GAHCHO KUÉ PROJECT

ENVIRONMENTAL IMPACT STATEMENT

SECTION 2

PROJECT ALTERNATIVES

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2 PROJECT ALTERNATIVES

2.1 INTRODUCTION

2.1.1 Context

Exploration of the mineral claims at Kennady Lake began in 1992. In 1995, Mountain Province Mining Inc. (now Mountain Province Diamonds Inc.) and partners discovered the first diamond-bearing kimberlite pipe at Kennady Lake, which they named “5034”. The Mountain Province Mining Inc. property was originally investigated by Canamera Geological, the original operator from 1992 to 1996. In 1997, De Beers Canada Inc. (De Beers) became the operator through Monopros, its wholly owned subsidiary. Monopros discovered three additional diamond bearing pipes, which were named the “Tesla”, “Tuzo”, and “Hearne” kimberlites. Monopros continued to delineate the ore bodies and confirm diamond grades from 1997 to 2000. As a result of this work, it was determined that Tesla is not suitable for mining, because of its small size and low diamond grade.

In 2000, De Beers completed a conceptual desk-top study that focused on the economic feasibility of the resource. A conceptual plan of the Gahcho Kué Project (Project) was prepared as part of this desktop study. A second desk-top study was carried out in 2002, which was also at the conceptual level. Based on a further bulk sample program in 2001/2002, the conceptual engineering was updated in 2002 and 2003. An action plan was developed in October 2003 to support a Class “A” Water License Application, and to collect environmental baseline information to support an environmental assessment. In 2005, De Beers submitted a Class ‘A’ Water License Application Report to the Mackenzie Valley Land and Water Board (MVLWB) [De Beers 2005]), which provided an overview of the Project description, existing environment, consultation, and an environmental screening for the Project.

Environmental studies and engineering have continued, resulting in further refinements. This section describes the planning and decisions made from 2000 through to the submission of the environmental impact statement (EIS).

During the development of the Project, a number of alternatives were considered. Some of the alternatives were adopted; others were rejected. Alternatives that were considered, but not included in the Project Description, are described herein.

This section does not limit its discussion of alternative means of the Project development to those De Beers considers technically and economically feasible. It also reports on alternatives De Beers considered and dismissed during the early stages of design. However, only the alternative means that were ultimately determined by De Beers to be both technically and economically feasible were incorporated into the Project design.

Alternatives that were adopted are described briefly in this section and in greater detail in Section 3, Project Description, which describes the current Project that has been assessed in this EIS.

2.1.2 Purpose and Scope

This section of the EIS was developed to meet the Terms of Reference concerning alternatives for the Gahcho Kué EIS released by the Gahcho Kué Panel on October 5, 2007 (Gahcho Kué Panel 2007). The Terms of Reference, specifically in Sections 3.1.2 and 3.2.6, require that the EIS provide a discussion of alternatives to the Project (i.e., functionally different ways to meet the Project need and achieve the Project purpose), and individual development components and activities of the Project (i.e., alternative means), including but not limited to the following list:

- disposal methods (e.g., alternative to back filling of pits, alternative designs for the mine rock pile, alternatives to the planned processed kimberlite containment [PKC] facilities);
- alternative transportation methods to reduce impacts along the ice road route;
- alternatives to the conventional two-week staff rotation;
- alternative reclamation methods (e.g., alternatives for refilling Kennady Lake); and
- other alternatives that the developer considered or may be considering (e.g., different extraction rates to extend the life of the mine, underground mining options).

Other requirements stipulated in the Terms of Reference related to alternatives include an assessment of alternative energy sources and energy conservation measures. These are addressed specifically in the Subject of Note: Alternative Energy Sources (Section 11.3). The Terms of Reference asks that responses to subjects of note must be comprehensive stand-alone analyses, and that there be only minimal cross-referencing with other parts of the EIS. Therefore, the detailed analysis of alternative energy sources and energy conservation measures is provided in Section 11.3 rather than Section 2.

2.1.3 Content

The alternatives section of the EIS will focus on the major decisions that were made in planning the Project as they relate to the selection of alternatives.

Section 2.2 addresses the specific alternatives to the development of the Project as required by the Terms of Reference, and examines:

- change in the timing of the Project to a later date;
- cancellation of the Project; and
- full accounting of potential opportunity costs in consideration of possible effects on:
  - eco-tourism;
  - outfitting activities; and
  - traditional harvesting.

Section 2.3 represents the main focus of the discussion of Project alternatives, and details the alternative means considered for carrying out the Project under the following headings:

- Mining Methods;
- Water Management;
- Management of Mine Rock and Processed Kimberlite (PK);
- Employee Work Schedule; and
- Transportation of Workers and Material.

Alternatives that relate to closure and reclamation will also be discussed within these headings.

An overview of the environmental conditions that influenced the Project design, citing specific examples, is provided in Section 2.4.

2.2 ALTERNATIVES TO THE DEVELOPMENT OF THE PROJECT

The purpose of the Project is to access and produce the ore held under mining leases by the Joint Venture for whom De Beers is the operator. However, issues raised in the Terms of Reference require a discussion of possible alternatives to the development of the Project. These are detailed in the following sections, drawing on the analysis and discussion included in Section 3.

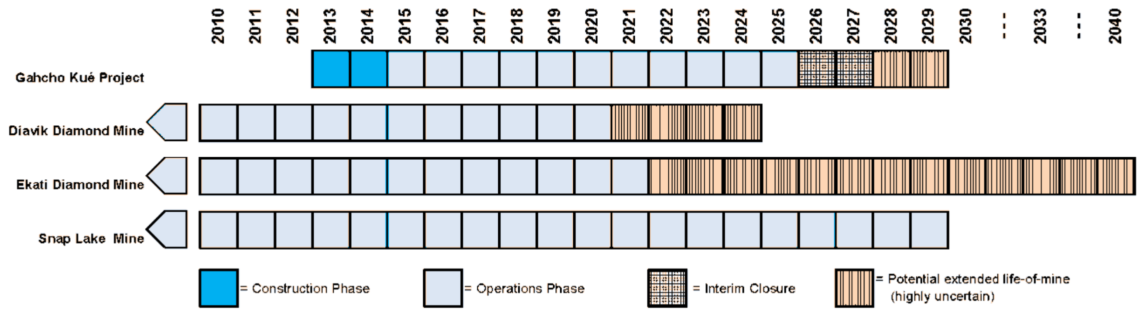
2.2.1 Change in the Timing of the Project

The best way to assess the benefit and implications of the Project is within the context of all other major economic development projects in the Northwest Territories (NWT) that are currently driven by diamond mining. Figure 2.2-1 illustrates the current timeframes proposed for existing and proposed diamond mines in the NWT, and their expected operational lifespan. The collective activity at these sites will slow in the latter half of the next decade, followed by approximately 10 years of gradual decline.

From Figure 2.2-1, it may be inferred that, for example, a delay in developing the Project for five years might have little effect on the economy, given that there are three of diamond mines already operating in the NWT. However, waiting for some of the existing operations to end before initiating the Project may prove to be harmful. Specifically, the local business survey (Section 12) indicated that most businesses and sectors in the NWT appear to have sufficient capacity and desire for more economic growth. They recognize that their future economic prospects rest with continued economic development, and that delays in the initiation of new projects may result in economic slow downs that would detrimentally affect the viability of their operations and investments.

Many local businesses have invested new capital and have realigned their human resources to meet the challenges of a growing economy and a tight labour supply market. The financial resources (tax revenues to government and profits to local businesses) that will result from added economic growth (in this case, the Project) are necessary to make further investments in infrastructure and business operations, so that the service demands over the next five to ten years can be met.

Figure 2.2-1 Project Lifespan for Current and Planned Diamond Mines in the Northwest Territories



Note: Estimated construction start date dependent on all permits and approvals, and is subject to change.

As discussed in the Key Line Of Inquiry: Long-term Social, Cultural, and Economic Effects (Section 12), the Project will likely have limited, if any, effect on inflation, population projections, or demand for most infrastructure services. More important, the issues and concerns raised in the Terms of Reference relate more to the overall, and cumulative, effect of economic development over the past decade on the people and communities of the NWT than the Project itself. Conversely, delaying the Project will have little or no effect on these issues or concerns. As discussed in Section 12, the Project will generate significant tax revenues and labour income, which continue after the slowdown of other mine operations. These financial resources will be critical to ensuring that investment in community sustainability is made to the benefit of future generations.

2.2.2 Cancellation of the Project

The cancellation of the Project will result in certain economic and social losses to the NWT, particularly if no other major economic development projects are initiated in its absence. Consequences of outright cancellation, which will be similar to a delay in starting the Project, albeit more long-term in nature, include:

- denying NWT and local businesses revenues and business profits from which future investments in social services, community infrastructure, and business development and capacity building can be made;
- limiting economic growth that would otherwise occur if the Project proceeded as planned, which could result in:
  - job losses and a decline in employment opportunities; and
  - a decline in local business activity and profits;

- denying opportunities to access financial resources to fund investments by NWT communities seeking to sustain their community's well-being after the diamond mining industry closes;
- failing to fulfill the defined purpose of the Project, including a loss in value of Joint Venture assets; and
- losing future benefits and contributions to sustainability associated with the Project, loss of business, training and employment opportunities for Aboriginals and other Northerners, and additional sources of government revenue.

For these reasons, De Beers decided against cancellation, and decided to proceed with the proposed development of the Project.

2.2.3 Full Accounting of Future Opportunity Costs

The Terms of Reference identified specific issues relating to the impact on eco-tourism, outfitting, and traditional harvesting activities; most specifically, the opportunity costs of proceeding with the Project in lieu of potential eco-tourism, outfitting, and traditional harvesting activities. A full accounting of potential opportunity costs to communities and governments associated with the development is provided in greater detail in Section 12.

Opportunity cost is the consideration of making another choice and trying to predict a future based upon that choice. In the case of the Project, this is equivalent to addressing the alternative economic development opportunities that will not proceed if the Project goes ahead. The expected value of the Project, if it proceeds, includes substantial local employment opportunities within the mine, supporting services and businesses, as well as many millions of dollars of labour income, local business profits, and tax revenue.

The Subject of Note: Tourism Potential and Wilderness Character (Section 12.7.3) presents information and data that benchmarks peak tourism times at lodges, and with outfitters, during the months of July and August. It states there are currently no outfitting operations around Kennady Lake, with the nearest operation located at Cook Lake, 25 kilometres (km) to the north of the Project site. As noted in Section 12.7.3, wilderness-based tourism has been declining steadily over the past decade, with the primary reasons listed as being the events in New York City on September 11, 2001, the high Canadian dollar, increasing fuel costs, and the draw of more exotic locations. The establishment and development of mines in the NWT was not included as a reason. Therefore, an interest in eco-tourism and outfitting does not currently exist in the Project area.

The Project is located in the Bedaghé Tué traditional area of the Łutselk'e Dene, which is to the east of the area selected by the Akaitcho as part of their interim land withdrawals. The Bedaghé Tué region was considered a transitioning point; an area through which people travelled in the spring and fall. The Łutselk'e Dene have previously identified the region east of the Project site, Artillery Lake and to the north at Aylmer Lake as their primary harvesting areas. The Łutselk'e Dene have expressed a concern that the Project will change the water quality in the Lockhart River system and affect the quality of the fish they eat. They have also linked employment at the mine as interfering with the opportunity to participate in traditional harvesting. However, surveys have indicated that mine employees are more likely to participate in traditional activities than non-mine employees (Section 12). The primary activity undertaken by mine employees when at home was to go out on the land. Mine employees do point out that the primary factor limiting participation in traditional activities is possessing sufficient funds to purchase equipment and fuel, which is supported by surveys completed by the Łutselk'e Dene (Section 12). Therefore, in the case of traditional activity participation, there is no apparent lost opportunity related to mine based employment. Rather, the opposite seems to be true.

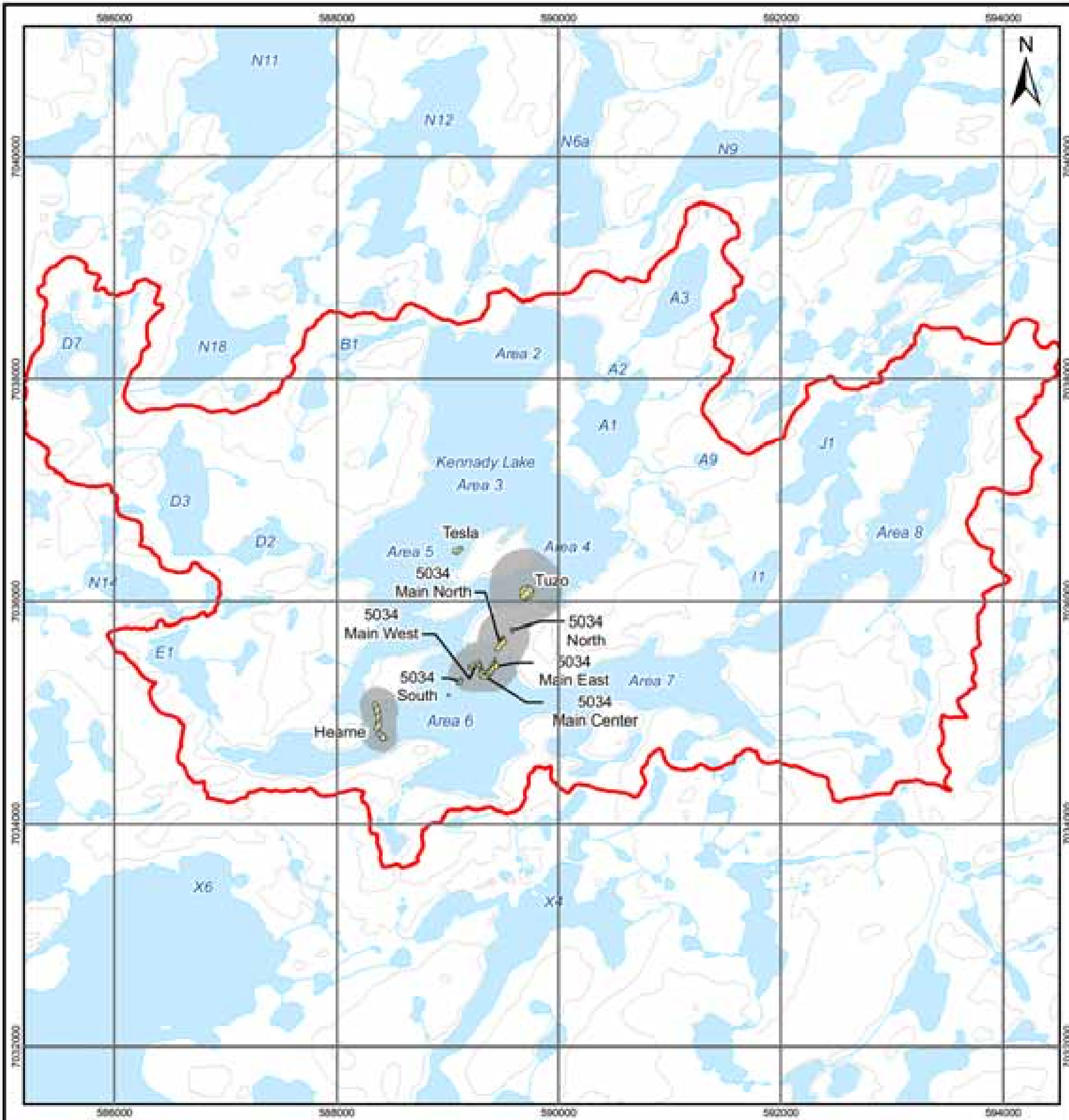
2.3 ALTERNATIVE MEANS OF CARRYING OUT THE PROJECT

Alternative means of carrying out the Project have been considered during all stages of design. Decisions were made based on economics, good engineering practice, environmental and sustainability considerations, safety, traditional knowledge, and community input.

2.3.1 Mining Methods

The Project's three ore bodies (i.e., 5034, Hearne, and Tuzo) consist of multiple, vertical kimberlite pipes located mainly in Kennady Lake under water depths ranging from 7 to 16 metres (m). The northernmost part of the 5034 ore body is under the tip of the peninsula west of the plant site, and is not completely under water (Figure 2.3-1). The following considerations were factored together when evaluating alternative means for mining the three ore bodies:

- underground versus open pit mining;
- mining sequence; and
- extraction rates.



LEGEND

- Watercourse
- Waterbody
- Contour (10m interval)
- Kimberlite
- Proposed Open Pit
- Watershed Boundary

NOTES
Base data source: National Topographic Base Data (NTDB) 1:50,000

GAHCHO KUÉ PROJECT

Location of 5035, Hearne, and Tuzo Kimberlite Pipes

PROJECTION: UTM Zone 12	DATUM: NAD83	DE BEERS CANADA
Scale 1:50,000 775 387.5 0 775 Metres		
FILE No: SON-2-001-GIS		DATE: December 1, 2010
JOB NO: 09-1365-1004	REVISION NO: 1	**Figure 2.3-1**
OFFICE: GOLD-CAL	DRAWN: CW	CHECK: JP

2.3.1.1 Underground and Open Pit Mine Alternatives

The kimberlite ore bodies for the Project are vertical pipes. Like the kimberlite pipes at the Ekati and Diavik diamond mines, the kimberlite pipes in Kennady Lake are most amenable to open pit mining. The kimberlite ore body mined at the Snap Lake Mine is uncommon among kimberlite ore bodies, because it consists of a thin, shallow dipped structure that makes open pit mining impractical and underground mining the preferred mining method. However, De Beers did consider both open pit and underground mining of the kimberlite pipes as an alternative mining option in the 2000 desktop study.

The 2000 desktop study concluded that underground mining was economically less favourable, compared to open pit mining, because both the capital cost and operating cost of the underground mine alternative were predicted to be substantially higher than the open pit alternative.

To keep the lake water out of underground workings, there would need to be a sufficient layer of competent, water-tight rock between the mine workings and the overlying lake. A minimum vertical separation of about 50 m to 100 m from the lake bottom to the underground workings would have to be maintained. In addition, it is usual for the transition zone between the host rock (e.g., granite) and the kimberlite pipe to be fractured, which could provide a conduit for the flow of surface water into the mine areas. Extensive grouting of the rock above the mine, backfilling of mined-out areas, and pumping and treatment of substantial amounts of groundwater flowing into the underground mine would be required. Maintaining a 100 m separation between the underground workings and the lake bottom would mean that about one-third to one-quarter of the ore could not be mined. This loss of the diamond resource was not considered in the 2000 desktop study; however, it would have a substantial negative effect on the Project economics. To prevent this loss of resource and the inflow of lake water, dewatering Kennady Lake would be required for both the underground and open-pit alternatives. A potential environmental advantage (i.e., not dewatering Kennady Lake) would not be achieved by choosing underground mining.

Management of groundwater inflow to the mine would have substantially greater environmental impacts on surface water quality for an underground mine compared to an open pit mine. Backfilling of the open pits with mine rock (i.e., rock surrounding the kimberlite) and PK provides an opportunity to co-dispose of some of the groundwater inflow, eliminating the need to discharge it to the environment. For an underground mine, all groundwater inflow would have to be discharged to surrounding surface waterbodies. The discharge of such groundwater would have a substantial negative environmental effect on surface water quality, because groundwater contains much higher concentrations of total dissolved solids (TDS) (e.g., calcium and magnesium) than the concentrations present in surface waters. The waterbodies near the Project are relatively small and, therefore, have less capacity to assimilate groundwater than larger lakes.

As a result of economic and environmental issues, only the open pit alternative was carried forward.

De Beers has considered the possibility of applying underground mining methods to the Project site once the initial open pits are completed, because all three ore bodies continue past the planned pit bottoms. However, the feasibility of this alternative could not be determined on the existing geological models; therefore, a combined open pit followed by underground mining approach is not planned at present. If future resource work identifies significant increases in ore quantities below 130 metres above sea level (masl), then the opportunity to extend the Project by underground mining may be re-assessed.

2.3.1.2 Mining Sequence

The order in which mining would proceed was based largely on economics, and management of mine rock and PK. The kimberlite pipes will be mined according to value (i.e., $/tonne). The 5034 ore body is the largest, and contains the highest ore grades. Mining the 5034 ore body first will provide the largest early return on the initial capital investment. Mining will commence on the accessible (northern) portion of 5034 to provide mine rock for construction of the dykes required for water management and storage of PK. The mined-out 5034 open pit will also provide the largest opening into which mine rock and PK can be deposited. To ensure a continuous supply of ore to the plant, ore in the Hearne Pit would be exposed while the 5034 Pit is being mined, and ore from the Tuzo Pit would be exposed while the Hearne Pit is being mined. This sequence was chosen, because of its more favourable aspects with respect to economics and management of mine rock.

2.3.1.3 Extraction Rates

Extraction rates were refined over time as information became available. The conceptual study in 2000 identified 1.5 million tonnes per year (Mt/y) as the maximum extraction rate for the mining operation. Different ore mining rates were tested in 2002, starting at 1 Mt/y and increasing in 0.5 Mt/y increments until the maximum was achieved. The annual financial return increased as extraction rates increased; however, extraction rates are limited by factors that affect the reliable production of the open pit and the mill. An extraction rate of 3.0 Mt/y has been selected for the Project.

Open pits are normally mined as quickly as possible for the following reasons:

- Extending the time a pit is open presents difficulties, because the pit walls tend to deteriorate with time. The sloughing of portions of the walls can present safety hazards to workers, and increase the maintenance required to keep the pit access road open.
- Increased groundwater inflow is also related to extraction rates. The longer a pit is open, the more groundwater flows into the pit. Inflowing groundwater will contain high concentrations of TDS, which are not expected to be acceptable for release to the environment. Mining the open pits as quickly as possible limits the amount of water that must be pumped from the open pit and isolated from the ambient surface waters.

Although a range of extraction rates were evaluated to determine the maximum sustainable rate, the maximum sustainable rate was determined to be the most ideal alternative from an environmental and technical perspective, as it will reduce the prospect of pit wall sloughing and reduce the amount of groundwater to be managed.

An issues and impacts scoping assessment completed for the 2002 desk-top study identified that the relatively short mining life of the Project as a potentially negative impact on Aboriginal communities who are seeking sustainable development. A shorter mine life also decreases the opportunities for contribution to the NWT economy. The Project has therefore been designed specifically to maximise its contributions to sustainability as outlined in Section 12.

2.3.2 Water Management

This section will include water management alternatives under the following headings:

- Dewatering of Kennady Lake;
- Discharge of Water from Kennady Lake; and
- Refilling of Kennady Lake.

2.3.2.1 Dewatering of Kennady Lake

For the purposes of mine planning, Kennady Lake has been divided into a number of areas or basins. Prior to 2009, the “basin” terminology was used, and five basins were defined, consisting of Basins K1 through K5. Since 2009, the five basins have been replaced with eight areas, Areas 1 through 8. They overlap as follows:

- Area 1 contains Lakes A1 and A2, which were not included in Basins K1 to K5;
- Area 2 corresponds to the northern portion of Basin K1;
- Area 3 consists of the central part of Basin K1;
- Area 4 corresponds to the area of Kennady Lake previously referred to as Basin K2;
- Area 5 consists of the southern portion of Basin K1;
- Area 6 corresponds to the area of Kennady Lake previously referred to as Basin K3;
- Area 7 corresponds to the area of Kennady Lake previously referred to as Basin K4; and
- Area 8 corresponds to the area of Kennady Lake previously referred to as Basin K5.

As shown in Figure 2.3-1, the 5034 and Hearne ore bodies are located in Area 6, and the Tuzo ore body is located in Area 4. In all three cases, the top of the kimberlite ore resides near the bottom of Kennady Lake in water depths ranging from approximately 7 to 16 m. Before mining can take place, the area above and around the pipes must be dewatered. Five alternative methods of completing the dewatering have been considered since 2000, with each option including dykes to keep water out of areas to be dewatered. The alternatives differ in the number of dykes required and the extent of the lake being dewatered. In all cases, the water in Area 8 remains unaltered from current conditions. The following alternatives to dewater the ore bodies were considered:

- Alternative 1: dewater Areas 4 and 6;
- Alternative 2: dewater Areas 4, 6 and 7;
- Alternative 3: dewater Areas 2 through 7;
- Alternative 4: dewater Areas 2 to 7 and displace water from Area 1; and
- Alternative 5: complete dewatering of Areas 1 to 6 and partial dewatering of Area 7.

For the reasons outlined below, Alternative 4 was selected for inclusion in the Project design.

2.3.2.1.1 Alternative 1: Dewater Areas 4 and 6

Alternative 1 was developed in 2000. Planning was at the conceptual level, and the primary focus of the desktop study was on the financial feasibility of the Project (i.e., whether project planning should continue). The other alternatives were developed as on-site data were gathered and planning progressed.

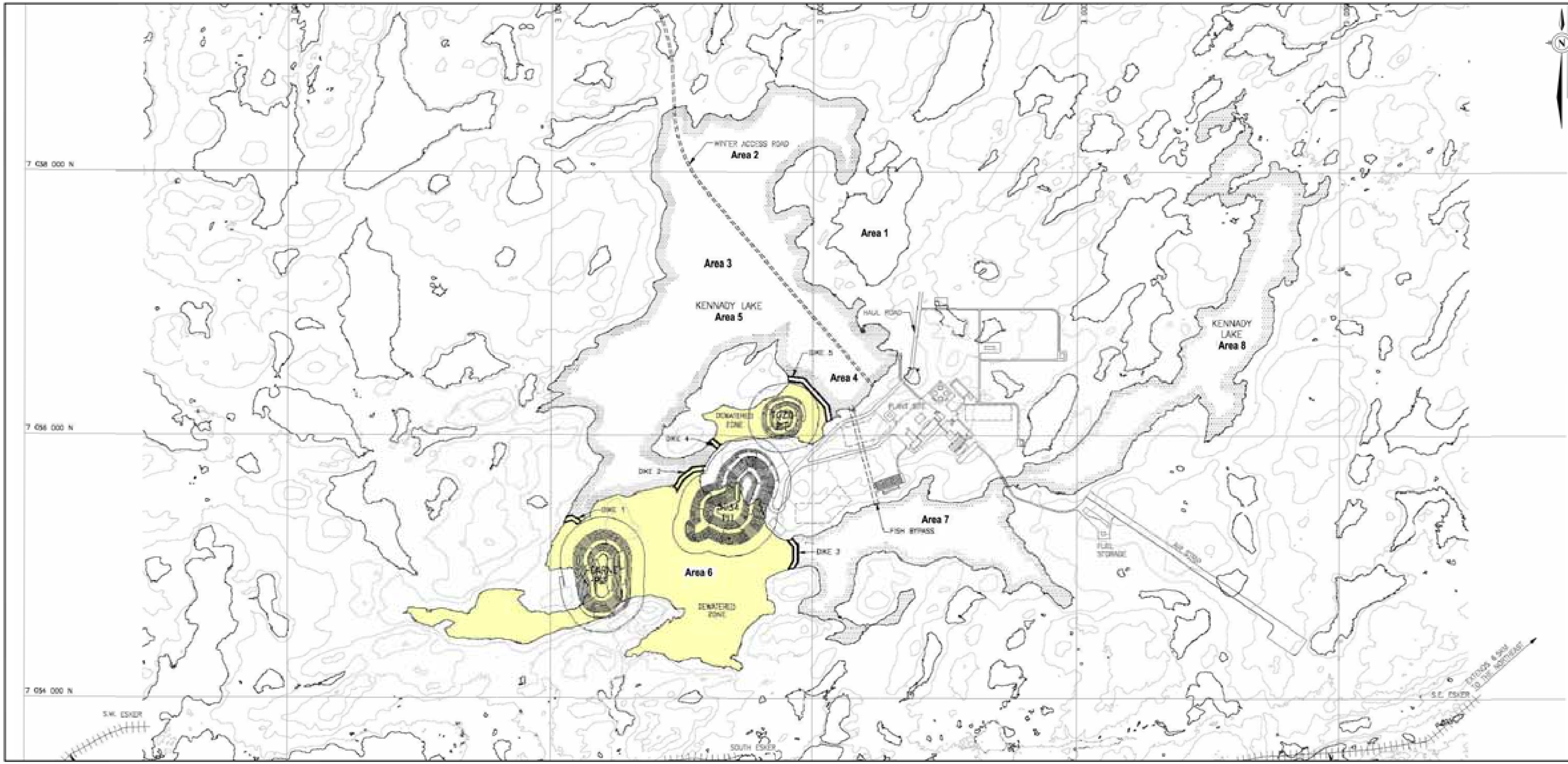
Alternative 1 involves the smallest alteration to Kennady Lake; however, construction of a series of five dykes would be required around the pit positions. Since the ore bodies are located in Areas 4 and 6, this alternative included dewatering all of Area 6 and approximately half of Area 4 (Figure 2.3-2).

In Alternative 1, dykes for the 5034 and Hearne pits would be constructed at the start of the Project, and those of the Tuzo Pit two years prior to the start of Tuzo mining. Constructing Dykes 1, 2 and 3 would allow for the isolation and dewatering of Area 6. Dewatering was assumed to take approximately four months. This would allow pre-mining to begin on the 5034 and Hearne pits. Later construction of Dykes 4 and 5 would allow the water above the Tuzo Pit to be drained and pre-mining to commence on that pit. The preliminary dyke sizes are summarized in Table 2.3-1. These estimates are approximate and were developed in the absence of detailed site-specific data. The dykes would be constructed using quarried rock, processed rock, and borrow material and would include a cut-off wall.

Table 2.3-1 Lengths and Maximum Heights of Dykes Included in Alternative 1 (Proposed in 2000)

Dyke Number	Design Length (m)	Maximum Height (m)
1	220	8.25
2	330	6.25
3	250	10.75
4	110	4.75
5	560	16.75

m = metre.



GAHCHO KUÉ PROJECT

Alternative 1 - Conceptual Plan for Dewatering Areas 4 and 6 (2000)

PROJECTION: UTM Zone 12		DATUM: NAD83	DE BEERS CANADA
SCALE 500 0 500 METRES			
FILE No: SON-2-001-CAD			DATE: December 3, 2010
JOB No: 09-1365-1004	REVISION No: 0		Figure 2.3-2
OFFICE: GOLD - SAS	DRAWN: TAH	CHECK: JB	

NOTES

Base data source: AMEC Figure 2.3-2 - Conceptual Plan for Dewatering Basins K2 and K3, 2002. Job No. 141731.Office: AMEC-VAN

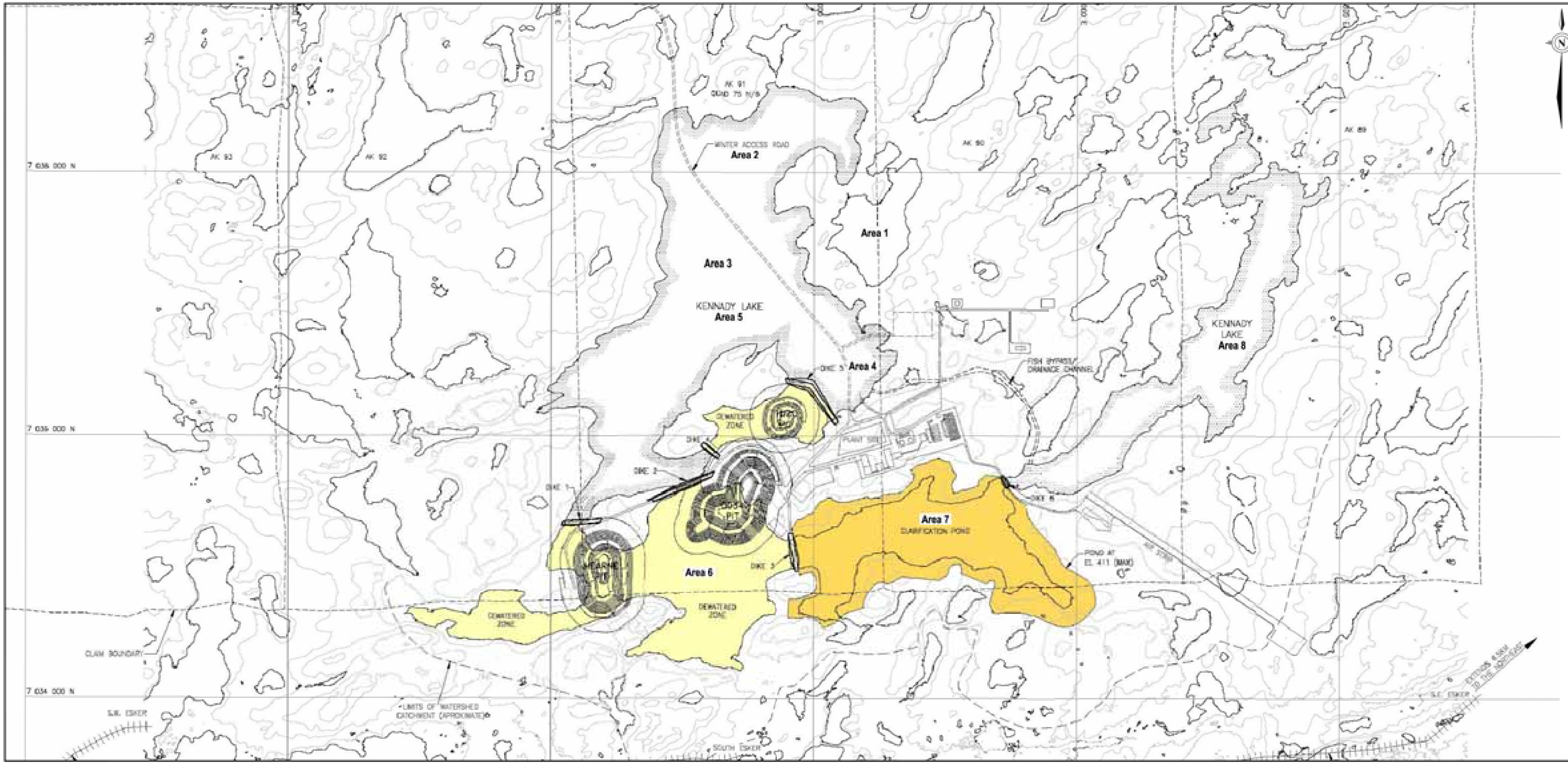
The dykes separating the northern portion of Kennady Lake from Areas 4 and 6 effectively divide the lake into two parts (Figure 2.3-2). Since Kennady Lake drains northward through the outlet of Area 8, this separation would disrupt the normal lake drainage, a feature common to all alternatives. Arctic grayling spawn in streams located downstream of Kennady Lake; therefore, the disruption of normal lake drainage has the potential to negatively affect spawning success in downstream systems. In Alternative 1, Arctic grayling in the north portion of Kennady Lake (i.e., in Areas 2, 3 and 5) would also be separated from their spawning grounds. A fish bypass connecting the two parts of the lake was proposed. It would start in the southeast corner of Area 4 near Dyke 5, cross the peninsula containing the plant site and empty into Area 7 (Figure 2.3-2). Drainage between the remaining northern and southern basins would be restored; it was uncertain, however, if Arctic grayling would use the new channel to reach their previous spawning areas.

The dewatering of Areas 4 and 6 would result in a loss of fish habitat during construction and operations. Some aquatic habitat could be restored after refilling, although the habitat would be altered, because the open pits and remnants of the dykes would remain.

2.3.2.1.2 Alternative 2: Dewater Areas 4, 6 and 7

Alternative 2 was created when the opportunity to use dyked lake areas to store PK and mine rock was identified. By adding one more dyke (i.e., increasing the number of dykes from five to six) on the southeast arm of Kennady Lake (i.e., in Area 7), the arm could be used as a clarification pond during initial lake dewatering and, subsequently, as a PKC facility.

The second alternative was also considered at a conceptual design stage of the Project. Area 7 would be dewatered first. Dykes 3 and 6, located between Areas 6 and 7 and Areas 7 and 8, respectively (Figure 2.3-3), would be constructed first to isolate Area 7, so that it could be dewatered. It was assumed that water could be pumped directly into Area 8 and then discharged through the natural lake outlet into downstream systems while the concentrations of total suspended solids (TSS) in the water remained below acceptable levels. After TSS levels increased in the areas being dewatered, the remaining water would be pumped to a water treatment plant prior to discharge into Area 8. After dewatering, Area 7 would become the clarification pond.



GAHCHO KUÉ PROJECT

Alternative 2 - Conceptual Plan for Dewatering Areas 4, 6 and 7 (2002)

PROJECTION: UTM Zone 12	DATUM: NAD83
SCALE 500 0 500 METRES	
FILE No: SON-2-002-CAD	DATE: December 6, 2010
JOB No: 09-1365-1004	REVISION No: 0
OFFICE: GOLD - SAS	DRAWN: TAH / CHECK: JB

DE BEERS CANADA

Figure 2.3-3

NOTES

Base data source: AMEC Figure 2.3-3 - Conceptual Plan for Dewatering Basins K2, K3 and K4, 2002. Job No. 141731.Office: AMEC-VAN

Dykes 1 and 2 would be constructed next, so that Area 6 could be dewatered, which would enable mining operations to commence (Figure 2.3-3). It was estimated that the dewatering would take about 60 days. It was assumed that approximately half of the water from Area 6 would have low concentrations of TSS and could be pumped into Area 8 without treatment. The remaining water would be pumped to the new clarification pond contained by Dykes 3 and 6. The water in the clarification pond would be allowed to settle throughout the duration of construction of the surface facilities and would be progressively discharged to the Kennady Lake outlet via the water treatment plant.

An impervious turbidity (silt) curtain would be installed at Dykes 1, 2 and 6; dyke construction would begin when the curtain was in place. The possibility still existed that the construction of these relatively large dams in the lake would impact negatively on the water quality.

Dykes 4 and 5 would be constructed before Year 8 of operations to allow time to dewater the enclosed part of Area 4 (Figure 2.3-3). Mining of the Tuzo Pit would then begin as scheduled.

The construction of these six dykes separate Areas 1, 2, 3 and 5 from Area 8. A by-pass channel between the northern part of Kennady Lake and the southeast arm was again proposed to maintain drainage to the lake outlet. An opportunity was identified to construct the channel in an area north of the proposed plant site (northeast of the channel proposed in 2000). One possible alignment for this channel extended from the northern part of Area 4 (just northeast of Dyke 5) to the eastern end of Area 8 (just east of Dyke 6) as shown in Figure 2.3-3.

As with Alternative 1, the movement of Arctic grayling to spawning areas would be an issue. The fish might use the new channel between the northern portion of Kennady Lake and the lake outlet, but there would be a high degree of uncertainty. Alternative 2 also involves the loss of more fish habitat during construction and operations than the first alternative (three basins rather than two). There would also be a permanent loss of fish habitat in Area 7. Although water levels in Areas 4 and 6 would be restored at closure, there would be the same changes in habitat that were mentioned for Alternative 1.

The second alternative has disadvantages that are consistent with the first alternative. Placement of dykes throughout Kennady Lake, while the lake is filled with water, would be difficult and costly. The conceptual design included the construction of six dykes, two of which would be significant structures. An economic analysis of this scenario showed that it was not feasible due to the high cost of construction in water and the additional complexity of constructing the large dykes (De Beers 2005).

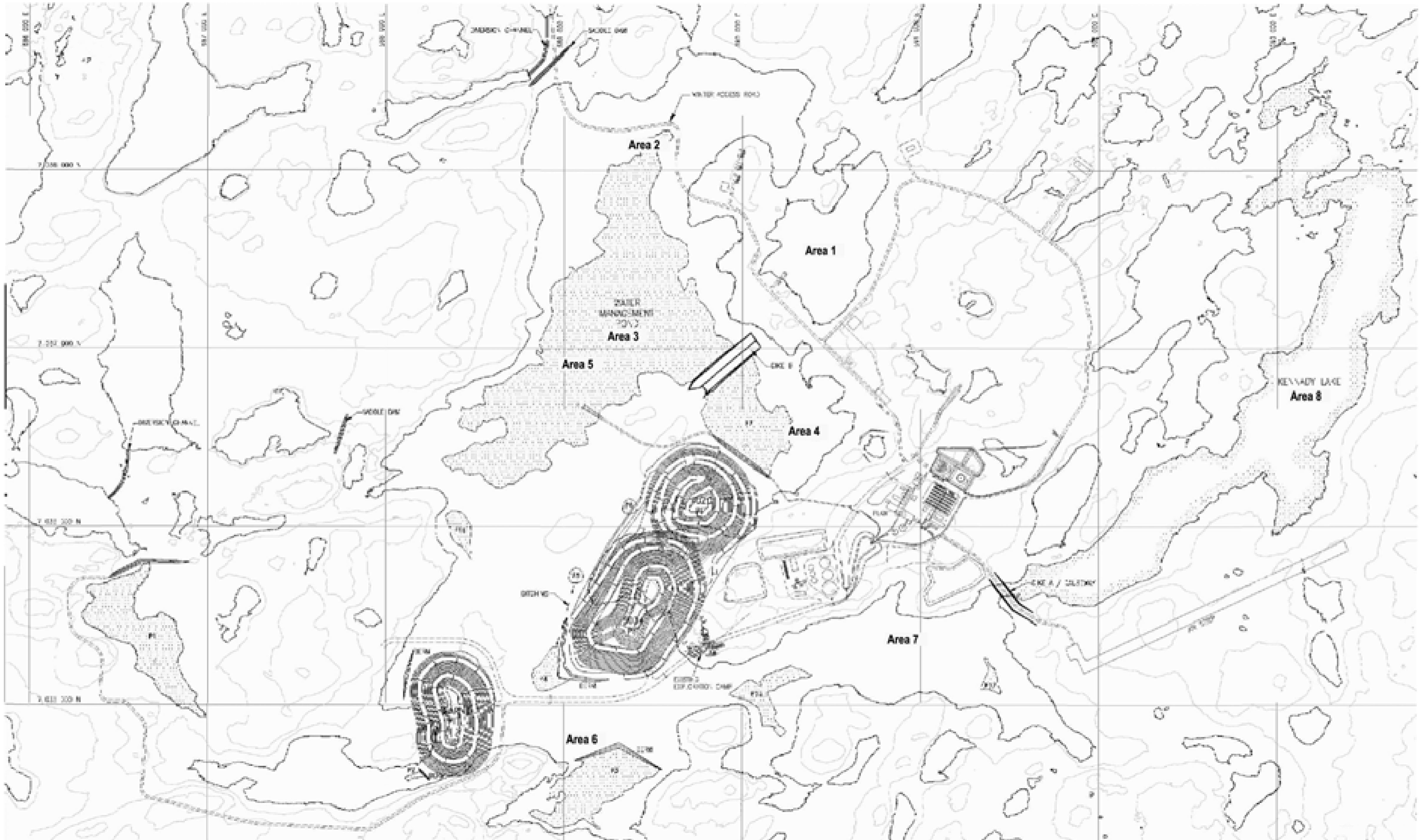
The greatest source of uncertainty in this alternative involved the dykes, in terms of the depth and nature of the organic sediments and other materials found at the bottom of Kennady Lake, as well as the competency of the underlying bedrock. Faults and joint planes in the dyke areas could also pose problems as they could become planes of weakness as mining progresses, and, in time, they could become water channels.

An option considered for the second alternative was to link the northern portion of Kennady Lake to waterbodies to the north of Kennady Lake (i.e., the northern portion of the lake to waterbodies in a different watershed to the north). Based on limited aerial survey data, the length and excavation depth of this channel would be significantly less than that of the proposed channel. However, this alternative would have the additional environmental impact of linking two previously unconnected watersheds and flow systems, which could affect fish migrations

2.3.2.1.3 Alternative 3: Dewater Areas 2 through 7

The third alternative involved the dewatering of Areas 4, 6 and 7 and the lowering of water levels in Areas 2, 3 and 5 (Figure 2.3-4). This third alternative would require construction of two water retaining dykes, one during pre-production and one during operation. Both structures would be only a few metres high, in contrast to the dykes required as part of Alternatives 1 and 2. Initial construction of a small dyke, named Dyke A, would occur between Areas 7 and 8 where Kennady Lake is shallow and narrow. The dyke would be constructed during the mine construction phase to isolate the remainder of the lake from Area 8. Area 8 would remain at its natural water level and discharge via the Kennady lake outlet, while water levels in the remaining areas of the lake would be lowered as required to allow development of the open pits. After some initial dewatering, a second dyke (Dyke B) would be constructed on the lake bed separating Areas 2, 3 and 5 from Area 4, as that part of the lake became dry.

The main advantage of this alternative over Alternatives 1 and 2 is the reduced number of dykes involved in the dewatering scheme, and consequential reduction in the overall risk profile associated with this dewatering alternative.



GAHCHO KUÉ PROJECT

Alternative 3 - Conceptual Plan for Dewatering Areas 2 through 7, (2005)

PROJECTION: UTM Zone 12	DATUM: NAD83
SCALE 500 0 500 METRES	DE BEERS CANADA
FILE No: SON-2-003-CAD	DATE: December 6, 2010
JOB No: 09-1365-1004	REVISION No: 0
OFFICE: GOLD - SAS	DRAWN: TAH
CHECK: JB	Figure 2.3-4

NOTES

Base data source: AMEC Figure 2.3-4 - Conceptual Plan for Dewatering Basins K1 to K4, 2005. Job No. 141731.Office: AMEC-VAN

2.3.2.1.4 Alternative 4: Dewater Areas 2 to 7 and Displace Water from Area 1

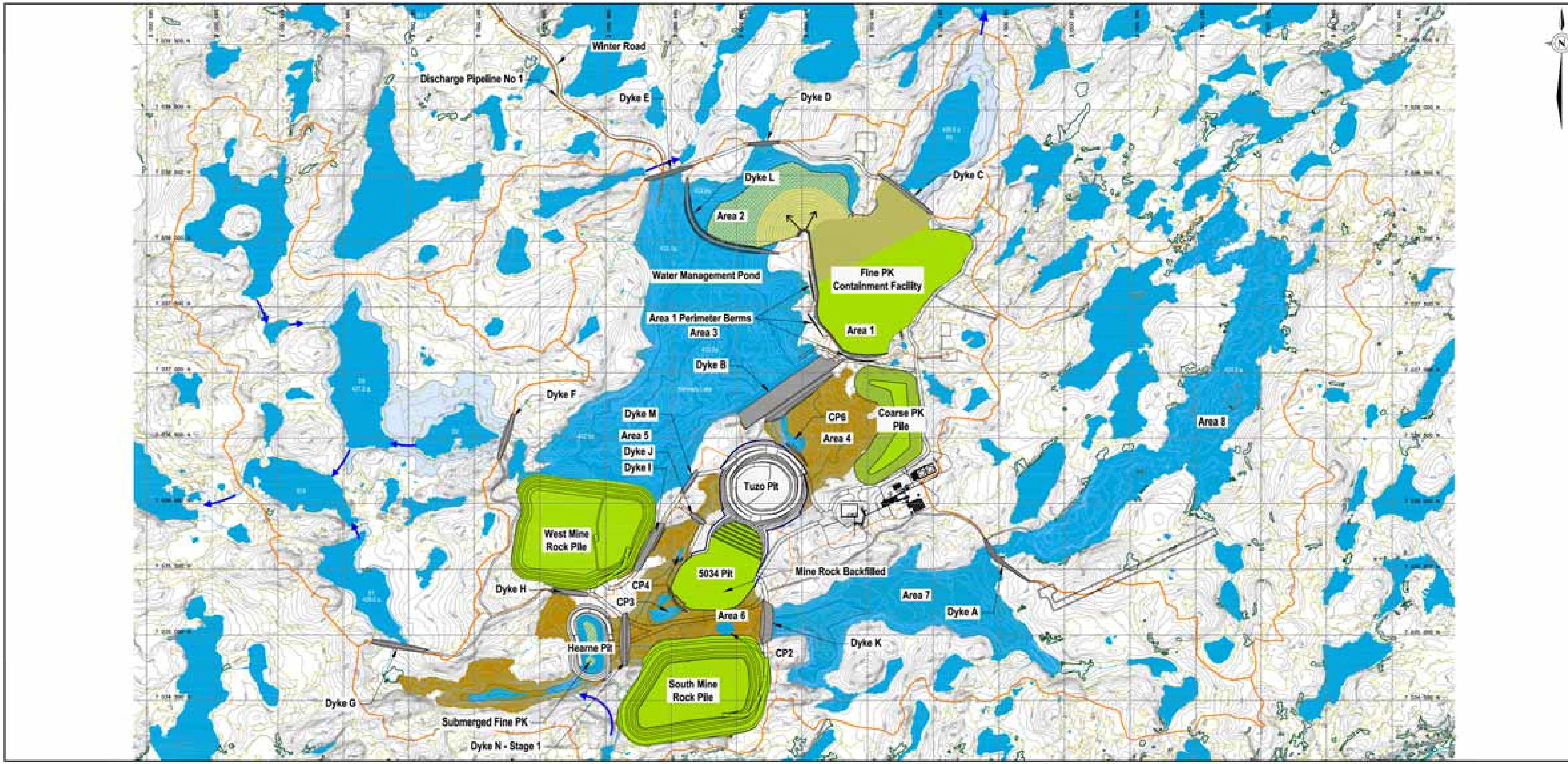
The objective of the dewatering program represented by Alternative 4 is to discharge up to 50 percent (%) of the water currently held in Areas 2 through 7 to neighbouring lakes. After this initial dewatering is complete, Areas 6 and 7 will be isolated and drained completely, with water being pumped from these areas into Areas 2 to 5.

Before dewatering can take place, various dykes will be built to both divert runoff water from Kennady Lake and later retain water affected by the Project within Areas 1 to 7 (Figure 2.3-5). A critical activity during the initial construction will be the creation of a water control basin by construction of Dyke A at the narrows separating Areas 7 and 8. Area 8, also known as Lake K5, represents the eastern section of Kennady Lake that will remain at the existing lake elevation.

As water levels decreases, the sills separating the northwest portions of the lake (Areas 2 to 5) from the areas containing the 5034 and Hearne ore bodies (Areas 6 and 7) will be exposed. Coffer dams will be constructed isolating the northern portion of the lake (Area 2 to 5) from the southern portion of the lake (Area 6 and 7), effectively splitting the partially dewatered lake into two major sections and allowing the complete drainage of the remaining water from Areas 6 and 7.

Water from Areas 6 and 7 will be discharged to external lakes until water no longer meets discharge criteria. Once that occurs, water from Areas 6 and 7 will be pumped into the south end of Area 5 until the region above the 5034 and Hearne ore bodies (Area 6 and 7) are dry and available for mining. A pervious dyke may be constructed within Area 5, if required, to assist settling of water pumped from Areas 6 and 7. In addition, the water held in Area 1 will gradually be displaced as the Fine PKC Facility is constructed and used.

By mid-year of Operations Year 5, Dyke B will be constructed to separate Areas 3 and 4 of Kennady Lake, thereby allowing dewatering of the southern portion of Area 4 so the Tuzo Pit can be mined. This dyke will be constructed using overburden till and mine rock from the open pits. Dyke B will be constructed to a crest elevation of 423.5 m, which is above the maximum projected operating level of the water management pond that will be located in Area 3. Water will be siphoned from Area 4 to the mined-out 5034 Pit to expose the area over the Tuzo Pit.



LEGEND

Existing Ground Contours
5m Index - 1m Intermediate

Bathymetry Contours
5m Index - 1m Intermediate

CP Collection Pond

Winter Road

Marsh Area

Scrub

Sub-watershed Boundary

Drainage Flow Direction

Discharge Pipeline

Coarse PK

Drained Area

Fine PK

Flooded Area

Lake/Pond

Mine Rock

Submerged PK

NOTES
Base data source: EBA Figure 4.10 - Stage 7 - Water Management During Mine Operation Year 8 (2022)

GAHCHO KUÉ PROJECT

Alternative 4 - Conceptual Plan for Dewatering Kennady Lake (2010)

PROJECTION: UTM Zone 12	DATUM: NAD83		DE BEERS CANADA
SCALE 500 0 500 METRES			
FILE No: SON-2-004-CAD			DATE: December 7, 2010
JOB No: 09-1365-1004	REVISION No: 0		Figure 2.3-5
OFFICE: GOLD - SAS	DRAWN: TAH	CHECK: JB	

Alternative 4 is similar to Alternative 3. It involves few dykes and a lower overall risk profile than Alternatives 1 or 2. Key differences between Alternatives 3 and 4 involve the displacement of water from Area 1 and the placement of berms in the western portion of the Project site in closer proximity to the active mining area. The displacement of water from Area 1 allows for the Fine PKC Facility to be built closer to the open pit mining operations, thereby reducing the size of the Project footprint. Similarly, strategic placement of berms in the western portion of the Project area isolates the Project from lakes in the E watershed that would otherwise form part of the water management system in Alternative 3.

2.3.2.1.5 Alternative 5: Complete Dewatering of Areas 1 to 6 and Partial Dewatering of Area 7

Alternative 5 is identical in general layout to Alternative 4. The only difference is that Alternative 5 involves the complete dewatering of Areas 1, 2, 3 and 5 during the construction phase of the Project. In other words, all of the water currently contained in these areas would be discharged during the construction of the Fine PKC Facility. This alternative was developed as a means of ensuring the complete removal of fish from these areas of Kennady Lake prior to their use as operational areas.

This alternative is more energy intensive than Alternative 4, because of the increased pumping demands. It would also appear to offer limited benefit to the environment, because the water removed from Areas 2, 3 and 5 would have to be replaced during the formation of the water management pond, which is required for the successful execution of the Project. As a result, this option was not selected.

2.3.2.1.6 Chosen Alternative

Alternative 4 was selected for inclusion in the Project design, because it offered:

- substantial reduction in risk from a dam safety perspective;
- opportunity to develop a more compact Project footprint;
- efficient use of the water currently residing in Kennady Lake;
- substantial improvement in Project economics; and
- opportunity for reduced complexity of mine construction.

Although dewatering most of Kennady Lake will notably affect aquatic life in the lake, Alternative 4 involves fewer, shallower dykes than Alternatives 1 or 2. It has a smaller footprint than Alternative 3, which positively impacts operational costs (due to shorter hauling distances). Alternative 4 also involves a more efficient use of the water currently contained in Kennady Lake, relative to Alternative 5. It is for these reasons that it was selected for use in the Project design.

2.3.2.2 Discharge from Kennady Lake

During construction, waters from the Project area will be released to the receiving environment as water levels in Kennady Lake are lowered to allow access to the 5034, Hearne and Tuzo ore bodies. During operations, waters may also be released. Alternatives considered during the development of the Project design included the following:

- Discharge exclusively to the existing lake outlet in Area 8;
- Discharge to Lake N11 and the existing lake outlet in Area 8;
- Discharge predominately to Lake N11, with limited use of the existing lake outlet in Area 8.

2.3.2.2.1 Alternative 1: Discharge to Existing Outlet

Alternative 1 was developed during the initial planning stages of the Project. During dewatering, it involves the release of water to the existing outlet of Kennady Lake in Area 8. It was assumed that at least half of the water would be pumped directly without treatment; the remaining water would be pumped to a water treatment plant to remove excess TSS before being discharged to Area 8 and released through the existing outlet.

During operations, discharge waters would continue to flow from the northern, unaffected portions of Kennady Lake to Area 8 via one or more diversion channels. No treatment of these waters was assumed to be necessary, since they have not been in contact with the Project.

2.3.2.2.2 Alternative 2: Discharge to Lake N11 and Existing Outlet

Discharge during Dewatering

After 2002, it was determined that the streams in the L and M watersheds located downstream from the outlet of Area 8 (Lake K5) were susceptible to impacts from high flow rates. Erosion of stream banks and an increase in suspended solids would likely occur if Kennady Lake was dewatered rapidly and discharged through its existing outlet.

To accommodate the need to dewater Kennady Lake rapidly during ice-free conditions, but protect the downstream watersheds, an alternative was proposed (De Beers 2005). The water discharged during the first phase of dewatering that would not require treatment would be pumped at the maximum rates, but the water would be pumped to two locations simultaneously:

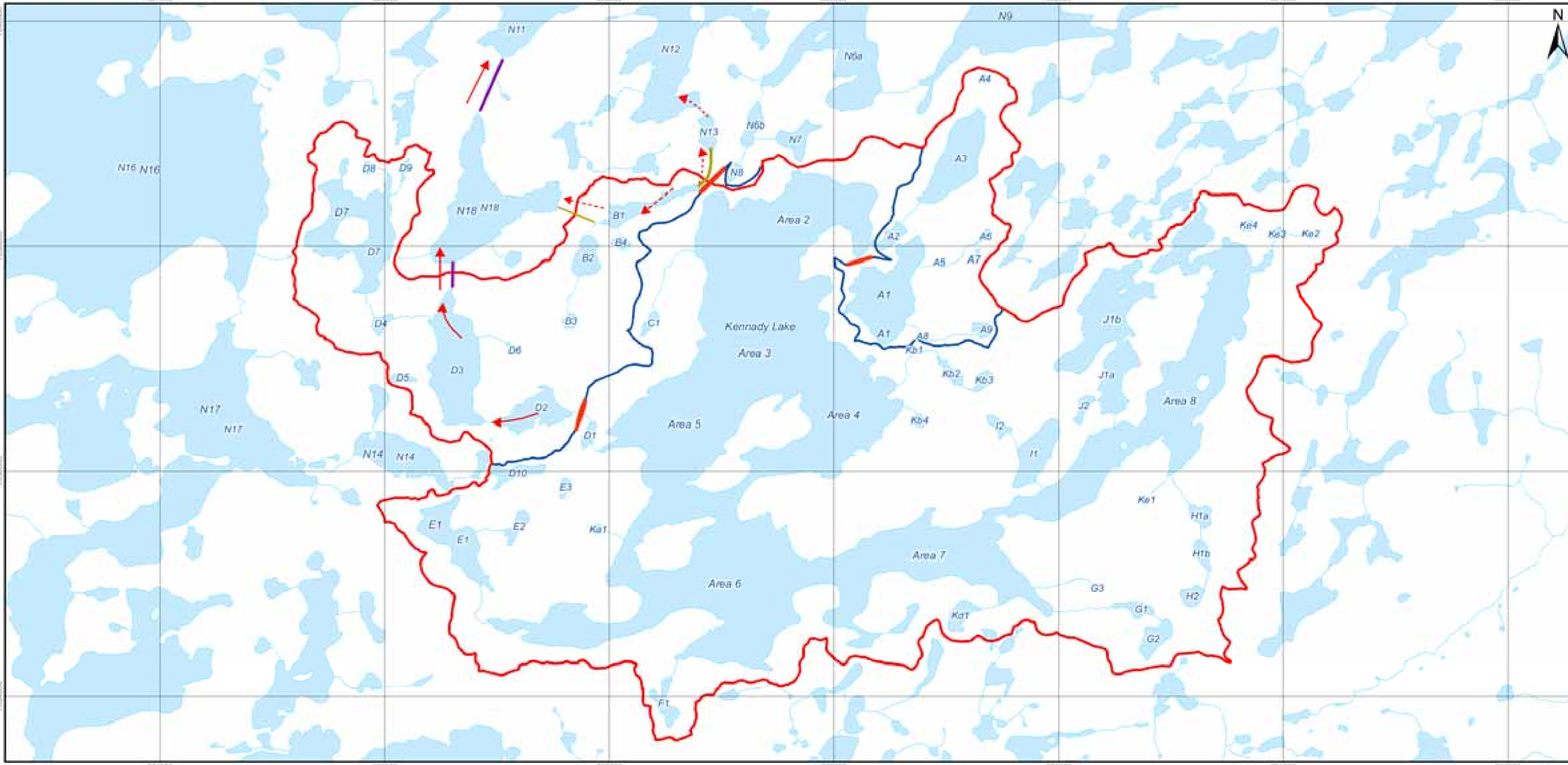
- the existing lake outlet in Area 8; and
- Lake N11 in the N watershed.

Once Dyke A was completed, two floating pump barges would begin to lower the water level of Kennady Lake. One of these barges would discharge to the eastern portion of Kennady Lake (Area 8), while the other would discharge water to the N watershed immediately to the north. The N watershed is larger and capable of receiving more pumped discharge than the Kennady Lake watershed. A pumping rate of 500,000 cubic metres per day (m^3/d) was proposed for Lake N11 (Figure 2.3-6), which would not result in downstream erosion effects. It was projected that the initial simultaneous pumping of Kennady Lake water to both the existing Kennady Lake outlet and Lake N11 would enable all of the first phase of dewatering to be completed in one open water season.

Later, as the water level in Kennady Lake declined, treatment of the water to remove suspended sediments was expected to become necessary prior to discharge. The rate of pumping would decrease, because all water would have to be treated. Once treatment began, pumping to Lake N11 would cease, and all water releases would occur via the existing lake outlet in Area 8.

Discharge during Operations

During operations, a key management objective would be to reduce the volume of water coming into contact with the mine area, as this water must be re-routed through the water treatment plant for removal of suspended solids before discharge to the existing lake outlet. A series of diversion berms and ditches would be constructed to divert runoff from those portions of the Kennady Lake watershed that can practically be diverted into adjoining watersheds. Diverting clean water from the watershed during operations would reduce the amount of treatment required.



LEGEND

- Watercourse
- Waterbody
- A2 Lake Identifier
- Kennady Lake Watershed
- Re-aligned Watershed Boundary
- Saddle Dam
- Diversion Channel
- Optional Diversion Channel
- Direction of Flow
- Direction of Optional Flow

NOTES

Base data source: National Topographic Base Data (NTDB) 1:50,000
Engineered features and re-aligned watershed: AMEC

GAHCHO KUÉ PROJECT

Diversion of Surface Water from Kennady Lake

PROJECTION:	DATUM:
UTM Zone 12	NAD83

Scale: 1:35,000
0.5 0.25 0 0.5
Kilometres

DE BEERS CANADA

FILE No:	DATE:
SON-2-002-GIS	December 1, 2010

JOB NO:	REVISION NO:	
09-1365-1004	1	
OFFICE:	DRAWN:	CHECK:
GOLD-CAL	CW	JP

Figure 2.3-6

Alternative 3: Discharge Predominately to Lake N11

The configuration of Alternative 3 is virtually identical to that of Alternative 2 during the dewatering of Kennady Lake. Water will continue to be discharged to both the existing lake outlet and Lake N11, and this activity will still be completed within one open water period.

Alternative 3 differs from Alternative 2 during operations, in that the targeted outlet is Lake N11, instead of the existing lake outlet in Area 8. Alternative 3 is also designed with the goal of minimizing discharge from the Project site during operations, with the exception of an annual release of water to Lake N11 if release water quality meets applicable criteria and discharge is necessary to maintain suitable storage within the operational water management system. To help achieve this goal, berms and ditches will be used to divert runoff from as much of the Kennady Lake watershed as possible and practical into adjoining watersheds.

2.3.2.2.3 Chosen Alternative

Alternative 3 was selected for incorporation into the Project design, because it provided an efficient dewatering process and an operational outlet to a larger system with more assimilative capacity than available through Alternatives 1 and 2.

2.3.2.3 Refilling Kennady Lake after Mine Closure

After the cessation of operations, Kennady Lake will be refilled. The method of refilling Kennady Lake was not addressed in the conceptual plans (2000 and 2002). In its Application to the (MVLWB), De Beers (2005) proposed the first alternative described here, although De Beers indicated that alternatives for refilling of Kennady Lake were being considered at that time. The following alternatives were considered:

- restoring the natural drainage and allowing the lake to refill from natural inflows; and
- restoring the natural drainage to Kennady Lake, but augmenting the incoming flow rate by pumping water from Lake N11 to Kennady Lake.

2.3.2.3.1 Alternative 1: Natural Refilling of Kennady Lake

During the second half of the mine life, when mine rock and PK are being backfilled into the mined-out 5034 and Hearne pits, groundwater inflows to active pits would be pumped into pits that are being backfilled. The backfill and groundwater would effectively accelerate the refilling of Kennady Lake by reducing the volume of air space within the mined out pits at closure.

Once operations cease, refilling of Kennady Lake would commence. This process would already have been accelerated by backfilling and restoring groundwater to the two backfilled pits. The runoff diversions constructed to reduce the effective catchment of the upper portion of Kennady Lake would be removed, restoring the baseline watershed boundary of Kennady Lake and yielding a larger runoff area to facilitate Kennady Lake restoration. During the initial phase of refilling, all water entering the northern and southern basins of Kennady Lake would be directed into the mined-out Tuzo Pit. The water level in that pit will gradually rise to a point where it would begin infilling a portion of 5034 Pit that could not be backfilled during operations. Once the mine pits were filled, the natural lake bed of Areas 2 through 7 would fill. To minimize the duration of the restoration period, the runoff to the north and south basins of Kennady Lake would not be discharged to Area 8 (as would occur during operations), but would be left to fill the lake. Based on average annual hydrologic conditions, the lake would require 24 years after the end of mining operations to refill to natural lake levels.

However, this alternative was rejected after 2005, because of potential effects downstream of Kennady Lake and the long time required to refill the lake. During the 24-year refilling period, there would be a limited outflow from Kennady Lake, which would impact negatively on the Arctic grayling that spawn in the streams below the lake. The long fill time would also correspondingly delay the time for complete lake recovery.

2.3.2.3.2 Alternative 2: Accelerated Refilling of Kennady Lake

To address the impacts of reduced downstream flows and delayed recovery of Kennady Lake because of the slow rate of refilling, De Beers incorporated the following refinements to the refilling plan:

1. Sufficient water will be diverted downstream of Kennady Lake during the refilling period, so that the Arctic grayling could spawn while the lake is being refilled.

2. De Beers would pump water from Lake N11 to Kennady Lake to shorten the refilling period. Planned pumping rates will be set accordingly to ensure that the total annual outflow from Lake N11 does not drop below the 1 in 5-year dry condition. During the pumping season, pumping rates will be adjusted, as required, to meet this objective. In years where the Lake N11 outflow is forecast to naturally fall below the 5-year dry condition, no pumping will occur. During periods of higher precipitation, more water would be pumped from Lake N11.

Pumping water from Lake N11 to Kennady Lake will allow the lake to be refilled in about 8 to 14 years while providing sufficient water for the Arctic grayling downstream.

2.3.2.3.3 Chosen Alternative

Alternative 2 is a more costly option, but it is the preferred alternative from an environmental perspective. It was selected, because it will help speed up the recovery of Kennady Lake by allowing the lake to refill faster. Drawing water from the N watershed will not only accelerate the refill time, but it will enable the provision of augmented flow to meet fish requirements downstream of Kennady Lake. Pumping rates will be managed so that the Lake N11 flow rate does not fall below the 1-in-5 year dry condition.

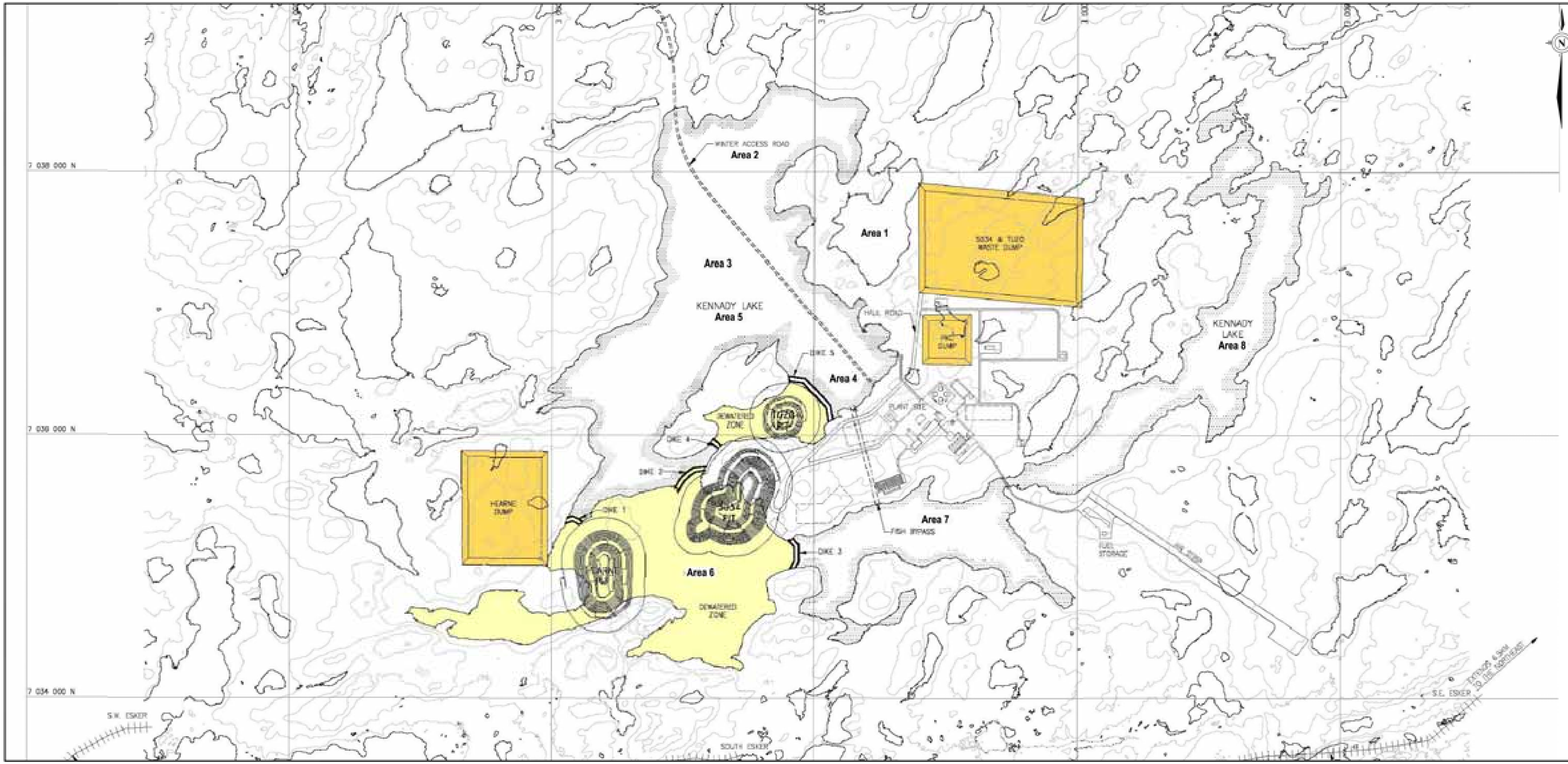
2.3.3 Management of Mine Rock and Processed Kimberlite

Recovery of the diamonds located within the Tuzo, 5034 and Hearne deposits will result in the generation of mine rock, coarse PK and fine PK that will require on-site disposal. Disposal alternatives considered during the development of the Project design included the following:

- Three on-land disposal structures;
- Area 7 PKC Facility with Two On-Land Mine Rock Piles;
- Two PKC Facilities and One Mine Rock Pile; and
- One Fine PKC Facility, One Coarse PK Pile and Two Mine Rock Piles.

2.3.3.1 Alternative 1: Three On-Land Disposal Structures

The first alternative, considered in 2000, was to place all of the mine rock on land close to the open pits. Two mine rock piles were proposed. One pile was to be located to the west of the Hearne Pit and would contain the mine rock from that pit (Figure 2.3-7). The second mine rock pile would be positioned in the northeast portion of the Project area, encroaching on Lake A1. This pile would receive the mine rock generated from mining in the Tuzo and 5034 pits. Coarse PK would also be sent to the mine rock piles, while fine PK would be sent to the Fine PKC Facility, which was to be located between the northeast mine rock pile and the plant site (Figure 2.3-7). Alternative 1 was developed in 2000 when planning was at a conceptual level, and the technical feasibility of implementing this alternative was not fully evaluated.



GAHCHO KUÉ PROJECT

Alternative 1 - Locations of Mine Rock Piles and the Processed Kimberlite Containment Facility (2000)

PROJECTION: UTM Zone 12	DATUM: NAD83
SCALE 500 0 500 METRES	
FILE No: SON-2-005-CAD	DATE: December 6, 2010
JOB No: 09-1365-1004	REVISION No: 0
OFFICE: GOLD - SAS	DRAWN: TAH CHECK: JB

Figure 2.3-7

NOTES

Base data source: AMEC Figure 2.3-6 - Locations of Waste Rock Piles and PKC, 2000. Job No. 141731.Office: AMEC-VAN

The 2000 conceptual site plan was audited in 2001. The audit recommended one significant change: to locate the mine rock piles to the south of the site within the Kennady Lake watershed.

2.3.3.2 Alternative 2: Area 7 PKC Facility with Two On-Land Mine Rock Piles

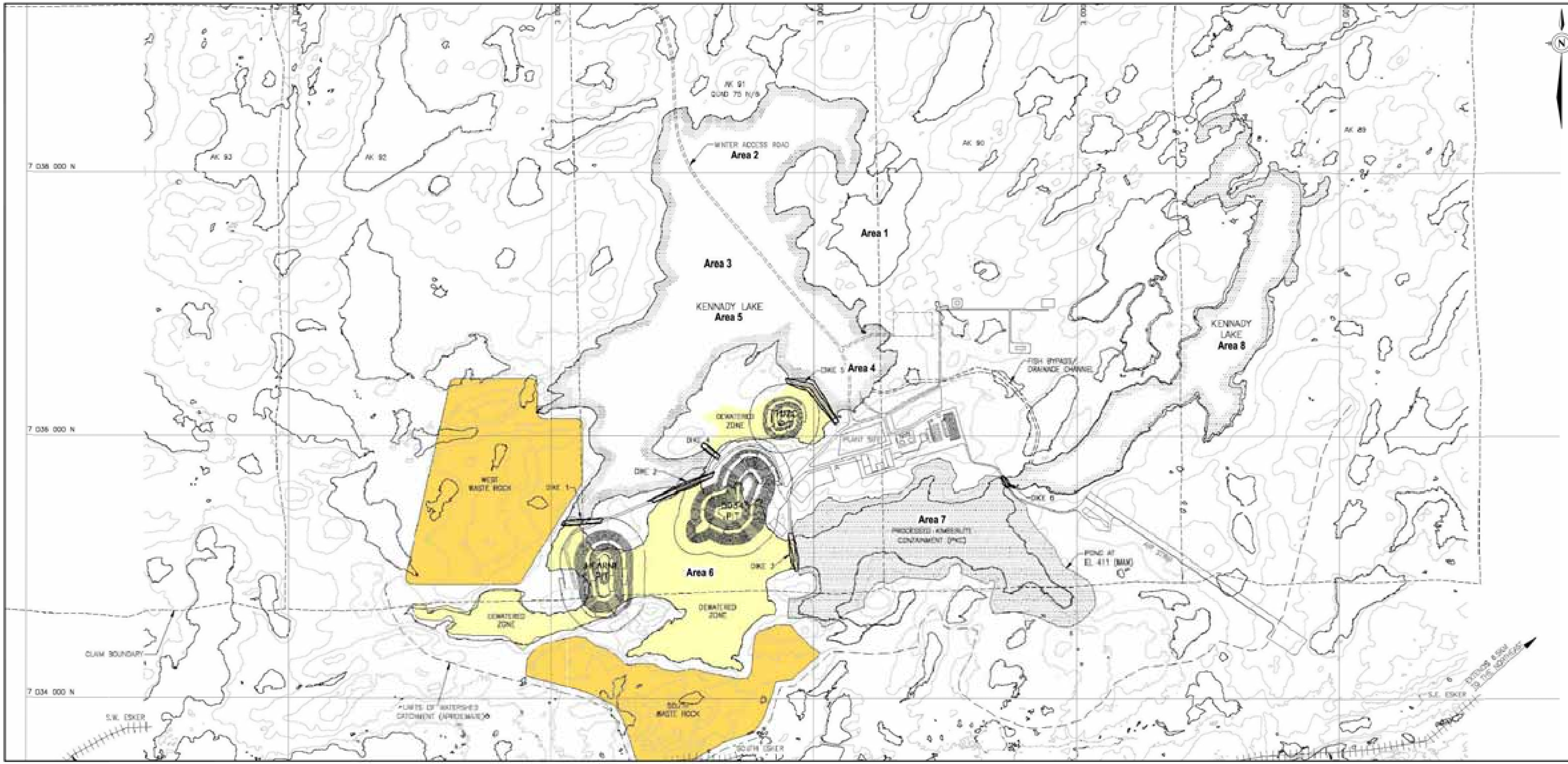
Mine Rock

Alternative 2 was developed in 2002, incorporating the results of the audit completed in 2001 of Alternative 1. It involved the construction of two on-land mine rock piles that would contain both mine rock and coarse PK, with the latter material being defined as follows:

- PK particles from the processing plant ranging in size from 1 millimetre (mm) to 6 mm; and
- PK particles from the degrit circuit ranging in size from 0.25 mm to 1.0 mm.

The mine rock piles would be situated as close to the mining area as possible without compromising any future pit expansion. One pile would be situated to the west of Kennady Lake, and one would be located to the southwest of the lake (Figure 2.3-8). The West Mine Rock Pile was located in the same general area as that included in Alternative 1; however, the West Mine Rock Pile included in Alternative 2 was larger and extended farther to the north and west. The southern mine rock pile located south of 5034 Pit was also large, and would contain waste from the 5034 and Tuzo pits. As previously noted, coarse PK would be trucked to and disposed of in both mine rock piles, which would be up to 100 m in height.

A third possible location for a mine rock pile to the northwest of Kennady Lake was considered and rejected. The ground on the northwest side of Kennady Lake does not provide as stable a base for the construction of such a structure. In addition, placing one or more mine rock piles northwest of Kennady Lake would interfere with the diversion of surface water runoff away from Kennady Lake during operations. As a result, Alternative 2 was developed within only two mine rock piles which were positioned to the west and southwest of Kennady Lake, as shown in Figure 2.3-8.



GAHCHO KUÉ PROJECT

Alternative 2 - Locations of Mine Rock Piles and the Processed Kimberlite Containment Facility (2002)

PROJECTION: UTM Zone 12	DATUM: NAD83	DE BEERS CANADA
SCALE 500 0 500 METRES		
FILE No: SON-2-006-CAD		DATE: December 6, 2010
JOB No: 09-1365-1004	REVISION No: 0	Figure 2.3-8
OFFICE: GOLD - SAS	DRAWN: TAH	CHECK: JB

NOTES

Base data source: AMEC Figure 2.3-7 - Locations of Waste Rock Piles and PKC, 2002. Job No. 141731.Office: AMEC-VAN

Processed Kimberlite

Alternative 2 incorporated a PKC facility that was to be located in a dewatered portion of Kennady Lake. More specifically, the construction of Dyke 6 between Areas 7 and 8 would allow Area 7 to be used as a clarification pond during initial lake dewatering and, subsequently, as a PKC facility (Figure 2.3-8).

The fine PK (i.e., PK particles smaller than 0.25 mm) would be pumped to the PKC as slurry, where the PK would be deposited progressively. It would be pumped initially to the southeast of the containment area, progressing to the west and north. This approach would leave the remaining containment to the northwest available for water collection from site runoff and PK slurry. Over the course of the operation, Dykes 3 and 6 would be raised approximately 7 m above their initial height for PK containment. A retention or ring dyke would be constructed around the entire PKC facility depending on the local ground elevation. The ring dyke along the southern limit of the containment facility would be designed to prevent any seepage from flowing outside the local watershed.

Although the PKC facility would fill virtually all of Area 7, a channel would be left along the north shore (i.e., the south bank of the plant site). The channel would be used to convey water from the northern portions of Kennady Lake to Area 8 after Dykes 3 and 6 were removed at Project closure. Water would flow from Area 6, through the channel in Area 7 to Area 8 and the lake outlet.

2.3.3.3 Alternative 3: Two PKC Facilities and One Mine Rock Pile

Mine Rock

Alternative 3, which was developed in 2005, involved the development of a single mine rock pile located in the southwest of the Project area. It also involved the backfilling of the 5034 and Hearne pits with mine rock and PK.

In 2005, it was estimated that approximately 188 million tonnes (Mt) of mine rock would be produced by the end of Year 9 of the operation, with 50 Mt directed to the mine rock pile and the remainder used for the construction of the external PKC facility, the backfilling of the Hearne Pit and the partial backfilling of the 5034 Pit. Between 7 and 14 Mt of mine rock from the Hearne Pit would be stockpiled for subsequent use as cover material for the external PKC facility.

Processed Kimberlite

Two alternatives were considered for the transportation of fine PK:

- as a slurry, which could be pumped to the containment facilities; or
- as a thickened slurry (paste), which could be dewatered to an extent that it would be suitable for truck transport.

Test work demonstrated that the fine PK must be transported as a slurry, as it could not be effectively dewatered. In contrast, coarse PK can be dewatered, which makes it amenable for loading and removal by trucks.

Initially, a limited amount of mine rock would be available for construction of containment facilities at mine start-up, and no mined-out pits would yet be available for the storage of PK. As a result, a short-term surface containment facility was included in the design of Alternative 3. It took the form of the small southwest arm of Kennady Lake. This facility, called the Southwest PKC Facility, was to be used during the first year of operation. After that, all PK would be sent to the on-land PKC facility that was to be developed in the northeast portion of the Project area (Figure 2.3-9), until such time that backfilling of the mined out pits could begin.

Placement of PK in the Southwest PKC Facility would occur after dewatering of this portion of Kennady Lake. As more mine rock became available, a lined water-tight dyke would be constructed at the east end of the storage area separating this small arm of Kennady Lake from the remaining lake basin (Figure 2.3-9). Thus, the dyke would isolate the PK in the Southwest PKC Facility from the rest of the lake after it was refilled. As part of closure, the entire Southwest PKC Facility would be covered with a thick layer of clean mine rock that would separate PK from the environment and allow for permafrost to develop in the PK.

With the progression of mining, more mine rock from the open pits would become available, and it would be used to construct the much larger on-land PKC facility. This on-land PKC facility would receive most of the PK produced during mining operations from Years 2 through 9. Beginning in Year 10, all coarse and fine PK would be placed in the mined-out pits, where it would be disposed of along with the mine rock being generated at that time.

GAHCHO KUÉ PROJECT

Alternative 3 - Locations of Mine Rock Piles and Processed Kimberlite Containment Facility (2005)

PROJECTION: UTM Zone 12	DATUM: NAD83	DE BEERS CANADA
SCALE 500 0 500 METRES		
FILE No: SON-2-007-CAD		DATE: December 6, 2010
JOB No: 09-1365-1004	REVISION No: 0	Figure 2.3-9
OFFICE: GOLD - SAS	DRAWN: TAH / CHECK: JB	

NOTES

Base data source: AMEC Figure 2.3-8 - Locations of Waste Rock Piles and PKC, 2005. Job No. 141731.Office: AMEC-VAN

The Tuzo Pit, which is the last pit to be mined, would remain open prior to lake refilling. The alternative of backfilling the Tuzo Pit with solid waste was rejected, because it would require the re-handling of a large amount of material (in the order of 40 to 50 Mt). This degree of materials re-handling would make the Project uneconomical.

2.3.3.4 Alternative 4: One Fine PKC Facility, One Coarse PK Pile and Two Mine Rock Piles

Mine Rock

Alternative 4 was developed using elements from both Alternatives 2 and 3. It includes pit backfilling and the creation of two mine rock piles. However, in Alternative 4, the west and South Mine Rock Piles are placed closer to the active mine pits, encroaching on or covering portions of the dewatered areas of Kennady Lake (Figure 2.3-5). They are smaller in size, because of the segregation of the coarse PK, which is placed in its own pile that is to be constructed in the vicinity of Area 4. Backfilling with mine rock also only occurs in the 5034 mine pit in this alternative.

Of the 226 Mt of mine rock expected to be produced to the end of mine operations, about 143 Mt would be directed to the designed mine rock piles. The remaining mine rock would be used as pit backfill and for the construction of roads, dykes, dams and other Project infrastructure. It would also be used in the reclamation of the Coarse PK Pile and the Fine PKC Facility.

The South Mine Rock Pile would hold mine rock from the 5034 Pit until Year 3. The 5034 mine rock generated in Years 3, 4 and 5 would be hauled to the West Mine Rock Pile. In Year 5, the 5034 Pit would be available for mine rock storage, and is designated to be the primary disposal area for Tuzo mine rock. Tuzo mine rock generated after the 5034 Pit is full would be placed in the West Mine Rock Pile. Hearne mine rock is to be placed in the West Mine Rock Pile as well, with some mine rock from the pits being diverted as required for use in site reclamation activities.

Processed Kimberlite

In Alternative 4, fine PK is to be disposed of as follows:

- During the first four years of operation (Years 1 to 4), fine PK is to be piped to the Fine PKC Facility and disposed of in the eastern portion of the facility that is located in Area 1.
- Starting in Year 5, fine PK would be deposited in the western portion of the facility in Area 2.

- Use of the Fine PKC Facility would cease in Year 8, and fine PK would be disposed of in the mined-out Hearne open pit.

Coarse PK would be segregated and initially placed in the Coarse PK Pile that is to be located largely on land adjacent to Area 4. In later years, coarse PK would be directed to the Fine PKC Facility, where it will be used in the reclamation of this facility. Coarse PK may also be deposited in the mined-out pits.

2.3.3.4.1 Chosen Alternative

Alternative 4 was selected for incorporation into the Project design, because it allows for a more compact disturbance footprint, which results in reduced hauling distances and improved operational economics. Alternative 4 also includes smaller rock piles than the alternatives, the efficient use of mine rock and PK as pit backfill and the effective use of local topography to limit the size of the Fine PKC Facility.

Locating the mine rock piles in the southwest portion of the Project site places them in an area of more favourable geotechnical conditions, in comparison to the northwest. The backfilling of the Hearne and 5034 pits with mine rock and PK will shorten the refilling time for Kennady Lake at closure. It also reduces the size of the external piles and disposal facilities, and provides an effective means of disposing of potential acid generating rock.

Placing the Fine PKC Facility in Areas 1 and 2 eliminates the need for two PKC facilities (as would be the case with Alternative 3) or the division of the refilled lake into two distinct parts (as would be the case with Alternative 2). The design of Alternative 4 is also expected to result in the progressive reclamation of the Fine PKC Facility and Coarse PK Pile during mine operations. It is for these reasons that Alternative 4 was selected.

2.3.4 Waste Disposal Alternatives

A number of disposal alternatives were considered for organic wastes, and were rejected. The rejected disposal alternatives included:

- Composting: composting would retain food wastes on-site in a form that would be attractive to wildlife.
- Truck all wastes to Yellowknife or Edmonton: winter road access is limited to a short period of the year. Wastes generated for the remainder of the year would need to be stored on-site where a large area resistant to wildlife access would be required.

- Landfill all solid wastes: the landfill would need to be fenced to prevent wildlife access, and the risk of wildlife attraction to the area would occur throughout the period of Project construction and operation.

Experience from other diamond mine projects in the Slave Geological Province indicates that preventing wildlife attraction to stored food wastes is problematic. Even if a storage area can be fenced and managed so that wildlife do not gain access to the site, they can still be attracted by the odours. The most effective method of preventing carnivore attraction to the Project site is to destroy food wastes as soon as the waste is generated, which is the approach incorporated in the Project design.

2.3.5 Transportation of Workers and Material to the Mine

2.3.5.1 Alternatives Transportation Methods

The Project is located in a remote area. Although alternative methods of transporting materials to the site were considered, such as using air travel as an alternative to the winter road, they were rejected due to cost and technical practicality (i.e., size and number of planes required to replace the need for road transportation). As a result, transportation by winter road is incorporated into the Project design.

2.3.5.2 Alignment of the Winter Road

No permanent roads exist near the Project. During the exploration period, workers and perishable supplies were brought in by air. Heavier materials and equipment were brought to Kennady Lake by the 120 km Winter Access Road from MacKay Lake connecting to the Tibbitt-to-Contwoyto Winter Road at km 271 (Figure 2.3-10). De Beers considered the following three routes for the Winter Access Road that will be required for the successful execution of the Project:

- a central route from the Tibbitt-to-Contwoyto Winter Road through Lake-of-the-Enemy to Kennady Lake;
- a route extending the Snap Lake Mine Winter Access Road eastwards to Kennady Lake; and
- the previously used northern route from the Tibbitt-to-Contwoyto road at MacKay Lake to Kennady Lake.

LEGEND

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

NOTES

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	DE BEERS CANADA
Scale 1:500,000 (10 5 0 10 Kilometres)		
FILE No: P-Other-045-GIS		DATE: October 7, 2010
JOB NO: 09-1365-1004	REVISION NO: 1	**Figure 3.10-2**
OFFICE: GOLD-CAL	DRAWN: CW	CHECK: PT

Alternative 1 – Central Route through Lake-of-the-Enemy

Lake-of-the-Enemy is a significant cultural location for Aboriginal people, because of the proximity of heritage sites and graves. The Yellowknives Dene requested that De Beers not use the route, because of its cultural importance. Because of these concerns, the central route alternative was rejected early in the assessment of alternatives.

Alternative 2 – Southern Route through the Snap Lake Mine

The southern route included the approved Winter Access Road to the Snap Lake Mine. From Snap Lake, the new route would go east to Lac Capot Blanc, then east to Munn Lake, and join the existing Gahcho Kué exploration Winter Access Road at Margaret Lake. The annual construction and maintenance costs for this route were approximately the same as the third alternative, and both of these routes were considered to have a similar environmental impact. This route was not selected due to difficulties in developing the route. However, should a viable routing option be identified for the southern route extension in the future, this option may be re-considered.

Alternative 3 – Existing Gahcho Kué Project Winter Access Road

The third alternative was to continue using the existing Winter Access Road to Kennady Lake from the Tibbitt-to-Contwoyto Winter Road at MacKay Lake (Figure 2.3-10).

De Beers recognizes that the Tibbitt-to-Contwoyto Winter Road is heavily used and that careful scheduling of the traffic on this road will be required. An alternative to a winter road would be a permanent all-weather road that would have to be constructed and maintained jointly by the NWT government and those mining companies that would benefit from such a road. Current, and projected, traffic levels do not justify an all-weather road specifically for the Project, and it is cost prohibitive for De Beers to take responsibility for its construction. As there is no control over the schedule of such construction, the Project cannot be dependant on the construction of such a road.

Chosen Alternative

The third alternative to continue to use the existing northern winter road from MacKay Lake to Kennady Lake was chosen. At the beginning of construction, the final section of the road crossing Kennady Lake will be shortened to accommodate construction requirements; no other alterations in this route are proposed.

2.3.6 Employee Work Schedule

De Beers considered an assessment of rotation alternatives in its Project design, which will be a 24-hour, 7-days a week operation. In considering alternative rotations, De Beers focused on meeting quality of life challenges (i.e., family life at home and traditional cultural activities) and labour force challenges (i.e., staffing positions necessary to carry out work on-site). The assessment of alternative rotation schedules revealed that two weeks on and two weeks off ('two and two') provided the greatest amount of time at home for the employees of the Project. The basis for this outcome included the time necessary to travel to and from the mine site. Over the course of an entire year, the time at home for employees participating in a 'two and two' schedule amounted to a gain of approximately 1,100 hours when compared to a daily work schedule, and 576 hours when compared to a four-days on and three-days off schedule ('four and three') (Table 2.3-2).

Table 2.3-2 Alternative Rotation Schedules for the Gahcho Kué Project

Considerations	Assumptions		
	2-weeks on/ 2-weeks off	4 days on/ 3 days off	Daily
Number of flights/month/shift	2	8	60
Average number of days/month	30	30	30
Travel time (hours)			
Average travel time between home and airport	0.50	0.50	0.50
Assembly at airport and flight time	2	2	2
Average time between plane arrival at airstrip and start of work or end of work and plane departure from Project site	1	1	1
Total (per travel day)	3.5	3.5	7 (two way travel)
Hours/shift	12	12	8
Total hours per day on travel days	15.5	15.5	15
Hours/days available in community during time-off	24	24	9 (work days) 24 (days off)
Years of operation	11	11	11
Number of family hours/year[a]	2,880[b]	2,304[c]	1,776[d]
Number of family hours over 11 year	31,680	25,344	19,536

[a] 8 hours for sleeping were removed from the calculation in all cases to focus on quality family time.

[b] 16 hours per day, 15 days per month, 12 months per year.

[c] 16 hours per day, 12 days per month (3 days per week for 4 weeks), 12 months per year.

[d] Days off = 16 hours per day, 2 days per week, 4 weeks per month, 12 months per year; days on = 1 hours per day, 5 days per week, 4 weeks per month, 12 months per year.

When considering a daily schedule option, adding 30 minutes to the travel time in one direction would result in a daily routine that was considered unrealistic for employees and for the Project to sustain. This would eliminate the possibility of flights from more distant NWT communities and thus restrict other potential labour to operate the mine. It would also eliminate flights from Edmonton and other locations outside the NWT. Roster rotation schedule alternatives, such as the 'four-and-three', would permit labour to travel from further distances from the Project; travel time for employees, and their time away from family, would be decreased compared to the daily schedule option.

The evaluation also considered an employee's time at home. In the case of the 'two-and-two' schedule, employees would be home for two weeks straight. Under a 'four-and-three' schedule, one rotation (or shift) would be home six days every two weeks. In the case of a daily schedule, there would be a requirement to maintain three shifts per day instead of two (due to the 12 hour days associated with the other roster alternatives), which would mean that employees would spend time at home each day; however, the quality of home time would be dependent on their shift. That is, only one of the three 8-hour shifts would allow home time to fall during the night, the others would be early morning/mid-morning and late afternoon/evening. Furthermore, the daily shift schedule would alternate, and would also require weekend work.

The additional shift required for a daily rotation schedule would require greater labour needs. Finding the additional labour to meet this shift requirement would represent a staffing challenge. Additional labour would likely come from other jurisdictions, and given the reduced time at home because of the additional travel time, attracting this labour would add to the challenge.

This analysis did not focus on costs, but additional costs (e.g., additional flights) were assumed. In the case of a daily rotation, the need for on-site accommodation would be reduced, but any cost savings would be more than offset by the cost of additional flights.

The time to adjust must be considered when determining quality of life issues related to time-at-home, even for local labour. First, one must consider the time needed to adjust from working a twelve-hour shift, and secondly, the time required to adjust to this shift schedule. The four-and-three schedule would require more frequent adjustments. Annually, more time at home and at work would be lost to adjustments with this rotation compared to the two-and-two rotation.

In conclusion, for the majority of employees, the 'two and two' rotation provided the greatest opportunity for home life for employees, and would provide De Beers with the greater opportunity to meet its labour needs.

2.4 ENVIRONMENTAL CONSIDERATIONS IN THE PROJECT DESIGN

Section 3.2.6 of the Terms of Reference asks that the EIS provide an overview of how environmental conditions have influenced the Project design. De Beers took the environment and sustainability into consideration through an iterative process between the Project's engineering and environmental teams. Initial engineering designs were improved and environmental design features were developed as engineering and environmental information was exchanged as it became available. The ways in which environmental conditions were considered in alternatives described in Section 2.3 are illustrated by the following examples:

- Many lakes exist in the Kennady Lake watershed with limited land areas on which to place the mine infrastructure, such as the mine site and storage areas for mine rock and PK. One of the reasons for backfilling the mine pits with mine rock and PK was to reduce the footprint requirements for surface placement of mine rock and PK. The Project was also designed with a compact footprint, because of the number of lakes and limitations on available land area.
- Management and discharge of groundwater inflow is one of the key environmental issues associated with diamond mines in the NWT. The natural chemistry of groundwater is much more saline than surface waters, and the discharge of saline groundwater can negatively impact surface water quality. The lakes surrounding Kennady Lake are relatively small and susceptible to changes in water quality. To minimize the discharge of saline groundwater to the receiving environment, groundwater inflows collected in the pit dewatering systems will be maintained, to the extent possible, within the operational water management system and placed into the mined out pits.
- The Fine PKC Facility, the Coarse PK Pile and the mine rock piles have been designed to freeze. Freezing reduces the potential for seepage from these structures and limits their interaction with the surrounding environment.
- Kennady Lake is a headwater lake with a relatively small watershed area. Consequently, the rate of natural outflow from Kennady Lake is quite low. The Project schedule requires dewatering of Kennady Lake at a pumping rate that will not result in bank erosion of downstream waterbodies (i.e., by remaining within the 1-in-2 wet year flood levels). To mitigate this concern, the initial phase of dewatering will split the

discharge between the outlet of Kennady Lake and the N watershed, which is larger and can accommodate more flow without causing erosion problems. The rate and timing of discharge has also been designed to prevent impacts to fish and fish habitat in the N watershed and downstream of Kennady Lake.

- Experience at other mines in the NWT and elsewhere has shown that careful management of wastes can prevent wildlife from being attracted to mine sites and reduce the number of wildlife incidents. Waste management practices for the Project will incorporate proven practices used at the Snap Lake Mine and other diamond mines in the NWT.
- Aggregate material is required for construction prior to development of the first open pit. All aggregate will be produced on site by crushing mine rock displaced by the construction of the mine pits or other facilities. The initial mine planning identified and intended to use esker resources to the southeast and southwest of Kennady Lake. More recently, a decision was made to not use the southeast esker, because it is located within the area of interest for the study area for a national park on the East Arm of Great Slave Lake.

In addition to these brief examples of how environmental considerations have influenced the Project, these features and others are identified and discussed in more detail throughout the EIS.

2.5 REFERENCES

2.5.1 Literature Cited

De Beers (De Beers Canada). 2005. Gahcho Kué Project Mackenzie Valley Land and Water Board Application Report. Yellowknife, N.W.T.

Gahcho Kué Panel. 2007. Terms of Reference for the Gahcho Kué Environmental Impact Statement. Mackenzie Valley Environmental Impact Review Board. Yellowknife, N.W.T. October 5, 2007.

2.6 ACRONYMS AND GLOSSARY

2.6.1 Acronyms and Abbreviations

De Beers	De Beers Canada Inc.
EIS	environmental impact statement
MVLWB	Mackenzie Valley Land and Water Board
NWT	Northwest Territories
PK	processed kimberlite
PKC	processed kimberlite containment
Project	Gahcho Kué Project
TDS	total dissolved solids
TSS	total suspended solids

2.6.2 Units of Measure

%	percent
km	kilometre
m	metre
mm	millimetre
m^3/day	cubic metres per day
masl	metres above sea level
Mt	million tonnes
Mt/y	million tonnes per year

2.6.3 Glossary

Backfilling	Using material to refill an excavated area.
Catchment	An area of land where water from precipitation drains into a body of water.
Coarse kimberlite	Coarse kimberlite particles range in size from 1.0 mm to 6 mm.
Degrit	A degrit module consists of cyclones that separate the fine kimberlite (less than 0.25 mm) from the grits (greater than 0.25 mm but less than 1.0 mm).
Dyke	A tabular body of igneous rock that cuts across the bedding or foliation of the rock it intrudes.
Entrainment	The entrapment of one substance by another substance.
Esker	An esker is a long, winding ridge of stratified sand and gravel believed to form in ice-walled tunnels by streams which flowed within and under glaciers. After the retaining ice walls melt away, stream deposits remain as long winding ridges.
Fine processed kimberlite	Fine processed kimberlite involves particles that are smaller than 0.25 mm.
Freeboard	The distance between the water level and the top of a containing structure such as a dyke crest or channel top of bank.
Groundwater	Water within interconnected pore spaces of the subsurface within the saturated zone below the water table.
Habitat	The place or environment where a plant or animal naturally or normally lives or occurs.
Infrastructure	Basic facilities, such as transportation, communications, power supplies and buildings, which enable an organization, project or community to function.
Open-pit mine	A mine where rock or mineral extraction from the earth is done using a pit or borrow open to the surface, rather than using a tunnel into the earth.
Ore body	An accumulation of ore, which is a type of rock that contains minerals with important elements that are typically mined.
Overburden	Materials of any nature, consolidated or unconsolidated, that overlie a deposit of useful materials. In the present situation, overburden refers to the soil and rock strata that overlie kimberlite deposits.
Permafrost	Permanently frozen subsoil occurring throughout the polar regions.
Pipes/kimberlite pipes	Typically vertical structures of volcanic rock in the Earth's crust that can contain diamonds.
Potentially acid generating	Rock with a ratio of neutralizing potential to acid potential (NP:AP) of less than 3 as determined by static tests.
Processed kimberlite	The material that remains after all economically and technically recoverable diamonds have been removed from the kimberlite during processing.
Processed kimberlite containment	On-site storage facility for storing processed kimberlite.
Runoff	The portion of water from rain and snow that flows over land to streams, ponds or other surface waterbodies. It is the portion of water from precipitation that does not infiltrate into the ground, or evaporate.

Sediment	Solid material that is transported by, suspended in, or deposited from water. It originates mostly from disintegrated rocks; it also includes chemical and biochemical precipitates and decomposed organic material, such as humus. The quantity, characteristics and cause of the occurrence of sediment in streams are influenced by environmental factors. Some major factors are degree of slope, length of slope soil characteristics, land usage and quantity and intensity of precipitation.
Seepage	Slow water movement in subsurface. Flow of water from man-made retaining structures. A spot or zone, where water oozes from the ground, often forming the source of a small spring.
Subject of Note	Issues that require serious attention and substantive analysis (as defined by the Terms of Reference (Gahcho Kué Panel 2007)
Till	Till is an unsorted glacial sediment. Glacial drift is a general term for the coarsely graded and extremely heterogeneous sediments of glacial origin. Glacial till is that part of glacial drift which was deposited directly by the glacier. It may vary from clays to mixtures of clay, sand, gravel, and boulders.
Total dissolved solids	The total concentration of all dissolved materials found in a water sample.
Total suspended solids	A measurement of the concentration of particulate matter found in water.
Turbidity	The cloudiness or haziness of a fluid caused by individual particles (suspended solids) in water that are generally invisible to the naked eye.
Mine rock	Excavated bed rock surrounding the kimberlite deposits. Mine rock consists primarily of granitic rock material.
Watershed	The entire catchment area of runoff containing a single outlet.