DE BEERS
CANADA

GAHCHO KUÉ PROJECT

April 5, 2012 File: S110-01-08

Chuck Hubert
Environmental Assessment Officer
Mackenzie Valley Environmental Impact Review Board
P.O. Box 938
Yellowknife NT X1A 2N7

Dear Mr. Hubert:

Yellowknives Dene First Nation - Information Request
Responses - Gahcho Kué Project Environmental Impact Review

De Beers is pleased to provide the Mackenzie Valley Environmental Impact Review Board with responses to Information Requests submitted by the Yellowknives Dene First Nation.

Sincerely,

Veronica Chisholm

Veronica Chisholm
Permitting Manager

Attachment

c: T. Slack, Research & Regulatory Specialist, Yellowknives Dene First Nation

April 2012

GAHCHO KUÉ PROJECT ENVIRONMENTAL IMPACT STATEMENT
INFORMATION REQUEST RESPONSES

Information Request Number: YKDFN_1.1

Source: Yellowknives Dene First Nation

Subject: Persistence of caribou used as endpoint metric

EIS Section: Section 1: Caribou

Preamble

Analyses of residual effects are conducted using pathway analysis (starting pg. 7-48). Potential pathways are described (through largely qualitative assessment) as no linkage, secondary, or primary. Secondary pathways – "*could result in a measurable and minor environmental change, but would have a negligible residual effect on a VC relative to baseline or guideline values*" (pg. 7-50) – were not analyzed further. Thus, unless a pathway was described as primary and could potentially "*result in environmentally significant effects on the* ***persistence*** *of caribou populations and continued opportunity for traditional and non-traditional use of caribou*" (pg. 7-50), they were not analyzed to their full extent. In other words, unless the **persistence** of the population was in jeopardy (as in a reasonable chance of elimination of the Bathurst herd), no determination of significance could be found. Persistence does not appear to be formally defined in the Gahcho Kue KLOI – caribou document, but in the Fortune NICO response to IRs (Response to YKDFN_2.1; December 2011) appears to be described as the minimum viable population defined by the smallest number of individuals in a population with a high probability of persisting over a long period of time. Using persistence of caribou appears to be a very low bar to clear. Sustainability of the herd might have been a more reasonable metric, and would have better considered the trade-off for Aboriginal communities between potential loss of harvest and development.

Request

1. Please justify further why persistence of caribou is the metric used to determine significance, and not sustainability that could better address harvesting.

2. The Proponent complete an analysis that evaluates the direct and indirect impacts of the mine on the sustainability of the herd, with a particular focus on not just the ability to hunt but the number of animals available for harvesters

Response to Question 1

Feedback from several groups (Yellowknife Dene First Nation, Tłı̂chô Government, and Gahcho Kué Panel) suggests that the term "population persistence" may have different interpretations, and create a stumbling block for the assessment process and evaluation of significance. For example, many people may interpret a persistent population as a population that is not able to support the harvesting of animals by people and predators in the ecosystem (i.e., is not ecologically functional). Several reviewers have suggested that the use of abundance and distribution or sustainability of the population for harvest provides a more meaningful assessment endpoint to evaluate the significance of effects on caribou and other wildlife.

In the interest of clarifying the interpretation of assessment endpoints and the evaluation of significance on caribou and other wildlife, the term persistence will no longer be used. Instead it is proposed that the evaluation of significance be determined from the predicted effects to the maintenance of the abundance and distribution (or sustainability) of populations, and the related impacts on the continued opportunities for traditional and non-traditional use of wildlife (e.g., availability of animals for harvesting).

The evaluation of significance of effects to wildlife still considers two assessment endpoints: 1) the maintenance of population abundance and distribution (sustainable populations), and 2) the continued opportunity for traditional and non-traditional use of wildlife (e.g., hunting, trapping, wildlife viewing). Assessment endpoints were intended to incorporate sustainability (De Beers 2010, Section 6.3.2, page 6-6).

Sustainable populations are capable of withstanding environmental change and accommodating stochastic population processes. Resilience and stability are key properties of the maintenance of the abundance and distribution of populations. Resilience includes that ability of the population to adapt to change (e.g., rate and degree of fluctuation in population abundance and distribution after a disturbance). Stability is determined by the trajectory of a population and is characterized by no long-term increasing or decreasing trend outside of natural population fluctuations and cycles (e.g., long-term cycles in caribou populations, predator-prey cycles). Resilience and stability influence the amount of risk to populations from development (Weaver et al. 1996). A sustainable population is one that will be present for many generations, protecting the ecological services humans benefit from when ecosystems are functional, such as the annual home range of Bathurst caribou, where there will be continued opportunity for consumptive and non-consumptive use of caribou by people that value these resources as part of their culture and livelihood (e.g., Hooper et al. 2005).

The maintenance of abundance and distribution of populations is similar in concept and application to population persistence, and does not change the classification and determination of the significance of impacts in the environmental impact statement (EIS). A sustainable population is one where caribou abundance and distribution will be maintained (or persist) into the future such that there will be continued opportunities for traditional and non-traditional use by people. The summary table for the classification of residual impacts (De Beers 2010, Section 7, Table 7.7-2) links the five primary pathways to effects on the population size and distribution of caribou (De Beers 2010, Section 7, Section 7.7).

De Beers 2010, Section 6.3.2 provides an example, using caribou, of the relationship between measurement endpoints (e.g., habitat quantity and quality), population abundance and distribution, and assessment endpoints (persistence, and continued opportunities for use of wildlife). The following paragraph is from Section 6.3.2 of the 2010 EIS (De Beers 2010; page 6-6).

"The overall significance of Project impacts on VCs is predicted by linking residual changes in measurement endpoints to impacts on the associated assessment endpoint. For example, changes to habitat quantity and quality are used to assess the significance of effects from the Project on the abundance and distribution of caribou, which influence the persistence of the population (assessment endpoint). Effects to caribou abundance and distribution are then used to predict impacts on the accessibility and availability of the population for traditional and non-traditional use of caribou (also an assessment endpoint)."

To demonstrate the direct relationships among abundance and distribution, persistence, and continued opportunities for traditional and non-traditional use of wildlife (i.e., sustainability), the concluding paragraph in De Beers 2010, Section 7.8 for caribou has been re-stated as follows.

"The weight of evidence from the analysis of the primary pathways predicts that the incremental impacts from the Project and cumulative impacts from the Project and other developments will not have a significant negative influence on the *maintenance of abundance and distribution* of caribou. Most of the incremental and cumulative impacts were predicted to be negligible to low in magnitude and reversible. The species has the capability to adapt to different disturbances and environmental selection pressures, in part because such life history strategies are needed to overcome the challenges of large fluctuations in population sizes that characterizes herd dynamics (e.g., Holling 1973; Gunderson 2000). This resilience in caribou populations suggests that the impacts from the Project and other developments should be reversible and not significantly affect the future *abundance and distribution* (*or sustainability*) of caribou populations. Subsequently, cumulative impacts from development also are not predicted to have a significant adverse effect on continued opportunities for use of caribou by people that value the animals as part of their culture and livelihood."

Response to Question 2

The 2010 EIS (De Beers 2010) predicts that the direct and indirect effects from the Project on the abundance and distribution of caribou should have a negligible influence on the availability of animals for harvesting (De Beers 2010; Section 7.7.2.2; Table 7.7-3). The Project is not expected to result in direct mortality of animals, and changes in the local distribution of animals around the Project (from direct and indirect habitat effects) should not result in a detectable change in caribou distribution on their seasonal and annual ranges.

The wildlife assessment did not consider value-based judgments in the selection of assessment endpoints (e.g., desired population size to maximize opportunity for subsistence or recreational hunting and trapping). Value-based perspectives about wildlife are important, and were a primary factor in selecting valued components (VCs) for the 2010 EIS (De Beers 2010, Section 6.3.1). However, competing values about wildlife population size, desirable harvest levels, and/or types of use may be held by different groups. Addressing value-based perspectives with respect to effects on wildlife is more appropriately left to the agencies responsible for making wildlife management and public interest decisions. By focusing the assessment on effects to the abundance and distribution of populations, the EIS could also evaluate the impacts from the Project on the availability of animals for the continued opportunity for traditional and non-traditional use of wildlife (sustainability of the population for harvesting).

References

De Beers (De Beers Canada Inc.). 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.

Gunderson, L.H. 2000. Ecological Resilience – In Theory and Application. Annual Review of Ecology and Systematics 31:425-439.

Holling, C.S. 1973. Resilience and Stability of Ecological Systems. Annual Review of Ecology and Systematics 4:1-23.

Hooper, D.U., F.S. Chapin, J.J. Ewel, A. Hector, P. Inchausti, S. Lavorel, J.H. Lawton, D.M. Lodge, M. Loreau, S. Naeem. B Schmid, H. Setala, A.J. Smstad, J. Vandermeer and D.A. Wardle. 2005. Effects of biodiversity on ecosystem functioning: a consensus of current knowledge. Ecological Monographs 75:3-35.

Weaver, J.L., P.C. Paquet and L.F. Ruggiero. 1996. Resilience and conservation of large carnivores in the Rocky Mountains. Conservation Biology 10: 964-976.

GAHCHO KUÉ PROJECT ENVIRONMENTAL IMPACT STATEMENT
INFORMATION REQUEST RESPONSES

Information Request Number: YKDFN_1.2

Source: Yellowknives Dene First Nation

Subject: Use of 40% habitat loss threshold

EIS Section: Section 1: Caribou

Terms of Reference Section:

Preamble

The proponent compares direct habitat loss to seasonal herd ranges (an obviously very small proportion, <0.1%). They quote "the cumulative direct disturbance to each seasonal range from the Project and other previous, existing and future developments is predicted to be less than or equal to 1.7% relative to reference conditions for seasonal ranges of Ahiak and Bathurst caribou. This change is well below the 40% threshold value identified for habitat loss associated with declines in bird and mammal species" (pg. 7-91 and elsewhere). This is an uninformative comparison. Many of the citations deal primarily with endangered species (e.g., Reed et al. 2003), and thus the comparison with the Bathurst caribou herd is incorrect. The 40% habitat loss value is often cited and rarely tested (Swift and Hannon 2010). Habitat loss thresholds has never been tested for barren-ground caribou, and are unlikely to be a valid assumption for barren-ground caribou in tundra situations where habitat loss or fragmentation is less of an issue compared with functional habitat loss caused by other forms of disturbance and displacement. Responses to habitat loss or fragmentation may be linear or non-linear, and likely vary among species and landscapes. If 40% habitat loss was the threshold for declines in caribou numbers and triggers of significance going in to these analyses, the proponent could have saved a lot of paper and computer time by simply stating no significance from the start. Requiring something to cause a significant decline before it is recognized as a significant effect sets a very low bar.

Reed, D.H., J.J O'Grady. B.W. Brook, J.D. Ballou, and R. Frankham. 2003. *Estimates of minimum viable population size for vertebrates and factors influencing those estimates.* Biological Conservation 113:23-34.

Swift, T.L., and S.J. Hannon. 2010. *Critical thresholds associated with habitat loss: a review of the concepts, evidence, and applications.* Biological Reviews 85:35–53.

Request

1. Please describe how a 40% value for habitat loss can be justified as a significance threshold for caribou in a tundra environment.

Response

The 40% value for habitat loss was not used as a threshold to identify potential significant effects on caribou abundance and distribution, and the continued opportunity for traditional and non-traditional use of caribou. This value and other values in the literature were intended to provide context for estimated direct and indirect (functional) decreases to habitat, which vary from less than 0.5% to 7.3% across seasonal ranges. Responses to habitat loss and fragmentation vary by species and landscape type, and caution should be used when applying results from one situation to another (Smith and Hannon 2010). This is why a screening level value of 20% change (i.e., percent loss of habitat quantity and quality) was used to define a high magnitude effect for caribou, and other wildlife Valued Components (VCs) (De Beers 2010, Section 7.7.1.1). A number of high magnitude effects that occur at the population level and are irreversible have the potential to significantly influence the abundance and distribution (previously persistence [see response to YKDFN_1.1]) of caribou, and other wildlife (De Beers 2010, Section 7.8.1).

The 20% screening level value does not represent an ecological threshold but rather a margin of safety prior to reaching a potential effects threshold. Several studies suggest that ecological thresholds for changes in population parameters occur when habitat loss is at least 40% (Andrén 1994, 1999; Fahrig 1997; Mönkkönen and Reunanen 1999; Flather and Bevers 2002; Swift and Hannon 2010). Environment Canada has conservatively derived range-specific disturbance thresholds of 35 to 45% for boreal caribou (Environment Canada 2011).

The lack of a known threshold for barren-ground caribou and other arctic wildlife should not preclude the application of estimates from other species, particularly when a conservative approach is used such as the 20% high magnitude effect value in the Environmental Impact Statement (EIS). Generalizations across species can be useful when thresholds are related to life history (e.g., high movement or dispersal ability) and landscape characteristics (large areas of contiguous habitat not influenced by development), which is the case for wildlife VCs assessed in the EIS (Swift and Hannon 2010; Cardillo and Meijaard 2012).

It should also be noted that conservatism was applied throughout the assessment so that effects would not be underestimated. For example, the estimates of incremental (Project-specific) and cumulative habitat changes for caribou and other wildlife were derived using conservative assumptions, which have likely overestimated changes. Some of these conservative assumptions include (also see De Beers 2010, Section 7.9.1.1.2):

- the physical footprint of all exploration sites was assigned a 500-metre radius and thus, were likely overestimated in spatial extent;
- linear disturbance footprints (e.g., winter roads) were described using excessive widths of 200 metres; this was done, in part, to meet the requirements of the raster format for GIS analyses;
- upon permitting, all development footprints remained on the landscape (i.e., footprints were permanent features); and
- the duration of zones of influence of mineral explorations sites were likely overestimated, for example, exploration sites were characterized by zones of influence for the entire 5-year duration of the permit period (even though a site may have only been active for one month of one year).

References

Andrén, H. 1994*. Effects of Habitat Fragmentation on Birds and Mammals In Landscape with Different Proportions of Suitable Habitat- A Review*. Oikos 71(3): 355-366.

Andrén, H. 1999. *Habitat Fragmentation, the Rand Sample Hypothesis, and Critical Thresholds.* Oikos 84(2): 306-308.

Cardillo, M. and E. Meijaard. 2012. *Are comparative studies of extinction risk useful for conservation?* Trends in Ecology and Evolution 27:167-171.

De Beers (De Beers Canada Inc.). 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.

Environment Canada, 2011. *Scientific Assessment to Inform the Identification of Critical Habitat for Woodland Caribou (Rangifer tarandus caribou), Boreal Population, in Canada: 2011 update*. Ottawa, Ontario, Canada. 102 pp. Plus appendices.

Fahrig, L. 1997*. Relative Effects of Habitat Loss and Fragmentation on Population Extinction.* Journal of Wildlife Management 61(3): 603-610.

Flather, C.H. and M. Bevers. 2002. *Patchy reaction-diffusion and population abundance: the relative importance of habitat amount and arrangement.* The American Naturalist 159:40-56.

Mönkkönen, M. and P. Reunanen. 1999. *On Critical Thresholds In Landscape Connectivity: A Management Perspective* Oikos 84(2): 302-305.

Suter, G.W., B.W. Cornaby, C.T. Hadden, R.N. Hull, M. Stack, and F.A. Zafran. 1995. *An Approach for Balancing Health and Ecological Risks at Hazardous Waste Sites.* Risk Analysis 15(2): 221-231.

Swift, T.L. and S.J. Hannon. 2010. *Critical thresholds associated with habitat loss: a review of the concepts, evidence, and applications*. Biological Reviews 85: 35-53.

April 2012

GAHCHO KUÉ PROJECT ENVIRONMENTAL IMPACT STATEMENT
INFORMATION REQUEST RESPONSES

Information Request Number: YKDFN_1.3

Source: Yellowknives Dene First Nation

Subject: Calculation of the impact of the zone of influence (ZOI)

EIS Section: Section 1: Caribou

Terms of Reference Section:

Preamble

Calculations of the effects of zone of influence on caribou distribution and abundance state *"It was predicted that the ZOI (geographic extent)... would be 15 km around the Project and other active mine sites. Specifically, active mines were estimated to reduce habitat quality by 95% within a 1 km radius, 50% from 1 to 5 km, and 25% from 5 to 15 km."* (pg. 7-147). A number of references are provided to justify these numbers. The references cited stating ZOIs are likely <5 km for caribou and other wildlife species all come from or summarize results from forested habitats, and the situation in tundra environments is likely quite different (longer sight lines unimpeded by trees, potentially great ability of stimuli (i.e., noise, dust) to travel over open, relatively flat habitat). Regardless, Boulanger et al. (2012) demonstrated an average 75% reduction in caribou occurrence within a 14 km ZOI, and did not assume or predict graduated zones of avoidance and relative abundance within this 14-km radius. The implicit assumption is that habitat quality is reduced as indexed by a behavioural avoidance (which Gahcho Kué was measuring and assessing) translates to reduced abundance (which they did not assess). While the concept of staggered zones of impact to reduced habitat quality may be valid, it may equally be incorrect (if for example, a mine provides higher predation risk right adjacent to the mine). When you do the math, if these zones relate to caribou occurrence (from habitat quality), then the proponent's analysis determines an average 28% reduction in caribou abundance within the 15 km ZOI, and overestimates caribou abundance by about 3 times beyond the overall 75% reduction in the entire ZOI as calculated by Boulanger et al. (2012).

Boulanger, J., K.G. Poole, A. Gunn, and J. Wierzchowski. 2012. *Estimating the zone of influence of industrial developments on wildlife: a migratory caribou and diamond mine case study.* Wildlife Biology 18: in press.

Request

1. The YKDFN requests that the Proponent justify their calculations of the impacts of reduced caribou occurrence within the ZOI;
2. The Proponent should also discuss the implications of a 28% versus 75% reduction in occurrence.

Response to Request 1

The zone of influence (ZOI) and disturbance coefficients (DCs) that were used in the 2010 Environmental Impact Statement (EIS) (De Beers 2010) represent conservative estimations of those identified by Boulanger et al. (2012). There is no evidence in Boulanger et al. (2012) to support the notion that the ZOIs and DCs applied in the caribou assessment in the 2010 EIS (De Beers 2010) were not ecologically conservative. Further, due to the sophisticated and complex analyses in Boulanger et al. (2012), some of their concluding statements do not appear to be completely consistent with the results, which can produce different interpretations of the study.

An important aspect of the analysis in the 2010 EIS (De Beers 2010) is that the 15 kilometres (km) ZOI applied to operating mines, including the Project, was extended from the edge of development footprints (De Beers 2010, Section 7.5.3.2, Table 7.5-9). This approach was also applied to other disturbance features such as exploration sites and linear developments (roads and transmission lines). The 2010 EIS (De Beers 2010) quantified direct habitat losses using the physical footprint (e.g., the mining complex) plus the indirect changes to habitat quality extending from the edge of the physical footprint to the boundary of the 15 km ZOI. This was a conservative approach. Although Boulanger et al. (2012) reported an 11 to 14 km ZOI for caribou around the Diavik-Ekati mining complex (depending on the use of collar data or aerial survey data), the ZOI was calculated from the centroid of the mining complex. The main point here is that the 14 km ZOI that is being proposed in Boulanger et al. (2012) is likely smaller using the ZOI definition in the 2010 EIS (De Beers 2010). For example, the distance across the Ekati and Diavik mines varies from 8 to 12 km and 4 to 5 km, respectively. The estimated ZOI in Boulanger et al. (2012) may be actually closer to 10 to 11 km when considering the distance from the edge of the mining footprint.

Although we agree, in part, with the reviewer's interpretation of conclusions drawn in Boulanger et al. (2012), it should be clarified that the research paper did not demonstrate an average 75% reduction in caribou occurrence within a 14 km ZOI. Boulanger et al. (2012) incorrectly state that "Caribou were about 4-times more likely to select habitat at greater distances from the two-mine complex than within the zone of influence". The issue is that the odds ratio being reported is for a continuous variable, and thus, the odds of observing a caribou should be reported as being 4-times higher at 14 km versus the centroid of the mining complex (0 km). The '4-times' statistic cannot be used to predict changes in the distribution of animals at increasing distances from mining developments. The prediction that there is a 75% reduction in caribou occurrence at the centroid of the core mine facilities area is not surprising given that zero to few caribou are recorded on/in roads, buildings, open pits and residual habitat patches. Unfortunately, Boulanger et al. (2012) have not provided any information on the odds or probabilities within the actual zone of influence, which is what the reader has been led to interpret.

Response to Request 2

Based on the response to Request 1, the actual reduction in the occurrence of caribou as a function of distance from the Ekati-Diavik mine complex within the 11 to 14 km ZOI estimated in Boulanger et al. (2012) is not known. Thus, an ecologically relevant assessment of the potential difference between the values used in the 2010 EIS (De Beers 2010) and the information reported in Boulanger et al. (2012) cannot be made at this time.

References

Boulanger, J., K.G. Poole, A. Gunn, and J. Wierzchowski. 2012. *Estimating the zone of influence of industrial developments on wildlife: a migratory caribou and diamond mine case study.* Wildlife Biology 18: in press.

De Beers (De Beers Canada Inc.). 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.

Information Request Number: YKDFN_1.4

Source: Yellowknives Dene First Nation

Subject: Energetics modelling

EIS Section:

Terms of Reference Section:

Preamble

The proponent used an energetic modelling approach (pg. 7-110) to conclude that Project-induced effects would have incremental and insignificant effects on caribou behaviour, energy balance and calf production (pg. 7-152). An independent review of the energetic model presented by Golder in the Gahcho Kue EA was conducted and concluded that how the model was applied offers an inadequate assessment of energy costs to caribou of the Gahcho Kue project (D. Russell, unpubl. data, December 2011). The review identified five main concerns with the model:

1. Failure to account for difference in activity of caribou in and out of ZOI. The Golder assessment mistakenly assumes that caribou that did not overtly react to the encounter (45% of encounters) within the ZOI had "normal" activity budgets;

2. Only considering half of the energy balance equation. The ability of caribou to meet their energy requirements can be affected by increasing energetically costly activities (which increase the requirement) and/or reducing energy intake (which reduces energy available to meet requirements). The Golder model only considers the energy expenditure side of the equation (and only compared with caribou not reacting to an encounter but still in the ZOI), not the energy intake side;

3. Comparing energy balance costs of insects to energy expenditure costs of encounters. First, the Golder model states the cost of insect harassment was 0.037 kg body weight per 1 unit of insect harassment (pg. 7-117). In fact the cost in Weladji et al (2003) study was 0.037 kg of **carcass** weight, not **body** weight, which increases the cost on a body weight basis to ~0.067 kg.

Secondly, change in fall weights of calves in Weladji et al (2003) has integrated all costs of insect harassment, thus accounting for all components of energy balance as described in the equation in the previous section. Thus it is not appropriate to apply the energy cost per encounter as determined by Golder to the full cost of insect harassment. Golder cost estimate misses most of the sources of energy costs;

4. Use of pregnancy rate instead of probability of pregnancy. Golder's approach models an individual caribou and thus they should be relating cost of encounters with that animals' probability of getting pregnant (0 or 1), not a population pregnancy rate; and,

5. Using 16 kg drop in fall body weight (resulting in 0% pregnancy rate; pg. 7-115) assumes that all animals are at maximum body weight going into the development zone and/or insect season. Many factors dictate the variability in caribou body condition entering the insect season. It is conceivable that a very limited number of encounters could result in a drop in body weight that reduces that individual's probability of pregnancy below 50%. That variability needs to be acknowledged.

Therefore, there appear to be errors in the Golder energetic analysis that underestimate the cost of development.

Weladji, R.B., O. Holand, and T. Almoy. 2003. Use of climate data to assess the effect of insect harassment on the autumn weight of reindeer (*Rangifer tarandus*) calves. Journal of Zoology 260:79-85.

Request

1. The proponent should revise their energetic model in light of this review (which can be provided to the proponent).

2. The assessment of significance should be re-examined based on revision to the energetic model.

Response

1. The energetic model does not require revision given the Supplementary Information provided below, and the general consensus of the underlying weak link between development and reproduction (also see Adamczewski et al. 2009 and Response by the Government of the Northwest Territories [GNWT] to Information Request Gahcho Kué Panel [GKP] 18 - submitted by the GNWT on March 2, 2012 to the Mackenzie Valley Environmental Impact Review Board [MVEIRB] http://www.reviewboard.ca/). Furthermore, the response by the GNWT to Information Request GKP 18 indicates that the energetic model used in the Environmental Impact Statement (EIS) is likely limited, but reasonable based on new information that has become available. The response also states that the developer should be credited for using a combination of models to assess the potential effects on caribou.

2. The rationale for not revising the energetic model is given in Response 1 and the Supplementary Information provided below. The determination of significance will not change given the small influence of development on caribou energy balance and reproduction.

Supplementary Information

The following discussion follows the points made in the pre-amble. It should also be made evident to the reviewer that the energetic model in Section 7 of the EIS was recently revised according to feedback from the GNWT Department of Environment and Natural Resources (ENR). Thus, our responses to the above points will follow the revisions described within the technical memorandum titled "Additional Information Regarding Energetics, Population Viability Analysis, and Effects of Access from the Winter Road, December 16, 2001 (http://www.reviewboard.ca/).

1. The EIS correctly assumed that a sensory disturbance event does not necessarily result in a behavioural response by caribou. Long-term monitoring data collected at the Ekati Diamond Mine shows that a sensory disturbance event elicits a behavioural response about 55% of the time (BHPB 2009). Further, the response following disturbances such as a blast or moving vehicle may be as subtle as a temporary stop

in feeding or a look in the direction of the disturbance (BHPB 2009). The EIS conservatively assumed that all responses were flight responses and that animals were excited for a 12-hr period following a sensory disturbance event. This was a very conservative assumption in the assessment.

2. A clear advantage of the energetic model used in the EIS was that it was a parsimonious model based on the best available ecological information. For example, the consensus in the scientific community is to apply a model with the least number of parameters as possible, while allowing for satisfactory descriptions of ecological phenomena (e.g., Akaike 1974). Further, the approach in calculating energetic costs was consistent with a well-cited study on caribou in the peer-reviewed literature (Bradshaw et al. 1998). The model assumed that individuals do not compensate for weight loss by increasing quality or quantity food intake following a disturbance event (Dale et al. 2008), and because of this assumption, it is anticipated that the model overestimated the effect on reproduction (De Beers 2010; Section 7, Page 7-116).

3. For clarification, although the EIS assumed that there was a 0.148 kilograms (kg) decrease in body weight with every 1 unit increase in insect harassment index (IHI) (Weladji et al. 2003), the IHI formula has since been revised. Assuming that the potential weight of a cow in autumn is closer to 100 kg, the revised prediction is a 0.185 kg decrease in body weight with every 1 unit increase in IHI. Another refinement to the IHI formula included the removal of the proposed threshold (14 potential harassment days) at which caribou may tolerate insect activity levels (See Figure 7.5-4 in EIS). This was done because ENR suggested that the relative influence of insect harassment is stronger than that described in the EIS. Regardless, further revision of the IHI formula will not affect the outcome of the assessment of caribou for reasons described under bullet 6 (see below).

4. The EIS modelled the implications of energetic costs from sensory disturbance events on body condition (i.e., weight) and parturition rate (i.e., the probably of pregnancy and reproduction the following spring)

for individual cows. The assessment considered a sample of the population represented by collared cows (1996 to 2009). Conclusions were drawn for the entire herd. The approach and manner in which conclusions were drawn are consistent with standard sampling designs in science and the scientific peer-reviewed literature.

5. The energetic model predicts that the incremental decrease in parturition rate from the Project (and the Taltson Hydroelectric Expansion Project) is about 0.003 units or 0.3% (see Additional Information Regarding Energetics, Population Viability Analyses, and Effects of Access from the Winter Road; December 16, 2011; http://www.reviewboard.ca/). Based on the expected number of disturbance encounters for the current landscape conditions with the Project and future developments, female caribou would have to increase their encounter rate during the summer-autumn exposure period by approximately 50-times to result in no calf production the following spring. In other words, a high number of encounters with disturbance are required to reduce body weight and the probability of reproduction the following spring. The point is that Project-related impacts on caribou energetics and reproduction is negligible and not likely measurable.

References

Adamczewski, J., J. Boulanger, B. Croft, D. Cluff, B. Elkin, J. Nishi, A. Kelly, A. D'Hont, and C. Nicholson. 2009*. Decline in the Bathurst caribou herd 2006-2009: a technical evaluation of field data and modelling (DRAFT).* Technical Report. Yellowknife, NWT. 105 p.

Akaike, H. 1974*. "A new look at the statistical model identification".* IEEE Transactions on Automatic Control 19: 716–723.

BHPB. 2009. Ekati Diamond Mine *2008 Wildlife Effects Monitoring Program.* Prepared by Rescan™ Environmental Services Ltd. for BHP Billiton Diamonds Inc.

Bradshaw, C.J.A., S. Boutin, and D.M. Hebert. 1998. *Energetic Implications of Disturbance Caused by Exploration to Woodland Caribou*. Canadian Journal of Zoology 76: 1319-1324.

De Beers (De Beers Canada Inc.). 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.

Weladji, R.B., O. Holand, and T. Almoy. 2003. *Use of Climatic Data to Assess the Effect of Insect Harassment on the Autumn Weight of Reindeer (Rangifer tarandus) calves*. Journal of Zoology 260:79-85.

GAHCHO KUÉ PROJECT ENVIRONMENTAL IMPACT STATEMENT
INFORMATION REQUEST RESPONSES

Information Request Number: YKDFN_1.5

Source: Yellowknives Dene First Nation

Subject: Handling of the Beverly caribou herd

Preamble

The wildlife baseline (pg. F4-9) acknowledges that Beverly numbers have declined perhaps 99% up to 2009. It also says the herd will have some, although low likelihood of interacting with the project *("The likelihood of large numbers of animals from the Beverly herd interacting with the Project was predicted to be too low to have detectable effects on the herd"* pg. 7-15; *"Although individuals from the Beverly herd can be expected to travel through the RSA during the autumn or winter periods in some years, the direct and indirect effects from the Project on the population are predicted to be negligible"* pg. 7-48). Similar statements are made regarding effects on population size and distribution of Beverly caribou (pg. 7-79). There is no work plan that demonstrates how these conclusions were reached. Given low numbers of the Beverly herd, project effects to even a few individuals (but a large proportion of the population) might result in a measureable change in population size.

Request

1. The Proponent should clarify what are the implications to the herd and project if the Beverly herd increases in numbers over the next 2 decades.

2. The Proponent should clarify what the impacts to the herd are if the mine effects even a small proportion of the herd then there is the possibility of significant impacts. Minor impacts to a small portion of the herd may lead to significant impacts on sustainability, but given the difficulties and uncertainties faced by the herd at presence, persistence is a clear issue.

Response

1. The estimated annual and seasonal home ranges for the Beverly herd (recently the Ahiak/Beverly herd) indicates that there is a low likelihood of individuals from this herd occurring in the Regional Study Area (RSA) during the northern migration, calving, post-calving, and summer dispersion periods (De Beers 2010, Figures 7.1-2 to 7.1-4). A small number of individuals may interact with the Project during the rut/fall migration and winter dispersion

periods. Between 1995 and 2007, one satellite-collared cow at one location occurred within the Project RSA (De Beers 2010, Table 7.3-2). It is also important to note that while a portion of the RSA overlaps with the historical range of the Beverley herd, the Project footprint itself appears to be entirely outside the known historical distribution of Beverly caribou.

If the Beverly herd recovers over the next two decades to the point that the seasonal ranges (and corresponding annual range) expand and encounters with the Project become more likely, then the implications of the Project for the Beverly herd are expected to be no greater than that predicted for the Bathurst herd in the 2010 Environmental Impact Statement (EIS) (De Beers 2012). This is because Bathurst caribou currently have higher levels of development within their annual and seasonal ranges and there is a much greater likelihood of encountering a development during seasonal movements (De Beers 2010, Section 7.5.2.1, Figure 7.5-1 and Figure 7.5-2). Thus, the conclusion of negligible to moderate impacts from the Project and other developments on the Bathurst herd would be a conservative (i.e., overestimate effects) prediction for the Beverly herd, and would be applicable to the herd at either a low or high point in the population cycle.

2. Even if there is a modest increase in the number of individual encounters with the Project the 13 to 14 years of construction and operation (period of the strongest potential influence), experience from the Ekati-Diavik mine complex with the Bathurst caribou indicates that Beverly caribou would likely feed and rest near the Project. Alternately, caribou also show an avoidance of mine sites, which has been estimated to range from 11 to 14 kilometres (km) (Boulanger et al. 2012). Long-term monitoring at Diavik, Ekati, and Snap Lake mines have shown that direct mine-related mortality of caribou is very low and infrequent (De Beers 2010, Section 7.4.2.2.3, page 7-74), such that it is likely not detectable at the population level relative to natural mortality factors. Further, the implications of caribou encounters with mining developments for reproduction are predicted to be minor (Golder 2011). A recent review by Adamczewski et al. (2009) also indicates that effects from the mines are limited and unlikely a major contributing factor in the decline of caribou relative to other environmental variables.

References

Adamczewski, J., J. Boulanger, B. Croft, D. Cluff, B. Elkin, J. Nishi, A. Kelly, A. D'Hont, and C. Nicholson. 2009. *Decline in the Bathurst caribou herd 2006-2009: a technical evaluation of field data and modelling (DRAFT).* Technical Report. Yellowknife, NWT. 105 p.

Boulanger, J., K.G. Poole, A. Gunn, and J. Wierzchowski. 2012. *Estimating the zone of influence of industrial developments on wildlife: a migratory caribou and diamond mine case study.* Wildlife Biology 18: in press.

De Beers (De Beers Canada Inc.). 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. 2012. Environmental Impact Statement Supplemental Information Submission for the Gahcho Kué Project. Submitted to the Mackenzie Valley Environmental Impact Review Board. April 2012.

Golder (Golder Associates Ltd.) 2011. *Additional Information Regarding Energetics, Population Viability Analysis and Effects from the Winter Road.* Technical Memorandum Submitted to De Beers Canada Inc. Available at: http://www.reviewboard.ca/registry/index.php. 12 pages.

Information Request Number: YKDFN_1.6

Source: Yellowknives Dene First Nation

Subject: Deposition of total suspended particulates (TSP)

EIS Section:

Terms of Reference Section:

Preamble

Dust may change habitat quantity and result in habitat fragmentation. The document acknowledges that dust deposition may cover vegetation and decrease abundance of caribou forage and alter caribou movement and behaviour (Table 7.4-1, and elsewhere). Use of the term “dust” is inconsistent, referring to total suspended particulates (TSP) deposition (pg. 7-65), but also apparently to fugitive dust which incorporates TSP as well as smaller PM_{10} and $PM_{2.5}$ particulates. Maximum deposition rate will occur within 100 metres (m) of footprint (pg. 7-71), but this does not acknowledge longer distance TSP deposition – out to 14 to 20 kilometres (km) at Ekati and Diavik – at lower concentrations (Rescan 2006). Low levels of TSP may be a casual mechanism for the observed approx. 14 km zone of influence observed at other open pit diamond mines (Boulanger et al. 2012), and may be enough to discourage caribou use of an area without having any direct or measureable effects on the vegetation. Thus, these influences may be a result of sensory disturbance rather than direct changes to vegetation.

Boulanger, J., K.G. Poole, A. Gunn, and J. Wierzchowski. 2012. *Estimating the zone of influence of industrial developments on wildlife: a migratory caribou and diamond mine case study.* Wildlife Biology 18: in press.

Rescan 2006. *EKATI Diamond Mine: CALPUFF Air Dispersion Modelling Assessment.* Report prepared for BHP Billiton Diamonds Inc. by Rescan Environmental Services Ltd., June 2006.

Request

1. The YKDFN requests that the Proponent clarify whether they are addressing fugitive dust or TSP in their assessment.

2. The YKDFN requests that the Proponent re-examine the pathways to include dust deposition affecting caribou distribution and abundance through sensory disturbance, rather than direct changes to vegetation.

3. The DAR repeatedly mentions that '99% (or maximum predicted deposition rate) of the dust falls within 100 m of the footprint'; pg. 7-71) or language to that effect, yet this only presents a portion of the picture. The YKDFN request that analysis and discussion be prepared for the other 1% of dust and evaluate it as part of the impacts.

Response

1. To clarify, fugitive dust refers to any particulate matter suspended in the air by wind action and human activities (De Beers 2010, Section 7.12.3). The 2010 Environmental Impact Statement (EIS) (De Beers 2010) uses total suspended particulates (TSP, particles of less than 100 micrometer [µm] diameter) as the measure of fugitive dust. For example, Table 11.4-26 (De Beers 2010) provides estimates of fugitive dust, measured in the TSP deposits per unit area. PM_{10} and $PM_{2.5}$ are defined as particulate matter with particle diameter less than 10 µm or 2.5 µm, and so are included within the TSP measurement.

2. The Yellowknives Dene First Nation (YKDFN) has requested that De Beers re-examine the pathways to include dust deposition affecting caribou distribution and abundance through sensory disturbance. This analysis is already included in the 2010 EIS (De Beers 2010, Sections 7.5.3.1 and 7.5.3.2). Boulanger et al. (2012) have postulated that dust is the most likely mechanism for the observed zone of influence (ZOI). However, this is an untested hypothesis, and the 2010 EIS (De Beers 2010) uses the resulting ZOI calculated by Boulanger et al. (2012) to support the assessment of indirect effects to caribou (De Beers 2010, Section 7.5.3.2). This is a more robust approach because the analysis would be unaffected if it were found that the ZOI were related to factors other than dust.

For example, on page 7-96 (De Beers 2010), the 2010 EIS states that "The combination of direct and indirect (noise, dust and other sensory disturbances) effects can create a ZOI around the Project that can change the behaviour and occurrence of caribou." This ZOI appears to be greater than the estimated spatial extent of the independent effects from project infrastructure, activities, dust, air or noise.

3. The YKDFN have also requested that an analysis be conducted that considers all dust deposition. The 2010 EIS (De Beers 2010) predicted that the maximum dust deposition rate outside of the Project footprint would be 5,520 kilogram per hectare per year (kg/ha/y), and that this would occur within 100 metres (m) of the Project footprint. The analysis of impacts to caribou assumed that dust deposition would extend beyond this distance when assessing indirect effects (i.e., up to 15 kilometres [km]). The ZOI for caribou assumed that all habitats within 1 km of the Project boundary would lose 95 percent (%) of their value to caribou, 50% within 5 km, and 25% within 5 to 15 km (De Beers 2010, Table 7.5-9). This analysis was completed to capture the full effects of dust deposition (and other sensory disturbance factors) on caribou (see Response 2).

References

Boulanger, J., K.G. Poole, A. Gunn, and J. Wierzchowski. 2012. Estimating the zone of influence of industrial developments on wildlife: a migratory caribou and diamond mine case study. Wildlife Biology 18: in press.

De Beers (De Beers Canada Inc.). 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.

Information Request Number: YKDFN 1.7

Source: Yellowknives Dene First Nation

Subject: Incorrect use of caribou life span and generation time

EIS Section:

Terms of Reference Section:

Preamble

The DEIS relates duration of impacts with caribou life spans, and *states "The duration of the impacts from the Project and other developments on population size and distribution is expected to occur over a period of 27 to 32 years (i.e., long term). It is predicted that impacts should be reversed within two caribou life spans"* (pg. 7-165, also pg. 7-162). It is more appropriate to use generation time for this metric. Generation time is not the age at first reproduction, but the mean age of parents at reproduction (Hernandez-Suarez 2011). COSEWIC (2004) assumed a generation time for Peary caribou of 7 years, but the basis for this was not provided. Boulanger (unpubl. data) recently conducted an analysis suggesting generation time for the Bathurst herd was approximately 8 years, but varied with changes in fecundity and survival rates. Percent changes in numbers related to generation time (generally 10 years or three generations, whichever is longer) is often used in assessing trends in populations (IUCN 2001, SARC 2010). Calculation of generation time can be complicated (Hernandez-Suarez 2011), and depends on the age structure and average age of the population, which for caribou can change over time. Use of life span instead of generation time minimizes the impact of development on caribou.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2004. *COSEWIC assessment and update status report on the Peary caribou Rangifer tarandus pearyi and the barren-ground caribou Rangifer tarandus groenlandicus (Dolphin and Union population) in Canada.* Ottawa. COSEWIC.

Hernandez-Suarez, C.M. 2011. *A note on the generation time.* Oikos 120:159-160.

IUCN (2001) *IUCN Red List Categories and Criteria: Version 3.1.* IUCN Species Survival Commission. IUCN, Gland, Switzerland and Cambridge, U.K. Available at http://www.redlist.org/).

SARC. 2010. *Northwest Territories Species at Risk Committee (SARC) Species Assessment Process.* Species at Risk Committee, Yellowknife, NT. Available at www.nwtspeciesatrisk.ca

Request

1. The proponent should use generation time, not life span, in calculations for the assessment, or justify why life span should be used.

2. The proponent should evaluate the residual impacts and the significance of utilizing generational time. Further, if generation time is utilized in any calculations, it should be identified, recomputed and compared to the original life span values.

Response

Caribou life spans (and human generations) was used to provide context about the duration of effects for the five primary pathways (i.e., how long caribou would be exposed to effects). This is explained in Section 7.7.1.3 (De Beers 2010). Regardless, most effects to caribou from the Project are activities that are expected to be reversible within 5 to 10 years following closure (i.e., duration of effect is 27 to 32 years) (also see De Beers 2010, Section 7 Table 7.7-2). The application of generation time or any other measure to provide this context will not change the duration of effects assessed, and thus, will not change the outcome of the assessment.

Reference

De Beers (De Beers Canada Inc.). 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.

GAHCHO KUÉ PROJECT ENVIRONMENTAL IMPACT STATEMENT
INFORMATION REQUEST RESPONSES

Information Request Number: YKDFN 1.8

Source: Yellowknives Dene First Nation

Subject: Use of canned packages in the assessment process

Preamble

The proponent uses a number of canned packages during the assessment, including FRAGSTATS to examine landscape fragmentation (pg. 7-83), RAMAS for population viability analysis (PVA; pg. 7-127), and friction modelling or least cost path analysis to identify the location of potential caribou movement pathways (pg. 7-26). Because of the Black Box nature of these packages, it is difficult for Aboriginal people trying to interpret an assessment of significance, and leads to a lack of transparency in the assessment process.

Request

1. The proponent should explain in greater detail and plain language how the inputs into these canned packages are treated in the program, and their implications to the assessment. For example, does the PVA consider the trade-off that may occur between caribou harvest for communities and development?

Response

The population viability analyses (PVAs) used in the 2010 Environmental Impact Statement (EIS) (De Beers 2010) considered the trade-off that may occur between caribou harvest for communities and development. All models considered demographic impacts from harvest, as illustrated in Table 7.5-18 (De Beers 2010). The models simulated a caribou population using a harvest rate of 4 percent (%) or 8%. The incremental effects test comparing outcomes from the "2010 baseline #3" model versus the "2010 baseline #1" model showed that a small increase in harvest decreases the projected final herd abundance by about 52% (De Beers 2010, Table 7.5-19). In contrast, the incremental effects test comparing outcomes from "Application future #1" model versus "2010 baseline #1" showed the application of the Project to the landscape decreases projected final herd abundance by about 1%. Further, the predicted 1% change is likely an overestimation given the number of conservatisms that were considered throughout the assessment. These are listed in Table 3 of the Technical Memorandum titled 'Response to the Draft Caribou Comments Provided by the

Government of the Northwest Territories – Department of Environmental and Natural Resources' (dated July 22, 2011; http://www.reviewboard.ca/ registry/ index.php) (Golder 2011).

Software packages such as RAMAS and FRAGSTATS provide tools for addressing complex ecological questions such as those outlined in the Terms of Reference (GKP 2007) (note: in Section 4.1 of the Terms of Reference, it is stated that the analyses must include substantive modeling). The software packages that were used for the wildlife assessment, as well as the modelling framework (or tools) that they provide, are commonly used in the peer-reviewed literature where there are hundreds of papers addressing similar ecological questions to those addressed in the 2010 Gahcho Kué EIS (De Beers 2010). For example, population viability analysis is a commonly used and well-accepted approach for evaluating the relative changes to population sizes under a suite of varying intrinsic and extrinsic factors that influence demographic rates. A recent search of the phrases "Population Viability Analysis" and "PVA" together in Web of Science® yielded over 100 peer-reviewed scientific articles since 2007.

In brief, PVA provides a quantitative modelling and assessment framework that explicitly incorporates variation and uncertainty in factors that influence population size and extinction probabilities, such as survival and reproduction rates (Akcakaya et al. 2004). The PVAs in the wildlife assessment were completed using stage-based (algebraic) models parameterized with survival and reproduction estimated from field studies using the software package RAMAS. But population viability analysis models are best used for estimating the relative population changes and risks from varying influences of human and natural factors (random and deterministic) on survival and reproduction rates (e.g., Curtis and Vincent 2008; Roger et al. 2011). This approach was used in the 2010 EIS (De Beers 2010) and is emphasized at various locations in the assessment (e.g., De Beers 2010, Section 7.5.4 and page 7-135). For example, the effects from changes to insect harassment and harvest levels were tested to determine the relative contribution of these factors to the abundance of caribou (De Beers 2010, Table 7.5-18).

Consistent with our modelling results, a recent review by Adamczewski et al. (2009) indicates that effects from the mines are limited and unlikely a major contributing factor in the decline of caribou relative to other environmental variables. Experience from the Ekati-Diavik mine complex indicates that caribou would likely feed and rest near the Project. Long-term monitoring at Diavik, Ekati, and Snap Lake mines have shown that direct mine-related mortality of caribou is very low and infrequent (De Beers 2010, Section 7.4.2.2.3, page 7-74), such that it is likely not detectable at the population level relative to natural mortality factors. As concluded in the 2010 EIS (De Beers 2010, Section 7.8.2, Page 7-172), cumulative impacts from development are not predicted to have a significant adverse effect on continued opportunities for use of caribou by people that value the animals as part of their culture and likelihood.

References

Adamczewski, J., J. Boulanger, B. Croft, D. Cluff, B. Elkin, J. Nishi, A. Kelly, A. D'Hont, and C. Nicholson. 2009. *Decline in the Bathurst caribou herd 2006-2009: a technical evaluation of field data and modelling (DRAFT).* Technical Report. Yellowknife, NWT. 105 p.

Akcakaya, H. R, M. A. Burgman, O. Kindvall, C. C. Wood, P. Sjorgen-Gulve, J. S. Hatfield, and M. A McMarthy (editors). 2004. *Species Conservation and Management: Case Studies.* Oxford University Press, New York.

Curtis, J. M., and Vincent, A. C. J. 2008. *Use of population viability analysis to evaluate CITES trade-management options for threatened marine fishes.* Conservation Biology 22:1225-1232.

De Beers (De Beers Canada Inc.). 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.

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

Golder (Golder Associated Ltd.). 2011. Response to the Draft Caribou Comments Provided by the Government of the Northwest Territories - Department of Environment and Natural Resources. Golder Technical Memorandum. Project No. 11-1365-0001/DMC-016. Submitted to De Beers Canada Inc. (Paul Cobban). July 22, 2011.

Roger, E., S. W. Laffan, and D. Ramp. 2011. *Road impacts a tipping point for wildlife populations in threatened landscapes.* Population Ecology 53:215-227.

Information Request Number: YKDFN 1.9

Source: Yellowknives Dene First Nation

Subject: Inadequate handling of the potential impact of the winter road

EIS Section: Section 1: Caribou

Terms of Reference Section:

Preamble

The potential pathways for effects to caribou table (Table 7.4-1) indicates that the winter access road and the Tibbitt-Contwoyto winter road may alter caribou movement and behaviour, and increase the risk of injury or mortality to caribou, which can affect population size, increase dust deposition and sensory disturbance, among other things (pgs 7-51-58). Reportedly there have only been three reported road-related wildlife mortalities along the Tibbitt-Contwoyto winter road between 1996 and 2009 (only one incident that killed five caribou), but reports verifying these data post 2001 are not cited, and are not available to verify methodology or accuracy (pg 7-75). With up to 11,000 trucks annually during an 8-12 week period each winter when caribou are potentially present, it is difficult to believe that only one group of caribou has ever been hit but a truck. Thus the conclusion of negligible residual effect (pg 7-76) is not supported (except of course that it uses persistence as the measurement metric – see IR YKDFN 1.1).

The Gahcho Kue winter access road will see up to 2,000 trucks per year during construction, decreasing to about 1,200 per year during operation (pg 7-101). Over a 12 week winter road period, this equate to approximately 25 and 14 trucks per day (pg 7-101). With warming temperatures and decreasing length of ice road season, the intensity of truck traffic will need to be increased. Analysis was not conducted on the impact of a shortened winter trucking season on the filter or semi-permeable barrier effect of the road under these conditions.

Request

1. The proponent should acknowledge the uncertainty in the caribou mortality data, and revise their pathway analysis accordingly.

2. Climate change may result in shorter winter trucking seasons in some years and more often in the future. The proponent should amend their analysis to consider the effects of a shortened ice road season on both caribou mortality and barriers to movement.

Response

1. Erik Madsen, Environmental Manager, with the Tibbitt-to-Contwoyto Winter Road (TCWR), provided the history of wildlife-vehicle collisions (Madsen 2010, pers. comm.) in addition to those documented by EBA (2001). This was confirmed with Alan Fitzgerald, Manager Special Projects, with Nuna Logistics (Fitzgerald 2012, pers. com). It is possible that some collisions occur but are not reported, but this is considered unlikely as it would require collusion between drivers and security.

   Data from 2000 through 2010, indicate that the TCWR opened as early as late January and closed as late as mid-April (De Beers 2010, Section 11.8.2.5.1; Table 11.8-6). This period of operation overlaps the winter range of caribou, which occurs from November through April. Mitigation used on the TCWR to reduce impacts to caribou includes communication between drivers and maintenance crews, and a caribou right-of-way policy (Fitzgerald 2012, pers. comm). Traffic volume and intensity (truck loads per operating day) peaked during 2007 (TCWRJV 2012) and no caribou collisions were reported for this or any other year since 1999. All available information regarding caribou mortality along the winter access road and the Tibbitt-Contwoyto winter road was included in the assessment (De Beers 2010, Section 11.8.2.5.1, Table 11.8-6). This information supports the prediction that there is a low risk of caribou mortality from vehicle collisions.

2. Even though climate change could result in a reduction of the operating season of the TCWR, ice road loading limits will still regulate traffic volume and intensity to provide safe driving conditions. The highest northbound traffic intensity and volume on the TCWR was 150 trucks per day occurring in 2007 when 10,922 northbound truck loads were hauled during a 73 day operating season (TCWRJV 2012). The Project predicts that up to 2,000 trucks may travel the TCWR and Gahcho Kué Winter Access Road during construction and up to 1,200 per year during operation. Between 2008

and 2011, at least 3,300 fewer trucks have used the TCWR annually, so total traffic volume including additional volume required for the Project should not exceed the maximum traffic levels observed in 2007.

Barrier effects to caribou from winter roads and climate change depend on a number of factors, such as the amount and intensity of traffic on the road, the proximity of wintering caribou to the road, snow depth, and caribou movement rates. Climate change may reduce the length of hauling season due to shorter winters (McGregor et al. 2008). A decrease in the operational period of the TCWR from climate change may reduce the influence of vehicles on caribou along the winter road. However, there is insufficient information on the actual response of caribou to vehicles on the winter roads and the physical structure of winter roads to predict effects to caribou movement and behaviour from climate change influences on the winter road.

References

De Beers (De Beers Canada Inc.). 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.

EBA (EBA Engineering Consultants Ltd.). 2001. *Tibbitt to Contwoyto Winter Road Environmental Setting Report.* Prepared by EBA Engineering Consultants for the Tibbitt to Contwoyto Winter Road Joint Venture, Yellowknife, NWT, September, 2001.

McGregor, R. V., M. Hasson, and D. Haley. 2008. *Climate change impacts and adaptation: Case studies of roads in northern Canada.* Prepared by EBA Engineering Consultants Ltd., Calgary, AB.

TCWRJV (Tibbitt to Contwoyto Winter Road Joint Venture). 2012. *Tibbitt-to-Contwoyto Winter Road Joint Venture website, http://jvtcwinterroad.ca/.*

Personal Communication

Fitzgerald, Alan. 2012. Manager, Special Projects. Nuna Logistics. Telephone correspondence. February 6, 2012.

Madsen, Erik. 2010. Director, Communities/External Relations & Winter Road Operations. Diavik Diamond Mines Inc. Email correspondence dated Sept. 21, 2010.

April 2012

GAHCHO KUÉ PROJECT ENVIRONMENTAL IMPACT STATEMENT
INFORMATION REQUEST RESPONSES

Information Request Number: YKDFN 1.10

Source: Yellowknives Dene First Nation

Subject: Quality of maps and figures in reports

EIS Section: Section 1: Caribou

Preamble

The digital file size of most of the major sections and annexes is reasonable, but most maps and figures are of such poor resolution as to be unreadable. Examples can be seen throughout the caribou KLOI (Section 7; e.g., Figs. 7.3-4, 7.5-8). This is a major hurdle in interpreting the information provided.

Request

1. To allow proper review of the EIA, the YKDFN requests that the Proponent supply the digital documents so that they provide figures and maps that are clear and legible.

Response

DeBeers acknowledges that due to file size restrictions on the Mackenzie Valley Environmental Impact Review Board (MVEIRB) website that some of the Figure resolution was reduced. De Beers distributed three copies of the 2011 Environmental Impact Statement (EIS) Update compact discs (CDs) (that provided higher resolution figures and maps) as follows:

- 13 October 2012, to Chief Sangris and Chief Tsetta (cc'd to the Director Land Management YKDFN – Randy Freeman).
- 13 October 2012, to Greg Empson.
- 13 October 2012, to Todd Slack.

Reference

De Beers (De Beers Canada Inc.). 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.

Information Request Number: YKDFN 1.11

Source: Yellowknives Dene First Nation

Subject: Airport fencing

EIS Section: Section 1: Caribou

Preamble

The proponent acknowledges that "*aircraft/vehicle collisions may cause injury/mortality to individual animals*" (Table 7.4-1), but is not clear whether fencing of the airstrip is proposed, and if so, what type of fencing will be used (to avoid the issues with electric fencing that have occurred at Ekati and Diavik). No aircraft collisions have caused mortality to caribou at existing mines, likely because they are fenced.

Request

1. The YKDFN requests that the Proponent clarify whether fencing of the airstrip is proposed, and if so, what type of fencing will be used.

Response

De Beers is not proposing to fence the airstrip at the Gahcho Kue Project. No fencing exists at the airstrip Snap Lake or Lupin mines nor at most of the community airstrips.

Information Request Number: YKDFN 1.12

Source: Yellowknives Dene First Nation

Subject: Winter Road Data, Impacts and Access

EIS Section: Section 1: Caribou

Terms of Reference Section:

Preamble

Section 11.8.4.3 references a decline in the number of vehicles stopping at the winter road (from 573 to 284). As this ‘checkpoint’ was a voluntary stopping point, there is a strong suspicion from YKDFN and other Parties that the data is not indicative of trend of reducing utilization that the proponent suggests. During the caribou harvesting restrictions, GNWT certainly intimated that the First Nations harvesting effort has remained very high.

Request

1. The proponent provides a discussion on the capture rate of the voluntary checkpoint and what indication that declining participation may have on their assertion and assumption.

Response

The Yellowknives Dene First Nation (YKDFN) have requested a discussion of the level of participation in the voluntary checkpoint at Ross Lake on the Tibbitt-to-Contwoyto Winter Road (TCWR). The checkpoint is run jointly by Environment and Natural Resources (ENR) and the YKDFN. All non-commercial users are asked to stop at the checkpoint to answer a questionnaire.

Results from 2004 to 2006 were reported by ENR (Zeimann 2007). Although this report acknowledged that not all non-commercial users are captured at the checkpoint, the decline in non-commercial use of the TCWR was believed to be related to shorter winter road seasons and a decrease in caribou availability. Zeimann (2007) states:

‘There are also instances when vehicles are missed. This is due to the fact that this past season there were problems finding a monitor and there are also times when the monitor is away from the station. ENR is, however, confident that the data gives a realistic number with respect to how many people are using the winter road.'

Reference:

Ziemann, J. 2007. *Tibbitt Lake to Contwoyto Winter Road Monitoring Station Report.* Department of Environment and Natural Resources, Government of the Northwest Territories. Manuscript Report No. 173. 8 pp. http://www.enr.gov.nt.ca/_live/documents/documentManagerUpload/Tibbitt_Lake_to_Contwoyto.pdf. Website accessed: April 2010.

GAHCHO KUÉ PROJECT ENVIRONMENTAL IMPACT STATEMENT
INFORMATION REQUEST RESPONSES

Information Request Number: YKDFN 1.13

Source: Yellowknives Dene First Nation

Subject: Winter Road – Restriction to Movement

EIS Section: Section 1: Caribou

Terms of Reference Section:

Preamble

Section 11.8.4 and 11.8.5 discusses the possibility of the winter road acting as a barrier to movement for wildlife. While the DAR acknowledges that the "presence of winter roads may represent a barrier to animals, and lead to fragmentation of the population within the RSA" it does little to evaluate this potential – it suggests that the winter road will likely be a "leaky barrier" (evidence from the North seems to confirm this) and that the fact of the winter road being limited to an 8 to 12 week period each year represents some mitigation. This would be true if it weren't for the fact that the 8 to 12 weeks that the road is in operation is the period which caribou are likely to be in the area, thus the effects on movement are in place. The DAR does not go on to meaningfully evaluate or assess these impacts, only suggesting that they low to minimal in magnitude.

Request

1. The proponent provides a thorough discussion on the likely direct and indirect impacts of the introduction of a leaky barrier to the movements of caribou.

2. Included as part of this discussion should be an analysis which considers the encounter of collared caribou with the winter road route. This analysis should focus on if an animal would encounter the road or the project during a year as well as the number of encounters (relative to the number of 'caribou years' of data.

   a. Furthermore, the proponent should provide information on the temporal resolution of the collaring data and the uncertainty that this injects into the analysis

b. Table 7.3.2 does not contain any indication how the company addressed the issue of standardizing the variances across the years. For instance, newer collars generally broadcast more often, especially during key parts of the year – so the raw results presented in this table present a misleading picture and can introduce bias.

Response

1. The physical (direct) effects from the Tibbitt-to-Contwoyto Winter Road (TCWR) on caribou were analyzed as part of the habitat quantity and fragmentation analysis (De Beers 2010, Section 7.5.2.2). Direct effects from vehicle mortality were assessed in Section 7.4.2.2.3 (De Beers 2010). Indirect effects to caribou movement and behaviour (distribution) from vehicle traffic and associated noise levels were assessed in Section 7.5.3.1.2 (De Beers 2010). Additional information on the predicted effects from increased vehicle traffic on the TCWR associated with the Gahcho Kué Project on caribou movement and behaviour is provided below.

   Construction represents the period of maximum vehicle traffic for a project. De Beers is not aware of other proposed mines that may also be in construction at the same time as the Gahcho Kué Project and that will also use the TCWR. Further, the projected maximum of 2,000 trips required during construction (and 1,200 during operations) of the Gahcho Kué Project will not cause winter road traffic to exceed the range of historic numbers. In addition, between 2008 and 2011, at least 3,300 fewer trucks have used the TCWR annually, so total traffic volume including additional volume required for the Project is not expected to exceed the maximum traffic levels observed in 2007. The magnitude of the effect to caribou abundance and distribution from vehicle traffic on the TCWR associated with the Gahcho Kué Project is predicted to be negligible to low (De Beers 2010, Section 7.6.2).

   The recorded caribou mortality from vehicle collisions is low (Fitzgerald, pers. comm.), and would result in negligible (non-measurable) change to caribou abundance. The effect of winter roads on caribou movement and behaviour has not been quantitatively analyzed, but likely depends on a number of factors such as the amount and intensity of traffic on the road, and associated noise, smells, and/or vibrations. It is likely that caribou exhibit predator avoidance behaviour and limit their distribution around the TCWR considering that harvesting from the road is permitted (with the exception of current harvesting ban).

The location and movement rate of caribou would also influence the likelihood of animals interacting with the TCWR. For example, during the operational period of the TCWR (late January to early April), caribou daily movement rate is lower than other seasons and the potential for interactions with vehicles and the road will partially depend on the distribution of animals (i.e., caribou encounter rate with the TCWR likely decreases with increasing distance from annual winter distribution of the herd).

2. Predicted encounter rates for the Gahcho Kué Project are provided in Figure 7.5-8 (De Beers 2010, Section 7.5.3.2.2). This analysis is beyond the Terms of Reference, as is a similar analysis of caribou encounter rates with the TCWR. Nevertheless, De Beers acknowledges that differences exist in the frequency (or time interval) in collar locations among years (De Beers 2010, Section 7.5.3.2.2 pages 7-111 to 7-112; Table 7.5-12). Because the time interval between locations was greater during earlier years (particularly 1996 to 2005), the movement paths (distance segments between locations) may have intersected a zone of influence rather than showing avoidance if more locations were available over a given length of time. Alternatively, because more recent collar data are based on shorter time intervals, movement paths are longer over a given period of time, resulting in greater potential to encounter developments. Thus, there is some uncertainty in the actual number of encounter rates for animals collared during 1996 to 2005. However, the intention of the assessment was to make the best use of available information.

   A supplementary analysis of caribou encounter rates with the TCWR and the Gahcho Kué Project Winter Access Road indicates that the historic encounter rate has been low, and predominantly contained within the area between Gordon Lake and the treeline (please see response to Information Request GKP 4). For example, no collared caribou encountered the Project Winter Access Road during the hypothetical operating period (January 26 to April 16) from 1996 through 2010. For those caribou that may be exposed to sensory disturbance, the results from studies of caribou observed near airstrips or roads showed that resting and feeding behaviour were common (Gunn et al. 1998; BHPB 2007). These results suggest that the presence of traffic does not necessarily lead to stress-associated behaviour.

The Environmental Impact Statement (EIS) included information on collared caribou cows from the Bathurst, Beverley and Akiak herds for the period of 1995 to 2010 to describe their seasonal ranges, and determine the extent that caribou from these herds might be influenced by the Project. More detailed information on the number of collar locations (satellite and GPS) within the regional study area for each herd and season provided additional support for predicting the likelihood of the Project influencing a particular herd (De Beers 2010, Section 7.3, Table 7.3-2). As mentioned above, the frequency of collar locations increased in 2006, and again in 2009 with the implementation of GPS collars, which can reduce bias in the results depending on the distribution of animals on their seasonal ranges. However, all available data are still appropriate for providing a relative measure of the potential for these caribou herds to be influenced by the Project.

References

BHPB. 2007. Ekati Diamond Mine 2006 Wildlife Effects Monitoring Program. Prepared by Rescan™ Environmental Services Ltd. for BHP Billiton Diamonds Inc.

De Beers (De Beers Canada Inc.). 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.

Gunn A., J. Dragon, S. Papik, D. Panayi, M. Svoboda, M. Sutherland, and M. D'Entremont. 1998. Summer Behaviour of Bathurst Caribou at Mine Sites and Response of Caribou to Fencing and Plastic Deflectors. Department of Resources, Wildlife and Economic Development, GNWT. Final Report to the West Kitikmeot/Slave Study.

Personal Communications

Fitzgerald, Alan. 2012. Manager, Special Projects. Nuna Logistics. Telephone correspondence. February 6, 2012.

GAHCHO KUÉ PROJECT ENVIRONMENTAL IMPACT STATEMENT
INFORMATION REQUEST RESPONSES

Information Request Number: YKDFN 1.14

Source: Yellowknives Dene First Nation

Subject: Winter Road – Monitoring

EIS Section: Section 1: Caribou

Terms of Reference Section:

Preamble

The winter roads are effectively operated as though they are independent of the mine itself and do not undertake monitoring activities directly related to the operation of the mine. Often the Wildlife Effects Monitoring Programs do not address the concerns or confirm the predictions made during EA. With this consideration, YKDFN want the company to make clear commitments on how they intend to verify their EA predictions with respect to road operations. It is not acceptable to simply make a statement during the permitting phase.

Request

1. How does the company intend to monitor the use and impacts of the winter road during the operations, closure and post-closure period.

Response

As stated in response to Government of the Northwest Territories (GNWT) IR 4: Based on the experience of the Snap Lake winter access road, which located approximately 40 kilometres (km) closer to Yellowknife, harvest of caribou from the Gahcho Kué Project winter access road is not anticipated to be an issue. However, De Beers recognizes that access is an important issue to communities and Department of Environment and Natural Resources of the Government of the Northwest Territories (ENR), and is prepared to participate in monitoring winter road use on the Project Winter Access Road. De Beers is currently a partner in the Tibbitt-to-Contwoyto Winter Road Joint Venture. De Beers understands that the joint venture currently provides funding to ENR to support monitoring along the Tibbitt-to-Contwoyto Winter Road, and the program may be applicable to the Project winter access road. ENR's experience with monitoring existing portions of the Tibbitt-to-Contwoyto Winter Road will be helpful in assessing possible monitoring and mitigation options.

As stated in response to Information Request TG_45, De Beers proposes to provide a Wildlife Effects Monitoring Program (WEMP) that engages communities and regulatory agencies, provides the feedback to the operational requirements of the Project, and meets all legal requirements (such as for species at risk). The most effective regional-scale monitoring approach would involve building on the studies undertaken to date at other diamond mines, which has led to collaboration with government and other industry partners. Such an approach is applicable to monitoring potential changes in caribou behaviour and movement from the Project winter access road and Tibbitt-to-Contwoyto Winter Road.

De Beers would support a GNWT-ENR initiative to undertake regional monitoring along the Tibbitt-to-Contwoyto Winter Road. Such an approach is consistent with verifying impact predictions in the Environmental Impact Statement (EIS), which were made at the population level. Data from Geographic Positioning System (GPS) collared caribou represent one of the most effective ways of studying changes in behaviour and movement of caribou as individuals encounter winter roads. Existing collar data should be examined to estimate the number of collared animals and frequency of collar locations for producing sufficient data for analyzing the response of caribou to winter roads. The study design should also incorporate local knowledge from communities. Furthermore, the estimated number and sex of collared animals should be evaluated with respect to other regional studies designed to provide information on adult survival rate, calf recruitment, and habitat selection. Thus, an important component of regional studies is to identify the response variables (e.g., changes in movement and behaviour and survival) to be monitored and the level of data required to measure changes in those variables.

GAHCHO KUÉ PROJECT ENVIRONMENTAL IMPACT STATEMENT
INFORMATION REQUEST RESPONSES

Information Request Number: YKDFN 1.15

Source: Yellowknives Dene First Nation

Subject: Caribou Habitat - basedata

EIS Section: Section 1: Caribou

Terms of Reference Section:

Preamble

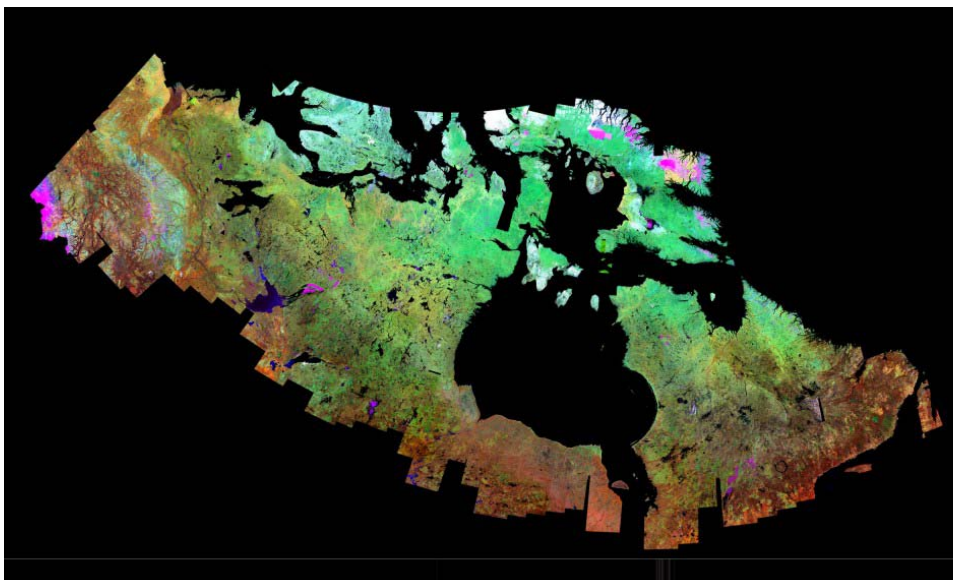
The proponent utilizes the Land Cover of Canada vegetation classification which has a 1 km resolution (pgs 7-83, 7-102) – the City of Yellowknife would be reduced to a few pixels, while Dettah is probably not detectable. This is a very low resolution basedata, which was then subjected to a modification process to resample it to a smaller resolution (down to 25-m resolution, then resampled to 200-m cell sizes (pg 7-83, 7-102). However, this does not improve the data, it simply slices the larger squares into smaller squares of the same value. Utilizing this data is only appropriate if the larger cells do a good job at approximating the actual landcover on the ground.

There are several high resolution datasets available for parts of the territory and from industrial projects in this extent. The creation of a unified legend/classification scheme would allow a comparison between the areas classified in the Land Cover of Canada and the higher resolution datasets, providing some indicator of the relative quality and confidence that the parties should have in the basedata. YKDFN have a real concern that the basedata used to complete the various analyses in the EIS may be producing results that will result in poor decisions and management as well as not assuring the Board or the Parties that the conclusions of no significant impacts are likely.

Request

1) The proponent should undertake a comparison between the Land Cover of Canada dataset and the higher resolution data available from around the NWT and Nunavut to ensure that the information being utilized in the models is valid for the purpose. Example datasets include vegetation classifications from Tyhee, Avalon, Ekati, Diavik, and Bathurst Port and Road as a start.

2) The proponent should provide a discussion why they chose not to use the 90 m (Extents found below) medium resolution Landcover of Canada (2005) or the 250m MODIS Landcover of Canada (2005) rather than a 1km version. These datasets would have provided a much improved picture of caribou use.



Pictured: Extent of the 90m Landsat Vegetation Classification.

Response

1) A comparison of the assessment database with a higher resolution dataset is not expected to change the impact predictions and determination of significance or reduce any uncertainty that may be linked to impact predictions for the following reasons.

   Because the assessment approach emphasized relative changes across seasonal ranges through time, it is anticipated that “pixel size” would have limited influences on the amount of change in landscape measurement endpoints (e.g., habitat quantity and fragmentation, and habitat quality). In other words, the classification of the magnitude of impacts should be similar if another landscape classification is used. Related to this point, there is no reason to believe that the assessment outcome will change given the low level of development within the annual and seasonal ranges of the Bathurst caribou herd. The proportion of the landscape that has been converted to development footprint is less than 0.5% on the annual and seasonal ranges (please see response to Information Request TG_44).

Data resolution and assessment-unit resolution can be separate issues. For example, fine-resolution data can be combined into large planning units (e.g., land use boundary units for mining developments) but the outcome of ranking habitat suitability across a large geographic area (approximately 300,000 square kilometre (km^2) for caribou and wolves, and 200,000 km^2 for grizzly bear and wolverine) will be similar to coarse-resolution data.

What is considered fine or coarse resolution depends on the objective of the analyses. The analysis of changes in landscape measures was completed at the second-order level, which is representative of the ecology and behaviour of caribou and carnivores at the scale of the seasonal ranges (Johnson 1980). At this scale, these species are selecting portions of the study area for a mosaic of certain habitat types to meet life history requirements, and not necessarily smaller scale features such as rock outcrops or individual water bodies and wetlands. Given the daily and seasonal movement rates of these animals relative to the resolution of land cover used, the assessment was appropriate and could be considered fine-grained.

The key point is that De Beers is not aware of any scientific literature that suggests that the assessment approach in the Environmental Impact Statement (EIS) is flawed. On the contrary, the approach in the EIS is consistent with Environment Canada's "Scientific Assessment to Inform the Identification of Critical Habitat for Woodland Caribou, Boreal Population, in Canada" (EC 2011). Other spatially extensive analyses, such as those undertaken for the wildlife assessment, typically include resolutions of 100 km^2 or greater (e.g., Wessells et al. 2000; Larsen and Rahbek 2003) and would consider the 1-km^2 resolution applied in the EIS as a 'fine-scale' resolution assessment.

2) The Atlas of Canada Landcover was used because at the time of the assessment, it was the only available database that provided vegetation coverage for the entire seasonal ranges of the Bathurst and Ahiak caribou

herds. Also, this database was being used by other researchers for similar studies, and was considered to be of "fine" resolution according to the spatial scale of the analysis (second order selection) and the ecology of the species (see Response 1).

Please also see response to Information Requests YKDFN_1.16 and YKDFN_1.18, which are similar to this information request.

References

EC (Environment Canada) 2011. *Scientific assessment to inform the identification of critical habitat for woodland caribou (Rangifer tarandus caribou), Boreal population, in Canad: 2011 update.* Ottawa, Ontario, Canada. 102 pp. Plus appendices.

Johnson, D.H. 1980. *The comparison of usage and availability measurements for evaluating resource preference.* Ecology 61:65-71.

Larsen, F. W. and C. Rahbek. 2003. *Influence of scale on conservation priority setting – a test on African mammals.* Biodiversity and Conservation 12:599-614.

Wessels, K. J., B. Reyers, and A. S. Van Jaarsveld. 2000. *Incorporating land cover information into regional biodiversity assessments in South Africa.* Animal Conservation 3:67-79.

Information Request Number: YKDFN 1.16

Source: Yellowknives Dene First Nation

Subject: Caribou Habitat – Habitat Suitability Modelling

EIS Section: Section 1: Caribou

Terms of Reference Section:

Preamble

The EIS, despite being voluminous, does not elaborate on how the proponent derived or defined the “good” vs. “bad” habitat other than to suggest that it applied Johnson’s method, though the later used a much higher resolution for its initial data.

These types of models generally work by comparing the habitat available to caribou to the habitat that they select. Utilizing the 1 km base data instead of higher resolution data creates a number of potential errors within the output. Firstly, with cells this large, the evaluation of choice becomes much different – each cell is, because of the initial resolution, a large area of 100 hectares that is effectively homogonous in the image. Thus, the availability of the habitat to be selected is much reduced. Secondly, this introduces potential errors of commission, where an animal is selecting one type of habitat within a larger more dominant class, but because of the relative difference in abundance, the more common class is spectrally dominant in the imagery – an easy example here would be stream banks on the tundra where shrubs and woody vegetation appears, but because its relatively small in area the pixel would be classed as the dominant area.

Request

1) The proponent should provide a clear explanation of the methods used to derive the habitats that caribou select for compared to what they select against.

2) The proponent should prepare a discussion which evaluates the predictive nature of the HSI models with differing resolutions of data, specifically addressing the issue of bias with larger pixels.

a. For example, in the current analysis which started with low resolution data (1 km/large pixels), if the starting vegetation is 'class A' there would be a significant bias that next, selected point would also be the same class.

3) A test sample should be prepared which compares the outcomes, coefficients, and selection preferences of caribou with different resolution basedata (90 m Landsat based landcover pictured above, 250 m MODIS). How does the use of different bases affect the results?

Response

1. Changes to preferred habitats were measured using resource selection function (RSF) models (i.e., statistical tools) that quantify caribou habitat use relative to its availability during a given time of year (Boyce and McDonald 1999; Boyce et al. 2002). The RSFs that were applied in the Environmental Impact Statement (EIS) were previously developed and published by Johnson et al. (2005). This paper currently has about 23 citations in the peer-reviewed literature.

   Additional details of how the caribou RSFs were developed can be found in the Johnson et al. publication in Wildlife Monographs (Issue 160, Pages 1-36). In brief, the Johnson et al. RSF was based on caribou collar (used) locations and available sample units, which were then contrasted with logistic regression using the following equation:

$$\widehat{w}(x) = exp(\beta_0 + X\beta)/\left(1 + exp(\beta_0 + X\beta)\right)$$

   where $\widehat{w}(x)$ is the probability of selection as a function of variables x_n, β_0 is the intercept, and $X\beta$ is the vector of the coefficients $\widehat{\beta_1}x_1 + \widehat{\beta_2}x_2 + \ldots + \widehat{\beta_n}x_n$ estimated from fixed-effects logistic regression (Manly et al. 2002). In Johnson et al. (2005), the RSF models were of relative probabilities. Thus, as part of the assessment, spatial predictions (maps) were binned into equal quantiles or habitat ranks (Boyce et al. 2002).

2. The intention of the habitat modelling was to generate habitat maps for varying levels of development on the landscape (from reference to future conditions) to predict the incremental and cumulative effects on caribou and other wildlife. Because the assessment approach emphasized relative changes in landscape measurement endpoints across seasonal ranges through time, it is anticipated that “pixel size” would have limited influences on the impact classification and determination of significance. But the reviewer should be made aware that data resolution and assessment-unit resolution can be separate issues. For example, fine-resolution data can be combined into large planning units (e.g., land use boundary units for mining developments) but the outcome of ranking habitat will be the same as if coarse-resolution data were used.

   The scale of the habitat assessments spanned approximately 300,000 square kilometres (km^2) for caribou and wolves, and 200,000 km^2 for grizzly bear and wolverine. The analysis of changes in landscape measures was completed at a scale where caribou and carnivores are selecting portions of the study area for a mosaic of certain habitat types to meet life history requirements, and not necessarily smaller scale features such as rock outcrops or individual water bodies and wetlands. Given the daily and seasonal movement rates of these animals relative to the resolution of land cover used, the assessment was appropriate and robust to the extreme biases presented by the reviewer. Other spatially extensive analyses, such as those undertaken for the caribou assessment, typically include resolutions of 100 km^2 or greater (e.g., Wessells et al. 2000; Larsen and Rahbek 2003) and would consider the 1-km^2 resolution applied in the EIS is a ‘fine-scale’ resolution.

3. De Beers is not aware of any scientific literature that suggests that the assessment approach in the EIS is flawed. Tests suggested by the reviewer are not required given the rationale provided in Response 2, and the response to Information Request YKDFN 1.15. Further, there is no reason to believe that the assessment outcome will change given the low level of development within the seasonal ranges of the Bathurst caribou herd. For example, supplementary analysis of changes to habitat quantity showed that physical footprint from mines, exploration sites, roads and other

developments covered 0.14% to 0.25% of the seasonal ranges (please see response to Information Request TG_44).

Additional analysis using a highly conservative estimate of indirect effects that removed all available habitat within the zones of influence of developments (null-habitat ZOI) also indicates that the approach used in the EIS produced confident and ecologically relevant impact predictions. The proportion of land cover within the null-habitat ZOI of development was 10.5% for the winter range, 7.8% for the northern migration range, 10.6% for the summer range, and 8.1% for the autumn range (see response to Information Request TB_44).

Please also see response to Information Requests YKDFN_1.15 and YKDFN_1.18, which are similar to this information request.

References

Boyce, M. S., and L. L. McDonald. 1999. *Relating populations to habitats using resource selection functions.* Trends in ecology and evolution 14:268-272.

Boyce, M. S., P. R. Vernier, S. E. Nielsen, and F. K. A. Schmiegelow. 2002. *Evaluating resource selection functions*. Ecological Modelling 157:281-300.

Johnson, C.J., M.S. Boyce, R.L. Case, H.D. Cluff, R.J. Gau, A. Gunn, and R. Mulders. 2005. *Cumulative Effects of Human Developments of Arctic Wildlife*. Wildlife Monographs 160:1-36.

Larsen, F. W. and C. Rahbek. 2003. *Influence of scale on conservation priority setting – a test on African mammals*. Biodiversity and Conservation 12:599-614.

Wessels, K. J., B. Reyers, and A. S. Van Jaarsveld. 2000. *Incorporating land cover information into regional biodiversity assessments in South Africa*. Animal Conservation 3:67-79.

GAHCHO KUÉ PROJECT ENVIRONMENTAL IMPACT STATEMENT
INFORMATION REQUEST RESPONSES

Information Request Number: YKDFN 1.17

Source: Yellowknives Dene First Nation

Subject: Economic impact of reduced caribou availability (Section 7.7.2.2, 7.3.3.4)

EIS Section: Section 1: Caribou

Terms of Reference Section:

Preamble

The impact from the project on the caribou population (1.5%) and distribution will increase the costs and reduce the success rate of hunters. Given that there is no substitute for land users to access, this will have a real economic cost that the company needs to evaluate for the Parties to understand the potential for significant impacts.

On the one hand, the Environmental Impact Statement (EIS) states “Availability of caribou for human use is related to changes in the population’s size and distribution of caribou”, while on the other it suggests that the resulting impact will be negligible to low. When this is combined with the impacts already occurring, YKDFN is concerned that the impact will be significant over time. Research from the Beverly Qamanirjuaq Management Board has indicated that each caribou not harvested has an economic replacement cost of approximately $1000.

Given that the project is expected to have a low impact to the fecundity and population of the Bathurst, Beverly and Ahiak Caribou herds, this will have a clear and obvious impact on harvesting success. The EIS tends to downplay the impacts on caribou to the mines, giving credence to a small number of publications generally focusing on the Central Arctic Herd as their references to evaluate the impact of development on the herd. However, this does not conform with the widely held experiences of traditional land users – the traditional knowledge (TK) holders of the YKDFN strongly believe that the mines have complicated the natural cycle of caribou populations.

The company suggests that impacts from insects have a much larger potential impact on the population of the herd, which may be true. However, this is moot as it is the impacts from the mine the issue here – they will be additive to those of the environment.

Request

1) The company should prepare an analysis that quantifies the economic impact of lost harvesting opportunities and reduced hunting success.

2) The company should conduct population modelling showing the impact of this minesite on caribou populations. This work is essential – the imposition of harvesting restrictions on the YKDFN is, without question, a significant impact – and if this minesite, even with its 'low' magnitude impact, results in a delay of the herd recovery (even a delay of a small magnitude), then this is something that the Parties need to understand to evaluate this project.

Response

1. The 2010 Environmental Impact Statement (EIS) (De Beers 2010) predicts that the direct and indirect effects from the construction, operation, and closure of the Project will have a negligible to low influence on the population size and distribution of the Bathurst herd (De Beers 2010, Section 7.7.2.1, Table 7.7-2). These small changes in the abundance and distribution of caribou are predicted to have a negligible influence on the availability of animals for harvesting (De Beers 2010, Section 7.7.2.2, Table 7.7-3). The analysis and assessment of effects to caribou are applicable to all phases of the population cycle. In other words, harvest opportunities will be similar with or without the Project on the landscape relative to the natural fluctuations in caribou abundance and distribution that occur over decades. Therefore, the Project is expected to result in no economic impacts from lost harvesting opportunities.

2. The impact of the Gahcho Kué Project on the abundance and distribution of caribou was completed in the 2010 EIS (De Beers 2010). The assessment included independent analyses of habitat quantity and fragmentation, habitat quality, and changes in parturition rate from encounters with development and insects. The results from these analyses were used as inputs in the population model to predict the relative contribution of effects from human and natural factors on caribou. In summary, the Project is not expected to

result in direct mortality of animals, and changes in the local distribution of animals around the Project (from direct and indirect habitat effects) should not result in a detectable change in caribou distribution on their seasonal and annual ranges. The energetic model showed that the Project would decrease parturition rates by less than 1 percent (%). Population viability models predicted that the Project had no statistically significant influence on the abundance of the caribou herd relative to reference conditions (i.e., decrease in final projected abundance was 1.5%). No health effects to caribou or people wanting to harvest caribou for country food are predicted (De Beers 2010, Section 7.5.5.3). Overall, the Project is not expected to influence the recovery of the Bathurst herd or associated harvest levels.

It is emphasized in a number of locations in the 2010 EIS (De Beers 2010) that population modeling (viability analysis) was used to estimate the incremental effect from the Project, natural factors (insects, deep snow) and human activities (previous, existing, and future developments, and hunting) on the relative changes in population size and risks to caribou. The population models were not used to predict the number of caribou in 5 years, 10 years, or 30 years from now (De Beers 2010, Section 7.5.4), which is well beyond the scope of the 2010 EIS (De Beers 2010) and the Terms of Reference (GKP 2007).

References

De Beers (De Beers Canada Inc.). 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.

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

GAHCHO KUÉ PROJECT ENVIRONMENTAL IMPACT STATEMENT
INFORMATION REQUEST RESPONSES

Information Request Number: YKDFN 1.18

Source: Yellowknives Dene First Nation

Subject: Carnivore Input Data – Image Manipulation (Starting Section 11.10.4.2.1)

EIS Section: Section 1b: Carnivore Analysis

Terms of Reference Section:

Preamble

The machinations used to develop the basedata used in this analysis are unclear. According to the EIS, the 1km Land Cover of Canada was the starting product, which was then 'up-sampled' into 25m cells. It was again re-sampled into 200m cells. From the presentations at the workshop in November, it seems that this is incorrect for the Carnivore analysis and the basedata was derived from the West Kitikmeot Slave Study.

Secondly, the company states that "Visual inspections of the distribution of cover data in the areas that overlapped the SGP and Land Cover of Canada guided the reclassification process". What YKDFN is unclear about is just how a visual inspection guide the process considering that each of the starting cells contained in excess of a thousand cells from the SGP dataset?

If the product was generated from the Land Cover of Canada there should be almost no visual difference between starting and final product, but when compared to the 25m scale, a small areal sample from the SGP (i.e. WKSS Vegetation Classification) would have a large diversity relative to the working product which would be nearly uniform at large scales.

Request

1) The Proponent must provide clear reference to what basedata was used for this analysis, including links to obtain and appropriate metadata for the Landcover of Canada.

2) The Proponent should be required to clearly explain just what modifications were undertaken to 'prepare' the data prior to analysis. If the wildlife analyses were completed on the 1km Landcover dataset, then the EIS is clear, but

based on the presentations provided to Parties and some of the models that were run, it seems likely that alternative data was used and prepared for input into the analysis.

3) The Proponent should be clearly required to explain what computational limitations required different analysis techniques than in 2005. Given the rapid increase in computing power, providing data not directly comparable to previous results, should not have been an issue. Indeed, the proponent has provided analysis based on input data with less than 40 times the resolution.

4) The proponent should clearly explain why they altered the processing scheme employed by Johnson 2005 and how this process produced a better result – the Johnson project used the WKSS data, and a moving 3x3 window to scale the data rather than simple nearest neighbor re-sampling.

5) The proponent should provide a clear explanation as to why the WKSS or CCRS's 90m Landsat vegetation dataset were not used.

6) If the original dataset was the 1km Landcover of Canada (as stated on page 11.10-99), the proponent should provide a clear explanation as to why the same study area/boundary was selected as in Johnson. This seems a very artificial and irregular boundary and a new study area reflecting natural terrain or watersheds should be considered.

7) In addition to the completion of relative accuracy assessment amongst datasets, the proponent should undertake an accuracy assessment of the dataset used, utilizing the vegetation sites collected for the WKSS in addition with the vegetation plots that the company has collected for the Snap Lake and Gahcho Kue project (and any additional vegetation information available, perhaps via other industry or government projects). By comparing these sites to the vegetation classifications used in the modeling work, the Parties will have an actual assessment to gauge the applicability of this data for the manner with which it is used in the sophisticated analyses undertaken.

8) The company should provide a discussion on the applicability of deriving fragmentation and edge statistics considering that they have affected both of these values through the re-sampling process.

9) The company should provide a discussion on the how the lack of resolution affects the "available resources" for the animals to choose from within the modeling effort and what this means when considering the models used – for example, if the rate of movement is very low, it is entirely conceivable that the animal wouldn't actually leave the original cell (1 km). This is critical in establishing the species selection preferences for different available habitats.

Response

1) The Atlas of Canada Landcover was used in the assessment. The database describes the distribution of land cover types across Canada, based on satellite data obtained in 1995. The land cover map contains 31 classes: 12 forest; 3 shrubland; 7 tundra/grasslands; 7 developed land types including cropland, mosaic and built-up areas; and 2 water cover types. This database is a product of images obtained in 1995 by the Advance Very High Resolution Radiometer (AVHRR) on board the NOAA-14 (National Oceanic Atmospheric Administration) satellite. The spatial resolution is about 1 kilometre square. Additional documentation can be found at: http://atlas.nrcan.gc.ca/site/english/maps/environment/land/landcover.

2) The above-mentioned land cover dataset was reclassified into "superclasses" as was done for the Matthews et al. (2001) classification that was used in Johnson et al. (2005). In brief, this was done by considering ecotype descriptions and similarities between land cover databases, as well as visual inspections for distributions of data in the areas that overlapped the Canada Landcover and the Matthews et al. (2002) classification for the Slave Geological Province. For example, the superclass "Heath Rock" in Johnson et al. (2005) included "Heath Boulder" and "Heath Bedrock", both of which were similar to "Bare Soil" and "Bedrock Tundra" in the Atlas of Canada Landcover, and thus, Bare Soil and Bedrock Tundra were classified as "Heath Rock" for the assessment.

The next steps for preparing the database for the assessment included the integration of an esker class (because one does not exist for the Canada Landcover), as well as the integrations of a novel and spatial human development database. Eskers were added by first re-sampling the raster images to a 25-metre (m) resolution, and then reclassifying cells that overlapped with esker features (obtained from 1:50,000 National Topographic System (NTS) topographic layers). Due to computational restrictions inherent to the spatial extent of the analysis being completed, the revised land cover (with the esker class) was re-sampled to 200 m. The development layer was then added in the same manner that eskers were included. All cells that intersected with human developments were classified according to the type of development. For example, all linear features were assigned a right-of-way (width) of 200 m. Similarly, the minimum radius for most developments (except exploration sites) was 200 m (12.6 hectares [ha]). A 500 m radius (78.5 ha) was used to delineate the area of physical and permanent disturbance for exploration sites. This approach contributed to an overestimation of effects from human developments on habitat.

3) There were inherent constraints to the work because of the spatial scale of the analyses, Environmental Impact Statement (EIS) scheduling, demands of other projects, and computer processing time required for the various scenarios (reference, 2000 baseline, 2006 baseline, 2010 baseline, application and future), species (Bathurst and Ahiak caribou herds, grizzly bear, wolverine, and wolf) and seasons (spring, summer, fall, and winter) that were included in the assessment. The approach used in the EIS produced confident and ecologically relevant impact predictions. The scale of the habitat assessments spanned approximately 300,000 square kilometres (km^2) for caribou and wolves, and 200,000 km^2 for grizzly bear and wolverine. The analysis of changes in landscape measures through different periods and degrees of development was completed at a scale of the seasonal ranges, and not necessarily smaller scale features such as rock outcrops or individual water bodies and wetlands (Johnson 1980).

4) Please see Response 2. Also, note that the nearest neighbour re-sampling method is a standard re-sampling method in Geographic Information System (GIS)-based habitat studies when there is a need for changing the resolution of a raster analysis. It is almost certain that this method was used at some

point in the study by Johnson et al. (2005) even though it is not explicitly stated in the paper. The general processing scheme for the assessment was similar to that executed in Johnson et al. (2005). Using the output from the reclassified dataset (see the related-process for this step in Response 2), patches of habitat per land cover type were identified such that each patch was a contiguous group of cells. Next, the proportional area of each patch relative to that available for the related habitat type in a seasonal range was determined (De Beers 2010, Section 7.5.3.2.1).

5) The Atlas of Canada Landcover was used so that the carnivore assessment in Section 11 (De Beers 2010) would be as consistent as possible with the caribou assessment in Section 7 (De Beers 2010). Use of one land cover is a robust approach from the perspective of maintaining a consistent and precise database (e.g., quality assurance and quality control). Furthermore, because the assessment approach emphasized relative changes, “pixel size” and/or ”classification type” will have limited influences on the outcome of the assessment. De Beers is not aware of any scientific literature that suggests that the assessment approach in the EIS is flawed. On the contrary, the approach in the EIS is consistent with the assessment methods being used by other agencies, for example, see Environment Canada’s “Scientific Assessment to Inform the Identification of Critical Habitat for Woodland Caribou, Boreal Population, in Canada” (EC 2011). Other spatially extensive analyses in the scientific literature that are similar to that undertaken for the carnivore assessment typically include resolutions of 100 km^2 or greater (e.g., Wessells et al. 2000; Larsen and Rahbek 2003) and would consider the 1-km^2 resolution applied in the EIS as a fine-scale resolution assessment.

6) The effects study area (i.e., Slave Geological Province [SGP]) used in the EIS represents an appropriate approach for meeting the Terms of Reference and completing the assessment for grizzly bear and wolverine for the following reasons.

- The area (and portion of the population) has experienced the largest rate and spatial extent of development in the Northwest Territories (NWT) and Nunavut, and therefore represents the most conservative (i.e., maximum effects) and appropriate spatial boundary for assessing cumulative effects on the population.

- Habitat selection and resource selection functions have been determined for the area (McLoughlin et al. 2002; Johnson et al. 2005).
- The area includes most of the study area used to determine carnivore abundance and demographic rates (e.g., McLoughlin et al. 2003; Boulanger and Mulders 2007).
- Using a larger area would have captured more natural ecological land cover types in the analysis, but would have also diluted the effects assessment because of the much lower ratio of human development to non-disturbed landscape outside of the SGP. De Beers contends that the study area used in the assessment for grizzly bear and wolverine was appropriate to meet the Terms of Reference, and provides the most confident and ecologically relevant impact predictions.

7) Tests suggested by the reviewer are not required given the rationale provided in Responses 3 and 5, and the response to Information Requests YKDFN 1.15 and 1.16.

   A comparison was completed on the cover composition between the classifications for two, 100 by 100 km areas of the SGP, one of which was between the Gahcho Kue Project and the Ekati-Diavik mine complex, and the other west of this area, closer to the treeline (Figure YKDFN 1.18-1). Differences are summarized Table YKDFN 1.18-1). In brief, the Atlas of Canada Landcover comprised more forest cover and heath tundra, but less heath rock, sedge, and water cover than that in the Matthews et al. (2001) classification. However, because the assessment approach emphasized relative changes, “classification type” should have limited influences on the amount of change in landscape measurement endpoints (e.g., habitat quantity and fragmentation, and habitat quality). In other words, the classification of the magnitude of impacts should be similar if another landscape classification is used.

Further, there is no reason to believe that the assessment outcome will change with additional effects testing given the low level of habitat that has been converted to development footprints within the seasonal ranges of carnivores. For example, the proportion of the landscape that has been converted to development footprint is less than 3% per seasonal range (De Beers 2010, Section 11.10.4). Thus, the reported levels of habitat loss within the assessment study areas are well below the 20% screening value that was used to identify potential significant effects in the residual impact classification of the EIS (e.g., De Beers 2010, Section 11.10.7).

Table YKDFN 1.18-1 Composition (% relative abundance) of Atlas of Landcover versus the Matthews et al. (2001) Classification for Two, 100 x 100 km Regions of the Slave Geological Province

Gahcho Kué Sample Area Cover Types	Canada Landcover (%)	Matthews et al. (%)	Wekweéti Sample Area Cover Types	Canada Landcover (%)	Mathews et al. (%)
Burn Old	0.1	0.0	Burn Old	0.2	1.1
Burn Young	0.0	0.0	Burn Young	0.0	0.4
Esker	1.3	0.4	Esker	2.1	1.9
Forest	16.2	0.9	Forest	39.0	10.5
Heath Rock	0.0	12.9	Heath Rock	0.1	12.6
Heath Tundra	46.2	30.9	Heath Tundra	44.2	20.1
Lichen Veneer	0.0	1.9	Lichen Veneer	0.0	8.9
Low Shrub	0.0	1.5	Low Shrub	0.0	3.4
Peatbog	0.0	0.0	Peatbog	0.0	3.0
Riparian	6.9	0.5	Riparian	2.3	1.7
Rock	4.9	3.1	Rock	3.5	3.3
Sedge	1.7	13.3	Sedge	0.1	6.5
Water	22.7	33.0	Water	8.5	24.9

8) The fragmentation analysis and the land cover database used in the EIS provide ecological relevance and rigor for the spatial scale of the assessment (i.e., at the seasonal range). Data processing and preparation steps for the land cover database are described in Response 2. Again, a detailed development layer was added to the revised and re-sampled (200-m cell size) Canada Landcover. Cells were then re-classified as certain types of

development when they overlapped with the development layer (which included polygons such as mine footprints and polylines such as winter roads, all season roads and transmission corridors). This approach contributed to an overestimation of effects from human developments on habitat. For example, all linear features were assigned a right-of-way (width) of 200 m because of the 200-m cell size applied to the land cover classification. It should be recognized that the development database has been an important stand-alone contribution for cumulative effects assessment in the north.

9) Please see Responses 3, 5 and 7. To provide some context with respect the land cover resolution and movement rate of species, data used in the EIS calculated an average movement rate for caribou at 9 km per day during the summer to autumn period (De Beers 2010, Section 7.5.3.2.2, page 7-119). Gunn et al. (2002) calculated similar daily movement rates during the summer period and about 2 to 3 km per day for the late winter (January to April). Daily movement rates for female and male grizzly bears varied from 4 to 12 km day from the spring to autumn seasons (McLoughlin et al. 1999).

Please also see response to Information Requests YKDFN_1.15 and YKDFN_1.16, which are similar to this information request

References

Boulanger, J. and R. Mulders. 2007. *Analysis of 2005 and 2006 Wolverine DNA Mark-recapture Sampling at Daring Lake, Ekati, Diavik, and Kennady Lake, Northwest Territories.* Draft Report prepared for Environment and Natural Resources, Government of the Northwest Territories by Integrated Ecological Research.

De Beers (De Beers Canada Inc.). 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.

EC (Environment Canada) 2011. *Scientific assessment to inform the identification of critical habitat for woodland caribou (Rangifer tarandus caribou), Boreal population, in Canad: 2011 update.* Ottawa, Ontario, Canada. 102 pp. Plus appendices.

Gunn, A., J. Dragon, and J. Boulanger. 2002. *Seasonal movements of satellite-collared caribou from the Bathurst herd.* Final Report to the West Kitikmeot Slave Study Society.

Johnson, D.H. 1980. *The comparison of usage and availability measurements for evaluating resource preference.* Ecology 61:65-71.

Johnson, C.J., M.S. Boyce, R.L. Case, H.D. Cluff, R.J. Gau, A. Gunn, and R. Mulders. 2005. *Cumulative Effects of Human Developments of Arctic Wildlife.* Wildlife Monographs 160:1-36.

Larsen, F. W. And C. Rahbek. 2003. *Influence of scale on conservation priority setting – a test on African mammals.* Biodiversity and Conservation 12:599-614.

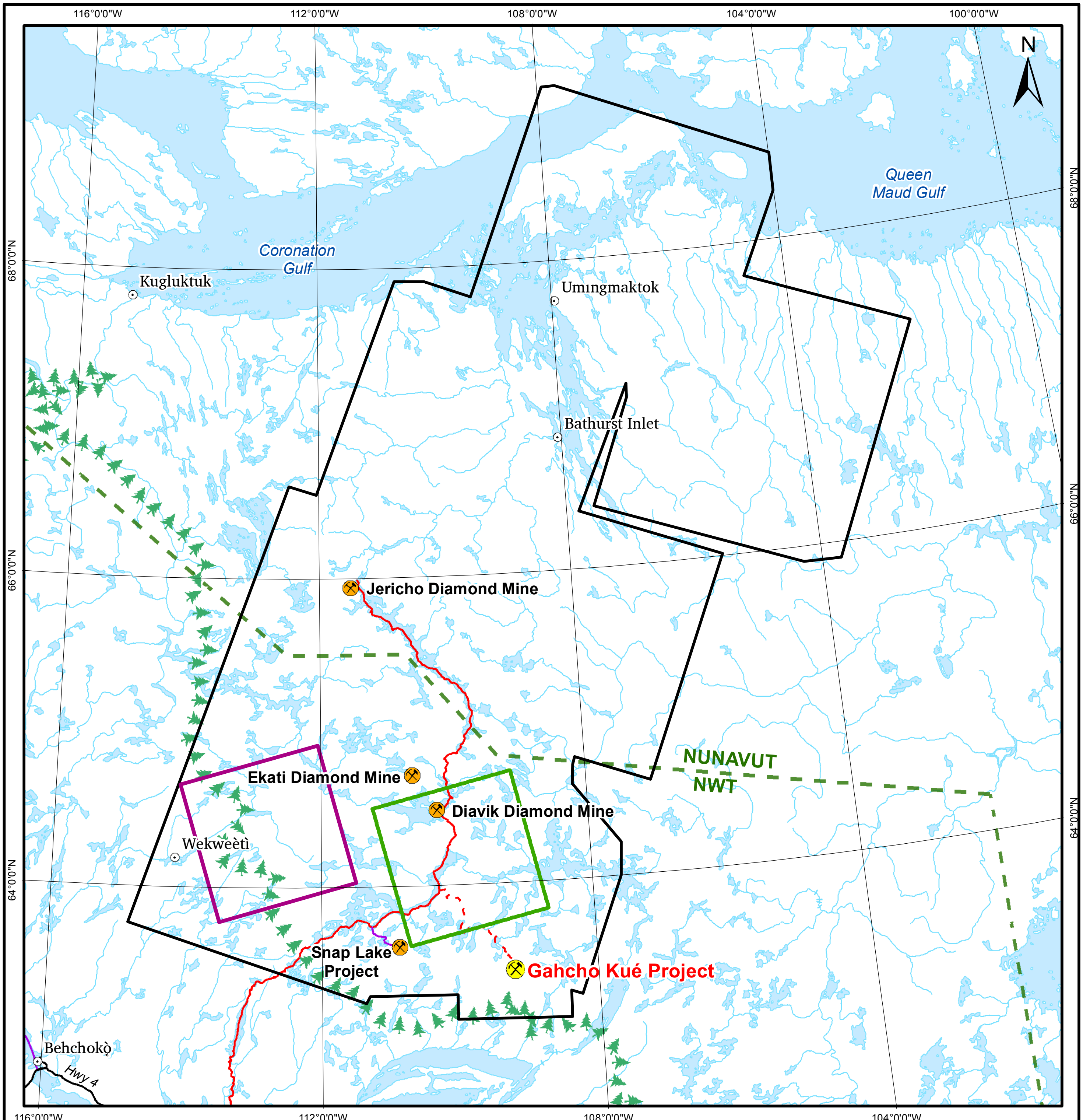
Matthews, S., H. Epp, and G. Smith. 2001. *Vegetation Classification for the West Kitikmeot/Slave Study Region.* Final Report to West Kitikmeot/Slave Study Society. Yellowknife, NWT.

McLoughlin, P.D., R.L. Case, R.J. Gau, S.H. Ferguson, and F. Messier. 1999. *Annual and seasonal movement patterns of barren-ground grizzly bears in the central Northwest Territories.* Ursus 11: 79-86.

McLoughlin, P.D., R.L. Case, R.J. Gau, H.D. Cluff, R. Mulders, and F. Messier. 2002. *Hierarchical habitat selection of barren-ground grizzly bears in the central Canadian Arctic.* Oecologia 132:102-108.

McLoughlin, P.D., K.M. Taylor, H.D. Cluff, R.J. Gau, R. Mulders, R.L. Case, S. Boutin, and F. Messier. 2003. *Demography of Barren-ground Grizzly Bears.* Canadian Journal of Zoology 81: 294-301.

Wessels, K. J., B. Reyers, and A. S. Van Jaarsveld. 2000. *Incorporating land cover information into regional biodiversity assessments in South Africa.* Animal Conservation 3:67-79.



LEGEND

- Gahcho Kué Project
- Existing Mine
- Territorial Capital
- Populated Place
- Highway
- Existing Winter Road
- Tibbitt-to-Contwoyto Winter Road
- Winter Access Road
- Watercourse
- Waterbody
- Treeline
- Territorial/Provincial Boundary
- Slave Geological Province
- Gahcho Kué Sample Area
- Wekweéti Sample Area

NOTES
Base data source: The Atlas of Canada

GAHCHO KUÉ PROJECT

Sample Areas (100 by 100 km) for Comparing Atlas of Canada Land Cover Versus Matthews et al. (2001) Classification in the Slave Geological Province

PROJECTION:	DATUM:
Canadian Lambert Conf. Conic	NAD83

Scale: 1:4,000,000
50 25 0 50
Kilometres

DE BEERS CANADA

FILE No:	DATE:
IR-Wild-007-GIS	April 5, 2012

JOB NO:	REVISION NO:
11-1365-0001	1

OFFICE:	DRAWN:	CHECK:
GOLD-SAS	JRC	JV

Figure YKDFN_1.18-1

G:\2011\1365\11-1365-0001 Gahcho Kue EIS Post-Submission\Mapping\MXD\Wildlife\IR-Wild-007-GIS.mxd

GAHCHO KUÉ PROJECT ENVIRONMENTAL IMPACT STATEMENT
INFORMATION REQUEST RESPONSES

Information Request Number: YKDFN 1.19

Source: Yellowknives Dene First Nation

Subject: Carnivore Input Data – Endpoint prediction utility (Section 11.10.4, 11.10.5, 11.10.6, 11.10.7 and 11.10.9)

EIS Section: Section 1b: Carnivore Analysis

Terms of Reference Section:

Preamble

While the EIS referenced using the Landcover of Canada dataset, the presentations in November (see slide 7 of Terrestrial presentation) referenced the Slave Geologic Province and the availability of high-resolution data. Data derived from 1km cells cannot be considered high resolution by any reasonable person, regardless of the degree of ‘up-sampling’ applied – you cannot derive additional resolution. Thus, it seems that the proponent utilized the SGP/WKSS dataset and the remainder of this information request is based on this assumption. The example provided by the proponent on slide 13 seems to confirm this – the 0-1km zone seems to have approximately 15-20 cells as the displayed scale (likely not 1:1). Lastly, in reviewing the Johnson 2004 and 2005 references (which the proponent is reproducing), the basedata used was the WKSS data.

The sections referenced outline numerous analyses that the proponent undertook, but there is no certainty that the basedata being utilized is credible and has sufficient rigor to be used in this way (this is true for either the LCC or the SGP/WKSS data).

Section 11.10.9 discusses uncertainty with the analysis and predictions that are made with regards to carnivores. However, at no point does the document discuss the fact that all of the assumptions based on models derived from the vegetation classification are highly suspect. When using analysis techniques such as fragmentation and habitat suitability, then the input data must have a high degree of certainty else the outputs, despite being subjected to complex modifications, are inherently of no value. The common expression for this type of situation is “GIGO” – Garbage In, Garbage Out.

This issue was raised at the session held at the Prince of Wales Northern Heritage Centre, but the proponent discounted the concern, suggesting that errors were systematic and did not affect the analysis. YKDFN strongly disagree – obviously the error is not systematic between the images as each scene is classified separately (and each has its own error values attached). It is not 'a wash' where all other things are equal – these errors matter - if the data feeding into the model is not correctly classified, then any conclusions reached on the impacts to habitat use and quality is effectively incorrect almost half the time.

In item 7 of the November 23rd response from the proponents consultant, the company suggests that this product was validated by a 'qualitative visual assessment'. While it certainly helps to confirm that the results make sense, this is not an applicable validation by itself. The mosaic in question is many thousands of pixels and the product that it was compared against was of a different resolution (with 1km cells vs. 25/30m) – thus each cell on the validation product would contain over a thousand cells to be compared – the variation seen, both correctly captured and erroneous, could not be 'validated'. This visual inspection also seems to have been used for the reclassification of other datasets, but again, it was unclear what the process entailed or if there was any tools used to evaluate the correctness of the final product.

The sophisticated models that the proponent employs (i.e. Habitat Suitability) rely on the relationship between site selection of a particular vegetation class and the types of habitats available that were not selected – these values inform sections 11.10.4.3 onwards and YKDFN feel that all results after this point are invalid until the input data can be appropriately verified. The dataset forming the foundation for this section – the West Kitikmeot Slave Study Vegetation Study from Matthews et al (2001) – has significant deficiencies that make it inappropriate for continued use without improvement.

The accuracy matrix (taken from Matthews et al. 2001) for the 8 scenes that form the mosaic which the proponent used are as follows:

Scene	Producer's Accuracy	User's Accuracy	Overall Accuracy
45-15	66	68	67
44-14	59	58	55
46-14	60	59	60
43-13	63	65	65
45-12	49	52	51
46-13	57	60	60
44-15	76	85	82
46-15	68	74	68

While these values all mean slightly different things, what should be clear is that the data is very uncertain and falls below commonly accepted benchmarks for usability (with the probable exception of scene 44-15). Image classification does not have a hard standard for acceptability, but the general rule of thumb and widespread best practice is to seek an accuracy exceeding 85% prior to use. As such, it is not clear if this dataset can provide sufficient predictive value to be used in these types of analysis.

Request

1) The products derived from this basedata should be re-evaluated for utility. If the original dataset cannot be improved, the subsequent analyses performed on the dataset should be ignored.

2) If the base data was not derived from WKSS data, the proponent should still consider if the principle assumption – that correctly represents the natural world - is valid. In this light, the applicability of the analyses and products produced here should be discussed.

3) If the WKSS data was used, the Proponent should prepare a summary for each scene in the SGP/WKSS Vegetation Classification that takes a series of proportionate (to the occurrence within the study area) random sample from the final working dataset. Each of these samples should be used to extract the habitat values (cross tabs) from the SGP/WKSS data to create a proportional table allowing parties to evaluate the general accuracy of the

final sub-sampled result from the Land Cover Classification of Canada. The result should be evaluated against the visual inspection which was completed.

Response

1. A comprehensive discussion of the rationale for not completing additional tests and/or evaluations is provided in the responses to Information Requests YKDFN_1.15, YKDFN_1.16, and YKDFN 1.18. In summary, the analysis of changes in habitat quantity and fragmentation, and habitat quality through different periods of time and degrees of development was completed at a scale of the seasonal ranges. Given the daily and seasonal movement rates of caribou and carnivores relative to the resolution of the land cover used, the assessment was appropriate meet the Terms of Reference, and provides confident and ecologically relevant impact predictions. Further, the classification of impacts and determination of significance is not expected to change given the low level of development within the seasonal ranges of caribou and carnivores.

2. The database was a modified classification from the Atlas of Canada Landcover, and the rationale for using this land cover is provided in the responses to Information Requests YKDFN_1.15, YKDFN_1.16, and YKDFN 1.18.

3. The land cover was not derived from the “WKSS data” - refer to responses to Information Requests YKDFN_1.15, YKDFN_1.16, and YKDFN 1.18.

Information Request Number: YKDFN 2.20

Source: Yellowknives Dene First Nation

Subject: Water Chemistry Pathways

EIS Section: Section 2: Fish and Water

Terms of Reference Section:

Preamble

From section 8.6 & 9.6 it is clear that some of the more substantive effects pathways (related to water chemistry) that are screened out of the assessment include the following;

- Erosion and entrainment of lake sediments in Area 3 and 5 due to continual alterations in water elevation during operations, increased shoreline erosion and re-suspension of bottom sediments caused by dewatering of Areas 1, 2, 4, 6 and 7 during construction, and refilling of Kennady Lake during closure.
- Removal of groundwater from the open pits and subsequent increases of surface flows and alterations in water chemistry.
- Development of seepage from rock piles and tailings areas.

These pathways have the potential to significantly affect surface flows and/or water chemistry. Effects may include; temporary and permanent loss of fish habitat in littoral and lotic environments, reduction in water quality including general and widespread increases in TSS, increases in acidity, increases in salinity, hardness and nutrients, and both upstream and downstream alterations in water quantity.

Request

These are among the central effects of the project and require clear, comprehensive statements on their potential effects. Specific criteria for continued discharge from the Water Management Pond are required for Parties to properly evaluate the likely magnitude of impacts to the local and regional watershed. YKDFN request that the proponent provide sufficient information to allow Parties and the Board to evaluate significance of impacts from water chemistry changes.

Response

A discussion relating to the three bullets above is provided below, as well as a response regarding discharge criteria.

A key component in the mine plan is to isolate Areas 2 to 7 of Kennady Lake and their drainage basins to establish a controlled area so that the three diamond-bearing kimberlite pipes, located under the lake bed in Kennady Lake, can be mined. This is achieved through the diversion of the upper B, D, and E watersheds to the N watershed and the A watershed to Area 8, and the construction of Dyke A to separate Area 7 from Area 8. These activities allow the dewatering of Areas 2 through 7 of Kennady Lake while maintaining habitat within Area 8, as well as the lakes within the upper watersheds. The controlled area represents the region from which all Project operations will be conducted, and allows De Beers to most importantly manage the mine footprint and water inflows and outflows, so that the environment outside of this area can be protected.

For the re-suspension of lake bottom sediments in Areas 3 and 5, the 2011 EIS Update (De Beers 2011) does not provide a description of the conditions in Areas 2 to 7 during construction and operations, particularly the water management pond (Areas 3 and 5), as the conditions would not have any effects on assessment endpoints during the operations period. Fish will also be removed during the fish salvage prior to, and during dewatering, and will not be present during mine operations. Therefore, water and sediment quality conditions in Areas 2 to 5 following the initial dewatering were not assessed as part of the EIS, nor were fish and fish habitat, because conditions in these areas will not be suitable to support a fish community.

During operations, Areas 6 and 7 will be completely dewatered and Areas 2 through 5 will be partially dewatered. Areas 2 to 5 will be dewatered to the maximum extent possible; i.e., until total suspended solids (TSS) in the Kennady

Lake water increases to a level that no longer meets the regulatory requirement for the discharge quality. However, it is estimated that a 2 to 3 metre (m) drawdown can be achieved before suspension of lake-bottom sediments would result in TSS levels that are too high to discharge to Lake N11. If possible, the water level will be drawn down further.

Effects analysis during construction and operation as a result of Project activities were limited to downstream waters, e.g., those lakes that received dewatering and operational discharges (i.e., Lake N11 and Area 8). This included effects to flows, water levels and channel/bank stability, water quality and aquatic health:

- An assessment of the potential effects of dewatering Kennady Lake and the watershed diversions to flows, water levels and channel/bank stability to lakes the N watershed and Area 8 is provided in Sections 9.7.3.1, 9.7.3.2, and 8.7.3.2, respectively, in the 2011 EIS Update (De Beers 2011). The assessment concluded that changes to the flow regime in downstream waters are not expected to cause adverse effects on channel or bank stability or erosion, as flow increases will be small relative to the existing flow regime.

- An assessment of effects to water quality and aquatic health in Area 8 and downstream lakes (e.g., Lake N11) due to the dewatering and operational discharge is provided in Sections 8.9.3.2 and 9.9.3.1 in the 2011 EIS Update (De Beers 2011). This assessment required water quality modelling to include the areas within the isolated Kennady Lake, taking account of key water quality constituents present in the water management pond during the operational period. The assessment concluded that changes to water quality in downstream lakes are not expected to result in adverse effects on aquatic health.

Additionally, potential effects from dewatering and operational discharge from Kennady Lake to Lake N11 and Area 8 will be mitigated by regulatory requirements, i.e., discharge criteria that will likely include TSS. As described in Section 3.9.3 of the 2012 EIS Supplement (De Beers 2012), dewatering discharge will be sampled regularly to monitor for compliance with TSS discharge limits to be specified by the Mackenzie Valley Land and Water Board in the water license, which will be required before the Project can operate.

At closure, the potential effects of pumping water from Lake N11 to Kennady Lake for refilling to water quality, sediment quality and aquatic health in Kennady Lake were assessed in Section 8.6.2.7 of the 2011 EIS Update. It is expected that the water quality of the water pumped from Lake N11 to supplement the Kennady Lake refilling will be similar to that measured in Kennady Lake during pre-development conditions. Pumping water from Lake N11 to supplement refilling will result in dilution of the water retained in Areas 3 and 5, and Kennady Lake; this change is positive, and as a result, residual effects to water quality from the pumping of supplemental water from Lake N11 are predicted to be negligible.

Since the submission of the 2011 EIS Update (De Beers 2011), supplemental modelling of TSS during the dewatering of Kennady Lake (i.e., Areas 3 and 5) has been conducted for the 2012 EIS Supplement (De Beers 2012). This modelling provides supporting information regarding the conditions in the water management pond during operations by evaluating the potential for sediment resuspension as a result of the dewatering, the extent of the increase in TSS concentrations, and the particular climatic conditions (i.e., wind direction, intensity, and frequency) that exacerbates TSS conditions within the drawn down Areas 3 and 5. A summary of the modelling results is provided in IR Response YKDFN_2.30.

Groundwater from the open pits and runoff and seepage from the processed kimberlite (PK) and mine rock storage facilities are included in the water quality assessment and incorporated as input source terms in the water quality model. This modelling provided a simulation of the changes to water chemistry in the water management pond during operations.

In order to undertake an assessment of effects to water quality in the receiving waters, comprehensive water quality modelling of the water management pond is required during dewatering and operations. Water quality within the water management pond during operations was derived using a flow and mass-balance water quality model, developed in GoldSim^{TM}, for a range of water chemistry parameters. This model accounted for the operational water balance within the controlled area, which included natural evaporation and precipitation, mine-contact and non-contact runoff, seepage, water transfers between areas (including groundwater inflows to the pits), and water recycled from the water management pond and the processing plant.

For each of these flows, a chemistry was assigned based on the source of the water: groundwater flows, natural runoff, and water that comes into contact with waste rock material (i.e., PK or mine rock). The chemistry assigned to these sources was based on baseline information or geochemical testing. Further information on the water quality modelling is provided in Appendix 8.I, Section 8 of the 2011 EIS Update (De Beers 2011). These source terms were updated in the 2012 EIS Supplement (De Beers 2012) based on ongoing and supplemental geochemical testing. A description of the most recent selected source term water chemistry for coarse and fine PK and mine rock is provided in the modelling report provided in Appendix 8.II of the 2012 EIS Supplement (De Beers 2012).

The modelling provides a sound basis to evaluate the chemistry of water that will establish within the water management pond during operations, so as to reliably project the chemistry of receiving waters in Lake N11 and downstream waters as a result of dewatering and operational discharge. This has allowed De Beers to make a determination that the Project is not expected to result in significant adverse effects to aquatic health.

De Beers recognizes that water quality predictions should not be used to predict absolute concentrations, but be used to provide an informed assessment of effects, and also as a planning tool and to develop monitoring plans (Appendix 8.I, Attachment 8.I.5; De Beers 2011). It is important to note that water quality modelling is based on inputs that have inherent variability and uncertainty, so conservative assumptions were used in the assessment to provide confidence that changes to water quality will not be worse than projected. It is anticipated that water quality in the controlled area (e.g., water management pond) and receiving waters will be monitored during operations to compare to

EIS predictions. If it is identified that the quality is worse than predictions, adaptive management strategies will be triggered to address the problem.

With respect to developing criteria for discharge, the development of water quality criteria objectives for the Project was not a requirement of the Terms of Reference (Gahcho Kué Panel 2007), and is typically addressed as part of the Water License Application and Approval Process. However, De Beers acknowledges the importance and benefit of setting water quality benchmarks, which will be used for the effects level evaluation for the receiving aquatic environment. There is also added benefit to undergo this process early in the Project review phase, and De Beers is currently developing these benchmarks for downstream lakes (e.g., Lake N11) during operations, and Kennady Lake in closure and post-closure It is planned that an initial iteration of proposed benchmarks and rationale will be prepared as a technical memorandum to the Mackenzie Valley Environmental Impact Review Board (MVEIRB) in 2012, which will form the basis for detailed consultation with government agencies and communities.

References

De Beers (De Beers Canada Inc.). 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. 2012. Environmental Impact Statement Supplemental Information Submission for the Gahcho Kué Project. Submitted to the Mackenzie Valley Environmental Impact Review Board. April 2012.

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

April 2012

GAHCHO KUÉ PROJECT ENVIRONMENTAL IMPACT STATEMENT
INFORMATION REQUEST RESPONSES

Information Request Number: YKDFN_2.21

Source: EIS Section: Annex J, Section J3-3

Subject: Bathymetry

EIS Section: 9.7.1.1

Preamble

There are bathymetric profiles and/or maps that have been developed for many of the lakes found within the study area. However, none of the maps contain area & volume data. These data are important for understanding the potential effects of alterations in water quantity associated with the project, for understanding the amount of fish habitat that is currently available, and for understanding how the amount of habitat might change if water levels are altered.

Request

To address this uncertainty, YKDFN request the company provide area & volume data were provided for all bathymetric maps.

Response

All bathymetry data collected during the 2010 and 2011 field seasons were presented in the 2010 Environmental Impact Statement (EIS) (De Beers 2010) and the 2011 EIS Update (De Beers 2011) baseline documents.

Bathymetry data collected during the 2010 open water season are presented in Section HH3.6 (De Beers 2010, Addendum HH). Calculated volumes and the water level surveys are presented in Table HH3-14. Bathymetry maps for each lake are presented in Addendum HH, Appendix HH.III (De Beers 2010).

Bathymetry data collected during the 2011 open water season are presented in Section 3.6 of the 2011 Climate and Hydrology Supplemental Monitoring repost (Golder 2012). Calculated volumes for each lake are presented in Table 16 and bathymetry maps for each lake are shown in Appendix E of the report (Golder 2012).

Volume data were extracted from the above documents and supplemented by corresponding areas, and presented below in Table YKDFN_2.21-1. Bathymetry data were not collected for Lake N16.

Table YKDFN_2.21-1 Lake Areas and Volumes Calculated from Measured Bathymetry

Lake Name	Date	Area [km^2]	Volume [m^3][(a)]
Lake A3	20 Jul 2010	0.238	1,110,000
Lake B1	22 Jul 2011	0.084	145,000
Lake B2	22 Jul 2011	0.066	59,700
Lake D10	21 Jul 2010	0.047	41,100
Lake D2	21 Jul 2010	0.125	65,400
Lake D3	25 Jul 2010	0.384	566,000
Lake D5	22 Jul 2010	0.014	6,180
Lake D7	23 Jul 2011	0.376	578,000
Lake E1	19 Jul 2010	0.210	290,000
Lake E2	22 Jul 2011	0.029	15,700
Lake E3	22 Jul 2011	0.011	4,390
Lake F1	19 Jul 2011	0.043	59,500
Lake G1	19 Jul 2011	0.027	20,300
Lake G2	19 Jul 2011	0.054	87,100
Lake H1a	18 Jul 2011	0.030	27,200
Lake H1b	18 Jul 2011	0.028	39,800
Lake I1	18 Jul 2011	0.130	498,000
Lake I2	18 Jul 2011	0.020	9,740
Lake J1	17 Jul 2011	0.491	679,000
Lake L2	17 Jul 2010	0.110	136,000
Lake L3	17 Jul 2010	0.036	21,400
Lake L13	17 Jul 2010	0.031	17,900
Lake M2	19 Aug 2010	0.308	631,000
Lake M3	19 Aug 2010	0.882	2,300,000
Lake M4	14 Aug 2010	0.807	3,880,000
Lake N1	18 Aug 2010	3.88	12,200,000
Lake N7	19 Jul 2010	0.051	48,200
Lake N11	16 Jul 2010	5.40	18,000,000
Lake N14	19 Jul 2010	0.219	278,000
Lake N14a	22 Jul 2010	0.034	41,800
Lake N14b	21 Jul 2010	0.020	8,990
Lake N17 (northeast embayment)	24 Jul 2010	0.891	2,990,000
Lake 410	20 Aug 2010	5.71	13,000,000
Kirk Lake (south embayment)	16 Aug 2010	9.68	19,300,000

[(a)] Volumes on the day of survey, as presented on bathymetry figures.

m^3 = cubic metres; km^2 = square kilometres.

References

De Beers (De Beers Canada Inc.). 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.

Golder (Golder Associates Ltd.). 2012. 2011 Climate and Hydrology Supplemental Monitoring Report. Report No. 11-1365-0001/DCN-049. Submitted to Mackenzie Valley Environmental Impact Review Board. March 2010.

April 2012

GAHCHO KUÉ PROJECT ENVIRONMENTAL IMPACT STATEMENT
INFORMATION REQUEST RESPONSES

Information Request Number: YKDFN 2.22

Source: Yellowknives Dene First Nation

Subject: Length and Weight for Fish (Addendum JJ, Table JJ.II-4, p. JJ.II-5; Annex J, Appendix J.I, Table J.I-57, Table J.I-58, Table J.I-82)

EIS Section: Section 2: Fish and Water

Terms of Reference Section:

Preamble

Length and weight measurements for fish provide the basis for understanding and comparing current and future fish condition. The condition of fish is one of the most important indicators of the health and productivity of an aquatic ecosystem, and is a parameter that can be used to indicate an alteration in ecosystem health. Fish length and weight have been measured for hundreds of fish and for several different species found within the study area.

The length/weight dataset is not complete (Lake Trout data for 2004 only, and one set of Slimy Sculpin data). This makes it impossible to check or recalculate the existing length/weight formula, reduces the ability to increase the data set in future years and will make it difficult to update and recalculate the fish condition formulae as additional data are collected.

Request

1) To ensure that future efforts can be used to strengthen and update current understanding, YKDFN request the proponent compile all length/weight measurements for fish into a database (including all years, not just 2004).

2) YKDFN request that the proponent compile all log length/log weight formulas into one table and to refine these formulae by developing Standard Weight equations (Murphy et al, 1990) for as many species as possible (See IR 2.4 below - Species List), but particularly for Lake Trout, Arctic Grayling and Slimy Sculpin. The Standard Weight equations could then be used to develop an understanding of Relative Weight for as many species as possible, for as many lakes as possible, and for as many times as possible.

Response

Data for this response was collated from the following sources: Canamera (1998), Jacques Whitford (2003, 2004), EBA and Jacques Whitford (2001), De Beers (2010), and Golder (2012).

1) The length and weight measurements for recorded fishes are available in a Microsoft Excel worksheet (GK Fish Life History 1996-2011March2012.xlsx). This file is provided on CD.

2) Standard log$_{10}$length (g) - log$_{10}$weight (mm) regressions were calculated for all species in Microsoft Excel. The coefficients for the regression formulas are located in Table YKDFN_2.22-1. Regressions were completed for all species by watershed, basin, and site, when sample size was equal to or greater than 10 ($n \geq 10$). For basins B, E, I, P, Lake 410, and Kirk Lake there were data from only one site in the basin (i.e., the regression was calculated using data from one site). For all other basins, measurement data from fish captured at all sites were used to calculate the regression.

Table YKDFN_2.22-1: Coefficients and Model Fit for the Log$_{10}$length (mm)-log$_{10}$weight (g) Regression Formulas for all Species Recorded in the Project Study Area, 1996-2011

Species Common Name (Scientific Name)	Watershed	Basin	Site	log length - log weight coefficients and r^2			*n*	Comments
				Intercept	Slope	r^2		
Arctic grayling (*Thymallus arcticus*)	All	All	All	-5.09	3.06	1.00	511	
	Kennady Lake	All	All	-5.16	3.09	0.98	161	
		A	All	-5.61	3.29	0.98	20	
			A1[a]	-5.66	3.30	0.99	12	
		B	B1[a]	-4.88	2.99	0.90	12	
		I	I1	-5.17	3.10	0.67	7	
		K[b]	All	-4.95	3.01	0.98	120	
			K1[a]	-5.30	3.14	0.99	22	
			K3[a]	-4.40	2.78	0.99	15	
			K4	-5.16	3.11	0.99	10	one small fish
			K5[a]	-5.17	3.09	0.97	67	
	Downstream of Kennady Lake	All	All	-5.20	3.11	0.99	133	
		L	All	-5.16	3.10	0.99	118	
			L1a[a]	-5.11	3.07	1.00	49	
			L2[a]	-5.06	3.04	0.99	39	
			L21	-3.83	2.57	0.92	18	no small fish
		M	All	-5.28	3.14	0.99	11	

Species Common Name (Scientific Name)	Watershed	Basin	Site	log length - log weight coefficients and r^2			*n*	Comments
				Intercept	Slope	r^2		
Arctic grayling (Thymallus arcticus) (continued)	N	N	All	-5.06	3.05	1.00	217	
			N2[(a)]	-5.43	3.20	1.00	14	
			N3[(a)]	-5.06	3.04	0.99	58	
			N4[(a)]	-4.91	2.97	0.97	62	
			N6[(a)]	-4.68	2.87	1.00	25	
			N12	-5.10	3.08	1.00	12	one small fish
			N14	-5.51	3.25	0.99	18	one small fish
			N18[(a)]	-5.13	3.10	0.99	18	
Burbot (*Lota lota*)	All	All	All	-5.02	2.92	0.99	123	
	Kennady Lake	All	All	-4.85	2.83	0.98	14	
		K	All	-4.91	2.86	0.99	10	
	Downstream of Kennady Lake	All	All	-4.94	2.88	0.98	23	
		L	All	-5.96	3.36	0.99	11	
		M	All	-4.11	2.46	0.95	8	
	N	N	All	-5.10	2.96	0.99	84	
			N4	-5.38	3.09	0.98	15	one large fish
			N11	-4.90	2.85	0.95	11	one small fish
Cisco (*Coregonus artedi*)	All	All	All	-5.52	3.25	0.97	95	
	Downstream of Kennady Lake	All	All	-5.03	3.04	0.89	60	
		410	410	-4.45	2.80	0.91	23	
		M	All	-5.73	3.34	0.89	37	
			M4	-4.95	3.00	0.90	35	no small fish
	N	N	N16	-5.68	3.30	0.99	35	
Lake chub (*Couesius plumbeus*)	All	All	All	-5.24	3.14	0.97	584	
	Kennady Lake	All	All	-4.35	2.69	0.96	22	
		K	All	-4.27	2.65	0.96	20	
	Downstream of Kennady Lake	All	All	-4.48	2.78	0.89	12	
	N	N	All	-5.28	3.16	0.97	550	
			N2	-5.30	3.16	0.97	45	
			N3	-5.09	3.09	0.92	27	
			N4	-4.93	2.99	0.99	55	
			N5	-4.87	2.96	0.98	35	
			N6	-5.42	3.23	0.94	108	
			N11	-5.31	3.17	0.98	111	
			N12	-5.45	3.23	0.97	57	
			N14a	-4.66	2.84	0.96	73	
			N17	-5.08	3.06	0.97	27	
Lake trout (*Salvelinus namaycush*)	All	All	All	-5.09	3.04	0.98	782	
	Kennady Lake	All	All	-5.16	3.08	0.98	363	
		I	I1[(a)]	-5.24	3.11	0.99	16	
		K[(b)]	All	-5.18	3.08	0.98	338	
			K1[(a)]	-5.33	3.14	0.98	112	
			K2[(a)]	-5.05	3.04	0.98	62	
			K3[(a)]	-5.07	3.04	0.98	70	
			K4[(a)]	-4.91	2.99	0.99	24	
			K5[(a)]	-5.30	3.12	0.98	66	

Species Common Name (Scientific Name)	Watershed	Basin	Site	log length - log weight coefficients and r^2			*n*	Comments
				Intercept	Slope	r^2		
	Downstream of Kennady Lake	All	All	-4.67	2.89	0.97	168	
		410	410[(a)]	-4.05	2.67	0.91	76	
		Kirk	Kirk[(a)]	-2.54	2.11	0.67	35	
		M	All	-4.85	2.96	0.99	56	
			M4[(a)]	-4.85	2.96	0.99	49	
	N	N	All	-5.15	3.06	0.98	247	
			N11[(a)]	-4.94	2.98	0.96	42	
			N12[(a)]	-2.76	2.17	0.69	12	
			N16[(a)]	-5.15	3.06	0.99	133	
			N17[(a)]	-5.46	3.18	0.99	23	
Lake whitefish (*Coregonus clupeaformis*)	All	All	All	-3.89	2.65	0.97	47	
	Downstream of Kennady Lake	All	All	-3.89	2.65	0.97	47	
		Kirk	Kirk	-3.89	2.65	0.97	47	
Longnose sucker (*Catostomus catostomus*)	All	All	All	-5.13	3.12	1.00	91	
	N	N	All	-5.14	3.12	1.00	89	
			N3	-4.25	2.79	0.88	73	
			N11	-5.26	3.20	0.98	111	
			N16	-5.12	3.11	1.00	57	
Ninespine stickleback (*Pungitius pungitius*)	All	All	All	-3.20	1.86	0.62	21	
	N	N	All	-3.25	1.90	0.65	20	
Northern pike (*Esox lucius*)	All	All	All	-5.23	3.04	1.00	143	
	Kennady Lake	All	All	-5.20	3.04	0.99	99	
		A	All	-5.48	3.13	1.00	6	
		D	All	-5.06	2.99	0.99	34	
			D2	-5.01	2.98	0.99	111	
		K[(b)]	All	-4.61	2.83	0.94	55	
			K4	-5.05	2.99	0.94	57	
			K5	-5.10	3.00	0.96	73	
	Downstream of Kennady Lake	All	All	-5.29	3.07	1.00	35	
		L	All	-5.42	3.13	1.00	11	
		M	All	-5.22	3.05	1.00	18	
	N	N	All	-4.84	2.87	0.99	9	
Round whitefish (*Prosopium cylindraceum*)	All	All	All	-5.34	3.15	0.97	823	
	Kennady Lake	A	All	-4.54	2.85	0.97	12	
			A1[(a)]	-4.54	2.85	0.97	12	
		All	All	-5.68	3.29	0.97	604	
		K[(b)]	All	-5.68	3.29	0.97	592	
			K1[(a)]	-5.56	3.23	0.97	161	
			K2[(a)]	-5.74	3.32	0.98	111	
			K3[(a)]	-5.48	3.21	0.93	100	
			K4[(a)]	-5.69	3.30	0.95	88	
			K5[(a)]	-5.48	3.19	0.97	132	
	Downstream of Kennady Lake	All	All	-4.98	3.01	0.99	72	
		410	410[(a)]	-4.50	2.81	0.93	47	
		L	All	-3.51	2.10	0.62	6	

Species Common Name (Scientific Name)	Watershed	Basin	Site	log length - log weight coefficients and r^2			n	Comments
				Intercept	Slope	r^2		
		M	All	-5.45	3.21	0.96	18	
			M4[a]	-5.74	3.31	0.97	11	
	N	N	All	-5.10	3.04	0.93	146	
			N2[a]	-4.51	2.81	0.88	35	
			N3[a]	-4.53	2.82	0.86	13	
			N16[a]	-5.38	3.14	0.97	87	
Slimy sculpin (*Cottus cognatus*)	All	All	All	-5.22	3.13	0.94	535	
	Kennady Lake	All	All	-6.38	3.76	0.94	11	
	Downstream of Kennady Lake	All	All	-5.23	3.14	0.94	299	
		410	410[b]	-4.58	2.78	0.95	25	
		Kirk	Kirk[a]	-4.68	2.81	0.93	34	
		L	All	-5.33	3.20	0.93	191	
			L1a[a]	-5.61	3.35	0.94	24	
			L1b[a]	-5.42	3.25	0.84	12	
			L2[a]	-5.25	3.15	0.92	153	
		M	All	-5.26	3.15	0.97	49	
			M1[a]	-5.36	3.20	0.98	23	
	N	N	All	-5.06	3.03	0.91	223	
			N1[a]	-4.62	2.76	0.82	17	
			N2[a]	-4.91	2.95	0.92	10	
			N3[a]	-4.78	2.86	0.91	54	
			N4[a]	-5.12	3.08	0.95	33	
			N5[a]	-5.88	3.48	0.97	12	
			N11[a]	-4.63	2.77	0.86	20	
			N12[a]	-4.28	2.61	0.83	13	
			N16[a]	-5.06	3.03	0.93	41	

[a] Used in W_s calculation – see item c.

[b] Basin K = Kennady Lake; sub-basins in Kennady Lake include K1 (Areas 2, 3, and 5), K2 (Area 4), K3 (Area 6), K4 (Area 7), and K5 (Area 8).

Relative weights are commonly used as measures of fish well-being (i.e., condition). Higher relative weights (i.e., W_r ≥100) may indicate more favourable environmental conditions (e.g., abundant prey, habitat cover) for fishes, while a lower relative weight (i.e., W_r ≤ 100) may indicate less favourable environmental conditions (Blackwell et al. 2000). Optimal W_r for fish in good habitat is typically near 100; however, this value may fluctuate depending on the population and season (Blackwell et al. 2000). Detailed information for the species discussed here is not available to determine optimum W_r, therefore for the discussion below, it is assumed that optimum W_r is 95 to 105.

Relative weights were calculated using standard weight (W_s) relationships for Arctic grayling, lake trout, slimy sculpin, and round whitefish using the 75th regression-line-percentile (RLP) technique as presented in Murphy et al. (1990). The RLP technique is the currently accepted approach for development of W_s equations (Pope and Kruse 2007). To calculate W_s equations, length-weight relationships from various populations are required. We used sites to define populations. For each species, the standard $\log_{10}$length-$\log_{10}$weight relationship was calculated for each site (i.e., population) where n ≥ 10 (Table YKDFN_2.22-2; Murphy et al. 1990). Sites where the r^2 value was greater than or equal to 0.9 for the $\log_{10}$length-$\log_{10}$weight relationship were included in the development of the W_s formula. Sites that were obviously missing a length category (e.g., no small fish were recorded) were excluded. The number of sites that met the criteria for analyses ranged from 9 to 12, depending on the species (Table YKDFN_2.22-2).

Table YKDFN_2.22-2: Standard Weight Coefficients and Summary for Arctic Grayling (ARGR), Lake Trout (LKTR), Slimy Sculpin (SLSC) and Round Whitefish (RNWH) in the Project Study Area, 1996-2011

Species	W_s					All Fish Recorded (1996-2011)
	Intercept	Slope	Number of Populations (N)	Total Sample Size (n)	Sample Size Range per Population (n)	Length Range [mm]
ARGR	-5.02	3.04	12	393	12-67	30-410
LKTR	-4.60	2.88	11	673	12-133	93-860
SLSC	-5.15	3.10	10	409	10-153	29-113
RNWH	-5.51	3.23	9	749	11-161	33-392

It should be noted that the W_s relationships were calculated using a small number of populations, some of which had few individuals (i.e., *n* = 10, Table YKDFN_2.22-1). Murphy et al. (1990) calculated W_s relationships using data from 16 populations where the sample size was greater than or equal to 10. However, Brown and Murphy (1996) recommended data from 50 populations to calculate standard weights. This quantity of data is not available for this Project. Therefore, the W_s relationships and predictions of standard and relative weights should be used and interpreted with caution. The W_s equations should be updated when new information is available for fish in the region.

Using $\log_{10}$length-$\log_{10}$weight relationships, the $\log_{10}$weight in 1-cm length intervals for each population was predicted over the minimum and maximum lengths for each species recorded in the study area. The $\log_{10}$weight values were then transformed (i.e., inverse log) to weight (termed 'expected weight') and the 75th percentile of the expected weights in each length interval was calculated. A regression was then performed on re-transformed $\log_{10}75^{th}$ percentile expected weights, versus the $\log_{10}$lengths, to determine parameter coefficients for the W_s equation.

The W_s equations calculated for Arctic grayling, lake trout, slimy sculpin, and round whitefish (Table YKDFN_2.22-2) were then used to calculate the W_s for each Arctic grayling, lake trout, slimy sculpin, and round whitefish recorded, respectively, from 1996-2011. The relative weights (W_r) for each Arctic grayling, lake trout, slimy sculpin, and round whitefish recorded were calculated using the following formula: $W_r = 100*(W/W_s)$. The mean W_r and standard deviation were calculated for fish per watershed, basin, season, and year.

The mean W_r for pooled Arctic grayling indicates that the captured fish were in normal condition (Table YKDFN_2.22-3). Note that the majority of fish included in the calculation of mean W_r were from basin K (Kennady Lake watershed), basin N (N watershed), and basin L (downstream of Kennady Lake watershed), and therefore, the pooled W_r reflects this bias. The mean W_r for each watershed indicates that Arctic grayling were in slightly better condition in watershed N, followed by Kennady Lake and downstream of Kennady Lake (Arctic grayling were not recorded in the Reference watershed). For basins, Arctic grayling appeared to be in the best condition in basin B and in the worst condition in basin P. This difference may be attributed to biases associated with small sample sizes (basin B: n = 12, basin P: n = 3), rather than a true difference in condition. Arctic grayling were in the best condition during the summer sampling season (Table YKDFN_2.22-4) and in 2005 (Table YKDFN_2.22-5).

The mean W_r for pooled lake trout were below normal condition. The majority of fish used in the calculation of mean W_r were from basin K (Kennady Lake watershed) and basin N (watershed N). The mean W_r for each watershed indicates that lake trout were in the best condition in the Kennady Lake watershed, followed by the reference, downstream of Kennady Lake, and N. Similar to Arctic grayling, lake trout appeared to be in the best condition in basin B. Lake trout appeared to be in the worst condition in the Kirk Lake basin. Overall, lake trout were in the best condition during the winter sampling season and in 2005. Note that winter sampling was conducted only in the Kennady Lake watershed.

The mean W_r for pooled round whitefish indicated that captured fish were in normal condition; however, the majority of fish in this calculation were from basin K (Kennady Lake watershed). The mean W_r for each watershed indicates that round whitefish were in the best condition downstream of Kennady Lake, followed by the Kennady Lake, Reference and N watersheds. Round whitefish appeared to be in the best condition in basin L. All basin populations were in relatively good condition (i.e., $W_r > 90$), but were in the lowest condition in basin N. Generally, round whitefish were in the best condition during the summer sampling season and in 2010.

The mean W_r for all slimy sculpin indicated that the fish recorded in the study area were in normal condition. This mean value is biased towards values in basin L (downstream of Kennady Lake) and basin N (watershed N) where the majority of fish were captured. The mean W_r for each watershed indicates that slimy sculpin were in the best condition downstream of Kennady Lake, followed by N, Kennady Lake, and Reference watersheds. Slimy sculpin appeared to be in the best condition in the L basin and were in the worst condition in the B basin. Slimy sculpin were only recorded during the summer and fall surveys, and were in slightly better condition in the summer and in 2004.

Table YKDFN_2.22-3 Mean Relative Weights (W_r) of Arctic Grayling, Lake Trout, Slimy Sculpin and Round Whitefish in each Watershed and Basin of the Project Study Area, 1996-2011

Species	Watershed	Basin	Mean W_r	Standard Deviation	*n*
Arctic grayling	All	All	98.0	18.1	511
	Kennady Lake	All	97.3	13.8	161
		A	93.7	18.4	20
		B	105.0	16.4	12
		D	90.7	-	2
		I	98.3	8.8	7
		K	97.1	12.7	120
	Downstream of Kennady Lake	All	97.1	17.1	133
		L	98.3	16.5	118
		M	95.3	16.6	11
		P	71.3	-	3
		Kirk	55.0	-	1
	N	N	99.2	21.2	217
Lake trout	All	All	89.2	13.6	782
	Kennady Lake	All	91.3	14.7	363
		A	102.1	3.9	5
		B	111.5	-	3
		D	73.8	-	1
		I	90.9	5.0	16
		K	91.0	14.7	338
	Downstream of Kennady Lake	All	89.5	11.3	168
		L	104.2	-	1
		M	90.4	11.5	56
		410	91.4	10.6	76
		Kirk	83.4	10.4	35
	N	N	85.9	12.7	247
	Reference	East	91.2	-	4

Species	Watershed	Basin	Mean W_r	Standard Deviation	*n*
Round whitefish	All	All	95.7	15.8	823
	Kennady Lake	All	95.8	13.6	604
		A	110.4	10.6	12
		K	95.5	13.5	592
	Downstream of Kennady Lake	All	105.3	26.1	72
		L	152.7	42.5	6
		M	103.7	22.0	18
		410	98.9	17.2	47
		Kirk	149.4	-	1
	N	N	90.6	15.6	146
	Reference	East	93.2	-	1
Slimy sculpin	All	All	98.0	18.3	535
	Kennady Lake	All	93.7	19.2	11
		A	87.7	-	4
		B	94.9	-	2
		K	98.1	23.3	5
	Downstream of Kennady Lake	All	99.8	17.6	299
		L	101.2	18.3	191
		M	98.5	14.6	49
		410	98.5	15.6	25
		Kirk	95.1	18.5	34
	N	N	96.0	19.0	223
	Reference	East	76.9	-	2

Table YKDFN_2.22-4: Mean Relative Weights (W_r) of Arctic Grayling, Lake Trout, Slimy Sculpin and Round Whitefish for each Sampling Season in the Project Study Area, 1996-2011

Species	Watershed	Fall			Spring			Summer			Winter		
		Mean W_r	*n*	SD	Mean W_r	*n*	SD	Mean W_r	*n*	SD	Mean W_r	*n*	SD
Arctic grayling	All	90.7	45	17	95.5	129	14	100.0	337	19			
	Kennady Lake	99.1	19	12	94.0	69	16	99.9	73	11			
	DS of Kennady Lake	85.6	16	19	98.3	40	12	98.9	77	18			
	N	82.9	10	14	95.1	20	11	100.5	187	22			
Lake trout	All	89.6	211	12	87.1	35	19	88.7	523	13	107.9	13	25
	Kennady Lake	90.8	149	12	83.9	7	13	90.7	194	15	107.9	13	25
	DS of Kennady Lake	86.1	22	8	85.4	11	17	90.3	135	11			
	N	86.7	40	15	89.6	17	21	85.4	190	11			
	Reference							91.2	4	6			
Round whitefish	All	95.4	191	17	83.7	7	9	96.0	625	16			
	Kennady Lake	97.5	172	16	75.5	1	-	95.2	431	13			
	DS of Kennady Lake	77.3	3	14	85.0	6	9	108.5	63	26			
	N	75.9	16	12				92.4	130	15			
	Reference							93.2	1	-			
Slimy sculpin	All	96.1	192	15				99.1	343	20			
	Kennady Lake	104.1	3	14				89.9	8	20			
	DS of Kennady Lake	96.7	150	14				102.9	149	21			
	N	93.1	39	18				96.6	184	19			
	Reference							76.9	2	12			

Table YKDFN_2.22-5: Mean Relative Weights (W_r) of Arctic Grayling, Lake Trout, Slimy Sculpin and Round Whitefish for each Sampling Season in the Project Study Area, 1996-2011.

Species	Watershed	1996			1999			2004			2005			2007			2010			2011		
		Mean W_r	n	SD	Mean W_r	n	SD	Mean W_r	n	SD	Mean W_r	n	SD	Mean W_r	n	SD	Mean W_r	n	SD	Mean W_r	n	SD
Arctic grayling	All	97.5	25	12.3	93.4	44	9.3	97.5	121	14.7	101.9	132	17.3	98.1	155	23.7	99.8	7	8.1	89.0	27	9.9
	Kennady Lake	97.9	19	12.2	95.1	39	8.0	96.7	92	15.6	112.5	7	11.6	102.0	4	14.0						
	DS of Kennady Lake	96.2	6	13.8	80.1	5	8.0	100.0	29	11.5	99.3	51	18.9	93.8	39	18.6	104.6	3	7.8			
	N										102.7	74	16.2	99.5	112	25.4	96.2	4	7.0	89.0	27	9.9
Lake trout	All	87.0	233	11.6	87.1	59	10.3	92.4	249	15.1	90.5	133	15.7	93.7	6	14.0	77.0	7	23.1	85.9	95	8.4
	Kennady Lake	86.6	122	11.7	86.6	35	12.4	94.8	196	14.8	111.5	3	35.3	101.6	4	4.3	67.8	3	31.6			
	DS of Kennady Lake	88.6	42	8.4				89.4	24	13.3	89.7	101	11.9				104.2	1				
	N	86.9	69	13.1	87.9	24	6.5	78.8	29	10.8	91.0	29	22.7	77.9	2	13.1	77.2	3	10.5	85.7	91	8.5
	Reference																			91.2	4	5.5
Round whitefish	All	89.6	299	11.9	88.9	95	8.1	100.2	298	14.0	106.4	72	18.1	110.4	12	10.6	125.0	12	40.9	91.6	35	18.7
	Kennady Lake	90.9	216	12.2	89.3	82	8.0	100.7	288	13.8				110.4	12	10.6	97.3	6	5.0			
	DS of Kennady Lake	93.4	10	14.1				88.5	9	13.7	105.0	47	20.1				152.7	6	42.5			
	N	84.9	73	9.3	86.5	13	8.7	64.3	1	-	109.0	25	13.8							91.5	34	19.0
	Reference																			93.2	1	-
Slimy sculpin	All							116.4	1	-	101.8	108	20.2	96.9	408	17.9	101.8	9	11.7	97.2	9	17.8
	Kennady Lake							116.4	1	-	83.8	3	20.3	94.8	7	18.5						
	DS of Kennady Lake										104.2	59	19.8	98.8	239	16.9	90.8	1	-			
	N										99.8	46	20.3	94.3	162	18.9	103.2	8	11.7	103.0	7	14.8
	Reference																			76.9	2	12.5

References

Blackwell, B.G., M.L. Brown, and D.W. Willis. 2000. Relative Weight (Wr) Status and Current Use in Fisheries Assessment and Management. *Review in Fisheries Science* 8:1-44.

Brown, M.L. and B.R. Murphy. 1996. Selection of a Minimum Sample Size for Application Regression-Line_Percentile Technique. North American Journal of Fisheries Management 16:427-432.

Canamera Geological Ltd. 1998. 1996 Environmental Baseline Studies: 5034 Diamond Project. Prepared by the Environmental Resources Division of Canamera Geological. Submitted to Monopros Ltd., Yellowknife, NT.

De Beers (De Beers Canada Inc.). 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.

EBA Engineering Consultants Ltd. (EBA), and Jacques Whitford Environment Ltd. 2001. Gahcho Kué (Kennady Lake) Environmental Baseline Investigations (2000). Submitted to De Beers Canada Exploration Limited, Yellowknife, NT.

Golder (Golder Associates Ltd.). 2012. 2011 Fish and Aquatic Resources Supplemental Monitoring Report. Supplemental Monitoring Report. Report No. 11-1365-0001/DCN-054. Submitted to Mackenzie Valley Environmental Impact Review Board. March 2010.

Jacques Whitford. 2003. Gahcho Kué (Kennady Lake) Limnological Survey of Potentially Affected Bodies of Water (2002). Project No. NTY71008. Final Report Submitted to De Beers Canada Exploration Inc., Yellowknife, NT.

Jacques Whitford. 2004. Baseline Limnology Program (2003) Gahcho Kué (Kennady Lake). Project No. NTY71037. Prepared for De Beers Canada Exploration Inc., Yellowknife, NT.

Pope, K.L., and C.G. Kruse. 2007. Condition. Chapter 10 in Analysis and Interpretation of Freshwater Fisheries Data. American Fisheries Society, Bethesda, Maryland, USA. Pg 423-471.

Murphy, B.R., M.L. Brown and T.A. Springer. 1990. Evaluation of the Relative Weight (W_r) Index, with New Applications to Walleye*. North American Journal of Fisheries Management* 10:85-97.

April 2012

GAHCHO KUÉ PROJECT ENVIRONMENTAL IMPACT STATEMENT
INFORMATION REQUEST RESPONSES

Information Request Number: YKDFN 2.23

Source: Yellowknives Dene First Nation

Subject: Species List for Fish (Annex J, Table J.4.6-1, p. J4-159; Table J4.4-31, p. J4-143; Table J4.4-33, p. J4-149; Table J4-61, p. J4-159; Addendum JJ, Table JJ4.4-4, p. JJ4-42; Section 9, Table 9.3-40; Table 9.3-42; Table 9.3-44

EIS Section: Section 2: Fish and Water

Terms of Reference Section:

Preamble

Over the past 15 years, a considerable amount of work has been undertaken for the purpose of developing species lists of fish for many of the lakes within the study area. These lists are scattered throughout the EIS document (above subject list is for example purposes and is not complete). These data are useful for increased understanding of the potential effects of the project on fish.

Request

The proponent should develop a single place for residence of the species lists - It would be useful for understanding potential effects of the project on fish to develop in one place a fish species list for each lake and stream that has been studied, and include comprehensive life history information for each species, such as spawning time/temperature, food preferences, years to sexual maturity, feeding/rearing/ spawning location etc.

Response

Data for this response was collated from the following sources: Canamera (1998), Jacques Whitford (2003, 2004), EBA and Jacques Whitford (2001), De Beers (2010), and Golder (2012).

A fish species list for each lake and stream that has been studied are provided in Tables YKDFN_2.23-1 and YKDFN_2.23-2. Data on the number of fish caught at each site by season, year, and capture method are available in a Microsoft Excel worksheet (GK Fish Catch 1996-2011March2012.xlsx). The life history data (i.e., length and weight measurements, sex, maturity, and age) for recorded fishes are available in a Microsoft Excel worksheet (GK Fish Life History1996-2011March2012.xlsx). These files are provided on CD to YKDFN.

Lake sites where fish sampling was conducted, but fish were not captured include: L4, L13, L14, L19, L20, A2, A4, A5, A6, A7, A8, A9, B2, D5, D10, E2, E3, F1, H1b, I2, J1a, J2, K1-2, Ka1, Kb1, Kb2, Kb3, Kb4, Kd1, N7, N13, and N14b. Similarly, fish were not captured at stream sites L11 and G1. These lake and stream sites are not included in Tables YKDFN_2.23-1 and YKDFN_2.23-2.

Life-history information for each species, including spawning time/temperature; food preferences, years to sexual maturity; feeding, spawning, and rearing location; and preferred spawning substrate are provided in Table YKDFN_2.23-3. The life-history information was obtained from site-specific data, where available; otherwise, a literature review was completed.

Table YKDFN_2.23-1: Fish Species List for each Lake in the Project Study Area, 1996-2011

Watershed	Site ID	Species[a]
Downstream of Kennady Lake	410	BURB, CISC, LKCH, LKTR, NRPK, RNWH, SLSC
	Kirk	CISC, LKTR, LKWH, NRPK, RNWH
	L1a	ARGR, SLSC
	L1b	NRPK
	L2	ARGR, NRPK
	L3	NRPK
	L18	ARGR, BURB, LKTR
	L21	ARGR
	M1	BURB, NRPK, RNWH
	M2	CISC, LKTR, NRPK, SLSC
	M3	BURB, LKTR, NRPK, RNWH
	M4	ARGR, CISC, LKCH, LKTR, NNST, RNWH, SLSC
Kennady Lake[b]	A1	ARGR, BURB, RNWH
	A3	ARGR, BURB, LKTR, NRPK, Unknown
	B1	ARGR, LKTR, NNST, SLSC
	D1	BURB, NRPK
	D2	NRPK
	D3	BURB, LKTR, NRPK
	D7	ARGR, BURB, NRPK
	E1	NRPK, SLSC
	G2	NNST
	H1a	NNST, SLSC
	I1	ARGR, LKTR, NNST, SLSC
	J1b	BURB
	K1	ARGR, BURB, LKCH, LKTR, NNST, NRPK, RNWH, SLSC
	K1/K3	BURB, SLSC
	K1-5	ARGR, BURB, LKCH, LKTR, NNST, NRPK
	K2	ARGR, LKCH, LKTR, NRPK, RNWH
	K3	ARGR, BURB, LKCH, LKTR, NNST, NRPK, RNWH

Watershed	Site ID	Species[a]
	K3-4	ARGR, LKTR, NRPK
	K4	ARGR, BURB, LKCH, LKTR, NNST, NRPK, RNWH, SLSC
	K5	ARGR, BURB, LKCH, LKTR, NNST, NRPK, RNWH, SLSC
N	N1	NRPK
	N2	ARGR, LKCH, LKTR, LNSC, NNST, RNWH, SLSC
	N3	ARGR, BURB, LKCH, LKTR, LNSC, NNST, RNWH
	N4	ARGR, LKCH
	N5	ARGR, BURB, LKCH, LKTR, LNSC, NNST, RNWH, SLSC
	N6	ARGR, BURB, LKCH, LKTR, LNSC, NNST, RNWH
	N6a	LKCH, LKTR
	N9	LKTR, RNWH
	N11	BURB, LKCH, LKTR, LNSC, NNST, NRPK, SLSC
	N12	ARGR, BURB, LKCH, LKTR, LNSC, NNST, SLSC
	N14	ARGR, LKCH, LKTR, LNSC, NNST, SLSC
	N14a	ARGR, LKCH, LNSC, NNST, SLSC
	N16	BURB, CISC, LKCH, LKTR, LNSC, NNST, RNWH, SLSC, WHSC
	N17	BURB, LKCH, LKTR, RNWH, SLSC
	N18	ARGR, CISC, LKCH
Reference	East	BURB, LKTR, RNWH, SLSC

[a] ARGR = Arctic grayling, BURB = burbot, LKCH = lake chub, LKTR = lake trout, LNSC = longnose sucker, NNST = ninespine stickleback, NRPK = northern pike, RNWH = round whitefish, SLSC = slimy sculpin, WHSC = white sucker.

[b] Basin K = Kennady Lake; sub-basins in Kennady Lake include sites K1 (includes Areas 2, 3, and 5), K2 (Area 4), K3 (Area 6), K4 (Area 7), and K5 (Area 8).

Table YKDFN_2.23-2: Fish Species List for each Stream in the Project Study Area, 1996-2011

Watershed	Site ID	Species[a]
Downstream of Kennady Lake	410	BURB, LKCH, SLSC
	K5	ARGR, BURB, LKCH, LKTR, LNSC, NRPK, RNWH, SLSC
	Kirk	ARGR, NNST, SLSC
	L1a	ARGR, BURB, LKCH, NRPK, SLSC
	L1b	ARGR, BURB, SLSC
	L1c	SLSC
	L2	ARGR, BURB, LKTR, NNST, NRPK, SLSC
	L3	ARGR, BURB, NRPK
	L13	BURB
	L14	RNWH
	L15	RNWH
	L18	RNWH, SLSC
	M1	ARGR, BURB, LKCH, LKTR, NRPK, RNWH, SLSC
	M2	BURB, LKCH, NNST, NRPK, SLSC
	M3	ARGR, BURB, NRPK, SLSC
	M4	ARGR, BURB, LKTR, NRPK, SLSC
	P4	ARGR, BURB
Kennady Lake	A1	ARGR, BURB, LKCH, NNST, NRPK, SLSC
	A2	ARGR, BURB, NRPK
	A3	ARGR, BURB, LKTR, NNST, NRPK
	B1	ARGR
	D1	ARGR, BURB, NNST
	D2	ARGR, BURB, NRPK , SLSC
	D4	SLSC
	D7	SLSC
	E1	ARGR, BURB, NNST, NRPK
	H1a	NNST, NRPK
	H1b	NNST
	J1a	ARGR
	Kd1	NNST
	Ke3	NNST
N	N1	BURB, LKCH, SLSC
	N2	ARGR, BURB, LKCH, LNSC, NNST, SLSC
	N3	ARGR, BURB, LKCH, LKTR, LNSC, SLSC
	N4	ARGR, BURB, LKCH, NNST, SLSC
	N5	ARGR, BURB, LKCH, LNSC, NNST, SLSC
	N6	ARGR, BURB, LKCH, NNST, SLSC
	N6b	BURB, LKCH, LNSC
	N9	BURB, LKCH, SLSC
	N11	BURB, LKCH, NNST, SLSC
	N12	ARGR, BURB, LKCH, NNST, SLSC
	N14	ARGR
	N14a	SLSC
	N15	LKCH , SLSC
	N16	ARGR, BURB, LKCH, LKTR, LNSC, SLSC
	N17	ARGR, BURB, LKCH, LKTR, LNSC, NNST, SLSC
	N18	ARGR, BURB, LKCH, LKTR, SLSC

(a) ARGR = Arctic grayling, BURB = burbot, LKCH = lake chub, LKTR = lake trout, LNSC = longnose sucker, NNST = ninespine stickleback, NRPK = northern pike, RNWH = round whitefish, SLSC = slimy sculpin

Table YKDFN_2.23-3: Life-History Information for each Species Recorded in the Project Study Area (1996-2011)

Species[a]	Spawning Time	Spawning Temperature (°C)	Spawning Location		Suitable Spawning Substrate	Food Preference	Years to sexual maturity	Feeding Location	Rearing Location
			Lake	Stream					
ARGR	Spring (early June)[b]	0-5 [b]		✓ Large spawning run in outlet of Kennady Lake (K5); smaller spawning run - N3, N12, A1, A2, B1, D1, E1, L3 [b]	large rock, cobble, gravel, fines	zooplankton and corixidae (data from Kennady Lake, M4 & N16) [b]	6-9 (406-508mm)	Kennady Lake - K1, K2, K3 and K4 (appear to avoid K5) [b]	K5, L2, L1a, L1b, N, and L3 provide summer rearing habitat [b]
BURB	November to May	0.6-1.7	✓	✓	gravel	invertebrates and fish	3-4 (280-480 mm, males mature at smaller sizes)	streams and lakes	rocky shores of stream
CISC	Late October	4-5	✓		cobble, gravel	zooplankton, invertebrates	3-6	lakes	lakes
LKTR	Late August and October[b]	5.5-14	✓ In Kennady Lake, boulder dominated shoreline in Basin K1 is likely an important spawning location; shoreline along the northeastern corner of the island separating Basins K1 and K2 may also provide spawning habitat; data indicates that they may spawn in other basins as well [b]		large rock, cobble	fish (Kennady Lake - RNWH, N16 - CISC) [b]	8/9 (450 mm) [b]	Kennady Lake: Summer - K1, K2, K3 and K4 (avoided K5), prefer K1; Spring: move into the outlet (near K5) likely to feed on spawning ARGR and/or their newly laid eggs. N16: move into tributaries in spring likely to feed on spawning ARGR and/or their newly laid eggs [b]	unknown
LKWH	September and October	<7.8	✓		large rock, cobble	invertebrates and small fishes	6-7	lakes	lakes
NRPK	Early June	4.4-11.1	Basin D is likely the primary spawning location, particularly lakes D2 & D3; may also spawn in K5[b]		gravel, fines, vegetation	zooplankton, invertebrates, fish	6 females; 5 males	prefer K4 and stream D1	vegetated rivers of bays
RNWH	Late October [b]	2-5.5 [b]	✓		gravel	Kennady Lake: zooplankton and bivalves; N16: chironomids [b]	5-8 (males >237 mm, females >268 mm) [b]	Kennady Lake: likely move extensively between all basins [b]	streams or lakes
WHSC	Early June	10	✓	✓	gravel	invertebrates	5-8	streams or lakes	streams or lakes
LNSC	Early June	5	✓	✓ Kennedy Lake: move into outlets and inlets to spawn [b]	gravel	invertebrates	5-7	streams or lakes	streams or lakes
LKCH	June-July	unknown	✓	✓	large rock, cobble	invertebrates	unknown	prefer lakes	prefer lakes
NNST	Summer	unknown	✓		vegetation	invertebrates	unknown	streams or lakes	streams or lakes
SLSC	June - July	~5	✓	✓	large rock, cobble	invertebrates	unknown	rocky bottoms of lakes or streams	rocky bottom of lakes or streams

Note: sub-basins in Kennady Lake include sites K1 (includes Areas 2, 3, and 5), K2 (Area 4), K3 (Area 6), K4 (Area 7), and K5 (Area 8).

(a) ARGR = Arctic grayling, BURB = burbot, CISC = cisco, LKCH = lake chub, LKTR = Lake trout, LKWH = lake whitefish, LNSC = longnose sucker, NNST = ninespine stickleback, NRPK = northern pike, RNWH = round whitefish, SCKR = unknown sucker, SLSC = slimy sculpin, WHSC = white sucker.

(b) Site-specific information is from Annex J and Addendum JJ of the EIS (De Beers 2010), Golder (2012), and references cited within. Remainder of information collated from a literature review (Scott and Crossman 1973, Nelson and Paetz 1992).

References

Canamera Geological Ltd. 1998. 1996 Environmental Baseline Studies: 5034 Diamond Project. Prepared by the Environmental Resources Division of Canamera Geological. Submitted to Monopros Ltd., Yellowknife, NT.

De Beers (De Beers Canada Inc.). 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.

EBA Engineering Consultants Ltd. (EBA), and Jacques Whitford Environment Ltd. 2001. Gahcho Kué (Kennady Lake) Environmental Baseline Investigations (2000). Submitted to De Beers Canada Exploration Limited, Yellowknife, NT.

Golder (Golder Associates Ltd.). 2012. 2011 Fish and Aquatic Resources Supplemental Monitoring Report. Supplemental Monitoring Report. Report No. 11-1365-0001/DCN-054. Submitted to Mackenzie Valley Environmental Impact Review Board. March 2010.

Jacques Whitford. 2003. Gahcho Kué (Kennady Lake) Limnological Survey of Potentially Affected Bodies of Water (2002). Project No. NTY71008. Final Report Submitted to De Beers Canada Exploration Inc., Yellowknife, NT.

Jacques Whitford. 2004. Baseline Limnology Program (2003) Gahcho Kué (Kennady Lake). Project No. NTY71037. Prepared for De Beers Canada Exploration Inc., Yellowknife, NT.

Nelson, J.S. and M.J. Paetz. 1992. *The Fishes of Alberta*. University of Alberta Press and University of Calgary Press. 2nd Edition.

Scott, W.B. and E.J. Crossman. 1973. Freshwater Fishes of Canada. Bulletin 184, Fisheries Research Board of Canada, Ottawa. 966 pp.

GAHCHO KUÉ PROJECT ENVIRONMENTAL IMPACT STATEMENT
INFORMATION REQUEST RESPONSES

Information Request Number: YKDFN 2.24

Source: Yellowknives Dene First Nation

Subject: Ground Water Chemistry

EIS Section: Section 2: Fish and Water

Preamble

The infiltration of groundwater into the open pits is a recognized effect of the project. The groundwater will be pumped out of the pits, into the Water Management Pond (i.e. Kennady Lake), and then into the downstream receiving environment (Lake N11, and Area 8). It is also recognized that the chemistry of groundwater is considerably different than surface water. Currently, however, there is almost no groundwater chemistry data summarized in Section 8, or 9 and there is no understanding or definition of baseline groundwater chemistry. This data gap makes it is difficult to evaluate the potential effect of groundwater discharge on the downstream receiving environment.

Request

The proponent should develop information and tables to allow for the evaluation of potential effects of groundwater on the receiving environment. At a minimum this should include a table summarizing groundwater chemistry, defining baseline groundwater chemistry using box and whisker plots, Piper Plots and a short descriptive paragraph.

Response

A brief summary description of baseline groundwater water quality for monitoring wells in the Kennady Lake watershed is provided in Section 11.6.6.2.2.4, Section 11.6 of the 2010 Environmental Impact Statement (EIS) (De Beers 2010). This summary is limited to range of total dissolved solids concentrations between shallow and deep groundwater systems, with depth profile comparisons to the Fritz and Frape profile (Fritz and Frape 1987).

A summary of groundwater chemistry inputs to the water quality model, including major ions and selected trace metals, are presented in Appendix 8.II, Section 8 of the 2011 EIS Update (De Beers 2011). These data were derived from the groundwater quality dataset for the Project that were collected from a number of monitoring bores in the Kennady Lake watershed in 2004, 2005, and 2011. For the water quality modelling in the EIS, this groundwater quality data was analysed and assigned to pit inflows component of the model for each of the pits to be mined in the Project. The summary in Appendix 8.II identifies the parameters that are correlated with total dissolved solids (TDS) (i.e., those that change with depth) and those that are present in relatively constant concentration with depth.

The authors have correctly identified that a detailed summary of baseline groundwater chemistry has not been provided in the EIS. It is also noted that this information request is consistent with Fisheries and Oceans Canada and Environment Canada information request number 6 (DFO&EC_6). As such De Beers are committed to review the groundwater dataset and as suggested by the author, provide box plots and piper plots for measured groundwater parameters concentrations collected from wells within the Kennady Lake watershed. This information will be provided as a technical memorandum, which will be submitted to the Mackenzie Valley Environmental Impact Review Board in April 2012.

References

De Beers (De Beers Canada Inc.). 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 (De Beers Canada Inc.). 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.

Fritz, P. and S.K. Frape. 1987. Geochemical trends for groundwaters from the Canadian Shield. In: Fritz, P. and S.K. Frape (eds) Saline Waters and Gases in Crystalline Rocks. Geological Association of Canada Special Paper 33.

Information Request Number: YKDFN 2.25

Source: Yellowknives Dene First Nation

Subject: Benthic Invertebrates – EPT Index (Annex J, Appendix J.I, Table J.I-29)

EIS Section: Section 2: Fish and Water

Preamble

Benthic invertebrates are a major food source for many species of fish. Benthic Invertebrate community data therefore provides an understanding of the quality of fish habitat. One of the most sensitive indicators of ecosystem stress is species richness. As disturbance and stress increase, species richness tends to decrease. Within streams, some of the species most sensitive to environmental disturbance include the mayflies (Ephemeroptera), stoneflies (Plecoptera) and caddisflies (Trichoptera). The number of Ephemeroptera, Plecoptera and Trichoptera taxa is a sensitive indicator of environmental stress within stream environments called the EPT Index. The data for calculating the EPT Index is already available, so this effort would require a simple compilation and calculation of the pertinent data.

Bray-Curtis Index of Dissimilarity (BCI) values for both stream and lake samples are not calculated. The data necessary for calculating BCI are available from a variety of locations. The BCI is an important parameter because it directly compares the benthic invertebrate communities between two sites, and is a sensitive indicator of changes in the benthic invertebrate community through space and over time. The BCI values can be analyzed using simple inferential statistics or in ordination techniques.

Request

1) It would be useful to calculate the EPT Index for all stream sites.

2) Calculate Bray-Curtis Index of Dissimilarity (BCI) for reference sites for both stream and lake samples. For the lake samples, combine five subsamples before calculation.

Response

1) Total EPT richness (i.e., the EPT index) was calculated for stream stations sampled in 2007, based on the pooled data for all samples collected at a station; data were reported in Addendum JJ, Appendix JJ.X, Table JJ.X-5 of the 2010 Gahcho Kué Project Environmental Impact Statement (EIS) (De Beers 2010). Stream benthic invertebrate data collected before the 2007 baseline program are unsuitable for calculating this index, because single samples were collected at each station, which do not provide representative data for the calculation of EPT richness at a location.

2) Bray-Curtis indices comparing stations within sampling areas (i.e., within lakes or lake basins) and among sampling areas were calculated based on data collected in Kennady Lake (Areas 3 and 5, And Area 8, formerly Basins K1 and K5) and Lake N11 using the 2007 data reported in Addendum JJ (De Beers 2010). Bray-Curtis indices were also calculated using the 2011 data, for 7 lakes, based on lake means (Golder 2012). These indices are provided below.

   The Bray-Curtis index is a dissimilarity index that compares community structure and taxon abundance between two benthic invertebrate samples. A value of 1 means that the two samples are completely different, with no species in common. A value of 0 means that the two samples are exactly the same.

2007 Benthic Invertebrate Data

The Bray-Curtis indices comparing Lake N11 stations and Kennady Lake Areas 3 and 5, Area 8 stations are shown in tables YKDFN_2.25-1, YKDFN_2.25-2, and YKDFN_2.25-3. These results indicate the range of benthic community dissimilarity within a lake or lake basin, which is attributed to habitat variation (e.g., water depth), physico-chemical characteristics (e.g., water and sediment quality) and background variability. The level of dissimilarity among stations within lakes was highly variable, ranging from 0.22 to 0.933, with the greatest range in Area 8 of Kennady Lake.

Table YKDFN_2.25-1 Bray-Curtis Indices Comparing Lake N11 Stations Sampled in 2007

Station	N11_C1	N11_C2	N11_C3
N11_C2	0.447	-	-
N11_C3	0.506	0.463	-
N11_C4	0.644	0.777	0.801

Table YKDFN_2.25-2 Bray-Curtis Indices Comparing Areas 3 and 5 (Kennady Lake Basin K1) Stations Sampled in 2007

Station	K1_1	K1_2	K1_3	K1_4
K1_2	0.303	-	-	-
K1_3	0.378	0.404	-	-
K1_4	0.345	0.499	0.393	-
K1_6	0.663	0.760	0.689	0.576

Table YKDFN_2.25-3 Bray-Curtis Indices Comparing Area 8 (Kennady Lake Basin K5) Stations Sampled in 2007

Station	K5_1	K5_2	K5_3	K5_4
K5_2	0.575	-	-	-
K5_3	0.637	0.628	-	-
K5_4	0.816	0.922	0.844	-
K5_5	0.835	0.933	0.841	0.220

The mean community of Lake N11 based on pooling data from all stations was then compared to the mean communities of the two Kennady Lake areas to evaluate the dissimilarity between benthic communities of the two lakes. Results are shown in Table YKDFN_2.25-4. These results indicate the range of benthic community dissimilarity among lakes or lake basins attributable to variation in habitat (e.g., water depth), physico-chemical characteristics (e.g., water and sediment quality) and background natural variation. The level of dissimilarity among lakes or basins can be characterized as moderate, with the index values ranging from 0.321 to 0.564.

Table YKDFN_2.25-4 Bray-Curtis Indices Comparing Lake N11 and two Kennady Lake Basins

Lake or Basin	Lake N11	Areas 3 and 5
Areas 3 and 5	0.321	-
Area 8	0.564	0.441

2011 Benthic Invertebrate Data

The Bray-Curtis Indices comparing the seven lakes sampled in 2011 are shown in Table YKDFN_2.25-5. The level of dissimilarity among lakes was moderate to high, with the index values ranging from 0.384 to 0.983.

Table YKDFN_2.25-5 Bray-Curtis Indices Comparing Lakes Sampled in 2011

Lake	East Lake	Lake N11	Lake M1	Lake M2	Lake M3	Lake M4
Lake N11	0.825	-	-	-	-	-
Lake M1	0.772	0.669	-	-	-	-
Lake M2	0.762	0.588	0.450	-	-	-
Lake M3	0.646	0.735	0.631	0.578	-	-
Lake M4	0.882	0.983	0.971	0.969	0.929	-
Lake L2	0.697	0.732	0.384	0.548	0.626	0.955

References

De Beers (De Beers Canada Inc.). 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.

Golder (Golder Associates Ltd.). 2012. 2011 Lower Trophic Organisms Supplemental Monitoring Report. Report No. 11-1365-0001/DCN-052. Submitted to Mackenzie Valley Environmental Impact Review Board. March 2012.

GAHCHO KUÉ PROJECT ENVIRONMENTAL IMPACT STATEMENT
INFORMATION REQUEST RESPONSES

Information Request Number: YKDFN 2.26

Source: Yellowknives Dene First Nation

Subject: Benthic Invertebrates – Temporal Consistency

EIS Section: Section 2: Fish and Water

Preamble

One of the fundamental principles of environmental monitoring is an unwavering and core commitment to consistency in sampling methodology. Temporal consistency, however, is a difficult standard to achieve; alterations in personnel, changes in project scope and definition, improvements in protocols can all result in collection of data that is incompatible over time. This is the situation with the benthic invertebrate data that has been collected for the Gahcho Kue EIS, and the result is that a competent understanding of baseline conditions has not yet been achieved for this project. Failure to maintain temporal consistency will result in collection of incompatible data that will provide only a limited understanding of baseline conditions and alterations over time.

Request

During summer 2012 the proponent should initiate a comprehensive sampling program for benthic invertebrates so that a complete baseline dataset can be developed that has data for all required lake and stream sites sampled at the same time using the same methods. For lake sediments, five or six subsamples should be collected for each sample such that there are at least 200 individuals per sample. For stream sites, three subsamples should be collected for each sample.

Response

A supplemental monitoring program for benthic invertebrates is not planned for 2012; however, a comprehensive baseline benthic sampling program was completed in 2011 and was partly reported by Golder (2012), which complements the baseline information on lower trophic communities reported in Annex J and Addendum JJ in the 2010 Environmental Impact Statement (EIS) (De Beers 2010). Additional reporting of 2011 data will occur in 2012. Results of these baseline studies will be used to develop the detailed study design for the Aquatic Effects Monitoring Program (AEMP).

As part of De Beers' ongoing monitoring commitment, additional baseline benthic invertebrate sampling (i.e., in potential reference lakes) will be completed and the existing baseline data will be augmented, as part of developing the detailed AEMP study design. Additionally, this will provide a more robust dataset to compare future sampling results to assess potential Project-related changes. The recommendations provided by the author of the information request with respect to monitoring of benthic invertebrates will be considered during the development of the detailed study design.

An environmental monitoring framework is currently being developed for the Gahcho Kué Project. The objectives of this framework are to define the criteria for AEMP monitoring taking a high level approach. The approach to aquatic effects monitoring for the Project is still conceptual, and detailed study designs and methods will be evaluated further through consultation with communities and regulatory agencies, and developed during the licensing phase of the Project.

References

De Beers (De Beers Canada Inc.). 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.

Golder (Golder Associates Ltd.). 2012. 2011 Lower Trophic Organisms Supplemental Monitoring Report. Report No. 11-1365-0001/DCN-052. Submitted to Mackenzie Valley Environmental Impact Review Board. March 2010.

April 2012

GAHCHO KUÉ PROJECT ENVIRONMENTAL IMPACT STATEMENT
INFORMATION REQUEST RESPONSES

Information Request Number: YKDFN 2.27

Source: Yellowknives Dene First Nation

Subject: Plankton Species Richness

EIS Section: Section 2: Fish and Water

Terms of Reference Section:

Preamble

One of the most sensitive indicators of ecosystem stress is species richness. As disturbance and stress increase, species richness tends to decrease. It would be useful to calculate taxon richness for phytoplankton and zooplankton communities to monitor for changes in species richness.

Request

The data for calculating species richness is already available, so this effort would require a simple compilation and calculation of the pertinent data.

Response

Phytoplankton and zooplankton richness values are available for 1996, 2004, 2005, 2007, and 2011. A summary of these results is provided in Tables YKDFN_2.27-1 to YKDFN_2.27-4 below. Phytoplankton and zooplankton richness values for 1996, 2004, 2005 (Kirk Lake only) and 2011 were included in Annex J and Addendum JJ of the the Environmental Impact Statement (De Beers 2010). Additional phytoplankton and zooplankton monitoring was completed in 2011 and results were submitted to the Mackenzie Valley Land and Water Board (Golder 2012).

References

De Beers (De Beers Canada Inc.). 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.

Golder (Golder Associates Ltd.). 2012. 2011 Lower Trophic Organisms Supplemental Monitoring Report. Report No. 11-1365-0001/DCN-052. Submitted to Mackenzie Valley Environmental Impact Review Board. March 2010.

Table YKDFN_2.27-1 Summary of Phytoplankton Taxonomic Richness in Lakes within the Local Study Area (1996, 2004, 2005 and 2007)

Taxonomic Group	1996[a]						2004[b]							2005[b]	2007[c]						
	Kennady Lake																				
	K1		K3		K5		Lake N16	Kennady Lake					Lake 410	Kirk Lake	Lake N16	Kennady Lake					Kirk Lake
	Summer	Fall	Summer	Fall	Summer	Fall		K1	K2	K3	K4	K5				K1	K2	K3	K4	K5	
Cyanobacteria	12	11	13	11	13	12	9	11	10	13	11	9	8	12	9	11	10	13	11	9	12
Chlorophyta	13	12	14	19	17	17	21	24	22	19	16	15	22	30	21	24	22	19	16	15	30
Chrysophyta	12	16	14	19	15	18	15	14	12	17	16	21	20	20	15	14	12	17	16	21	20
Cryptophyta	1	4	3	6	4	6	2	2	3	4	2	2	3	2	2	2	3	4	2	2	2
Bacillariophyta	17	10	20	14	17	23	6	6	7	11	8	6	9	9	6	6	7	11	8	6	9
Pyrrophyta	3	2	4	4	4	6	3	2	1	2	1	2	5	3	3	2	1	2	1	2	3
Euglenophyta	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Taxa	**59**	**55**	**68**	**73**	**70**	**83**	**56**	**59**	**55**	**66**	**54**	**54**	**67**	**76**	**56**	**59**	**55**	**66**	**54**	**54**	**76**

Sources:

[a] Annex J (De Beers 2010).

[b] Annex J (De Beers 2010).

[c] Addendum JJ (De Beers 2010).

Table YKDFN_2.27-2 Summary of Phytoplankton Taxonomic Richness in Lakes within the Local Study Area (2011)

Taxonomic Group	2011[a]															
	East Lake (Reference Lake)					East Lake Mean	Lake L2	Lake M1	Lake M2	Lake M3	Lake M4	Lake N11					Lake N11 Mean
	D1	D2	D3	D4	D5							D1	D2	D3	D4	D5	
Cyanobacteria	6	6	6	5	5	6	3	4	5	5	7	7	6	7	5	6	6
Chlorophyta	13	12	13	11	12	12	4	7	12	9	10	14	13	14	14	14	14
Chrysophyta	12	11	12	12	10	11	15	12	13	12	11	9	9	9	10	12	10
Cryptophyta	2	1	2	2	2	2	3	2	3	4	3	2	2	2	1	2	2
Bacillariophyta	4	5	5	6	5	5	3	2	3	2	4	2	2	2	2	2	2
Pyrrophyta	1	1	1	1	1	1	2	2	2	1	1	1	1	1	0	1	1
Euglenophyta	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Total Taxa	**39**	**36**	**39**	**37**	**35**	**37**	**31**	**31**	**37**	**33**	**36**	**34**	**33**	**36**	**32**	**37**	**34**

Source:

[a] Golder (2012).

Table YKDFN_2.27-3 Summary of Zooplankton Species Richness in Lakes within the Local Study Area (1996, 2004, 2005 and 2007)

Taxonomic Group	1996[(a)]						2004[(b)]							2005[(b)]	2007[(c)]							
	Kennady Lake						Kennady Lake					Control Lake	Lake 410	Kirk Lake	Lake N16	Kennady Lake					Lake 410	Kirk Lake
	K1		K3		K5																	
	Summer	Fall	Summer	Fall	Summer	Fall	K1	K2	K3	K4	K5					K1	K2	K3	K4	K5		
Cladocera	2	3	1	3	4	1	3	3	3	3	3	2	3	2	3	3	3	3	3	4	5	6
Calanoida	3	3	4	3	2	1	4	4	4	4	4	3	4	4	3	4	4	4	4	4	4	4
Cyclopoida	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	3
Rotifera	2	5	2	6	3	1	1	2	1	1	1	2	1	4	5	6	6	6	4	6	4	4
Total Taxa	**9**	**13**	**9**	**14**	**10**	**4**	**9**	**10**	**9**	**9**	**9**	**8**	**9**	**11**	**12**	**14**	**14**	**14**	**12**	**15**	**15**	**17**

Sources:

(a) Annex J (De Beers 2010).

(b) Annex J (De Beers 2010).

(c) Addendum JJ (De Beers 2010).

Table YKDFN_2.27-4 Summary of Zooplankton Species Richness in Lakes within the Local Study Area (2011)

Taxonomic Group	2011[a]																
	East Lake					East Lake Mean	Lake L2	Lake M1	Lake M2	Lake M3	Lake M4	Lake N11					Lake N11 Mean
	D1	D2	D3	D4	D5							D1	D2	D3	D4	D5	
Cladocera	3	3	3	2	3	3	2	3	3	3	3	2	2	2	2	2	2
Calanoida	3	4	4	3	4	4	4	4	5	4	3	4	3	3	3	3	3
Cyclopoida	2	2	2	2	2	2	3	2	2	2	2	2	2	3	2	2	2
Rotifera	4	4	4	3	3	4	3	4	4	4	4	4	4	4	4	4	4
Total Taxa	**12**	**13**	**12**	**9**	**12**	**12**	**13**	**13**	**14**	**14**	**12**	**12**	**12**	**12**	**11**	**11**	**12**

Source:

[a] Golder (2012).

GAHCHO KUÉ PROJECT ENVIRONMENTAL IMPACT STATEMENT
INFORMATION REQUEST RESPONSES

Information Request Number: YKDFN 2.28

Source: Yellowknives Dene First Nation

Subject: Plankton Species Sampling (Annex J, Sections J3.4 and J4.3)

EIS Section: Section 2: Fish and Water

Preamble

Use of a single sample to characterize phytoplankton and zooplankton community. Because of the rapid growth rates and short generation times of phytoplankton and zooplankton, species composition and total biomass of phytoplankton and zooplankton within a lake can change quickly over time. This means that characteristics of the phytoplankton and zooplankton community within a lake cannot be characterized with a single sample, as has been done for the Gahcho Kue EIS.

For development of a competent baseline understanding of biomass and community structure, it is essential to sample phytoplankton and zooplankton in reference lakes, Kennady Lake and downstream lakes once every two weeks for at least one entire open water season and then twice through the winter.

Request

YKDFN request that the company commit to developing and implementing this within their Aquatic Effects Monitoring Program. Alternatively, water clarity and Chla could serve as proxies for primary productivity, though in this case information regarding community structure would be lost. If water clarity and Chla are substituted, then a comprehensive sampling program will be required to develop a competent understanding of water clarity and Chla. These two parameters should be sampled twice per month through the open water season for reference lakes, Kennady Lake and downstream lakes.

Response

A supplemental monitoring program for phytoplankton is not planned for 2012; however, De Beers is committed to ongoing monitoring. An environmental monitoring framework is currently being developed for the Gahcho Kué Project.

The objectives of this framework are to define the criteria for Aquatic Effects Monitoring Program (AEMP) monitoring taking a high level approach. The approach to aquatic effects monitoring for the Project is still conceptual, and detailed study designs and methods will be evaluated further through consultation with communities and regulatory agencies, and developed during the licensing phase of the Project. The recommendations provided by the author of the information request with respect to phytoplankton and zooplankton monitoring will be considered during the development of the detailed study design.

In reference to the preamble, baseline information on lower trophic communities is reported in Annex J and Addendum JJ in the 2010 Environmental Impact Statement (EIS) (De Beers 2010). Additionally, supplemental monitoring data collected in 2011 is reported in Golder (2012). As part of De Beers' ongoing monitoring commitment, additional phytoplankton and chlorophyll *a* sampling will be completed and the existing baseline data will be augmented. This will provide a more robust dataset to compare future sampling results to assess potential Project-related changes.

References

De Beers (De Beers Canada Inc.). 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.

Golder (Golder Associates Ltd.). 2012. 2011 Lower Trophic Organisms Supplemental Monitoring Report. Report No. 11-1365-0001/DCN-052. Submitted to Mackenzie Valley Environmental Impact Review Board. March 2012.

April 2012

GAHCHO KUÉ PROJECT ENVIRONMENTAL IMPACT STATEMENT
INFORMATION REQUEST RESPONSES

Information Request Number: YKDFN 2.29

Source: Yellowknives Dene First Nation

Subject: Eutrophication

EIS Section: Section 8.8, Section 9.8, Sections 10.5.3 to 10.5.6 - J.3.4.1, p. J.3-32; data for Chla (Annex J, Appendix JJ, Table J.I-14) and Secchi depth (Annex J, Table J.4.2-1; Appendix J.I, Tables J.I-4&5

Preamble

It is expected that eutrophication will be one of the effects of the project on Kennady Lake and the downstream receiving environment. Currently, the assessment uses broad categories of productivity such as oligotrophic, mesotrophic, eutrophic. For tracking the effect of nutrient enrichment, it would be useful to calculate a more precise estimate of lake productivity.

The Trophic State Index (Carlson and Simpson 1996) uses Chla and nutrient parameters to calculate a value that indicates the Trophic State. These values can then be compared through space and time to precisely determine the effect of increases in nutrient concentration on productivity within the aquatic environment. Currently, the amount of data is not sufficient for calculation of a TSI, so it would be of great benefit during future monitoring programs to increase measurement of both Chla and Secchi depth.

Request

The proponent should calculate the TSI for reference lakes, Kennady Lake, and downstream lakes using Chla, TP, TN, and/or Secchi depth measurements.

Response

There are several ways of defining the trophic state of a waterbody; TSI, or trophic status indicator (Carlson 1977, Carlson and Simpson 1996) is one of them. The TSI scale ranges from 1 to 100 for three index variables (i.e., Secchi depth, total phosphorus [TP] and chlorophyll *a* [Chl *a*]), which can be used as a basis for comparing the relative trophic state of a waterbody. The TSI approach has subsequently been supplemented with total nitrogen (TN) (Kratzer and Brezonik 1981), but this index was designed to be used in nitrogen-limiting conditions, which do not apply to the waterbodies in the local study area (LSA). Low TSI values for each variable indicate lower levels of biological productivity, and higher TSI values indicate higher levels.

Trophic status of the waterbodies under baseline conditions was defined by TP concentrations, with reference to Chl *a* concentrations and Secchi depth. This assessment directly indicates the trophic state of a waterbody (Environment Canada 2004; OECD 1982) and is well-accepted by most limnologists.

Total phosphorus, Secchi depth and Chl *a* data have been collected during aquatic baseline studies and on-going supplemental monitoring programs, although not always consistently, as baseline programs completed prior to 2010 at different times by different companies, and were designed in response to different mine plans. These TP and Chl *a* data are reported for waterbodies in the Kennady Lake watershed in Annex I: Water Quality Baseline, Addendum II: Additional Water Quality Baseline Information Report (De Beers 2010), Section 8: Key Line of Inquiry: Water Quality and Fish in Kennady Lake (De Beers 2011. Sections 8.3.6.2.1 and 8.3.7.2.1), and the 2011 Water Quality and Sediment Quality Supplemental Monitoring report (Golder 2012a), and Secchi depth data are reported in Annex J: Fisheries and Aquatic Resources Baseline, and Addendum JJ: Additional Fish and Aquatic Resources Baseline Information report (De Beers 2010), and the 2011 Fish and Aquatic Resources Supplemental Monitoring report (Golder 2012b).

The average baseline values of TP (0.006 mg/L), Secchi depth (8 m), Chl *a* (0.001 mg/L) indicate that Kennady Lake is an oligotrophic lake (Environment Canada 2004; OECD 1982). The same trophic status classification applies if the TSIs are calculated using values obtained in the baseline and monitoring programs (i.e., TP: 30, Secchi depth: 30, Chl *a*: 33) also indicate oligotrophy. However, since TSI values range in a wider scale, they give an opportunity to identify small changes in trophic level rather than three main categories of the trophic level (viz., oligotrophic, mesotrophic and eutrophic). They are “unitless” values, and the scale is generally easy to understand for non-technical people. As suggested by the author, ongoing monitoring will include reporting of the TSI index.

References

Carlson, R.E. 1977. A trophic state index for lakes. Limnology and Oceanography. 22:361-369.

Carlson, R.E. and J. Simpson. 1996. A Coordinator's Guide to Volunteer Lake Monitoring Methods. North American Lake Management Society. 96 pp.

De Beers (De Beers Canada Inc.). 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.

Environment Canada. 2004. Canadian guidance framework for the management of phosphorous in freshwater systems. Ecosystem health: Science-based Solutions Report No. 1-8. National Guidelines and Standards Office, Water Policy and Coordination Directorate, Environment Canada, pp. 114.

Golder (Golder Associates Ltd.). 2012a. 2011 Water Quality and Sediment Quality Supplemental Monitoring Report. Supplemental Monitoring Report. Report No. 11-1365-0001/DCN-050. Submitted to Mackenzie Valley Environmental Impact Review Board. March 2010.

Golder. 2012b. 2011 Fish and Aquatic Resources Supplemental Monitoring Report. Supplemental Monitoring Report. Report No. 11-1365-0001/DCN-054. Submitted to Mackenzie Valley Environmental Impact Review Board. March 2010.

Kratzer, C. R., and Brezonik, P. L. 1981. A Carlson-Type Trophic State Index for Nitrogen in Florida Lakes. Water Resources Bulletin 17: 713-715.

OECD. 1982. Eutrophication of Waters, Monitoring, Assessment and Control. Organization for Economic Co-operation and Development (OECD), Paris. 154 pp.

Information Request Number: YKDFN 2.30

Source: Yellowknives Dene First Nation

Subject: Total Suspended Sediment

EIS Section: Section 9.6

Terms of Reference Section:

Preamble

Dewatering of Kennady Lake during construction, and discharge of water from the Water Management Pond during operations, has the potential to entrain large amounts of suspended sediment into Kennady Lake and release this sediment into the downstream receiving environment. Within Section 9 of the EIS, the potential downstream effect of suspended solids has been discounted from the effects assessment.

Request

The proponent should complete analyses which determine the areal extent, estimate the total amount, and measure the chemistry, of flocculent sediment in Kennady Lake.

Response

During construction and operations, pumped discharge from Kennady Lake will only occur while regulatory requirements, including for total suspended solids (TSS) concentration, in the discharge are met. Discharge will be sampled regularly to monitor for compliance with TSS discharge limits to be specified by the Mackenzie Valley Land and Water Board in the water license, which will be required before the Project can operate.

However, supplemental to the 2011 EIS Update (De Beers 2011), modelling of TSS during the dewatering of Kennady Lake (i.e., Areas 3 and 5) has been conducted for the 2012 EIS Supplement (De Beers 2012). This modelling evaluates the potential for sediment resuspension as a result of the dewatering, the extent of the increase in TSS concentrations, and the particular climatic conditions (i.e., wind direction, intensity and frequency) that exacerbates TSS conditions within the drawn down Areas 3 and 5. A summary of this modelling is provided below.

It is anticipated that changes to sediment chemistry in Areas 3 and 5 will be negligible and not expected to deviate from baseline conditions, despite the potential to use flocculants to manage elevated TSS in the water management pond. The Project Description (Section 3 of the 2012 EIS Supplement, De Beers 2012) states that during dewatering, any excess capacity of Areas 3 and 5 can be used to settle and/or store water unsuitable for release directly to the adjacent N lakes watershed. To extend the amount of time that dewatering can potentially occur from Areas 3 and 5, flocculant may be added as required to reduce TSS in sediment-laden waters that are transferred to Areas 3 and 5 from Areas 6 and 7. The area that has been assigned as a settling area in the southern end of Area 5 to receive the flocculant-treated water will eventually be covered by the West Mine Rock Pile, eliminating any potential for effects to sediment quality in the refilled lake due to the settled flocculant material. For the most part, sediment that is entrained from the upper layer of the lake bed or shoreline during the dewatering process is expected to possess similar geochemical characteristics to other lake bed areas within Kennady Lake it settles to.

The water quality modelling for Lake N11, which receives dewatering and operational discharge from Areas 3 and 5, included a source term for TSS that was consistent with baseline TSS concentrations. It is an assumption in the modelling, that potential TSS effects in discharge would be mitigated by retaining waters within the water management pond if they do not meet TSS discharge criteria, or by treating prior to release to ensure discharge criteria are met. Additionally, any TSS in the pumped discharge to Lake N11 would be expected to attenuate rapidly within localized proximity of the outfall.

De Beers is committed to undertaking regular monitoring and follow-up testing of water and sediment during the Project (De Beers 2011, Section 8.16). This is anticipated to include water quality of pumped discharge and receiving waters (i.e., Lake N11), and sediment quality in Kennady Lake (e.g., the water management pond). If it is identified that the water or sediment is worse than predictions, adaptive management strategies will be triggered to address the problem.

TSS Modelling Summary

As the water level is drawn down in Kennady Lake, the modelling conducted for the 2012 EIS Supplement (De Beers 2012) suggests localized areas of high TSS and turbidity will occur in shallow areas along the downwind shorelines. Although TSS discharge criteria for receiving waterbodies is in the order of approximately 25 milligrams per litre (mg/L), localized areas of the isolated and dewatered Kennady Lake will have concentrations greater than 100 mg/L for a few days (De Beers 2012). Wind-induced mixing would also cause elevated levels of TSS throughout most of the basin for longer periods of time.

The modelling of TSS was based on three linked systems. The first system predicted wave geometry for single wind storms on the lake by applying the classic forecasting equations for waves in shallow water, as presented in U.S. Army Corps of Engineers (1984). Secondly, the modelling used equations developed by Sheng and Lick (1979) to predict wind-induced resuspension of bed sediment for shallow water areas in Lake Erie, which were successfully applied by Laenen and LeTourneau (1996) in Upper Klamath Lake, Oregon. Finally, the modelling employed the Generalized Environmental Modelling System for Surface waters (GEMSS®) (ERM 2012) to simulate hydrodynamic dispersion of TSS in the lake.

Increases in TSS and turbidity in the drawn-down Kennady Lake will likely be related to resuspension of the silt and clay from new source areas as they become exposed to disturbance within the lake. The maximum depth of the disturbance caused by a water wave sufficient to cause suspension of sediment is referred to as the resuspension zone. In Kennady Lake before draw down, much of the finer sediment material has been winnowed from the resuspension zone over the years and deposited in deeper zones of the lake beneath the resuspension zone. Drawing Kennady Lake down, especially below 2 m and beyond a large proportion of the littoral zone that is typically comprised of a cobble boulder substrate, will expose new areas of the lake bed to resuspension activity.

Modelling suggests that after a drawdown of 3 m, a single wind storm with wind speeds of 6 metres per second (m/s) over a 6 hour (h) period has the potential to cause elevated TSS in the order of 50 mg/L to 1,000 mg/L on the downwind shore for 2 to 30 days after the occurrence of the storm, with elevated levels of TSS lasting until the lake freezes (De Beer 2012). Following freeze-up, TSS concentrations are expected to settle out completely. Similarly, when water levels return to pre-development levels TSS concentrations are expected to be similar to baseline concentrations.

References

De Beers (De Beers Canada Inc.). 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. 2012. *Environmental Impact Statement Supplemental Information Submission for the Gahcho Kué Project*. Submitted to the Mackenzie Valley Environmental Impact Review Board. April 2012.

ERM. 2012. Generalized Environmental Modeling System for Surfacewaters (GEMSS®). http://www.erm-smg.com/gemss.html

Laenen, A. and A.P. Letourneau. 1996. Upper Klamath Basin Nutrient Loading Study-Estimate of Wind-Induced Resuspension of Bed Sediment During Periods of Low Lake Elevation. US Geological Survey Open-File Report 95-414. Portland, OR, USA. 11 pp.

Sheng, Y.P. and W. Lick. 1979. The Transport and Resuspension of Sediments in a Shallow Lake. *Journal of Geophysical Research* 84:1809-1826.

US Army Corps of Engineers. 1984. Chapter 3 Wave and Water Level Predictions. In Shore Protection Manual, Volume 1. Department of the Army Waterways Experiment Station. Washington, DC, USA. p. 55-77.

April 2012

GAHCHO KUÉ PROJECT ENVIRONMENTAL IMPACT STATEMENT
INFORMATION REQUEST RESPONSES

Information Request Number: YKDFN 2.31

Source: Yellowknives Dene First Nation

Subject: Baseline Water Chemistry (Tables 9.3-19 & 8.3-21)

EIS Section: Section 2: Fish and Water

Terms of Reference Section:

Preamble

Baseline conditions are of prime importance in understanding and recognizing project effects in future years. A simple yet effective approach to defining baseline water chemistry is to develop a description of baseline water chemistry using box plot analysis (median, 25%, 75%, and definition of outliers) and Piper Plots. The use of box and whisker plots is superior to the use of maxima and minima because these latter values provide no understanding of the upper and lower bounds of baseline condition. The use of box and whisker plots allows for the identification of outliers, which is always important for water chemistry datasets.

Request

The proponent should develop box and whisker plots should be for the water chemistry data of all lakes and streams in the Study Area, and the box plots should be used to define upper and lower bounds of baseline water chemistry.

Response

A comprehensive description of baseline water quality for the Kennady Lake watershed and downstream lakes is provided in Annex I and Addendum II of the Environmental Impact Statement (EIS) (De Beers 2010, with summary information provided in Sections 8.3 and 9.3 of the 2011 EIS Update [De Beers 2011]). These data represent lakes and streams in the Kennady Lake watershed (Tables 8.3-21 and 8.3-23) collected between 1995 and 2010, the L and M watersheds (Table 9.3-19) collected between 1998 and 2010, the N watersheds (Table 9.3-21) collected between 1998 and 2010, and Lake 410 and Kirk Lake (Table 9.3-24) collected between 2004 and 2010. This data represent 33 locations for physico-chemical field water quality measurements (surface) and 28 locations for water column profiles and chemical analyses during open-water seasons in the Kennady Lake watershed. For the downstream lakes and streams, this data represent 19 sampled locations for physico-chemical field water quality measurements (surface) and 16 sampled locations for water column profiles and chemical analyses during open-water seasons. However, limited data were collected during under-ice conditions: the data represent 5 sampled locations in the Kennady Lake watershed for physico-chemical field water quality measurements (surface) and 5 sampled locations for water column profiles and chemical analyses, and for the downstream lakes, the data represent 5 sampled locations in the Kennady Lake watershed for physico-chemical field water quality measurements (surface) and 3 sampled locations for water column profiles and chemical analyses.

Supplemental monitoring was conducted in the Kennady Lake watershed and the local study area (LSA) in 2011, with the data presented in Golder (2012). For the Kennady Lake watershed, the 2011 monitoring program sampled 11 lake sites during under-ice conditions and 11 lake sites and one stream site (inlets/outlets) during open-water conditions for water quality profile measurements and chemical analyses. For the downstream lakes, the program included 19 lake sites during under-ice conditions and 23 lake sites and five stream sites (inlets/outlets) during open-water conditions for water quality profile measurements and chemical analyses. An additional open water quality program was conducted in 2011 to collect pre-development aquatic effects monitoring program (AEMP)-type data: this included comprehensive sampling in Lake 410, Lake N11, East Lake, and Area 8 in shallow and deep lake zones. This data will be reported in 2012. De Beers is committed to ongoing monitoring, with focussed work in 2012 including monitoring at five screened reference lakes during under-ice and open water conditions, and in the D-E-N lakes during open water conditions.

Summary statistics of baseline data collected from lakes in the Kennady Lake and downstream watersheds prior to 2011 have been presented in tabular form (i.e., median, minimum, maximum, number of observations and water quality guideline exceedances) in the 2011 EIS Update (De Beers 2011, Tables 8.3-21, 8.3-23, 9.3-19, 9.3-21, and 9.3-24). As suggested by the author, box plots and piper plots have been generated for water quality parameters measured in the downstream lakes, separated by under-ice and open water conditions and include the following:

Boxplots

- Figure YKDFN 2.31-1 for Kennady Lake Areas 2 to 8 [A for under-ice data and B for open-water data]);
- Figure YKDFN 2.31-2 for Small Lakes within Kennady Lake watershed; and
- Figure YKDFN 2.31-3 for Downstream Lakes.

Piper Plots

- Figure YKDFN 2.31-4 for Kennady Lake Areas;
- Figure YKDFN 2.31-5 for Small Lakes in Kennady Lake watershed; and,
- Figure YKDFN 2.31-6 for Downstream Lakes.

Data collected in the 2011 supplemental monitoring program have also been included in these plots.

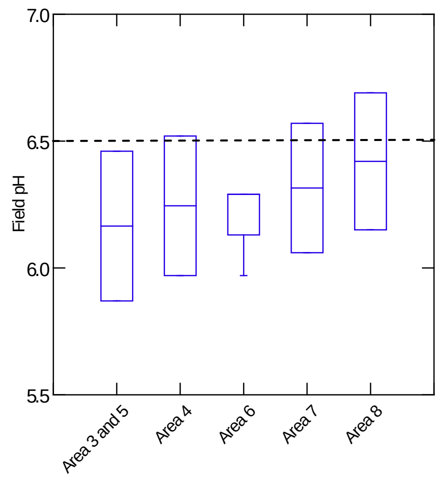
As many of the water quality parameters in downstream lakes were measured under the analytical method detection limit (MDL), especially in the earlier sampling program, we have set conditions on the data presented in the plots. For example, only those parameters that had measurements that exceeded Canadian Council of Ministers of the Environment (CCME) water quality guidelines or were detected in more than 50% samples have been presented. Therefore, not all parameters that were analyzed have been presented. Boxplots have not been generated for the stream water quality data, due to insufficient data.

Figure YKDFN 2.31-1: Summary of Historical Water Quality Data in Box Plots for Kennady Lake Areas during 1995 to 2011. A) Under-Ice Conditions B) Open-Water Conditions

Note: The box and whisker plot visually marks the following statistics: horizontal line within each box indicates the median of the data, outer edges of each box indicate 25th and 75th percentile, whiskers indicate minimum and maximum and the dotted line crossing the entire plot denotes CCME Water Quality Guidelines (not shown in case of no exceedances). In the case of dependent variables (i.e. pH, temperature, hardness), the guideline is based on the median value of the dataset.

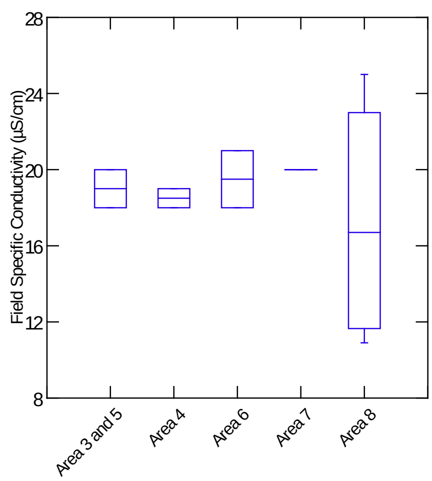
Outliers (asterisk signs) were discrete data points with values more than 1.5 times the inter-quartile range and extreme outliers (open circles) were more than 3.0 times the inter-quartile range. Some extreme outlier values are not plotted but reported in the footnote. The number of data used to derive the box and whisker plots are also noted in the footnote. Data with concentrations reported as being below the detection limit were adjusted to the MDL value.

Figure YKDFN 2.31-1.A1: Under-Ice Field pH in Kennady Lake Areas



Note: Sample count per site: Areas 3 and 5 = 2; Area 4 = 2; Area 6 = 3; Area 7 = 2; Area 8 = 2.

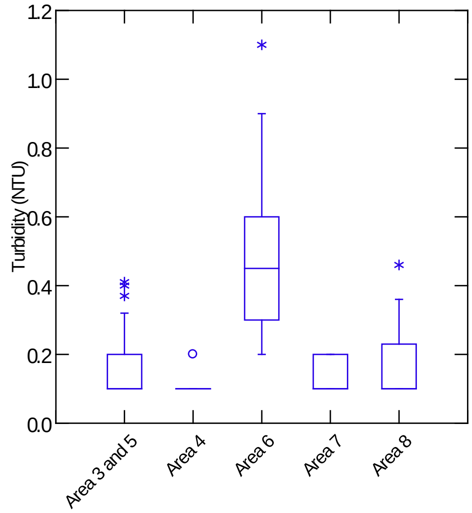
Figure YKDFN 2.31-1.A2: Under-Ice Specific Conductivity in Kennady Lake Areas



Note: µS/cm = microSiemens per centimetre.

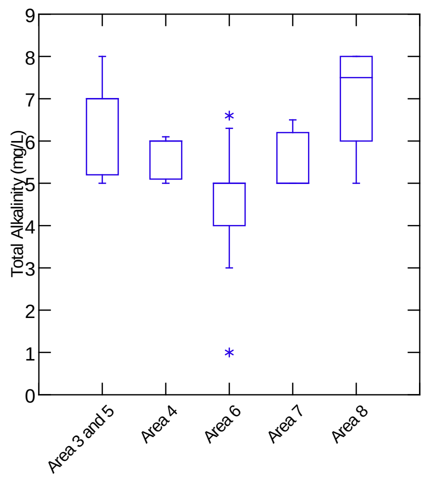
Sample count per site: Areas 3 and 5 = 2; Area 4 = 2; Area 6 = 2; Area 7 = 2; Area 8 = 4.

Figure YKDFN 2.31-1.A3: Under-Ice Turbidity in Kennady Lake Areas



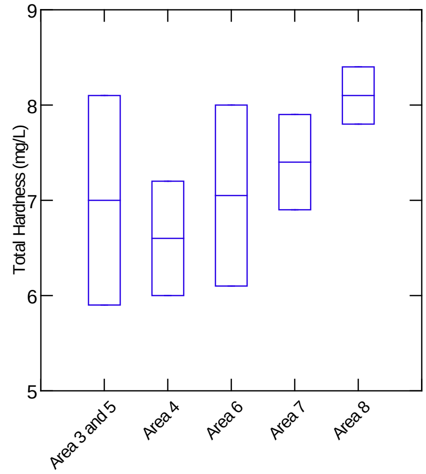
Note: NTU = Nephelometric Turbidity Units.
Sample count per site: Areas 3 and 5 = 32; Area 4 = 5; Area 6 = 20; Area 7 = 5; Area 8 = 28.
Extreme outlier not plotted = 1.9 NTU at Area 6

Figure YKDFN 2.31-1.A4: Under-Ice Total Alkalinity in Kennady Lake Areas



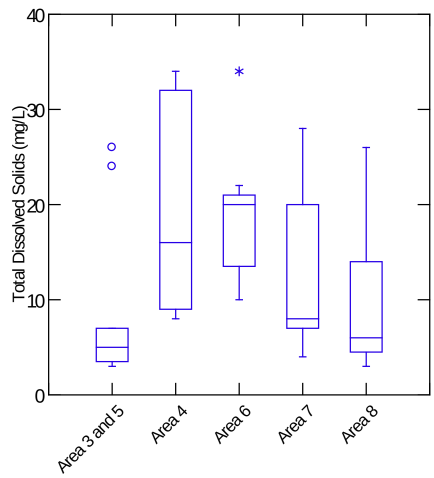
Note: mg/L = milligrams per litre; total alkalinity presented as calcium carbonate.
Sample count per site: Areas 3 and 5 = 41; Area 4 = 5; Area 6 = 23; Area 7 = 5; Area 8 = 28.

Figure YKDFN 2.31-1.A5: Under-Ice Total Hardness in Kennady Lake Areas



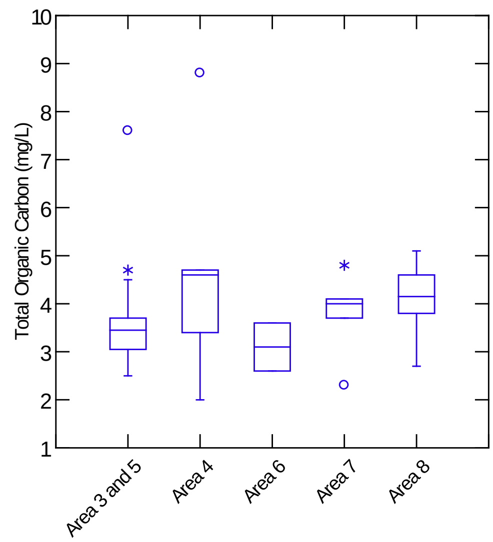
Note: mg/L = milligrams per litre; total hardness presented as calcium carbonate.
Sample count per site: Areas 3 and 5 = 2; Area 4 = 2; Area 6 = 2; Area 7 = 2; Area 8 = 2.

Figure YKDFN 2.31-1.A6: Under-Ice Total Dissolved Solids in Kennady Lake Areas



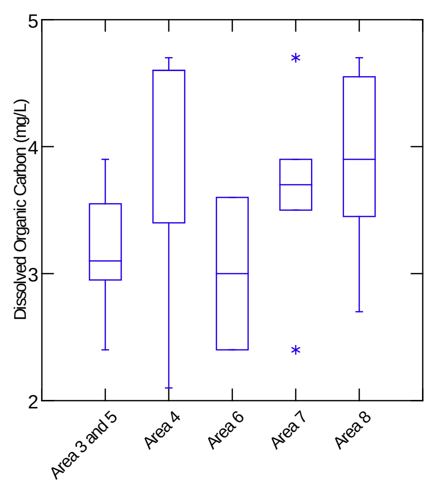
Note: mg/L = milligrams per litre.
Sample count per site: Areas 3 and 5 = 11; Area 4 = 5; Area 6 = 15; Area 7 = 5; Area 8 = 8.

Figure YKDFN 2.31-1.A7: Under-Ice Total Organic Carbon in Kennady Lake Areas



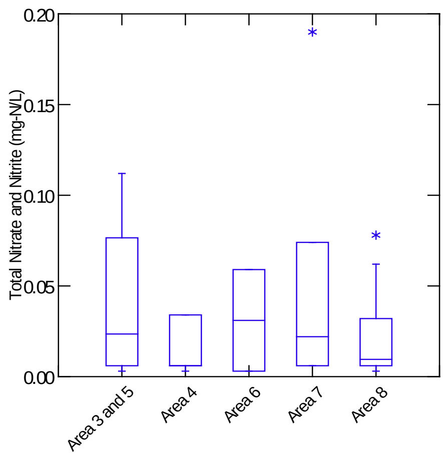
Note: mg/L = milligrams per litre.
Sample count per site: Areas 3 and 5 = 32; Area 4 = 5; Area 6 = 2; Area 7 = 5; Area 8 = 8.

Figure YKDFN 2.31-1.A8: Under-Ice Dissolved Organic Carbon in Kennady Lake Areas



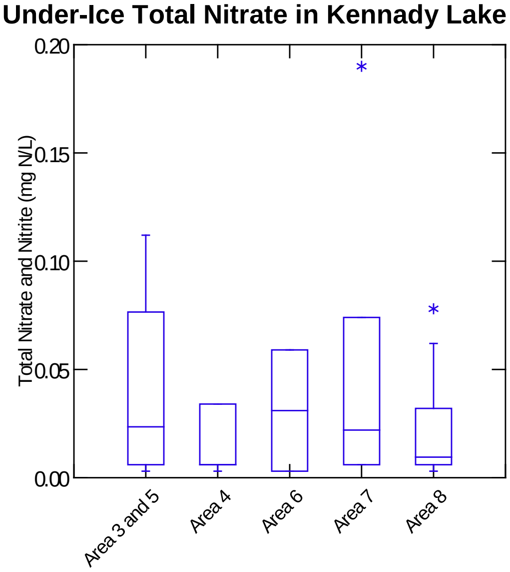
Note: mg/L = milligrams per litre.
Sample count per site: Areas 3 and 5 = 11; Area 4 = 5; Area 6 = 2; Area 7 = 5; Area 8 = 8.

Figure YKDFN 2.31-1.A9: Under-Ice Total Nitrate and Nitrite in Kennady Lake Areas



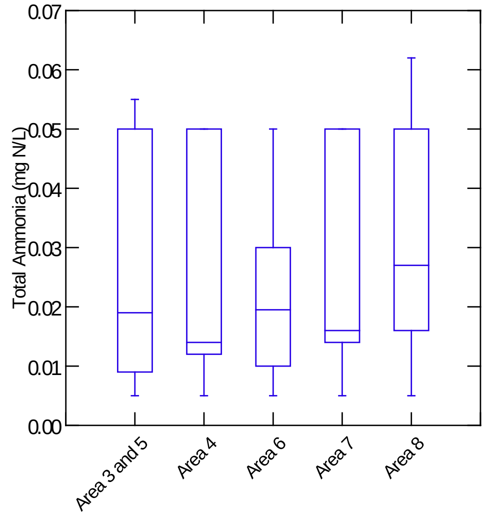
Note: mg N/L = milligrams nitrogen per litre.
Sample count per site was: Areas 3 and 5 = 28; Area 4 = 5; Area 6 = 2; Area 7 = 5; Area 8 = 20.
Extreme outlier not plotted = 0.34 mg/L at Areas 3 and 5.

Figure YKDFN 2.31-1.A10: Under-Ice Total Nitrate in Kennady Lake Areas



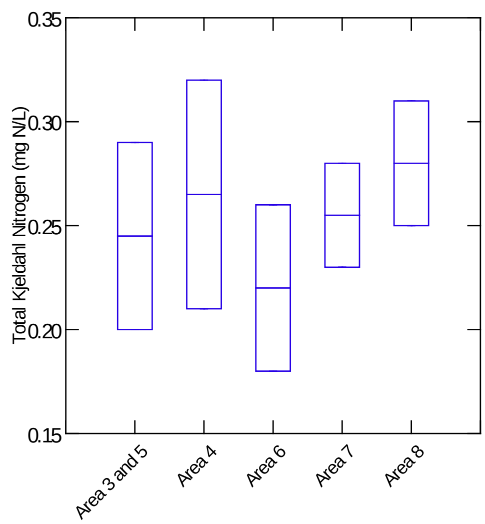
Note: mg N/L = milligrams nitrogen per litre.
Sample count per site: Areas 3 and 5 = 41; Area 4 = 5; Area 6 = 2; Area 7 = 5; Area 8 = 20.

Figure YKDFN 2.31-1.A11: Under-Ice Total Ammonia in Kennady Lake Areas



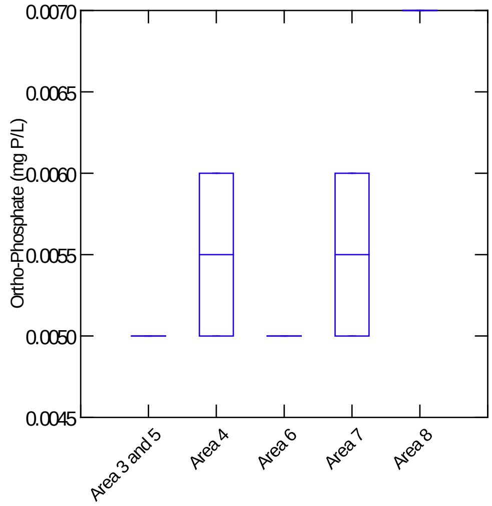
Note: mg N/L = milligrams nitrogen per litre.
Sample count per site: Areas 3 and 5 = 41; Area 4 = 5; Area 6 = 22; Area 7 = 5; Area 8 = 28.

Figure YKDFN 2.31-1.A12: Under-Ice Total Kjeldahl Nitrogen in Kennady Lake Areas



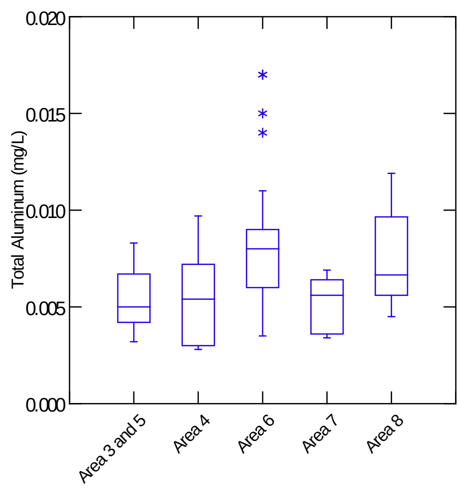
Note: mg N/L = milligrams nitrogen per litre.
Sample count per site: Areas 3 and 5 = 2; Area 4 = 2; Area 6 = 2; Area 7 = 2; Area 8 = 2.

Figure YKDFN 2.31-1.A13: Under-Ice Orthophosphate in Kennady Lake Areas



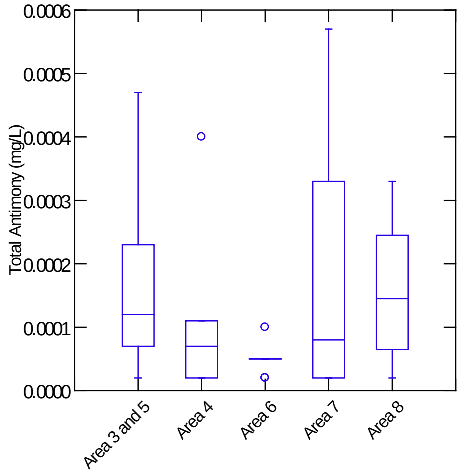
Note: mg P/L = milligrams phosphorus per litre.
Sample count per site: Areas 3 and 5 = 2; Area 4 = 2; Area 6 = 2; Area 7 = 2; Area 8 = 2.

Figure YKDFN 2.31-1.A14: Under-Ice Total Aluminum in Kennady Lake Areas



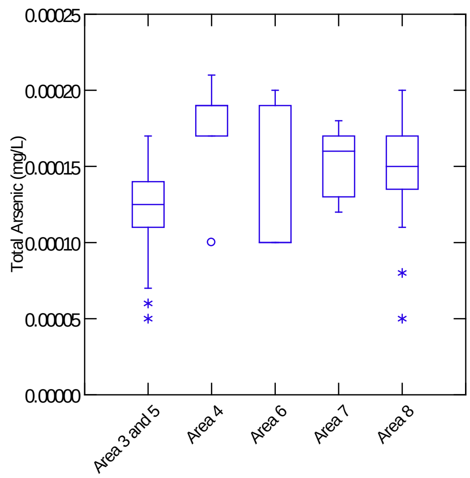
Note: mg/L = milligrams per litre.
Sample count per site: Areas 3 and 5 = 41; Area 4 = 5; Area 6 = 22; Area 7 = 5; Area 8 = 28.
Extreme outlier not plotted = 0.05 mg/L at Area 6.

Figure YKDFN 2.31-1.A15: Under-Ice Total Antimony in Kennady Lake Areas



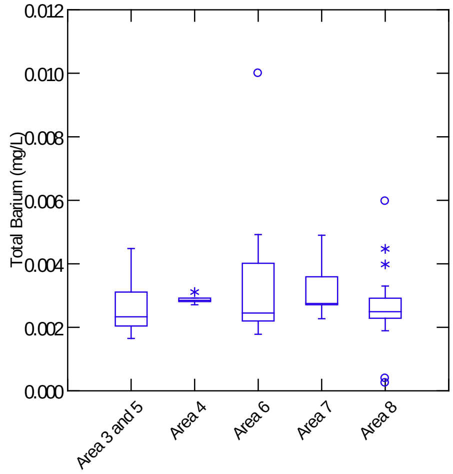
Note: mg/L = milligrams per litre.
Sample count per site: Areas 3 and 5 = 41; Area 4 = 5; Area 6 = 23; Area 7 = 5; Area 8 = 28.

Figure YKDFN 2.31-1.A16: Under-Ice Total Arsenic in Kennady Lake Areas



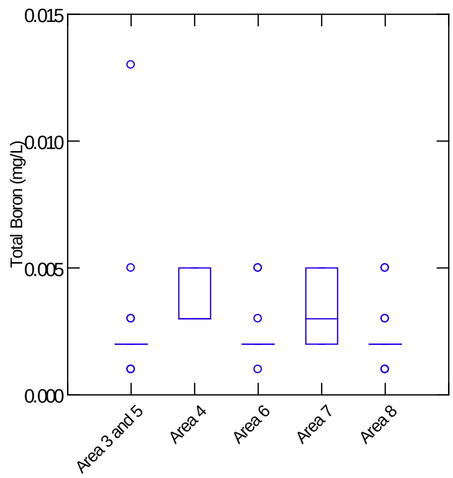
Note: mg/L = milligrams per litre.
Sample count per site: Areas 3 and 5 = 40; Area 4 = 5; Area 6 = 23; Area 7 = 5; Area 8 = 28.
Extreme outlier not plotted = 0.0007 mg/L at Areas 3 and 5.

Figure YKDFN 2.31-1.A17: Under-Ice Total Barium in Kennady Lake Areas



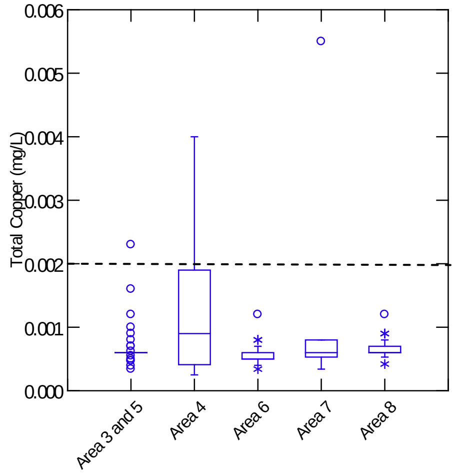
Note: mg/L = milligrams per litre.
Sample count per site: Areas 3 and 5 = 41; Area 4 = 5; Area 6 = 23; Area 7 = 5; Area 8 = 28.

Figure YKDFN 2.31-1.A18: Under-Ice Total Boron in Kennady Lake Areas



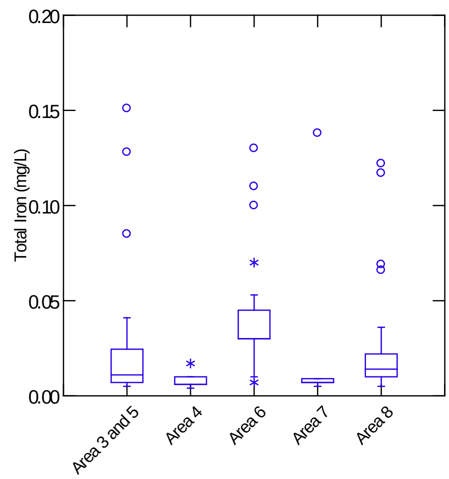
Note: mg/L = milligrams per litre.
Sample count per site: Areas 3 and 5 = 41; Area 4 = 5; Area 6 = 22; Area 7 = 5; Area 8 = 28.

Figure YKDFN 2.31-1.A19: Under-Ice Total Copper in Kennady Lake Areas



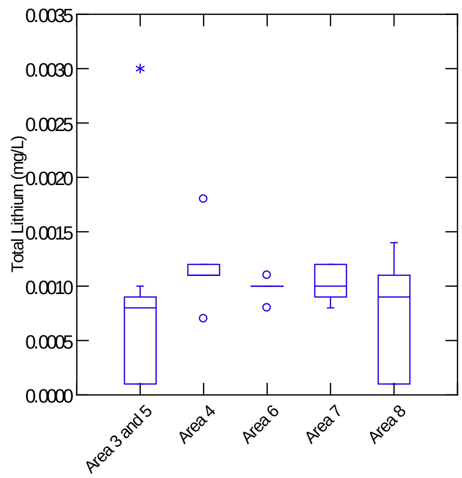
Note: mg/L = milligrams per litre.
Sample count per site: Areas 3 and 5 = 39; Area 4 = 5; Area 6 = 22; Area 7 = 5; Area 8 = 28.
Extreme outliers not plotted = 0.0153 and 0.311 mg/L at Areas 3 and 5 and 0.01 mg/L at Area 6.

Figure YKDFN 2.31-1.A20: Under-Ice Total Iron in Kennady Lake Areas



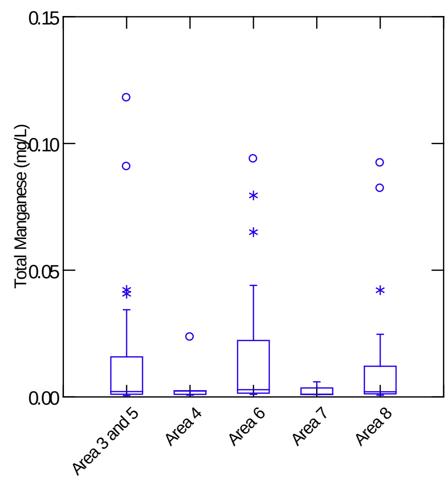
Note: mg/L = milligrams per litre.
Sample count per site: Areas 3 and 5 = 39; Area 4 = 5; Area 6 = 23; Area 7 = 5; Area 8 = 27.
Extreme outliers not plotted = 0.261 and 0.433 mg/L at Areas 3 and 5 and 0.596 mg/L at Area 8.

Figure YKDFN 2.31-1.A21: Under-Ice Total Lithium in Kennady Lake Areas



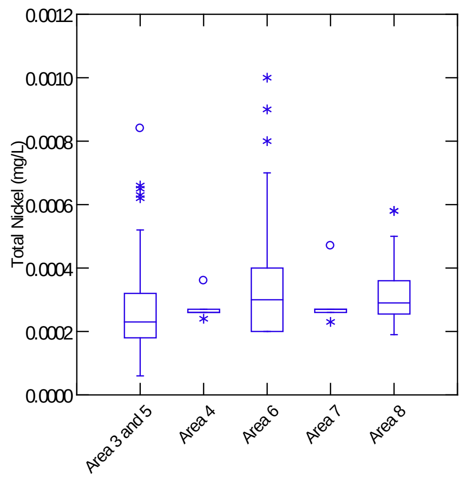
Note: mg/L = milligrams per litre.
Sample count per site: Areas 3 and 5 = 41; Area 4 = 5; Area 6 = 22; Area 7 = 5; Area 8 = 28.
Extreme outlier not plotted = 0.015 mg/L at Area 6.

Figure YKDFN 2.31-1.A22: Under-Ice Total Manganese in Kennady Lake Areas



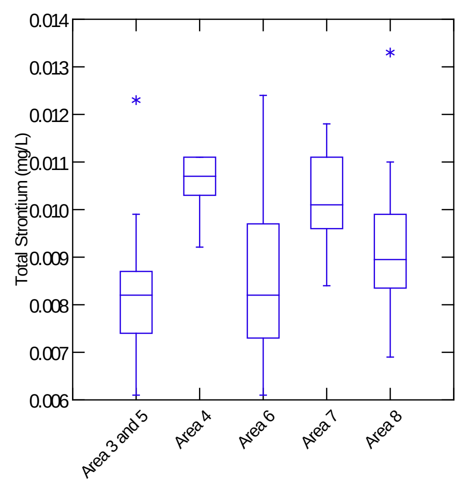
Note: mg/L = milligrams per litre.
Sample count per site: Areas 3 and 5 = 35; Area 4 = 5; Area 6 = 23; Area 7 = 4; Area 8 = 26.
Extreme outliers not plotted = 0.134, 0.18, 0.202, 0.24, 0.251and 0.378 mg/L at Areas 3 and 5; 0.201 mg/L at Area 7, and 0.207 and 0.438 mg/L at Area 8.

Figure YKDFN 2.31-1.A23: Under-Ice Total Nickel in Kennady Lake Areas



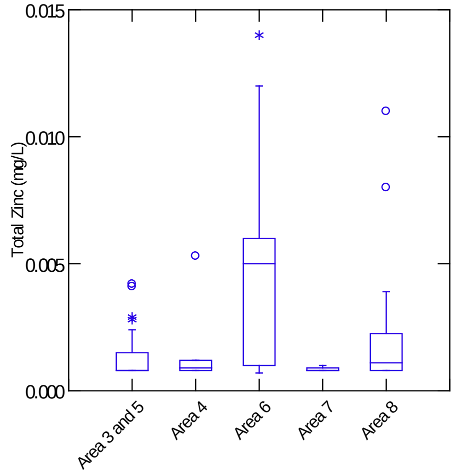
Note: mg/L = milligrams per litre.
Sample count per site: Areas 3 and 5 = 41; Area 4 = 5; Area 6 = 22; Area 7 = 5; Area 8 = 28.

Figure YKDFN 2.31-1.A24: Under-Ice Total Strontium in Kennady Lake Areas



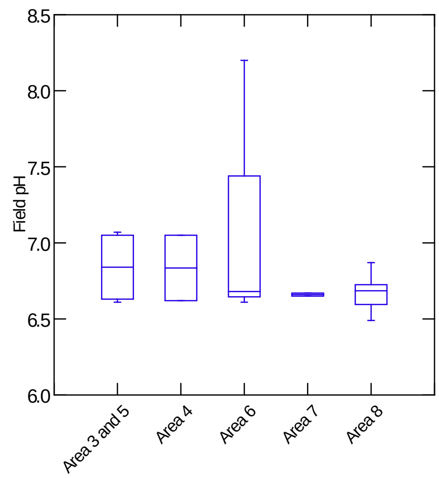
Note: mg/L = milligrams per litre.
Sample count per site: Areas 3 and 5 = 41; Area 4 = 5; Area 6 = 23; Area 7 = 5; Area 8 = 28.

Figure YKDFN 2.31-1.A25: Under-Ice Total Zinc in Kennady Lake Areas



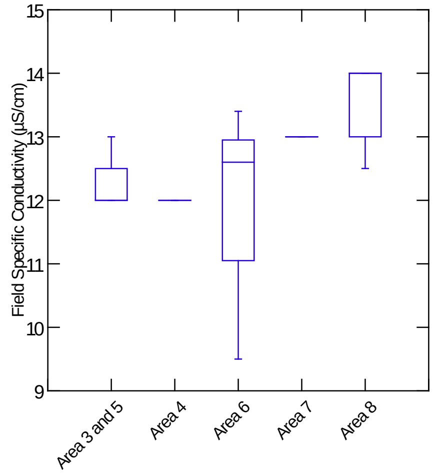
Note: mg/L = milligrams per litre.
Sample count per site: Areas 3 and 5 = 41; Area 4 = 5; Area 6 = 23; Area 7 = 5; Area 8 = 28.

Figure YKDFN 2.31-1.B1: Open-Water Field pH in Kennady Lake Areas



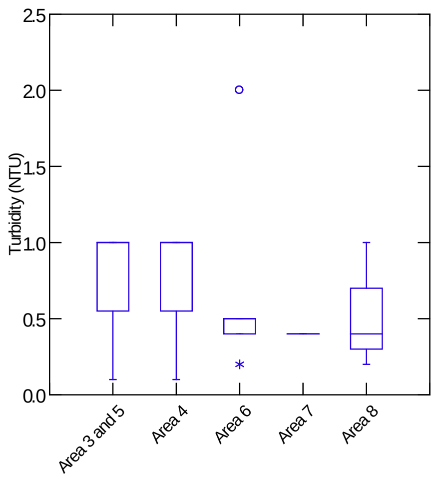
Note: Sample count per site: Areas 3 and 5 = 5; Area 4 = 3; Area 6 = 13; Area 7 = 2; Area 8 = 16.

Figure YKDFN 2.31-1.B2: Open-Water Specific Conductivity in Kennady Lake Areas



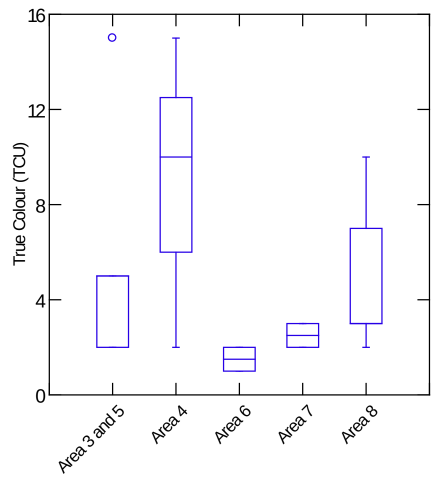
Note: µS/cm = microSiemens per centimetre.
Sample count per site: Areas 3 and 5 = 5; Area 4 = 3; Area 6 = 13; Area 7 = 2; Area 8 = 16.

Figure YKDFN 2.31-1.B3: Open-Water Turbidity in Kennady Lake Areas



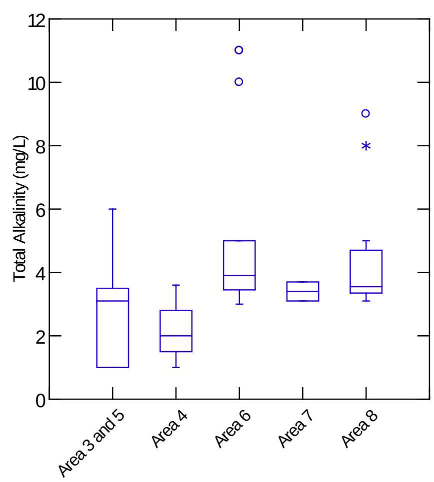
Note: NTU = Nephelometric Turbidity Units.
Sample count per site: Areas 3 and 5 = 4; Area 4 = 3; Area 6 = 9; Area 7 =1; Area 8 = 15.

Figure YKDFN 2.31-1.B4: Open-Water True Colour in Kennady Lake Areas



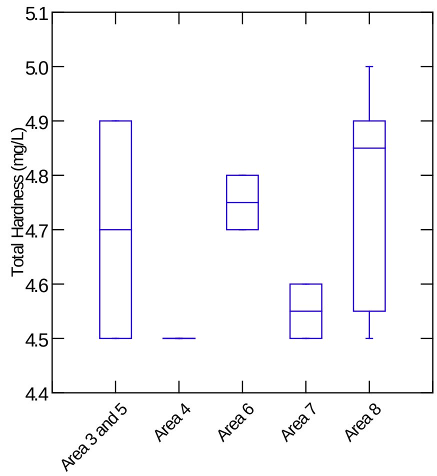
Note: TCU = True Colour Units.
Sample count per site: Areas 3 and 5 = 5; Area 4 = 3; Area 6 = 4; Area 7 = 2; Area 8 = 16.

Figure YKDFN 2.31-1.B5: Open-Water Total Alkalinity in Kennady Lake Areas



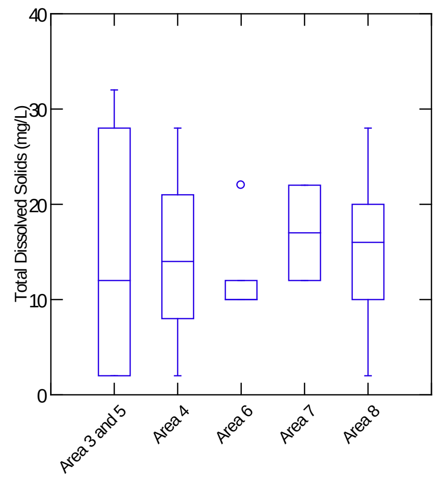
Note: mg/L = milligrams per litre; total alkalinity presented as calcium carbonate.
Sample count per site: Areas 3 and 5 = 5; Area 4 = 3; Area 6 = 20; Area 7 = 2; Area 8 = 16.

Figure YKDFN 2.31-1.B6: Open-Water Hardness in Kennady Lake Areas



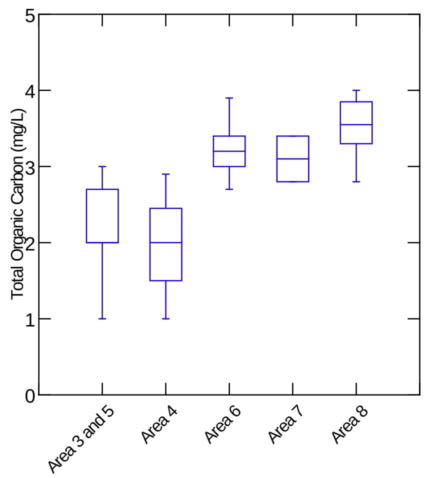
Note: mg/L = milligrams per litre.
Sample count per site: Areas 3 and 5 = 5; Area 4 = 3; Area 6 = 20; Area 7 = 2; Area 8 = 16.

Figure YKDFN 2.31-1.B7: Open-Water Total Dissolved Solids in Kennady Lake Areas



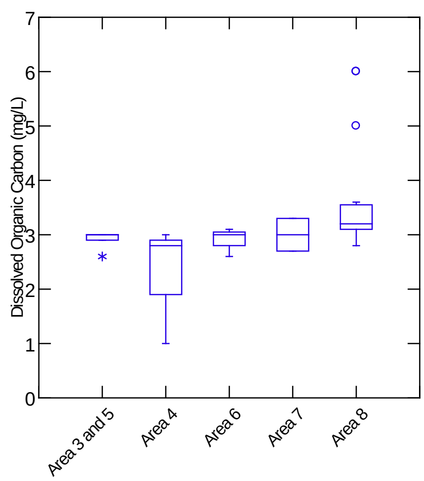
Note: mg/L = milligrams per litre.
Sample count per site: Areas 3 and 5 = 5; Area 4 = 3; Area 6 = 5; Area 7 = 2; Area 8 = 16.

Figure YKDFN 2.31-1.B8: Open-Water Total Organic Carbon in Kennady Lake Areas



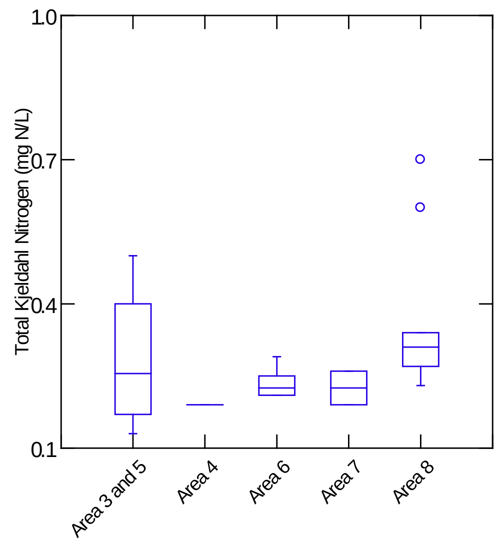
Note: mg/L = milligrams per litre.
Sample count per site: Areas 3 and 5 = 5; Area 4 = 3; Area 6 = 8; Area 7 = 2; Area 8 = 16.

Figure YKDFN 2.31-1.B9: Open-Water Dissolved Organic Carbon in Kennady Lake Areas



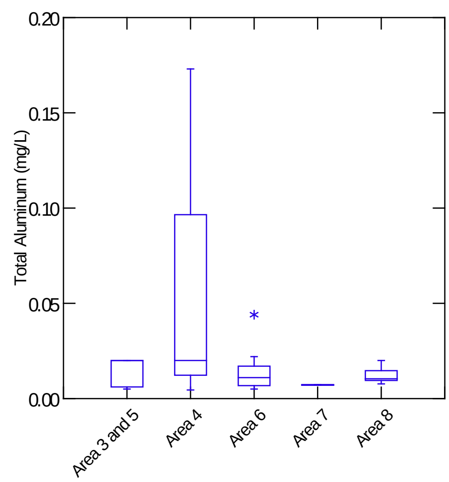
Note: mg/L = milligrams per litre.
Sample count per site: Areas 3 and 5 = 5; Area 4 = 3; Area 6 = 4; Area 7 = 2; Area 8 = 16.

Figure YKDFN 2.31-1.B10: Open-Water Total Kjeldahl Nitrogen in Kennady Lake Areas



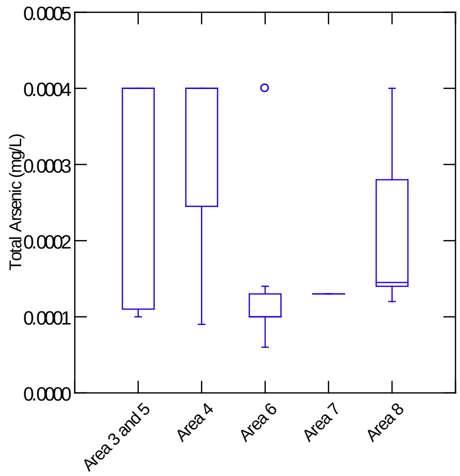
Note: mg N/L = milligrams nitrogen per litre.
Sample count per site: Areas 3 and 5 = 5; Area 4 = 1; Area 6 = 6; Area 7 = 2; Area 8 = 14.
Extreme outlier not plotted = 1.3 mg N/L at Areas 3 and 5.

Figure YKDFN 2.31-1.B11: Open-Water Total Aluminum in Kennady Lake Areas



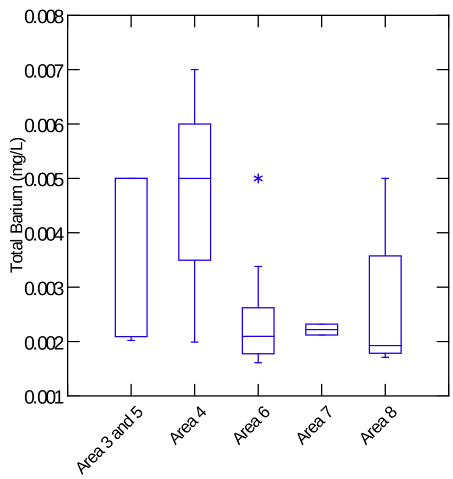
Note: mg/L = milligrams per litre.
Sample count per site: Areas 3 and 5 = 5; Area 4 = 3; Area 6 = 26; Area 7 = 2; Area 8 = 16.
Extreme outlier not plotted = 0.73 mg/L at Area 6.

Figure YKDFN 2.31-1.B12: Open-Water Total Arsenic in Kennady Lake Areas



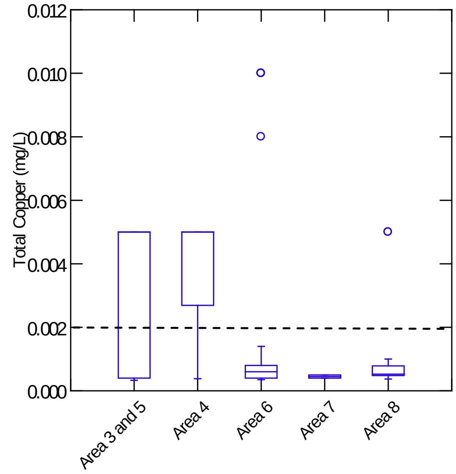
Note: mg/L = milligrams per litre.
Sample count per site: Areas 3 and 5 = 5; Area 4 = 3; Area 6 = 26; Area 7 = 2; Area 8 = 16.
Extreme outlier not plotted = 0.001 mg/L at Area 6.

Figure YKDFN 2.31-1.B13: Open-Water Total Barium in Kennady Lake Areas



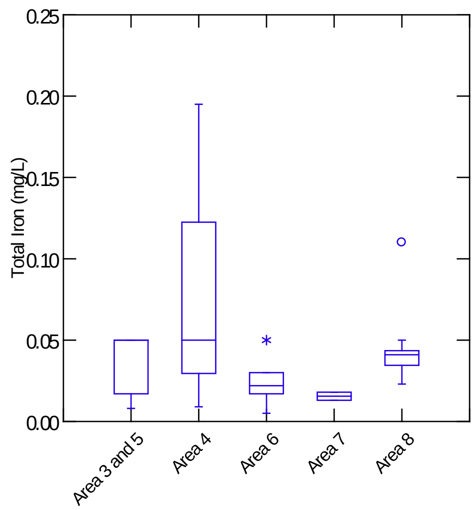
Note: mg/L = milligrams per litre.
Sample count per site was: Areas 3 and 5 = 5; Area 4 = 3; Area 6 = 24; Area 7 = 2; Area 8 = 16.

Figure YKDFN 2.31-1.B14: Open-Water Total Copper in Kennady Lake Areas



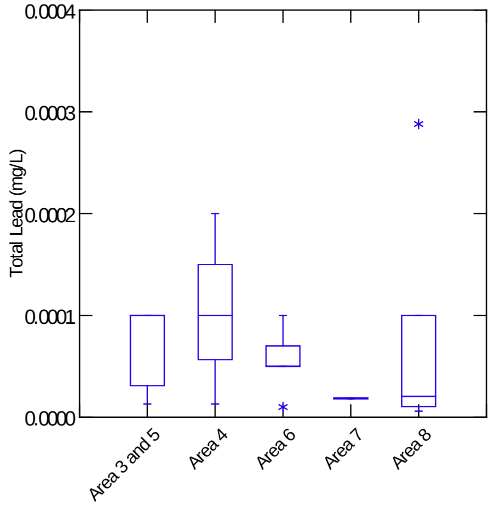
Note: mg/L = milligrams per litre.
Sample count per site: Areas 3 and 5 = 5; Area 4 = 3; Area 6 = 27; Area 7 = 2; Area 8 = 16.

Figure YKDFN 2.31-1.B15: Open-Water Total Iron in Kennady Lake Areas



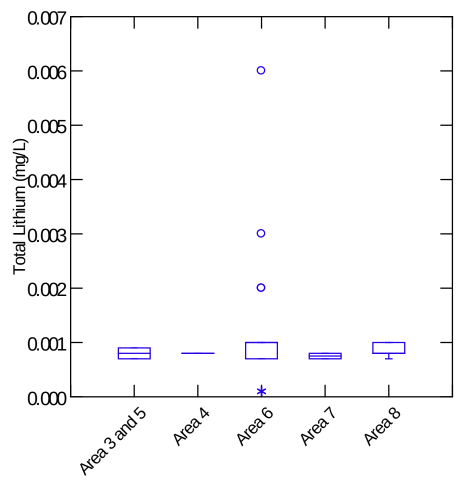
Note: mg/L = milligrams per litre.
Sample count per site: Areas 3 and 5 = 5; Area 4 = 3; Area 6 = 27; Area 7 = 2; Area 8 = 16.

Figure YKDFN 2.31-1.B16: Open-Water Total Lead in Kennady Lake Areas



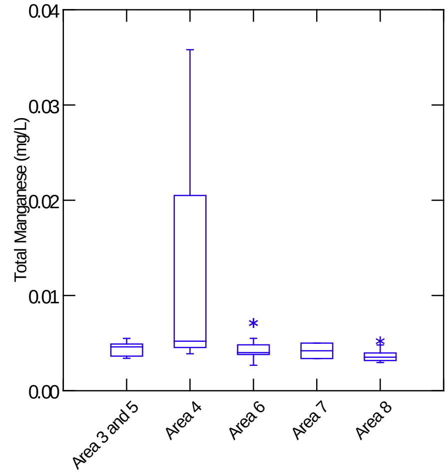
Note: mg/L = milligrams per litre.
Sample count per site: Areas 3 and 5 = 5; Area 4 = 3; Area 6 = 24; Area 7 = 2; Area 8 = 16.

Figure YKDFN 2.31-1.B17: Open-Water Total Lithium in Kennady Lake Areas



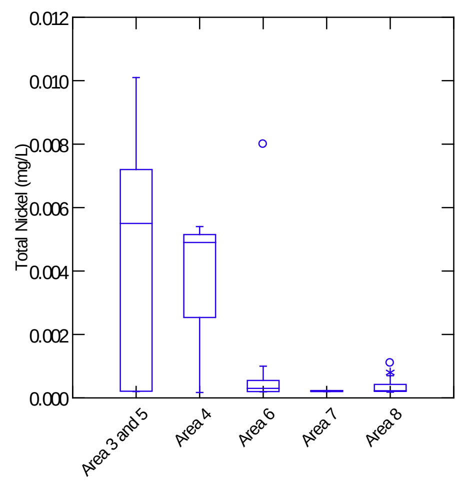
Note: mg/L = milligrams per litre.
Sample count per site: Areas 3 and 5 = 2; Area 4 = 1; Area 6 = 18; Area 7 = 2; Area 8 = 12.

Figure YKDFN 2.31-1.B18: Open-Water Total Manganese in Kennady Lake Areas



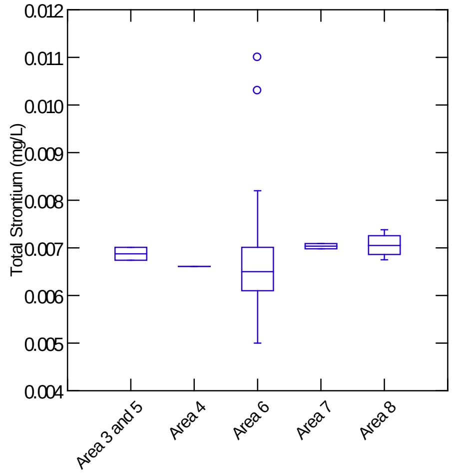
Note: mg/L = milligrams per litre.
Sample count per site: Areas 3 and 5 = 5; Area 4 = 3; Area 6 = 27; Area 7 = 2; Area 8 = 16.

Figure YKDFN 2.31-1.B19: Open-Water Total Nickel in Kennady Lake Areas



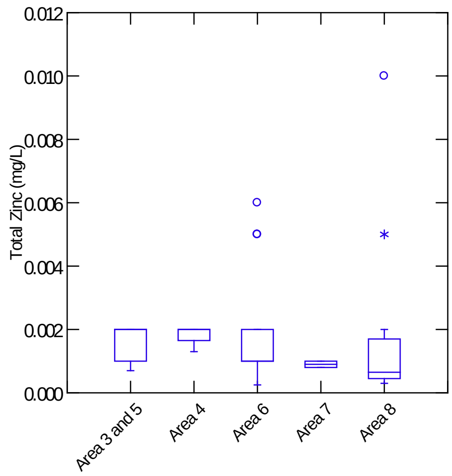
Note: mg/L = milligrams per litre.
Sample count per site: Areas 3 and 5 = 5; Area 4 = 3; Area 6 = 27; Area 7 = 2; Area 8 = 16.

Figure YKDFN 2.31-1.B20: Open-Water Total Strontium in Kennady Lake Areas



Note: mg/L = milligrams per litre.
Sample count per site was: Areas 3 and 5 = 2; Area 4 = 1; Area 6 = 24; Area 7 = 2; Area 8 = 12.
Extreme outlier not plotted = 0.02 mg/L at Area 6.

Figure YKDFN 2.31-1.B21: Open-Water Total Zinc in Kennady Lake Areas



Note: mg/L = milligrams per litre.
Sample count per site was: Areas 3 and 5 = 5; Area 4 = 3; Area 6 = 26; Area 7 = 2; Area 8 = 16.
Extreme outlier not plotted = 0.063 mg/L at Area 6.

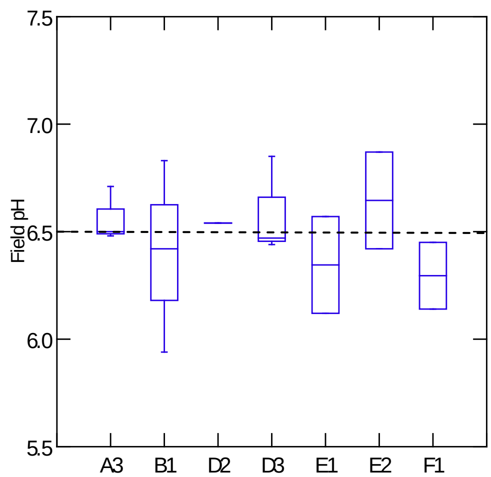
Figure YKDFN 2.31-2: Summary of Historical Water Quality Data (open-water data only) in Box Plots for Small Lakes of Kennady Lake Watershed during 1995 to 2011

Open-Water Condition data only

Note: The box and whisker plot visually marks the following statistics: horizontal line within each box indicates the median of the data, outer edges of each box indicate 25th and 75th percentile whiskers indicate minimum and maximum and the dotted line crossing the entire plot denotes CCME Water Quality Guidelines (not shown in case of no exceedances). In the case of dependent variables (i.e. pH, temperature, hardness), the guideline is based on the median value of the dataset.

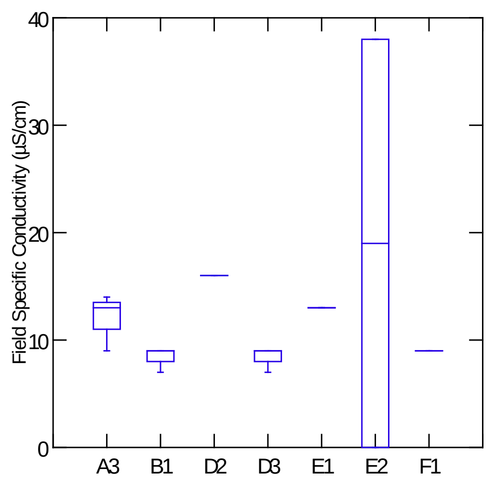
Outliers (asterisk signs) were discrete data points with values more than 1.5 times the inter-quartile range and extreme outliers (open circles) were more than 3.0 times the inter-quartile range. Some extreme outlier values are not plotted but reported in the footnote. The number of data used to derive the box and whisker plots are also noted in the footnote. Data with concentrations reported as being below the detection limit were adjusted to the MDL value.

Figure YKDFN 2.31-2.1: Open-Water Field pH in Small Lakes of Kennady Lake Watershed



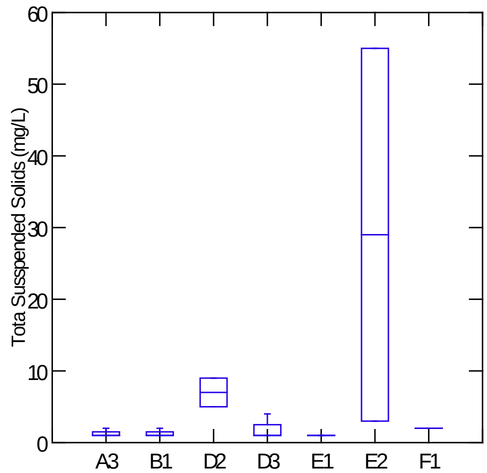
Note: Sample count per site: A3 = 3; B1 = 3; D2 = 2; D3 = 3; E1 = 2; E2 = 2; F1 = 2.

Figure YKDFN 2.31-2.2: Open-Water Specific Conductivity in Small Lakes of Kennady Lake Watershed



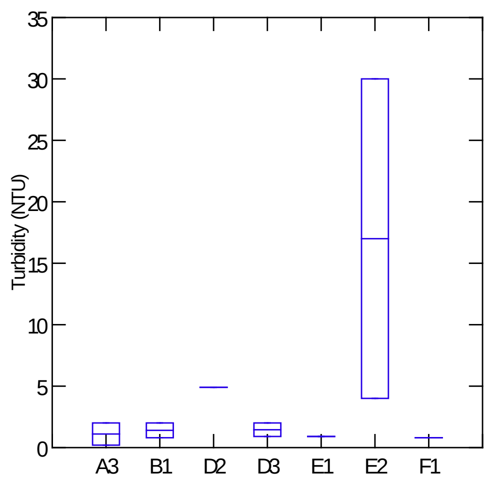
Note: µS/cm = microSiemens per centimetre.
Sample count per site: A3 = 3; B1 = 3; D2 = 2; D3 = 3; E1 = 2; E2 = 2; F1 = 2.

Figure YKDFN 2.31-2.3: Open-Water Total Suspended Solids in Small Lakes of Kennady Lake Watershed



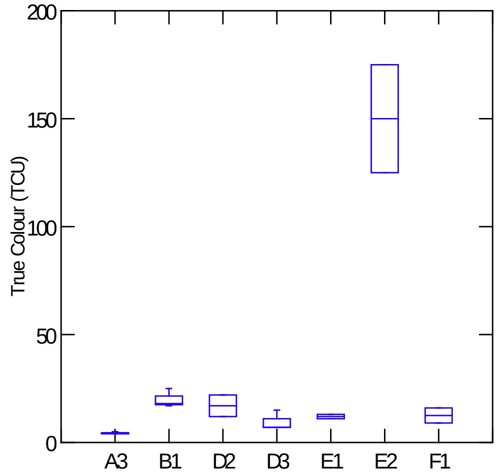
Note: mg/L = milligrams per litre.
Sample count per site: A3 = 3; B1 = 3; D2 = 2; D3 = 3; E1 = 2; E2 = 2; F1 = 2.

Figure YKDFN 2.31-2.4: Open-Water Turbidity in Small Lakes of Kennady Lake Watershed



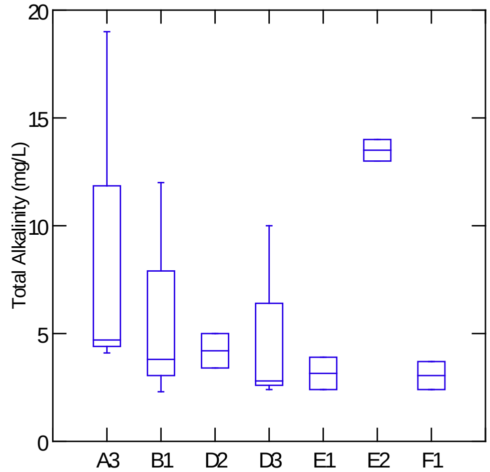
Note: NTU = Nephelometric Turbidity Units.
Sample count per site: A3 = 2; B1 = 2; D2 = 1; D3 = 2; E1 = 1; E2 = 2; F1 = 1.

Figure YKDFN 2.31-2.5: Open-Water True Colour in Small Lakes of Kennady Lake Watershed



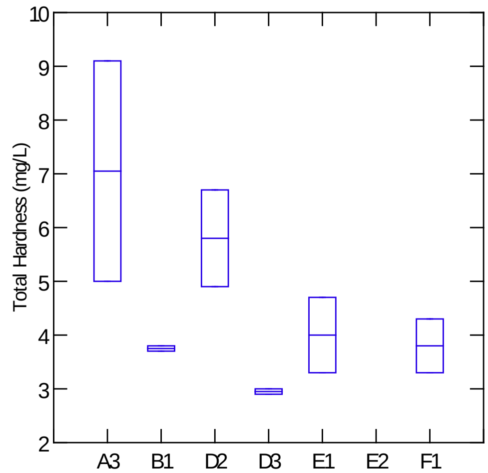
Note: TCU = True Colour Units.
Sample count per site: A3 = 3; B1 = 3; D2 = 2; D3 = 3; E1 = 2; E2 = 2; F1 = 2.

Figure YKDFN 2.31-2.6: Open-Water Total Alkalinity in Small Lakes of Kennady Lake Watershed



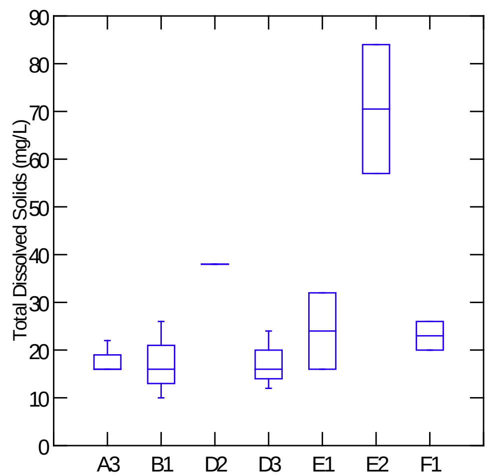
Note: mg/L = milligrams per litre; total alkalinity presented as calcium carbonate.
Sample count per site: A3 = 3; B1 = 3; D2 = 2; D3 = 3; E1 = 2; E2 = 2; F1 = 2.

Figure YKDFN 2.31-2.7: Open-Water Total Hardness in Small Lakes of Kennady Lake Watershed



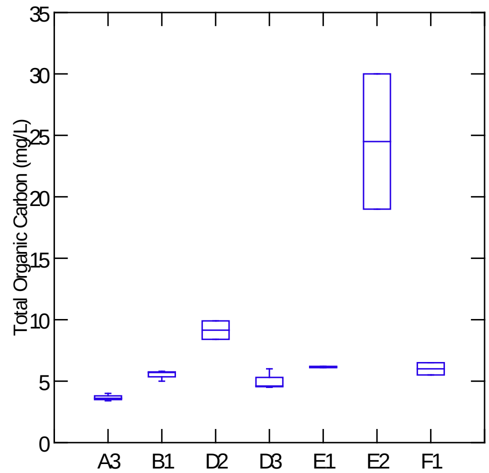
Note: mg/L = milligrams per litre.
Sample count per site: A3 = 2; B1 = 2; D2 = 2; D3 = 2; E1 = 2; E2 = 0; F1 = 2.

Figure YKDFN 2.31-2.8: Open-Water Total Dissolved Solids in Small Lakes of Kennady Lake Watershed



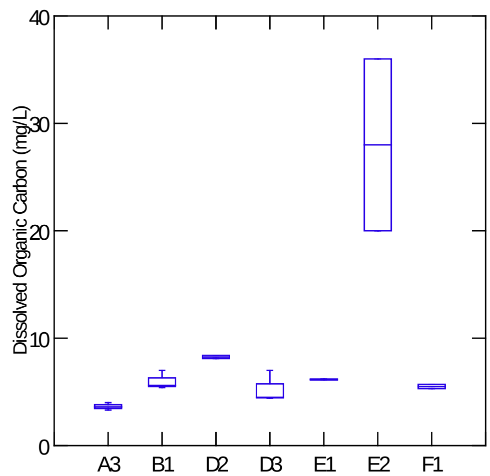
Note: mg/L = milligrams per litre.
Sample count per site: A3 = 3; B1 = 3; D2 = 2; D3 = 3; E1 = 2; E2 = 2; F1 = 2.

Figure YKDFN 2.31-2.9: Open-Water Total Organic Carbon in Small Lakes of Kennady Lake Watershed



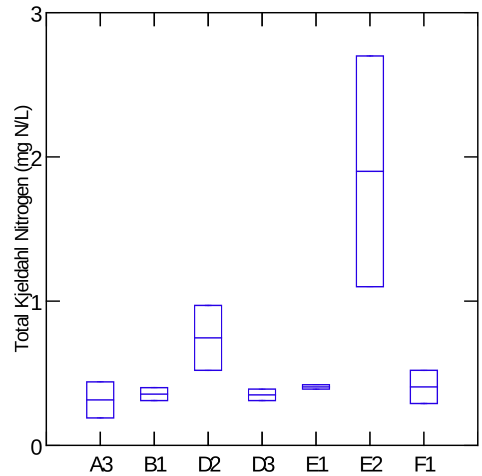
Note: mg/L = milligrams per litre.
Sample count per site: A3 = 3; B1 = 3; D2 = 2; D3 = 3; E1 = 2; E2 = 2; F1 = 2.

Figure YKDFN 2.31-2.10: Open-Water Dissolved Organic Carbon in Small Lakes of Kennady Lake Watershed



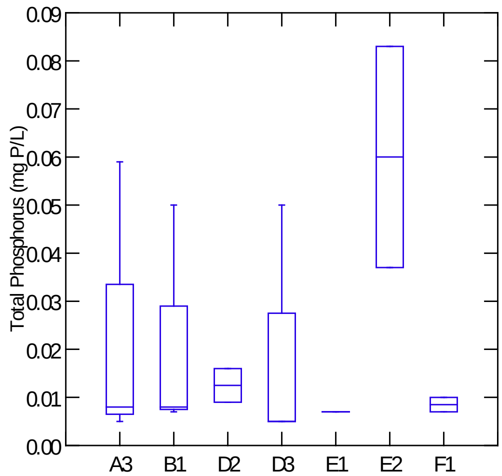
Note: mg/L = milligrams per litre.
Sample count per site: A3 = 3; B1 = 3; D2 = 2; D3 = 3; E1 = 2; E2 = 2; F1 = 2.

Figure YKDFN 2.31-2.11: Open-Water Total Kjeldahl Nitrogen in Small Lakes of Kennady Lake Watershed



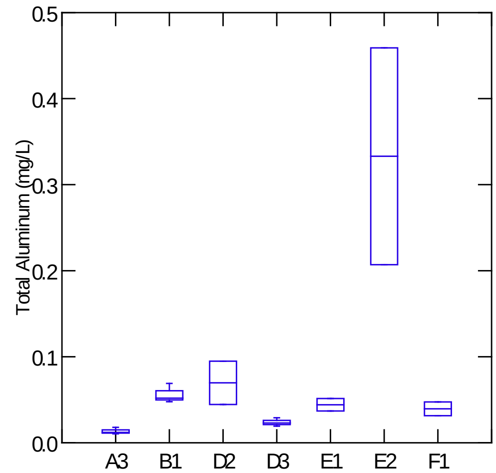
Note: mg N/L = milligrams nitrogen per litre.
Sample count per site: A3 = 3; B1 = 3; D2 = 2; D3 = 3; E1 = 2; E2 = 2; F1 = 2.

Figure YKDFN 2.31-2.12: Open-Water Total Phosphorus in Small Lakes of Kennady Lake Watershed



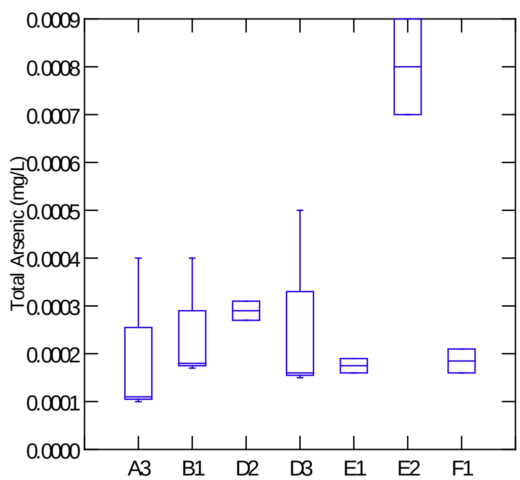
Note: mg P/L = milligrams phosphorus per litre.
Sample count per site: A3 = 3; B1 = 3; D2 = 2; D3 = 3; E1 = 2; E2 = 2; F1 = 2.

Figure YKDFN 2.31-2.13: Open-Water Total Aluminum in Small Lakes of Kennady Lake Watershed



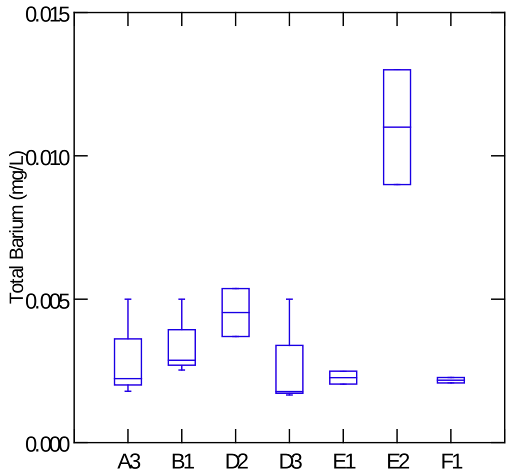
Note: mg/L = milligrams per litre.
Sample count per site: A3 = 3; B1 = 3; D2 = 2; D3 = 3; E1 = 2; E2 = 2; F1 = 2.

Figure YKDFN 2.31-2.14: Open-Water Total Arsenic in Small Lakes of Kennady Lake Watershed



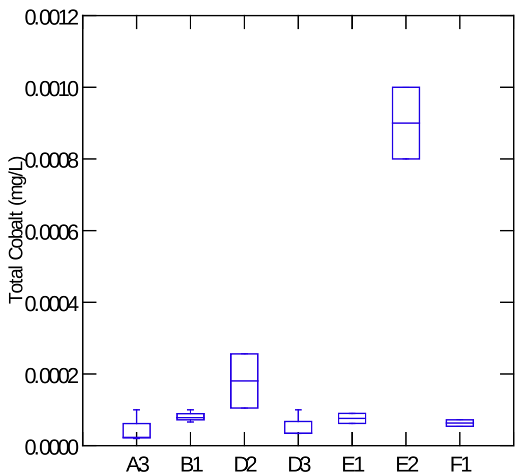
Note: mg/L = milligrams per litre.
Sample count per site: A3 = 3; B1 = 3; D2 = 2; D3 = 3; E1 = 2; E2 = 2; F1 = 2.

Figure YKDFN 2.31-2.15: Open-Water Total Barium in Small Lakes of Kennady Lake Watershed



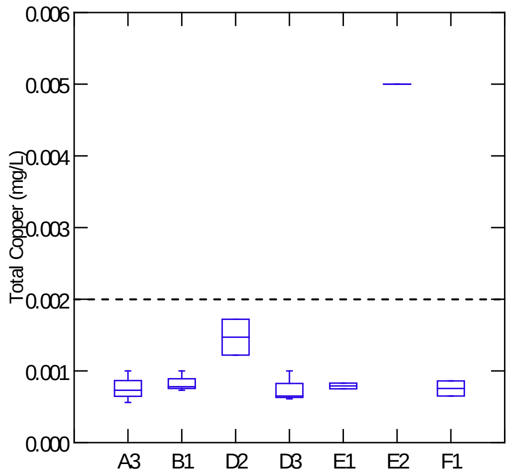
Note: mg/L = milligrams per litre.
Sample count per site: A3 = 3; B1 = 3; D2 = 2; D3 = 3; E1 = 2; E2 = 2; F1 = 2.

Figure YKDFN 2.31-2.16: Open-Water Total Cobalt in Small Lakes of Kennady Lake Watershed



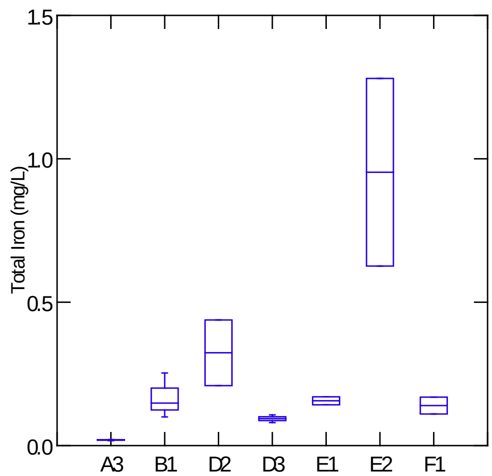
Note: mg/L = milligrams per litre.
Sample count per site: A3 = 3; B1 = 3; D2 = 2; D3 = 3; E1 = 2; E2 = 2; F1 = 2.

Figure YKDFN 2.31-2.17: Open-Water Total Copper in Small Lakes of Kennady Lake Watershed



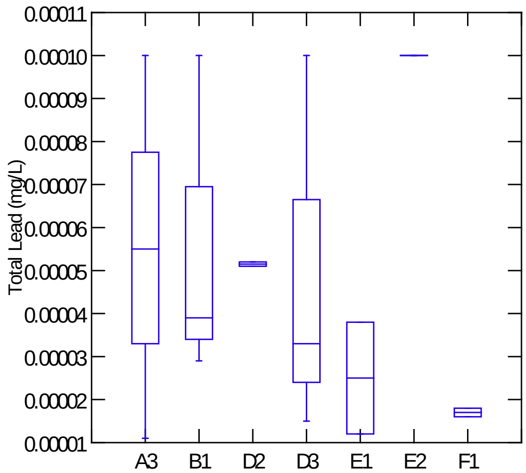
Note: mg/L = milligrams per litre.
Sample count per site: A3 = 3; B1 = 3; D2 = 2; D3 = 3; E1 = 2; E2 = 2; F1 = 2.

Figure YKDFN 2.31-2.18: Open-Water Total Iron in Small Lakes of Kennady Lake Watershed



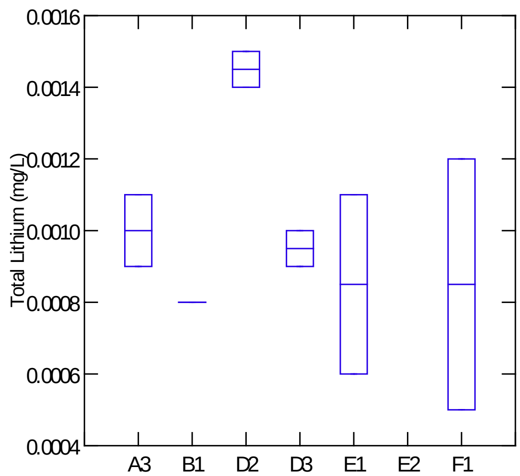
Note: mg/L = milligrams per litre.
Sample count per site: A3 = 3; B1 = 3; D2 = 2; D3 = 3; E1 = 2; E2 = 2; F1 = 2.

Figure YKDFN 2.31-2.19: Open-Water Total Lead in Small Lakes of Kennady Lake Watershed



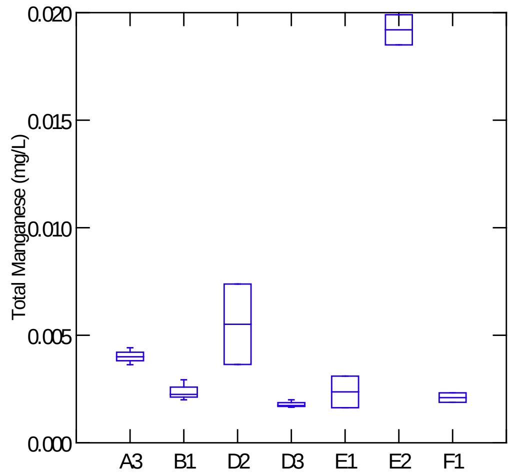
Note: mg/L = milligrams per litre.
Sample count per site: A3 = 3; B1 = 3; D2 = 2; D3 = 3; E1 = 2; E2 = 2; F1 = 2.

Figure YKDFN 2.31-2.20: Open-Water Total Lithium in Small Lakes of Kennady Lake Watershed



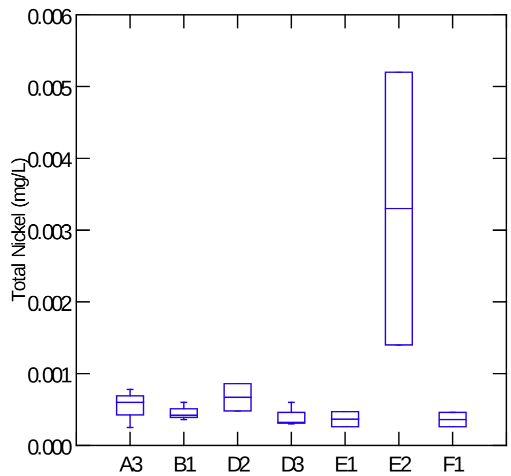
Note: mg/L = milligrams per litre.
Sample count per site: A3 = 1; B1 = 1; D2 = 2; D3 = 1; E1 = 2; E2 = 0; F1 = 2.

Figure YKDFN 2.31-2.21: Open-Water Total Manganese in Small Lakes of Kennady Lake Watershed



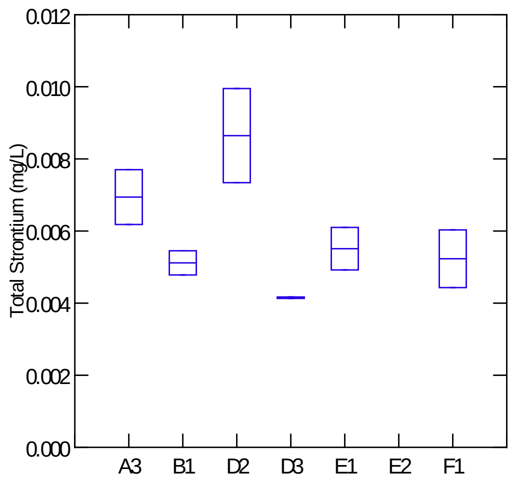
Note: mg/L = milligrams per litre.
Sample count per site: A3 = 3; B1 = 3; D2 = 2; D3 = 3; E1 = 2; E2 = 2; F1 = 2.

Figure YKDFN 2.31-2.22: Open-Water Total Nickel in Small Lakes of Kennady Lake Watershed



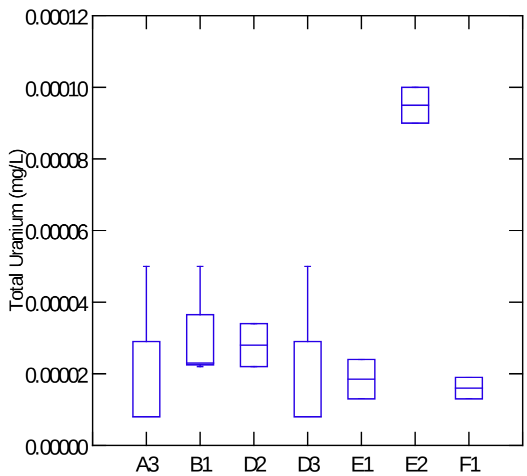
Note: mg/L = milligrams per litre.
Sample count per site was: A3 = 3; B1 = 3; D2 = 2; D3 = 3; E1 = 2; E2 = 2; F1 = 2.

Figure YKDFN 2.31-2.23: Open-Water Total Strontium in Small Lakes of Kennady Lake Watershed



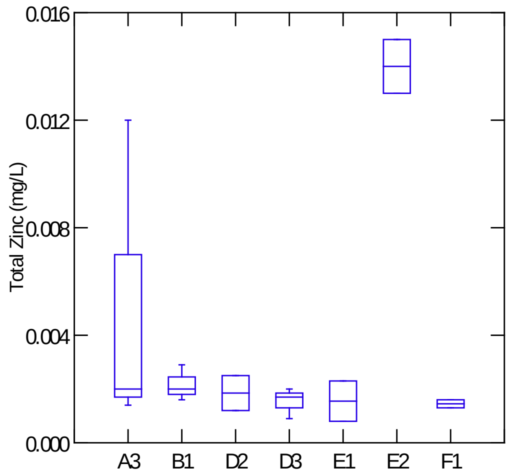
Note: mg/L = milligrams per litre.
Sample count per site: A3 = 2; B1 = 2; D2 = 2; D3 = 2; E1 = 2; E2 = 0; F1 = 2.

Figure YKDFN 2.31-2.24: Open-Water Total Uranium in Small Lakes of Kennady Lake Watershed



Note: mg/L = milligrams per litre.
Sample count per site: A3 = 3; B1 = 3; D2 = 2; D3 = 3; E1 = 2; E2 = 2; F1 = 2.

Figure YKDFN 2.31-2.25: Open-Water Total Zinc in Small Lakes of Kennady Lake Watershed



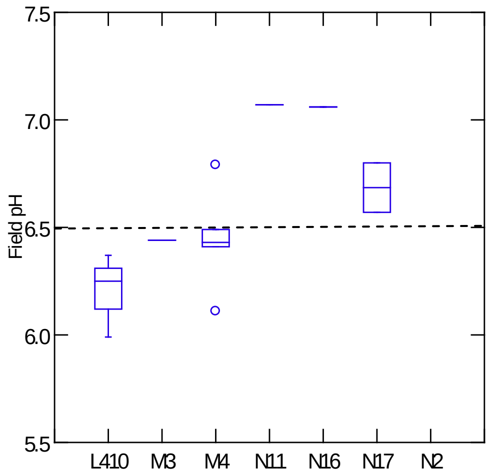
Note: mg/L = milligrams per litre.
Sample count per site: A3 = 3; B1 = 3; D2 = 2; D3 = 3; E1 = 2; E2 = 2; F1 = 2.

Figure YKDFN 2.31-3: Summary of historical Water Quality Data in Box Plots for Downstream Lakes of Kennady Lake during 1998 to 2011. A) Under-Ice Conditions, B) Open-Water Conditions.

Note: The box and whisker plot visually marks the following statistics: horizontal line within each box indicates the median of the data, outer edges of each box indicate 25th and 75th percentile whiskers indicate minimum and maximum and the dotted line crossing the entire plot denotes CCME Water Quality Guidelines (not shown in case of no exceedances). In the case of dependent variables (i.e. pH, temperature, hardness), the guideline is based on the median value of the dataset.

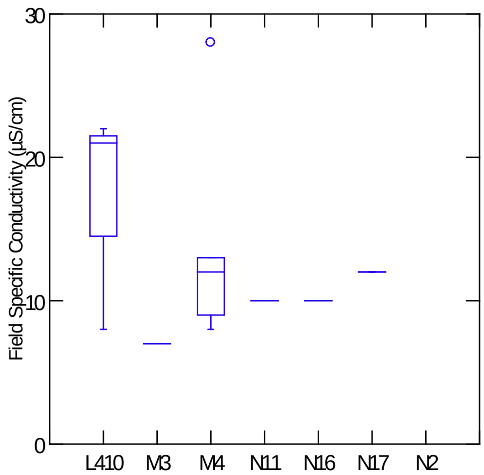
Outliers (asterisk signs) were discrete data points with values more than 1.5 times the inter-quartile range and extreme outliers (open circles) were more than 3.0 times the inter-quartile range. Some extreme outlier values are not plotted but reported in the footnote. The number of data used to derive the box and whisker plots are also noted in the footnote. Data with concentrations reported as being below the detection limit were adjusted to the MDL value.

Figure YKDFN 2.31-3.A1: Under-Ice Field pH in Downstream Lakes



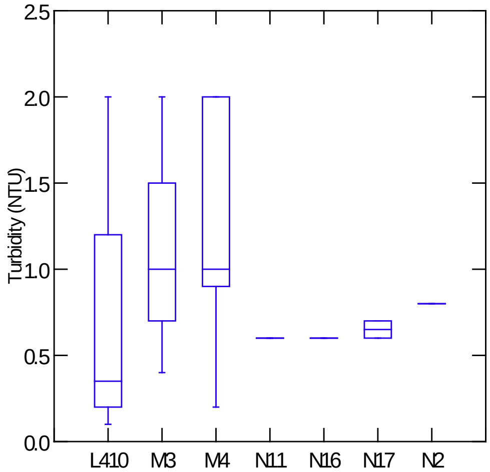
Note: Sample count per site: L410 = 4; M3 = 3; M4 = 6; N11 = 1; N16 = 1; N17 = 2; N2 = 1.

Figure YKDFN 2.31-3.A2: Under-Ice Specific Conductivity in Downstream Lakes



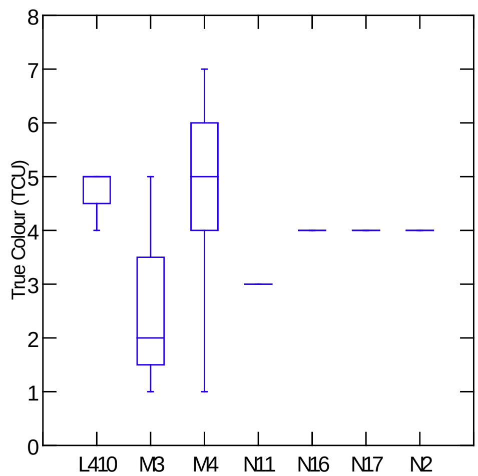
Note: µS/cm = microSiemens per centimetre.
Sample count per site: L410 = 4; M3 = 3; M4 = 6; N11 = 1; N16 = 1; N17 = 2; N2 = 1.

Figure YKDFN 2.31-3.A3: Under-Ice Turbidity in Downstream Lakes



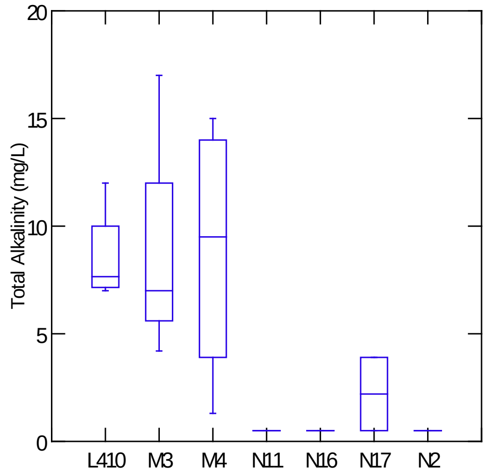
Note: NTU = Nephelometric Turbidity Units.
Sample count per site: L410 = 4; M3 = 3; M4 = 5; N11 = 1; N16 = 1; N17 = 2; N2 = 1.

Figure YKDFN 2.31-3.A4: Under-Ice True Colour in Downstream Lakes



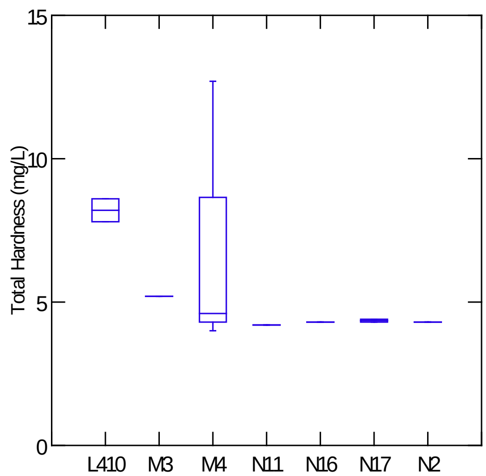
Note: TCU = True Colour Units.
Sample count per site: L410 = 4; M3 = 3; M4 = 6; N11 = 1; N16 = 1; N17 = 2; N2 = 1.

Figure YKDFN 2.31-3.A5: Under-Ice Total Alkalinity in Downstream Lakes



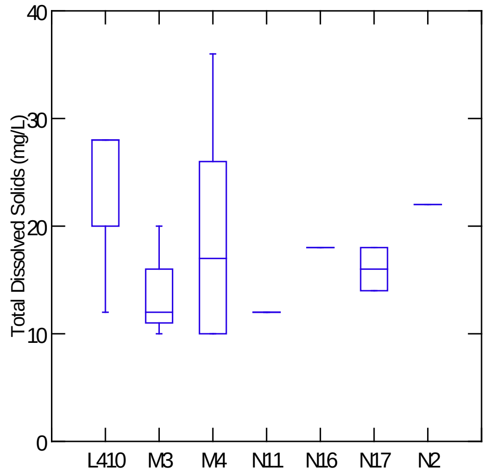
Note: mg/L = milligrams per litre; total alkalinity presented as calcium carbonate.
Sample count per site: L410 = 4; M3 = 3; M4 = 6; N11 = 1; N16 = 1; N17 = 2; N2 = 1.

Figure YKDFN 2.31-3.A6: Under-Ice Total Hardness in Downstream Lakes



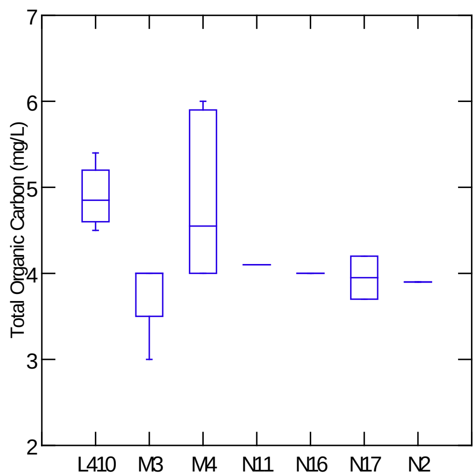
Note: mg/L = milligrams per litre.
Sample count per site: L410 = 2; M3 = 1; M4 = 3; N11 = 1; N16 = 1; N17 = 2; N2 = 1.

Figure YKDFN 2.31-3.A7: Under-Ice Total Dissolved Solids in Downstream Lakes



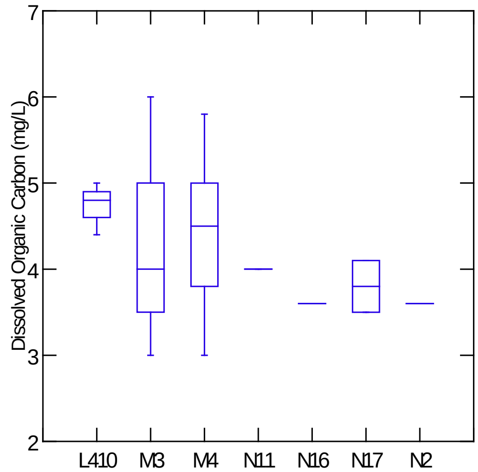
Note: mg/L = milligrams per litre.
Sample count per site: L410 = 3; M3 = 3; M4 = 6; N11 = 1; N16 = 1; N17 = 2; N2 = 1.

Figure YKDFN 2.31-3.A8: Under-Ice Total Organic Carbon in Downstream Lakes



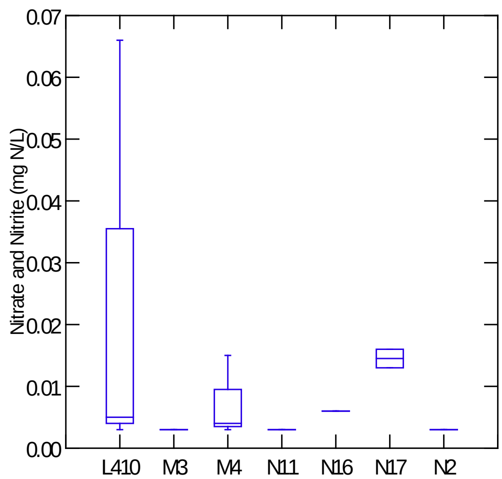
Note: mg/L = milligrams per litre.
Sample count per site: L410 = 4; M3 = 3; M4 = 6; N11 = 1; N16 = 1; N17 = 2; N2 = 1.

Figure YKDFN 2.31-3.A9: Under-Ice Dissolved Organic Carbon in Downstream Lakes



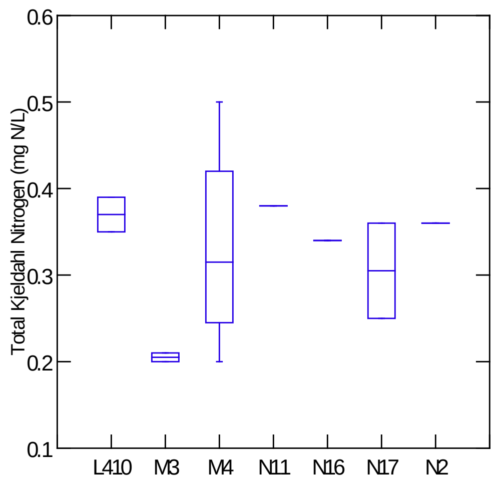
Note: mg/L = milligrams per litre.
Sample count per site: L410 = 3; M3 = 3; M4 = 6; N11 = 1; N16 = 1; N17 = 2; N2 = 1.

Figure YKDFN 2.31-3.A10: Under-Ice Total Nitrate and Nitrite in Downstream Lakes



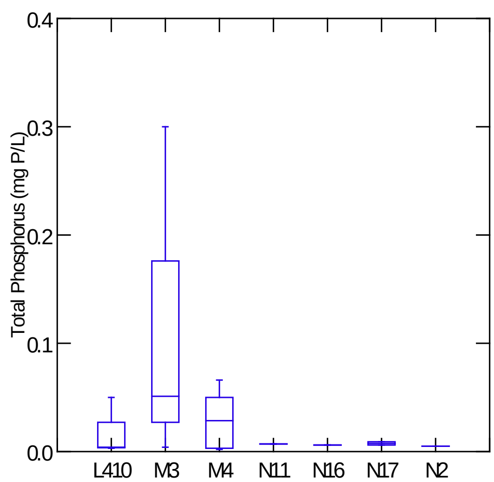
Note: mg N/L = milligrams nitrogen per litre.
Sample count per site: L410 = 3; M3 = 1; M4 = 3; N11 = 1; N16 = 1; N17 = 2; N2 = 1.

Figure YKDFN 2.31-3.A11: Under-Ice Total Kjeldahl Nitrogen in Downstream Lakes



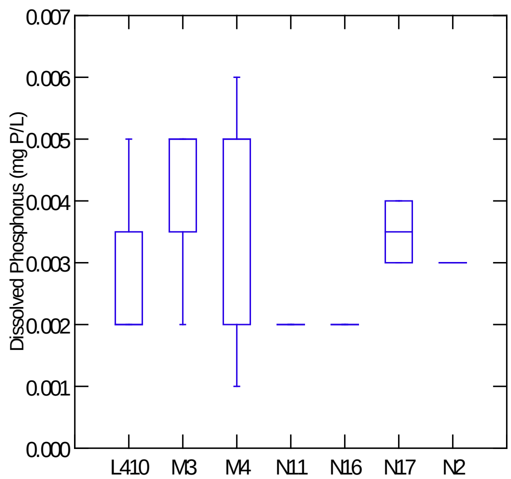
Note: mg N/L = milligrams nitrogen per litre.
Sample count per site: L410 = 2; M3 = 2; M4 = 4; N11 = 1; N16 = 1; N17 = 2; N2 = 1.

Figure YKDFN 2.31-3.A12: Under-Ice Total Phosphorus in Downstream Lakes



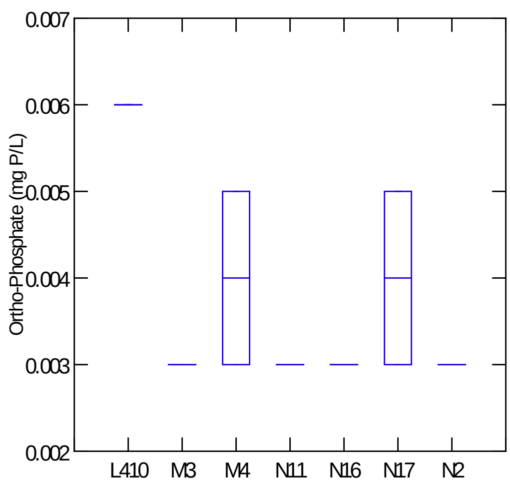
Note: mg P/L = milligrams phosphorus per litre.
Sample count per site: L410 = 3; M3 = 4; M4 = 6; N11 = 1; N16 = 1; N17 = 2; N2 = 1.

Figure YKDFN 2.31-3.A13: Under-Ice Dissolved Phosphorus in Downstream Lakes



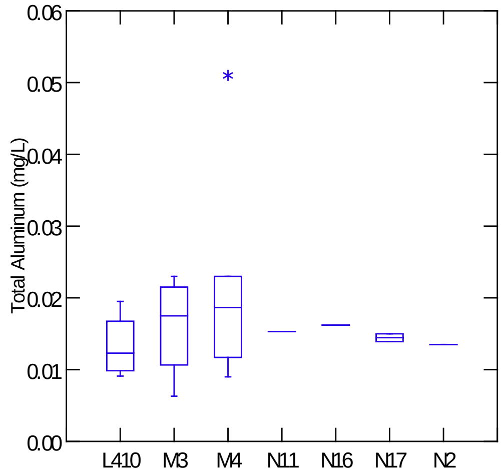
Note: mg P/L = milligrams phosphorus per litre.
Sample count per site: L410 = 3; M3 = 3; M4 = 6; N11 = 1; N16 = 1; N17 = 2; N2 = 1.

Figure YKDFN 2.31-3.A14: Under-Ice Orthophosphate in Downstream Lakes



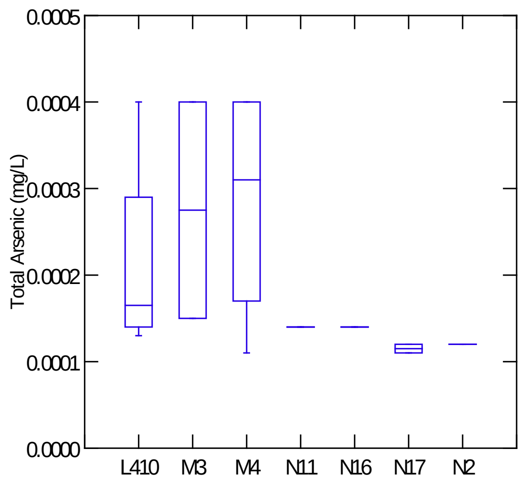
Note: mg P/L = milligrams phosphorus per litre.
Sample count per site: L410 = 2; M3 = 1; M4 = 2; N11 = 1; N16 = 1; N17 = 2; N2 = 1.

Figure YKDFN 2.31-3.A15: Under-Ice Total Aluminum in Downstream Lakes



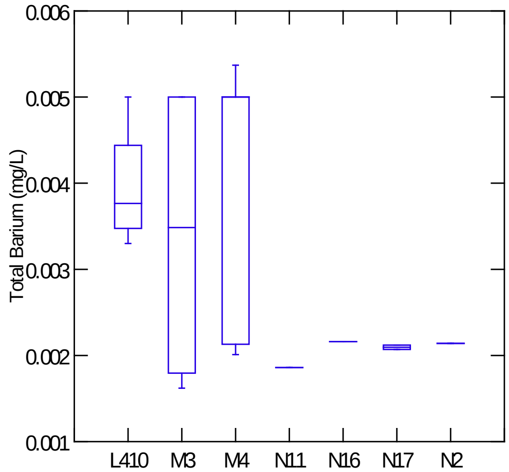
Note: mg/L = milligrams per litre.
Sample count per site: L410 = 4; M3 = 4; M4 = 6; N11 = 1; N16 = 1; N17 = 2; N2 = 1.

Figure YKDFN 2.31-3.A16: Under-Ice Total Arsenic in Downstream Lakes



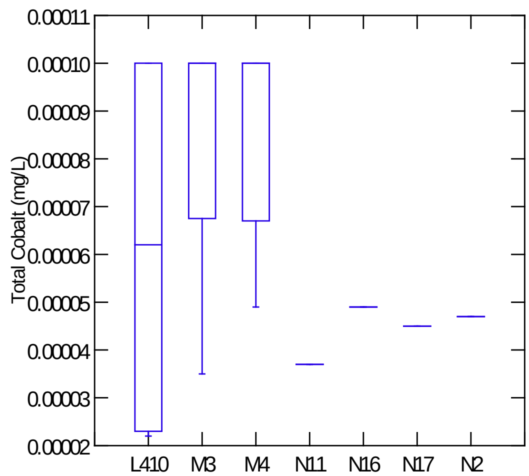
Note: mg/L = milligrams per litre.
Sample count per site was: L410 = 4; M3 = 4; M4 = 5; N11 = 1; N16 = 1; N17 = 2; N2 = 1.
Extreme outlier not plotted = 0.0008 mg/L at Lake M4.

Figure YKDFN 2.31-3.A17: Under-Ice Total Barium in Downstream Lakes



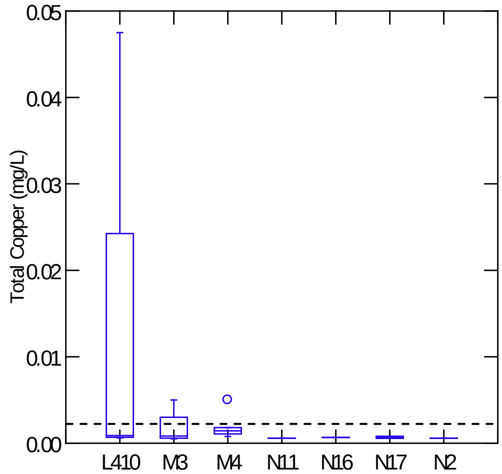
Note: mg/L = milligrams per litre.
Sample count per site: L410 = 4; M3 = 4; M4 = 6; N11 = 1; N16 = 1; N17 = 2; N2 = 1.

Figure YKDFN 2.31-3.A18: Under-Ice Total Cobalt in Downstream Lakes



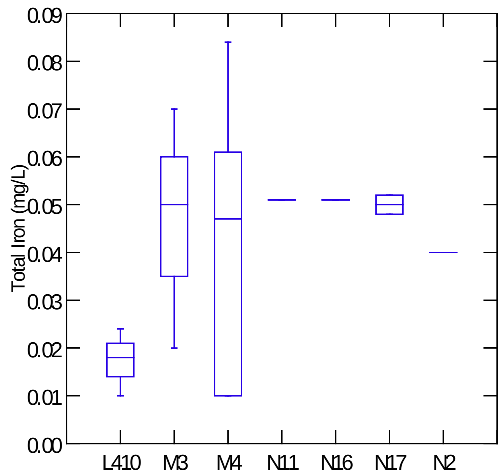
Note: mg/L = milligrams per litre.
Sample count per site: L410 = 4; M3 = 4; M4 = 6; N11 = 1; N16 = 1; N17 = 2; N2 = 1.

Figure YKDFN 2.31-3.A19: Under-Ice Total Copper in Downstream Lakes



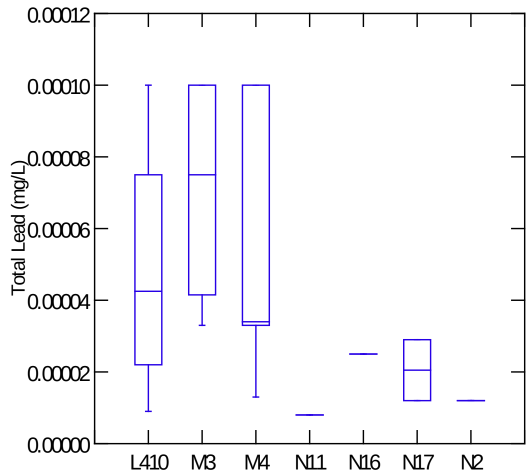
Note: mg/L = milligrams per litre.
Sample count per site: L410 = 4; M3 = 4; M4 = 6; N11 = 1; N16 = 1; N17 = 2; N2 = 1.

Figure YKDFN 2.31-3.A20: Under-Ice Total Iron in Downstream Lakes



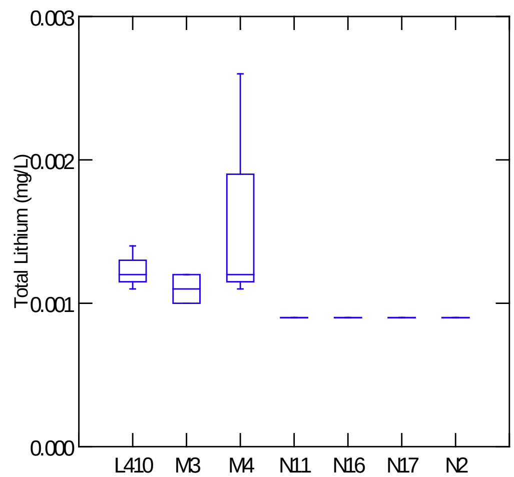
Note: mg/L = milligrams per litre.
Sample count per site: L410 = 4; M3 = 4; M4 = 6; N11 = 1; N16 = 1; N17 = 2; N2 = 1.

Figure YKDFN 2.31-3.A21: Under-Ice Total Lead in Downstream Lakes



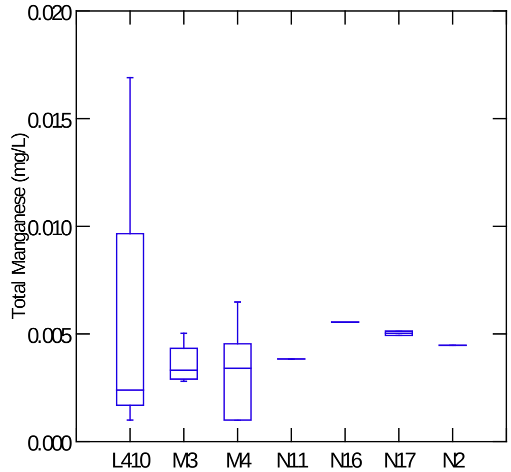
Note: mg/L = milligrams per litre.
Sample count per site was: L410 = 4; M3 = 4; M4 = 5; N11 = 1; N16 = 1; N17 = 2; N2 = 1.
Extreme outlier not plotted = 0.0004 mg/L Lake M4.

Figure YKDFN 2.31-3.A22: Under-Ice Total Lithium in Downstream Lakes



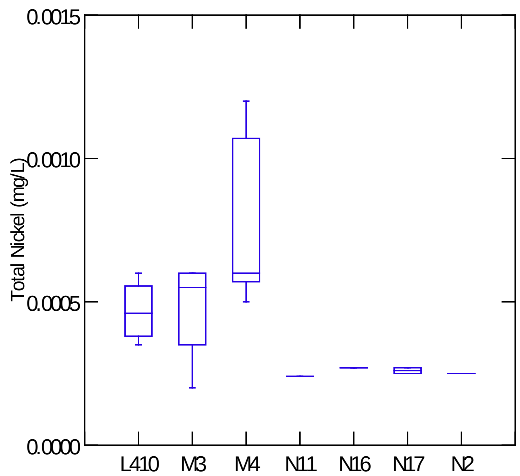
Note: mg/L = milligrams per litre.
Sample count per site: L410 = 3; M3 = 2; M4 = 3; N11 = 1; N16 = 1; N17 = 2; N2 = 1.

Figure YKDFN 2.31-3.A23: Under-Ice Total Manganese in Downstream Lakes



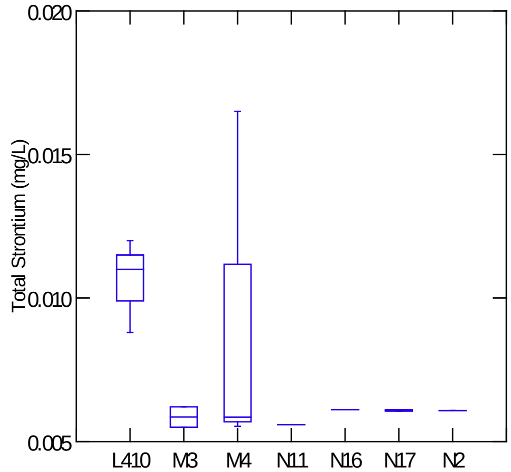
Note: mg/L = milligrams per litre.
Sample count per site: L410 = 4; M3 = 4; M4 = 6; N11 = 1; N16 = 1; N17 = 2; N2 = 1.

Figure YKDFN 2.31-3.A24: Under-Ice Total Nickel in Downstream Lakes



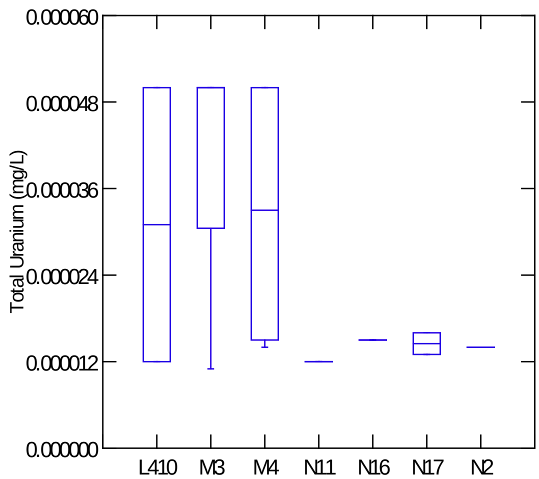
Note: mg/L = milligrams per litre.
Sample count per site was: L410 = 4; M3 = 4; M4 = 5; N11 = 1; N16 = 1; N17 = 2; N2 = 1.

Figure YKDFN 2.31-3.A25: Under-Ice Total Strontium in Downstream Lakes



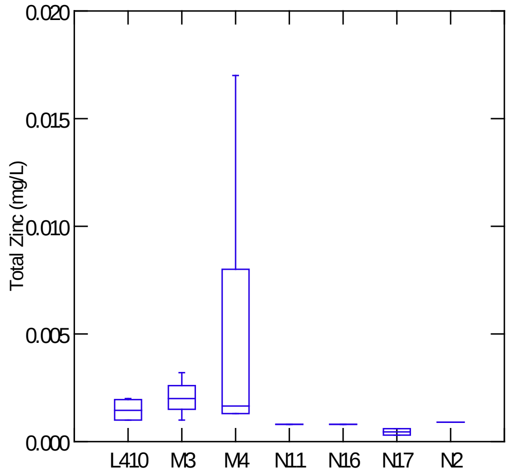
Note: mg/L = milligrams per litre.
Sample count per site: L410 = 3; M3 = 2; M4 = 3; N11 = 1; N16 = 1; N17 = 2; N2 = 1.

Figure YKDFN 2.31-3.A26: Under-Ice Total Uranium in Downstream Lakes



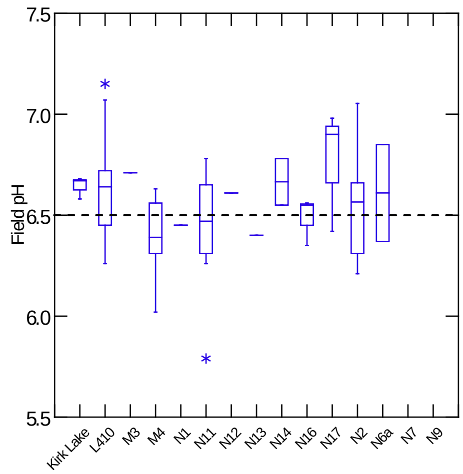
Note: mg/L = milligrams per litre.
Sample count per site: L410 = 4; M3 = 3; M4 = 6; N11 = 1; N16 = 1; N17 = 2; N2 = 1.

Figure YKDFN 2.31-3.A27: Under-Ice Total Zinc in Downstream Lakes



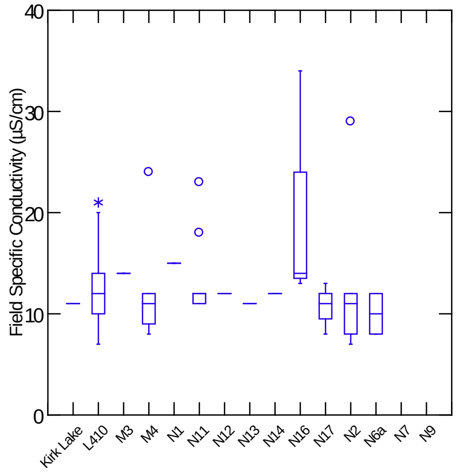
Note: mg/L = milligrams per litre.
Sample count per site was: L410 = 4; M3 = 4; M4 = 6; N11 = 1; N16 = 1; N17 = 2; N2 = 1.

Figure YKDFN 2.31-3.B1: Open-Water Field pH in Downstream Lakes



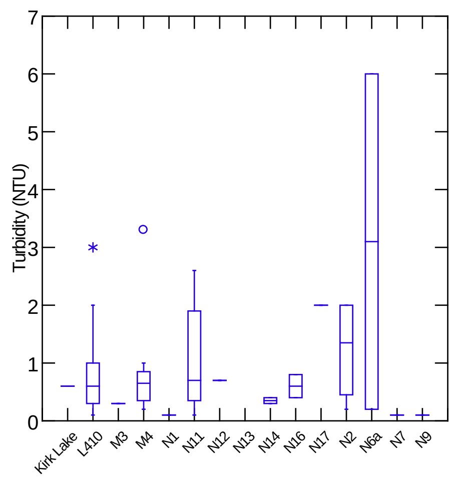
Note: Sample count per site: Kirk Lake = 3; L410 = 33; M3 = 1; M4 = 10; N1 = 1; N11 = 14; N12 = 1; N13 = 1; N14 = 2; N16 = 3; N17 = 3; N2 = 6; N6a = 2; N7 = 3; N9 = 3.

Figure YKDFN 2.31-3.B2: Open-Water Specific Conductivity in Downstream Lakes



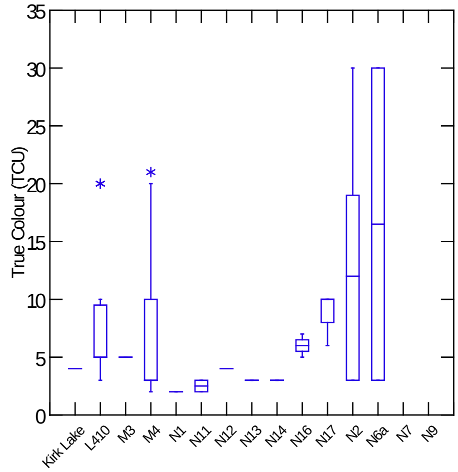
Note: µS/cm = microSiemens per centimetre.
Sample count per site: Kirk Lake = 3; L410 = 33; M3 = 1; M4 = 10; N1 = 1; N11 = 14; N12 = 1; N13 = 1; N14 = 2; N16 = 3; N17 = 3; N2 = 6; N6a = 2; N7 = 3; N9 = 3.

Figure YKDFN 2.31-3.B3: Open-Water Turbidity in Downstream Lakes



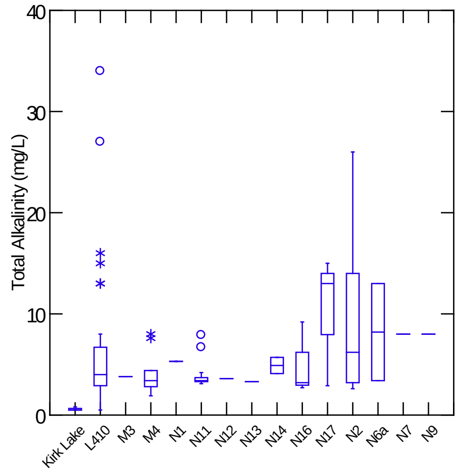
Note: NTU = Nephelometric Turbidity Units.
Sample count per site: Kirk Lake = 3; L410 = 27; M3 = 1; M4 = 8; N1 = 1; N11 = 12; N12 = 1; N13 = 0; N14 = 2; N16 = 2; N17 = 2; N2 = 4; N6a = 2; N7 = 3; N9 = 3.

Figure YKDFN 2.31-3.B4: Open-Water True Colour in Downstream Lakes



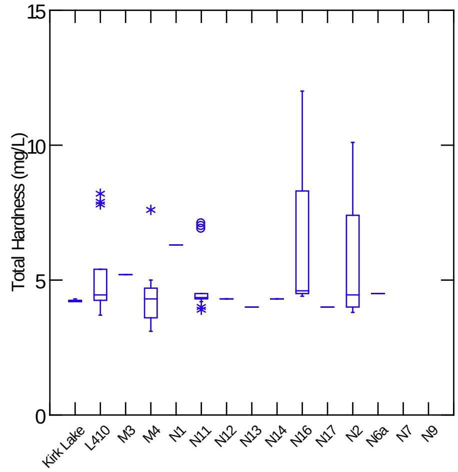
Note: TCU = True Colour Units.
Sample count per site: Kirk Lake = 3; L410 = 27; M3 = 1; M4 = 10; N1 = 1; N11 = 14; N12 = 1; N13 = 1; N14 = 2; N16 = 3; N17 = 3; N2 = 6; N6a = 2; N7 = 0; N9 = 0.

Figure YKDFN 2.31-3.B5: Open-Water Total Alkalinity in Downstream Lakes



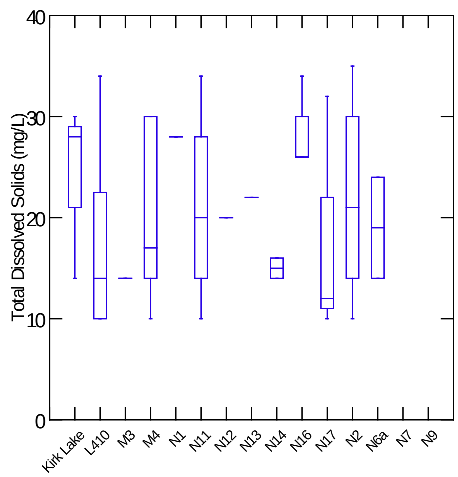
Note: mg/L = milligrams per litre; total alkalinity presented as calcium carbonate.
Sample count per site: Kirk Lake = 3; L410 = 33; M3 = 1; M4 = 10; N1 = 1; N11 = 14; N12 = 1; N13 = 1; N14 = 2; N16 = 3; N17 = 3; N2 = 6; N6a = 2; N7 = 3; N9 = 3.

Figure YKDFN 2.31-3.B6: Open-Water Total Hardness in Downstream Lakes



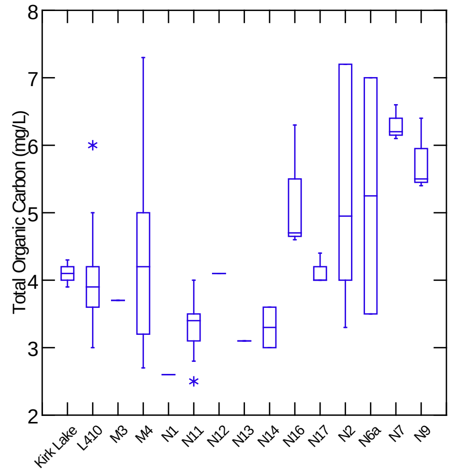
Note: mg/L = milligrams per litre.
Sample count per site: Kirk Lake = 3; L410 = 16; M3 = 1; M4 = 9; N1 = 1; N11 = 14; N12 = 1; N13 = 1; N14 = 2; N16 = 3; N17 = 1; N2 = 4; N6a = 1; N7 = 0; N9 = 0.

Figure YKDFN 2.31-3.B7: Open-Water Total Dissolved Solids in Downstream Lakes



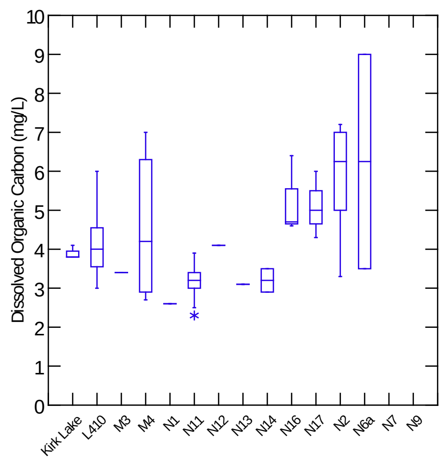
Note: mg/L = milligrams per litre.
Sample count per site: Kirk Lake = 3; L410 = 32; M3 = 1; M4 = 10; N1 = 1; N11 = 13; N12 = 1; N13 = 1; N14 = 2; N16 = 3; N17 = 3; N2 = 6; N6a = 2; N7 = 0; N9 = 0.
Extreme outlier not plotted = 52 mg/L at Lake 410 and 52 mg/L and Lake N11.

Figure YKDFN 2.31-3.B8: Open-Water Total Organic Carbon in Downstream Lakes



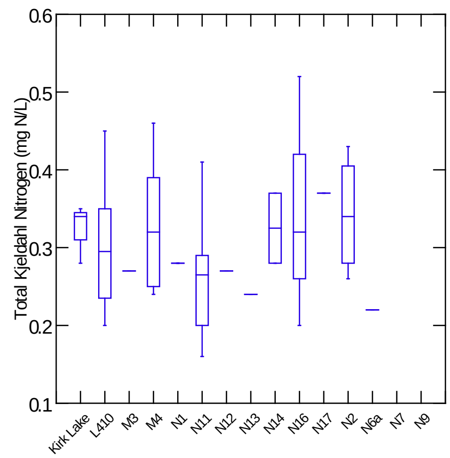
Note: mg/L = milligrams per litre.
Sample count per site: Kirk Lake = 3; L410 = 33; M3 = 1; M4 = 10; N1 = 1; N11 = 14; N12 = 1; N13 = 1; N14 = 2; N16 = 3; N17 = 3; N2 = 6; N6a = 2; N7 = 3; N9 = 3.

Figure YKDFN 2.31-3.B9: Open-Water Dissolved Organic Carbon in Downstream Lakes



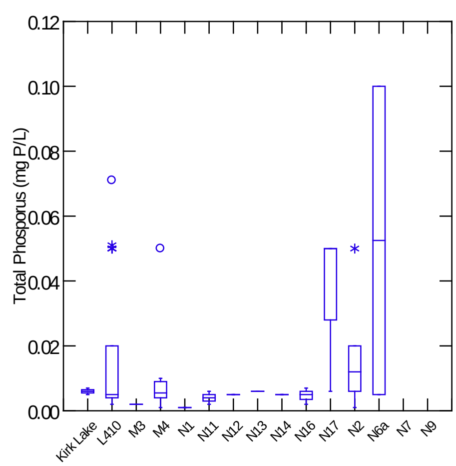
Note: mg/L = milligrams per litre.
Sample count per site: Kirk Lake = 3; L410 = 27; M3 = 1; M4 = 10; N1 = 1; N11 = 14; N12 = 1; N13 = 1; N14 = 2; N16 = 3; N17 = 3; N2 = 6; N6a = 2; N7 = 0; N9 = 0.

Figure YKDFN 2.31-3.B10: Open-Water Total Kjeldahl Nitrogen in Downstream Lakes



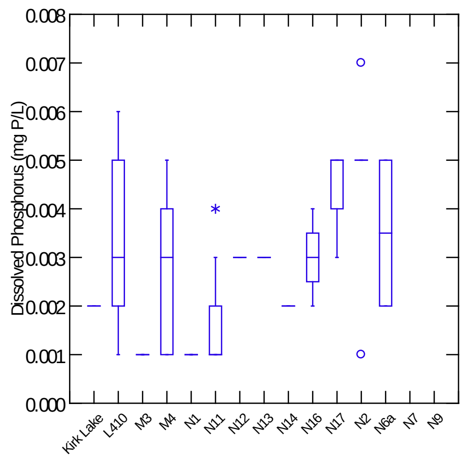
Note: mg N/L = milligrams nitrogen per litre.
Sample count per site was: Kirk Lake = 3; L410 = 24; M3 = 1; M4 = 9; N1 = 1; N11 = 14; N12 = 1; N13 = 1; N14 = 2; N16 = 3; N17 = 1; N2 =4; N6a = 1; N7 = 0; N9 = 0.
Extreme outlier not plotted = 0.63 mg/L at Lake N4.

Figure YKDFN 2.31-3.B11: Open-Water Total Phosphorus in Downstream Lakes



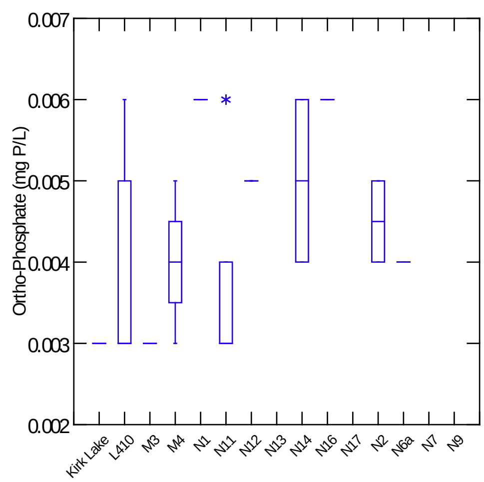
Note: mg P/L = milligrams phosphorus per litre.
Sample count per site: Kirk Lake = 3; L410 = 27; M3 = 1; M4 = 10; N1 = 1; N11 = 14; N12 = 1; N13 = 1; N14 = 2; N16 = 3; N17 = 1; N2 = 6; N6a = 2; N7 = 0; N9 = 0.

Figure YKDFN 2.31-3.B12: Open-Water Dissolved Phosphorus in Downstream Lakes



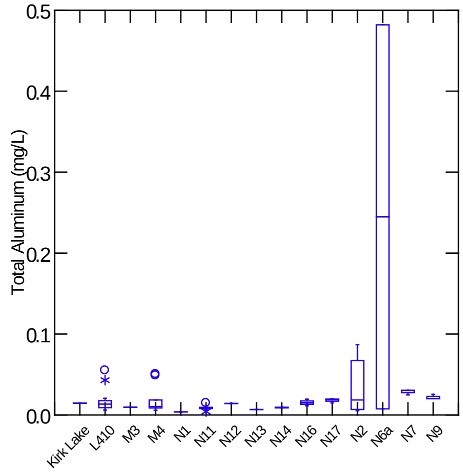
Note: mg P/L = milligrams phosphorus per litre.
Sample count per site: Kirk Lake = 3; L410 = 27; M3 = 1; M4 = 10; N1 = 1; N11 = 14; N12 = 1; N13 = 1; N14 = 2; N16 = 3; N17 = 3; N2 = 6; N6a = 2; N7 = 0; N9 = 0.

Figure YKDFN 2.31-3.B13: Open-Water Orthophosphate in Downstream Lakes



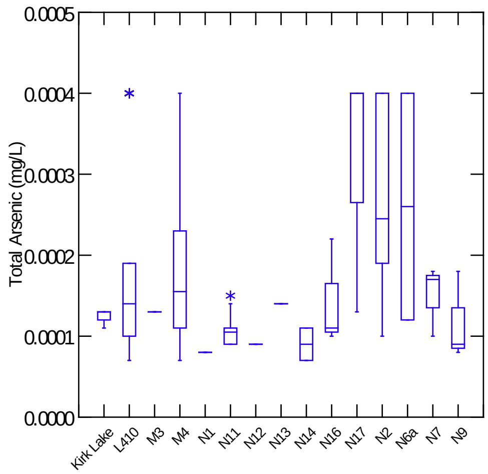
Note: mg P/L = milligrams phosphorus per litre.
Sample count per site: Kirk Lake = 3; L410 = 13; M3 = 1; M4 = 7; N1 = 1; N11 = 12; N12 = 1; N13 = 0; N14 = 2; N16 = 2; N17 = 0; N2 = 2; N6a = 1; N7 = 0; N9 = 0.

Figure YKDFN 2.31-3.B14: Open-Water Total Aluminum in Downstream Lakes



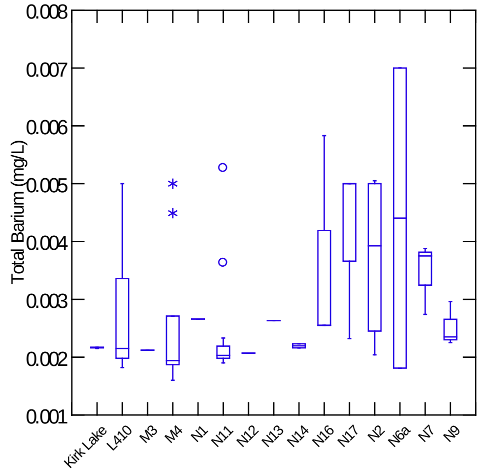
Note: mg/L = milligrams per litre.
Sample count per site: Kirk Lake = 3; L410 = 33; M3 = 1; M4 = 10; N1 = 1; N11 = 14; N12 = 1; N13 = 1; N14 = 2; N16 = 3; N17 = 3; N2 = 6; N6a = 2; N7 = 3; N9 = 3.

Figure YKDFN 2.31-3.B15: Open-Water Total Arsenic in Downstream Lakes



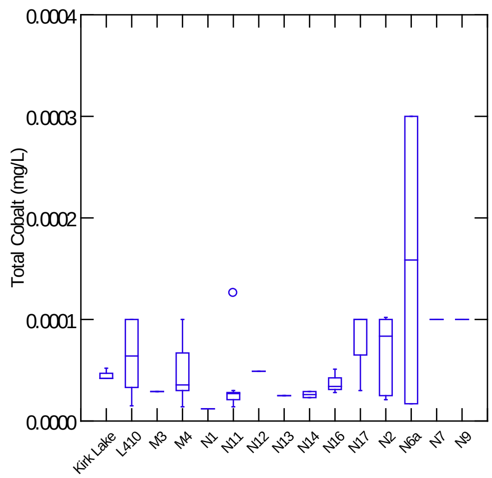
Note: mg/L = milligrams per litre.
Sample count per site: Kirk Lake = 3; L410 = 33; M3 = 1; M4 = 10; N1 = 1; N11 = 14; N12 = 1; N13 = 1; N14 = 2; N16 = 3; N17 = 3; N2 = 6; N6a = 2; N7 = 3; N9 = 3.

Figure YKDFN 2.31-3.B16: Open-Water Total Barium in Downstream Lakes



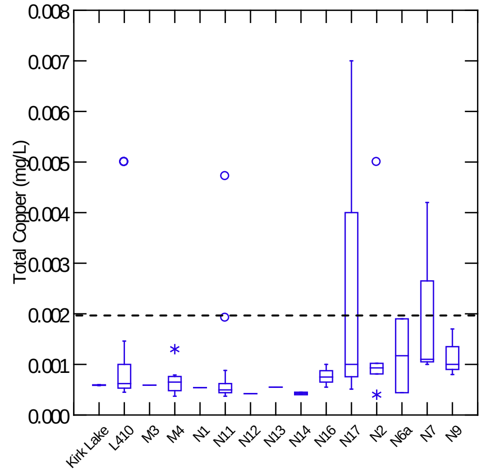
Note: mg/L = milligrams per litre.
Sample count per site: Kirk Lake = 3; L410 = 33; M3 = 1; M4 = 10; N1 = 1; N11 = 14; N12 = 1; N13 = 1; N14 = 2; N16 = 3; N17 = 3; N2 = 6; N6a = 2; N7 = 3; N9 = 3.

Figure YKDFN 2.31-3.B17: Open-Water Total Cobalt in Downstream Lakes



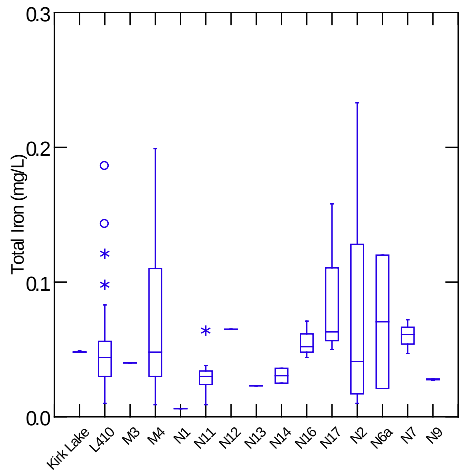
Note: mg/L = milligrams per litre.
Sample count per site was: Kirk Lake = 3; L410 = 33; M3 = 1; M4 = 10; N1 = 1; N11 = 14; N12 = 1; N13 = 1; N14 = 2; N16 = 3; N17 = 3; N2 = 6; N6a = 2; N7 = 3; N9 = 3.
Extreme outlier not plotted = 0.00178 mg/L Lake N11.

Figure YKDFN 2.31-3.B18: Open-Water Total Copper in Downstream Lakes



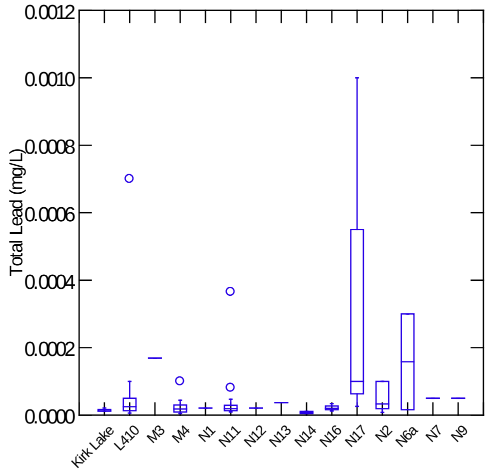
Note: mg/L = milligrams per litre.
Sample count per site: Kirk Lake = 3; L410 = 33; M3 = 1; M4 = 10; N1 = 1; N11 = 14; N12 = 1; N13 = 1; N14 = 2; N16 = 3; N17 = 3; N2 = 6; N6a = 2; N7 = 3; N9 = 3.

Figure YKDFN 2.31-3.B19: Open-Water Total Iron in Downstream Lakes



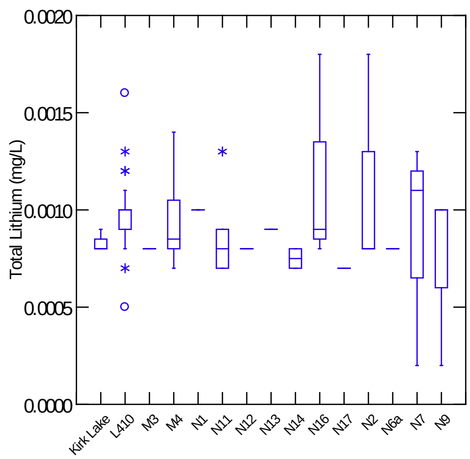
Note: mg/L = milligrams per litre.
Sample count per site was: Kirk Lake = 3; L410 = 33; M3 = 1; M4 = 10; N1 = 1; N11 = 14; N12 = 1; N13 = 1; N14 = 2; N16 = 3; N17 = 3; N2 = 6; N6a = 2; N7 = 3; N9 = 3.
Extreme outlier not plotted = 0.343 mg/L Lake N11.

Figure YKDFN 2.31-3.B20: Open-Water Total Lead in Downstream Lakes



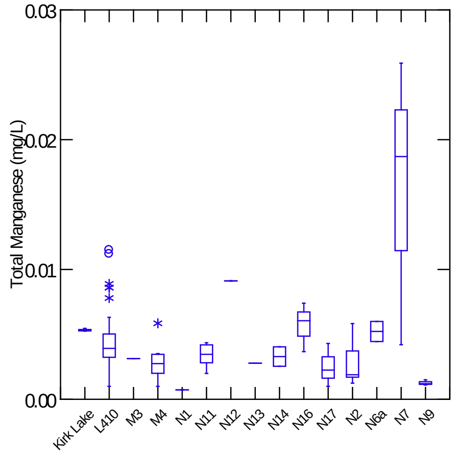
Note: mg/L = milligrams per litre.
Sample count per site: Kirk Lake = 3; L410 = 33; M3 = 1; M4 = 10; N1 = 1; N11 = 14; N12 = 1; N13 = 1; N14 = 2; N16 = 3; N17 = 3; N2 = 6; N6a = 2; N7 = 3; N9 = 3.

Figure YKDFN 2.31-3.B21: Open-Water Total Lithium in Downstream Lakes



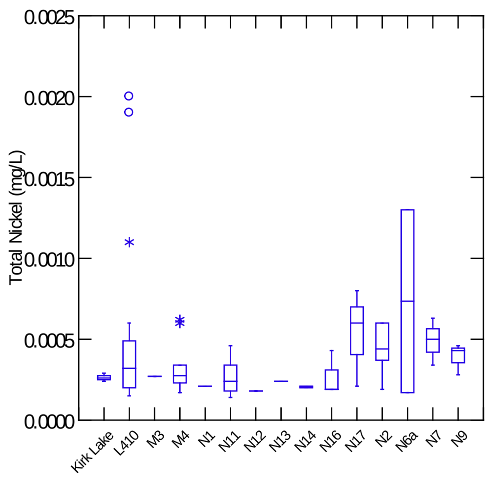
Note: mg/L = milligrams per litre.
Sample count per site was: Kirk Lake = 3; L410 = 25; M3 = 1; M4 = 9; N1 = 1; N11 = 14; N12 = 1; N13 = 1; N14 = 2; N16 = 3; N17 = 1; N2 = 4; N6a = 1; N7 = 3; N9 = 3.
Extreme outlier not plotted = 0.0094 mg/L at Lake M4.

Figure YKDFN 2.31-3.B22: Open-Water Total Manganese in Downstream Lakes



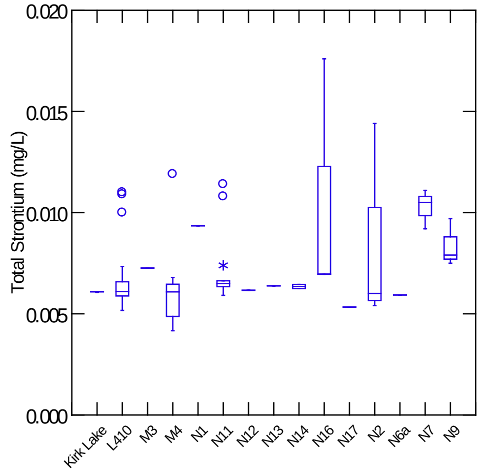
Note: mg/L = milligrams per litre.
Sample count per site was: Kirk Lake = 3; L410 = 33; M3 = 1; M4 = 10; N1 = 1; N11 = 14; N12 = 1; N13 = 1; N14 = 2; N16 = 3; N17 = 3; N2 = 6; N6a = 2; N7 = 3; N9 = 3.
Extreme outlier not plotted = 0.213 mg/L at Lake N11.

Figure YKDFN 2.31-3.B23: Open-Water Total Nickel in Downstream Lakes



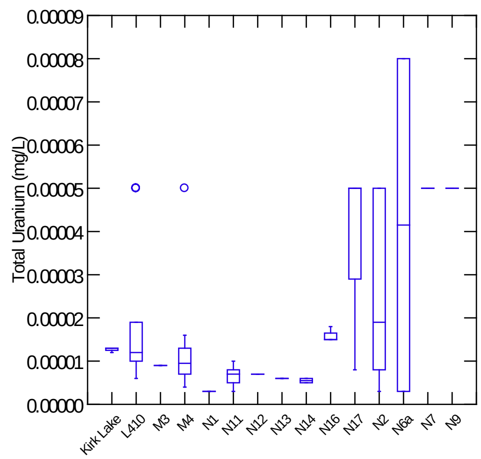
Note: mg/L = milligrams per litre.
Sample count per site was: Kirk Lake = 3; L410 = 33; M3 = 1; M4 = 10; N1 = 1; N11 = 14; N12 = 1; N13 = 1; N14 = 2; N16 = 3; N17 = 3; N2 = 6; N6a = 2; N7 = 3; N9 = 3.
Extreme outlier not plotted = 0.006 mg/L at Lake N11.

Figure YKDFN 2.31-3.B24: Open-Water Total Strontium in Downstream Lakes



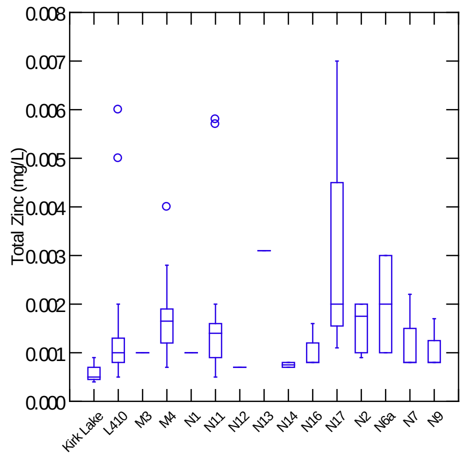
Note: mg/L = milligrams per litre.
Sample count per site: Kirk Lake = 3; L410 = 25; M3 = 1; M4 = 9; N1 = 1; N11 = 14; N12 = 1; N13 = 1; N14 = 2; N16 = 3; N17 = 1; N2 = 4; N6a = 1; N7 = 3; N9 = 3.

Figure YKDFN 2.31-3.B25: Open-Water Total Uranium in Downstream Lakes



Note: mg/L = milligrams per litre.
Sample count per site: Kirk Lake = 3; L410 = 33; M3 = 1; M4 = 10; N1 = 1; N11 = 14; N12 = 1; N13 = 1; N14 = 2; N16 = 3; N17 = 3; N2 = 6; N6a = 2; N7 = 3; N9 = 3.

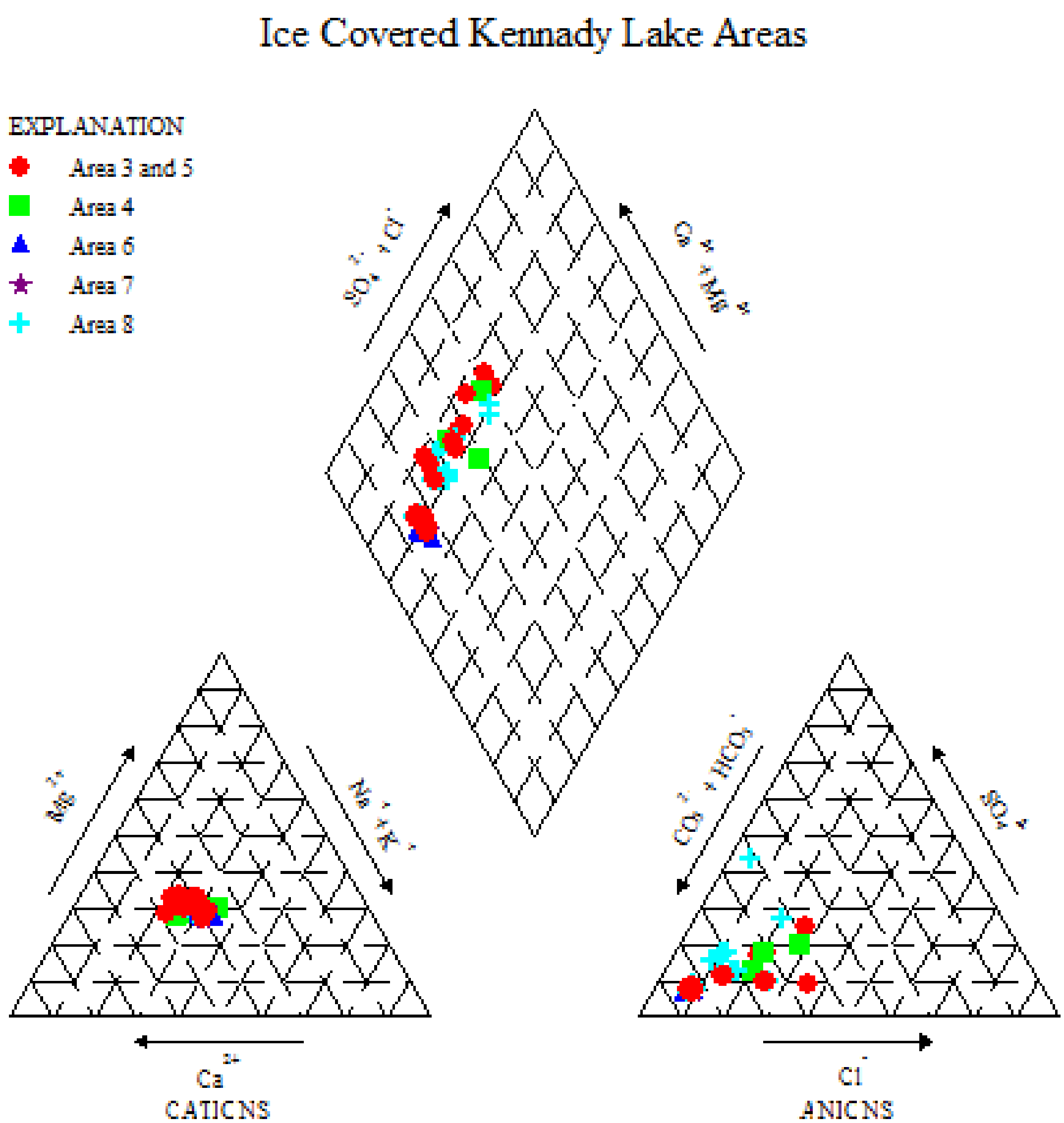
Figure YKDFN 2.31-3.B26: Open-Water Total Zinc in Downstream Lakes



Note: mg/L = milligrams per litre.
Sample count per site was: Kirk Lake = 3; L410 = 33; M3 = 1; M4 = 10; N1 = 1; N11 = 14; N12 = 1; N13 = 1; N14 = 2; N16 = 3; N17 = 3; N2 = 6; N6a = 2; N7 = 3; N9 = 3.
Extreme outliers not plotted = 0.014 mg/L at Lake N11 and 0.024 mg/L at Lake 410.

Figure YKDFN 2.31-4: Piper Plots Showing Relative Distribution of Major Ions in Samples Collected from Kennady Lake Areas during 1995 to 2011

A: ice-covered conditions



B: open water conditions

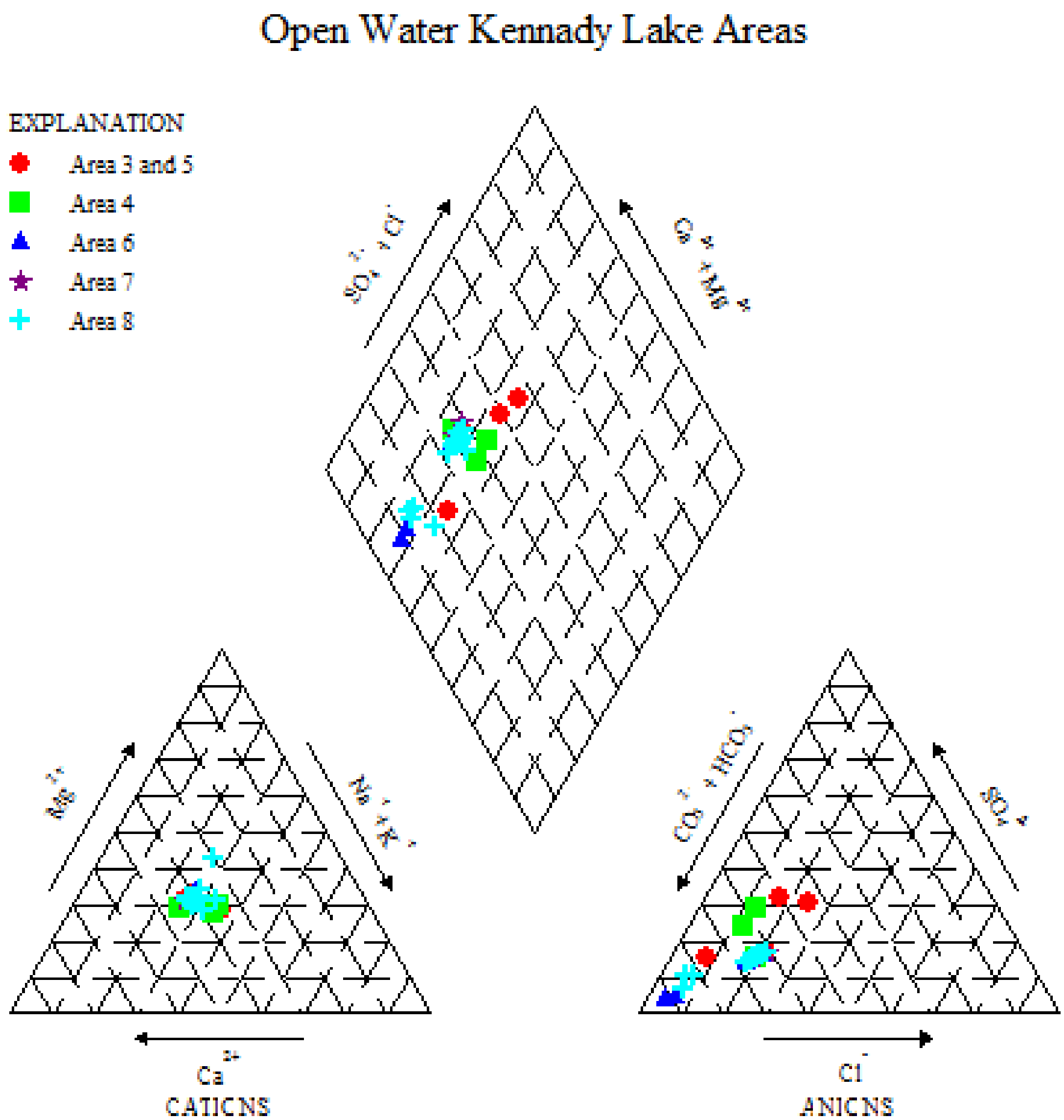


Figure YKDFN 2.31-5: Piper Plots Showing Relative Distribution of Major Ions in Samples Collected from Small Lakes in the Kennady Lake during 1995 to 2011

Open water conditions

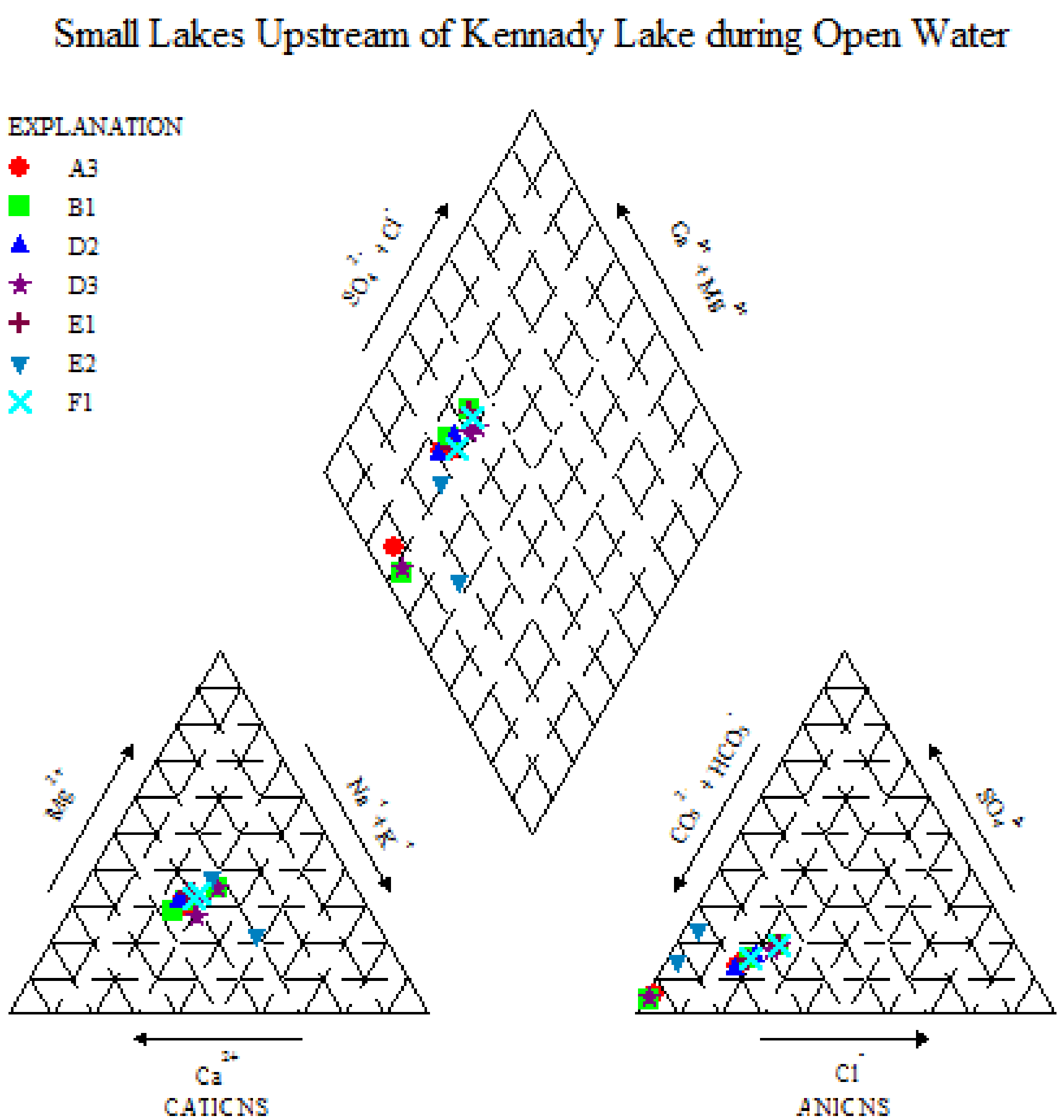
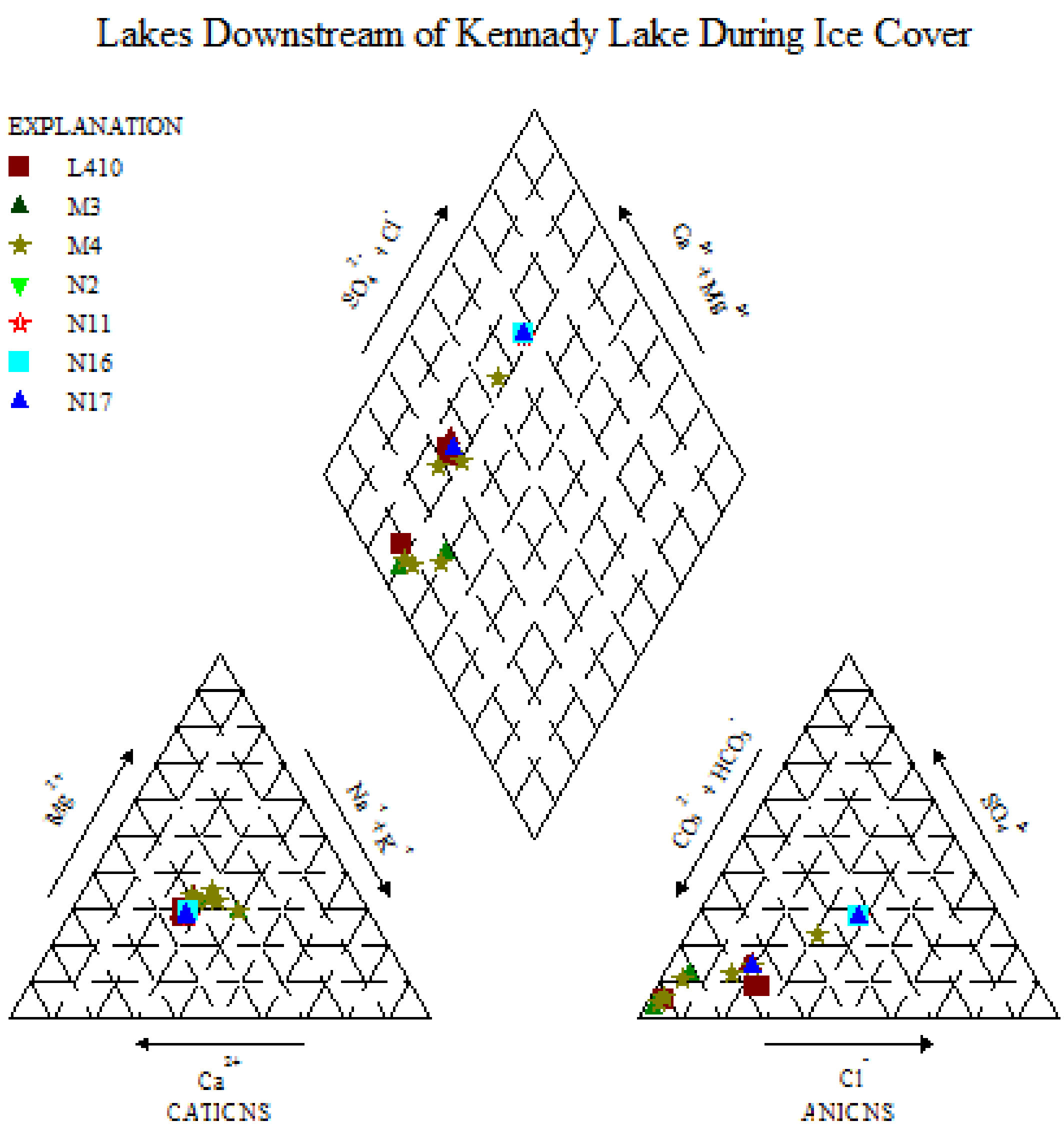
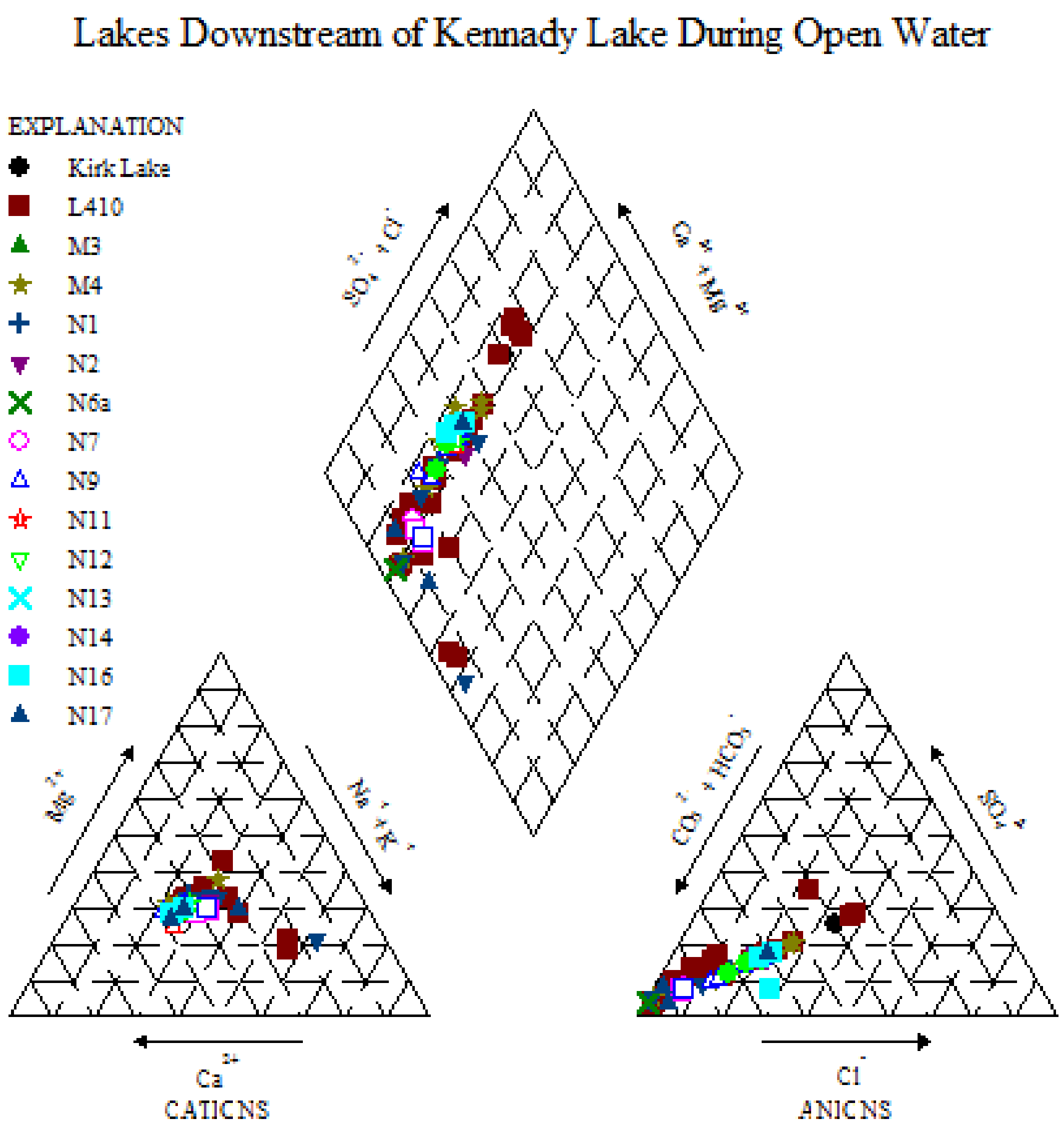


Figure YKDFN 2.31-6: Piper Plots Showing Relative Distribution of Major Ions in Samples Collected from Downstream Lakes during 1998 to 2011

A. Under-ice conditions



B. Open water conditions



References

De Beers (De Beers Canada Inc.). 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.

Golder (Golder Associates Ltd.). 2012. 2011 Water Quality and Sediment Quality Supplemental Monitoring Report. Report No. 11-1365-0001/DCN-050. Submitted to Mackenzie Valley Environmental Impact Review Board. March 2012.

GAHCHO KUÉ PROJECT ENVIRONMENTAL IMPACT STATEMENT
INFORMATION REQUEST RESPONSES

Information Request Number: YKDFN 2.32

Source: Yellowknives Dene First Nation

Subject: Downstream Receiving Environment (Section 9)

EIS Section: Section 2: Fish and Water

Preamble

Lake N1 and N11 are the immediate downstream receiving environments for discharges from the Water Management Pond. As such, they will be the most affected by alterations in water chemistry caused by project discharges. Currently, however, there is almost no baseline data for Lake N1 or Lake N11. Fish studies, invertebrate samples, sediment cores, water chemistry data, phytoplankton samples and zooplankton data for these lakes are all missing from the EIS. The lack of baseline data for Lake N1 and Lake N11 means that there will be no ability to understand effects of the project on these two lakes once construction and operations begin.

Request

It is essential that the proponent commit to developing and implement a monitoring program for Lake N11 and Lake N1.

Response

An environmental monitoring framework is currently being developed for the Gahcho Kué Project. The objectives of this framework are to define the criteria for the Aquatic Effects Monitoring Program (AEMP) monitoring taking a high level approach. The approach to aquatic effects monitoring for the Project is still conceptual, and detailed study designs and methods will be evaluated further through consultation with communities and regulatory agencies, and developed during the licensing phase of the Project. The recommendations provided by the author of the IR with respect to the inclusion of Lakes N1 and N11 will be considered during the development of the detailed study design.

In reference to limited baseline aquatic data in Lakes N1 and N11, this is accepted by De Beers; however, baseline fish information in Lakes N1 and N11 is reported in Annex J and Addendum JJ in the 2010 Environmental Impact Statement (EIS) (De Beers 2010). Additionally, supplemental monitoring data collected in 2011 for lower trophic organisms in Lake N11 is reported Golder (2012a), and supplemental monitoring data collected in 2011 for water and sediment quality in Lakes N2, N11, N14, and N17 is reported in Golder (2012b). As part of De Beers' ongoing monitoring commitment, additional sampling of key downstream lakes and streams will be completed and the existing baseline data will be augmented. This will provide a more robust dataset to compare future sampling results to assess potential Project-related changes.

References

De Beers (De Beers Canada Inc.). 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.

Golder (Golder Associates Ltd.). 2012a. 2011 Lower Trophic Organisms Supplemental Monitoring Report. Report No. 11-1365-0001/DCN-052. Submitted to Mackenzie Valley Environmental Impact Review Board. March 2010.

Golder. 2012b. 2011 Water Quality and Sediment Quality Supplemental Monitoring Report. Report No. 11-1365-0001/DCN-050. Submitted to Mackenzie Valley Environmental Impact Review Board. March 2010.

GAHCHO KUÉ PROJECT ENVIRONMENTAL IMPACT STATEMENT
INFORMATION REQUEST RESPONSES

Information Request Number: YKDFN 2.33

Source: Yellowknives Dene First Nation

Subject: Monitoring and Follow-up for Fish and Wildlife (Section 8.16 & 9.15)

EIS Section: Section 2: Fish and Water

Preamble

Consistency in monitoring methods is of central importance in development of monitoring programs. Lack of consistency in methods, and sampling times and locations will reduce the effectiveness of the monitoring program. Considering the lack of consistency in the existing data, it is essential that a Monitoring Program be developed that will provide as much continuity with the extant data as is possible, while at the same time ensuring that required improvements are also implemented.

Request

"Effects monitoring programs will include a Surveillance Network Program (SNP) that focuses primarily on Project site operations as well as a more broadly focused Aquatic Effects Monitoring Program (AEMP). De Beers will develop the scope of the SNP and AEMP in consultation with regulators and interested parties. It is anticipated, however, that the AEMP will include water flow, water quality and sediment quality components, along with components focused on lower trophic communities (i.e., plankton and benthic invertebrates), fish and fish habitat. Sampling areas are likely to be located in the Kennady Lake watershed, potentially affected areas of the N watershed and the A, B, D, and E watersheds, Lake 410, and Kirk Lake, and a suitable reference lake. Components of the AEMP will be developed according to a common, statistically-based study design incorporating regulatory guidance and current scientific principles related to aquatic monitoring." (p. 8-516 & p. 9-428).

YKDFN request that the proponent provide discussion on its commitment to ensure that future monitoring are completed in such a way that allows the historic data be fully utilized – a focus of this discussion should be the relationship between regulators desires and the company's commitments.

Response

Baseline data will be used and built upon to the greatest extent possible. De Beers is currently reviewing the aquatic baseline programs to ensure alignment with future effects monitoring carried out pursuant to an Aquatic Effects Monitoring Program (AEMP). Both the program review and input from regulators and communities will shape the development of the AEMP as the Project moves through the Environmental Impact Review (EIR) and regulatory processes. De Beers is committed to the development of a suitable AEMP for the Gahcho Kué Project.

An environmental monitoring framework is being developed for the Project. The objectives of this framework are to define the criteria for AEMP monitoring taking a high level approach. The approach to aquatic effects monitoring for the Project is still conceptual, and detailed study designs and methods will be evaluated further through consultation with communities and regulatory agencies, and developed during the licensing phase of the Project.

Information Request Number: YKDFN 2.34

Source: Yellowknives Dene First Nation

Subject: Monitoring and Follow-up – Diversion Channels (Section 8.16 & 9.15, p8-270)

EIS Section: Section 2: Fish and Water

Terms of Reference Section:

Preamble

Statement on page 8-270. "*All diversion channels will be designed and constructed to prevent erosion and sedimentation and to incorporate lessons learned from the Ekati Diamond Mine (Jones et al. 2003*)" The solution throughout this volume is to armour banks to prevent sedimentation. If this is the only solution, the same issues identified in Jones et al (2003) will occur again.

Request

YKDFN request further clarification on the companies intentions to limit sedimentation. Included in this should be review of lessons learned from the Ekati mine and Diavik mines, and how construction of the diversion channels will incorporate these lessons learned.

Response

No diversion channels are planned for the GK development. Excavations are limited to the plant sites, airstrip and mine pit areas. The cuts are based in areas known to have underlying rock. Fill areas over permafrost ground including the road network and airstrip fill zones are constructed using fill-only techniques so that underlying permafrost remains undisturbed and is allowed to aggrade further into the fill zones.

These design techniques are based on experience and "review of lessons learned" from Ekati/Diavik to avoid constructing ditches in permafrost areas. The GK design precludes the use of ditching and diversion channels. Lessons learned are that ditches into permafrost zones expose new "active layers" from the ditch surfaces resulting in previously frozen ground being exposed to seasonal melting. In ice-rich ground areas this can compound and continue to melt unless sufficient overcut and armor layering of the ditch surfaces is installed to prevent the natural ground from the active zone thaw cycle.

GAHCHO KUÉ PROJECT ENVIRONMENTAL IMPACT STATEMENT
INFORMATION REQUEST RESPONSES

Information Request Number: YKDFN 2.35

Source: Yellowknives Dene First Nation

Subject: Monitoring and Follow-up – Fish Migrations (Section 8.16 & 9.15, p8-389)

EIS Section: Section 2: Fish and Water

Preamble

On page 8-389 the EIS states "*Although the dykes will in effect isolate the northern pike populations within their respective watersheds for the duration of mine operations (and permanently in Lake A3), it is likely that the isolated populations will be self-sustaining*." Although the assumption that isolated populations would be self-sustaining is likely accurate there is less confidence in predicting whether these isolated populations, especially the northern pike population in Lake A3 would retain the same level of productive capacity. Isolation may result in only marginally sustainable fish populations in Lake A3 as the Isolation can result in the loss of nutrients, invertebrates and forage fish to Lake A3. Additionally, this isolation would eliminate any fish recruitment, not only for northern pike but also other fish species found in Lake A3. These restrictions could result in lower productive capacity within the lake and could reduce the effectiveness of the lake ecosystem to respond to changes within the environment.

"*The diversion of the A, B, D, and E watersheds are not expected to change migration patterns of fish in the N watershed, such that populations of fish are negatively affected. During baseline sampling, northern pike have not been captured in lakes and streams in the N watershed, although they are present in Kennady Lake and downstream to Lake 410; therefore, it appears that northern pike are absent from the N watershed, or are present in extremely low numbers*" (Page 8-39). It is difficult to ascertain the presence, absence or abundance of northern pike in the N watershed due to the low fish sampling effort placed on the lakes in this watershed. Even if northern pike are not accessing the N watershed via the existing potential pathway there is not enough information presented to preclude northern pike from not using an alternative pathway as might be created through the diversions. If northern pike are absent from the N watershed the introduction of northern pike through the diversions may have negative consequences on existing fish populations in this watershed.

Request

The sustainability of fish populations at current levels within Lake A3 after isolation requires further substantiation. Further study is likely required on fish populations and energy pathways to allow for meaningful monitoring of lake fish populations after isolation.

Additional fish sampling is recommended in the N watershed to determine presence and relative abundance of fish species. A more complete analysis is recommended on why northern pike may not be using the existing access to the N watershed and what would prevent this species from utilizing an alternative access when made available to it.

Response

Due to the supplemental mitigation associated with the Fine Processed Kimberlite Containment (PKC) Facility, Lake A3 is no longer isolated from the remainder of the A watershed. This watershed will be diverted away during operations, but reconnected to Kennady Lake at closure. The assessment of effects associated with the A watershed diversion is provided in the 2012 Environmental Impact Statement (EIS) Supplement (De Beers 2012).

Additional baseline fish and fish habitat sampling was conducted in the N Watershed during 2011, with the results summarized in the 2011 Fish and Aquatic Resources Supplemental Monitoring report (Golder 2012). As described in this baseline report, increased sampling effort was conducted in the N Watershed to target northern pike, which had not been collected previously in this watershed. Lakes and streams in the N watershed with high potential northern pike habitat were identified for sampling. In total, 11 northern pike were captured: four in Lake N1 and seven in Lake N11. The results indicate that northern pike are present in the N Watershed, but likely at low abundance due to limited spawning and rearing habitat, and poor connectivity between waterbodies.

References

De Beers (De Beers Canada Inc.). 2012. Environmental Impact Statement Supplemental Information Submission for the Gahcho Kué Project. Submitted to the Mackenzie Valley Environmental Impact Review Board. April 2012.

Golder (Golder Associates Ltd.). 2012. 2011 Fish and Aquatic Resources Supplemental Monitoring Report. Report No. 11-1365-0001/DCN-054. Submitted to Mackenzie Valley Environmental Impact Review Board. March 2012.

Information Request Number: YKDFN 2.36

Source: Yellowknives Dene First Nation

Subject: Conceptual Fish Habitat Compensation Plan

EIS Section: Section 2: Fish and Water

Terms of Reference Section:

Preamble

The areas of dewatering or partial dewatering but otherwise unaltered are not part of the compensation plan. However, there will be a loss of productive capacity in these areas for 20+ years and potentially up to 70 years for some species before productive capacity may reach baseline levels. Section 8.10.3.2 (P. 8-379) effects of Dewatering on Fish and fish Habitat it states; *"Although Areas 2 to 5 will only be partially dewatered and will serve as the WMP for the Project, the depth, habitat, suspended sediment and water quality conditions in these areas will not be suitable to support a fish community".* It has also been stated in the EIS that Area 8 of Kennady Lake will have reduced productive capacity once it has been segregated from the remainder of the lake.

Dewatering an area and having it dewatered for an extended period of time is a form of habitat alteration. Calculations of habitat area and habitat units for these dewatered and partially dewatered areas are not used in determining compensation levels. The long-term loss of productive capacity of some systems and potential habitat alteration due to dewatering may lead to the net loss of productive capacity of fish habitat which is not compensated for.

The productive capacity of some fish habitat will be removed or reduced over several or more decades. The exclusion of fish habitat that is removed or affected over long-periods of time from the calculation of fish habitat compensation will make it difficult, if at all possible to meet the principle of the Departments of Fisheries and Oceans *Policy for the Management of Fish Habitat* guiding principle of "No Net Loss" of productive capacity of fish habitat.

Request

1) The long-term loss of productive capacity and uncertainty of whether full productive capacity will be reached should be addressed in the Conceptual Fish Habitat Compensation Plan. The disruption (temporary loss) of fish habitat is one of the three elements; habitat alteration, disruption and destruction, which should be considered when assessing habitat compensation requirements.

2) In the Conceptual fish Habitat Compensation Plan It is difficult to determine how the habitat units were used in the calculation of area required for compensation. On the surface it appears that in the end the total amount of surface area lost regardless of its habitat value is compensated by an area slightly larger (1.3 x post closure) and is compensation based on surface area and not habitat units. There should be greater transparency on how surface area of compensated habitat relates to the habitat units lost and gained. It would be beneficial to have a table of habitat units showing losses and potential gains through compensation.

Response

1) As described in the Conceptual Compensation Plan (CCP, Appendix 3.II) of the 2010 Gahcho Kué Project EIS (De Beers 2010), construction and operation of the mine will cause harmful alteration, disruption, or destruction (HADD) of fish habitat in the Kennady Lake watershed. The affected habitat areas include portions of Kennady Lake and adjacent lakes within the Kennady Lake watershed that will be permanently lost, portions that will be physically altered after dewatering and later submerged in the refilled Kennady Lake, and portions that will be dewatered (or partially dewatered) but not otherwise physically altered before being submerged in the refilled Kennady Lake.

   The dewatered, but otherwise physically unaltered areas that will be re-submerged will provide habitats after closure that will have the same physical characteristics as those areas had prior to Project development. However, De Beers acknowledges that these areas will not be re-submerged until at or near the end of mine operations, and therefore, are expected to be considered a temporary loss of fish habitat.

From discussions with Fisheries and Oceans Canada (DFO), it is recognized that compensation will be required for these areas. De Beers is committed to continuing to work with DFO and communities on coming to agreement on the appropriate type of compensation for these areas as part of the ongoing development of the detailed fish habitat compensation plan. The objective of the detailed compensation plan will be to achieve no net loss of fish habitat according to DFO's Fish Habitat Management Policy.

2) In the CCP, habitat losses were calculated both in terms of surface area and habitat units (HUs) (De Beers 2010, Section 3.II.4.1). For habitat gains (De Beers 2010, Section 3.II.4.2), preliminary estimates of gains potentially achieved from the compensation options under consideration were quantified, using surface area only, as a way of indicating the potential gains available. Detailed quantification of habitat gains achieved by the selected compensation options will be included in the detailed compensation plan, including the quantification in terms of HUs. As described in Section 3.II.7.3 of the CCP (De Beers 2010), the determination of compensation ratios based on HUs will also be completed as part of the development of the detailed compensation plan. Development of the detailed compensation plan, including finalization of options will occur through discussions with DFO and communities.

Reference

De Beers (De Beers Canada Inc.). 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.

April 2012

GAHCHO KUÉ PROJECT ENVIRONMENTAL IMPACT STATEMENT
INFORMATION REQUEST RESPONSES

Information Request Number: YKDFN 3.37

Source: Yellowknives Dene First Nation

Subject: Definition of “Potential to change the project” (Section 13.4.2)

EIS Section: Section 3: Cumulative Effects

Terms of Reference Section:

Preamble

The term “potential to change the Project” as used in determining reasonably foreseeable projects for use in the cumulative effects assessment is not defined.

The list of reasonably foreseeable projects has been developed based on three criteria (Section 13.4.2, p.13-11), which includes activities that “have the potential to change the Project or the impact predictions”. It is not clear what is meant by: “potential to change the Project”. This is not a commonly used criterion for determining whether an external project or activity is “reasonably foreseeable”.

Request

1) Define this criterion

2) Provide reference to best practice or guidance that recommends the reasonably foreseeable projects be included based on “potential to change the project”

Response

To clarify, the criterion used in the 2010 Environmental Impact Statement (EIS) (De Beers 2010) was that the reasonably foreseeable future project should “have the potential to change the Project or the impact predictions.” The two components of this criterion are addressed below.

The criterion of ‘changing the Project’ was included in context of the Taltson Hydroelectric Expansion Project. This reasonably foreseeable future project would have a large influence on the operation of the Gahcho Kué Project. By providing a source of hydroelectric power, there would be reduced mine emissions and winter road traffic.

The criterion of 'potential to change the impact predictions' was derived from the Mackenzie Valley Review Board Guidelines for Impact Assessment (March, 2004). These guidelines state that the cumulative effects assessment should include "past, present and reasonably foreseeable future developments, so long as they have the potential to affect the same components as the proposed development" (MVEIRB 2004). The Guidelines provide further clarification:

"These other developments may be near the proposed development, with immediately overlapping zones of influence. Distant developments should also be included if they affect a mobile resource that moves into the study area (e.g., water in river, or caribou along a migration route), or if the effects of distant developments travel before reaching receptors (e.g., long-range contaminants)" (MVEIRB 2004, page 78).

Using this guidance, the 2010 EIS (De Beers 2010) screened all reasonably foreseeable future developments for overlap with either the terrestrial, aquatic, or socio-economic environment (De Beers 2010, Table 13.4-1), prior to assessing their cumulative impact.

References

De Beers (De Beers Canada Inc.). 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.

MVEIRB (Makenzie Valley Environmetal Impact Review Board). 2004. Environmental Impact Assessment Fuidelines. March 2004. Available at: http://www.reviewboard.ca/upload/ref_library/MVE%20EIA%20Guidelines_1195078754.pdf

Information Request Number: YKDFN 3.38

Source: Yellowknives Dene First Nation

Subject: Reasonably Foreseeable Projects (Section 13.4.2)

EIS Section: Section 3: Cumulative Effects

Terms of Reference Section:

Preamble

Section 13.4 describes generally how reasonably foreseeable projects were selected for the cumulative effects assessment. Table 13.4-1 suggests that the RSA for the terrestrial environment cumulative effects assessment is based on the seasonal ranges of the Bathurst and Ahiak caribou herds, grizzly bear, wolverine and wolf. The list of reasonably foreseeable projects used in the assessment is based on an evaluation of the potential of reasonably foreseeable activities, as defined on p.13-11, Section 13.4.2 within this RSA, to overlap with the Project's effects

This list of reasonably foreseeable projects within the RSA includes several advanced exploration and mining developments within NWT. A review of publicly available government information for some of these VCs (for example Bathurst and Ahiak caribou):

http://www.enr.gov.nt.ca/_live/pages/wpPages/Bathurst_Caribou_Herd.aspx and
http://www.enr.gov.nt.ca/_live/pages/wpPages/Ahiak_Caribou_Herd.aspx

suggests that other advanced exploration projects such as Izok and High Lake, Hope Bay, Hackett River and Kiggavik, and the Bathurst Inlet Port and Road are within the range of these broadest-ranging VCs. To be consistent with the methodology described in section 13.4, these projects should be included in the list of reasonably foreseeable developments, for the purpose of scoping the cumulative effects assessment, at least initially for the pathways analysis.

Request

1) More information should be requested regarding the criteria for selecting the specific reasonably foreseeable projects and for excluding others, based on the range of the specific VCs provided in Table 13.4-1.

2) Specifically, the proponent should explain why they chose to exclude the following from their analysis:

   a. Existing Operations:

      i. Jericho – Existing Diamond Mine (See De Beers terrestrial presentation, slide 10)

   b. Active NIRB Reviews:

      i. Bathurst Port and Road (BIPR) – Submitted to NIRB in 2004

      ii. High Lake (MMR) – Submitted to NIRB in 2006

      iii. Hackett River (Xstrata/Sabina) - Submitted to NIRB in 2008

   c. Reasonably Foreseeable (proposed and sufficient level of detail exists):

      i. Ulu/Lupin – Elgin Mining

      ii. Back River – Sabina Gold and Silver

   YKDFN suggest that individual explanations would be most useful, comparing and contrasting the selection (or exclusion) of the project against the criteria in 13.4.2 as well as the six projects that the proponent selected.

3) The company should provide the date at which they received the development data for exploration projects in Nunavut. Additionally, the

company should undertake a comparison of the exploration effort in Nunavut today (2012) vs. what value was used in the analysis (number of projects, size of projects, and overall investment).

Response

(1) and (2) De Beers refers the YKDFN to the response for Information Request TG_44, which contains a supplementary cumulative effects assessment on Bathurst caribou using the following additional reasonably foreseeable future developments that were not included in the Environmental Impact Statement (EIS).

(1) The proposed Tlicho Road (an all-land road route connecting Highway 3 with Gameti).

(2) The NICO Project (including the NICO Project Access Road [an all-season road connecting the NICO Project to the proposed Tlicho Road]).

(3) The Bathurst Inlet Port and Road.

(4) The High Lake Project was included as an active mine, rather than an exploration camp.

(5) The Jericho Diamond Mine was assumed to be operational.

The Hackett River, Ulu, Back River and Lupin projects listed by the YKDFN were included in the development database used in the EIS (De Beers 2010, Section 13.4) and the supplementary assessment (De Beers 2012) as exploration camps or a closed mine (in the case of Lupin).

This supplementary analysis did not change the conclusions in the EIS. For example, the proportion of direct disturbance to the annual range was negligible at 0.26% and similar to the winter range (0.25%). The physical footprint from developments covered 0.14%, 0.21%, and 0.17% of the northern migration, summer, and autumn ranges, respectively (see TG_44). In the EIS, the proportion of each seasonal range disturbed by the physical footprints of previous, existing and reasonably foreseeable developments was similar:

- winter range = 0.22%;
- northern migration range = 0.11%;
- summer range = 0.18%; and
- rut / autumn range = 0.16%.

The supplementary analysis also showed that indirect changes to habitat were similar to effect sizes calculated in the EIS (see TG_44).

With regards to the request for further information on the development data for Nunavut, De Beers has provided the YKDFN with a copy of the database used to describe previous and existing developments in the EIS.

3. De Beers received information on exploration projects in Nunavut from Aboriginal Affairs and Northern Development Canada in early 2010 for integration in the EIS. A brief search of the Nunavut Impact Review Board public registry for 2011 (completed in mid-March 2012) did not indicate any new mineral exploration camp applications, confirming that the cumulative effects analysis provides a relevant and appropriate estimate of the amount of mineral exploration on the landscape.

References

De Beers (De Beers Canada Inc.). 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. 2012. Environmental Impact Statement Supplemental Information Submission for the Gahcho Kué Project. Submitted to the Mackenzie Valley Environmental Impact Review Board. April 2012.

GAHCHO KUÉ PROJECT ENVIRONMENTAL IMPACT STATEMENT
INFORMATION REQUEST RESPONSES

Information Request Number: YKDFN 3.39

Source: Yellowknives Dene First Nation

Subject: Residual effects of existing activities (Section 13)

EIS Section: Section 3: Cumulative Effects

Terms of Reference Section:

Preamble

The cumulative effects assessment methodology does not describe which projects or activities contribute to the baseline (2010) conditions, nor which residual impacts of these activities potentially interact with Gahcho Kue.

The approach to cumulative effects assessment considers a “Baseline Case”, “Application Case” and “Future Case”. The baseline case is defined as conditions existing prior to the Gahcho Kue project (2010) and include environmental conditions prior to mineral and other development activity (reference conditions), as well as existing conditions subject to previous and existing projects. The baseline case was determined by compiling a database of previous and existing developments, based on information obtained from various regulators, developers and personal knowledge.

As is noted in the CEA, baseline (2010) conditions may already reflect cumulatively impacted conditions of environmental VCs. The Gahcho Kue project is not being developed in an un-impacted area. As was stated in the introduction to this section, concern has been expressed that “this is the 5th diamond mine in the area”. While individual Key Lines of Inquiry sections do provide some assessment of the footprint of different types of activities (e.g., section 7.5.2.1), there appears to be little or no discussion of how specific residual impacts of these activities contribute to this baseline condition. For example, what are the specific residual impacts of the Snap Lake or EKATI or Diavik mines or the Tibbitt-Contwoyto road that have the potential to overlap with those of Gahcho Kue? In some cases these are elaborated on within the various individual assessment sections, but they are not specifically included in the stand-alone cumulative effects assessment section.

To our knowledge, the development database, or any summary thereof, referenced in 13.4 and 7.5.2.1 was not submitted as part of the CEA. The Review Board Environmental Impact Assessment Guidelines (2004) recommend that all past, present and reasonably foreseeable projects be included in the assessment, and describe how these developments may interact with the project. It is of little value to conduct or review a cumulative effects assessment without first listing past and present developments or activities and without having some understanding of the residual impacts, and potentially overlapping impact of these activities, other than the simple footprint.

Request

1) The proponents should provide a list of “past” and “present” activities which contribute to the baseline (2010) assessment case

2) For each of these, the proponent should provide information to indicate all impacts to VCs of these activities that have the potential to interact cumulatively with the Gahcho Kué project.

Response

1. There are 551 developments incorporated into the database for analyzing and assessing cumulative effects on terrestrial valued components (VCs) within their defined study areas. A description of the development database is provided in Section 13.4 (De Beers 2010). A summary of previous (“past”) and existing (“present”) developments used in the cumulative effects analyses is provided for each terrestrial VC (i.e., vegetation, caribou, other ungulates, carnivores, and birds) in the Environmental Impact Statement (EIS). For example, Section 7, Table 7.5-1 (De Beers 2010) describes the type of developments, footprint area, number of each development type and the linear feature length for each of the Bathurst and Ahiak caribou herds (De Beers 2010, Section 7.5.2.1). Section 7, Figures 7.5-1 and 7.5-2 (De Beers 2010) show where these developments are located within the Bathurst and Ahiak caribou study areas, respectively. On March 21, 2012, the development database shapefile used in the cumulative effects analysis of terrestrial VCs was provided to the Yellowknife Dene First Nation.

2. To meet the Terms of Reference, the cumulative effects analysis in the EIS followed the guidelines of the Mackenzie Valley Environmental Impact Review Board (MVEIRB [2004]) including:

   - identify the VCs for the proposed project;
   - determine what other past, present, and reasonably foreseeable future developments could affect the VCs;
   - predict the effects of the proposed project in combination with these other developments; and
   - identify ways to manage the combined effects.

Section 13 (De Beers 2010) provides a summary of the cumulative effects analyses completed for each VC in the EIS. The details of these analyses are contained within their respective Key Line of Inquiry and Subject of Note sections. This included a pathways analysis, which was used to focus the analysis and assessment on the key pathways that result in changes to measurement endpoints and associated effects on VCs. All primary pathways from the Gahcho Kué Project were analyzed for cumulative effects with other developments, after applying mitigation designs, policies, and procedures.

Project pathways assessed as no linkage and secondary were predicted to have no detectable and negligible influences on VCs, respectively, and would not combine with similar pathways from previous, current, and reasonably foreseeable developments to cause significant effects. As demonstrated in the EIS, the changes from most secondary pathways occur within the physical Project footprint. In some exceptions, effects are anticipated to extend a short distance beyond the Project footprint (such as dust). However, the combination of these pathways (additive, synergistic or multiplicative) is not producing incremental or cumulative effects beyond the local scale that are not captured by the primary pathways. In other words, the cumulative interaction of secondary pathways from the Project and other developments is captured in the more detailed analysis and assessment of significance of the primary pathways.

In summary, the analysis was spatially explicit so that the number and geographic location of developments varied for each VC depending on the study area. Study areas were designed to be large enough to capture the maximum direct and indirect effects on the defined population, which included the Gahcho Kué Project. A key point is that the analysis assumed that the effects from the Gahcho Kué Project interacted cumulatively with effects from all other developments in the VC study areas. The analysis was also completed across time, from reference conditions (baseline with no to little development) through varying development conditions on the landscape (e.g., 2000, 2006, 2010), and the application of the Project and reasonably foreseeable developments (e.g., see De Beers 2010, Sections 7.5.3.2.1, 11.10.4.3.2 and 11.10.5.2.2). The approach used in the EIS to predict cumulative effects is consistent with MVEIRB (2004) Guidelines and was appropriate for meeting the Terms of Reference.

References

De Beers (De Beers Canada Inc.). 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.

Mackenzie Valley Environmental Impact Review Board (MVEIRB). 2004. Environmental Impact Assessment Guidelines. March 2004.

Information Request Number: YKDFN 4.40

Source: Yellowknives Dene First Nation

Subject: Residual effects of existing activities (Section 13)

EIS Section: Section 4: Closure and Reclamation

Terms of Reference Section:

Preamble

The closure and mining scenario is extremely dependant on a sequential and highly interdependent management scenario. With De Beers other mine in the NWT, we have seen that some of the key foundations that were advanced in the EA have not been enacted, despite several years of operations. Paste production and contaminant land farming are two such examples. Additionally, at the BHP site, we have seen the mine plan change numerous times over the operational life.

YKDFN support the progressive reclamation foundation of the mine plan – it is common sense to deposit the waste rock from one pit into another. However, this brings certain challenges with it as well – while reducing the environmental impact, it introduces a particular lack of flexibility to the mine plan. Changes made to the plan (for whatever reason), as seen at Snap Lake and Ekati will have ripple effects to the management of environment at the site.

Request

The proponent should undertake contingency planning that considers what happens if various components of the mine are altered or delayed (e.g. pit development). Milestones identified as essential should be recognized, with the discussion and identification of contingencies or management options available as the mine evolves. Contained within this discussion should be the identification of what options are removed as potential contingencies occur.

Response

The development plans outlined in the environmental impact statement (EIS) (De Beers 2010) are designed with the knowledge that development and operations may be altered as new information becomes available and as such contingency planning are inherent to the designs. Key to this process are the waste and water management plans which provide flexibility within an isolated control basin as well as multiple years of excess storage capacity to accommodate conditions for many different scenarios. Thus ample time is available to make appropriate design and operational modifications should they be necessary.

Use of the mined out pits is an inherent part of the design. The mine plans proposed, purposely accelerate the completion of the 5034 and the Hearne pits in order to utilize their storage volume as part of the progressive reclamation program.

After initial lake dewatering, the development as set forth has the capability to operate on a closed system basis for several years without discharge to the environment. This provides for additional passive treatment (additional time for settling) and/or design adaptations to the water management plans. A hierarchy of contingencies beyond the excess storage capacity is available to the operator.

For example, additional storage capacity can be created in Areas 6 and 7 to hold additional water. Likewise once specific water quality issues are known, then specific treatment adaptations can be applied.

Additional waste storage capacity is available in the West Rock Pile and the Hearne Pit for potential increases in waste rock or fine processed kimberlite (PK) quantities.

Reclamation and closure planning would be continually updated throughout the mine's operational life to address predicted versus actual conditions in accordance with guidelines proposed by AANDC (AANDC 2011).

Reference

AANDC 2011. DRAFT Guidelines for the Closure and Reclamation of Advanced Mineral Exploration and Mine Sites in the Northwest Territories. Aboriginal Affairs and North Development Canada. August 11, 2011.

De Beers (De Beers Canada Inc.). 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.

Information Request Number: YKDFN 4.41

Source: Yellowknives Dene First Nation

Subject: Conceptual Reclamation Plan (Section 3.12 Closure and Reclamation)

EIS Section: Section 4: Closure and Reclamation

Terms of Reference Section:

Preamble

The EIS did not include a preliminary closure plan.

In the Avalon Rare Minerals Environmental Assessment, the Board required the submission of "conceptual monitoring and management plans" for the DAR to be accepted in conformity. The preliminary closure plan is a critical step to understand the cradle to crave nature of a mineral development. Though this process is not an Environmental Assessment, the higher scrutiny attached to an Environmental Impact Assessment should require this information. The information available in 3.12 goes some of the way to providing the data for the Mine Components and closure Objectives so completing a preliminary closure plan that outlines these commitments and the site goals shouldn't be difficult.

Request

The proponent should be required to submit the preliminary closure plan, utilizing the best practices from other closure plans and the MVLWB guidelines.

Response

The conceptual closure plan is described in the environmental impact statement (EIS) Section 3.12 (De Beers 2010) and in July 2011 MVEIRB issued a statement that the EIS achieved conformity. DeBeers plans to provide updates to the closure plan consistent with the AANDC/MVLWB Closure and Reclamation guidelines (AANDC and MVLWB 2011).

References

AANDC and MVLWB 2011. DRAFT Guidelines for the Closure and Reclamation of Advanced Mineral Exploration and Mine Sites in the Northwest Territories. Aboriginal Affairs and North Development Canada and Mackenzie Valley Land and Water Board. August 11, 2011.

De Beers (De Beers Canada Inc.). 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.

GAHCHO KUÉ PROJECT ENVIRONMENTAL IMPACT STATEMENT
INFORMATION REQUEST RESPONSES

Information Request Number: YKDFN 4.42

Source: Yellowknives Dene First Nation

Subject: Conceptual Reclamation Plan (Section 3.12 Closure and Reclamation)

EIS Section: Section 5: Culture and Archaeology

Terms of Reference Section:

Preamble

The archaeologists divided the study area into high, medium and low potential areas. Presumably, this was used to govern the survey effort outside of the areas that would be directly affected by road construction, quarrying, or infrastructure. However, there is nothing that explains what the survey effort was, nor how it was broken down and if this proved to be a valid technique (i.e., more sites were found in the high potential areas than the low).

Request

1) YKDFN request the company provide a clear, plain language discussion on the plan of action for the moderate and high significance sites that will be impacted?

2) Provide a map indicating the high, medium and low potential areas

3) Create a map identifying (and quantifying) the survey effort. Areas to be disturbed that have not been surveyed should be uniquely identified

4) Create a table that presents the standardized results – 'sites per survey unit effort' for each of the categories.

Response

1) In the permit reports prepared by Jean Bussey of Points West Heritage Consulting Ltd. (Points West) and in the 2010 Environmental Impact Statement (EIS) (De Beers 2010, Section 12, Appendix 12.III), it has been recommended that surface artifacts be collected and excavation be undertaken at all sites in conflict that are suggestive of moderate or high significance. The final decision on actions to be undertaken at each site is the responsibility of the Prince of Wales Northern Heritage Centre. Community consultation is ongoing and any

input relating to archaeological mitigation that is captured at meetings will be shared with the Prince of Wales Northern Heritage Centre.

2) Attached is a map identified as Figure YKDFN_4.42-1. This map shows areas of moderate to high archaeological potential and areas of low archaeological potential. It was not feasible to separate moderate potential from high potential at this scale and because both areas were examined with the same intensity, it was not deemed necessary. Please note that it is possible that small areas of low potential could occur within the moderate to high potential areas. It is also possible that small areas of moderate to high potential could occur within low potential areas. The latter is particularly likely along the shore of Kennady Lake, where relatively level areas that are too small to show at a scale of 1:25,000 that are representative of moderate to high potential were discovered. Intensive boat survey conducted along the shore of Kennady Lake, in conjunction with low level helicopter reconnaissance, identified such areas.

3) The area adjacent to Kennady Lake (see attached Figure YKDFN_4.42-2), including the entire mine footprint, has been examined through a combination of helicopter, boat and foot reconnaissance. All potential gravel sources have been traversed. To the best of our knowledge, all portages along the existing winter road have been traversed. Because Points West did not conduct the majority of the inventory, which was primarily undertaken by Callum Thomson of Jacques Whitford between 1998 to 2003, it is not possible to provide a map of the areas that have and have not been surveyed, but all moderate to high potential areas within the mine footprint have been examined on the ground, as have a sample of the low potential areas.

Points West conducted limited archaeological surveys of specific locations that represent changes from the original plan examined by Callum Thomson. With such a limited area of examination, a map would not provide much value or clarity, but examples of areas examined by Points West personnel are provided below.

All three portages associated with a revised winter road to a gravel source southwest of the mine footprint were surveyed by Points West although the majority of this route was suggestive of low archaeological potential. One new site was found on high potential terrain overlooking a lake and several hundred metres from the road route. Over half of the original route, also on low potential terrain was also traversed on foot.

Approximately one-half of another possible road route north of the west arm of Kennady Lake was surveyed by Points West although the majority was on terrain with low archaeological potential. One site was found on a small rise that represented moderate potential terrain.

Selected upland areas inland from Kennady Lake were surveyed in response to revised development plans; an estimated 10 percent (%) of the area traversed was on low potential terrain. Three sites were found on areas with moderate to high archaeological potential.

Approximately one-half of a proposed waterline was surveyed although the entire route was on low archaeological potential terrain. No archaeological sites were discovered.

Eight of the new sites found by Points West involved eskers with high archaeological potential that were under consideration as possible sources of gravel. There was no low potential terrain affected by the gravel sources identified. None of these gravel sources are currently under consideration for development.

All moderate to high potential terrain within the mine footprint has been surveyed. Much of the area along the south side of Kennady Lake surveyed by Callum Thomson prior to 2003, was resurveyed by Points West in 2004 and 2005 with the intended purpose of relocating his sites in order to assess their significance. The same applies to a portion of the east side of the lake at its northern end and the north side of the west arm of Kennady Lake. Only one new site was found and it may have been south of Thomson's original study area. This indicated to Points West that Thomson's work was thorough.

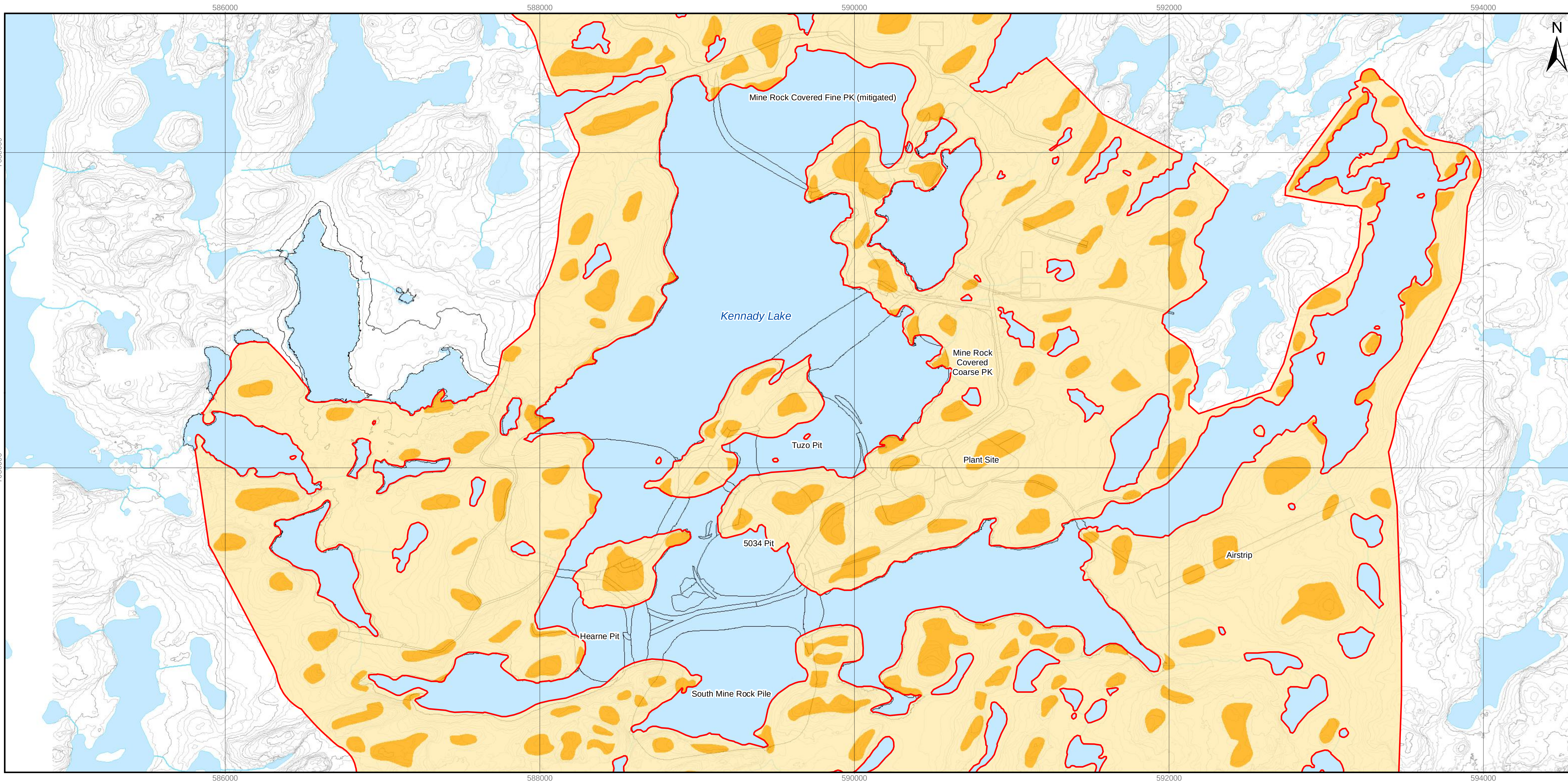
Within the mine footprint, Thomson surveyed the majority of the originally proposed mine facilities, various exploration areas and gravel sources, as well as the winter road. As the YKDFN is familiar with his work, they know that he is thorough and covers all types of terrain with the same enthusiasm. However, because Points West was not present during his surveys, it is not possible to provide a map. The sites he recorded that are within the mine footprint were revisited by Points West; all were on either moderate or high potential landforms.

Details of the archaeological sites, as well as the methodology, are provided in Annex L and the site and potential assessments are provided in Section 12, Appendix 12.III of the 2010 EIS (De Beers 2010).

4) As detailed above, intensive judgemental archaeological surveys has been conducted within the mine footprint and at identified areas of proposed exploration or development. Archaeological surveys involved all types of landforms/terrain. Given this sampling approach, which is largely based on professional judgement and field characteristics, a “sites per unit effort” table is not possible, nor would it add value. The work was thorough and resulted in the discovery of 253 new sites in an area with only one previously recorded site (Annex L and Appendix 12.III in Section 12 of the 2010 EIS [De Beers 2010]). It should also be acknowledged that De Beers supported going beyond the boundaries of a development area to ensure adjacent areas did not contain sites that might be affected.

Reference

De Beers (De Beers Canada Inc.). 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.



I:\CLIENTS\DE_BEERS\11-1365-0001\Mapping\MXD\Archaeology\B2011-Archy-002-GIS.mxd

LEGEND

- Waterbody
- Watercourse
- Index Contour (5m interval)
- Intermediate Contour (1m interval)
- Project Footprint
- Approximate Boundary of the Area Around the Proposed Mine which was Intensively Examined via Helicopter, Boat and/or Ground Reconnaissance

Archaeology Potential

- Area of Moderate to High Archaeological Potential (may include small areas of low potential)
- Area of Low Archaeological Potential (may include small areas of moderate to high archaeological potential, especially along the shore of Kennady Lake)

NOTES

Base Data Source: Eagle Mapping Ltd.

GAHCHO KUÉ PROJECT

Archaeological Potential Around Kennady Lake

PROJECTION: UTM Zone 12	DATUM: NAD83
Scale: 1:25,000 (250 125 0 250 500 Meters)	
FILE No: B2011-Archy-002-GIS	DATE: March 23, 2012
JOB NO: 11-1365-0001	REVISION NO: 1
OFFICE: GOLD-CAL	DRAWN: CW
CHECK: JB	

DE BEERS CANADA

Figure YKDFN_4.42-1

LEGEND

- Gahcho Kué Project
- Winter Access Road
- Contour (10m interval)
- Waterbody
- Archaeology Reconnaisance Area

NOTES

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

I:\CLIENTS\DE_BEERS\11-1365-0001\Mapping\MXD\Archaeology\B2011-Archy-001-GIS.mxd

GAHCHO KUÉ PROJECT

Areas Covered Intensively During Helicopter, Boat, and Ground Reconnaissance

PROJECTION: UTM Zone 12	DATUM: NAD83
Scale: 1:25,000 (500 250 0 500 Meters)	DE BEERS CANADA
FILE No: B2011-Archy-001-GIS	DATE: March 23, 2012
JOB NO: 11-1365-0001	REVISION NO: 1
OFFICE: GOLD-CAL	DRAWN: CW / CHECK: JB

Figure YKDFN_4.42-2

GAHCHO KUÉ PROJECT ENVIRONMENTAL IMPACT STATEMENT
INFORMATION REQUEST RESPONSES

Information Request Number: YKDFN_4.43

Source: Yellowknives Dene First Nation

Subject: Integration of TK into assessment

EIS Section: 5.4.2.1.3

Terms of Reference Section:

Preamble

The section provides no depth to the methods by which the proponent considered the data available. On the face of it, it does not seem as though they incorporated any traditional knowledge into the actual assessment, suggesting that because the Key Lines of Inquiry analyzed many of the principal topics of the TK holders, then the assessment would consider the effects of the project. This implicitly suggests that they did not view traditional knowledge as evidence.

The proponent indicated that the information available to them could be contradictory – citing two examples extracted from the internet as their source. However, by only relying on secondary sources the available information is not thorough to arrive at a consensus.

Request

1) The proponent should provide a discussion as to how they incorporated traditional knowledge into the assessment methods.

Response

Traditional Knowledge (TK) has been incorporated into the 2010 Environmental Impact Statement (EIS) (De Beers 2010) through the preparation of a TK baseline, and the integration of TK, as data, by discipline leads into their respective assessments.

A TK baseline was prepared through literature review of available TK information relating to Aboriginal groups potentially affected by the Project. The TK Baseline is found in the 2010 EIS, Annex M, and is summarised in Section 5 (De Beers 2010). TK information found in the Annex M was reviewed by discipline leads and incorporated into their respective sections. Section 5.4.2 of the EIS (De Beers 2010) summarizes how the information was reviewed by discipline leads, and also summarizes the TK data that was used by the various disciplines in their analyses. For example, the following provides a detailed summary of where TK was included in the key line of inquiry (KLOI) – Caribou (De Beers 2010, Section 7).

- Section 7- Key Line of Inquiry: Caribou;
  - Section 7.2- Summary;
    - Section 7.3.1- Existing Environment: General Setting;
      - Section 7.3.2.1- Existing Environment: Gahcho Kué Project Baseline Study;
      - Section 7.3.2.3- Existing Environment: Methods- Traditional Knowledge and Resource Use;
      - Section 7.3.2.4- Existing Environment: Methods- Socio-economics;
        - Section 7.3.3.2.3- Existing Environment: Results- Review of Regional Effects Monitoring and Research Programs- Caribou Population Characteristics;
      - Section 7.3.3.3- Existing Environment: Results- Traditional Knowledge and Resource Use;
      - Section 7.3.3.4- Existing Environment: Results- Socio-economics Related to Caribou;
  - Section 7.4.1- Pathway Analysis- Methods
  - Section 7.5.1- Effects on Population Size and Distribution of Caribou- General Approach;
        - Section 7.5.3.2.2- Effects on Population Size and Distribution of Caribou- Habitat Quality, Behaviour, and Movement- Effects on Behaviour, Energy Balance, and Calf Production;
      - Section 7.5.5.2- Effects on Population Size and Distribution of Caribou- Related Effects on People- Availability of Caribou;

- Section 7.6.4- Residual Effects Summary- Related Effects on People;
- Section 7.8.2- Environmental Significance- Results;
- Section 7.9- Uncertainty; and
- Section 7.10- Monitoring and Follow-up.

Similarly, references to TK are found throughout the entire EIS (De Beers 2010) in baseline studies, pathway analysis, effects assessment, monitoring and follow-up summaries.

While De Beers is confident that it has sufficient and applicable TK/Traditional Land Use (TLU) from secondary sources to incorporate TK into the project design, to predict effects and to identify appropriate mitigation measures, De Beers also notes that for a number of years, it has been encouraging the Yellowknives Dene First Nation to proceed with a TK/TLU Study for the Gahcho Kué Project. Discussions between De Beers and the Yellowknives Dene First Nation, eventually led to a formal offer from De Beers to the Yellowknives Dene First Nation to support the undertaking of a TK/TLU Study in 2009. The Yellowknives Dene First Nation accepted the offer to complete a TK/TLU Study for the Gahcho Kué Project in 2010 and acknowledged that they would develop a scope of work and budget to complete the study. Since 2010, De Beers has encouraged the Yellowknives Dene First Nation to submit the scope of work and budget so that work on the study could be initiated and completed.

When De Beers submitted the Gahcho Kué EIS in December 2010, De Beers had not yet received a proposal from the Yellowknives Dene First Nation. During November 28 – December 2, 2011 the MVEIRB hosted EIS Analysis Session regarding the proposed Gahcho Kué Project. Panel staff encouraged all environmental impact review (EIR) Aboriginal participants to complete and submit any outstanding TK reports so that it can be considered by the Panel (see for example, EIS Analysis Session November 29, 2011 Transcript Vol. 2 at pp. 122-123). De Beers has encouraged the Yellowknives Dene First Nation to undertake a TK/TLU Study, with De Beers' support and has encouraged the Yellowknives Dene First Nation to complete such a study so that it can form part of the public record for the Project EIR. The most recent correspondence in which De Beers encouraged the Yellowknives Dene First Nation to move forward on this matter was in February 2012.

Over the years there has been and will continue to be many opportunities for Yellowknives Dene First Nation to provide traditional knowledge information into the EIR process for the Project and De Beers will continue to encourage the Yellowknives Dene First Nation to provide that information. It should also be noted that Traditional Knowledge/Traditional Land Use studies are being completed by the Tlicho Government, the Lutsel K'e Dene First Nation and the Deninu Kué First Nation. De Beers expects that those studies will be completed and form part of the public record for the Project EIR.

When the results of the Traditional Knowledge/Traditional Land Use studies, including a study undertaken by the Yellowknives Dene First Nation for the Gahcho Kué Project are made available, De Beers will use the information from that study to validate impact predictions, to evaluate whether additional mitigation is needed, and to discuss how to incorporate their TK into future monitoring programs.

Reference

De Beers (De Beers Canada Inc.). 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.

GAHCHO KUÉ PROJECT ENVIRONMENTAL IMPACT STATEMENT
INFORMATION REQUEST RESPONSES

Information Request Number: YKDFN_4.44

Source: Yellowknives Dene First Nation

Subject: Traditional Knowledge – reliance on secondary sources

EIS Section: 5.4.2.1.3, Annex M

Terms of Reference Section:

Preamble

"De Beers is confident that it has sufficient and applicable TK from secondary sources to incorporate TK into the project design, to predict effects and to identify appropriate mitigation measures (p5-12)".

The secondary sources used to capture the breadth of the Yellowknives Dene First Nation's experience with this area and the Valued Ecosystem Components amounts to three reference books with a North American focus and a single day of hearings for the Drybones Bay hearing. These references provide little in the way of actual TK and the company should acknowledge the information gap.

The results presented in section M4 only discusses cultural identity, toponyms and traditional land use. The traditional land use section (M4.3.1, M4.5) is entirely historical, which is predictable given the resources that it accessed. However, it shows that the company has little understanding of the Yellowknives Dene traditional use of the Gahcho Kue region, one of the two primary user groups of the area (section 5-16) – "[Tlicho Government] confirmed that the Project was located in a shared area with the Akaitcho Dene First nation and that the primary user of that area was the Yellowknives Dene First Nation".

Request

1) How can the company state that they are confident that they have sufficient TK data when it is drawn from such ineffective sources?

2) What information was taken from these sources and how did it influence project design, effects predictions and mitigation measures?

Response

Traditional Knowledge (TK) was collected through community engagement activities, the discussion of existing secondary sources, and the review and incorporation of primary source data. The results of consultation can be found in Section 4 of the 2010 environmental impact assessment (EIS) (De Beers 2010). The results of the review of secondary sources are discussed in Annex M and Section 5 of the 2010 EIS (De Beers 2010).

Community Engagement

De Beers has been engaged in community engagement activities since 1998. Between 1998 and 2005, De Beers conducted exploration and Project planning. This involved meeting with Tlicho, LKDFN, DKFN, TKDFN, Treaty 8 (Akaitcho), North Slave Métis Alliance and the NWT Métis Nation. Concerns were identified pertaining to: water quality, fish health and habitat, wildlife (in particular caribou) health, environmental pollutants, the preservation of archaeological heritage, environmental monitoring and general socio-economic issues (e.g., employment, training, business opportunities).

De Beers also participated in Mackenzie Valley Environmental Impact Review Board (MVEIRB) community scoping workshops in 2006 wherein a range of social, environmental and economic themes were identified by the previously mentioned Aboriginal groups.

Following the release of the Gahcho Kué Terms of Reference (2007), De Beers entered into community engagement between 2007 and 2010. Initial meetings were held with community leaders to discuss the engagement process. De Beers then conducted both community meetings and open houses in Behchoko, Gameti, Wekweeti, Whati, Fort Resolution, and Lutsel K’e to identify important resources and Traditional Land Use (TLU) activities in the study area. Further meetings were held with the North Slave Métis Alliance (NSMA), the Yellowknives Dene First Nation (YKDFN), the Deninu Kué First Nation, the Lutsel K’e Dene First Nation (LKDFN), the Tlicho Government and the NWT Métis Nation. The following key lines of inquiry and subjects of note were identified:

- Water Quality and Fish in Kennady Lake;
- Caribou;
- Carnivore Mortality;
- Long-term Biophysical Effects, Closure and Reclamation;
- Downstream Water Effects;
- Long-term Social, Cultural, and Economic Effects;
- Social Disparity Within and Between Communities; and
- Aboriginal Rights and Community Engagement.

From 2010 until 2011, De Beers conducted a public information campaign and planned community activities such as open houses, community meetings and community representative site visits. These activities confirmed many of the concerns raised in the community engagement process. During this period, De Beers also conducted meetings leading to the EIS submission with Indian and Northern Affairs Canada (now Aboriginal Affairs and Northern Development Canada), the Government of the Northwest Territories, Environment Canada and Fisheries and Oceans Canada.

Community engagement, the public information campaign and the 2010 EIS lead-up meetings culminated in the planning of a series of issue-based workshops (2011) held in Yellowknife. These workshops were to provide regulators and individual agencies with the opportunity to discuss topics of interest with De Beers, as they relate to the Project.

Future community engagement will include workshops, hosted site visits, community meetings and discussions with community leadership. De Beers will continue to invite community leadership to provide input regarding how De Beers engages their communities.

All of these activities resulted in De Beers having a strong understanding of the environment in which it was proposing to construct the Project, as well as a strong understanding of the issues of concern to Aboriginal communities.

Literature Review and Assessment

The literatures review (De Beers 2010, Annex M4.4 and Section 5.3.1) further identifies specific traditional resources and TLU activities in the study area. Many of these features had been mentioned during the community engagement and information campaign efforts of De Beers.

Assessments of potential effects made in the EIS (De Beers 2010) consider information gathered on people's knowledge of traditional resources (e.g., wildlife, plants and water) and cultural sites through community engagement and literature review results. Assessments also consider the potential effects of the Project on human use of resources.

Combined with both a strong understanding of the environment in which it is proposing to build the project and a strong understanding of the issues of concern to Aboriginal communities, De Beers is confident that it has sufficient and applicable TK from secondary sources to incorporate TK into the project design, to predict effects and to identify appropriate mitigation measures.

Primary Data Collection and Incorporation

De Beers has encouraged the YKDFN to undertake a TK/TLU study with De Beers' assistance. These efforts are outlined in De Beer's response to YKDFN_4.43. When the results of TK/TLU studies, including a study undertaken by the Yellowknives Dene First Nation for the Gahcho Kué Project are made available, De Beers will use the information from that study to validate impact predictions, to evaluate whether additional mitigation is needed, and to discuss how to incorporate their TK into future monitoring programs.

2. Traditional Knowledge is woven throughout the 2010 EIS. For example, for the Key Lines of Inquiry (KLOI) for Caribou (De Beers 2010, Section 7), TK is found in the summary, baseline study, socio-economic assessment, pathway analysis, effects assessment, uncertainty, and monitoring and follow-up sections of the KLOI for Caribou:

- Section 7- Key Line of Inquiry: Caribou;
  - Section 7.2- Summary;
    - Section 7.3.1- Existing Environment: General Setting;
      - Section 7.3.2.1- Existing Environment: Gahcho Kué Project Baseline Study;
      - Section 7.3.2.3- Existing Environment: Methods- Traditional Knowledge and Resource Use;
      - Section 7.3.2.4- Existing Environment: Methods- Socio-economics;
        - Section 7.3.3.2.3- Existing Environment: Results- Review of Regional Effects Monitoring and Research Programs- Caribou Population Characteristics;
      - Section 7.3.3.3- Existing Environment: Results- Traditional Knowledge and Resource Use;
      - Section 7.3.3.4- Existing Environment: Results- Socio-economics Related to Caribou;
  - Section 7.4.1- Pathway Analysis- Methods
  - Section 7.5.1- Effects on Population Size and Distribution of Caribou- General Approach;
        - Section 7.5.3.2.2- Effects on Population Size and Distribution of Caribou- Habitat Quality, Behaviour, and Movement- Effects on Behaviour, Energy Balance, and Calf Production;
      - Section 7.5.5.2- Effects on Population Size and Distribution of Caribou- Related Effects on People- Availability of Caribou;
  - Section 7.6.4- Residual Effects Summary- Related Effects on People;
- Section 7.8.2- Environmental Significance- Results;
- Section 7.9- Uncertainty; and
- Section 7.10- Monitoring and Follow-up.

Similarly, references to TK are found throughout the entire 2010 EIS in baseline studies, pathway analysis, effects assessment, monitoring and follow-up summaries.

TK will be considered during Project closure and reclamation activities. Road closure and reclamation will be completed in accordance with best practices, taking into account the information provided by traditional sources. Reclamation planning is based on the feedback from open houses and traditional knowledge information.

Section 5.4.5 of the EIS (De Beers 2010) details plans for incorporating TK into all stages of the Project life: the assessment, permitting, construction, operations and closure of the Project (De Beers 2010). In general, this will be achieved by advancing engagement activities, finalizing TK studies with Aboriginal Authorities, hosting site visits, involving Elders and youth in monitoring programs and providing workshops.

References

De Beers (De Beers Canada Inc.). 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.

April 2012

GAHCHO KUÉ PROJECT ENVIRONMENTAL IMPACT STATEMENT
INFORMATION REQUEST RESPONSES

Information Request Number: YKDFN 4.45

Source: Yellowknives Dene First Nation

Subject: Cultural Identity EIS Section: Section 5: Culture and Archaeology

Terms of Reference Section:

Preamble

On page M4-1, the company discuss the importance of cultural identity landscape and indicates the 'results' of their work.

On page M4-3, the company states that the YKDFN are Chipewyan.

While portions of the community have a Chipewyan heritage, the majority of the membership has Dogrib heritage and the *Weledeh* dialect is more similar to the Tlicho.

Request

De Beers should acknowledge and correct their error, perhaps restating their level of confidence in their understanding of traditional knowledge.

Response

Annex M4.3.1 (page M4-3) in the Environmental Impact Statement (EIS) (De Beers 2010) recognizes that the Yellowknives Dene First Nation (YKDFN) have both Chipewyan and Dogrib heritage (De Beers 2010). For example, De Beers 2010, Section M4.5.1 elaborates on the heritage of the YKDFN, stating that the YKDFN began intermarrying with the Chipewyan of Fort Resolution in the 1800s, and, later, the Tlicho (formerly called the Dogrib) in the 1900s. The discussion of YKDFN Traditional Land Use (TLU)/Traditional Knowledge (TK) also considers Lutsel'ke Dene First Nation (LKDFN), and Tlicho heritage.

De Beers is currently working with the YKDFN to arrange TK/TLU studies. When the results of the studies become available, De Beers will validate impacts and discuss how best to incorporate traditional knowledge in future monitoring programs.

References

De Beers (De Beers Canada Inc.). 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.