Kilometres) | | |
| FILE No: B2012-Heritage-001-GIS | | DATE: February 7, 2012 |
| JOB NO: 11-1365-0012 | REVISION NO: 8 | Figure 1 |
| OFFICE: GOLD-CAL | DRAWN: JH | CHECK: |

I:\CLIENTS\DE BEERS\11-1365-0001\Mapping\MXD\General\Section1\B2011-Heritage-001-GIS.mxd

# 2 FRAMEWORK OVERVIEW

## 2.1 OBJECTIVE AND SCOPE

The EMMF outlines the functional integration of monitoring programs within an adaptive management approach. As such, this EMMF document describes monitoring components, interaction among components, and the process that links these to adaptive management. Adaptive management was discussed extensively in a recent guidance document for application in aquatic effects monitoring programs in the Northwest Territories (WLWB 2010). In this document, an Adaptive Management Response Framework is proposed, which links monitoring results to management response. It is acknowledged that the exact definition of adaptive management varies among monitoring components, but typically adheres to having four themes as follows:

1. learning in order to reduce management uncertainties;
2. using what is learned to change policy and practice;
3. focusing on improving management; and
4. doing the above in a formal, structured and systematic way.

The following key monitoring components are discussed as part of the EMMF:

- Terrestrial Ecosystem Monitoring Program (TEMP), including the Wildlife Monitoring Program (WMP) and the Soils and Vegetation Monitoring Program (SVMP);
- Aquatic Effects Monitoring Program (AEMP),
- Groundwater Monitoring Program (GMP); and
- Air Quality Monitoring Program (AQMP).

While the Surveillance Network Program (SNP) is a compliance monitoring requirement under the water licence, the SNP is discussed as relevant to the AEMP. Considerations are presented towards developing the AEMP and SNP to complement each other and avoid duplication in data collection and reporting. A coordinated effort will also be made with other regulatory monitoring requirements that may apply to the Project.

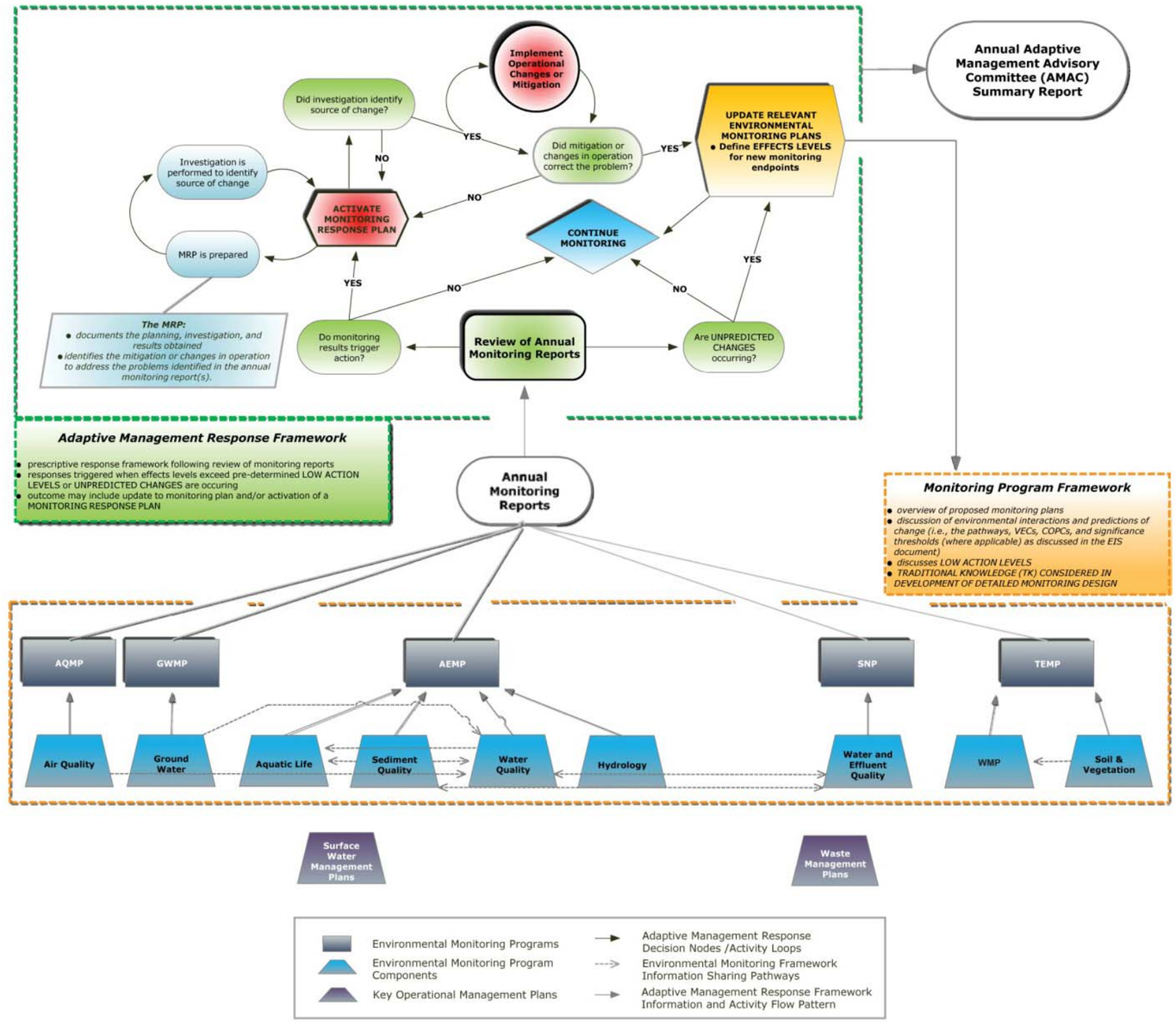
Although similar monitoring programs exist at other mine sites, detailed study designs are site-specific and cannot be broadly applied without due consideration. Therefore, the EMMF provides the approach being considered for

various environmental components, and not the fully developed environmental monitoring programs, which will be advanced as part of the permitting phase for the Project. Detailed monitoring program development requires substantial work and involves considerable regulatory, community and stakeholder input, and careful consideration of available TK. Therefore, **it is understood that some monitoring components may be adjusted as the Project proceeds through the Environmental Impact Review (EIR) process based on on-going monitoring, stakeholder input, the Panel's decision report and the subsequent permitting process.**

## 2.2 CONCEPT DIAGRAM

In an effort to effectively integrate environmental monitoring for the Project with an adaptive management approach, a preliminary concept diagram was developed that visually represents the connections and inter-dependencies among monitoring programs, and outlines the actions to be taken at various stages of the monitoring and adaptive management process (Figure 2). The lower part of the concept diagram encompasses the individual monitoring components and indicates their over-arching environmental monitoring programs (e.g., AEMP, TEMP). The upper half of the concept diagram is the Adaptive Management Response Framework, which includes the management and monitoring response pathways to be taken in the event of unpredicted changes occurring in the environment.

**Figure 2 Gahcho Kué Project Environmental Monitoring and Management Framework: Preliminary Concept Map**



The Adaptive Management Response Framework will be implemented collaboratively by an Adaptive Management Advisory Committee(s) coordinated by De Beers. The committee will be responsible for reviewing monitoring reports and providing input on areas of study and management actions.

At the core of successful adaptive management is the functional integration of multiple monitoring programs, and effective communication at all levels. The necessity of communication within the EMMF is indicated by the arrows in Figure 2. Arrows in the lower part of the diagram represent the inter-relationships among monitoring components and the necessary information sharing pathways for effective interpretation of environmental data analysis.

If the results of a monitoring program indicate that predicted changes are occurring beyond what was predicted, a Monitoring Response Plan will be developed, and efforts will then be initiated to identify and respond to the source of the change. Other adaptive outcomes of the response framework may include the continuation of monitoring as planned, or adjusting the monitoring effort as necessary. The advisory committee would prepare an annual summary report of outcomes of the Adaptive Management Response Framework.

## 2.3 TRADITIONAL KNOWLEDGE

Traditional Knowledge (TK) generally refers to the long-standing traditions and practices of local communities. It considers the wisdom, knowledge, and teachings of the people and in particular, the elders within these communities (INAC 2009a). The need to understand what is happening to the land, water, and wildlife through monitoring is a common comment made by community members regarding mining in the North. De Beers understands that TK about the land and the environment can bring a different perspective than western science. Where provided, TK will be used to improve monitoring programs and management practices.

TK-based monitoring programs may also be undertaken to address key concerns with results being shared through the Adaptive Management Advisory Committee. Additional information regarding TK related to the Project can be found in the EIS document, in Section 5 and Annex M (De Beers 2010).

# 3 TERRESTRIAL ECOSYSTEM MONITORING PROGRAM

## 3.1 SCOPE

The primary influences to the terrestrial ecosystem from the Project are related to vegetation and habitat loss, and changes to habitat quality (from factors such as dust). Environmental design features and mitigation are intended to limit the magnitude, duration, and geographic extent of these Project effects.

The Project will lead to the direct loss and alteration of vegetation and landscape features that currently provide wildlife habitat within the Project footprint. This includes tundra, ponds, riparian zones, and rocky areas. These local changes in habitat can influence the abundance and distribution of wildlife, particularly species with small seasonal ranges such as upland breeding birds. The Terrestrial Ecosystem Monitoring Program is anticipated to consist of a wildlife component, and a soil and vegetation component.

## 3.2 WILDLIFE MONITORING PROGRAM

### 3.2.1 Objectives

This conceptual WMP presented in this section outlines how De Beers proposes to monitor wildlife surrounding the Project. In the EIS, no significant effects were predicted on the abundance and distribution of wildlife from the addition of the Project to the existing landscape. Environmental design features and mitigation are intended to limit the magnitude, duration, and geographic extent of effects from the Project on wildlife.

The WMP will be designed to determine the effectiveness of mitigation, reduce uncertainties, suggest new mitigation, and contribute to regional monitoring initiatives. The WMP will be designed to achieve the following specific objectives:

- monitor the Project's effect on wildlife;
- determine the effectiveness of environmental design features and mitigation based on monitoring results, and if required, identify new environmental design features and mitigation;

- identify opportunities to participate in regional and collaborative monitoring programs to support cumulative effects assessment and management.

In a broad context, the monitoring proposed within this document falls into one of two broad categories.

1. Site surveillance monitoring, feeding directly into the adaptive management of mine operations. Examples include monitoring wildlife observations and wildlife interactions with the Project. Supplemental targeted studies may be developed as needed through the Adaptive Management Response Framework.
2. Regional monitoring, which contributes to collaborative regional or national monitoring initiatives generally focused at the population level. An example of regional monitoring is contributions to the Barren-ground Caribou Management Strategy.

Documents reviewed to develop this monitoring plan included:

- The Snap Lake Wildlife Effects Monitoring Program (De Beers 2008);
- The Snap Lake Wildlife Management Plan (De Beers 2007);
- The Jericho Diamond Project Wildlife Mitigation and Monitoring Plan (Tahera 2005);
- The Diavik Diamond Mine Wildlife Monitoring Report (DDMI 2010);
- The Ekati Diamond Mine Wildlife Monitoring Report (BHP Billiton 2010); and
- Report of the diamond mine monitoring workshop (Marshall 2009).

Wildlife monitoring components being considered by De Beers include the following:

- wildlife surveillance monitoring;
- monitoring of direct habitat loss and alteration;
- waste management monitoring;
- monitoring of public access to the Project Winter Access Road;
- site monitoring for selected wildlife species;
- contributions to regional monitoring for selected wildlife species.

Each of these components is discussed in further detail in the following sections.

### 3.2.2 Wildlife Surveillance Monitoring

Wildlife is expected to continue to be present in the vicinity of the Project during construction, operation, and closure and some wildlife species are attracted to human activity. Thus, interactions between the Project and wildlife are anticipated. Incidents are defined here as any wildlife interaction that requires a response by Project personnel. Species that are often attracted to industrial developments in the NWT include gulls, ravens, fox, wolverine, and bears.

Wildlife surveillance monitoring is proposed to identify the species, number, and location of wildlife incidents, identify risks to wildlife and construction crews, and to describe general effects to wildlife. General monitoring also includes recording the presence of all wildlife (i.e., common and uncommon species, and species at risk) within and around the Project footprint. The program is intended to provide direct feedback on project mitigation to site operations particularly regarding the effectiveness of waste management and wildlife management practices.

Surveillance monitoring of wildlife presence and movements within and around the Project will help to keep environment staff apprised of wildlife activity and the potential for problems, and estimate the effectiveness of mitigation. Regular inspections for wildlife or fresh wildlife sign around the Project, and regular communication with all staff will provide early warning of wildlife presence on-site before issues arise. This survey will consist of an inspection of all areas in the Project site, scanning observations of wildlife, and records of recent wildlife sign (e.g., tracks, scat). The survey will be completed on foot and by truck, and environment staff will record the area surveyed, and the nature and location of all observations.

Project staff and contractors will be required to report all observations of large mammals to environment staff, both at the Project site, and along the Winter Access Road. Environment staff will respond to, investigate, and record the presence and incidents involving deterrent actions, injury, or mortality of animals, and complete follow-up procedures or actions as necessary. Wildlife sighting logs will be maintained at various areas around the Project site for staff to record observations of wildlife. If wildlife mortality occurs, environment staff will conduct an investigation to determine the cause, collect photographs, and store the carcass until further notice from the department of Environment and Natural Resources (ENR). All wildlife sightings, deterrent actions, injuries, and mortalities will be reported in the annual Wildlife Monitoring Report.

Surveys for wildlife presence within and around the Project will occur systematically at least once per week. Investigation and reporting of incidents will be completed as they occur. Monitoring will be continuous throughout the construction, operation, and closure phases of the Project. Environment staff may at any time suggest changes to environmental design features, mitigation practices, or the need for additional training for staff, as a result of their investigations.

### 3.2.3 Monitoring Direct Habitat Loss and Alteration

Construction of the Project will lead to the direct loss and alteration of vegetation and landscape features that currently provide wildlife habitat, such as tundra vegetation, ponds, and riparian zones. These local changes in habitat can influence the abundance and distribution of wildlife.

These changes will predominantly occur in phases throughout operation. Following initial construction of the Project, there will be several distinct phases of operation as each ore body is mined, as the rock piles and processed kimberlite containment facilities expand, and areas of Kennady Lake are isolated. It will be necessary to maintain a record of the actual sequence of operations to document habitat loss and alteration.

As-built drawings of the Project footprint and facilities will be prepared. These will be used to document the total Project area, compared against existing vegetation maps to estimate vegetation classes disturbed, and as a measure of habitat loss for wildlife.

Typically, these maps are created through the purchase of satellite imagery, then delineated and digitized in a GIS platform. However, De Beers may suggest alternate means of producing the as-built maps if the information is available through engineering activities.

### 3.2.4 Monitoring Waste Management

Carnivores and scavengers have a keen sense of smell and can be attracted from long distances if food items are frequently present. Mining projects in the Arctic have reported carnivore and scavenger attraction, including wolverine, fox, grizzly bear, raven, and gulls. This increases the risk for accidental mortality of wildlife (e.g., collisions with vehicles) and the potential for wildlife interactions with the Project.

Good waste management practices and staff education are key to decreasing the availability of attractants at mine sites. Environmental design features, mitigation, and management plans will be implemented at the Project to limit the attraction of wildlife, and the associated increased risks of wildlife interactions and wildlife mortality. These mitigation strategies will be similar to management practices and policies tested at other mines, including Snap Lake, in the NWT and Nunavut (e.g., De Beers 2008).

In conjunction with the weekly Wildlife Surveillance Monitoring, environment staff will complete inspections of all waste management process components that involve potential attractants. The process will be described in the Waste Management Plan. Inspections will include surveys of waste storage, transfer, incineration, landfill, and grey and sewage water treatment. Observations of wildlife and wildlife sign near waste or waste management facilities will be recorded. Wildlife incidents and wildlife deterrent actions will be reported to determine if they were linked to waste management processes.

Inspections will be completed by environment staff, and will document the areas inspected, the attractants found, any infractions of the Waste Management Plan, and follow-up actions. Inspections will be completed systematically at least once per week throughout the year and during construction, operation, and closure.

Should the inspections identify potential or actual availability of wildlife attractants (food waste in particular), or should observations of wildlife, wildlife sign, or wildlife incidents point to problems in the waste management process, immediate corrective actions will be taken or suggested by the environment staff. Some level of wildlife activity is anticipated regardless of the efficiency of waste management, as wildlife may be present naturally, or be attracted to site, even if there is no food reward. Regardless, the potential or actual availability of food waste for wildlife will be the trigger to initiate an investigation and corrective action.

### 3.2.5 Monitoring of Winter Road Access

A 120-km Project Winter Access Road, at kilometre 271 of the Tibbitt-to-Contwoyto Winter Road (Mackay Lake), is proposed (Figure 3). The winter road is currently permitting and has been used occasionally to bring supplies to the exploration site. Should the Project proceed, it would require that the existing Winter Access Road be used annually into closure. Concerns regarding the access road relate to the potential for increased harvesting of caribou.


## LEGEND

- Gahcho Kué Project
- Tibbitt-to-Contwoyto Winter Road
- Winter Access Road
- Watercourse
- Waterbody
- Index Contour (100m interval)
- Intermediate Contour (20m interval)

NOTES

Source: Figure 3.10-2 in De Beers 2010
Base data source: National Topographic Base Data (NTDB) 1:250,000

# GAHCHO KUÉ PROJECT

## Winter Access Road to Project Site

| | |
|---|---|
| PROJECTION: UTM Zone 12 | DATUM: NAD83 |
| Scale: 1:500,000 | |
| 10 5 0 10 Kilometres | |
| FILE No: P2011-Other-045-GIS | DATE: March 9, 2012 |
| JOB NO: 11-1365-0001 | REVISION NO: 1 |
| OFFICE: GOLD-CAL | DRAWN: CW / CHECK: PT |

De Beers Canada

**Figure 3**

I:\CLIENTS\DE_BEERS\11-1365-0001\Mapping\MXD\General\Section3\P2011-Other-045-GIS.mxd

Three options are being considered to monitor road use by non-Project vehicles.

- Regular and frequent inspections of the road undertaken by De Beers Protective Services personnel. Inspections are undertaken by driving the length of the Winter Access Road between the Project site and Mackay Lake (i.e., km 271 of the Tibbitt-to-Contwoyto Winter Road). All observations of non-Project vehicles would be recorded and provided in annual reports. This information will be provided immediately to ENR if a concern is identified. A standardized reporting form will be developed in consultation with ENR.
- Hiring a community monitor, who will be stationed at a rest stop along the road. Check in by non-Project road users would be voluntary. Observations of non-Project vehicles would be recorded and provided in annual reports, or immediately to ENR in the event a concern is noted. A standardized reporting form will be developed in consultation with ENR.
- ENR may choose to establish an access monitoring station through the Tibbitt-to-Contwoyto Winter Road Joint Venture.

### 3.2.6 Caribou

Barren-ground caribou are a migratory species that show a large degree of variation in migration routes from year to year. Barren-ground caribou from the Bathurst herd are the most likely population to occur in the regional study area (RSA), although Ahiak and Beverly barren-ground herds may also be present occasionally.

Caribou that enter the Project site may be at risk from mine infrastructure and activities (e.g., vehicle and aircraft collisions). Mitigation, particularly caribou protection procedures, is anticipated to limit the risks to the health, injury, and mortality of caribou. Wildlife Surveillance Monitoring is expected to determine the effectiveness of mitigation and caribou protection procedures, and provide information for further mitigation and protection if required.

Environment staff will document the presence of caribou near construction areas, summarize observations of caribou, communicate this information to construction managers, and carry out any deterrent action that may be necessary. Further, movements of satellite collared caribou will be monitored to provide an indication of approaching caribou, and may be used to monitor habitat use in the RSA.

De Beers recognizes the importance of caribou to the culture and economy of the Northwest Territories. Concerns have been raised regarding possible cumulative

effects of harvesting, development, and climate change to caribou (ENR 2011). De Beers proposes to contribute to population level monitoring of the Bathurst caribou herd, the strategy of which is outlined in the Barren-ground Caribou Management Strategy (ENR 2011). Although the details of this contribution have not yet been defined, discussions between ENR and De Beers continue.

### 3.2.7 Wolves

Baseline studies of wolf denning in the RSA indicated that wolf denning density is very low. Further, monitoring at other diamond mines has indicated that wolves continue to use historic denning locations within the respective study areas. As wolf dens are found in low density, they do not provide useful indicators of mine-related effects to wildlife. However, ENR is undertaking regional monitoring of wolf populations and predation, as a component of the Barren-ground Caribou Management Strategy (ENR 2011). De Beers has contributed to this monitoring initiative in 2012 and will consider future contributions to this initiative.

### 3.2.8 Grizzly Bears

A joint regional grizzly bear monitoring proposal is being discussed among ENR, and Rio Tinto Canada Inc., BHP Billiton Canada Inc., and De Beers Canada Inc. The monitoring would centre on the Ekati, Diavik, Snap Lake and proposed Gahcho Kué mines. The proposal involves deployment of standardized hair snagging posts over a 30,000 $km^2$ area. Discussions among De Beers, ENR, and the other partners are currently underway to advance the monitoring program.

### 3.2.9 Wolverine

The Western population of Wolverine is currently not considered a species at risk (Appendix I) although the GNWT is currently undertaking studies to collect information on the age classes, sex ratio, home ranges and harvest patterns of wolverine on the tundra. There have been wolverine mortalities at other mine sites in the region however the number of such incidents has decreased notably, as waste management practices have improved. Hair snagging studies were undertaken in the study area in 2004 and 2005, and snow tracking was undertaken in 2011 and 2012 to collect baseline data. De Beers will consider participating in regional monitoring pending re-assessment of the COSEWIC status of western populations of wolverine in 2013, and subject to further discussion with ENR.

Wolverine hair snagging following methods described in Boulanger et al. (unpublished) is proposed as the primary means of monitoring wolverine. The monitoring schedule used at other diamond mines has been two consecutive years of 'baseline', and monitoring three years following.

### 3.2.10 Raptors

Raptors are birds of prey and include falcons, eagles, hawks, and owls. Raptor species observed nesting within the RSA include peregrine falcon (likely the tundris subspecies), gyrfalcon, rough-legged hawk, and short-eared owl. Of these, the peregrine falcon and the short-eared owl are considered species at risk. The nearest active nest site is 18 km from the proposed mine site.

Mitigation involves reducing the likelihood of raptors nesting at site, through the Wildlife Surveillance Monitoring. Environment staff will include surveys for raptor nesting activity within the Project site, as part of the Wildlife Surveillance Monitoring. Any reports or observations of raptor nesting activity on Project structures or within open pits will be documented and reported. In these cases, the follow-up action will be determined in consultation with ENR, and will consider any hazards to the nest. Ideally, the nest will be allowed to remain intact and Project staff will be requested to avoid disturbing the nest. Further monitoring is proposed to contribute to the North American Peregrine Falcon Survey.

To contribute data to the North American Peregrine Falcon Survey, nest site visits will be completed by helicopter using standard fly-by methods to identify occupying species and to count eggs and young. Nest sites will be visited during late May or early June to determine occupancy, and during mid to late July to determine nest success and productivity. Nests will be considered occupied if at least one adult bird is observed. Nests will be recorded as successful if at least one chick is observed in the nest. The presence of eggs and chicks will be noted, and the number of eggs and chicks will be recorded, if possible. Raptor nest monitoring data may be made available to ENR for regional monitoring purposes, or to the North American Peregrine Falcon survey, which occurs every five years (next scheduled for 2015).

### 3.2.11 Waterbirds

Waterbirds include ducks, geese, loons, and grebes (and the horned grebe, considered a species at risk). Because of the Project, there will diversion of water, de-watering of Kennady Lake, and effluent discharge.

To provide for the safety of waterbirds using the Project area, the collection ponds and Water Management Pond will be surveyed from the ground for the presence of waterbirds as part of Wildlife Surveillance Monitoring. Weekly surveys will be completed for waterbirds during the open-water season (likely May to November or until they have flown south to wintering areas) from construction through closure. Environment Canada will be informed if there is regular use of Water Management Ponds by waterbirds.

### 3.2.12 Shorebirds

Shorebirds (including plovers and sandpipers) are found in low densities in the central Canadian Arctic. The value of monitoring this community is limited, and shorebirds are not monitored at other diamond mines. However, there is a standard technique for monitoring shorebirds, the Protocol for Regional and International Shorebird Monitoring (PRISM). De Beers is considering contributing to regional population monitoring through the PRISM initiative.

### 3.2.13 Songbirds

Songbirds (including sparrows, finches and other small perching birds) are abundant and easily monitored on the barren-lands. Monitoring of songbird density and diversity at other diamond mines has indicated that songbirds continue to be present and breed next to the mine footprint (Male and Nol 2005). However, as there is little monitoring of long-term trends in upland bird populations in Canadian tundra environments, De Beers is considering a monitoring program to contribute to international monitoring initiatives. The program eBird (ebird.org) provides an on-line bird checklist database that users can contribute data. The eBird program collects observations from birders, then shared with a global community of educators, land managers, ornithologists, and conservation biologists. Monitoring of songbirds near the Project in a manner compatible with eBird is being considered.

## 3.3 SOILS AND VEGETATION MONITORING PROGRAM

### 3.3.1 Objectives

This conceptual SVMP presented in this section outlines how De Beers proposes to monitor soil and vegetation surrounding the Project. In the EIS, no significant effects were predicted on either of these components and there are no rare soil or vegetation types in the project area. Environmental design features and mitigation are intended to limit the magnitude, duration, and geographic extent of effects from the Project on soils and vegetation.

The SVMP will be designed to determine the effectiveness of mitigation, reduce uncertainties, and suggest new mitigation.

Soil and vegetation monitoring components being considered by De Beers include the following:

- general soil and vegetation monitoring; and
- progressive reclamation monitoring.

Each of these components is discussed in further detail in the following sections.

The soil and vegetation study area will generally be equivalent to that defined in baseline studies, and corresponds with the boundaries established for the wildlife baseline local study area (LSA) (De Beers 2010, Annex F). The boundaries were chosen based on the area that may be influenced by the Project, and where the majority of direct Project-related effects will likely occur. The LSA is also intended to capture small-scale indirect effects, such as dust deposition.

### 3.3.2 Soil Monitoring

The present scope of the proposed monitoring for soil is consistent with the monitoring programs conducted at other northern diamond mines. In terrestrial areas, dust deposition and air emissions may alter soil properties by deposition of metals and other airborne contaminants, which could influence vegetation and terrestrial wildlife.

A small network of monitoring stations (e.g., $SO_2$ and $NO_2$, particulates, and dustfall) will be established around the Project site, targeting locations where vegetation and soils are considered most sensitive and where predicted concentrations and dust deposition rates are elevated. This program will involve the establishment of permanent plots that can be monitored throughout the Project life. Baseline data will be collected prior to Project construction. At the permanent plots, both soil and vegetation material will be monitored for various parameters, including metals. In addition, soil chemistry, such as pH will also be measured. This program will collect data every four to five years to evaluate changes in environmental quality over time.

A permafrost monitoring program will also be established to monitor active layer depths and soil temperature changes over time. For a period of time following closure, additional monitoring sites will be established on the reclaimed mine areas to allow monitoring of re-establishment of permafrost.

### 3.3.3 Vegetation Monitoring

The scope of the proposed vegetation monitoring is consistent with the monitoring programs conducted at other northern diamond mines. With the development of the Project and associated road infrastructure, there is potential for localized effects to vegetation composition and abundance as a result of dust deposition. As such, a Permanent Vegetation Plot (PVP) monitoring program will be established to examine vegetation composition and abundance over time to determine if Project operations are having an effect on tundra vegetation communities

The plot distribution plan will be developed prior to arriving in the field and maybe refined in the field to account for local microsite variations. An estimate of plant species percent cover for all vascular and non-vascular (e.g., mosses and lichens) plant species within the PVP will be made. In cases where non-vascular or vascular plants cannot be identified in the field, specimens will be collected for identification by vascular or non-vascular plant experts.

### 3.3.4 Progressive Reclamation Monitoring

Monitoring data will be collected during surveys associated with progressive reclamation, to evaluate the success of reclamation and provide information to guide subsequent reclamation efforts. The reclaimed sites to be monitored will be selected based on the locations and type of reclamation activities, and will be fully documented. Information collected at each reclamation monitoring site will include the following:

- a description of the type of previous development (e.g., mine pit, roads, etc.);
- a description of the reclamation activity (e.g., reclamation material depths, re-contouring, seed mix);
- the date when the reclamation activities were initiated and completed;
- the vegetation types;
- the specific data pertaining to vegetation, soils and wildlife at each site; and
- periodic follow-up activity.

Data collected during reclamation monitoring will be analyzed to track changes and trends in reclamation success.

# 4 AQUATIC ECOSYSTEM MONITORING

## 4.1 OBJECTIVE AND SCOPE

The approach to aquatic effects monitoring is conceptual at this time. Detailed study designs and methods will be developed for the licensing phase of the Project, with an attempt to coordinate the AEMP with other regulatory monitoring and reporting requirements. This document serves to compile the current state of information and anticipated approach of the various aquatic monitoring programs. The overall objectives of aquatic ecosystem monitoring for the Project are as follows:

- to evaluate the short-term and long-term effects of the Project on the aquatic ecosystems of surrounding and downstream surface waters;
- to compare the results of monitoring to EIS predictions;
- to provide the data necessary for adaptive management; and,
- to evaluate the effectiveness of environmental design features and mitigation implemented as part of project design and adaptive management.

The Aquatic Effects Monitoring Program (AEMP) will consider the guidelines prepared by Aboriginal And Northern Affairs Canada (AANDC) on designing and implementing programs in the Northwest Territories (INAC 2009b), and the draft guidance for applying traditional knowledge in the design of AEMPs (INAC 2009c). Consideration will also be given to the draft adaptive management guidelines from the Wek'éezhìi Land and Water Board (WLWB 2010).

## 4.2 AQUATIC EFFECTS MONITORING PROGRAM

Major components of the AEMP are anticipated to include hydrology, water quality, sediment quality, lower trophic communities (i.e., plankton, periphyton and benthic invertebrates), and fish (health, tissue quality and populations). Of these components, plankton and periphyton monitoring will begin as special studies and will only be included in the final AEMP design if their value and feasibility are demonstrated during the special studies. A hydrology component is included because predicted stream flow and water level changes necessitate collection of data to support biological monitoring components and verification of EIS predictions. Fish habitat compensation monitoring and groundwater monitoring will also be undertaken, but would not be part of the AEMP.

Although the Adaptive Management Response Framework would be implemented annually to review AEMP reporting, it is expected a comprehensive review of the AEMP study design and associated data will be undertaken every three to five years.

### 4.2.1 Study Areas

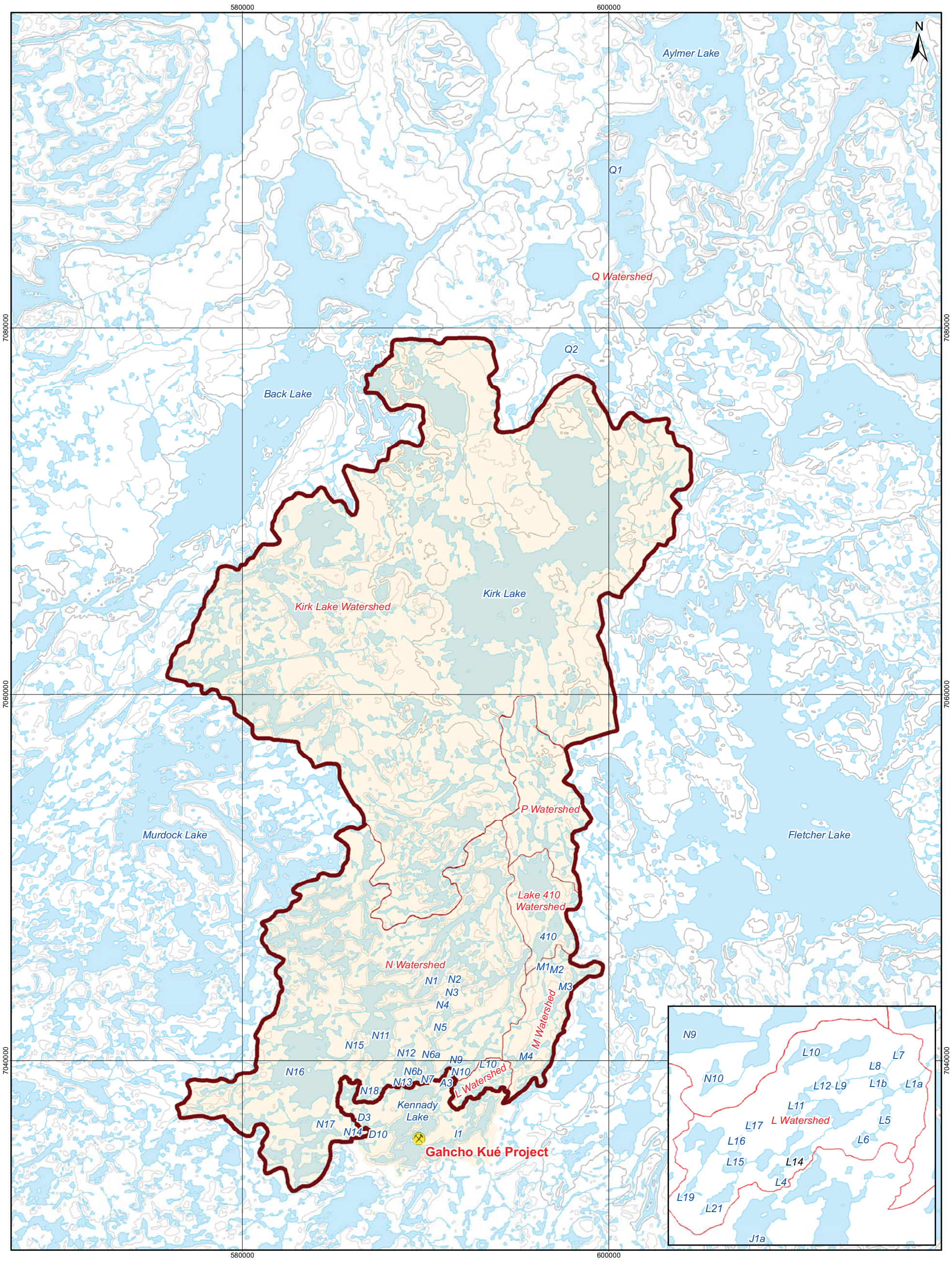
The AEMP study area will generally be equivalent to the aquatics LSA defined in the EIS and will encompass a portion of the Lockhart River watershed (De Beers 2010, 2011), with the potential exception of reference lakes. The study area is defined by the watersheds of the lakes and streams that may be directly affected by the proposed Project, and includes the Kennady Lake watershed and downstream watersheds, to the outlet of Kirk Lake (Figure 4).

Reference lakes and streams will be selected during detailed study design, and may be located outside the Lockhart River watershed. Reference waterbodies will be chosen to best represent conditions outside of the influence of the Project that match exposure areas in terms of physical characteristics and biological communities. For example, flows and lake morphology would be comparable between exposure and reference areas to minimize variation in water and sediment quality and biota.

Sampling areas will be shared among components to the maximum extent possible; i.e., all aquatic components will be sampled at a standard set of core stations within each selected sampling area, with the exception of large-bodied fish, which will require a program of larger spatial scale and may necessitate selection of different reference areas to maximize similarity in fish community between reference and exposure areas.

### 4.2.2 General Considerations

Monitoring methods (i.e., sampling methods, chemistry analyses) will be consistent with those used during the baseline studies, wherever possible. Field and laboratory procedures will include quality assurance/quality control (QA/QC) processes for all aspects of sampling and analysis, including data acquisition, sampling, as well as data analysis and interpretation.




## LEGEND

- Gahcho Kué Project
- Watercourse
- Waterbody
- K1 Lake Identifier
- Index Contour (100m interval)
- Intermediate Contour (20m interval)
- Baseline Local Study Area
- Downstream Water Effects Boundary
- Watershed Boundary

NOTES

Base data source: National Topographic Base Data (NTDB) 1:250,000 096C

# GAHCHO KUÉ PROJECT

## Downstream Water Effects Local Study Area

| | | |
|---|---|---|
| PROJECTION: UTM Zone 12 | DATUM: NAD83 | |
| Scale: 1:200,000 (2.5 1.25 0 2.5 Kilometres) | | DE BEERS CANADA |
| FILE No: E2011-Fish-008-GIS | | DATE: April 20, 2012 |
| JOB NO: 11-1365-0001 | REVISION NO: 2 | |
| OFFICE: GOLD-CAL | DRAWN: ANK / CHECK: JF | Figure 4 |

I:\CLIENTS\DE_BEERS\11-1365-0001\Mapping\MXD\Fish\E2011-Fish-008-GIS.mxd

Components of the AEMP will be designed according to a statistically-based overall study design that incorporates regulatory guidance and currently accepted scientific principles. The overall design will apply to most components; i.e., water quality, sediment quality and benthic invertebrate samples will be collected at a common set of "core" stations, and data collected by these components will be analyzed using the same statistical tests. The hydrology and fish components will be exceptions, because:

1. hydrological measurements (discharges, lake levels) will need to be collected at fixed locations that may not be situated in monitoring areas appropriate for other monitoring components that are selected based on aquatic habitat, and
2. large-bodied fish are mobile and thus not amenable to monitoring using a fixed station-based approach, and the distribution of aquatic habitat will need to be taken into consideration in the monitoring program design.

An overall sampling design that is integrated to the extent possible will allow efficient data collection by cross-trained field crews and consistent data analysis by components when evaluating monitoring data.

The detailed study design will include selection and justification for the overall design approach (i.e., control/impact versus gradient study, or a combination thereof). It will also include effects levels for the aquatic components (i.e., water quality, sediment quality, lower trophic organisms, and fish) that will link the monitoring results to adaptive management. These actions are necessary to ensure that the Project-related effects on the receiving environment remain within an acceptable range, and allow the operator and regulators to act appropriately to environmental change.

Sampling areas will be based on results of water quality modelling and predicted changes in hydrological conditions. Sampling areas will typically represent areas subject to defined levels of exposure to water discharged from the mine area, or selected parameters of concern (e.g., phosphorus), or waterbodies with predicted changes that are of concern to aquatic life (e.g., increased water levels, reduced flows). The number of stations in each area (i.e., per lake or stream reach) will be determined using statistical power analysis of baseline data and regulatory guidance for aquatic environmental effects monitoring.

It is anticipated that the majority of core AEMP stations designated for water quality, sediment quality, and benthic invertebrate sampling will be located in habitat that is representative of lakes in the Project area and will be standardized by physical features (especially water depth) to the extent possible. Additional stations or reaches in streams will be established to monitor changes in aquatic

life due to changes in flow or other habitat features (i.e., primarily for benthic invertebrate and fish sampling, with water quality and physical habitat data as supporting information).

Based on predicted water quality and hydrology, sampling areas are anticipated to be located in Kennady Lake, selected lakes in the N watershed (Lake N11, Lake N1, and possibly others) and the A, B, D, and E watersheds, as well as Lake 410, Kirk Lake, and two or three suitable reference lakes. It may be necessary to select lakes representative of certain types or levels of predicted effects, rather than monitoring all potentially affected lakes. Stream sampling areas will be selected based on fish habitat characteristics, in relation to predicted effects to hydrology and water quality.

The specifics of the AEMP design are expected to evolve over the life of the Project as part of adaptive management practices, and as dictated by changes in potential effects resulting from mine activity. In addition, the scope of the AEMP is expected to change, because monitoring effort in watersheds adjacent and downstream of Kennady Lake is expected to decline when operations cease. However, monitoring of Kennady Lake and the reference lake(s) will be maintained during all phases of the Project, although frequency of sampling may vary by project phase.

### 4.2.3 Hydrology

Hydrology monitoring focuses on surface water levels, flows, and channel/bank stability. It is an important environmental monitoring component of the Project due to the diversion of the upper watersheds of Kennady Lake as a result of the planned dewatering and refilling of Kennady Lake. These changes will affect hydrology in terms of water quantity and seasonal patterns of flow. Hydrology data will also be necessary to provide supporting information for the water quality and biological monitoring components.

Baseline hydrology in the area of the Project is detailed in Annex H (Climate and Hydrology Baseline), and Addendum HH (Additional Climate and Hydrology Baseline Information) of the 2010 EIS (De Beers 2010). It is summarized in Section 8 (KLOI: Water Quality and Fish in Kennady Lake, subsection 8.3) and Section 9 (KLOI: Downstream Water Effects, subsection 9.3). Supplemental hydrological and climatology monitoring information collected in 2011 is provided in the Climate and Hydrology Supplemental Monitoring Report (De Beers 2012a) and the Shoreline and Channel Erosion Assessment Report (De Beers 2012f).

## Monitoring Approach

Hydrology monitoring under the AEMP will focus on flow rates, water levels and channel morphology at key locations, and will provide supporting information for the interpretation of biological monitoring data. Parameters that will be monitored include discharges, water levels, and bed and channel erosion at key locations, as well as key meteorological parameters. Climate monitoring, including continuous measurements of rainfall and temperature, will be performed to allow validation of the hydrological model, assessment of seasonal conditions and to provide data for water management decision-making (i.e., a comprehensive weather station was installed on site in the summer of 2011). Flow in all piped and/or pumped discharges to lakes (e.g., to Area 8) will be monitored continuously.

Flow rates and water levels will be monitored during all phases of the Project at key lake outlets in the Kennady Lake watershed, and areas downstream. Hydrological monitoring of the reconnected watershed will occur at similar sites selected during the baseline surveys. During construction and operation, continuous monitoring at the Area 8 outlet and the outlet of Lake N11 will occur during dewatering over the open-water period, and seasonally thereafter. At closure, during the drawdown of diverted lakes in the B, D, and E watersheds, lake water surface elevations and discharges from the lakes will be monitored until they are restored to pre-development levels. Monitoring is expected to be less frequent in post-closure than during operations or closure, but is expected to persist for several years after the removal of Dyke A. The primary purpose of this monitoring will be to determine that the post-closure watershed hydrology is similar to baseline conditions, taking into account the modified watershed and lake areas.

A supplemental detailed survey of future shoreline areas of lakes that will be raised will be undertaken to identify areas of significant erosion potential on a finer spatial during construction. This survey will be performed during construction to establish a baseline for future monitoring. The monitoring program will include visual inspection and photographic records of shoreline characteristics, surveys of monitoring transects, and periodic TSS monitoring. Should areas of significant erosion be identified during construction and operations, mitigation, including placement of rock armour material to arrest erosion, will be undertaken. At closure, re-established shorelines will be inspected on an annual basis until it is evident that shorelines are stable or until required mitigation is implemented and shown to be effective.

During operations, monitoring activities will vary by season. During the late season low flow period, in advance of the following season's spring thaw and freshet, observations will be undertaken to assess the integrity of the outlets and

stream courses to monitor for the development of channel or bank erosion. Prior to the spring thaw (or snowmelt), snow surveys will be used to provide an early estimate of spring runoff. This is a reliable method to project annual watershed runoff volumes, and should be considered in years when substantial flow changes are planned for the Kennady Lake and adjacent watersheds (e.g., dewatering and refilling). Downstream of Kennady Lake, monitoring will also occur on a seasonal basis, with particular focus on any flow augmentation to assess that downstream flows during spring melt spawning and rearing habitat meet requirements of Arctic grayling.

Hydrometric monitoring to provide measurements of lake levels and lake outlet discharges at key locations, including diversion channels at lake outlets, during open water conditions will be undertaken using hydrometric stations or gauging collection processes similar to those used during the baseline program (De Beers 2010, Sections 8 and 9, Annex H and Addendum HH). Channel erosion monitoring will include quantitative and qualitative components. At key locations, permanent channel transect markers will be established prior to dewatering discharges to monitor bed and bank geometry, and monitoring will continue through the dewatering period.

### 4.2.4 Water Quality

Water quality comprises the chemical constituents that characterize a waterbody and reflects the geomorphology and condition of the watershed. Water chemistry, along with measurements of key biological variables (e.g., chlorophyll *a*), can also provide an indication of the productivity of the waterbody. Water quality is a key environmental monitoring component of the Project, due to construction and operations activities that have the potential to impact water quality in receiving environments.

Water quality data will be evaluated by comparison to benchmarks developed based on water quality guidelines, or site-specific objectives developed specifically for surface waters sampled by the AEMP. Data will also be evaluated by statistical comparisons of selected parameters between reference lakes and exposure areas in Kennady Lake and other monitored lakes.

Baseline water quality in the Project area is detailed in Annex I (Water Quality Baseline) and Addendum II (Additional Water Quality Baseline Information) of the EIS (De Beers 2010). It is summarized in Section 8 (KLOI: Water Quality and Fish in Kennady Lake, subsection 8.3) and Section 9 (KLOI: Downstream Water Effects, subsection 9.3) and. Updates to water quality are provided in the 2011 EIS Update (De Beers 2011). Supplemental water quality information collected in

2011 is provided in the Water Quality and Sediment Quality Supplemental Monitoring Report (De Beers 2012d).

## Monitoring Approach

Water quality parameters monitored during operations will be consistent with those measured during baseline surveys, and will include field parameters (dissolved oxygen, conductivity, water temperature, pH), conventional parameters (hardness, alkalinity, total organic carbon, total suspended solids, total dissolved solids), major ions, metals, nutrients (e.g., phosphorus and nitrogen), and selected organic parameters. Sampling points will include the water management pond and collection ponds, Area 8, the Area 8 outlet, key downstream lakes and suitable reference lakes.

Sampling will occur at core AEMP stations in reference and exposure areas on a seasonal basis (i.e., open water and under-ice conditions, at a minimum) to verify effect predictions related to changes in water quality and provide supporting information for verifying potential effects to aquatic health.

Water quality monitoring at closure will continue to measure parameters monitored during operations, as may be defined in a water licence. Sampling points will potentially include a subset of core AEMP stations, selected lakes in the upper watershed, the partially backfilled Hearne Pit and open Tuzo Pit, Areas 3 through 7, Area 8, the inflow discharge point in Area 3, and a reference lake. Monitoring of Kennady Lake during refilling will test water quality predictions and once refilling is complete, provide a basis for measuring compliance with requirements for the removal of Dyke A.

Post-closure water quality monitoring will continue to focus on parameters monitored during operations and closure. Sampling points will potentially include a subset of core AEMP stations, and the partially backfilled Hearne Pit and open Tuzo Pit basins, Areas 3 through 7, Area 8 in Kennady Lake, and reference lakes.

Sampling will maintain a seasonal approach (i.e., open water and under-ice), but may occur on a less frequent basis than during operations and closure. Monitoring would be expected to continue until conditions of a water licence are met. Sampling will continue in the reference lakes during that time as well to provide a comparison with background temporal trends.

### 4.2.5 Sediment Quality

Sediment quality comprises the physical and chemical constituents of sediment in lakes and streams, and reflects the geomorphology and condition of the watershed. Much like water chemistry, sediment chemistry is responsive to changes in inputs, such as dust deposition, watershed runoff and water discharges. Alterations to the lake bed from Project activities after the dewatering of Kennady Lake may lead to increased sediment deposition.

Baseline sediment quality in the Project area is discussed in the 2010 EIS and the 2011 EIS Update (De Beers 2010, 2011), specifically in Section 8 (KLOI: Water Quality and Fish in Kennady Lake, subsection 8.8), Section 9 (KLOI: Downstream Water Effects subsection 9.8), Annex I (Water Quality Baseline), and Addendum II (Additional Water Quality Baseline Information). Baseline sediment data was also presented in the 2011 supplemental sediment quality data is provided in the Water Quality and Sediment Quality Supplemental Monitoring Report (De Beers 2012d).

#### Monitoring Approach

Sediment quality will be monitored at the core AEMP stations where water quality will also be monitored. Sediment quality monitoring will follow a comparable scope and schedule during closure and post-closure phases of the Project. Sediment quality parameters will include particle size distribution, total organic carbon, and total nitrogen and phosphorus and metals. Sampling methods and analysis procedures will be consistent with methods used during the baseline survey period. Bottom sediments will be sampled once during each monitoring year, in conjunction with benthic invertebrate monitoring. It is anticipated that two types of sediment samples will be collected:

- composite samples consisting of sufficient material from the top 1 cm of sediment cores for analysis of particle size, total organic carbon and concentrations of metals; and
- composite samples consisting of several grabs, for analysis of particle size, total organic carbon, as supporting variables for the benthic invertebrate component.

Sediment quality data (top 1 cm core data) will be evaluated by comparisons to baseline sediment quality and sediment quality guidelines (i.e., Canadian Interim Sediment Quality Guidelines, Probable Effect Levels), and by statistical comparisons of selected parameters between reference and exposure areas. The analysis will take into account existing background spatial trends in sediment

chemistry to the extent possible. Grab sediment data will be used as supporting habitat data in the benthic invertebrate community analysis.

### 4.2.6 Lower Trophic Communites

Lower trophic communities (plankton, periphyton, benthic invertebrates) reflect water quality and physical conditions, and are useful indicators of nutrient status. Benthic invertebrates also serve as an indicator of sediment quality. Changes in the abundance and distribution of plankton and periphyton influence lake productivity and, thus, relate to fish population and fish health. Changes in the abundance and distribution of benthic invertebrates, much like plankton, reflect lake productivity as well, and provide an indication of changes in availability of food for fish.

Baseline information regarding plankton is discussed in the 2010 EIS and the 2011 EIS Update (De Beers 2010, 2011), specifically in Section 8 (KLOI: Water Quality and Fish in Kennady Lake, subsection 8.3), Section 9 (KLOI: Downstream Water Effects subsection 9.3), Annex J (Fisheries and Aquatic Resources Baseline), and Addendum JJ (Additional Fisheries and Aquatic Resources Baseline Information). Supplemental plankton monitoring information collected in 2011 is provided in the Lower Trophic Organisms Supplemental Monitoring Report (De Beers 2012c).

Baseline information regarding benthic invertebrates in the Project area is discussed in the 2010 EIS and the 2011 EIS Update (De Beers 2010, 2011), specifically in Section 8 (KLOI: Water Quality and Fish in Kennady Lake, subsection 8.3), Section 9 (KLOI: Downstream Water Effects subsection 9.3), Annex J (Fisheries and Aquatic Resources Baseline), and Addendum JJ (Additional Fisheries and Aquatic Resources Baseline Information). Supplemental plankton monitoring information collected in 2011 is provided in the Lower Trophic Organisms Supplemental Monitoring Report (De Beers 2012c).

#### Monitoring Approach

De Beers, in consultation with interested parties, is currently reviewing the approach for incorporating lower trophic monitoring into an AEMP, especially phytoplankton, periphyton and zooplankton. Common approaches to monitoring these lower trophic groups are limited to seasonal-based programs during open water conditions. As these groups are often very dynamic (i.e., due to rapid growth rates and short generation times, plankton species composition and total biomass), alternate means of detecting changes due to Project activities may be identified.

It is anticipated that benthic invertebrates will be monitored in standardized habitat at the core AEMP stations once during the open-water period, in conjunction with sediment sampling. Samples will be analyzed for taxonomic composition and abundance of benthic invertebrates, and the data will be analyzed by statistical comparisons of selected variables (i.e., total density, richness, and community indices) between reference and exposure areas.

### 4.2.7 Fish

Fish surveys include fish health surveys and tissue analyses, and fish population surveys. Fish health surveys involve the assessment of fish growth and development, including an internal exam observing pathology, parasite burden, and reproductive status. Fish tissue analyses provide information on the quality of fish for human consumption, while also providing an indication of bioavailability (i.e., availability of a chemical in the environment for uptake by an organism) and bio-accessibility (i.e., accessibility of a chemical under the influence of digestive or other physiological processes that may change chemical properties relating to uptake potential into tissues) of contaminants in the aquatic ecosystem.

Fish population surveys assess the state of the ecosystem and allow for evaluation of changes in population structure in the Project area over time. The primary assessment endpoints for fish at the Project relate to the abundance and persistence of large-bodied fish (i.e., lake trout, northern pike and Arctic grayling). Fish may be affected by changes in channel morphology, water volume and flow patterns, water or sediment chemistry, habitat availability, or changes in lower trophic community structure.

Baseline information regarding fish and fish habitat is discussed in the 2010 EIS and the 2011 EIS Update (De Beers 2010, 2011), specifically in Section 8 (KLOI: Water Quality and Fish in Kennady Lake, subsection 8.3), Section 9 (KLOI: Downstream Water Effects subsection 9.3), Annex J (Fisheries and Aquatic Resources Baseline), and Addendum JJ (Additional Fisheries and Aquatic Resources Baseline Information). Supplemental fish and fish habitat monitoring information collected in 2011 is provided in the Fish and Aquatic Resources Supplemental Monitoring Report (De Beers 2012b).

#### Monitoring Approach

The objective of the fish monitoring program will be to determine if any effects are occurring through changes in water quality, quantity or flow as a result of Project activities. Fisheries data collected during fish salvages may be used to complement data collected by the AEMP.

Monitoring and sampling techniques, and analysis procedures, will be consistent with methods used during the baseline survey to the extent possible.

### Fish Population Monitoring

Fish communities (e.g., species assemblages) will be monitored in summer on an annual basis until the end of dewatering, and subsequently at three-year intervals. Monitoring will indicate if fish populations in the diverted watersheds are sustainable during operations, and whether Project diversions alter the resident communities.

Fish migration in key areas will be monitored annually through the end of dewatering, and then at three year intervals. This program will include spring, summer, and fall sampling periods to document spring spawning migration, summer rearing success, and fall migration, and will establish the effectiveness of constructed diversion channels for fish migration. Monitoring of spring spawning migrations and summer rearing densities of Arctic grayling in key areas will be conducted every three years.

Fish communities will be monitored at three year intervals initially during refilling to confirm that fish populations in Kennady Lake (i.e., Area 8) and downstream waterbodies are sustainable for spring spawning migration, summer rearing success and fall migration.

Fish migration will be monitored for a defined period of time after the exclusion structures are removed in the channels of restored watersheds to ensure fish movement between these watersheds and Kennady Lake. This program will include spring, summer, and fall sampling periods to document spring spawning migration, summer rearing success, and fall migration.

### Fish Health and Tissue Monitoring

Fish health will be monitored in waterbodies affected by the Project using small-bodied forage fish, such as slimy sculpin (*Cottus cognatus*) or lake chub (*Couesius plumbeus*). Small-bodied fish are relatively sedentary with small home ranges and, therefore, can provide site-specific information on mine-related effects. Survival, energy use, and energy storage will be assessed during lethal and non-lethal fish health surveys every three years in Kennady Lake (i.e., area 8) and in one or more reference lakes.

Fish health measurement endpoints that will be assessed include fish age, weight, length, internal and external condition, pathology, relative gonad and liver weight (i.e., organ weight normalized to carcass weight), and condition factor (i.e., an index that considers weight and length of the fish).

Population age structure and length frequency distributions will also be included in the fish health survey analyses. Parasite burden will be considered as parasite load can influence fish health parameters such as condition and energy use and energy storage, and can vary between exposure and reference areas independently of mine influence. Non-lethal fish health surveys will involve collection of target species, and measured endpoints will include length and weigh and external condition. Fish aging will be performed in non-lethal surveys when possible (i.e., if scales or fin rays are appropriate aging structures for the target fish species).

Large-bodied fish surveys will be performed for population monitoring (i.e., non-lethal surveys), as well as limited lethal surveys to monitor fish tissue contaminant concentrations. If possible, non-lethal methods may be applied for fish tissue sampling (e.g., tissue plugs) to limit the impact on local fish populations, but the feasibility of these methods will be determined during the detailed monitoring program development. Large-bodied fish survey sample locations will include Kennady Lake (i.e., area 8), flooded areas (i.e., the B, D and E watersheds), Lake N11, and one or more reference areas.

At closure, monitoring of small bodied fish in the refilling lake will be conducted every three years to track ecosystem recovery in Kennady Lake. Monitoring will provide temporal trends and the information will be useful to determine when Kennady Lake could support a piscivorous fish community (i.e., large bodied fish) to allow the removal of fish exclusion structures in the re-aligned A, B, D, and E watersheds, as well as removal of Dyke A.

Metal concentrations in small-bodied forage fish in Area 8 and a reference lake will be measured every three years using composite samples (i.e., 2 to 4 fish per sample) to provide sufficient tissue volume for analyses. Small-bodied fish are an important link to lower trophic communities; as they are forage feeders, whole-body tissue analysis will be a reliable indicator of metal enrichment in the aquatic habitat and sediment of Area 8 resulting from the Project. This monitoring will be initiated prior to the Project development to provide existing condition information.

Metal concentrations in large-bodied piscivorous fish, such as lake trout (*Salvelinus namaycush*), northern pike (*Esox lucius*), or burbot (*Lota lota*), will be measured in Area 8, N11, flooded areas, and one or more reference lakes. This program will be conducted every five years after initiation of mining and will be used to determine if metals concentrations in the top predatory fish change during operation and closure phases. Statistical analyses will be performed comparing exposure area fish tissue metal concentrations to reference lake samples.

Post-closure monitoring of small bodied and large bodied fish health and fish tissue will continue for a defined period of time until a reasonable path to recovery has been demonstrated in Kennady Lake and the downstream watershed.

## 4.3 GROUNDWATER MONITORING PROGRAM

As the pits are developed, groundwater will be induced to flow to the pits due to the upward movement of deep, higher total dissolved solids (TDS) groundwater. The groundwater monitoring program was developed to provide data to aid in the management of groundwater and surface water for the project. Apparent trends in groundwater quality and quantity will be tracked and adaptive management and/or mitigation will be applied, if necessary, to the handling of surface and groundwater to be protective of the environment during all phases of mining.

### 4.3.1 Monitoring Approach

Groundwater monitoring will occur at the onset of development to determine the response of the environment to the disturbance by mining. The hydrogeological conditions will be monitored for changes throughout each phase of the Project. Groundwater quality monitoring will mostly occur quarterly during the development of the first open pit, and is expected to be scaled down to an annual to semi-annual frequency during development of the Hearne and Tuzo pits. Water level monitoring will mostly occur on a daily basis (transducers and data-loggers will be installed for this purpose) during the development of the first open pit, and it is expected that the frequency of these measurements will be scaled down during development of the Hearne and Tuzo pits. The quality and quantity of pit inflows will also be monitored during operations.

Groundwater will be monitored using four wells located on the east and west side of the portion of Kennady Lake that will be dewatered, two of which will remain following pit development (MPV-05-236C and MPV-05-238C). The remaining two wells (MPV-05-239C and MPV-05-240C) located within open pit development areas will also be monitored until their removal during development of respective pits.

# 5 AIR QUALITY MONITORING PROGRAM

Operations at the Project are expected to generate atmospheric emissions from fossil fuel combustion and fugitive dust sources. Combustion products include oxides of nitrogen ($NO_X$), carbon monoxide (CO), sulphur dioxide ($SO_2$), particulate matter (PM), and volatile organic compounds. Trends in air quality will be tracked and adaptive management and/or mitigation will be applied, if necessary, during all phases of the Project.

A detailed account of baseline information regarding air quality is discussed at length in the 2010 EIS and the 2011 EIS Update (De Beers 2010, 2011), specifically in Section 11.4 (Subject of Note Air Quality), and Annex B (Air Quality Baseline).

## 5.1.1 Study Area

The air quality monitoring study area will be similar to the air quality assessment LSA defined in the 2010 EIS and is defined as an area in the immediate vicinity of the Project. The LSA is defined by an area of 15 x 15 km, which includes the Project footprint as described in the EIS (Section 11.4, SON Air Quality; De Beers 2010).

## 5.1.2 Monitoring Approach

An emissions test for one of the power generators will be conducted after Project start-up to confirm estimated emission rates documented in Appendix 11.4.II of the 2010 EIS. After start-up, periodic emission testing will be conducted. The tests will include $SO_2$, $NO_2$, CO, and $PM_{2.5}$.

A post-commissioning stack test of the waste incinerator will also be conducted. Its focus will be on determination of the in-stack concentrations are consistent with manufacturer specifications. In accordance with the Environment Canada Technical Document on Batch Incineration (Environment Canada 2010), stack testing can be carried out as required by the regulatory authorities to verify incinerator performance. De Beers will develop an incineration management plan to ensure best management practices are undertaken at site.

Finally, a small network of monitoring stations will be established on the perimeter of Project site for monitoring $SO_2$, $NO_2$, particulates and dustfall. These stations will be at locations where vegetation and soils are considered most sensitive and where dust may occur based on predominant wind direction. In addition, stations will be established in a wider area to evaluate dust deposition.

# 6 REFERENCES

BHPB (BHP Billiton Canada Inc.). 2010. Ekati Diamond Mine 2009 Wildlife Effects Monitoring Program. Prepared by Rescan Environmental Services Ltd. for BHP Billiton Diamonds Inc. March 2010.

Condit, R. 1995. Research in large, long-term tropical forest plots. Trends in Ecological Evolution. **10**:18-22.

Dale, V.H., Beyeler, S.C., and B. Jackson. 2002. Understory vegetation indicators of anthropogenic disturbance in longleaf pine forests at Fort Benning, Georgia, USA. Ecological Indicators **1**:155-170.

DDMI (De Beers Diamond Mine Inc.). 2010. 2009 Wildlife Monitoring Program. Prepared by Diavik Diamond Mines Inc. April 2010.

De Beers (De Beers Canada Inc.). 2004. Snap Lake Diamond Project: Wildlife Effects Monitoring Program. Prepared for De Beers Canada Inc. by Golder Associates Ltd.

De Beers. 2007. Snap Lake Project: Wildlife Management Plan. Prepared for De Beers Canada Inc. by Golder Associates Ltd.

De Beers. 2010. *Environmental Impact Statement for the Gahcho Kué Project.* Volumes 1, 2, 3a, 3b, 4, 5, 6a, 6b, 7 and Annexes A through N. Submitted to Mackenzie Valley Environmental Impact Review Board. December 2010.

De Beers. 2011. *Environmental Impact Statement for the Gahcho Kué Project.* Volumes 3a Revision 2, 3b Revision 2, 4 Revision 2, and 5 Revision 2. Submitted to the Mackenzie Valley Environmental Impact Review Board in Response to the Environmental Impact Statement Conformity Review. July 2011.

De Beers. 2012a. *2011 Climate and Hydrology Supplemental Monitoring Report: Environmental Impact Statement Supplemental Information Submission for the Gahcho Kué Project*. Submitted to the Mackenzie Valley Environmental Impact Review Board. *In progress.*

De Beers. 2012b. 2011 Fish and Aquatic Resources Supplemental Monitoring Report. Environmental Impact Statement Supplemental Information Submission for the Gahcho Kué Project. Submitted to the Mackenzie Valley Environmental Impact Review Board. 2012.

De Beers. 2012c. 2011 Lower Trophic Organisms Supplemental Monitoring Report Environmental Impact Statement Supplemental Information Submission for the Gahcho Kué Project. Submitted to the Mackenzie Valley Environmental Impact Review Board. 2012.

De Beers. 2012d. 2011 Water Quality and Sediment Quality Supplemental Monitoring Report. Environmental Impact Statement Supplemental Information Submission for the Gahcho Kué Project. Submitted to the Mackenzie Valley Environmental Impact Review Board. 2012.

De Beers. 2012e. 2011 Wildlife Supplemental Monitoring Report. Environmental Impact Statement Supplemental Information Submission for the Gahcho Kué Project. Submitted to the Mackenzie Valley Environmental Impact Review Board. 2012.

De Beers. 2012f. 2011 Shoreline and Channel Erosion Assessment Report. Environmental Impact Statement Supplemental Information Submission for the Gahcho Kué Project. Submitted to the Mackenzie Valley Environmental Impact Review Board. 2012.EC (Environment Canada). 1981. The Clean Air Act – Compilation Of Regulations And Guidelines. Regulations, Codes And Protocols Report EPS 1-AP-81-1. Air Pollution Control Division.

EC. 2002. Metal mining guidance document for aquatic environmental effects monitoring. 2002.

Gahcho Kué Panel. 2007. Terms of Reference for the Gahcho Kué Environmental Impact Statement. Mackenzie Valley Environmental Impact Review Board. Yellowknife, N.W.T.

GNWT (Government of the Northwest Territories). 2011. Guideline for Ambient Air Quality Standards in the Northwest Territories. Department of Environment and Natural Resources. 5pp.

IMG-Golder Corp. 2008. Standardized protocols for collection of monitoring information for the NWT cumulative impact monitoring program working group and valued components advisory teams. Prepared for Indian and Northern Affairs Canada.

INAC (Indian and Northern Affairs Canada). 2009a. A Citizen's Guide to INAC's Environmental Stewardship Roles in the NWT Ottawa, ON, Aboriginal and Northern Development Canada, Renewable Resources & Environment. March 2009.

INAC. 2009b. Designing and implementing aquatic effects monitoring programs for development projects in the Northwest Territories. Prepared by MacDonald Environmental Services Ltd., Zajdlik and Associates inc., and Water Resource Divisions, INAC, Yellowknife. Volumes 1 to 6 plus appendices.

INAC. 2009c. Draft toolbox for applying traditional knowledge in aquatic effects monitoring plans (AEMPs) in the NWT. Prepared by Water Resource Divisions, INAC, and Brenda Parlee, University of Alberta. December 2009 draft. 30 p. + appendices.

Kavik-AXYS Inc. 2008. Data collection protocols for the Northwest Territories cumulative impact monitoring program. Valued Components: Caribou Fish Habitat, Population & Harvest Water & Sediment Quality. Prepared for: Indian and Northern Affairs Canada.

Marshall, R. 2009. Diamond mine wildlife monitoring workshop report. Prepared by Rob Marshall for Diavik Diamond Mines Inc.

NWTSAR (Northwest Territories Species At Risk). 2012. Website, http://nwtspeciesatrisk.ca. Accessed 2 March 2012.

SRPR (Species at Risk Public Registry). 2012. Website, http://www.sararegistry.gc.ca. Accessed 2 March 2012.

Tahera (Tahera Diamond Corporation). 2005. Proposed Wildlife Mitigation and Monitoring Plan for the Jericho Diamond Project. Prepared for the Tahera Diamond Corporation by Golder Associates Ltd.

Wilson, D. and R. Bromley. 2001. Functional and numerical response of predators to cyclic lemming abundance: effects on loss on goose nests. Canadian Journal of Zoology. 79: 525-532

WLWB (Wek'eezhı`i Land and Water Board). 2010. Guidelines for adaptive management - a response framework for aquatic effects monitoring. Yellowknife, NT, Wek'eezhı`i Land and Water Board.

# APPENDIX I

# LISTED SPECIES IN THE PROJECT REGION

**Listed Species in the Project Region**

| Common Name | COSEWIC Status[(a)] | SARA Status[(a)] | NWT General Status Rank[(b)] |
|---|---|---|---|
| Wolverine (western population) | special concern | no status | sensitive |
| Grizzly bear (northwestern population) | special concern | no status | sensitive |
| Peregrine falcon (anatum-tundris complex) | Threatened | schedule 1 | sensitive |
| Horned grebe | special concern | no status | secure |
| Short-eared owl | special concern | schedule 3 | sensitive |
| Rusty blackbird | special concern | schedule 1 | may be at risk |

(a) SRPR 2012.

(b) NWTSAR 2012.