July 3, 2015

Mackenzie Valley Environmental Impact Review Board
200 Scotia Centre
P.O. Box 938
Yellowknife, NT
X1A 2N7

Attention: Chuck Hubert, Senior Environmental Assessment Officer

Re: EA1314-01 Jay Project, Dominion Diamond Ekati Corporation Developer's Assessment Report – Responses to Round 2 Information Requests

Dear Mr. Chuck Hubert:

Dominion Diamond is pleased to provide you with the responses to the Round 2 Information Requests received following review of the Jay Project Developer's Assessment Report (DAR) Round 1 information requests, technical sessions, and technical session undertaking responses. As part of our continued commitment to provide information in a timely manner, we have included the following documents to accompany this letter:

- Dominion Diamond is providing responses to 70 Round 2 information requests from Deninu K'ue First Nation (DKFN), Environment Canada (EC), Government of the Northwest Territories (GNWT), Independent Environmental Monitoring Agency (IEMA), Łutselk'e Dene First Nation (LKDFN), the Mackenzie Valley Environmental Impact Review Board (MVEIRB), the North Slave Métis Alliance (NSMA), and Transport Canada (TC). Note that of the total 79 information requests that were submitted, 9 were addressed to other parties, so responses for those are not provided.

- Dominion Diamond is submitting the Technical Memorandum "Jay Project – Uncertainty Analyses Methods and Results for Hydrogeological Modelling" that provides analyses to assess the degree of uncertainty or probability associated with the hydrogeological modelling in the DAR.

- Dominion Diamond is submitting the Technical Memorandum "Jay Project – Pit Lake Hydrodynamic Modelling – Lower bound Scenario" to update the

Project water quality model for a Lower Bound Scenario, including the pit lake hydrodynamic models.

- Dominion Diamond is submitting a separate letter summarizing recommendations and potential revisions to conceptual management plans for the Jay Project from the workshops held on June 25 and 26, 2015.

As submitted previously for the Round 1 Information Request responses, an updated Online Review System (ORS) Excel spreadsheet is also included for the MVEIRB ORS.

We would like to reaffirm our commitment to work diligently with the MVEIRB and other parties to provide information and responses in a timely manner throughout the remainder of the process.

Regards,

Richard Bargery
Manager, Permitting Jay Project
Dominion Diamond Corporation

Information Request Number:	DAR-DKFN-IR2-01
Source:	Deninu K'ue First Nation Information Requests from Rosy Bjornson
Subject:	Barren-Ground Caribou
DAR Section(s):	12

Preamble (DKFN):

In its assessment, the Dominion Diamond Ekati Corporation (Dominion Diamond) has assumed, what it calls the maximum potential effect of the project, meaning that caribou were conservatively assumed to be deflected by the Jay Project (and the full Ekati project). Despite, this approach, Dominion Diamond does acknowledge that all caribou will not be deflected around the project since mitigation plans are being developed for the project roads.

Request (DKFN):

If caribou are in close proximity to the mine infrastructure it is expected that they would experience higher levels of stress and increased energy expenditures, exposure to poorer forage quality (as a result of dust deposition) compared to if they were deflected around the mine at the zone of influence distance. The overly conservative approach taken by Dominion Diamond may be unrealistic and not representative of the true condition and unknown effects may occur that are not accounted for in the DAR. Given the current population status and declines of the Bathurst Caribou Herd, additional stewardship activities from industry are warranted. Therefore we request the following:

a. Based on data from past monitoring programs at the Ekati Mine, what proportion of the Bathurst caribou herd can be expected to interact with the mine infrastructure?

b. What proportion of the current population, based on the most recent population estimates, of the Bathurst caribou herd does this represent?

Response:

In the Developer's Assessment Report (DAR), 17 potential effects pathways were identified by which Project components or activities might affect barren-ground caribou. These pathways represent a number of effects including potential mortality due to vehicle and aircraft collisions or drinking contaminated water, changes in habitat quality and quantity from dust deposition, air emissions and altered water levels, and sensory disturbance from mining activities. The pathways screening step analysis identified 14 of the potential pathways as no linkage or secondary (negligible), leaving three primary pathways for fuller detailed analyses. In the analyses of the residual effects of those three pathways, the assumption was made that all animals would be deflected around the Ekati and Diavik mines, incurring energetic costs associated with the additional distance travelled. Additional energetic costs were modelled through interactions of caribou with the zones of influence (ZOIs) for all active developments on the entire summer-autumn range, including mineral exploration sites. The ZOIs applied in the analyses were determined using empirical data from aerial surveys and radio-collared Bathurst caribou travelling through the Lac de Gras area near the Ekati and Diavik mines (Boulanger et al. 2012). The express purpose in using ZOIs is to represent the effects of all disturbances on caribou behaviour and distribution, including the change in forage quality from dust deposition noted in the request.

The modelled energetic costs incurred by caribou encountering the ZOIs and deflected around the Ekati and Diavik mines were applied to all females in the population and a conservative relationship between energetic cost and loss of calf production was applied in population modelling of the Bathurst herd (the population modelling report [MVEIRB-IR-15] produced in response to the Adequacy Review of the DAR). The modelling approach is described in MVEIRB-IR-15 as being overly conservative. An overly conservative approach is one that more than accounts for the Project-specific and cumulative effects of development. Even with the applied approach, the effects were concluded to be not significant at any phase of the Bathurst caribou population cycle. The pathways analysis and residual effects analyses in the DAR, and the additional analysis completed in the information requests provides a comprehensive assessment of the Project-specific and cumulative effects of development on barren-ground caribou.

Regarding the request for additional stewardship measures, on June 1, 2015 Dominion Diamond submitted a conceptual Wildlife Effects Monitoring Plan (WEMP) and Caribou Road Mitigation Plan (CRMP) for the Jay Project that includes a list of mitigation strategies for barren-ground caribou. A workshop to discuss the conceptual WEMP and CRMP was held on June 25, 2015.

Response to a) and b)

The specific information request was for an estimate of the proportion of the Bathurst herd interacting with the Ekati Mine infrastructure. The only individually identifiable animals whose movements are known and for which a proportional encounter rate can be determined are the radio-collared caribou from the Bathurst herd. To examine these data, a movement path was created in a Geographical Information System (GIS) from the set of location data for each calendar year for each collared caribou from the Bathurst herd. The intersections of the movement path with the Ekati Mine infrastructure and Misery Road were determined for each animal in each year (Table 1-1). The proportion of individual radio-collared caribou interacting with the Ekati Mine and the Misery Road are also presented, along with an estimate of the standard error of each annual estimate. The historic proportions of collared caribou interacting annually with the Ekati Mine infrastructure and the Misery Road are the best estimates of the overall proportion of female Bathurst caribou that may interact with the Ekati Mine infrastructure and the Misery Road in any year in the future. As Table 1-1 shows, there is considerable year-to-year variation in the estimates and associated standard errors, independent of population size. Through the WEMP and CRMP, Dominion Diamond will continue to monitor caribou interactions with the Ekati Mine, Jay Project, and Misery and Jay roads using information from radio-collared caribou, cameras, and incidental observations.

Table 1-1 Encounters of Radio-collared Bathurst Herd Caribou with Ekati Mine Infrastructure and Misery Road, 2006 to 2014

Year	Bathurst Herd Size[(a)]	Total Collared Caribou Monitoring Days[(b)] (number of collared animals)	Total Ekati Mine Infrastructure and Misery Road Encounters by Collared Caribou[(b)] (number of individual caribou)	Proportion of Collared Caribou Encountering Ekati Mine Infrastructure and Misery Road (SE)[(c)]
2006	128,000	5,393 (18)	8 (7)	0.39 (0.12)
2007	96,000	6,600 (22)	8 (5)	0.23 (0.09)
2008	64,000	5,669 (33)	1 (1)	0.03 (0.03)
2009	32,000	5,999 (29)	10 (4)	0.14 (0.07)
2010	33,000	4,958 (20)	7 (5)	0.25 (0.10)
2011	34,000	4,548 (20)	1 (1)	0.05 (0.05)
2012	35,000	5,943 (25)	6 (4)	0.16 (0.07)
2013	-	4,373 (23)	1 (1)	0.04 (0.04)
2014	-	4,139 (19)	9 (6)	0.32 (0.11)

(a) Herd size in 2006, 2009, and 2012 from photo census of Bathurst calving grounds. All other years prior to 2012 were predicted from linear relationship between photo-census estimates.

(b) Annual totals January 1 to December 31

(c) Number of individual collared animals that encountered the Ekati Mine divided by total number of collared animals. SE is 1 standard error of the estimate, based on the binomial distribution.

References:

Boulanger J, Poole KG, Gunn A, Wierzchowski J. 2012. Estimating the Zone of Influence of Industrial Developments on Wildlife: a Migratory Caribou Rangifer tarandus groenlandicus and diamond mine case study. Wildlife Biol 18: 164-179.

Information Request Number:	DAR-DKFN-IR2-02
Source:	Deninu K'ue First Nation Information Requests from Rosy Bjornson
Subject:	Barren-Ground Caribou
DAR Section(s):	12.4.2.3 (page 12-114)

Preamble (DKFN):

In this assessment Dominion Diamond assumes that caribou are exposed to one major disturbance event per day when residing within a zone of influence (ZOI).

Request (DKFN):

Please provide a description of what "one major disturbance event" would be?

Response:

In Section 12 (Barren-ground Caribou) of the Developer's Assessment Report (DAR), a major disturbance event was defined as an anthropogenic sensory disturbance that results in a reaction by caribou and included a flight response (running or trotting for 15 minutes), additional travel of 2.11 kilometres, and an extended excitement cost (10% of basal metabolic rate for 12 hours), and no compensatory foraging for a 24 hour period. Examples of sensory disturbances types provided in the DAR included noise or visual disturbances (viewscape) from a human walking or working outside, a moving vehicle, blasting, and/or a plane flying overhead (page 12-102).

DOMINION DIAMOND

Information Request Number:	DAR-DKFN-IR2-03
Source:	Deninu K'ue First Nation Information Requests from Rosy Bjornson
Subject:	Barren-Ground Caribou
DAR Section(s):	12.4.2.3 (page 12-116)

Preamble (DKFN):

In the last paragraph of this section the proponent states:

For those summers when insect harassment is low, female encounters with disturbance would be required to exceed 525 disturbance events so that there is an expenditure of 20% of 100 kg (i.e., 20 kg),and no calf production the following year. If considering the effects from severe insect harassment and disturbance encounters, then approximately 385 disturbance events per individual would be required to reduce parturition to zero, resulting in no calf production. Based on the expected number of disturbance encounters for current landscape conditions with the Project and future developments (approximately 28), female caribou would have to increase their encounter rate per day by approximately 14 to 19 times to result in no calf production the following spring.

Request (DKFN):

Please clarify for the results of this analysis the reference to female encounters. Is this referring to all females within the Bathurst Caribou Herd or caribou on an individual level?

Response:

The energetic analysis was designed to describe what the cumulative energetic costs from sensory disturbance would mean to a typical caribou cow moving across the landscape and encountering zones of influence of different developments (disturbance event). The referenced paragraph of Section 12.4.2.3 of the Developer's Assessment Report (DAR) quantifies how many disturbance events would be required to achieve no calf production the following spring for a typical caribou based on the equation on page 12-108 of the DAR. The quantity was determined without and with the effect of severe insect harassment. The maximum mean annual encounter rate of collared caribou was used to predict the effects to the probability that a typical cow would successfully give birth to a calf the following spring (i.e., fecundity). The change in fecundity was then applied to the stage matrix in the population model, which represents herd-wide effects.

DOMINION DIAMOND

Information Request Number: DAR-DKFN-IR2-04

Source: Deninu K'ue First Nation Information Requests from Rosy Bjornson

Subject: Barren-Ground Caribou

DAR Section(s): 12.6.2 (page 12-131)

Preamble (DKFN):

In the last paragraph on this page the proponent states:

Natural environmental factors that operate over large scales of space and time will likely have greater influences on seasonal distributions of caribou than the incremental and cumulative impacts from the Project and other developments. For example, studies of caribou have shown that the historical cumulative effect of overgrazing on calving, summer or winter ranges can result in periodic range shifts and large population fluctuations (Messier et al. 1988; Ferguson and Messier 2000; Tyler 2010). Climate change and weather can also influence the seasonal distribution of caribou by modifying insect levels, food abundance (primary productivity), timing of spring plant growth, snow depth and hardness, predator numbers (and alternative prey), and burns (Sharma et al. 2009; Vors and Boyce 2009; Festa-Bianchet et al. 2011; Kerby and Post 2013).

Request (DKFN):

We request that the proponent confirm:

a. Have periodic range shifts and large population fluctuations of the Bathurst Caribou Herd been attributed to overgrazing on calving, summer or winter ranges within the past five years?

b. How climate change and weather has influenced the seasonal distribution of the Bathurst Caribou Herd over the past five years?

Response:

a) There has been no research on the Bathurst caribou herd directly related to overgrazing on calving, summer, or winter ranges within the past five years. However, recent research on range conditions indicates that leaf biomass (from remote sensing data) has been annually variable on the Bathurst calving range (Chen et al. 2014) and has increased on Bathurst summer range since the late 1980s (Russell 2014). Temporal patterns of forage conditions on Bathurst winter areas are unknown. However, Barrier and Johnson (2012) estimated the carrying capacity of the late-winter range lichen stores could support approximately 280,000 to 480,000 caribou from their 2008 and 2009 data, which is at least 8 times higher than the most recent Bathurst photo census estimate of 35,000 animals completed in 2012.

b) The response to Mackenzie Valley Environmental Impact Review Board Adequacy Item 8.2 (Response DAR-MVEIRB-09) provided an analysis of temporal patterns in seasonal ranges of the Bathurst collared cows and from three different climate data sources for the summer to autumn period. The analysis detected a temporal decrease in the size of the Bathurst caribou post-calving and autumn ranges and no change in the spring and winter ranges from 1996 to 2013. The analysis also demonstrated that Bathurst caribou tended to use similar seasonal ranges in successive years.

The analysis of climate variables for the summer range (post-calving to autumn period) included mean daily temperature (degrees Celsius), total daily precipitation (millimetres), total seasonal precipitation (mm), and a Keetch Byram drought index (KBDI) from a CircumArctic Rangifer Monitoring and Assessment Network (CARMA) data set (1979 to 2009) and interannual patterns in temperature and precipitation recorded at the Diavik and Snap Lake mines from 1998 to 2014. Although differences among years were detected for several variables, no temporal trends at broad spatial scales were evident. Thus, the temporal trends detected for Bathurst post-calving and autumn seasonal ranges are unlikely related to the climate variables evaluated.

References:

Chen W, White L, Adamczewski JZ, Croft B, Garner K, Pellissey JS, Clark K, Olthof I, Latifovic R, Finstad GL. 2014. Assessing the impacts of summer range on Bathurst caribou’s productivity and abundance since 1985. Natural Resources 5:130-145.

Barrier TA, Johnson CJ. 2012. The influence of fire history on selection of foraging sites by barren-ground caribou. Ecoscience 19:177-188.

Russell D. 2014. Kiggavik Project Effects: Energy-Protein and Population Modeling of the Qamanirjuaq Caribou Herd. Prepared for EDI Environmental Dynamics Inc.

Information Request Number: DAR-DKFN-IR2-05

Source: Deninu K'ue First Nation Information Requests from Rosy Bjornson

Subject: Traditional Wildlife Harvesting

DAR Section(s): 15.4.1.2.1 (Page 15-45)

Preamble (DKFN):

In the last paragraph on this page the proponent states:

As a result of the above factors, negative cumulative effects are predicted for effects on traditional wildlife harvesting that will impede the ability to harvest wildlife in some preferred areas. However, alternative preferred areas and resources are expected to continue to be available and unaffected. The incremental effects of the Project alone are expected to result in only minor effects on the continued opportunity to participate in traditional wildlife harvesting.

Request (DKFN):

We request that the proponent confirm:

a. Where the proponent believes the alternative preferred areas and resources that are expected to continue to be available and unaffected are for members of the Deninu Kue First Nation?

Response:

Information relating to Deninu K'ue First Nation (DKFN) areas of use are provided in the Traditional Land Use and Traditional Knowledge Baseline Report (Annex XVII) of the Developer's Assessment Report (DAR). The traditional territory of the DKFN extends from the south of Great Slave Lake, north and east of Great Slave Lake, and well into the Barrenlands. The asserted territory of the Akaitcho First Nation, including the DKFN, shown in documents for the BC Hydro Site C Project (Traditions 2013) illustrates an area extending from the northern portions of Alberta, north to the Coppermine River and ranging to the border with Nunavut in the east, and including the communities of N'Dilo and Yellowknife in the west.

While the Ekati Mine area is identified by the DKFN as a wildlife harvesting area used by DKFN land users, it is assumed that wildlife harvesting also occurs in other areas within the DKFN traditional territory. This is supported by the following additional information about areas reported to be used by DKFN land users for hunting:

- Vanden Berg (2013) documents the extensive current and historic use of the Slave River region for traditional activities, include wildlife harvesting; however, some DKFN members indicated they have observed environmental changes in this area due to development.
- DKFN (2012) documents the extensive current and historic use of the Barrenlands by DKFN land users, although It was also noted that changes have been experienced in the Barrenlands due to development, such as the creation of winter roads.

- One interviewee in DKFN (2012: 272) reported that they hunt caribou

  > *"… as far as Gordon Lake, Mackay Lake, Beniah Lake, Duncan Lake, in around Yellowknife, East of Yellowknife toward Caribou Islands, Rocher River, Simpson Island, BigNarrows, up by Lutsel K'e, Christie Bay, as far as Reliance….[and] all around Rae and Bechoko. Hunted caribou there all the way up to Lac la Martre"*

- The same interviewee noted that they also hunt moose

  > *"all the way out to Rocher River as far as Lutsel K'e. All the way around the lake on the highway"*

- Areas of use reported in DKFN (2012) include Gordon Lake, Lac de Gras, Artillery Lake, Contwoyto Lake, and Lockhart Lake and the Slave Lake region.
- It was noted moose and caribou are consumed almost equally, while bison also supplements the traditional summer diet (Dezé 2009). Bison and moose are found almost exclusively south of the treeline.

This assessment also incorporated the results from Sections 12 and 13 on barren-ground caribou and other wildlife, respectively. Sections 12 and 13 of the DAR evaluated whether the incremental and cumulative changes from the Project and other developments on habitat quantity, arrangement and connectivity, habitat quality (occupancy, movement, and behaviour), and survival and reproduction would result in a significant effect to self-sustaining and ecologically effective caribou and other wildlife populations. Ecological effectiveness includes interactions or ecological services that benefit other wildlife and the environment, including the use of wildlife by people. The results of the residual effects analysis determined that cumulative effects from industrial development would not significantly influence the ability of caribou and other wildlife to be self-sustaining or ecologically effective.

The analysis in Section 15 predicted that the incremental and cumulative changes to measurement indicators from the Project and other developments would not result in a significant effect to continued opportunities to participate in traditional wildlife harvesting. In assessing the incremental and cumulative effects from the Project and other developments on the continued opportunities for traditional use of wildlife resources, the DAR considered the knowledge that the abundance and distribution of caribou and other wildlife naturally fluctuate through time.

For example, previous historic periods of low Bathurst numbers occurred when there were no mines, and the Ahiak and Blue-nose East herds have declined rapidly between 2000 and 2006 without the influence of mining (Adamczewski et. al 2009). A large part of the Bathurst herd's decline is the result of a natural demographic cycle reflecting large-scale weather patterns and natural factors including predation and harvest (Adamczewski et. al 2009; Boulanger et al. 2011; Festa-Bianchet et al. 2011). The relative contribution of the Jay Project, an expansion in an already disturbed area that is largely within an existing zone of influence, is expected to be small.

Although the Ekati Mine area has been identified by the DKFN as a wildlife harvesting area used by DKFN land users, other areas within the DKFN traditional territory have also been identified for wildlife harvesting. Wildlife populations exhibit natural cycles in abundance and distribution, and opportunities to harvest Bathurst caribou and other herds have traditionally been subject to the fluctuating availability of animals based on the phase of the population cycle (Festa-Bianchet et al. 2011), which would be similar for other wildlife resources. Effects from the Project and other developments in the Lac de Gras area on animal abundance and distribution are predicted to not contribute significantly to continued opportunities for traditional use of wildlife resources.

References:

Adamczewski JZ, Boulanger J, Croft B, Cluff D, Elkin B, Nishi J, Kelly A, D'Hont A, Nicholson C. 2009. Decline of the Bathurst Caribou Herd 2006-2009: A technical evaluation of field data and modeling. Draft technical report December 2009. GNWT.

Boulanger J, Gunn A, Adamczewski J, Croft B. 2011. A Data-Driven Demographic Model to Explore the Decline of the Bathurst Caribou Herd. J Wild Manage 75:883-896.

Dezé (Dezé Energy Corporation Ltd.). 2009. Taltson Hydroelectric Expansion Project Developer's Assessment Report. Dezé Energy, Yellowknife, NWT, Canada.

DKFN (Deninu K'ue First Nation). 2012. The Deninu K'ue Ethno-history Report. Prepared for De Beers Canada for the Gahcho Kué Project. NWT, Canada.

Festa-Bianchet M, Ray JC, Boutin S, Côté SD, Gunn A. 2011. Conservation of caribou (*Rangifer tarandus*) in Canada: an uncertain future. Can J Zool 89:419-434.

Traditions (Traditions Consulting Services Inc.) 2013. Site C Clean Energy Project. Volume 5, Appendix A05, Part 3. Revised Aboriginal Land and Resource Use Summary: Deninu K'ue First Nation. Final Report. Prepared for BC Hydro Power and Authority.

Vanden Berg (Vanden Berg & Associates). 2013. DKFN Ethno-history report: Site C Dam and Traditional Land Use. March 11, 2013.

DOMINION DIAMOND

Information Request Number: DAR-DKFN-IR2-06

Source: Deninu K'ue First Nation Information Requests from Rosy Bjornson

Subject: Barren-Ground Caribou (Cumulative Effects Assessment)

DAR Section(s): 17.8

Preamble (DKFN):

On page 17-22 in the second paragraph, the proponent makes the following statements in regard to the cumulative effects assessment on caribou:

Effects from sensory disturbance on habitat quality and calf production are anticipated to be reversible in the long term (*perhaps* 5 to 10 years following the end of closure of a project),and *should* be within the resilience limits and adaptive capacity of the Bathurst herd. (emphasis added).

Request (DKFN):

The proponent has not instilled a high level of confidence in the cumulative effects assessment when subjective words are used. We request that the proponent:

a. Provide a cumulative effects assessment on the Bathurst Caribou Herd with a higher level of certainty in the assessment.

Response:

The assessment approach used in the Developer's Assessment Report (DAR) was to apply conservative assumptions to predict maximum effects from changes in habitat quality and sensory disturbance (DAR Sections 12.4.2.2 and 12.4.2.3). This was done to manage uncertainty, such as for the magnitude and temporal and spatial extents of effects, and provide confidence that the assessment would not underestimate effects levels (i.e., precautionary approach). Throughout the DAR there is also discussion about uncertainty associated with zones of influence (ZOI), which is related to temporal changes in the magnitude and spatial extent of ZOI, such as habituation to disturbance by caribou and the type, size and level of activity of different developments (Haskell and Ballard 2008; ERM Rescan 2014a,b; Johnson and Russell 2014). With respect to future conditions, the maximum spatial and temporal scales of development were applied for the Reasonably Foreseeable Development (RFD) Case in the cumulative effects assessment. The determination is that there should be no significant Project-specific or cumulative effects on the ability of the Bathurst caribou herd (and the Ahiak and Beverly herds) to be self-sustaining and ecologically effective.

The actual duration of effects on wildlife after the closure of human developments is unknown (Vistnes and Nellemann 2008). This reflects a lack of long-term monitoring studies documenting the resilience of caribou to development and the time required to reverse effects from changes in habitat quality after closure and reclamation of mine sites (or other industrial development). An additional challenge to understanding future conditions in complex systems is the difficulty of forecasting a future that may be outside the range of observable baseline environmental conditions (Walther et al. 2002). Consequently, extending the assessment into the future (RFD Case) decreases confidence in effects predictions as reflected in the text from page 17-22 quoted in the preamble to this information request.

Although effects are anticipated to be reversed within 5 to 10 years following closure, they were not applied to the models (i.e., the numerical analyses of the cumulative effects of sensory disturbance presented in the DAR did not include any future reversal of development-related effects). The assumptions and conditions applied to the models were designed to overestimate indirect effects from disturbance, including sensory disturbance, by creating an RFD scenario based on conservative conditions. It should be noted that in Round 1 Information Requests, Appendix D presents an analysis using hypothetical scenarios of decreasing ZOI following closure of the Diavik Mine to predict the temporal and spatial extents of the reversal of habitat quality for caribou.

In the DAR, the confidence in the predictions for the RFD Case is based on the consistent low effect sizes (i.e., magnitudes of change) that were determined from the incremental and cumulative changes from the Project and other developments for habitat quantity and habitat quality, and energetics. The use of a conservative RFD scenario provides confidence that the assessment has not underestimated the incremental and cumulative effects from the Project and other developments on caribou. There is no strong mechanism by which development causes an adverse and long-term or permanent change in population survival and reproduction rates, supporting the determination of no significant effects.

References:

ERM Rescan (ERM Rescan Environmental Services Ltd.). 2014a. Ekati Diamond Mine: 2013 WEMP Addendum Wildlife Camera Monitoring Summary Report. Prepared for Dominion Diamond Ekati Corporation by ERM Rescan, Yellowknife, NWT, Canada.

ERM Rescan. 2014b. Ekati Diamond Mine: 2013 Wildlife Effects Monitoring Program. Prepared for Dominion Diamond Ekati Corporation. March 2014.

Haskell SP, Ballard WB. 2008. Annual re-habituation of calving caribou to oilfields in northern Alaska: implications for expanding development. Can J Zoolog 86:627-637.

Johnson CJ, Russell DE. 2014. Long-term distribution responses of a migratory caribou herd to human disturbance. Biol Conserv 177:52-63.Vistnes I, Nelleman C. 2008. The Matter of Spatial and Temporal Scales: a Review of Reindeer and Caribou Response to Human Activity. Polar Biol 31:399-407.

Vistnes I, Nellemann C. 2008. The matter of spatial and temporal scales: a review of reindeer and caribou response to human activity. Polar Biology 31:399-407.

Walther GR, Post E, Convey P, Menzel A, Parmesan C, Beebee TJC, Fromentin JM, Hoegh-Guldberg O, Bairlein F. 2002. Ecological responses to recent climate change. Nature 416: 389-395.

Information Request Number: DAR-DKFN-IR2-07

Source: Deninu K'ue First Nation Information Requests from Rosy Bjornson

Subject: Conceptual Offsetting Plan

DAR Section(s): Appendix 9A

Preamble (DKFN):

In its conceptual offsetting plan the proponent has identified several options that focus on local fisheries of concern and engage communities.

Request (DKFN):

Will the proponent agree to exploring offsetting options with the DKFN around the community of Fort Resolution?

Response:

Dominion Diamond is committed to working with all impacted communities to identify potential offsetting measures for the Jay Project that meet community interests and meet the requirements of the Fisheries Protection Policy Statement (DFO 2013) and comply with the Applications for Authorization under Paragraph 35(2)(b) of the Fisheries Act Regulations.

Fort Resolution is identified as a potentially affected community for the Jay Project. Therefore, Dominion Diamond is prepared to consider potential offsetting options around that community that are identified and supported by the Deninu K'ue First Nation and Fort Resolution Métis Council.

References:

DFO (Fisheries and Oceans Canada). 2013. Fisheries Protection Policy Statement. Ottawa, ON, Canada. ISBN 978-1-100-22885-3.

DOMINION DIAMOND

Information Request Number: DAR-DKFN-IR2-08

Source: Deninu K'ue First Nation Information Requests from Rosy Bjornson

Subject: Conceptual Wildlife Effects Monitoring Plan

DAR Section(s): Jay Project Conceptual Wildlife Effects Monitoring Plan (WEMP)

Preamble (DKFN):

Eight main objectives are identified in section 1.4 of the Wildlife Effects Monitoring Plan that fulfill requirements of the Environmental Agreement. A further four objectives are identified in section 3.2 as overall objectives of monitoring and then individual objectives for various components of the WEMP are identified in section 5.

Request (DKFN):

The objectives of the WEMP should focus on measureable parameters that will determine 1) if the predicted effects identified in the environmental assessment are realized; 2) if the proposed mitigation measures are effective and 3) if further actions are required to reduce effects. In addition, the monitoring of various components related to wildlife are only meaningful when results are related to the direct and/or indirect effects on wildlife species. For example, monitoring of direct habitat loss from the mine development should be placed in the context of the direct and/or indirect effects on wildlife species. We request:

a. Clear objectives for the WEMP be identified that can be monitored and tracked during the life of the project. This approach should be similar to that taken for the objectives identified in the Conceptual Aquatic Effects Monitoring Program Design Plan.

Response:

The objectives suggested by the Deninu K'ue First Nation (DKFN) are included in the requirements of the Ekati Mine Environmental Agreement (1997) and listed in Section 1.2 of the Conceptual Wildlife Effects Monitoring Plan (Plan) for the Jay Project. These requirements are also consistent with requirements of the Northwest Territories (NWT) *Wildlife Act*. Specific objectives regarding monitoring of wildlife habitat, mitigation related to waste management and direct mine-related mortality, and valued components and other wildlife are provided in Section 5 of the Plan. As per Section 1.3, the Plan intended to incorporate effects identified through the Jay Project environmental assessment and the associated changes to the Wildlife Effects Monitoring Program (WEMP) proposed as a result. The Plan was also intended to engage interested parties and solicit feedback for these changes through the Jay Environmental Assessment process. Subsequent versions of the Ekati Mine WEMP will be developed that address this feedback.

Pending approval, the Jay Project would become part of the existing Ekati Mine operation and be added to and covered by the existing Ekati Mine management plans to comply with the Environmental Agreement (1997), NWT *Wildlife Act*, and other requirements. The Ekati Mine management plans and monitoring reports are routinely circulated to communities, regulators, and the Independent Environmental Monitoring Agency for review and recommendations for improvement. While the Wildlife

Effects Monitoring Plan for the Jay Project is conceptual, Dominion Diamond welcomes the recommendation by DKFN and will consider this recommendation along with other feedback when further revision of the Ekati Mine WEMP is undertaken.

DOMINION DIAMOND

Information Request Number:	DAR-EC-IR2-01
Source:	Environment Canada Information Requests from Sarah Robertson
Subject:	Mixing Zone
DAR Section(s):	Jay Technical Sessions

Preamble (EC):

The mixing zone around the diffuser discharge into Lac du Sauvage was discussed at the Yellowknife Technical Sessions but questions did not come to full resolution. The Proponent stated at these sessions that a conceptual 200 m mixing zone design was being used in the interim, until the regulatory stage at which point the mixing zone will be established. It is Environment Canada's (EC) opinion that the extent of the mixing zone and the impacts within that zone should be established during the environmental assessment to ensure all potential impacts are captured and understood prior to a determination of significance. The pollution prevention provisions of the Fisheries Act apply and the Proponent is required to comply with the obligations under this legislation. The mixing zone will effectively attenuate parameters in the effluent that may be discharged at concentrations which could have sublethal toxicity, i.e. which may have chronic effects on organisms in the receiving environment. To evaluate the impacts associated with effluent discharge, it is necessary to identify the extent and magnitude of the zone of chronic toxicity. Data from sublethal toxicity testing of simulated effluent can be used to achieve this goal. Test data would provide an indication of the biological responses to an integrated mixture of parameters found in the effluent. The use of standard organisms and protocols provides confidence in the results, and different trophic levels can be evaluated (algae, plants, Ceriodaphnia, fish) with appropriately sensitive and representative tests used.

Request (EC):

EC requests that the Proponent;

1. Provide an estimate of the extent of the mixing zone, and the predicted concentrations of parameters of concern at the edge of the mixing zone. How has the size of the mixing zone been minimized to the extent possible?

2. Identify and discuss the potential sublethal effects within the mixing zone in Lac du Sauvage and include bioassay data on simulated effluent to support the discussion.

Response:

1. *Provide an estimate of the extent of the mixing zone, and the predicted concentrations of parameters of concern at the edge of the mixing zone. How has the size of the mixing zone been minimized to the extent possible?*

In the Developer’s Assessment Report (DAR), Dominion Diamond suggested a mixing zone for the Jay Project (Project) of 200 metres (m) from the proposed diffuser for Misery Pit minewater discharge to Lac du Sauvage (Section 8.5.4 and Appendix 8F). The extent of the mixing zone was estimated by conducting near-field mixing studies using the CORMIX model.

For the DAR and subsequent modelling updates (Golder 2015), near-field mixing studies were conducted to understand how effluent will initially mix in the receiving environment. The near-field mixing studies predicted maximum concentrations in Lac du Sauvage based on conceptual diffuser outfall characteristics, maximum effluent discharge characteristics, constant lake water characteristics, and minimum dilution factors. The near-field mixing studies projected that:

- minimum dilution factors will be observed during the open-water condition[1]; and,
- dilution of effluent would occur at distances up to 200 m during the open-water condition (Tables 1-1 and 1- 2).

Concentrations are highest near the diffuser (Appendix 8F) and decrease over the 200 m distance from the diffuser for the Reasonable Estimate Case (Table 1-1) and the Updated Assessment Case (Table 1-2). It is noted that these maximum predicted concentrations are likely above what is expected to occur because these predictions were based on the maximum effluent concentrations (i.e., maximum under-ice concentrations at the end of open pit operations) and minimum dilution factors, which are unlikely to occur at the same time.

The 200 m mixing zone suggested by Dominion Diamond for the Project is similar to other regulated mixing zones in the Northwest Territories (e.g., Snap Lake Mine [De Beers 2002], Gahcho Kué Mine (MVLWB 2014]). Ratification of the mixing zone for the Water Licence, however, will be an outcome of the permitting (Water Licensing) process. In conjunction with the development of documentation associated with the permitting requirements, a final diffuser design will be completed, and, if necessary, development of site specific water quality objectives (SSWQO) beyond those already approved for the Ekati Mine (Elphick et al. 2011; Rescan 2012a,b,c,d,e).

Key elements of the water management plan that have contributed to minimizing the extent of the mixing zone are associated with the discharge of minewater from Misery Pit to Lac du Sauvage to limit the amount of change to the receiving environment and avoid adverse environmental effects. These include the restriction of site discharge to five years or less in late operations, as well as design and location considerations associated with the diffuser to maximize attenuation of the discharge (e.g., depth of diffuser location, number of ports, port position in the water column, angle of discharge). The latter will be subject to more detailed design once the permitting phase is underway, as well as a plume delineation study, which is expected to be a requirement of the Water Licence once the diffuser is operational so that the plume and discharge attenuation can be compared to modelled expectations. This approach would be consistent with the current requirements of the Ekati Mine Water Licence for the Sable Project.

The mixing zone will be finalized in a manner that is based on final operating plans and it will require approval of the Wek'èezhìı Land and Water Board after a public review process. Dominion Diamond will propose a final mixing zone that is consistent with the Policy published by the Land and Water Boards of the Mackenzie Valley for this purpose (MVLWB 2011). Based on the modelling completed to date for the purpose of the environmental assessment, Dominion Diamond anticipates that the final mixing zone will not be greater than 200 m from the diffuser.

[1] Minimum dilution is predicted for the open-water condition because the lake current, which is perpendicular to the discharge, acts to deflect the discharge and reduce mixing with the lake water.

Table 1-1 Predicted Dilution and Maximum Concentrations for Select Constituents at the Edge of the Mixing Zone in Lac du Sauvage from the Near-field Mixing Study - Reasonable Estimate Case[a]

Parameter	Maximum Lake Concentration[b] (mg/L)	Maximum Discharge Concentration[c] (mg/L)	Distance: 200 m Minimum Dilution	Distance: 200 m Maximum Concentration (mg/L)
Under Ice				
Total Dissolved Solids	44	1,150	34	77
Chloride	16	605	34	33
Total Phosphorus (as P)	0.011	0.15	34	0.015
Nitrate (as N)	0.49	13	34	0.9
Strontium	0.58	4	34	0.68
Open Water				
Total Dissolved Solids	33	804	24	65
Chloride	9.2	395	24	25
Total Phosphorus (as P)	0.0094	0.11	24	0.014
Nitrate (as N)	0.41	11	24	0.9
Strontium	0.37	2.6	24	0.46

a) Based on CORMIX modelling results, assuming a 10 m port spacing.
b) Based on the reasonable estimate case/updated assessment case model predictions from the Lac du Sauvage model.
c) Based on the reasonable estimate case/updated assessment case model predictions from the site water quality model.
m = metre; mg/L = milligrams per litre; N = nitrogen; P = phosphorus; - = unitless.

Table 1-2 Predicted Dilution and Maximum Constituent Concentrations at the Edge of the Mixing Zone in Lac du Sauvage from the Near-field Mixing Study – Updated Assessment Case[a]

Parameter	Maximum Lake Concentration[b] (mg/L)	Maximum Discharge Concentration[c] (mg/L)	Distance: 200 m Minimum Dilution	Distance: 200 m Maximum Concentration (mg/L)
Under Ice				
Total Dissolved Solids	95	2,925	34	178
Chloride	49	1,712	34	98
Total Phosphorus (as P)	0.011	0.22	34	0.017
Nitrate (as N)	0.81	20	34	1.4
Strontium	0.34	11	34	0.65
Open Water				
Total Dissolved Solids	65	2,091	26	143
Chloride	33	1,196	26	78
Total Phosphorus (as P)	0.0075	0.16	26	0.013
Nitrate (as N)	0.57	16	26	1.2
Strontium	0.22	8	26	0.52

a) Based on CORMIX modelling results, assuming a 10 m port spacing.
b) Based on the reasonable estimate case/updated assessment case model predictions from the Lac du Sauvage model.
c) Based on the reasonable estimate case/updated assessment case model predictions from the site water quality model.
m = metre; mg/L = milligrams per litre; N = nitrogen; P = phosphorus; - = unitless.

2. *Identify and discuss the potential sublethal effects within the mixing zone in Lac du Sauvage and include bioassay data on simulated effluent to support the discussion.*

The mixing zone adjacent to the diffuser outfall represents the portion of the lake where the discharge first mixes with the receiving environment. Within this zone, constituent concentrations may exceed water quality guidelines or objectives (CCME 2003) and sublethal effects may occur (Environment Canada 2005). Sublethal effects are defined as a measurable biological change that is detrimental to the biological organism, but below the level that causes death within a test period (Environment Canada 2005). However, chronic toxicity (Environment Canada 2005), defined as long-term effects on basic processes, such as metabolism, growth, or reproduction, as a result of exposure to a toxicant, is not expected within the mixing zone of Lac du Sauvage. The aquatic health assessment in the DAR (Section 8.5.5) demonstrated that no chronic toxicity is expected within the mixing zone. Projected water quality constituent concentrations at assessment node LDS-P1 during operations, which is representative of average concentrations within the 200 m mixing zone, are anticipated to be below federal and provincial WQGs and SSWQOs, which are based on scientifically defensible toxicological data. These WQGs and SSWQOs are conservative in regards to protecting aquatic life in that predicted concentrations below these values indicate the potential for chronic toxicity is negligible. At the extent of the mixing zone, constituent concentrations will meet water quality objectives and no sublethal effects or chronic toxicity will occur.

Additional bioassay testing on simulated minewater is not considered necessary for the environmental assessment process. As part of the DAR, simulated site-specific minewater was tested for acute toxicity (Appendix 8H in the DAR); results demonstrated that the minewater from open pit mining would not be expected to be acutely toxic (bioassay data are provided in Appendix 8H). Further, Dominion Diamond has committed that no discharge of any minewater from the Misery Pit to Lac du Sauvage will occur if acutely toxic. During operations, monitoring of minewater in the Misery Pit (as a requirement under the Water Licence) will be undertaken; the monitoring will be conducted in early operations (i.e., prior to discharge to Lac du Sauvage) and late operations (i.e., during the discharge period). Minewater monitoring will include chemical analysis and acute and chronic toxicity testing. Similar to toxicity testing requirements at the Ekati Mine, toxicity testing is expected to include acute lethality testing with Rainbow Trout and waterflea, and chronic toxicity testing with the green algae, *Pseudokirchneriella subcapitata,* and the cladoceran, *Ceriodaphnia dubia* (WLWB 2014). This testing will track water quality conditions in the pit (i.e., end-of-pipe) to prevent water that is acutely toxic from being discharged to Lac du Sauvage and to identify the potential for chronic toxicity in Lac du Sauvage as a result of the minewater discharge. Monitoring within and outside of the mixing zone will also be used to track water quality conditions and potential for sub-lethal effects.

References:

CCME (Canadian Council of Ministers of the Environment). 2003. Canadian Water Quality Guidelines for the Protection Aquatic Life: Guidance on the Site-Specific Application of Water Quality Guidelines in Canada: Procedures for Deriving Numerical Water Quality Objectives. In: Canadian Environmental Quality Guidelines. Canadian Council of Ministers of the Environment. Winnipeg, MB, Canada.

De Beers (De Beers Canada Inc.). 2002. The Snap Lake Diamond Mine Environmental Assessment Report. Submitted to the Mackenzie Valley Environmental Impact Review Board. Yellowknife, NWT, Canada.

Elphick JRF, Bergh KD, Bailey HC. 2011. Chronic toxicity of chloride to freshwater species: effects of hardness and implications for water quality guidelines. Environ Toxicol Chem 30: 230-246.

Environment Canada. 2005. Guidance Document on Statistical Methods for Environmental Toxicity Tests. EPS 1/RM/46. March 2005. Method Development and Applications Section, Environmental Technology Centre, Environment Canada. Ottawa, ON, Canada.

Golder (Golder Associates Ltd.). 2015. Jay Project - Compendium of Supplemental Water Quality Modelling. Submitted to Mackenzie Valley Environmental Impact Review Board. April 2015.

MVLWB (Mackenzie Valley Land and Water Board). 2011. Water and Effluent Quality Management Policy. March 31, 2011. Mackenzie Valley Land and Water Board.

MVLWB. 2014. Land Use Permit and Water Licence (MV2005C0032 and MV2005L2-0015). Reasons for Decision. August 11, 2014. Mackenzie Valley Land and Water Board. Yellowknife, NWT, Canada.

Rescan (Rescan Environmental Services Ltd.). 2012a. EKATI Diamond Mine: Site-Specific Water Quality Objective for Potassium. Prepared for BHP Billiton Canada Inc. Yellowknife, NWT, Canada.

Rescan. 2012b. EKATI Diamond Mine: Site-specific Water Quality Objective for Sulphate. Prepared for BHP Billiton Canada Inc. Yellowknife, NWT, Canada.

Rescan. 2012c. EKATI Diamond Mine: Site-Specific Water Quality Objective for Nitrate, 2012. Prepared for BHP Billiton Canada Inc. Yellowknife, NWT, Canada.

Rescan. 2012d. EKATI Diamond Mine: Site Specific Water Quality Objective for Molybdenum, 2011. Prepared for BHP Billiton Canada Inc. Yellowknife, NWT, Canada.

Rescan. 2012e. EKATI Diamond Mine: Site-specific Water Quality Objective for Vanadium. Prepared for BHP Billiton Canada Inc. Yellowknife, NWT, Canada.

WLWB (Wek'èezhìı Land and Water Board). 2014. Surveillance Network Program (Effective June 6, 2014) Annexed to Water Licence W2012L2-0001. June 6, 2014. Wek'èezhìı Land and Water Board.

Information Request Number:	DAR-EC-IR2-02
Source:	Environment Canada Information Requests from Sarah Robertson
Subject:	Misery Pit Discharge Quality to Lac de Gras
DAR Section(s):	Jay Technical Sessions Undertaking Response DAR-MVEIRB-UT-12

Preamble (EC):

In response to undertaking DAR-MVEIRB-UT-12, the Proponent provided information regarding the water quality of the Misery pit discharge to Lac de Gras, modelled up to 200 years following closure. Over the 200 year modelling period, 70,000 m^3 per year is expected to discharge to Lac de Gras and there is a projected increase in chemical concentrations over time due to the upward flux of total dissolved solids (TDS) and other constituents into the monimolimnion and mixolimnion. During this time period a number of water quality parameters in the mixolimnion are projected to increase above CCME guidelines, including copper, chloride, total phosphorus, manganese, TDS, aluminum, iron and nickel. Although concentrations of simulated maximum Misery Pit discharge are provided in Table 4-2 of the Compendium of Supplemental Water Quality Modelling, it is unclear if these are maximums of one particular snapshot, or the maximum over the 200 year modelled period. Also, manganese, iron and nickel are excluded from this table.

Request (EC):

EC requests that the Proponent;

1. Clarify the specific concentrations that are anticipated during the post closure period, which were not provided in the response.

2. Provide the concentrations of the parameters that are discussed in the response to DAR-MVEIRB-UT-12. Additionally, as the modelling is projecting an upward trend in these particular parameters, at what time post closure do the concentrations level off and no longer increase?

Response:

1. and 2. In DAR-MVEIRB-UT-12, Dominion Diamond identified a number of water quality constituents in the Misery Pit mixolimnion that were projected to potentially increase above generic guidelines for the protection of aquatic life, trophic status, wildlife, or aesthetic drinking water under the Reasonable Estimate Case.

   Further review of this undertaking indicated that hardness, which is also projected to increase in the Misery Pit, was not factored into the guideline comparison. Hardness is one of several potential toxicity modifying factors to consider when evaluating potential risk of toxicity; increasing hardness ameliorates toxicity of a number of constituents (e.g., chloride, copper, nickel). With hardness accounted for, the projected chloride concentrations over the modelled timeframe snapshots do not exceed the hardness-dependent site-specific water quality objective (SSWQO; Elphick et al. 2011), and the projected nickel concentration at 200 years does not exceed the hardness-dependent guideline.

The projected maximum water quality constituent concentrations of the mixolimnion of the Misery Pit (depth-averaged) at modelled time steps of 10 years, 50 years, 100 years, and 200 years into post-closure (after back-flooding of the Misery Pit) are provided in Table 2-1.

Table 2-1 Misery Pit Mixolimnion Projected Maximum Water Quality Constituent Concentrations

Constituent	Units	Guideline Concentration	Misery Pit Mixolimnion Maximum Concentrations[(a)]			
			Post Closure Year 10	Post Closure Year 50	Post Closure Year 100	Post Closure Year 200
Major Ion Constituents						
Total dissolved solids	mg/L	500[(b)]	72	388	**543**	**598**
Chloride	mg/L	273 and 388[(c)]	37	225	315	341
Hardness	mg/L	-	63	282	395	438
Nutrient Constituents						
Total phosphorus	mg/L	0.020[(d)]	0.014	**0.036**	**0.05**	**0.061**
Metal Constituents						
Aluminum	mg/L	0.1[(e,f)]	0.017	0.044	0.069	0.1
Copper	mg/L	0.002 and 0.004[(e,g)]	**0.0025**	**0.0069**	**0.011**	**0.016**
Iron	mg/L	0.3[(b,e)]	0.051	0.16	0.25	**0.37**
Manganese	mg/L	0.05[(b)]	0.023	**0.075**	**0.12**	**0.17**
Mercury	mg/L	0.000026[(e)]	0.0000093	**0.000031**	**0.000051**	**0.000077**
Nickel	mg/L	0.025 and 0.150[(e,h)]	0.004	0.012	0.018	0.028

Note: Bold values indicate constituent concentration above the guideline.

a) Water quality constituent concentrations represent the Reasonable Estimate Case (Golder 2015).

b) Operational Guidance or Aesthetic Objective - Canadian Drinking Water Quality Guidelines (Health Canada 2014).

c) Hardness-dependent water quality benchmarks for chloride as per Elphick et al. (2011); water hardness of 60 milligrams per litre (mg/L) for post-closure at Year 10, and >160 mg/L for the remaining time periods.

d) Mesotrophic trigger level for Canadian lakes (CCME 2004).

e) Canadian Water Quality Guideline (CWQG) for the Protection of Aquatic Life (PAL) (CCME 1999)

f) pH-dependent benchmark for aluminum, assuming pH>6.5.

g) Hardness-dependent water quality benchmarks for copper as per CCME (1999); water hardness of 0 to 120 milligrams per litre (mg/L) for post-closure at Year 10, and >180 mg/L for the remaining time periods.

h) Hardness-dependent water quality benchmarks for nickel as per CCME (1999); water hardness of 0 to 60 milligrams per litre (mg/L) for post-closure at Year 10, and >180 mg/L for the remaining time periods.

Under the Reasonable Estimate Case, the concentrations of these constituents continue to show an upward trajectory at Year 200 of post-closure, but are anticipated to stabilize at a point of time beyond the modelling timeframe. Extrapolating beyond this 200 year timeframe into the future represents a challenge as a result of the uncertainty bound by the conservatism associated with the modelling.

In the response to DAR-GNWT-IR2-6, Dominion Diamond provided an outline of mitigation options that could be implemented to improve post-closure water quality in the Misery Pit, if required. Two freshwater cap depths (30 metres [m] and 60 m) were evaluated in the Misery Pit post-closure water quality model. The results indicated that the 60 m cap resulted in lower surface water constituent concentrations in the Misery Pit discharge to Lac de Gras during post-closure because it reduced the amount of mixing between the mixolimnion and the monimolimnion. The 60 m cap option was, therefore, carried forward into the Developer’s Assessment Report (DAR). Following this assessment of freshwater cap depths, it is, therefore, conceivable that constituent concentrations in the mixolimnion of Misery Pit sourced from water being displaced from the monimolimnion could be further reduced through increasing the depth of the freshwater cap in the Misery Pit. There is sufficient space in the Jay Pit to accommodate a larger transfer

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of minewater from Misery Pit to the Jay Pit for this consideration (the Jay Pit has a 120 m freshwater cap). The optimal depth of the freshwater cap required to achieve closure objectives would depend on the actual conditions observed in the Misery Pit during operations. Therefore, as additional operational monitoring data from the Misery Pit becomes available, Dominion Diamond will update water quality predictions in parallel with ongoing operational and closure monitoring and planned pit lake research studies (ICRP; BHP Billiton 2011) so that Misery Pit satisfies closure goals and objectives, and does not pose an environmental risk.

The closure objectives for pit lakes at the Ekati Mine are provided in Section 5.2.7 of the Ekati Mine Interim Closure and Reclamation Plan (ICRP; BHP Billiton 2011), which has been approved by the Wek'èezhii Land and Water Board, and includes the objective that water in pits at the Ekati Mine meets closure water quality criteria. The Misery Pit lake will be incorporated into subsequent amendments of the ICRP.

In post-closure, the Misery Pit lake will be a new surface waterbody with water quality that is expected to be different from existing surface waters in the Lac de Gras watershed. In post-closure, the Misery Pit lake will be isolated from Lac de Gras, with a short period of overflow to Lac de Gras limited to freshet. Current modelled projections of water quality constituents are expected to meet closure objectives, which include representing a low risk for potential impairment to human or wildlife use.

References:

BHP Billiton (BHP Billiton Canada Inc.). 2011. Ekati Diamond Mine Interim Closure and Reclamation Plan. Prepared for the Wek'èezhii Land and Water Board. 842 pp.

CCME (Canadian Council of Ministers of the Environment). 1999 with updates to 2015. Canadian Water Quality Guidelines for the Protection of Aquatic Life. In: Canadian Environmental Quality Guidelines. Canadian Council of Ministers of the Environment. Winnipeg, MB, Canada.

CCME. 2004. Canadian Water Quality Guidelines for the Protection of Aquatic Life: Phosphorus: Canadian Guidance Framework for the Management of Freshwater Systems. In: Canadian Environmental Quality Guidelines. Canadian Council of Ministers of the Environment. Winnipeg, MB, Canada.

Elphick JR, Bergh KD, Bailey HC. 2011. Chronic toxicity of chloride to freshwater species: effects of hardness and implications for water quality guidelines. Environ Toxicol Chem 30(1): 239-46.

Golder (Golder Associates Ltd.). 2015. Jay Project - Compendium of Supplemental Water Quality Modelling. Submitted to Mackenzie Valley Environmental Impact Review Board. April 2015.

Health Canada. 2014. Guidelines for Canadian Drinking Water Quality. Summary Table.. Prepared by the Federal-Provincial Subcommittee on Drinking Water of the Federal-Provincial-Territorial Committee on Health and the Environment. October 2014. Ottawa, ON, Canada.

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Information Request Number: DAR-EC-IR2-03

Source: Environment Canada Information Requests from Sarah Robertson

Subject: Phosphorus Loadings to Lac du Sauvage

DAR Section(s): Jay Technical Sessions Undertaking Response DAR-MVEIRB-UT-15

Preamble (EC):

Loadings are also a useful measure in an aquatic ecosystem, as the total amount of phosphorus entering a system can influence the potential for internal recycling and associated eutrophication effects. Increases in the lake phosphorus budget associated with ongoing loadings can lead to: changes in type and number of plants, increased turbidity, increased organic matter falling to the bottom of the system, and associated winter anoxia. When oxygen is depleted, phosphorus that is locked in the sediment can be released back into the water column, propagating the nutrient issues. EC acknowledges the usefulness of orthophosphate loadings to project concentrations of orthophosphate and total phosphorus in the Lac du Sauvage. However, the overall effects of the loadings also need to be assessed for potential impacts, as loadings can further exacerbate an increase in productivity.

Request (EC):

EC requests the Proponent provide the anticipated effects in the immediate and adjacent receiving environment given the projected annual loadings of 1,798 kg/year during late operations.

Response:

The anticipated effects of projected phosphorus annual loadings to Lac du Sauvage and increases of phosphorus in the immediate and adjacent receiving environment of Lac du Sauvage, and downstream into Lac de Gras, were assessed and discussed in the Developer’s Assessment Report (DAR). In particular, Section 8 of the DAR included an evaluation at the location of the conceptual diffuser (i.e., assessment node LDS-P1), and anticipated effects in other areas of Lac du Sauvage (i.e., LDS-P2 and LDS-P3; Map 8.5-1 in the DAR), and through Lac de Gras (i.e., LDG-P1 to LDG-P6; Map 8.5-2 in the DAR). Within Section 9 of the DAR (Fish and Fish Habitat), the effects of projected phosphorus increases to Lac du Sauvage extended further within the lake (Figure 9.4-2 in the DAR), and included additional representative nodes for each basin (i.e., AA-1, AB-1, AC-1, AD-1, AE-1, and AF-1; Map 8F2.2-1 in the DAR). The anticipated effects of phosphorus loads in the receiving environment were further explained in the Round 1 information requests (IR) responses (i.e., DAR-MVEIRB-IR-26, DAR-IEMA-IR-15, DAR-EC-IR-19, and DAR-KIA-IR-106).

Supplemental discussion on total loadings of phosphorus (as ortho-phosphate) to Lac du Sauvage and Lac de Gras, during all phases of the Jay Project (Project), was provided in the response to DAR-MVEIRB-IR-61 and Undertaking 15 (DAR-MVEIRB-UT-15) from the Jay Project Technical Sessions. Phosphorus loadings to Lac du Sauvage (presented in DAR-MVEIRB-UT-15) and Lac de Gras (presented in DAR-MVEIRB-IR-61) were based on the updated assessment case (Golder 2015). As stated in Appendix 8F of the DAR and discussed during the Technical Sessions (April 22 to 23, 2015), the modelling used in the DAR was developed under conservative assumptions for source term inputs (e.g., geochemistry inputs, groundwater flows), so it is expected that the modelled phosphorus projections are overestimated; the conservative assumptions used in the DAR still apply to the updated predictions.

The updated phosphorus concentrations in Golder (2015) did not change the conclusions for the assessment of water quality and fish and fish habitat presented in the DAR.

In the DAR, the water quality assessment related to increases in phosphorus in Lac du Sauvage and Lac de Gras considered both concentrations and total loadings (the DAR described concentrations for all water quality constituents, but loads were factored in the water quality modelling to derive the lake concentrations of these constituents). In-lake concentrations of total phosphorus were predicted by summing the predicted in-lake orthophosphate concentrations with the 2009 median total organic phosphorus concentration. The Project was assumed to affect the loadings of orthophosphate (inorganic phosphorus) and not organic phosphorus.

Based on the results of the hydrodynamic model, Misery Pit discharge to Lac du Sauvage will mix through the lake, with projected phosphorus concentrations expected to remain within the range measured under existing conditions. The hydrodynamic model accounted for nutrient cycling within the receiving environment and projected effects to other water quality constituents as a result of the increased phosphorus concentrations (e.g., dissolved oxygen, chlorophyll *a*). Phosphorus concentrations are projected to continue to decrease through post-closure and will return to conditions similar to those prior to the Project development.

The projected concentrations of total phosphorus (TP) were used to evaluate potential effects to trophic status, lower trophic levels, and aquatic health in Lac du Sauvage and Lac de Gras. Section 8 of the DAR concluded that TP concentrations will change from baseline conditions in Lac du Sauvage between 2025 to 2033, particularly during the period of minewater discharge from the Misery Pit. Section 9 concluded that as a result of these projected TP changes, the biomass of phytoplankton, zooplankton, and benthic invertebrates in Lac du Sauvage will likely increase during operations, but a clear, defined change in composition of plankton and benthic invertebrate communities would not be expected (Section 9.4.4). Based on the predicted concentrations of TP, Lac du Sauvage is predicted to remain oligotrophic to slightly mesotrophic during operations and closure (Section 8.5.4.2.2, page 356).

References:

Golder (Golder Associates Ltd.). 2015. Jay Project - Compendium of Supplemental Water Quality Modelling. Submitted to Mackenzie Valley Environmental Impact Review Board. April 2015.

DOMINION DIAMOND

Information Request Number: DAR-GNWT-IR2-2

Source: GNWT-Lands Information Requests from Melissa Pink

Subject: Project Mine Fleet and Equipment Procurement

DAR Section(s): 7.3.2.2.1, 7.4.2.1.1, 7.4.2.2.2 & 7.4.2.2.4

Preamble (GNWT):

The Proponent indicates in sections 7.4.2.1.1, 7.4.2.2.2 & 7.4.2.2.4 of the DAR that diesel fired generators and the mine fleet are the most significant sources of PM2.5 and NOx and are therefore the largest contributors to the predicted air quality ambient standard exceedances. Section 7.3.2.2.1 describes operational methods by which emissions from these sources can be reduced; however, the Proponent does not consider the design performance of the equipment. Specifically, the Proponent does not mention any plans for purchasing high efficiency, low emission mine equipment and vehicles to ensure source emissions are minimized. Procurement policy applying the principle of Best Available Technology (BAT), in addition to optimized operational methods, are vital actions to ensure emissions and associated environmental impacts from the mine are minimized. This principle is important for both new and life-cycle replacement equipment.

Request (GNWT):

The GNWT requests that the Proponent apply a procurement policy such that all emission-generating equipment be selected using the principle of Best Available Technology in order to minimize emissions from the mine and reduce impacts to the environment.

Response:

Dominion Diamond is committed to minimizing emissions from mine equipment according to the established principles of Best Available Technology Economically Available (BATEA). All equipment operating at the Ekati Mine has a set preventative maintenance plan that ensures equipment is operating at optimal conditions and performance.

Dominion Diamond expects that the vast majority of equipment to be used at the Jay Project will be sourced new, and therefore, will meet the most advanced emissions control standards at time of purchase. Dominion Diamond’s current fleet, as provided in responses from the Air Quality engagement meeting on May 7, 2015 (see Table 2-1), is also very young, with almost all major mining equipment commissioned in the last five years.

However, mining can be unpredictable, and as needs change, Dominion Diamond occasionally relies on older fleet to meet emerging or unforeseen needs. Given the difficult logistics associated with operating a remote site, and the high costs of delivering and commissioning new equipment, this is a business necessity for Dominion Diamond.

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Table 2-1 Summary of Ekati Mine Truck Fleet, as of April 29, 2015

Ekati Unit Number	Model	Year of Acquisition
TKD7471	CAT 777 F	2010
TKD7472	CAT 777 F	2010
TKD7473	CAT 777 F	2010
TKD7474	CAT 777 F	2010
TKD7475	CAT 777 F	2010
TKD7476	CAT 777 F	2010
TKD7477	CAT 777 F	2010
TKD7478	CAT 777 F	2010
TKD7479	CAT 777 F	2010
TKD7480	CAT 789 C	2003
TKD7481	CAT 789 C	2003
TKD7482	CAT 789 C	2003
TKD7483	CAT 777 F	2011
TKD7484	CAT 777 F	2011
TKD7485	CAT 777 F	2011
TKD7486	CAT 777 F	2011
TKD7487	CAT 777 F	2011
TKD7488	CAT 777 F	2011
TKD7489	CAT 777 F	2011
TKD7490	CAT 777 F	2011
TKD7491	CAT 777 F	2011
TKD7492	CAT 777 G	2014
TKD7493	CAT 777 G	2014
TKD7494	CAT 777 G	2014
TKD7495	CAT 777 G	2014
TKD7496	CAT 777 G	2014
TKD7497	CAT 777 G	2014
TKD6805	Western Star Dual Powered Road Train	2015

Information Request Number:	DAR-GNWT-IR2-03
Source:	Government of Northwest Territories - Lands Information Requests from Melissa Pink
Subject:	Assessment Boundaries
DAR Section(s):	8.1.4 and 9.1.4

Preamble (GNWT):

During the technical sessions, there were several discussions related to the appropriateness of assessment boundaries for the various Valued Components. Specifically, several parties noted that the selection of the outlet of Lac de Gras as a location to determine effects, which is the case within the Developer’s Assessment for water quality and fish and fish habitat, may not be appropriate.

For example, regarding fish populations, GNWT noted that there is no evidence provided to date illustrating that Lac de Gras and Lac du Sauvage share a fish population, and as such fish populations within Lac du Sauvage should be assessed on their own merit. This is specific with existing guidance in this area, such as with the Fisheries Protection Provisions (FPP) presented by Randall et al (2013) where a precautionary approach to management should apply to projects where uncertainty of impacts to populations exists since it is related to the spatial scale of the impact. This paper recommends that predictors of habitat quality be assessed on a small scale using production for projects with uncertainty. As a result, GNWT representatives asked a line of questioning regarding fish and fish habitat on Day 4 of the Technical Sessions when it was requested that the impact assessment be revised to reflect that there will be no effects to fish populations within Lac du Sauvage (Jay Pipe Technical Session, Day 4, Page 109). DDEC responded that they stand by their original assessment (Jay Pipe Technical Session, Day 4, Page 110); however the GNWT maintains that DDEC should re-consider the effects assessment with the boundaries limited to Lac du Sauvage to demonstrate that there will be no significant effects to fish populations within that lake. This would include effects assessments related to fish and fish habitat, as well as water quality.

Also, due to the potential for cumulative impacts from projects on Lac de Gras, the issue of residual effects on ecosystem productivity needs mentioning. Bradford et al (2014) discussed how impacts to habit quality and quantity that are not yet on the ecosystem transformation level would be difficult to assess as the largest effect may overwhelm the smaller effects. Overlapping development signals at the Lac de Gras outlet would limit or impede the assessment of smaller but relevant ecosystem changes to water quality and fish resulting from Jay Project within Lac du Sauvage.

Similarly, ENR supports a line of questioning initiated by the Review Board during Day 3 of the technical sessions:

“If using a smaller, more Jay-specific study area would change the determination of significance effects, given that the effects study area would be much smaller?” Kate Mansfield, Jay Pipe Technical Sessions Day 3, Page 151

While that line of questioning was specific to hydrology, GNWT concurs that a Jay-specific study area may impact the determination of significance effects, and as such should be considered for all Valued Components.

The GNWT remains concerned that a larger than necessary effects assessment boundary may mask significant impacts specific to Lac du Sauvage. As such, the GNWT maintains the opinion that the use of Lac de Gras as the assessment boundary is not the appropriate scale for assessing habitat and water quality changes from Jay Project. It is important to note that a determination of significance does not equate to a rejection of the project but rather highlights the necessity to implement mitigation measures to address any effects as may be anticipated.

Reference:

Randall, R.G., Bradford, M.J., Clarke, K.D., and Rice, J.C. 2013. A science-based interpretation of ongoing productivity of commercial, recreational or Aboriginal fisheries. DFO Can. Sci. Advise. Sec. Res. Doc. 2012/112 iv + 26 p.

Request (GNWT):

GNWT requests that DDEC re-evaluate the effects assessment presented in the DAR so that is the boundaries are limited to Lac du Sauvage to demonstrate that there will be no significant effects as a result of the Jay Project. Specifically, GNWT requests that the following Valued Components are addressed:

- Fish and Fish Habitat – Effects assessment boundaries be reduced from outlet of Lac de Gras to outlet of Lac du Sauvage; and,
- Water Quality – Effects assessment boundaries be reduced from outlet of Lac de Gras to outlet of Lac du Sauvage

Response:

1. Fish and Fish Habitat

The selection of the boundary for assessing residual effects (i.e., the Effects Study Area [ESA]) for fish Valued Components (VCs) is described in the Developer’s Assessment Report (DAR) (Section 9.1.4.2). Additional details and justification for the ESA were also provided in the Round 1 Information Request (IR) response DAR-GNWT-IR-49. The ESA is defined by the biological properties of the fish VCs (Arctic Grayling, Lake Trout, and Lake Whitefish) and also considers the physical properties of the environment in which the VCs occupy to fulfil their life history requirements. For fish VCs, the most relevant factor in defining the assessment boundary is the spatial scale of the population or fisheries unit under examination (Randall et al. 2013), with the goal of providing an ecologically relevant classification of impacts.

As part of the evaluation of environmental significance of the Project on VCs, all residual effects are rated or classified for magnitude, duration, frequency, reversibility, likelihood, and geographic extent of the predicted change (Section 9.6.1.1 in the DAR). Magnitude is the primary criterion used to determine environmental significance, while geographic extent and duration are used as modifiers and to provide context when assigning magnitude. Magnitude is a measure of the intensity of a residual effect on a VC.

For example, magnitude can represent the degree of change caused by the Project relative to baseline conditions (i.e., effect size). For fish VCs, magnitude is a function of the numerical and qualitative changes in measurement indicators and the associated influence on the abundance and distribution of the population. Project-specific (incremental) and cumulative changes in physical (e.g., habitat quantity, quality, and fragmentation) and biological (e.g., survival, reproduction, movement, and behaviour) measurement indicators result in effects on the abundance and distribution of populations. The assessment endpoint for fish and other aquatic life VCs is self-sustaining and ecologically effective populations (i.e., ongoing fisheries productivity), and thus, the magnitude of residual effects is assessed at the population level.

The primary consideration for including Lac de Gras within the assessment boundary was the high potential for movement of fish VCs between Lac du Sauvage and Lac de Gras through the Lac du Sauvage outlet locally known as “the Narrows” (Photo 3-1). For a detailed description of the physical properties of the Lac du Sauvage outlet, see Annex X of the DAR (also see Round 1 IR response DAR-MVEIRB-IR-64). In brief, the narrowing of the two lakes provides a relatively wide channel (minimum bankfull width of approximately 45 metres [m]) that is short in length (210 m) and provides flows that permit a year-round corridor for free movement of fish, particularly for species with large home ranges. Such a corridor would also provide opportunities for breeding between individuals originating from Lac du Sauvage and Lac de Gras.

Photo 3-1 Lac du Sauvage Outlet Facing Lac du Sauvage

Fish VCs such as Lake Trout, Lake Whitefish, and Arctic Grayling typically exhibit large home ranges or undergo extensive seasonal migrations (e.g., Walch and Bergersen 1982; West et al. 1992; Dillon 2002; Muhlfeld et al. 2012). Muhfeld et al. (2012) contend that Lake Trout are capable of moving throughout connected river and lake systems (up to 230 kilometres [km]) in the western United States and that warm water temperatures function as an impediment to occupancy of the river during summer. Baseline studies conducted in the Kennady Lake area for the Gahcho Kué Project (De Beers 2010) showed that tagged Lake Trout can move almost 8 km, with records of Lake Trout moving into the outlet streams of both Kennady Lake and Lake N16 in spring, and of Lake Trout travelling downstream of Kennady Lake through a series of small lakes and streams further downstream. Similarly, Arctic Grayling have been shown to undergo extensive migrations between foraging and overwintering areas in Alaska, travelling as much as 100 km between systems (West et al. 1992). With year-round connectivity between Lac du Sauvage and Lac de Gras, it is likely a significant number of individuals within these populations occupy habitats in each of the lakes.

There are additional reasons to suspect movement of fish VCs between Lac du Sauvage and Lac de Gras. A telemetry (i.e., fish-tracking) study identified movement of radio-tagged Lake Trout into the Narrows from Lac de Gras in 2001 (Dillon 2002; Fitzsimmons 2013), suggesting movement between these two systems. Dillon (2002) could not relocate all of the tagged fish in their limited sampling area (which included Lac de Gras but excluded most of Lac du Sauvage) and contend that tagged Lake Trout may have migrated out of Lac de Gras to inhabit the waters of Lac du Sauvage. Such migrations are supported by the fact that there are potentially more productive waters for foraging in Lac du Savage (summarized in DAR Section 9.2.1), but greater quantities of high quality spawning shoals in Lac de Gras (DAR Section 9.2.4.1.1), which creates the potential for spawning and foraging migrations of fish VCs between these two lakes throughout the open water season. Similar movements have been previously reported for Lake Trout between Priest Lake and Upper Priest Lake in Idaho, USA (Venard and Scarneccia 2005), connected by the Upper Priest Lake outlet, which is 70 m wide channel, 2 to 3 m deep. In this system, Lake Trout were found to move readily between the two lakes, with the majority of movement occurring at night during the spring and fall months. Movements of Lake Trout and Lake Whitefish were also documented between two adjacent or connected lakes (White Lake and Big Trout Lake) in Algonquin Park, Ontario. Kennedy (1941) observed seasonal movement of these species between the two lakes in the spring through a narrow channel.

Based on the telemetry study in Lac du Sauvage area, and observations made in other lakes with similar connectivity, it seems highly unlikely that populations of fish VCs are geographically restricted to Lac du Sauvage. Large-bodied fish are highly mobile species and the Narrows provides opportunities for fish to move freely between Lac du Sauvage and Lac de Gras, and therefore, opportunities for interbreeding between individuals originating from Lac du Sauvage and Lac de Gras.

As the effects assessment was designed to capture the maximum spatial extent of potential effects from the Project, potential movement of VCs between Lac de Sauvage and Lac de Gras necessitated its inclusion within the boundaries of the assessment. Although the Government of Northwest Territories (GNWT) noted in the preamble that there is no evidence provided to date illustrating that Lac de Gras and Lac du Sauvage share a fish population, the supporting literature and basic principles underlying ecology of fish do suggest otherwise. Furthermore, consideration of an ESA using only Lac du Sauvage for fish that may be affected by the Project would fail to capture cumulative effects from existing and reasonably foreseeable developments in the Lac de Gras watershed, and inadequately predict impacts at the population scale. Any changes to habitat (water quality or quantity) in Lac de Gras may have implications for the abundance and distribution of fish in Lac du Sauvage, and therefore, the boundary of any assessment for fish should reflect these potential effects. Similarly, as Randall et al. (2013) suggests using the spatial scale of the population or fisheries unit under examination, it is our interpretation that these authors do not recommend a smaller scale for assessing effects from developments such as the Jay Project. According to Randall et al. (2013), the Jay Project would be defined as a major project with the potential to affect the ecosystem, and therefore, is best evaluated by assessing changes in fish production at the population scale within the geographic boundaries of the Lac du Sauvage and Lac de Gras ecosystem. A higher level of scale is required beyond the boundary of Lac du Sauvage because VC populations are not geographically restricted to this waterbody.

The DAR quantified changes to habitat quantity and quality at the scale of Lac du Sauvage (e.g., see DAR Section 9.4.3.1.1; Tables 9.4-3 and 9.4-4). For additional details on the predicted effects to habitat types at the scale of Lac du Sauvage, please see the related Round 1 IR response to DAR-GNWT-IR-49. For the assessment of indirect effects to fish VCs, such as changes to the abundance and composition of plankton and benthic invertebrates (i.e., food base), and habitat through changes to trophic state and water quality in Lac du Sauvage and Lac de Gras, see DAR Section 9.4.3.2.3.

The DAR concluded that the amount of cumulative change to habitat quality and quantity for the Application Case is expected to result in no measurable effect to population abundance for fish VCs. Effects, if any, would be limited to a minor, local change in the distribution of fish VCs. These conclusions remain valid at a reduced assessment scale of Lac du Sauvage. Furthermore, the summary of the residual impact classification presented in DAR Table 9.6-2 remains unchanged using either a scale of Lac du Sauvage or a scale of Lac du Sauvage and Lac de Gras combined for an ESA. The magnitude of effects to the productivity of fisheries would remain low for all primary pathways, including habitat quantity and quality pathways. At the scale of Lac du Sauvage or Lac du Sauvage and Lac de Gras combined for an ESA, the cumulative changes from the Project and other developments would not have a significant adverse effect on the assessment endpoints of self-sustaining and ecologically effective populations of Arctic Grayling, Lake Trout, and Lake Whitefish, and ongoing fisheries productivity.

2. Water Quality

The selection of the boundary for the ESA for the water quality VC is described in Section 8.1.4 of the DAR. Additional details and justification for the ESA were also provided in response to adequacy review DAR-MVEIRB-20, at the April 2015 Technical Sessions, and in response to undertaking DAR-MVEIRB-UT-14. In Section 8.7.1 of the DAR, the methods used to assign significance were described. In response to Round 1 IR DAR-MVEIRB-IR-06, more explanation was provided on how significance of the Project to water quality was assigned.

The DAR fully considered the predicted magnitude, geographic extent, frequency, reversibility, and likelihood of the Project to change or affect water quality in Lac du Sauvage, as well as Lac de Gras, and the numerous small lakes within the watershed that are connected to these larger lakes. The areal extent of the ESA is considered appropriate for the DAR as it encompasses the extent of lakes and waterbodies where measureable effects are anticipated to occur, as well as having importance for traditional use.

Magnitude is the primary criterion used to determine environmental significance, while geographic extent and duration are used as modifiers and to provide context when assigning magnitude. For water quality, magnitude is evaluated relative to guidelines and objectives because they are based on scientifically defensible toxicological data, which are used to evaluate measured or modelled data. Concentrations for all water quality constituents are predicted to be less than guidelines and objectives (see Table 8.5-13 in the DAR for all guidelines and objectives considered) at all times during the life of mine, and at all assessment nodes in both Lac du Sauvage and Lac de Gras (Tables 8.5-24 and 8.5-25 in the DAR) and in the supplemental modelling compendium (Golder 2015a). For this reason, magnitude was classified as low in both Lac du Sauvage and Lac de Gras.

Geographical extent was categorized as local for both Lac du Sauvage and Lac de Gras. The definition provided in the DAR for local was “predicted maximum spatial extent of direct and indirect effects from changes to measurement indicators due to a project or activity”. Local geographical extent was set to the outlet of Lac de Gras to account for Project activities and cumulative effects from existing activities at the Ekati Mine and Diavik Mine. Discharge of minewater is considered the key project activity that results in change or alteration of water quality in the lakes and there will be discharge in both watersheds from the Project and existing operations.

Within the DAR, consideration of the potential effects of Project activities to Lac du Sauvage was completed, and the residual impact classification included ratings applied to a specific effects statement for Lac du Sauvage: “effects to water quality in Lac du Sauvage”. A summary of the effects to Lac du Sauvage from the Project was presented in the DAR (page 8-840). However, the ESA was established to account for incremental and cumulative effects, and the significance determination accounted for potential impacts to both Lac du Sauvage and Lac de Gras.

If the effects assessment boundary is reduced from the outlet of Lac de Gras to solely the outlet of Lac du Sauvage, it would fail to capture cumulative effects from existing and reasonably foreseeable developments in the Lac de Gras watershed. It would also fail to capture the Project effects as they pertain to the Koala watershed, which flows to Lac de Gras. Therefore, such an adjustment to the ESA would result in an assessment that would inadequately predict and assess impacts at an appropriate scale. However, that being said, at a reduced assessment scale of Lac du Sauvage, a conclusion of no significant adverse effects for Lac du Sauvage would still be concluded based on the ratings of residual effects as follows:

- the magnitude rating would remain low, as maximum projected constituent concentrations will be less than screening values, with no measureable change to aquatic health or the sustainability of the aquatic ecosystem;
- the geographic extent will be local to regional because measurable changes to water quality from the Project would flow into Lac de Gras; and,
- the duration would remain long-term to permanent despite the short-term nature of the minewater discharge because of the long-term influences from the waste rock storage area and Jay Pit (for the Application Case, some water quality constituents return to existing conditions but others remain slightly above existing conditions).

As stated in the DAR, when the layers of conservatism applied throughout the assessment are considered (i.e., illustrated in the differences to modelled water quality outcomes presented in the Reasonable Estimate Case [Golder 2015a] and the Lower Bound Scenario [Golder 2015b]), it could be argued that the residual effects to water quality are more appropriately classified as being long-term, and therefore, reversible. However, regardless of the conservatism, the low magnitude rating for the effects to water quality drives the conclusion; that is, peak changes to water quality throughout Lac du Sauvage, which occur at the end of mine operations (and Misery Pit minewater discharge to Lac du Sauvage), do not exceed guidelines or objectives, nor do they present a risk to aquatic health or continued traditional use.

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.

Dillon (Dillon Consulting Ltd.). 2002. Lake Trout Habitat Utilization Study, 2001. Technical Report – Final. Prepared for Diavik Diamond Mines Inc., Yellowknife, NWT, Canada.

Fitzsimmons JD. 2013. Assessment of the use of dikes at Diavik Diamond Mine Lac de Gras for Lake Trout Spawning 2011. Unpublished Report. Available http://www.mvlwb.ca/Boards/WLWB/; accessed June 10, 2015. 24 pages.

Golder (Golder Associates Ltd.) 2015a. Jay Project - Compendium of Supplemental Water Quality Modelling. Submitted to Mackenzie Valley Environmental Impact Review Board. April 2015.

Golder. 2015b. Jay Project – Pit Lake Hydrodynamic Modelling – Lower Bound Scenario. Project 1419751. Submitted to Mackenzie Valley Environmental Impact Review Board. July 2015.

Kennedy WA. 1941. The migration of fish from a shallow to a deep lake in spring and early summer. Transactions of the American Fisheries Society 1: 391-396.

Muhlfeld CC, Giersch JJ, Marotz, B. 2012. Seasonal movements of non-native lake trout in a connected lake and river system. Fisheries Management and Ecology 19: 224-232.

Randall RG, Bradford MJ, Clarke KD, Rice JC. 2013. A science-based interpretation of ongoing productivity of commercial, recreational or Aboriginal fisheries. DFO Canadian Science Advisory Secretariat Research Document 2012/112 iv + 26 p.

Walch LA, Bergersen EP. 1982. Home range and activity patterns of lake trout in central Colorado. Fisheries Research 1: 311-318.

West RL, Smith MW, Barber WE, Reynolds JB, Hop H. 1992. Autumn migration and overwintering of Arctic Grayling in coastal streams of the Arctic National Wildlife Refuge, Alaska. Transactions of the American Fisheries Society 121: 709-715.

Venard JA, Scarneccia DL. 2005. Seasonally dependent movement of Lake Trout between two Northern Idaho lakes. North American Journal of Fisheries Management 25: 635-639.

DOMINION DIAMOND

Information Request Number:	DAR-GNWT-IR2-04
Source:	Government of Northwest Territories - Lands Information Requests from Melissa Pink
Subject:	Effects Level Within Mixing Zones
DAR Section(s):	Jay Technical Sessions (April 23, 2015 Transcript, Pages 41 and 53)

Preamble (GNWT):

During Day 4 of the technical sessions, GNWT staff conducted a line of questioning related to determining the extent, duration and magnitude of effect that would be occurring within the mixing zone. It was ascertained through that line of inquiry that the duration of impact is effectively the period of discharge, approximately a 5 year period (Mr. John Faithful, Jay Pipe Technical Sessions Day 3, Page 53). Also, the spatial extent of the mixing zone is estimated to be 200m (Mr. John Faithful, Jay Pipe Technical Sessions Day 3, Page 41). However, the methodology utilized to determine the extent of the mixing zone was not clear. While there is no set policy for setting mixing zone sizes in the NWT, the GNWT generally looks to CCME documents for guidance. The CCME guidance document on the site specific application of water quality guidelines (CCME, 2003) provides 14 factors that should be considered when establishing mixing zones. Three of these points are that the mixing zone should be as small as possible, that conditions within the mixing zone should not cause acute or short-term chronic toxicity to aquatic organisms, and wastewater discharged to the receiving water system must not be acutely toxic to aquatic organisms. In that regard, based on the evidence provided by DDEC to date, the GNWT believes that effluent discharged to Lac du Sauvage may be acutely toxic to daphnids during open pit mining (DAR Appendix 8H –"Attachment B Daphnia magna toxicity testing of "End of Open Pit Mining" predicted ion balance" displays a 45 ± 35 survival% for Daphnia magna at 100% effluent). Also, there was no discussion in the DAR regarding the potential for chronic toxicity effects within the mixing zone.

At this time, it is still unclear as to the predicted effects to aquatic species within the mixing zone during the time of discharge and if this effect will extend into the closure period. It is GNWT's position that in order to make a determination on significance, the levels of effects that will be occurring within that area must be clearly understood. There has been no discussion to date on which species will experience effects, and the level of those effects, within this area.

As well, the scale of the area being affected within the context of Lac du Sauvage as a whole should be presented (note the DAR assessment boundary is the outlet of Lac de Gras). The percentage of the population of affected species (i.e. percentage of the lake impacted) should be quantified in the context of Lac du Sauvage using a clear assessment of overall magnitude of impact determined by the particular combination of concentration relative to chronic effect values, spatial extent, and duration of exposure.

Reference:

Environment Canada. 2003. Revised Technical Guidance on How to Conduct Effluent Plume Delineation Studies.

DOMINION DIAMOND

Request (GNWT):

ENR requests that DDEC provide the following information:

1. The areal extent of the effluent plume defined by the point at which SSWQOs for Lac du Sauvage will be met.
2. The anticipated water quality within the mixing zone (end-of-pipe to end of mixing zone) during discharge and the rate of reduction post closure (i.e. the amount of time before concentrations are reduced to closure objectives);
3. The aquatic species that are anticipated to experience chronic toxicity within the mixing zone area including the effects level and assessment endpoints (i.e. EC20 for growth, IC10 for reproduction, etc.) and the parameters responsible for the noted toxicity;
4. Evidence that the predicted end-of-pipe effluent will not be acutely toxic to aquatic species at 100% effluent;
5. A discussion of the scale of the area being impacted by the mixing zone in the context of the volume of Lac du Sauvage expressed as a percentage (i.e. mixing zone volume/volume of Lac du Sauvage).
6. A discussion on how the previous points translate to a determination of significance as it relates to aquatic species within Lac du Sauvage.
7. An assessment of alternative strategies to address toxicity issues identified at the end- of-pipe or within the mixing zone in the context of the Jay Project that includes discharge strategies, discharge timing alternatives to avoid discharge of the poorest quality effluent, treatment options, etc.

Response:

1. The areal extent of the effluent plume defined by the point at which SSWQOs for Lac du Sauvage will be met.

In the Developer’s Assessment Report (DAR), Dominion Diamond suggested a mixing zone for the Jay Project (Project) of 200 metres (m) from the proposed diffuser for Misery Pit minewater discharge to Lac du Sauvage (Section 8.5.4 and Appendix 8F). This distance is based on near-field mixing studies using the CORMIX model, as described in Appendix 8F, Attachment 8F1, and is similar to other regulated mixing zones in the Northwest Territories (e.g., Snap Lake Mine [De Beers 2002], Gahcho Kué Mine [MVLWB 2014]).

The CORMIX modelling was conducted to understand how effluent will initially mix in the receiving environment. The near-field mixing assessment predicted maximum concentrations in Lac du Sauvage based on conceptual diffuser outfall characteristics, maximum effluent discharge characteristics, constant lake water characteristics, and minimum dilution factors. Effective dispersion of the Misery Pit minewater discharge to Lac du Sauvage under these conceptual design conditions was shown to be achievable within a 200 m mixing zone (see the response to DAR-EC-IR2-01), such that maximum concentrations of constituents at the extent of the mixing zone will be less than the SSWQOs and WQGs.

With an mixing zone of 200 m (i.e., a nominal circular radius of 200 m), the areal extent of the effluent plume in Lac du Sauvage, which has a surface area of 86.4 km^2 (Section 8.2.4.2.1 of the DAR) is small (0.15%) relative to the size of the lake.

Confirmation of the mixing zone for the Water Licence will be an outcome of the permitting process; the Water Licence application and associated documentation to the Wek'èezhìı Land and Water Board (WLWB) will also include information on the final diffuser design and the recommendation and finalization of SSWQO.

2. *The anticipated water quality within the mixing zone (end-of-pipe to end of mixing zone) during discharge and the rate of reduction post closure (i.e. the amount of time before concentrations are reduced to closure objectives).*

The response to DAR-EC-IR2-01 provides projected dilution factors and maximum concentrations of select constituents in Lac du Sauvage at 200 m from the conceptual diffuser outfall during Misery Pit minewater discharge to Lac du Sauvage. The predicted concentrations within the mixing zone were based on the maximum discharge concentration of constituents during site discharge.

As described in the DAR (Section 8.5.4.2.2), concentrations of constituents in Lac du Sauvage are projected to increase during the late operations phase in response to the discharge of minewater from the Misery Pit. Peak concentrations in Lac du Sauvage are projected at the end of late operations (2030) after which concentrations are predicted to promptly decrease through the closure and post-closure phase in response to discontinued discharge from the Misery Pit. A long-term steady state concentration in Lac du Sauvage is predicted to be reached early in post-closure (by 2038) and to be maintained for the remainder of the modelled post-closure period.

Closure objectives will be developed for the Project during the water licencing phase that will be protective of the environment; these closure objectives will be incorporated into the approved Interim Closure and Reclamation Plan for the Ekati Mine (BHP Billiton 2011).

3. *The aquatic species that are anticipated to experience chronic toxicity within the mixing zone area including the effects level and assessment endpoints (i.e., EC20 for growth, IC10 for reproduction, etc.) and the parameters responsible for the noted toxicity.*

Immediately adjacent to the diffuser outfall in Lac du Sauvage (i.e., within the mixing zone), constituent concentrations potentially exceeding SSWQOs and WQGs may occur resulting in potential sublethal effects. However, at the extent of the mixing zone, constituent concentrations will meet SSWQOs and WQGs; no chronic toxicity is anticipated at this point.

As stated above, predicted concentrations at assessment node LDS-P1 during operations, which is representative of average concentrations within the mixing zone, are anticipated to be below federal and provincial WQGs and SSWQOs. The WQGs and SSWQOs used in the DAR are based on scientifically defensible toxicological data, and are conservative in regards to protecting aquatic life in that predicted concentrations below these values indicate that the potential for chronic toxicity is negligible. Monitoring will be conducted to track conditions in the receiving environment and the potential for sublethal effects.

4. *Evidence that the predicted end-of-pipe effluent will not be acutely toxic to aquatic species at 100% effluent.*

As stated in the response to DAR-EC-IR2-1, Dominion Diamond has committed that no discharge of any minewater from the Misery Pit to Lac du Sauvage will occur if acutely toxic. To meet this commitment, monitoring of minewater in the Misery Pit (as a requirement under the Water Licence) will be undertaken during operations; the monitoring will be conducted in early operations (i.e., during the phase when there is no discharge to Lac du Sauvage) and late operations (i.e., during the discharge period). Minewater monitoring will include chemical analysis and acute and chronic toxicity testing. Similar to toxicity testing requirements at the Ekati Mine, toxicity testing is expected to include acute lethality testing with Rainbow Trout and waterflea, and chronic toxicity testing with the green algae, *Pseudokirchneriella subcapitata,* and the cladoceran, *Ceriodaphnia dubia* (WLWB 2014). This testing will track water quality conditions in the pit (i.e., end-of-pipe) to prevent water that is acutely toxic from being discharged to Lac du Sauvage.

As described in the response to first round Information Request DAR-EC-IR-20, if trends in Misery Pit water quality indicate an unexpected and unacceptably high risk of harm to the receiving environment, adaptive management strategies would be applied. These adaptive management strategies are outlined in the DAR (Appendix 3A; Section 3.5.5.2.1) and re-iterated in DAR-EC-IR-20. See response to DAR-GNWT-IR2-06 for additional information.

Toxicity tests, using simulated minewater, were undertaken to determine whether minewater would be acutely toxic (Appendix 8H in the DAR). The simulated minewater used in the acute toxicity tests was based on projected minewater concentrations of total dissolved solids (TDS) and major ions at the end of mining operations based on the conservative assessment case as presented in the DAR (Appendix 8E in the DAR). The test species (Rainbow Trout, *Oncorhynchus mykiss*, and the waterflea, *Daphnia magna*) and procedures used to evaluate toxicity of the simulated minewater are the same currently used to evaluate toxicity of Ekati Mine effluent discharges. Results of the toxicity tests demonstrated that the minewater from open pit mining are not likely to be acutely toxic (bioassay data are provided in Appendix 8H).

It was noted in the DAR that the Misery Pit discharge water quality is most sensitive to groundwater inflows. Therefore, the reduced groundwater inflows used in the Reasonable Estimate Case (Golder 2015) generally result in lower major ion concentrations (Table 4-2 in Golder [2015]) compared to those projected in the DAR. For example, peak under ice total dissolved solids (TDS; 1,150 mg/L) and chloride (605 mg/L) concentrations in the Reasonable Estimate Case are approximately one-third of the peak DAR concentrations of 2,925 mg/L and 1,712 mg/L, respectively. The lower concentrations under the Reasonable Estimate Case provide additional support that Misery Pit minewater is not likely to be acutely toxic.

5. *A discussion of the scale of the area being impacted by the mixing zone in the context of the volume of Lac du Sauvage expressed as a percentage (i.e., mixing zone volume/ volume of Lac du Sauvage).*

The volume of Lac du Sauvage represented by the conceptual mixing zone (200 m radius) is approximately 2,010,600 cubic metres (m^3), or 0.3% of the volume of Lac du Sauvage (631,000,000 m^3; Section 8.2.4.2.1 of the DAR). The extent of the effluent plume in Lac du Sauvage in the context of volume is, therefore, small relative to the size of the lake.

6. *A discussion on how the previous points translate to a determination of significance as it relates to aquatic species within Lac du Sauvage.*

Effects of effluent discharge (and subsequent constituent loading) to Lac du Sauvage and Lac de Gras for the life of the Mine from the Project and cumulative sources were quantitatively projected using water quality models (Section 8.5.4.1 of the DAR). Modelled results over all Project phases and into post-closure were evaluated relative to SSWQOs and WQGs (Table 8.5-13 in the DAR), which are based on scientifically defensible toxicological data. As stated above in response to Question 1, evaluation of the predictions relative to these SSWQOs and WQGs provided a means to evaluate the potential for changes in water quality to affect aquatic health (Section 8.5.5). The water quality assessment presented in the DAR considered the effect of the quantitative predictions on water quality and effects to end users to determine significance. Based on the modelled water quality predictions for Lac du Sauvage and Lac de Gras for the Application Case, the Project will not have a significant adverse effect on the maintenance or suitability of water to support a healthy and sustainable ecosystem, or on the continued opportunity for the traditional use of water, including use as a drinking water source.

7. *An assessment of alternative strategies to address toxicity issues identified at the end- of-pipe or within the mixing zone in the context of the Jay Project that includes discharge strategies, discharge timing alternatives to avoid discharge of the poorest quality effluent, treatment options, etc.*

Minewater monitoring (i.e., constituent chemistry and toxicity testing) will be conducted in the Misery Pit before, and during, discharge to Lac du Sauvage to provide an early warning of potential toxicity issues at the end-of-pipe or within the mixing zone. If trends in Misery Pit water quality indicate an unexpected and unacceptably high risk of harm to the receiving environment, adaptive management strategies would be applied. These adaptive management strategies are outlined in the DAR (Appendix 3A; Section 3.5.5.2.1) and re-iterated in DAR-EC-IR-20; also see DAR-GNWT-IR2-06.

References:

BHP Billiton (BHP Billiton Canada Inc.). 2011. Ekati Diamond Mine Interim Closure and Reclamation Plan. Prepared for the Wek'èezhìı Land and Water Board. 842 pp.

De Beers (De Beers Canada Inc.). 2002. The Snap Lake Diamond Mine Environmental Assessment Report. Submitted to the Mackenzie Valley Environmental Impact Review Board. Yellowknife, NWT, Canada.

Golder (Golder Associates Ltd.). 2015. Jay Project - Compendium of Supplemental Water Quality Modelling. Submitted to Mackenzie Valley Environmental Impact Review Board. April 2015.

MVLWB (Mackenzie Valley Land and Water Board). 2014. Land Use Permit and Water Licence (MV2005C0032 and MV2005L2-0015). Reasons for Decision. August 11, 2014. Mackenzie Valley Land and Water Board.

DOMINION DIAMOND

Information Request Number:	DAR-GNWT-IR2-05
Source:	Government of Northwest Territories - Lands Information Requests from Melissa Pink
Subject:	Contingencies
DAR Section(s):	Jay Technical Sessions (Day 3, Transcript Page 214 to 215)

Preamble (GNWT):

The GNWT has noted that the uncertainty surrounding the groundwater modelling has not been quantified. It is important to ensure that this aspect of the assessment is well understood, since the implications of not correctly estimating groundwater inflows can have a significant impact on planned water management. Under some scenarios, the GNWT is concerned that the resulting water quality of Misery Pit water will result in effluent water quality which will result in an inability to meet the proposed SSWQOs in Lac du Sauvage. These SSWQOs are set to a level to be protective of aquatic species within Lac du Sauvage and as a result it is the GNWT's position that this situation could result in a significant impact to Lac du Sauvage.

As such, it is paramount that DDEC investigate contingency options to ensure that, should the aforementioned situation arise, there are sufficient resources present to prevent the discharge of this water into the receiving environment. During the technical sessions, DDEC noted that approximately 9.2 million cubic metres of storage volume exists (or will exist) within King Pond, Misery Pit and Lynx Pit (Jay Technical Sessions, Day 3, Page 214). This equates to approximately 18 months of storage capacity based on DDEC's statement that the 3 million cubic metre capacity of Lynx Pit equates to 6 months additional storage. Regarding the Lynx Pit, however, it is the GNWT's understanding that this will be used as a settling pond when dewatering the impounded portion of Lac du Sauvage (DDEC 2014). The Lynx Pit will then be allowed to fill over a period of 2.5 years via natural inflows Golder (2014, § 4.4). If the Lynx Pit is completely filled within 2.5 years of dike dewatering it is not clear how the Lynx Pit can be used to provide additional contingency mine water storage.

Additionally, the storage of higher TDS water within other areas of the mine may result in additional environmental factors that may have additional risks/significant impacts to the environment and consequences to closure options and feasibility of the mine. For example, DDEC stated that an additional 80,000,000 cubic metres of storage is available in existing mining structures on the main Ekati site (Jay Technical Sessions, Day 3, Page 215). The costs associated with pumping large quantities of water from the Misery site to the main Ekati site are unclear and the GNWT is unsure if this represents a truly feasible option.

Finally, the list of contingency actions outlined in the Developer's Assessment Report also included water treatment as a potential option should pit water be of a lesser quality than anticipated. The feasibility of this option has not been discussed to date. Given the limited effectiveness of water storage in the long-term and the potential conflict with acceptable closure options for the site, the GNWT concludes that the option related to water treatment should be investigated more thoroughly to ascertain if sufficient contingency options exist on site in the event that groundwater predictions are underestimated.

Reference:

DDEC (Dominion Diamond Ekati Corporation). 2014. Dominion Diamond Ekati Developer's Assessment Report Jay Project. Golder. 2014. Dominion Diamond Ekati Corporation, Lac Du Sauvage Northwest Territories Canada. Jay Project Mine Water Management Plan. Submitted to Dominion Diamond Ekati Corporation. October 2014.

Request (GNWT):

The GNWT requests that DDEC provide the following information:

1. Clarification on the water management contingency planning with respect to the Lynx Pit.
2. Details on the feasibility of the option related to pumping mine water to the main Ekati site and provide conclusions on the acceptability of this option based on those results.
3. Details on the feasibility of the option related to treating mine water on site to avoid long term storage of high TDS water on site. This analysis should include the proportion of mine water that would require treatment, volumes of the brine stream, storage options for the brine stream, any transportation costs, etc.

The aforementioned options should be compared and a decision on contingency for mine water on site be selected based on the outcome of these results.

Response:

Note of clarification: during operation of the Jay Project, a minimum of 3 million cubic metres (m^3) of contingency storage will exist within Misery Pit (not Lynx Pit as stated in the Preamble). This storage volume comes from the 10 metres (m) of freeboard. This equates to 1.1 years of storage capacity during the first year of operation and 0.4 years during the last year (Developer's Assessment Report [DAR] Appendix 3A, Mine Water Management Plan, page 25), based on Jay Pit inflow volumes as presented in the DAR. This scenario is considered the Environmental Assessment conservative assessment case (or updated assessment case in water quality modelling predictions [Golder 2015a]). As the Jay Pit is developed (depth increases) inflow volumes are predicted to increase, hence the change in storage capacity over time. In comparison, for the reasonable estimate case, presented in Golder (2015a), the contingency storage capacity in Misery Pit allows for 0.5 years of inflows to be stored during the last year of operation. Based on the assumptions used in the lower bound modelling case (Golder 2015b), Misery Pit allows for 1 year of inflows to be stored, during the last year of operation.

Adaptive management planning options outlined in Section 8.3 of the Mine Water Management Plan (DAR Appendix 3A) are non-specific at this point in time, as various factors would need to be considered in order to select which option or options best suit the condition. Such factors would include the quantity of water to be managed, water quality requiring management, and anticipated duration of management (short-term versus long-term). The primary consideration in the evaluation and selection of appropriate adaptive management response actions is the nature of minewater quality upset that has occurred. For example, response actions would be different to address elevated total suspended solids (TSS) versus elevated metals or elevated total dissolved solids (TDS). The adaptive management responses would be further different for various specific metals or various specific constituents of TDS.

Regardless of the specific nature of the water quality issue to be addressed, adaptive management response plans are reviewed and approved by the Wek'èezhìı Land and Water Board (WLWB) prior to implementation under the Ekati Mine Water Licence, and this procedure is expected to continue for the Jay Project. This process engages all parties in the development of the response plan prior to implementation.

1. If Lynx Pit was to be considered for use as part of an adaptive management strategy for minewater management, then some or all the water within the Lynx Pit from dewatering of the diked area in Lac du Sauvage would first need to be discharged. Use of Lynx Pit could conceptually become available once any elevated levels of TSS had reduced to a level suitable for discharge to the environment. It is estimated that elevated levels of TSS will settle relatively quickly within Lynx Pit (1 to 2 years). Lynx Pit will have an approximate capacity of 5.2 million m^3 and is proximal to the Misery Pit. The pipeline and pumping system that will be used to transfer water from Misery Pit to the Lynx Pit during the dewatering phase for the Jay Pit will remain in place during Jay mining to facilitate use of the Lynx Pit, if necessary. A mechanism (e.g., natural channel or pipeline) for suitably discharging this water would be selected to be protective of the environment. The selection would be based on various considerations, such as the volume of water to be discharged, rate of discharge, and time of year. The potential use/selection of Lynx Pit as part of an adaptive management response plan could affect the closure plan for this pit; if this were necessary, the details and process would be determined as part of the response plan approved by the WLWB and incorporated into the final closure plan for the Ekati Mine.
2. As per the existing Ekati Mine Interim Closure and Reclamation Plan, the closure scenario for other pits at the main Ekati site (e.g., Fox, Pigeon, Beartooth) include pumping of freshwater for back-flooding. Due to the length of pipeline and power required to pump water from the Jay Project area to the main Ekati site, the consideration for using of any of the pits at the main Ekati site for minewater storage would only be feasible if a longer term solution was required, and potentially seasonal water transfer would be considered. The use of pit(s) at the Ekati site for minewater storage as part of an adaptive management response plan could affect the closure plan for those pit(s); if this were necessary, the details and process would be determined as part of the response plan approved by the WLWB and incorporated into the final closure plan for the Ekati Mine.
3. It is not possible to provide the levels of detail requested for a potential adaptive management response plan because the fundamental circumstance to be addressed is not known, including the volume, concentration, parameters for treatment, discharge standards, and duration of any potential treatment. Design and costing for any treatment option, including disposal of the residue would be considered if necessary, based on volumes and water quality obtained from the monitoring of water quantity and quality in Jay Pit and Misery Pit. The details of the design for any adaptive management response plan would be reviewed and approved through the WLWB. Further information on the potential for water treatment as an adaptive management response was provided to the Mackenzie Valley Environmental Impact Review Board on April 7, 2015 in response to Information Requests received from the Diavik Mine (DAR-DDMI-IR-Minewater Management Alternatives).

It is not possible to pre-select an adaptive management response plan as it will depend on the water requiring management (quantity, quality, and duration of management required). Hence, and consistent with the Ekati Mine Environmental Agreement, the Jay Project Mine Water Management Plan provides for adaptive management wherein monitoring results are regularly evaluated against pre-defined thresholds to trigger, if necessary, development and implementation of situation-specific response plans. There is a successful history of adaptive management at the Ekati Mine that demonstrates the effectiveness of this approach on a site-specific basis. The Mine Water Management Plan describes a number of feasible options that could form the basis of a water quality response plan, should this be necessary. Additionally, the Mine Water Management Plan provides for 5 to 6 years of site-specific data collection before minewater discharge is required, which ensures adequate time for the adaptive management process without risk to the aquatic receiving environment.

References:

Golder (Golder Associates Ltd.). 2015a. Jay Project - Compendium of Supplemental Water Quality Modelling. Submitted to Mackenzie Valley Environmental Impact Review Board. April 2015.

Golder. 2015b. Jay Project – Pit Lake Hydrodynamic Modelling – Lower Bound Scenario. Submitted to Mackenzie Valley Environmental Impact Review Board. July 2015.

Information Request Number:	DAR-GNWT-IR2-06
Source:	Government of Northwest Territories – Lands Information Requests from Melissa Pink
Subject:	Closure at Misery Pit
DAR Section(s):	Jay Technical Sessions Undertaking Response DAR-MVEIRB-UT-12; Jay Project Conceptual Closure and Reclamation Plan (Section 5.1)

Preamble (GNWT):

ENR understands that long term water quality in Misery pit could have TDS concentrations of 700 mg/L, even if meromixis does become established. ENR is not certain how this concentration would change in the event that the actual groundwater quantity and quality encountered during the project differs from what is predicted by the modelling. Further, DDEC identifies in the response to Undertaking 12 that concentrations of copper, chloride, total phosphorous, manganese, aluminum, iron and nickel will also exceed generic guidelines for the protection of aquatic life, trophic status, wildlife or drinking water aesthetics in the Misery Pit during the post closure period.

Section 5.1 of the Jay Project Conceptual Closure and Reclamation Plan identifies that the closure plan for the Jay Project facilities have been designed to fit into the closure framework established for the Ekati site. The overall closure goal is “to return the Ekati Mine site to viable, and wherever practicable, self-sustaining ecosystems that are compatible with a healthy environment, human activities, and the surrounding environment.” The closure objectives have been established, but the closure criteria have not been finalized. ENR’s understanding of the objectives for the pit lakes in the Interim Closure and Reclamation Plan are that the company’s final design will be conducive to the establishment of a self-sustaining aquatic ecosystem, but that the company would not be responsible for ensuring that such an ecosystem became successfully established. This would include consideration of physical characteristics, such as constructing littoral zones around the edge, and pit water quality.

ENR is concerned that the predicted post–closure water quality in the Misery Pit will not meet the closure objectives in that the water quality will not be conducive to establishment of a self-sustaining aquatic ecosystem that is compatible with the surrounding environment.

DDEC identifies in response to Undertaking 12 that one potential mitigation strategy that could improve water quality in the Misery Pit would be to pump additional water from the Misery Pit into Jay Pit and provide a deeper freshwater cap for the Misery Pit. The potential effectiveness of this option was not quantified.

References:

BHP Billiton Canada Inc., 2011. EKATI Diamond Mine, Interim Closure and Reclamation Plan.

Dominion Diamonds Ekati Corporation, 2015. EA1314-01 Jay Project, Dominion Diamond Corporation Developer’s Assessment Report – Responses to Undertakings, DAR-MVEIRB_UT-12.

Golder (Golder Associates Ltd.). 2014. Jay Project Conceptual Closure and Reclamation Plan Report. Prepared for Dominion Diamond Ekati Corporation. Yellowknife, NWT, Canada.

DOMINION DIAMOND

Request (GNWT):

ENR requests that DDEC provide an evaluation of the feasibility and effectiveness of all available mitigation options that could be implemented to improve post-closure water quality in the Misery Pit. The premise for these evaluations should be that final closure would align with the existing and approved closure goals and objectives for the Misery Pit.

Response:

The post-closure surface water quality in the Misery Pit is a function of the following two processes:

- mixing of water stored in the monimolimnion with the overlying mixolimnion; and,
- runoff from the wall rock exposed above the final Misery pit lake elevation.

In Undertaking #12 (DAR-MVEIRB-UT-12) from the Jay Project Technical Sessions in Yellowknife (April 21 to 24, 2015), Dominion Diamond identified the following eight constituents that were projected to increase to concentrations greater than the generic guidelines for the protection of aquatic life, trophic status, wildlife, or aesthetic drinking water: total dissolved solids (TDS), chloride, total phosphorus (TP), aluminium, copper, iron, manganese, and nickel. Detailed water quality modelling of the Misery Pit indicated that TDS and chloride concentrations in the pit after closure (i.e., following back-flooding) are related to water stored in the mixolimnion mixing with water stored in the monimolimnion, whereas, increases of metals concentrations during post-closure is a result of loading originating from the wall rock. Total phosphorus concentrations increase as result of both of these sources.

During the development of the Project water management plan for the Developer's Assessment Report (DAR), 30 and 60 metre (m) freshwater caps were evaluated in the Misery Pit post-closure water quality model. The results of this assessment indicated that a deeper freshwater cap in the Misery Pit minimized the amount of mixing between the mixolimnion and the monimolimnion; the 60 m cap was, therefore, carried forward into the assessment since it resulted in lower surface water constituent concentrations in the Misery Pit discharge to Lac de Gras during post-closure. Following this assessment outcome, it is, therefore, conceivable that constituent concentrations in the mixolimnion that are sourced from water being displaced from the monimolimnion could be further limited through increasing the depth of the freshwater cap in the Misery Pit. The optimal size of the freshwater cap required to limit guideline exceedances for these eight constituents will depend on the actual conditions observed in the Misery Pit (i.e., site-specific data collected during operations). Therefore, as additional operational monitoring data from the Misery Pit becomes available, Dominion Diamond will update water quality predictions in parallel with ongoing operational monitoring and prior to closure to make sure that the Misery Pit is closed in a manner that satisfies closure goals and objectives, and therefore, does not pose an environmental risk. However, Dominion Diamond considers further evaluation of the optimal Misery Pit freshwater cap premature until an understanding of the constituents that will require adaptive management are established.

The majority of the constituents that were projected to increase to concentrations greater than the generic guidelines for the protection of aquatic life, trophic status, wildlife, or aesthetic drinking water originate from the exposed metasediment wall rock above the final Misery pit lake elevation (i.e., aluminium, copper, iron, manganese, and nickel). This information is not limited to the DAR and updated modelling results (Dominion Diamond 2015). Prior to the Jay Project assessment (i.e., in the absence of the Jay Project), Rescan (2013) predicted these same constituents, including TP, would be present in the closure scenario for the Misery Pit at concentrations greater than water quality benchmarks. Rescan (2013) concluded “there is evidence that current pit wall runoff predictions for meta-sediment may be high and with additional research there is some confidence that future predictions may show that water quality in the surface layers of these pit lakes will also be below Water Quality Benchmarks” (page ii).

Water quality modelling of the Misery Pit included in the DAR and subsequent updates, and previous modelling of the Misery Pit completed by Rescan (2013), was based on conservative assumptions. Therefore, additional study is required to develop a better understanding of the Misery Pit wall rock runoff water quality prior to evaluating mitigation strategies for these constituents. The additional study may include additional geochemical testing of the exposed wall rock to better constrain model input source terms in future model updates.

The closure objectives for pit lakes at the Ekati Mine are provided in Section 5.2.7 of the Ekati Mine Interim Closure and Reclamation Plan (ICRP; BHP Billiton 2011), which has been approved by the Wek'èezhìı Land and Water Board, and includes the objective that pit lake water meets closure water quality criteria. The Misery Pit will be incorporated into subsequent versions of the ICRP.

References:

BHP Billiton (BHP Billiton Canada Inc.). 2011. Ekati Diamond Mine Interim Closure and Reclamation Plan. Prepared for the Wek'èezhìı Land and Water Board. 842 pp.

Dominion Diamond (Dominion Diamond Ekati Corporation). 2015. Jay Project – Compendium of Supplemental Water Quality Modelling. April 2015.

Rescan (Rescan Environmental Services Ltd.). 2013. Ekati Diamond Mine. Modeling Predictions of Water Quality for Pit Lakes. November 2013. Project #0194118-0202.

Information Request Number:	DAR-GNWT-IR2-07
Source:	Government of Northwest Territories - Lands Information Requests from Melissa Pink
Subject:	Viability of Minewater Management Plan
DAR Section(s):	Round 1 Information Request Response DAR-GNWT-IR-62

Preamble (GNWT):

The viability of the minewater management plan is contingent upon permanent stratification in several pits. An initial meeting with DDEC was helpful in understanding this aspect of the mine water management plan and forestalled some questions. Further questions were addressed in the response to IRs (DDEC, 2015, DAR-GNWT-IR-62), in a face to face meeting during the technical meeting and a subsequent teleconference. The major theme of the questioning has to do with the likelihood that the pit lakes will stratify and remain permanently stratified.

Stratification in Jay Pit Lake is based on modelling using CE-QUAL-W2 version 3.7 (Cole and Wells, 2011). Inputs to the model are based on additional 2D and 3D modelling of connate water flow. Of primary concern is the effect of changes in TDS concentrations, flows and elevation on pit lake stability.

References:

Cole TM, Wells S. 2011. CE-QUAL-W2: A Two-Dimensional, Laterally Averaged, Hydrodynamic and Water Quality Model, Version 3.7; User Manual. Prepared for US Army Corps of Engineers Waterways Experiment Station. Washington, DC, USA.

Request (GNWT):

The Government of the Northwest Territories intends to use most probable, as well as, a potential yet probable lower bound scenario to assess meromixis using CE-QUAL-W2 version 3.7 (Cole and Wells, 2011). In order to do so in a timely manner and to ensure transparency and comparability with results provided by DDEC, the Government of the Northwest Territories requests all input files to the CE-QUAL-W2 version 3.7. These files include but may not be limited to the following:

- The general control file including any adjusted kinetic parameters;
- Calibration data and associated final boundary conditions including inflows and outflows, head boundary conditions if used, surface boundary conditions, etc;
- The volume-area-elevation table after adjustment to match the project table;
- The boundary files following calibration;
- Bathymetry file;
- Vertical and/or longitudinal profile input files; and
- Hydraulic parameters.

DOMINION DIAMOND

Response:

Dominion Diamond Ekati Corporation (Dominion Diamond), Golder Associates Ltd. (Golder), the Government of the Northwest Territories (GNWT) and their consultant (Barry Zajdlik) met via teleconference on June 30, 2015 to discuss the model input data requested in this information request. During the call, GNWT stated their primary concern was the uncertainty around meromixis not forming in the Jay Pit should total dissolved solids [TDS] concentrations be less than predicted in the DAR and reasonable estimate model (Golder 2015a) scenarios. GNWT indicated they intended to develop a CE-QUAL-W2 pit lake hydrodynamic model and modify the model input TDS concentrations in the mixolimnion and monimolimnion within the pits to evaluate if meromixis would remain stable under these conditions.

Dominion Diamond and Golder explained that the inputs to the hydrodynamic model are a function of several other models and the pit lake hydrodynamic models cannot be run in isolation of these models. For example, the initial conditions (e.g., mixolimnion TDS, monimolimnion TDS, and pycnocline elevation) in the Jay and Misery Pits cannot be arbitrarily assigned without first evaluating if these conditions occur as a result of the outputs from the hydrogeological, hydrological, and site water quality models that were developed based on the Mine Water Management Plan for the Jay Project (Appendix 3A of the Developer's Assessment Report [DAR]). The details of the model linkages are provided in Appendix 8E and 8G of the DAR.

Dominion Diamond also explained during the call that they had already initiated a lower bound model hydrogeological model scenario based on a previous request from GNWT at the Technical Sessions in April 2015, and that the results of this modelling were subsequently being carried forward into the site and pit lake hydrodynamic models to evaluate the stability of the pit lakes under these conditions (Golder 2015b). GNWT were not aware that the lower bound hydrogeological model was being carried through to the pit lake hydrodynamic stability model to evaluate the likelihood of meromixis forming in the Jay and Misery Pits under these conditions. Based on this information, GNWT stated they were satisfied that a lower bound scenario was being evaluated, and as a result, no longer required the model input data requested in this information request.

Another outcome of the teleconference was that Dominion Diamond would host a water quality modelling workshop for GNWT and their consultants in Toronto on July 6, 2015 to go through the pit lake hydrodynamic models in detail, including the model input files, model setup, structure, and inherent assumptions. Dominion Diamond also proposed to present the results of all the model scenarios that have been completed to date, including the subsequent model scenarios requested by the GNWT following the April 2015 technical sessions (i.e., the lower bound scenario).

References:

Golder Associates Ltd. (Golder) 2015a. Jay Project – Compendium of Supplemental Water Quality Modeling. Report Number 1419751. April 7, 2015.

Golder 2015b. Jay Project – Pit Lake Hydrodynamic Modelling – Lower Bound Scenario. Project 1419751. July 3, 2015.

DOMINION DIAMOND

Information Request Number:	DAR-GNWT-IR2-08
Source:	Government of Northwest Territories - Lands Information Requests from Melissa Pink
Subject:	Stability of Meromixis Post-Closure
DAR Section(s):	Jay Project Compendium of Supplemental Water Quality Modelling

Preamble (GNWT):

During the technical sessions, there were several discussions related to the stability and longevity of meromictic conditions in both Jay Pit and Misery Pit Lakes. It is the GNWT's understanding that the modeling performed by Dominion Diamond for meromictic conditions in both pit lakes have only investigated the development of meromixis based on the parameters of high TDS, different wind sheltering coefficients and increased meteorological data (from 7 to 14 years) (Golder 2015).

In Dominion Diamond's Homework Item No. 22, DDEC reported salt rejection (exclusion) was not included in the model due the added complexities of the model. It should be noted that ice exclusion has been used by BHP Billiton in their Koala watershed modeling report (Rescan 2012) and BHP Billiton noted the importance of including it for water quality modeling for pit lakes for Ekati (Rescan 2013).

It has been shown in pit lakes similar to Jay and Misery, the three primary drivers for establishing and retaining stability of meromixis are salinity, depth of lakes, and ice cover (Pieters and Lawrence 2014). Two cases have been presented by Dominion Diamond, the DAR Case and Updated Assessment Case, but both present high TDS concentrations in the monimolimnion relative to the low TDS concentrations in the mixolimnion. No lower bound case of low TDS concentrations below the Updated Assessment Case TDS concentrations for the monimolimnion has been modeled to date.

While it is possible a pit lake with a strong chemocline with little change to salinity concentrations over time will result in a strongly meromictic pit lake (which are the cases presented in the Compendium of Supplemental Water Quality Modeling by Dominion Diamond) this may not be the case with a weaker chemocline or halocline. It is stated in the DAR Mine Water Management Plan that the decreases to the monimolimnion concentrations of the Misery Pit due to groundwater seepage post-closure were not considered in the modeling for the purpose of conservatism. However, lower concentrations of the monimolimnion have a direct impact on the stability of meromixis and should be further investigated.

Ice exclusion is a significant driver in the stability of meromixis in pit lakes. Stability is compromised when there is a more saline inflow to the epilimnion, which would increase the potential for under-ice mixing the following winter (Pieters and Lawrence 2014). The risk of under-ice mixing of the pit lake is enhanced during a winter with thick ice and high salt exclusion. This is partially significant for Misery Pit Lake, as the predicted future surface TDS concentrations are in the range of 429 mg/L to 728 mg/L at 200 years post-closure. As described by Pieters and Lawrence (2014), the higher the mass of salt excluded from the ice, the lower the salt deficit ratio and the greater the potential of mixing of the monimolimnion with the mixolimnion. An example of this scenario is the Colomac mine north of Yellowknife, where groundwater acted to reduce the salinity of the deep water. This diluting of the monimolimnion coupled with under-ice mixing from salt exclusion suggests the degree of meromixis can change over time. This pit lake was identified as a weak meromictic lake as a result. Pieters and Lawrence have provided direction on assessing ice exclusion using box models (Lawrence 2008) and salt deficit ratios (Pieters and Lawrence 2014)

References:

Golder (Golder Associates Ltd.). 2015. Jay Project Compendium of Supplemental Water Quality Modelling. Prepared for Dominion Diamond Ekati Corporation. Yellowknife, NWT, Canada.

Lawrence, G. 2008. Physical Processes and Meromixis in Pit Lakes. Presentation to the Wek'eezhii Land and Water Board. Link: http://www.mvlwb.ca/Boards/WLWB/Registry/2003/MV2003L2-0013/MV2003L2-0008%20-%20Presentation%20Pit%20Lakes%20-%20Part%201%20Studies%20-%20Part%202%20Meromixis%20-%20Mar24%2008.pdf

Pieters, P. and Lawrence, G.A. 2014. Physical processes and meromixis in pit lakes subject to ice cover. Canadian Journal of Civil Engineering, 41: 569-578. www.dx.doi.org/10.1139/cjce-2012-0132

Rescan. 2012. EKATI Diamond Mine: Water Quality Modelling of the Koala Watershed. Prepared for BHP Billiton Canada Inc. by Rescan Environmental Services Ltd.: Yellowknife, Northwest Territories.

Request (GNWT):

GNWT requests that DDEC provide further information and discussion regarding the influence of ice exclusion on the stability of meromictic conditions in both Jay Pit and Misery Pit Lakes. This should include calculation of salt deficit ratios and meromictic ratios for Jay and Misery Pit lakes for all presented cases post closure (e.g. DAR Case and Updated Assessment Case). GNWT encourages DDEC to replicate the methods presented in Section 6 of Ekati Diamond Mine Modeling Predictions of Water Quality for Pit Lakes (Rescan 2013) for comparison with this review.

Note, Rescan (2013) referenced document is provided as a separate attachment in the IR submission.

Response:

Salt exclusion during ice formation was not included in the pit lake hydrodynamic models developed for the DAR or the Reasonable Estimate Case (Golder 2015). Salt exclusion during ice formation was added to the Updated Assessment Case and Reasonable Estimate Case hydrodynamic models of the Misery Pit and Jay Pit lakes as part of this information request. Similar to the hydrodynamic and water quality models of Lac du Sauvage and Lac de Gras, the ice thickness on Misery Pit and Jay Pit lakes was assumed to be 1.5 metres (m), and 100 percent (%) of the salt was assumed to be excluded from the ice during ice formation. The rationale for the selection of these parameters is provided in Section 8F2.2.2.2 of Appendix 8F of the DAR.

In the Misery Pit (Figure 8-1) and Jay Pit (Figure 8-2) hydrodynamic models with salt exclusion, salt rejected during ice formation was predicted to migrate downward through the mixolimnion. In general terms, because the rejected salt is predicted to plunge to the monimolimnion each year, concentrations of total dissolved solids (TDS) in the mixolimnion in models with salt exclusion are lower than concentrations of TDS in the mixolimnion in models without salt exclusion over time. Due to the large volume of the Misery and Jay pit lakes, the difference in concentrations with and without salt rejection in the mixolimnion and monimolimnion is minimal. The mass of salt excluded from the ice was not sufficient to increase the concentration of TDS in the mixolimnion to that of the monimolimnion. As a result, salt-driven mixing was not predicted to occur, and Misery Pit and Jay Pit lakes were predicted to remain stratified during the entire 200-year simulation period for both the Updated Assessment Case and Reasonable Estimate Case models.

For Misery Pit and Jay Pit lakes, salt deficit ratios were calculated using Equation 1 (Pieters and Lawrence 2014).

$$Salt\ deficit\ ratio = \frac{\int_0^h (S(h)-S(z))A(z)dz}{h_i^* S(0)A(0)} \quad \text{Equation (1)}$$

Where,

S(h) = the salinity at the bottom;

S(z) = salinity;

A(z) = area of the pit as a function of depth;

z = depth below the ice;

h_i^* = the effective ice thickness.

S(0) = the salinity at the surface; and,

A(0) = the surface area of the pit.

The effective ice thickness is calculated using Equation 2 (Pieters and Lawrence 2014).

$$h_i^* = f_b h_i \quad \text{Equation (2)}$$

Where,

h_i = the thickness of black ice; and,

f_b = the fraction of salt excluded from black ice.

For Misery Pit and Jay Pit lakes, the salinity stabilities and meromictic ratios were calculated using Equations 3 and 4, respectively (Rescan 2013).

$$Salinity\ stability = \frac{g\beta}{A_0}\int_0^H (S(z)-\bar{S})\, zA(z)dz \quad \text{Equation (3)}$$

Where,

g = gravity (9.8 m/s^2);

β = 0.8

A_0 = the surface area of the pit;

H = the total depth;

$S(z)$ = salinity as a function of depth;

$\bar{S}$ = the average salinity;

z = the depth from the surface; and,

$A(z)$ = area of the pit as a function of depth.

$$Meromictic\ ratio = \frac{St_S^*}{\Delta St_S}$$

Equation (4)

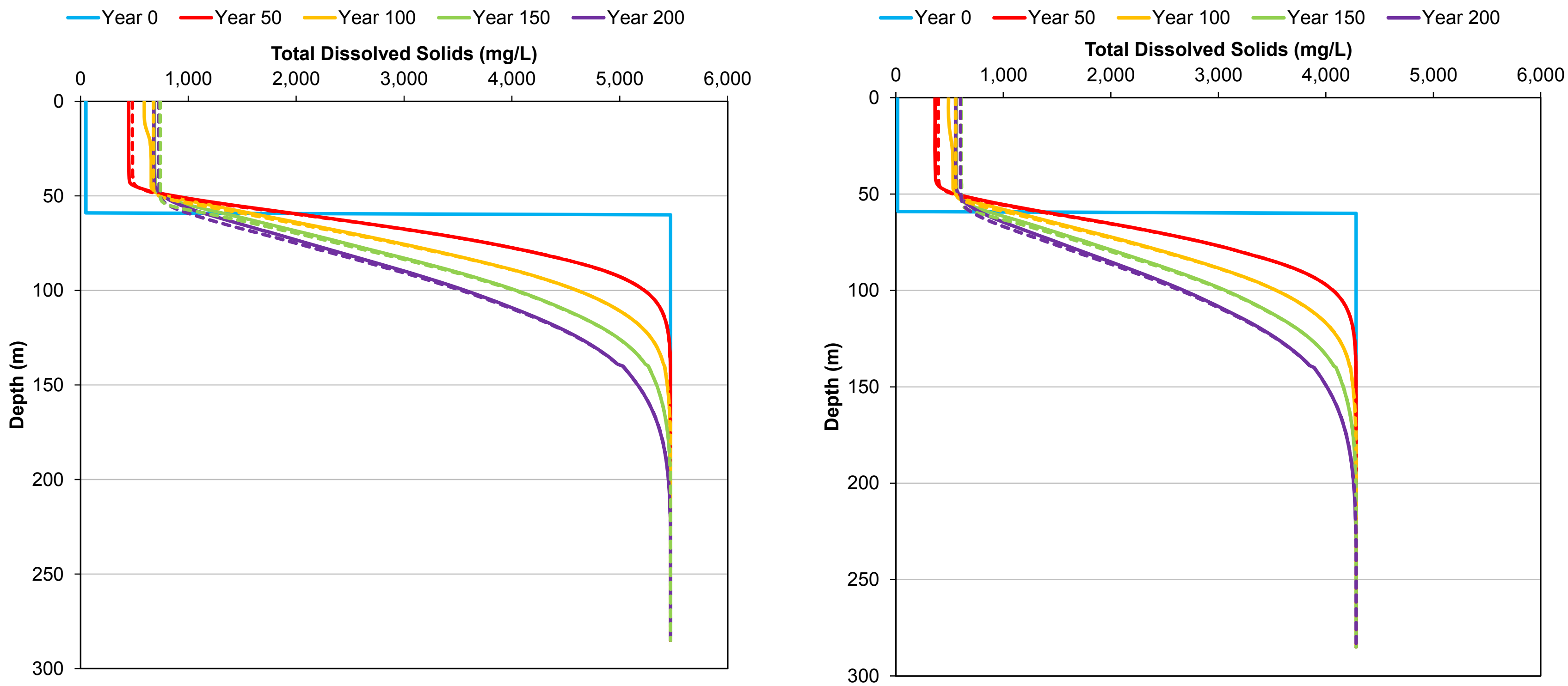
Where,

St^*_S = the salinity stability in late August (end of the warming period); and,

ΔSt_S = changes in salinity stability over the fall.

The salt deficit ratios (Table 8-1) and the meromictic ratios (Table 8-2) for Misery Pit and Jay Pit support predictions that these pit lakes will remain stratified during the entire 200-year simulation period. The salt deficit ratios in these lakes are very large because of the large volume of water in the mixolimnion. For comparison, Faro Pit and Waterline Pit lakes were observed to be meromictic; these pit lakes had salt deficit ratios of 10 (Pieters and Lawrence 2014). The higher the salt deficit ratio, the more likely the lake is to be meromictic. The salt deficit ratios for Misery Pit and Jay Pit are much greater than 10. In Rescan (2013), Faro Pit lake was classified as meromictic and it had a meromictic ratio of approximately 35. Waterline Pit and Zone 2 Pit lakes were classified as weakly meromictic and had meromictic ratios of 15 and 8, respectively. The higher the meromictic ratio, the more likely the lake is to be meromictic. The meromictic ratios for Misery Pit and Jay Pit are much greater than 35, which also supports the prediction that these lakes will be meromictic.

Figure 8-1 Predicted Total Dissolved Solids Profiles over a 200 Year Period after Closure of Misery Pit with and without Salt Exclusion during Ice Formation

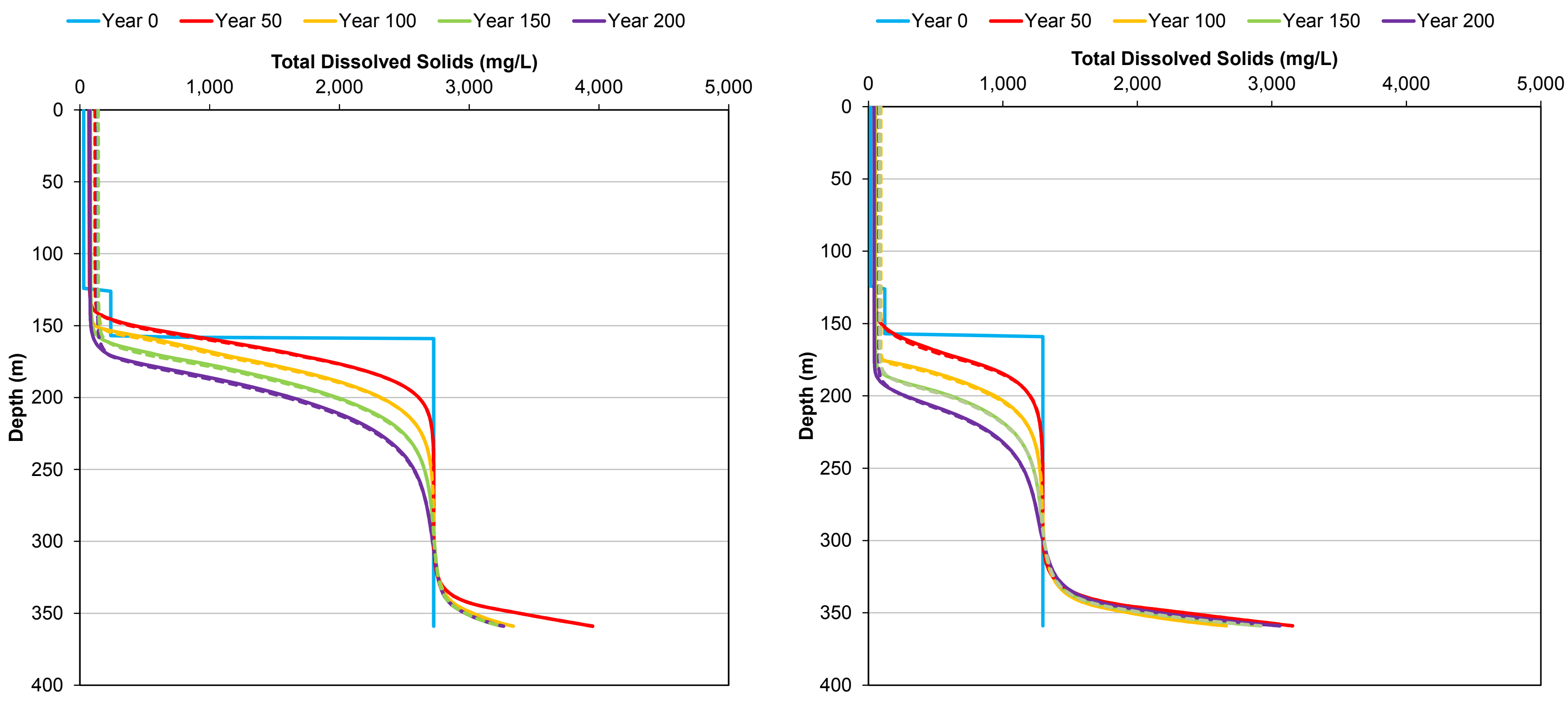


(a) Updated Assessment Case

(b) Reasonable Estimate Case

Note: Solid lines = salt exclusion; dashed lines = no salt exclusion.
mg/L = milligrams per litre; m = metre.

Figure 8-2 Predicted Total Dissolved Solids Profiles over a 200 Year Period after Closure of Jay Pit with and without Salt Exclusion during Ice Formation



(a) Updated Assessment Case

(b) Reasonable Estimate Case

Note: Solid lines = salt exclusion; dashed lines = no salt exclusion.
mg/L = milligrams per litre; m = metre.

Table 8-1 Predicted Salt Deficit Ratios[a]

Salt Deficit[a]	Updated Assessment Case		Reasonable Estimate Case	
	Misery Pit	Jay Pit	Misery Pit	Jay Pit
Year 0	2,655	3,870	5,789	7,980
Year 200	300	768	290	1,401

[a] The salt deficit ratios were calculated using a black ice thickness (i.e., h_i) of 1.5 m and a salt exclusion factor (i.e., f_b) of 1.

Table 8-2 Predicted Salinity Stabilities and Meromictic Ratios

Pit	Updated Assessment Case			
	Year	St_S^* (J/m^2)	ΔSt_S (J/m^2)	Meromictic Ratio
Misery	0	131,623	54	2,416
	200	117,949	214	552
Jay	0	22,854	37	610
	200	16,114	18	872
	Reasonable Estimate Case			
Misery	0	103,531	34	3,037
	200	91,663	184	497
Jay	0	10,891	24	457
	200	6,409	9.6	669

J/m^2 = joules per square metre; St^*_S = the salinity stability in late August; ΔSt_S = changes in salinity stability over the fall.

References:

Golder (Golder Associates Ltd.). 2015. Jay Project - Compendium of Supplemental Water Quality Modelling. Submitted to Mackenzie Valley Environmental Impact Review Board. April 2015.

Pieters P, Lawrence GA. 2014. Physical processes and meromixis in pit lakes subject to ice cover. Canadian Journal of Civil Engineering, 41: 569-578. www.dx.doi.org/10.1139/cjce-2012-0132

Rescan (Rescan Environmental Services Ltd.). 2013. EKATI Diamond Mine: Modelling Predictions for Water Quality of Pit Lakes. Prepared for BHP Billiton Canada Inc. by Rescan Environmental Services Ltd.: Yellowknife, NWT, Canada.

Information Request Number:	DAR-GNWT-IR2-09
Source:	Government of Northwest Territories – Lands Information Requests from Melissa Pink
Subject:	Hydrogeologic Monitoring During Operations and Post-Closure
DAR Section(s):	8.8; Round 1 Information Request Response DAR-GWNT-IR-11

Preamble (GNWT):

Section 8 of the DAR and Information Request #DAR-GWNT-IR-11 included discussion on the topic of hydrogeologic monitoring for the Jay Project. Within Section 8.8 of the DAR, DDEC outlines the broad objectives associated with the proposed groundwater monitoring program. The scope includes water quantity and quality monitoring at the following:

- Groundwater inflows to the open pit
- Seepage mapping at the open pit (preferential pathways)
- Westbay multi-level monitoring well near Jay Pit

DDEC has noted that the monitoring programs are proposed to address the uncertainties associated with the effect predictions and performance of environmental design features and mitigation measures, which will allow analysis to confirm effects predictions, identify unanticipated effects and provide for the implementation of adaptive management.

Section 8.8 of the DAR also states that modification to the proposed monitoring schedule would be based on a comparison of the monitored information to the predicted values. If the observed values or changes are less than predicted, then the intervals between monitoring events would likely be increased (i.e., less frequently sampled). If the observed values or changes are greater than predicted, then the monitoring will continue as deemed necessary.

The proposed monitoring to evaluate impact predictions for the Panda, Koala and Misery Pits, which are the proposed disposal sites for processed kimberlite and saline groundwater inflows from the Jay Pit, are uncertain. It is unclear if there is a proposed scope of groundwater monitoring that:

- Includes the Panda and Koala Pits, which are proposed to receive processed kimberlite generated from the Jay Project.
- Includes a duration at all monitoring areas that encompasses the entire period of EA predictions from construction through post closure.

Request (GNWT):

GNWT requests that DDEC address the following hydrogeologic monitoring items:

1. Provide additional details regarding any hydrogeological monitoring program proposed related to the Panda, Koala and Misery Pits.
2. Provide additional details regarding the duration of proposed hydrogeological monitoring for the Jay, Panda, Koala and Misery Pits. The response shall address if the duration of monitoring will extend throughout the impact prediction duration and include phases such as operations, establishment of meromixis within the open pits, and post closure conditions.
3. DDEC to commit to including in the appropriate monitoring and/or adaptive management plan, the final details of the groundwater monitoring programs, such as measurement frequencies, reporting requirements, and establishment of pre-defined action levels or thresholds which are linked to key mitigation techniques (such as calibration of numerical models and re-evaluation of initial predictions).

Response:

Groundwater is not currently used for drinking water or any project-related use in the Jay Project (Project) area. However, groundwater is a valued component due to the contribution of groundwater to the water quality of lakes and streams (Developer's Assessment Report [DAR] Section 8.1.3). Therefore, the hydrogeological monitoring plan at the Jay, Koala, Panda, and Misery pits is intended to connect the monitoring plan to the concern to regulators, communities, and Dominion Diamond – that being the impact on surface water quality of possible changes in the quantity or quality of groundwater discharge to surface water. Consequently, Dominion Diamond will rely on monitoring of pit lake and surface water quality to assess the effects of changes to groundwater flow or quality on the environment.

During mining and during an initial period of pit lake development, the open pit will act as a sink for groundwater flow and groundwater flow will be directed into the pit. Groundwater quality would then be assessed by the quality of the inflow and/or the pit lake quality.

During post-closure, density gradients will become more important and due to the buoyancy of lower density freshwater, groundwater flow originating from the pit lakes or mine pore water would not likely discharge to nearby lower elevation lakes underlain by open taliks in observable quantities. Although groundwater recharge and discharge are expected to occur within open taliks beneath the pit lakes, these fluxes are expected to be many times less than surface water inputs (DAR Section 8). As discussed in the Hydrogeology Baseline (Annex IX of the DAR), the total dissolved solids (TDS) of groundwater (or salinity) is expected to increase with depth resulting in increased density of groundwater with depth. This increase in density with depth will result in fluid density gradients that counteract the upward gradients to lower elevation lakes, as the less dense fresher water will have greater buoyancy than deeper saline groundwater (Post et al. 2007). During the post-closure period, monitoring of the surface water quality for indicators of groundwater from the pit lakes and/or mine pore water would be monitored to assess the effects of groundwater discharge to surface water on the environment.

1. Hydrogeological monitoring at the Koala and Panda pits will consist of the following:

- During mining operations at the Jay Pit, the Koala and Panda pits are filled with processed kimberlite (PK) and allowed to flood. The presence of fine PK in the underground workings will restrict potential groundwater movement as compared to the current closure plan of water-only backfilling. As the water level in the pits will be below the level of local lakes underlain by open taliks, groundwater flow, if present, would be towards the Panda and Koala underground workings (which intersect the deep groundwater regime). During this period, when safe access to the water level in the pits is available, physico-chemical pit profile measurements will be collected, including water samples from the water column, approximately twice a year.
- At closure, the water level of the (combined) Panda/Koala pit lake will be greater (less than 3 metres) than the receiving waterbody (Kodiak Lake). This gradient in hydraulic head could conceptually result in groundwater flow from the underground workings to the deep groundwater regime. This is considered unlikely to occur in measureable quantities because of the very low head differential and because PK solids will have filled the underground workings, further reducing the possibility of groundwater interaction. As presented in the response to Round 1 information request DAR-GNWT-IR-11, Dominion Diamond estimated that the likely groundwater flow path from the flooded pits would be in a southwest direction towards Kodiak Lake. Consequently, the closure water quality monitoring program will include monitoring of Kodiak Lake at various depths in the water column.

Hydrogeological monitoring for the Misery Pit will be conducted to confirm the predicted development of the meromixis in the Misery Pit. Water quality samples will be collected and water column profiles (e.g., electrical conductivity [EC] and temperature) will be measured twice per year during operations when safe access to the water level in the pit is available. A Misery Pit-specific correlation between EC and TDS/chloride will be established based on this monitoring, and based on initial results, Dominion Diamond will consider deploying EC probes at various depths in the water column for continuous EC measurement recorded on dataloggers.

Results of the hydrogeological assessment (DAR Appendix 8C), indicate that seepage from the Misery Pit Lake could reach the bottom of Lac de Gras within 10 years after closure. However, this discharge is predicted to be very low at 0.003% of the overall surface water balance for this lake, and consequently this was classified as a secondary pathway with minor residual effects (DAR Section 8.4.2.4.2). Consequently, the closure water quality monitoring program will include monitoring of Lac de Gras in the vicinity of the conceptual groundwater inflow.

2. Pit monitoring for Jay, Panda, Koala, and Misery pits will be undertaken throughout mine operations, during closure, and for some period post-closure. Consistent with the approved Ekati Mine Interim Closure and Reclamation Plan, monitoring is conceptually planned for a nominal ten-year period post-closure. The monitoring programs will be expected to evolve over time based on results and circumstances, as regulated by the Wek'èezhìı Land and Water Board.

3. The Ekati Mine water monitoring plans and response framework that are approved and regulated by the Wek'èezhìi Land and Water Board are planned to be amended to incorporate the Jay Project. Those plans will include final details on groundwater monitoring programs that will

include recommendations on measurement frequencies, reporting requirements, and action levels. Also see the response to DAR-GNWT-IR2-10.

References:

Post V, Kooi H, Simmons C. 2007. Using hydraulic head measurements in variable-density ground water flow analyses. Ground Water—November-December 2007. Vol. 45, No. 6: 664–671.

DOMINION DIAMOND

Information Request Number:	DAR-GNWT-IR2-10
Source:	Government of Northwest Territories - Lands Information Requests from Melissa Pink
Subject:	Calibration of the 3-D Hydrogeologic Model
DAR Section(s):	8.8; Appendix 8A

Preamble (GNWT):

Section 8.8 of the DAR entitled Follow-up and Monitoring, provides a broad discussion of proposed monitoring programs, and states that monitoring will be used to verify the effects predictions. DDEC also proposes that if monitoring results indicate effects that are different from predicted effects, or the requirement for additional mitigation measures, then adaptive management will be implemented. Additionally, special studies intended to supplement monitoring data would be considered.

A 3-D hydrogeological model was applied to predict inflow water quality and mine inflows during operations. Various assumptions were applied to model this system as a result of the availability of information pre-mining. During mine operation, hydrogeologic data are proposed to be collected and compared to predicted effects. Thus, there will be an opportunity to improve the predictions of the 3D hydrogeological model after mining commences, should the hydrogeologic monitoring data support the need to re-calibrate the 3-D model.

As was noted during the Technical Sessions, re-calibration of the mine inflow model for the Diavik site was warranted after mining commenced, in part due to higher measured pit inflows than initially predicted. Thus hydrogeological model refinement, after the environmental assessment predictions have been completed, has been applied to other mine sites in a similar hydrogeologic setting.

It is unclear if, or when, an evaluation of the 3-D hydrogeological model's performance will occur, and what action levels or thresholds will be established to refine the initial 3-D model in order improve prediction confidence and better mitigate against significant unexpected impacts.

Request (GNWT):

The GNWT requests:

1. DDEC provide additional information with regards to the approach to evaluate if the 3 D hydrogeological model will require re-calibration. The response shall include discussion related to the action levels or thresholds to trigger the re-calibration of the 3- D model. For example and where permissible, the action levels or thresholds could be related to a measured variance from the DAR predictions or a pre-determined phase/year of pit development.

2. DDEC commit to including in the appropriate adaptive management plan, the final action levels or thresholds that would trigger the re-calibration of the 3-D hydrogeological model.

Response:

1. and 2.

Dominion Diamond anticipates that the hydrogeological models for the Jay and Misery pits will be calibrated to site-specific data and re-run based on the monitoring data collected through operations at the Jay Pit. This update would be planned prior to the initiation of minewater discharge from the Misery Pit to Lac du Sauvage (5 to 6 years into mine operations). This timeframe provides adequate time for establishing a good database of site-specific information and provides for updated predictions in Misery Pit prior to discharge, and in the Jay Pit after closure.

Updates to one or both of the hydrogeological models would also be considered over the life of the Jay Project (i.e., initial, late operational, or closure phases), if site-specific data were unacceptably different than predicted. Action levels will be developed during the licensing and permitting phase of the Jay Project, which if reached, would as one likely response, trigger the re-calibration of one or both of the three-dimensional hydrogeological models, either in advance of the Misery Pit discharge period, during the discharge period, or during the Jay back-flooding period, depending on monitoring data.

Consistent with other northern diamond mine operations, it is anticipated that action levels associated with groundwater management could be based on variance of measured groundwater inflow rates and chemistry (i.e., quantity and quality, such that inflow rates and/or chemistry are notably different [e.g., greater] than predicted for a given duration of time) to the Developer’s Assessment Report or updated predictions. These action levels will be clearly specified in the appropriate adaptive management plan.

Information Request Number:	DAR-GNWT-IR2-11
Source:	Government of Northwest Territories - Lands Information Requests from Melissa Pink
Subject:	Sediment and Water Quality
DAR Section(s):	Round 1 Information Request Response DAR-GNWT-IR-60

Preamble (GNWT):

In the first round of Information Requests, the Government of Northwest Territories requested "that DDEC provide either the analyses using the latest sampling results or the raw data in order to determine whether changes in sediment quality are occurring in Lac du Sauvage". DDEC complied by providing some analyses (DDEC, 2015, DAR-GNWT-IR-60) but stated in reference to 2014 data that "those data are not yet published". Since that time, the DDEC Jay Project 2014 Water and Sediment Quality Supplemental Baseline Report, April 2015 was released.

Request (GNWT):

GNWT requests that the data presented in Appendix D Water Quality Data and Appendix E Sediment Quality Data of this report are provided in electronic format to confirm conclusions reached by DDEC. Additionally, all available metal, ions, nutrient, hydrocarbon, PCDD and PCDF sediment data for Lac du Sauvage are requested in electronic format.

Response:

Water and sediment quality data collected during the 2014 baseline study are provided in electronic format (Excel) in file DAR-GNWT-IR2-11(Supporting Excel File).xlsx (Tables 11-1 to 11-21).

All available sediment quality data collected from Lac du Sauvage, which were used for the DAR and subsequent reporting, are provided in electronic format (Excel) in file DAR-GNWT-IR2-11(Supporting Excel File).xlsx (Table 11-22).

Where applicable, summary water quality and sediment quality data are provided in the Excel file.

List of Tables in the Supporting Excel File:

DOMINION DIAMOND

Information Request Number: DAR-GNWT-IR2-12

Source: GNWT-Lands Information Requests from Melissa Pink

Subject: Hydrocarbon Control

DAR Section(s): Section 1.2.4.1

Preamble (GNWT):

The Rio Tinto Diavik facility is experiencing fugitive losses of hydraulic fluids to such an extent that hydrocarbons are being detected in its mine water storage pond (i.e. North Inlet) and potentially in the receiving environment. This may be due to the failure of hydraulic seals due to low temperature operations. On February 19, 2014, the Wek'?ezh?i Land and Water Board provided a directive to Rio Tinto to modify the Operational Phase Contingency Plan to provide:

1. Descriptions of the specific source control measures that will be/have been put in place to minimize hydrocarbon contamination from the underground;
2. Detailed description of previous versus improved internal spill reporting procedures; and,
3. Hydrocarbon management performance tracking including a monitoring program.

Request (GNWT):

The Government of the Northwest Territories requests that DDEC provide impact predictions from hydrocarbon losses during operations and their plans to control hydrocarbon contamination and monitor losses to the receiving environment.

Response:

1) There are a number of established and effective hydrocarbon prevention and control measures in place at the Ekati Mine that would be applicable to the Jay Project. These are described in the Spill Response Plan and the Waste Management Plan (which includes the hydrocarbon-contaminated materials management plan), both of which are approved by the Wek'èezhìı Land and Water Board. The prevention and control measures include:

   - Hydrocarbon source control measured at the Ekati Mine operation, as well as in the underground, include a preventative maintenance schedule for operating equipment and proper training.
   - Around the Ekati Mine, and in the underground areas and shops, spill kits and equipment are available so spills can be immediately addressed and cleaned up before they have the chance to migrate into the sumps.
   - Temperatures in the underground are kept at working conditions so that hoses do not get too cold and brittle and break.
   - Daily equipment inspections are completed to identify any issues or weak areas that can be fixed before a break or spill occurs.

2) Improved spill reporting is a result of education campaigns, during site orientation for all staff and visitors, and annually for staff and Emergency Response Teams. In addition to the Government of the Northwest Territories spill reporting requirements, Dominion Diamond has developed an internal spill reporting database. Dominion Diamond requires all spills, no matter the size, be reported internally. This database incorporates reportable and non-reportable spills, and includes Ekati-specific information including the mine location where the spill occurred, department responsible for the spill, the root cause of the spill, and any required follow-up actions. Spill response, training, responsibilities, and reporting are outlined in the Spill Contingency Plan as approved by the Wek'èezhìi Land and Water Board.

   Effluent water quality is monitored prior to discharge as part of the Water Licence Surveillance Network Program. This identifies and prevents any unexpected hydrocarbon releases to the environment.

3) As discussed in Section 1.2.4.1 of the Developer's Assessment Report (DAR), an evaluation of spills that have occurred at the Ekati Mine has been completed with the overall intent to establish an understanding of past performance, as a means of anticipating future performance. This evaluation included hydrocarbon diesel fuel spills which accounted for 14% of the spills that were evaluated. As noted in the DAR, Dominion Diamond will look to build on this preliminary evaluation to identify improvements/modifications to spill prevention mechanisms that are currently in place.

Information Request Number:	DAR-GNWT-IR2-13
Source:	Government of Northwest Territories - Lands Information Requests from Melissa Pink
Subject:	Mercury
DAR Section(s):	8

Preamble (GNWT):

The Government of the Northwest Territories has reviewed the mercury concentrations in sediment within Lac du Sauvage from the baseline record. The GNWT notes that 72% of mercury concentrations in Lac du Sauvage exceed the selected Interim Sediment Quality Guideline (ISQG) and 2% exceed the selected Probably Effect Level (PEL).

The DAR is silent on whether the development of the Jay Pipe would alter the rate/frequency or the magnitude of mercury exceedences in sediment samples within Lac du Sauvage.

Request (GNWT):

The GNWT requests that DDEC:

1. Provide a description of potential sources of mercury from the Jay Pipe development and whether they may influence the existing mercury concentrations in the sediment in Lac du Sauvage.

2. Tabulate each sample location in Lac du Sauvage and clearly identify where mercury concentrations exceed the ISQG and PEL.

Response:

1. *Provide a description of potential sources of mercury from the Jay Pipe development and whether they may influence the existing mercury concentrations in the sediment in Lac du Sauvage.*

Potential sources of mercury from the Jay Project (Project) could include disturbance of sediment during dike construction (considered a secondary pathway in the effects assessment; Section 8.4.2.4.2 in the Developer's Assessment Report [DAR]) and minewater release to Lac du Sauvage (considered a primary pathway in the effects assessment; Section 8.5.4 in the DAR).

As described in the DAR (Section 8.4.3.2), sediment and erosion controls such as silt curtains will be used to reduce the transport of sediment from dike construction activities into Lac du Sauvage, and silt fences will be used to reduce the transport of sediment from general land-based land disturbance activities. These practices will be consistent with those used at the Ekati Mine. Through the use of silt curtains and timing of construction activities, construction of the dike in Lac du Sauvage was considered to have a minor effect on water and sediment quality, and thus this activity is not anticipated to influence mercury concentrations in the sediment in Lac du Sauvage.

As described in Appendix 8E of the Developer's Assessment Report (DAR), a site water quality model was developed to assess the range of water quality conditions of site discharges during dewatering, operations, and closure. In the model, each flow that could influence site discharge water quality for the Project was itemized and assigned a source term chemical profile based on geochemical testing of waste rock materials, observed mine site facility drainage at the Ekati Mine operations, and baseline surface and groundwater quality monitoring data.

The mercury source terms and concentrations used in the site model are summarized in Table 13-1 with a note on where the information was originally documented. Projected concentrations of mercury in minewater discharged from the Misery Pit are provided in Table 13-2. Maximum concentrations of total mercury in the minewater discharge are projected to be higher than the aquatic life guideline (0.026 µg/L; CCME 1999), but less than the drinking water quality guideline (1.0 µg/L; Health Canada 2012).

Table 13-1 Sources of Mercury included in the Mine Site Water Quality Model

Source of Mercury		Dissolved Mercury (mg/L)	Documented in:
Non-contact Runoff		0.00000025	DAR/Appendix 8E Table 3-1
Groundwater		0.000025	DAR/ Appendix 8E Table 3-3
Waste Rock Runoff (99th percentile)		0.000040	DAR/ Appendix 8E Table 3-4
Wall Rock (Humidity Cell Tests) Granite:	Freshet	0.000010	DAR/ Appendix 8E Table 3-6
	Steady-State	0.00050	
Wall Rock (Humidity Cell Tests) Kimberlite	Freshet	0.00010	
	Steady-State	0.00050	
Wall Rock (Humidity Cell Tests) Metasediment	Freshet	0.000010	
	Steady-State	0.00050	
Theoretical Particulate Concentrations	Misery Pit	0.000085	DAR/ Appendix 8E Table 3-7
	Jay WRSA	0.000075	
Jay Waste Rock Storage Area Runoff - Post-Closure (Maximum)		0.000040	DAR/ Appendix 8E Table 7-3

DAR = Developer's Assessment Report

Table 13-2 Predicted Mercury Concentration in Discharge from Misery Pit

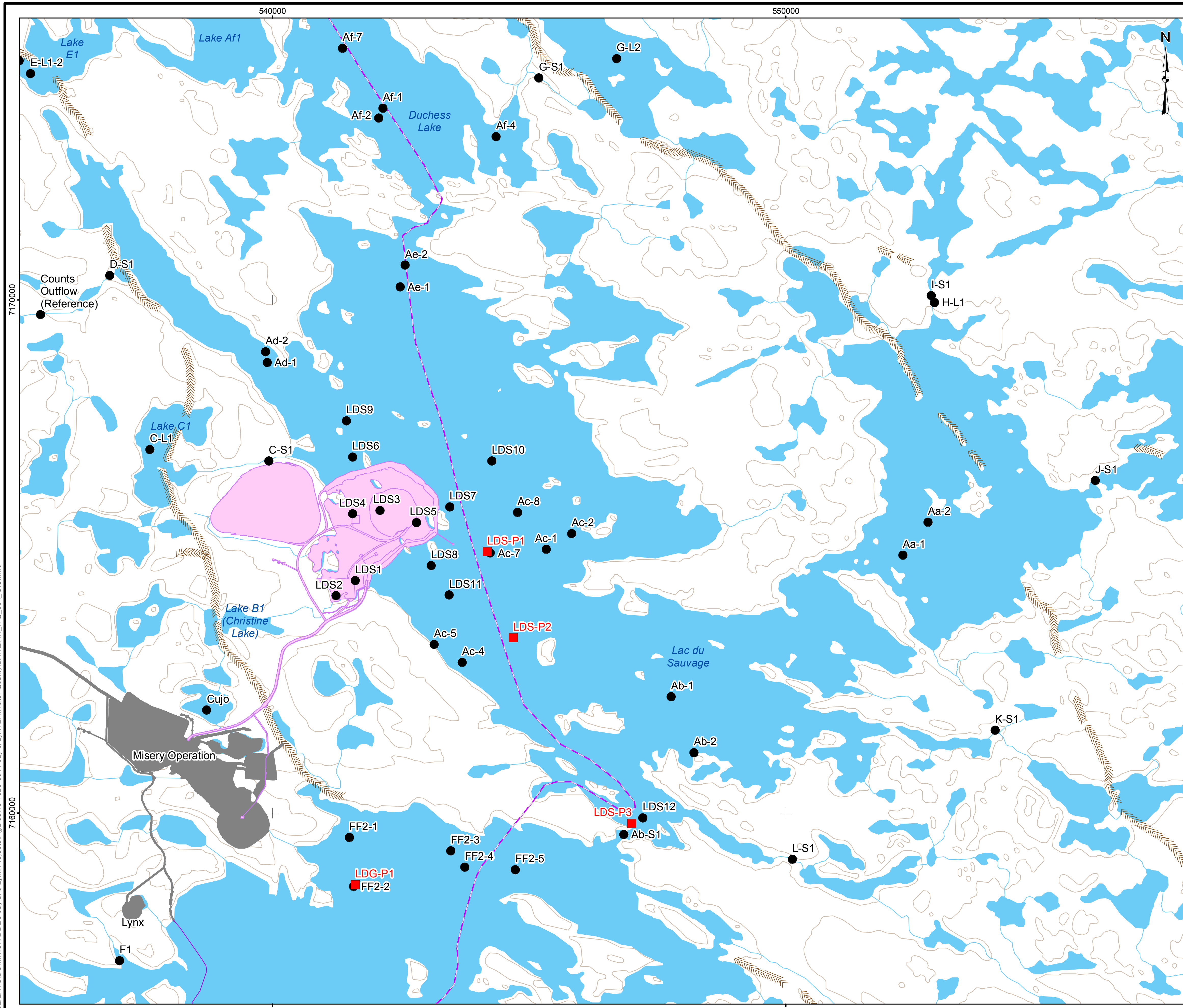
Model Scenarios			Dissolved Mercury (mg/L)	Total Mercury (mg/L)	Documented in:
Maximum Predicted Concentrations (Mean Daily Values) in Misery Pit Discharge to Lac du Sauvage	Operations - Post-Diavik Shutdown (2023 - 2030)	Under Ice	0.000024	0.000109	DAR/ Appendix 8E Table 7-1
		Open Water	0.000021	0.000105	
Maximum Predicted Concentrations (Mean Daily Values) in Misery Pit Overflow to Lac de Gras[(a)]	Post-Closure (>August 2032)	Under Ice	0.000084	0.000168	
		Open Water	0.000081	0.000166	
Maximum Concentrations (Mean Daily Values) in Post-Closure Discharges		Misery Pit Monimolimnion[(a)]	0.000024	-	DAR/ Appendix 8E Table 7-2
		Jay Pit Monimolimnion	0.000012	-	

[a)] This does not flow to Lac du Sauvage.

Projected mercury concentrations in water were modelled for Lac du Sauvage and Lac de Gras for all Project phases using lake hydrodynamic models. All concentrations are predicted to remain lower than the aquatic life guideline for mercury (Section 8.5.4 of the DAR). Based on the existing concentrations of mercury in the sediment of Lac du Sauvage (data shown in Table 13-3), and the predicted concentrations of mercury in the discharge water and within Lac du Sauvage during the discharge period, it is not anticipated that activities associated with the operation of the Project will influence sediment mercury concentrations in Lac du Sauvage.

2. *Tabulate each sample location in Lac du Sauvage and clearly identify where mercury concentrations exceed the ISQG and PEL.*

Baseline mercury sediment data considered in the DAR, and supplemental information requests, are provided in Table 13-3. The range of sediment mercury concentrations in Lac du Sauvage is 0.0062 to 5.6 mg/kg as dry weight (dw), with a median value of 0.017 mg/kg dw (n = 59). Exceedances to CCME (2001) Interim Sediment Quality Guidelines (ISQG; 0.17 mg/kg dw) for mercury were measured in two samples collected from station LDS3 in 2006; exceedances to CCME Probable Effects Levels (PEL; 0.486 mg/kg dw) for mercury were measured in one sample collected from station LDS3 in 2006 (shown on Map 8.5-1 in the DAR and Map 13-1, provided below).



LEGEND

- EKATI MINE FOOTPRINT
- PROPOSED JAY FOOTPRINT
- WINTER ROAD
- TIBBITT TO CONTWOYTO WINTER ROAD
- NORTHERN PORTION OF TIBBITT TO CONTWOYTO WINTER ROAD
- ELEVATION CONTOUR (20 m INTERVAL)
- ESKER
- WATERCOURSE
- WATERBODY
- BASELINE STATION
- ASSESSMENT LOCATION

REFERENCE

NATIONAL TOPOGRAPHIC BASE DATA (NTDB) 1:250,000
CANVEC © NATURAL RESOURCES CANADA, 2012
NATURAL RESOURCES CANADA, CENTRE FOR TOPOGRAPHIC INFORMATION, 2012
DATUM: NAD83 PROJECTION: UTM ZONE 12N

DOCUMENT

DEVELOPER'S ASSESSMENT REPORT

3 0 3

SCALE 1:75,000 KILOMETRES

PROJECT

DOMINION DIAMOND

JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE

ASSESSMENT LOCATIONS AND BASELINE STATIONS IN LAC DU SAUVAGE

Golder Associates

PROJECT	13-1328-0041		FILE No. DAR_WQ_004_GIS	
DESIGN	CP	14/08/14	SCALE AS SHOWN	REV 0
GIS	JG	16/10/14	MAP 13-1	
CHECK	CP	16/10/14		
REVIEW	KM	16/10/14		

G:\CLIENTS\DOMINION\DDEC Jay and Lynx Projects\Figures\13-1328-0041 Jay & Lynx EA\Water Quality\DAR\DAR_WQ_004_GIS.mxd

Table 13-3 Surficial Sediment Mercury Data for Lac du Sauvage (2006 to 2014)

Source	Station	Sample Method	Sampling Date	Easting (NAD 83, 12W)	Northing (NAD 83, 12W)	Mercury (µg/g dw)[(a)]
Rescan (2007)	LdS1(1)	Ekman	1-Aug-06	541616	7164530	0.048
Rescan (2007)	LdS1(2)	Ekman	1-Aug-06	541616	7164530	0.011
Rescan (2007)	LdS1(3)	Ekman	1-Aug-06	541616	7164530	0.026
Rescan (2007)	LdS2(1)	Ekman	3-Aug-06	541240	7164235	0.0062
Rescan (2007)	LdS2(2)	Ekman	3-Aug-06	541240	7164235	<0.005
Rescan (2007)	LdS2(3)	Ekman	3-Aug-06	541240	7164235	<0.005
Rescan (2007)	LdS3(1)	Ekman	1-Aug-06	542100	7165897	**5.6**[(I, P)]
Rescan (2007)	LdS3(2)	Ekman	1-Aug-06	542100	7165897	**0.29**[(I)]
Rescan (2007)	LdS3(3)	Ekman	1-Aug-06	542100	7165897	0.11
Rescan (2007)	LdS4(1)	Ekman	1-Aug-06	541562	7165829	0.079
Rescan (2007)	LdS4(2)	Ekman	1-Aug-06	541562	7165829	0.042
Rescan (2007)	LdS4(3)	Ekman	1-Aug-06	541562	7165829	0.02
Rescan (2007)	LdS5(1)	Ekman	5-Aug-06	542807	7165661	0.028
Rescan (2007)	LdS5(2)	Ekman	5-Aug-06	542807	7165661	0.018
Rescan (2007)	LdS5(3)	Ekman	5-Aug-06	542807	7165661	0.012
Rescan (2007)	LdS6(1)	Ekman	3-Aug-06	541561	7166937	0.024
Rescan (2007)	LdS6(2)	Ekman	3-Aug-06	541561	7166937	0.016
Rescan (2007)	LdS6(3)	Ekman	3-Aug-06	541561	7166937	0.037
Rescan (2007)	LdS7(1)	Ekman	3-Aug-06	543454	7165968	0.045
Rescan (2007)	LdS8(1)	Ekman	5-Aug-06	543092	7164820	0.023
Rescan (2007)	LdS8(2)	Ekman	5-Aug-06	543092	7164820	0.034
Rescan (2007)	LdS8(3)	Ekman	5-Aug-06	543092	7164820	0.02
Rescan (2007)	LdS10(1)	Ekman	3-Aug-06	544277	7166862	0.026
Rescan (2007)	LdS10(2)	Ekman	3-Aug-06	544277	7166862	0.029
Rescan (2007)	LdS10(3)	Ekman	3-Aug-06	544277	7166862	0.088
Rescan (2007)	LdS11(1)	Ekman	3-Aug-06	543447	7164247	0.055
Rescan (2007)	LdS11(2)	Ekman	3-Aug-06	543447	7164247	0.007
Rescan (2007)	LdS11(3)	Ekman	3-Aug-06	543447	7164247	0.039
Rescan (2007)	LdS12(1)	Ekman	3-Aug-06	547219	7159909	0.011
Rescan (2007)	LdS12(2)	Ekman	3-Aug-06	547219	7159909	0.017
Rescan (2007)	LdS12(3)	Ekman	3-Aug-06	547219	7159909	0.0073
Rescan (2012)	LdS1 (1)	Ekman	14-Aug-11	541616	7164530	0.015
Rescan (2012)	LdS1(2)	Ekman	14-Aug-11	541616	7164530	0.013
Rescan (2012)	LdS1(3)	Ekman	14-Aug-11	541616	7164530	0.011
Rescan (2012)	LdS1(1) 1 cm	Core	14-Aug-11	541616	7164530	0.015
Rescan (2012)	LdS1(2) 1 cm	Core	14-Aug-11	541616	7164530	0.014
Rescan (2012)	LdS1(3) 1 cm	Core	14-Aug-11	541616	7164530	0.014
Rescan (2012)	LdS1(1) 2 cm	Core	14-Aug-11	541616	7164530	0.011
Rescan (2012)	LdS1(2) 2 cm	Core	14-Aug-11	541616	7164530	0.012
Rescan (2012)	LdS1(3) 2 cm	Core	14-Aug-11	541616	7164530	0.01
Dominion Diamond (2014)	Aa-1	Ekman	27-Aug-13	552282	7165025	0.017
Dominion Diamond (2014)	Aa-2	Ekman	27-Aug-13	542589	7170675	0.013
Dominion Diamond (2014)	Ab-1	Ekman	26-Aug-13	547766	7162266	0.024
Dominion Diamond (2014)	Ab-2	Ekman	26-Aug-13	548215	7161177	0.026
Dominion Diamond (2014)	Ac-1	Ekman	25-Aug-13	543339	7165138	0.014
Dominion Diamond (2014)	Ac-2	Ekman	25-Aug-13	545832	7165447	0.006
Dominion Diamond (2014)	Ac-4	Ekman	19-Aug-13	543695	7162938	0.024

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Table 13-3 Surficial Sediment Mercury Data for Lac du Sauvage (2006 to 2014)

Source	Station	Sample Method	Sampling Date	Easting (NAD 83, 12W)	Northing (NAD 83, 12W)	Mercury (µg/g dw)[(a)]
Dominion Diamond (2014)	Ac-5	Ekman	19-Aug-13	543149	7163287	0.031
Dominion Diamond (2014)	Ac-7	Ekman	24-Aug-13	544247	7165068	0.028
Dominion Diamond (2014)	Ac-8	Ekman	24-Aug-13	544777	7165855	0.011
Dominion Diamond (2014)	Ad-1	Ekman	17-Aug-13	539898	7168781	0.036
Dominion Diamond (2014)	Ad-2	Ekman	17-Aug-13	539868	7168991	0.012
Dominion Diamond (2014)	Ae-1	Ekman	18-Aug-13	542494	7170252	0.014
Dominion Diamond (2014)	Ae-2	Ekman	16-Aug-13	542589	7170675	0.010
Dominion Diamond (2015)	Aa-1	Ekman	12-Sep-14	552282	7165025	0.012
Dominion Diamond (2015)	Ab-1	Ekman	11-Sep-14	547766	7162266	0.019
Dominion Diamond (2015)	Ac-1	Ekman	11-Sep-14	543339	7165138	0.014
Dominion Diamond (2015)	Ac-4	Ekman	9-Sep-14	543695	7162938	0.018
Dominion Diamond (2015)	Ac-7	Ekman	9-Sep-14	544247	7165068	0.016
Dominion Diamond (2015)	Ad-1	Ekman	5-Sep-14	539898	7168781	0.016
Dominion Diamond (2015)	Ae-1	Ekman	8-Sep-14	542494	7170252	0.014

Sources: Rescan (2007, 2012), Dominion Diamond (2014, 2015).

Note:

[(a)] Results are from a composite sample collected at each station; unless otherwise indicated in the station name, the sample was collected from the top 5 cm.

Bolded concentrations are higher than sediment quality guidelines.

[(I)] value higher than the Interim Sediment Quality Guideline (CCME 2001).

[(P)] value higher than the Probable Effects Level (CCME 2001).

m = metre; µg/g dw = micrograms per gram as dry weight; NAD = North American Datum; <= less than.

References:

CCME (Canadian Council of Ministers of the Environment). 1999. Canadian Environmental Quality Guidelines, with updates to 2014. Publication No. 1299. Winnipeg, MB, Canada. ISBN: 1-896997-34-1.

CCME (Canadian Council of Ministers of the Environment). 2001. Canadian Sediment Quality Guidelines for the Protection of Aquatic Life: Introduction. Updated. Canadian Environmental Quality Guidelines, 1999. Winnipeg, MB, Canada.

Health Canada. 2012. Summary of Guidelines for Canadian Drinking Water Quality (CDWQ). Prepared by the Federal-Provincial Subcommittee on Drinking Water of the Federal-Provincial-Territorial Committee on Environmental and Occupational Health. Ottawa, ON, Canada.

Rescan (Rescan Environmental Services Ltd.). 2007. Ekati Diamond Mine 2006 Jay Pipe Aquatic Baseline. Prepared for BHP Billiton Canada Inc. Yellowknife, NWT, Canada.

Rescan. 2012. Ekati Diamond Mine 2011 Aquatic Effects Monitoring Program Annual Report. Prepared for BHP Billiton Canada Inc. Yellowknife, NWT, Canada.

Dominion Diamond (Dominion Diamond Ekati Corporation). 2014. Developers Assessment Report for the Jay Project, Annex XI Water and Sediment Quality Baseline. November 2014

Dominion Diamond. 2015. 2014 Water and Sediment Quality Supplemental Baseline Report for the Jay Project. Prepared by Golder Associates Ltd., April 2015. Yellowknife, NWT, Canada.

DOMINION DIAMOND

Information Request Number: DAR-GNWT-IR2-14

Source: GNWT-Lands Information Requests from Melissa Pink

Subject: Jay Pipe Dike Geotechnical Investigations

DAR Section(s): Pre-Feasiblity Design Report: 3.7. 3.8, 4.2, 4.2.2, 4.2.4, 15.0

Preamble (GNWT):

Sections 3.7, 3.8, 4.2, 4.2.2, and 4.2.4 of the pre-feasibility design report for the Jay Dike (Golder, 2014) noted gaps in geotechnical information performed in 2014, including unreliable (Section 3.8, page 6) ground penetration radar (GPR) survey that did not correlate well to drilling data to delineate the contact between lakebed sediment and competent soil and bedrock contact. Additionally the pre-feasibility design report noted recommendations for future work that included additional geotechnical investigations. From the pre-feasibility report, these recommendations include:

- An underwater visual assessment comprising photographs and video of the lakebed surface should be carried out along the Jay Dike alignment. This will provide an indication of the number of cobbles and boulders visible on the lakebed surface.
- A cone penetration test (CPT) program should be carried out to better characterize the geotechnical parameters of the lakebed sediment and fine-grained competent soil. It is assumed that the CPT will reach refusal in the competent soil/till, due to the higher density and granular nature of this material. To perform CPTs in the fine-grained competent till, pre-drilling through the granular competent soil may be required. The CPT data will be used to refine interpreted material thickness and assumed material properties. The CPTs can be carried in combination with the sonic drilling.
- Closely spaced bedrock profile drilling should be carried out to evaluate lakebed soil thickness and bedrock depth. An air track rotary percussive drill rig (i.e., Sandvik DX500, formerly known as the Tamrock Ranger 500) could be used to determine the depth of bedrock.
- Drilling and coring along the dike alignment should be carried out using a sonic drill rig in areas where air track drilling is not possible, which will generally be in intermediate and deeper zones, to obtain stratigraphic information and characterization of the underlying lakebed soils. As part of the drilling, downhole hydrogeological testing is to be carried out at select locations within the bedrock and select samples collected for geotechnical laboratory testing.
- Diamond drilling (HQ3, triple-tube system) should be carried out to characterize shallow bedrock and conduct hydrogeological testing (slug injection, slug withdrawal, and constant rate injection) in the bedrock using pneumatic packers. Testing would be carried out over shorter intervals of the shallow bedrock would be tested to characterize changes in the permeability of the shallow bedrock.
- Additional bedrock drilling could be conducted to assess or characterize the presence of bedrock structures with the potential to have higher hydraulic conductivity (i.e., faults).

- Installation of thermistor strings at select islands and abutments along the dike alignment is recommended. The data obtained from the thermistors will help to better understand the ground thermal profile changes with time.
- Geotechnical laboratory testing of samples collected during sonic drilling should be conducted.
- Sonic drilling and sampling should be performed within the proposed Lynx pit pre-stripping area. This material is intended to characterize and estimate the quantity and quality of competent soil material available. Representative samples of competent soil obtained from Lynx drilling will be used to carry out mix design testing for the Cement Soil Bentonite (CSB) backfill.
- As an interim measure, mix design testing with competent soil obtained from stripping of the Pigeon Pit will be used for initial mix design testing.
- Crushed waste rock material should be evaluated for use as fine filter and coarse filter.

Additionally, Golder (2014) also stated within Section 15.0 that, “In support of the recommendations for future work, Golder has proposed to Dominion Diamond a winter 2015 geotechnical and hydrogeological investigation program which includes borehole locations, drilling equipment, on-site field testing, instrumentation, and geotechnical laboratory testing for the Jay Dike and Lynx Pit pre-stripping projects. Refer to the draft Winter 2015 Jay Dike Geotechnical and Hydrogeological Investigation Program report for further details regarding the proposed investigation (Golder 2014i).

The results of the 2015 winter geotechnical investigation should be used to refine the interpreted stratigraphy along the dike alignment. Furthermore, the assumptions used in the pre-feasibility design analyses should be compared with the geotechnical investigation results and additional analyses be performed as necessary.”

Request (GNWT):

GNWT recommends that DDEC provide clarification on whether they have committed to the geotechnical investigation recommendations described in the pre-feasibility design report for the Jay Dike (Golder, 2014) to aid in the final design of the dike.

Response:

Yes. Please see response to Homework item #1 from Jay Technical Sessions.

This information request is similar to the request made by Mr. Brian Watts, retained by the Mackenzie Valley Environmental Impact Review Board as a reviewer, during the Jay Technical Sessions held on April 20, 2015 (Day 1). Dominion Diamond took the request as Homework Assignment #1, and provided a response on April 21, 2015 (Jay Technical Sessions, Day 2, pages 20-21 of the transcript).

Section 15 of the Jay Project Pre-feasibility Dike Design Report (Golder 2014), dated December 8, 2014, provided recommendations for future work to advance the dike design to a detailed design level.

The recommendations were organized under two (2) headings:

1) Evaluation of foundation conditons, and
2) Evaluation of potential construction materials.

All recommendations related to foundation conditions (heading one), have been completed as part of the 2015 winter investigation program, with the exception of the first recommendation. This recommendation involves conducting an underwater visual assessment of the lakebed surface for the presence of cobbles and boulders. Dominion Diamond has committed to carrying out this work once ice on Lac du Sauvage has melted. This work will be done during the summer of 2015.

In terms of the recommendations related to construction materials (heading two), mix design testing for the cement-soil-bentonite, using till samples obtained from the Pigeon Pit have been completed. Additional till samples will be collected from Lynx Pit pre-stripping operations, and further testing conducted. Sufficient information from the testing carried out on the samples obtained from the Pigeon Pit exists to support detailed design.

Once a crusher contractor is selected to produce the fine and coarse filter materials, then samples will be collected and testing conducted. This testing is not required for the detailed design, but will form a part of the quality control and quality assurance programs implemented during the construction.

References:

Golder (Golder Associates Ltd.). 2014. Jay Project Pre-feasibility Dike Design. Reference Number 1313280041-E14069-R_Rev0-2020. Submitted to Dominon Diamond Ekati Corporation. December 8, 2014.

Information Request Number:	DAR-GNWT-IR2-15
Source:	Government of Northwest Territories - Lands Information Requests from Melissa Pink
Subject:	Jay Pipe Dike Construction Technique and Turbidity Management
DAR Section(s):	Jay Project Pre-Feasibility Design Report Sections 6.4, 8.1, 8.2, and 10.0

Preamble (GNWT):

Section 6.4 of the pre-feasibility design report for the Jay Dike (Golder, 2014) noted the dike construction method and sequence, which includes both construction in the summer and winter seasons. It is noted that, “The upstream portion of the rockfill platform will be placed during the winter, while ice exists over the lake, to minimize the generation of turbidity within the lake. A slow rate of placement will be used and modified based on turbidity measurements. The remaining portion of the platform will be placed during the summer, at a rapid rate.”

Further, Section 8.1 and 8.2 of Golder (2014) noted turbidity management for construction in both the summer and winter seasons, respectively. The turbidity management for summer construction includes the use of redundant parallel turbidity curtains installed prior to ice breakup in the lake each season. However, turbidity curtains will not be used during the winter construction season. For winter construction of the rockfill platform, it is noted that, “ice cover will limit the transportation of disturbed sediments via wind and wave erosion… if placement is carried out at a sufficiently slow rate, it is anticipated that rockfill could be placed during the winter and meet the required turbidity levels.” It is unclear what the term “sufficiently slow” means, and how that may impact the planned construction schedule and sequencing noted in Section 10.0. Further, turbidity criteria, monitoring locations and depths, intervals, and adaptive management triggers/responses have yet to be defined at this stage of design. However, those should be better understood in order to mitigate against unacceptable turbidity generated from construction on water quality in Lac du Sauvage, and how turbidity monitoring may affect construction duration and sequencing.

Specific to turbidity management during the construction and dewatering of the Meadowbank dike, a Water Quality Monitoring and Management Plan was developed that included, without limitation: applicable turbidity criteria, monitoring locations and adaptive management triggers/responses to mitigate against elevated turbidity in the surface water.

Reference:

Golder, 2014 - Golder Associates, 2014. Jay Project Pre-feasibility Dike Design Report. Reference Number 1313280041-E14069-R-Rev0-2020. Submitted to Dominion Diamond Ekati Corporation. December 2014.

Request (GNWT):

GNWT requests that additional details associated with the following be provided:

1. The Jay pipe dike is proposed to be constructed in a similar manner as the Meadowbank dike and will include winter construction. Specific to winter construction of the dike, GNWT requests additional information to describe the term “sufficiently slow” with regards to rockfill placement for the dike and how this criterion will be measured and monitored during construction to mitigate against elevated turbidity in the surface water.

2. Specific to winter construction of the dike, GNWT requests additional information on the typical rate of rockfill placement for the Meadowbank dike and lessons learned regarding the correlation between rate of rockfill placement and turbidity increases in the surface water. This information will assist with understanding the feasibility of this mitigation method.

3. Specific to winter construction of the dike, if the rate of rockfill placement is reduced to mitigate against high turbidity in the surface water, GNWT requests additional details on the potential implications for the timing for dike construction. For example, would the sequencing of dike construction be able to accommodate rockfill placement in different locations to maintain the planned winter construction schedule, or will this result in a longer time overall to construct the dike?

Response:

1. The following provides additional information regarding the amount of rockfill scheduled to be placed during the winter construction period and the rate of placement:
    - approximately 1.9 million cubic metres (3.2 million tonnes) of rockfill is required to construct the upstream portion of the pre-feasibility Jay Dike;
    - assuming placement over a 7 month period (November 2016 to May 2017), and placement 24-hours per day, then there is approximately 5,040 hours for placement of this volume of material;
    - each truck (CAT 789D MSD II Body) has an approximate capacity of 194 tonnes; and,
    - therefore, the slowest average upstream rockfill construction rate requires 3.3 truck-loads per hour to achieve the above schedule.

    This is approximately equivalent to 15,000 tonnes of rockfill placed per day.

    The rate of placement will vary and will be adjusted based on the results from turbidity monitoring. Placement will occur from two working fronts (i.e., north abutment and south abutment), which means approximately 1.7 truckloads of rockfill will be placed per hour, per working front. If necessary, additional placement fronts can be created by placing a portion of the upstream rockfill and subsequently widening it. This would further increase the time between loads dumped into the water at each work area. In general, a slow rate of placement would be considered to be 20 minutes or more between loads. Rockfill will first be dumped onto the existing platform and then pushed with a dozer or placed with an excavator into the lake. With these mitigation measures and schedule flexibility for upstream rockfill placement, the proposed construction methodology is considered suitable and protective of the environment.

It is expected that a water quality monitoring and management plan for dike construction will be prepared for the Wek'èezhìı Land and Water Board prior to the start of construction. As part of the Water Licence process, total suspended solids (TSS) limits will be established for the Jay Dike construction. However, in general, the concept for the water quality monitoring plan would be that turbidity measurements would be collected using a probe that would permit measurements through the water column at various depths. A relationship between turbidity (in Nephelometric Turbidity Units [NTU]) and TSS (in milligrams per litre [mg/L]) would be established, such that turbidity values measured by the probe could be converted to TSS (DFO 2000). Each turbidity reading would be converted to TSS using the relationship, and compared to the TSS limits established in the Water Licence.

A similar program to that implemented for construction of the southern portion of the Bay-Goose Dike at the Meadowbank Mine in 2010 (AEM 2010, 2011) is anticipated to be proposed for the winter construction of the Jay Dike. Approximately three monitoring stations, conceptually 100 m in front of each rockfill placement zone would be established and monitored. Turbidity measurements would be collected from designated monitoring stations, at least once per day in front of each area of rockfill placement. As rockfill placement advances, these stations would progressively be moved. If the turbidity readings from the probe indicate that the short term limit of TSS concentration was exceeded, then corrective actions would be implemented. Placement would resume once TSS concentrations dropped to a suitable level. A representative water sample would be collected, at an appropriate schedule, from a zone with elevated turbidity levels for laboratory analysis to allow for quality assurance/quality control of the turbidity-TSS relationship and calibration of the field monitoring equipment.

2. Based on the information presented from winter rockfill placement for the south portion of the Bay-Goose Dike construction, approximately 2,400 tonnes of rockfill were placed per day (AEM 2011). Rockfill placement at the Meadowbank Mine occurred between February 17 and June 27, 2010. Only on one occasion was the short term limit for TSS exceeded. Placement was stopped for one day and then resumed. Monitoring indicated the elevated plume existed over a short interval of the water column (8 to 10 metres) and around a single monitoring station. Within one day, the TSS levels had significantly reduced and placement resumed.

3. Winter rockfill placement for the Jay Dike is scheduled to occur from both the north and south abutments, meaning there will be two placement fronts. Additional placement areas could be created if necessary.

References:

AEM (Agnico-Eagle Mines Ltd., Meadowbank Division) 2010. Water Quality Monitoring and Management Plan for Dike Construction and Dewatering, Version 4, April 2010.

AEM. 2011. Report: 2010 Causeway and Dike Construction Monitoring Report. March 2011.

DFO (Fisheries and Oceans Canada). 2000. Effects of sediment on fish and their habitat. Habitat Status Report 2000/01 E, DFO Pacific Region, January 2000, 9p.

DOMINION DIAMOND

Information Request Number:	DAR-GNWT-IR2-16
Source:	Government of Northwest Territories - Lands Information Requests from Melissa Pink
Subject:	Turbidity
DAR Section(s):	8.4.2.3.2

Preamble (GNWT):

The GNWT has several concerns regarding the effectiveness of proposed mitigation measures as they relate to controlling the release of sediment for both the winter and summer periods. This is crucial as ineffectiveness of these mitigation actions may cause significant impacts to the adjacent aquatic environment (e.g. nearby Lake Trout spawning habitat).

For example, the rationalization for not using turbidity curtains during the winter rests on the absence of wind and wave effects and a turbidity monitoring program. Details that have not been presented include:

- The expected levels of turbidity during placement of the rock shell particularly in deeper depositional areas.
- A turbidity threshold and the associated management plan.
- The methodology used to measure turbidity and how that method will be employed during the winter.
- Predicted TSS isopleths during winter.

Also the potential for turbidity associated with trenching of the central portion of the dike has not been discussed.

Finally, St. Lawrence Centre (1993; loc. cit. DDEC 2014) advises against using silt curtains when water is deeper than 6.5 metres. As a result, the GNWT is concerned that silt curtains may be ineffective in this regard. Additional information regarding the effectiveness of this mitigation action is warranted.

Request (GNWT):

GNWT requests that additional details regarding:

a) the rationalization to not use turbidity curtains during the winter be provided including:

   - The expected levels of turbidity during placement of the rock shell particularly in deeper depositional areas.
   - A turbidity threshold and the associated management plan.
   - The methodology used to measure turbidity and how that method will be employed during the winter.

- Predicted TSS isopleths during winter.

b) GNWT requests additional information on the potential for turbidity associated with trenching of the central portion of the dike.

c) GNWT requests DDEC outline reasons that they believe the use of silt curtains in Lac du Sauvage will be effective in deep water areas (i.e. >6.5m).

Response:

a) Turbidity curtains are proposed to be installed in Lac du Sauvage, once ice has melted from the lake surface, such that they are in place prior to commencement of the in-water summer dike construction activities. On the upstream side of the dike, double curtains will be installed. The purpose of the primary (inner) curtains is to limit the extent of total suspended solids (TSS) mobilization through summer dike construction activities. The secondary (outer) curtains are to act as a backup if problems occur with the inner curtains. On the downstream side of the dike, a single row of curtains will be installed.

The integrity of turbidity curtains cannot be maintained during the winter months due to ice formation and movement. Slow placement of the rockfill during the winter, with the implementation of an appropriate monitoring plan, similar to that developed and implemented at the Meadowbank Mine during placement of rockfill, will be utilized for Jay Dike construction in a manner that will be protective of the environment. The slow rate of rockfill placement, under ice conditions, when there is no wind or waves, will effectively serve to limit the extent of the area with elevated concentrations of TSS, in a manner that is analogous to the deployment of silt curtains.

It is expected that a water quality monitoring and management plan for dike construction will be prepared for the Wek'èezhìı Land and Water Board, prior to the start of construction. As part of the Water Licence process, TSS limits will be established for the Jay Dike construction. However, in general, the concept would be that turbidity measurements would be collected using a probe that would permit measurements through the water column at various depths. A relationship between turbidity (in Nephelometric Turbidity Units [NTU]) and TSS (in milligrams per litre [mg/L]) would be established, such that turbidity values measured by the probe could be converted to TSS (DFO 2000). Each turbidity reading would be converted to TSS using the relationship, and compared to the TSS limits established in the Water Licence.

A similar program to that implemented for construction of the southern portion of the Bay-Goose Dike at the Meadowbank Mine in 2010 (AEM 2010, 2011) is anticipated to be proposed for the winter construction of the Jay Dike. Approximately three monitoring stations, conceptually 100 m in front of each rockfill placement zone would be established and monitored. Turbidity measurements would be collected from the designated monitoring stations, at least once per day, for each area of rockfill placement. At each monitoring station, a hole would be cut in the ice and the probe deployed through the water column and readings recorded. As rockfill placement advances, these stations would progressively be moved. A representative water sample would be collected, at an appropriate schedule, from a zone with elevated turbidity levels for laboratory analysis to allow for quality assurance/quality control of the turbidity-TSS relationship and calibration of the field monitoring equipment.

If turbidity readings from the probe indicate that the short term limit of TSS concentration was exceeded corrective actions would be implemented. Placement would resume once TSS concentrations dropped to a suitable level.

It is recognized that the amount (thickness) of soft sediments vary along the dike alignment. Areas with thicker deposits of soft sediment have the potential to generate more turbidity in the lake as a result of rockfill placement than areas with thinner deposits. The rate of rockfill placement will be adjusted, based on the results of the turbidity monitoring.

b) Turbidity is expected to be generated primarily as a result of the following dike construction activities:

- rockfill placement;
- removal of material from the central trench (i.e., rockfill, lakebed soils, lakebed sediments); and,
- placement of fine and coarse filters within the central trench.

Activities occur concurrently along different portions of the dike, and therefore, isolating the relative contribution of one activity from another on the overall turbidity generated is not possible.

Prior to commencement of in-water summer dike construction activities, turbidity curtains will be installed within the lake and will be maintained until these construction activities are completed and turbidity levels have decreased to the required level. It is anticipated that the level would be established during the water licence stage of the permitting process.

c) One of the primary reasons for placing the upstream rockfill shell of the dike during the winter, is that this rockfill provides anchoring locations and protection (from wind and wave action) for the inner turbidity curtains used to protect the environment during summer construction. The dike alignment has been selected, where possible, to be located in shallower water around the Jay kimberlite pipe. Similarly, the planned location of the turbidity curtains has been selected such that, where possible, the curtains will be deployed in shallower water. However, some portions of the turbidity curtains will be required to be installed in deeper water (>6.5 m). This situation has been required during construction of other dikes in similar environments. For example, the A21 dike being constructed at the Diavik Mine includes installation of turbidity curtains in water depths in excess of 20 m (BGC 2014). During the construction of the A418 dike at the Diavik Mine in 2005, turbidity curtains were deployed in water up to 10 m deep and were generally successful (Rescan / LKDFN 2005). DDMI (2013) reported that turbidity management practices implemented during the construction of the A154 and A418 dikes, which included the installation of turbidity curtains in water depths up to 10 m deep, were successful. For the south portion of the Bay-Goose Dike at the Meadowbank Mine, secondary turbidity barriers were installed in areas with water depths up to 10 m and were effective (AEM 2010).

References:

AEM (Agnico-Eagle Mines Ltd., Meadowbank Division) 2010. Water Quality Monitoring and Management Plan for Dike Construction and Dewatering, Version 4, April 2010.

AEM. 2011. Report: 2010 Causeway and Dike Construction Monitoring Report. March 2011.

BGC (BGC Engineering Inc.) 2014. A21 Dike Project, Quality Assurance/Quality Control Plan for Construction of A21 Dike, Rev. B, Issued for Tender. Prepared for Diavik Diamond Mines Inc., November 28, 2014.

DDMI (Diavik Diamond Mines Inc.) 2013. A21 Dike: Construction Environmental Management Plan: 2013 Update, Version 2.0., Document No. CSLR-002-0513 R2. June 1, 2013.

DFO (Fisheries and Oceans Canada). 2000. Effects of sediment on fish and their habitat. Habitat Status Report 2000/01 E, DFO Pacific Region, January 2000, 9p.

Rescan / LKDFN (Rescan Environmental Services Ltd./Lutsel K'e Dene First Nation) 2005. A418 Dike Turbidity Monitoring Program Report, Prepared for Diavik Diamond Mines Inc., November 2005.

Information Request Number:	DAR-GNWT-IR2-17
Source:	Government of Northwest Territories - Lands Information Requests from Melissa Pink
Subject:	Jay Pipe Lake Bottom Sediment Management
DAR Section(s):	Jay Project Pre-feasibility Dike Design

Preamble (GNWT):

As noted in Golder (2014), the soils located within the extents of the Jay Pit, consist of:

- Very soft to soft, non-cohesive lakebed sediments (ranging in thickness from 0 to 5.8 m thick); or
- Competent soil generally understood to be either glacial till, glacial outwash, or glacial fluvial deposits (ranging in thickness between 0.6 m to 10.9 m); or
- Competent bedrock.

Where lakebed soils do not exist, a layer of cobbles and boulders is present above bedrock, and is typically found in shallower water along portions of shoreline or along islands.

The soils within the Jay Pit are scheduled to be excavated between October 2019 and the middle to autumn 2020 and stored in the waste rock storage area. A volume of about 15 to 20 million cubic metres of material will be removed, not counting the material from the receding 60° slopes in the overburden which could add another ~100,000 m^3 per thaw season.

It is noted that this material will be stored in the waste rock storage area. This area is estimated at about 3 km^2 or 3,000,000 m^2. Therefore, the layer of lake bottom sediment and lacustrian soil will fill the storage area to a height of possibly 5 or 6 metres. The heavy haul trucks likely cannot run on this material and haul roads will likely be required to reach the centre and opposite side of the storage area.

Naturally, without a perimeter containment dike, these fine lacustrian silts and clayey materials will be washed away, under heavy rain periods and during the spring run-off, directly into the environment and the western part of Lac du Savage. During the technical sessions, it was noted that containment dikes may be required and could be accommodated in the waste rock storage area.

In addition, this sloppy material will be difficult to hold in haul trucks and loss of material all along the haul roads has potential to occur. Spillage from the haul trucks has the potential to be a source of turbidity to Lac du Savage via surface water run-off.

Request (GNWT):

1. GNWT requests that DDEC provide further information regarding the sequence, construction approaches and/or methods employed to contain the lake bed sediments within the waste rock pile area. The response shall demonstrate that adequate storage volume is available in the waste rock

storage area to contain the sediments and how the sediments will be contained and deposited (i.e., built up) within waste rock storage area.

2. If sediments are removed from the Jay pit area seasonally during operations, GNWT requests that DDEC provide the storage location for these materials.
3. GNWT requests that DDEC describe the potential for lake bed sediment spillage from haul trucks to occur and the proposed management of this spillage to mitigate against turbidity load to surface water.

Response:

1. As stated in the Project Developer's Assessment Report (DAR), the total volume of overburden soils and waste rock from the Jay Pit is approximately 108,699,000 cubic metres (m^3). The storage capacity of the Jay waste rock storage area (WRSA) is approximately 120,200,000 m^3, which provides approximately 11,000,000 m^3 of contingency storage. The footprint area of the Jay WRSA is approximately 251 hectares (ha).

   As part of dike construction, a combination of lakebed sediments and competent soil will be excavated and placed in the WRSA. The lakebed sediments (estimated 60,000 m^3) removed for dike construction are anticipated to have higher water content and may require more management. The competent soils (estimated 200,000 m^3) removed for dike construction will have lower water content and transport of these materials to the WRSA is not anticipated to require special management.

   As presented in Section 3.5.6 of the DAR, the quantity of overburden soils removed from stripping the Jay Pit is estimated to be 12,831,000 tonnes, which is estimated to be equal to approximately 6,753,000 m^3 in the WRSA. The majority of the overburden material stripped from the Jay Pit will comprise competent soils such as till. Only a small portion of the overburden soil, between about 5 percent (%) and 10%, is anticipated to be finer grained lakebed sediments. The majority of the lakebed sediments will partially drain and consolidate during dewatering and are anticipated to be in a solid soil form for transport, not a slurry. In addition, a portion of the stripping of the overburden soils will be completed during winter months so some of the soils will be frozen.

   The total volume of overburden soils to be stored in the WRSA is approximately 7,013,000 m^3 which accounts for approximately 6.5% of the total volume of material to be stored in the WRSA.

   Overburden soils will be placed in the interior area of the WRSA footprint. It is anticipated that the overburden soils will be placed over approximately one third of the total footprint of the WRSA which could result in thicknesses up to 8 or 9 metres (m). Waste rock will be placed around and over top of the overburden soils to the design limits of the pile as the WRSA is developed. This will lead to encapsulation of the soils within waste rock.

   If the lakebed sediments are found to have a moisture content that is high enough to inhibit truck traffic required for placement of subsequent lifts, the wet lakebed soils could be placed separately in either the mined-out quarry within the Jay WRSA footprint (if available), or internal containment dikes could be constructed out of rockfill or till within the WRSA footprint for containment of the wet sediments.

Staged development plans for each 2 to 3 years of operation/placement will be prepared for the Jay WRSA as part of the detailed design. These plans will include placement areas for overburden soils.

2. Overburden soils are not anticipated to be removed from the Jay Pit after initial pit stripping is complete. The pit slope design includes a 9.5 m wide catch bench for each 10 m height of overburden slope and annual removal of overburden soils requiring storage in the WRSA is not expected to be required.

3. Management of spillage of sediments from haul trucks, if necessary, may use such means as tailgates and/or side boards for haul trucks to reduce this potential. If substantial spillage occurs on the road between the dike and WRSA, it will be cleaned up, as deemed necessary. Silt curtains will be in place for the construction of the Jay Dike and will provide protection against sedimentation outside of the diked area in Lac du Sauvage from all aspects of the dike construction. Sediments removed for stripping of the Jay Pit are not anticipated to be wet enough to lead to substantial spillage during hauling.

DOMINION DIAMOND

Information Request Number: DAR-GNWT-IR2-18

Source: GNWT-Lands Information Requests from Melissa Pink

Subject: Hydrology Model Reliability

DAR Section(s): 8

Preamble (GNWT):

The DAR contains only subjective descriptions of model reliability - i.e. the developer makes subjective statements on the reliability of the model he himself developed. In the first round of IRs, and during the April 2015 Technical Session, the GNWT expressed a number of concerns as to the lack of objective and quantitative evaluations of the accuracy and error limits of the hydrologic modelling. An outcome of the Technical Sessions was Undertaking 07, by which the Developer agreed to undertake a quantitative evaluation of model performance, using measurement parameters and procedures such as outlined in Moriasi et al. 2007. The submitted Undertaking 07 covers the following aspects:

1. The only hydrologic model component assessed is the discharge at the Desteffany Lake station. Although that location has the most data and is thus suitable for evaluation of the model as such, it is located some distance downstream of the project and may not represent how well the model performs nearer to the project. There are more upstream locations where project effects are of greater concern - notably Lac du Sauvage and Lac de Gras and their outlets. Due to a lack of observational data at the former, only the Lac de Gras location would be amenable to quantitative evaluation of model performance.

2. Model performance was computed using four parameters as listed below, with GNWT’s comments listed where applicable.

   a. Coefficient of Efficiency (Nash-Sutcliffe Coefficient) - NSE. No comment.

   b. Root-Mean-Square Error standard deviation ratio - RSR. No comment.

   c. Average percent error in annual maximum peaks - APEP. There appears to be a typographical error in the equation used - the second equal sign should be a multiplication sign.

   d. Percent Bias - PBIAS. There appear to be typographical errors in each of the three equation used - the 1/n, 1/m and 1/l terms, as well as the second equal sign should be eliminated.

3. Model performance was rated based on the results of the computed parameter values, as summarized in Table 7-1. (See attached document for entire IR, including Table 7-1 from the developer's response DAR-MVEIRB-UT-07).

AMEC conducted check computations for the above parameters and confirms the values listed in Table 7-1 except that a value of 13.1 was found instead of the listed 8.7 for the APEP.

It is noted that the model shows a consistent bias in over-predicting discharges and runoff volumes, in the order of 13 - 18%. That result agrees with Figure 7-1 which shows that a large portion of the percent exceedance probability curve for modelled flows lies above that of the observed flows. Those results then put into doubt the claim in the DAR and IR responses that the model was calibrated to the mean runoff volume or yield.

The use of the average percent error in annual maximum peaks obscures the large variation in the percent error from year to year, which AMEC found to range from 109% to - 39%, i.e. modelled peaks were 109% greater to 39% lower than the observed values for specific years. Those values do not seem to support the performance rating of “good”.

Reference

Moriasi, D. N., J. G. Arnold, M. W. Van Liew, R. L. Bigner, R. D. Harmel, and T. L. Veith. (2007). Model evaluation guidelines for systematic quantification of accuracy in watershed simulations. Transactions of ASABE, American Society of Agricultural and Biological Engineers, 50(3): 885-900.

Request (GNWT):

The GNWT requests DDEC:

1. Conduct additional quantitative evaluation of model performance, using the same parameters, but applied to Lac de Gras water levels using the available five years of data as per IR-33 Figure 33.3. Water levels should be expressed as stage above estimated zero flow rather than geodetic elevation.

2. Confirm the appropriate form of the parameter equations used.

3. Provide an explanation for the consistent over-estimation of annual runoff volume, especially when that parameter is claimed to have been a primary basis for model calibration. Perhaps one or more runoff coefficients have been set at unrealistically high values.

4. With respect to annual peak discharges, DDEC provide:

   - The APEP value in Table 7-1 be checked and confirmed.
   - The skill of the model in simulating annual peaks be further evaluated by preparing a correlation plot of modelled versus observed annual peaks for the years of record.
   - A discussion be provided as to the factors leading to the divergence between modelled and observed values in the correlation plot.

In conclusion, GNWT requests that the range of uncertainty in model simulations, as found from the computations presented in Undertaking 07, and supplemented as necessary to further quantify that uncertainty, should be applied to the predictions of project effects made by the model.

Response:

1. As requested, quantitative evaluation of the Jay Regional Hydrology Model for Lac de Gras water levels (as stage above the estimated zero flow elevation) has been completed using available Lac de Gras water level spanning the period of 2008 to 2013. Validation of the Jay Regional Hydrology Model based on Lac de Gras water levels is expected to provide less insight into the predicted long-term model error or uncertainty than the evaluation at the Coppermine River at Desteffany Lake outlet for the following reasons:

   - The available Lac de Gras water levels at the time of the model calibration are from July 2008 to November 2013, providing only four years of complete data (and two additional partial years) for calibration and performance evaluation. The period of record at the downstream Environment Canada Station for the Coppermine River below Desteffany Lake provides a much longer period of record to evaluate the model performance incorporating data that includes average, wet, and dry years.
   - Lac de Gras water levels are not continuously measured, but are rather surveyed lake levels or interpreted from A418-V933 (a piezometer situated on the upstream side of the A418 Dike cut-off). Over the period of 2008 to 2013, an average of 2 manual surveys and 21 interpretations of Lac de Gras water levels from A418-V933 per year have been completed. Daily water levels for Lac de Gras were derived using linear interpolation between surveys of interpreted water levels.

Table 18-1 includes the results of the quantitative evaluation of model performance for Lac de Gras water levels (as stage above the estimated zero flow elevation) based on the limited observed data available.

Table 18-1 Statistical Evaluation of Model Performance for Lac de Gras Stage

Performance Metric	Sample Size[a]	Daily	Monthly	Annual	Model Performance Rating[b]
Coefficient of Efficiency, NSE [-]	1,945 D 64 M	0.19	0.08	-	Unsatisfactory
RMSE-observations standard deviation ratio [-]	1,945 D 64 M	0.90	0.96	-	Unsatisfactory
Percent Bias [%][c]	1,945 D 64 M 4 Y[d]	9.2	10.2	2.4[d]	Very Good
Average percent error in annual peaks [%][e]	6 Y	-	-	8.0	-
Average Error in Annual peaks [m]	6 Y	-	-	0.05	-

a) Sample size includes concurrent records of observed and modelled data, D= days, M=months, and Y=years.
b) Model performance rating based on literature review compiled in Krause et al. 2005 and Moriasi et al. 2007.
c) Positive bias indicates a bias above observed data.
d) Only complete data years were included in the annual data sets for comparison; 2008 and 2013 are not complete data years at time of model calibration.
e) Analysis of annual peaks includes all years with observed freshet peak water levels.
NSE = Nash-Sutcliffe Coefficient; RMSE = Root-Mean-Square Error; % = percent; m = metre; - = not a relevant statistic or rating.

Note that visually, the water level hydrographs presented in Figure F3-12 in Appendix F of Annex X of the Developer's Assessment Report (DAR) qualitatively match slopes of rising and falling limbs of the hydrographs, and are close on annual low water levels, although for some years, peaks do not match and the modelled hydrographs may lead or lag the measured hydrographs. The observed leads and lags could be indicative of differences in precipitation (e.g., annual snowpack or summer rainstorms) between the modelled and measured cases. This is precisely the effect referenced in DAR Annex X, Appendix F, Section F2 of the DAR, which states that "The water balance model considers physical characteristics of the basins and derived long-term meteorology for the hydrology baseline study area (BSA). The baseline meteorology is intended to represent the long-term mean and variability at the Project, but is not intended to represent conditions at specific locations on specific dates. For example, a rainstorm that may have occurred in the Lac du Sauvage basin in the summer of a specific year may not be present in the baseline meteorology series. Similarly, differences in site-specific snowpack and temperature are expected to be present for any given year. However, over the long term, mean and extreme rainfall characteristics at that location should be represented."

2) The comments of GNWT are noted and the corrected parameter equations for the Desteffany Lake discharge are shown below. The errors in the performance metric equations provided in the text of Undertaking #7 (DAR-MVEIRB-UT-07) included typographical errors as identified in the Preamble, but the equations used for calculations were of the correct form.

I. Model performance in modelling the overall hydrograph shape:

a) Coefficient of Efficiency (Nash-Sutcliffe Coefficient) of Daily (CE_{DF}) and Monthly (CE_{MF}) Flows:

$$CE_{DF} = 1 - \left[\frac{\sum_{h=1}^{n}\left(Q_h - \hat{Q}_h\right)^2}{\sum_{h=1}^{n}(Q_h - \bar{Q}_{DF})^2}\right]$$

$$CE_{MF} = 1 - \left[\frac{\sum_{i=1}^{m}\left(Qm_i - \hat{Q}m_i\right)^2}{\sum_{i=1}^{m}(Qm_i - \bar{Q}m_{MF})^2}\right]$$

b) RMSE-observations standard deviation ratio (RSR) of daily and monthly flows:

$$RSR_{DF} = \frac{RMSE}{STDEV_{obs}} = \left[\frac{\sqrt{\sum_{h=1}^{n}\left(Q_h - \hat{Q}_h\right)^2}}{\sqrt{\sum_{h=1}^{n}(Q_h - \bar{Q}_{DF})^2}}\right]$$

$$RSR_{MF} = \frac{RMSE}{STDEV_{obs}} = \left[\frac{\sqrt{\sum_{i=1}^{m}\left(Qm_i - \hat{Q}m_i\right)^2}}{\sqrt{\sum_{i=1}^{m}(Qm_i - \bar{Q}m_{MF})^2}}\right]$$

II. Model performance of hydrograph peaks:

a) Average percent error in annual maximum peaks ($APEP$):

$$APEP = \frac{1}{p}\sum_{j=1}^{p}\frac{\hat{Q}_j - Qmax_j}{Qmax_j} \times 100$$

b) Absolute average percent error in annual maximum peaks (AAPEP), added for discussions in this response:

$$AAPEP = \frac{1}{p}\sum_{j=1}^{p}\frac{\left|\hat{Q}_j - Qmax_j\right|}{Qmax_j} \times 100$$

III. Model performance in reproducing streamflow volumes:

a) Percent bias of daily(*$PBIAS_{DF}$*)/monthly(*$PBIAS_{MF}$*) flow volumes:

$$PBIAS_{DF} = \left[\frac{\sum_{h=1}^{n}\left(\hat{Q}_h - Q_h\right) \times 100}{\sum_{h=1}^{n}(Q_h)}\right]$$

$$PBIAS_{MF} = \left[\frac{\sum_{i=1}^{m}\left(\hat{Q}m_i - Qm_i\right) \times 100}{\sum_{i=1}^{m}(Qm_i)}\right]$$

b) Percent bias of annual flow (*$PBIAS_{AV}$*) volumes (for complete years only):

$$PBIAS_{AV} = \left[\frac{\sum_{k=1}^{l}\left(\hat{V}a_k - Va_k\right) \times 100}{\sum_{k=1}^{l}(Va_k)}\right]$$

Where:

- *n* is the sample size for the daily flow record (both observed and modelled congruent series);
- *m* is the sample size for the monthly flow record (both observed and modelled congruent series);
- *p* is the sample size for the annual maximum peak flow record (both observed and modelled congruent series);
- *l* is the sample size for the annual volume record (both observed and modelled congruent series);
- Q_h is the observed mean daily flow and $\hat{Q}_h$ is the modelled mean daily flow in day *h;*
- $\bar{Q}_{DF}$ is the mean of the observed mean daily flows;
- $\bar{Q}m_{MF}$ is the mean of the observed mean monthly flows;
- Qm_i is the observed mean flow and $\hat{Q}m_i$ is the modelled mean flow in month *I;*
- RMSE is the Root Mean Square Error;
- $STDEV_{obs}$ is the Standard Deviation of the observed data set;
- $\hat{\hat{Q}}_j$ is the modelled annual peak daily flow and $Qmax_j$ is the observed annual peak daily flow in year *j;* and,
- $\hat{V}a_k$ is the modelled annual flow volume and Va_k is the observed annual flow volume in year k.

3. The prediction of annual runoff volume (of water yield) at the Coppermine River below Desteffany Lake (Station 10PA001) has an average over-prediction over the 12 year (complete years) period-of-record at Station 10PA001 of 13%. The predicted water yield, however, is not consistently over-predicted, as the model also under-predicts water yields for given years in the record, but has an average of 13%.

   Model calibration for water yield is described in Section F3.2 in Appendix F of Annex X of the DAR. This was primarily (not exclusively) based on the long-term derived water yield at Desteffany Lake (i.e., Lac de Gras long-term water yield assumed equivalent to the Desteffany lake water yield). The long-term derived water yield at the Coppermine River below Desteffany Lake (Station 10PA001) used for calibration (150.2 millimetres [mm]) is not equal to the short-term observed period-of-record water yield (145.4 mm) at Station 10PA001. The long-term water yield is based on the observed record as well as the long-term water yield at the downstream Coppermine River at Outlet of Point Lake (Station 10PB001) to provide a longer period of observed data.

Comparison of the modelled long-term water yield at Station 10PA001 (159.9 mm), over the modelled period-of-record (1964 to 2013) to the derived annual water yield over the period of record from the downstream Station 10PB001 of 150.2 mm, would result in a percent bias of 6.5%. Use of the longer period of record for this comparison reduces the effect of short-term trends or cycles.

Percent bias is one performance metric for model evaluation, in addition to the others presented in DAR-MVEIRB-UT-07 and updated in part 4 of this response, and therefore, should not be evaluated in isolation, but rather be used in conjunction with other statistics (Moriasi et al. 2007). The prediction of low-flow and annual peak flow regimes (both important hydrological regimes for erosion potential and aquatics assessments) at the Coppermine River below Desteffany Lake are satisfactorily predicted, as can visually be seen in the Percent Exceedance Curve (Figure 7-1 in DAR-MVEIRB-UT-07). Percent bias of the annual water yield, based on the long-term derived period-of-record is 6.5% (over-estimation), which has a performance rating of good (Moriasi et al. 2007).

4. The APEP calculated value in Table 7-1 of DAR-MVEIRB-UT-07 has been checked and corrected. In review, the sample size for the APEP calculation should be 17 years (from 19 years indicated in Table 7-1), and 1994, 1999, and 2012 (only 1994 was excluded in DAR-MVEIRB-UT-07) should be excluded from the analysis. The observed data in 1994, 1999, and 2012 are missing the peak annual discharges, and therefore, should not be used in a performance metric to compare annual peak observed discharges to modelled annual peak discharges.

   The revised APEP is 4.8%. Removal of years 1994, 1999, and 2012 result in a variation in prediction of the peak annual discharges from -39% to 60%. In addition, the absolute average percent error in annual peak (AAPEP) has been calculated (the equation is provided above), to provide context to the performance of calibrated models in literature. The AAPEP is 25%. The calculated values are provided in Table 18-2.

Table 18-2 Supporting Calculations for the Coppermine River below Desteffany Lake Annual Peak Error Evaluation

Year	Maximum Annual Observed Discharge (m^3/s)[(a)]	Maximum Annual Modelled Discharge (m^3/s)	APEP (%)	AAPEP (%)
1994	N/A[(b)]	N/A[(b)]	N/A[(b)]	N/A[(b)]
1995	111	83.19	-25.1	25.1
1996	161	123.2	-23.5	23.5
1997	164	127.6	-22.2	22.2
1998	62.7	100.6	60.4	60.4
1999	N/A[(b)]	N/A[b]	N/A[(b)]	N/A[(b)]
2000	154	109.7	-28.8	28.8
2001	294	178.4	-39.3	39.3

Table 18-2 Supporting Calculations for the Coppermine River below Desteffany Lake Annual Peak Error Evaluation

Year	Maximum Annual Observed Discharge (m^3/s)[(a)]	Maximum Annual Modelled Discharge (m^3/s)	APEP (%)	AAPEP (%)
2002	69.4	92.42	33.2	33.2
2003	95.4	102.5	7.44	7.44
2004	76.6	79.55	3.85	3.85
2005	89.1	97.84	9.81	9.81
2006	120	124.2	3.50	3.50
2007	131	116.1	-11.4	11.4
2008	74.7	101.1	35.3	35.3
2009	104	84.05	-19.2	19.2
2010	76.1	88.54	16.3	16.3
2011	43.6	64.62	48.2	48.2
2012	N/A[(b)]	N/A[(b)]	N/A[(b)]	N/A[(b)]
2013	76.0	101.2	33.2	33.2
Average	**112**	**104**	**4.8**	**24.7**

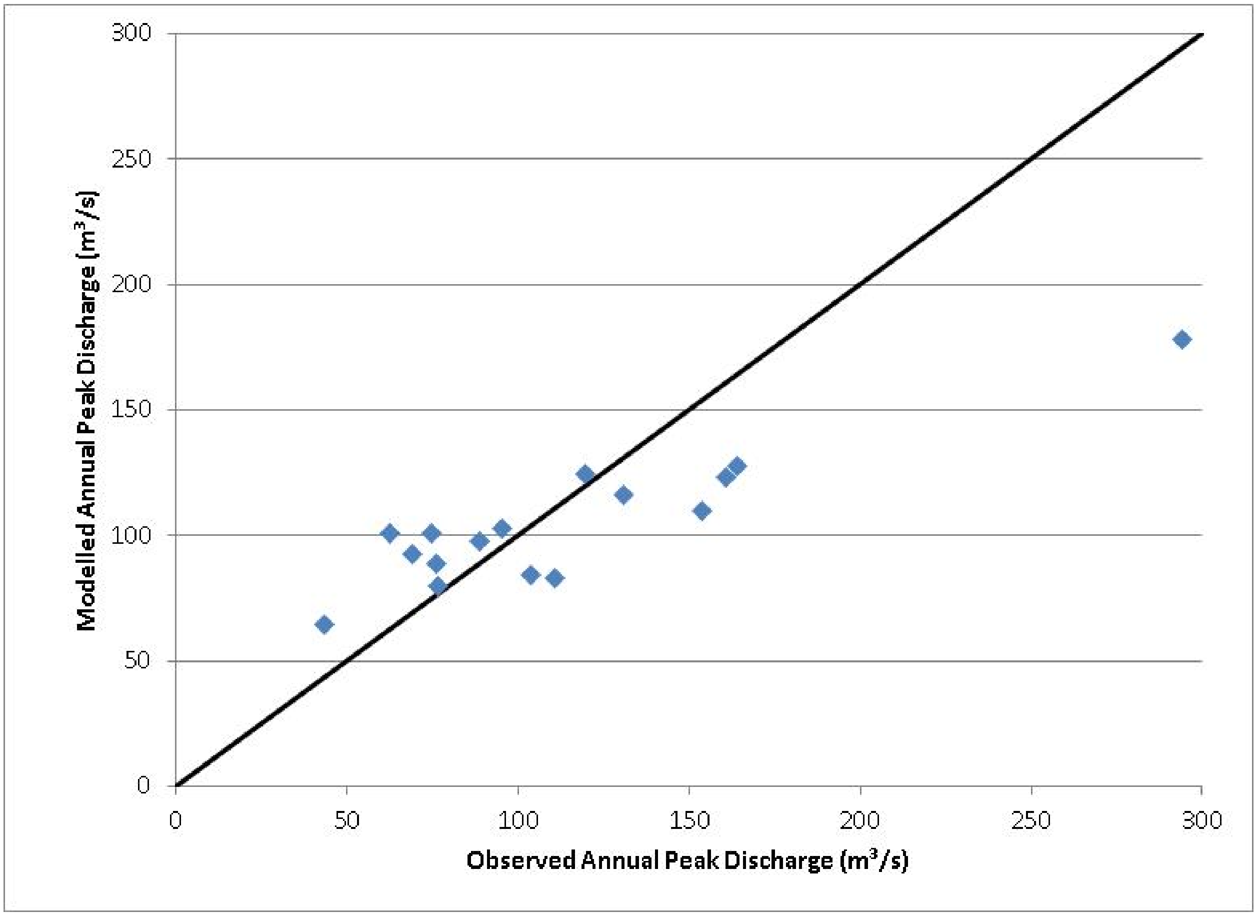
a) Observed discharge at the Environment Canada Station 10PA001 (Coppermine River below Desteffany Lake) (Environment Canada 2014).

b) Observed data records for these years do not include the peak observed discharges.

APEP = Average percent error in annual maximum peaks; AAPEP = Absolute average percent error in annual maximum peaks; N/A = not applicable; m^3/s = cubic metres per second; % = percent.

As requested, a correlation plot of observed maximum annual discharges to modelled maximum annual discharges for the years of record with observed peak flows is provided in Figure 18-1.

Figure 18-1: Correlation Plot of Observed and Modelled Annual peak Discharges



m^3/s = cubic metres per second

Modelled annual peak flows on the Coppermine River below Desteffany Lake may diverge from the observed discharges at the Environment Canada Station for the following reasons:

- Observed data records of the peak annual discharges have the greatest uncertainty and are subject to the greatest error due to reduced confidence in the stage-discharge rating curves at flood stages. In addition, observed peak data are missing in multiple years of record, reducing the sample size for comparison.
- Divergence of the peak annual discharges when matching observed and modelled values is expected because the Jay Regional Hydrology Model uses a single derived climate record to represent the meteorological conditions across the entire watershed. Due to limited available meteorological data, the modelling of internal point climate data is not possible, and the modelled results are, therefore, intended to represent the discharge characteristics rather than match the observed hydrograph. In reality, local climate not observed at the available climate stations may contribute to the observed peak discharges, and observed climate at the climate stations applied to the entire watershed, may only contribute to a portion of the watershed. This can lead to an

over or under-estimation of the annual peak discharges. This was explicitly noted in Annex X, Appendix F, Section F2 of the DAR, which states that "The water balance model considers physical characteristics of the basins and derived long-term meteorology for the hydrology baseline study area (BSA). The baseline meteorology is intended to represent the long-term mean and variability at the Project, but is not intended to represent conditions at specific locations on specific dates. For example, a rainstorm that may have occurred in the Lac du Sauvage basin in the summer of a specific year may not be present in the baseline meteorology series. Similarly, differences in site-specific snowpack and temperature are expected to be present for any given year. However, over the long term, mean and extreme rainfall characteristics at that location should be represented."

To provide context into the calculated AAPEP (24.7%), and the error in annual peaks ranging from -39% to 60%, a comparison will be made to an existing study which calculated the AAPEP for four basins using 12 different models (Reed et al. 2004). The data were collected as part of the Distributed Model Intercomparison Project to compare distributed hydrology models. In this study, the four models (of a total 12) with the greatest statistical performance statistics (Nash-Sutcliffe Efficiencies in the range of 0.7 to 0.9 [average of 0.75] and correlation coefficients in the range of 0.65 to 0.9 [average of 0.79]) were used to compare AAPEP. The range of the calculated AAPEP for the four best performing calibrated hydrological models (out of 12 models) was 11% to 42%, with an average of 23%.

The Average AAPEP of 25%, calculated for the Jay Regional Hydrology Model, is within the range of calibrated results, and near the average, for the best performing models completed in the Reed et al. (2004) study. In consideration of the observed data record, the sparsity of available calibration data within the Desteffany Lake watershed, and the acceptable range of performance for well-performing calibrated distributed hydrological models, the prediction of annual peak discharges is in an acceptable range, and therefore appropriate for the purposes of effects assessments completed in the DAR.

Conclusion

The water balance model can only be validated at assessment nodes where long-term records of observed data are available. The uncertainty reflected by validation at a specific node may not be representative of the uncertainty at other nodes in the model.

The only assessment node where long-term data exists that is suitable for model validation and estimation of uncertainty is at the long-term monitoring station on the Coppermine River below Desteffany Lake. The uncertainty calculated from the comparison of the observed and modelled discharge time series at that assessment node is not directly applicable to other assessment nodes.

The predicted cumulative effects to flows and water levels at the assessment nodes presented in the DAR, subsequent Information Requests and Undertakings are generally small and within baseline variability. At assessment nodes where the predicted effects to flows are small (within 10% of baseline), the uncertainty associated with modelled results is not sufficient to alter the conclusions of the DAR. Assessment nodes with potential cumulative effects within 10% of baseline include Desteffany Lake, Lac de Gras, Lake Ac35, and Lake B0.

The assessment nodes with larger predicted changes from baseline conditions in the DAR included Lake C1, Lake C17, and Lac du Sauvage. These were all temporary changes and did not necessarily include all Project phases or all hydrological metrics (e.g., high, medium, and low flows of various durations). At Lake C1, potential effects were conservatively estimated based on the potential location of the Enhanced Permeability Zone. At Lake C17, potential effects were conservatively estimated by considering the contingency adaptive management plan, which would require all waste rock storage area runoff and seepage to be managed within the Jay sump during operations, thereby reducing the contributing drainage area to Lake C17. The potential changes at Lake C1 and Lake C17 have been conservatively estimated, and will be monitored and managed, as necessary; uncertainty in the model does not affect monitoring and management plans. These conservative assessments were also carried through for assessment by the fish and fish habitat component in the DAR.

Predicted changes for Lac du Sauvage are greatest during back-flooding. To manage the uncertainty of the predicted changes to the flows and water levels in Lac du Sauvage, a Jay Pit and diked area back-flooding pumping plan will be developed prior to closure. It is expected that this plan will be submitted for approval under the water licence process and will be required prior to back-flooding (currently scheduled to commence in 2030). As part of the back-flooding pumping plan, Dominion Diamond will implement mitigation, as required, through an adaptive management plan, including the reduction of pumping rates to protect fish habitat in the Lac du Sauvage Narrows. Additional information will be collected during operations as part of the Aquatic Effects Monitoring Program to further characterize baseline conditions at the Narrows, including depths and widths under naturally occurring low-flow conditions in the winter. The adaptive management plan for the potential reduction in pumping rates during closure, as mitigation to avoid adverse effects to fish habitat at the Lac du Sauvage Narrows, will be developed as part of the back-flooding pumping plan.

References:

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DOMINION DIAMOND

Information Request Number: DAR-GNWT-IR2-19

Source: GNWT-Lands Information Requests from Melissa Pink

Subject: Waste Incineration

DAR Section(s): 3

Preamble (GNWT):

The Proponent indicated during the technical session that they do not have a schedule for regular incinerator stack testing. ENR believes that stack testing is an essential compliance tool to ensure the equipment is operating as designed and that emission levels remain below the Canadian Council of Ministers of the Environment (CCME) Canada-Wide Standards (CWS) for Dioxins, Furans and Mercury. Due to the toxicity and bio accumulative properties of Dioxins and Furans, CCME has slated these compounds for virtual elimination from the environment. The CCME recommends annual stack testing for Dioxins and Furans (CWS for Dioxins & Furans, 2001) for waste incinerators. ENR recognizes that the Proponent currently has comprehensive incinerator and waste management practices in place, and has demonstrated compliance to the CWS from a 2014 stack test. Continued efforts to maintain proper operation and management of the incinerators are important to minimize the formation and release of these toxic compounds; however, regular stack testing is still necessary as the only quantitative method to verify the effectiveness of those efforts, or conversely, to incite mitigative actions.

Reference

Moriasi, D. N., J. G. Arnold, M. W. Van Liew, R. L. Bigner, R. D. Harmel, and T. L. Veith. (2007). Model evaluation guidelines for systematic quantification of accuracy in watershed simulations. Transactions of ASABE, American Society of Agricultural and Biological Engineers, 50(3): 885-900.

Request (GNWT):

The GNWT had requested that the Proponent commit to undertaking stack tests of their incinerators every 3 years, as a component of overall incineration management. This is to ensure that incinerator emissions remain below the CWS and impacts to the environment are minimized. This commitment was discussed further at the May 7, 2015 meeting between the Proponent, the GNWT, and Environment Canada and the minutes noted that the Proponent agreed to ‘commit to the 3-year incinerator stack testing cycle’. Through this IR, the GNWT requests that the Proponent submit a detailed stack testing program including information on testing, reporting, and compliance procedures. As part of this program, the GNWT requests that all test results are submitted to ENR and Environment Canada within 45 days of completing a stack test. In the event of a failed stack test, GNWT requests that the Proponent develop and submit an Adaptive Management Response Plan within 90 days of the failed stack test. The Adaptive Management Response Plan should contain an assessment of the incinerator operations and management, and measures to improve them. Measures should be implemented immediately. Effectiveness of the adaptive management response measures and compliance to the CWS should be confirmed with a second stack test within 6 months of the original stack test. All stack tests should be conducted in accordance with national standards, and include detailed documentation to demonstrate that representative composition and batch size of waste were used during the testing process.

Response:

Dominion Diamond has committed to undertake stack testing on the operating incinerators on the 3 year schedule. This was discussed in the Jay Project Technical Sessions, and a commitment to stack testing was made following the May 7, 2015 air quality meeting that included the Government of the Northwest Territories (GNWT) staff. Dominion Diamond has committed to updating the Incinerator Management Plan as part of the updated Waste Management Plans, as per the requirement in the Water Licence. Stack testing will follow current standards for this work, data will be circulated to GNWT, and other parties, and follow up actions will be implemented if necessary. Details on these operating procedures will be finalized during the regulatory permitting process.

Dominion Diamond provided a draft conceptual Air Quality Emissions Monitoring and Management Plan (AQEMMP) for the Jay Project to the Mackenzie Valley Environmental Impact Review Board for discussion on June 1, 2015, and followed up with a workshop on June 26, 2015 to engage with regulatory and community groups. The development of the Jay Project AQEMMP is ongoing and the schedule for testing and reporting will still be discussed, and finalized during the Jay regulatory process. Dominion Diamond will host a technical workshop to discuss the proposed triggers and technical components of the AQEMMP in July 2015 and will also provide an engagement schedule for the AQEMMP.

Information Request Number: DAR-IEMA-IR2-01

Source: Independent Environmental Monitoring Agency Information Requests from Kevin O'Reilly

Subject: Fish Impact Predictions

DAR Section(s): Round 1 Information Request Response DAR-MVEIRB-IR-67

Preamble (IEMA):

DDEC states "The amount of cumulative change to spawning shoal habitat for the Application Case is expected to result in no measurable effect to population abundance and distribution for fish." It is not clear what the extent of change will be from reference conditions in terms of abundance or distribution for all VEC fish species.

Request (IEMA):

DDEC should clarify, for each VEC fish species, whether or not there will be measurable changes to fish abundance and distribution as a result of cumulative impacts on spawning habitat.

Response:

The objective of Section 9 of the Developer's Assessment Report (DAR) is to assess incremental and cumulative effects for valued components (VCs), including fish VCs, where Jay Project (Project) effects could contribute to a cumulative effect. Therefore, incremental and cumulative effects of the Project and other developments are analyzed and assessed together in the fish and fish habitat section of the DAR (Section 9). The fish and fish habitat assessment considered changes to spawning habitat for fish VCs (Lake Trout, Lake Whitefish, and Arctic Grayling), and how those changes could potentially affect the assessment endpoints of ongoing fisheries productivity and self-sustaining and ecologically effective fish populations. No measurable effects to the abundance of Lake Trout, Lake Whitefish, or Arctic Grayling are expected to result from changes to spawning habitat (DAR Section 9.6). Effects, if any, would be limited to a minor or local change in the distribution of fish within Lac du Sauvage, with no measurable cumulative effects to the ongoing productivity of fisheries in the Effects Study Area (ESA). These effects are not considered to significantly affect the Traditional Land Use assessment endpoint of continued opportunities for resource users to participate in traditional fishing (see the reply to Round 1 information request DAR-Tlicho-IR-22; DAR Section 15.4).

To clarify, the assessment included a reference condition (i.e., no or minimal human development) in the Base Case. The Base Case also included a 2014 baseline condition which included effects due to previous and existing developments prior the Project (i.e., Ekati and Diavik operations). The analyses also considered an Application Case by adding the Project to the 2014 baseline condition. The cumulative effects analysis for fish VCs in the DAR was based on a comparison of the Application Case, which considers previous and existing development footprints combined with the Project footprint, versus the reference condition. It is important to note that the Application Case was also used to identify the incremental changes from the Project that are predicted to occur between the 2014 baseline conditions and the Application Case. In the response to Round 1 Information Request DAR-MVEIRB-IR-78, the cumulative effects analysis for fish and fish habitat was expanded to include a Reasonably Foreseeable Development (RFD) Case, which included effects from the Diavik Mine A21 pit plus those described for the Application Case (see the response to DAR-MVEIRB-IR-78).

Incremental and cumulative effects on fish habitat, including spawning habitat, for fish VCs are described throughout most of DAR Sections 9.4 to 9.6. The development of the Project is expected to directly affect the availability of habitat through losses of fish habitat incurred by footprints in Lac du Sauvage and adjacent sub-basins. The greatest changes will be a result of the construction of the Jay Dike, the dewatering of the diked area in Lac du Sauvage where the pit will be located, and the construction of the Sub-Basin B Diversion Channel. Residual effects may include a decrease in available rocky shoals for spawning and rearing Lake Trout and Lake Whitefish, and a decrease in available tributary stream habitats for spawning and rearing Arctic Grayling. Such residual effects are evaluated under the following primary pathways in DAR Section 9.4.3.1:

- *The construction of the horseshoe dike and Jay Pit within Lac du Sauvage will result in the direct loss or alteration of habitat, affecting fish and other aquatic life within Lac du Sauvage and Lac de Gras.*
- *The dewatering of the diked area will result in the direct loss or alteration of habitat in Lac du Sauvage, affecting fish and other aquatic life within Lac du Sauvage and Lac de Gras.*
- *The construction of the horseshoe dike and diversion channel may alter access to tributary stream habitats to Lac du Sauvage, resulting in habitat loss for Arctic Grayling, Lake Trout, and Lake Whitefish.*

The direct effects of the diked area in Lac du Sauvage on Lake Trout and Lake Whitefish habitat are evaluated in DAR Section 9.4.3.1.1. The assessment was based, in part, on the results of the 2013 baseline habitat survey in Lac du Sauvage and previous studies of spawning habitat (Golder 1997; Rescan 2007). All previously completed surveys described a low availability of suitable shoal habitat for spawning Lake Trout and Lake Whitefish within the proposed footprint area (Annex XIV, Section 3.2.3; also see the responses to Round 1 Information Requests DAR-KIA-IR-94 and DAR-MVEIRB-67). Given the low availability of suitable shoal habitat within the proposed diked area, and the availability of suitable habitat elsewhere in Lac du Sauvage and Lac de Gras (DAR 9.4.3.1; Golder 1997; Rescan 2007), any incremental and cumulative effects to assessment endpoints of Lake Trout and Lake Whitefish VCs resulting from a decrease in shoal habitat for the Jay Project are expected to be non-measurable. The same conclusions are drawn using lake area as a habitat surrogate for quantifying effects. Furthermore, the cumulative loss of lake habitat from existing and proposed developments remains low if considering the A21 dike at the Diavik Mine as an RFD. Therefore, no measurable effects to the abundance of Lake Trout and Lake Whitefish are expected to result from incremental and cumulative changes (e.g., existing, proposed, and reasonably foreseeable footprints) to spawning shoal habitat. Effects, if any, would be limited to a minor or local change in the distribution of Lake Trout and Lake Whitefish, with no measurable cumulative effect to the ongoing productivity of fisheries in the Effects Study Area.

The effects of the Sub-Basin B Diversion Channel on fish VCs are evaluated in Section 9.4.3.1 of the DAR. Recently collected information on habitat types in the affected streams (in 2013 and 2014), summarized in DAR Annex XIV Section 3.2.3 and the 2014 Fish and Fish Habitat Supplemental Baseline Report (Dominion Diamond 2015), informed the assessment of effects to spawning habitat for Arctic

Grayling (also see the response to Round 1 IR DAR-DFO-IR-12). There will be no direct losses of spawning habitat within any watercourses caused by direct overlap with the construction of the Jay Dike or associated Project infrastructure; however, temporary loss of habitat quantity will occur due to the diversion of waters on the lower section of Stream Ac35 and most of Stream B0 (see DAR Section 9.4.3.1.3).

The main functions provided by Stream Ac35 and B0 for fish VCs include corridors on lower sections of the streams for movement of Arctic Grayling to upstream locations, and spawning and rearing habitat for Arctic Grayling, typically at upstream locations (Dominion Diamond 2015). Baseline surveys identified that most spawning locations are located at upstream locations and above the diversion channel. Using stream length as a surrogate measure to describe habitat losses for Arctic Grayling in the ESA, the diverted stream sections represent a minor loss related to the availability of tributary stream habitat. The Sub-Basin B Diversion Channel will reduce losses by facilitating the upstream movement of Arctic Grayling from Lac du Sauvage to spawning locations in Stream B1 (upstream of B0) and Ac35 (DAR Section 9.3.2.1.3; responses to Round 1 IRs DAR-KIA-IR-98, and DAR-MVEIRB-IR-68).

As concluded for Lake Trout and Lake Whitefish, no measurable effects to the abundance of Arctic Grayling are expected to result from changes to spawning habitat for the Application Case. Effects, if any, would be limited to a minor or local change in the distribution of Arctic Grayling within Lac du Sauvage, with no measurable cumulative effects to the ongoing productivity of fisheries in the ESA. Note that there are no existing developments affecting tributaries of Lac de Gras and Lac du Sauvage, such that reference conditions and 2014 baseline conditions are considered equivalent for the Base Case at an assessment scale of spawning habitat for Arctic Grayling.

Changes to spawning habitat associated with the existing Diavik Mine footprint in Lac de Gras combined with the proposed Project footprint in Lac du Sauvage and tributary streams are expected to have no measurable cumulative effect on the ongoing productivity of fisheries in the Effects Study Area. These effects are not considered to significantly affect the assessment endpoints for fish and fish habitat. Furthermore, continued opportunities for resource users to participate in traditional fishing will be maintained. Any Project-related losses of fish habitat (i.e., serious harm to fish) will be addressed in the final offsetting plan (based on the Conceptual Offsetting Plan in Appendix 9A of the DAR) submitted with the application for a *Fisheries Act* Authorization during the regulatory phase of the Project.

References:

Dominion Diamond (Dominion Diamond Ekati Corporation). 2015. 2014 Fish and Fish Habitat Supplemental Baseline Report for the Jay Project. Prepared by Golder Associates Ltd., April 2015. Yellowknife, NWT, Canada.

Golder (Golder Associates Ltd.). 1997. Technical Memorandum #12-2, Shoal Habitat Survey, Lac de Gras and Lac du Sauvage, Summer 1996. Environmental Baseline Program. Submitted to Diavik Diamond Mines Inc. Yellowknife, NWT, Canada. Doc No. TM12-2.

Rescan (Rescan Environmental Services Ltd.). 2007. Ekati Diamond Mine. 2006 Jay Pipe Aquatic Baseline. Prepared for BHP Billiton Diamonds Inc. Yellowknife, NWT, Canada, 325 pp.

Information Request Number:	DAR-IEMA-IR2-02
Source:	Independent Environmental Monitoring Agency Information Requests from Kevin O'Reilly
Subject:	Air Quality Assessment Update
DAR Section(s):	Jay Project Air Quality Assessment Update Memo (Table 4.3, submitted to MVEIRB on January 19, 2015)

Preamble (IEMA):

DDEC now predicts annual exceedances of NWT Ambient Air Quality Guidelines would cover an area of 309 ha from the original estimate of 169 ha. DDEC also states “Results from the air quality assessment [are] passed on to vegetation and water quality teams for their assessments, which are then considered in barren-ground caribou, wildlife, fish and fish habitat assessment” (DAR-MVEIRB-UT-24, Table 24.1). It is not clear whether DDEC has reassessed its predicted impacts on water quality, aquatic biota and wildlife following these changes in its predicted dust deposition and air quality exceedances.

Request (IEMA):

DDEC should verify the accuracy of its impact predictions and significance determinations on water quality, aquatic biota, vegetation and wildlife as a result of the increased area of dust deposition exceedances.

Response:

In the Developer’s Assessment Report (DAR) for the Jay Project (Project), the assessment of the effects of the Project on air quality was provided in Section 7. As described in Section 7.3.2.1, the changes in air quality were included in the assessments of vegetation, wildlife, caribou, water quality, and fish and fish habitat. Subsequent to the filing of the DAR, updated air dispersion modelling predictions were provided in the Jay Project Air Quality Assessment Update Memo (Golder 2015). As described in the Air Quality Assessment Update Memo, the revisions have little effect on the assessment as a whole, and the impact classification and prediction of significance on all air quality endpoints remain unchanged from the DAR.

The results were also reviewed in the context of the other component assessments. A summary of the impact predictions and significance determinations for the vegetation, wildlife, caribou, water quality, and fish and fish habitat assessments based on the updated air dispersion modelling predictions from the Jay Project Air Quality Assessment Update Memo (Golder 2015) is provided in the following sections. Note that the Human and Wildlife Risk Assessment (Dominion Diamond 2015) was based on the updated modelling results.

Vegetation, Wildlife, and Caribou

An analysis of the potential impacts to vegetation, wildlife, and caribou was completed based on the updated air quality predictions.

The Jay Project Air Quality Assessment Update (Golder 2015) resulted in small changes in the predicted particulate (dust) concentrations in the air and deposition rates relative to values reported in the DAR and that were subsequently used to assess effects on vegetation, wildlife, and caribou. For example, the maximum off-site annual particulate matter with a mean aerodynamic diameter of 2.5 microns (µm) or smaller ($PM_{2.5}$) concentration resulting from the Project has been updated to 39.1 micrograms per cubic metre ($\mu g/m^3$), which is lower than the 39.4 $\mu g/m^3$ provided in the DAR. The maximum off-site annual total suspended particulate (TSP) concentration resulting from the Project has been updated to 512 $\mu g/m^3$, which is lower than the 607 $\mu g/m^3$ reported in the DAR. The total area exceeding the annual Northwest Territories (NWT) ambient air quality standards for $PM_{2.5}$ and TSP increased based on the updated air quality predictions. However, the offsite area with predicted $PM_{2.5}$ and TSP concentrations above the annual NWT air quality standards (GNWT-ENR 2014) remains within 1 kilometre (km) of the emission sources (e.g., Jay Pit), which was predicted in the DAR (e.g., Section 12.3.2.2.2, pages 12-57 to 12-59). The results of the updated air quality analysis predicted that the estimated maximum dust deposition rate outside of the Project footprint is approximately 4,727 kilograms per hectare per year (kg/ha/yr), which is slightly higher than the 4,722 kg/ha/yr reported in the DAR. These small, local changes in predicted maximum concentrations and deposition rates do not alter the results of the pathway analysis, impact classification, or determination of significance for vegetation, wildlife, and caribou provided in the DAR.

Water Quality

The updated air modelling results for particulate matter (Golder 2015) project slightly higher deposition rates of total suspended solids (TSS) at the assessment lakes that are in closer proximity to the Jay Pit (e.g., Christine Lake). The updated assessment was undertaken with the same conservative assumptions used in the DAR (Section 8.5.4.1.1). Similar to the DAR, concentrations of TSS are projected to increase between the Base Case and Application Case at Christine Lake (4 km from Jay Pit), Cujo Lake (5 km from Jay Pit), and Counts Lake (9 km from Jay Pit) (e.g., TSS concentrations: 10 mg/L, 1.5 mg/L, and 3 mg/L, respectively, compared to 9.5 mg/L, 1.2 mg/L, and 2.4 mg/L respectively in the DAR; Table 8.5-23). Updated deposition rates were relatively similar between the Base Case and Application Case for Nema, Vulture, and Slipper lakes resulting in TSS concentrations that were similar to those presented in the DAR (e.g., TSS concentrations: 0.45 mg/L, 0.2 mg/L, and 0.75 mg/L, respectively, compared to 0.46 mg/L, 0.38 mg/L, and 0.46 mg/L respectively from the DAR; Table 8.5-23). The lesser influence of aerial deposition effects to these lakes during the Application Case compared to the Base Case was attributed in the DAR to the reduction of operational activities at the Ekati and Misery operations to small lakes further afield from the Project.

The small changes to the projected TSS concentrations from dust deposition relative to values reported in the DAR do not alter the conclusions in the DAR. As per the response to Round 1 Information Request DAR-IEMA-IR14, and the findings of dust deposition studies undertaken at Diavik (DDMI 2009, 2011) and Ekati (Rescan 2012), it is maintained that the deposition of dust sourced from Project activities has negligible potential to result in adverse changes to water quality in adjacent waterbodies. Overall, therefore, changes in the air quality predictions (i.e., air deposition effects to lakes within close proximity to Project activities) as a result of the Jay Project Air Quality Assessment Update (Golder 2015) do not alter the pathway analysis, assessment of the results, impact classification, nor determination of significance for water quality presented in Section 8 of the DAR.

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Fish

An analysis of the potential effects of the dust deposition, based on updated TSP deposition prediction values from the Jay Project Air Quality Assessment Update (Golder 2015), on fish and fish habitat was provided in the response to the DAR-IEMA-IR14. Based on the analysis, it was concluded that:

- The data from the AEMP at the Ekati Mine concluded that deposition of dust has a negligible potential to change water quality as compared to direct deposition of effluent to the aquatic environment.
- Wave action and associated currents that often characterize high-quality shoals for spawning likely maintain shoals relative free of sediment accumulation in Lac de Gras.
- Most of the high-quality shoal habitats in the Effects Study Area for fish Valued Components are located in Lac de Gras where dust deposition from the Project will be low.

Overall, the changes in the air quality predictions as a result of the Jay Project Air Quality Assessment Update (Golder 2015) do not alter the results of the pathway analysis, impact classification, and determination of significance for fish and fish habitat in Section 9 of the DAR.

References:

DDMI (Diavik Diamond Mines Inc.). 2009. Aquatic Effects Monitoring Program. 2008 Annual Report. Yellowknife, NWT. April 2009.

DDMI. 2011. Lakebed Sediment, Water Quality and Benthic Invertebrate Study. A154 Dike: Year 4 Results. A418 Dike: Year 2 Results. Yellowknife, NWT. August 2011.

Dominion Diamond (Dominion Diamond Ekati Corporation). 2015. Human and Wildlife Health Risk Assessment Report for the Jay Project. Prepared by Golder Associates Ltd. February 2015.

GNWT-ENR (Environment and Natural Resources, Government of the Northwest Territories). 2014. Guideline for Ambient Air Quality Standards in the Northwest Territories. Yellowknife, NWT, Canada, 5 pp.

Golder (Golder Associates Ltd.). 2015. Technical Memorandum: Jay Project Air Quality Assessment Update. Issued January 19, 2015.

Rescan (Rescan Environmental Services Ltd.) 2012. Ekati Diamond Mine, 2012 Aquatic Effects Monitoring Program Re-evaluation. Prepared for BHP Billiton Canada Inc. Yellowknife, NWT, Canada.

DOMINION DIAMOND

Information Request Number:	DAR-IEMA-IR2-03
Source:	Independent Environmental Monitoring Agency Information Requests from Kevin O'Reilly
Subject:	Reclamation of Ore Transfer Pad and Diked Area
DAR Section(s):	Jay Technical Sessions (Fish and Fish Habitat Presentation, Map on Page 14)

Preamble (IEMA):

It appears the Ore Transfer Pad is part of the above-water features near the pit that will be inundated with water at closure. It is not clear how DDEC would avoid possible kimberlite contamination of the pit lake water.

Request (IEMA):

DDEC should explain how the Ore Transfer Pad will be reclaimed so as avoid kimberlite contamination of Jay pit water quality at closure.

Response:

Ore storage pads are included in the Ekati Mine Interim Closure and Reclamation Plan (ICRP; BHP Billiton 2011). As per Section 5.7.9.7 of the ICRP, ore will be removed from ore storage areas and the pads will be re-contoured and scarified as necessary. The ICRP is expected to be amended to include Jay Project components during regulatory process with the Wek'èezhìı Land and Water Board such that these requirements will apply to transfer pads constructed for the Jay Project.

As described above, kimberlite will not be left on the pad when the area is back-flooded. However, kimberlite is not characterized as potentially acid generating. The water in contact with any small amounts of residual kimberlite within the ore storage pad during back-flooding is not expected to produce measureable quantities of constituents in the water and is considered to be of negligible risk. Water quality monitoring within the diked area and Lac du Sauvage is planned during and after back-flooding, which will document water quality post closure.

References:

BHP Billiton (BHP Billiton Canada Inc.). 2011. Ekati Diamond Mine Interim Closure and Reclamation Plan. Prepared for the Wek'èezhìı Land and Water Board. 842 pp.

DOMINION DIAMOND

Information Request Number:	DAR-IEMA-IR2-04
Source:	Independent Environmental Monitoring Agency Information Requests from Kevin O'Reilly
Subject:	Compensatory Mitigation
DAR Section(s):	Jay Project Conceptual Wildlife Effects Monitoring Plan (Draft submitted June 2015, section 4, page 4-1)

Preamble (IEMA):

The third level of "standard mitigation hierarchy" addresses reclaiming, such as measures taken to rehabilitate degraded ecosystems or restore ecological function. The document does not consider compensatory mitigation (off-setting), which are measures implemented when despite avoidance and minimization, there are still net effects to caribou or their habitat. Given acknowledged net effects of development to caribou and their habitat and the perilous state of the herd, the company should explore all options to mitigate potential impacts. These might involve working collaboratively with those responsible for existing project that affect caribou to propose habitat trade-offs (to remove areas from potential development) or herd management to reduce other stresses on the herd. This should include consideration of further caribou mitigation, off-setting and compensatory mitigation as part of the existing and future Ekati operations.

Request (IEMA):

Dominion should add the option of compensatory mitigation to the types of mitigation available.

Response:

Dominion Diamond provided a summary of hierarchial mitigation associated with Jay Project (Project) components and activities in a response to the Mackenzie Valley Environmental Impact Review Board's Round 1 Information Request DAR-MVEIRB-IR-90. This response included mitigation according to the standard mitigation hierarchy (IFC 2012; BBOP 2015).

- **Avoid**: measures taken to completely avoid creating impacts from the outset, such as careful spatial or temporal placement of elements of infrastructure and engineered designs of facilities (e.g., waste rock storage areas).
- **Minimize**: measures taken to reduce the duration, intensity and / or extent of impacts that cannot be avoided.
- **Reclaim**: measures taken to rehabilitate degraded ecosystems or restore ecological function following exposure to impacts that cannot be completely avoided and/ or minimized.
- **Offset**: measures taken to compensate for any residual significant, adverse impacts that cannot be avoided, minimized and / or rehabilitated or restored. Offsets are achieved once compensation is sufficient that the outcome is no net loss or a net gain for the feature (e.g., valued component) for which compensation was developed. Offsets can take the form of positive management interventions,

such as restoration of degraded habitat, arrested degradation or averted risk, and protecting areas where there is imminent or projected loss.

Adverse effects from a project should be mitigated as much as possible using avoidance, followed by minimization, reclamation, and finally, offsetting (BBOP 2015). This is because effects that are avoided entirely or minimized mean that the effects from a project prior to implementing reclamation or offsetting are reduced. Table 90-1 in DAR-MVEIRB-IR-90 shows that the Project will use mitigation that avoids, minimizes, and reclaims adverse effects associated with all caribou and wildlife pathways identified for the Project. The results of the DAR indicate that there are no significant adverse effects from the Project on caribou and wildlife, and therefore, no offset mitigation has been proposed.

References:

BBOP (Business and Biodiversity Offset Programme). 2015. Mitigation Hierarchy. Available at: http://bbop.forest-trends.org/pages/mitigation_hierarchy. Accessed February 4, 2015.

IFC (International Finance Corporation). 2012. Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources. January 12, 2012.

Information Request Number:	DAR-IEMA-IR2-05
Source:	Independent Environmental Monitoring Agency Information Requests from Kevin O'Reilly
Subject:	Caribou Monitoring
DAR Section(s):	Jay Project Conceptual Wildlife Effects Monitoring Plan (Draft submitted June 2015, section 5.4, pages 5-8 to 5-16)

Preamble (IEMA):

Caribou monitoring methods are limited to incidental observations, behaviour/response to stressors, LLCF monitoring, and camera trapping (section 5.4, pgs 5-8 – 5-16). There is no discussion in this document about monitoring to trigger intensified mitigation along the road. Collars would play a larger role at greater distances, and road surveys or height of land surveys or some other innovative monitoring method could be employed at medium to closer distances. Although these will likely be provided in the revised caribou (wildlife) road mitigation plan, they should be outlined in the main document.

Request (IEMA):

Dominion should provide details on monitoring that will be conducted to trigger mitigation for reducing sensory disturbance and the semi-permeable barrier effects of the roads.

Response:

Dominion Diamond is considering a number of different options for detecting and monitoring caribou at intermediate scales before caribou would be detected by road surveys. The options currently being considered include use of drones to survey for caribou and supporting the deployment of high location frequency global positioning system (GPS) collars that are geo-referenced to the Ekati Mine (including the Jay Project) jointly with communities and the Government of the Northwest Territories. These represent new technologies that are currently not being used for this purpose and Dominion Diamond will complete due diligence to determine whether these, or other, options are feasible and could provide value-added information for caribou monitoring and mitigation. At this time, Dominion Diamond cannot provide details on either of these monitoring options, as the information is not available. Dominion Diamond will also consider feedback on intermediate monitoring provided by regulators, communities, and the Independent Environmental Monitoring Agency during the Jay Project management and monitoring plan workshops currently scheduled for June 25 and 26, 2015.

DOMINION DIAMOND

Information Request Number: DAR-IEMA-IR2-06

Source: Independent Environmental Monitoring Agency Information Requests from Kevin O'Reilly

Subject: Mitigation of Effects on Caribou - Boulanger et al. 2012 and Caribou Zone of Influence Technical Task Group 2015

DAR Section(s): 12

Preamble (IEMA):

The Boulanger et al. (2012) report determined a 14-km zone of influence (ZOI) for caribou surrounding the Ekati and Diavik mines from 2003–08 (the referenced document is provided to the Review Board for the public registry). More recent analyses have enabled more efficient determination of ZOI on an annual basis that can be used to examine trends in ZOI distance and magnitude over time (Appendix C in The Caribou Zone of Influence Technical Task Group. 2015. Draft guidance for monitoring the zone of influence (ZOI) of anthropogenic disturbance on barren-ground caribou, 10 Mar 2015 and provided to the Review Board with this IR for the public registry). Annual variation in ZOI could be related to patterns of mining activity (blasting, ore hauling, etc.). Dominion has shown that aerial survey data from 2009 and 2012 are available (response to DAR-IEMA-IR-24). These two years are important in that they occurred during the lowest levels of herd size and when activity at Misery increased. Examination of the relationship between ZOI distance and magnitude with patterns of mine activity would provide direction to more effective mitigation of project effects. This analysis should indicate further opportunities for mitigation of effects on caribou that can be applied to the proposed Jay Project and existing operations.

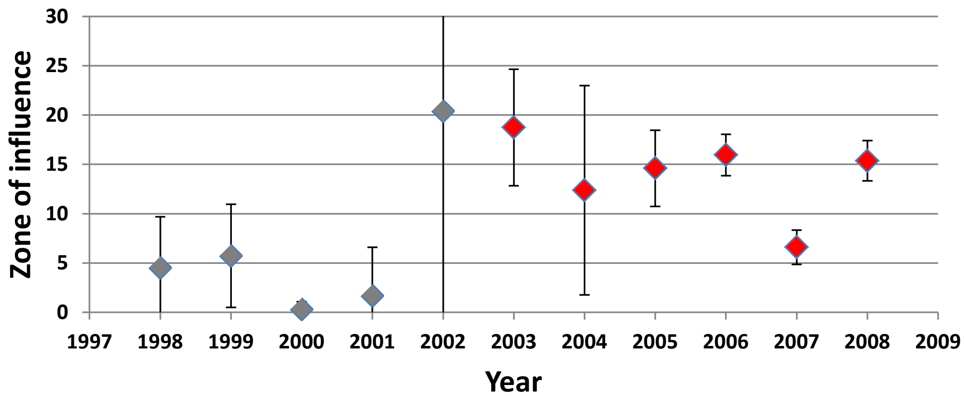
Request (IEMA):

Dominion should analyze the 2009 and 2012 aerial survey data from within the combined Ekati-Diavik study area using the new R code analysis to produce estimates of ZOI distance and magnitude. It would be even more helpful if DDEC would provide measures of mine activity on an annual basis that could be correlated with changes in ZOI. Those measures could include annual levels of blasting (amount of ammonium nitrate), amount of cumulative traffic, numbers of flights and a GANTT diagram showing underground and open pit timing. The lessons learned from this analysis should then be applied to adaptive management and mitigation of effects in relation to caribou from the Jay Project and existing operations.

Response:

Figure 3 of Appendix C (GNWT-ENR 2015), which provides annual zone of influence (ZOI) estimates from post-calving aerial survey data, shows very little annual variation (Figure 6-1). This figure indicates that ZOI estimates from 1998 to 2002 were not statistically significant (i.e., not statistically different than 0 kilometre [km]) and from 2003 to 2008 were statistically significant. For the years with statistically significant results, the confidence limits overlap one another indicating they are unlikely unique (Figure 6-1). Overall, the confidence limits from the annual point estimates overlap the ZOI of 14 km of Boulanger et al. (2012) and the 15 km used in the Developer's Assessment Report (DAR), and suggest little year-to-year variation. The exception is for 2007 when the ZOI was estimated to be 7 km and the upper confidence interval did not overlap 14 km. In other words, in 2007, the ZOI was significantly smaller than the 15 km ZOI assumed in the DAR.

Figure 6-1 Yearly Zone of Influence Estimates (± 95% CI) for Ekati and Diavik, 1998 to 2008 from in Appendix C (Boulanger 2015) in *Draft Guidance for Monitoring the Zone of Influence (*GNWT-ENR 2015).



Note: Estimates that were not statistically significant are shown in grey.
% = percent; CI =confidence interval; ± = plus or equal to.

The Bathurst herd declined by approximately 90 percent (%) from 350,000 animals in 1996 to 32,000 animals in 2009, which overlaps the temporal extent of the data and analysis of Boulanger et al. (2012). The estimate of the Bathurst herd in 2012 was 35,000 animals, respectively, and suggested the herd had stabilized between 2009 and 2012. Thus, there was very little additional change to the Bathurst herd size and any relationship between annual ZOI estimates and herd size would largely be captured in the results of Boulanger et al. (2012). As well, Table 2 of Boulanger et al. (2012) shows that the ZOI estimate and confidence intervals resulting from a model which pools all 11 years (1998 to 2008) of aerial survey data (i.e., assumes no temporal variation) are nearly identical to those estimated for the operational period of 2003 to 2008. This similarity demonstrates that temporal stratification did not significantly alter the ZOI estimate and in combination with the little temporal variation shown in Figure 6-1, that generation of annual estimates from 2009 and 2012 aerial survey data is unlikely to change the ZOI demonstrated. Thus, there is not an empirical basis for carrying out the requested analysis and the inclusion of two additional years of aerial survey data are unlikely to change the results of the DAR.

With the inclusion of the Jay Project in the Ekati Mine Wildlife Effects Monitoring Program (WEMP), Dominion Diamond will also provide further analysis of the caribou ZOI and examine relationships with annual mine activity as part of the WEMP reporting process.

References:

Boulanger J. 2015. Estimation of Zone of Influence of Mine Sites on Caribou Populations: New Analysis Methods and Sample Size Requirements. Prepared by Integrated Ecological Research for The Government of the Northwest Territories, Nelson, BC.

Boulanger J, Poole KG, Gunn A, Wierzchowski J. 2012. Estimating the Zone of Influence of Industrial Developments on Wildlife: a Migratory Caribou *Rangifer tarandus groenlandicus* and diamond mine case study. Wildlife Biol 18: 164-179.

GNWT-ENR (Government of the Northwest Territories, Department of Environment and Natural Resources). 2015. Draft Guidance for Monitoring the Zone of Influence (ZOI) of Anthropogenic Disturbance on Barren-ground Caribou. Prepared by the Caribou Zone of Influence Technical Task Group for the Government of the Northwest Territories, Yellowknife, NWT.

Information Request Number:	DAR-LKDFN-IR2-01
Source:	Lutsel K'e Dene First Nation Information Requests from Peter Unger
Subject:	Ambient Air Quality Guidelines
DAR Section(s):	Technical Session Undertaking #17

Preamble (LKDFN):

The GNWT has clarified the legal status of the NWT Ambient Air Quality Guidelines (AAQGs) as not being legally binding, but applying to the project area. The GNWT is currently developing legally binding air quality regulations.

The AAQGs were established to define acceptable air quality parameters for all parts of the Northwest Territories, including development projects. In the absence of legally binding regime, the AAQGs are the only available guidance from a regulatory body in the Northwest Territories. Given that this sole measure for what is acceptable air quality was designed with mining projects in mind and applies to the project area, as has been explicitly indicated, it would only seem logical that this should also be the benchmark for significance for the project's air quality.

Request (LKDFN):

LKDFN requests that the proponent amend the definition of significance to include all exceedances of the AAQGs. Barring this, LKDFN wishes to know what steps the proponent is taking to prepare for the new air quality regulations being developed by the GNWT and if the project's definition of significance will change if new air quality regulations set legally binding limits at similar levels to those outlined in the AAQGs.

Response:

In keeping with widely accepted practices in Canada for conducting environmental assessments, the determination of the significance for air quality includes a number of criteria, only one of which is magnitude. Dominion Diamond believes that the use of the Northwest Territories (NWT) ambient air quality guideline (GNWT-ENR 2014) within the development area in the Developer's Assessment Report (DAR) is appropriate for determining magnitude, one of the residual impact criteria used to evaluate significance of effects on air quality, where exceedances indicate a high magnitude. Other criteria considered when evaluating the potential significance of air quality effects include geographic extent, duration, frequency, reversibility, and likelihood. Based on available literature and experience from other projects, a significant air quality effect would occur if the Jay Project (Project) were to irreversibly result in ambient air concentrations beyond the development area that frequently or consistently exceed relevant established ambient air quality criteria, and that could not be mitigated. In the DAR, Section 7.1.4.1, the development area is defined as:

"An area that includes the Project footprint and the mine footprints of the Ekati Mine and Diavik Mine. This area is either already physically disturbed by existing or planned mining activities, or has limited public access."

The development area includes mine pits and haul roads which are sources of vehicle exhaust and fugitive dust emissions. It is Dominion Diamond's view that this area is not considered a part of natural environment. This view is consistent with the Canadian Council of Ministers of the Environment (CCME) when developing Canada Wide Standards upon which the Government of Northwest Territories (GNWT) previously based its ambient air quality guideline. Specifically, the CCME (2000) acknowledged that achievement of the standards were to be based on community-oriented monitoring sites" (CCME 2000), with an emphasis on areas "where people live, work and play rather than at the expected maximum impact point for specific emission sources" (CCME 2000). Given this acknowledgement by the CCME, it would be inconsistent for the GNWT to apply the ambient air quality guidelines within the development of a mine, just as it would for them to apply the ambient air quality guidelines at the end of a vehicle exhaust pipe or at the top of a stack. An example of a regulatory air standard that does apply at a point of discharge is the Canada Wide Standard for Dioxins and Furans (CCME 2001), which sets specific limits to the concentration of air contaminants in the exhaust gases. Because the mine pits and haul roads at the Project are themselves sources of vehicle exhaust and fugitive dust emissions, trying to apply the NWT ambient air quality guidelines within the development areas would be inconsistent with the intent of the CCME, and would be effectively applying them at the point of discharge, which is not the purpose of ambient air quality criteria.

Furthermore, the GNWT has adopted regulations specifically for the protection of the health and safety of workers at mines. The Government of the Northwest Territories Mine Health and Safety Regulations (Section 9.02) states that employees shall not be exposed to airborne chemical or physical substances in excess of those specified in the 1994-1995 Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices published by the American Conference of Governmental Industrial Hygienists (GNWT 2015). These thresholds are higher than the NWT ambient air quality guidelines and would be applicable inside the development area.

It is Dominion Diamond's intent to apply the NWT ambient air quality guidelines (GNWT-ENR 2014) as standards or targets for purposes of air quality monitoring and management at the Project. Therefore, the fact that the NWT ambient air quality guidelines are non-legally binding, as clarified by the GNWT Department of Environment and Natural Resources (ENR) in a letter (GNWT-ENR 2015) responding to Undertaking 17 from the Mackenzie Valley Environmental Impact Review Board (MVEIRB) Technical Sessions for the Project on April 24, 2015, will have no effect on how Dominion Diamond plans to manage the air quality at the Project.

Dominion Diamond, in its proposed Conceptual Air Quality and Emission Monitoring and Management Plan for the Jay Project (AQEMMP; Dominion Diamond 2015) submitted to the MVEIRB on June 1, 2015, and discussed with parties during a workshop on June 26, plans to include an adaptive management approach to the management of air quality at the Project. The NWT ambient air quality guidelines, regardless of their current non-legally binding status, will be used as the bases for the criteria that will trigger appropriate management actions as proposed in the AQEMMP. If new ambient air quality guideline or standard values are adopted by the GNWT in the future, the AQEMMP for the Project will be updated to reflect the changes in the guidelines or standards.

References:

CCME (Canadian Council of the Ministers of the Environment). 2000. Canada-Wide Standards for Particulate Matter (PM) and Ozone. June 2000.

CCME. 2001. Canada-Wide Standards for Dioxins and Furans. May 2001.

Dominion Diamond (Dominion Diamond Corporation). 2015. Conceptual Air Quality and Emission Monitoring and Management Plan for the Jay Project – DRAFT. Prepared by Golder Associates Ltd. June 2015. Available at: http://www.reviewboard.ca/registry/project.php?project_id=674

GNWT (Government of Northwest Territories). 2015. Mine Health and Safety Act. Mine Health and Safety Regulations. Available at https://www.justice.gov.nt.ca/en/files/legislation/mine-health-and-safety/mine-health-and-safety.r1.pdf.

GNWT-ENR (Environment and Natural Resources, Government of the Northwest Territories). 2015. Re: Understanding #17 Air Quality – GNWT Ambient Air Quality Guidelines [open letter]. Available at http://www.reviewboard.ca/upload/project_document/EA1314-01_Undertaking__17_from_tech_session_-_ENR_response.PDF.

GNWT-ENR. 2014. Guideline for Ambient Air Quality Standards in the Northwest Territories. Yellowknife, NWT, Canada, 5 pp.

Information Request Number:	DAR-LKDFN-IR2-03
Source:	Lutsel K'e Dene First Nation Information Requests from Peter Unger
Subject:	Caribou avoidance and power lines
DAR Section(s):	Jay Technical Sessions (Day 2 Transcript)

Preamble (LKDFN):

Recent research suggests that power lines could have more significant impacts on caribou than previously assumed (Breyer, HL; Gurarie, E; Borger, L; Panzacchi, M, Basille, M; Herfindal, I; Van Moorter, B; Lele, SR; and Matthiopoulos, J. 2014. ‘You shall not pass!’: quantifying barrier permeability and proximity avoidance by animals. Journal of Animal Ecology. doi: 10.1111/1365-2656.12275; Tyler, N., Stokkan, K.-A., Hogg, C., Nellemann, C., Vistnes, A.-I. and Jeffery, G. 2014. Ultraviolet Vision and Avoidance of Power Lines in Birds and Mammals. Conservation Biology, 28: 630–631. doi: 10.1111/cobi.12262). Despite this, DDEC has stated that it currently has no measures in place to mitigate avoidance by caribou (Technical Session, Day 2). DDEC has cited a level of uncertainty as to the level of impact on caribou.

Given the level of uncertainty and that no measures are being implemented to mitigate the impacts of power lines on caribou movement, it would be good to gain a bit more certainty as to how power lines affect caribou migrations in the Northwest Territories.

Request (LKDFN):

LKDFN requests that DDEC include studies on caribou avoidance of power lines as part of the caribou monitoring program for this project. LKDFN requests that DDEC publish the methodology for observations of interactions between caribou and power lines before operations begin.

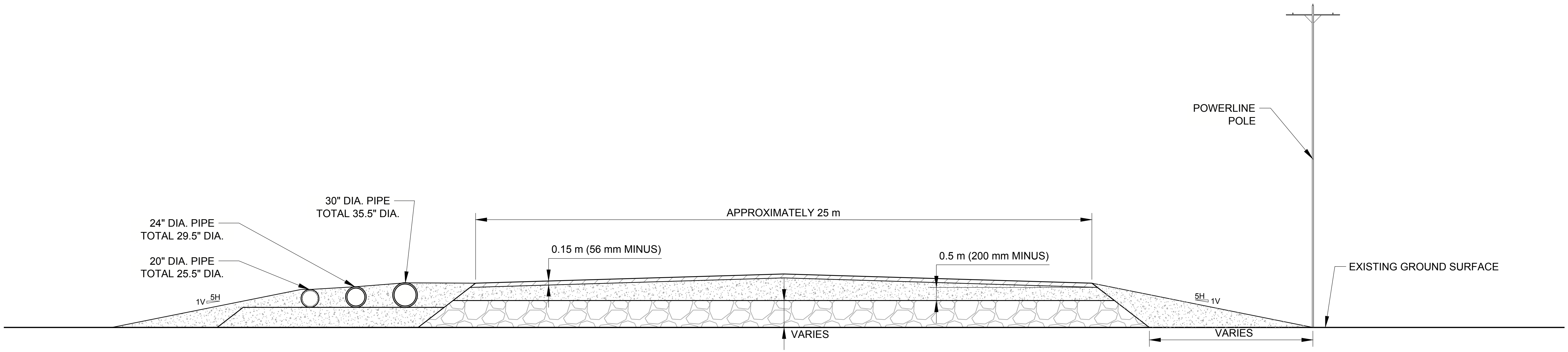
Response:

As shown in the corresponding Map 94-1 of the response to DAR-MVEIRB-IR-94 (also provided below as Figure 3-1), the power line proposed for the Jay Project (Project) will be constructed within 25 metres of the Jay Road. As noted in the response to DAR-LKDFN-IR-16 during the first round of information requests, a qualitative analysis of the potential effects of the power distribution line was presented in the Developer’s Assessment Report (DAR) Section 12.4.2.2.2 (pages 12-97 and 12-98). The analysis identified a range of magnitude of observed effects from power lines, roads, traffic, and human activity levels on caribou (Berger et al. 2000; Reimers et al. 2000; Vistnes and Nellemann 2001; Reimers et al. 2007; Vistnes et al. 2008). Potential effects from corona noise and ultraviolet light were also considered (Flydal et al. 2003, 2009; Harper 2014; Hogg et al. 2014; Tyler et al. 2014). Overall, the information suggests that above-ground power lines have smaller effects on caribou movement and distribution than the physical presence of roads and vehicle traffic. Therefore, it will not be possible to distinguish an avoidance effect of the Project power line versus the effect from the Jay Road. Additionally, other sources of disturbance such as noise, smells, dust, or vibration will be present during Project construction and operation, which prevent isolation of different sensory disturbance effects.

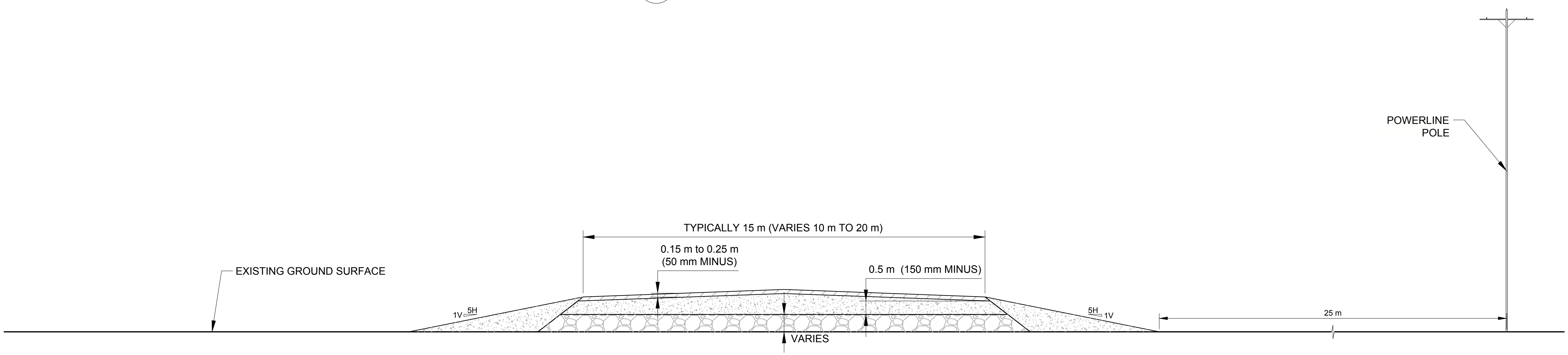
As identified in the response to DAR-MVEIRB-IR-01, experiments that identify cause and effect relationships with a zone of influence will be subject to practical constraints. For example, studies have detected correlative changes in caribou behaviour near mines (see Section 12.2.1.1.2 of the DAR), but it is unknown whether these behavioural changes (e.g., a zone of influence) are in response to mine-related noise, smells, dust, vibration, or other sensory disturbance. Since these potential disturbances occur at the same time during mine construction and operation, the relative contribution from the residual effect of each type to an observed behavioral change is unknown. There are several technical challenges and constraints to establishing cause and effect relationships between a type of sensory disturbance and behavioural changes. These include:

- isolation of sensory disturbance types;
- representative controls; and,
- sufficient replication at the scale of development to provide confidence in conclusions.

Such an experiment would require a substantial change in how mines operate, which would affect the feasibility. It may also require a reduction of other types of mitigation, which may have consequences to the target wildlife species or other components of the receiving environment. Monitoring of Project roads (and associated power lines) would be within the existing scope of the Ekati Mine Wildlife Effects Monitoring Program, which will be amended to include the Project.



A **JAY ROAD CARIBOU CROSSING**



B **TYPICAL MISERY ROAD CARIBOU CROSSING**

LEGEND

- ROAD BASE
- ROAD SURFACING
- ROCKFILL

NOTES

1. ALL UNITS IN METRES UNLESS OTHERWISE NOTED.
2. ELEVATION IN METRES ABOVE SEA LEVEL.
3. TOTAL DIAMETER INCLUDES 2.75" OF INSULATION AND HEAT TRACING. DIA. = OUTSIDE DIAMETER DIMENSION.
4. BERM TO BE CONSTRUCTED WHERE ROAD FILL THICKNESS EXCEEDS 3 m. MINIMUM OPERATION WIDTH TO BE MAINTAINED.
5. GEOMETRY OF ROAD AND PIPELINE BENCH VARIES BASED ON TERRAIN.

0 2.5 5
SCALE METRES

REV	DATE	DESCRIPTION	DRW	DES	CHK	RVW
0	2015-04-02	ISSUED FOR FINAL	RW	CM	FE	FD
B	2015-03-26	DRAFT-ISSUED FOR REVIEW	RW	CM	-	-

SEAL / PERMIT

CLIENT
DOMINION DIAMOND

CONSULTANT
Golder Associates

PROJECT 1419751.3200.35
JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE
TYPICAL SECTIONS
CARIBOU CROSSINGS

DRAWING No. 3-1
SHEET No. 1 OF 1

SHEET SIZE ANSI D

DOMINION DIAMOND

References:

Berger R, Martinez I, Wisener M. 2000. Analysis of GPS Relocation Data (1995-1999) for the Owl Lake Woodland Caribou – Report to Manitoba Hydro, Manitoba Conservation, Pine Falls Paper Company, Manitoba Model Forest and Time to Respect Earth's Ecosystems. 88 pp + appendices.

Flydal K, Rogstad I, Per E, Reimers E. 2003. Reindeer (Rangifer tarandus tarandus) Perception of noise from powerlines. Rangifer 23:21-24.

Flydal K, Korslund L, Reimers E, Johansen F, Colman JE. 2009. Effects of power lines on area use and behaviour of semi-domestic reindeer in enclosures. Int J Ecol: 2009.

Harper M. 2014. Lines Designer, McGregor Construction 2000 Ltd. Calgary, AB, Canada. E-mail. July 8, 2014.

Hogg C, Neveu M, Stokkan K-A, Folkow L, Cottrill P, Douglas R, Hunt DM, Jeffrey G. 2014. Arctic reindeer extend their visual range into the ultraviolet. J Exp Biol 214: 2017-2019.

Reimers E, Flydal K, Stenseth R. 2000. High Voltage Power Lines and Their Effect on Reindeer: A Research Programme in Progress. Polar Res:75-82.

Reimers E, Dahle B, Eftestøl S, Colman JE, Gaare E. 2007. Effects of a power line on migration and range use of wild reindeer. Biol Conserv 134: 484-494.

Tyler N, Stokkan K-A, Hogg C, Nellemann C, Vistnes A-I, Jeffery G. 2014. Ultraviolet vision and avoidance of power lines in birds and mammals. Conserv Biol 3: 630-632.

Vistnes I, Nellemann C. 2001. Avoidance of cabins, roads, and power lines by reindeer during calving. J Wildlife Manage 65: 915–925.

Vistnes II, Nellemann C, Jordhøy P, Støen, O-G. 2008. Summer distribution of wild reindeer in relation to human activity and insect stress. Polar Biol 31:1307-1317.

DOMINION DIAMOND

Information Request Number:	DAR-LKDFN-IR2-05
Source:	Lutsel K'e Dene First Nation Information Requests from Peter Unger
Subject:	Greenhouse gas emissions/alternative energy
DAR Section(s):	7

Preamble (LKDFN):

The proponent has always maintained that the Jay Project is an expansion of the Ekati mine and not a new project. DDEC has also stated that it has an internal policy on GHG reduction with targets.

Given that the project is considered an expansion of the Ekati mine and that therefore this project will be extending the life of the mine. It seems reasonable to think longer-term about this mine. If DDEC has reduction of GHG emissions as a goal, alternative energies seem to be a reasonable choice.

Request (LKDFN):

If the Ekati mine's life is extended through this project, and the proponent has a sincere intention to reduce greenhouse gas emissions, why has there been no serious consideration of alternative energies, such as the wind turbines installed at Diavik?

Response:

Dominion Diamond is committed to reducing overall greenhouse gas emissions from the Ekati Mine. As noted in the response to DAR-NSMA-IR2-04, Dominion Diamond has set the following targets for reducing greenhouse gas emissions for fiscal year 2016 (February 1, 2015 to January 31, 2016):

- Reduce energy baseload by 5%
- Reduce Greenhouse Gas Emissions by 5%
- Realize energy savings of $2 million
- Reduce fuel consumption by 5%

Dominion Diamond will continue to set targets for greenhouse gas emissions annually for the life of the Ekati Mine and this will be reported as part of the Air Quality Monitoring Program report, Mining Association of Canada Towards Sustainable Mining Program, and the Environment Canada Greenhouse Gas Inventory.

Since Dominion Diamond has taken ownership of the Ekati Mine, several programs and improvements have been put in place. Dominion Diamond has put in place a Greenhouse Gas and Energy Management Steering Committee comprising of energy leaders in each area of the business. The Steering Committee's mandate is to "*ensure that effective and efficient energy use remains part of the way that we do business and to ensure that we seek out opportunities to reduce our energy use and greenhouse gas emissions at Ekati".* The Steering Committee has prepared and released a monthly dashboard on energy and diesel use and emissions generated for the information of staff. The Steering Committee is also responsible for reviewing and identifying projects that meet the above mandate, including consideration of potential alternative energy projects.

Some key initiatives that have occurred since the purchase of the Ekati Mine include the purchase and commissioning of a large-scale composter that will reduce the need to operate two incinerators, and the purchase and testing of biodiesel use in some equipment. Reducing the use of incinerators down to only one will decrease the amount of diesel used, as well as eliminate emissions from the incinerator stack. The biodiesel was tested in a loader, a grader, and in a light vehicle at various blends in 2014. Preliminary results indicated a reduction in emissions, and testing is ongoing this year.

Information Request Number:	DAR-MVEIRB-IR2-01
Source:	Mackenzie Valley Environmental Impact Review Board Information Requests from Chuck Hubert
Subject:	Neutralization Potential to Acid Generation Potential
DAR Section(s):	Annex VIII

Preamble (MVEIRB):

Annex VIII of the DAR presents the Geochemistry Baseline assessment for the Jay Expansion project performed by Golder Associates. In this Annex, Golder indicates that they calculated the ratio of neutralization potential to acid generation potential (NP/AP) using the bulk NP (which consumes neutralization capacity of a sample with a known amount of acid and then back titrates to determine how much acid was consumed), with total sulfur as the basis for AP. Using total sulfur is somewhat conservative for estimating AP since sulfide, the form of total sulfur that generates the acid, is generally 50% to 95% of the total sulfur. However, the bulk NP may overestimate actual NP under field conditions. An alternative for NP would be to use the carbonate neutralization potential (calculated from inorganic carbon content), which has also been measured and reported in the Geochemistry Baseline Report. The bulk NP, by definition, measures both non-carbonate and carbonate neutralization, so is expected to be higher than carbonate NP. The bulk NP includes neutralizing effects from non-carbonate alkaline minerals like calcic feldspars, olivine, amphiboles, etc. These other alkaline minerals are not as “labile” for neutralizing any acid generated as carbonates typically are. The Geochemical Baseline Report acknowledges this in a couple of places (e.g., the last sentence on page 3-4 and the last bullet on page 4-15). The humidity cell data also suggest that bulk NP is a bit of an overstatement of “active” NP for the Jay Project waste rock because, for example, the depletion analysis for the metasediments indicates that the bulk NP is depleted well after the AP is exhausted, however the leachate from several of the cells is acidic. The concentration trend data presented (e.g., Figure 4.3-3) indicate that pH drops over the first 20 or so weeks and then stays constant or rises slightly and that constituent concentrations in the leachate increase while pH is dropping and then decrease after 50 or so weeks. This suggests that the carbonate NP is depleted within the first 20 weeks and the non-carbonate NP doesn’t become important until after around 50 weeks.

Request (MVEIRB):

Calculate the overall net neutralization potential of the combined waste rock using both the bulk and carbonate neutralization potential to determine if there is a significant difference, and to establish if the potential for ARD and the waste management plans need to be revised to consider that not all of the bulk NP is available to neutralize acids generated by the metasediments. Please also integrate the results and observations of seepage monitoring performed throughout the Ekati Mine over the past fifteen years into this evaluation.

Response:

Table 1-1 provides the total tonnages and relative proportions of each lithology that will be stored in the Jay waste rock storage area (WRSA) at the cessation of mining in the Jay Pit.

Table 1-1 Jay Waste Rock Storage Area Tonnages and Relative Proportions

Lithology	Tonnage (t)	Relative Percent (%)
Granite	128,768,741	75
Overburden	10,176,638	
Metasediment	45,881,440	25
Kimberlite	72,428	0.039
Total Waste	184,899,247	100

To calculate the overall net neutralization potential (NNP) of the Jay WRSA, the total acid potential (AP), bulk neutralization potential (bulk-NP), and carbonate neutralization potential (CO_3-NP) were estimated based on the median and average values of these parameters measured in waste rock samples from the Jay and Misery Pits (Geochemistry Baseline; Annex VIII of the Developer's Assessment Report [DAR]).

Sixty samples representative of waste rock to be mined from the Jay Pit were available at the time the DAR was completed. To optimize the evaluation of the acid rock drainage (ARD) potential, results of geochemical testing from Misery waste rock were included for calculation of the AP, bulk-NP, and CO_3-NP. Geochemical test results from Misery waste rock samples provide a reasonable analogue of the Jay waste rock for the following reasons:

- The Misery Pit is located near the proposed location of the Jay Pit; and,
- The Misery WRSA contains similar waste rock types (i.e., mainly granite and metasediment) as those to be mined from the Jay Pit, albeit in different proportions.

The AP of the Jay WRSA was calculated using total sulphur (see Annex VIII of the DAR for total sulphur concentrations). This provides a conservative estimate of the AP since it assumes all of the sulphur in the samples is available to react. The bulk-NP was derived from direct measurement and CO_3-NP was calculated from measured total inorganic carbon concentrations. Additional detail regarding the procedures for determination of these parameters is provided in Annex VIII of the DAR.

Using the proposed waste rock tonnages presented in Table 1-1, the average and median total AP, bulk-NP, and CO_3-NP were calculated for each lithology and summed to determine these parameters for the entire Jay WRSA. The bulk-NNP and CO_3-NNP were subsequently calculated by subtracting the AP from the bulk-NP and the CO_3-NP, respectively. Calculated values for bulk-NNP and CO_3-NNP for the Jay WRSA are provided in Table 1-2.

Comparison of the neutralization potential ratio (NPR), calculated as the ratio of NP to AP, to screening criteria is generally the more accepted approach for determining ARD potential (INAP 2009; MEND 2009). Therefore, bulk-NPR and CO_3-NPR were also calculated for the Jay WRSA (Table 1-2).

Table 1-2 Jay Waste Rock Storage Area Net Neutralization Potential and Neutralization Potential Ratios

Lithology	Bulk-NP (tonnes $CaCO_3$)	CO_3-NP (tonnes $CaCO_3$)	AP (tonnes $CaCO_3$)	Bulk-NNP (tonnes $CaCO_3$)	CO_3-NNP (tonnes $CaCO_3$)	Bulk-NPR	CO_3-NPR
Median							
Granite	695	253	22	673	231	32	11.6
Kimberlite	20	5.1	0.23	20	5	88.7	22.7
Metasediment	413	104	227	186	-122	1.82	0.46
Total	**1,128**	**362**	**248**	**879**	**114**	**4.5**	**1.5**
Average							
Granite	1,375	294	113	1,261	181	12.1	2.6
Kimberlite	17	5.6	0.63	17	5	27.5	9.0
Metasediment	822	280	229	593	51	3.6	1.22
Total	**2,214**	**579**	**343**	**1,871**	**237**	**6.5**	**1.7**

NP = neutralization potential; AP = acid potential; NNP = net neutralization potential; NPR = neutralization potential ratio; $CaCO_3$ = calcium carbonate; CO_3 = carbonate.

The bulk-NNP and CO_3-NNP for the Jay WRSA were positive for both the median and average scenarios (Table 1-2), indicating the Jay WRSA will contain more NP than AP. The Global Acid Rock Drainage (GARD) Guide (INAP 2009) and the Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials (MEND 2009) provide the following characterization criteria:

- Samples with an NPR>2 are non-potentially acid generating (non-PAG);
- Samples with NPR<2 but greater than 1 have uncertain acid potential; and,
- Samples with an NPR<1 are potentially acid generating (PAG).

Based on the expected waste rock tonnages (Table 1-1), the Jay WRSA is calculated to have median and average bulk-NPR values of 4.5 and 6.5, respectively. The CO_3-NPR values were calculated as 1.5 and 1.7 for the median and average scenarios, respectively. Using the above criteria, the Jay WRSA is characterized as non-PAG based on the bulk-NPR and as having uncertain acid generating potential based on CO_3-NPR.

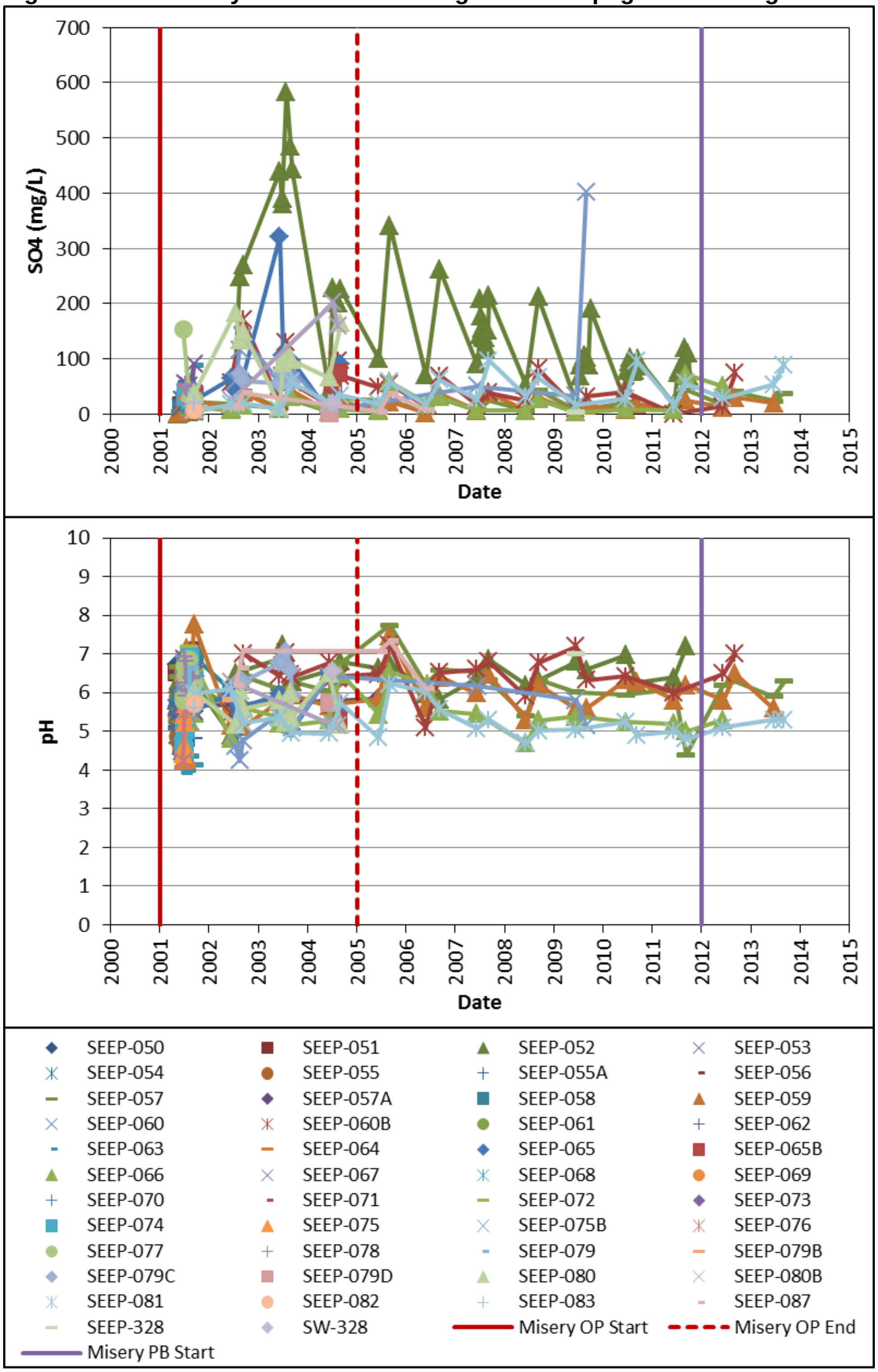
The above calculations include the following conservative assumptions:

- Acid potential is calculated using total sulphur;
- The pile does not include the 5-metre cover of non-PAG granite at closure to promote permafrost development;
- A reduction factor was not applied to account for lower sulphide oxidation of materials stored deeper in the pile, where oxygen will be limited; and,
- Permafrost, which would limit ingress of oxygen and water, does not develop within the pile.

Based on the calculation of bulk-NNP, CO_3-NPR, bulk-NPR, CO_3-NPR and the inherent assumptions included in the calculation, the Jay WRSA is not considered to be PAG and the proposed waste management strategy for the Jay Project does not require refinement. Management of the Jay WRSA, including monitoring and testing, will be incorporated into the Ekati Mine Waste Rock and Ore Management Plan (WROMP).

Supporting evidence is provided by the Misery WRSA, located approximately three kilometres southwest of the proposed Jay WRSA. This pile contains a larger percentage of metasedimentary waste rock (approximately 52%) than is anticipated for the Jay facility. Seepage monitoring results from the Misery WRSA (Figure 1-1) indicate drainage is circumneutral and exhibits a decreasing trend in sulphate concentrations (SRK 2014). Since the metasedimentary material is the most reactive, these empirical field data suggest that acid generation in the Jay WRSA is unlikely.

Figure 1-1 Misery Waste Rock Storage Area Seepage Monitoring Results



SO_4 = sulphate; mg/L = milligrams per litre

References:

INAP (International Network for Acid Prevention). 2009. Global Acid Rock Drainage Guide. Available at: www.gardguide.com. Accessed: Jun 30, 2015

MEND (Mine Environment Neutral Drainage). 2009. Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials. MEND Report 1.20.1. December 2009.

SRK (SRK Consulting). 2014. 2014 Waste Rock and Waste Rock Storage Area Seepage Survey Report – FINAL. Prepared for Dominion Diamond Ekati Corporation. Submitted April 2015.

Information Request Number:	DAR-MVEIRB-IR2-02
Source:	Mackenzie Valley Environmental Impact Review Board Information Requests from Chuck Hubert
Subject:	Pre-feasibility dike design report
DAR Section(s):	Jay Project Pre-feasibility Dike Design (Appendix E of Round 1 IR Responses on April 7)

Preamble (MVEIRB):

Drawing 300-10 shows all lacustrine sediments absent beneath the footprint of the rockfill section. In Section 7.2 Stability Analysis, the third paragraph starts with "During construction of the rockfill platform, it is anticipated that rockfill will penetrate and/or displace the soft lakebed sediment." For sake of argument if: the average thickness of the lacustrine sediments is 2.5 m, the average width of the dyke is 100 m, and the length of the dyke over the sediments is 4000 m, then the lacustrine soils have a volume of one million cubic meters. Since no dredging is specified, this silt will either be displaced (as a mud wave) or incorporated into the rockfill. The silt quantity expected to be removed as listed in Appendix E is 60,000 cubic meters. This quantity is all from the central section excavation. In Appendix C Section 4.2 Dyke Stability paragraph 4 states " To be conservative, the dyke stability models also considered scenarios where a 1 m layer of lakebed sediment remains beneath the rockfill. Figure C2 in Appendix C shows lakebed sediment. Figures C8, C9, C10, and C11 do not show the lacustrine sediments. Table C-4 Material Properties for Stability Modelling lists only friction angles for lakebed sediments with no undrained strengths listed. Table C11 gives Factor of Safety for on-going construction which is either 1.1 or 1.0. Presumably, this is for the drained friction angles in Table C-4. The undrained strength of the lacustrine sediments will govern the stability of the rockfill dyke slopes. Otherwise it will not fail ("displaced or incorporated into the rockfill") as stated by the designers.

Request (MVEIRB):

a) If some of the silt is displaced as a mud wave at the leading edge of rockfill placement, it will build up and have to be removed. How is this mud wave going to be removed? Where is this lacustrine silt going to be deposited?

b) Given that the designers assumed failure of the lacustrine sediments to achieve displacement or incorporation into the rockfill, why is the FOS based on the drained strength during construction? Why is the design criteria set at a FOS of 1.3 when this cannot be achieved? Please clarify.

Response:

a) Based on information obtained from the cone penetration testing conducted as part of the winter 2015 investigation program, the lakebed sediments typically consist of two layers of materials, each with varying thickness. The upper layer of the lakebed sediment is very soft, sensitive fines that will readily be suspended within the water column or incorporated into the rockfill as the rockfill is placed, and are not anticipated to have sufficient consistency to form a mud wave. The second, lower layer consists of a firm to stiff, low to non-plastic silt. During cone penetration, this material displayed a dilative response. The degree of rockfill penetration or movement of this lower layer is anticipated to vary. Based on experience obtained during construction of the Bay-Goose Dike at the Meadowbank Mine, mud waves were not detected during rockfill placement, and following dewatering, no mud wave was evident along the downstream toe of either the Bay-Goose or East Dike.

If a sufficient thickness of silt develops during rockfill placement of the Jay Dike, deemed to be a concern for dike stability or to improve constructability, this material could be removed using either a long reach excavator, clam shell, dredge, or other mechanical mechanism. This equipment will be on site and will be used for excavation and removal of lakebed sediment material from the central trench. Silt curtains will be in place while in-water, summer construction activities are carried out. The silt curtains will limit the extent of total suspended solids (TSS) mobilization within Lac du Sauvage as a result of dike construction.

Excavated lakebed sediment will be transported to the waste rock storage area (WRSA) for disposal. Trucks will have tailgates and/or other containment mechanisms to minimize spillage of the excavated lakebed material. If the quarry is developed within the WRSA, this facility would be utilized for placement/containment of the lakebed sediments. If the quarry is not developed, containment cells constructed of either rockfill and/or till will be constructed within the WRSA footprint for disposal of this material. The location of these cells has not been defined yet, but would be away from the perimeter of the WRSA. The detailed design for the WRSA will contain details regarding placement of waste construction materials. If dredging is used to remove lakebed sediments, then the King Pond Settling Facility may be utilized for water with elevated TSS.

b) The detailed design for the Jay Dike is in progress. The design will incorporate information obtained from the 2014 and 2015 investigation programs. The design will include additional stability analyses. It is anticipated that the detailed design report would be submitted to the Wek´èezhìi Land and Water Board during the Water Licence permitting phase for the Jay Project.

Stability analyses presented as part of the pre-feasibility dike design, did not consider conditions immediately following or during rockfill placement (short term stability conditions); they analyzed conditions following rockfill placement with loaded haul trucks travelling along the rockfill shell crest. Two cases were assessed: one without lakebed sediments in the foundation of the rockfill shell; and a sensitivity case, which included a 1 metre thick layer of lakebed sediment beneath the rockfill shell for which drained parameters of the lakebed sediments were utilized. The analyses were utilized to demonstrate that a factor of safety of 1.3 or greater could be achieved for loaded trucks travelling along the rockfill shell with an appropriate setback distance from the rockfill shell edge.

Information Request Number:	DAR-MVEIRB-IR2-03
Source:	Mackenzie Valley Environmental Impact Review Board Information Requests from Chuck Hubert
Subject:	Caribou - assessment endpoints and significance determination
DAR Section(s):	Technical session, April 21, Impacts to caribou, transcripts p 257-262

Preamble (MVEIRB):

In the first round of information requests, the Review Board asked parties (IR#77) to state their views on the developer's choice of assessment endpoints for caribou in determining significance of impacts. IEMA responded to the Review Board with an alternative to the ecological assessment endpoint of "self-sustaining and ecologically effective" for caribou as presented in Dominion's Jay Project DAR (DAR table 12.1-1).

IEMA proposed that Dominion Diamond should also include the following assessment endpoints into significance determination: "safety of caribou for human consumption" and "continued ability of Aboriginal groups to sustainably harvest caribou". During the technical session on May 21, Board staff asked parties if they would support the assessment endpoint for caribou as proposed by IEMA. Positive responses were received from DKFN, NSMA, GNWT and LKDFN. Parties generally agreed that the ability of Aboriginal people to continue to harvest caribou is a desirable assessment endpoint.

Request (MVEIRB):

a) Please conduct an effects assessment of the Jay Project combining the existing assessment endpoint in table 12.1-1, Chapter 12 of the DAR with the following assessment endpoints: "safety of caribou for human consumption" and "continued ability of Aboriginal groups to sustainably harvest caribou".

b) Please combine and incorporate these assessment endpoints into the determination of significance for the Jay Project on caribou with those described in Section 12.6.1.2 of the DAR.

c) Please conduct a cumulative effects assessment using the combined assessment endpoints described above with reasonably foreseeable developments including Sable, Diavik A21 and the Jay underground scenario as described in the technical session undertakings (DAR-MVEIRB-UT-04).

Response:

a), b), c) Dominion Diamond submitted a Human and Wildlife (including caribou) Health Risk Assessment as part of the Developer's Assessment Report (DAR) in February 2015. The multimedia risk assessment for human health estimated long-term risks for combined exposures to constituents of potential concern in air, water, soil, sediment, plants, fish, wild game and background dietary intake. The results of the human health multimedia risk assessment, which considered Jay Project (Project) activities contributing to deposition of particulate matter to terrestrial environments, and emission of substances to aquatic environments, during the life of the Project indicated that the residual effects of the Project to human health are not significant. Thus, the Project is predicted to have no significant effects on the safety of caribou for human consumption.

Section 15 on Culture included ‘continued opportunities to participate in traditional wildlife harvesting’ as an assessment endpoint. For this assessment endpoint, Section 15 considered the following measurement indicators in the determination of significance:

- availability (abundance and distribution) of traditionally harvested wildlife resources;
- disturbance to preferred wildlife harvesting areas;
- physical access to preferred land use areas;
- sensory disturbances (i.e., dust, viewscape, light, and noise);
- social and economic factors affecting participation in traditional land use;
- Aboriginal land users’ intangible relationship with the land; and,
- concerns regarding ecological and human health.

This assessment also incorporated the results from Section 12 on barren-ground caribou. Section 12 of the DAR evaluated whether the incremental and cumulative changes from the Project and other developments on habitat quantity, arrangement and connectivity, habitat quality (occupancy, movement, and behaviour), and survival and reproduction would result in a significant effect to self-sustaining and ecologically effective caribou populations. Ecological effectiveness includes interactions or ecological services that benefit other wildlife and the environment, including the use of caribou by people. The results of the residual effects analysis determined that cumulative effects from industrial development would not significantly influence the ability of caribou to be self-sustaining or ecologically effective.

The information from the caribou section was then used in the culture section (Section 15), which focuses on societal values, to determine if the changes in caribou measurement indicators would result in significant effects to the use of caribou by people (Section 12.1.3). Analyses of ecological significance and societal values of effects to caribou are both important to enable decision makers, or what Ehrlich and Ross (2015) call “significance determiners”, to provide an informed judgement about the Project. The approach in the DAR is to allow the significance determiners to consider the evidence on effects to ecological and societal values separately, before integrating the two when making a final informed decision about the Jay Project.

The analysis in Section 15 predicted that the incremental and cumulative changes to measurement indicators from the Project and other developments would not result in a significant effect to continued opportunities to participate in traditional wildlife harvesting (or the ability to sustainably harvest caribou). In assessing the incremental and cumulative effects from the Project and other developments on the continued opportunities for traditional use of caribou, the DAR considered the evidence that the population of barren-ground caribou herds changes greatly over decades of time. The effects from development on traditional use of caribou was assessed while also considering the natural processes that affect the availability (abundance, distribution, and access) of animals.

Natural cycles in the abundance and distribution of caribou populations have been reported in several Traditional Knowledge and scientific studies (Thorpe 2000; Zalatan et al. 2006; Sandlos 2007; Bergerud et al. 2008; Adamczewski et. al 2009; Festa-Bianchet et al. 2011). Previous historic periods of low Bathurst numbers occurred when there were no mines, and the Ahiak and Blue-nose East herds have declined rapidly between 2000 and 2006 without the influence of mining (Adamczewski et. al 2009). A large part of the Bathurst herd's decline (and other barren-ground populations) is the result of a natural demographic cycle reflecting large-scale weather patterns and natural factors including predation and harvest (Adamczewski et. al 2009; Boulanger et al. 2011; Festa-Bianchet et al. 2011). The relative contribution of the Jay Project, an expansion in an already disturbed area that is largely within an existing zone of influence, to the residual effects on caribou is expected to be small. The natural decline of the Bathurst caribou herd since the 1990s may be considered or perceived as statistically, ecologically and culturally significant. However, the weight of evidence in the DAR and additional analyses provided in adequacy review and information request responses indicates that previous and existing developments had little measurable effects on caribou survival and fecundity, and no significant contribution to the decline.

Opportunities to harvest Bathurst caribou and other herds have traditionally been subject to the fluctuating availability of animals based on the phase of the population cycle (Festa-Bianchet et al. 2011). The current low population level of the Bathurst herd, as with historic low population levels, have always affected the amount of sustainable harvest from the population. As well, harvest opportunities and ability have been and will continue to be influenced by the increasing number of people in the Northwest Territories, a shift to wage-earning, and changing technologies for hunting (e.g., snowmobiles, all-terrain vehicles, aircraft, winter roads, and rapid communications). Threats to caribou abundance and distribution, and sustainable harvest of animals (self-sustaining and ecologically effective populations) can occur when changes in hunting technologies adversely alter the relationship between harvest rate and animal abundance, or the population is currently in decline from other factors (Festa-Bianchet et al. 2011).

The analyses in the DAR, and the additional analysis completed in the adequacy review and information requests provides a comprehensive assessment of the Project-specific and cumulative effects of development on ecological and societal values of barren-ground caribou. The weight of evidence indicates that the incremental and cumulative effects from the Jay Project and previous, existing, and future developments (including Sable, Diavik A21, and Jay underground) do not significantly influence the ability of caribou to be self-sustaining and ecologically effective, safe to eat, or provide continued opportunities to participate in traditional wildlife harvesting. Adding or modifying assessment endpoints does not change the residual effects analysis or confidence in the impact classification and determination of significance.

References:

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DOMINION DIAMOND

Information Request Number:	DAR-MVEIRB-IR2-04
Source:	Mackenzie Valley Environmental Impact Review Board Information Requests from Chuck Hubert
Subject:	Caribou - assessment endpoints and significance determination
DAR Section(s):	Technical session, April 21, Impacts to caribou, transcripts p 257-262

Preamble (MVEIRB):

In its response to the undertaking MVEIRB-UT-03, Dominion provides examples of strategies to mitigate light pollution. These include fully shielded lighting fixtures, lighting design that involves tilt and orientation and switches or motion detectors in high illumination areas not occupied on a continuous basis.

Request (MVEIRB):

As described in its response to DAR-MVEIRB-UT-03 for the Jay Project, describe the mitigation strategies to which Dominion Diamond will commit to implementing for light pollution. Please also describe how, when and where these mitigation strategies will be implemented and monitored for success.

Response:

As the reviewer noted, DAR-MVEIRB-UT-03 describes possible mitigation strategies for light pollution. These include utilization of fully shielded lighting fixtures, lighting design that involves tilt and orientation and meets the required light levels to ensure worker health and safety onsite while minimizing luminous flux, and where possible, dark colours or lower-reflectivity surfaces on buildings and other structures. Another mitigation option includes the use of switches or motion detectors in high illumination areas not occupied on a continuous basis (i.e., to light the area only when occupied).

Dominion Diamond is committed to consider these and other mitigation strategies and their applicability to the Jay Project prior to the commencement of construction of new fixed structures or facilities. As discussed in the response to DAR-LKDFN-IR2-03, there are challenges with monitoring the effects or environmental success of mitigation for individual sensory effects (e.g., sounds, light, vehicles) on wildlife. Similarly, it is unlikely that a monitoring program would be possible that would isolate the effectiveness of light reduction strategies on caribou. Nonetheless, Dominion Diamond will seek to mitigate light effects to the extent practicable, as it does with other sources of sensory disturbance to wildlife, and the wildlife monitoring programs will seek to assess the overall effectiveness of the collective mitigations of sensory disturbances on wildlife if possible.

DOMINION DIAMOND

Information Request Number:	DAR-MVEIRB-IR2-05
Source:	Mackenzie Valley Environmental Impact Review Board Information Requests from Chuck Hubert
Subject:	Caribou - dustfall and mine levels of activity
DAR Section(s):	DAR-MVEIRB-IR-97 response follow-up

Preamble (MVEIRB):

The DAR presents monitoring data that has not yet, but could potentially be used to inform mitigation measures for the effects of dust on caribou from the Jay project. For example, dustfall levels as indexed by concentration of metals in lichens were higher in 2005 than in 2008. This was a time when ore was mined from Beartooth and Fox open pits and underground at Koala and Panda pits. Although mining at the Misery Pit stopped in 2005, ore was trucked along the Misery Road until fall 2007. Rescan (2011) reports that "Misery haul road was a major contributor to ambient PM2.5 concentrations within the EKATI claim boundary." In 2009-2011, total dustfall was higher near the Fox haul road compared to the Misery haul road, although dust suppression for 2009 to 2011 did not differ from previously. MVEIRB-IR-97 (follow-up) was partially unanswered. It included a requirement to describe how mitigation to reduce dustfall changed in 2005-2012 relative to changes in mining activity, and to provide a table (or graph) showing an indicator of mine activity to determine correlations with dustfall with a focus on comparing the two periods. In response to MVEIRB-IR-97 and YKDFN IR 04MVEIRB-IR-78 the Developer described that A 21 will not increase dustfall despite the return of Diavik to open-pit mining (because A 21 will maintain Diavik's production level). When the two existing Diavik pits went underground, the dustfall declined. In the response to YKDFN IR 04 Dominion wrote; "Estimates of dust deposition rates at the Diavik Mine boundary have shown a reduction from 1,850 mg/dm2/year for the 2002 to 2005 period to 550 mg/dm2/year for the 2010 to 2013 period".

Request (MVEIRB):

a) Clarify if mitigation reduced dustfall when dustfall changed 2005-2008 or if the change in dust was relative to mining activity.

b) Summarize mine activity (e.g. rock trucked; diesel; truck mileage) in a table to determine correlations with dustfall.

c) Describe how the correlation could guide adaptive management, to decide if and when mitigation should be intensified or reduced.

d) Explain why A 21 open pit construction and operation at Diavik will not increase cumulative dustfall in the area.

e) What was recorded at local dust stations and with lichen monitoring, what was recorded for caribou responses to Fox ore trucks during Fox pit production, and what was the mitigation for dust?

DOMINION DIAMOND

Response:

a) The change in measurements between the 2005 and 2008 lichen results can be attributed to both mitigation and change of mining activity. It is likely a combination of reduced traffic intensity along Misery Road, and applications of DL-10 in 2008 around the Ekati Mine main camp and on the Fox Haul Road.

b) Data are not available in a format that would allow for a table of material moved, diesel used, and mileage to be generated at this point in time. Dust generation is influenced by many variables including vehicle speed, precipitation, temperature, relative humidity, suppression use, winds, trucks loads, and truck weights, and therefore, a direct correlation between mine activity and dust is not practical. In broad terms, more dust is generated if suppression programs are not in place, and more dust is generated from larger equipment if not taking into account of larger haul trucks will result in fewer trips (e.g., larger haul trucks will result in less dust emissions per unit of ore or waste rock moved due to fewer trips required). During the life of the mine, the mining activity has changed (surface, underground) and locations have changed (closer or farther from the processing plant) which also impact the potential for dust generation, resulting in changes in dust deposition. Availability of water for road watering (Inspector Approval) and limitation of the application of DL-10 (dry, no rain) also affect the monthly and annual dust measurements.

c) The Ekati Mine will start to track operational data that may be useful in the future to do an analysis of levels of activity with dust deposition. However, per the response above to part (b), it may be not practical to pursue a temporally refined correlation between the mine activity and dust generation using monthly dustfall measurements that would lead to effective adaptive management triggers. The lag time between measurements taken and when measurement results are received make response planning around dust with triggers from the dustfall measurements impractical. An ongoing program of road watering and chemical suppressant application is the most effective way to reduce dust generation. An effective trigger that can lead to timely response is a visual observation and reporting program. The appropriate management activities can be implemented without a trigger from the dustfall monitoring program.

d) The potential effects of the Diavik Mine A21 open pit dust emissions through ambient concentration (in-air concentration) and deposition pathways were considered as a part of the evaluation of the cumulative effects of the Jay Project (Project) in combination with the A21 development in the response to Round 1 Information Request DAR-MVEIRB-IR-78. The construction and operation of the A21 open pit at the Diavik Mine will increase the overall dust deposition and accumulation in the region. However, measurable increases in the dust deposition rates and accumulation will be confined to areas in the immediate vicinity of the A21 pit rather than near the Project which is located approximately 17 kilometres (km) northeast of the A21 pit. The two most recent Ekati Mine air quality monitoring reports (BHP Billiton 2012; Dominion Diamond 2015), covering a period between 2009 to 2014, indicated that dustfall measurements at 1,000 metres (m) or 1 km from the haul roads (Fox Road and Misery Road) were comparable to dustfall measurements collected at background dustfall stations (AQ-49 and AQ-54) located 19 km and 34 km from the Pigeon Pit. The Diavik Mine air quality monitoring report (DDMI 2014) concluded that the dustfall measurements are indistinguishable from the background measurements at a distance between 400 m and 700 m from the Diavik Mine boundary based on 2002 to 2013 data. Even if a conservative assumption is made that dustfall measurements will not reach the background level until at 5 km away from the haul roads at both the Project and the A21 open pit, there is still approximately 7 km between the two proposed developments. Therefore, the construction and operation of the A21 open pit will not have a substantial contribution to the dustfall deposition and accumulation in the immediate vicinity of the Project because the areas of most substantial dust deposition from these two developments do not spatially overlap.

e) Results of dust and lichen monitoring are reported in the 3 year Air Quality Monitoring Program report. The two most recent Ekati Mine air quality monitoring reports (BHP Billiton 2012; Dominion Diamond 2015), covering a period between 2009 to 2014, indicated that dustfall measurements at 1,000 m or 1 km from the haul roads (Fox Road and Misery Road) were comparable to dustfall measurements collected at background dustfall stations (AQ-49 and AQ-54) located 19 km and 34 km from the Ekati Mine. Results from the lichen sampling program indicate that the spatial extent of the influence of dust from the mine is relatively small and concentrated to the area south of the main buildings. Long-range transport does appear to influence some measured parameters, but they are also related to and affected by Arctic Haze.

Due to low sample sizes at the Ekati Mine (i.e., restricted to the highly variable number of caribou that pass through the Ekati Mine in any year), caribou behaviour cannot be analyzed by area of site. For this reason, a comprehensive analysis of all data collected from 2010 to 2013 was undertaken as part of the 2013 Wildlife Effects Monitoring Program Report, Appendix 5.1. Among the main categories of potential industrial stressor events, those involving light vehicles or humans on foot occurred most frequently during the focal watches and scan surveys conducted within 200 m of mine infrastructure. A mean rate of 45.2 stressor events/day involving light vehicles and 21 stressor events/day involving humans on foot occurred during observations. Near the mine, stressor events involving medium vehicles, heavy vehicles or aircraft occurred at roughly the same rate (mean rate = 10.7 stressor events/day). After a stressor event, male and female caribou in and around the Ekati site responded, on average, for 35 seconds and 16 seconds to industrial stressors respectively before returning to a stress-free state. Attached please find the Ekati Diamond Mine 2013 Wildlife Effects Monitoring Program, Appendix 5.1 Caribou Behaviour Direct Monitoring Program which is a comprehensive analysis of caribou behaviour at the Ekati Mine.

DL-10 was applied as a chemical dust suppressant on the Fox Haul Road except for areas within 30 m of a waterbody or water crossing until 2014 when mining at Fox was completed. The dust suppressant EK-35 was used on the Ekati Mine air strip annually in accordance with Boeing regulations to assist in the control of fugitive dust from incoming and outgoing aircraft and associated vehicle traffic. Road watering was used on the Misery Road until 2012 and then DL-10 was used based on the anticipated increased haul traffic the Misery Pushback project. Based on conditions observed, one to two applications of DL-10 would be applied to the heavy traffic areas (including haul roads), with multiple applications of road watering where DL-10 was not applied.

References:

BHP Billiton (BHP Billiton Diamonds Inc.). 2012. Ekati Diamond Mine 2011 Air Quality Monitoring Program. May 2012.

Dominion Diamond (Dominion Diamond Ekati Corporation). 2015. Ekati Diamond Mine 2014 Air Quality Monitoring Program. April 2015.

DDMI (Diavik Diamond Mines Inc.). 2014. Aquatic Effects Monitoring Program Version 3.0 (2011 to 2013) summary report. Submitted to the Wek’eezhii Land and Water Board on October 15, 2014.

Attachment A:

Ekati Diamond Mine 2013 Wildlife Effects Monitoring Program: Appendix 5.1, Caribou Behaviour Direct Monitoring Program

Appendix 5.1

Caribou Behaviour Direct Monitoring Program

APPPENDIX 5.1

CARIBOU BEHAVIOUR DIRECT MONITORING PROGRAM

Table of Contents

List of Figures

FIGURE **PAGE**

List of Tables

TABLE **PAGE**

Introduction

As part of compliance monitoring for the Ekati Diamond Mine and Diavik Diamond Mines Inc. (DDMI), both mines have conducted behaviour monitoring of caribou in order to evaluate the type and magnitude of caribou response to the presence and operation of these mines. This appendix reports on these results and presents a detailed statistical analysis of these results.

Industrial operations produce a variety of activities which have the potential to alter wildlife behaviour and/or movement patterns, including visual and auditory disturbances from vehicles, machines, and explosives (Nellemann and Cameron 1996; Bradshaw, Boutin, and Hebert 1997; Webster 1997). A limited number of studies have investigated caribou behavioural responses to these kinds of potential stressors arising from industrial operations (Bradshaw, Boutin, and Hebert 1997; Wolfe, Griffith, and Gray Wolfe 2000). Results from these investigations demonstrate ways in which industrial development can deleteriously affect caribou behaviour.

In a study by Calef et al. (1976), low flying aircraft were found to induce alarm responses or strong escape responses, which may vary from trotting to uncontrolled running at full speed when aircraft are particularly close. Such responses can result in injuries to caribou, particularly to juveniles and pre-partum cows (Calef, DeBock, and Lortie 1976). In a study conducted on Dempster Highway, Yukon Territory, barren ground caribou fled for an average of 58 sec. from a pickup truck moving along the road at 56-81 km/h, with some individuals exhibiting urination prior to flight, tail erection during flight, or excitation jumps (Horejsi 1981). Svalbard reindeer spent a median time of 38 sec. moving away from snowmobile provocations, 22 sec. of which was spent running (Tyler 1991). In southern Norway, Reindeer were found to cover distances of 134 m - 2.3 km during flight from snowmobiles (Reimers, Eftestøl, and Colman 2003).

The response of caribou to industrial operations was evaluated because attending to stressors, running from disturbances, and avoiding stress events in other ways may impose direct energetic costs on individual caribou (Nilssen et al. 1984; Bradshaw, Boutin, and Hebert 1998) or indirect costs due to reductions in the time individuals have available for feeding or resting (Nellemann and Cameron 1996). In turn, these costs to individuals could have population-level consequences for caribou.

Migratory tundra caribou from the Bathurst herd, and to a lesser extent the Beverly herd (formerly the Ahiak herd), have been exposed to potential industrial stressors arising from the Ekati Diamond Mine and DDMI since the early to mid-1990s. Based on ten years of aerial survey and satellite transmitter collar data on the distribution and movement of caribou, Boulanger et al. (2012) selected a base habitat (and season) model to predict caribou presence/absence around the two-mine complex. An additional predictor variable, distance from mine, was then added to the model, after which the authors used segmented regression to determine the most likely distance at which the mine has no influence on the habitat selection of caribou. On the basis of this statistical approach, Boulanger et al. (2012) identified a 14-km or 11-km zone of influence (ZOI) around the two-mine complex, depending on whether they analyzed the aerial survey data or the data based on satellite-collar locations. Each year, however, thousands of caribou are observed in close proximity to the mine sites, grazing for long periods of time on the tundra, walking through the sites, or migrating along routes immediately adjacent to mine infrastructure (Rescan 2012b, 2013b).

Caribou are present in the region around the Ekati Diamond Mine and DDMI (i.e., the two-mine complex region) during the spring for a brief period as they move north to the calving grounds, and for a longer period during the summer and early fall when they are actively feeding and accumulating fat reserves for the winter. The Bathurst herd winters below the treeline out of the Ekati Diamond Mine and DDMI region, while the Beverly (formerly Ahiak) herd winters on the tundra, including the area of tundra around the two-mine complex, at very low density. Behavioural studies were carried out predominantly during the summer and early fall, when caribou are most abundant in the region.

In the present study, human observers on foot recorded their direct visual observations of behaviour, made in a planned and carefully structured manner, to achieve the following aims:

- to characterize average caribou activity budgets in the Ekati Diamond Mine and DDMI region at the individual and group levels, based on behavioural observations;
- to quantify the rates at which several potential industrial stressors occurred at different distances from the mines during the behavioural observations of caribou individuals and groups;
- to test whether component behaviours of the activity budgets changed when stressor events happened; and
- to test the extent to which behaviour at the group level depended on proximity to nearest mine infrastructure and on non-anthropogenic known to modulate caribou behaviour.

Methods

ACTIVITY BUDGETS AND CATEGORIES OF COMPONENT BEHAVIOURS

An activity budget describes how an animal's behaviour is partitioned into the different activities required for homeostasis, survival, growth, and reproduction. Because they relate directly to bioenergentic expenditures (e.g., energy used while fleeing from predators or disturbances) and caloric gains (via feeding), activity budgets provide a useful framework for evaluating non-lethal effects of development on wildlife management (Christiansen, Rasmussen, and Lusseau 2013).

Two different approaches, focal watches and scan sample surveys (Altmann 1974), have been used to record the behaviours of caribou in the region around the two-mine complex, and the present investigation examines these data collected between 2010 and 2013. Focal observations of a single animal are ideal for obtaining information on activity budgets (i.e., the proportion of time an animal is engaged in different behaviours), the temporal sequence of behaviours relative to stressors or other stimuli, and the length of time it takes the animal to return to a non-stressed state following a stressor event (Martin and Bateson 1993). Scan samples of a group of animals, on the other hand, are more useful for quantifying the frequencies of dominant behaviours in a group over a period of time, which can be thought of as an activity budget at the group level (or an average of individual activity budgets for all members of the herd or group being surveyed).

The following information was recorded for every focal watch or scan survey: location; date; sampling method (focal or scan); observer name; age/sex class of focal individual (bull, cow, or calf); air temperature, percentage cloud cover and other notes on general weather pattern; codes for the presence and severity of blood-feeding insects; presence/absence of wolves and grizzly bears; distance and direction of the observer with respect to the animal(s) being observed; and distance and direction to nearest mine infrastructure. In addition, total group size and group composition (relative frequencies of bulls, cows, and calves) were visually estimated for all scan surveys, as well as for those focal watches of individuals in groups.

Results from prior work around the Ekati Diamond Mine (Rescan 2012b, 2013b) suggest that seven categories of behaviours account for most or all of the caribou activity observed in the region. Following established terminology and the general descriptions of caribou behaviour that have been published (Pruitt 1960; Skogland 1980), the seven categories of activity were delineated as follows:

- standing;
- walking;
- trotting;
- running;
- feeding (i.e., actively grazing, ruminating, chewing cud);
- bedding (e.g., sitting with all four legs tucked under body, lying down, sleeping on the ground);
- exhibiting alertness (e.g., quickly raising the head and orienting it toward a stimulus, pricking the ears and rotating them towards a stimulus, remaining motionless in an alarm posture);

Among these categories, being alert, trotting, and running were considered stress-response behaviours, whereas feeding, bedding, and standing were considered to be indicative of a non-stressed state (Calef, DeBock, and Lortie 1976; Horejsi 1981; Tyler 1991; Nellemann and Cameron 1996; Wolfe, Griffith, and Gray Wolfe 2000; Reimers, Eftestøl, and Colman 2003). The remaining category, walking, was considered a neutral behaviour.

At every time point during the focal watches and scan surveys, the dominant activity of the focal individual, or each individual in the group being surveyed, was assigned to one of the seven defined activity categories, or, when necessary in rare cases, to an eighth category for 'other' behaviours. The observers were instructed to make notes on the type of alternate behaviour being performed if an individual caribou's activity was assigned to this eight category of activity (e.g., sparring with another male).

For cases in which two behaviours were simultaneously recorded for an individual, the present analysis required assigning the corresponding time interval to a single dominant activity as follows: bedded and other (i.e., chewing) = feeding; alert and feeding = alert; bedded and alert = alert; standing and alert = alert; feeding and alert = alert; feeding and walking = feeding; feeding and standing = feeding; alert and trotting = trotting; alert and running = running; other (e.g., urinating) and any of the seven main activity categories = that main activity. The decision to simplify the data in this manner was made prior to any knowledge of statistical patterns of variation in the data. As a result of the simplification: activity budgets summed to 100% in a straightforward manner for nearly all individuals; power was enhanced for some of the statistical comparisons; and the interpretation of results was clearer than when behaviours are assigned to multiple activity budget categories simultaneously.

Whenever a potential industrial stressor occurred during a focal watch or scan survey, its time of occurrence was recorded. Potential industrial stressors included visible and/or audible stimuli arising from the following sources:

- mine staff on foot (i.e., humans other than observers of the focal individual or group; recorded as 'Hu');
- light vehicles, such as pickup trucks ('LV');
- medium vehicles, such as water trucks and buses ('MV');
- heavy vehicles, such as Haulmax off-highway dump trucks ('HV');
- helicopters ('Heli');
- fixed-wing aircraft ('Plane');

Following the methodology established for making observations of caribou behaviour at the Ekati Diamond Mine (Rescan 2013b) the observers were also instructed to record distant blasts in mine pits (i.e., 'Blast'), which were only audible. However, no such stressor events occurred during the caribou observations from 2010 to 2013.

Observers were also instructed to record several natural (i.e., non-industrial) stressors. In addition to noting the state, and estimating the intensity level of chronic stress from biting insects (see above), observers recorded acute wildlife stressors ('Wi') due to approach of caribou predators (i.e., grizzly bears or wolves). The observers also made notes on natural stressor events arising from agonistic interactions with other caribou. Though harassment by other caribou was somewhat common, stressor events caused by large predators were extremely rare during the behavioural observations. All natural stressor events due to predatory wildlife and other caribou were excluded from statistical analyses of the effects of industrial stressors on caribou behaviour.

FOCAL WATCHES OF INDIVIDUAL CARIBOU

To date, the Ekati Diamond Mine has performed all focal watches of caribou in the region. Between October 8, 2011 and November 8, 2013, the Ekati Diamond Mine conducted a total of 62 focal watches (on 62 unique individuals) during which one or more stressor events occurred and for which all the essential data (e.g., stressor type and occurrence time) were recorded. No focal watch data at all were available from 2010. Focal watches from 2011 to 2013 that were less than 20 min in total duration were excluded from calculations of the estimated occurrence rates of industrial stressor events (see below). To more accurately estimate the proportions of time that individuals spent performing different activities, focal watches also had to be a minimum of 20 minutes to be included in the general activity budget profile for 2013 (Figure 5.3-1 in Chapter 5.3 of this report) or the average activity budget profile for 2010 to 2013 (Figure A5.1-1). To avoid biases resulting from the exclusion of highly stressed caribou that fled from view following stressor events, however, focal watches of all durations were included in analyses of how various caribou behaviours changed following the different types of stressors (described below).

Just prior to the beginning of each focal watch, a wildlife technician selected an individual caribou in the local area to observe, either a lone individual or an individual within a group of caribou. The technician began the focal watch by recording setting data and several characteristics of the focal animal (described above). The observer then noted the start time of the focal watch, as well as the focal animal's current behaviour/activity. Whenever the animal's behaviour corresponded to the 'other' category of behaviours, the wildlife technician made notes on the alternative behaviour being performed. Ideally (for the purpose of clear activity budget analysis), the behavioural categories are treated as mutually exclusive, and the individual's activity at any given time is assigned to just one of the categories. As the focal watch progressed, the observer recorded every time point (hr : min : sec) when the focal animal switched activity to a new behavioural category or an industrial or wildlife stressor occurred. In the field datasheets and saved data logs, one column of data recorded the times of switch-points between consecutive behaviours, and (for clarity) a separate column recorded the occurrence tines of stressors, whether the focal animal's behaviour changed simultaneously or not.

SCAN SURVEYS OF CARIBOU GROUPS

In contrast to the focal watch data, which have only been collected by the Ekati Diamond Mine, the two mines have worked collaboratively to collect scan survey data across a large range of distances from mine infrastructure. DDMI has focussed on caribou groups located outside the ZOI proposed by Boulanger et al. (2012)—i.e., further than 11 to 14 km from either mine—whereas the Ekati Diamond Mine aimed to focus on groups found reasonably close to mine infrastructure. The effort has been unbalanced, however, with DDMI collecting more data. Between November 11, 2010 and November 8, 2013, the Ekati Diamond Mine conducted five usable scans of five unique caribou groups located 15 – 300 m from the closest mine infrastructure. From September 7, 2012 and September 8, 2013, DDMI conducted 169 usable scans of unique caribou groups located 7 – 108 km from the nearest mine infrastructure, plus a single scan of a caribou group located 30 m from mine infrastructure.

Duration of the logged scan surveys varied from 20 – 67 min. To more accurately estimate the overall activity profiles of individual caribou groups, the minimum allowable total duration of the scan surveys was 20 min. Just prior to each survey, a focal caribou group was chosen from all caribou groups in the local area, and the setting data and group characteristics (described above) were recorded for that group. The observer then selected a subset of animals, in which the activity of each subset member could be rapidly scanned and recorded in less than 30 sec per scan sample. The start time of the survey was recorded, and the first scan was made (i.e., the number of animals engaged in each category of behaviour was recorded). Subsequent scans were then made at regular scan intervals (typically, exactly every 4 min). During each scan the time was recorded (hr:min:sec), and counts were made of the numbers of animals engaging in each category of activity.

With small groups, it was usually feasible to record the current activity of each group member at each scan time point. With larger groups, the observer only attempted to watch the subset of animals that were close enough to allow for careful observations during any given scan. If necessary to achieve scans that were rapid and high quality, the composition of the focal subset was allowed to vary somewhat from scan to scan. Even with such variation in the subset of observed animals, the resulting scan samples still provide an estimate of the distribution of activities among caribou individuals in groups, from which a group-level activity budget can be quantified (Altmann 1974). As the scan sample survey proceeded, the observer also recorded the types and occurrence times (hr: min:sec) of all industrial and wildlife stressors. For clarity, separate columns of data were used to record the times of the scan samples and the times of stressor events.

STATISTICS

Analysis of Focal Watch Data

Changes in given caribou behaviours that coincided with specific stressors were investigated with the paired Wilcoxon signed rank test (Whitlock and Schluter 2009). This test was used to evaluate the difference in number of seconds that individuals spent performing behaviours of interest in defined time windows before and after specific potential stressors. This nonparametric test is appropriate for comparing pre- and post-stressor times, because data on the number of seconds in windows bounded by 0 and 30 seconds are not normally distributed, and the two bounded time periods like this are likely to exhibit unequal variances. As a paired difference procedure, the Wilcoxon test also accounts for the intrinsic serial dependency of before-after time series data.

The present analysis is the first one in which this kind of before-after statistical comparison has been made using caribou focal watch data from the Ekati Diamond Mine study area. Consequently, there were no pre-existing results upon which to define durations of the time windows *a priori*. Instead, the time windows were defined as 30 seconds post-hoc based on the following considerations. This period of time corresponds well to the average continuous lengths of time that male and female caribou exhibited stress-response behaviours (defined above) before returning to a neutral or non-stressed state following potential industrial stressors arising from the Ekati Diamond Mine: mean for males = 35 seconds ± 10 standard error (SE.); mean for females = 16 sec. ± 3 SE The appropriateness of a 30 second time window is also supported by the average duration of caribou stress-responses to industrial stressors in other studies (Horejsi 1981; Tyler 1991).

Multiple potential stressors occurred during some focal watches. Therefore, to ensure that each animal had sufficient time to recover from any prior stressor and return to its typical baseline state before any stressor event considered in the paired Wilcoxon comparisons, the analysis only included data for stressor events that were preceded by at least a 4 min period free from all stressors (industrial or natural). Pseudoreplication (Hurlbert 1984) was avoided by only including data for the first case of each industrial stressor event that occurred during each focal watch.

The Wilcoxon tests were performed using R version 2.14.0, a programming language for statistical computation and data visualization (R Core Development Team 2011). Stripcharts were produced in R to visualize patterns of behavioural change between the pre- and post-stressor windows. In each of these plots, the pre and post time data for all individuals were plotted on the left and right sides of a stripchart. Within each category, the data were randomly shifted by a small amount along the x-axis to help separate data points for clearer visualization. Paired data points for each individual were connected by a line segment. Reading left to right, upward sloping segments show individuals that performed more of the behaviour following the stressors, while downward sloping segments highlight individuals that performed less of the behaviour following the stressors. Thus, the overall distribution of line-segment angles indicates the strength of the predominant change in caribou behaviour coincident with a specific type of industrial stressor.

Analysis of Scan Sample Data

Scan survey data for each caribou group were converted into a group-level activity budget. This was accomplished by computing the proportion of animals assigned to each behavioural category during each scan. The activity budget for each group was then computed by conducting a time-weighted average of the resulting proportions across all the scans that were made in a given survey. Weighted averages were necessary because some surveys contained scans of variable duration.

Principal components analysis (PCA) was performed on the group activity budgets (i.e., average proportion of animals performing each category of activity throughout the scan surveys) to determine the major axes of behavioural variation among caribou groups. This multivariate ordination technique produces a linear combination of variables defining a first principal component (PC), which accounts for the axis of greatest variation through the multivariate dataset. The data transformation underlying PCA also produces a series of subsequent PC axes (up to the number of data variables minus one), each of which successively accounts for the highest amount of remaining variation, subject to the constraint that each PC is uncorrelated with all preceding PCs.

Proportional data are not valid for standard PCA. Instead, the data were analyzed with robust PCA (Filzmoser, Hron, and Reimann 2009), a method specifically designed for compositional data. Such data describe the composition of something in terms of how different components contribute to the whole; thus, proportional caribou activity budgets are a type of compositional data. Prior to this analysis, the group-level activity budget data were transformed by adding 0.0001 to the average proportion computed for each caribou group and category of behaviour. Robust PCA was then performed on the transformed data using the R package 'robCompositions' (Templ, Hron, and Filzmoser 2014).

Next, a 'distance biplot' (Legendre and Legendre 1998) was constructed, using a custom-written R script, to display PC1 and PC2 from the robust PCA. In the scan sample dataset, together PC1 and PC2 accounted for 67.9% of the total behavioural variation that was quantified among the observed caribou groups. Thus, a distance biplot for these first two PCs summarizes the predominant patterns of behavioural variation among caribou groups in this region. To construct such a summary figure, all observed caribou groups were graphed in a scatterplot according to their PC1 and PC2 scores. Next, factor loadings (i.e., variable loading) for the first two PCs were plotted on the graph. Each loading was shown as a red arrow, which started at the origin of the graph and ended at coordinates defined by that factor's loading on the first two PCs (coordinates were multiplied by ten for clarity). The arrow for each factor was then labeled according the factor's corresponding variable name (i.e., behavioural category name). The relative magnitude and sign of each factor loading (i.e., length and direction of each arrow) indicates, respectively, how strongly each variable influences the scores along that PC, and whether the influence is a positive one or a negative one.

Finally, linear models (Neter and Wasserman 1974) were evaluated in R to test possible relationships between each feature of caribou group behaviour (i.e., response variable) and distance from nearest mine infrastructure (the main predictor variable of interest). An attempt was also made to include important non-anthropogenic biological variables in the model, to account for other possible causes of behavioural variation, while testing the effect of distance from mine infrastructure. Four such biological variables were considered for inclusion in the linear models: season during which each observation was made; time of day for each observation; group size; and severity of blood-feeding insects.When caribou respond strongly (by constantly moving or shuddering, for example) to avoid harassment by parasitic and biting insects, their energy expenditures may increase, and the time available for feeding may decrease (Toupin, Huot, and Manseau 1996; Mörschel and Klein 1997). However, the severity of insect presence could not be included in the models predicting group activity budget components due to incompleteness of the insect abundance data. In addition, time of day is one of the most important general influences on animal behaviour (Alcock 1997). Time data were complete for the scan surveys, yet there was no pre-existing model for how to code time in meaningful manner throughout the year, given large seasonal fluctuations in day length at the Ekati Diamond Mine. Caribou appear to have lost their endogenous circadian rhythm, though the melatonin cycle in caribou is acutely photoperiod sensitive (Lu et al. 2010). This raises the possibility that many of caribou behaviours are particularly sensitive to light. Coding time of the scan surveys in terms of sun azimuth and elevation was one approach that was considered. Ultimately, however, time was excluded from consideration, owing to the lack of a clear model of expected diel variation in the measured behaviours as a function of these sun position variables.

It was possible to include season and total group size in the models. The timing of seasonal migrations and the yearly rutting (i.e., mating) and calving cycle has been described previously for the Bathurst and Beverly herds of migratory tundra caribou (Boulanger et al. 2004; Boulanger et al. 2012; Rescan 2012b, 2012a, 2013b, 2013a). Based on these studies, season was coded categorically as follows: (a) northern migration, April 21 to May 31; (b) calving and post-calving period, June 1 to July 31; (c) summer, August 1 to September 15; (d) transition period between summer and southern migration, September 16 to October 22; (e) southern migration, October 23 to November 26; and (f) winter, November 27 to April 20. Season was treated as a factor with unordered levels in the models; this accounted for seasonal variation in caribou activity without requiring a specific shape for the relationship between activity and season (e.g., linear, quadratic, etc.). Between 2010 and 2013, most scan surveys of caribou herds were made in the two-mine complex region during summer (season (c): usable data collected from 55 unique groups) or the transition period between summer and the southern migration (season (d): 116 groups). Caribou are consistently abundant in the region and the weather is particularly conducive to behavioural observations during these two periods. Usable data were only collected from four groups outside these two periods. Visually estimated total group size (range = 2 to 700 individuals per group) was treated as a continuous integer variable.

Each linear model took one of the following group activity variables as the response: proportion of total group activity budget allocated to walking; proportion of total group activity budget engaged in non-stressed behaviours (i.e., being bedded, feeding, or standing); proportion of total activity budget spent performing stress-response behaviours (being alert, trotting, or running); or PC1 score for the group activity budget dataset, which can be interpreted as a ‘composite group activity score’ (see Results).

Prior to model fitting, response variables defined as activity budget proportions were arcsine transformed, which is accomplished taking the arcsine of the square-root of each proportion (Whitlock and Schluter 2009). Transformations made the resulting variables more closely approximate normally-distributed data, and it improved variance equality across different distances from mine infrastructure. The R function ‘lm’ (R Core Development Team 2011) was then used to fit each response variable to three explanatory variables (distance from nearest mine infrastructure, season, and group size). The models included the main effects and all possible two- and three-way interactions corresponding to these explanatory variables. Type II sums of squares were used to evaluate statistical significance of the different model terms due to large differences in the number of groups sampled per season (Neter and Wasserman 1974). In R, the use of type II sums of squares is accomplished by applying the 'Anova' function from the 'car' package (Fox et al. 2013) to the object returned by 'lm' for each model.

Note that, in addition to the direct observations of caribou behaviour via the focal watches and scan surveys that are described here, two other caribou monitoring programs are also being conducted — based on remote cameras and satellite collar studies. Both of these methods are unsuitable for evaluating behavioural responses on the scale of several minutes following a disturbance event, as is evaluated in this study.

Results

GENERAL FEATURES OF THE AVERAGE ACTIVITY BUDGETS OF CARIBOU BULLS AND COWS IN THE ENVIRONMENT AROUND THE EKATI DIAMOND MINE

Averaged across all available focal watches—regardless of what types of industrial or natural stressors occurred during the watches, if any—overall activity budgets of caribou adults differed slightly between bulls and cows (Figure A5.1-1). Cows spent more time bedded than bulls, while bulls spent more time standing than cows. The overall activity budgets shown in Figure A5.1-1 were mostly based on surveys of individual caribou from groups of animals passing through the Ekati Diamond Mine site (distance from nearest mine-related infrastructure = 0 – 500 m for 61 focal watches). Only one usable focal watch was conducted further away from the mine site (watch conducted on September 21, 2013, 100 km from nearest mine-related infrastructure).

A large majority of the focal observations were made between July 18 and November 5—i.e., from the end of the calving period to the middle of the southern migration (Rescan 2012b, 2013b)—when caribou are consistently present at site.

During this period, non-stressed behaviours dominated the activity budgets of adult male and female caribou, which respectively spent an average of 80% and 79% of the time bedded, feeding, or standing (Figure A5.1-1). Walking was the fourth most common activity of caribou adults. In contrast, stress-related behaviours were much less common, with bulls and cows respectively exhibiting alertness 7.5% and 5.5% of the time on average. Trotting and running were rarely exhibited by focal adults. On average, these activities together made up only 1.2% and 0.7% of the total activity budgets of males and females, respectively (Figure A5.1-1).

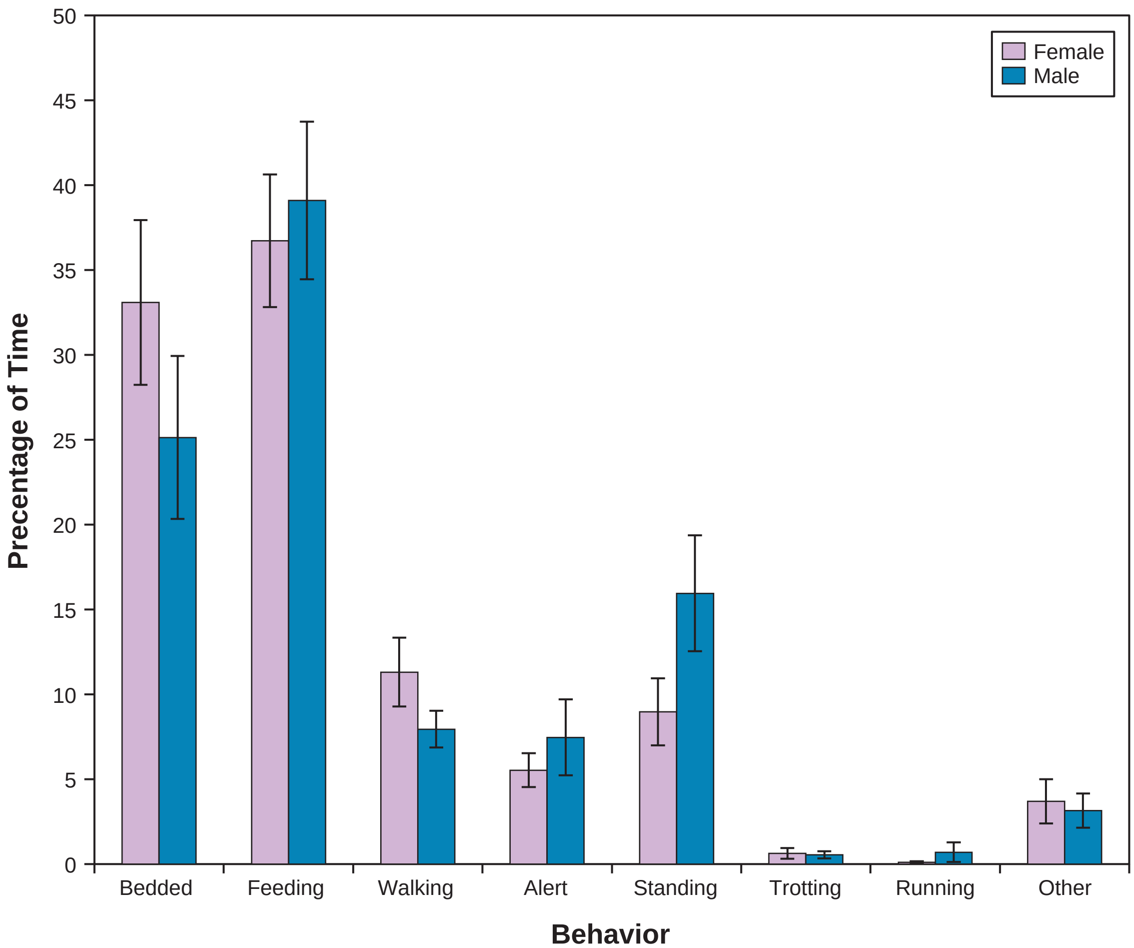
Running was the most intense category of caribou locomotion recorded during the focal watches and scan surveys. No stressor was identified in about 75% of the cases in which caribou were seen running. Though the presence of stressful stimuli that went undetected is likely, the response of the focal animal or group cannot be taken as evidence of the presence and nature of a cryptic stimulus, such as a predator.

Of all the instances in which caribou adults ran, about 15% of these cases coincided with confirmed non-anthropogenic stimuli known to be highly stressful to caribou, the majority of which involved parasitic or biting insects (Toupin, Huot, and Manseau 1996; Mörschel and Klein 1997). Only one of the non-anthropogenic stressor events was caused by a natural predator of caribou (a grizzly bear in this case): During a survey by DDMI, which was conducted on September 13, 2013 at a site 59 km from the nearest mine infrastructure (i.e., survey ID# 4974), all members of a small caribou group ran when approached by the grizzly bear. These anecdotal associations between known stressful stimuli and high speed flight, suggests that running might be a rather reliable indicator of high stress in caribou.

The remaining running events (approximately 20% of all cases) coincided with the following industrial stressors: machinery generated noise (1 case); a light vehicle (1 event caused by a pickup truck); and a medium vehicle (1 case). The event involving the medium vehicle was observed during a focal watch performed by the Ekati Diamond Mine on April 22, 2013, when a water truck driving down Airport Road triggered running behaviour by a focal individual and eleven other group members, all of whom were located 167 m away from the road and water truck when running commenced. Despite the few well-documented instances of running that were triggered by industrial or natural stressors, running was the rarest component behaviour of caribou activity budgets, overall (Figure A5.1-1).

Figure A5.1-1

General Activity Budgets of Bulls and Cows at the Ekati Diamond Mine, Averaged across All Focal Watches and Conditions from October 2010 to November 2013



Note: Error bars represent standard error.

RATES OF INDUSTRIAL STRESSORS DURING FOCAL WATCHES AND SCAN SURVEYS

Among the main categories of potential industrial stressor events, those involving light vehicles or humans on foot occurred most frequently during the focal watches and scan surveys conducted within 200 m of mine infrastructure (Figure A5.1-2). A mean rate of 45.2 stressor events/day ± 10.7 SE involving light vehicles and 21.0 stressor events/day ± 9.4 SE. involving humans on foot occurred during behavior observations of caribou individuals or groups found 0 – 200 m from the nearest mine infrastructure. At this close proximity to the mine, potential stressor events involving medium vehicles, heavy vehicles, or aircraft occurred at roughly the same rate (mean rate = 10.7 – 11.8 stressor events/day; see Figure A5.1-2).

Not surprisingly, rates of all categories of industrial stressors dropped as distance from nearest mine infrastructure increased. Although stimuli from light vehicles remained somewhat common a sites located 200 m – 2 km from mine infrastructure (mean rate = 28.1 stressor events/day ± 6.3 SE), rates of all other classes of potential stressors were low during the focal watches and scan surveys of caribou performed within this range of distances from nearest mine infrastructure (mean rate = 1.9 – 7.1 stressor events/day; Figure A5.1-2).

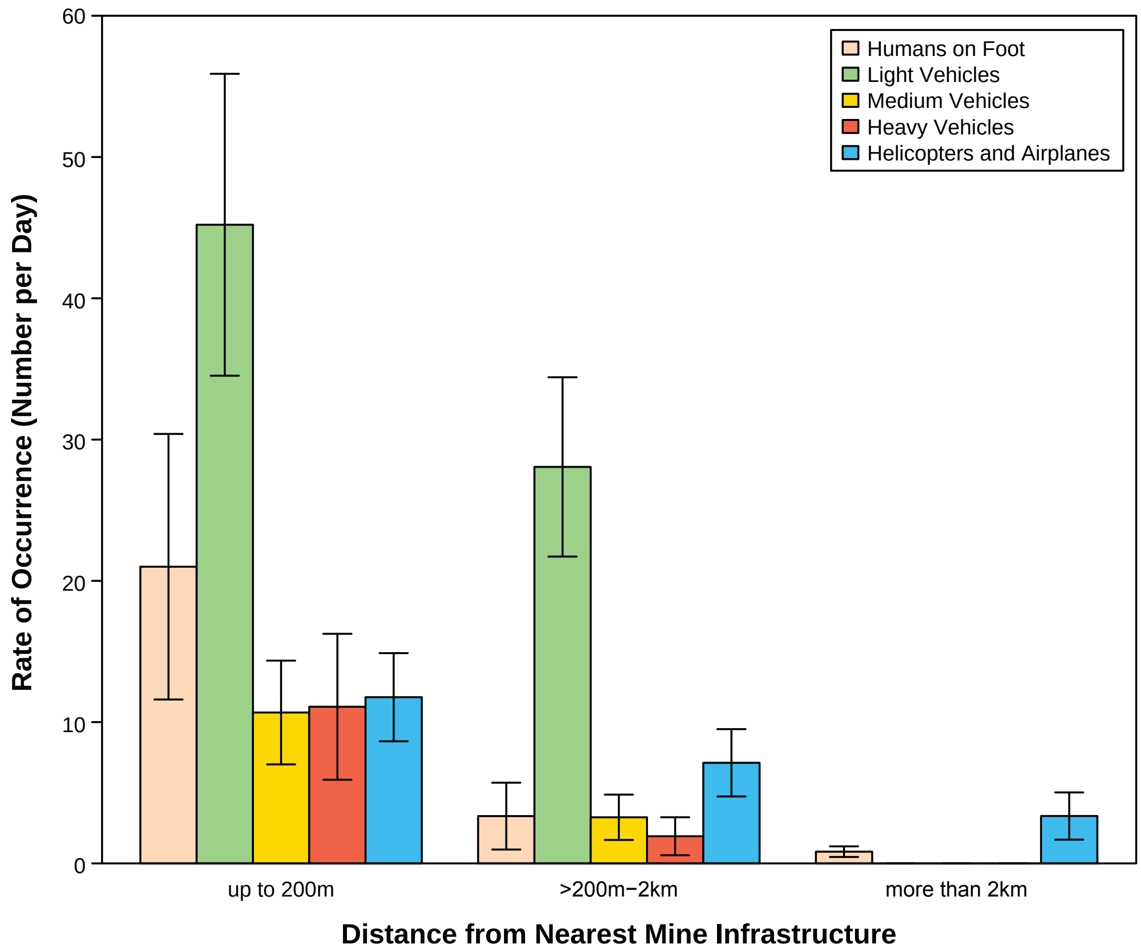
The rates of potential industrial stressors dropped drastically beyond 2 km from the nearest mine infrastructure. During the behavioural observations that were made more than 2 km from mine infrastructure, the only recorded stressors were humans on foot (mean rate = 0.8 stressor events/day ± 0.4 SE) and aircraft (i.e., helicopters and airplanes combined; mean rate = 3.4 stressor events/day ± 1.7 SE). At these distances from the mine, it is likely that all potential stressor events involving humans on foot were generated by other members of the crews that conducted the caribou group surveys. Similarly, many of the events involving potentially stressful stimuli from aircraft at these distant sites likely arose from the same helicopters that transported the field crews to and from the sites where the behavioural observations were made. No events involving any of the other industrial stressor types were recorded during behavioral observations made more than 2 km from infrastructure of either the Ekati Diamond Mind or DDMI. (Figure A5.1-2).

CHANGES IN CARIBOU BEHAVIOUR AS A RESULT OF INDUSTRIAL STRESSORS AT THE EKATI DIAMOND MINE

Caribou were predicted to increase their alertness following stressful stimuli (Pruitt, 1960; Horejsi 1981, Tyler 1991). Results of the matched-pairs tests for differences in duration of alert behaviour between pre- and post-stress windows confirmed this prediction for human stressors and stimuli arising from all size classes of vehicles, combined (Figure A5.1-3). Wilcoxon test results for these comparisons were $P = 0.0222$ for stressor events involving humans and $P = 0.00152$ for stressor events arising from any motor vehicle, bus, haul truck, or other mining vehicle (these and all other matched-pairs tests two-sided). In light of this evidence of statistically significant stress-related responses to some industrial stimuli, the continuous length of time that caribou exhibited any stress-response behaviour (i.e., being alert, trotting, or running) following a potential stressor before returning to a neutral or non-stressed state (i.e., feeding, bedding, standing, or walking) was averaged across individuals and stressor types in the focal watch dataset. Doing so revealed that male and female caribou in and around the Ekati Diamond Mine site responded, on average, for 35 sec ± 10 SE and 16 sec ± 3 SE to industrial stressors before returning to a stress-free state.

Figure A5.1-2

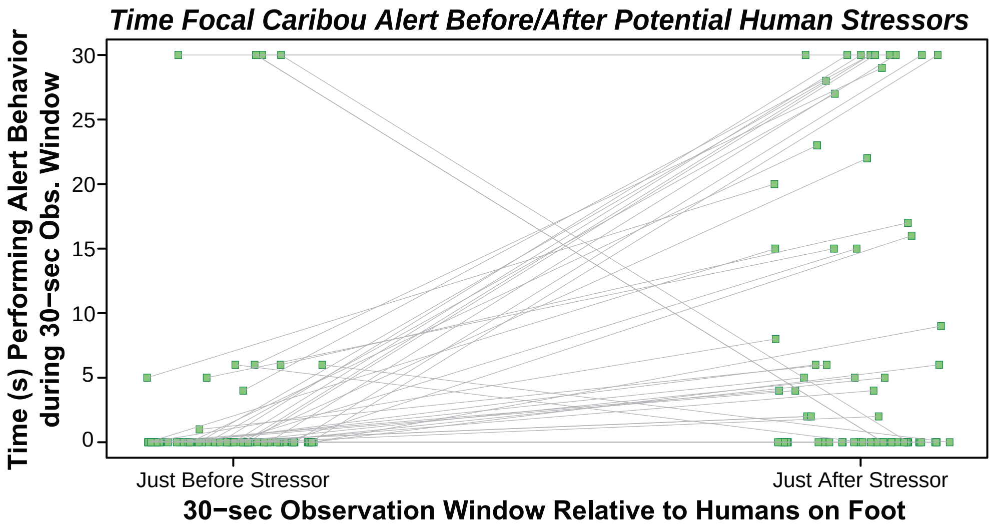
Rates of Potential Stressors Noted during Caribou Focal Watches and Scan Surveys by Distance from Nearest Mine Infrastructure, 2010 to 2013

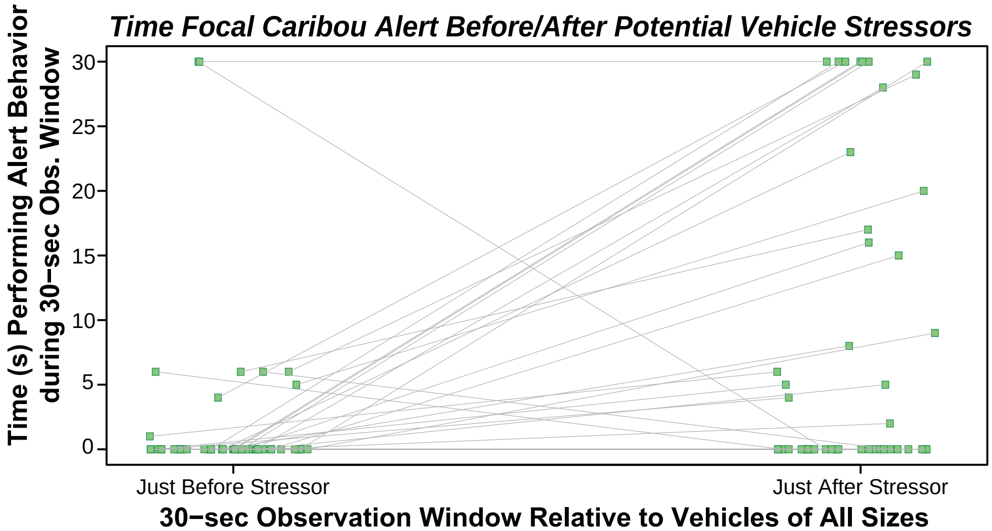


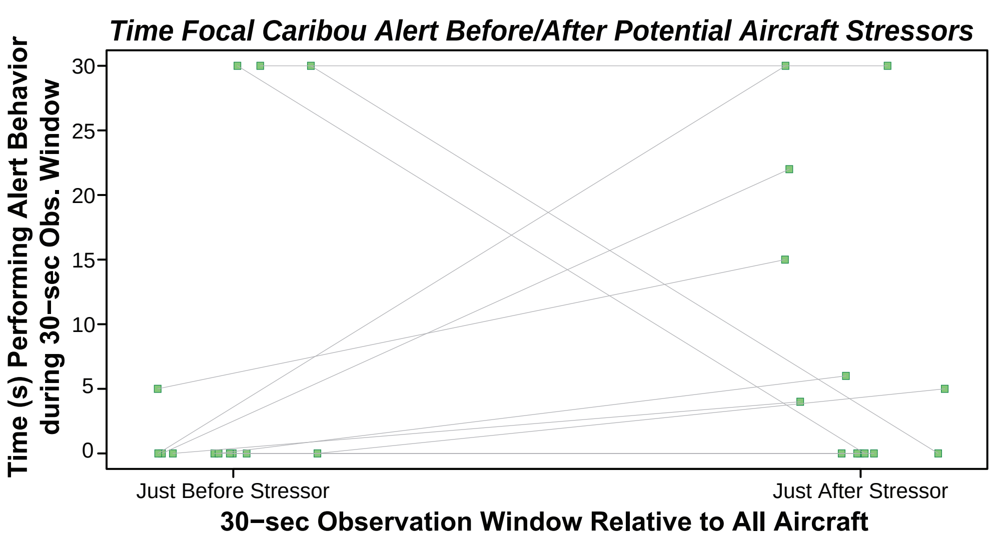
Note: error bars represent standard error.

Figure A5.1-3

Time Caribou Spent Exhibiting Alert Behavior during 30-second Observation Windows before and after Potential Stressors, 2010 to 2013







Considered alone, stressor events involving just light vehicles (*P* = 0.0298) or just medium vehicles (*P* = 0.0355) were also significantly associated with increased alertness (plots not shown). However, there was no evidence of a significant association between alertness and heavy vehicles (HV) (*P* = 0.423; HV data not shown separately); this was possible due in large part to the low sample size for this class of industrial stressor. Similarly, caribou alertness did not change significantly in the presence of helicopters (*P* = 0.999), fixed-wing aircraft (*P* = 0.498), or helicopters and fixed-wing aircraft combined (Figure A5.1-3; *P* = 0.622).

Daytime feeding was predicted to decrease when caribou are exposed to stress response (Calef, DeBock, and Lortie 1976; Toupin, Huot, and Manseau 1996; Bradshaw, Boutin, and Hebert 1997; Mörschel and Klein 1997; Webster 1997; Reimers, Eftestøl, and Colman 2003). Despite this prediction, no difference was found in the proportion of time spent feeding before and after any specific stressor type (i.e., Hu, LV, MV, HV, Heli, or Plane; all *P* > 0.198) or any combination of stressor types (i.e., LV+MV+HV, Heli+Plane; *P* > 0.800 in both cases). Consistent with the kinds of changes that are predicted for non-stressed behaviours, the proportion of time that caribou spent either bedded or standing decreased significantly following industrials stressors (all stressor types combined; Figure A5.1-4; *P* = 0.00126). There seemed to be a tendency for proportion of time spent walking to decrease following all industrial stressors (Figure A5.1-4), but this trend was only marginally significant (*P* = 0.0677). Consistent with the expected direction of behavioural change, increases in trotting or running following industrial stressors were seen in more caribou (3 individuals) than decreases (1 individual); due to their overall rarity, however, there was very little statistical power to detect changes in their rates of production (Figure A5.1-4).

GROUP-LEVEL ACTIVITY BUDGETS IN THE EKATI DIAMOND MINE AND DIAVIK DIAMOND MINES INC. REGION

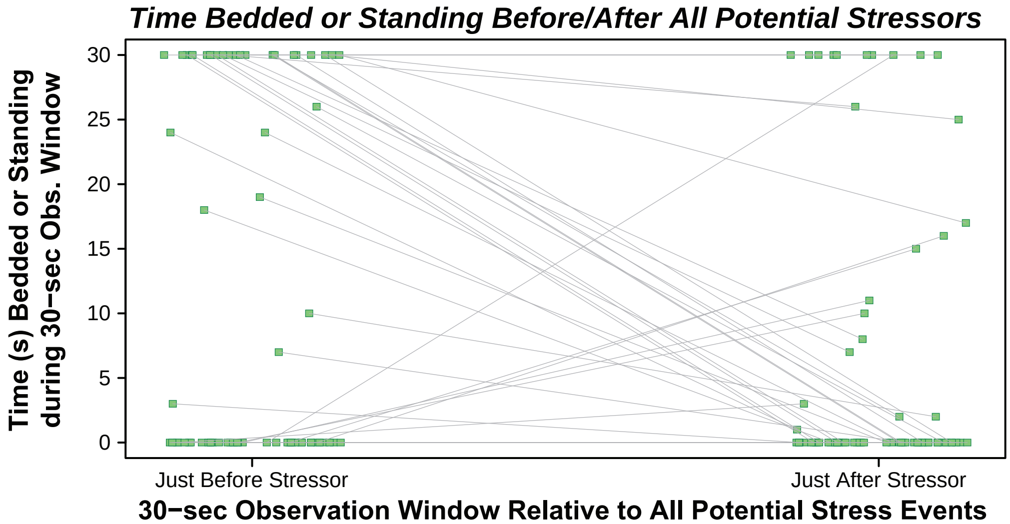
Caribou groups could be classed into three groups; ones that generally exhibited relaxed behaviours – bedding and standing, groups that exhibited more energetic activities, including feeding and groups that expressed alarmed or stressed behaviours. Robust PCA of scan survey data revealed that the most frequent behaviours of focal individuals (feeding, bedding, standing, and walking; Figure A5.1-1) also made important contributions to variation in group-level activity budgets. The first two PC axes found by this analysis captured more than three times the amount of behavioural variation among caribou groups than the remaining four PC axes (Table A5.1-1). A distance biplot of these key axes (Figure A5.1-5) provides a convenient way to visualize and interpret the meaning of PC1 and PC2, which account for more than 75% of total variation in group behaviour.

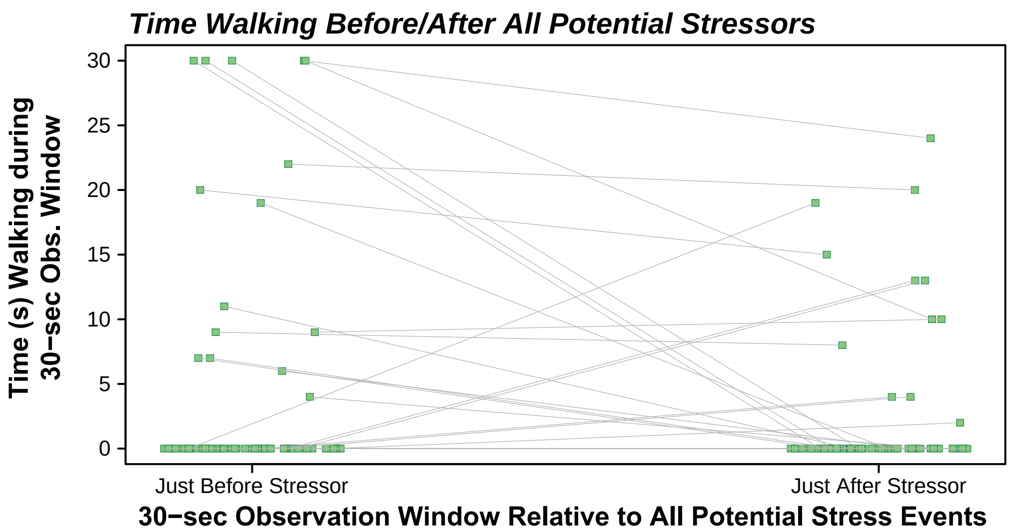
Table A5.1-1. Summary of Robust PCA on Group Activity Budgets (2010 – 2013), Showing the Eigenvalue, % of Total Variation Explained, and Factor Loadings for the Six Resulting Principal Components (PCs)

PCA Summary Statistic	PC 1	PC 2	PC 3	PC 4	PC 5	PC 6
Eigenvalue	40.925	1.754	11.428	4.755	0.375	7.77×10^{-16}
% of Total Variation Explained	54.55%	23.38%	15.23%	6.34%	0.50%	< 0.01%
‘Bedding’ Factor Loading	-0.7869	0.2668	0.2729	-0.3008	0.0413	0.0000
‘Feeding’ Factor Loading	0.1830	0.0196	-0.6811	-0.5974	0.0506	0.0000
‘Standing’ Factor Loading	-0.0163	-0.8934	0.2342	-0.0621	0.0001	0.0000
‘Being Alert’ Factor Loading	0.0125	0.0935	-0.1407	0.4212	0.1738	0.7879
‘Walking’ Factor Loading	0.5887	0.3208	0.5906	-0.2412	0.0258	0.0000
‘Trotting’ Factor Loading	0.0159	0.0903	-0.1438	0.4561	0.5333	-0.5794
‘Running’ Factor Loading	0.0031	0.1025	-0.1322	0.3243	-0.8249	-0.2085

Figure A5.1-4

Time Caribou Spent Exhibiting Different Types of Behavior during 30-second Observation Windows before and after Any Potential Stressor, 2010 to 2013





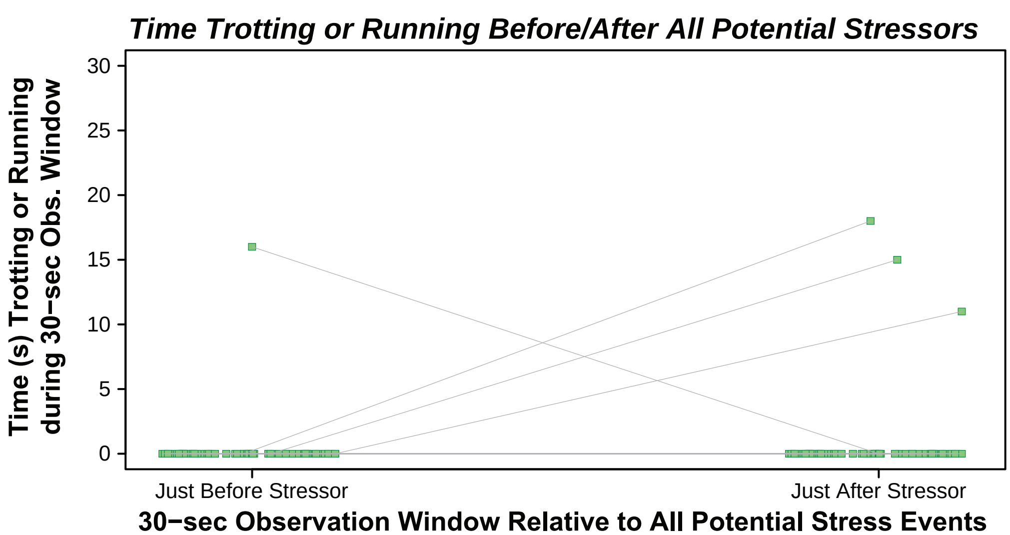


Figure A5.1-5

Principal Axes of Activity Budget Variation among Caribou Groups at All Distances from Nearest Mine Infrastructure, 2010 to 2013

In addition to showing the distribution of groups along PC1 and PC2, the distance biplot contains seven red arrows starting at the origin and ending at coordinates defined by each variable's factor loadings (Figure A5.1-5) on the first two PC axes (also called factor axes). Plotted in this manner, each arrow graphically represents the sign (direction of arrow) and magnitude (length) of each behaviour's factor loading (i.e., linear weighting) on each of the two axes (Figure A5.1-5). The longest arrows in Figure A5.1-5 correspond to bedding, standing, and walking, because variation in these three activities was responsible for most of the activity budget variation represented by PC1 and PC2. The points located far from the origin and linearly arrayed along the bedding and walking arrows represent groups whose activity budgets consisted mostly of bedding or walking, though behaviours other than also loaded on the other PC axes, which described the remaining 25% of behavioural variation. Moreover, the fairly tight cluster of points located roughly in the middle of the acute angle between the standing and walking arrows, and again rather far from the origin, correspond to groups that slit their activity between these two behaviours but exhibited few other behaviours during the scan surveys.

Table A5.1-1 provides factor loadings for all PC axes across all measured behaviours, revealing a clear biological interpretation for this first PC axis. Both of the quiescent, stationary behaviours (i.e., bedding and standing) were negatively loaded on PC1, with bedding having a stronger negative loading than standing (also see Figure A5.1-1). Accordingly, these two behaviours were more common in groups with negative PC1 scores. In contrast, all behaviours involving vigilance or motion were positively loaded on PC1 (Table A5.1-1), indicating that they were more frequently observed in groups with high PC1 scores. Thus, the values along PC1, which account for nearly 55% of total behavioural variation, provide a 'composite group activity score' that distinguishes quiescent groups (low values) from groups exhibiting high intensity movements, activities, and/or vigilance (high values) or intermediate levels of activity (values near zero).

RELATIONSHIP BETWEEN GROUP ACTIVITY AND DISTANCE FROM NEAREST MINING INFRASTRUCTURE

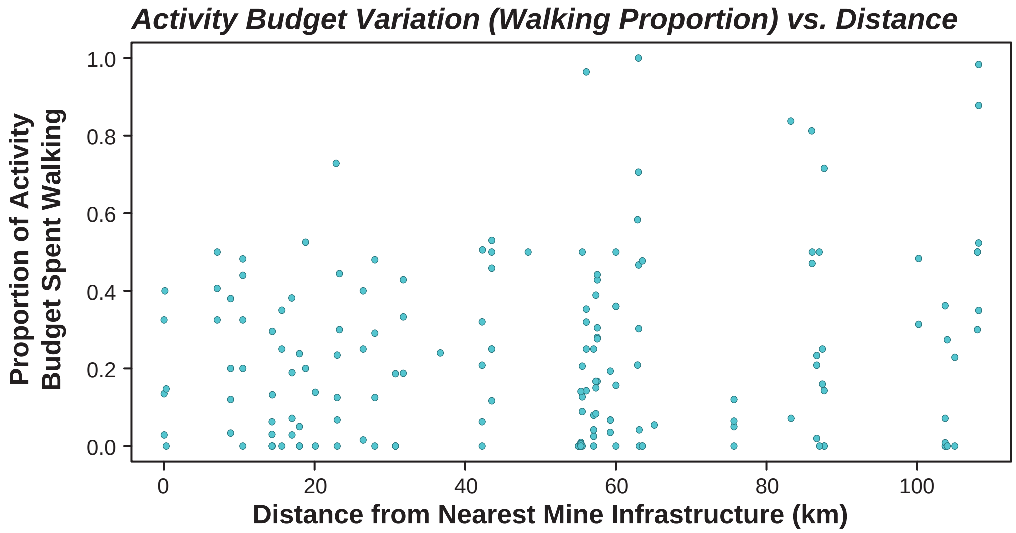
Distance from nearest mine infrastructure exhibited no significant influence on caribou group activity patterns in the region around the two-mine complex. Figure A5.1-6 (top panel) shows the proportion of group-level activity budgets spent walking (i.e., time-weighted average fraction of individuals observed walking during scan surveys) plotted against the minimum distance to infrastructure at either mine. Over all of the observed groups, moderately low proportions of the group activity budgets were allocated to walking, and the proportion did not appear to vary with distance (Figure A5.1-6, top panel). Based on the corresponding linear model, distance to infrastructure, season, and group size did not significantly affect walking proportion of the group-level activity budgets (overall model results: multiple R^2 = 0.0694, $F_{11,163}$ = 1.105, P = 0.3603).

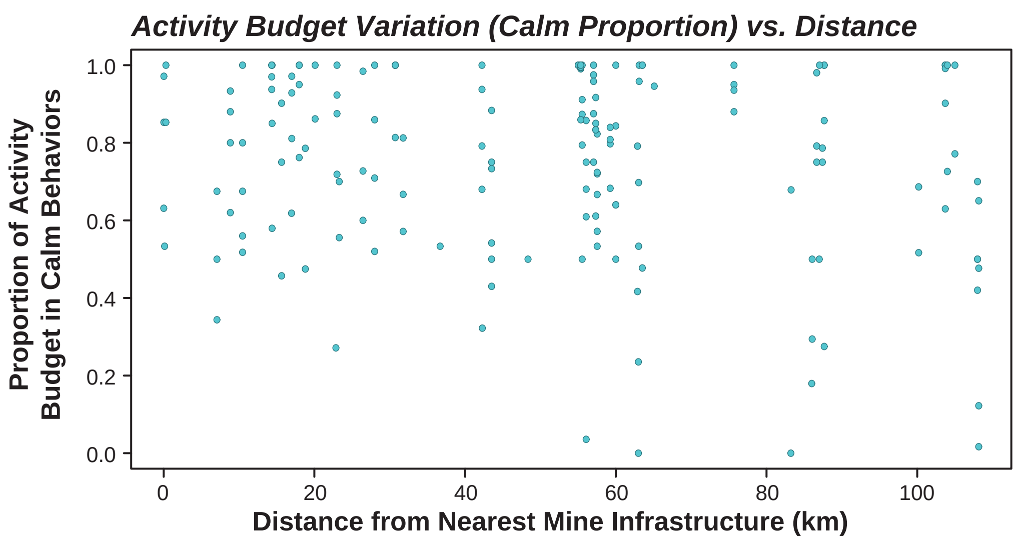
On average, caribou groups in the region tended to exhibit a large proportion their total activity in calm behaviours (Figure A5.1-6, middle panel) and very small proportion of total activity in stress behaviours (Figure A5.1-6, bottom panel). As in the case of walking proportion, linear models revealed no significant effects of distance, season, or group size on these other aspects of group activity budgets (calm-behaviour proportion: multiple R^2 = 0.0867, $F_{11,163}$ = 1.406, P = 0.1743; stress-behaviour proportion: multiple R^2 = 0.0818, $F_{11,163}$ = 1.321, P = 0.2169).

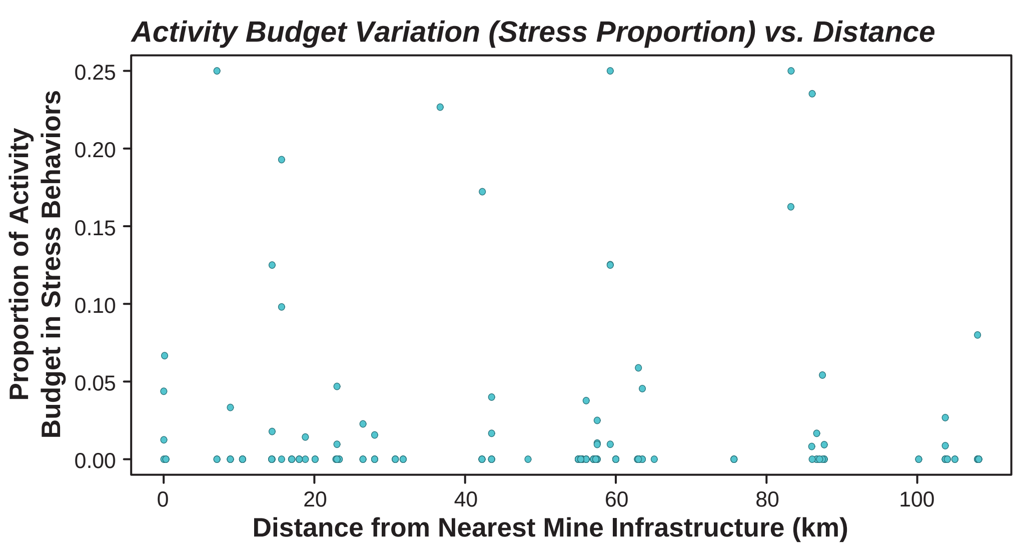
Visually, the variation in composite activity score across all groups observed around the Ekati Diamond Mine and DDMI (Figure A5.1-7) suggested two discrete activity budget states for caribou groups in this region: a high activity level state (i.e., high composite activity scores) and a low activity level state (i.e., low scores). However, there was no indication in the plot that the two-state pattern varied according to group proximity to mining infrastructure.

Figure A5.1-6

Proportion of Group Activity Budgets in Different Behaviours Plotted against the Distance from Nearest Mine Infrastructure, 2010 to 2013







In contrast to the models for walking, calm-behaviour, and stress-behaviour proportions which were not-significant, the overall linear model for composite group activity score was statistically significant (multiple R^2 = 0.1355, $F_{11,163}$ = 2.322, P = 0.0113). Defined as PC1 of the group activity budget data, the composite activity score was influenced by all categories of caribou behaviour to some degree, and this score captured 54.55% of total group-level activity budget variation (Table A5.1-1). Accordingly, the composite group activity score was more informative than any of the other response variables. The linear model contained a significant main effect of season on this key metric of general activity level (P = 0.000468), though none of the other main effects or interactions was significant (Table A5.1-2).

Table A5.1-2. ANOVA Table (Type II Tests) for Linear Model of the Relationship Between 'Composite Group Activity Score' (PC1) and Main Effects and Interactions of Three Explanatory Variables (Distance from Nearest Mine Infrastructure, Total Group Size, and Season)

Term in Linear Model	Sum of Squares	Degrees of Freedom	*F*-value	*P*-value (*F*)
Distance from Nearest Mine Infrastructure	51.96	2	1.428	0.243
Group Size	1.844	1	0.101	0.751
Season	**369.6**	**4**	**5.079**	**0.000698**
Distance * Size Interaction	33.63	1	1.849	0.176
Distance * Season Interaction	72.34	3	1.326	0.268
Size * Season Interaction	50.99	1	2.803	0.0960
Distance * Size * Season Interaction	1.038	1	0.057	0.811
Residuals:	2965.9	163	N/A	N/A

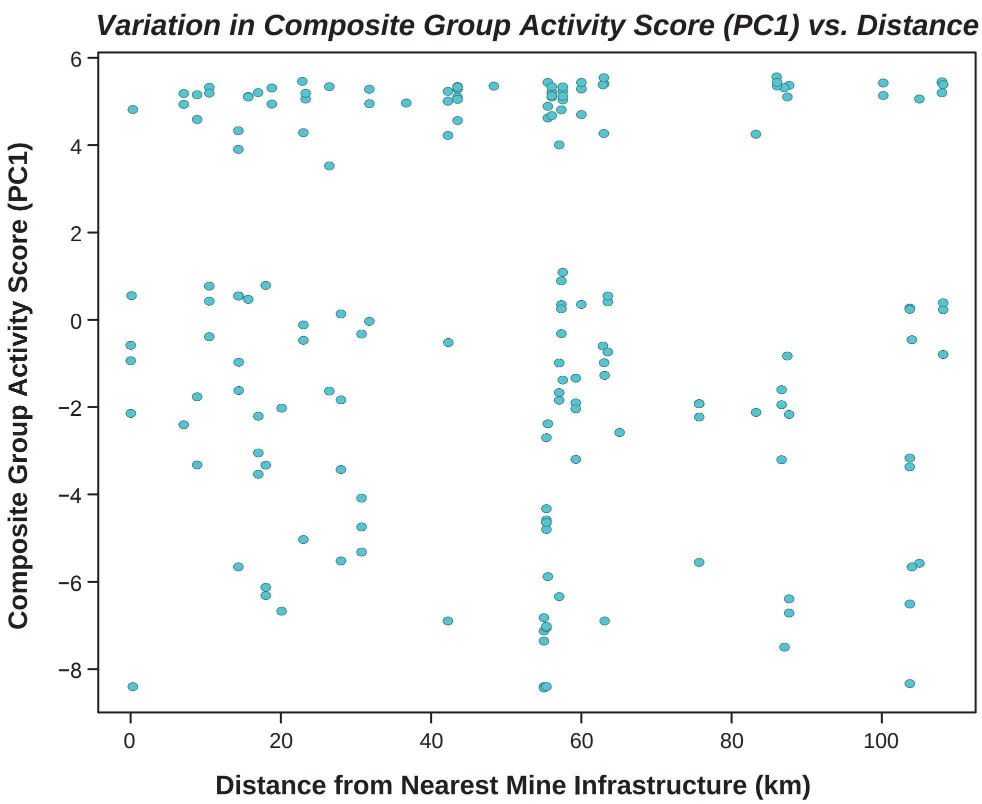
Table Footnote: Boldface text used for statistically significant model term.

Almost all caribou group surveys were performed in two nominal seasons, summer (August 1 to September 15) and the transition period between summer and southern migration (September 16 to October 22). The mean composite activity score of caribou groups in summer was 1.93 ± 0.53SE; most groups in the discrete band of points along the top of Figure A5.1-7 were observed during this period. By contrast, most groups in the lower half of Figure A5.1-7 were observed during the transition period leading up to the southern migration. Mean composite activity score across all observations in the post-summer transition period was -0.81 ± 0.41 SE. The difference between these means is consistent with the interpretation that the caribou groups were generally more active in summer than when transitioning from summer to the southern migration they undertake to overwinter.

Finding that an expected effect of season on group-level activity budgets was statistically significant implies that the scan survey data are robust, and the modeling approach valid, for testing potential effects on caribou group behaviour. An inability to reject the null hypothesis that proximity to the mine has no effect on group activity budgets is intriguing in this context. Caution is nevertheless warranted when interpreting the finding that distance from mine infrastructure had no significant effect on the composite group activity score lack of significance for distance due to a moderate gap in the dataset, which places limits on the strength and robustness of the analysis. Specifically, only a fairly small number of groups (18 groups out of 175 groups total from the scan surveys, or 10.3% of all observations) have been surveyed within 14 km of mine infrastructure, the ZOI identified by Boulanger et al. (2012). In addition, no usable data have been collected from groups located between 0.3 km and 7 km from the nearest mine infrastructure.

Figure A5.1-7

Greatest Axis of Group Activity Budget Variation Plotted against Distance from Nearest Mine Infrastructure, 2010 and 2013



Discussion

For a number of years, structured observations of caribou behaviour have been made in close proximity (< 300 m) to the Ekati Diamond Mine and at a greater distance (7 to 108 km). Two well-established methods for behavioural research have been used. A focal watch protocol has been used to quantify activity budgets of caribou individuals near the Ekati Diamond Mine, whereas a scan survey method has been used to quantify activity budgets at the group level throughout the larger geographic region. From 2010 to 2013 all focal watches of caribou individuals were conducted by staff of the Ekati Diamond Mine. In contrast, scan surveys of caribou groups during these years were performed by both the Ekati Diamond Mine (survey conducted 15 to 300 m from mine infrastructure) and DDMI (all but one survey conducted 7 to 108 km from mine infrastructure), who have agreed to share the data for ongoing investigations. Analyses were designed and carried out using the resulting behavioural datasets for 2010 to 2013 to characterize the overall activity patterns of caribou individuals and groups in the region, and to help answer the following questions: What effects, if any, do industrial stressors from mining activities have on the activity budgets of individuals at the Ekati Diamond Mines? How does proximity to mine infrastructure affect activity patterns of caribou herds in the wider geographic region around the two-mine complex? Specifically, is there evidence that the mines affect caribou groups as far away as the 14 km ZOI proposed by Boulanger et al. (2012)?

The activity budgets of individuals observed at or near the Ekati Diamond Mine (all but one focal watch 0 to 500 m from mine infrastructure) were dominated by behaviours indicating a stress-free (i.e., feeding and bedding) or neutral state (i.e., walking). The next most common behaviour produced by focal individuals was alertness, an indicator of stress. Observations were rarely made of trotting or running; these flight behaviours are likely to be produced in response to elevated or sustained levels of threat compared to those that induce alertness. Despite the prevalence of calm behaviours in the activity budgets of caribou at the Ekati Diamond Mine, significant increases in the time invested in alertness occurred after three classes of industrial stressors (i.e., mine staff on foot, light vehicles, and medium vehicles).

Though changes in caribou behaviour due to mining activities are detectable at the Ekati Diamond Mine, other data imply that the changes may be small in magnitude and perhaps might rapidly become inconsequential beyond 2 km from the nearest mine infrastructure. No class of industrial stressor at the Ekati Diamond Mine triggered a stereotyped stress response in caribou with high certainty, as might be expected for rapid flight behaviours in response to the direct approach of the large mammalian predators that naturally prey on caribou (e.g., grizzly bears and wolves). Instead, when a significant stressor-induced effect was detected, it involved a moderate change in average probability of a behaviour across focal individuals. In focal caribou in which a stress-response behaviour was, in fact, produced at a higher rate following a certain type of industrial stressor, such individuals only responded for an average of 35 sec ± 10 SE (males) or an average of 16 sec ± 3 SE (females) to each stressor event before returning to a stress-free state. In addition, there was a sharp decline in the rate of industrial stressors observed during the behavioral observations that were made beyond 2 km from mine infrastructure. Given the rates of industrial stressor events beyond 2 km, even those caribou with near certain probabilities of response to mine-generated stressors would be expected to allocate no more than several minutes of their quiescent or feeding time a day to increased vigilance (alertness) as well as, perhaps, flight from stressors.

Activity budgets of caribou groups were quantified between from 0 to 108 km from the nearest mining infrastructure. Consistent with the activity budgets of caribou individuals close to the Ekati Diamond Mine, calm or neutral behaviours tended to dominate the activity budgets of groups, and stress-response behaviours contributed little to these activity patterns. When linear modeling was used to investigate potential effects on three separate response variables (proportions of total group activity allocated to walking, all calm behaviours, or all stress behaviours), no significant effects were found for distance from mine infrastructure, season, or group size. However, the first principal component axis (PC1) for the herd-level dataset was more informative than the other three response variables. PC1 accounted for more than half of all measured variation in group activity, and it was loaded by behavioural variables in such a way that it seemed to represent a measure of composite group activity level. An obvious pattern in the distribution of PC1 scores was the presence of just two discrete activity levels (low or high) among the caribou groups. Though PC1 was not significantly influenced by distance from mine infrastructure or group size, season did have a significant main effect in the linear model. The data suggest that caribou groups were more active in summer than during the transition between summer and the southern migration. Finding a biologically-significant influence of season on caribou activity patterns supports the utility of these collaborative scan survey data for testing other biological effects on the behaviour of caribou around the two-mine complex (including anthropogenic effects, such as the proposed ZOI).

The non-significant effect of distance from mine infrastructure on the composite group activity score (i.e., PC1) is consistent with the absence of a ZOI for group activity level, or a reduced ZOI for this particular endpoint, in contrast to the 14 km ZOI identified by Boulanger et al. (2012). However, only 18 groups yielding usable data were surveyed within 14 km of mine infrastructure from 2010 – 2013 (out of 175 groups total), and there are no data for groups that were located 0.3to 7 km away from mine infrastructure, a region of particular interest in light of the present results and the work by Boulanger et al. (2012). Consequently, the null hypothesis that the activity budgets of caribou herds are unaffected by proximity to the mines requires further consideration after additional data are collected to fill these gaps.

Possibilities of bias arise when different crews of wildlife technicians are largely responsible for collecting observational data on animal behavior from different geographic regions and distances from mine infrastructure. Thus, it would be profitable to attempt to further standardize field protocols and coordinate data collection and recording methods between mines before new data are collected. Periodic reciprocal sampling, in which field crews from one mine make observations in the areas normally visited by the other mine, should also be considered.

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DOMINION DIAMOND

Information Request Number: DAR-MVEIRB-IR2-06

Source: Mackenzie Valley Environmental Impact Review Board Information Requests from Chuck Hubert

Subject: Caribou - ZOI size

DAR Section(s): 12.4.2.2.1 (Table 12.4-15); Round 1 Information Request Responses Appendix D

Preamble (MVEIRB):

Appendix D acknowledges that the Jay project will increase ZOI but the details are not provided. The DAR Table 12.4-15 gives the areas of habitat altered but the figures include other developments rather than the mine zone of influence area. Appendix D Map 2 suggests closure of Diavik will reduce ZOI by ~10 km to south, implying that ZOI depends on mine activities. The corollary of this implication is that any other developments in Diavik-Ekati area would also increase ZOI (and projected cumulative effects).

Request (MVEIRB):

To clarify please provide the area and periphery length of the Ekati ZOI, the Ekati+Jay ZOI and the Ekati+Jay+Sable ZOI. The three areas and periphery measurements will increase understanding of the encounter rates for caribou.

Response:

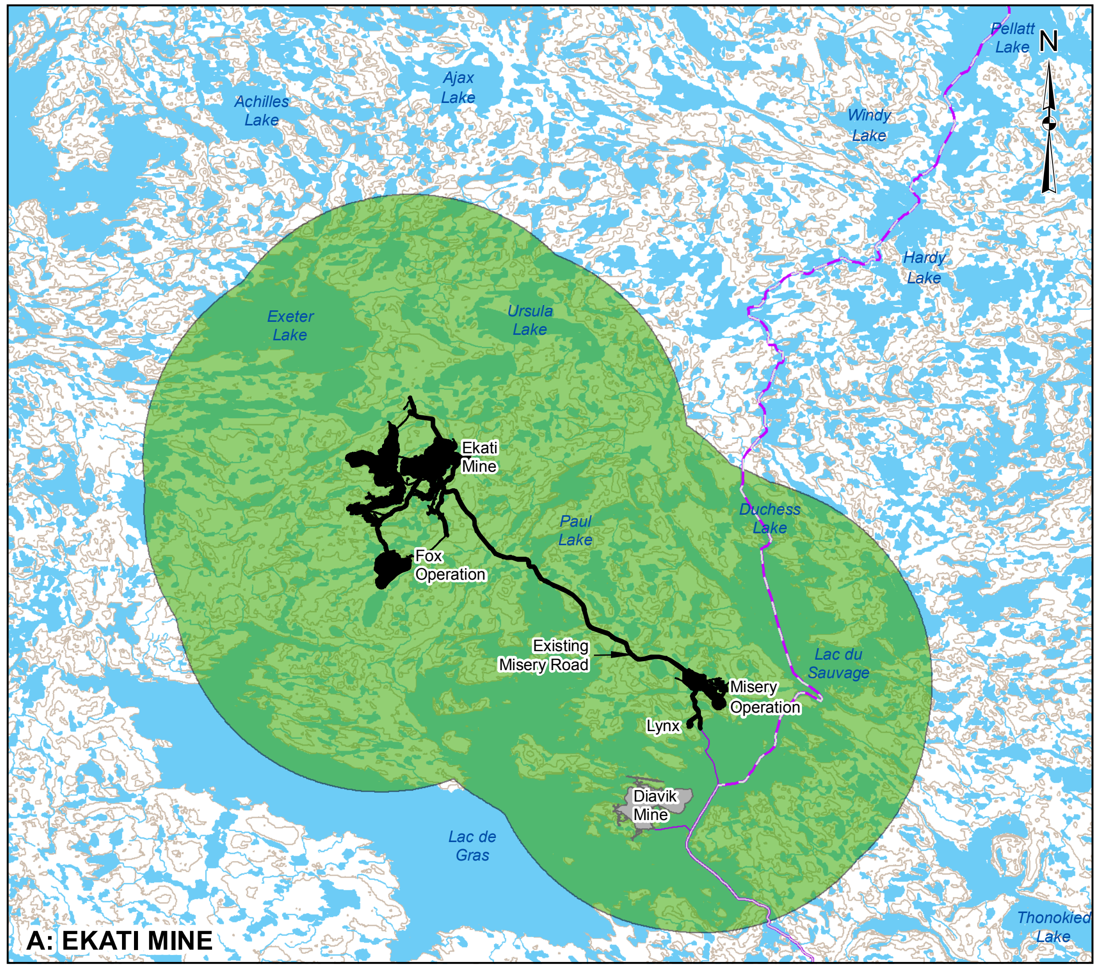
As requested, a 15 kilometre (km) zone of influence (ZOI) was placed around: the Ekati Mine; Ekati Mine with the Jay Project and Jay Road; and the Ekati Mine with the Jay Project, Jay Road, Sable Project, and Sable Road (Map 6-1). In all cases, the Ekati Mine was defined as illustrated in Map 6-1 (a), including the Misery Road and Misery waste rock storage area. To be consistent with the request, all development associated with the Diavik Mine were excluded from these analyses. Zones of influence including the Diavik Mine were presented in Appendix D included with the first round of information requests. Note that for Appendix D calculations, ZOI areas were terrestrial habitats only.

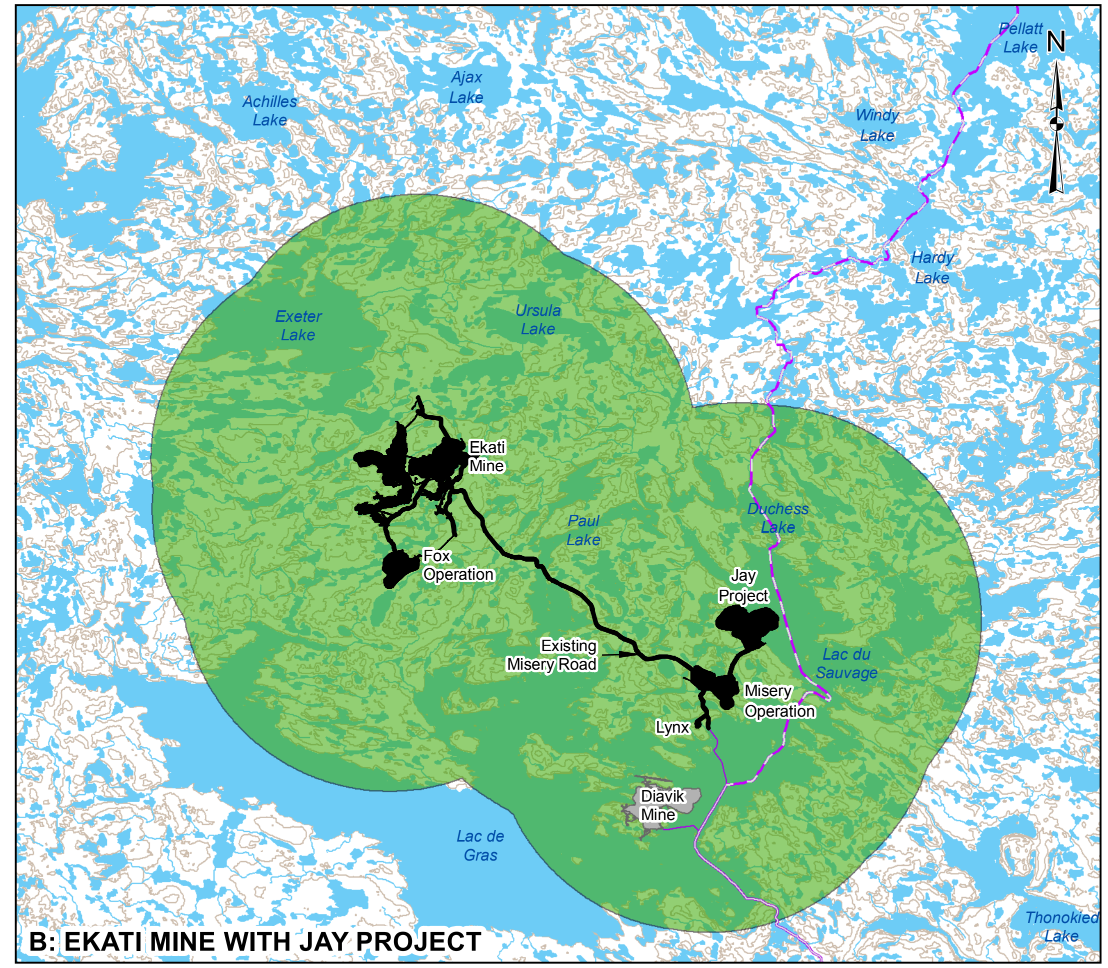
The areas within the ZOI around each of the three scenarios and the perimeter measurement of each ZOI are presented in Table 6-1.

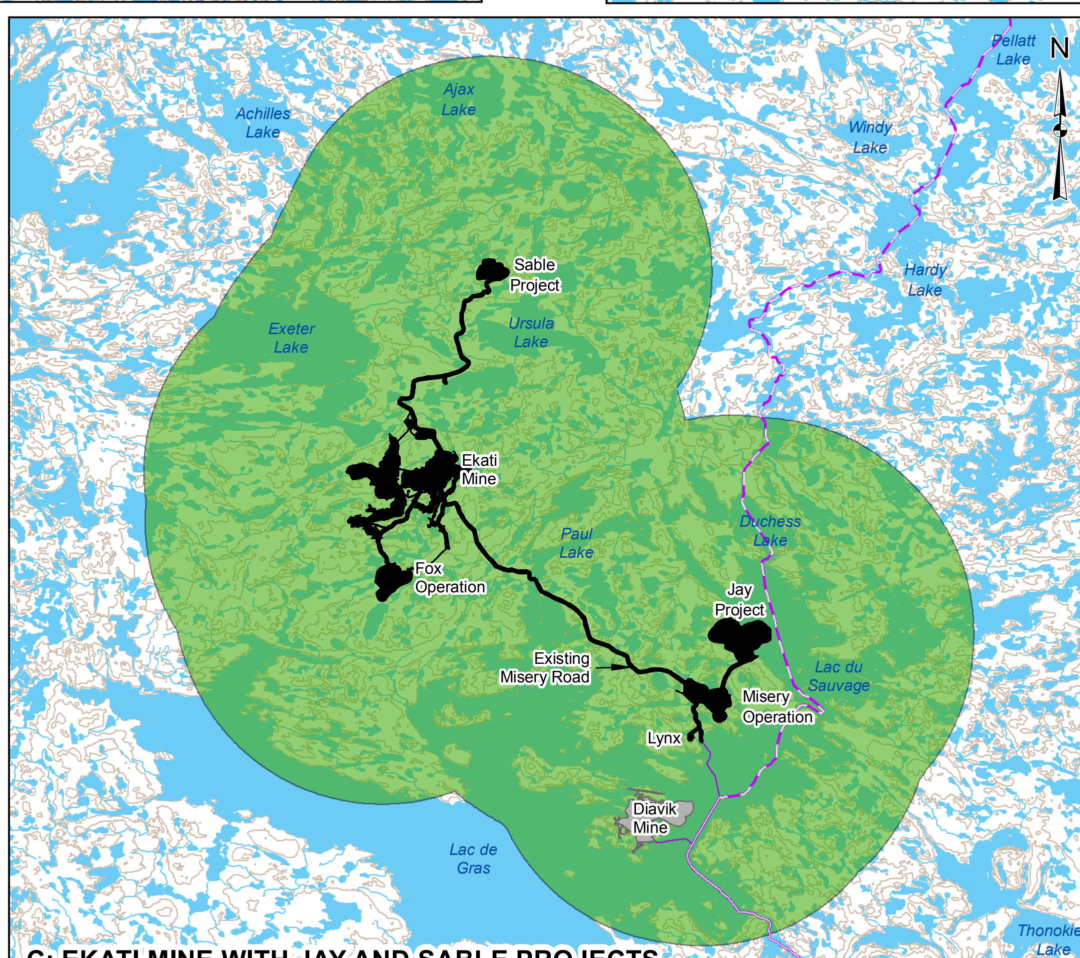
Table 6-1 Areas and Perimeters of 15 Kilometre Zones of Influence Around the Ekati Mine With and Without Jay and Sable Projects and Roads

Developments Included	Total Area (km^2) within the Zone of Influence (ZOI)	ZOI Perimeter (km)
Ekati Mine	2,108	177
Ekati Mine, Jay Project, and Jay Road	2,260	184
Ekati Mine, Jay Project, Jay Road, Sable Project, and Sable Road	2,639	206

km = kilometre; km^2 = square kilometres.







LEGEND

- DIAVIK MINE FOOTPRINT
- WINTER ROAD
- TIBBITT TO CONTWOYTO WINTER ROAD
- NORTHERN PORTION OF TIBBITT TO CONTWOYTO WINTER ROAD
- ELEVATION CONTOUR (20 m INTERVAL)
- WATERCOURSE
- WATERBODY
- DEVELOPMENT FOOTPRINT
- 15 KM ZONE OF INFLUENCE

REFERENCE

NATIONAL TOPOGRAPHIC BASE DATA (NTDB) 1:250,000
CANVEC © NATURAL RESOURCES CANADA, 2012
NATURAL RESOURCES CANADA, CENTRE FOR TOPOGRAPHIC INFORMATION, 2012
DATUM: NAD83 PROJECTION: UTM ZONE 12N

10 0 10
SCALE 1:560,000 KILOMETRES

PROJECT
DOMINION DIAMOND
JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE
DEVELOPMENT FOOTPRINTS AND 15 KM ZONES OF INFLUENCE

Golder Associates

PROJECT	1419751.3400.50		FILE No.	
DESIGN	JR	22/06/15	SCALE AS SHOWN	REV 0
GIS	ANK	03/07/15	MAP 6-1	
CHECK	JR	03/07/15		
REVIEW	JV	03/07/15		

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DOMINION DIAMOND

Information Request Number:	DAR-MVEIRB-IR2-07
Source:	Mackenzie Valley Environmental Impact Review Board Information Requests from Chuck Hubert
Subject:	Caribou habitat loss
DAR Section(s):	12.4.2.2.2 (Table 12.4-18)

Preamble (MVEIRB):

The DAR Table 12.4-18 provides estimates of relative changes in amount of different quality habitats on the autumn range of the Bathurst caribou herd. However, using the fall range of the herd at peak size may dilute the effect of habitat loss, given the decline of the size of the fall range for since 2010. See figure 9.1 of the Volume 1 of the Adequacy Responses.(PR#254)

Request (MVEIRB):

Please provide the relative loss of all different quality habitats on the autumn range of the Bathurst caribou herd from reference conditions to application case based on the average size of the fall range 2010-2014.

Response:

General Approach used in the Developer's Assessment Report

The Developer's Assessment Report (DAR) used data from multi-year seasonal ranges and a temporal and spatially explicit development layer to calculate the changes in the amount of different quality habitats for each season under reference conditions, 2014 baseline conditions, Application Case, and Reasonably Foreseeable Development (RFD) Case. The ranges were delineated from radio-collar data that were collected from April 1996 to October 2013 from individuals of the Bathurst caribou herd. The multi-year autumn range (determined using data collected from September 1 to October 31 of each year) was 139,054 square kilometres. The kernel density analysis used in the determination of the autumn range preferentially weighted areas with higher densities of caribou collar locations (i.e., the size, location, and shape of the range was a function of core use areas over time).

The purpose in using a seasonal range determined from multiple years was to include areas and habitats used in some years but not all years and, importantly, to include habitat that is of value to the herd at different phases in the population cycle. To preferentially consider seasonal ranges determined when the Bathurst herd is at the low phase of the population cycle, as in this information request, would preclude an assessment of the effects from development on the larger autumn range required to support the herd at the increasing phase of the cycle. Density-dependent resource selection in a less dense (i.e., smaller) population should allow more selective use of habitat and use of smaller seasonal ranges (McLoughlin et al. 2006), which suggests the quality of available habitat should be higher at the low phase of a population cycle. Available habitat at the high phase of a population cycle is more likely to be limiting to the herd and given the greater spatial extent of the range, is more likely to include a greater number of developments. The use of larger seasonal ranges in the residual effects analysis is a conservative approach to the assessment of Project-specific and cumulative effects of development, and reflects the long-term temporal scope of the assessment, as required by the Terms of Reference.

Methods for Calculating Habitat Quality in the DAR and the Implications to the Information Request

In the DAR (Section 12.4.2.2.1), the analysis of changes in habitat quality from human developments for each seasonal range (including the autumn range) was based on calculations of the resource selection function (RSF) values (i.e., relative habitat quality) for each raster cell in a Geographical Information System (GIS) layer. The analysis relied on:

- a habitat-specific RSF patch coefficient (Johnson et al. 2005); and,
- a seasonal range-specific habitat patch weight determined independently for each seasonal range (Johnson 2009).

If a new autumn range were calculated for each year, then a different RSF (i.e., habitat value) layer would need to be generated for each year. A direct comparison of autumn range quality calculated in the DAR with the period requested (2010 to 2014) would be problematic and uninformative for the following reasons:

1. The location of each annual seasonal range is unique. Autumn ranges change in size, shape, and location each year (e.g., Map 7-1). Assessing habitat quality based on a mean range size is not an appropriate measure as there is no corresponding average range location and shape that is biologically meaningful;
2. The number of active developments (i.e., projects with zones of influence [ZOIs]) and the specific active developments will change each year with range size and location;
3. The approach for determining RSF values used in the DAR (Johnson et al. 2005; Johnson 2009; Section 12.4.2.2.1) would require that each annual autumn range have equal quantities of high, good, low, and poor habitat, prior to the addition of active developments and associated ZOIs; and,
4. The patch weight values determined for each GIS raster cell will be different for each year-specific seasonal range. In other words, a specific point on the ground, represented by a GIS raster cell in an analysis, will have a different RSF value for each year if the seasonal range boundaries differ from year to year.

The consequence of these conditions of the method is that each annual autumn range would, by definition, have approximately 25 percent (%) of each of high, good, low, and poor habitat. Each time a new range is defined the underlying landscape values must be reset. The assessment requested would require recalculating the RSF values for each raster cell in each annual range, reassigning all cells to habitat quality quartiles, reapplying disturbance layers, and quantifying habitat loss by category. Each assessment of the change in habitat quality would be only relevant to that specific individual year. Comparisons of development-related changes in habitat quality across each annual autumn range, which are based on different spatial location and magnitude of underlying landscape values, are not directly interpretable. The approach in the DAR was to maintain constant RSF values within each seasonal range (across the landscape and time) and apply the development layer across the ranges at key snapshots in time (reference conditions, 2014 Base Case, Application, and RFD cases) to provide an ecologically relevant and transparent numerical analysis of anthropogenic-related changes in habitat quality.

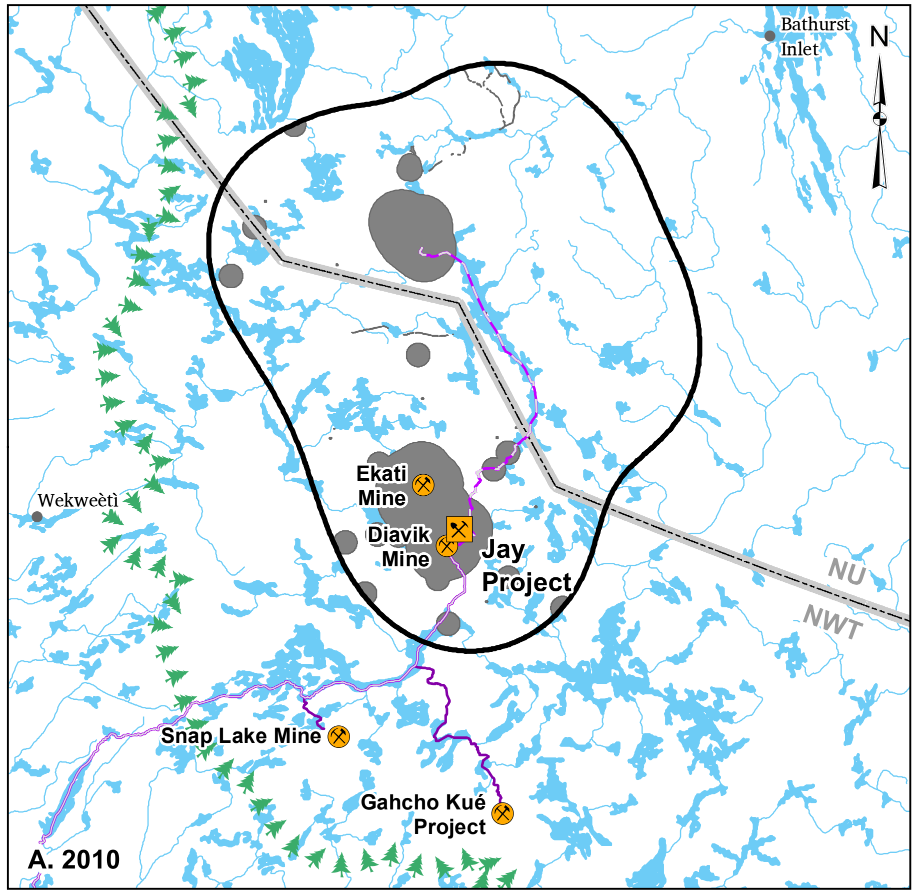
A useful surrogate measure to assessing change in habitat as per the information request is to examine the proportion of each annual autumn range that is occupied by active developments and associated ZOIs, and the physical footprint from inactive developments. The year-specific autumn ranges were calculated for 2010 to 2014 using the same 95% kernel method applied in the DAR. Map 7-1 shows the autumn range boundaries for each year and the inactive and active developments that year, represented as development footprints and ZOIs, respectively, as applied in the DAR. An exception was 2014 where the development footprints and ZOIs from 2013 were applied because a verified updated development layer is currently not available.

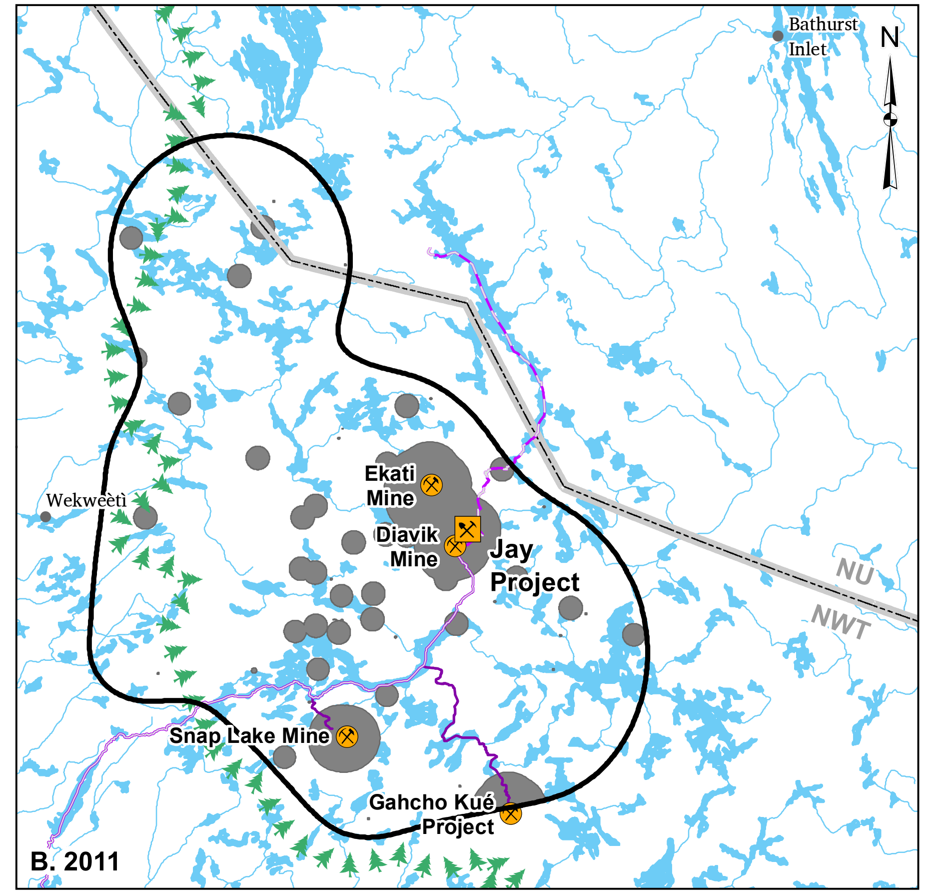
The total area of the autumn range for each year is presented in Table 7-1 along with the area and percentage of the autumn range that is within development footprints and ZOIs.

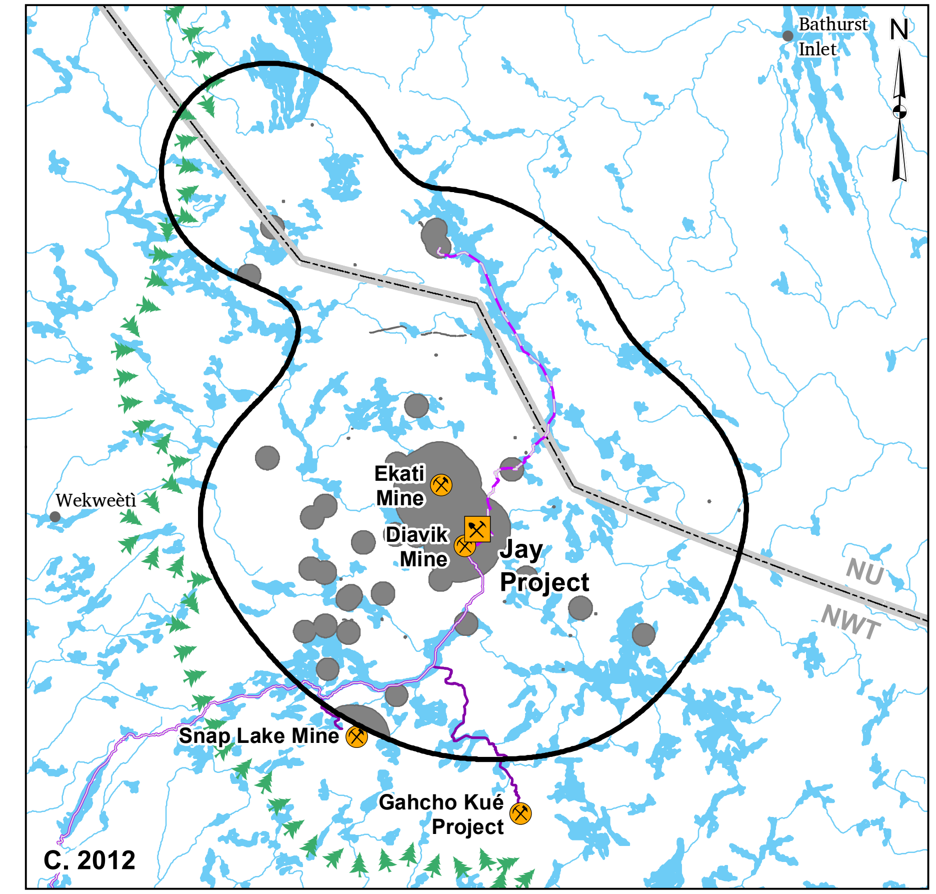
Table 7-1 Autumn Range Areas of the Bathurst Caribou Herd 2010 to 2014 and the amount of Development Within Each Year's Range

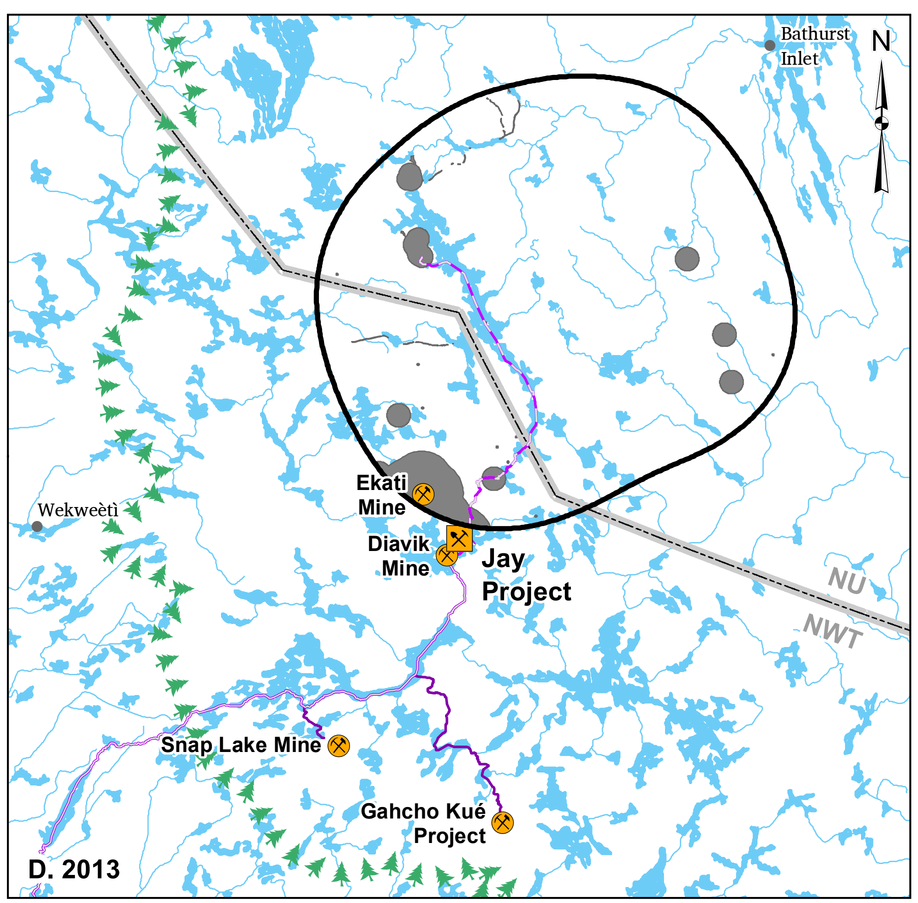
Year	Autumn Range Area (km^2)	Development Area (km^2)[a]	% Development in Range
2010	43,639	5,050	11.6
2011	53,329	6,353	11.9
2012	56,831	5,024	8.8
2013	36,125	1,731	4.8
2014[b]	56,772	4,812	8.5

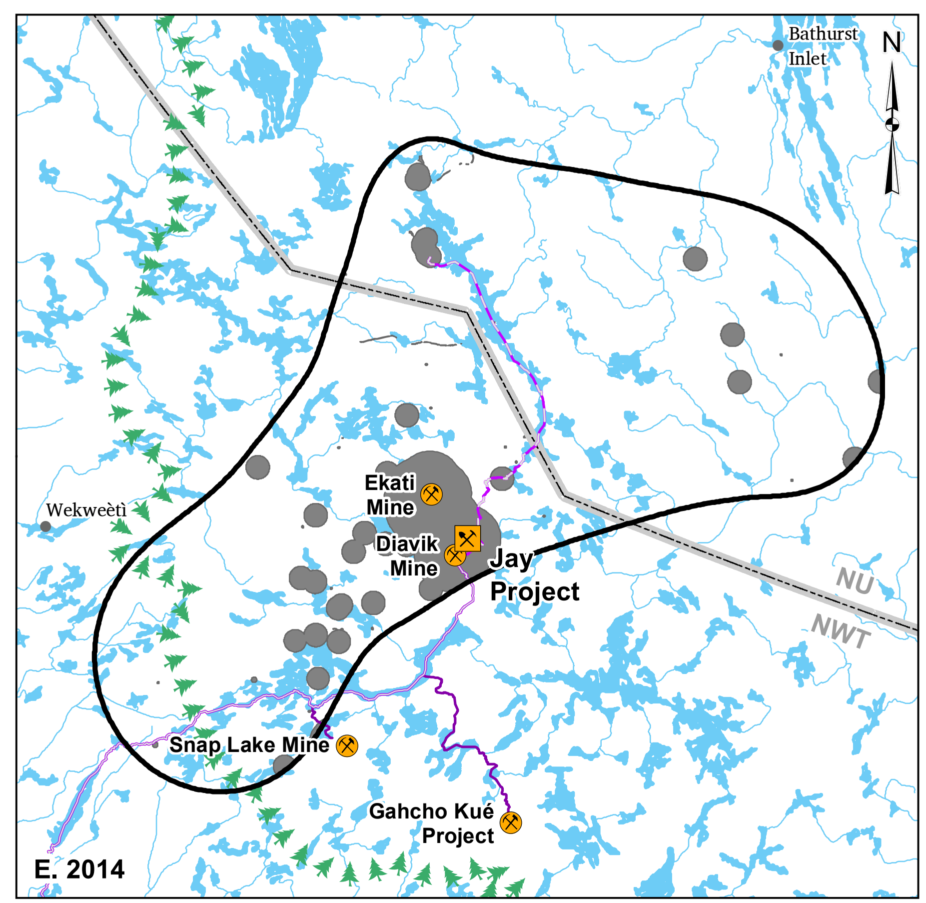
a) Development area is the total area within development footprints and associated zones of influence (ZOIs) for active projects
b) 2014 calculations used the 2013 development layer and associated ZOIs











LEGEND

- JAY PROJECT
- EXISTING MINE OR PROJECT
- POPULATED PLACE
- WINTER ROAD
- TIBBITT TO CONTWOYTO WINTER ROAD
- NORTHERN PORTION OF TIBBITT TO CONTWOYTO WINTER ROAD
- TERRITORIAL/PROVINCIAL BOUNDARY
- TREELINE
- WATERCOURSE
- WATERBODY
- AUTUMN RANGE
- DEVELOPMENT AND ZOI FOOTPRINT

NOTES

1. AUTUMN RANGES DETERMINED FROM SATELLITE RADIO-COLLARED BATHURST HERD CARIBOU LOCATIONS BY DERNEL DENSITY ANALYSIES, EXCLUDING SMALL OUTLIER POLYGONS

REFERENCE

WATER OBTAINED FROM ATLAS OF CANADA
NATURAL RESOURCES CANADA, CENTRE FOR TOPOGRAPHIC INFORMATION, 2012
PROJECTION: CANADA LAMBERT CONFORMAL CONIC

70 0 70
SCALE 1:3,500,000 KILOMETRES

PROJECT
DOMINION DIAMOND™

JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE

AUTUMN RANGES AND DEVELOPMENTS WITH ZONES OF INFLUENCE FOR INDIVIDUAL YEARS FROM 2010 TO 2014

Golder Associates

PROJECT	1419751.3400.50		FILE No.
DESIGN	JR	22/06/15	SCALE AS SHOWN REV 0
GIS	ANK	03/07/15	**MAP 7-1**
CHECK	JR	03/07/15	
REVIEW	JV	03/07/15	

Human developments reduce the quantity and quality of habitat available to Bathurst caribou and are predicted to result in measurable changes to abundance and distribution within and around ZOIs, but the effects are likely within the resilience limits and adaptive capacity of the population (Section 12.6.2). Without assessing the quality of the affected range, the results show that the percentage of the annual autumn range within development footprints and ZOIs has varied through time (Table 7-1). In the 2010 to 2014 period, the percentage of the autumn range influenced by development was highest in 2010 and 2011. The DAR also demonstrated that the percentage of the effects study area (combined seasonal ranges) covered by ZOIs (exploration sites only) changed through time, with a decreasing trend from 2008 (10.4%) through 2013 (9.2%) (Section 12.4.2.2.1; Figure 12.4-1).

References:

Johnson CJ, Boyce MS, Case RL, Cluff HD, Gau RJ, Gunn A, Mulders R. 2005. Cumulative effects of human developments on Arctic wildlife. Wildlife Monogr 160: 1-36.

Johnson CJ. 2009. Associate Professor, University of Northern British Columbia. Prince George, BC, Canada. E-mail. June 25, 2009.

McLoughlin PD, Boyce MS, Coulson T, Clutton-Brock T. 2006 Lifetime reproductive success and density dependent, multi-variable resource selection. Proc R Soc. B 273:1449–1454.

Information Request Number:	DAR-MVEIRB-IR2-08
Source:	Mackenzie Valley Environmental Impact Review Board Information Requests from Chuck Hubert
Subject:	Caribou - Integrating information on local caribou numbers with encounter rates
DAR Section(s):	12.2.2.1

Preamble (MVEIRB):

The assumption in the use of the satellite-collared caribou is that the collared caribou are representative of herd movements. Projection of incremental and cumulative effects is largely based on the encounter rates of the collared caribou with the Zone of Influence and the rates correlate with the results of the aerial surveys. At a finer scale such as the Misery Road, the correlation between collared caribou data and the actual encounters has not been examined. To examine the representativeness of the collared caribou, the rate of encounters could be compared with the sightings of caribou. The annual WEMP reports, but not the DAR, describe incidental caribou sightings at Ekati which have been collected since 2006 (Rescan 2012). The cameras are an additional dataset to build a composite picture of caribou abundance and distribution at Ekati (allowing for repeated sightings).

Request (MVEIRB):

a) Summarize as tables or maps the annual and monthly incidental caribou sightings (2006-2014) and camera sightings at Misery Road.

b) Table or graph the incidental and camera sightings relative to the encounter rates of collared caribou with the Zone of Influence.

Response:

The information requested is summarized for available years in the period from 2006 to 2014 (Table 8-1). Incidental observation data are available as annual summaries. Radio-collared caribou and camera data from the Misery Road were summarized for the period of June 15 to October 31. This time period is consistent with the encounter analysis presented in the Developer’s Assessment Report and the Sable Addendum; they coincide with the post-calving and autumn seasons and represent times when calves accompanying adult females are likely most vulnerable to predation and changes to the nutritional condition of the cow. Except for collar data, which were provided by the Department of Environment and Natural Resources, all information was obtained from Ekati Mine Wildlife Effects Monitoring Program annual reports.

If comparing data from different sources from 2006 to 2014 it should be noted:

- all radio-collared caribou were adult females;
- incidental observations represent the number and times caribou were reported by Ekati Mine site staff;
- incidental observations were not categorized by age and sex; and,
- camera observations were not categorized by age and sex.

Table 8-1 Summary of Incidental Caribou Sightings by Ekati Mine Staff, Caribou Observed by Cameras along Misery Road, Zone of Influence Encounters and Misery Road Crossings by Radio-collared Caribou, and Caribou Observed During Aerial Survey Program, 2006 to 2014

Year	Bathurst Herd Size[(a)]	Total Caribou Incidentally Observed	Percent Incidental Observations[(b)]	Total Caribou Observed by Camera along Misery Road	Total Camera Days	Mean Number of Caribou per Camera per Day	Total Collared Caribou Monitoring Days[(c)] (total number of collared animals)	Number of ZOI Encounters by Collared Caribou[(c)] (number of different animals)	Number of Misery Road Crossings by Collared Caribou[(c)] (number of different animals)	Total Caribou Observed During Aerial Survey Monitoring Program [(c)] (number of surveys)
2006	128,000	20,403	15.9	-	-	-	1,993 (15)	148 (14)	2 (2)	8,585 (17)
2007	96,000	20,092	20.9	-	-	-	2,633 (20)	302 (20)	3 (2)	9,793 (13)
2008	64,000	876	1.4	-	-	-	1,791 (15)	141 (14)	0	10,063 (23)
2009	32,000	19,633	61.4	-	-	-	1,837 (14)	260 (14)	4 (3)	19,215 (14)
2010	33,000	11,571	35.1	-	-	-	1,911 (19)	214 (19)	5 (3)	no survey
2011	34,000	14,766	43.4	336	4,495	0.08	1,898 (18)	188 (16)	0	no survey
2012	35,000	4,674	13.4	1,389	8,542	0.16	2,499 (22)	376 (21)	0	3,490 (9)
2013	-	2,652	-	654	9,059	0.07	1,586 (13)	134 (12)	0	no survey
2014	-	1,508	-	-	-	-	2,143 (17)	140 (15)[(d)]	0	no survey

[(a)] Herd size in 2006, 2009, and 2012 from photo census of Bathurst calving grounds. All other years prior to 2012 were predicted from linear relationship between photo-census estimates.

[(b)] Total caribou incidentally observed divided by estimated herd size.

[(c)] For the June 15 to October 31 period (as assessed for ZOI encounters in the DAR)

[(d)] 2014 encounter rate estimate used the 2013 development layer and ZOIs

ZOI = zone of influence.

DOMINION DIAMOND

Information Request Number:	DAR-MVEIRB-IR2-09
Source:	Mackenzie Valley Environmental Impact Review Board Information Requests from Chuck Hubert
Subject:	Lac de Gras Water Quality
DAR Section(s):	Jay Technical Sessions Undertaking Response DAR-MVEIRB-UT-08; Jay Technical Session April 22 Transcript (Pages 248 and 250)

Preamble (MVEIRB):

Undertaking 8, as recorded by the Review Board and Dominion Diamond, requested information regarding "a comparison of the volumes of Lac de Gras and Snap Lake (including residency time/turnover of water in Lac de Gras) and the total volumes of effluent that will be discharged into these lakes". The Review Board believes that the intent of the original question posed by the YKDFN was not adequately captured by this wording. The Review Board, therefore, would like to clarify this question based on statements taken directly from the Technical Session transcript.

Request (MVEIRB):

a) Based on known volumes, effluent source loads (including Diavik and Ekati operations) and recharge rates, please provide an estimate of the percentage of Lac de Gras and Lac du Sauvage that would be effluent by the end of mine operations.

b) Please quantitatively demonstrate that this effluent concentration will allow both Lac de Gras and Lac du Sauvage to remain below significance thresholds for water quality.

Response:

a) The maximum proportions of Lac du Sauvage and Lac de Gras predicted to be effluent (also referred to as minewater discharge in the Developer’s Assessment Report [DAR]), as based on the updated assessment case model (Golder 2015), occur during late operations of the Jay Project, are approximately 4 percent (%) and 6%, respectively. These proportions are predicted to decrease in the closure and post-closure periods. The proportions of Lac du Sauvage and Lac de Gras predicted to be minewater, respectively, were estimated from the lake hydrodynamic and site water quality models using chemically conservative conditions (i.e., assumed no natural degradation of constituents in the receiving environment).

b) As discussed in Section 8.5.4.1 of the DAR, effects of minewater discharge (and subsequent constituent loading) to Lac du Sauvage and Lac de Gras for the life of the Mine from the Project and cumulative sources were quantitatively predicted using water quality models. Results were quantitatively evaluated relative to guidelines and objectives that are based on scientifically defensible toxicological data. Within Section 8.5.6.2 of the DAR, water quality changes in both Lac du Sauvage and Lac de Gras (due to Project activities) were modelled for the life of mine and into the post-closure period (to 2060). The modelled predictions were compared to site-specific water quality objectives developed for the Ekati Mine (Elphick et al. 2011; Rescan 2012a,b,c,d,e), Canadian water quality guidelines (CWQG) for the protection of aquatic life (CCME 1999), Health Canada drinking water quality guidelines (DWQG; Health Canada 2012), a strontium effects benchmark (McPherson et al. 2014), other Provincial guidelines (BCMOE 2010), existing data representing current baseline conditions, and reference condition data, where applicable (Table 8.5-13 of the DAR). All predicted concentrations were less than the guidelines and objectives, and thus, no constituents of concern were identified.

The predicted water quality concentrations were evaluated to determine if the Project could cause a significant adverse effect to the water quality valued component assessment endpoint. For water quality, significance focused on potential for effects to aquatic ecosystems, aquatic health, and drinking water uses. Based on the modelled water quality predictions for Lac du Sauvage and Lac de Gras for the Application Case, the Project will not have a significant adverse effect on the maintenance or suitability of water to support healthy and sustainable ecosystems in Lac du Sauvage and Lac de Gras, or on the continued opportunity for the traditional use of water, including use as a drinking water source.

References:

BCMOE (British Columbia Ministry of Environment). 2010. Water Quality Guidelines (Criteria) Reports. January 2010. Available at: http://www.env.gov.bc.ca/wat/wq/wq_guidelines.html#working. Accessed July 2014.

CCME (Canadian Council of Ministers of the Environment). 1999. Canadian Environmental Quality Guidelines, with updates to 2014. Publication No. 1299. Winnipeg, MB, Canada. ISBN: 1-896997-34-1.

Elphick JRF, Bergh KD, Bailey HC. 2011. Chronic toxicity of chloride to freshwater species: effects of hardness and implications for water quality guidelines. Environ Toxicol Chem 30: 230-246.

Golder (Golder Associates Ltd.). 2015. Jay Project - Compendium of Supplemental Water Quality Modelling. Submitted to Mackenzie Valley Environmental Impact Review Board. April 2015.

Health Canada. 2012. Summary of Guidelines for Canadian Drinking Water Quality (CDWQ). Prepared by the Federal-Provincial Subcommittee on Drinking Water of the Federal-Provincial-Territorial Committee on Environmental and Occupational Health. Ottawa, ON, Canada.

McPherson C, Lawrence G, Elphick J, Chapman PM. 2014. Development of a strontium chronic effects benchmark for aquatic life in freshwater. Environ Toxicol Chem. DOI: 10.1002/etc.2696.

Rescan (Rescan Environmental Services Ltd.). 2012a. EKATI Diamond Mine: Site-Specific Water Quality Objective for Potassium. Prepared for BHP Billiton Canada Inc. Yellowknife, NWT, Canada.

Rescan. 2012b. EKATI Diamond Mine: Site-specific Water Quality Objective for Sulphate. Prepared for BHP Billiton Canada Inc. Yellowknife, NWT, Canada.

Rescan. 2012c. EKATI Diamond Mine: Site-Specific Water Quality Objective for Nitrate, 2012. Prepared for BHP Billiton Canada Inc. Yellowknife, NWT, Canada.

Rescan. 2012d. EKATI Diamond Mine: Site Specific Water Quality Objective for Molybdenum, 2011. Prepared for BHP Billiton Canada Inc. Yellowknife, NWT, Canada.

Rescan. 2012e. EKATI Diamond Mine: Site-specific Water Quality Objective for Vanadium. Prepared for BHP Billiton Canada Inc. Yellowknife, NWT, Canada.

DOMINION DIAMOND

Information Request Number:	DAR-MVEIRB-IR2-10
Source:	Mackenzie Valley Environmental Impact Review Board Information Requests from Chuck Hubert
Subject:	Wildlife
DAR Section(s):	To ENR and Dominion Diamond- Technical Session Day 1- Wildlife (Technical Session transcript April 20 p137).

Preamble (MVEIRB):

The Review Board initiated a line of questioning regarding the potential for adverse effects on raptors and raptor nesting locations during pit flooding activities that have been approved as part of closure. Based on the discussion that followed, it was determined that, from ENR's perspective and assuming appropriate mitigation measures were followed, no significant adverse effects would be expected. The Review Board is required to consider potential effects to species at risk, including raptors such as Peregrine Falcons, under section 79 of the Species at Risk Act.

Request (MVEIRB):

Will Dominion Diamond commit to working collaboratively with the GNWT to incorporate raptor nesting deterrence and additional monitoring and management activities as required in the open pit flooding plans?

Response:

Dominion Diamond is committed to continue working collaboratively with the Government of the Northwest Territories, Environment and Natural Resources (GNWT-ENR) to identify and mitigate any potential risks or impacts to raptors and their nests during mining operations and pit back-flooding during closure. Dominion Diamond will continue to monitor all pits during operations and engage with GNWT-ENR on the appropriate preventative measures or deterrent methods to ensure the safety of raptors, their nests and young during both operations and closure.

DOMINION DIAMOND

Information Request Number:	DAR-MVEIRB-IR2-13
Source:	Mackenzie Valley Environmental Impact Review Board Information Requests from Chuck Hubert
Subject:	Impacts to traditional fishing and significance determination
DAR Section(s):	Round 1 Information Request Response DAR- Tłı̨chǫ-IR-22

Preamble (MVEIRB):

In its response to Tlicho Government's IR 22, Dominion Diamond states "The residual impact classification of cumulative effects to the opportunities to participate in traditional fishing were determined to be negative, low to moderate in magnitude, regional, long term, continuous and irreversible. These effects are not considered to significantly affect the assessment endpoint of maintaining continued opportunities to participate in traditional fishing". This determination is extremely important, as it relates directly to the ability of aboriginal peoples to continue traditional activities and exercise treaty rights.

Request (MVEIRB):

Please provide rationale for the determination of non-significance for an impact of the project on the opportunities for participation in traditional fishing that is negative, moderate, regional, continuous and irreversible.

Response:

Results from the residual impact classification in Section 15.4.1.3 of the Developer’s Assessment Report (DAR) were used to determine the environmental significance from the Project and other developments on the assessment endpoint of continued opportunities for participation in traditional fishing. The classification of impacts were based on changes in measurement indicators, which represent properties of the environment that when changed, could result in, or contribute to, an effect on the assessment endpoint. Six criteria were considered: magnitude, geographic extent, duration, frequency, reversibility, and likelihood of change. Of these criteria, magnitude is the primary criterion used to determine significance, while geographic extent and duration (which includes reversibility) are used as modifiers and to provide context when assigning magnitude. To assess the effects on continued opportunities to participate in traditional fish harvesting, the following measurement indicators were identified (Table 15.2-1 of the DAR; also see the reply to Round 1 Information Request DAR- Tłı̨chǫ-IR-22):

- the availability of fish;
- disturbance of preferred fishing areas;
- physical access to preferred fishing areas;
- sensory disturbances (i.e., dust, viewscape, light, and noise);
- social and economic factors affecting participation in Traditional Land Use (TLU);
- Aboriginal land users’ intangible relationship with the land; and,

- concerns regarding ecological and human health.

The culture assessment also incorporated the results from Section 9 on fish and fish habitat. Section 9 of the DAR evaluated the incremental and cumulative changes from the Project and other developments on habitat quantity (includes surface hydrology and water quality indicators), habitat arrangement and connectivity (fragmentation), habitat quality (includes surface hydrology and water quality indicators), survival and reproduction, and the abundance and distribution of fish. The changes in these measurement indicators were used to determine if the Project and other developments would result in a significant effect to self-sustaining and ecologically effective populations of fish valued components (Arctic Grayling, Lake Trout, and Lake Whitefish). Ecological effectiveness includes interactions or ecological services that benefit other aquatic species and the environment, including the use of fish valued components (VCs) by people. The results of the residual effects analysis determined that cumulative effects from industrial development (including the Jay Project) would not significantly influence the ability of fish VCs to be self-sustaining or ecologically effective.

The information from the fish and fish habitat section was then used in the culture section (Section 15), which focuses on societal values, to determine if the changes in fish and fish habitat measurement indicators would result in significant effects to the use of fish by people. Although there will be a small loss of fishing areas in the diked and dewatered portions of Lac du Sauvage, this is not expected to result in a measurable effect on the ability of traditionally important fish species to be self-sustaining and ecologically effective. Furthermore, fish located within the diked area will be removed through a fish-out program (Appendix 9B), which will be planned and carried out with the involvement of the potentially affected Aboriginal groups.

Regarding the effects of the Project on access to fishing areas, no change in road access is expected because the Jay Road will not be accessible to the public. Boat access through the Lac du Sauvage-Lac de Gras Narrows may be used to access fishing areas at the Narrows, Lac de Gras, and Lac du Sauvage. No measurable changes in the navigability of the Narrows are predicted due to the Project when boat use would be expected. Similarly, the expected cumulative changes in water levels and flows are not expected to adversely affect navigation in Lac du Sauvage, the Narrows, or Lac de Gras (Section 8.5.3.3.5 of the DAR).

In addition to the physical and biological effects on fish distribution and fishing areas, positive and negative effects on social and economic factors affecting participation in traditional land use are expected. Sensory disturbances are expected due to the Project in combination with existing developments. A Human and Wildlife Health Risk Assessment (submitted as part of the DAR in February 2015) indicated that the Project is predicted to have no significant effects on the safety of fish for human consumption. Yet an increased concern in ecological and human health is considered to exist for previous and existing developments, and will likely continue for the Project and future developments. Sensory disturbance and perceived health effects have the potential to alter TLU practices for affected Aboriginal groups. The extent to which Aboriginal people will alter their harvesting practices and avoid traditional areas influenced by development is difficult to quantify. However, it is expected that preferred fishing areas in the Coppermine River, Great Slave Lake and nearly all of Lac du Sauvage and Lac de Gras (e.g., the Narrows) would continue to be available for traditional fishing activities.

Further information regarding predicted changes to each of these measurement indicators is provided in Section 15.4.1.2.2 of the DAR. Based on the predicted changes, the residual impact classification of cumulative effects to the opportunities to participate in traditional fishing were determined to be negative in direction, low to moderate in magnitude, regional, continuous, and irreversible (Section 15.4.1.3.1). It is important to note that reversibility is not achievable for many cultural indicators in environmental assessments (Section 15.2.6.1.1). Cultural effects are part of an ongoing process of interdependent social and cultural change, and an individual's responses to that change generally cannot be reversed to one or all of the pre-project conditions. Cultural effects are a function of the interaction of a project(s) and the broader, continuously evolving, economic, social, and cultural factors in the environment. As a result, all effects were conservatively assessed as irreversible within the culture assessment. However, an irreversible effect is not sufficient to be determined as significant, particularly for effects that are low to moderate in magnitude and localized to specific areas of the TLU region (magnitude is the primary criterion for determining significance). The TLU study area is largely undisturbed by operating mines with little overlap; people still have the ability to visit and use traditionally preferred fishing areas in the region. Furthermore, the availability of fish will be maintained in Lac du Sauvage and Lac de Gras with the development of the Jay Project.

In summary, the analyses in the DAR, and the additional analysis completed in the information requests provides a comprehensive assessment of the Project-specific and cumulative effects of development on ecological and societal values of fish VCs. The weight of evidence indicates that the incremental and cumulative effects from the Jay Project and previous, existing, and future developments (including Diavik A21) do not significantly influence the ability of Arctic Grayling, Lake Trout, and Lake Whitefish to be self-sustaining and ecologically effective, safe to eat, or provide continued opportunities to participate in traditional fishing.

DOMINION DIAMOND

Information Request Number:	DAR-MVEIRB-IR2-14
Source:	Mackenzie Valley Environmental Impact Review Board Information Requests from Chuck Hubert
Subject:	Closure Objectives for Aquatic Communities
DAR Section(s):	Round 1 Information Request Response DAR-YKDFN-IR-02

Preamble (MVEIRB):

IR#2 asks for information regarding what type of ecosystem will be attained post-closure. Dominion Diamond's response is that "similar aquatic communities" will be present post-closure.

Request (MVEIRB):

The Review Board seeks clarification on what, in Dominion Diamond's opinion, "similar aquatic communities" means with respect to overall closure objectives. Specifically, will closure conditions be similar to reference or baseline conditions? What metrics will be used to determine similarity? How closely must the aquatic communities in closure resemble reference or baseline communities in order for the closure objective to be met?

Response:

Note that this Information Request (IR) references the response to Round 1 IR DAR-YKDFN-IR-01.

As described in DAR-YKDFN-IR-01, once water quality conditions within the diked area meet closure criteria, the dike will be breached to allow connectivity with the main body of Lac du Sauvage. The water quality acceptability criteria will be determined through the water licencing process through the Wek'èezhìı Land and Water Board (WLWB) prior to closure. The dike breaching will allow water circulation with the main basin to maintain water quality similar to Lac du Sauvage and to support re-establishment of aquatic species.

Due to the connectivity of the diked area with adjacent habitats, natural colonization after breaching is predicted to occur and allow re-establishment of a healthy functioning aquatic ecosystem. Plankton and drifting larval life-stages will be carried into the diked area from back-flooding and from natural currents and would also be present immediately after the dike is breached. Larger, mobile species that forage across a large home range are expected to enter the reconnected diked area freely and would occupy the new vacant habitats quickly.

The physical (i.e., rocky littoral areas and pelagic zones) and chemical (i.e., water quality) environment of the area will be similar to conditions in the main body of Lac du Sauvage. It is expected that fish and other aquatic organisms will naturally occupy and colonize the diked area from adjacent habitats carried in by lake currents or through normal daily or seasonal movements. The outer edges of the dike remnants will be available to fish and may provide fish habitat.

In DAR-YKDFN-IR-01, the commitments for the diked area and Jay Pit at closure are that after back-flooding and reconnection to Lac du Sauvage, the diked area will support a similar aquatic community that is present in the main basin of Lac du Sauvage through natural processes (e.g., daily and seasonal movements, migrations, and dispersal). In general, “similar” means resembling, but not identical. ‘Similar aquatic communities’ would, therefore, mean that the aquatic communities would generally resemble other types of like habitats within Lac du Sauvage. For example, in post-closure, the reconnected diked area is predicted to be generally similar in biotic (phytoplankton, zooplankton ,and benthic invertebrate density, diversity, community composition) and physical attributes (fetch, surface water light and temperature patterns, and water quality conditions) as other parts of Lac du Sauvage.

Although the Jay Pit represents a permanent loss of lake bottom habitat, the area above the pit will provide suitable conditions for pelagic species such as Lake Trout and Cisco. Similarly, the dike remnants will represent a permanent loss of lake area, but the dike may provide similar habitat function at closure as the shallow boulder habitats present along the shorelines and islands within Lac du Sauvage and Lac de Gras (see Section 9.4.3.1.1 and Appendix 9A of the Developer’s Assessment Report for more information on changes to fish habitat quantity). Therefore, fish presence and habitat use, and relative abundance is expected to be generally similar to other habitats in Lac du Sauvage. It is expected that all fish species present in Lac du Sauvage (Arctic Grayling, Lake Trout, Lake Whitefish, Round Whitefish, Burbot, Slimy Sculpin, Cisco, Ninespine Stickleback, and Northern Pike) could use the habitats within the diked area.

Version 2.4 of the Ekati Mine Interim Closure and Reclamation Plan (ICRP) was approved by the WLWB in November 2011 (BHP Billiton 2011) and will be updated to incorporate the Jay Project as part of future regulatory processes with the WLWB. The closure objectives for the diked area will be incorporated into subsequent revisions of the ICRP, with the final details included in the final closure plan two years prior to closure.

As described in the Draft Conceptual Aquatic Effects Monitoring Program (AEMP) Design Plan for the Jay Project (Dominion Diamond 2015), an AEMP will be required for the Project by the Water Licence, and will involve monitoring programs focused on the aquatic receiving environment. The AEMP Design Plan for closure, and post-closure periods will be prepared later in the life of the Project, taking into account knowledge and experience accumulated over a decade of monitoring under the AEMP. As part of these later iterations, the post-closure study design for water, sediment, and biological monitoring (e.g., plankton, benthic invertebrates, fish) to be conducted within the diked area will be developed.

References:

BHP Billiton (BHP Billiton Canada Inc.). 2011. Ekati Diamond Mine Interim Closure and Reclamation Plan. Prepared for the Wek'èezhìı Land and Water Board. 842 pp.

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DOMINION DIAMOND

Information Request Number:	DAR-MVEIRB-IR2-15
Source:	Mackenzie Valley Environmental Impact Review Board Information Requests from Chuck Hubert
Subject:	Fish, Lac du Sauvage
DAR Section(s):	Conceptual Offsetting Plan- S09A p27

Preamble (MVEIRB):

p27 of the Conceptual Offsetting plan says the "predicted abundance (of fish) in Lac du Sauvage is ~197,000 fish using median density statistic and 828,200 using the 75th percentile". The DAR also indicates that between 7100 and 23400 fish will be removed from Lac du Sauvage during the fish out. This corresponds to ~3.6% of the fish in this lake (DAR p9-173).

Request (MVEIRB):

Please provide an estimate of what percent change to and absolute number of fish removed from the fish population in Lac du Sauvage would constitute a significant adverse effect? The Review Board also requests information on when a less variable population estimate will be available in order to appropriately quantify offsetting requirements.

Response:

Residual effects to fish and fish habitat from the fish-out pathway are discussed in Section 9 of the Developer's Assessment Report (DAR Section 9.4.3.1.2). Before the dewatering, a fish-out will be conducted to remove fish from the dewatered area of Lac du Sauvage. To estimate the number of fish to be removed from the dewatered area for the environmental assessment, fish densities were calculated for yearling and older fish using hydroacoustic data (DAR Section 9.2; Annex XIV). The predicted abundance in the dewatered area was approximately 7,100 fish. For comparison, the predicted abundance estimated in Lac du Sauvage was approximately 197,400 fish. Thus, approximately 3.6% of the total number of fish in Lac du Sauvage will be targeted for removal from the dewatered area. Assuming the same density of fish in Lac du Sauvage applies to Lac de Gras, a much smaller percentage of the fish population (i.e., less than 1%) will be affected at the scale of the Effects Study Area (ESA).

As summarized in DAR Section 9.4.3.1.2, the amount of direct mortality from the removal of fish before dewatering (i.e., the fish-out) is expected to result in minor effects to population abundance and distribution for fish Valued Components (VCs; Arctic Grayling, Lake Trout, and Lake Whitefish). The fish-out is considered to be a low magnitude impact, occurring at the regional scale for the assessment of fish and fish habitat. The numbers of fish being removed are small in comparison to the overall population; as such, the residual effects to the abundance of VC species in the ESA would not be measurable. Effects, if any, would be limited to a minor or local change in the distribution of fish within Lac du Sauvage. Furthermore, the recovery of mortality effects to Arctic Grayling, Lake Trout, and Lake Whitefish populations from the fish-out is expected to begin during the operations phase, with a complete recovery of the abundance of fish to occur within the operations phase.

The effects from the development of the Jay Project (Project), which includes mortality effects from the fish-out, are predicted to not have a significant adverse impact on the ability of Arctic Grayling, Lake Trout, and Lake Whitefish populations to be self-sustaining and ecologically effective, where self-sustaining and ecologically effective populations of fish VCs are the foundation for ongoing fisheries productivity.

Significance

The definition of 'significant' for the assessment of fish and fish habitat is provided in Section 9.6.1.2 in the Developer's Assessment Report. Although the emphasis is on 'loss of habitat' in the provided definition, loss or removal of fish (from the fish-out) can be used synonymously with loss of habitat. Significant is defined on page 9-211 as the following:

> "impacts are measurable at the population level and likely to decrease resilience and increase the risk to self-sustaining and ecologically effective fish populations. Loss of habitat that causes permanent adverse changes to survival or reproduction at a population level would likely be significant. A significant effect may also result from habitat loss that affects fish movement and restricts population connectivity, disrupting the potential for demographic rescue between adjacent waterbodies, such that it causes permanent adverse changes to survival or reproduction at a population level."

As noted in Section 9.6.1.2, changes in measurement indicators cannot be quantified with a high degree of confidence to evaluate whether thresholds are expected to be exceeded. Critical thresholds, such as, the amount of quality habitat required to maintain a specific number of individuals required for a self-sustaining population, or an ecologically effective population are not available for the assessment of most VCs in the biophysical environment (e.g., fish, vegetation, and wildlife species). Moreover, ecological thresholds vary by species, watershed type, and spatial scale (Fahrig 1997; Swift and Hannon 2010). Consequently, a detailed and transparent account of the predicted effects associated with incremental and cumulative changes to each measurement indicator are provided for each VC using available scientific literature, logical reasoning, and experience of the practitioners completing the assessment (reasoned narrative approach). Furthermore, magnitude classification was applied conservatively to avoid underestimating effects (i.e., a precautionary approach).

Although critical thresholds are not available for fish VCs in Arctic lakes, the expectation is that such thresholds for the maintenance of self-sustaining populations are considerably higher than the reported incremental and cumulative changes from the Project and other existing developments. Fish populations can be highly resilient to disturbance, such as harvests, and there are many examples in the literature that describe the resiliency of fish populations, particularly salmonid populations (e.g., Rose et al. 2001; Sundstrom et al. 2013; Syslo et al. 2013; Vincenzi et al. 2008; Vincenzi et al. 2012). Underlying responses to disturbance are compensatory density-dependent mechanisms that play critical roles in the recovery of a population and contribute to explaining the peculiar resilience to population collapses often showed by salmonids. For populations regulated by density-dependent effects, increases in individual growth, survival, and reproduction rates can result when population densities are reduced or new habitat becomes accessible, which in turn can promote a numerical increase in populations. Furthermore, recovery can be remarkably quick. Some salmonid species can recover within three years from a serious disturbance event (e.g., high mortality from a catastrophic drought or flood event; Vincenzi et al. 2008).

Another example of the resilience of salmonid populations is represented by the Gila Trout population of McKnight Creek (New Mexico and Arizona, USA), which recovered within a few years to pre-event conditions after a catastrophic flood that caused a 90 percent (%) drop in population abundance (Propst and Stefferud 1997). Similarly, Post (2013) noted in his review of research published on the resiliency of fisheries that a reasonable threshold for defining a collapsed fishery is the removal of 90% or more of fish from a system at carrying capacity; whereas a threshold for defining an overfished population (i.e., a temporary state of ecologically ineffectiveness) is the annual removal of 10% to 50% of fish from a system at carrying capacity. A specific example for Lake Trout includes the fishery in Lake Michigan, where the stock collapsed when the abundance of Lake Trout greater than or equal to 1-year age declined by 95% (Hansen 1999). The harvest levels that trigger a non self-sustaining population are clearly higher than the level of fish-out in Lac du Sauvage for the Project. Post fish-out abundance of fish in Lac du Sauvage and Lac de Gras will remain high (greater than 99% of the fish at carrying capacity).

Population Modelling

To supplement the reply to the request by the Mackenzie Valley Environmental Impact Review Board, population modelling was performed to further assess the potential effects to the self-sustaining populations from the fish-out, and also to confirm the resiliency of salmonid populations on a site-specific basis. The models were age-based Leslie matrices developed within a commonly used software package (i.e., RAMAS; Akçakaya 2005) that provides transparency and repeatability of methods. Lake Trout was selected for population (demographic) modelling because of the relative greater availability of demographic information for Lake Trout. However, recognizing that the required survival and fecundity data for the models were collected outside of the Lac du Sauvage-Lac de Gras region (Attachment A), the models were used to compare trends across different fish-out scenarios (i.e., to quantify relative changes), rather than used to estimate future population sizes of Lake Trout under a specific scenario.

A 20-year simulation that spans approximately two generations of Lake Trout was replicated 1,000 times per model to predict population abundance for Lake Trout, where year 1 represents the fish-out. Input parameters included survival and fecundity rates and associated errors (see Attachment A), carrying capacity (K = 124,362 female fish), initial population size (same as K), and level of fish-out. Density-dependence was specified for all vital rates under a scramble competition function, whereas population size decreases, the amount of resources per individual increases (Akçakaya et al. 2004). The maximum rate of growth was conservatively specified as 1.2 (R_{max}), towards the lower end of values reported in the literature for populations of Lake Trout at lower latitude locations (R = 1.14 to 1.43; Syslo et al. 2011; Cox et al. 2013).

It is important to note the models were run at the scale of Lac du Sauvage, rather than the full scale of the ESA (Lac du Sauvage and Lac de Gras), because 'carrying capacity' and 'initial population size' inputs were only available for Lac du Sauvage. These inputs were derived from hydroacoustic surveys performed in Lac du Sauvage in 2013 (see DAR Section 9.2.4.1.4). Thus, it was assumed that Lac du Sauvage was a closed system with no opportunities for 'rescue' from fish in Lac de Gras or adjacent populations (e.g., Duchess Lake), even though movement of fish VCs between lakes is expected to be common (see the reply to Round 1 Information Request DAR-GNWT-IR2-03).

The following scenarios were modelled for the Lake Trout population in Lac du Sauvage (females only) using the same vital rates and assumptions but with different levels of a one-time harvest during year 1 of the simulation (i.e., fish-out):

- A baseline model with a stage matrix derived (where possible) from demographic data for Lake Trout in Arctic lakes;
- A Jay fish-out model with the same stage matrix used in the baseline model, but with 3.6% of the population removed from Lac du Sauvage during year 1 of the simulations; and,
- Three supplemental fish-out models describing the potential effects of the hypothetical removal of 10%, 50%, and 90% of fish from Lac du Sauvage.

Results from these models were compared to quantify the change in model outputs, which included the abundance of fish at year 10 and 20 of the simulation. For example, the difference between the predicted abundances between the baseline model and the Jay fish-out model at year 10 and 20 of the simulations estimated the incremental effect of the fish-out, and the duration of effects, if any.

The average population sizes from the model for the Jay fish-out (removal of 3.6% of the population) after 10 and 20 years were within 1% of baseline (no fish-out) average population sizes (Table 15-1) suggesting that the fish-out will have non-measureable ecological effects on the self-sustaining population. Loss of individuals from the population would be replaced within 10 years of the fish-out. The modelling of additional hypothetical scenarios (Table 15-1) confirms the resiliency of populations to harvests of large proportions of the initial population size. Even with a 90% harvest rate, the population remains self-sustaining, predicted to return to 80% of the baseline population size after 20 years post-fish-out.

Table 15-1 Harvest Scenarios Used in the Population Viability Analysis for the Lake Trout Population (Females Only) in Lac du Sauvage

Model scenario	Number of fish harvested during fish-out at year 1 (% of initial population)	Average female population size after 10 years (% relative effect size compared to baseline)	Average female population size after 20 years (% relative effect size compared to baseline)
Baseline	-	120,337	116,536
Jay fish-out	2,240 (3.6%)	119,095 (<1%)	115,010 (<1%)
10% harvest	6,218 (10%)	116,196 (3%)	117,578 (<1%)
50% harvest	31,091 (50%)	101,194 (16%)	106,325 (9%)
90% harvest	55,963 (90%)	45,221 (38%)	92,827 (20%)

% = percent; <= less than.

Summary

The ability of a fish population to regulate itself is an important mechanism for self-sustaining populations because it operates to offset to the losses incurred by disturbance with either rapid or time-lagged recoveries (Rose et al. 2001). Rose et al. (2001) summarized how density-dependent processes lead to compensatory responses at the population level by reviewing long-term field monitoring studies, experimental studies, and computer modelling exercises. Based on their work and other examples in the fisheries literature, combined with the results from above modelling exercise, there is no risk of approaching levels that would trigger a non-sustaining VC population or a permanent change in the ecological effectiveness of the population as a result of the fish-out in Lac du Sauvage. The effects from development, which includes mortality effects from the fish-out, are predicted to not have a significant adverse impact on the ability of Arctic Grayling, Lake Trout, and Lake Whitefish populations to be self-sustaining and ecologically effective, where self-sustaining and ecologically effective populations of fish VCs are the foundation for ongoing fisheries productivity.

Offsetting Calculations

The information provided by the 2013 hydroacoustic surveys of Lac du Sauvage provides sufficient information for the assessment of fish and fish habitat in the DAR (Section 9), including an assessment of losses for the Conceptual Offsetting Plan (Section 9A) (see the reply to Round 1 Information Request DAR-KIA-IR-95). Additional information on the number of fish in the diked area will be obtained during the fish-out, and will be compared to estimates generated from baseline hydroacoustic surveys (see DAR Section 9.2.4.1.4). If the fish-out estimates are meaningfully different (higher or lower) from those generated by hydroacoustic surveys, the calculation of losses in the final offsetting plan will be updated accordingly through engagement with Fisheries and Oceans Canada (DFO). The final offsetting plan will be submitted during the permitting phase of the Project to meet DFO’s Fisheries Productivity Investment Policy (DFO 2013).

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Attachment A:

Vital Rates Used to Construct Population Matrices for Lake Trout in Lac du Sauvage

DOMINION DIAMOND

Background

Vital rates used in the Lake Trout models were obtained from the literature (Table 15-A1). Rates were obtained from studies conducted on unexploited populations in the Northwest Territories (NWT) and Alaska (AK) and studies conducted in lakes in Ontario (ON). When data could not be obtained from Canadian or northern lakes, data from a Lake Trout population demographics study in Montana (MT; Cox et al. 2013) were used.

Data on fecundity-at-age and the probability of maturity were not available for northern Lake Trout populations. Fecundity-at-age values were, therefore, estimated using the slope of the regression of fecundity at age from Cox et al. (2013) and the average fecundity for 12 Lake Trout populations in the NWT and AK. The probability of maturity is typically estimated using a binary logistic regression of maturity at age. The slope of the binary regression from Cox et al. (2013) and the average of seven reported ages at maturity from studies in the NWT, AK, and ON were used to estimate the probability of maturity.

Survival rates were not available in the literature from northern lakes; estimates were obtained from populations in ON and MT. Egg to age-1 survival rates were estimated from five studies conducted in Lake Superior. Adult survival rates were estimated from 14 studies in ON. Age-1 and age-2 survival rates were estimated using rates derived from Swan Lake, MT (Cox et al. 2013) after adjusting to reflect the difference in the observed adult growth rates from Canadian population and the rate reported in Swan Lake. Survival rates of Lake Trout age-3 and older were assumed to be the same as the adult survival rates (Cox et al. 2013).

Table 15-A1 Estimated Vital Rates Used in the Population Models for Lake Trout in Lac du Sauvage

Variable	Age	Mean	SD	Data Sources
Fecundity	1 to 7	0	0	Healy 1978; Roberge and Dunn 1985; De Beers 2014, Burr 1987; Cox et al. 2013
	8	2348	1645	
	9	2942	2061	
	10	3687	2582	
	11	4619	3235	
	12	5552	3888	
	13+	6673	4673	
Age at Maturation	-	9.59	2.41	Scott and Crossman 1973; Trippel 1993; Cox et al. 2013
Probability of maturity	1 to 7	0	-	Scott and Crossman 1973; Trippel 1993; Cox et al. 2013
	8	0.02	n/a	
	9	0.19	n/a	
	10	0.73	n/a	
	11	0.97	n/a	
	12+	1	-	

Table 15-A1 Estimated Vital Rates Used in the Population Models for Lake Trout in Lac du Sauvage

Variable	Age	Mean	SD	Data Sources
Proportion of offspring that are female	all	0.5	-	
Egg to age-1 survival	0	0.0043	0.00074	Walters et al. 1980; Matuszek et al. 1990; Ferreri et al. 1995; Shuter et al. 1998
Age-1 survival	1	0.404	0.0808	Cox et al. 2013
Age-2 survival	2	0.701	0.144	Cox et al. 2013
Asymptotic survival	3+	0.826	0.076	Trippel 1993; Mills et al. 2002

n/a = not available; - = not applicable; SD = 1 standard deviation.

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DOMINION DIAMOND

Information Request Number: DAR-MVEIRB-IR2-17

Source: Mackenzie Valley Environmental Impact Review Board Information Requests from Chuck Hubert

Subject: Fish

DAR Section(s): Conceptual Fish Out Plan- S09B p8

Preamble (MVEIRB):

p.8 of the Conceptual fish out plan indicates that "turbidity curtains will be installed near the portion of the alignment where dike construction will occur" and that "once isolation structures are in place, gill netting would begin". Additionally, table 3.2-1 on p.3-6 of the Project Description document clearly states that construction activities will include "fish-out within (the) diked area".

Request (MVEIRB):

Since there is no fish-out between the diked area and turbidity curtain during dike construction, how will fish located between the outer wall of the dike and the turbidity curtains be managed?

Response:

Prior to summer-season construction of the Jay Dike, turbidity curtains will be installed near the alignment, adjacent to the inner and outer perimeter of the dike alignment (Dominion Diamond 2015). The relatively small area of water that is contained within the curtains may include fish. However, it is anticipated that most of the resident fish will evacuate the immediate area in response to construction activities and that the potential for fish to be isolated between the dike and the turbidity curtains will be low. Fish often exhibit avoidance behaviours in response to noise and vibrations (Nedwell et al. 1998; Nedwell et al. 2003; Turnpenny and Nedwell 1994), which are expected to result during curtain placement and from movement of the curtains in the water column upon installation. Although it is likely that some small-bodied fishes with limited mobility may become isolated in shallow areas when the turbidity curtain is installed, large-bodied fish with greater mobility, such as Arctic Grayling, Lake Trout, and Lake Whitefish, are more likely to avoid the turbidity curtain containment area with the initiation of construction activities.

The potential issue of ‘trapped’ fish or fish mortalities within the contained areas of turbidity curtains has not been documented as a concern for other similar developments based on the available reports, for example, Portage Lake at the Meadowbank Mine (Agnico 2011; DFO 2011) and Lac de Gras at the Diavik Mine (Diavik 2002, 2007; McEachern et al. 2003). Within the cited reports, there is no mention of ‘trapped’ fish or fish mortalities in the contained areas of the turbidity curtains in lakes during dike construction at the Meadowbank or Diavik mines, likely because most fish avoid or move away from the affected areas during construction activities.

As construction of the dike will commence following the installation of the turbidity curtains, it may not be feasible to recover any fish isolated between the turbidity curtains and the dike due to safety concerns related to nearby construction activities. Opportunities to salvage fish or to remove fish in the turbidity curtain containment areas during the fish-out may be explored if fish are observed within the containment areas, and when and where the construction plan allows these fishing efforts to safely occur. Fishing methods would be similar to those described for ‘Phase 2’ of the conceptual fish-out plan in Appendix 9B of the Developer’s Assessment Report, and may include a combination of trapping (e.g., minnow trapping, fyke net trapping) and portable electrofishing techniques. All unavoidable losses of fish, including fish removed during the fish-out and fish that may be lost within the turbidity curtain containment area, will be quantified as serious harm to fish as per the Fisheries Protection Policy Statement (DFO 2013) and addressed in the final offsetting plan for the Jay Project. The final offsetting and fish-out plan will be part of the application for an authorization under paragraph 35(2)(b) of the *Fisheries Act*, which will be submitted during the regulatory phase of the Project.

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DOMINION DIAMOND

Information Request Number: DAR-MVEIRB-IR2-18

Source: Mackenzie Valley Environmental Impact Review Board Information Requests from Chuck Hubert

Subject: Closure

DAR Section(s): Round 1 Information Request Response DAR-MVEIRB-IR-24

Preamble (MVEIRB):

MVEIRB IR 24 inquired about the influence of pit closure on water quality downstream of the LLCF. In its response, Dominion Diamond states that "When water quality monitoring in the back-flooded pits indicates closure criteria have been achieved, the Panda/Koala pit lakes will be reconnected to the Koala watershed, and they will flow into Kodiak Lake". The Jay project uses the Panda and Koala pits for long term storage of processed kimberlite. The Review Board requires information on the long term stability of closure infrastructure in order to ensure that no significant adverse effects to fish and fish habitat or water quality occur following the completion of closure activities.

Request (MVEIRB):

Following connection of the Panda and Koala lakes to Kodiak lake, will the Panda Diversion Channel be maintained? What work will be conducted in either the Panda Diversion Channel or the pit lakes system in order to maintain fish passage post-closure?

Response:

The Panda Diversion Channel is a permanent structure that will remain in place post-closure. This is described in the Ekati Mine Interim Closure and Reclamation Plan (ICRP; BHP Billiton 2011), which has been approved by the Wek'èezhìı Land and Water Board. The Panda Diversion Channel was constructed in 1997 to divert stream water around the Panda and Koala mining areas, and to provide compensation for stream habitat that was lost for construction of the Ekati Mine. The Panda Diversion Channel was designed and constructed to be a permanent channel as part of a habitat compensation agreement for an authorization from Fisheries and Oceans Canada under the *Fisheries Act* for the Ekati Mine (SCA96021). The channel was monitored under the Fisheries Authorization and reported on annually until 2012, at which time, it was determined that the channel was successfully providing fish habitat as intended. Monitoring under the Fisheries Authorization was no longer necessary after that time. Bank stabilization work was undertaken from 2010 to 2014 and reported to the Wek'èezhìı Land and Water Board. In addition to the channel bank modifications, the ICRP describes the removal of culverts and construction of a high-flow overflow channel at Panda Dam. No other work is anticipated for the Panda Diversion Channel for the maintenance of post-closure fish passage.

During operations of the Jay Project, the Panda and Koala pits and underground workings will be filled with fine processed kimberlite up to 30 m below the final pit lake overflow elevation. As described in Section 3.5.8.6 of the Jay Project Developer’s Assessment Report, reclamation of the Panda and Koala open pits would proceed by pumping freshwater into the pits as a ‘cap’. This pumping scenario is an improvement over the current ICRP because substantively less freshwater is required, which reduces requirements from the source areas. Other aspects of reclamation of the Panda and Koala open pits would proceed as described in the approved ICRP. The closure work includes construction of an outflow channel between the Panda/Koala Pit Lake and the receiving environment (Kodiak Lake). Flow from the Panda/Koala Pit Lake into Kodiak Lake will be reconnected when water quality has been demonstrated to meet the closure water quality criteria. Flow from the pit lake to the receiving environment is predicted to be low, and likely, intermittent; nonetheless, as described in the ICRP, the channel design will intend to create the possibility for fish to safely move into and out of the pit lake.

The closure objectives for pit lakes at the Ekati Mine are provided in Section 5.2.7 of the ICRP, and include the following:

- remaining operational, engineered structures meet appropriate design levels;
- no significant impacts to source lake aquatic habitats;
- surface drainage patterns at pit lakes are established to ensure runoff is channelled through the watershed;
- pit lake water meets water licence criteria;
- facilitate the establishment of a self-sustaining aquatic ecosystem in the pit lakes; and,
- pit lakes are safe for fish passage.

References:

BHP Billiton (BHP Billiton Canada Inc.). 2011. Ekati Diamond Mine Interim Closure and Reclamation Plan. Prepared for the Wek'èezhìı Land and Water Board. 842 pp.

DOMINION DIAMOND

Information Request Number:	DAR-MVEIRB-IR2-19
Source:	Mackenzie Valley Environmental Impact Review Board Information Requests from Chuck Hubert
Subject:	Closure Plans and Pit Flooding
DAR Section(s):	Round 1 Information Request Response DAR-GNWT-IR-45

Preamble (MVEIRB):

GNWT 45 asks for information about measures that will be in place during the reconnection of Lynx Pit Lake to Lac de Gras that will prevent erosion and other adverse effects. Dominion Diamond indicates that the "final design of Lynx Pit Lake Outlet will include erosion protection features within the natural outlet channel to LDG, if required".

Request (MVEIRB):

Will Dominion Diamond commit to developing re-connection plans for all flooded pit lakes as a requirement of its water license?

Response:

The Ekati Mine Interim Closure and Reclamation Plan (ICRP) was approved by the Wek'èezhìı Land and Water Board in November 2011 (BHP Billiton 2011), and various updates have subsequently been approved though the Annual Reclamation Progress Reports. An outflow channel from the Lynx pit lake is part of the approved closure plan for the Lynx Pit, which has been incorporated into the ICRP. Outflow channels to connect all of the end pit lakes to the local receiving lakes are a requirement of the approved ICRP. The Jay Pit will be the single exception because it will be flooded under Lac du Sauvage.

References:

BHP Billiton (BHP Billiton Canada Inc.). 2011. Ekati Diamond Mine Interim Closure and Reclamation Plan. Prepared for the Wek'èezhìı Land and Water Board. 842 pp.

Information Request Number:	DAR-MVEIRB-IR2-20
Source:	Mackenzie Valley Environmental Impact Review Board Information Requests from Chuck Hubert
Subject:	Aquatic Habitat Alteration
DAR Section(s):	Round 1 Information Request Response DAR-MVEIRB-IR-20

Preamble (MVEIRB):

MVEIRB 20 asks for possible mitigations in case of adverse effects to habitat in lake C1 associated with changing water levels in Lac du Sauvage. Dominion Diamond's response indicates that "the need for, and extent of any, mitigation would be discussed with DFO as part of the monitoring and adaptive management framework".

Request (MVEIRB):

The Review Board seeks information regarding what framework(s) exists, or could be put in place, between DFO and Dominion Diamond that would enable such adaptive management?

Response:

Potential changes in water levels in Lake C1 are a result of the conservative predictions in the hydrogeological model related to the location of the enhanced permeability zone (EPZ) near the Jay pipe. With these conservative assumptions in place, the resulting potential effect on Lake C1 is anticipated to be limited to small changes in water level and within the natural range of variability (i.e., less than 0.04 metres [m] in the open water season). Therefore, there is limited potential for these water level changes to affect water quality and sediment, and effects to fish habitat are expected to be negligible. Lake C1 is a relatively deep lake (23.5 m in maximum depth), with habitat connectivity between Lac du Sauvage and Lake C1 maintained by Stream C1.

Despite the expectation of only a small water level change in Lake C1 during mining, water levels and outlet discharge will be monitored to track the hydrological conditions at Lake C1 as part of the environmental monitoring programs. As described in Section 8.3 of the Draft Conceptual Aquatic Effects Monitoring Program (Conceptual AEMP) Design Plan for the Jay Project (Dominion Diamond 2015), monitoring in small lakes and streams located close to Project infrastructure will be considered in the AEMP Design Plan, including Lake C1 and Stream C1. In the Conceptual AEMP, Lake C1 and Stream C1 have been identified for potential sampling, including hydrological and water quality monitoring (Table 8.4-1).

As per Section 9 of the Conceptual AEMP, the Water Licence requires an adaptive management component to be included in the AEMP. The Ekati Mine Aquatic Response Framework, as part of the adaptive management component of the Ekati Mine AEMP, would be expanded to incorporate the Jay Project. The goal of the Response Framework is to systematically respond to monitoring results such that the potential for significant adverse effects is identified, and mitigation actions are undertaken and confirmed effective to prevent such effects from occurring. This is accomplished by implementing appropriate adaptive management responses at predefined “Action Levels”, which are triggered before a significant adverse effect could occur.

If an action level is exceeded, a Wek'èezhìı Land and Water Board-approved AEMP Response Plan will be implemented, which may include additional monitoring and possibly management responses (e.g., changes to mitigation), as appropriate.

In the unlikely event that observations collected in the early stages of mining indicate that the EPZ near the Jay pipe does affect lake levels or outlet water flow in Lake C1, then the ecological significance of these changes would need to be considered. That is, is the reduction in water levels large enough such that fish populations in Lake C1 may be adversely affected through the loss of overwintering or spawning habitat? If so, Fisheries and Oceans Canada would be engaged in the development of the Response Plan, and mitigation options, such as additional water pumping to Lake C1 may be considered if appropriate.

References:

Dominion Diamond (Dominion Diamond Ekati Corporation). 2015. Conceptual Aquatic Effects Monitoring Program Design Plan for the Jay Project. DRAFT. Prepared by Golder Associates Ltd. June 2015.

DOMINION DIAMOND

Information Request Number:	DAR-MVEIRB-IR2-21
Source:	Mackenzie Valley Environmental Impact Review Board Information Requests from Chuck Hubert
Subject:	Hydrogeological Baseline Study Area
DAR Section(s):	Round 1 Information Request Response DAR-MVEIRB–IR-22

Preamble (MVEIRB):

MVEIRB 22 asks for details describing the boundary of hydrologic baseline study area (BSA). Discussion at the technical session (April 22 p129) indicates that the hydrologic BSA for the Jay project EA was "established prior to the extraction of the Cardinal part of the project, or part of the original mine plan". The Review Board needs to understand the predicted effects of the Jay project on hydrologic valued components are defensible in the context of the Jay project as opposed to the Jay and Cardinal project.

Request (MVEIRB):

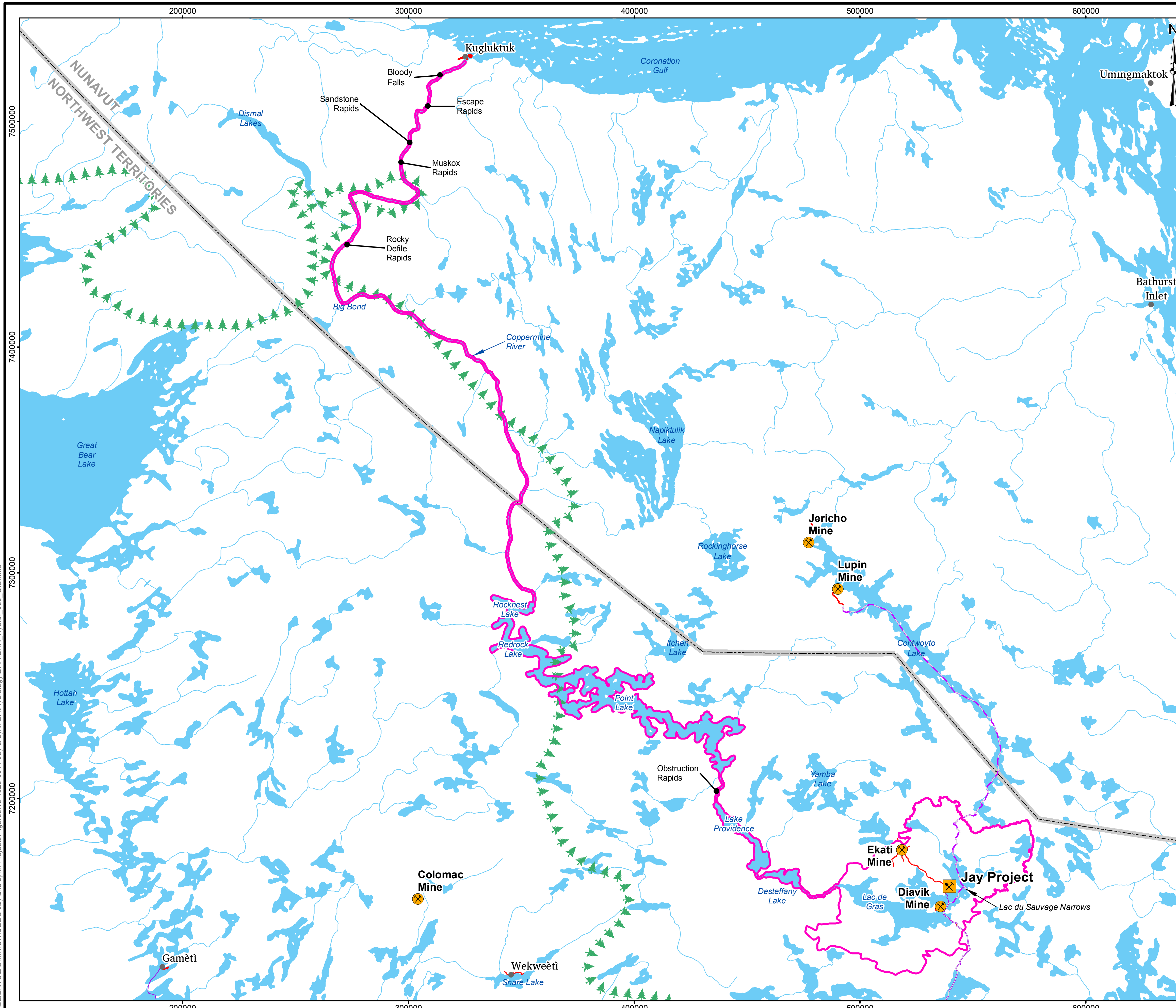
The Review Board seeks clarity on why a larger BSA would still be considered appropriate for the Jay project assessment. What is the effect of using a smaller, more Jay-specific, BSA on the determination of significance for any hydrological valued components?

Response:

Note that Round 1 Information Request (IR) DAR-MVEIRB–IR-22 described the hydrogeological baseline study area (BSA). However, the Preamble and Request for this IR reference the hydrological BSA; as such, the response below provides additional information for the hydrology BSA.

As described in Section 6.1.3 of the Developer's Assessment Report (DAR), BSAs were designed to characterize existing environmental conditions on a continuum of spatial scales from the Jay Project (Project) site to broader, regional levels. Data collected at the Project site and local scales were used to provide precise measures of baseline environmental conditions and predict the direct and indirect changes from the Project on valued components (VCs). Data collected at larger scales were used to measure broader-scale baseline environmental conditions, and provide regional context for the combined direct and indirect effects from the Project on VCs. BSAs may not necessarily represent the spatial boundary for the effects analysis (i.e., effects study area [ESA]). Selection of the boundary for ESAs was based on the physical and biological properties of VCs and designed to capture the maximum spatial extent of potential effects from the Project and other previous, existing, and reasonably foreseeable future developments.

The spatial boundaries for the hydrology VC are described in Section 8.1.4.2 of the DAR. As discussed in the Jay Project Technical Sessions (April 22, 2015), the Hydrology BSA (Map 21-1) used for the Project was established prior to the removal of the Cardinal pipe from the Project. Larger water transfers and diversions associated with the Jay-Cardinal project would possibly have had measurable effects further downstream on the Coppermine River, so baseline data were compiled through to the mouth of that river.



LEGEND

- JAY PROJECT
- EXISTING MINE OR PROJECT
- POPULATED PLACE
- ALL-SEASON ROAD
- WINTER ROAD
- TIBBITT TO CONTWOYTO WINTER ROAD
- NORTHERN PORTION OF TIBBITT TO CONTWOYTO WINTER ROAD
- TREELINE
- TERRITORIAL/PROVINCIAL BOUNDARY
- WATERCOURSE
- WATERBODY
- FALLS / RAPIDS
- BASELINE STUDY AREA

REFERENCE

WATER OBTAINED FROM ATLAS OF CANADA
NATURAL RESOURCES CANADA, CENTRE FOR TOPOGRAPHIC INFORMATION, 2012
DATUM: NAD83 PROJECTION: UTM ZONE 12N

DOCUMENT

DEVELOPER'S ASSESSMENT REPORT

40 0 40
SCALE 1:1,700,000 KILOMETRES

PROJECT
DOMINION DIAMOND
JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE

BASELINE STUDY AREA FOR WATER QUANTITY

Golder Associates

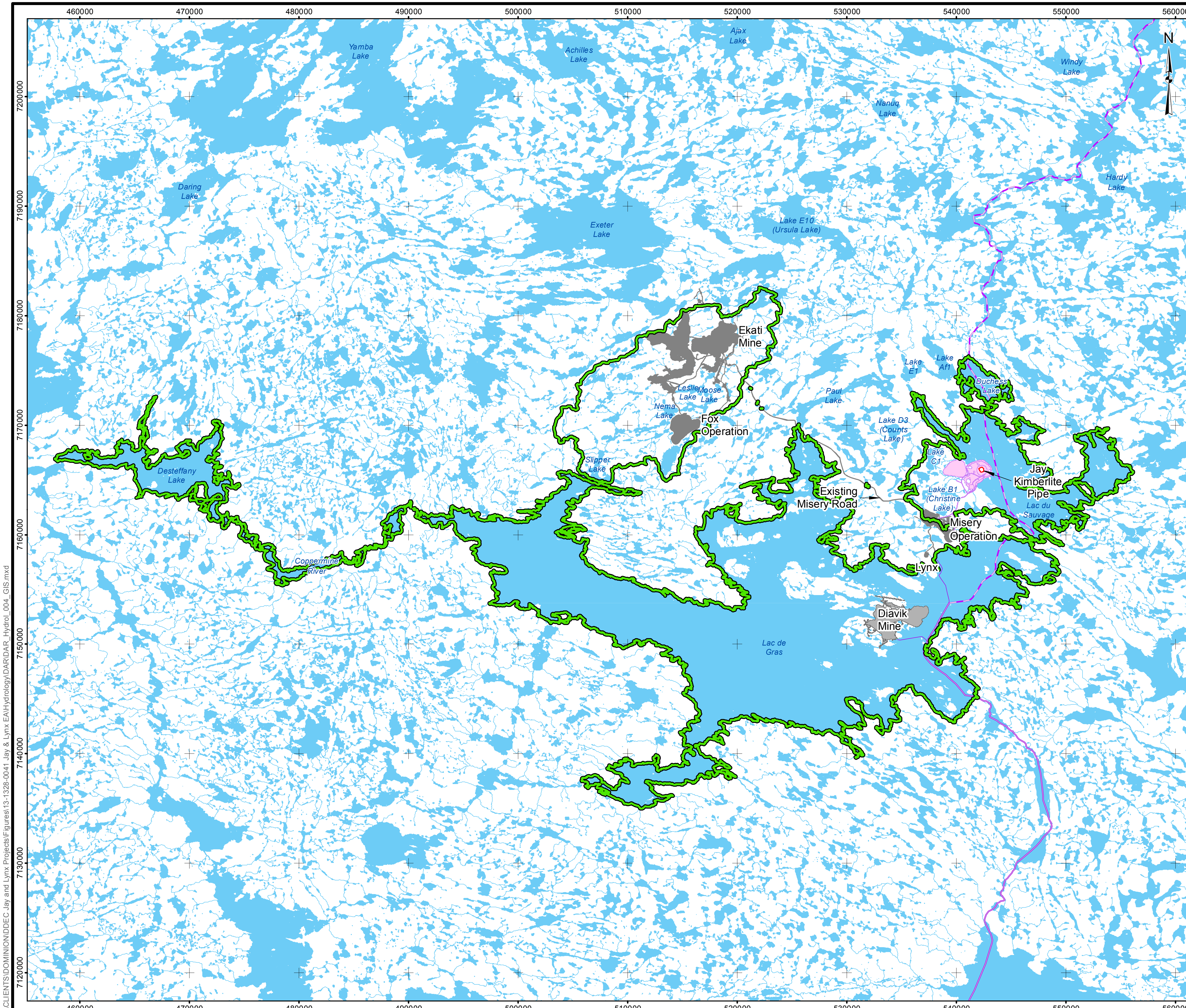
PROJECT		13-1328-0041	FILE No. DAR_Hydrol_005_GIS
DESIGN	NS	29/08/14	SCALE AS SHOWN REV 0
GIS	LR/AK	20/10/14	
CHECK	CV	20/10/14	**MAP 21-1**
REVIEW	NS	20/10/14	

During review of the selected hydrology BSA for the Project, as part of the DAR, it was determined that the hydrology BSA was applicable for the Project and that predicted effects to water levels and discharges (for the valued component of hydrology) at assessment locations would not change the data carried forward into related DAR assessment endpoints. The hydrology BSA also completely covers the hydrogeological BSA and ESA (DAR Map 8.1-2) so that input could be provided to assess potential interaction of groundwater flows with lake water levels, and to provide areas of watershed units (i.e., as Lac du Sauvage flows and water levels were assessed, the BSA included the contributing drainage area to Lac du Sauvage). In addition, rather than reducing the size of the BSA and discarding regional, hydrologically similar data, the BSA was selected to allow for the compilation and comparison of the predicted hydrological regime to historical baseline data within the BSA.

As described in Section 8.1.4.2, the hydrology ESA is the area within the BSA where Project activities could potentially have direct or cumulative effects on biological receptors or end-users. These Project activities include mine infrastructure such as buildings, roads, open pits, dikes, diversion channels, and tailings and waste rock storage facilities. The ESA (Map 21-2) is limited to the area where measureable effects, or changes in water quantity, are anticipated to occur. The ESA is within the BSA and includes lakes and streams within sub-basin B (Christine Creek sub-basin) and sub-basin C of the Lac du Sauvage watershed, Duchess Lake, Stream Ac35, the area locally draining to Lac du Sauvage near the Project footprint, Lac du Sauvage to the outlet, Lac de Gras to the outlet, the Koala watershed, and the Coppermine River to the outlet of Desteffany Lake. This area includes existing developments (i.e., the Ekati and Diavik mines), which have the potential to overlap with the Project in all Project phases.

The predicted effects of the Project on hydrology (water levels, flows, and erosion potential) are based on selected representative assessment nodes within the hydrology ESA, and are not a function of the size of the BSA. The use of a smaller BSA would not change the assessment of potential effects to hydrology at assessed nodes in the DAR. Assessment nodes were chosen at streams or lakes potentially affected due to Project activities, and are therefore, defensible in the context of the Project. The use a smaller BSA would have no effects on the conclusions of the DAR related to surface water.

Hydrological effects are also not evaluated for significance; rather, changes at selected nodes, due to the Project, are used as inputs to assessments by other disciplines, including water quality and fish and fish habitat.



LEGEND

- EKATI MINE FOOTPRINT
- DIAVIK MINE FOOTPRINT
- PROPOSED JAY FOOTPRINT
- KIMBERLITE PIPE
- WINTER ROAD
- TIBBITT TO CONTWOYTO WINTER ROAD
- NORTHERN PORTION OF TIBBITT TO CONTWOYTO WINTER ROAD
- WATERCOURSE
- WATERBODY
- EFFECTS STUDY AREA

REFERENCE

NATIONAL TOPOGRAPHIC BASE DATA (NTDB) 1:250,000
CANVEC © NATURAL RESOURCES CANADA, 2012
NATURAL RESOURCES CANADA, CENTRE FOR TOPOGRAPHIC INFORMATION, 2012
DATUM: NAD83 PROJECTION: UTM ZONE 12N

DOCUMENT

DEVELOPER'S ASSESSMENT REPORT

10 0 10
SCALE 1:350,000 KILOMETRES

PROJECT
DOMINION DIAMOND
JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE
EFFECTS STUDY AREA FOR WATER QUANTITY

Golder Associates

PROJECT		13-1328-0041	FILE No. DAR_Hydrol_004_GIS
DESIGN	CV	29/08/14	SCALE AS SHOWN REV 0
GIS	LMR	17/10/14	MAP 21-2
CHECK	CV	17/10/14	
REVIEW	NS	17/10/14	

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DOMINION DIAMOND

Information Request Number:	DAR-MVEIRB-IR2-22
Source:	Mackenzie Valley Environmental Impact Review Board Information Requests from Chuck Hubert
Subject:	Closure objectives
DAR Section(s):	Round 1 Information Request Response DAR-IEMA-IR-04

Preamble (MVEIRB):

IEMA's IR 4 asks whether contaminants of potential concern and nutrients will return to baseline or reference conditions post-closure. Dominion Diamond's response was difficult to understand, yet seems to indicate that some parameters will return to baseline conditions, while others will return to reference and that some might potentially return to neither.

Request (MVEIRB):

Please provide a simple table outlining the expected closure conditions for all contaminants of potential concern and nutrients (i.e., returning to reference, baseline or neither condition).

Response:

As described in the Developer's Assessment Report (DAR), and in the response to Round 1 Information Request (IR) DAR-IEMA-IR-04, water quality in Lac de Gras is predicted to change from existing conditions as a result of the activities associated with the Jay Project (Project). For the closure phase, predicted values were compared to guidelines and objectives, existing conditions (to 2014), and reference conditions (to 2000).

For all phases of the assessment, concentrations are projected to be less than aquatic life and drinking water guidelines and objectives. In the post-closure period of the Project (i.e., 2033 to 2060), concentrations of some constituents in Lac de Gras (as modelled in the DAR, and the Updated Assessment and Reasonable Estimate Cases [Golder 2015]) are predicted to return to reference conditions or conditions represented by the normal range[1] (2007 to 2013), while concentrations of other constituents are predicted to remain slightly elevated above the normal range, or reference and/or existing conditions (i.e., there is a small persistent effect to water quality conditions for some water quality constituents). Projected concentrations in Lac de Gras for the last year of post-closure (i.e., Year 2059) for the Updated Assessment Case, (Golder 2015), along with comparison data representing the reference condition, existing condition, and the normal range are provided in Table 22-1. Projections were also developed for a Reasonable Estimate Case (Golder 2015); for that modelling scenario, projected concentrations were lower than or similar to those projected for the Updated Assessment Case, and thus, the summary statements in this response apply to both sets of modelled projections.

Projected concentrations in the last year of post-closure (i.e., indicative of the long-term condition and the furthest time period used in the water quality modelling) as compared to guidelines and objectives, the reference condition, the normal range, and existing conditions are summarized as follows:

[1] Normal range is defined as the reference area mean ± 2 standard deviations (Golder 2014).

- Maximum concentrations for all constituents are projected to be less than all guidelines and benchmarks (based on scientifically defensible toxicological data) considered in the environmental assessment (Table 8.5-13 in the DAR);
- Maximum concentrations are projected to be greater than the reference condition, the normal range, or existing conditions, where reference data were available, for the following constituents:
  - total dissolved solids (higher than the normal range[2] at all assessment nodes, but less than existing conditions);
  - sodium (higher than the normal range at LDG-P6, but less than existing conditions);
  - nitrate (higher than the normal range and existing conditions[3], with the exception of FF2);
  - ammonia (higher than the reference condition[4] at all assessment nodes);
  - arsenic (higher than the reference condition at all assessment nodes);
  - barium (higher than the normal range and existing conditions at all assessment nodes);
  - molybdenum (higher than the normal range and existing conditions at all assessment nodes);
  - strontium (higher than the normal range and existing conditions at all assessment nodes); and,
  - uranium (higher than the normal range and existing conditions at all assessment nodes)
- Maximum projected concentrations are less than the reference condition, the normal range, or existing conditions, where reference data were available, for the following constituents:
  - total suspended solids, calcium, chloride, magnesium, sulphate, total phosphorus, aluminum, cadmium, chromium, copper, lead, manganese, nickel, and zinc.
- Projected beryllium, bismuth, cobalt, mercury, selenium, silver, and vanadium concentrations were at or below existing condition detection levels, and are considered to be consistent with existing condition data.

[2] Highlighted in green in Table 22-1.
[3] Highlighted in yellow in Table 22-1
[4] Highlighted in blue in Table 22-1.

DOMINION DIAMOND

Table 22-1 Reference Condition, Normal Range, Existing Conditions, and Projected Depth Averaged Constituent Concentrations (Updated Assessment Case) in Lac de Gras for the Year 2059

Parameter	Unit	Reference Condition (a)	Normal Range (b)		Existing Conditions (Measured Baseline Maximum) (e)						Updated Assessment Case - Year 2059 (Golder 2015)(f)																	
		Whole Lake	Far Field Reference Areas		(Far Field 2)		(Far Field A)		(Slipper Bay)		LDG-P1			LDG-P2			LDG-P3			LDG-P4			LDG-P5			LDG-P6		
		Open-Water and Under-Ice	Under-Ice	Open-Water																								
		Range (25th to 75th %ile)	Upper Limit (d)	Upper Limit (d)	Under-Ice	Open-Water	Under-Ice	Open-Water	Under-Ice	Open-Water	Min	Med	Max	Min	Med	Max	Min	Med	Max	Min	Med	Max	Min	Med	Max	Min	Med	Max
Physical Parameters																												
Temperature	°C	-	-	-	-	-	-	-	-	-	0.3	0.4	11.2	0.3	0.5	10.3	0.3	0.4	13.1	0.26	0.51	12.9	0.28	0.41	11.5	0.09	0.21	13.5
Dissolved Oxygen	mg/L	-	-	-	-	-	-	-	-	-	10.7	12.1	13.9	9.1	11.9	13.9	10.4	12.0	13.8	9.5	11.4	13.8	8.6	11.4	13.9	9.8	12.7	13.9
Conventional Parameters																												
Hardness	mg/L	-	7	6.3	14	<10	7.1	<10	14	11	4.4	4.6	4.8	4.4	4.7	4.9	4.4	4.8	4.9	4.4	4.7	4.8	4.5	4.7	4.9	4.4	4.8	5.6
Total dissolved solids	mg/L	-	8.4	6.2	22	30	21	30	30	35	10.9	11.4	11.8	10.8	11.8	12.2	11.1	11.9	12.2	11.0	11.7	12.1	11.2	11.7	12.2	11.1	12.3	14.1
Total suspended solids	mg/L	<1 to 3.0			3	<3	<3	3	<3	3.5	1.2	1.3	1.3	1.2	1.3	1.4	1.3	1.3	1.4	1.2	1.3	1.4	1.3	1.3	1.4	1.2	1.4	1.6
Major Ions																												
Calcium	mg/L	-	1.2	1.1	3.9	1.7	1.3	1.1	2.6	2.2	0.9	0.9	1.0	0.9	1.0	1.0	0.9	1.0	1.0	0.9	0.9	1.0	0.9	0.9	1.0	0.9	1.0	1.1
Chloride	mg/L	-	1.2	0.99	2.5	2.6	1.2	1.7	5.5	5.8	0.9	0.9	1.0	0.9	0.9	1.0	0.9	0.9	1.0	0.9	0.9	1.0	0.9	0.9	1.0	0.9	1.0	1.1
Fluoride	mg/L	-	-	-	<0.05	<0.05	<0.05	<0.05	-	0.026	0.008	0.009	0.009	0.008	0.009	0.009	0.009	0.009	0.009	0.008	0.009	0.009	0.009	0.009	0.009	0.008	0.009	0.011
Magnesium	mg/L	-	0.8	0.75	1.3	0.93	0.92	0.76	1.9	1.5	0.5	0.6	0.6	0.5	0.6	0.6	0.5	0.6	0.6	0.5	0.6	0.6	0.5	0.6	0.6	0.5	0.6	0.7
Potassium	mg/L	-			1.2	0.95	0.75	0.7	1.7	1.6	0.5	0.5	0.6	0.5	0.6	0.6	0.5	0.6	0.6	0.5	0.6	0.6	0.5	0.6	0.6	0.5	0.6	0.7
Sodium	mg/L	-	0.81	0.83	1.8	1.9	<1	<1	3.7	4.7	0.7	0.7	0.8	0.7	0.8	0.8	0.7	0.8	0.8	0.7	0.8	0.8	0.7	0.8	0.8	0.7	0.8	0.9
Sulphate	mg/L	-	3.3	2.6	3.4	3.4	2.8	3.2	7.2	7.2	1.2	1.3	1.4	1.2	1.4	1.4	1.3	1.4	1.4	1.3	1.4	1.4	1.3	1.4	1.4	1.3	1.4	1.6
Nutrients																												
Nitrate	mg-N/L	-	0.018	0.0043	0.19	0.03	<0.02	<0.02	0.082	0.01	0.021	0.026	0.027	0.018	0.021	0.021	0.018	0.020	0.021	0.018	0.020	0.021	0.019	0.020	0.021	0.019	0.021	0.024
Total ammonia	mg-N/L	0.005 to 0.010	0.03	0.009	0.049	0.042	0.046	0.042	0.021	0.015	0.010	0.011	0.013	0.008	0.010	0.012	0.008	0.009	0.011	0.008	0.009	0.011	0.008	0.009	0.011	0.008	0.010	0.012
Total nitrogen	mg-N/L	-	-	-	0.197	0.197	0.158	0.158	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total phosphorus	mg-P/L	<0.002 to 0.0042			<0.005	0.01	<0.005	<0.005	0.0029	0.0086	0.0023	0.0025	0.0026	0.0023	0.0025	0.0026	0.0023	0.0025	0.0026	0.0023	0.0025	0.0025	0.0024	0.0025	0.0025	0.0023	0.0025	0.0027
Orthophosphate	mg-P/L	-	-	-	<0.005	<0.005	<0.005	0.006	0.001	0.001	0.0010	0.0011	0.0011	0.0009	0.0011	0.0012	0.0009	0.0011	0.0012	0.0009	0.0011	0.0011	0.0010	0.0011	0.0011	0.0009	0.0011	0.0013
Reactive Silica	mg/L	-	-	-	-	-	-	-	-	-	0.115	0.119	0.124	0.114	0.123	0.128	0.116	0.123	0.127	0.113	0.120	0.125	0.113	0.120	0.125	0.113	0.126	0.145
Total Metals																												
Aluminum	µg/L	3.2 to 18.8	4.3	6.3	12	7.7	4.6	7.2	7.7	84	6.93	7.04	8.21	6.97	7.28	8.39	7.21	7.53	8.56	7.53	7.79	9.03	7.58	7.88	9.36	7.64	8.45	9.62
Arsenic	µg/L	0.18 to 0.21	-	-	0.39	0.3	0.19	0.23	0.22	0.43	0.253	0.261	0.263	0.255	0.263	0.264	0.258	0.266	0.267	0.262	0.270	0.271	0.265	0.271	0.273	0.265	0.274	0.279
Barium	µg/L	-	2.2	2	3.6	3.1	2.3	2.8	4.2	4.8	3.65	4.57	4.61	3.68	4.61	4.63	3.75	4.67	4.69	3.81	4.73	4.75	3.87	4.75	4.78	3.87	4.78	4.90
Beryllium	µg/L	-	-	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100
Bismuth	µg/L	-	-	-	<0.005	<0.005	<0.005	<0.2	<0.005	<0.01	0.0004	0.0004	0.0004	0.0004	0.0004	0.0005	0.0004	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0006
Cadmium	µg/L	**<0.05** to **<0.2** (DL>C)	-	-	<0.05	<0.05	<0.05	<0.05	<0.01	0.017	0.027	0.027	0.028	0.027	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.029	0.028	0.029	0.029
Chromium	µg/L	0.185 to **1.2** (C)	0.092	0.06	0.2	0.28	<0.1	0.21	<0.2	0.49	0.044	0.046	0.047	0.045	0.047	0.047	0.047	0.049	0.049	0.049	0.051	0.052	0.050	0.051	0.054	0.050	0.053	0.056
Cobalt	µg/L	-	-	-	<0.1	<0.1	0.19	<0.1	<0.1	0.32	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.053
Copper	µg/L	<0.6 to 1.0	-	-	0.97	0.75	0.67	1	0.75	1.8	0.344	0.349	0.353	0.347	0.352	0.354	0.353	0.358	0.359	0.358	0.365	0.367	0.363	0.367	0.375	0.363	0.373	0.380
Iron	µg/L	-	-	-	10	24	9.1	9.5	<10	164	4.27	4.32	7.08	4.26	4.50	7.25	4.38	4.62	7.31	4.53	4.73	7.47	4.56	4.78	7.61	4.59	5.09	7.72
Lead	µg/L	<0.05 to 0.07	-	-	0.38	0.051	0.074	0.056	<0.05	0.07	0.026	0.026	0.026	0.026	0.026	0.027	0.026	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.027
Manganese	µg/L	-	2.6	4.5	1.2	4	1.6	4.2	2.9	41	1.47	1.48	3.64	1.47	1.51	3.66	1.50	1.54	3.68	1.55	1.58	3.73	1.55	1.59	3.76	1.56	1.66	3.79

Table 22-1 Reference Condition, Normal Range, Existing Conditions, and Projected Depth Averaged Constituent Concentrations (Updated Assessment Case) in Lac de Gras for the Year 2059

Parameter	Unit	Reference Condition (a)	Normal Range (b)		Existing Conditions (Measured Baseline Maximum) (e)						Updated Assessment Case - Year 2059 (Golder 2015)(f)																	
		Whole Lake	Far Field Reference Areas		(Far Field 2)		(Far Field A)		(Slipper Bay)		LDG-P1			LDG-P2			LDG-P3			LDG-P4			LDG-P5			LDG-P6		
		Open-Water and Under-Ice	Under-Ice	Open-Water																								
		Range (25th to 75th %ile)	Upper Limit (d)	Upper Limit (d)	Under-Ice	Open-Water	Under-Ice	Open-Water	Under-Ice	Open-Water	Min	Med	Max	Min	Med	Max	Min	Med	Max	Min	Med	Max	Min	Med	Max	Min	Med	Max
Mercury	µg/L	-	-	-	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
Molybdenum	µg/L	-	0.14	0.14	0.49	0.59	0.15	0.73	1.2	1.3	1.36	1.47	1.57	1.42	1.55	1.60	1.57	1.68	1.73	1.71	1.86	1.94	1.81	1.91	2.13	1.83	2.07	2.27
Nickel	µg/L	0.5 to 1.4	-	-	0.82	0.77	1.7	1.3	1.1	2.5	0.778	0.919	0.925	0.782	0.924	0.927	0.791	0.932	0.935	0.799	0.941	0.943	0.808	0.943	0.947	0.807	0.948	0.963
Selenium	µg/L	-	-	-	<0.1	<0.1	0.1	<0.1	<0.2	<0.1	0.059	0.060	0.061	0.060	0.061	0.061	0.061	0.062	0.062	0.062	0.063	0.064	0.063	0.064	0.065	0.063	0.065	0.066
Silver	µg/L	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050
Strontium	µg/L	-	9	8.6	18	20	10	9.8	36	29	27.0	31.0	32.0	27.9	32.0	32.8	29.7	33.6	34.3	31.2	35.3	35.7	32.5	35.7	36.3	32.6	37.2	39.9
Uranium	µg/L	-	0.05	0.05	0.12	0.096	0.05	<0.05	0.033	0.087	0.099	0.100	0.100	0.099	0.100	0.102	0.100	0.101	0.102	0.100	0.100	0.102	0.100	0.101	0.102	0.100	0.101	0.104
Vanadium	µg/L	-	-	-	<0.2	<0.2	<0.2	<0.2	<0.05	0.13	0.078	0.084	0.088	0.082	0.088	0.091	0.088	0.094	0.096	0.094	0.102	0.104	0.099	0.104	0.112	0.100	0.112	0.118
Zinc	µg/L	<0.8 to 6.5	-	-	4.1	4.4	2.3	3.3	11	3.1	0.460	0.466	0.471	0.463	0.471	0.473	0.471	0.478	0.480	0.479	0.487	0.491	0.484	0.490	0.501	0.485	0.499	0.508

Notes

(a) reference condition data as reported in DAR Table 8.2-50 (DDMI 2001).
(b) the normal range describes the natural variability of Lac de Gras and is based on data collected from 2007 to 2013 during the Diavik AEMP programs (Golder 2014)
(c) the lower limit represents the minimum of two standard deviations from the mean.
(d) the upper limit represents the maximum of two standard deviations from the mean.
(e) measured baseline maximum used for screening; where the maximum value was less than the detection limit, a value equal to the detection limit was used as the maximum:
Source for FF2: DDMI 2011, 2012, 2013 (FF2-1M, FF2-2B, FF2-2M, FF2-2, FF2-3M, FF2-4M, FF2-5B, FF2-5M, and FF2-5T sampled in 2010, 2011, and 2012) and Dominion Diamond 2015 (FF2-1, FF2-2, FF2-3, FF204, and FF2-5 sampled in 2014).
Source for FFA: DDMI 2011 and 2012 (FFA-1, FFA-2, FFA-3, FFA-4, and FFA-5 sampled in 2010 and 2011).
Source for Slipper Bay: Rescan 2011, 2012; ERM Rescan 2013 (S2 and S3 sampled in 2010, 2011, and 2012) and Dominion Diamond 2015 (S2, S3, S5, and S6 sampled in 2014).
(f) range of projected concentrations for the last year of modelled post-closure (Year 2059) in Lac de Gras
(g) in cases where all values in the reference areas were below the detection limit, the lower limits of the normal range were considered to be equal to zero (Golder 2014).

Bolded concentrations are higher (or lower for pH) than relevant water quality guidelines.
Projected concentration is more than the reference condition.
Projected concentration is more than the normal range.
Projected concentration is more than the normal range and the existing condition.

(C) = concentration higher than the relevant chronic aquatic life guideline or beyond the recommended pH range.
(DL>C) = analytical detection limit was higher than the relevant chronic aquatic life guideline.
< = less than; - = no guideline or data; µg/L = micrograms per litre; mg/L = milligrams per litre; mg-N/L = milligrams of nitrogen per litre; mg-P/L = milligrams of phosphorus per litre.

References:

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Golder. 2015. Jay Project - Compendium of Supplemental Water Quality Modelling. Submitted to Mackenzie Valley Environmental Impact Review Board. April 2015.

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Information Request Number:	DAR-MVEIRB-IR2-23
Source:	Mackenzie Valley Environmental Impact Review Board Information Requests from Chuck Hubert
Subject:	Misery pit water quality management strategies
DAR Section(s):	Round 1 Information Request Response DAR-MVEIRB-IR-40

Preamble (MVEIRB):

MVEIRB IR 40 requested information regarding water quality predictions in the Misery Pit. In its response (DAR-MVEIRB-IR-40 p 6), Dominion states that "One of the key advantages of the water management strategy is the majority of the minewater will be managed through the Misery Pit during operations....This approach allows sufficient monitoring results to be collected to develop a key understanding of the controls on Misery Pit water quality, facilitating proactive design of mitigation strategies, should they be required."

Request (MVEIRB):

It is unclear to the Review Board how increased settling time could alleviate water quality concerns due to elevated nutrients or dissolved metals concentrations in Misery Pit. Please either explain how settling time would lower nutrient or metals concentrations within Misery Pit or provide a list of additional potential mitigation options, should Misery Pit water quality prove to be unsuitable for discharge due to these contaminants of potential concern.

Response:

The response to Round 1 information request (IR) DAR-MVEIRB-IR-40 makes no reference to settling of nutrients or dissolved metals in Misery Pit, nor are these constituent groups modelled as particulate bound fractions. As described in Appendix 8E of the Developer’s Assessment Report (DAR), dissolved metals and nutrients were considered as conservative constituents, and settling or dimunition through mineral precipitation or natural degradation, respectively, was not accounted for in the Misery Pit. This approach is appropriate for providing a conservative estimate of the Misery Pit discharge water quality.

In the DAR, projected Misery Pit discharge water quality was modelled stochastically for 200 realizations. In each realization, a randomly selected input concentration was assigned to each constituent in dissolved form for the Misery Pit wall rock runoff and the Jay waste rock storage area runoff and seepage. These drainages were mixed with other inflows to the Misery Pit (e.g., groundwater pumped from the Jay Pit) to project the Misery Pit discharge water quality. In the model, natural particulate concentrations and a particulate fraction assuming 15 milligrams per litre (mg/L) of total suspended sediment of wall rock material was added to the projected dissolved concentrations. Details of the water quality model development are provided in Appendix 8E of the DAR.

The average projected Misery Pit discharge water quality, based on these 200 realizations, was carried forward into the downstream model to assess impacts of the Jay Project on Lac du Sauvage (operational discharge) and Lac de Gras (closure pit overflow) in the DAR. At the request of the Mackenzie Valley

Environmental Impact Review Board, the projected 99th percentile Misery Pit discharge water quality for select constituents was evaluated in the Lac du Sauvage and Lac de Gras hydrodynamic models. The results of this modelling are provided in the response to Round 1 IR DAR-MVEIRB-IR-40.

As noted in the preamble to this IR, the response to Round 1 IR DAR-MVEIRB-IR-40, indicates that the Jay Project water management plan facilitates monitoring in the Misery Pit prior to discharge being required. Water balance modelling indicates discharge from Misery Pit will not be required until Year 5 or 6 of operations, allowing sufficient site-specific water quality monitoring to be collected to validate model projections and allow for proactive implementation of adaptive management strategies if the operational Misery Pit water quality is greater than predicted.

If water quality monitoring within the Misery Pit indicates conditions differ from the DAR predictions and represent a potential risk to the receiving environment, Dominion Diamond will implement adaptive management strategies that may involve improvement or modifications to the minewater management plan or temporary use of the contingencies included in the design of the water management structures (Section 8.3, Appendix 3A of the DAR). The adaptive management strategies were provided in responses to the previous information requests (Round 1 IRs DAR-GNWT-IR-58 and DAR-EC-IR-15), and include the following:

- maintaining a storage contingency allowance in the existing King Pond throughout the construction and operations stage for use as an additional total suspended solids management facility during construction and operations phase, or for short-term emergency minewater storage;
- maintaining the contingency storage in the Misery Pit (approximately 3 million cubic metres throughout the operations stage for use as emergency minewater storage (upper 10 metres of the pit);
- maintaining pumping capacity and a pipeline between the Misery and Lynx pits throughout the operations stage to allow for lowering of the Lynx Pit water level to generate additional contingency minewater storage, if required;
- increasing storage capacity in the Jay runoff sump and mine inflows sump (e.g., constructing containment berms around the sumps) to augment temporary minewater storage capacity within the diked area;
- consideration of direct discharge to the environment from the Jay runoff sump, if water is found to meet established discharge criteria (the discharge locations used during the initial stages of dewatering would be used);
- use of storage capacity available at the Ekati site (e.g., construction of pumping and pipeline system from the Misery site to the Ekati site); and,
- treatment of parameters of concern prior to discharge to Lac du Sauvage.

Adaptive management options that provide additional storage for minewater may, in certain circumstances, be used to directly address certain water quality concerns such as suspended sediment, or they may provide additional time for implementation of other response plans.

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Information Request Number:	DAR-MVEIRB-IR2-24
Source:	Mackenzie Valley Environmental Impact Review Board Information Requests from Chuck Hubert
Subject:	Long term closure and stewardship
DAR Section(s):	Round 1 Information Request Response DAR-EC-IR-22

Preamble (MVEIRB):

Dominion Diamond's interim closure and reclamation plan indicates that closure objectives for open pits include "any permanent lake stratification caused by meromixis remains stable and pit lake water meets water licence criteria" (ICRP p-5-33). Dominion Diamond's response to EC-IR-22 indicates that pit lake water quality modelling was conducted for the 200 years following closure, and that no scenarios of full lake turn-over were modelled due to the projected stability of meromictic conditions (DAR-EC-IR-22). Despite the predicted low probability of a full turn-over of the pit lakes in the 200 years following closure, more information about the potential effects of such an event is required to evaluate the risk over the longer term (as risk is a function of both likelihood and consequence).

Request (MVEIRB):

a) For the pit lakes used for the Jay project for water management and processed kimberlite storage, please describe what would happen downstream if turnover occurs post-closure. Please quantitatively demonstrate if water quality in Lac du Sauvage, Lac de Gras and the Coppermine River would still be below significance thresholds established in the DAR if the pit lakes were to turnover (individually and collectively).

b) If the turnover of these pit lakes would affect water quality in these three water bodies such that significance thresholds are exceeded, please describe the types of circumstances or events that could initiate such a change. Please estimate the return periods of any such events.

Response:

For the Jay Project (the Project), Dominion Diamond proposes to store processed kimberlite (PK) in the mined out Panda and Koala pits. At the cessation of mining, the PK will be covered with a shallow freshwater cap and subsequently drain to the Koala watershed via the Long Lake Containment Facility and subsequently to Lac de Gras. The freshwater cap overlying PK in Panda and Koala will be shallow (approximately 30 metres [m] thick). Meromictic conditions, as described in Appendix 8G of the Developer’s Assessment Report (DAR) for the back-flooded Misery and Jay pits, are not anticipated to develop in the Panda and Koala pits. The pits were, therefore, assumed to be fully mixed in water quality modelling included in the DAR and discharge was modelled using a mass balance approach (ERM Rescan 2014).

As part of the DAR, a pit lake hydrodynamic model was developed for the Jay and Misery Pits (Appendix 8G). The results of this modelling indicated that meromixis will occur in both pits and remain stable in the long-term. The water quality modelling completed in the DAR was based on several conservative assumptions for the purpose of assessing impacts of the Project to surface water quality in Lac du Sauvage and Lac de Gras. To provide a more reasonable estimate of Project discharge water quality during operations and post-closure, a reasonable estimate case was developed (Golder 2015a). This scenario considered a reduction in the conservatism built into the hydrogeological model and resulted in lower total dissolved solids (TDS) concentrations in the back-flooded Jay and Misery Pits. The Jay and Misery Pit hydrodynamic model indicated both pits would become, and remain, meromictic in the long-term in the reasonable estimate case. Details of this modelling are provided in the Jay Project Compendium of Supplemental Water Quality Modelling (Golder 2015a).

The modelling completed to date provides confidence that meromixis will remain stable in the Jay and Misery Pits and that an over-turn is not considered a likely event for the Project. Several examples of meromictic pit lakes were also provided in the Round 1 Information Request response to DAR-GNWT-IR-62. However, as discussed in Round 1 Information Request DAR-LKDFN-IR-05, there are potential causes of a pit lake over-turn; these include climate and meteorological events, direct physical disruption, and human error.

- The model simulation that predicted the stability of the pycnocline considered measured wind events at an hourly frequency over the past 14 years. A sensitivity analysis that considered a 25 percent higher wind speed over the entire duration of the simulation resulted in a slightly deeper pycnocline, but not a complete turnover event in either the Jay or Misery Pit. Given that the simulation exceeded any reasonably foreseeable meteorological event, a disruption of the pycnocline due to a prolonged wind storm is considered highly unlikely, and therefore, a return period for such an event that will result in a turnover cannot be predicted.
- The stability of the pycnocline could be disrupted by direct input of materials into the monimolimnion. For example pit wall failures have been documented to disrupt meromixis in Summer Camp Lake (Parshley and Bolwell 2003) and Berkeley Pit Lake (Gammons and Duaime 2006).
- Human error could disrupt meromixis if the pit filling waters were not placed in such a way as to maximize the density gradient and minimize turbulence.

However, due to the random nature of such events, a return period cannot be confidently predicted for these causes of pit turnover.

During the Project technical sessions (April 20 to 24, 2015), the Mackenzie Valley Environmental Impact Review Board (MVEIRB) raised concerns that meromixis might not occur should the groundwater quantity and quality to the Jay Pit during operations be less than predicted in the reasonable estimate case. To address this concern, Dominion Diamond retained Golder Associates Ltd. (Golder) to update the Project water quality model for a lower bound scenario (Golder 2015b).

Water quality modelling completed as part of the DAR and the reasonable estimate (Golder 2015a) cases indicated groundwater inflows to the Jay Pit were the main control on site discharge water quality and the initial pit lake concentrations following back-flooding. Therefore, the lower bound scenario was defined as a reduction in the Jay Pit enhanced permeability zone (EPZ), bedrock hydraulic conductivity, and porosity. The following were the key findings of the lower bound scenario:

- Jay Pit groundwater inflows and TDS concentrations were lower in comparison to the reasonable estimate and DAR cases;
- The reduced groundwater inflows delay the timing of discharge from Misery Pit to Lac du Sauvage until the last year of operations;
- The reduced groundwater inflow TDS concentrations to the Jay Pit result in a decrease in the Misery Pit discharge TDS concentrations to Lac du Sauvage and mixolimnion and monimolimnion concentrations in the Misery and Jay Pits; and,
- Although the Jay and Misery Pits have much lower mixolimnion and monimolimnion TDS concentrations in comparison to the reasonable estimate case, hydrodynamic modelling indicates the pits will stratify and remain stratified during the 200-year model timeframe.

Additional details related to the lower bound modelling scenario are provided in Golder (2015b).

The water quality modelling scenarios completed to date are considered to bracket the range of possible conditions for the Project (e.g., DAR, reasonable estimate, and lower bound cases) and indicate meromixis will form during closure of the Jay Project and remain stable in the long-term. Therefore, over-turning of the pits (or a fully mixed condition) is not considered to represent a realistic scenario for the Project. Nevertheless, to address the request of the MVEIRB, the Lac du Sauvage and Lac de Gras hydrodynamic water quality models were updated for three scenarios in response to this information request (Table 24-1). Water quality projected in these scenarios was evaluated at the same Lac du Sauvage and Lac de Gras assessment nodes used in the DAR.

Table 24-1 Description of the Model Scenarios Included in this Response

Scenario	Description	Results Provided in:	
		Tables	Figures
A	Mixed Jay Pit: • over-turn of Jay Pit immediately following back-flooding	24-2 (LDS) 24-3 (LDG)	24-1 to 24-9 (LDS) 24-10 to 24-18 (LDG)
B	Mixed Misery Pit: • over-turn of Misery Pit immediately following back-flooding[(a)]	24-3 (LDG)	24-19 to 24-27 (LDG)
C	Mixed Jay Pit and Misery Pit: • over-turn of Misery and Jay pits immediately following back-flooding	24-3 (LDG)	24-28 to 24-36 (LDG)

a) this scenario will only influence Lac de Gras since Lac du Sauvage is upstream of Misery Pit discharges during post-closure.
LDS = Lac du Sauvage; LDG = Lac de Gras.

The stability of the pit lake stratification can weaken if the density difference between the mixolimnion and the monimolimnion decreases. Therefore, the above scenarios were only evaluated for the reasonable estimate case. Use of the DAR projections is considered to provide an overly conservative estimate of Lac du Sauvage and Lac de Gras water quality should the pits overturn. Therefore, use of the reasonable estimate case result is considered to provide a conservative estimate of Lac du Sauvage and Lac de Gras water quality in the event the pits overturn. Since the lower bound scenario (Golder 2015b) would result in lower constituent concentrations in Lac du Sauvage and Lac de Gras following a pit overturn, in comparison to the reasonable estimate case, the lower bound scenario was not evaluated as part of this information request.

Predicted maximum of depth-averaged water quality in Lac du Sauvage and Lac de Gras for a range of select key water quality constituents (i.e., TDS, chloride, sulphate, nitrate, ammonia, total phosphorus [TP], chlorophyll *a*, aluminum, and arsenic) are provided in Tables 24-2 and 24-3, respectively. Only the post-closure period results are provided in Tables 24-2 and 24-3 as the turn-over, or mixing of the pit lakes, if it were to occur, only changes post-closure predictions in the downstream lakes; there is no change to predictions for the operations or closure phases. For discussion purposes, the results of the reasonable estimate case (from Golder 2015a) are also provided in the tables. The time-series figures show the entire modelled period. In all cases, the new scenario predictions are shown along with the stratified, reasonable estimate, predictions for discussion purposes.

Predicted maximum, depth-averaged, concentrations for Lac du Sauvage, under the stratified Jay Pit and the mixed Jay Pit scenarios are provided in Table 24-2 for the subset of key constituents. Predicted concentrations are higher for the mixed Jay Pit scenario as compared to the stratified Jay Pit scenario, but concentrations under both scenarios are predicted to be less than the screening values used in the water quality assessment (Table 8.5-13 in the DAR). This occurs as a result of the small capacity of the Jay monimolimnion (27 million cubic metres [m^3]) in comparison to the overlying mixolimnion and transition layer (93 million m^3) and the large assimilative capacity of Lac du Sauvage. As illustrated in the time-series figures attached to this response (Figures 24-1 to 24-9) for the stratified Jay Pit scenario, peak concentrations are predicted in late operations with decreasing concentrations through closure and post-closure. For the mixed Jay Pit (Scenario A), there is an upward trend at the start of post-closure related to the modelled turn-over. For this scenario, the peak in post-closure is predicted to be higher than the peak in operations for the stratified Jay Pit. After the turn-over of Jay Pit, and mixing with Lac du Sauvage, concentrations in Lac du Sauvage are predicted to decrease through the post-closure period. For the stratified and mixed Jay Pit (Scenario A) scenarios, concentrations at the end of the modelled post-closure period are predicted to be similar.

Included in Table 24-3 are the predicted maximum, depth-averaged concentrations for Lac de Gras, in the post-closure period, for four model scenarios: stratified Jay and Misery pits (Reasonable Estimate Case), mixed Jay Pit and stratified Misery Pit (Scenario A), stratified Jay Pit and mixed Misery Pit (Scenario B), and mixed Jay and Misery pits (Scenario C). Overall, predicted concentrations are highest for Scenario C, followed by Scenario A, Scenario B, and lowest for the stratified Jay Pit and Misery Pit scenario. In all scenarios, concentrations are predicted to be less than the screening values used in the water quality assessment (Table 8.5-13 in the DAR).

The time-series predictions are similar for Scenario B and the stratified Jay Pit and Misery Pit scenario (Figures 24-19 to 24-27). For most constituents, the predicted values are the same in both of the time-series trends suggesting that turn-over of Misery Pit has little effect on predicted water quality in Lac de Gras as a result of the limited inflow of Misery Pit water on an annual basis (i.e. approximately 70,000 cubic metres per year [m^3/y]). For chloride, there is a minor separation in the predictions toward later in the post-closure period.

The time-series predictions for Scenario A (mixed Jay Pit; Figures 24-10 to 24-18) and Scenario C (mixed Jay and Misery pits; Figures 24-28 to 24-36) are very similar. For both scenarios A and C, there is a discernible second peak in the early post-closure period as compared to the stratified Jay and Misery Pit scenario where concentrations are predicted to continually decrease from the start to the end of the post-closure period. Prediction scenarios A and C suggest that the turn-over of Jay Pit could have an effect on the predicted water quality in Lac de Gras; these scenarios predict a bimodal peak of concentrations over the life of the model period (i.e., one peak in operations and a second peak in early post-closure). For all scenarios, the long-term water quality in Lac de Gras (i.e., toward the end of the modelled post-closure period) is predicted to decrease to levels similar to existing conditions, reference conditions, and/or the normal range.

In Lac du Sauvage, concentrations are higher under the Jay Pit mixing scenario as compared to the Jay Pit stratified scenario, and there is a bimodal pattern to the temporal trend in predicted concentrations over time. In Lac de Gras, concentrations are higher under the Jay Pit mixing scenario (for both mixed and stratified Misery Pit) as compared to the Jay Pit stratified scenario (both mixed and stratified Misery Pit). Under all scenarios, concentrations are predicted to be less than aquatic life and drinking water guidelines, and thus, a significant adverse effect on the maintenance or suitability of water to support a healthy and sustainable ecosystems in Lac du Sauvage and Lac de Gras, or on the continued opportunity for the traditional use of water, including use as a drinking water source, under these turnover scenarios is not anticipated.

It is important to note that modelling included in the DAR, the Compendium of Supplemental Modeling (Golder 2015a) and the Lower Bound Scenario (Golder 2015b) indicated meromixis will form in the Jay and Misery Pits and remain stable in post-closure. Therefore, the model scenarios included in this information request are considered unlikely.

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Table 24-2 Predicted Maximum of Depth-Averaged Water Quality in Lac du Sauvage

Parameter	Units	Post-Closure (2034 - 2060)					
		LDS-P1		LDS-P2		LDS-P3	
		Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water
Reasonable Estimate Case - Stratified Jay Pit Lake (Golder 2015a)							
Total dissolved solids	mg/L	13	11	13	11	15	11
Chloride	mg/L	1.0	0.93	1.0	0.92	1.1	0.85
Sulphate	mg/L	1.4	1.2	1.3	1.2	1.6	1.1
Total ammonia	mg-N/L	0.038	0.028	0.037	0.026	0.041	0.025
Nitrate	mg-N/L	0.029	0.025	0.028	0.023	0.029	0.022
Total phosphorus (calculated)	mg-P/L	0.0075	0.0073	0.0075	0.0073	0.0079	0.0073
Phytoplankton (as Chlorophyll a)	µg/L	2.1	2.9	2.1	2.8	2.1	2.9
Total aluminum	µg/L	12	16	12	15	13	15
Total arsenic	µg/L	0.36	0.31	0.36	0.31	0.36	0.31
Reasonable Estimate Case - Mixed Jay Pit Lake (Scenario A)							
Total dissolved solids	mg/L	43	36	42	37	42	33
Chloride	mg/L	19	16	18	16	18	14
Sulphate	mg/L	1.6	1.4	1.6	1.4	1.6	1.3
Total ammonia	mg-N/L	0.098	0.059	0.097	0.059	0.096	0.055
Nitrate	mg-N/L	0.33	0.26	0.32	0.26	0.31	0.24
Total phosphorus (calculated)	mg-P/L	0.0096	0.0075	0.0096	0.0075	0.0094	0.0072
Phytoplankton (as Chlorophyll *a*)	µg/L	5.7	7.4	5.8	7.3	5.9	7.3
Total aluminum	µg/L	14	16	14	16	14	16
Total arsenic	µg/L	0.42	0.36	0.42	0.36	0.42	0.36

Note: See figures 24-1 to 24-9 for the time-series predictions of these constituents; for comparison purposes, the stratified Jay Pit predictions are included in the figure.
mg/L = milligrams per litre; mg-N/L = milligrams as nitrogen per litre; mg-P/L = milligrams as phosphorus per litre; µg/L = micrograms per litre.

Table 24-3 Predicted Maximum of Depth-Averaged Water Quality in Lac de Gras

Parameter	Units	Post-Closure (2034 - 2060)											
		LDG-P1		LDG-P2		LDG-P3		LDG-P4		LDG-P5		LDG-P6	
		Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water
Reasonable Estimate Case - Stratified Jay Pit and Misery Pit Lakes (Golder 2015a)													
Total dissolved solids	mg/L	15	14	15	15	15	14	15	14	15	15	18	14
Chloride	mg/L	1.4	1.3	1.5	1.5	1.5	1.4	1.6	1.6	1.6	1.7	1.9	1.6
Sulphate	mg/L	1.9	1.8	2.1	2.0	2.0	1.9	2.0	2.0	2.1	2.0	2.4	2.0
Total ammonia	mg-N/L	0.015	0.013	0.014	0.012	0.014	0.012	0.014	0.012	0.014	0.012	0.016	0.012
Nitrate	mg-N/L	0.023	0.022	0.022	0.021	0.022	0.02	0.023	0.027	0.024	0.029	0.028	0.028
Total phosphorus (calculated)	mg-P/L	0.0027	0.0026	0.0027	0.0026	0.0027	0.0026	0.0027	0.0025	0.0027	0.0026	0.0029	0.0025
Phytoplankton (as Chlorophyll *a*)	µg/L	0.47	0.51	0.56	0.7	0.53	0.67	0.55	0.67	0.55	0.67	0.55	0.73
Total aluminum	µg/L	12	13	12	13	12	13	13	13	13	14	14	14
Total arsenic	µg/L	0.27	0.26	0.27	0.27	0.28	0.27	0.28	0.28	0.28	0.28	0.29	0.28
Reasonable Estimate Case - Mixed Jay Pit Lake and Stratified Misery Pit Lake (Scenario A)[a]													
Total dissolved solids	mg/L	17	17	16	16	16	15	16	15	17	16	19	16
Chloride	mg/L	3.5	3.8	3.0	2.9	3.0	2.8	3.0	2.8	3.0	2.9	3.5	2.9
Sulphate	mg/L	1.9	1.8	2.1	2.0	2.0	1.9	2.1	2.0	2.1	2.0	2.4	2.0
Total ammonia	mg-N/L	0.02	0.019	0.017	0.015	0.016	0.015	0.016	0.014	0.016	0.014	0.018	0.014
Nitrate	mg-N/L	0.049	0.052	0.03	0.028	0.029	0.027	0.03	0.032	0.031	0.036	0.036	0.034
Total phosphorus (calculated)	mg-P/L	0.0029	0.0028	0.0028	0.0027	0.0028	0.0026	0.0027	0.0025	0.0027	0.0027	0.0029	0.0025
Phytoplankton (as Chlorophyll *a*)	µg/L	0.75	0.83	0.81	1.1	0.76	0.96	0.73	0.92	0.73	0.89	0.73	0.97
Total aluminum	µg/L	12	12	12	13	12	12	13	12	13	13	14	13
Total arsenic	µg/L	0.27	0.25	0.27	0.26	0.28	0.26	0.28	0.26	0.28	0.27	0.29	0.27
Reasonable Estimate Case - Stratified Jay Pit Lake and Mixed Misery Pit Lake (Scenario B)[b]													
Total dissolved solids	mg/L	14	14	15	15	15	14	15	14	15	15	18	14
Chloride	mg/L	2.0	1.9	2.1	2.0	2.0	1.9	2.1	2.0	2.1	2.1	2.5	2.1
Sulphate	mg/L	1.9	1.8	2.1	2.0	2.0	1.9	2.0	2.0	2.1	2.0	2.4	2.0
Total ammonia	mg-N/L	0.015	0.013	0.014	0.012	0.014	0.012	0.014	0.012	0.014	0.012	0.016	0.012
Nitrate	mg-N/L	0.023	0.022	0.022	0.021	0.022	0.02	0.023	0.026	0.024	0.03	0.028	0.028
Total phosphorus (calculated)	mg-P/L	0.0027	0.0026	0.0027	0.0026	0.0027	0.0026	0.0027	0.0025	0.0027	0.0026	0.0029	0.0025

Table 24-3 Predicted Maximum of Depth-Averaged Water Quality in Lac de Gras

Parameter	Units	Post-Closure (2034 - 2060)											
		LDG-P1		LDG-P2		LDG-P3		LDG-P4		LDG-P5		LDG-P6	
		Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water
Phytoplankton (as Chlorophyll *a*)	µg/L	0.47	0.51	0.55	0.7	0.52	0.67	0.54	0.67	0.54	0.66	0.54	0.73
Total aluminum	µg/L	12	12	12	13	12	12	13	12	13	13	14	13
Total arsenic	µg/L	0.27	0.25	0.27	0.26	0.28	0.26	0.28	0.26	0.28	0.27	0.29	0.27
Reasonable Estimate Case - Mixed Jay Pit and Misery Pit Lakes (Scenario C)[c]													
Total dissolved solids	mg/L	17	17	17	16	16	16	16	15	17	16	19	16
Chloride	mg/L	3.5	3.8	3.1	2.9	3.0	2.8	3.0	2.9	3.0	2.9	3.5	2.9
Sulphate	mg/L	1.9	1.8	2.1	2.0	2.0	1.9	2.0	2.0	2.1	2.0	2.4	2.0
Total ammonia	mg-N/L	0.02	0.019	0.018	0.015	0.017	0.015	0.016	0.015	0.016	0.015	0.018	0.014
Nitrate	mg-N/L	0.049	0.053	0.031	0.029	0.029	0.027	0.03	0.032	0.031	0.036	0.036	0.034
Total phosphorus (calculated)	mg-P/L	0.0029	0.0028	0.0028	0.0027	0.0028	0.0026	0.0027	0.0025	0.0027	0.0027	0.0029	0.0026
Phytoplankton (as Chlorophyll *a*)	µg/L	0.74	0.83	0.81	1.1	0.75	0.96	0.73	0.92	0.73	0.89	0.73	0.97
Total aluminum	µg/L	12	12	12	13	12	12	13	12	13	13	14	13
Total arsenic	µg/L	0.27	0.25	0.27	0.28	0.27	0.26	0.28	0.26	0.28	0.27	0.29	0.27

a) See figures 24-10 to 24-18 for the time-series predictions of these constituents; for comparison purposes, the stratified Jay and Misery Pit predictions are included in the figure.
b) See figures 24-19 to 24-27 for the time-series predictions of these constituents; for comparison purposes, the stratified Jay and Misery Pit predictions are included in the figure.
c) See figures 24-28 to 24-36 for the time-series predictions of these constituents; for comparison purposes, the stratified Jay and Misery Pit predictions are included in the figure.
mg/L = milligrams per litre; mg-N/L = milligrams as nitrogen per litre; mg-P/L = milligrams as phosphorus per litre; µg/L = micrograms per litre.

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ERM Rescan (ERM Rescan Environmental Services Ltd.) 2014. Water Balance and Water Quality Modelling Related to the Jay Project. Submitted to Dominion Diamond Ekati Corporation, Yellowknife, NWT, Canada.

Gammons CH, Duaime TE. 2006. Long term changes in the limnology and geochemistry of the Berkeley Pit Lake Butte, Montana. Mine Water and the Environment. 25: 76-85.

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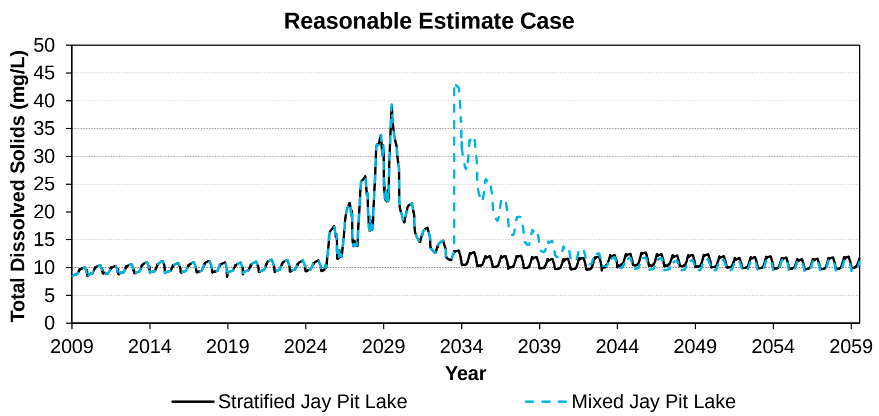
Parshley JV, Bowell RKJ. 2003. The Limnology of Summer Camp Pit Lake: A Case Study. Mine Water and the Environment. 22:170–186.

Attachment A:

Time Series Figures

Figure 24-1 Predicted Depth-Averaged Total Dissolved Solids Concentrations in Lac du Sauvage-Scenario A



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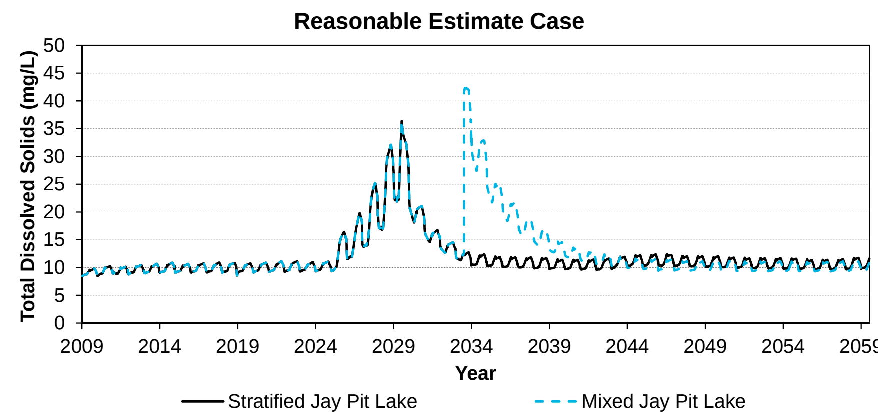

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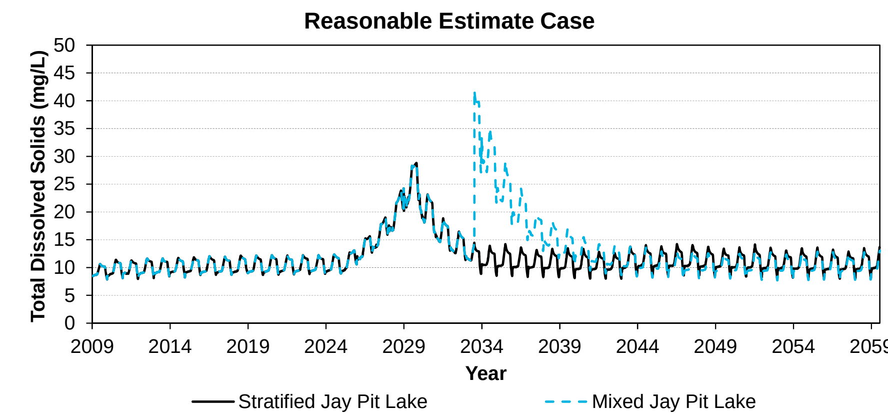

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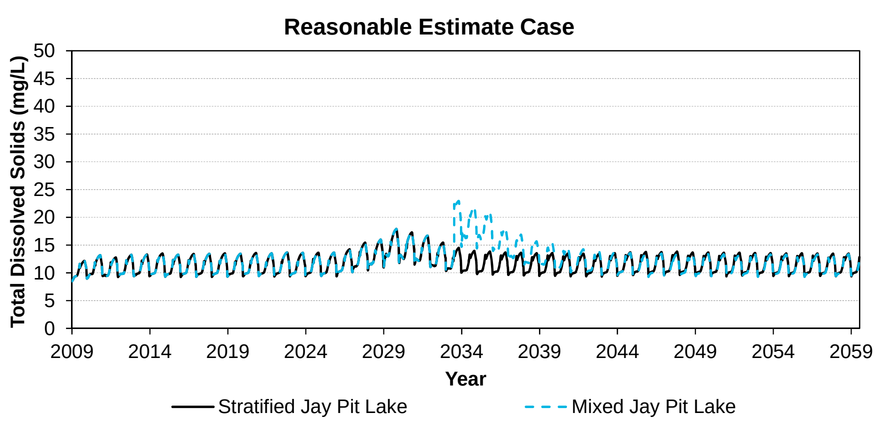

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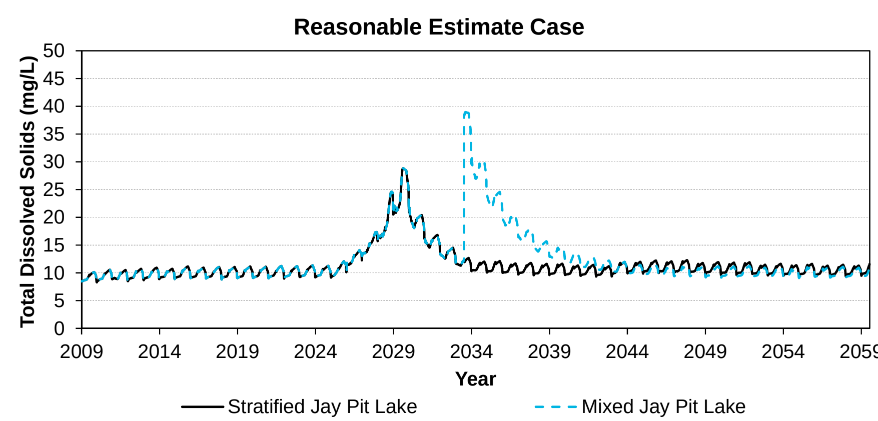

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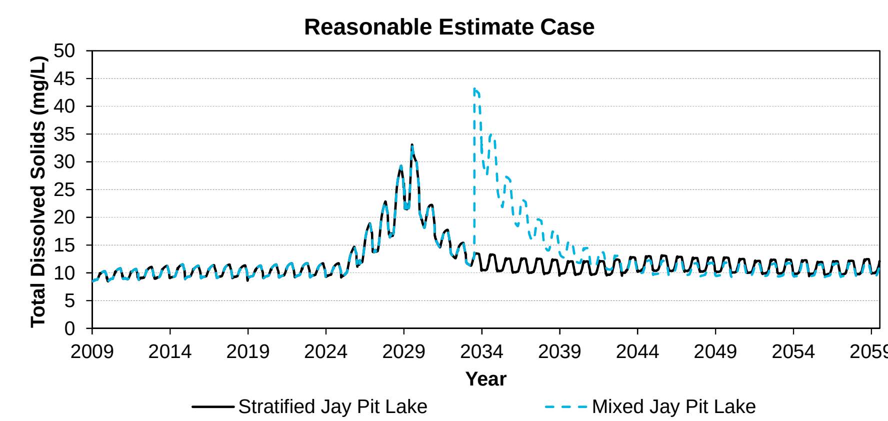

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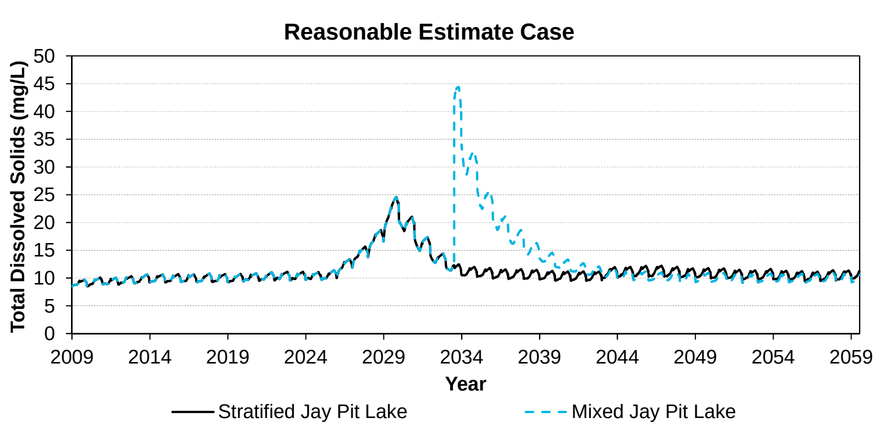

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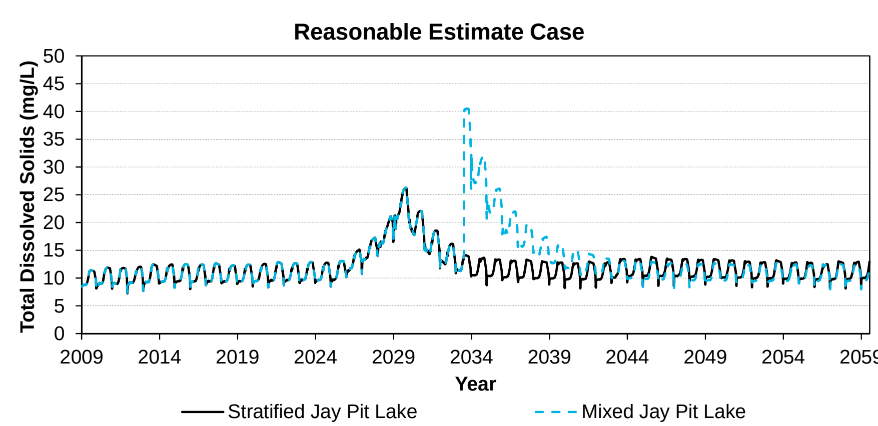

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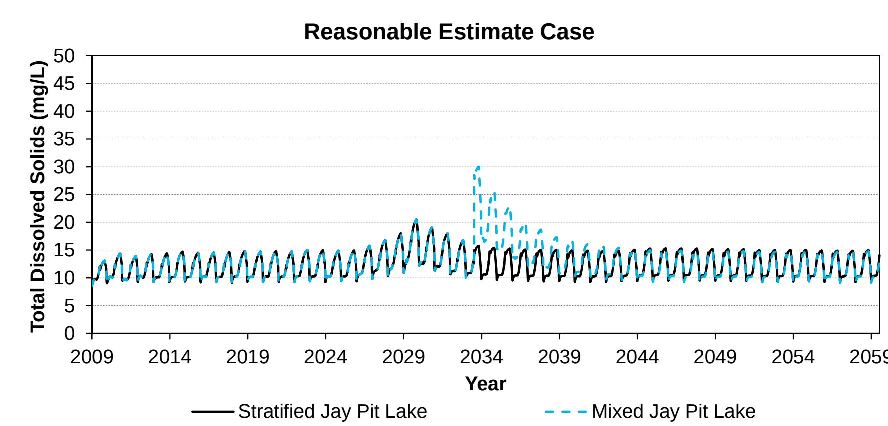

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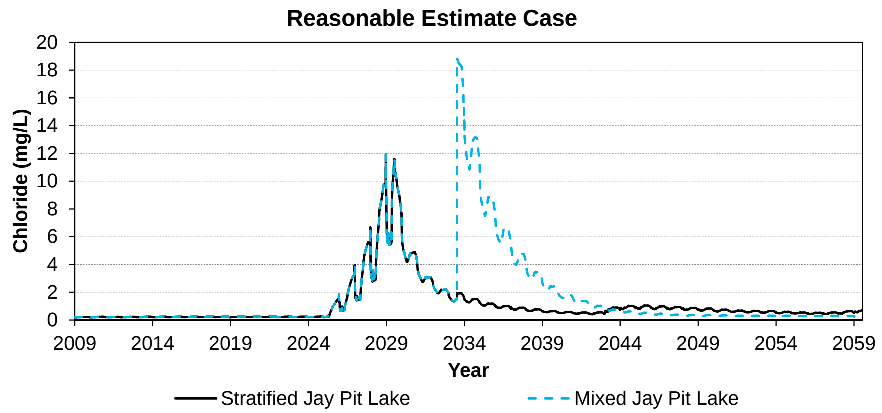
Figure 24-2 Predicted Depth-Averaged Chloride Concentrations in Lac du Sauvage-Scenario A



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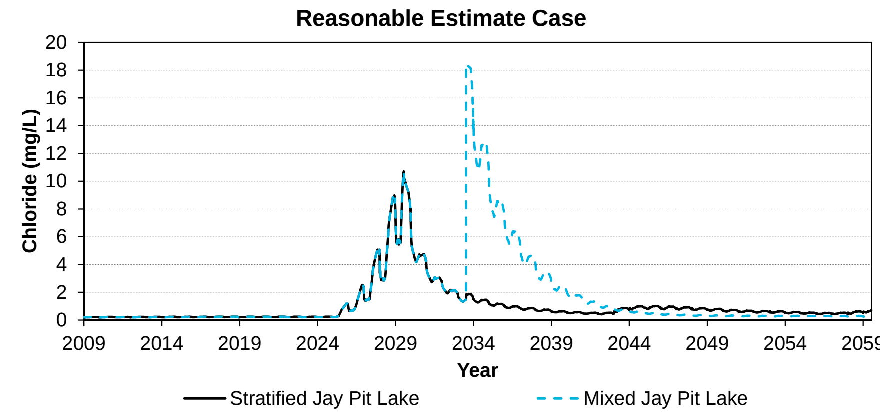

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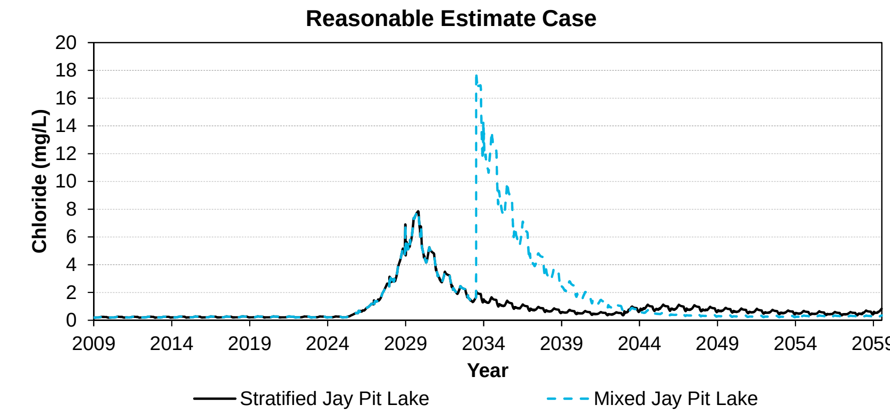

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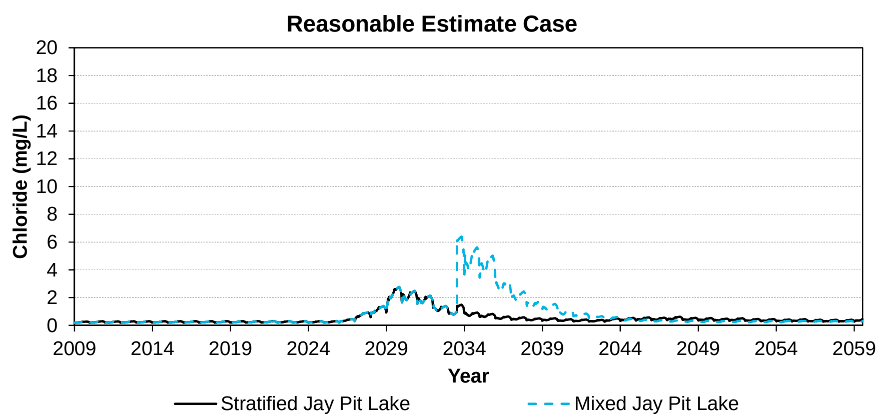

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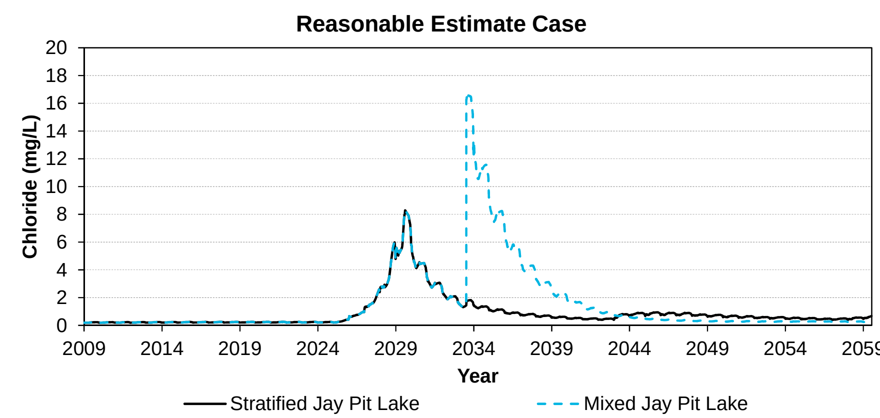

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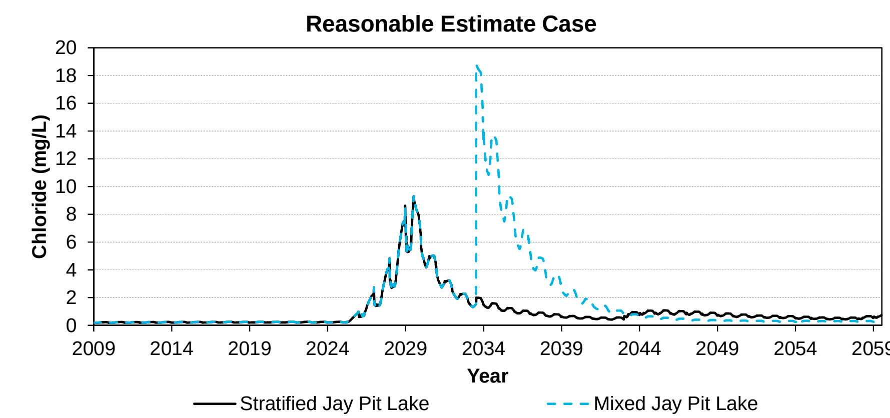

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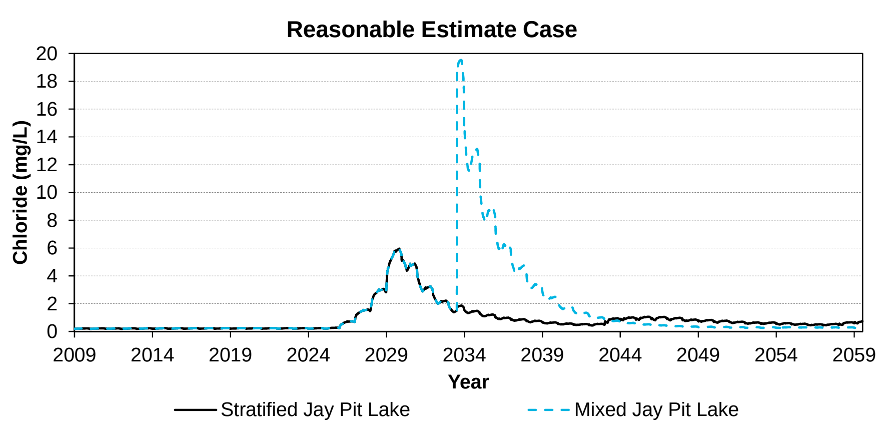

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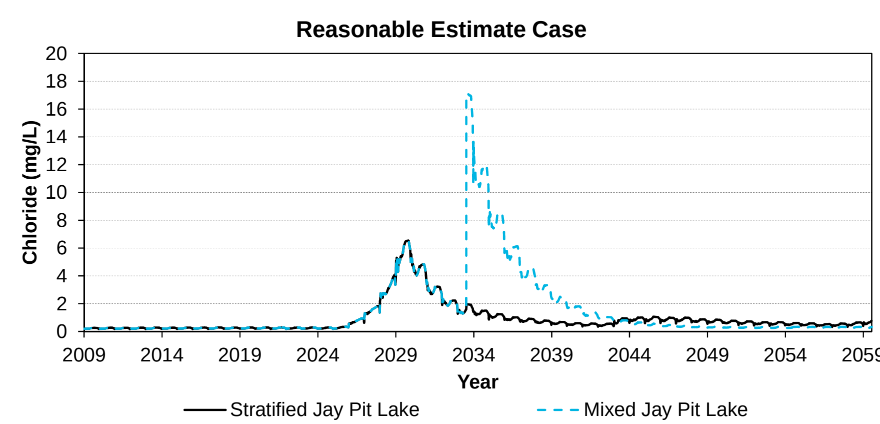

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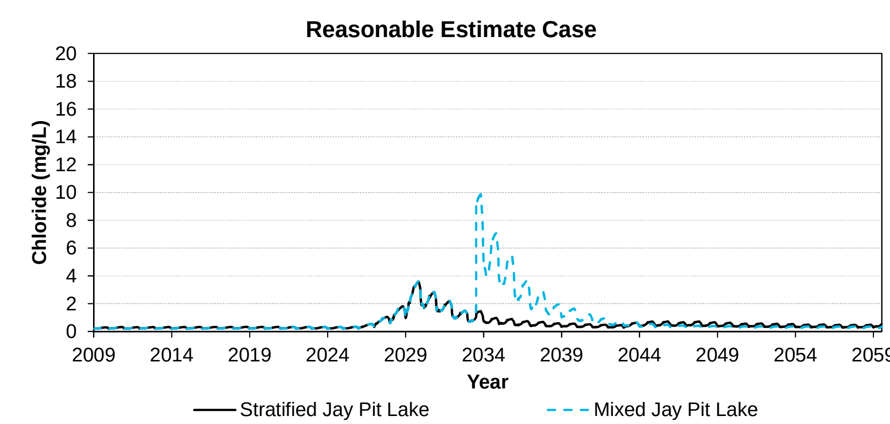

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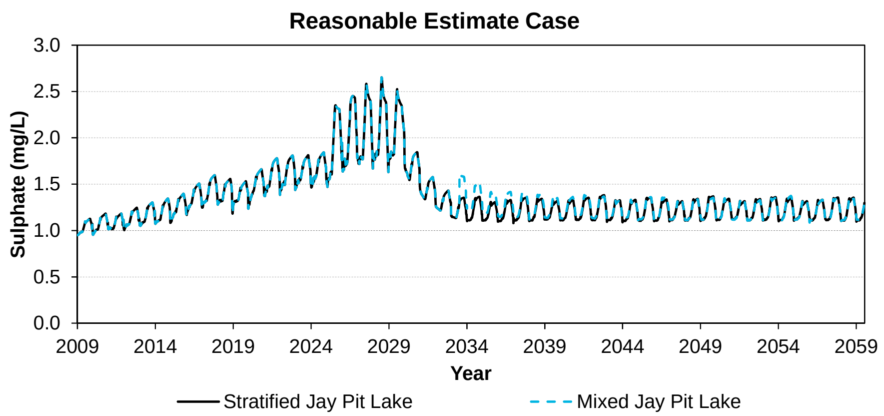
Figure 24-3 Predicted Depth-Averaged Sulphate Concentrations in Lac du Sauvage-Scenario A



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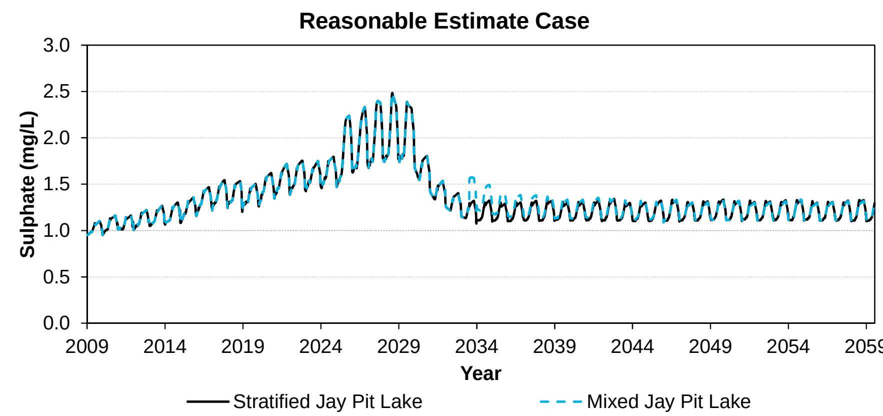

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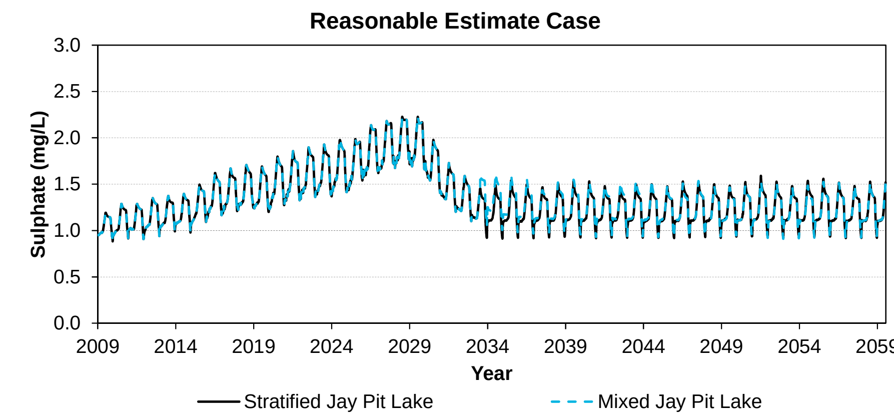

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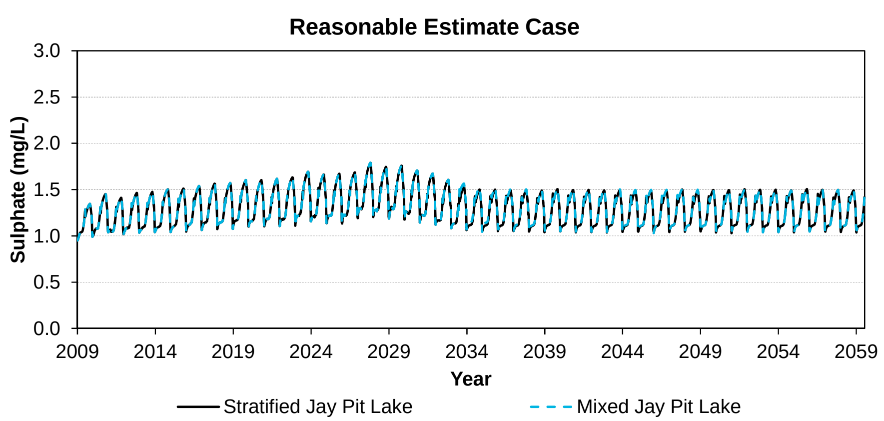

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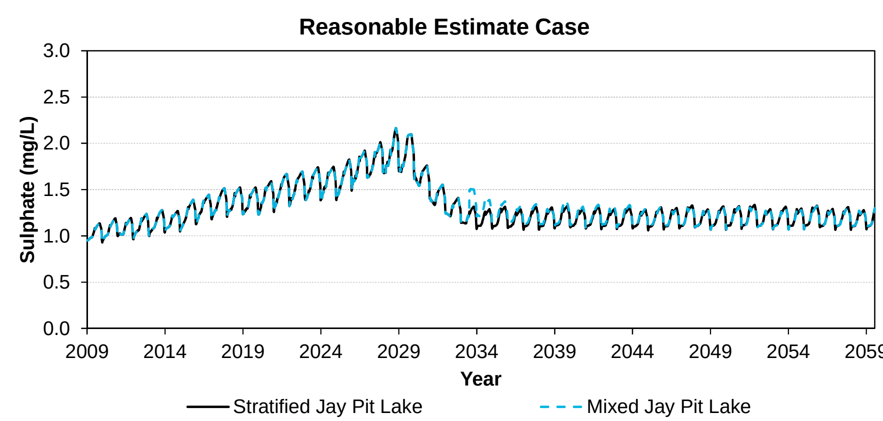

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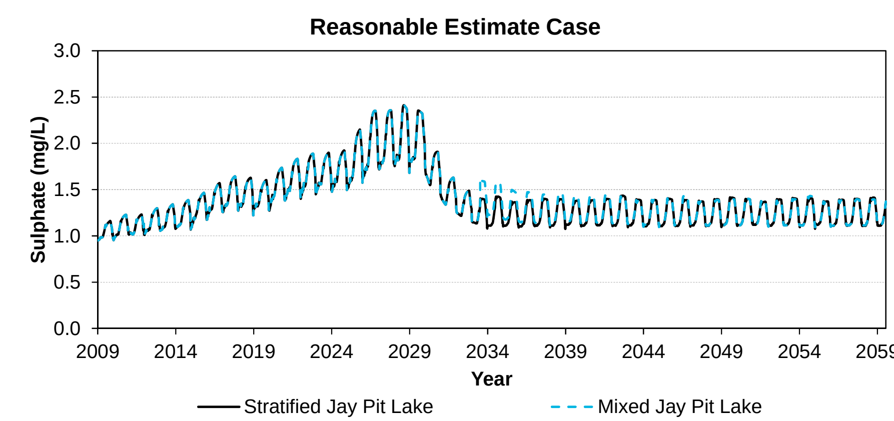

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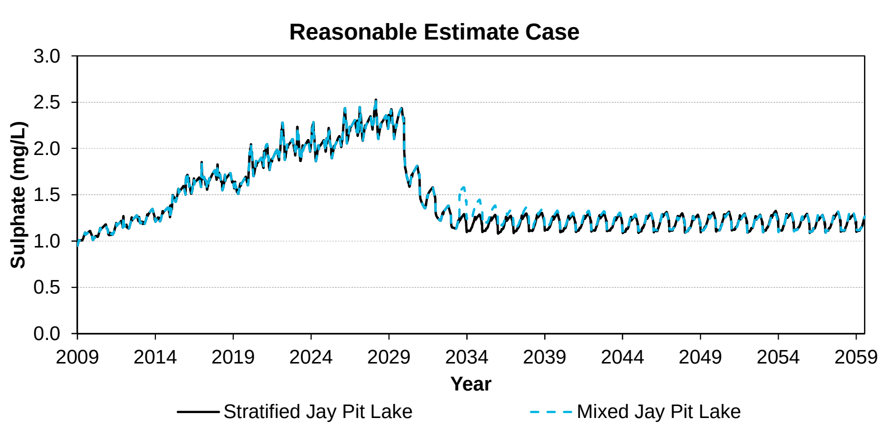

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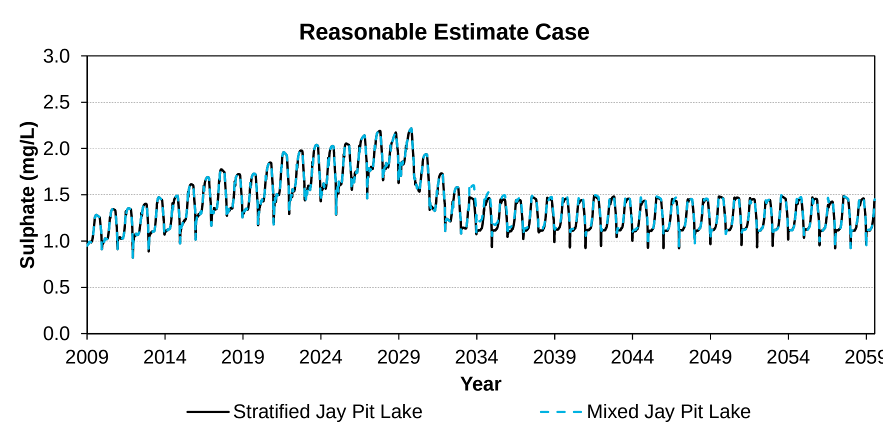

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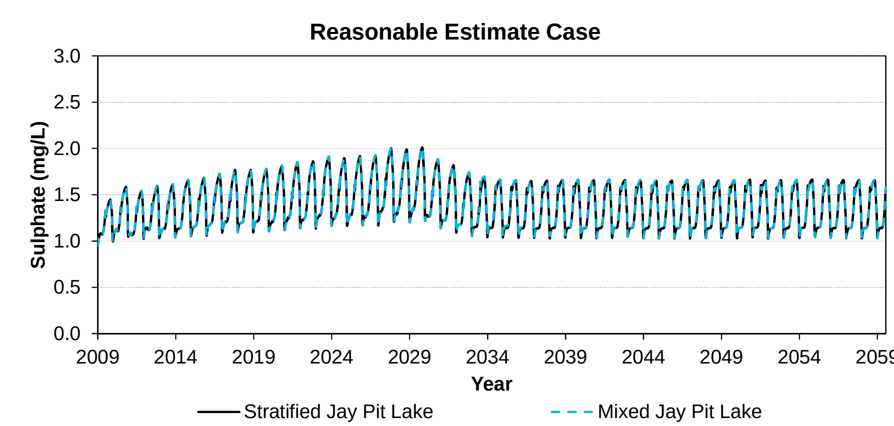

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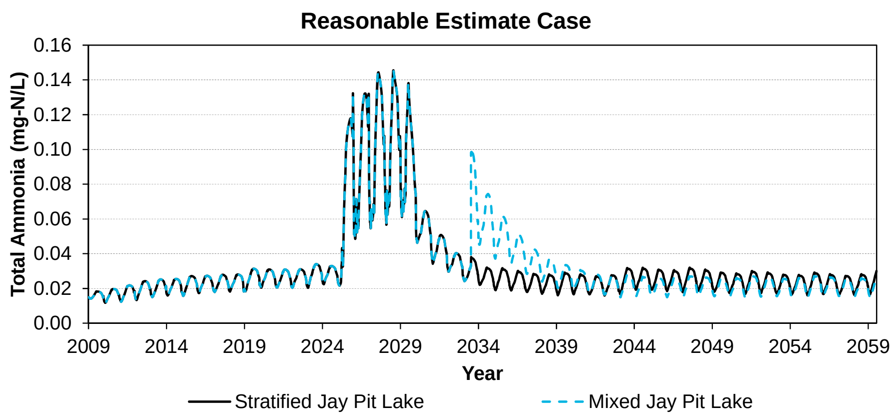
Figure 24-4 Predicted Depth-Averaged Total Ammonia Concentrations in Lac du Sauvage-Scenario A



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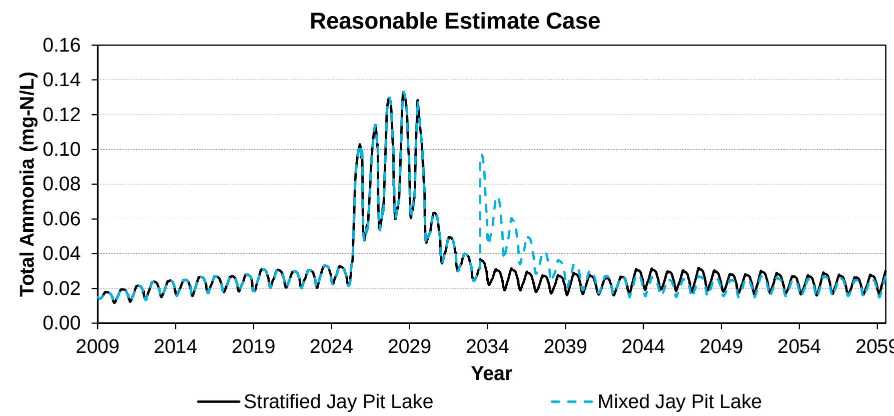

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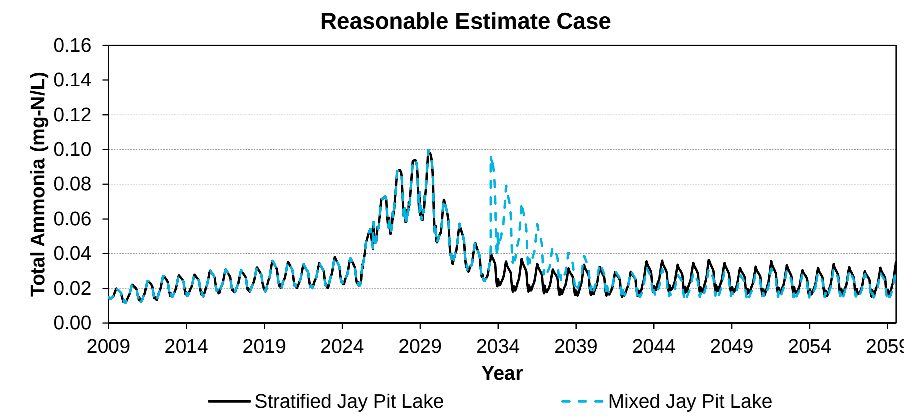

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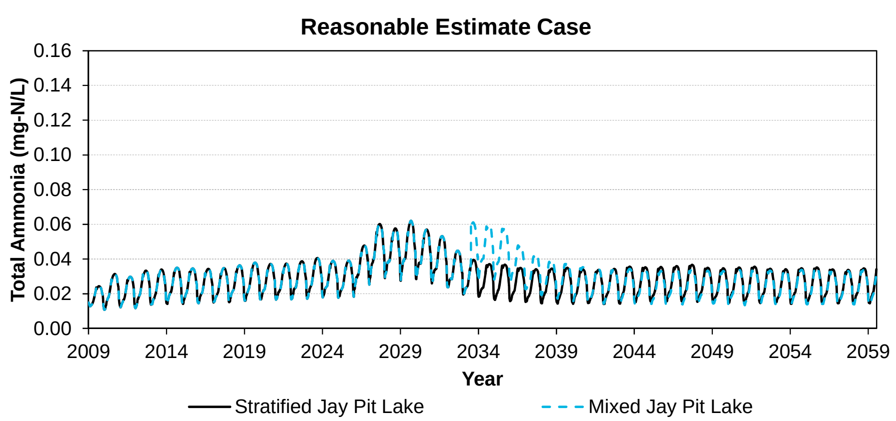

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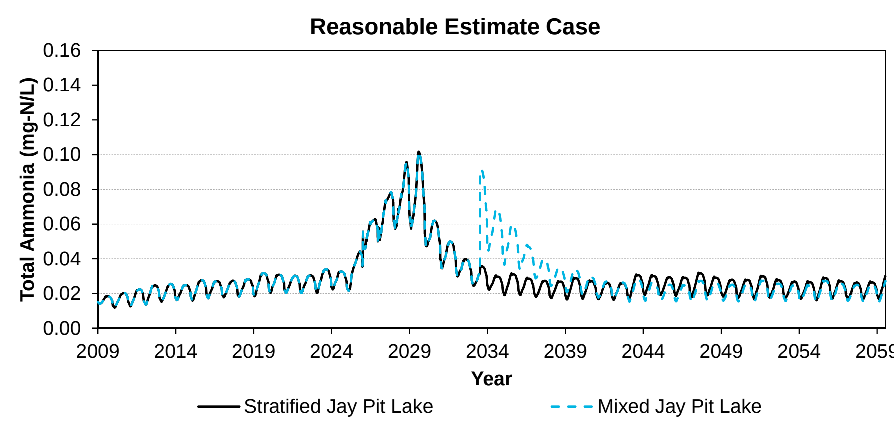

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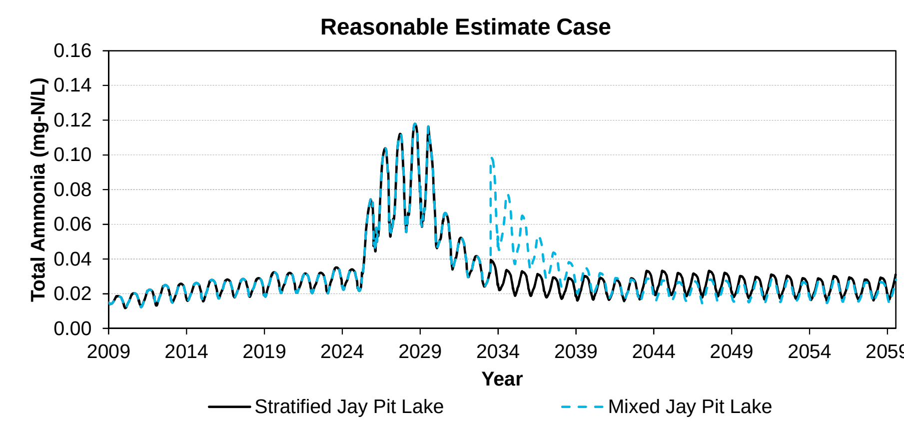

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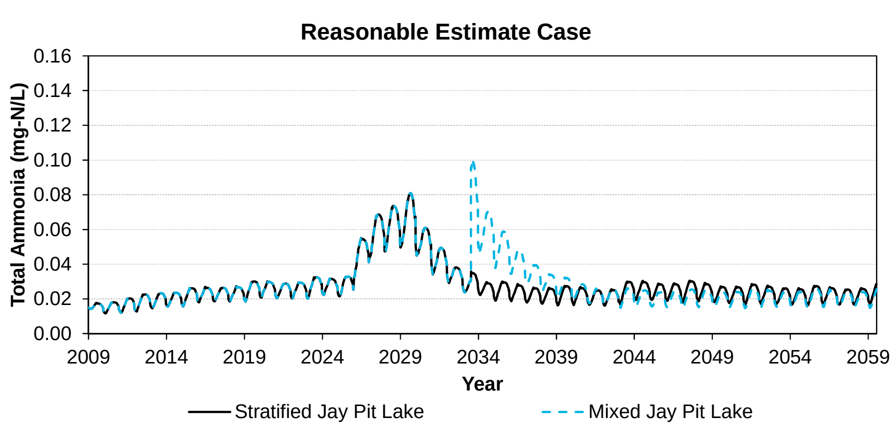

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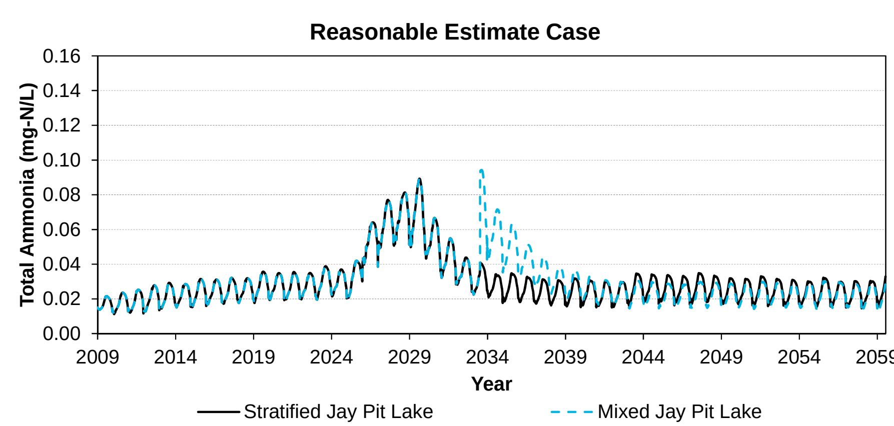

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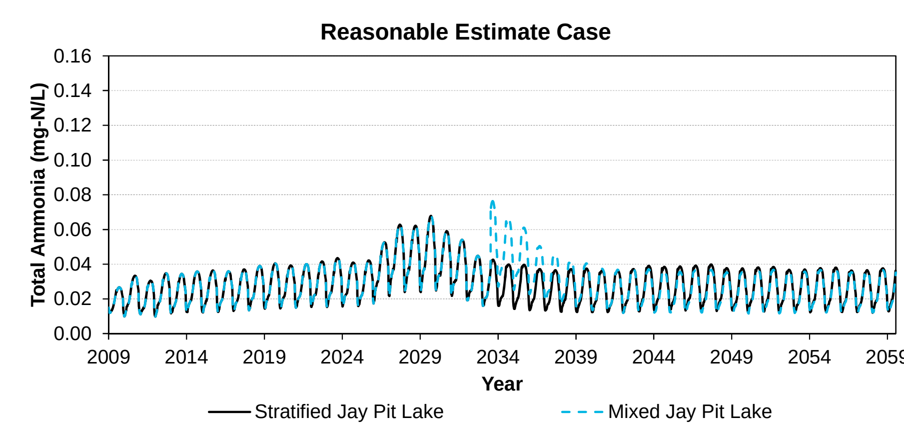

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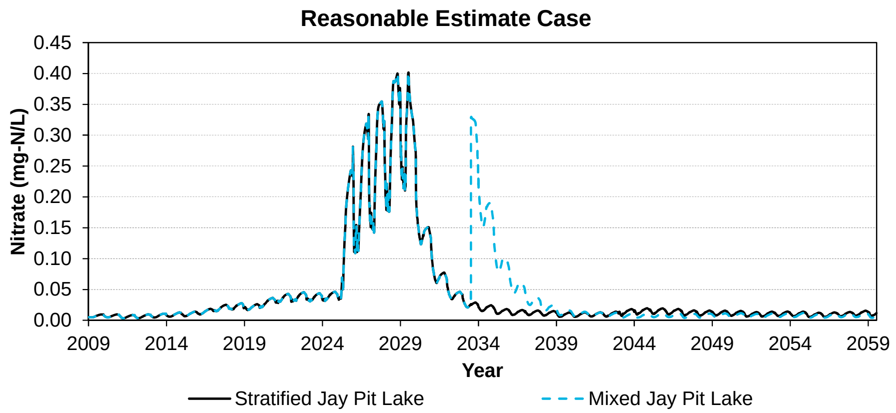
Figure 24-5 Predicted Depth-Averaged Nitrate Concentrations in Lac du Sauvage-Scenario A



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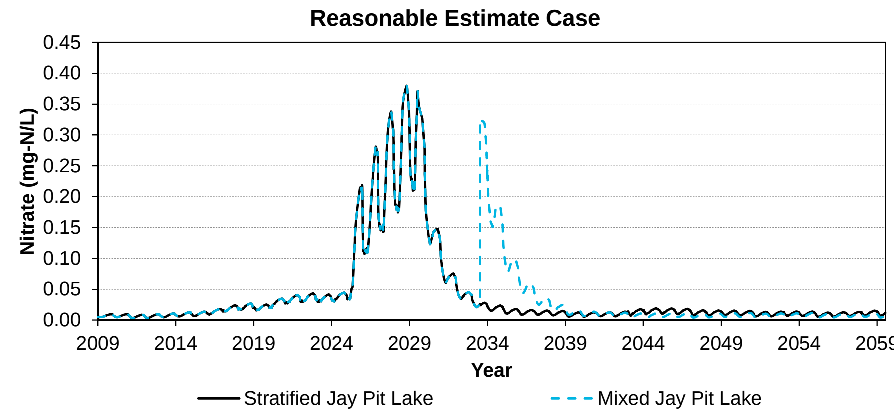

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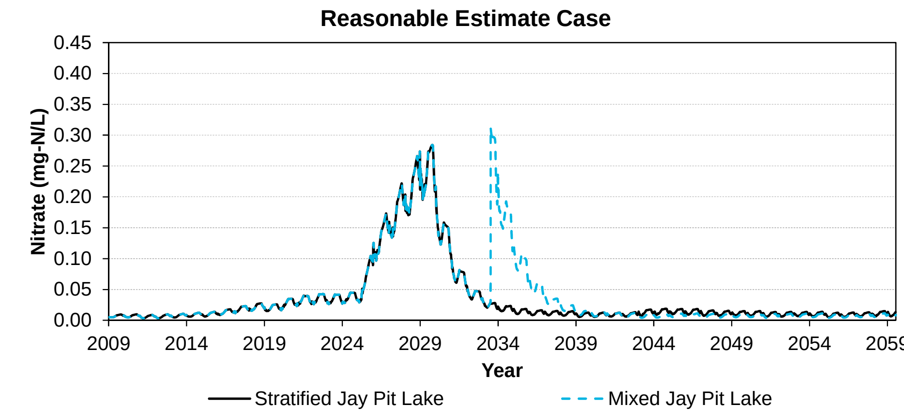

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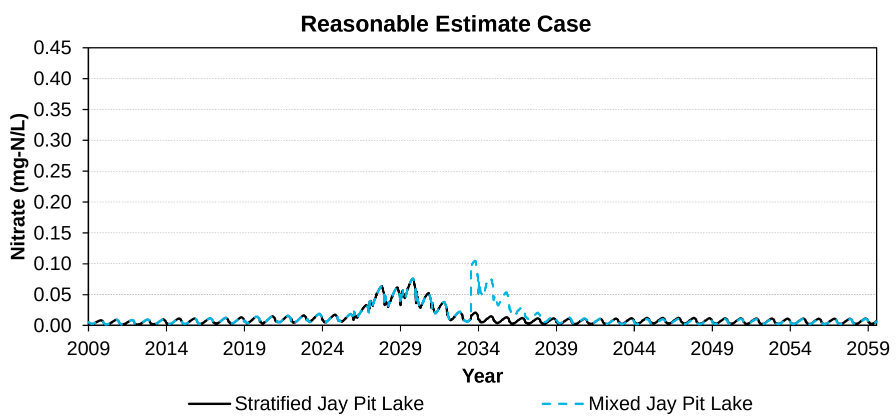

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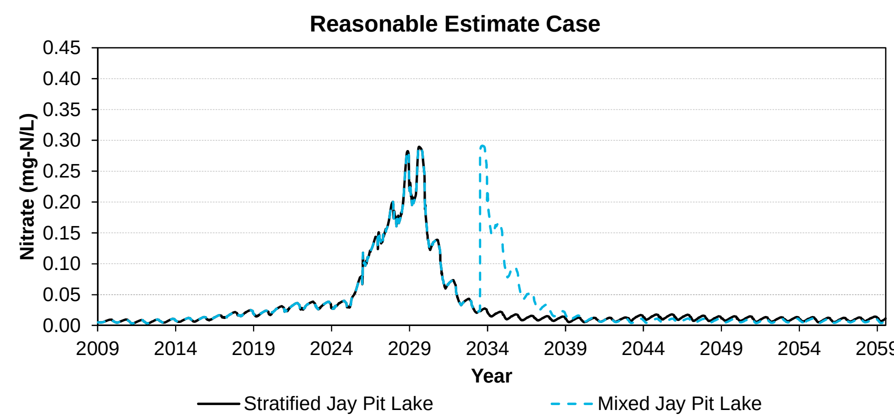

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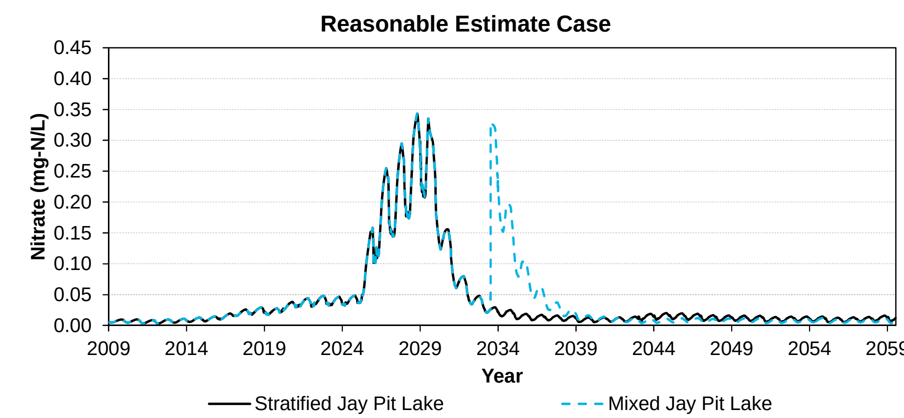

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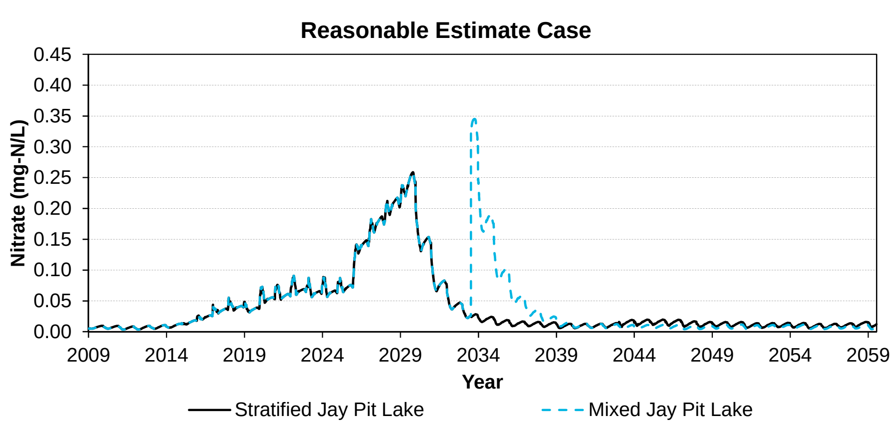

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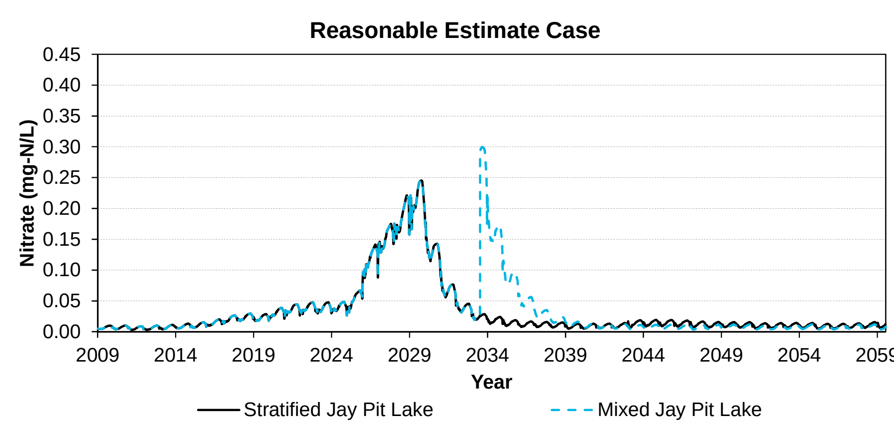

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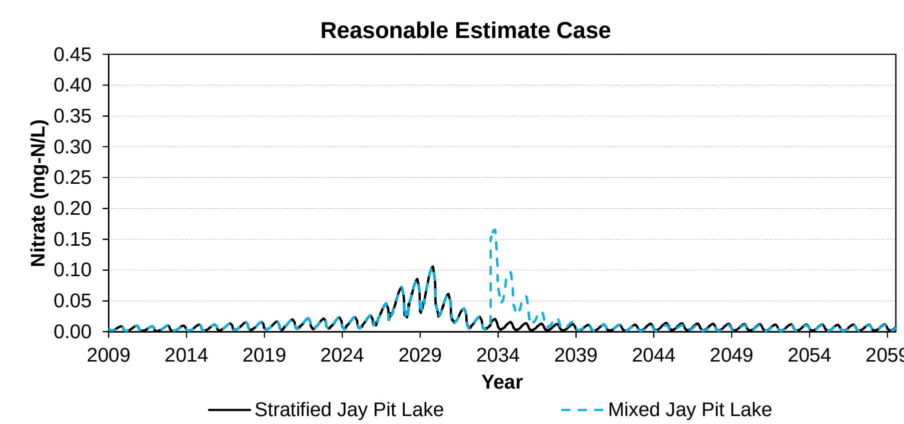

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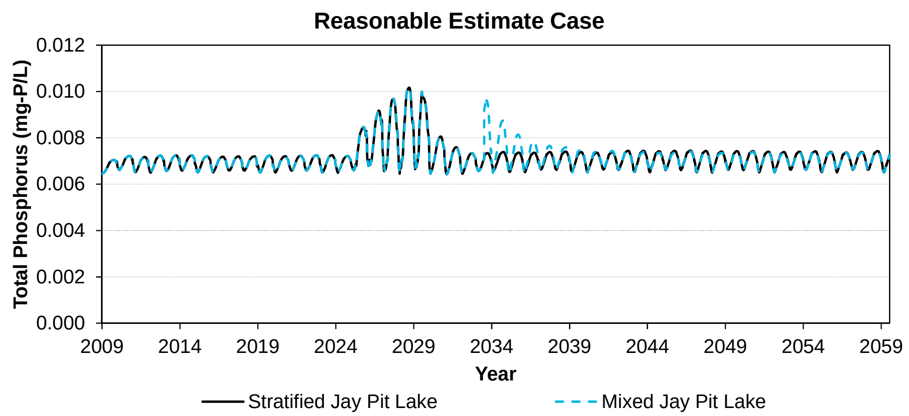
Figure 24-6 Predicted Depth-Averaged Total Phosphorus Concentrations in Lac du Sauvage-Scenario A



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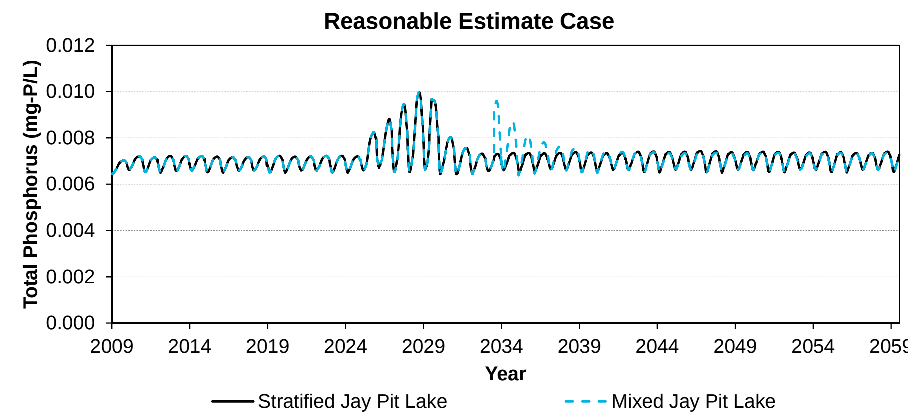

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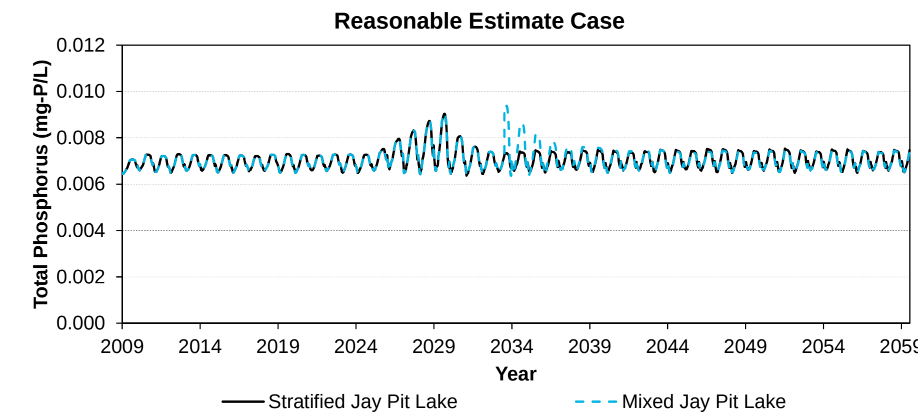

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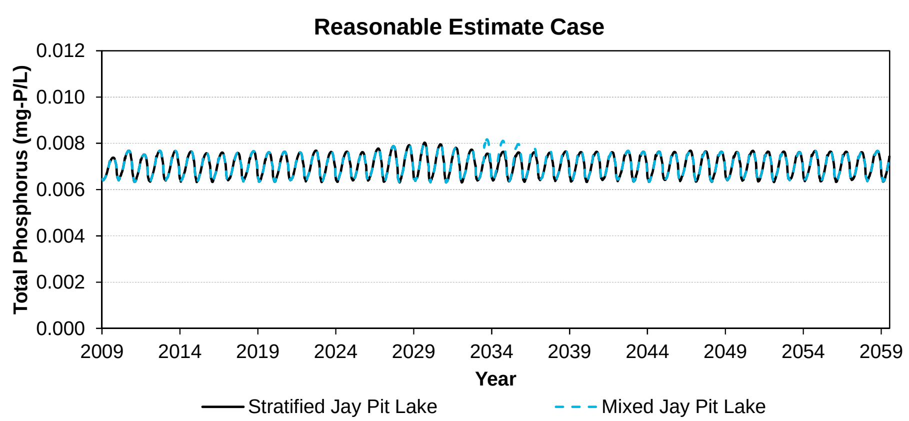

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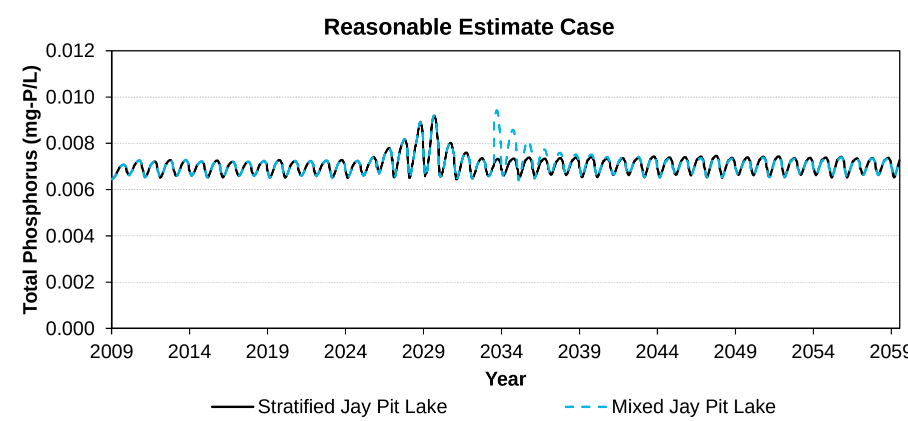

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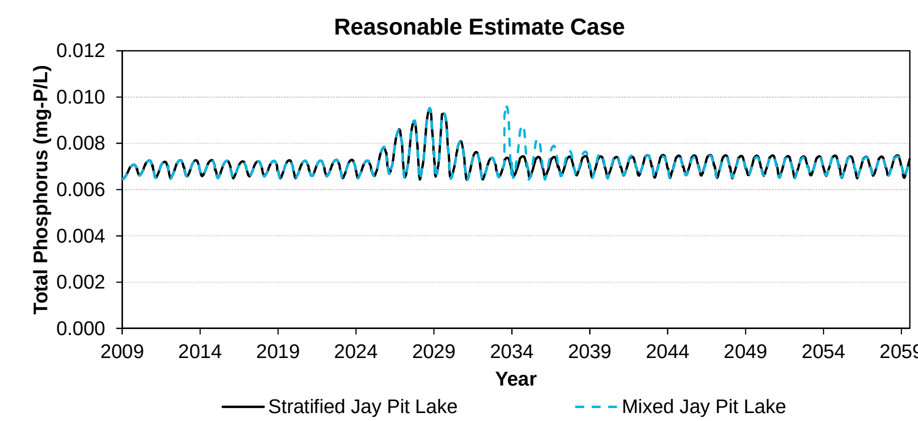

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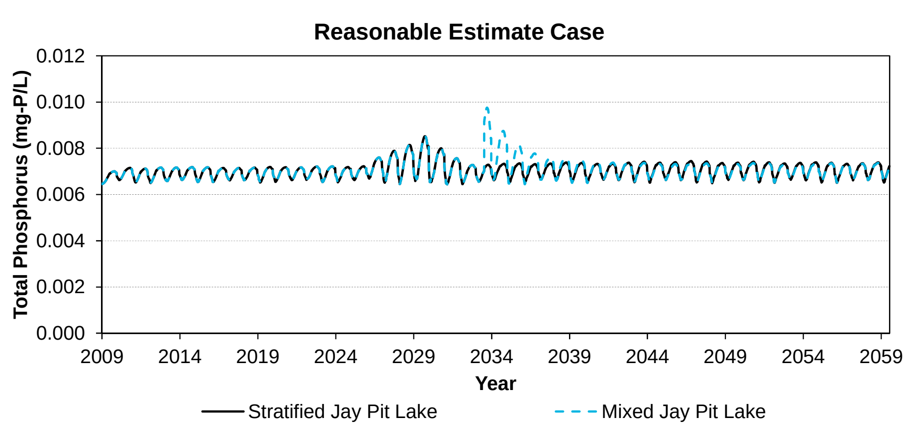

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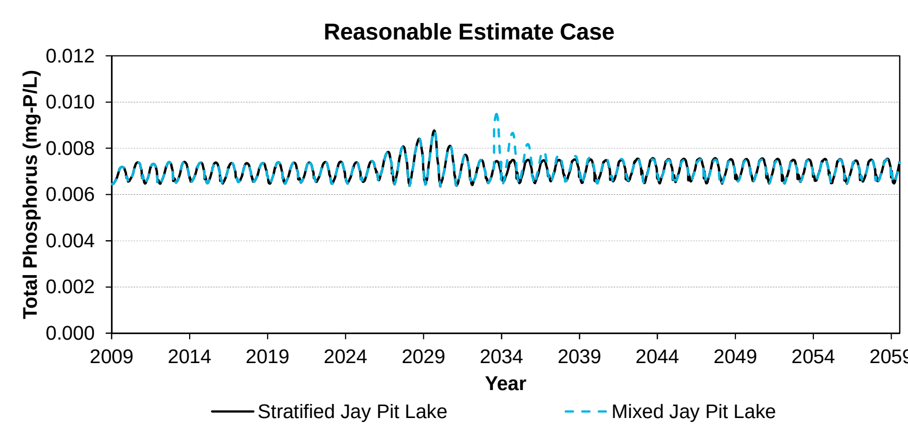

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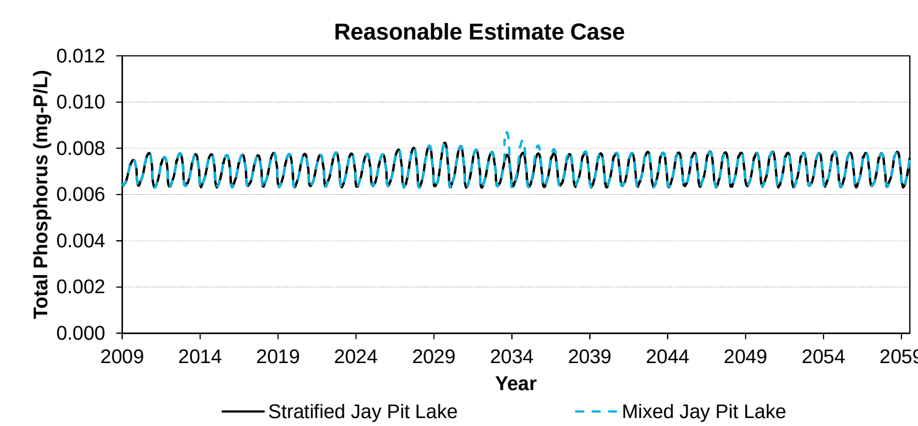

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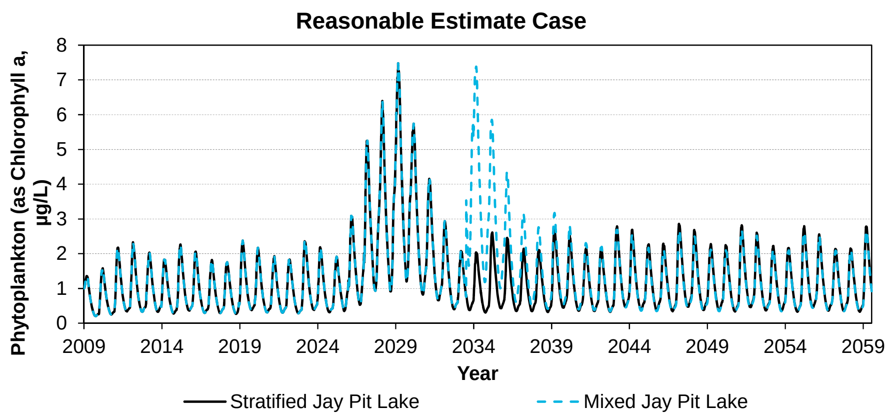
Figure 24-7 Predicted Depth-Averaged Phytoplankton Concentrations in Lac du Sauvage-Scenario A



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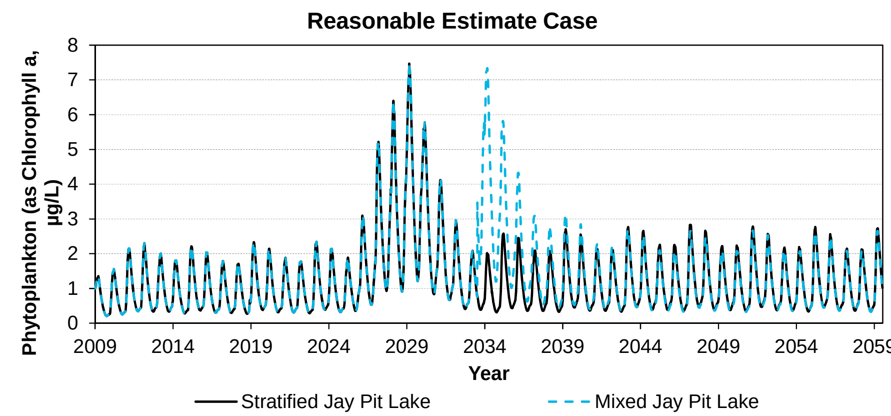
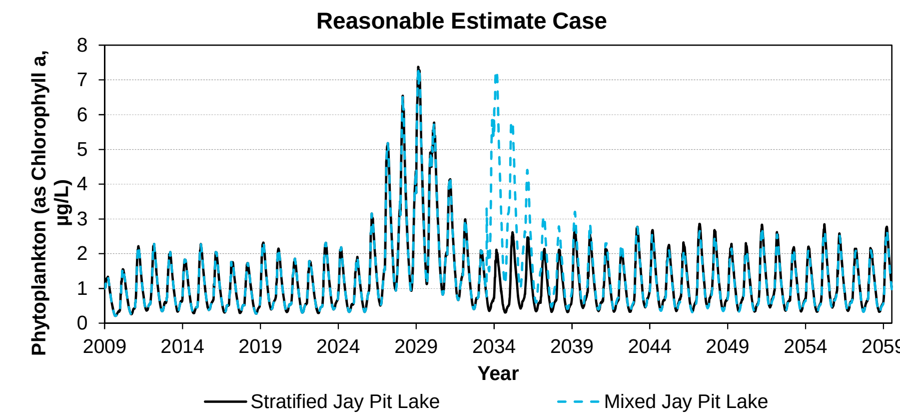
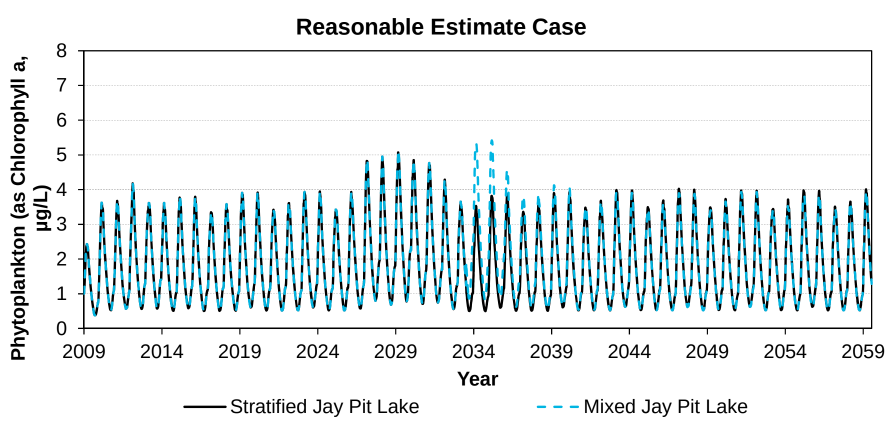


LDS-P2



LDS-P3



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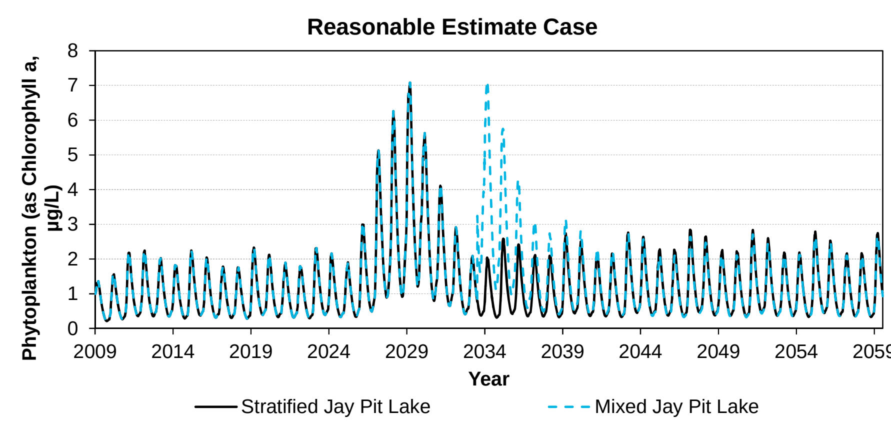

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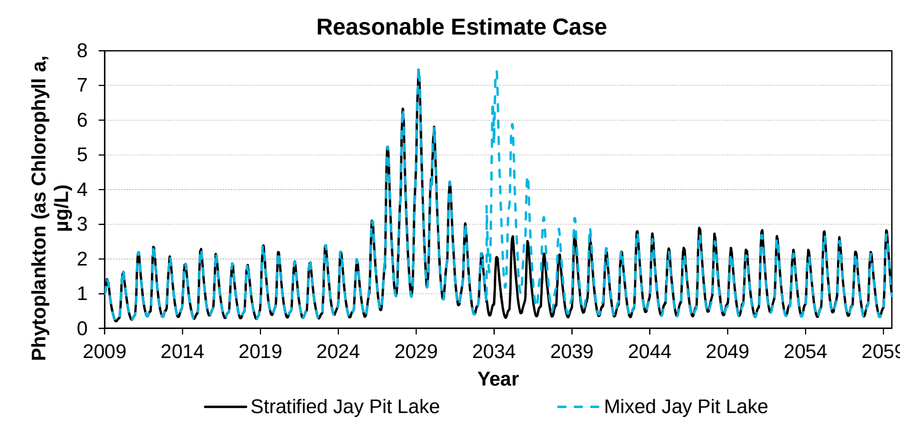

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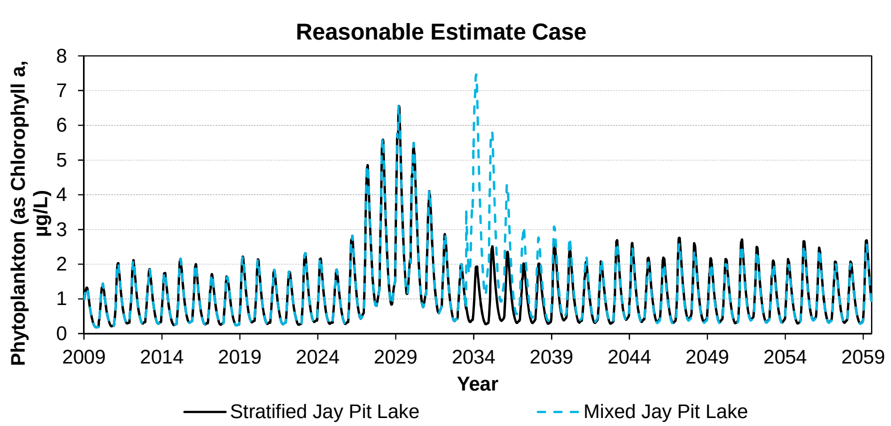

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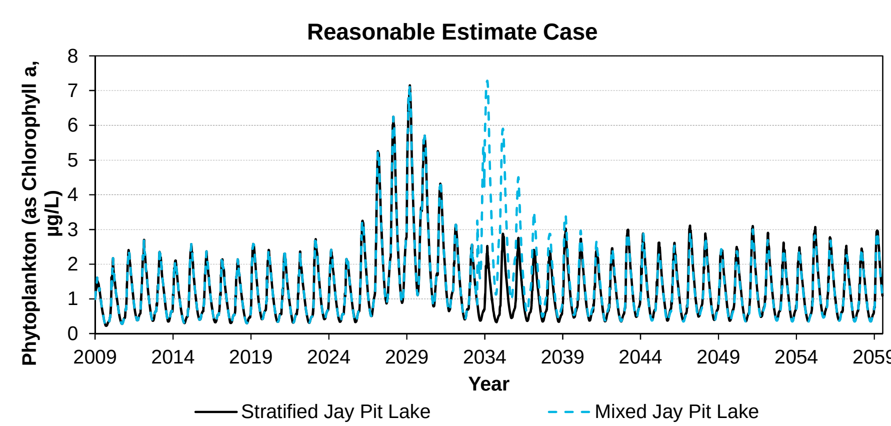

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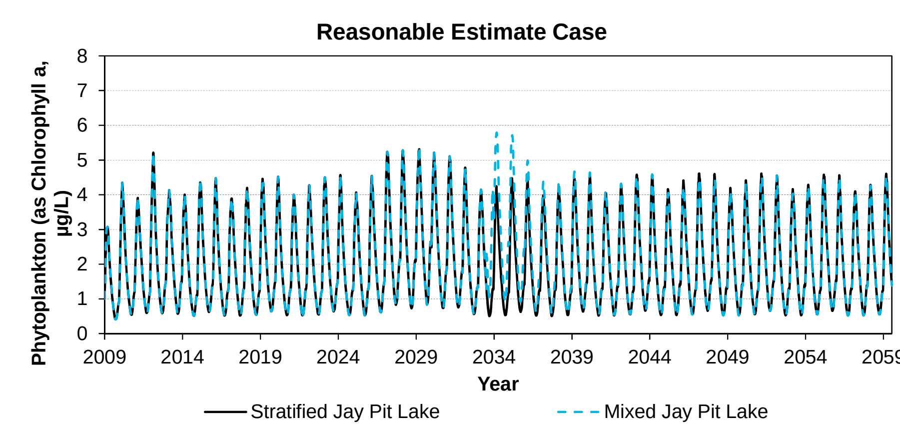

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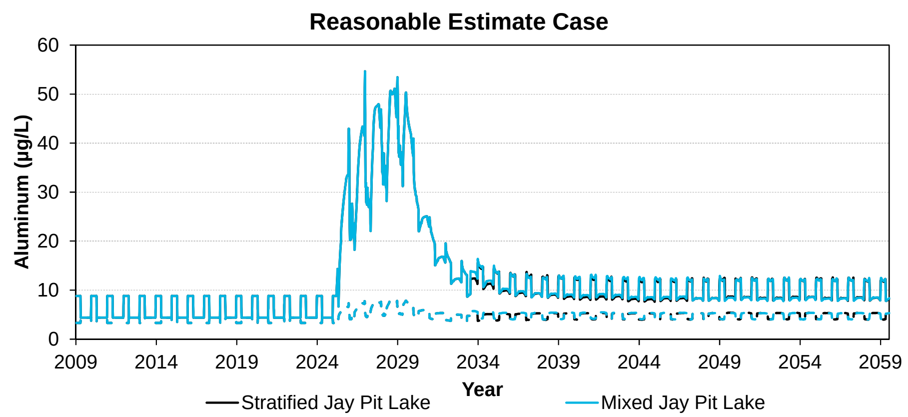
Figure 24-8 Predicted Depth-Averaged Total and Dissolved Aluminum Concentrations in Lac du Sauvage-Scenario A



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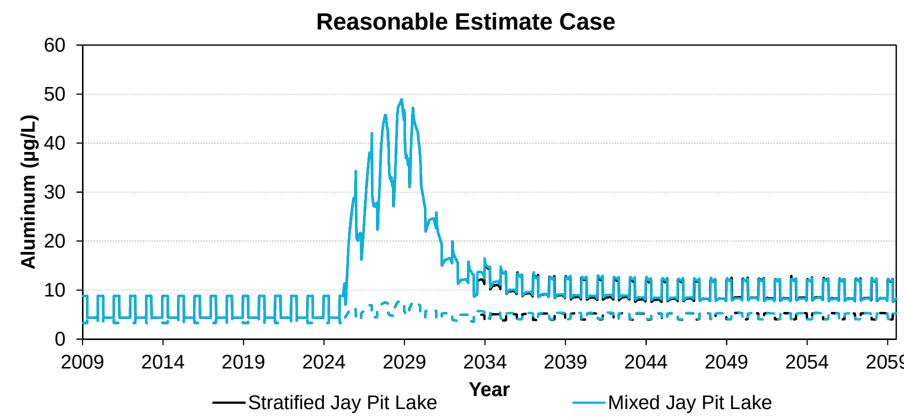
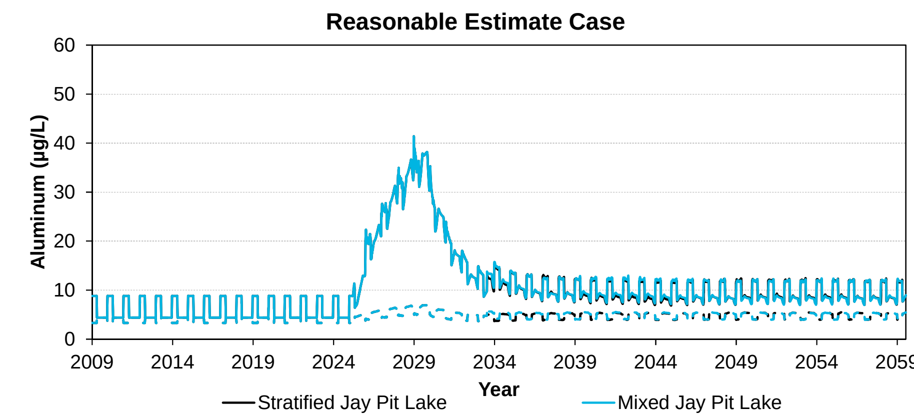
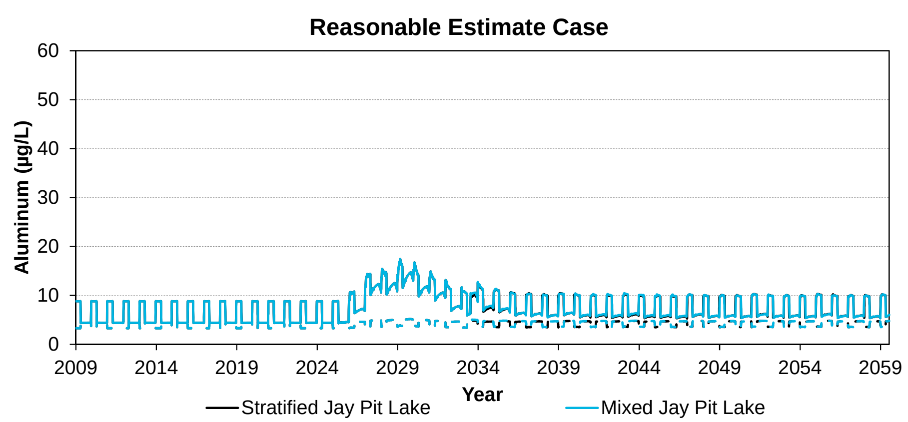


LDS-P2



LDS-P3



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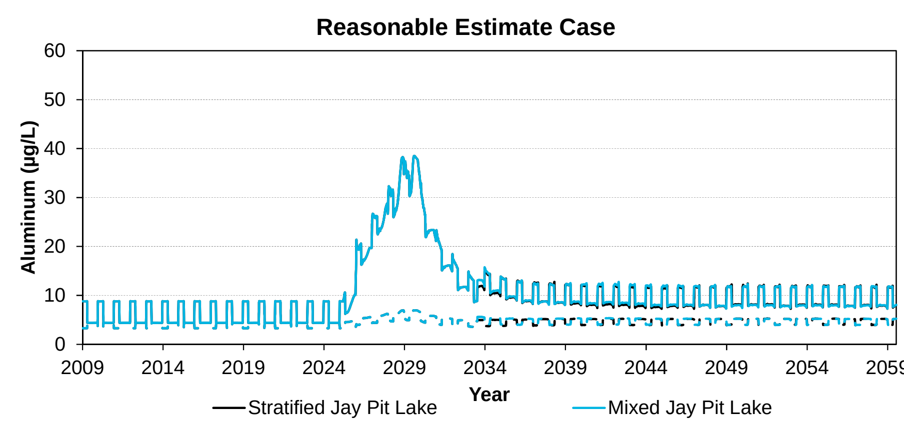

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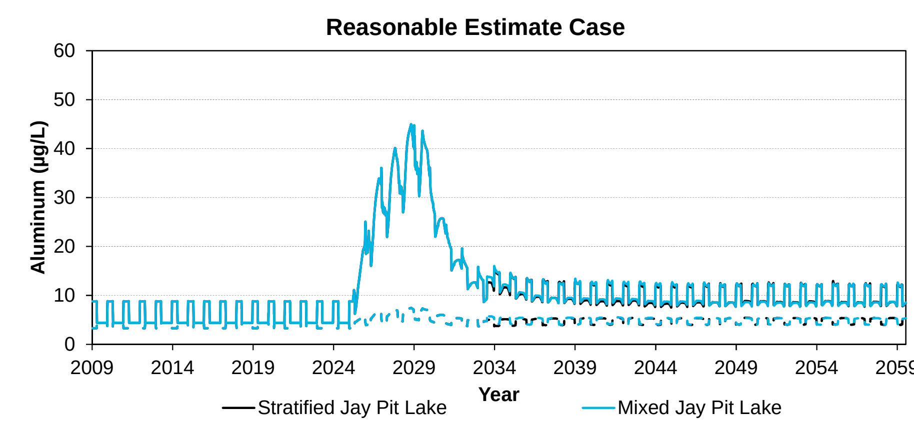

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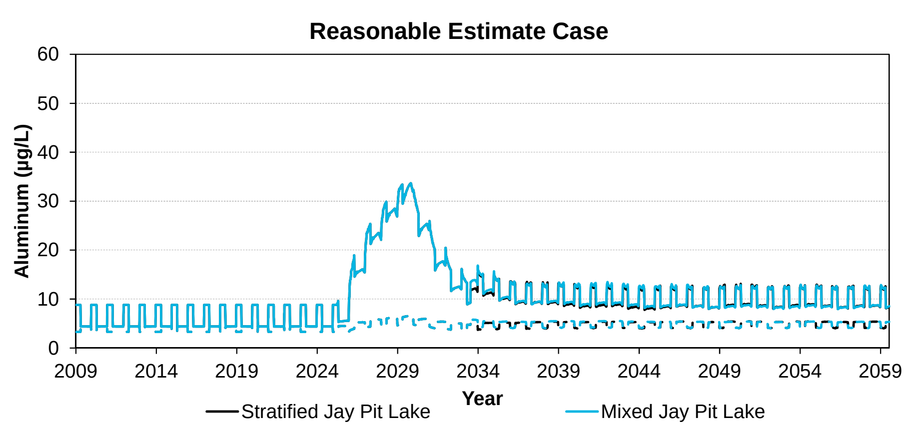

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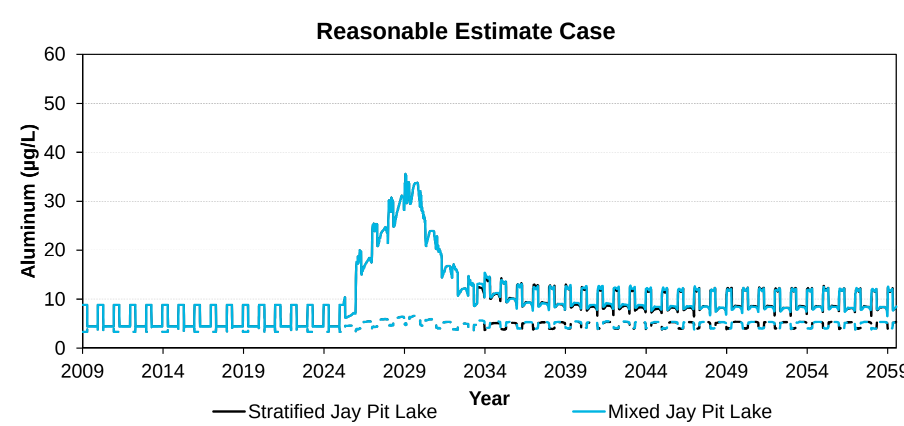

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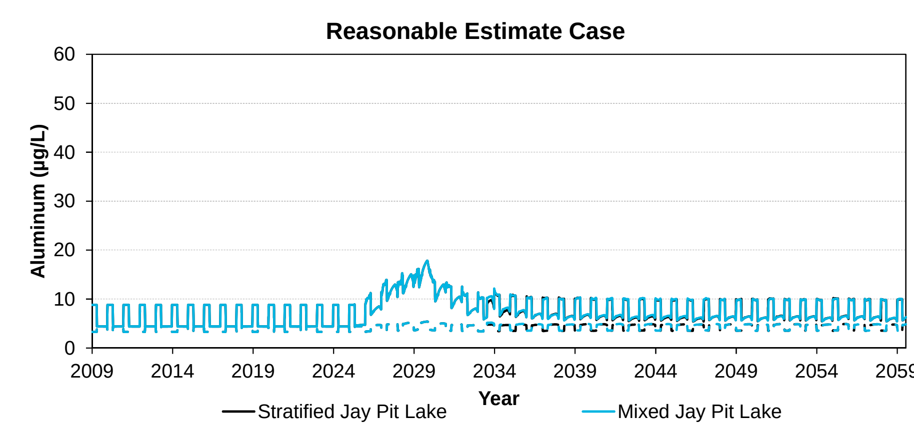

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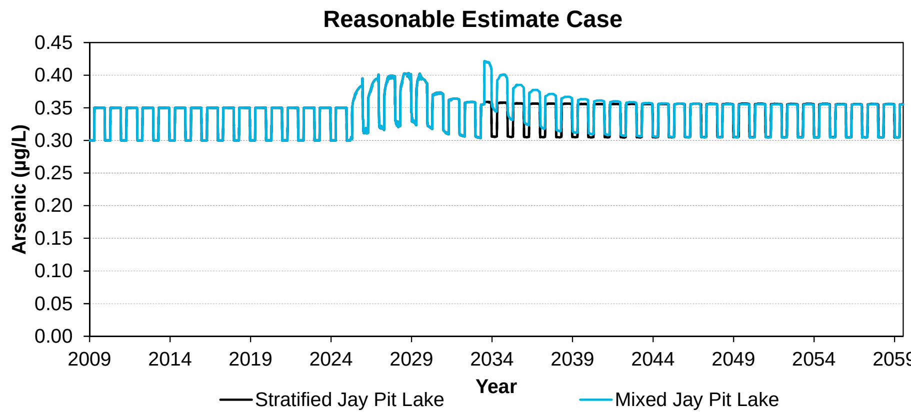
Figure 24-9 Predicted Depth-Averaged Total and Dissolved Arsenic Concentrations in Lac du Sauvage-Scenario A



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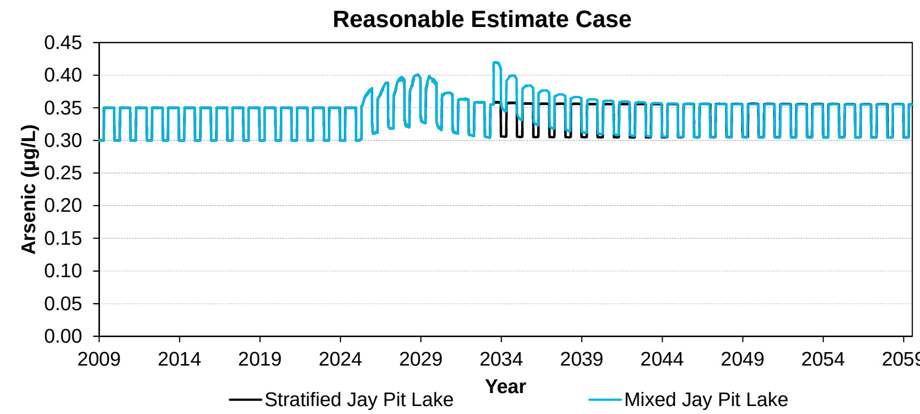
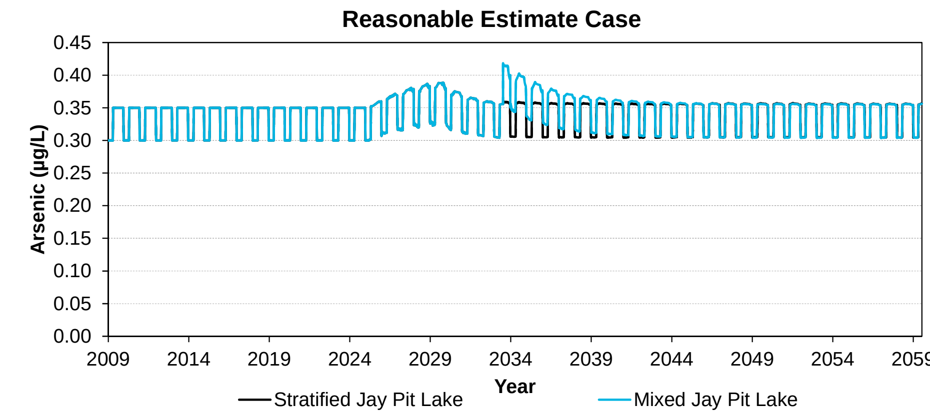
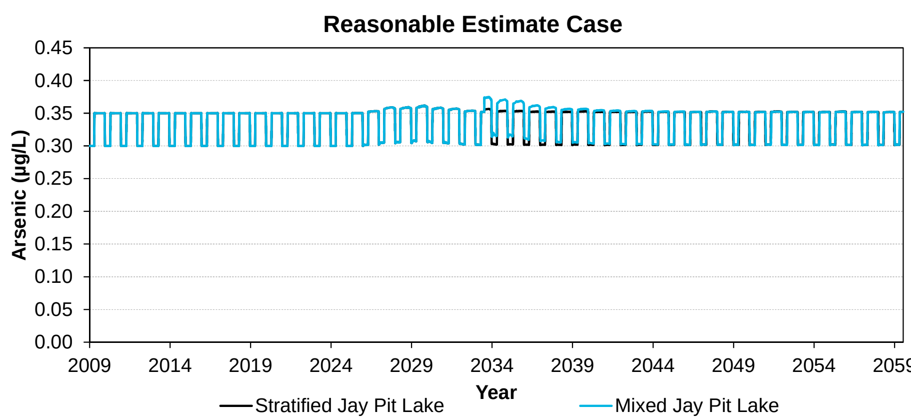


LDS-P2



LDS-P3



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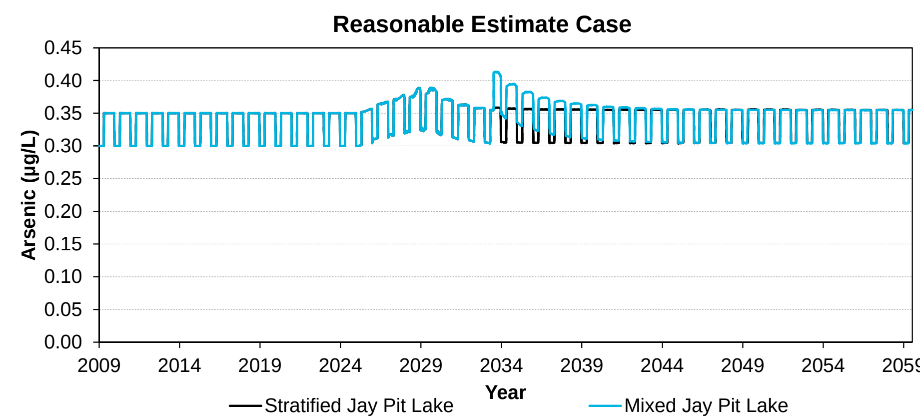

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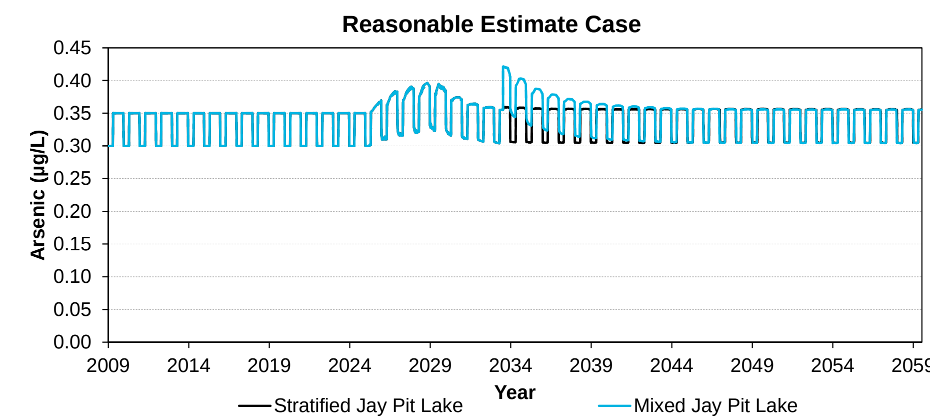

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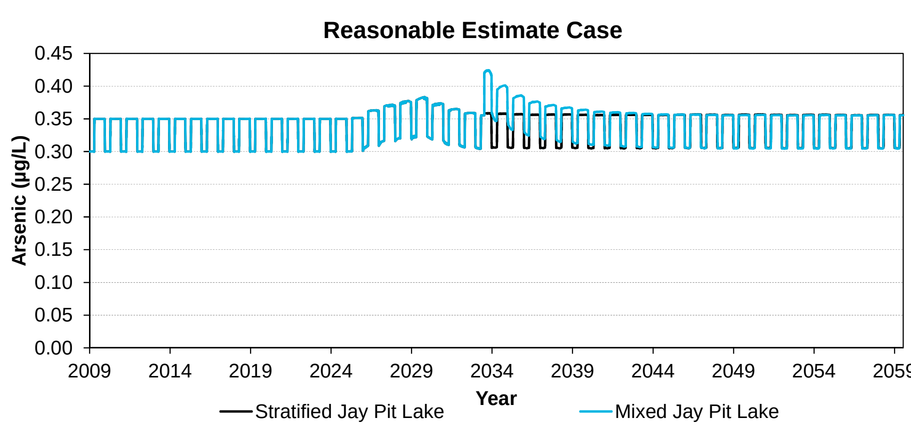

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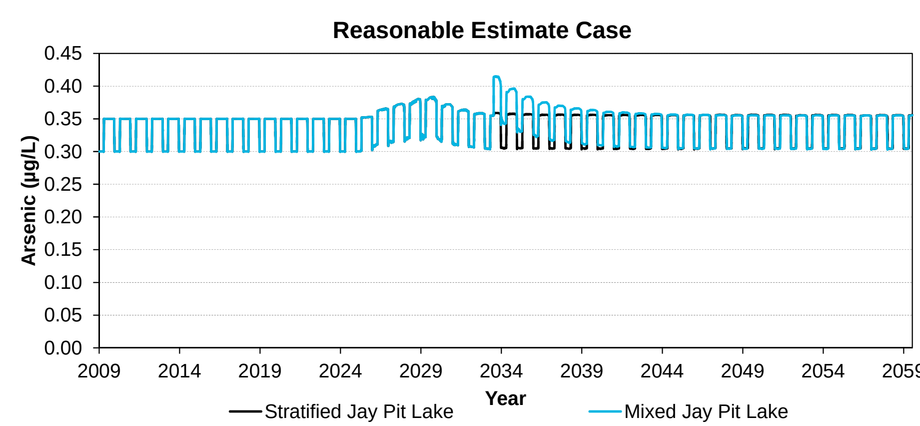

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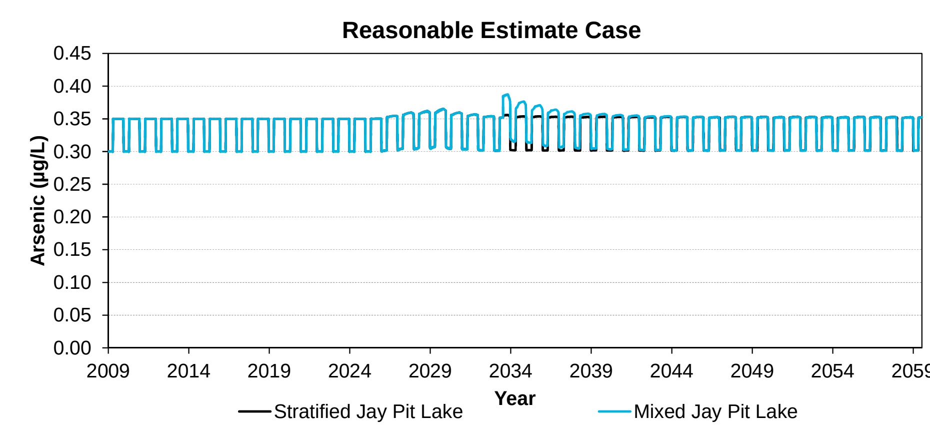
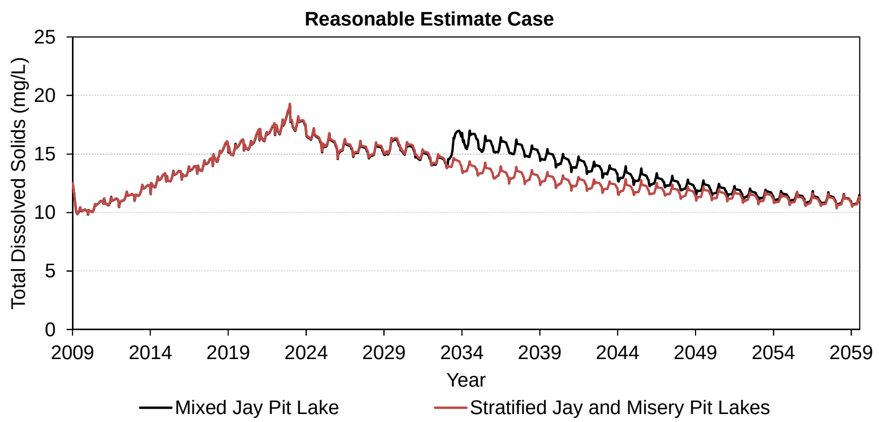
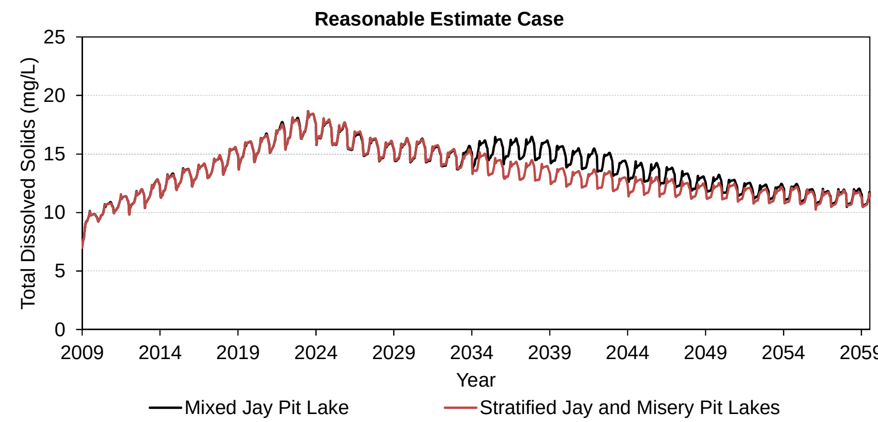


AF

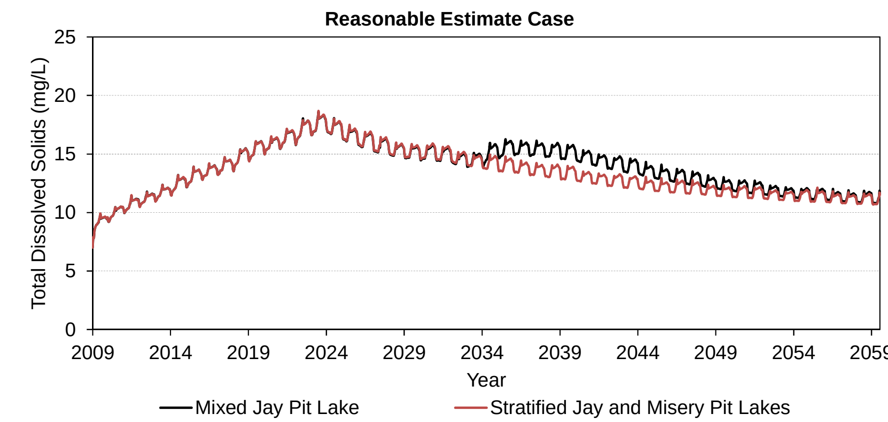
Figure 24-10: Predicted Depth-Averaged Total Dissolved Solids Concentrations in Lac de Gras – Scenario A



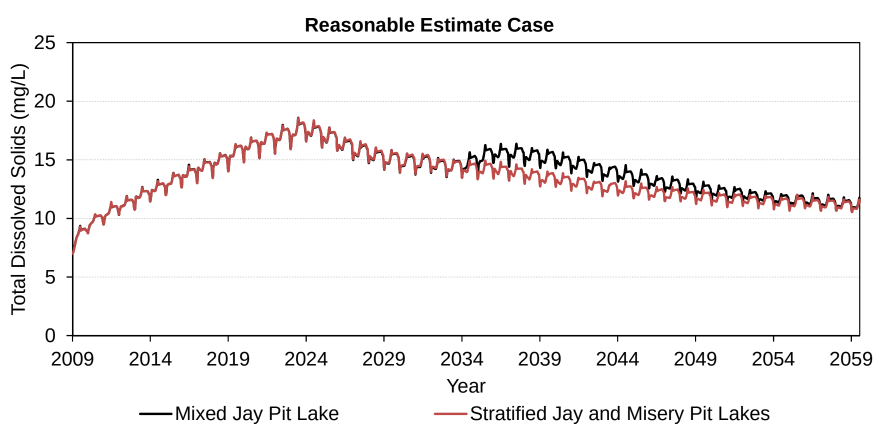
LDG-P1



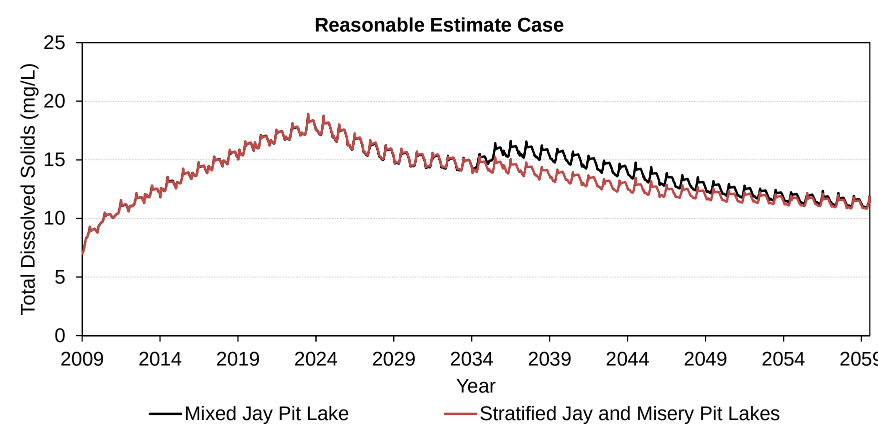
LDG-P2



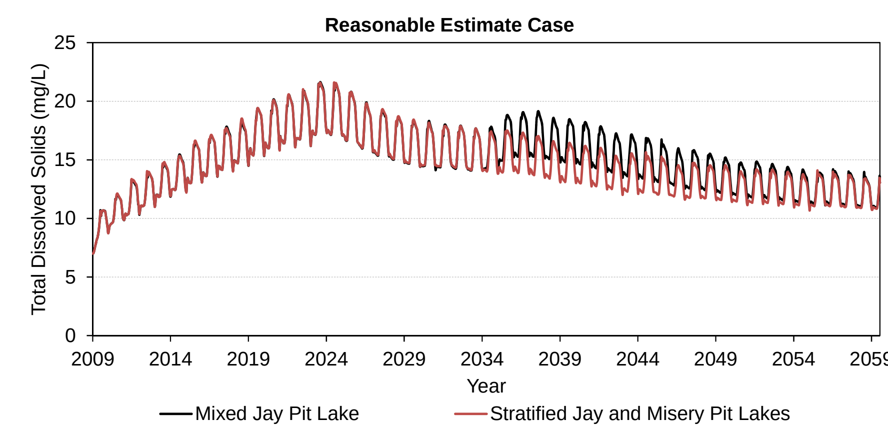
LDG-P3



LDG-P4

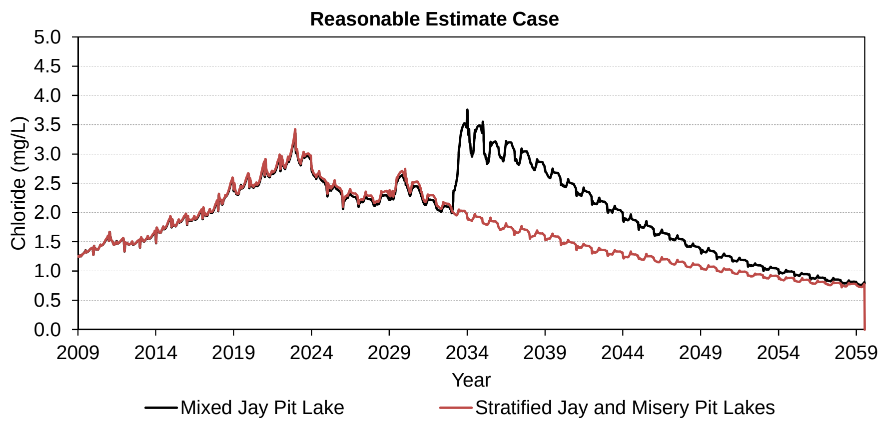


LDG-P5



LDG-P6

Figure 24-11: Predicted Depth-Averaged Chloride Concentrations in Lac de Gras– Scenario A



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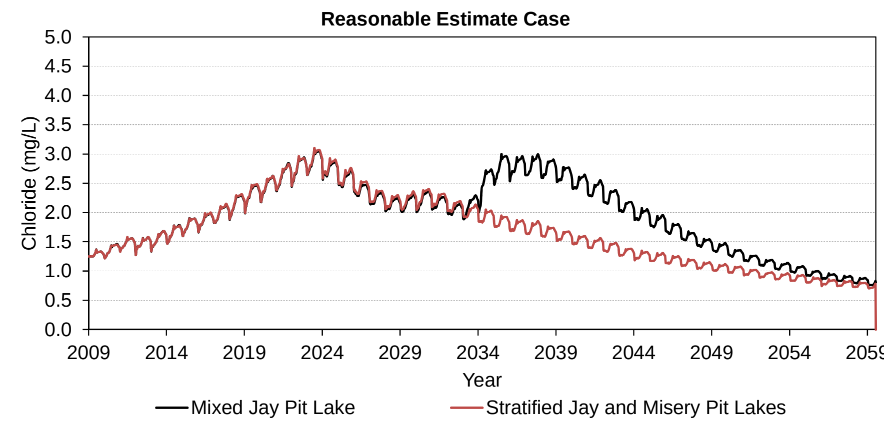

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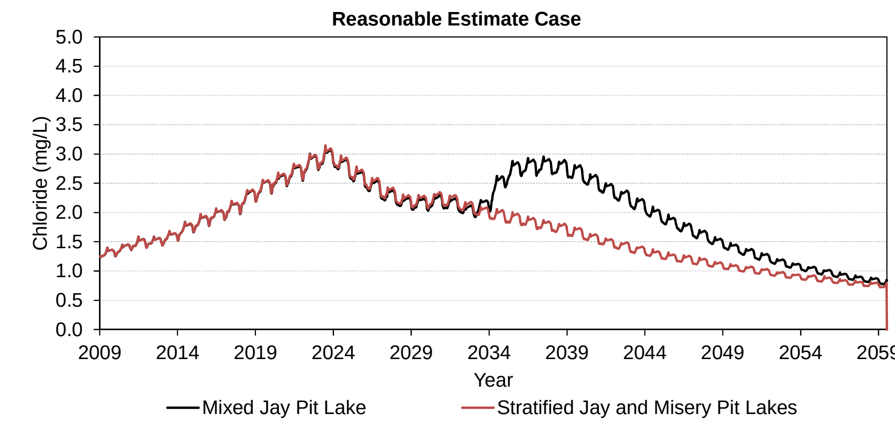
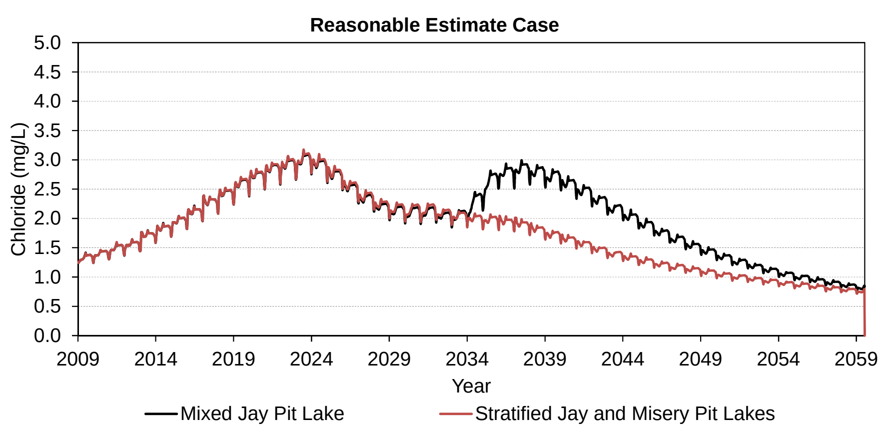


LDG-P3



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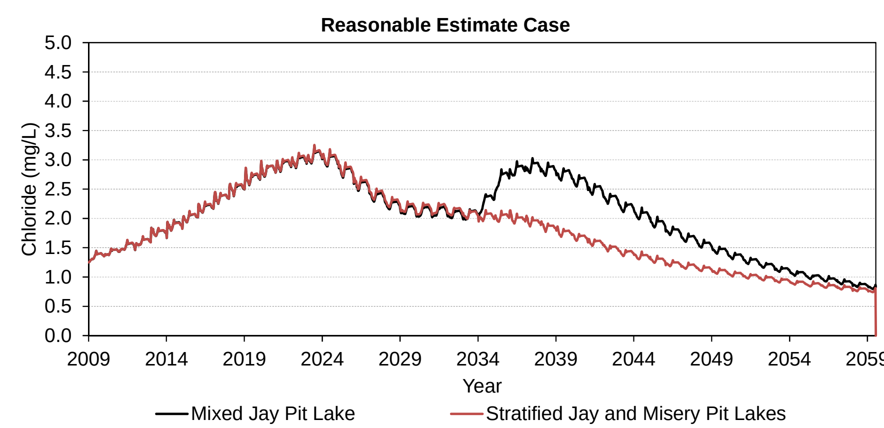

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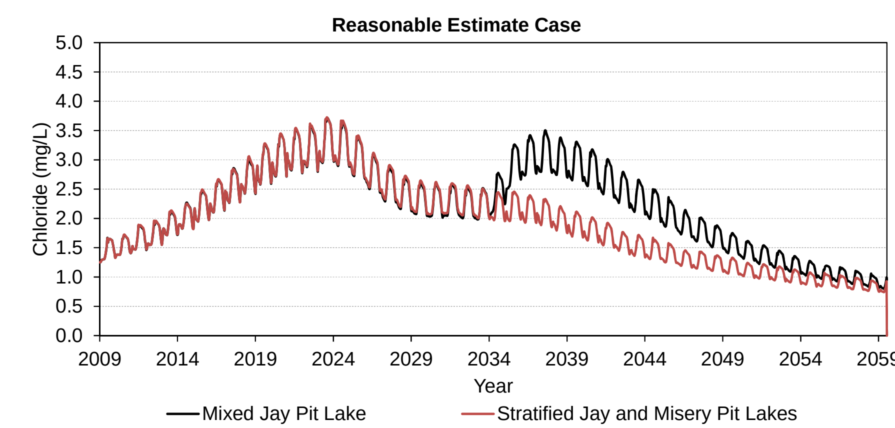
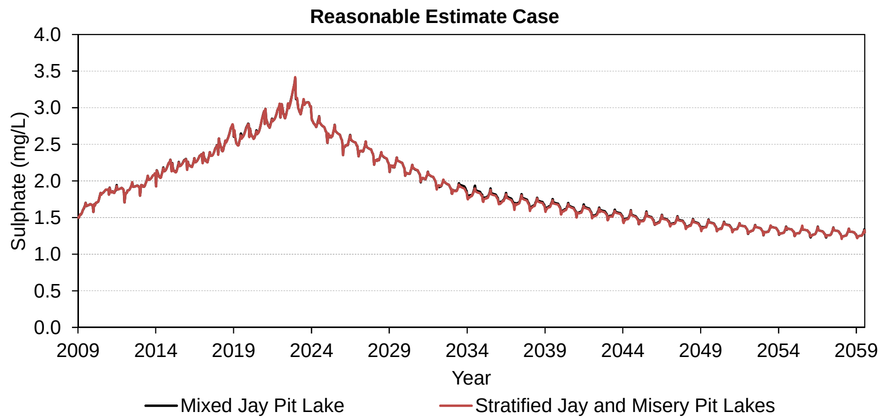
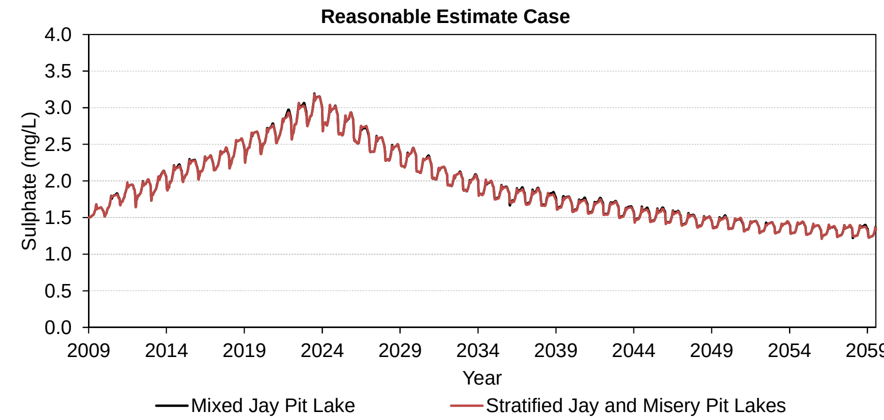


LDG-P6

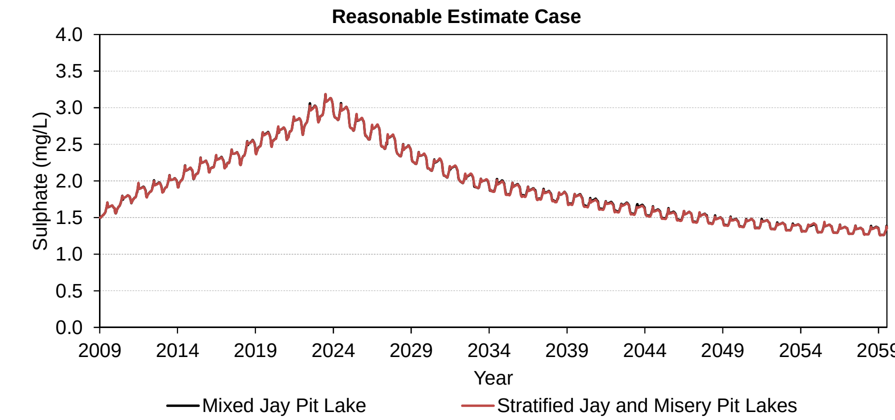
Figure 24-12: Predicted Depth-Averaged Sulphate Concentrations in Lac de Gras– Scenario A



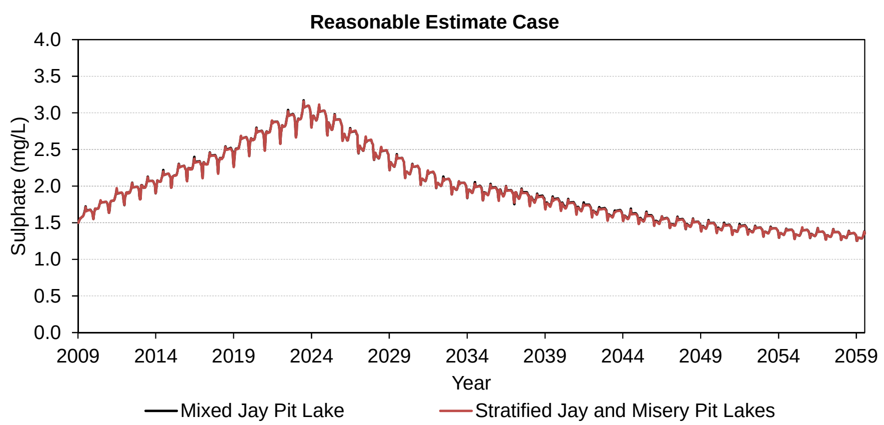
LDG-P1



LDG-P2



LDG-P3



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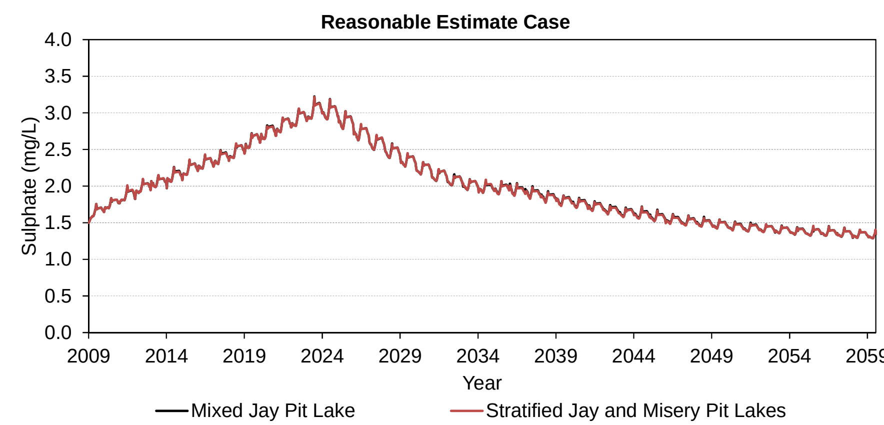

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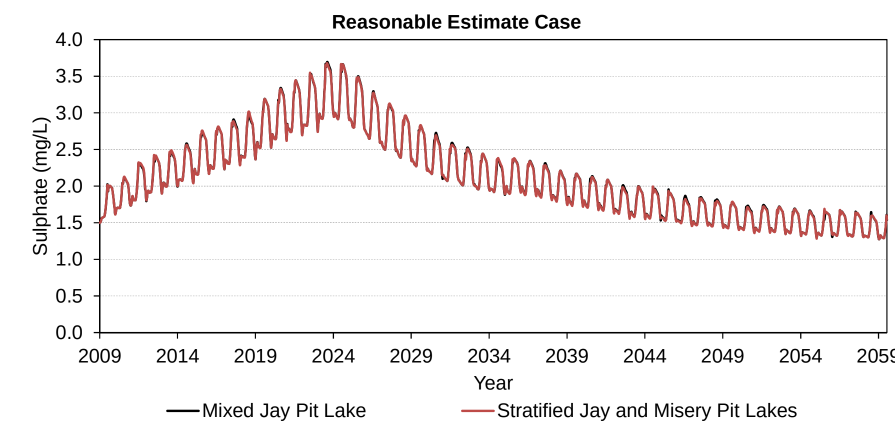
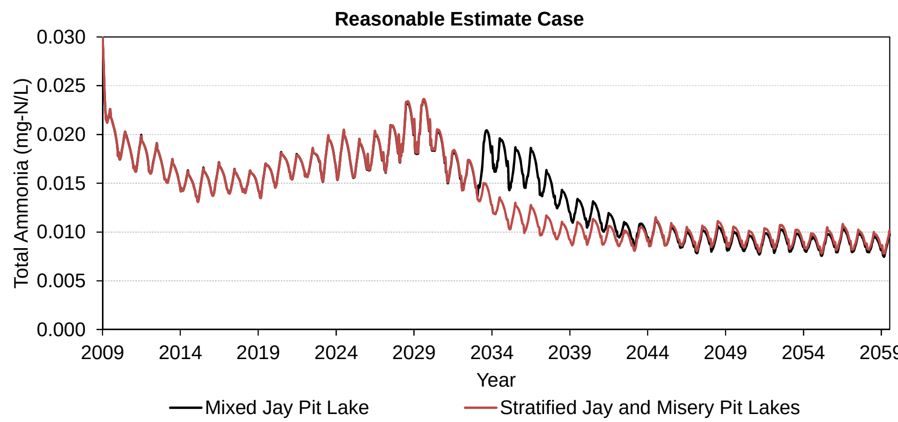
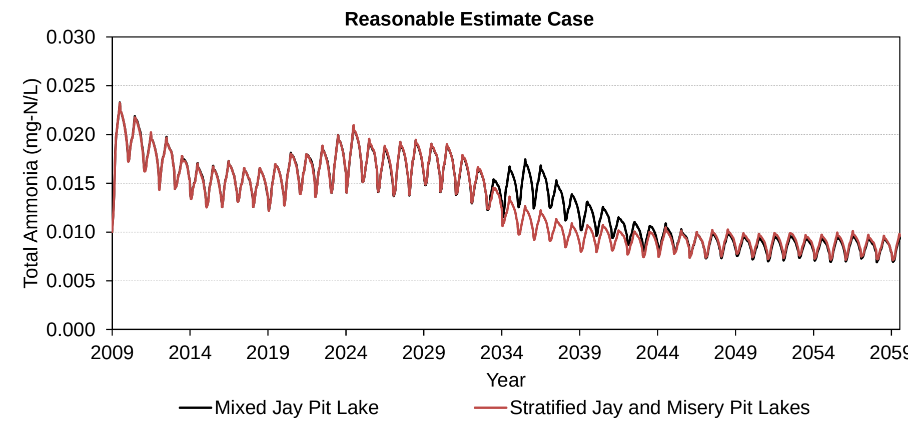


LDG-P6

Figure 24-13: Predicted Depth-Averaged Total Ammonia Concentrations in Lac de Gras– Scenario A



LDG-P1



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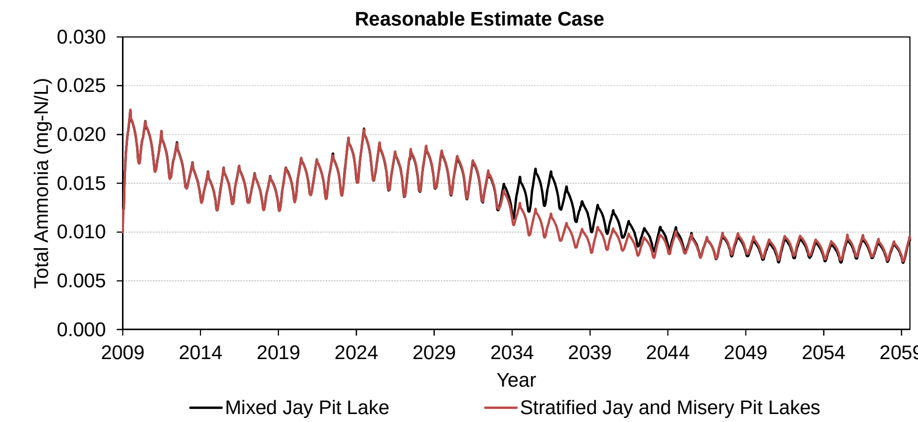
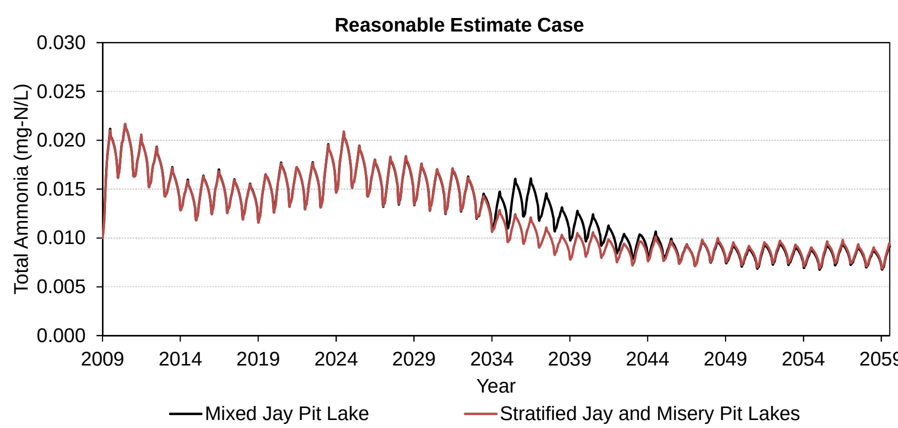


LDG-P3



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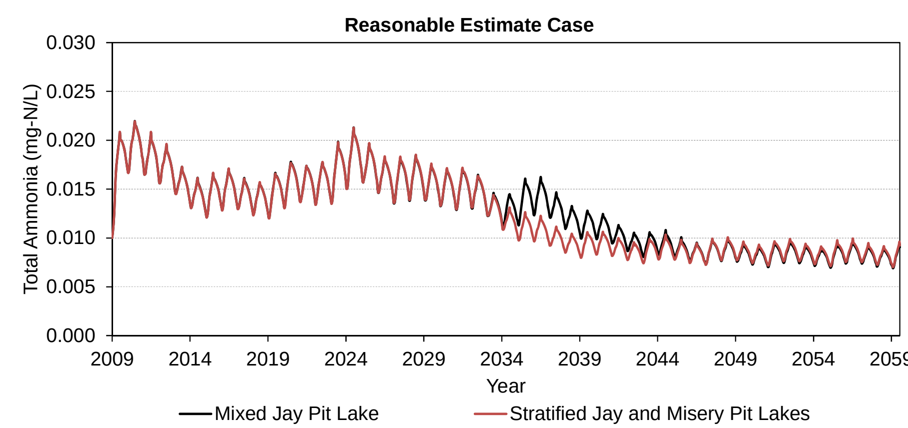

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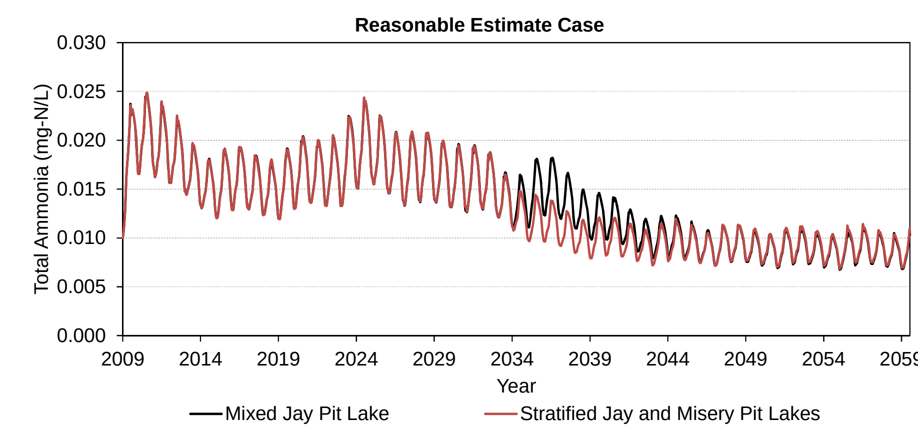
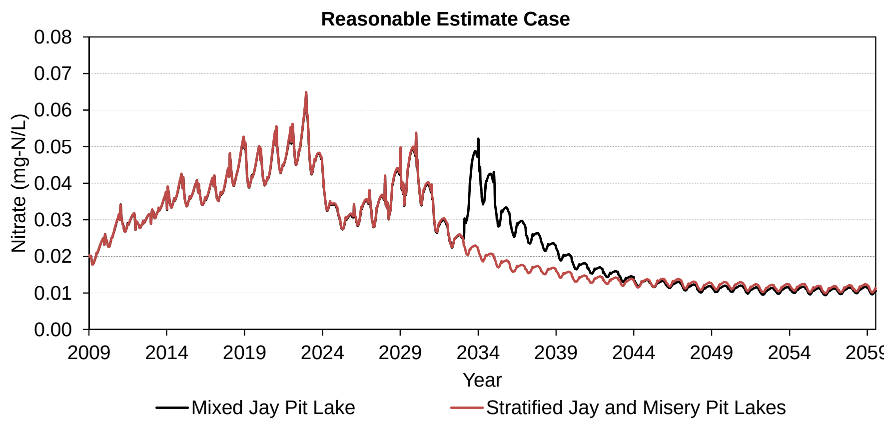


LDG-P6

Figure 24-14: Predicted Depth-Averaged Nitrate Concentrations in Lac de Gras– Scenario A



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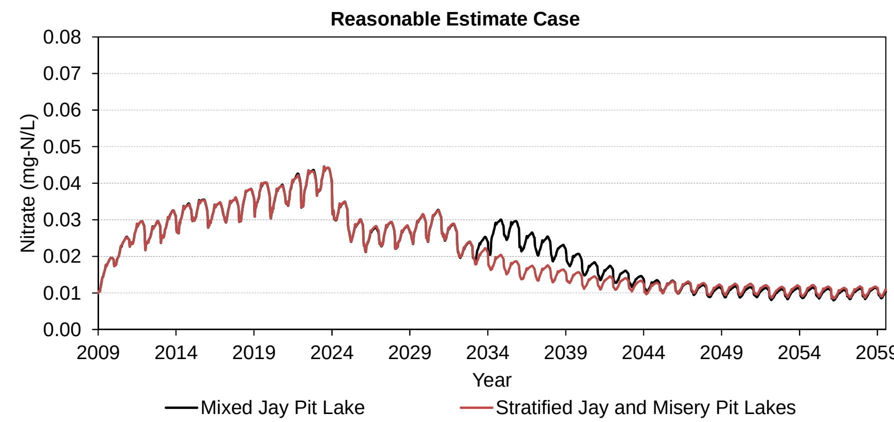

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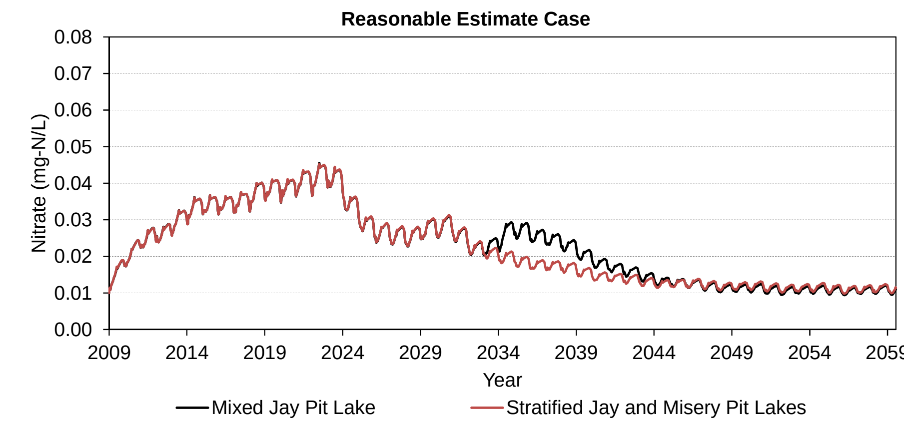

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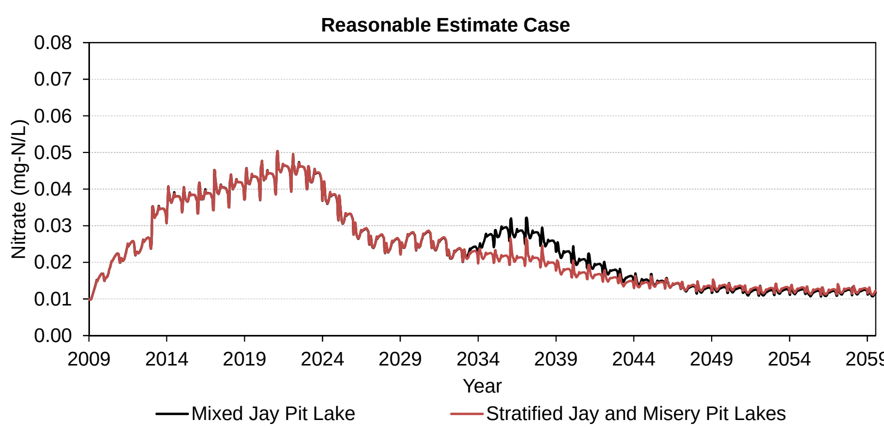

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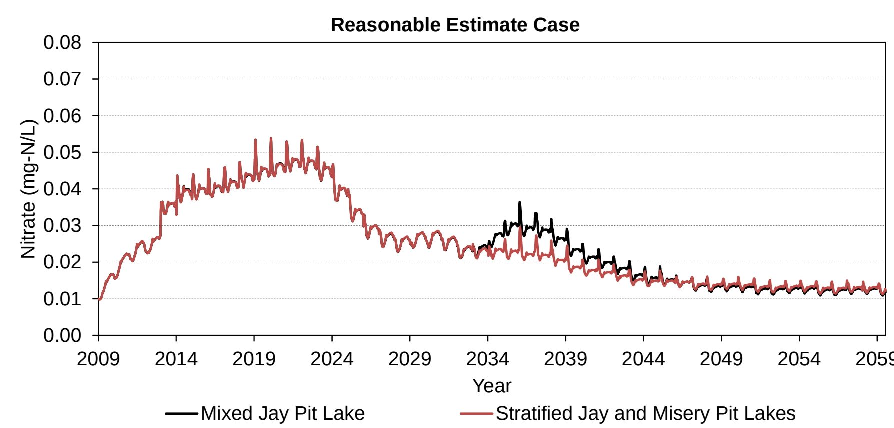

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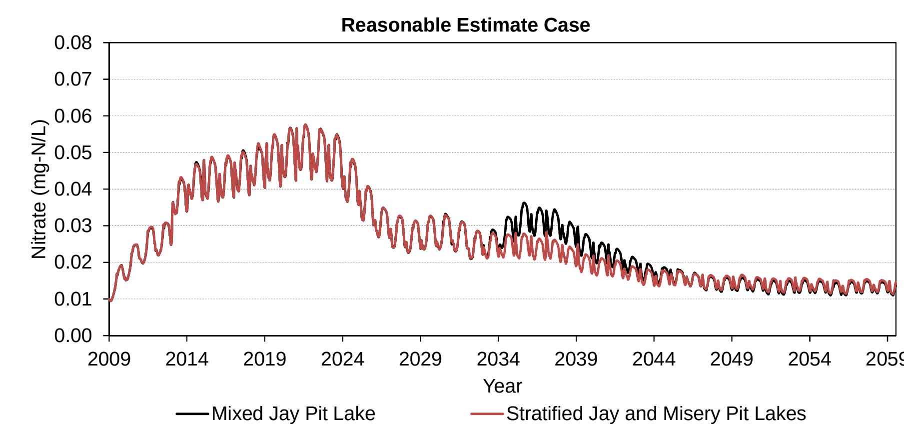


LDG-P6

Figure 24-15: Predicted Depth-Averaged Total Phosphorus Concentrations in Lac de Gras– Scenario A

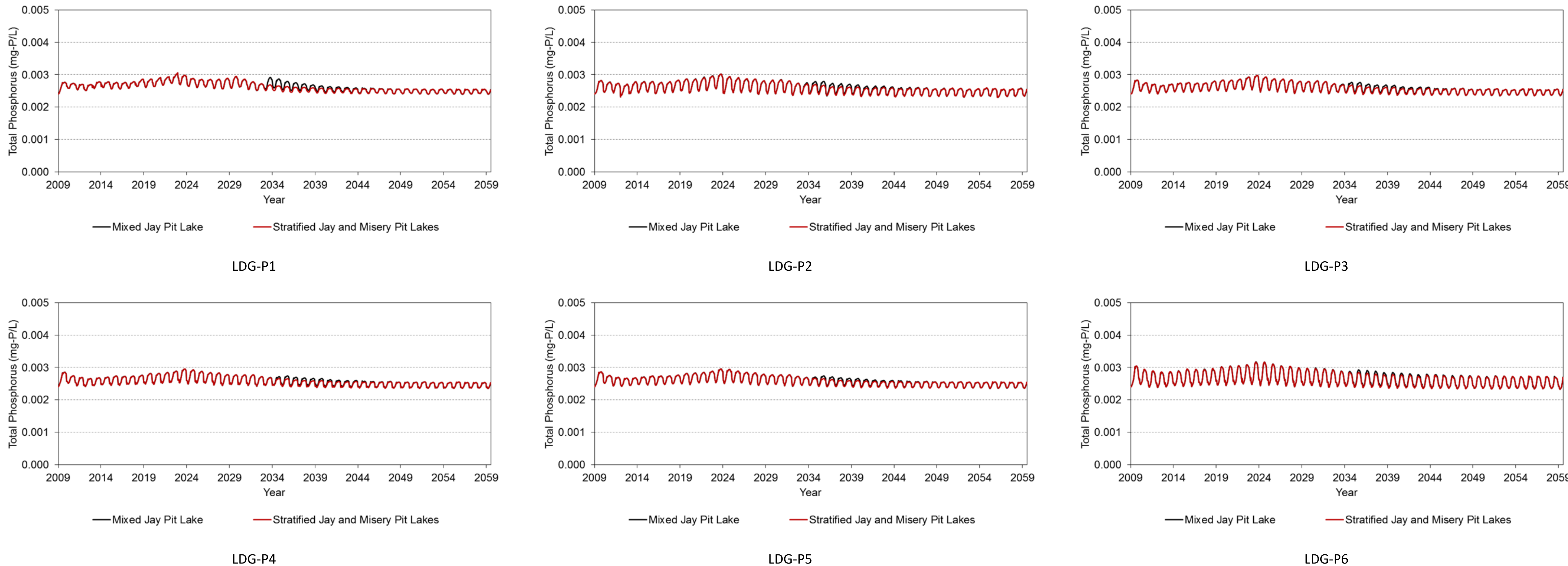
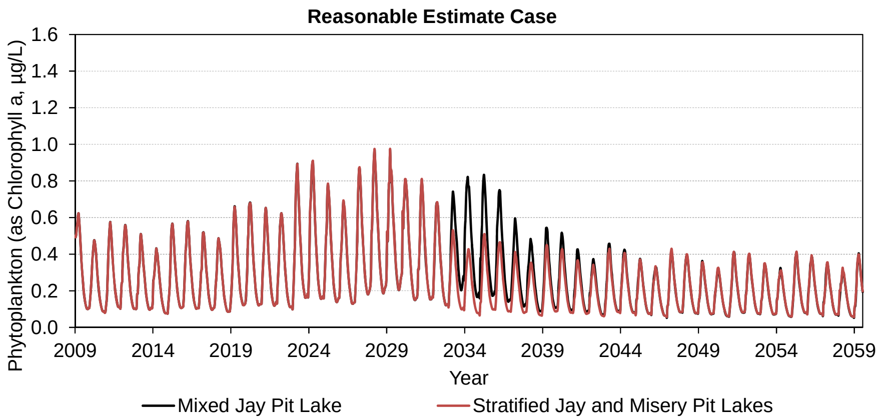
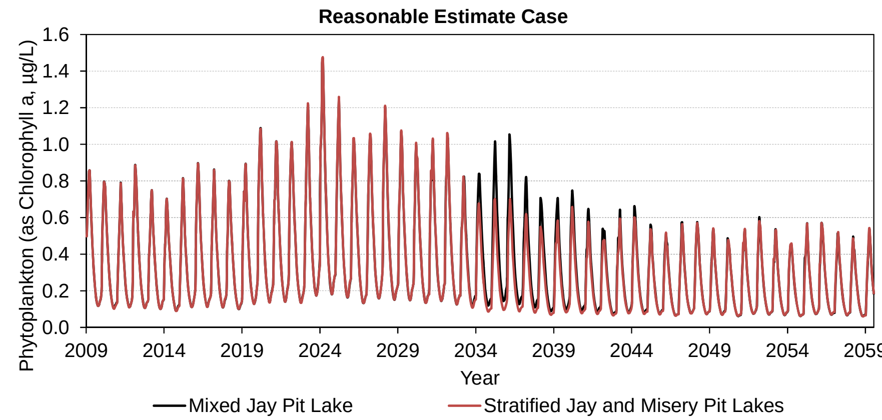


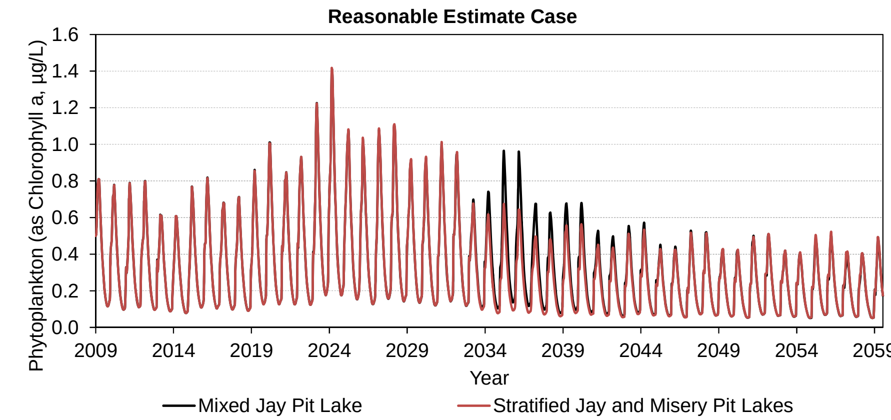
Figure 24-16: Predicted Depth-Averaged Phytoplankton Concentrations in Lac de Gras– Scenario A



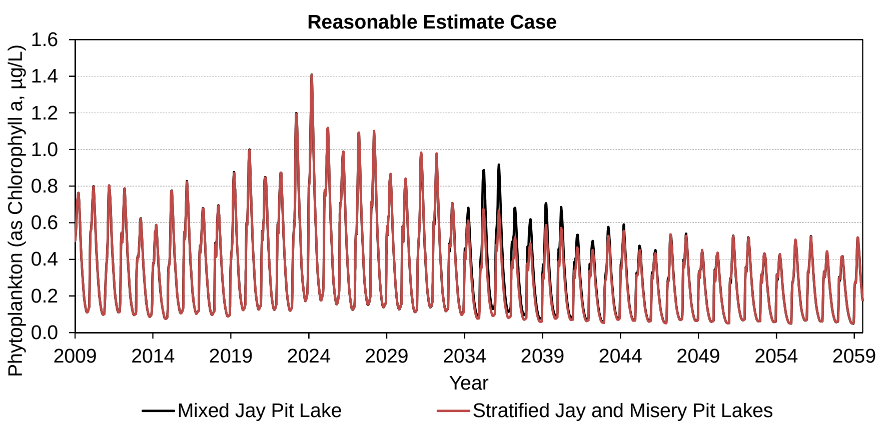
LDG-P1



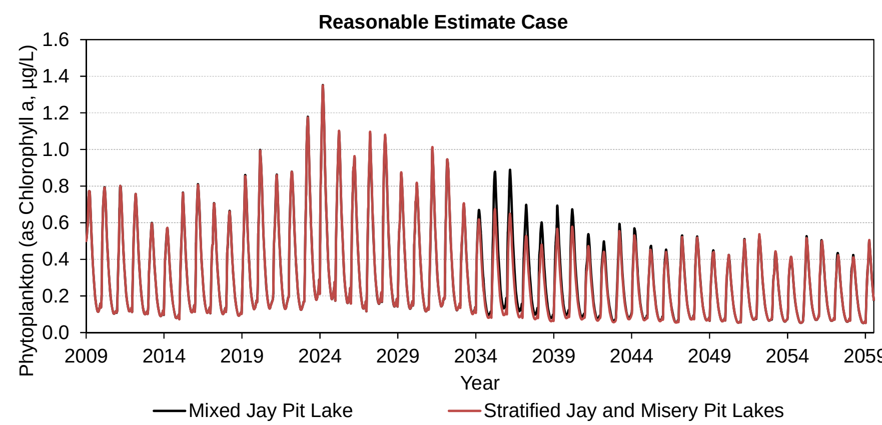
LDG-P2



LDG-P3



LDG-P4



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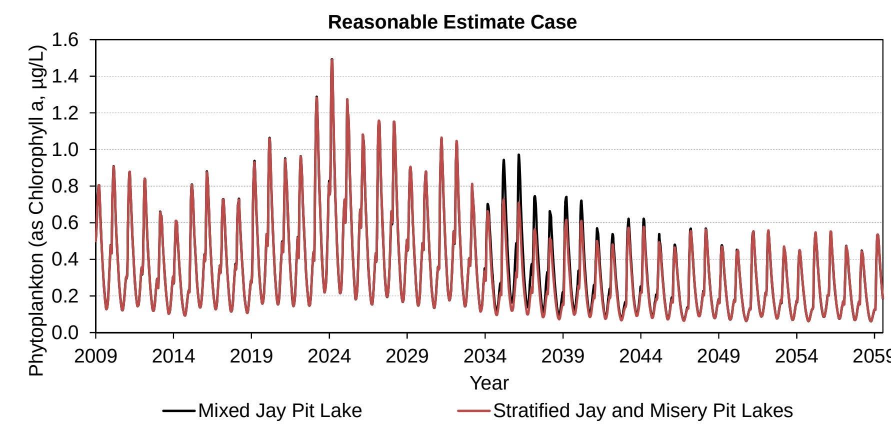
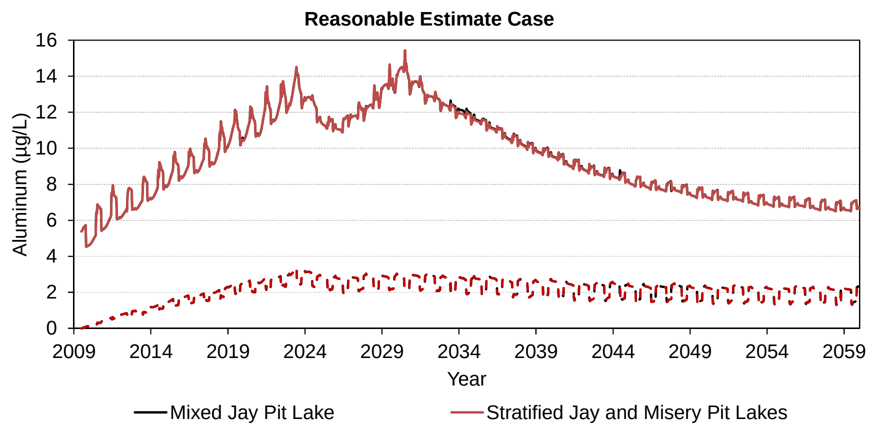
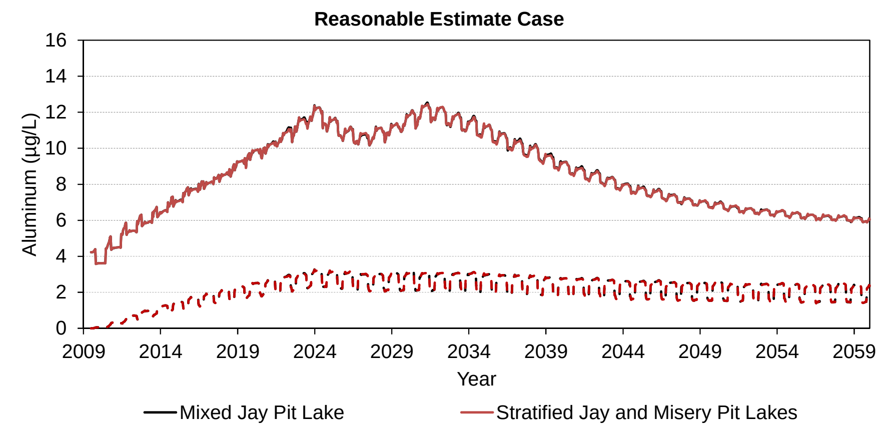


LDG-P6

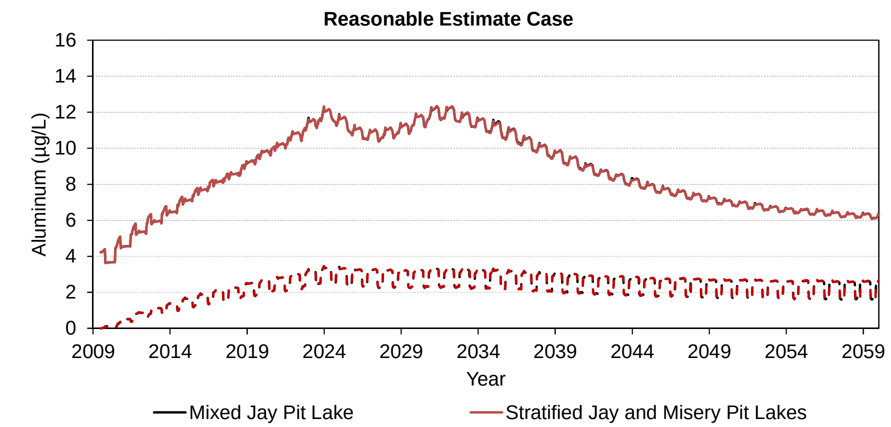
Figure 24-17: Predicted Depth-Averaged Total and Dissolved Aluminum Concentrations in Lac de Gras– Scenario A



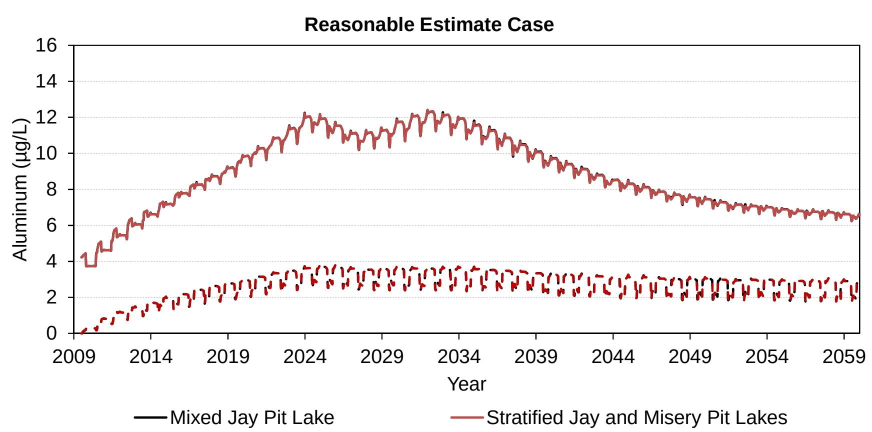
LDG-P1



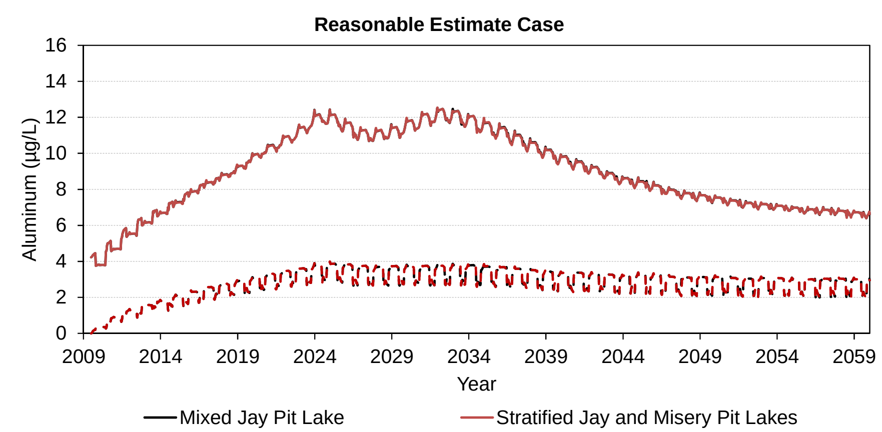
LDG-P2



LDG-P3



LDG-P4



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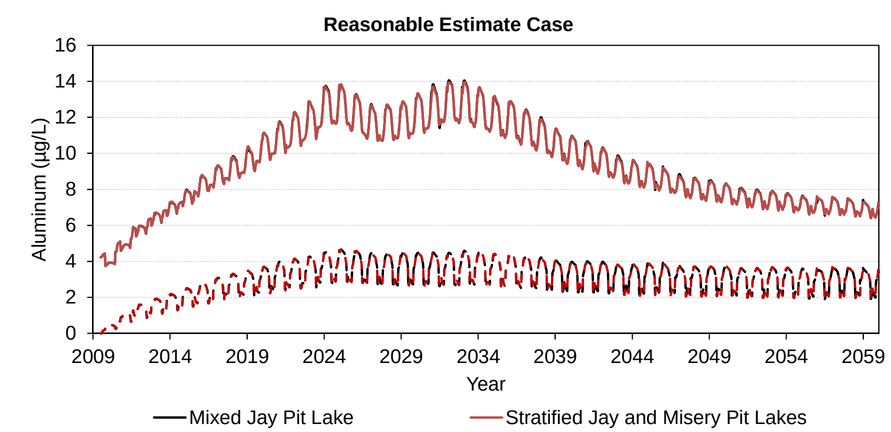
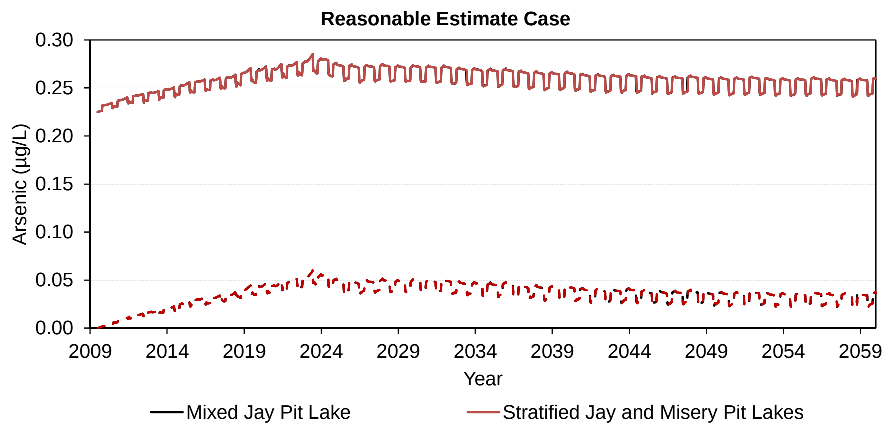


LDG-P6

Figure 24-18: Predicted Depth-Averaged Total and Dissolved Arsenic Concentrations in Lac de Gras– Scenario A



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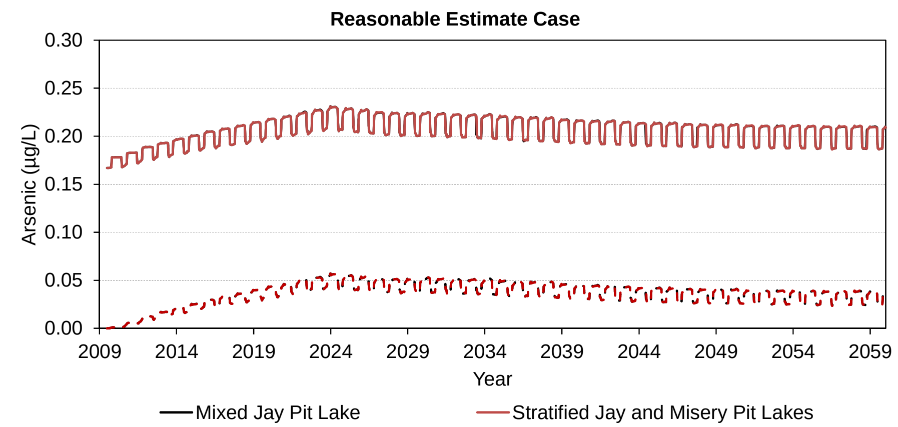

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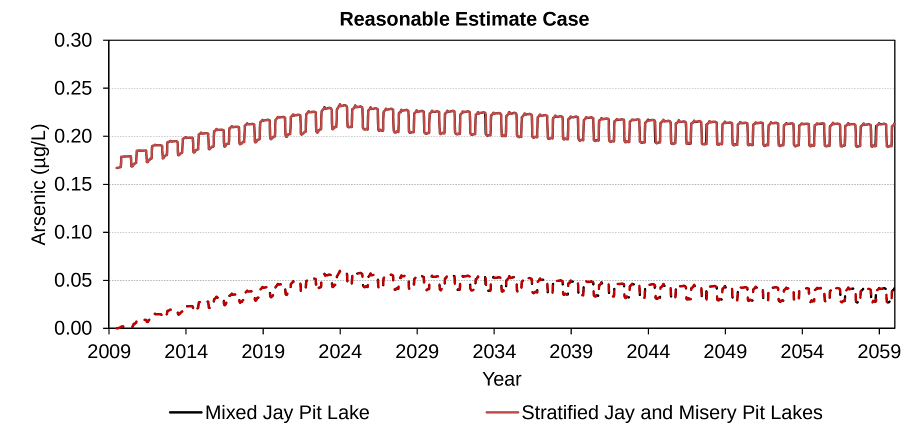

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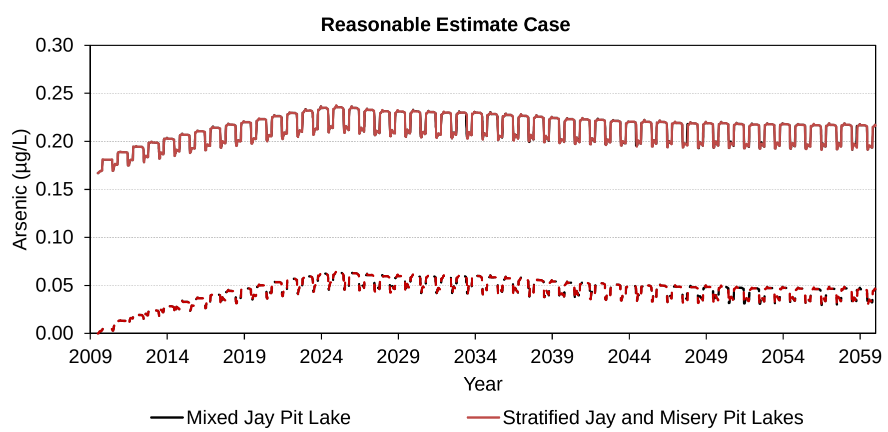
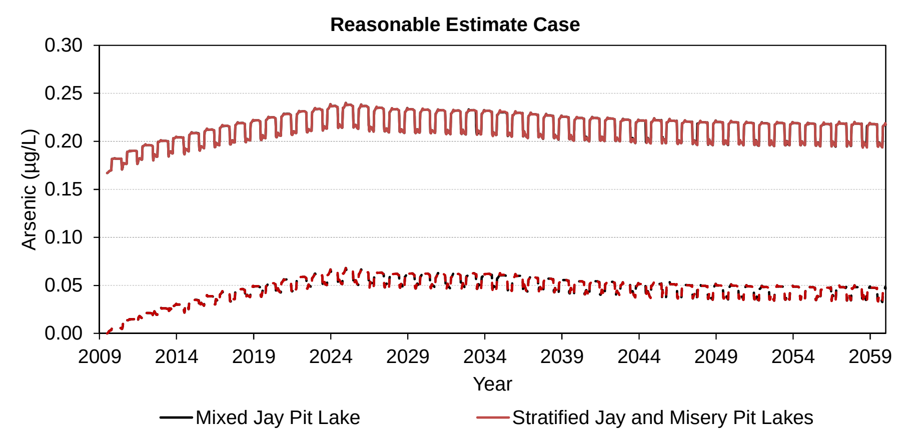


LDG-P4



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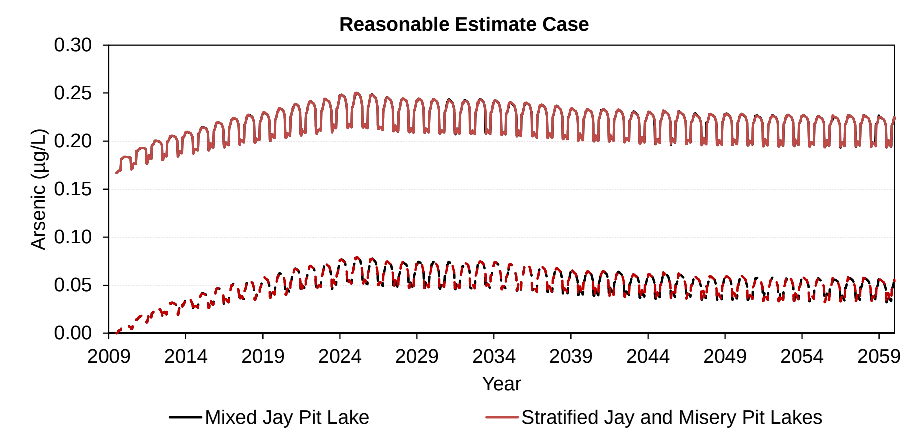
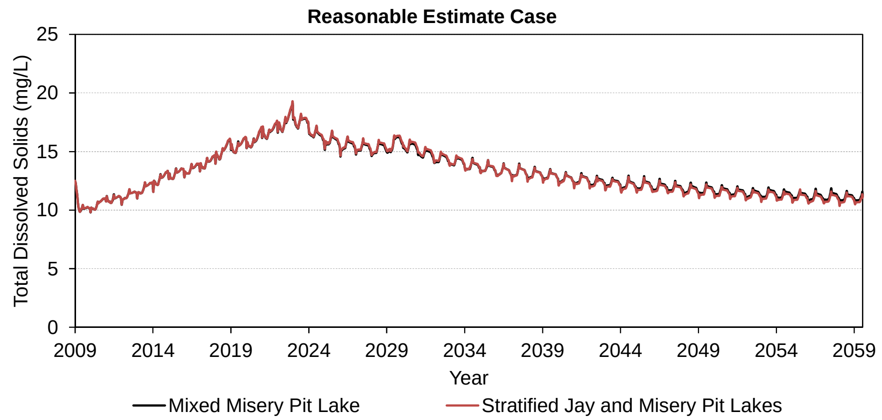
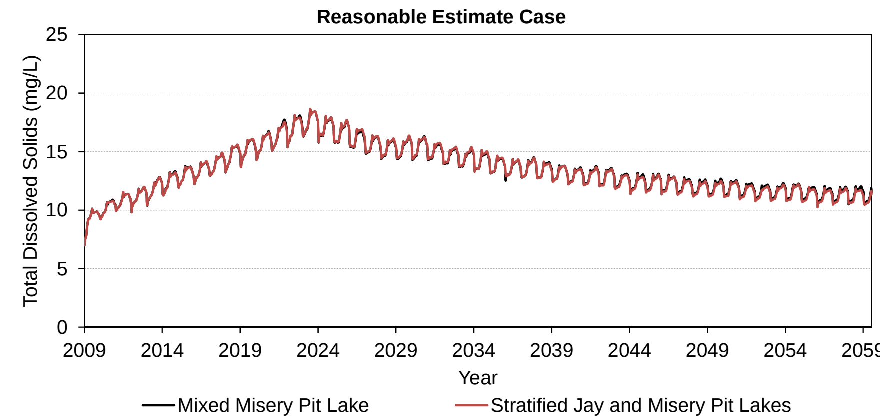


LDG-P6

Figure 24-19: Predicted Depth-Averaged Total Dissolved Solids Concentrations in Lac de Gras – Scenario B



LDG-P1



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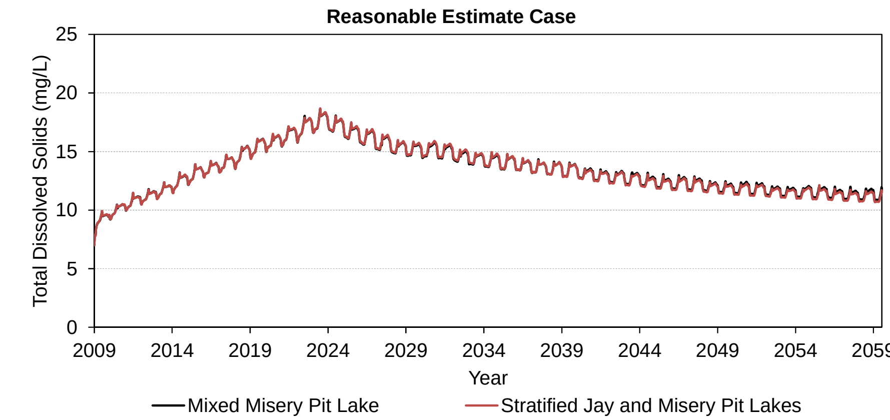

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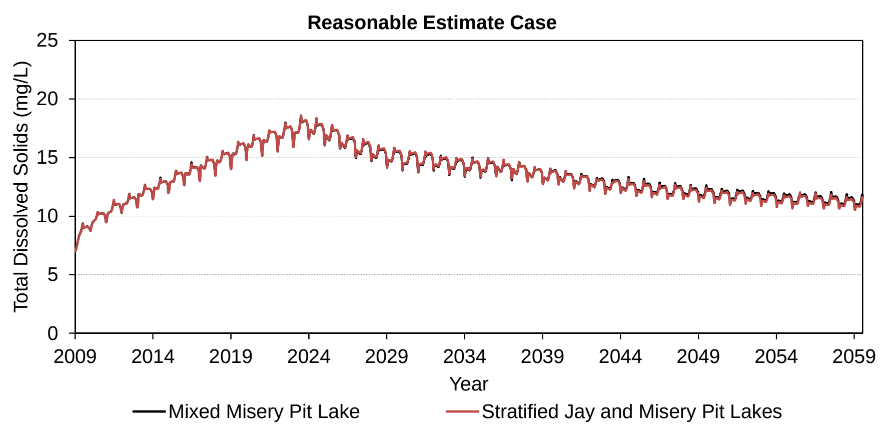

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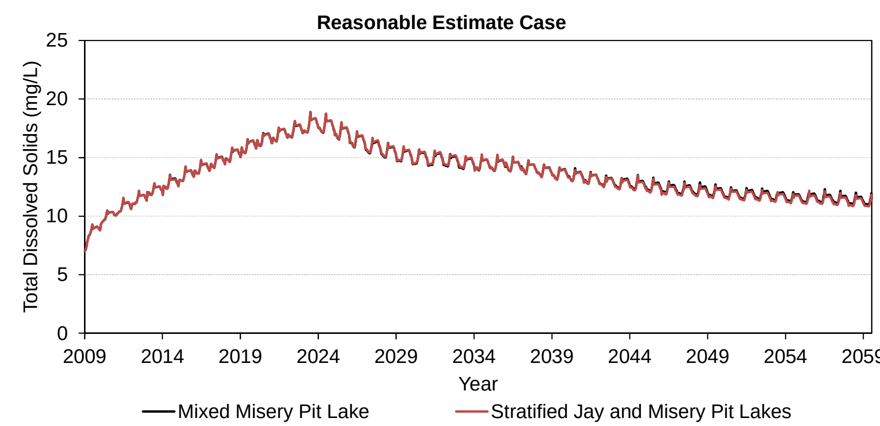

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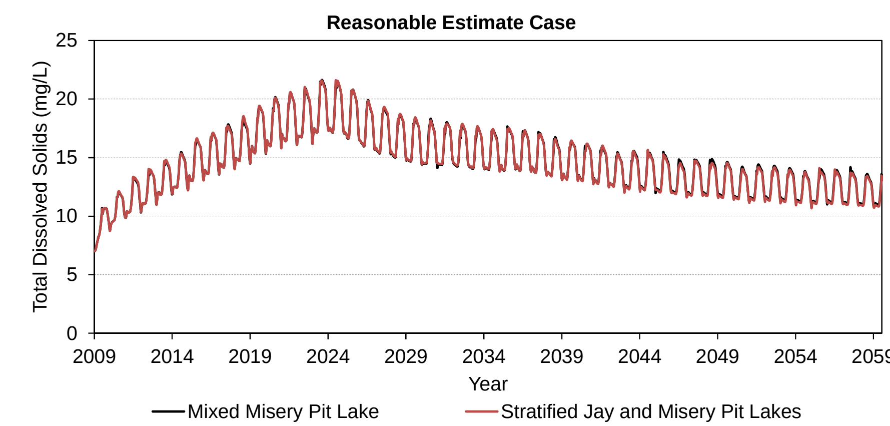
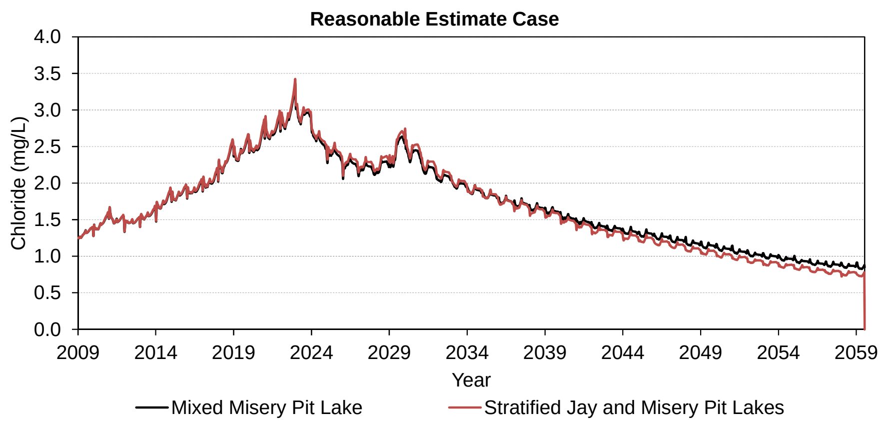
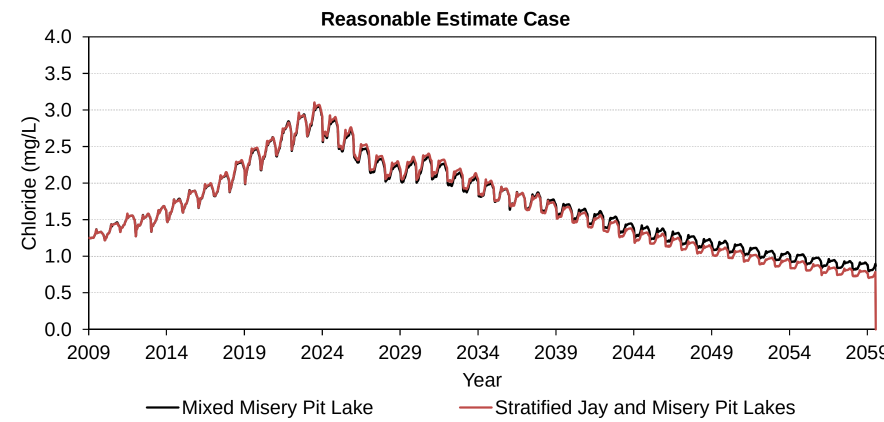


LDG-P6

Figure 24-20: Predicted Depth-Averaged Chloride Concentrations in Lac de Gras– Scenario B



LDG-P1



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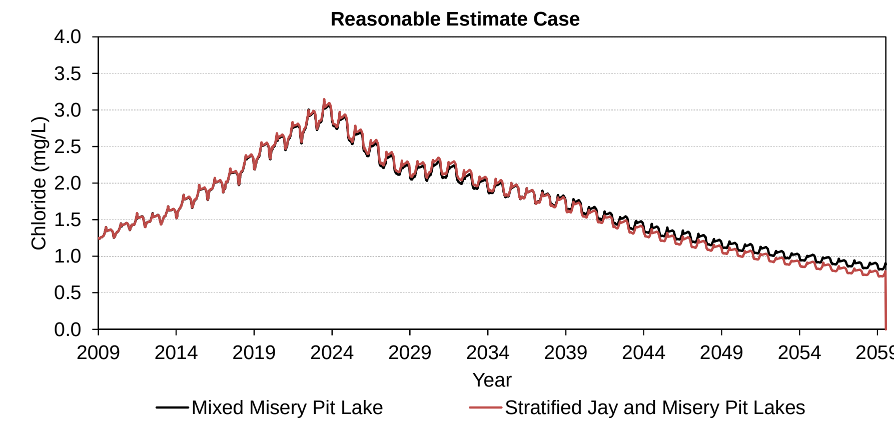
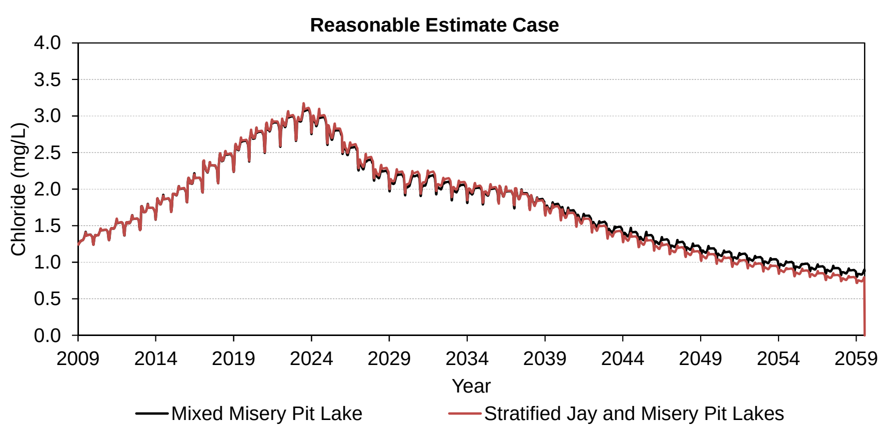


LDG-P3



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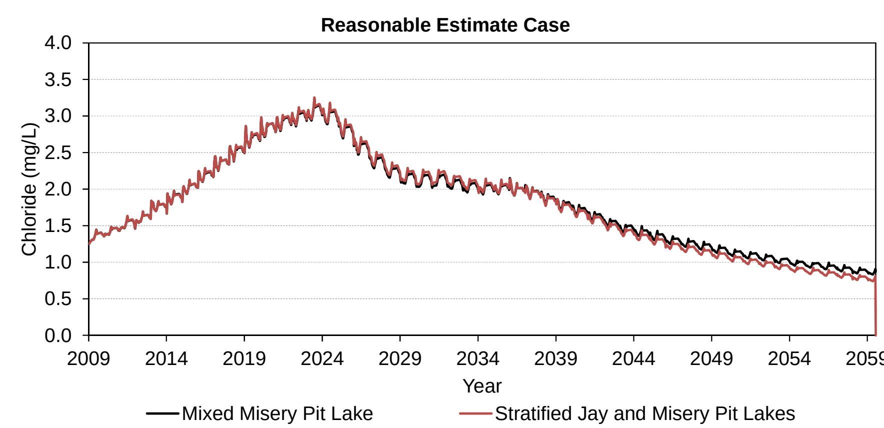

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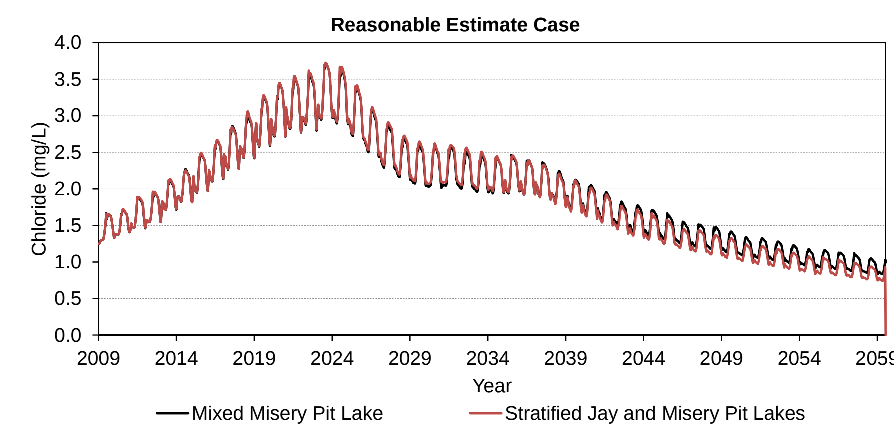
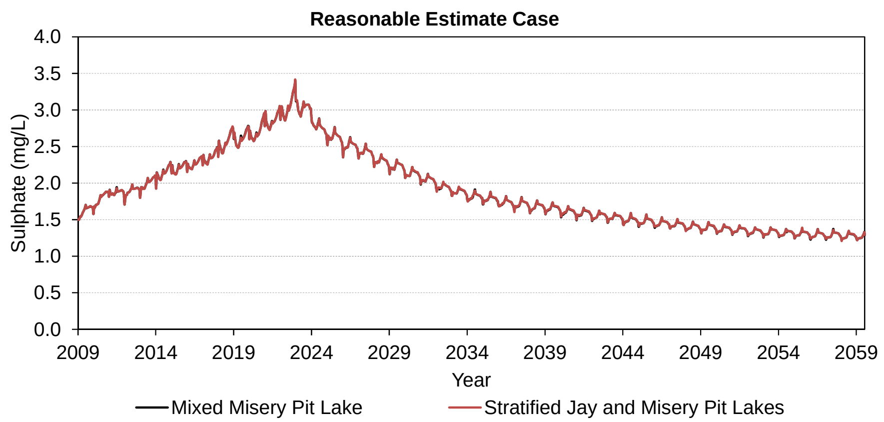


LDG-P6

Figure 24-21: Predicted Depth-Averaged Sulphate Concentrations in Lac de Gras– Scenario B



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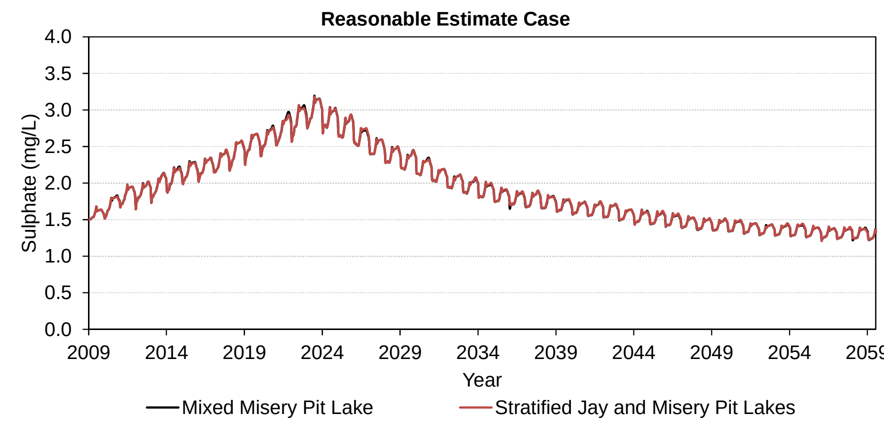

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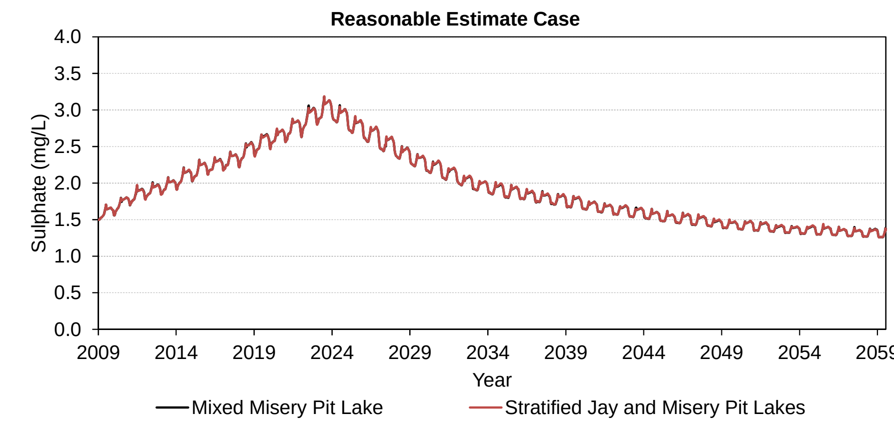
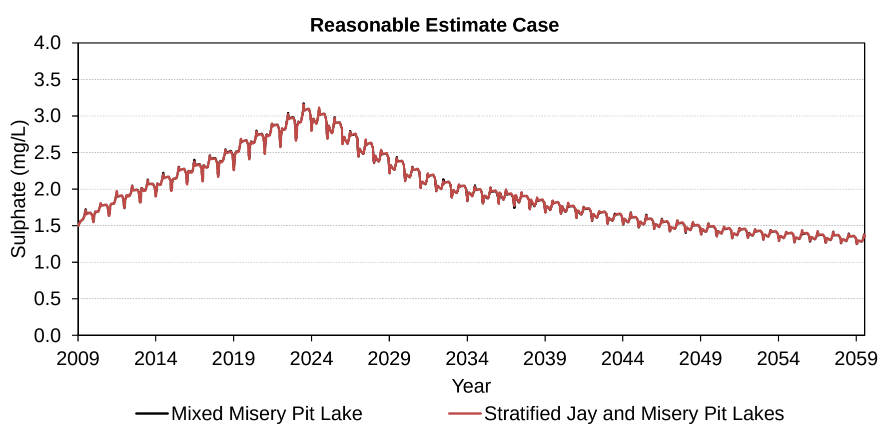


LDG-P3



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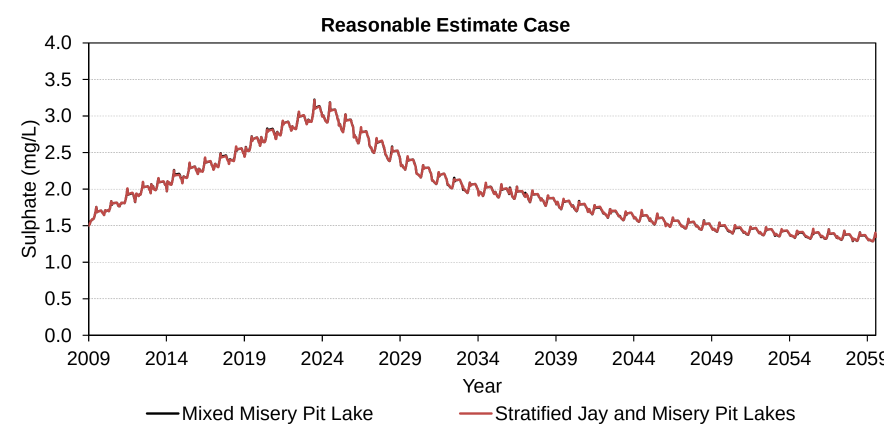

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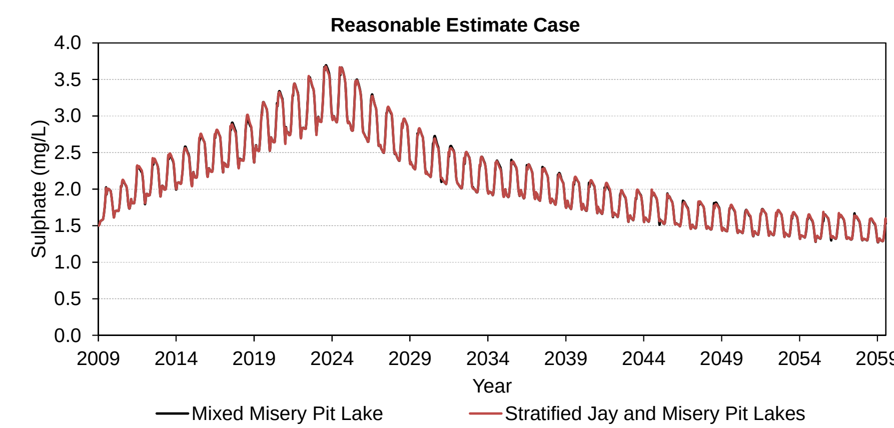
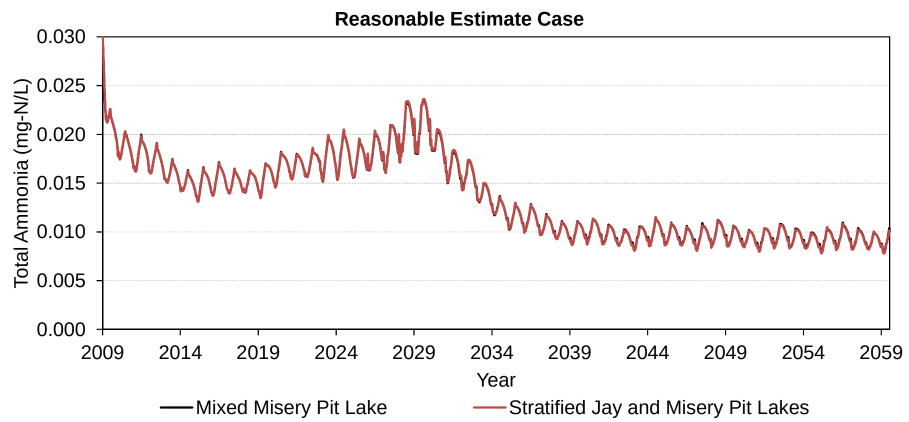
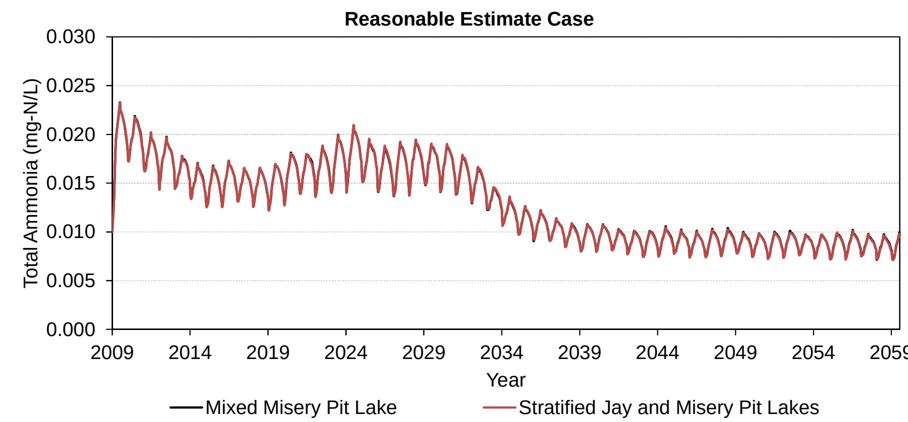


LDG-P6

Figure 24-22: Predicted Depth-Averaged Total Ammonia Concentrations in Lac de Gras– Scenario B



LDG-P1



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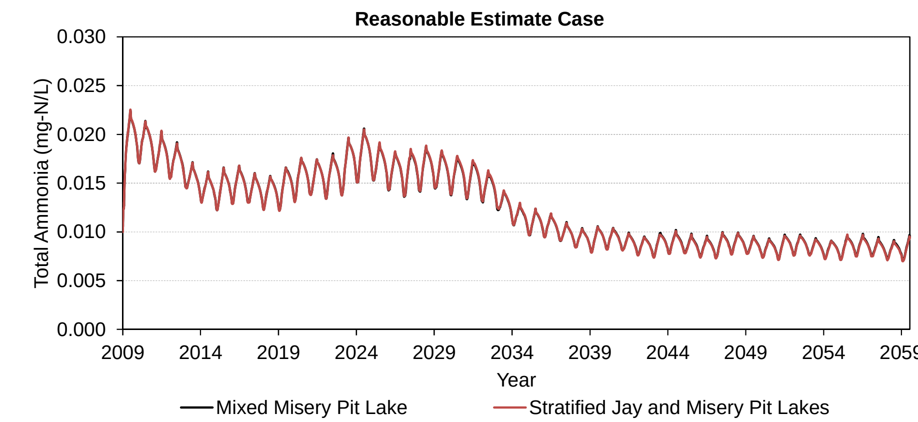

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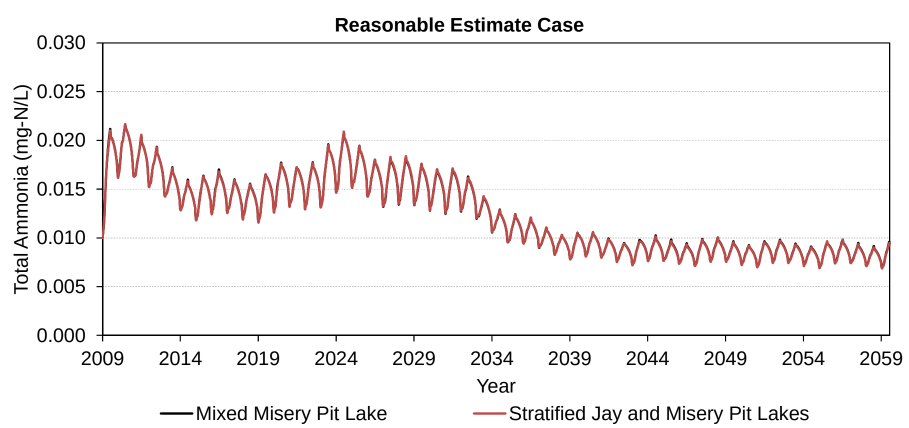
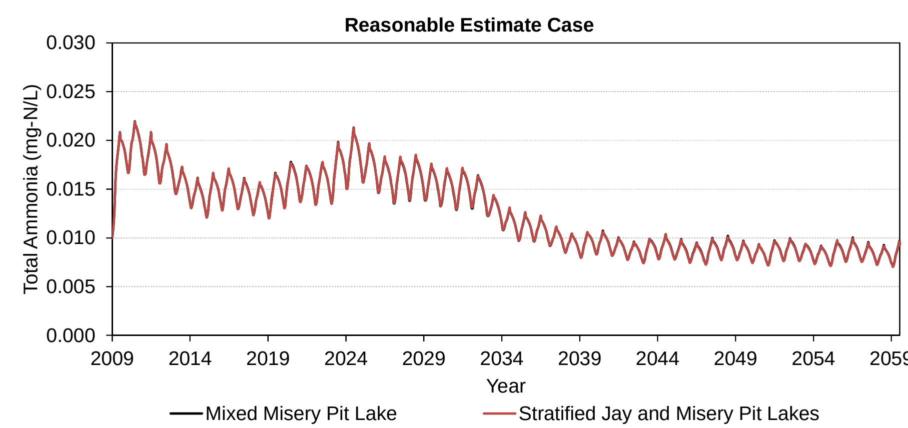


LDG-P4



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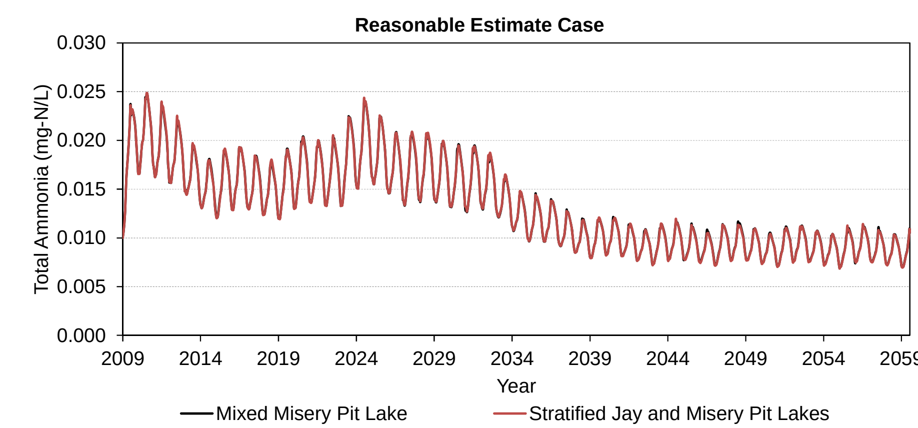
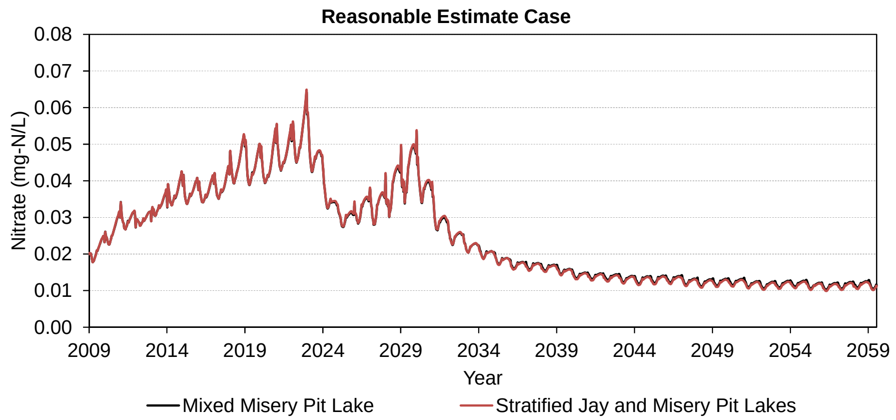


LDG-P6

Figure 24-23: Predicted Depth-Averaged Nitrate Concentrations in Lac de Gras– Scenario B



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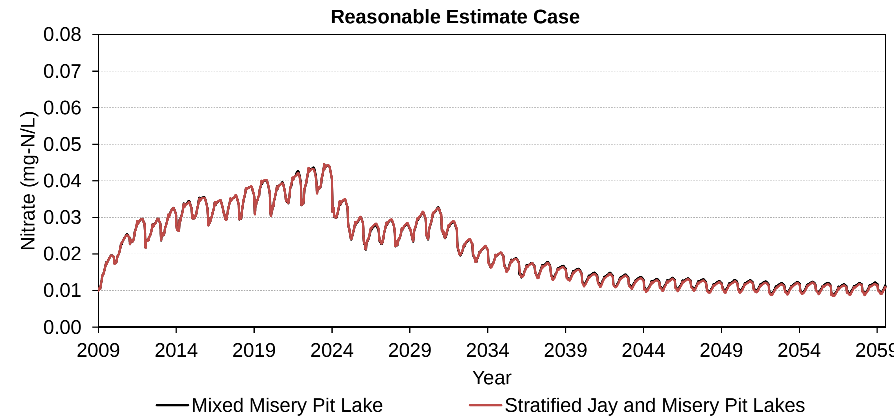

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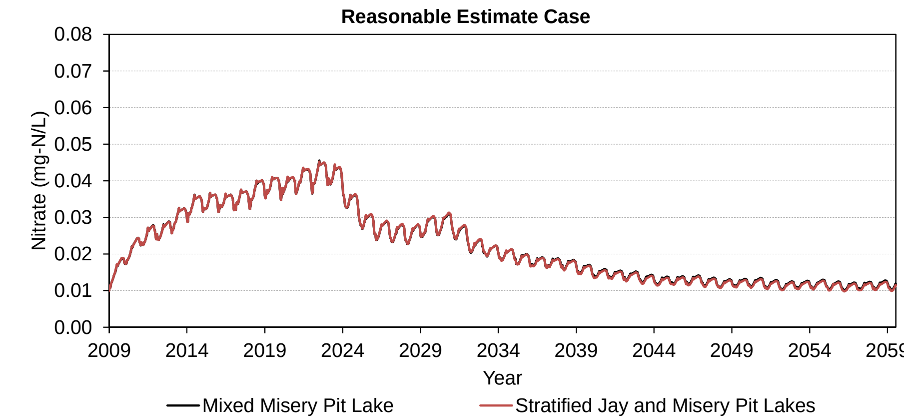

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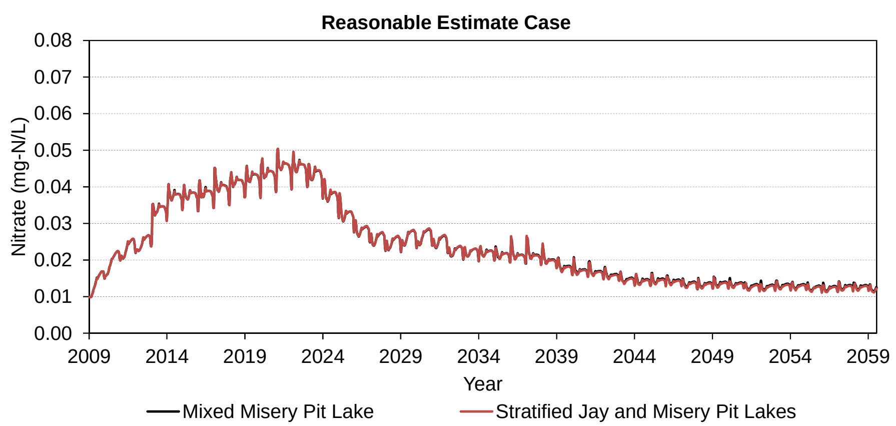

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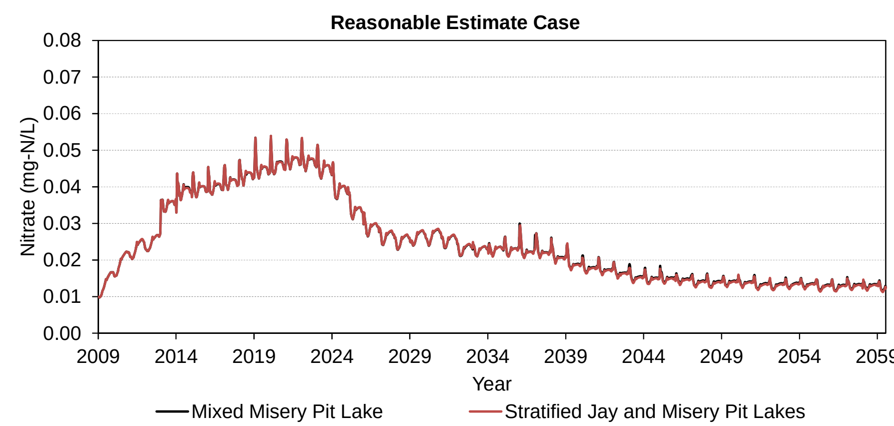

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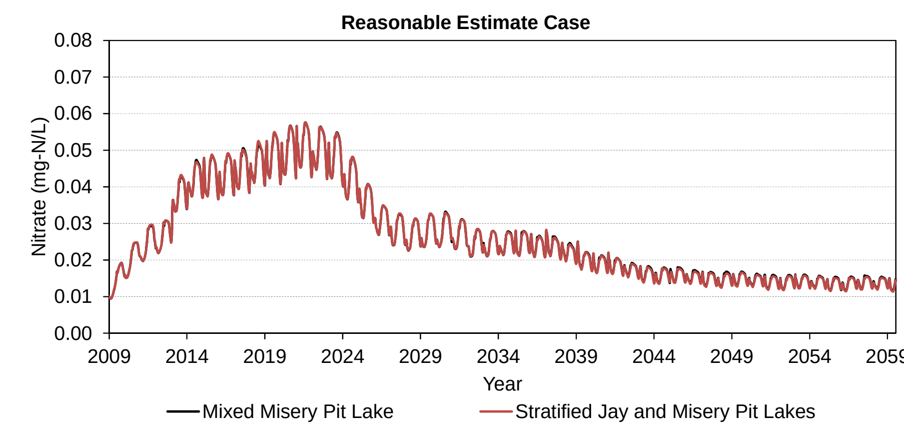
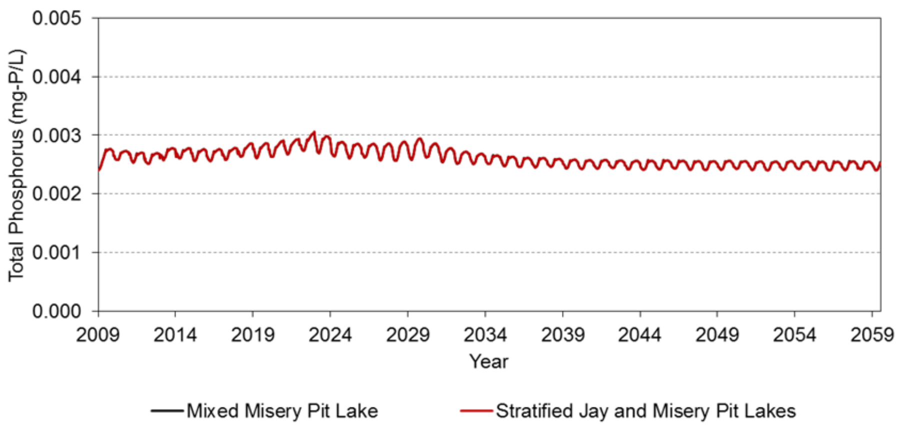
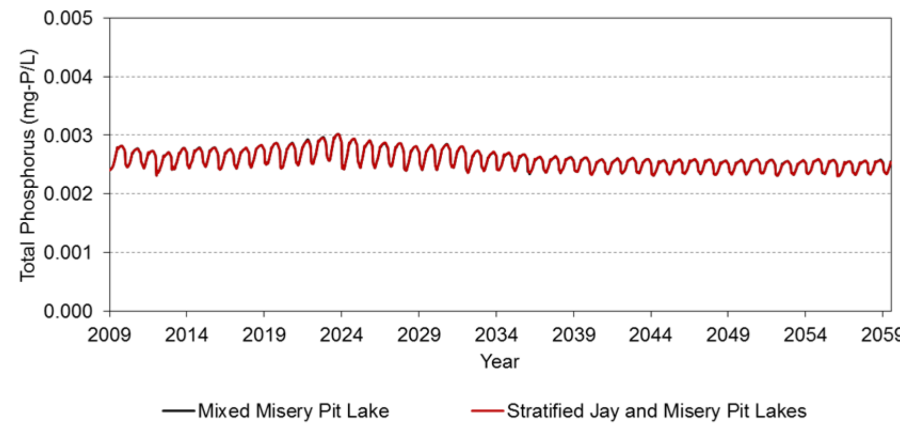


LDG-P6

Figure 24-24: Predicted Depth-Averaged Total Phosphorus Concentrations in Lac de Gras– Scenario B



LDG-P1



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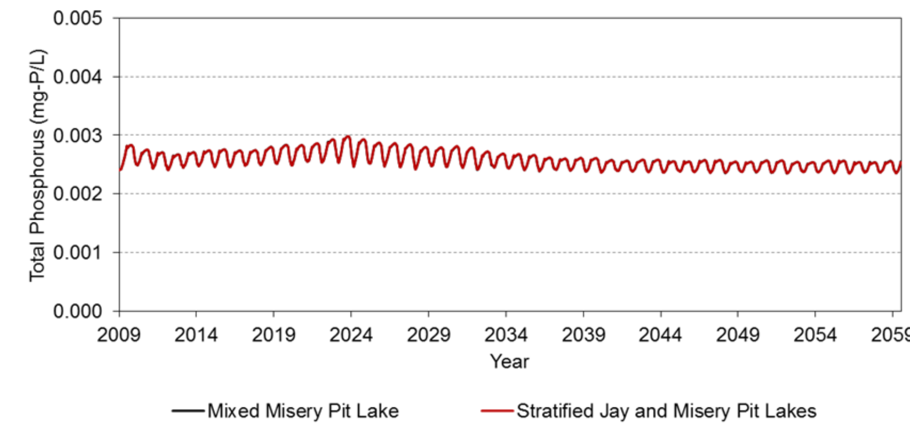

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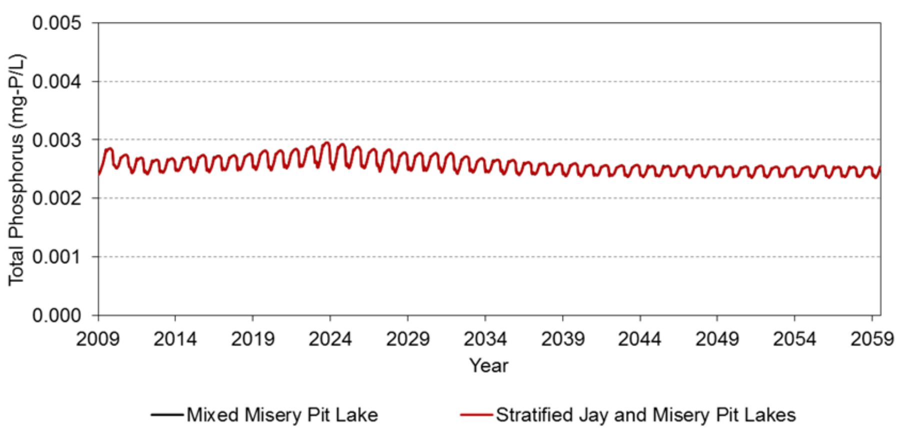

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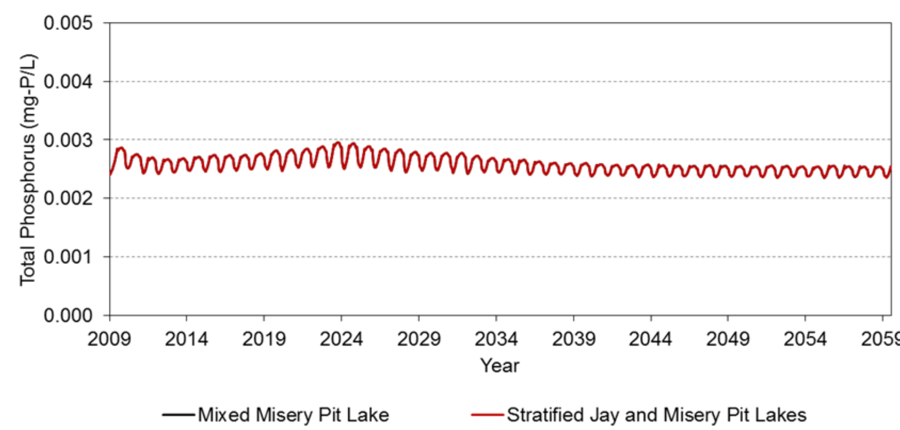

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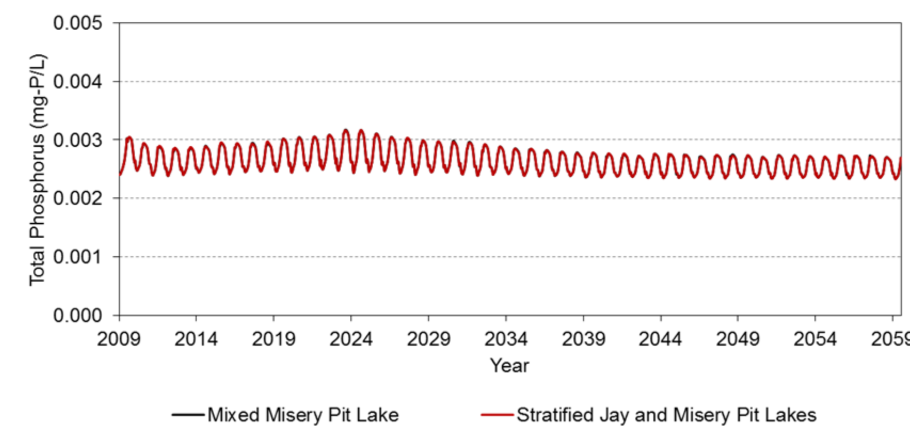
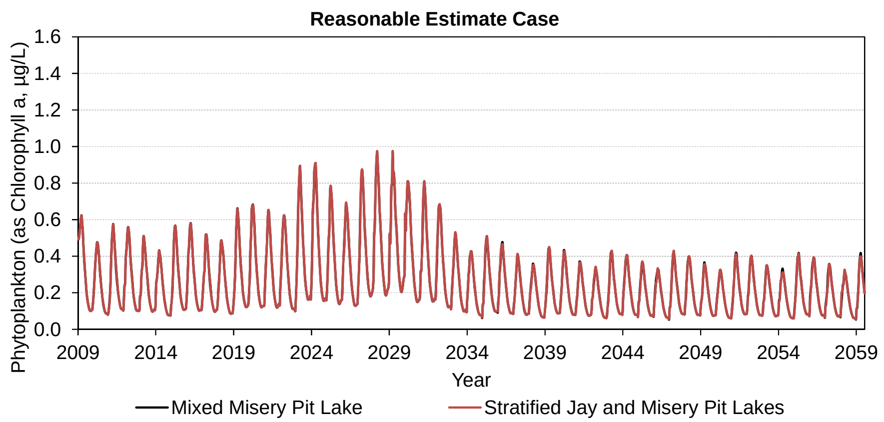
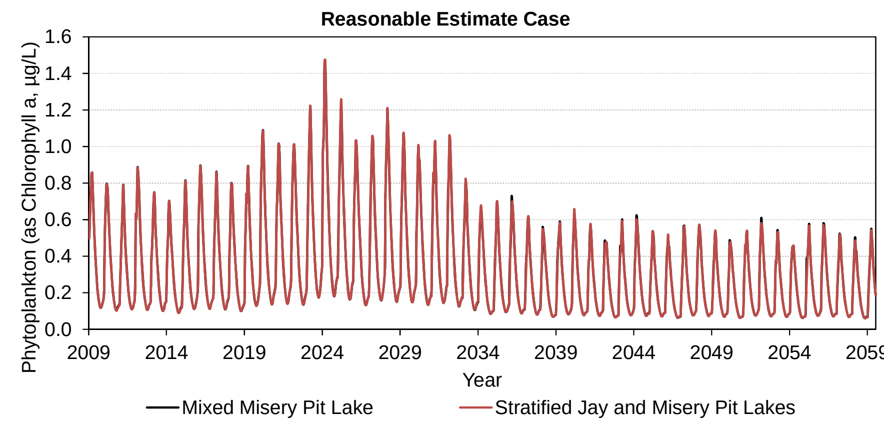


LDG-P6

Figure 24-25: Predicted Depth-Averaged Phytoplankton Concentrations in Lac de Gras– Scenario B



LDG-P1



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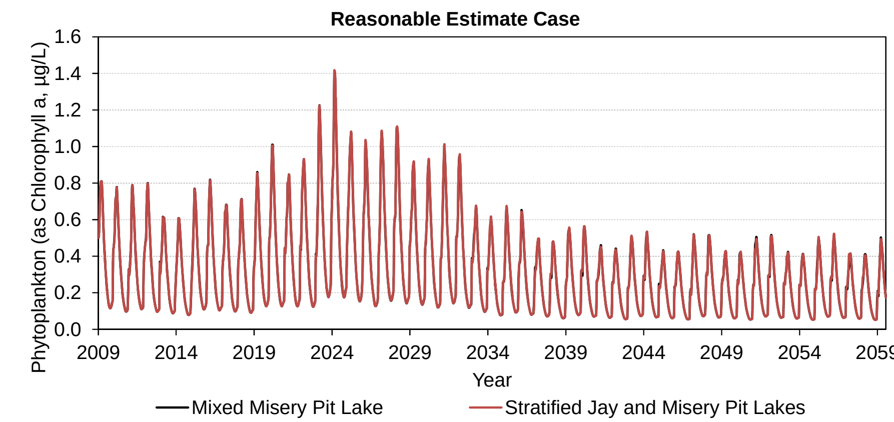

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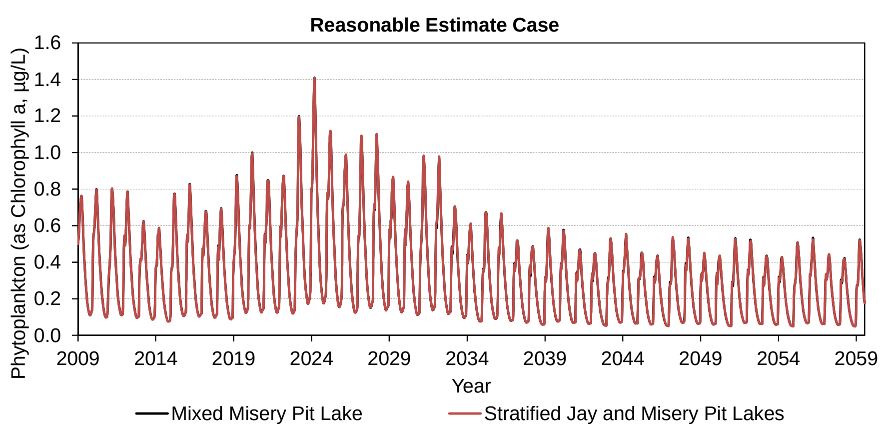
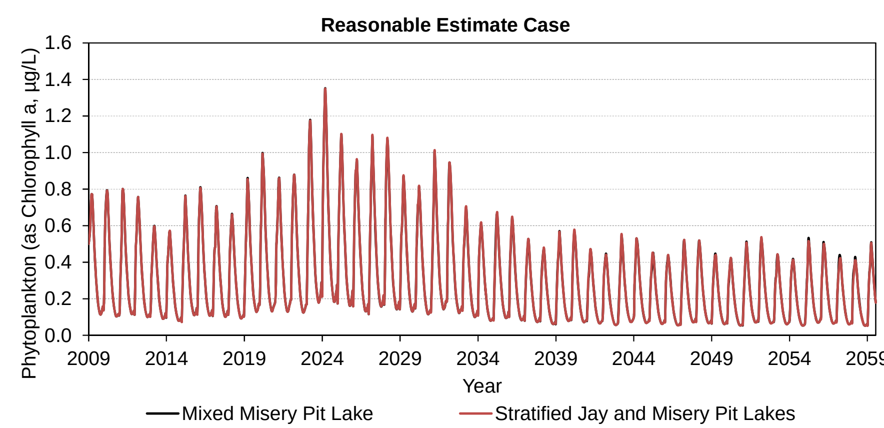


LDG-P4



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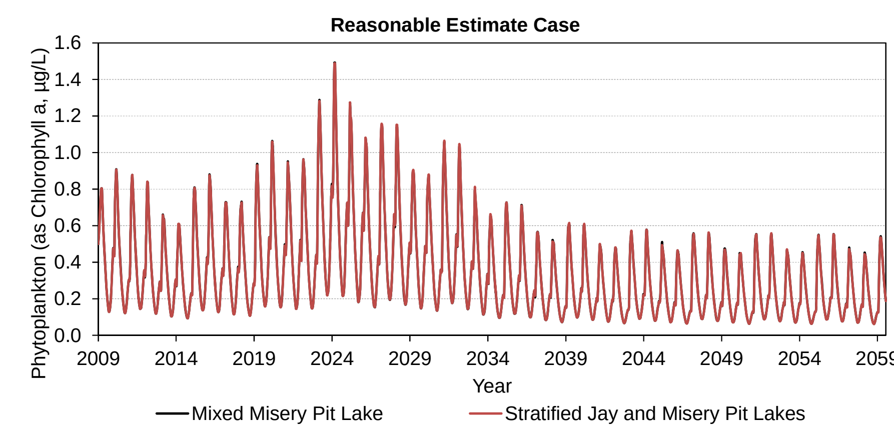
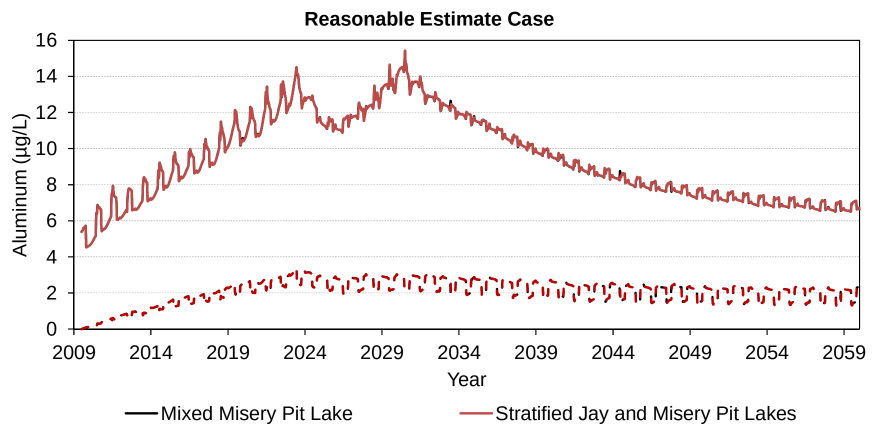
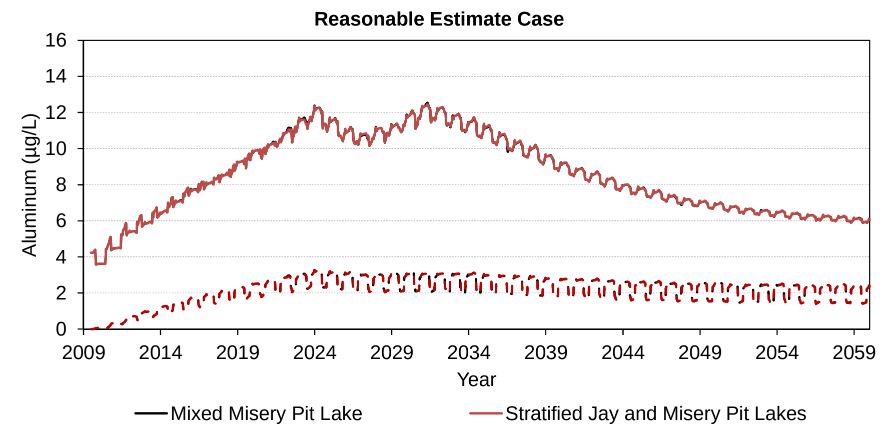


LDG-P6

Figure 24-26: Predicted Depth-Averaged Total and Dissolved Aluminum Concentrations in Lac de Gras– Scenario B



LDG-P1



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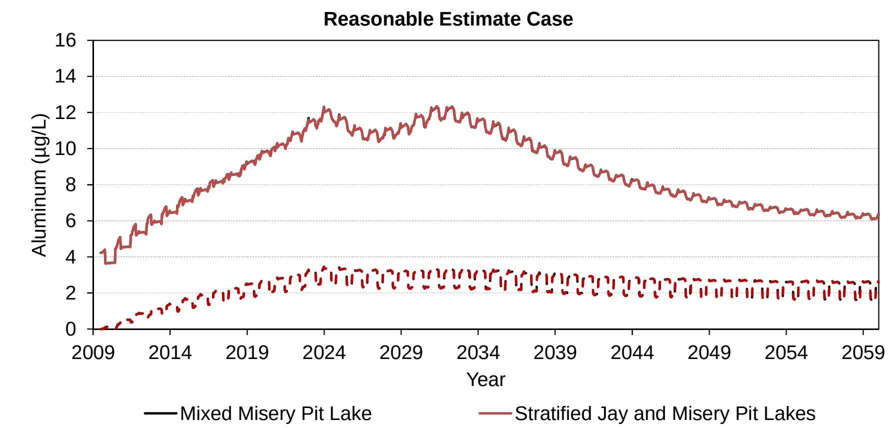
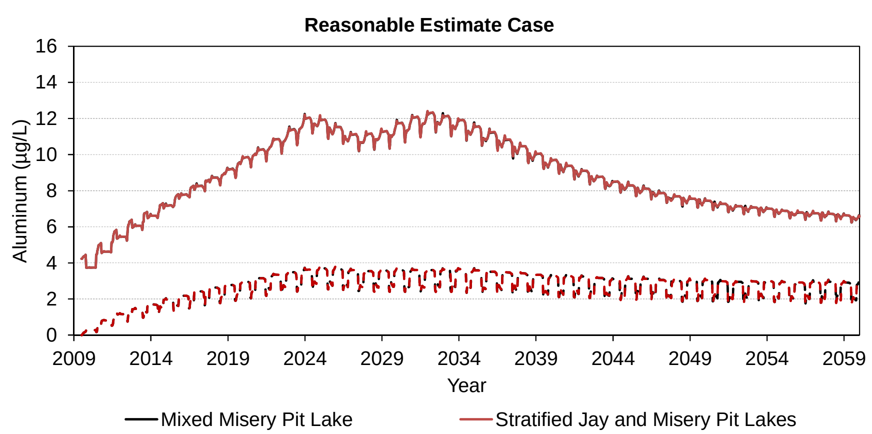
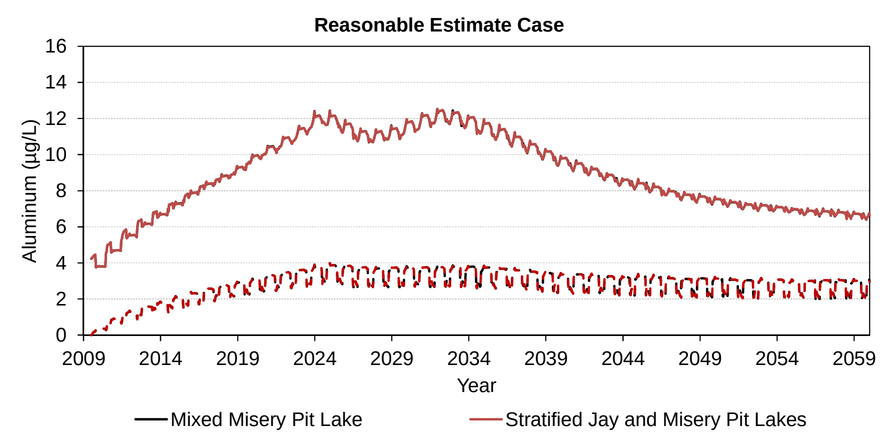


LDG-P3



LDG-P4



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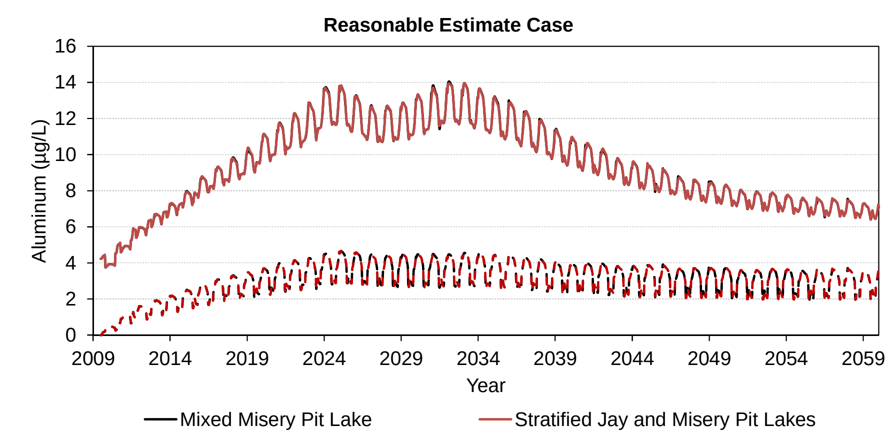


LDG-P6

Figure 24-27: Predicted Depth-Averaged Total and Dissolved Arsenic Concentrations in Lac de Gras– Scenario B

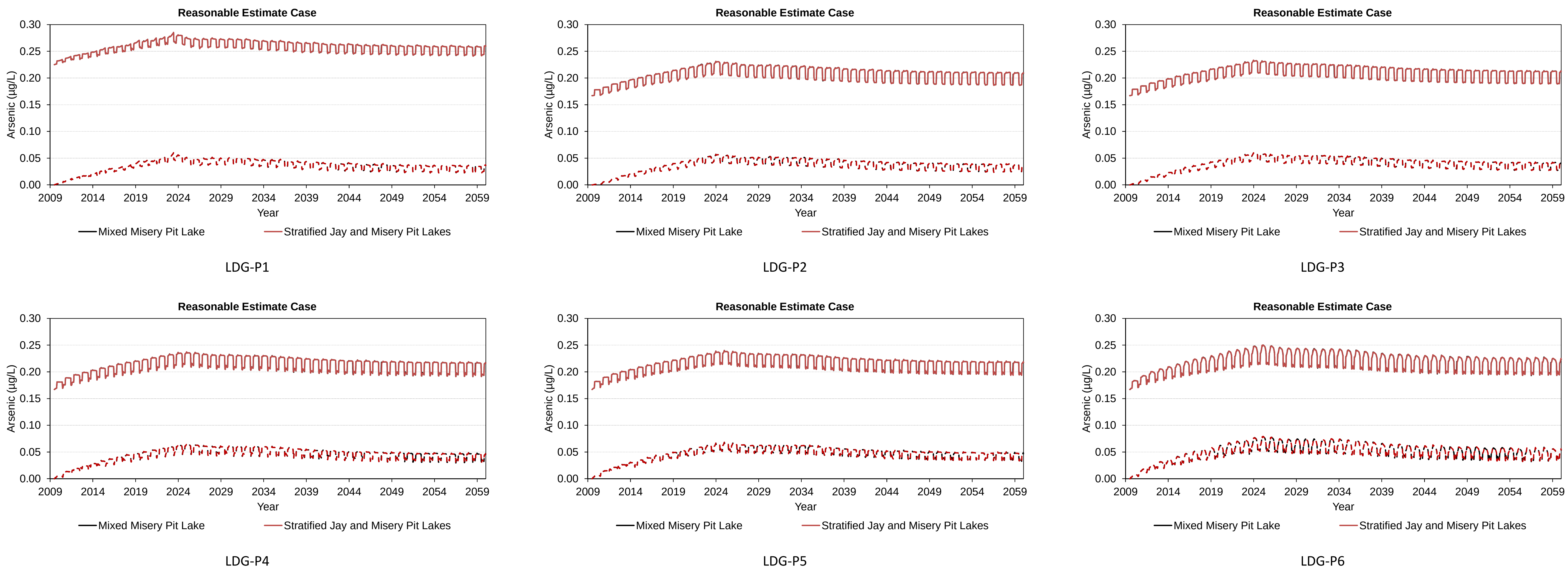
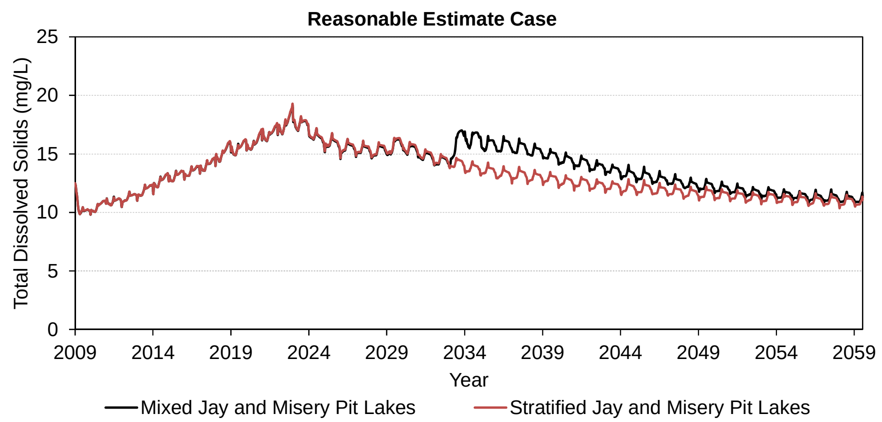
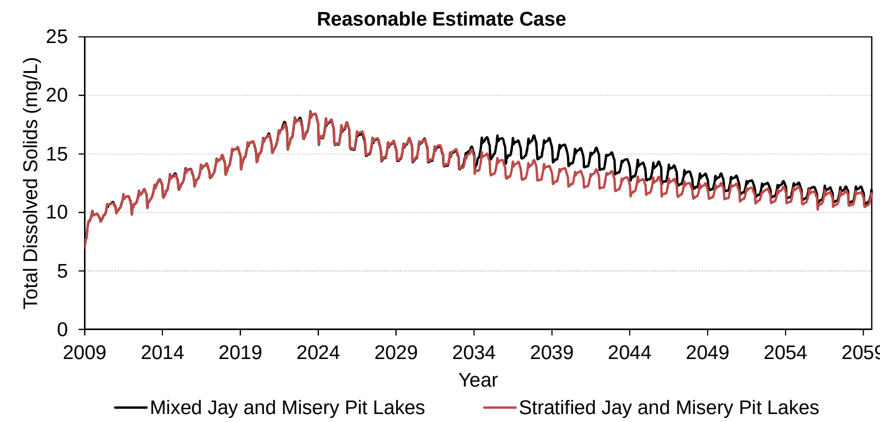


Figure 24-28: Predicted Depth-Averaged Total Dissolved Solids Concentrations in Lac de Gras– Scenario C



LDG-P1



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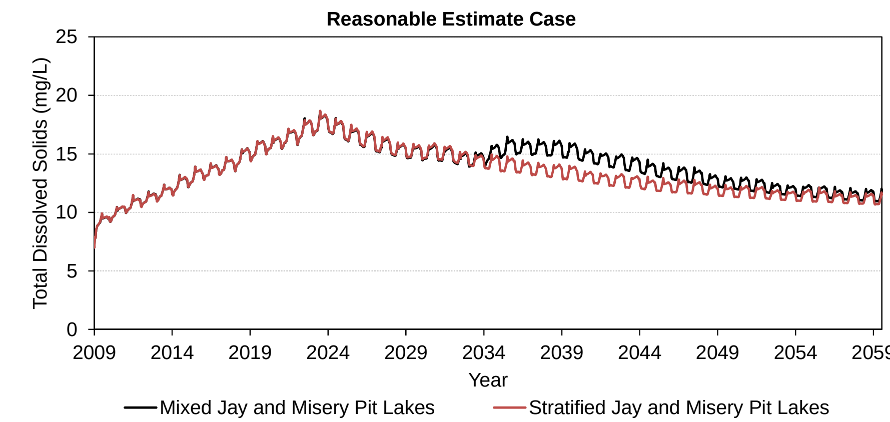

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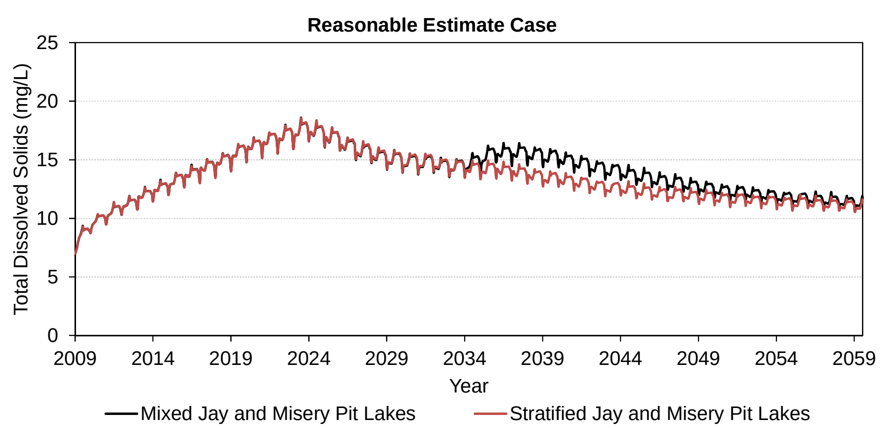

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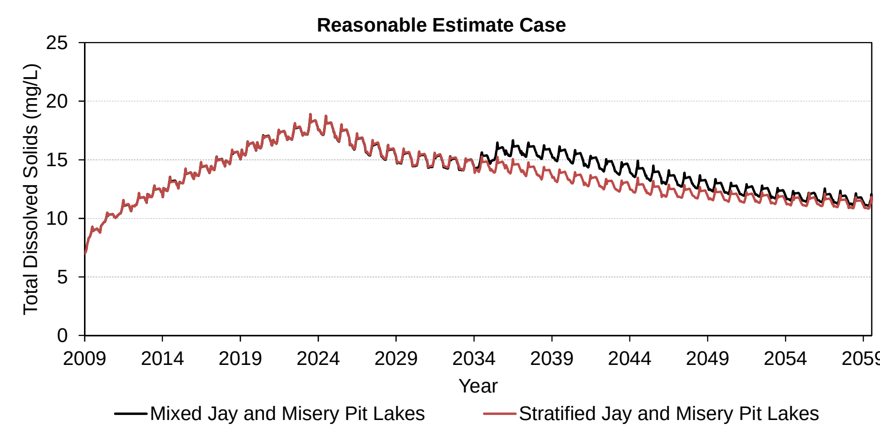

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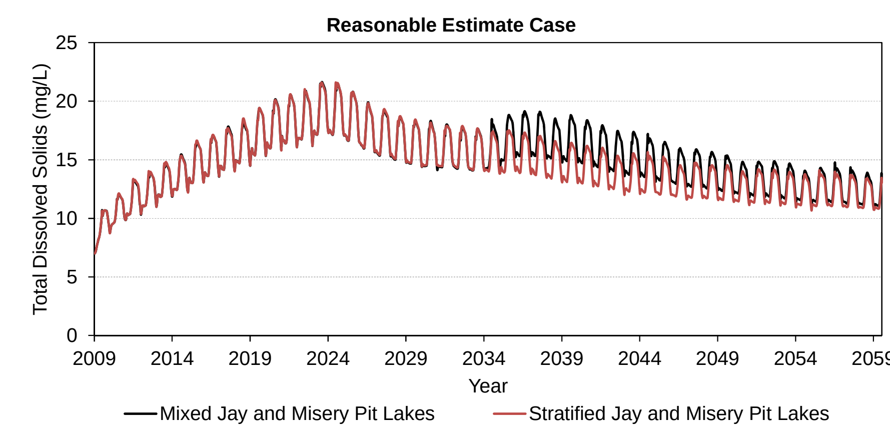
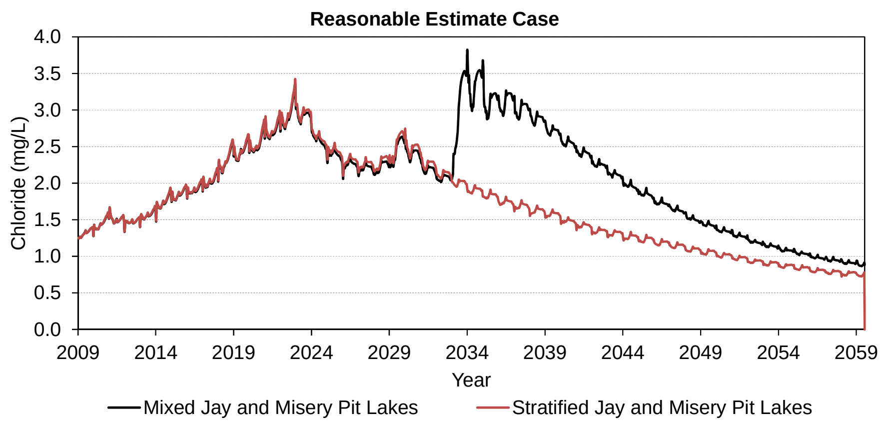
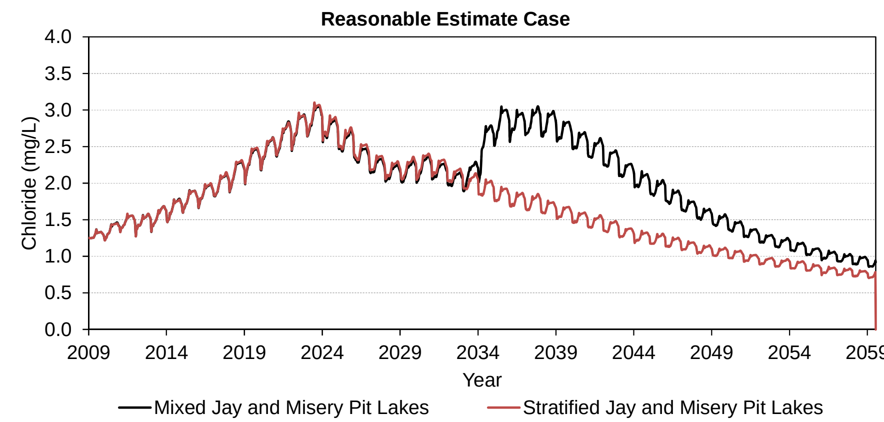


LDG-P6

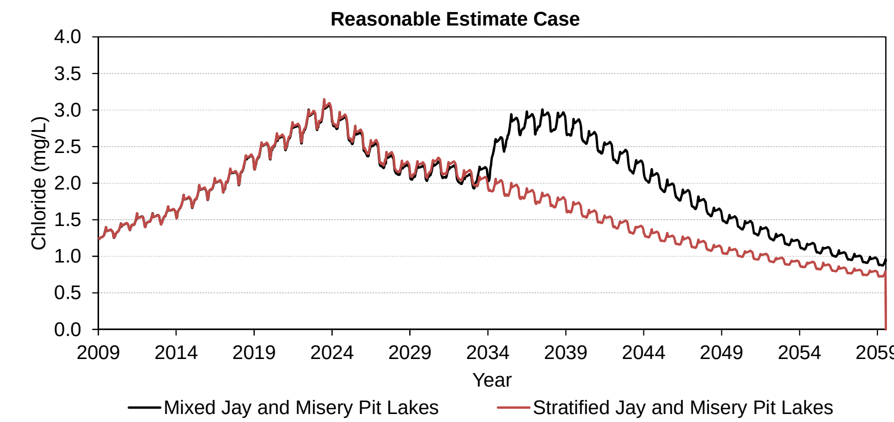
Figure 24-29: Predicted Depth-Averaged Chloride Concentrations in Lac de Gras– Scenario C



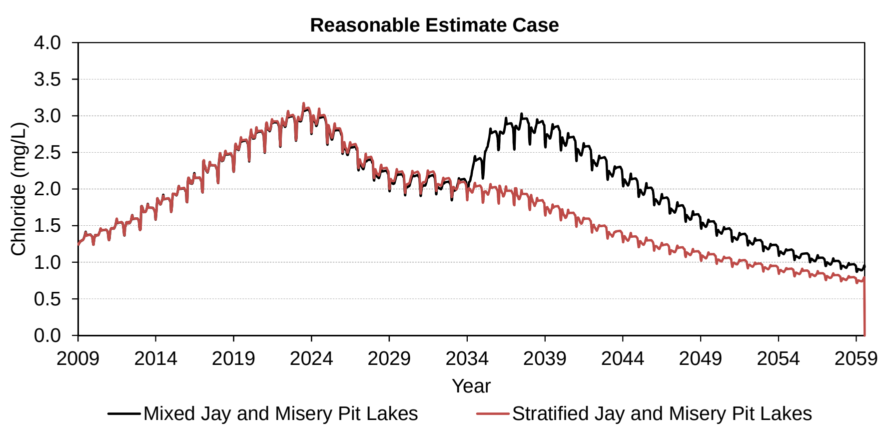
LDG-P1



LDG-P2



LDG-P3



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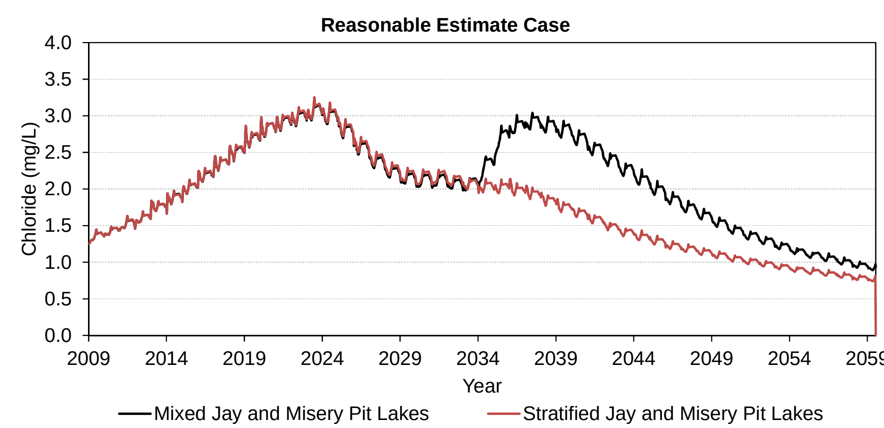

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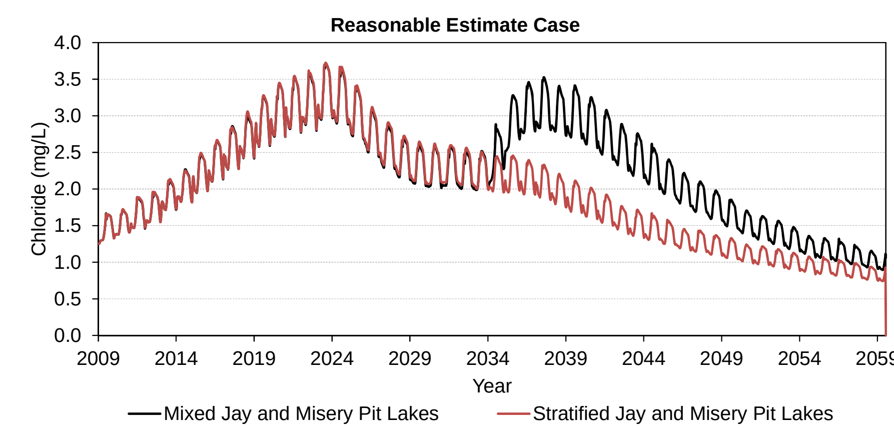
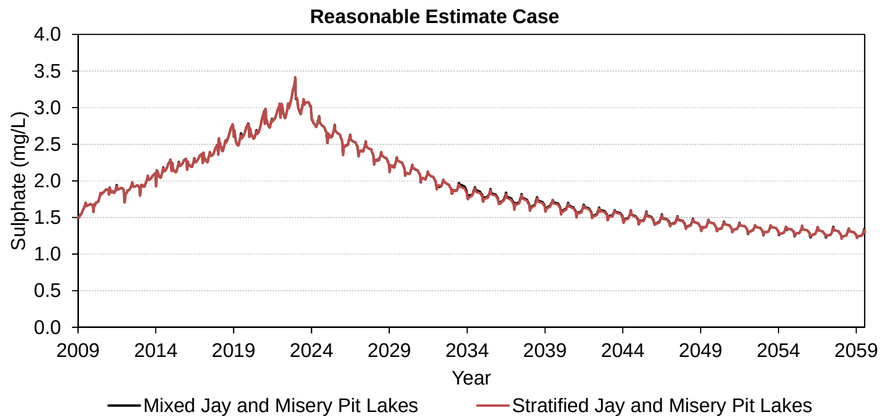


LDG-P6

Figure 24-30: Predicted Depth-Averaged Sulphate Concentrations in Lac de Gras– Scenario C



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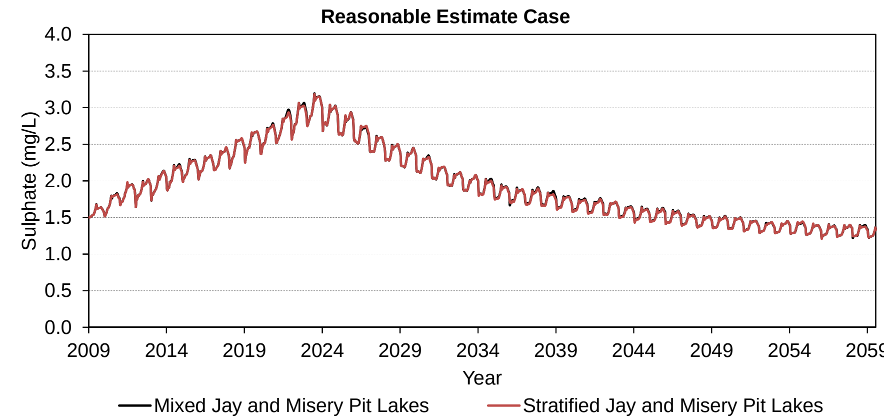

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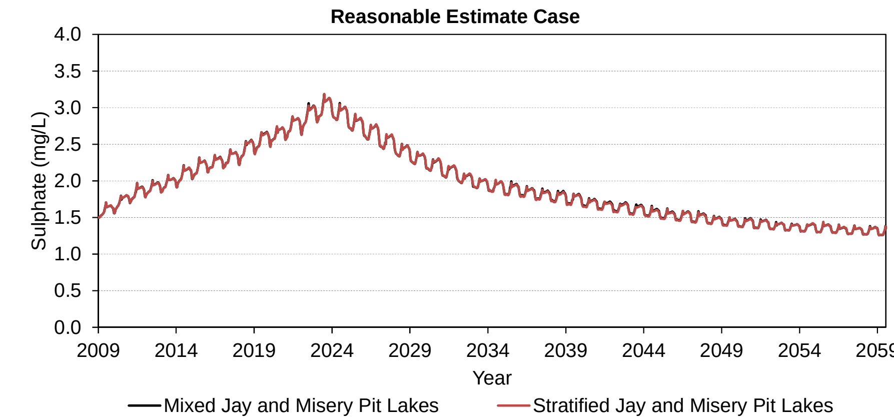

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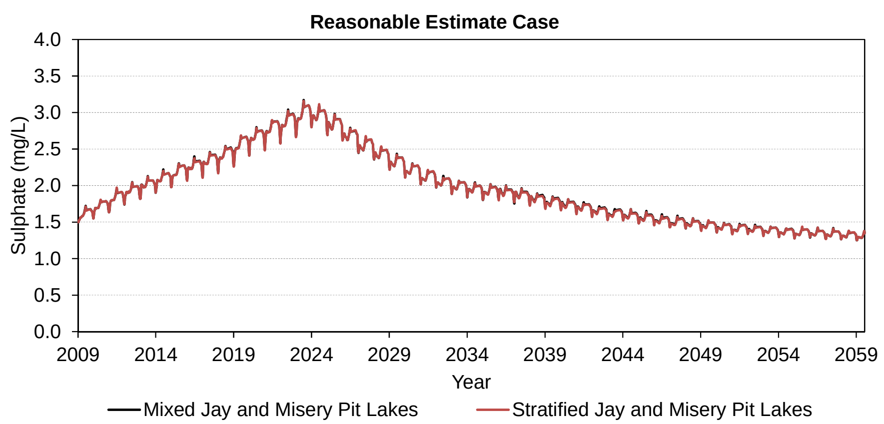

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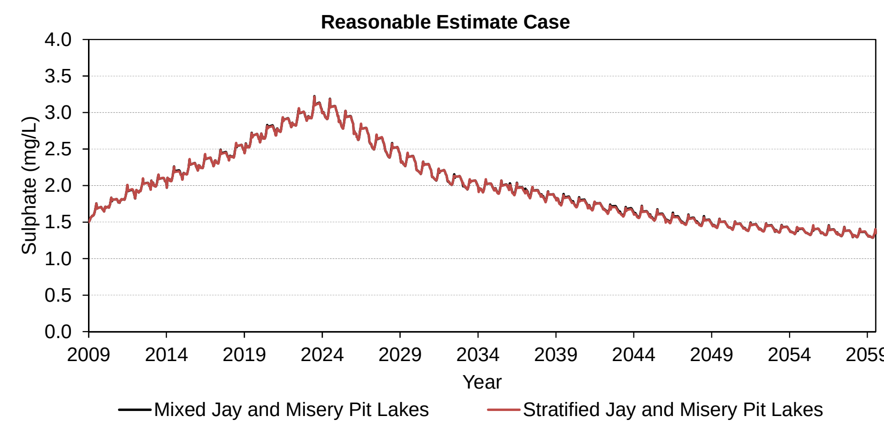

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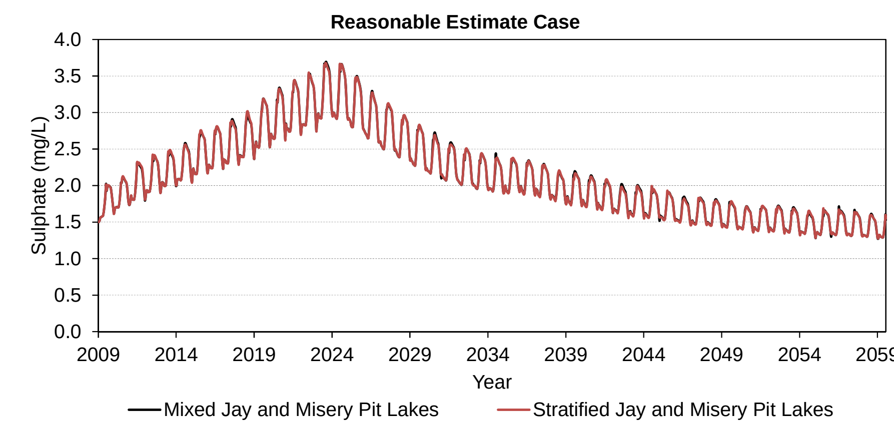

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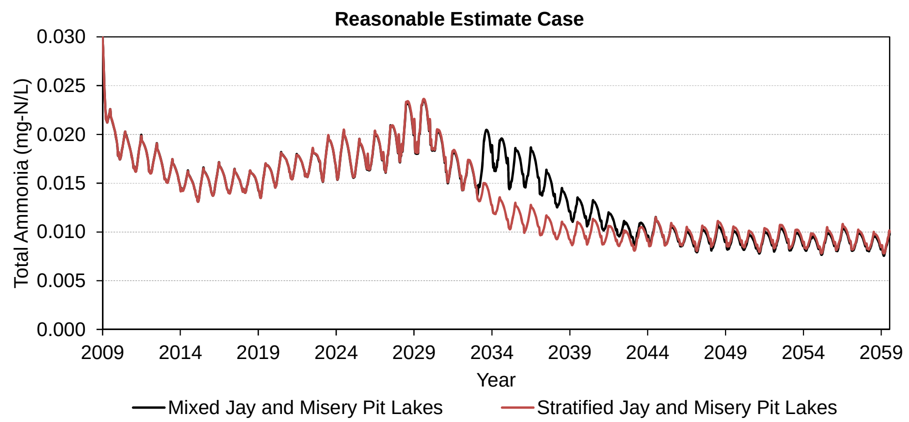
Figure 24-31: Predicted Depth-Averaged Total Ammonia Concentrations in Lac de Gras– Scenario C



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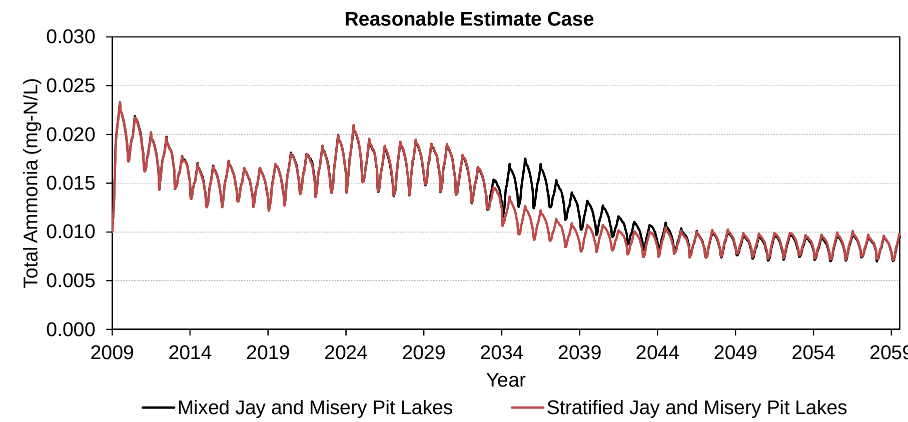

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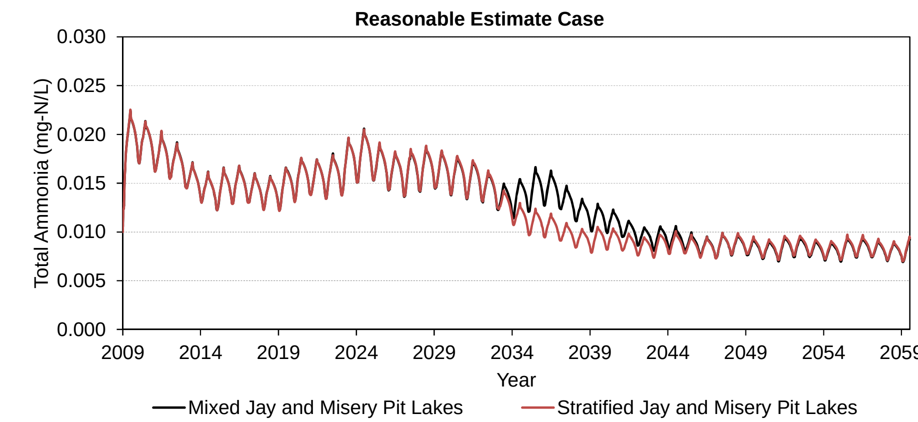

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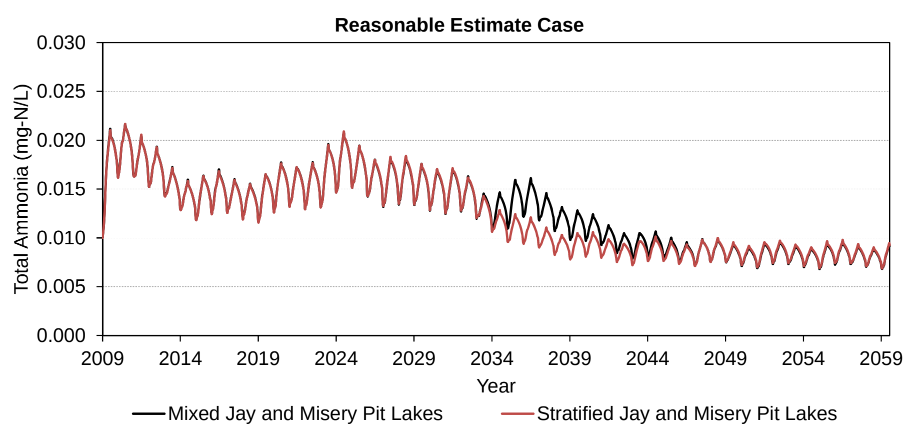

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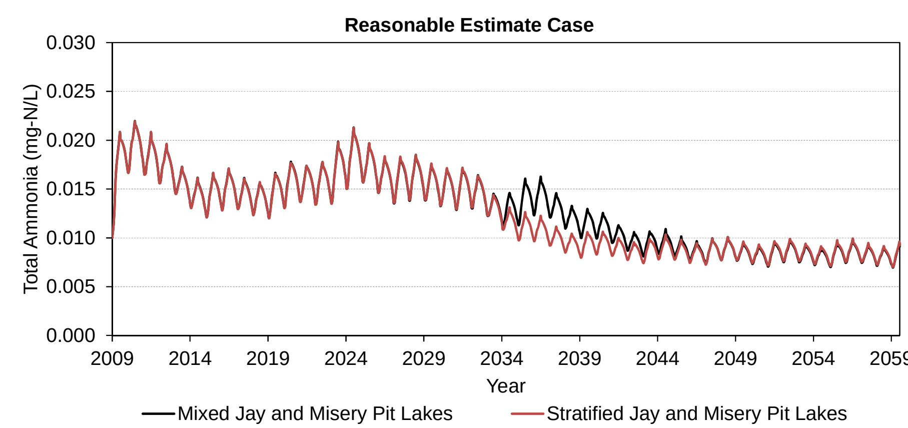

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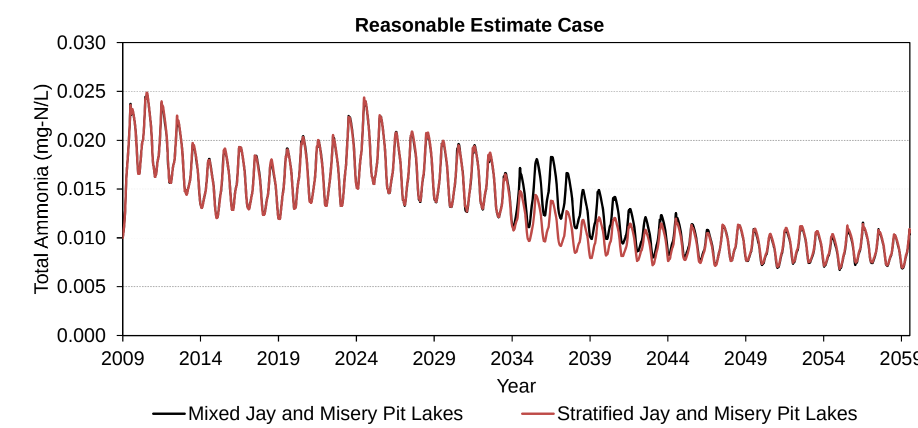

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Figure 24-32: Predicted Depth-Averaged Nitrate Concentrations in Lac de Gras– Scenario C

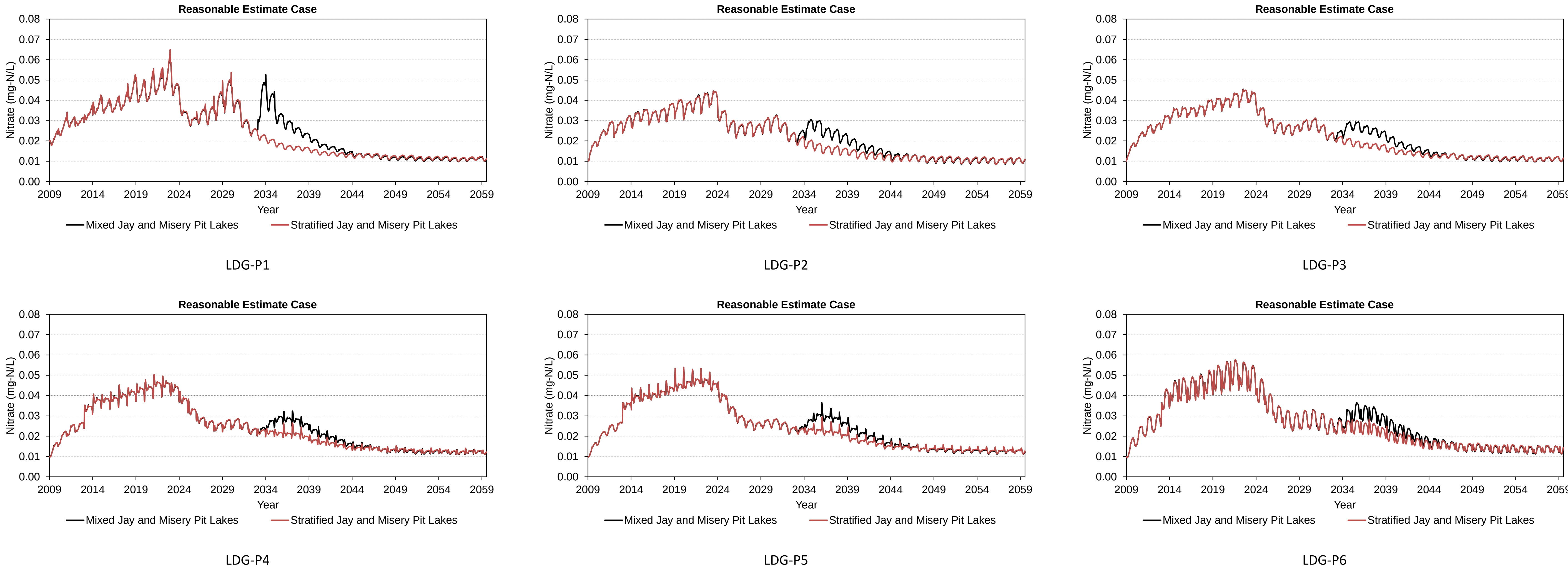
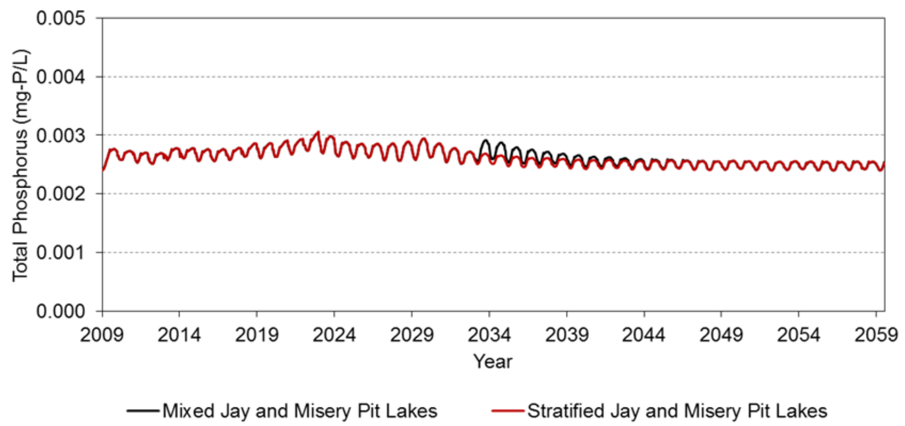


Figure 24-33: Predicted Depth-Averaged Total Phosphorus Concentrations in Lac de Gras– Scenario C



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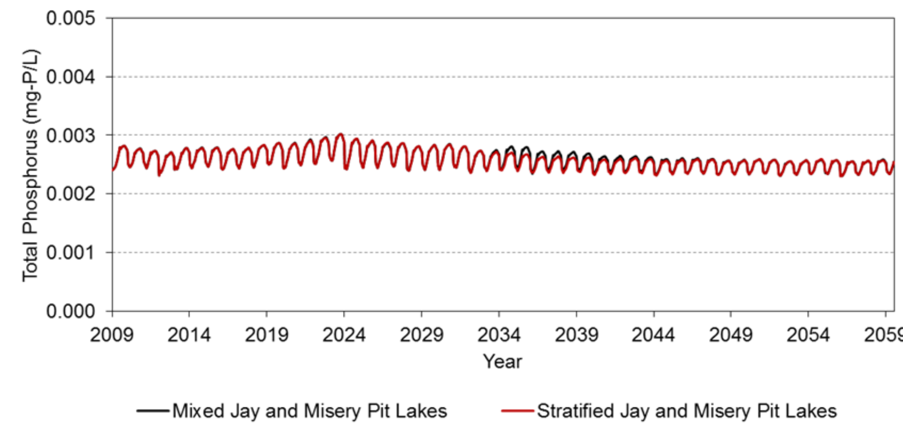

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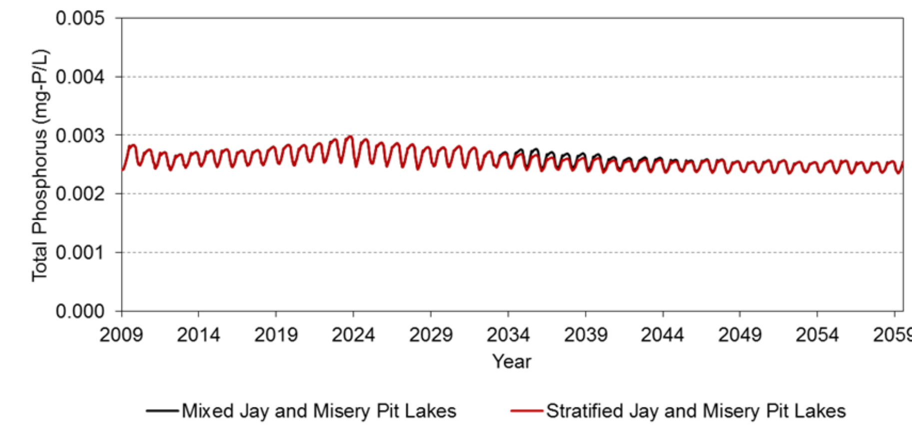

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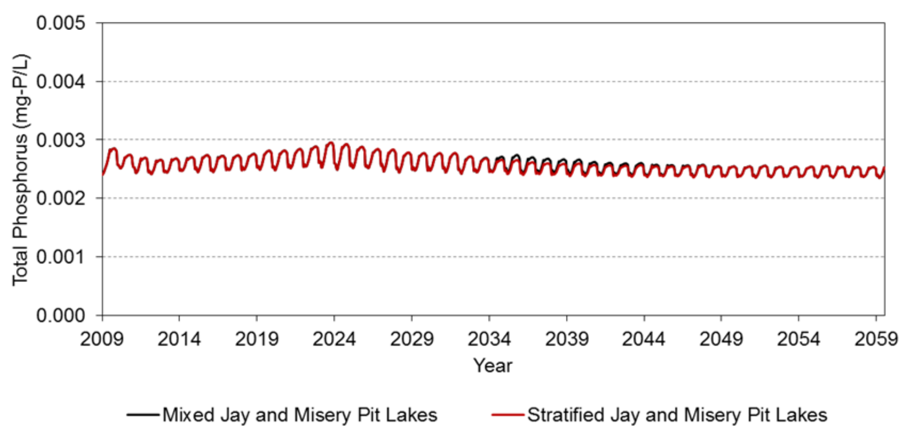

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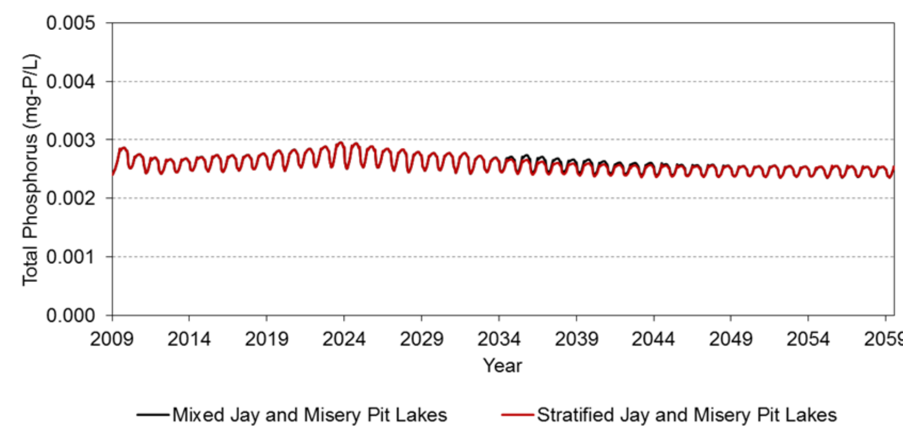

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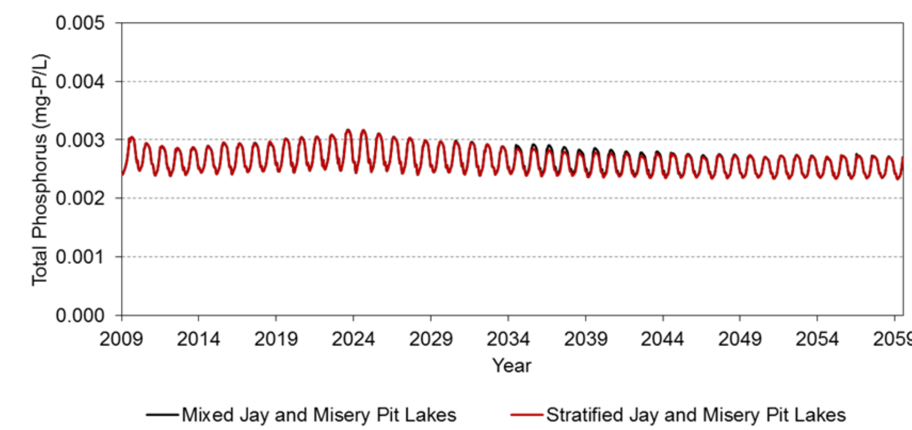
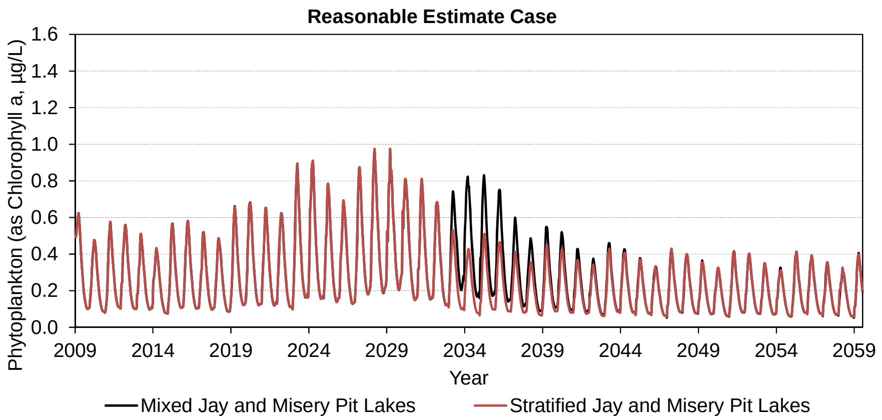


LDG-P6

Figure 24-34: Predicted Depth-Averaged Phytoplankton Concentrations in Lac de Gras– Scenario C



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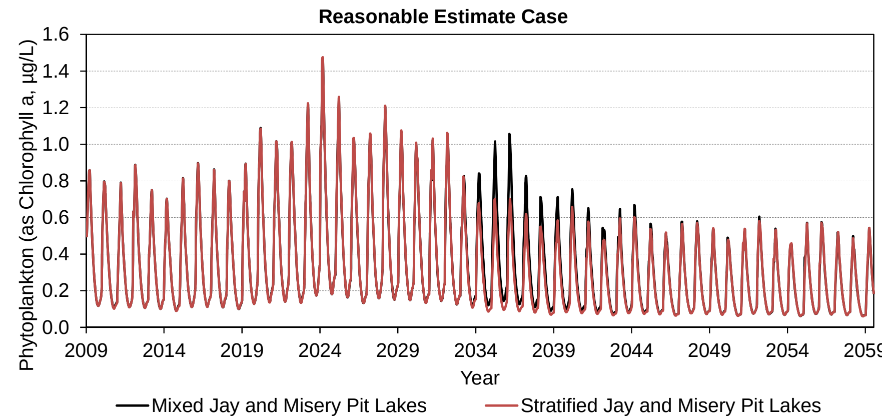

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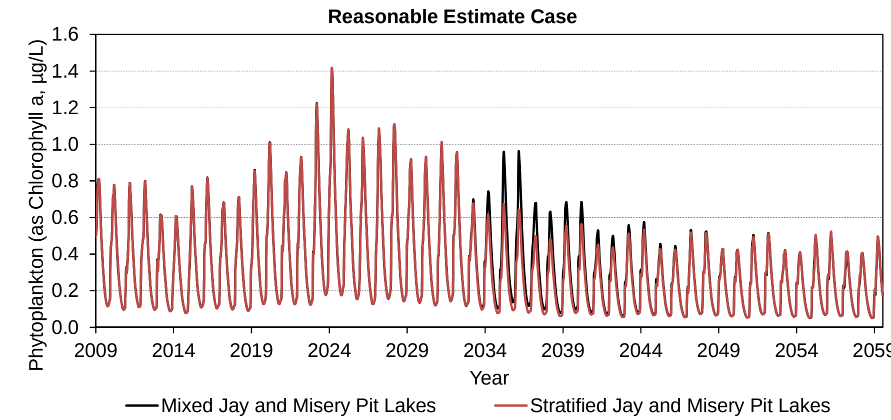

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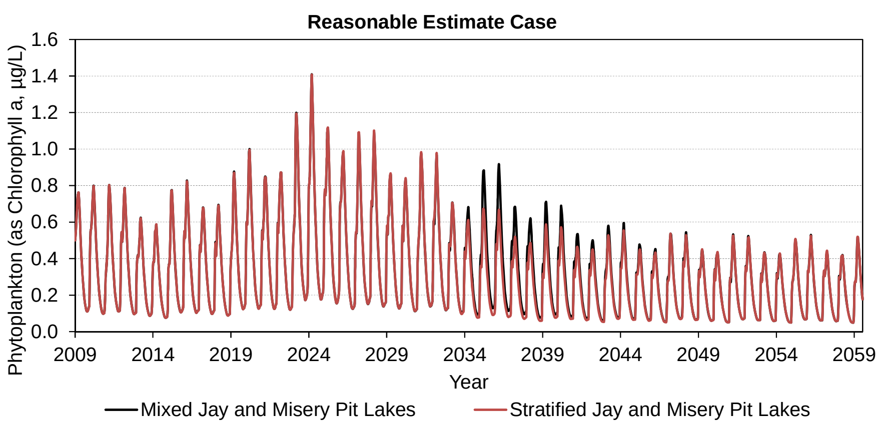

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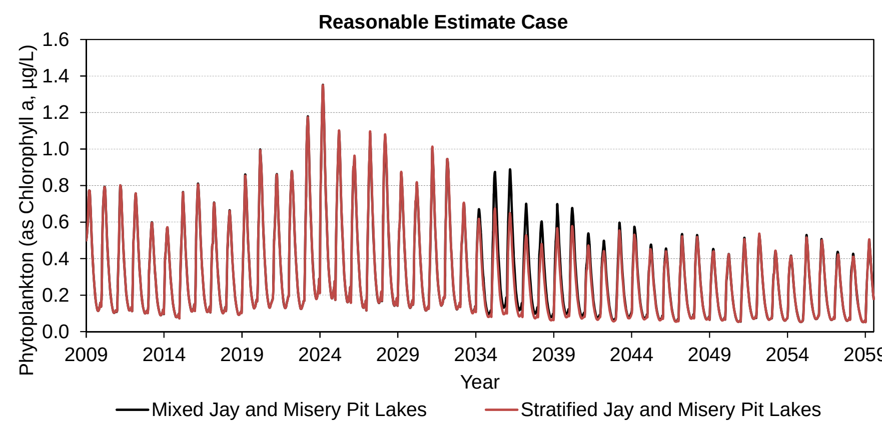

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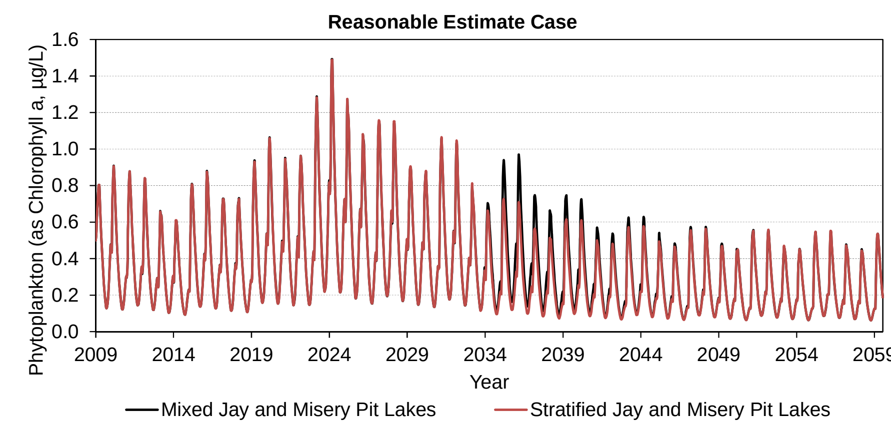

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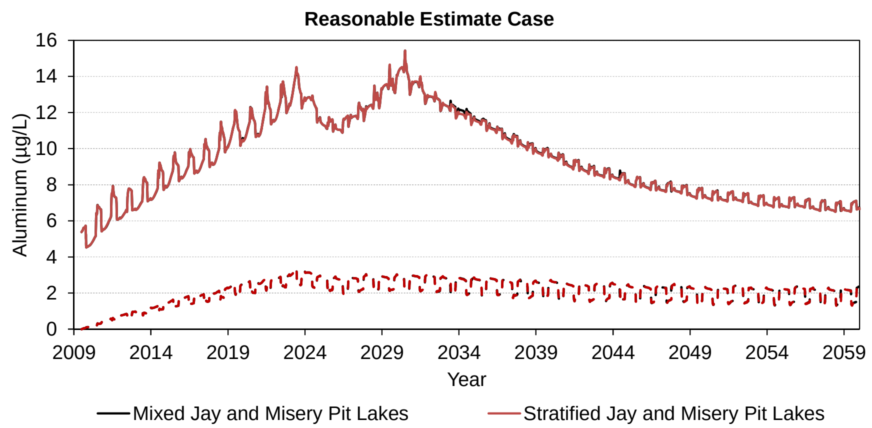
Figure 24-35: Predicted Depth-Averaged Total and Dissolved Aluminum Concentrations in Lac de Gras– Scenario C



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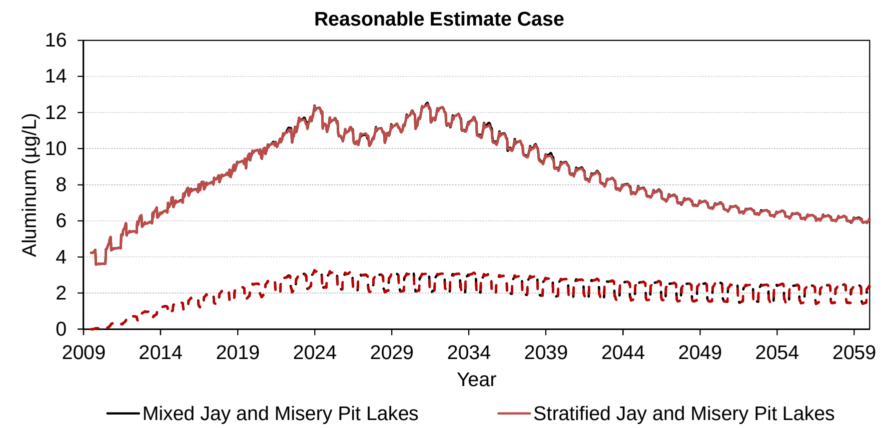

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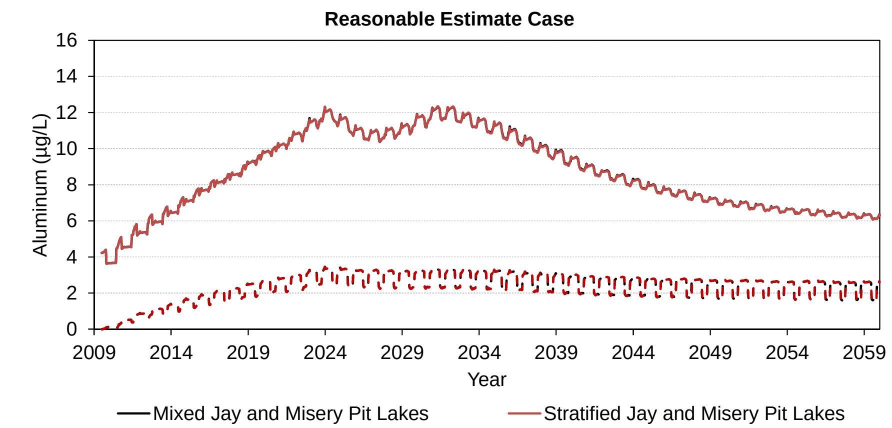

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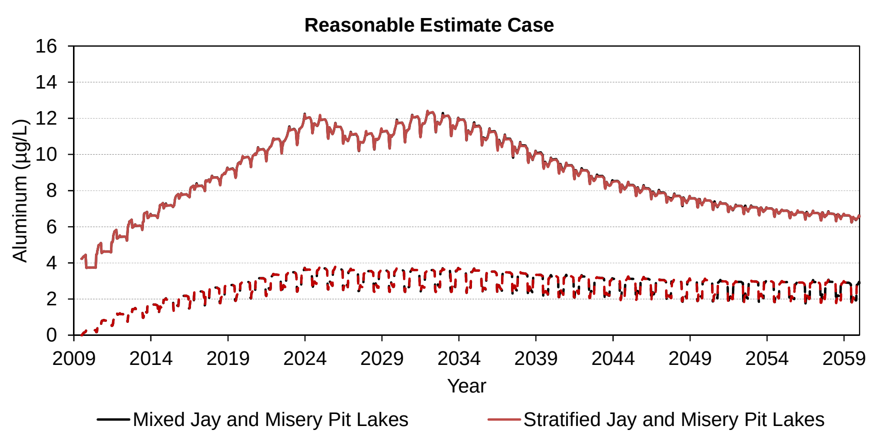

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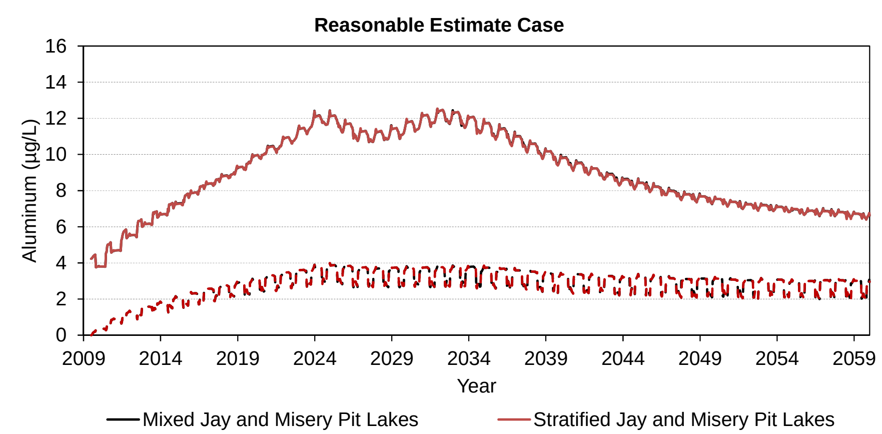

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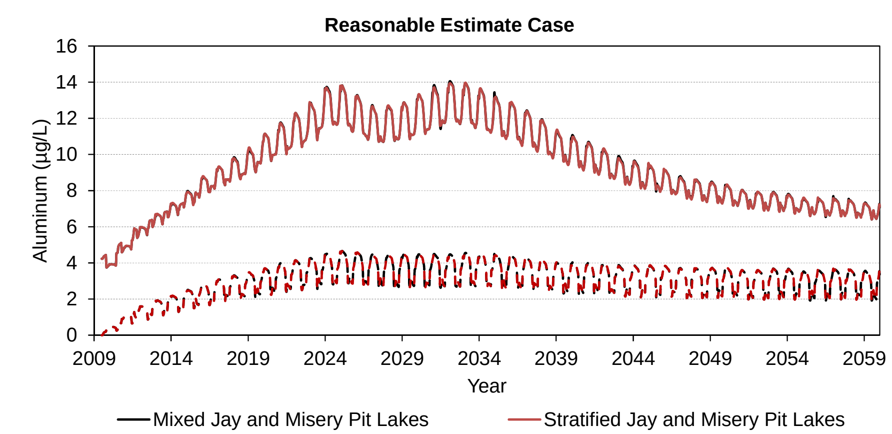
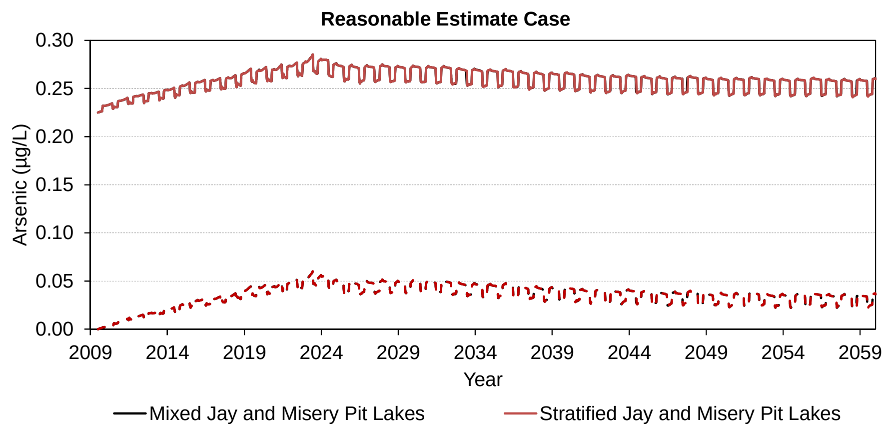


LDG-P6

Figure 24-36: Predicted Depth-Averaged Total and Dissolved Arsenic Concentrations in Lac de Gras– Scenario C



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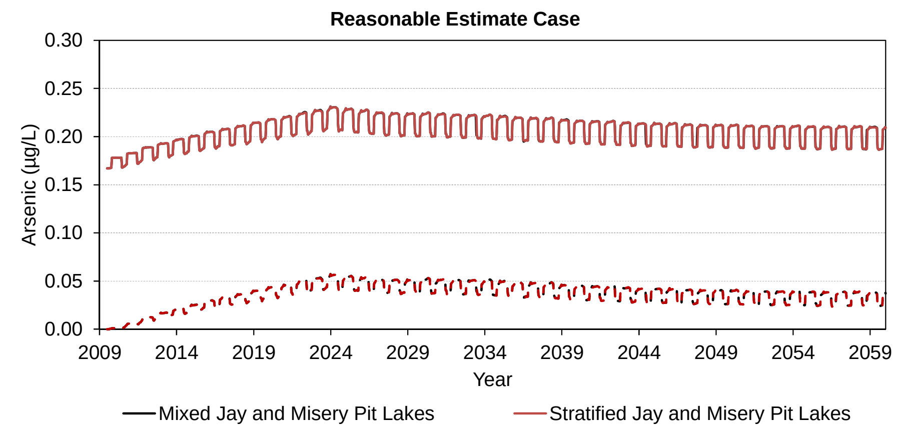

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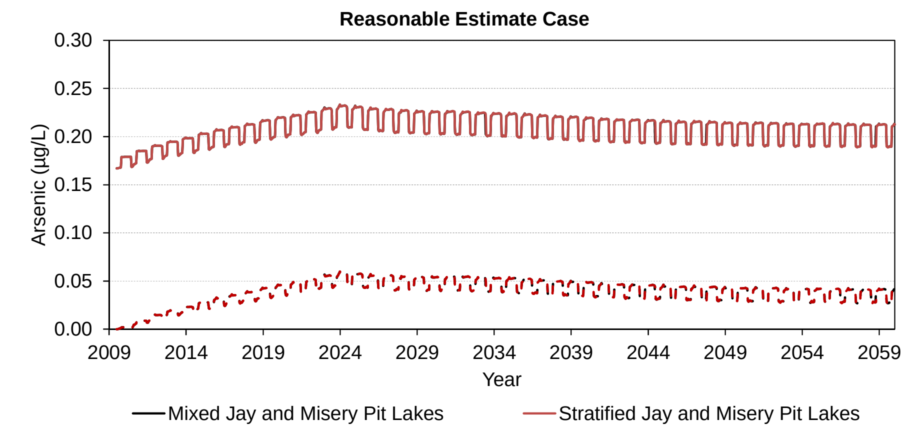

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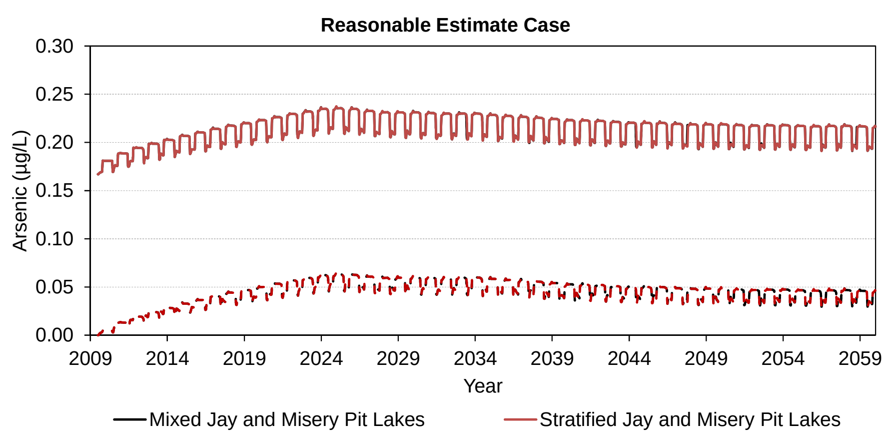

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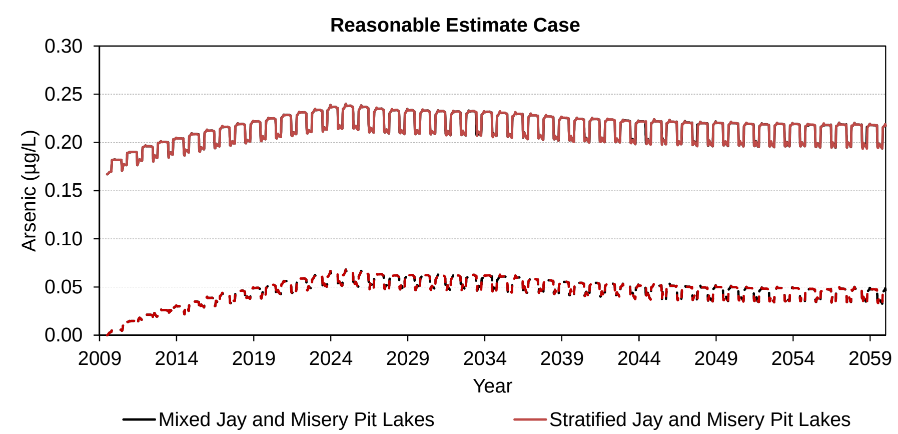

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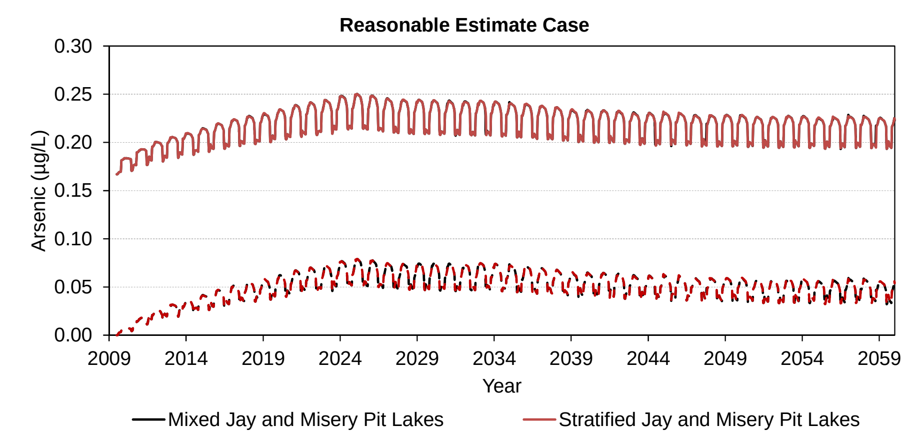


LDG-P6

Information Request Number:	DAR-MVEIRB-IR2-25
Source:	Mackenzie Valley Environmental Impact Review Board Information Requests from Chuck Hubert
Subject:	Water Quantity - the effect on the Narrows.
DAR Section(s):	Jay Technical Sessions (Transcript from 24-April-2015, page 24, follow-up from response to homework assignment 17)

Preamble (MVEIRB):

Dominion stated that the significance threshold for the Narrows would be if fish passage was prevented, "resulting in a long-term or permanent decrease in survival or reproduction rates which may decrease resilience and increase the risk to self-sustaining and ecological effective fish populations" and that this "would only occur if habitat fragmentation extended across multiple years..." Dominion stated that it considered it "highly unlikely" that water levels at the Narrows would ever be that low. The statement needs additional evidence to support it.

Request (MVEIRB):

Please quantify the likelihood of the Narrows approaching a level where fish passage may be inhibited. This will include consideration of a sequence of multiple years of below average rainfall for the Lac du Sauvage catchment area and the modelling predictions (see IR 26 below).

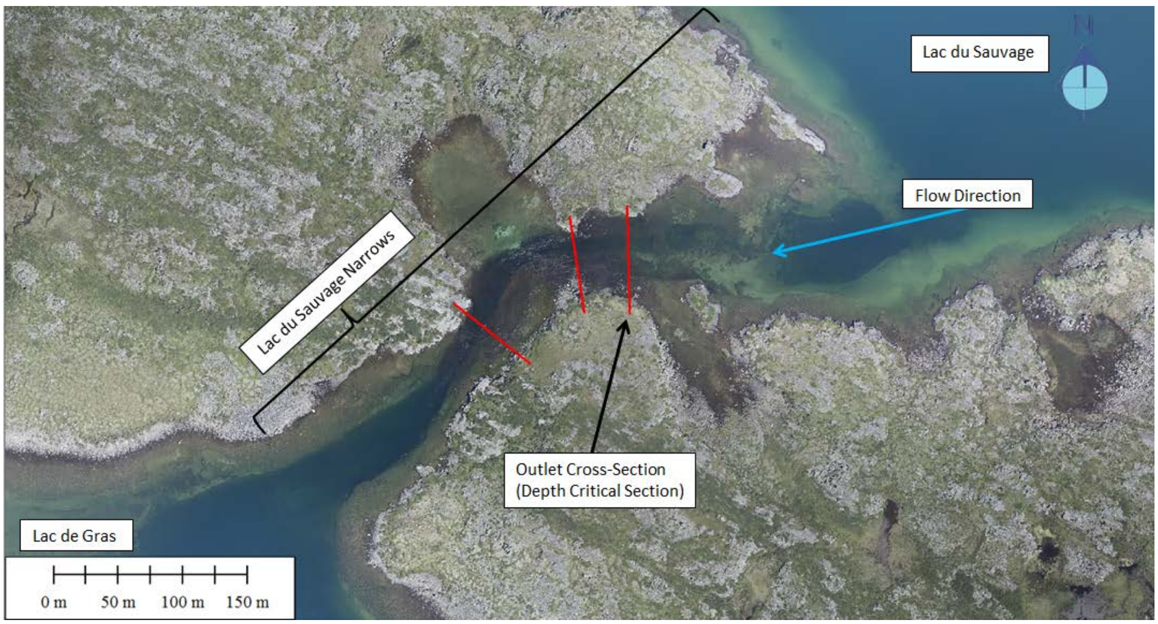
Response:

Assessments of the available water depth within the Lac du Sauvage Narrows (the Narrows) have been completed for all Jay Project (Project) phases in Section 8.5.3.2 of the Developer's Assessment Report (DAR), with available depths during the Jay Pit back-flooding presented in Section 8.5.3.2.4 of the DAR. The methods are discussed in Section 8D3.1.4 of Appendix 8D of the DAR. Figure 8.5-60 of the DAR (and Tables in Section 8D5.5.3.6 of Appendix 8D of the DAR) provides the predicted effects to the maximum depth (depth available for fish passage) at the critical outlet transect in the Narrows during back-flooding, with the assessment of these changes on fish habitat and passage in Section 9.4.3.3 of the DAR. For a full discussion of the available depths in the Narrows for baseline and all Project Phases, please refer to the above sections of the DAR. An overview discussion and derivation of percent exceedance curves is provided below to quantify the likelihood water levels approaching a critical level for passage for fish Valued Components (VCs; Arctic Grayling, Lake Trout, and Lake Whitefish).

The methodology to predict the available depths for fish migration during the Jay Pit back-flooding (the phase with the greatest potential reduction in Lac du Sauvage water levels) includes analysis of the second consecutive full year of pumping according to the proposed pumping schedule over the 1965 to 2013 climate data (with one-year time steps). This methodology captures the natural variability in climate trends including multiple years of below average precipitation (annual precipitation for all years is shown in Table B-4 in Appendix B of Annex X [Hydrology Baseline Report] of the DAR). Estimates are based on the pumping schedule without adaptive management of pumping rates as discussed in the responses to Round 1 Information Requests DAR-KIA-IR-108 and DAR-GNWT-IR-57. This is considered to be a conservative estimate, as this method does not include adaptive management (i.e., reduction of rate and/or duration) of the pumping based on the results of monitoring program proposed during the back-flooding period at the Narrows.

The critical transect that had limiting depths and widths was determined based on the surveyed transects. A plan view of the surveyed transects and the critical transect (the outlet transect with the lake sill) is shown in Figure 25-1.

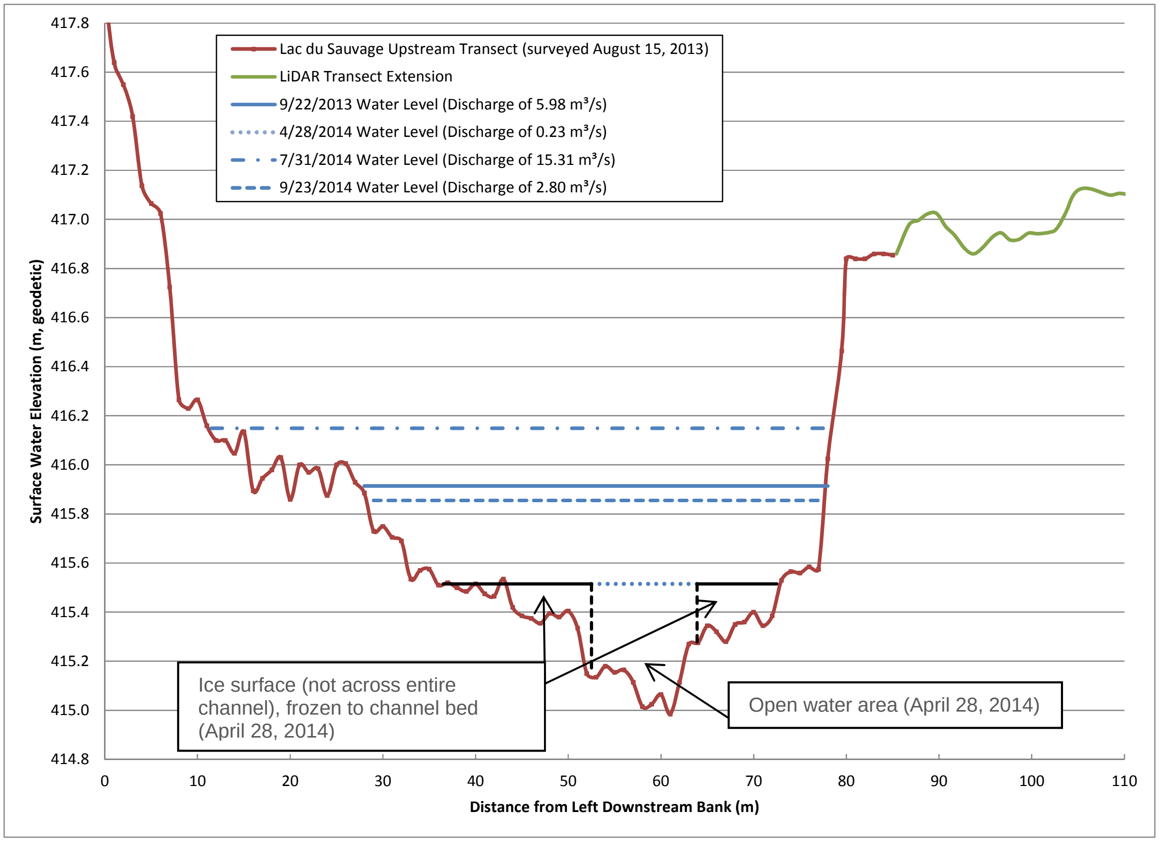
Figure 25-1 Lac du Sauvage Narrows 2013 Cross-Section Survey Locations



m = metre.

In addition to the plan view of transects, the critical transect for fish passage is shown in Figure 25-2. Surveyed water levels, including the lowest surveyed water levels during 2013 and 2014 field programs, are shown on the transect to provide context to the predicted maximum depths available for fish passage during low water periods.

Figure 25-2 Lac du Sauvage Narrows Outlet Cross-Section and Surveyed Water Levels (full range of all measured discharges during 2013 and 2014 field seasons)



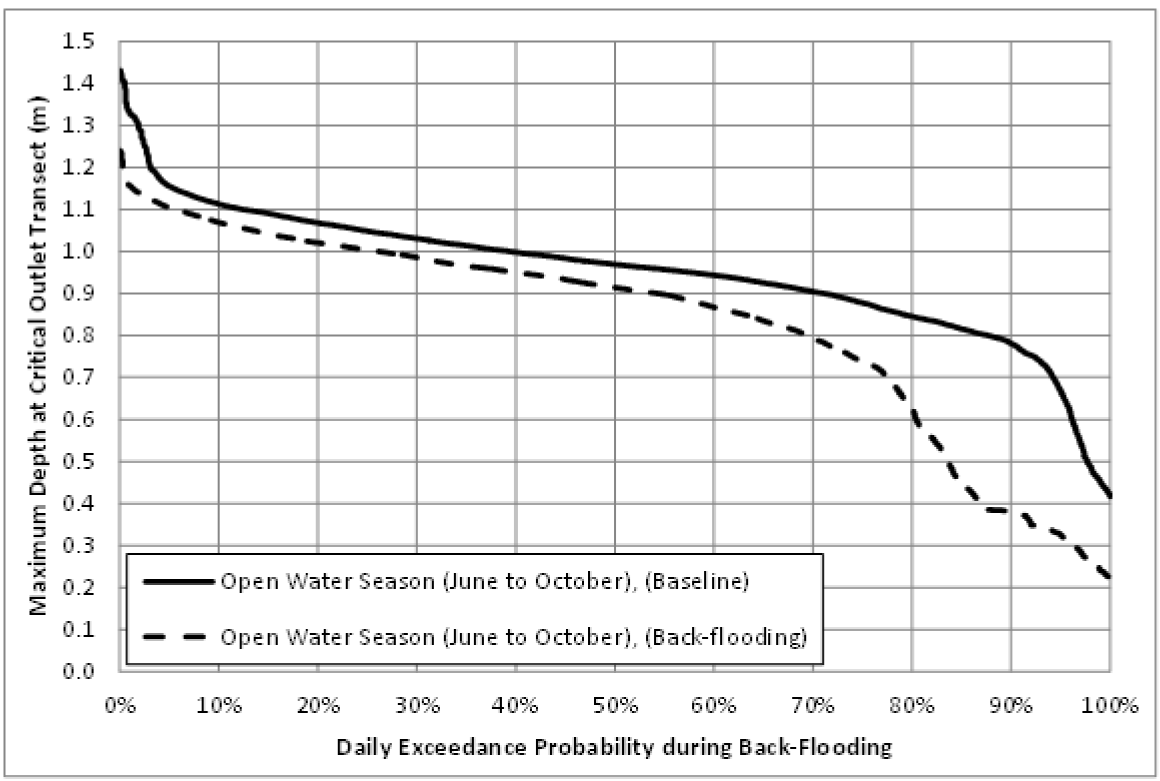
m = metre; % = percent.

To quantify the likelihood of water levels in the Narrows approaching a critical level during the Project, percent exceedance curves for the mean daily maximum depths at the critical outlet transect during back-flooding are shown below, followed by a discussion of the potential effects to fish migration. These curves consider the lower precipitation years across the derived climate record and are based on depths modelled during the second consecutive full year of pumping (i.e., the third year of pumping represents the year of largest changes; see DAR Figure 8.5-54). The predictions represent the maximum effect that may occur over the four year period of pumping.

Figure 25-3 shows the percent exceedance curves for the maximum depths at the critical outlet transect over the open-water season at the Narrows (estimated as June to October). The cases presented include baseline conditions and during back-flooding over the period of record. Figure 25-4 shows the shows the percent exceedance curves for the maximum depths at the critical outlet transect at the Narrows during June and October. These months were selected as they show the greatest reduction in depth during the open-water period and are also important months for fish movements: June for potential spawning migrations by Arctic Grayling, and October for potential spawning migrations by Lake Trout and Lake Whitefish and also overwintering movements for fish.

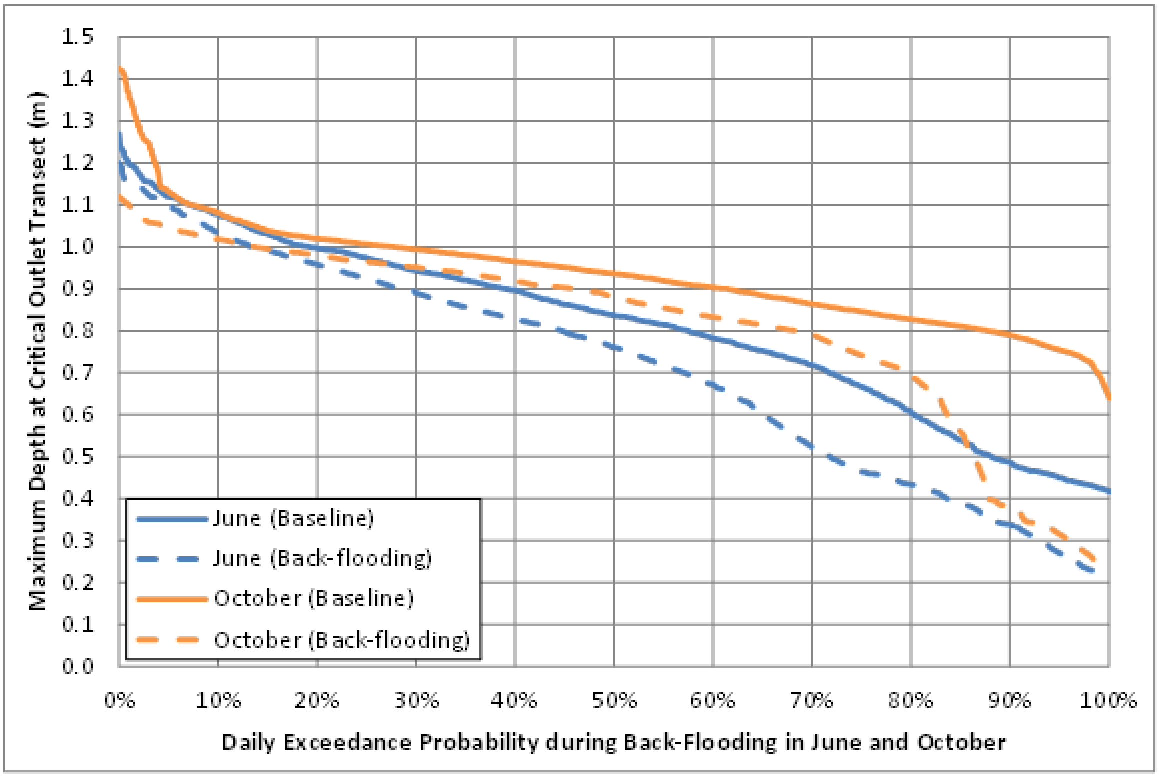
Based on the plots of depth, it can be noted that the depth associated with the 90% exceedence value under baseline conditions (i.e., a naturally low-flow condition) would be equalled or exceeded 70% of the time under back-flooding conditions. Although a shift in the frequency of lower flow conditions is expected, the absolute depth present at the Narrows is likely still sufficient to allow for fish passage. Minimum depths to achieve fish passage are typically in the range of 0.2 m to 0.3 m based on available literature for fish passage of large-bodied salmonids (0.2 m identified in Dryden and Stein [1975]; Webb [1975]; Bell [1986]; Government of British Columbia [2013]; 0.3 m identified in State of California [2002]). Using 0.3 m as a conservative threshold, it is predicted that 95% of the flow conditions encountered during back-flooding would allow for fish passage and depths will remain above 0.2 m under the current pumping regime without additional mitigation (Figure 25-3). Furthermore, depths will remain above 0.3 m more than 90% of the time during June and October when migratory movements may be occurring (Figure 25-4). In the event that flows dropped below a depth that could inhibit fish passage, additional mitigations would be implemented, such as reduced pumping rates or complete stoppage of pumping until water levels increased.

Figure 25-3 Percent Exceedance Curves for Maximum Channel Depths at the Lac du Sauvage Narrows Critical Transect for Fish Passage under Baseline and Back-flooding Conditions



m = metre; % = percent.

Figure 25-4 Percent Exceedance Curves for Maximum Channel Depths at the Lac du Sauvage Narrows Critical Transect for Fish Passage under Baseline and Back-flooding Conditions



m[2]/s = cubic metres per second; LiDAR = iight detection and ranging; m = metre.

In summary (as stated in the DAR Section 9.6.2), the effects to habitat in Lac du Sauvage Narrows related to pumping water from Lac du Sauvage to back-flood the Jay Pit and diked area are expected to be low in magnitude, short-term (i.e., less than four years), and regional in geographic extent. During anticipated low flow time periods, pumping rates out of Lac du Sauvage into the pits and dewatered area may be reduced and pumping rates may be managed, which will further reduce the downstream effects. Any effects to fish VCs would be reversible upon the cessation of back-flooding activities.

References:

Bell MC (Ed). 1986. Fisheries handbook of engineering requirements and biological criteria. Report No. NTIS AD/A167-877. Fish Passage Development and Evaluation Program, U.S. Army Corps of Engineers, North Pacific Division, Portland, Oregon USA.

Dryden RL, Stein JM. 1975. Guidelines for the protection of the fish resources of the Northwest Territories during highway construction and operation. Technical Report No. CEN/T-75-1. Department of the Environment, Fish and Marine Service.

Government of British Columbia. 2013. Culvert and fish passage. British Columbia Ministry of Transportation and Infrastructure. Updated May 2013. 9 pp.

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Webb PW. 1975. Hydrodynamics and energetics of fish propulsion. Bulletin of the Fisheries Research Board of Canada 190: 159.

DOMINION DIAMOND

Information Request Number: DAR-MVEIRB-IR2-26

Source: Mackenzie Valley Environmental Review Board Information Requests from Chuck Hubert

Subject: Closure - confidence in closure predictions for meromixes within Misery Pit and effect on the Narrows.

DAR Section(s): 8; Jay Project Water Quality Modelling Compendium

Preamble (MVEIRB):

Not enough evidence has been presented to demonstrate the potential quality of water that would overflow from the Misery Pit to Lac de Gras after closure and the potential effects of changing water levels throughout the life of the Jay project on the Narrows. The modelling completed by Dominion was done for what it considers a "worst case scenario." This worst case was described by Dominion as representing an over-estimate of the amount of groundwater to manage and of the TDS concentrations. The Review Board has concerns related to the potential effects from overestimating the quantity and quality of the water and needs to understand the range of possible outcomes in order to understand what the likely significant adverse impacts may be. The Review Board is particularly concerned with:

- Possible outcomes related to the quality of water discharged to Lac du Sauvage during operations;
- The effect of decreased water levels and flows at the Narrows, and;
- The quality of the overflow from Misery to Lac de Gras post closure.

Request (MVEIRB):

Please provide the range of possibilities for the water predictions and, at a minimum, consider the following:

1. a reduction in the amount of water from the diked area pumped to Misery Pit during construction. The BGC report prepared for the Diavik A21 pit noted that 74% of the water within the diked off area for A418 was pumped directly to Lac de Gras. The modelling completed by Dominion assumed 50% of the water would be pumped to Misery. At a minimum, Dominion should consider 74% of water being discharged to Lac du Sauvage.

2. a reduction in rainfall. The water balance modelling assumed average rainfall for the duration of the model (construction to closure). If rainfall is below average the proportion of freshwater within the Misery pit would decrease. This would affect the quality of the water discharged during operations and the quality of the overflow water during post-closure. Dominion should complete the water balance model using the observed rainfall in the area and output the full range of realizations;

3. a range of TDS concentrations. TDS concentrations vary with depth. A range of TDS profiles should be considered. This should be presented in such a way that the Review board can have a clear understanding of the range of possible outcomes and should at a minimum consider the lower bound and upper bound limits for total dissolved solids with depth as described in the DAR.

4. a reduction in the groundwater quantity:

   - Dominion stated during the technical session (April 22, 2015 transcript, page 31, lines 15 - 24) that the hydraulic conductivities used in the model were not consistently observed during the 2015 drill program. A reduction in hydraulic conductivity would reduce the amount of groundwater to manage. Dominion will consider a range of hydraulic conductivity values for the EPZ and competent bedrock for depths to estimate how this may affect the water quality and quantity predictions. The competent bedrock should also be assessed since a reduction in EPZ flows may increase the proportional contribution of the competent bedrock. The estimates should consider both the upper and lower bounds.
   - The EPZ is continuous in the model (vertically and laterally). Related to the vertical dimensions, Dominion used EPZ widths of 100 m and 60 m and demonstrated that the width affects the amount of groundwater. Dominion will provide evidence to if smaller widths are possible and provide quantity and quality estimates with the smaller width.
   - Regarding the lateral extent of the EPZ, Dominion stated in the technical session (April 22 transcript, page 32) that a shorter range (2 km as opposed to over the entire model domain) reduced groundwater flows by 24%. This should be considered in the estimated range of predictions. Dominion will present evidence about what the extents for the groundwater model could be and provide estimates for groundwater predictions that reflect those extents.

The model predictions should be provided in detail and should describe the likelihood of the estimates quantitatively.

Response:

Question 1

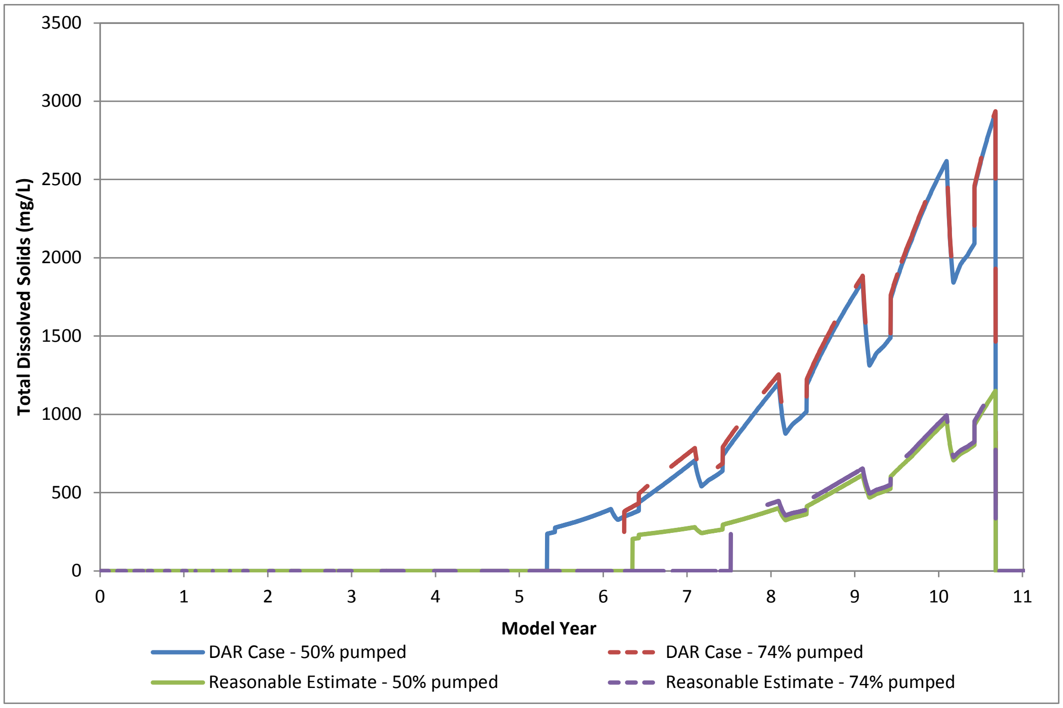
The water balance model was updated to include the assumption that 74 percent (%) of the water in the diked area bounding the Jay Pit development would be pumped to Lac du Sauvage during construction. The remaining 26% of the water is assumed to be pumped to Misery Pit. All other inputs to the model were unchanged from those presented in the Developer's Assessment Report (DAR).

To evaluate the influence of this change on water quality, total dissolved solids (TDS) concentrations in Misery Pit discharge were evaluated for the DAR and reasonable estimate cases. Updated predictions for these parameters are provided in Figure 26-1, respectively. For comparison, the results assuming only 50% of the water is pumped from the diked area to Lac du Sauvage during construction are also presented.

Pumping of an additional 24% of water stored in the diked area to Lac du Sauvage results in numerical differences in the TDS concentrations of the Misery Pit discharge, but it does not result in a material change to the discharge water quality. For example, minor increases in TDS concentrations are observed during the first two years of discharge from Misery Pit (Figure 26-1). This is the result of less freshwater being pumped to the Misery Pit during dewatering and the Misery Pit containing a higher proportion of groundwater in comparison to the scenario that includes pumping 50% of the water from the diked area. However, by the end of mine life, the projected Misery Pit discharge TDS concentrations under the 74% scenario are similar to concentrations assuming 50% of the water stored in the diked area is pumped to Lac du Sauvage. The results also indicate that pumping of additional water from dewatering the diked area to Lac du Sauvage during construction delays the requirement to operational discharge from the Misery Pit by approximately one year (Figure 26-1).

The actual volume of water to be pumped to Misery Pit during construction will be based on the observed total suspended solids (TSS) concentrations in the diked area during dewatering. The two sensitivity analyses completed (i.e. pumping of 50% and 74% of water in the diked area) indicate the Misery Pit discharge is not sensitive to the volume of water pumped during construction and peak TDS concentrations are similar for both scenarios.

Figure 26-1 Projected Total Dissolved Solids Concentrations under Two Diked Area Dewatering Scenarios – Misery Pit Discharge



mg/L = milligrams per litre; % = percent.

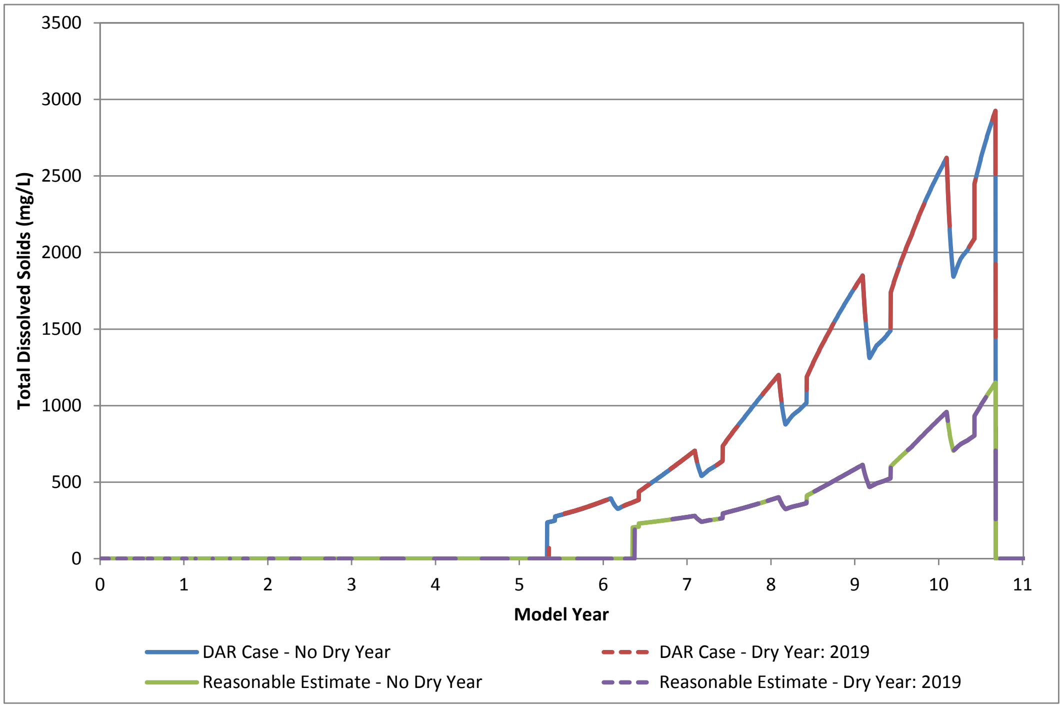
Question 2

To evaluate changes to water quality predictions, the model was updated to include a 1-in-100 dry year precipitation depth (referred to as the dry year) based on the climate data used in the DAR. It is unlikely that consecutive dry years will occur throughout the life of the Project; therefore, in each model iteration, only one dry year was assumed to occur of the Project life, with all other years represented by average precipitation years. The following three model iterations were completed:

- Iteration 1 – dry year occurs in Year 1 of operations;
- Iteration 2 – dry year occurs in Year 5 of operations; and,
- Iteration 3 – dry year occurs in Year 10 of operations.

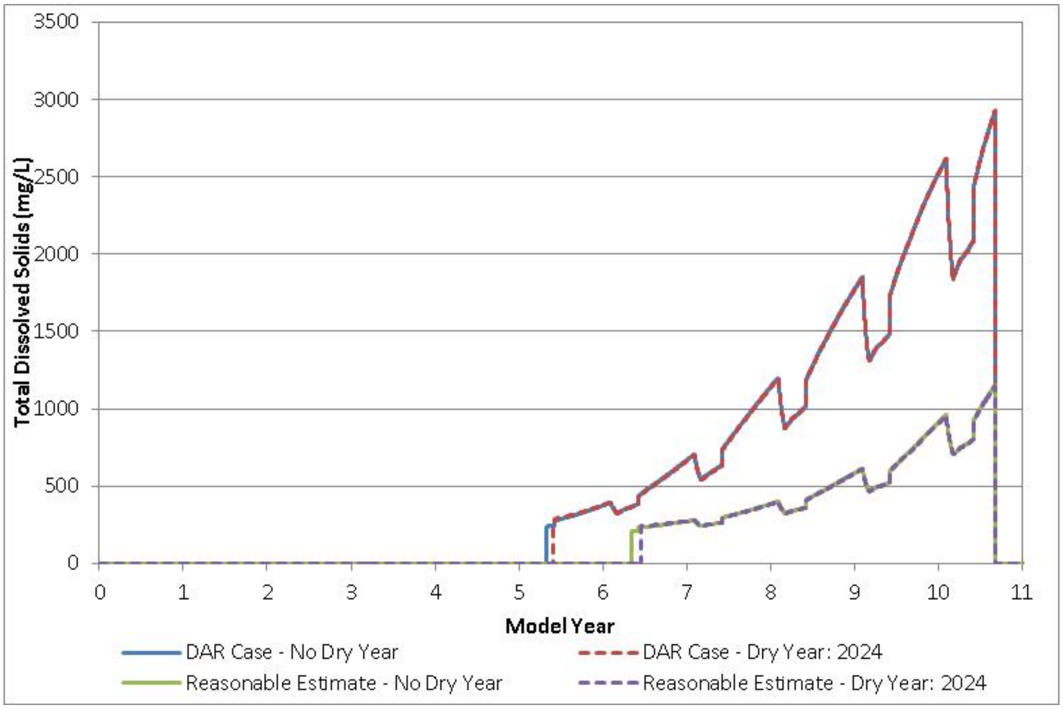
The above iterations were evaluated for both the DAR and Reasonable Estimate Cases. Projected Misery Pit discharge TDS concentrations for the three iterations are presented in Figure 26-2 through 26-4.

Figure 26-2 Iteration 1 – Projected TDS Concentrations – Dry Year in Year 1 of Operations



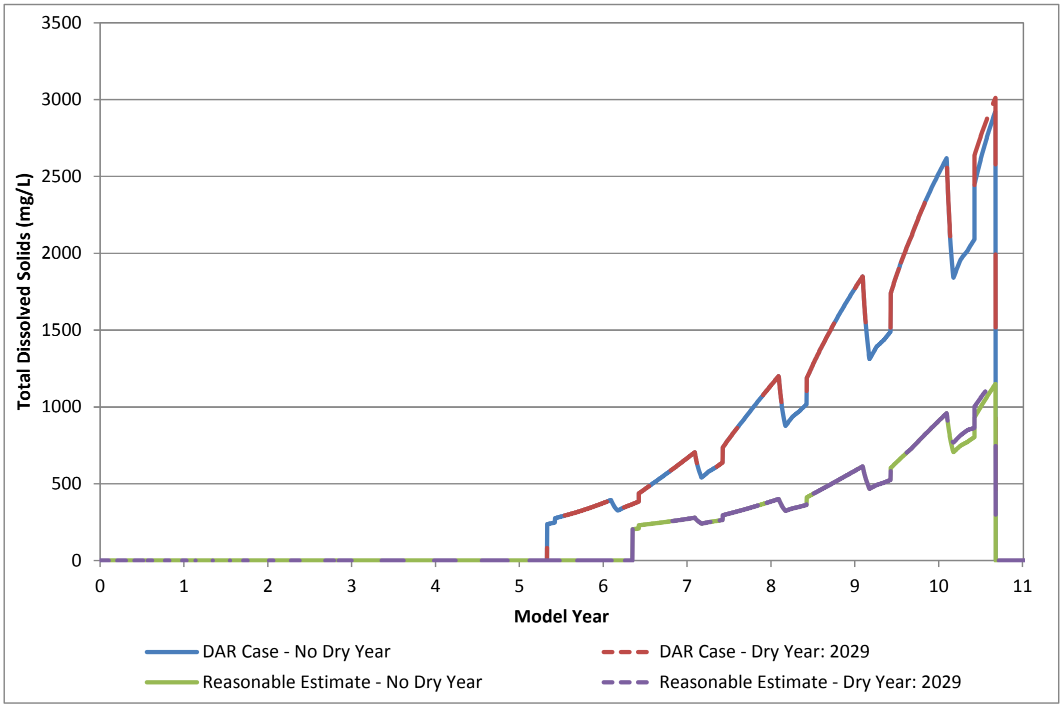
mg/L = milligrams per litre; % = percent.

Figure 26-3 Iteration 2 – Projected TDS Concentrations – Dry Year in Year 5 of Operations



mg/L = milligrams per litre.

Figure 26-4 Iteration 3 – Projected TDS Concentrations – Dry Year in Year 5 of Operations



mg/L = milligrams per litre.

The following are the key findings of the dry year modelling:

- Projected Misery Pit discharge TDS concentrations are identical for the DAR and Reasonable Estimate Cases if a dry year occurs during Year 1 of operations (Figure 26-2);
- Projected Misery Pit discharge TDS concentrations are identical for the DAR and Reasonable Estimate Cases if a dry year occurs during Year 5 of operations; however, the timing of discharge is slightly delayed (Figure 26-3); and,
- Projected open water concentrations in Misery Pit discharge are slightly higher if a dry year occurs during Year 10 of operations; however, projected peak under-ice concentrations are similar (Figure 26-4).

Water balance modelling indicates that groundwater inflow to the Jay Pit during mining represents the majority of the water that requires management at the Jay Project. Water quality modelling of the Misery Pit demonstrates that discharge concentrations are sensitive to fluctuations in groundwater inflows (i.e., DAR versus Reasonable Estimate Cases) and are less sensitive to dry year events (Figures 26-2 to 26-4).

Question 3

A probability distribution for TDS is included in the Monte Carlo analyses (Golder 2015a). The distribution is triangular, with site data defining the apex of the triangle, the high end of the triangle approximately twice the profile, and the lower end of the triangle approximately five times less. The results of the Monte Carlo and First Order Approximation (FOA) analyses are presented in a technical memorandum which will be submitted to the Mackenzie Valley Environmental Impact Review Board (MVEIRB) on July 3, 2015 with the responses to the Round 2 Information Requests. The analyses will clearly show the uncertainty related to the Lower Bound (discussed in Part 4 of this response), Reasonable Estimate Case (Golder 2015b), and Environmental Assessment (EA) Conservative Case (DAR Appendix 8A).

Question 4

There are three parts to Question 4. Dominion Diamond’s responses are provided below:

i. Dominion Diamond has undertaken a Monte Carlo analysis, which in addition to varying the hydraulic conductivity of the assumed enhanced permeability zone (EPZ), considers the effects on the groundwater inflow quantity and quality of varying the porosity, the TDS profile, and the width of the EPZ (Golder 2015a). Dominion Diamond agrees with MVEIRB that the Monte Carlo analysis that looks only at the parameters of the EPZ, does not account for uncertainty in the competent rock outside of the EPZ; a reduction in the hydraulic conductivity in the EPZ would likely increase the proportion of groundwater inflow coming from the competent rock. Therefore, in addition to the Monte Carlo analyses that examines the uncertainty related to properties of the EPZ only, Dominion Diamond has also included the results of a First Order Approximation (FOA) analysis that examines the uncertainty related to the EPZ and the uncertainty related to the hydraulic conductivity of the bedrock outside of the EPZ. The FOA analysis examines the uncertainty in inflow quality and quantity predictions due to the combined uncertainty related to the following:

   - Uncertainty in the hydraulic conductivity of the kimberlite;
   - Uncertainty in the hydraulic conductivity of the EPZ;

- Uncertainty in the width of the EPZ;
- Uncertainty in the hydraulic conductivity of the country rock;
- Uncertainty in the hydraulic conductivity of the weathered rock;
- Uncertainty in the TDS profile;
- Uncertainty in the porosity; and,
- Uncertainty in the specific storage.

ii. Groundwater inflow quantity and quality are the result of the combined effects of not only the width and hydraulic conductivity of the EPZ, but the porosity and TDS profile of the EPZ, as well as the hydraulic conductivity outside the EPZ (among other effects). The Monte Carlo and FOA analyses assess the probability of these combined effects, which would include a smaller EPZ width.

In addition, a Lower Bound Scenario has been developed, which considers a smaller width for the EPZ, and a lower hydraulic conductivity. This Lower Bound Scenario has been run through the three-dimensional (3D) groundwater model, and subsequently, the site water quality model and post-closure groundwater and hydrodynamic models, to examine if meromictic conditions would be sustained in the Jay and Misery pits in post-closure. The Lower Bound Scenario assumes a thinner EPZ (20 metres wide), with lower hydraulic conductivity (1×10^{-6} metres per second [m/s]) and porosity (0.005) than considered in the Reasonable Estimate and EA Conservative Scenarios. Predicted groundwater flows from the Lower Bound Scenario are much less than predicted in the other assessment cases, with only 3,300 cubic metres per day (m^3/d) predicted to report to the Jay Pit in the final year of mining in comparison with 13,700 m^3/day for the same period in the Reasonable Estimate Case and 21,300 m^3/day in the EA Conservative Scenario. Predicted groundwater quality is also lower with TDS reaching only 5,100 milligrams per litre (mg/L) in the final year of mining in comparison with 7,100 mg/L for the same period in the Reasonable Estimate Case and 7,300 mg/L in the EA Conservative Scenario. Additional details of this modelling are provided in Golder (2015c).

iii. Although the lateral extent of the EPZ is not considered in the Monte Carlo or FOA analyses, variance of other parameters in the Monte Carlo and FOA analyses, such as width and hydraulic conductivity, should indirectly account for a reduced extent of the EPZ. Results of the sensitivity analysis presented in Table 8A3-6 of the DAR demonstrated that a less extensive EPZ would result in lower groundwater inflow quantities and lower TDS concentrations than predicted in the EA Conservative and Reasonable Estimate Cases. This outcome is similar to less transmissive EPZ discussed above for the Lower Bound Scenario.

Dominion Diamond confirms that the Monte Carlo and FOA analyses will provide a quantitative estimate of the uncertainty in groundwater inflow quantity and quality. The results of these analyses will be presented in a memorandum to be submitted to MVEIRB on July 3, 2015.

References:

Golder (Golder Associates Ltd.). 2015a. Jay Project – Uncertainty Analyses Methods and Results for Hydrogeological Modelling. Submitted to Mackenzie Valley Environmental Impact Review Board. July 2015.

Golder. 2015b. Jay Project - Compendium of Supplemental Water Quality Modelling. Submitted to Mackenzie Valley Environmental Impact Review Board. April 2015.

Golder 2015c. Jay and Misery Pit Hydrodynamic Models – Lower Bound Scenario. Submitted to Mackenzie Valley Environmental Impact Review Board. July 2015.

DOMINION DIAMOND

Information Request Number:	DAR-MVEIRB-IR2-27
Source:	Mackenzie Valley Environmental Impact Review Board Information Requests from Chuck Hubert
Subject:	Clarification of definition for "assessment endpoints
DAR Section(s):	6.2.2

Preamble (MVEIRB):

Assessment endpoints are defined in the DAR, section 6.2.2, as "qualitative expressions used to determine the significance of effects on VCs and represent the key properties of VCs that should be protected for future human generations (i.e., incorporates sustainability)." The DAR elaborates on assessment endpoints as:

> *...typically not quantifiable and require the identification of one or more measurement indicators that can be directly linked to the assessment endpoint. Measurement indicators represent properties or attributes of the environment and VCs that, when changed, could result in, or contribute to, an effect on assessment endpoints. Measurement indicators may be quantitative (e.g., concentrations of metals in surface water) or qualitative (e.g., movement and behaviour of wildlife from disturbance to habitat and travel corridors). Measurement indicators also provide the primary factors for discussing the uncertainty of effects on VCs and, subsequently, are key variables for study in follow-up and monitoring programs.*

Assessment endpoints are recognized processes in the field of ecological risk assessment. It is not clear if the provided definition is a standard definition or a definition modified for the Northwest Territories environment.

Request (MVEIRB):

Please indicate the source of the definition used for assessment endpoints in the DAR. Please describe and provide rationale for any variances between the described definition and an established standard definition.

Response:

The term assessment endpoint was adopted from the literature on ecological risk assessment. Suter (2000) defines an assessment endpoint as “an explicit expression of the environmental value to be protected, operationally defined by an ecological entity and its attributes”. In the Developer’s Assessment Report (DAR), assessment endpoints are qualitative expressions used to determine the significance of effects on valued components (VCs) and represent the key properties of VCs that should be protected for future human generations (Section 6.2.2), and as such meets the definition provided by Suter (2000). Indicators are measures used in environmental monitoring programs to provide an indication of the condition of the environment (Suter 2000). As described in the DAR, and stated above, measurement indicators provide the primary factors for discussing the uncertainty of effects on VCs, and subsequently, are key variables for study in follow-up and monitoring programs (Section 6.2.2, page 6-6).

The DAR used these concepts in ecological risk assessment to define assessment endpoints and measurement indicators according to the type of VC and associated knowledge of established guidelines and standards. In ecological risk assessment, the assessment endpoint is typically a quantitative expression and linked to a known guideline. In the DAR, assessment endpoints were typically not quantifiable and required the identification of one or more measurement indicators that could be directly linked to the assessment endpoint. However, in some cases, where possible, the assessment endpoint was based on or linked to quantitative guidelines or standards, where available.

For example, the assessment endpoint for the air quality VC in the DAR is the qualitative expression of “compliance with applicable regulatory ambient air quality standards and objectives”, which quantitatively compares air quality predictions to compliance with the Northwest Territories (NWT) ambient air quality standards (Section 7.1.3). The NWT ambient air quality standards were developed to be protective of human health and the environment. For the water quality VC, the assessment endpoint was “the maintenance or suitability of water to support a healthy and sustainable ecosystem, or the continued opportunity for the traditional use of water, including use as a drinking water source”, and as such, took into account the concept of protection for the end users (i.e., aquatic biota, wildlife, and humans). The assessment approach was to evaluate if a change in concentration of water quality constituents (i.e., numerical measurement indicators), would be significant to an end user and thus directly address the assessment endpoint (e.g., a change in water quality would alter the suitability of the water to support aquatic life and maintain ecological function).

Assessment endpoints for remaining VCs in the DAR are qualitative expressions of the ecological (and cultural and socio-economic) entity and valued attributes that require protection. This was necessary because there are no known quantitative thresholds and screening values, or established guidelines for VCs such as fish and fish habitat, vegetation, barren-ground caribou and other wildlife, traditional land use, culture, and socio-economics. Nonetheless, self-sustaining and ecologically effective plant, wildlife and fish populations, ongoing fisheries productivity, sustainability of long-term socio-economic properties, and continued opportunities for traditional land use are attributes of the VC that are worthy of protection (Section 6.2.2, Table 6.2-1). Importantly, the approach for determining significance was consistent across all VCs with assessment endpoints. The magnitude, geographic extent, and duration (which includes reversibility) of the changes in measurement indicators, after mitigation, were used to predict the significance of residual effects to assessment endpoints (Section 6.7).

References:

Suter GW. 2000. Generic assessment endpoints are needed for ecological risk assessment. Risk Analysis 20:173-178.

Information Request Number:	DAR-MVEIRB-IR2-28
Source:	Mackenzie Valley Environmental Impact Review Board Information Requests from Chuck Hubert
Subject:	Assessment endpoint for Air Quality
DAR Section(s):	7.1.3 (Page 7-3); Jay Technical Sessions (Air Quality Presentation)

Preamble (MVEIRB):

It is unclear how the definition of "assessment endpoint" provided by the developer applies to the assessment endpoint identified for air quality, which is the GNWT Guideline for Ambient Air Quality. An assessment endpoint must consider an ecological component and the effects it may experience due to the project. The assessment endpoint provided by the developer does not consider an ecological component, although it is implied in the standard because the standards states that meeting the standards protects human health and environment.

Request (MVEIRB):

a) Please explain how Dominion is in compliance with the Ambient Air Quality Guideline?

b) What is the method by which Dominion determines that it is complying with the GNWT Ambient Air Quality Guidelines?

c) At what distance from the source of emissions is compliance measured in order to meet the assessment endpoint.

d) Please describe the triggers for applying mitigations that are intended to mitigate effects to air quality?

e) Are valued components other than ambient air quality, such as people, vegetation, water or wildlife, considered when determining triggers and action levels for the implementation of mitigation?

Response:

a) The Developer's Assessment Report (DAR) and the Jay Project (Project) Air Quality Assessment Update Memo (Golder 2015) acknowledge that based on the modelling predictions, which can be conservative, there is a potential for ground-level concentrations of nitrogen dioxide (NO_2), particulate matter with a mean aerodynamic diameter of 2.5 microns (µm) or smaller ($PM_{2.5}$), and total suspended particulate (TSP) to exceed the Northwest Territories (NWT) ambient air quality guidelines outside the development area. In the DAR, the development area is defined as:

   "An area that includes the Project footprint and the mine footprints of the Ekati Mine and Diavik Mine. This area is either already physically disturbed by existing or planned mining activities, or has limited public access."

The development area includes mine pits and haul roads at the Ekati Mine, the Diavik Mine, and the Jay Project, which are all sources of vehicle exhaust and fugitive dust emissions. It is in Dominion Diamond's view that the development area is not considered a part of natural environment; and NWT ambient air quality guidelines are not applicable within the development area despite further clarifications on the NWT guidelines provided by Government of Northwest Territories Department of Environment and Natural Resources (GNWT-ENR) in a letter (GNWT-ENR) responding to Undertaking 17 from the Mackenzie Valley Environmental Impact Review Board (MVEIRB) Technical Sessions for the Project on April 24, 2015.

Dominion Diamond's view is consistent with the Canadian Council of Ministers of the Environment (CCME) when developing Canada Wide Standards upon which the GNWT previously based its ambient air quality guideline. Specifically, the CCME (2000) acknowledged that achievement of the standards were to be based on community-oriented monitoring sites" (CCME 2000), with an emphasis on areas "where people live, work and play rather than at the expected maximum impact point for specific emission sources" (CCME 2000). Given this acknowledgement by the CCME, it would be inconsistent for the GNWT to apply the ambient air quality guidelines within the development of a mine, just as it would for them to apply the ambient air quality guidelines at the end of a vehicle exhaust pipe or at the top of a stack. An example of a regulatory air standard that does apply at a point of discharge is the Canada Wide Standard for Dioxins and Furans (CCME 2001), which sets specific limits to the concentration of air contaminants in the exhaust gases. Because the mine pits and haul roads at the Project are themselves sources of vehicle exhaust and fugitive dust emissions, trying to apply the NWT ambient air quality guidelines within the development areas would be inconsistent with the intent of the CCME, and would be effectively applying them at the point of discharge, which is not the purpose of ambient air quality criteria.

Furthermore, the GNWT has adopted regulations specifically for the protection of the health and safety of workers at mines. The Government of the Northwest Territories Mine Health and Safety Regulations (Section 9.02) states that employees shall not be exposed to airborne chemical or physical substances in excess of those specified in the 1994-1995 Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices published by the American Conference of Governmental Industrial Hygienists (GNWT 2015). These thresholds are higher than the NWT ambient air quality guidelines and would be applicable inside the development area.

The modelling results in the environmental assessment process guide Dominion Diamond in the development of an appropriate air quality management plan for the Project. The approach to be used by Dominion Diamond for demonstrating compliance with NWT ambient air quality guidelines, despite the guidelines' non-legal binding status (GNWT-ENR 2015), will be the same as is used for its current operations at the Ekati Mine. Determination of compliance with the NWT ambient air quality guidelines (GNWT-ENR 2014) at the existing Dominion Diamond Ekati Mine is based on onsite ambient air quality monitoring data. The current air quality monitoring program consists of continuous monitoring of sulphur dioxide (SO_2), NO_2, $PM_{2.5}$, and TSP. The data collected are compared to the NWT ambient air quality guidelines and reported to the GNWT, Environment Canada, Independent Environmental Monitoring Agency, Wek'èezhìı Land and Water Board, and communities every three years.

Data from the most recent monitoring period (2012 to 2014) indicated that there were 24-hour $PM_{2.5}$ and TSP measurements that exceeded the NWT guidelines. However, the majority of the exceedances were related to distant wildfires. Of the 364 TSP measurements collected by the two High Volume Air Sampler stations and two Partisol stations, three measurements exceeded the 24-hour NWT standard of 120 micrograms per cubic metre ($\mu g/m^3$); two of these exceedances were due to distant wildfires and the other exceedance occurred on a very windy day. At the onsite Continuous Air Monitoring Station, the NWT standards for 24-hour $PM_{2.5}$ and TSP were exceeded 28 and 15 times, respectively, over the same three year period. All of the $PM_{2.5}$ exceedances and 12 of the 15 TSP exceedances were attributed to distant wildfires. Only six TSP exceedances were attributable to causes other than distant wildfires.

b) The method by which Dominion Diamond determines whether its existing operations at the Ekati Mine are compliant with the NWT ambient air quality guidelines is based on onsite monitoring data collected under its current Ekati 2009 Air Monitoring and Management Plan (BHP Billiton 2009). Subsequent changes were made to the 2009 plan based on suggestions from GNWT and other stakeholders. To manage the potential air quality changes resulting from the proposed Project, Dominion Diamond has submitted a Conceptual Air Quality and Emission Monitoring and Management Plan (AQEMMP) for the Jay Project (Dominion Diamond 2015) to the Mackenzie Valley Environmental Impact Review Board (MVEIRB) on June 1, 2015 for feedback and comment. The new plan uses the dispersion modelling results from the DAR and the Project Air Quality Assessment Update Memo (Golder 2015) to identify the locations where higher concentrations of emitted compounds are expected. Based on feedback from regulators and communities during the Jay Project Technical Sessions in April 2015, the new plan also incorporates an adaptive management approach for managing air quality surrounding the Project. Details on the adaptive management component of the plan are provided below in the response for part d). For the Project, Dominion Diamond is committed to continuing to demonstrate compliance with the NWT ambient air quality guidelines through monitoring.

c) The assessment endpoint for air quality in the DAR is compliance with regulatory ambient air quality criteria outside of the development area based on rationale provided in part a) of this response. Dispersion modelling results from the DAR and Project Air Quality Assessment Update Memo (Golder 2015) predicted exceedances of the NO_2, $PM_{2.5}$, and TSP ambient air quality guidelines outside of the development area (as defined in the DAR and part a) of this response). The predicted exceedances were not due to a single emission source but rather, were due to multiple emission sources such as mine pits and haul roads, many of which are located immediately adjacent to the Project's footprint boundary (a part of the development area for existing and proposed mines in the study area). The predicted maximum distance to achieve compliance with the NWT guidelines reported in the DAR is relative to the Project's footprint boundary. Table 28-1 shows the maximum distance from the Project's footprint boundary to where the predicted ground-level concentrations fall below the NWT ambient air quality guidelines. All locations beyond these distances have predicted ground-level concentrations that are in compliance with NWT guidelines.

Table 28-1 Application Case Maximum Distances to Exceedances of Northwest Territories Ambient Air Quality Guidelines

Compound	Averaging Period	Maximum Distances of Exceedance from Emission Sources or Project's Footprint Boundary (km)
NO_2	1-hour	0.1
	24-hour	0.3
	Annual	<0.1
$PM_{2.5}$	24-hour	5.5
	Annual	0.8
TSP	24-hour	3.5
	Annual	0.6

NO_2 = nitrogen dioxide; $PM_{2.5}$ = particulate matter less than 2.5 microns; TSP = total suspended particulate; km = kilometre; <= less than.

d) A draft Conceptual Air Quality and Emission Monitoring and Management Plan for the Project (Dominion Diamond 2015) was submitted to the MVEIRB for comments on June 1, 2015. A subsequent workshop with Dominion Diamond, regulators, and communities was held on June 26, 2015, and a follow-up technical meeting on the conceptual plan is scheduled for July 2015. The draft conceptual plan proposes three triggering thresholds and corresponding required actions for ambient concentrations of SO_2, NO_2, $PM_{2.5}$, and TSP above the proposed thresholds. The three levels of management actions based on the respective triggers are:

- Action Level 1 – continue monitoring, no mitigation necessary.
- Action Level 2 – internal review and development and implementation of a response plan.
- Action level 3 – external review and development and implementation of a response plan.

Both Action Level 2 and Action Level 3 will require a review of the ambient monitoring data and emissions to determine whether the cause of the elevated concentrations or trend measured is related to mine equipment, mine operation, or natural causes (e.g., wildfires). Based on the findings of the review, Dominion Diamond will undertake the appropriate mitigation steps if the mine equipment or operation is identified as the cause of the elevated concentrations or trend.

For SO_2, the trigger levels are as follows:

- Trigger Level I – annual concentrations below the maximum DAR prediction and less than 20 percent (%) of the applicable criteria (NWT ambient air quality guideline).
- Trigger Level II – concentrations above the maximum annual concentrations predicted in the DAR and between 20% and 50% of the applicable criteria, and greater than +40% year to year change.
- Trigger Level III – annual concentrations above 50% of the applicable criteria and more than +20% year to year change.

For NO_2, $PM_{2.5}$ and TSP, the trigger levels are as follows:

- Trigger Level I – concentrations less than 80% of the applicable ambient air quality guidelines and less than +20% year to year change.
- Trigger Level II – concentrations less than 80% of the applicable ambient air quality guidelines and +20% year to year change.
- Trigger Level III – concentrations above 80% of the applicable ambient air quality guidelines and more than +10% year to year change.

Table 28-2 summarizes the criteria that will be used to determine “compliance” with trigger levels described above.

Table 28-2 Criteria Used to Determine Compliance with Trigger Levels

Parameter	Criteria (µg/m³)	Source
Annual SO_2	30	NWT Ambient Air Quality Guideline
Annual NO_2	60	NWT Ambient Air Quality Guideline
Annual TSP	60	NWT Ambient Air Quality Guideline
Annual $PM_{2.5}$	10	NWT Ambient Air Quality Guideline

Source: GNWT-ENR 2014.

SO_2 = sulphur dioxide; NO_2 = nitrogen dioxide; $PM_{2.5}$ = particulate matter with a mean aerodynamic diameter of 2.5 microns (µm) or smaller; TSP = total suspended particulate; km = kilometre; µg/m³ = micrograms per cubic metre; NWT = Northwest Territories.

Table 28-3 shows each of the Action Levels and the criteria required to trigger the appropriate Action Levels.

Table 28-3 Action Level Triggering Criteria

Criteria	Action Level 1	Action Level II	Action Level I
SO_2			
Concentration below the maximum dispersion model prediction	√		
Concentration below 20% of the applicable air quality standard	√		
Concentration above the maximum prediction from the DAR		√	
Concentration between 20% and 50% of the applicable criteria		√	
Concentration greater than +40% change year to year		√	
Concentration greater than 50% of the applicable criteria			√
Concentration greater than +20% change year to year			√
NO_2, $PM_{2.5}$ and TSP			
Concentration below 80% of the applicable air quality standard	√	√	
Concentration less than +20% change year to year	√		
Concentration greater than +20% change year to year		√	
Concentration greater than 80% of applicable air quality standard			√
Concentration greater than +10% change year to year			√

DAR = Developer's Assessment Report; SO_2 = sulphur dioxide; NO_2 = nitrogen dioxide; $PM_{2.5}$ = particulate matter with a mean aerodynamic diameter of 2.5 microns (µm) or smaller; TSP = total suspended particulate; % = percent.

e) The trigger values for action levels for the implementation of mitigation in the AQEMMP are based on NWT ambient air quality guidelines. During the development of these guidelines, GNWT considered the protection of human health and the environment which includes the other valued components such as people, vegetation, water and wildlife. Other monitoring plans, such as the Aquatic Effects Monitoring Program (AEMP) and the Wildlife Effects Monitoring Plan (WEMP) provide monitoring and adaptive management for the aquatic and terrestrial environments. These monitoring programs also consider the relevant results of the air quality monitoring in the interpretation of their results. A conceptual AEMP and WEMP for the Jay Project were also submitted to MVEIRB on June 1, 2015.

References:

CCME (Canadian Council of Ministers of the Environment). 2000. Canada-Wide Standards for Particulate Matter and Ozone. Ottawa, ON, Canada, 10 pp.

BHP Billiton (BHP Billiton Diamonds Inc.). 2009. Ekati Diamond Mine Air Quality Management and Monitoring Plan. March 2009.

Dominion Diamond (Dominion Diamond Ekati Corporation). 2015. Conceptual Air Quality and Emission Monitoring and Management Plan for the Jay Project – DRAFT. Prepared by Golder Associates Ltd. June 2015. Available at: http://www.reviewboard.ca/registry/project.php?project_id=674

GNWT-ENR (Environment and Natural Resources, Government of the Northwest Territories). 2014. Guideline for Ambient Air Quality Standards in the Northwest Territories. Yellowknife, NWT, Canada, 5 pp.

Golder (Golder Associates Ltd.). 2015. Technical Memorandum: Jay Project Air Quality Assessment Update. Issued January 19, 2015.

DOMINION DIAMOND

Information Request Number:	DAR-MVEIRB-IR2-29
Source:	Mackenzie Valley Environmental Impact Review Board Information Requests from Chuck Hubert
Subject:	Greenhouse gas emissions
DAR Section(s):	Jay Project Technical Sessions (March 24 Transcripts pages 45-46, and 96)

Preamble (MVEIRB):

In the Review Board's view, responses to round one information requests and the technical session transcripts reveal that Dominion has not adequately answered questions regarding emission of greenhouse gasses at Ekati and changes in emissions due to the Jay project. For example, in response to a question from a party on targets to reduce energy consumption and greenhouse gas emissions (March 25 technical session transcripts, p96), Dominion responded that "those are internal at this time" (March 25 Technical session transcripts p96). In addition, GNWT asked Dominion whether it would "commit to reviewing the prices of solar energy at your facility and adding that generation capacity" and further "commit to getting some cost estimates on what adding solar (energy) to your project would be" (Ibid. p110-111). Dominion responded that "this is one of those issue that is going to have to move to another phase of the process" (Ibid. p.111). In order to conduct a fair and transparent EA process, both parties and the Review Board require answers to the questions above as well as the following questions.

Request (MVEIRB):

a) Please provide a quantitative analysis of greenhouse gas reduction strategies that Dominion has implemented at the mine site to date including the amount of greenhouse gas emissions reduced due to these strategies.

b) Please provide any additional greenhouse reduction strategies Dominion intends to implement as part of the Jay Project.

c) Please describe and quantify the change in greenhouse gas emissions from all sources from the existing Ekati Mine to the continued operation of the Ekati Mine with the Jay Project.

d) Please provide greenhouse gas reduction targets for the Jay Project.

Response:

a) Since Dominion Diamond took ownership of the Ekati Mine, several programs and improvements have been put in place. Dominion Diamond has put in place a Greenhouse Gas and Energy Management Steering Committee comprising of energy leaders in each area of the business. The Steering Committee's mandate is to "*ensure that effective and efficient energy use remains part of the way that we do business and to ensure that we seek out opportunities to reduce our energy use and greenhouse gas emissions at Ekati".* The Steering Committee has prepared and released a monthly dashboard on energy and diesel use and emissions generated for the information of staff. The Steering Committee is also responsible for reviewing and identifying projects that meet the above mandate (see Table 29-1), as well as potential alternative energy projects.

Table 29-1 provides a list of recent and current greenhouse gas (GHG) emission reduction initiatives at the Ekati Mine. The table also provides the estimated direct GHG emissions reduced annually from these initiatives. Other initiatives that have been undertaken by the Dominion Diamond for the goal of reducing fuel consumption, but not listed in Table 29-1, such as the "No Idle" vehicle campaign and onsite shuttle service program, also contributed to GHG emission reductions.

b) Dominion Diamond will continue to set targets for GHG annually for the life of the Ekati Mine and the Jay Project, and this will be reported as part of the Air Quality Monitoring Program report, Mining Association of Canada Towards Sustainable Mining Program, and the Environment Canada Greenhouse Gas Inventory.

c) A summary of the year-by-year GHG emission estimate for the Ekati Mine and the Jay Project was provided in the response to Round 1 information request DAR-MVEIRB-IR-73, and is also provided below as Table 29-2. The summary covers a period between 2015 and 2033, which covers the construction phase (2016-2018), operation phase (2019-2029), and closure phase (2030-2033) of the Jay Project.

d) Targets for GHG reductions have not been set for the Jay Project. Dominion Diamond will continue to set targets for GHG emissions on an annual basis. Targets will be selected with consideration of the stage of the Project (e.g., construction, operation). Examples of the targets set for Ekati Mine's 2016 fiscal year (February 1, 2015 to January 31, 2016) are:

- Reduce energy baseload by 5%
- Reduce fuel consumption by 5%
- Realize energy savings of $2 million
- Reduce GHG emissions by 5%

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Table 29-1 Current and Past Greenhouse Gas Emission Reduction Initiatives at the Ekati Mine

Initiative name	Description	Estimated Litres of Diesel Offset (10^3litres)	Estimated GHG Emissions Reduced Annually (tonnes CO_2e per year)[(a)]	Status
Baseloading	Baseload 1-2 gensets to increase fuel-efficiency	833	2,376	Completed
Vaporphase heat exchanger	Optimize heat capture in glycol loop by improving cleaning strategy for Vaporphase heat exchanger system	530	1,512	Completed
Composter	Install composter to replace incinerator	227	648	Implementation phase
Outbuilding energy audit	Eliminate unused outbuildings, unnecessary heating and lighting in remote buildings	455	1,298	Implementation phase
Equipment idling	Reduce unnecessary equipment idling	114	325	Analysis phase
Accommodations	Improve energy efficiency in accommodations	76	217	Analysis phase
Motors	Re-evaluate sizing of key motors in the process plant to optimize efficiency and power draw	455	1,298	Analysis phase
Total		**2,690**	**7,673**	

a) GHG emissions only included emissions reduced from combustion of diesel at the Ekati Mine. They do not include additional GHG emission reduction from the transportation of diesel to the Ekati Mine via the Winter Road.

CO_2e = CO_2 equivalent

The target for energy reduction results in energy savings based on the initiatives listed in Table 29-1 (assuming $1.30/L delivered) through the reduction of diesel use in the generators and the reduction of diesel that needs to be shipped to the Ekati Mine via the Winter Road, resulting in reduced traffic load and GHGs generated.

Some key initiatives include the purchase and commissioning of a large scale composter that will reduce the need to operate two incinerators, and the purchase and testing of biodiesel use in some equipment. Reducing the use of incinerators down to only one will decrease the amount of diesel used, as well as eliminate emissions from the incinerator stack. The biodiesel was tested in a loader, a grader and in a light vehicle at various blends in 2014. Preliminary results indicated a reduction in emissions and testing is ongoing this year.

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Table 29-2 Annual Greenhouse Gas Emissions Based on Fuel Usage for the Life Cycle of Ekati Mine

Source	Maximum Annual GHG Emissions (kt CO_2e/yr)																		
	Base Case	Construction Phase			Operation Phase											Closure Phase			
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Generators	158	158	158	158	158	158	158	158	158	158	158	158	158	158	158	26	26	26	20
Boilers/heaters	29	29	29	29	9	9	9	9	9	9	9	9	9	9	9	9	9	9	7
Mine Fleet	79	79	79	79	80	229	231	231	231	204	155	127	111	82	48	48	48	48	36
Transportation-Winter Road	2	5	5	5	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Transportation-Aircraft	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Construction Equipment	—	47	92	21	16	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	271	320	366	294	269	402	403	403	403	376	327	299	283	255	220	89	89	89	68

GHG = greenhouse gas; kt CO_2e/yr = kilotonnes carbon dioxide equivalent per year; — = no emission.

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Information Request Number:	DAR-MVEIRB-IR2-30
Source:	Mackenzie Valley Environmental Impact Review Board Information Requests from Chuck Hubert
Subject:	Socioeconomic trends and determination of significance
DAR Section(s):	Round 1 Information Request Response DAR-Tłı̨chǫ-IR-14

Preamble (MVEIRB):

Many of the health and well-being indicator trends identified for effected communities in the Community and Diamonds Report (Table 14-1) are adverse (such as increasing rates of sexually transmitted infections, increasing crime rates, decreasing use of aboriginal language). In its response to Tłı̨chǫ Government's IR14, Dominion Diamond states that "Given that the Jay Project is an extension of the existing Ekati Mine, and does not represent a completely new development to the territory, the assessment assumes that if all else is equal then the Jay Project itself would not lead to new or different trends in health and well-being indicators." Dominion further states, in section 14.6 of the DAR, that "Given the limited possibility for the Project to result in change... the Project's effects on health and well-being are not assessed as significant". The developer's argument appears to be that (a) a continuation of an adverse trend could not constitute a significant adverse impact, and that (b) since the Jay project is not solely able to address or responsible for a negative trend, therefore its effects are not significant. The Review Board understands that a project's potential contribution to cumulative impacts on health and wellbeing must be viewed both within a project-specific and broader socioeconomic context. However, if a) and b) above were true, then no project could ever cause significant cumulative or indirect effects on health and well-being.

Request (MVEIRB):

Please provide rationale for these two statements as premises in the assessment of health and well-being indicators.

Response:

The Information Request DAR-MVEIRB-IR2-30 asks for clarification on what appears to be Dominion Diamond's arguments for determining the significance of the Jay Project (Project)'s effects on health and well-being. The first argument, as interpreted above by the reviewer, is:

a. "a continuation of an adverse trend could not constitute a significant adverse impact."

It is not the intention of the Developer's Assessment Report (DAR) to suggest that "a continuation of an adverse trend could not constitute a significant adverse impact". The existing adverse health and wellbeing trends in the Northwest Territories (NWT; as identified by the Communities and Diamonds initiative [GNWT 2015]) are identified in the DAR, but significance is not assigned to baseline conditions or trends, as the focus of the DAR is on the assessment of the *Project's effect* on these conditions, and the potential cumulative effect of the Project in conjunction with other developments (i.e., Application Case). As noted in the DAR, the approach to defining the assessment cases and cumulative effects scenarios for the purpose of significance determination is unique for socio-economic impact assessment (Section 14.1.2.6) and, in specific, health and wellbeing assessment (Section 14.1.2.7.3).

Significance in socio-economic assessment is determined for Project effects on the basis of the expected result for most people or of the effect's manifestation at the community level. That is to say, if the Project results in a change to the health and wellbeing of most people in communities, or if the effects create community or societal concern over the status of health and wellbeing, it could have a significant effect[1]. Based on this definition, if the DAR were to assess the significance of baseline health and wellbeing conditions alone, it would conclude that the existing adverse trends in health and wellbeing indicators are likely significant. However, the DAR did not assess the significance of changing baseline trends of health and wellbeing in isolation, but instead assessed the incremental effects of the Project on baseline trends. That is, the DAR completed an analysis of baseline conditions and trends to provide context for assessing and determining whether the Project contributes significantly to existing adverse cumulative effects. The analysis of the relative contribution of the Project to any identified significant adverse cumulative effects is completed for the Application Case (Section 6.7.2). It was determined that the Project's effect on the existing adverse health and wellbeing trends was not significant. Part b. of this response provides further discussion of this determination of significance of Project effects on baseline trends.

b. "since the Jay project is not solely able to address or responsible for a negative trend, therefore its effects are not significant."

The significant existing adverse health and wellbeing trends are part of a broader socio-economic context in which the effects of diamond mining are considered in conjunction with other socio-economic and cultural factors. There is, however, difficulty in disentangling social change resulting from mining specifically, as opposed to from other forces of change. It is similarly difficult to establish a direct correlation between the mining industry alone, and broad trends in health and wellbeing in the NWT. The Communities and Diamonds initiative (GNWT 2015) tracks indicators of health and wellbeing in communities, but does not draw conclusions as to whether or not adverse trends[2] in indicators are specifically caused by mining[3]. This is not to suggest that these trends are not, in some way, influenced by mining or other activities occurring since diamond mining began in the late 1990s. It is likely that economic, social, and other factors that have interacted over the past two decades have combined to influence the trends reported in Communities and Diamonds.

To understand how the Project could influence these existing trends, the DAR identifies pathways that describe how the Project could affect health and wellbeing. As an extension of an existing mine, the Jay Project is not expected to generate new employment or new incomes. The Project will employ the existing operations workforce from the Ekati Mine, and is not expected to bring about population change in communities, or associated adverse social effects (e.g., demand for health, social or protective services, changes in demographic profiles of communities). There are several pathways through which the Project can influence health and wellbeing. The Project will provide medical and counselling services to employees and their families, and community investment for education and health and wellbeing initiatives, and will maintain a 2:2 rotation schedule; however, this will not be a new benefit for those

[1] Please refer to Section 14.1.2.7.2 of the DAR for a full description of the approach that the Maximizing Benefits and Minimizing Impacts to Communities Key Line of Inquiry (KLOI) takes to the determination of significance.
[2] Communities and Diamonds identifies potential years of life lost, single-parent families, sexually transmitted infections, crimes, violent crime, other criminal code crime, property crime, federal statute crime, and knowledge of an Aboriginal language as indicators displaying adverse trends.
[3] Further analysis of the Communities and Diamonds reporting, and the health and wellbeing indicators and trends therein, can be found in the response to Round 1 IR DAR-Tłı̨chǫ-IR-16.

affected. The Project itself is not expected to result in a change in health and wellbeing conditions from the existing baseline conditions[4].

The addition of the Gahcho Kué Mine[5] occurs prior to the development of the Jay Project, and so is considered in the discussion of the Base Case. It is against this case that the Project's effects are assessed, and significance is determined, along with cumulative effects from the Project and previous and existing developments (Application Case). When the Project begins operation, it will, as noted above, maintain the existing Ekati Mine operational workforce. At this time, the Gahcho Kué Mine and the Project are not expected to interact to generate population growth through labour demand, as the Diavik and Snap Lake mines will be closing, creating a negative labour demand scenario relative to baseline conditions. As is the case with the Project's incremental effect, there is no cumulative population growth effect, or associated adverse social effects.

It is based on this analysis that the determination of the significance of the Project's effect on health and wellbeing (as opposed to the significance of the existing trends in isolation) is derived. Therefore, it is suggested that the position of the DAR is as follows:

a. The existing adverse health and wellbeing trends identified by the Communities and Diamonds initiative (GNWT 2015), and the continuation of these trends (i.e., worsening adverse trends and improving positive trends) are significant;
b. The ability of Dominion Diamond to address (i.e., mitigate) existing adverse health and wellbeing conditions and trends is not a determinant of the significance of those conditions and trends. Mitigations are, however, considered in the determination of the significance of the *Project's* effects. Dominion Diamond acknowledges that adverse health and wellbeing trends exist, are significant, and may continue into the future. While the Project is predicted to not contribute to these adverse trends, Dominion Diamond is committed to working with the Government of the Northwest Territories, health and wellbeing-focused organizations, and communities to proactively address them to the extent possible[6]; and,
c. The Project, as an extension of an existing mine, does not change the health and wellbeing conditions in communities, or alter existing health and wellbeing trends. The Project neither improves, nor worsens the baseline conditions to a point where most people or communities will experience a change in their health and wellbeing. As a result, the effect of the Project on the existing health and wellbeing of communities is considered not significant.

The determination that the Project is not expected to contribute to significant effects on health and wellbeing does not imply that no project could ever cause significant effects. If a project changed the baseline scenario by either improving or worsening health and wellbeing trends, then it could have a significant effect. It is not the intention of the DAR to suggest otherwise, or to suggest that the existing adverse health and wellbeing conditions in communities are not significant. It is regretful that this position

[4] Please refer to Sections 14.1.4.2, 14.6.3, and 14.6.4 of the DAR for further discussion of the Project's health and wellbeing pathways and effects.
[5] The Gahcho Kué mine is considered along with the Diavik and Snap Lake mines in the cumulative effects assessment approach for socio-economics.
[6] Please refer to Section 14.1.3 of the DAR for a discussion of the social management practices that will be in place for the Project. The response to the adequacy review, and to DAR-NSMA-IR2-01 provide further detail on Dominion Diamond's existing and planned efforts to address adverse health and wellbeing conditions in communities within the socio-economic local study area.

was unclear in the original DAR submission, but it is Dominion Diamond's hope that this Information Request response clarifies this important topic.

References:

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DOMINION DIAMOND

Information Request Number: DAR-MVEIRB-IR2-31

Source: Mackenzie Valley Environmental Impact Review Board Information Requests from Chuck Hubert

Subject: Health and well-being indicator levels of significance.

DAR Section(s): 14.6

Preamble (MVEIRB):

Section 14.6 of the DAR states that "... the Project's effects on health and well-being are not assessed as significant". Indicators within the 2014 Communities and Diamonds report (PR#415) suggest adverse trends in several health and well-being indicators in communities effected by diamond mining (See Summary table on p7 of the 2014 Communities and Diamonds report for a list of these indicators). The Review Board needs to understand what parties and the developer deem a reasonable rate of change to health and well-being indicators that have an adverse trend. The Board also seeks to understand parties' and the developer's views on significance thresholds for these health and well-being indicators.

Request (MVEIRB):

a) Please provide an opinion on what rate of change would be acceptable for health and well-being indicators that are currently trending adversely in potentially affected diamond mine communities as listed in the 2014 Communities and Diamonds report.

b) Please describe thresholds beyond which significant adverse effects to people and communities might be expected to occur for the health and well-being indicators referenced above.

Response:

a) The 2014 Communities and Diamonds report identifies the following health and wellbeing indicators[1] as trending adversely in the local study area (LSA) communities:

- Potential years of life lost;
- Single-parent families;
- Sexually transmitted infections;
- Crimes;
- Violent crimes;
- Other criminal code crimes;
- Property crimes;
- Federal statute crime; and,
- Knowledge of an Aboriginal language.

There are no established acceptable rates of adverse change for these health and wellbeing indicators in the Northwest Territories (NWT). Establishing acceptable rates of change is not

[1] "A measurable variable chosen to represent the state of a [valued environmental] component" (CEAA 2015). Indicators identified by the Communities and Diamonds initiative were selected in public consultation with communities (GNWT 2015a).

appropriate, as any adverse change in these indicators (i.e., suicide, family violence, etc.) is of importance to individuals, communities and society[2]. Where a biophysical assessment may allow for an acceptable rate of adverse change to an indicator (e.g., the acceptable mortality rate of a species in relation to population stability), the same determination is not applicable to the assessment of changes in health and wellbeing indicators, as the assessment endpoint (i.e., supporting physical and mental health and wellbeing, and minimizing negative effects to people) is not comparable. For example, no number of suicides in a community would be considered “acceptable”, as suicide results, by its very nature, in the loss of life. Neither the Communities and Diamonds initiative nor the Developer’s Assessment Report (DAR) attempt to establish acceptable rates of change for health and wellbeing indicators.

b) For the purpose of Environmental Assessment, a threshold is “a limit of tolerance of a [Valued Environmental Component[3]] to an effect, that if exceeded, results in an adverse response by that [Valued Environmental Component]” (CEAA 2014). As described in Section 6.7.2 of the DAR, for some Valued Components (VCs), such as air quality or water quality, standards, guidelines, or threshold values are known, which provides confidence in effects predictions and determining environmental significance. For other VCs of the biophysical and human environments, social and ecological benchmarks or effects thresholds are not known and challenging to define, which creates uncertainty in determining the significance of predicted effects. Similarly, in monitoring and management plans, thresholds can be developed and used to identify triggers for action and adaptive management. For example, the Wek'èezhìı Land and Water Board (2010) identifies significance thresholds of low, moderate, and high, each of which is associated with an adaptive management response (i.e., low: identify mitigations; moderate: implement mitigation to stop or slow trend; and high: implement mitigation to reverse trend).

This same approach is not necessarily applicable to adverse change in health and wellbeing indicators, as there are no discrete values under which adverse changes are considered acceptable. No thresholds have been established for change in health and wellbeing indicators beyond which the change would be considered “significant”. This is true both of the evaluation of existing health and wellbeing trends, and the process of Socio-economic Impact Assessment (SEIA). Studies of health and wellbeing change in the Canadian North (e.g., INAC 2003; Boyd et al. 2010; Gibson and Clinck 2008; GNWT 2015a; Parlee 2006; Parlee and Marlowe 2001; Petrov et al. 2013; RESDA, 2011; Tsetta et al. 2005) have established indicators for the purpose of monitoring, but do not specifically identify thresholds beyond which adverse changes in the indicators would be considered unacceptable, or significant. Other studies (e.g., Salmo et al. 2004) have gone so far as to suggest that, while thresholds can be proposed for environmental indicators, the same is not appropriate for social (including health and wellbeing) indicators given their more qualitative nature, and their reliance on the values and experience of affected populations.

The Mackenzie Valley Environmental Impact Review Board (MVEIRB)-commissioned report on Issues and Recommendations for Social and Economic Impact Assessment in the Mackenzie Valley (MVEIRB n.d.) makes note of the importance of mitigation and monitoring to ensure that thresholds

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[2] Please refer to the response to Round 1 IR DAR-MVEIRB-IR2-30 for a complete discussion of the significance of existing adverse health and wellbeing trends.
[3] “Any part of the environment that is considered important by the proponent, public, scientists and government involved in the assessment process. Importance may be determined on the basis of cultural values or scientific concern” (CEAA 2014).

are not crossed, but also notes that "*thresholds for social and economic limits of acceptable change are … generally … poorly understood*", and that pre-existing legal thresholds of acceptable change are particularly absent for social and economic effects. The report notes that, for SEIA, the assessment of effects must "*instead rely on other means to make a significance determination*". Finally, the report suggests that the establishment of thresholds for socio-economic change should be undertaken by the NWT Cumulative Impacts Monitoring Program (CIMP), and by the Cumulative Effects Assessment and Monitoring Framework (CEAMF). The CIMP (GNWT n.d.) states that "*although NWT CIMP [defines] 'environment' to include both biophysical … and human…, it currently places an emphasis on the biophysical environment*", and has yet to establish thresholds for acceptable rates of change in health and wellbeing indicators. The same is true of the NWT CEAMF (GNWT 2015b).

The MVEIRB SEIA Guidelines (2007) notes that, in the determination of significance, "*thresholds of manageable change … as expressed in plans, strategies and goal statements*" should be considered, but does not establish these thresholds. In the case of the LSA communities, no known quantitative thresholds of change in health and wellbeing indicators has been established for either planning or management purposes that would determine "cut off" or designated limit of acceptability.

The DAR does not attempt to establish thresholds beyond which an adverse effect to health and wellbeing would be considered significant. Rather, the DAR determines the significance of the Project's effect on health and wellbeing based on the nuanced, often qualitative criteria identified in Section 14.1.2.7.2 of the DAR, as opposed to an exceedance of a quantitative threshold. Significance is determined for Project effects on the basis of the expected result for most people or of the effect's manifestation at the community level. That is to say, if the Project results in a change to the health and wellbeing of most people in communities, or if its effects create community or societal concern over the status of health and wellbeing, it would have a significant effect.

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Information Request Number:	DAR-NSMA-IR2-01
Source:	North Slave Métis Alliance Information Requests from Shin Shiga
Subject:	Socio-Economics
DAR Section(s):	14; Ekati Mine Socio-Economic Agreement (Section 4.3.4)

Preamble (NSMA):

In this agreement BHP (now DDEC) agreed to provide "encouragement to women who apply to be employed in non-traditional occupations" and develop "a strategy for the training, recruitment and employment of women in traditional and non-traditional occupations." Developer and GNWT have further obligations to monitor the related indicators.

Request (NSMA):

1. Please provide the "strategy for the training, recruitment and employment of women".
2. Please describe how DDEC uses the monitoring program results to modify and improve the strategy and programs. How are the programs evaluated? How often?

Response:

1) As noted in the response to Round 1 Information Request (IR) DAR-NSMA-IR-29, Dominion Diamond recognizes there are barriers to women entering the workforce, particularly the mining workforce, in the Northwest Territories (NWT). The Northern Women in Mining, Oil and Gas Project (NWMOGP; Status of Women Council of the NWT 2010) has identified the following prominent barriers specific to women:

    1. Women have not, traditionally, been encouraged to gain an education related to trades-based occupations, and as a result, may lack the technical skills required for positions in mining. As identified by participants of the NWMOGP, a lack of relevant education, and the cost of obtaining an education, were the most prevalent barriers to securing employment in mining.
    2. Low levels of literacy, and more unique to women, numeracy (i.e., mathematical skills), are a barrier to pursuing an education in the trades that would provide the skills needed for mining employment.
    3. Being the primary or, in some cases, only caregiver for small children can be a barrier to women entering trades-based occupations. The traditional view is that women should remain home to care for children. The lack of qualified childcare facilities is also an issue.
    4. There are perceptions that mine sites are work environments best suited for men. Women may feel intimidated in this type of environment, and so may lack the confidence or desire to work in a male-dominated workplace.

    These barriers echo those identified by the Women in Mining Canada (2010) report, but with an additional emphasis on Northern women lacking the appropriate education and training needed for employment in the mining industry. This trend has, however, begun to change in recent years. More women in the NWT are being trained in mining-related careers through the Mine Training Society. Since 2004, 20 percent (%) to 35% of those enrolled in programs with the society have been women (Jones 2015).

Together, the issues identified in the list above act as barriers to the training, recruitment, and employment of women in the mining industry. While a single proponent is not able to address broad societal issues in their entirety, Dominion Diamond has undertaken activities to try to minimize these barriers to the training and employment of women, where possible:

1. Dominion Diamond provides scholarships in the support of educational attainment, with the aim of removing barriers associated with the cost of an education.
2. Dominion Diamond will continue to run the Women in the Workforce Program, designed to promote the training, hiring, and advancement of women in non-traditional roles.
3. On a case-by-case basis, Dominion Diamond evaluates alternate schedules for women with children, including flexible office hours for Yellowknife-based staff, and flexible rotations for mine-site workers, such as a four (4) days on / three (3) days off rotation instead of a two (2) weeks on/ two (2) weeks off rotation. This shorter period away from home allows some women to split caregiver duties with another family member, or to use other childcare arrangements as available.
4. Dominion Diamond is committed to maintaining a workplace free of discrimination and/or hostility towards women. The Company has a Harassment & Discrimination Policy that outlines the process individuals can follow in raising a concern of harassment and/or discrimination and having the concern addressed in a timely fashion.
5. Dominion Diamond is also committed to engaging with communities to provide information to potential female employment candidates that encourages their application, and reiterates the company's zero tolerance policy towards harassment and gender discrimination.
6. Dominion Diamond has implemented a Recruitment Policy that ensures qualified female applicants are given priority consideration for both traditional and non-traditional roles. With the creation and institution of this formal policy, it is Dominion Diamond's goal to increase the proportion of women working for the company over the operational life of the Jay Project.
7. Dominion Diamond will continue to support external organizations such as the Mine Training Society by providing work placements to students, including females, at the mine site with the view to ensuring students are able to gain practical hands-on work experience, but also enable them to experience life at the mine.

2) Dominion Diamond monitors the level of female labour force content at the Ekati Mine, as well as the prevalence of women in non-traditional roles. The mining industry in Canada as a whole has seen 14% to 17% female representation in the mining labour force since 2010 (MIHRC 2010; Statistics Canada 2015). In 2013, the rate of employment of women at the Ekati Mine was in line with the mining industry average at 15% of the total workforce. Dominion Diamond will take the following steps to evaluate the status of the employment of women at the Ekati Mine, and to develop strategies to improve performance:

   1. Dominion Diamond will track feedback received from Exit Interviews completed by exiting female employees to identify barriers to successful retention. If such barriers are identified, Dominion Diamond is committed to investigating what can be done to address the issue. Mechanisms to

address barriers will be developed as part of Dominion Diamond's commitment to ongoing improvement, and will be specific to the issue in question.

2. Where employment barriers for women are seen as related specifically to social issues, Dominion Diamond is committed to raising these issues with the Government of the Northwest Territories to determine how the two parties can work together to improve or remove the barrier that is being experienced.

In addition, Dominion Diamond evaluates its programs aimed at improving the training and recruitment of women in the North, and will continue to adapt programs in response to feedback from female employees and community members interested in a career in mining.

Regardless of achievement of industry averages of women in the workforce, Dominion Diamond is committed to engaging women, and building capacity of the female workforce in the NWT. To this end, Dominion Diamond will continue to participate in the programs and initiatives detailed in Part 1 of this response, and will continue to work with communities to identify strategies for employing women.

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Information Request Number:	DAR-NSMA-IR2-04
Source:	North Slave Métis Alliance Information Requests from Shin Shiga
Subject:	Climate Change
DAR Section(s):	17

Preamble (NSMA):

DDEC commented during the April 2015 Technical Session that it had an internal policy and target for GHG reduction. NSMA is of the view that this information is relevant as it informs to what extent DDEC is trying to reduce GHG emission.

Request (NSMA):

Please make DDEC target for GHG reduction available. Please also list what actions have been taken, and are planned to take place. Please quantify each action in terms of cost (or $ saved), CO2 equivalent reduced (in % and tons), and whether the initiative maybe categorized as; energy saving, renewable energy, or off-setting.

Response:

Dominion Diamond has set the following targets for fiscal year 2016 (February 1, 2015 to January 31, 2016):

- Reduce energy baseload by 5 percent (%)
- Reduce greenhouse gas (GHG) emissions by 5%
- Realize energy savings of $2 million
- Reduce fuel consumption by 5%

Dominion Diamond will continue to set targets for greenhouse gas emissions annually for the life of the Ekati Mine and this will be reported as part of the Air Quality Monitoring Program report, Mining Association of Canada Towards Sustainable Mining Program, and the Environment Canada Greenhouse Gas Inventory.

Since Dominion Diamond has taken ownership of the Ekati Mine, several programs and improvements have been put in place. Dominion Diamond has put in place a Greenhouse Gas and Energy Management Steering Committee comprising of energy leaders in each area of the business. The Steering Committee's mandate is to "*ensure that effective and efficient energy use remains part of the way that we do business and to ensure that we seek out opportunities to reduce our energy use and greenhouse gas emissions at Ekati".* The Steering Committee has prepared and released a monthly dashboard on energy and diesel use and emissions generated for the information of staff. The Steering Committee is also responsible for reviewing and identifying projects that meet the above mandate (see Table 4-1), as well as potential alternative energy projects.

The target for energy reduction results in energy savings based on the initiatives listed in Table 4-1 (assuming $1.30/litre delivered) through the reduction of diesel use in the generators and the reduction of diesel that needs to be shipped to the Ekati Mine via the Winter Road, resulting in reduced traffic load and GHGs generated.

Some key initiatives include the purchase and commissioning of a large scale composter that will reduce the need to operate two incinerators, and the purchase and testing of biodiesel use in some equipment. Reducing the use of incinerators down to only one will decrease the amount of diesel used, as well as eliminate emissions from the incinerator stack. The biodiesel was tested in a loader, a grader, and in a light vehicle at various blends in 2014. Preliminary results indicated a reduction in emissions and testing is ongoing this year.

Table 4-1 Past and Current Greenhouse Gas Emission Reduction Initiatives at the Ekati Mine

Initiative name	Description	Estimated Litres of Diesel Offset (10^3litres)	Estimated GHG Emissions Reduced Annually (tonnes CO_2e per year)[(a)]	Status
Baseloading	Baseload 1-2 gensets to increase fuel-efficiency	833	2,376	Completed
Vaporphase heat exchanger	Optimize heat capture in glycol loop by improving cleaning strategy for Vaporphase heat exchanger system	530	1,512	Completed
Composter	Install composter to replace incinerator	227	648	Implementation phase
Outbuilding energy audit	Eliminate unused outbuildings, unnecessary heating and lighting in remote buildings	455	1,298	Implementation phase
Equipment idling	Reduce unnecessary equipment idling	114	325	Analysis phase
Accommodations	Improve energy efficiency in accommodations	76	217	Analysis phase
Motors	Re-evaluate sizing of key motors in the processing plant to optimize efficiency and power draw	455	1,298	Analysis phase
Total		**2,690**	**7,673**	

a) GHG emissions only included emissions reduced from combustion of diesel at the Ekati Mine. They do not include additional GHG emission reduction from the transportation of diesel to the Ekati Mine via the Winter Road.

CO_2e = CO_2 equivalent

Information Request Number:	DAR-TC-IR2-01
Source:	Transportation Canada Information Requests from Sarah Robertson
Subject:	Navigation Protection Act Authorization
DAR Section(s):	8

Preamble (TC):

It is understood that Dominion Diamond anticipates to “Opt-In” under the Navigation Protection Act and submit a Notice of Work form for the proposed dike and dewatering activities within Lac du Sauvage. Based on the information Transport Canada has to date, any remaining in-water works/activities proposed by Dominion Diamond for the Jay Project are not on waterways listed in the NPA Schedule and are therefore does not require an application or to give notice to TC regarding the proposed project activities. Section 4(1) of the NPA contains a provision which allows Dominion Diamond the option to request to “opt-in” to Transport Canada’s legislative regime and the NPA review process for any, or all of the in-water works/activities related to the jay Project. If accepted by TC under Section 4(1) then all provisions and review processes of the NPA would apply to the work. The following website provides more information on the NPA: http://www.tc.gc.ca/eng/programs-621.html

Request (TC):

Does Dominion Diamond anticipate a request to “Opt-In” for any remaining in-water works / activities proposed for the Jay Project?

Response:

A review of potential effects to navigability has been completed for all Jay Project (Project) activities, including infrastructure (Waste Rock Storage Areas, haul roads, pipelines, etc.) at watercourses, and the predicted changes in water levels and flows at waterbodies and watercourses. The watercourses crossed by the Project infrastructure are identified and discussed in Section 8.4.2.4.1 and shown on Map 8.4-1 of the Developer’s Assessment Report (DAR), and are determined to be non-navigable watercourses based on reconnaissance and field studies. In addition, an assessment of changes in water levels at lakes affected by the Project (other than Lac du Sauvage) considering surface water and groundwater was completed in Sections 8.4.2.4.1 and 8.5.3.2 of the DAR, which indicate that the predicted changes in water levels will have no effects to lake navigability at lakes other than Lac du Sauvage.

Based on a review of navigability and potential effects to navigability at watercourses and waterbodies affected by the Project, Dominion Diamond does not anticipate to “Opt-In” to Transport Canada’s legislative regime and the *Navigation Protection Act* review process for any other in-water works/activities related to the Project, other than the proposed dike, dewatering, and back-flooding activities within Lac du Sauvage.

DOMINION DIAMOND

Information Request Number:	DAR-TC-IR2-02
Source:	Transportation Canada Information Requests from Sarah Robertson
Subject:	Navigation Protection Act Authorization
DAR Section(s):	8

Preamble (TC):

It is understood that Dominion Diamond anticipates to "Opt-In" under the Navigation Protection Act and submit a Notice of Work form for the proposed dike and dewatering activities within Lac du Sauvage.

Request (TC):

What is the known use of Lac du Sauvage for navigational purposes? Past and present.

Response:

The Lac du Sauvage area remains part of the traditional landscape of the Subarctic Dene, Inuit, and Métis people. This area remains an important part of their traditional territories embodying many social and cultural memories and connections. Information related to traditional travel routes, including the use of waterbodies and watercourses, can be found in the Traditional Land Use and Traditional Knowledge Baseline Report (Annex XVII) of the Developer's Assessment Report (DAR). It is noted that historically, Dene people travelled largely by water in the spring, summer, and fall. Lac de Gras and surrounding area was reported as used for travel, both by water and land, by multiple Aboriginal groups. There is the potential that this may include Lac du Sauvage. Historical Inuit travel was predominately by foot, rather than by water, yet the Inuit hunted caribou from water using long thin kayaks in areas where caribou were plentiful. It was also noted that there were a lot of caribou at Tahikpak (Lac de Gras), crossing the Narrows (between Lac du Sauvage and Lac de Gras). Therefore, there is the potential that portions of Lac du Sauvage or the Narrows were travelled to support hunting in this manner.

Community Engagement Workshops were held with Aboriginal communities in preparation for submission of the DAR. Information regarding the use of Lac du Sauvage for navigational purposes provided at the workshops includes the following:

> *I stayed on an island in the south end of Lac du Sauvage when I was 19. My ancestors are from here. It is part of a traditional canoe route that leads to Contwoyto Lake*.

No reported current use of Lac du Sauvage for navigational purposes by Aboriginal land users was identified during Jay Project engagement or literature review. However, Lac de Gras, Lac du Sauvage, and the surrounding watershed remain a significant part of their traditional territories and the expectation is that they will be available for traditional land use activities in the future.

A description regarding the non-traditional use of Lac du Sauvage can be found in the Socio-Economic Baseline Report, Annex XV, Section 3.8 (Non-Traditional Land Use) of the DAR. In general, non-traditional land use in the vicinity of Lac du Sauvage is limited and no reported use of Lac du Sauvage for navigational purposes has been identified.