May 28, 2015

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

Re: EA1314-01 Jay Project Dominion Diamond Corporation Developer's Assessment Report – Stakeholder Engagement, Government of the Northwest Territories, Environment and Natural Resources

Dear Mr. Hubert:

Dominion Diamond is committed to engaging with potentially affected stakeholders on the Jay Project and has undertaken several engagement discussions with the Government of the Northwest Territories, Environment and Natural Resources (GNWT) and their technical consultants following an engagement meeting held February 3, 2015 in Yellowknife and the Technical Sessions for the Jay Project Developer's Assessment Report (DAR) in April 2015. Dominion Diamond meetings with the GNWT have focused on a number of technical questions arising from information presented in the DAR, Round 1 Information Requests, and discussions at the Technical Sessions.

Technical discussions from the Technical Sessions onwards have been focused on hydrogeological modelling and subsequent predictions on surface water quality (i.e., quantification of the uncertainty in the DAR predictions for hydrogeology and development of a lower bound case) and the implications for end of mine water quality for these various bounds on the meromictic conditions in the Jay and Misery Pits. This engagement has involved face to face meetings, conference calls, and email communication.

A summary of the meetings between Dominion Diamond and GNWT are described below.

Date: April 22, 2015
Discussion: Following Day 3 of the Technical Sessions in Yellowknife, a meeting was held to discuss the hydrogeological modelling in the DAR. The meeting notes were posted to the Mackenzie Valley Environmental Impact Review Board (MVEIRB) public registry:
http://www.reviewboard.ca/upload/project_document/EA1314-01_GNWT-Dominion_meeting_summary_April_22__2015.PDF

Date: April 28, 2015
Discussion: A follow-up telephone/online meeting was held to discuss a proposed approach to supplemental modelling to address GNWT's concerns. Based on the feedback received during the Technical Sessions, Dominion Diamond proposes to evaluate a lower bound scenario, and a subsequent evaluation of meromixis in the Misery and Jay pits based on the predicted total dissolved concentrations. A presentation was prepared for the meeting, and is provided to the MVEIRB public registry in this submission.

Date: April 29, 2014
Discussion: Dominion Diamond received a written question from the GNWT regarding the stitching together of the 2-dimensional and 3-dimensional hydrogeological models. A formal response was prepared and submitted to the GNWT on May 25, 2015, and also provided to the MVEIRB public registry in this submission.

Date: May 1-6, 2015
Discussion: GNWT provided additional written information based on the April 28, 2015 meeting and associated presentation materials to Dominion Diamond (included in this submission). Dominion Diamond provided an email summary of a proposed stochastic modelling approach to address GNWT's concerns with respect to quantification of the uncertainty in the hydrogeological model. GNWT subsequently provided additional thoughts on the approach.

Date: May 11, 2015
Discussion: A memo was prepared entitled "Jay Project – Uncertainty Stochastic Approach and Response to the GNWT" (Golder 2015) that outlines the proposed approach for addressing the degree of uncertainty or probability associated with the Environmental Assessment Conservative Scenario and the lower bound case that will be developed. The memo was provided to the GNWT on May 11, 2015 and is included in this submission to the MVEIRB public registry.

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DOMINION DIAMOND

Date: May 15-28, 2015
Discussion: Further questions were received and clarification of approach was provided. The hydrogeological modelling has been initiated and the results will be summarized in a technical memorandum which is expected to be provided with the responses to the Round 2 Information Requests.

Dominion Diamond recognizes the importance of all Parties concerns and is committed to work diligently to provide information and responses in a timely manner throughout the DAR review process.

Regards,

Richard Bargery
Manager, Permitting Jay Project
Dominion Diamond Corporation

April 28, 2015

Technical Session Follow-up Proposed Approach to Supplemental Modelling

Agenda

- Understanding of GNWT's and MVEIRB's concerns
- Lower bound model scenario
- Discussion

Issues

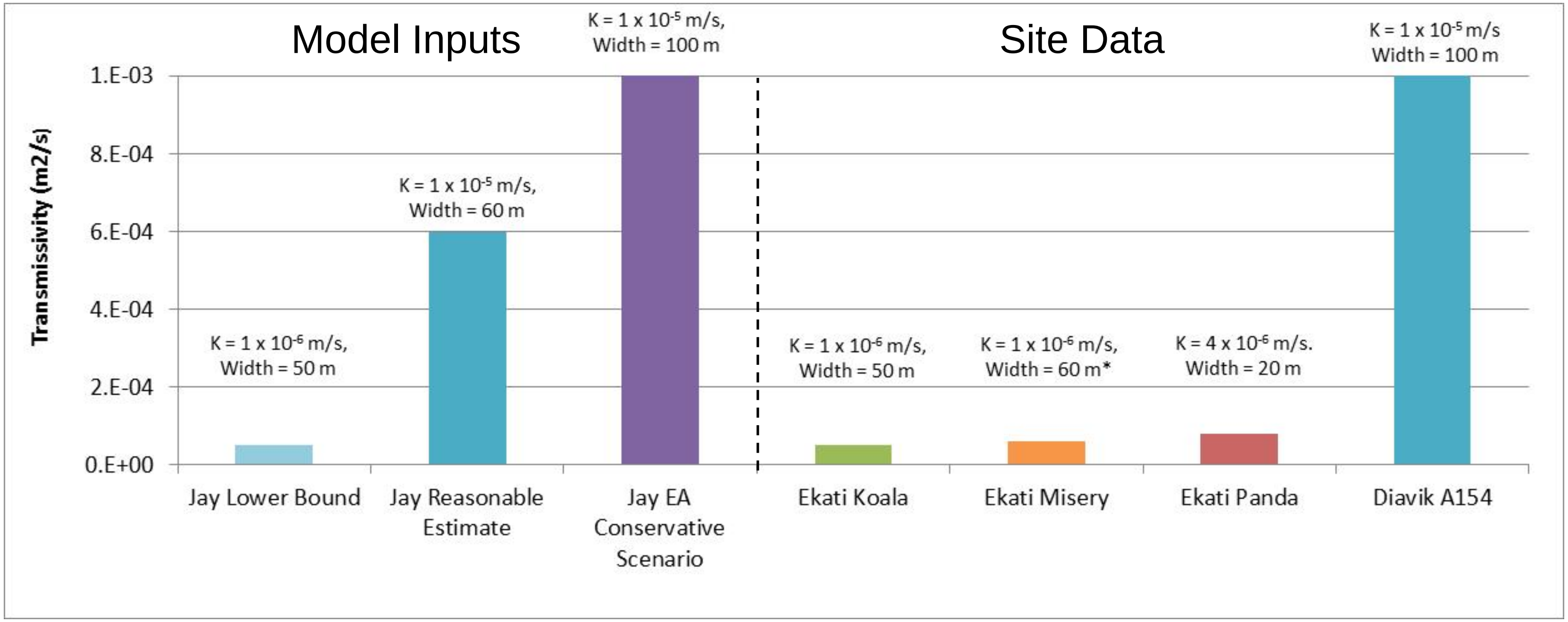
- GNWT – Modelling completed to date cannot be used to assign confidence limits to the likelihood of model scenarios occurring;

- MVEIRB/GNWT – Lower bound case has not been assessed. This scenario is important to address the likelihood of stable meromixis developing and persisting should TDS concentrations be less than predicted.

Lower Bound Model Approach

- The water quality projections provided as part of the reasonable estimate scenario represent the best estimate Project discharge water quality during operations, closure and post-closure
- This scenario indicates meromixis will form and remain stable in the Misery and Jay Pits during post-closure
- To evaluate if meromixis will form in the Misery and Jay Pits in the event TDS concentrations are over-predicted, Dominion/Golder proposes to evaluate a lower bound scenario
- The following inputs are recommended for the lower bound scenario
  - An EPZ hydraulic conductivity of $1x10^{-6}$
  - Decreasing EPZ hydraulic conductivities with depth
  - An EPZ thickness of 50 metres
- Golder does not recommend reducing the input parameters further since this is not considered to be a realistic scenario for the Project

Lower Bound Model Approach



*Conservatively high estimate for Misery Pit

Discussion

TECHNICAL MEMORANDUM

File:	**2015 - GNWT**
To:	**GNWT – ENR, Water Resources Division**
Attention:	**Mr. Nathen Richea, Manager**
Subject:	**DDEC J-Pipe Hydrogeological Review (SC446014) – Quantifying the uncertainty of the hydrogeologic modeling for pit inflows and water quality.**
Author(s):	**Jamie VanGulck, Ph.D., P.Eng.**
Page Total:	**2**
Date:	**May 1, 2015**

Further to recent correspondence[1] and discussions[2] [3] [4] between the Government of the Northwest Territories (GNWT) and Dominion Diamond regarding the hydrogeologic model for pit inflow and water quality, the GNWT provides the following additional items of clarification.

Dominion has completed a determinist estimate of pit inflows and water quality, which in their opinion, is conservative based on professional experience/judgment for the model assumptions and inputs. The GNWT notes that the level of conservatism has not been quantified and there is perceived uncertainty regarding the enhanced permeability zone (EPZ) characteristics and total dissolved solids (TDS) concentrations in the groundwater. The GNWT has requested Dominion complete further analysis (Monte Carlo simulations) of the hydrogeologic modeling to quantify the conservatism and the sensitivity of select model inputs to the predicted pit inflows and water quality. It is the GNWT's understanding that Dominion does not consider the analysis to quantify the conservatism to be warranted.

To further advance the proposed Monte Carlo analysis, provided below is a description of the general approach to complete the hydrogeologic modeling.

- To reduce the potential for excess computation time, a 2-D model of the hydrogeologic setting instead of a 3-D model could be employed. The 2-D analysis would encompass all time periods of active mining and post-closure, including: pit construction, pit flooding, and long-term post-operations. This differs from the current modeling where a 3-D model was used during pit operations and flooding and a 2-D model for post-operations.
- The 2-D analysis would include the effects of water density. This differs from the current modeling where density effects were not modeled for the 3-D model of pit operations and flooding, but was included in the 2-D model of post-operations.
- The parameters to assess in the Monte Carlo analysis have been selected to represent the primary contributors to pit inflows and water quality, and include the TDS concentrations in the groundwater and the EPZ hydraulic conductivity, effective porosity and width. Thus, four parameters in total have been targeted to perturb in the Monte Carlo analysis in order to assess their influence on the model results. Dominion has noted previously that porosity does not have as much influence as the hydraulic conductivity, and that transmissivity (which is related to hydraulic conductivity and width of the EPZ) may be a better parameter to

[1] April 16, 2015 email from GNWT to Dominion Diamond titled "Ekati hydrogeology request".

[2] April 22 and 23, 2015 Mackenzie Valley Environmental Impact Review Board technical session.

[3] April 22, 2015 meeting notes regarding hydrogeologic modeling submitted to the Mackenzie Valley Environmental Impact Review Board.

[4] April 28, 2015 teleconference between Dominion Diamond, GNWT and their respective consultants.

consider in assessing water flow. It is acknowledged that there may be instances where a combination of model inputs (e.g., high hydraulic conductivity and large width) may give rise to conditions that are not reasonable for the hydrogeologic setting. These conditions would need to be discounted in the interpretation of the Monte Carlo results.

- Each of the four parameters to perturb in the Monte Carlo analysis will require a probability density function (PDF). As noted by Dominion, there are instances where select parameters have limited sampling events and therefore a PDF based on the site measurements may not be permissible. It is noted herein that a reasonable PDF can still be selected to for each parameter to provide meaningful results. Zajdlik & Associates Inc. (2015)[5] has provided further guidance on this subject.
- The following probability density functions are desired from the Monte Carlo analysis:
  - Cumulative pit inflows at end of mining
  - Average pit TDS concentration at end of mining
  - Cumulative pit inflows at end of pit flooding
  - Average pit TDS concentrations at end of pit flooding

  The probability density functions at end of mining would provide a means to understand the level of risk associated with mine water management leaving Jay Pit. The probability density functions at end of pit flooding would provide a means to understand the level of risk associated with pit lake water quality and lake stratification.

  In addition to the probability density functions, the following time series plots would aid in interpreting the results:

  - Cumulative pit inflows over time for the mean, 5% and 95% confidence limits, EA reference case and EA conservative case.
  - Average pit TDS concentration over time for the mean, 5% and 95% confidence limits, EA reference case and EA conservative case.
- The pit TDS concentration for a lower confidence limit should be used in the pit stratification analysis to address the likelihood of stable meromixis developing.

[5] Zajdlik & Associates Inc. May 1, 2015 memorandum to the Government of the Northwest Territories titled "Simulation Distributions".

Zajdlik & Associates Inc.

Memo

To: Paul Green, Rick Walbourne, Nathen Richea

From: B. Zajdlik

CC: Jamie Van Gulck

Date: 27/05/2015

Re: Simulation Distributions

Dear Paul, Rick and Nathen

Jamie Van Gulck (ARKTIS Solutions Inc) identified 4 parameters that should be varied in the Monte Carlo simulations discussed. Jamie and I discussed the variables and have agreed on the distributions and parameterizations which are presented below.

Enhanced Permeability Zone (EPZ) Width

Three local EPZ widths are available. These are Ekati Koala – 50 m, Ekati Panda – 20 m and Diavik A154 – 100 m (Table 4.4-1, Annex IX – Hydrogeology Baseline Report for the Jay Project). The widths are inferred or back calculated widths. Dominion Diamond Mine Ekati Corporation (DDEC) believes that the Dewey fault represents an unusually large or outlying EPZ. As the widths are back calculated there is some uncertainty associated with each width. Jamie Van Gulck (ARKTIS Solutions Inc) suggested that each measurement could vary by 20%; however this uncertainty cannot be verified.

As the mechanism driving fault widths is due to a variety of factors acting in concert (i.e. multiplicatively) a log normal distribution is expected. If we use the Dewey fault width of 100 m with a 20% uncertainty we have a range of 80 – 120 m for the fault width. Using DDEC's assertion that this measurement is outlying we can assume that it represents the 90^{th} percentile of the lognormal distribution. However we have no way estimating the dispersion of this distribution given the very limited amount of information available. Therefore I propose a rectangular distribution bounded by 20*(1-0.2) = 16 and 100*(1+0.2) = 120.

Porosity

Porosity is like the EPZ width, driven by factors acting in concert and again, a lognormal distribution is likely. However the absence of data precludes assessing this hypothesis and therefore a rectangular distribution is recommended. The uncertainty in the available porosity estimates is 10% (Jamie Van Gulck pers. comm.). However this uncertainty cannot be verified. Therefore the rectangular distribution should be bounded by minimum*0.9 and the maximum*1.1.

Hydraulic Conductivity

Using the information in the DDEC IR6 Response, Table 6.1 hydraulic conductivity is shown to vary with depth.

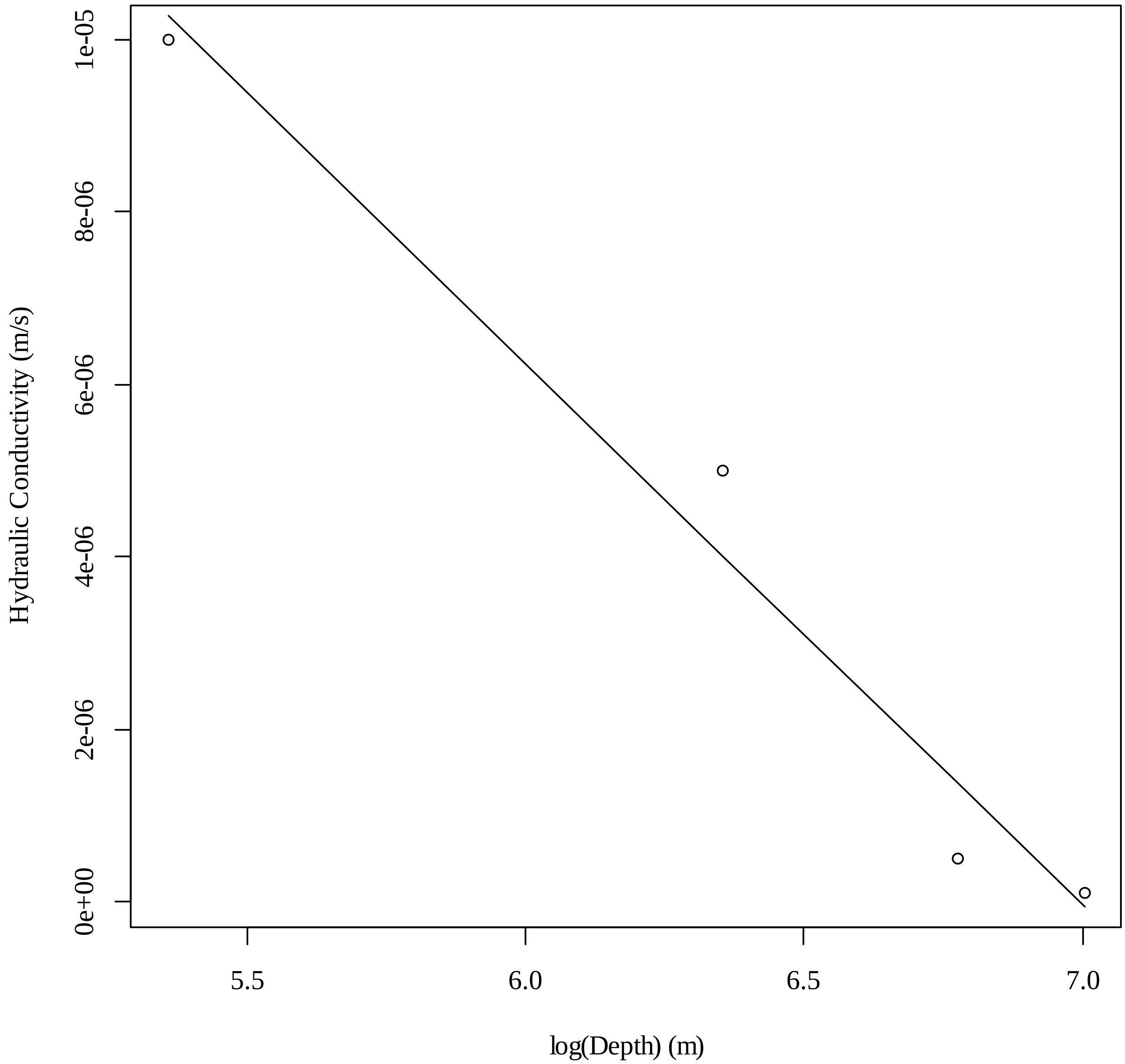


Figure 1: Hydraulic Conductivity by log(Depth)

The fitted model is

Hydraulic Conductivity = 4.392e-05 -6.280e-06(log(depth)).

Note that a natural logarithm is used and depths are mid depths based on the ranges provided.

The intercept and slope standard errors are respectively 4.873e-06 and 7.610e-07. The residual mean square error is 9.1900e-13. Visual model diagnostics indicate no egregious failures of assumptions (although the data set is quite limited). The fitted model should be used to predict hydraulic conductivities that vary with depth. The Monte Carlo simulation should use the depth specific 95% prediction interval.

Total Dissolved Solids

Total dissolved solids vary with depth Figure 8.2-2 (DDEC, 2014). The slope of the Jay Baseline Profile was obtained from a regional scale database (Frape and Frtiz profile, DDEC 2014, Figure 8.2-2) and the intercept of that regression line is adjusted to intercept the 3 available samples. It is my understanding that subsequent to production of this graphic, additional samples were collected from the proposed Jay Pit site. A regression analysis should be conducted using the additional observations. The Monte Carlo simulation would use the extrapolated values and associated depth specific prediction intervals as input to the meromixis model. Due to the lack of data at depth the prediction intervals will be quite wide at depth as interval width is a function of distance from the mean of the observed independent variable. Optimally, this uncertainty would be reduced by collecting TDS measurements at greater depth.

A less desirable alternative is to use the Frape and Fritz regression and allow the intercept to vary from 110 to 1,000 mg/L TDS which is approximately the TDS range at depth = 0m. Each realization would use the randomly selected intercept and the existing slope to predict depth specific TDS concentrations. This alternative is less desirable as it assumes that the Frape and Fritz profile estimated using data from the Canadian Shield applies to the Jay Pit site. There does not appear to be any locally available data (Ekati or Rio Tinto) that is deeper than the deepest Jay Pit sample to corroborate the Frape and Fritz regression.

A plausible distribution for the intercepts is the triangular with limits at 110 and 1000 mg/L TDS with a mode equal to the intercept of the Jay Pit regression (approximately 140 mg/L).

References

DDEC (Dominion Diamond Ekati Corporation). 2014. Dominion Diamond Ekati Developer's Assessment Report Jay Project.

Golder Associates

TECHNICAL MEMORANDUM

DATE May 11, 2015 **PROJECT No.** 1419751

TO Mr. Richard Bargery
Dominion Diamond Ekati Corporation

CC Mr. Elliot Holland, Ms. Claudine Lee and Mr. Eric Denholm

FROM Don Chorley and Christine Bieber **EMAIL** dchorley@golder.com

JAY PROJECT – UNCERTAINTY/STOCHASTIC APPROACH AND RESPONSE TO THE GNWT

1.0 INTRODUCTION

Dominion Diamond Ekati Corporation (Dominion Diamond) submitted a Developer's Assessment Report (DAR) to the Mackenzie Valley Environmental Impact Review Board (MVEIRB) in November 2014. Following the Jay Project (Project) technical sessions held in Yellowknife between April 21 and 24, 2015, Dominion Diamond agreed to provide analyses that would assess the degree of uncertainty or probability associated with the EA Conservative Scenario and a lower bound case that will be developed. Furthermore, it was agreed that Dominion Diamond would provide a summary of the approach that we are proposing to the Government of Northwest Territories (GNWT) for their review and comments.

On May 5, 2015, Dominion Diamond presented the proposed approach in an e-mail from Richard Bargery of Dominion Diamond to Nathen Richea of the GNWT. On May 6, 2015, Mr. Richea provided in an e-mail with attachments, a request for clarification on the first order approximation approach (FOA) and the probability distribution functions (PDFs) that GWNT's consultants (ARKTIS) recommend for the Monte Carlo simulation. The purpose of this memorandum is to provide clarification and detail on the FOA method and to respond to the Monte Carlo approach recommended by ARKTIS and, in particular, to provide the revised PDFs that we propose to use in the Monte Carlo simulation.

2.0 FIRST ORDER APPROXIMATION

The first order approximation approach is described in Benjamin and Cornell (1970). The approach is deterministic, but it allows us to use the results from the full 3D numerical hydrogeological model developed for the Jay Project to assess uncertainties. Over a shorter computational time, the uncertainty can be assessed for a larger number of parameters than those proposed in Monte Carlo simulation proposed below. In our approximation, it is assumed that the PDFs for the hydraulic conductivities in the kimberlite, the enhanced permeability zone (EPZ), country rock and weather bedrock, and the PDF for storage properties are all log-normal; whereas, the distributions of porosity, EPZ width, and TDS are normal. The standard deviation, variance, and coefficient of variation will be calculated for each model input parameter based on the assumption that for each parameter, two standard deviations are encompassed between the mean value and the upper or lower bound. For a normal distribution of parameter values, the standard deviation can be calculated by the following:

$$\sigma_X = \frac{1}{2}(X - m_X) \qquad (1)$$

where m_x is the mean value of the variable X, and the value of X substituted into this equation is a value of the variable, which is 2 standard deviations from the mean value. By definition, the coefficient of variation is $V = \frac{\sigma_x}{m_X}$, and the variance is $Var = \sigma_x^2$.

For a log-normal distribution of parameter values, the standard deviation of the natural log of a parameter Y is normally distributed; therefore, the standard deviation of ln Y is:

$$\sigma_{\ln Y} = \frac{1}{2}\ln\left(Y / m_Y\right) \qquad (2)$$

The coefficient of variation of the variable Y is related to the standard deviation of ln Y by the formula (pg. 266, Benjamin and Cornell 1970):

$$\sigma_{\ln Y}^2 = \ln(V_y^2 + 1) \qquad (3)$$

The standard deviation of the variable Y can then be calculated as $\sigma_Y = V_Y m_Y$ and the variance of Y follows as $Var = \sigma_Y^2$.

The uncertainty in the model predictions is a function of uncertainty in each of the input parameters. Assuming these hydraulic parameters are uncorrelated, a first order approximation of the variance can be calculated by the following (pg. 180-186, Benjamin and Cornell 1970):

$$Var[Q] \approx \sum_{i-1}^{I} \left(\frac{\Delta Q}{\Delta X_i}\right)^2 Var[X_i] \qquad (4)$$

where *Q* is the predicted inflow, X_i is a hydraulic parameter such as hydraulic conductivity, and *I* is the total number hydraulic parameters that the predicted inflow depends on. For each parameter, two simulations will be performed for which the parameter is adjusted to its upper bound value and lower bound value.

3.0 MONTE CARLO

As written in Mr. Richea's e-mail, we also agree that we are near to a resolution on the uncertainty approach for the supplemental groundwater modelling work for the Jay Project. Many of the GNWT recommendations have been incorporated into our analyses with some refinement to take into account analog sites near to the Jay Pit, recent research, and our experience in the north.

3.1 General Approach

The 2D model of the enhanced permeability zone (EPZ), as recommended by the GNWT, will be run as a surrogate for the full 3D model developed for the Jay Project. The model will reduce computational time and allow us to provide results within the time frame for the second round of Information Requests. These results cannot be directly compared with the results of the 3D model, but the uncertainty of EPZ in the EA Conservative Scenario in the DAR and the lower bound estimate will be assessed.

Because of the boundary conditions required to predict inflow total dissolved solids (TDS) concentrations and concerns regarding individual model run stability, we have decided on a manual implementation of the stochastic simulations. This will consist of three general steps:

- A random generator will be used to sample each of the probability distribution functions to determine each 2D model run. Unreasonable realizations, such as very low porosity together with high hydraulic conductivity, will be rejected. A justification for rejection of any unreasonable parameter combinations will be provided in the associated reporting;
- Each 2D model simulation will be manually run and checked for stability, convergence, and mass balance; and,
- The results of the 2D model runs will be used to develop a probability assessment of the groundwater inflow quantity and TDS concentration. The location of the EPZ used in the EA Conservative Scenario, in the Reasonable Estimate Case, and the lower bound case will all be plotted to indicate relative probability.

3.2 Parameters

The following provides a discussion of our proposed parameters. We are largely in agreement with GNWT, but have minor revisions in the parameters based on nearby analog sites, published material, and experience in the north (DAR Annex IX). We propose the same four parameters as those proposed by the GNWT, namely EPZ width, porosity, hydraulic conductivity, and TDS depth profile. Each of these four parameters is discussed below together with our proposed distributions and parameterizations.

3.2.1 Width of the EPZ

We agree in principle with the probability distribution function that the GNWT recommends for the width of the EPZ with the following exceptions:

- The width of Duey's Fault at Diavik has been measured accurately through observations in the open pit and through horizontal boreholes in the underground; therefore, the high end with should be 100 metres (m), not 120 m.
- A reasonable lower bound for the width is considered to be 10 m.

This distribution will define the width of the EPZ over its entire depth. This introduces some conservatism in the 2D model compared to the 3D model. The width in the EA Conservative scenario in the 3D model is stepped down with depth; from 0 to 400 m it is 100 m wide, and from 400 to the bottom of the model it is 60 m wide.

The probability distribution function for width is, therefore, rectangular, bounded by 10 m and 100 m.

3.2.2 Porosity

We agree with the GNWT parameter distribution for porosity; however, porosity in fractured rock is weakly correlated with hydraulic conductivity; therefore, scenarios with unreasonable combinations of very low porosities and high hydraulic conductivities would be discarded with documentation and justification provided in associated reporting. Our recommended PDF is also rectangular and bounded by 0.002 and 0.05.

3.2.3 Hydraulic Conductivity

We agree that the PDF for hydraulic conductivity in the upper 400 m of the EPZ should be a log-normal distribution, but one that considers the data from other kimberlite pipes in the vicinity of the Jay Pipes (DAR Annex IX, Table 4.4-1), as well as the EA Conservative Scenario (based on the hydraulic properties of Duey's Fault) that is presented in Table 6.1 of the DDEC IR6. All of these other EPZs (including two other pipes at Diavik) generally have hydraulic conductivities at least one order of magnitude less than Duey's or are much thinner. Our proposed distribution has a mean of 5×10^{-6} metres per second (m/s) with a lower estimate (5th percentile value) of 1×10^{-6} m/s and a upper estimate (95th percentile value) of 2.5×10^{-5} m/s, which is a factor of 2.5 greater than the hydraulic conductivity in Duey's Fault (and that applied in the EA Conservative Scenario model).

Similar to the GNWT's recommendation for reduction of hydraulic conductivity with depth, the above probability distribution will define the hydraulic conductivity in the first 400 m depth, with the hydraulic conductivity at greater depths stepped down at the same rate that is in the EA Conservative Scenario.

3.2.4 TDS Profile

Our parameter distribution is equivalent to that proposed by the GNWT, with a triangular PDF with limits of 110 and 1,000 milligrams per litre (mg/L) TDS, and a mode equal to the intercept of the Jay Pit regression of about 540 mg/L, not 140 mg/L as presented in the ARKTIS memo (we think that this is likely a typographical error).

4.0 CLOSURE

We trust that the above discussion satisfies your current requirements.

REGISTERED PROFESSIONAL GEOLOGIST
May 11, 2015
DWC
D.W. CHORLEY
LICENSEE
NWT/NU

CBieber

Christine Bieber, M.Sc., P.Geo
Senior Hydrogeologist

Don Chorley, M.Sc., P.Geo
Principal, Senior Hydrogeologist

dwc

5.0 REFERENCES

Benjamin, J.R and C.A. Cornell. 1970. Probability, Statistics, and Decision for Civil Engineers. Published by McGraw Hill Inc.

Dominion Diamond (Dominion Diamond Ekati Corporation) 2014. Jay Project Developer's Assessment Report. October 2014.

Zajdlik & Associates Inc. 2015. Simulation Distributions. Memo to Paul Green, Rick Walbourne, and Nathen Richea of the GNWT from B. Zajdlik dated May 6, 2015.

Follow-up Item:	1
Source:	April 29, 2015 email from GNWT to Dominion Diamond
Subject:	Resolving perceived inconsistencies between the 3-D and 2-D hydrogeologic models.
DAR Section(s):	8

Preamble (GNWT):

In Appendix 8A of the DAR, it is stated that at the end of Period 13 of the 3-D hydrogeologic model (model) the hydraulic gradient between the flooded pit and surrounding surface water is expected to be negligible, and groundwater inflows to the flooded pit after this time were assessed using the post closure 2-D model (Appendix 8B). Discussions on April 22nd inform the end of Period 12 represented the transition from 3D to 2D modeling, however, discussion within the DDEC response[1] to the GNWT's IR#8 and language with Appendix 8B of the DAR suggest that the 2D model simulations begin following the end of Period 14 with Year 1 of the 2D model representing 2034.

Request (GNWT):

To clarify DDEC's predictions for the hydrogeologic conditions during post mining phase and at the important transition from the 3-D model (which doesn't include density effects on flow) to the 2-D (which does include density effects on flow), could DDEC please provide a single summary table presenting select inputs/predictions from the already completed model simulations over a time period from the final year of active mining/pit dewatering (i.e., maximum inflow) to the end of the 3D model and through the first 5 years of the 2-D model. The summary table should include the following information for both Reference Case and EA Conservative Scenario predictions, with values presented in annual intervals similar to the DAR:

- Rates of groundwater inflow to the Jay Pit (m^3/d)
- TDS concentrations of groundwater inflows to the Jay Pit (mg/L)
- Rates of any other inflows to the Jay Pit (e.g. surface water, precipitation, pumping, etc.) m^3/d)
- TDS concentrations assigned to any other inflows to the Jay Pit (mg/L)
- Rates of any water losses, and associated TDS concentrations from the Jay Pit to groundwater (m^3/d, mg/L)
- Rates of any water losses, and associated TDS concentrations from the Jay Pit to the overlying surface water cap (m^3/d, mg/L)

[1] April 7, 2015 Dominion Diamond responses to IR.

For comparison of the spatial profiles within this time period, please provide:

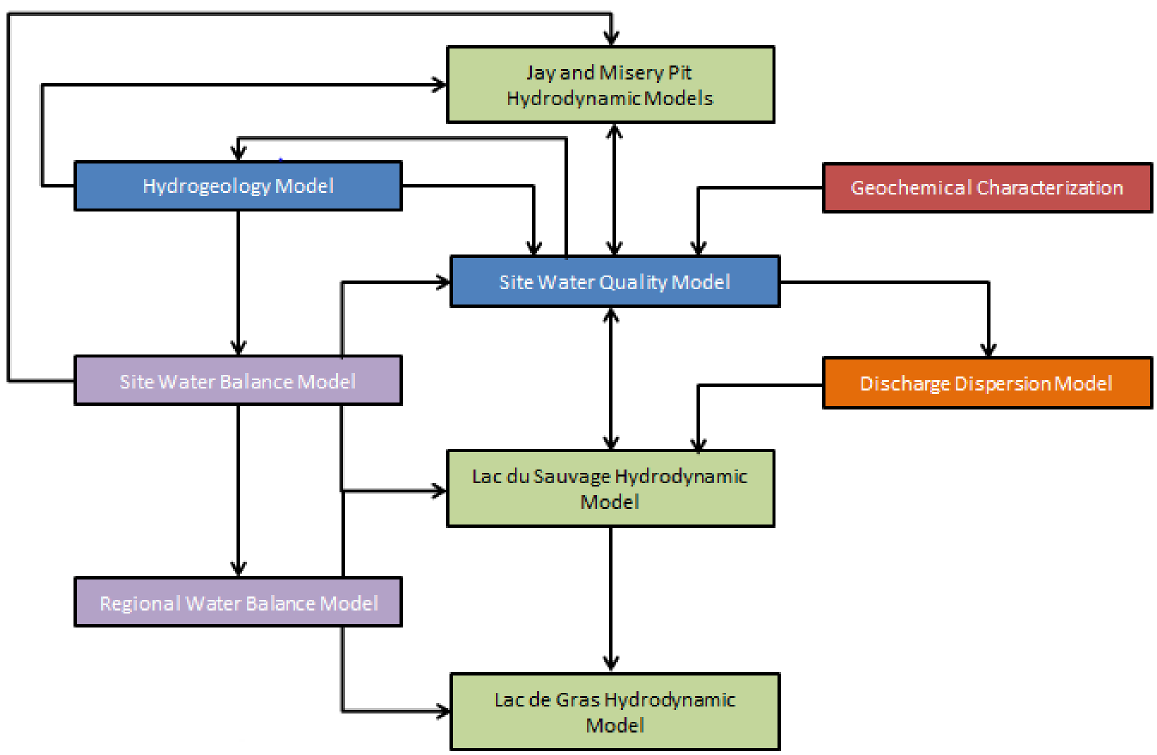
- Cross-sectional profiles (consistent with Figure 8A4-3 from the 3-D model report) detailing hydraulic conditions and TDS concentrations across the model domain representing the end of each year during Jay Pit flooding and final conditions at the end of the 3-D model for both the Reference Case and EA Conservative Scenario. Only Period 12 was presented within the DAR.

Response:

Summary Information

To evaluate impacts of the Jay Project (Project) on surface water quantity and quality in Lac du Sauvage and Lac de Gras, several interlinked models were developed. There is no one model that can be used to account for all of the processes that can influence water quality; therefore, independent models, interlinked at various nodes and times were developed (Figure 1). This approach is documented in Mine Water and the Environment (Vandenberg et al. 2015) and is commensurate with other mine development applications in the Northwest Territories.

Figure 1 Jay Project – Conceptual Water Quality Model



The Government of Northwest Territories (GNWT) requested information related to the linking of the 2D and 3D hydrogeological models that were developed as part of the Developer's Assessment Report (DAR). As noted above, several models were developed for the purpose of assessing impacts to surface water quantity and quality at the Project. Therefore, although the GNWT request is focused on the hydrogeological models, the requested information was extracted from five interlinked models. Information was collated from the following models:

- Site water balance and water quality model (Appendix 8E of the DAR) at end of mining and during the refilling period – groundwater quantity and quality in this model were derived from the predictions of the 3-dimesional (3D) hydrogeological model that are summarized in Table 8A3-5, and Table 8A4-1 of Appendix 8A of the DAR; and,
- CE-QUAL-W2 hydrodynamic model (Appendix 8G of the DAR) during the post-closure period – groundwater quantity and quality in this model were derived from the predictions of the 2-dimensional (2D) hydrogeological model (Appendix 8B of the DAR).

Outputs from the CE-QUAL-W2 results are also linked to the site water quality model during post-closure (Figure 1). However, since the CE-QUAL-W2 model is of a higher resolution than the site water quality model, it was considered more appropriate to extract the information from this model during the post-closure period.

The summary tables requested by GNWT are provided in Tables 1 to 3. The inflows and outflows are annual averages. It should be noted that these inflows and outflows may vary throughout the year, and the models for operation and closure account for these changes on a daily basis. For example, precipitation is modelled on a daily basis and varies substantially on a seasonal basis. Similarly, groundwater inflows during the refilling period decrease as the pit fills, and net groundwater inflow becomes net outflow in the later part of 2032; therefore, on an average annual basis, both groundwater inflow and groundwater outflow are recorded for this year.

Table 1 Jay Pit Inflow Volumes and Total Dissolved Solids Concentrations - Updated Assessment Case

Component		Unit	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Inflows														
Groundwater Inflow[(a)]	TDS	mg/L	7,352	6,993	1,811	866	-	5,569	5,409	5,194	5,224	4,847	4,588	4,409
	Flow	m^3/d	21,268	11,306	5,171	853	-	64	55	44	37	33	29	25
Surface Water Inflow[(b)]	TDS	mg/L	56	34	34	34	11	6.5	6	6	6	6	6	6
	Flow	m^3/d	4,033	4,026	4,033	4,009	3475	3,470	3,495	3,489	3,495	3,495	3,495	3,489
Pumped Flow from Misery Pit	TDS	mg/L	-	3,514	-	-	-	-	-	-	-	-	-	-
	Flow	m^3/d	-	37,512	-	-	-	-	-	-	-	-	-	-
Pumped Flow from Lac du Sauvage	TDS	mg/L	-	53	31	21	14	-	-	-	-	-	-	-
	Flow	m^3/d	-	46,356	60,559	86,164	72592	-	-	-	-	-	-	-
Waste Rock Storage Area Runoff	TDS	mg/L	350	350	350	350	350	350	350	350	350	350	350	350
	Flow	m^3/d	1,380	1,413	1,415	1,408	1411	1,409	1,418	1,416	1,418	1,418	1,418	1,416
Net Precipitation	Flow	m^3/d	12	-204	-307	-371	-61	247	266	268	266	266	266	268
Outflows														
Groundwater Outflow[(c)]	TDS	mg/L	-	-	-	3,949	882	4,250	4,170	3,989	3,837	3,747	3,688	3,624
	Flow	m^3/d	-	-	-	1250	9580	72	66	62	60	59	58	57
Jay Overflow to Lac du Sauvage	TDS	mg/L	-	-	100	111	-	25	34	38	40	43	45	46
	Flow	m^3/d	-	-	1,194	5,038	-	5,263	5,172	5,157	5,162	5,153	5,144	5,142

Notes:

(a) Total groundwater inflow including connate water from deep seated groundwater and lakewater losses from Lac du Sauvage.

(b) Includes pit wall runoff, developed areas runoff, dewatered area runoff (disturbed natural vegetation from draining of the diked area), and natural runoff.

(c) Consists of groundwater losses from the bottom of the Jay Pit, as well as from the Jay Pit diked off area.

TDS = total dissolved solids; mg/L = milligrams per litre; m^3/d = cubic metres per day; - = not available.

Table 2 Jay Pit Inflow Volumes and Total Dissolved Solids Concentrations - Reasonable Estimate Case

Component		Unit	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Inflows														
Groundwater Inflow[(a)]	TDS	mg/L	7,111	3,394	925	105	11	6,944	6,671	6,248	5,878	5,561	5,342	5,035
	Flow	m^3/d	13,700	8,877	5,465	2,354	38	77	70	60	52	45	37	32
Surface Water Inflow[(b)]	TDS	mg/L	57	37	37	36	11	6.5	6	6	6	6	6	6
	Flow	m^3/d	4,033	4,026	4,033	4,004	3,475	3,470	3,495	3,489	3,495	3,495	3,495	3,489
Pumped Flow from Misery Pit	TDS	mg/L	-	1,703	-	-	-	-	-	-	-	-	-	-
	Flow	m^3/d	-	37,512	-	-	-	-	-	-	-	-	-	-
Pumped Flow from Lac du Sauvage	TDS	mg/L	-	19	13	11	8.7	-	-	-	-	-	-	-
	Flow	m^3/d	-	46,356	60,460	86,164	71,310	-	-	-	-	-	-	-
Waste Rock Storage Area Runoff	TDS	mg/L	350	199	199	199	199	199	199	199	199	199	199	199
	Flow	m^3/d	1,380	1,413	1,415	1,406	1,411	1,409	1,418	1,416	1,418	1,418	1,418	1,416
Net Precipitation	Flow	m^3/d	12	-200	-302	-371	-60	247	266	268	266	266	266	268
Outflows														
Groundwater Outflow[(c)]	TDS	mg/L	-	-	-	1,824	217	1,884	1,843	1,799	1,914	2,109	2,239	2,288
	Flow	m^3/d	-	-	-	511	8,384	78	75	71	68	65	60	57
Jay Overflow to Lac du Sauvage	TDS	mg/L	-	-	57	62	-	15	19	22	24	26	27	28
	Flow	m^3/d	-	-	1,194	4,822	-	5,264	5,177	5,167	5,168	5,161	5,153	5,147

Notes:

(a) Total groundwater inflow including connate water from deep seated groundwater and lakewater losses from Lac du Sauvage.

(b) Includes pit wall runoff, developed areas runoff, dewatered area runoff (disturbed natural vegetation from draining of the diked area), and natural runoff.

(c) Consists of groundwater losses from the bottom of the Jay Pit, as well as from the Jay Pit diked off area.

TDS = total dissolved solids; mg/L = milligrams per litre; m^3/d = cubic metres per day; - = not available.

Table 3 Jay Pit Monimolimnion Transfer Volumes and Total Dissolved Solids Concentrations

Jay Pit Monimolimnion		Unit	Post-Closure (Year)						
			2034	2035	2036	2037	2038	2039	2040
Updated Assessment Case	TDS	mg/L	2,736	2,736	2,736	2,736	2,736	2,736	2,736
	Flow	m^3/d	793	438	363	346	255	220	236
Reasonable Estimate Case	TDS	mg/L	1,297	1,297	1,297	1,297	1,297	1,297	1,297
	Flow	m^3/d	1,214	549	421	470	275	203	258

Notes:

Flow rates and TDS concentrations are estimates of transfer volumes and TDS concentrations based on the hydrodynamic model results, which indicate the mass transfer will result in a thicker transition zone.

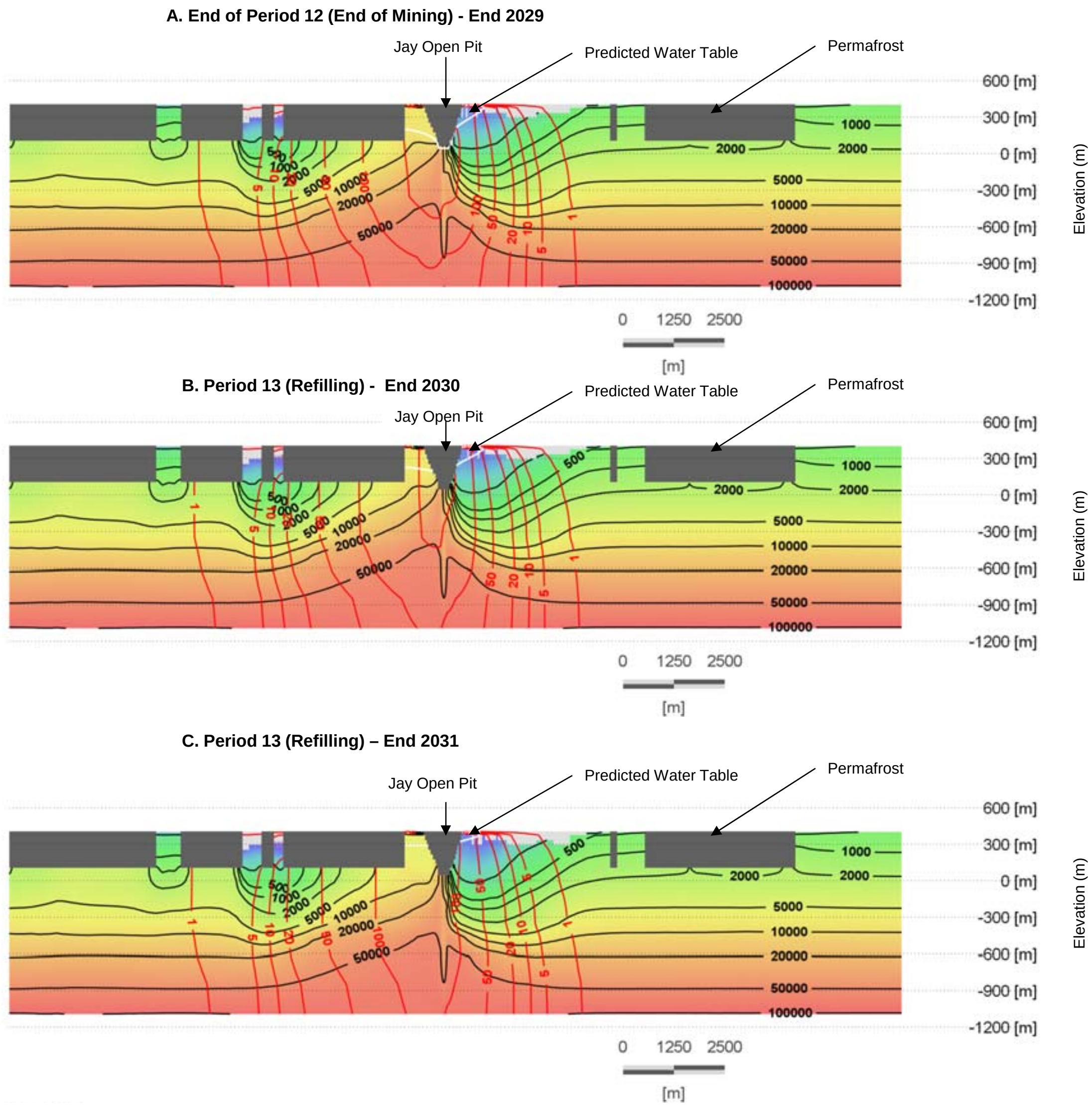
Changes in TDS concentrations in the monimolimnion were predicted to be minimal between 2034 and 2040 and were set at the initial concentrations.

TDS = total dissolved solids; mg/L = milligrams per litre; m^3/d = cubic metres per day.

Simulation of Total Dissolved Solids in the 2D and 3D groundwater models

To clarify, the initial condition for the total dissolved solids (TDS) of groundwater within the pit walls in the post-closure hydrogeologic model presented in Appendix 8B relied on the TDS profile predicted for the end of Period 12 (the end of mining) which corresponds to maximum upwelling of high TDS water beneath the pit. This initial condition was selected to provide conservatively high estimates of TDS upwelling as input to the 2D density-driven transport model. The predictions of density-driven transport between groundwater in pit walls and the Jay pit lake were in turn used as input to the post-closure hydrodynamic model. Changes in the TDS profile in groundwater surrounding the pit due to density-driven sinking of high TDS groundwater, and loss of low TDS during the closure period (refilling) were intentionally neglected to provide conservatively high predictions of density-driven exchange in post-closure.

The cross-sectional profiles (consistent with Figure 8A4-3 from the 3D model report) detailing hydraulic conditions and TDS concentrations across the model domain representing the end of each year during Jay Pit flooding and final conditions at the end of the 3D model for both the Reference Case and EA Conservative Scenario are included in Figures 2 to 5. Figures 3 and 5, which represent conditions at the end of 2032 and 2033, do not show TDS concentrations across the model domain, as in the later part of closure, there is no groundwater inflow predicted to the Jay Pit. Instead, groundwater outflow from the Jay Pit to groundwater is predicted. Because calculation of the water quality in the Jay Pit requires integration of all components of minewater (including surface water inputs), the TDS of water lost from the Jay Pit during closure was calculated within and accounted for in the water quality model, and these components are presented in Tables 1 and 2.



Legend

— 5 — Drawdown Contour (m)

- **2000** – TDS Concentration Contour (mg/L)

Shading on Panel B represent initial TDS concentration in mg/L.

- 103311
- 42967.9
- 17870.7
- 7432.56
- 3091.26
- 1285.68
- 534.725
- 222.396
- 92.4965
- 38.47
- 16

Note
Transport was not simulated in the groundwater model after 2031. in the Environmental Assessment Conservative Scenario as the model predicted net outflow from the pit after this period.
The TDS of water exiting the Jay Pit was accounted for in the water quality model.
Vertical Exaggeration of three is shown.

PROJECT
DOMINION DIAMOND EKATI CORPORATION
JAY PROJECT
NORTHWEST TERRITORIES, CANADA

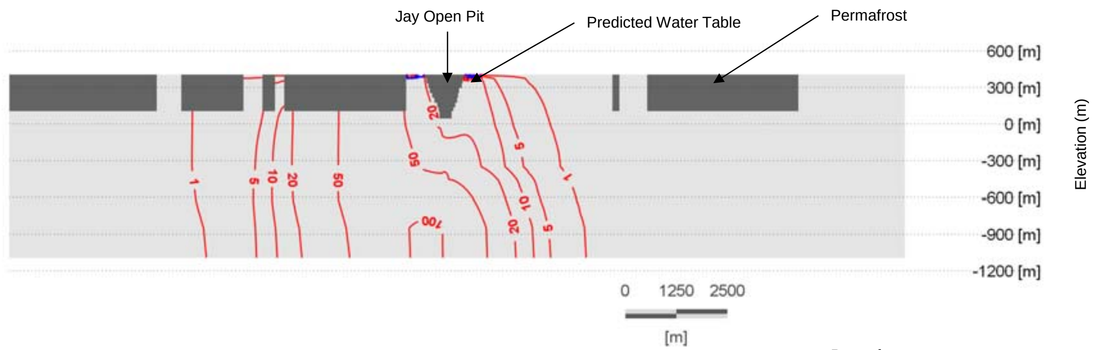
TITLE
PREDICTED DRAWDOWN AND TDS 2029 TO 2031– EA CONSERVATIVE SCENARIO - HYDROGEOLOGICAL MODEL

PROJECT	1419751		FILE No.
DESIGN	CB	20/05/2015	SCALE AS SHOWN REV 0
CADD	CB	20/05/2015	
CHECK	DC	21/05/2015	**FIGURE: 2**
REVIEW	DC	21/05/2015	

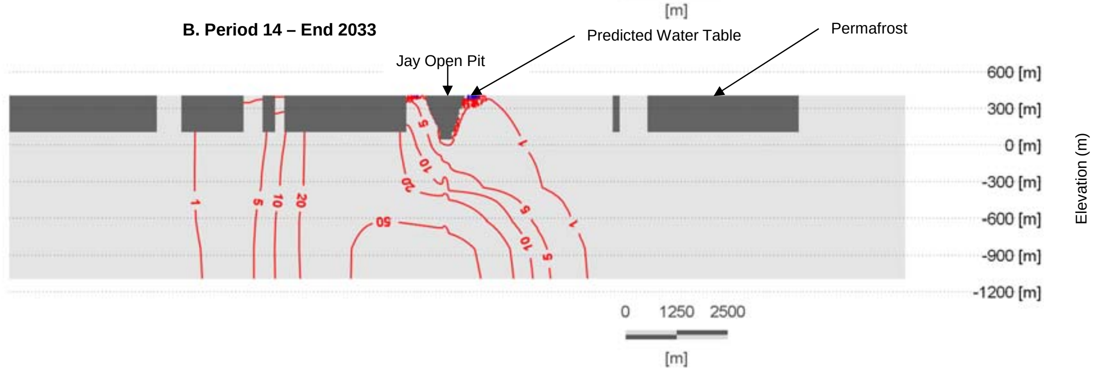
Legend

— 5 — Drawdown Contour (m)

A. Period 13 – End 2032

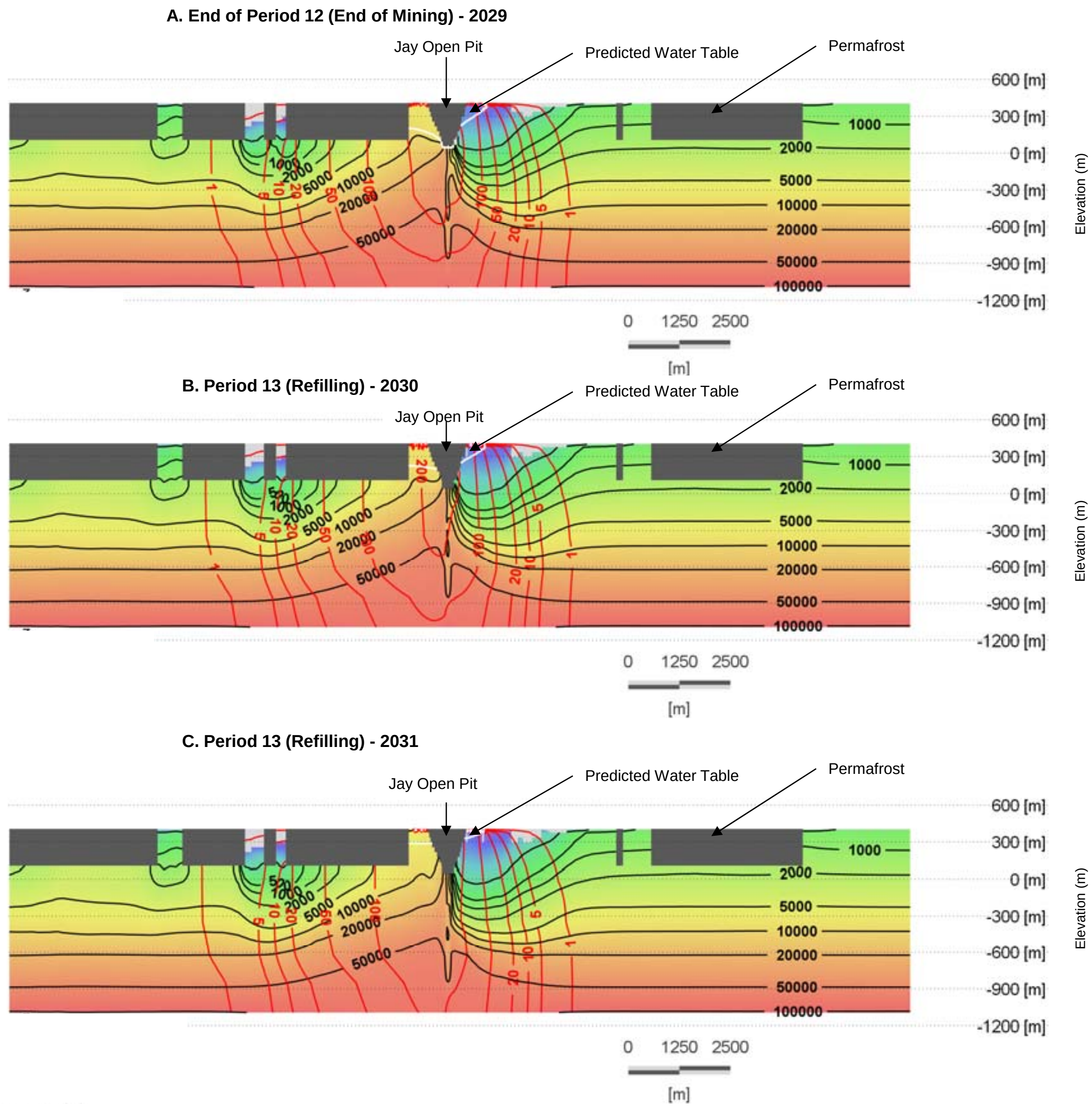


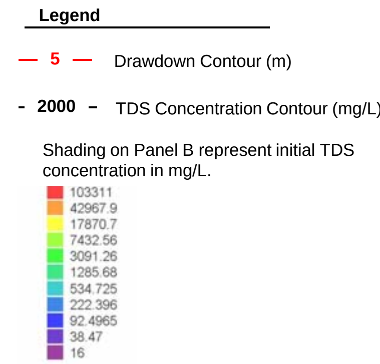
B. Period 14 – End 2033



Note
Transport was not simulated in the groundwater model beyond the third quarter of 2031 as the model predicted net outflow from the pit after this period.
The TDS of water exiting the Jay Pit was accounted for in the water quality model.
Vertical Exaggeration of three is shown.

PROJECT	DOMINION DIAMOND EKATI CORPORATION JAY PROJECT NORTHWEST TERRITORIES, CANADA			
TITLE	**PREDICTED DRAWDOWN AND TDS 2032 TO 2033 – EA CONSERVATIVE SCENARIO - HYDROGEOLOGICAL MODEL**			
Golder Associates	PROJECT		1419751	FILE No.
	DESIGN	CB	20/05/2015	SCALE AS SHOWN REV 0
	CADD	CB	20/05/2015	**FIGURE: 3**
	CHECK	DC	21/05/2015	
	REVIEW	DC	21/05/2015	





Note

Transport was not simulated in the groundwater model after 2031. in the Environmental Assessment Conservative Scenario as the model predicted net outflow from the pit after this period.
The TDS of water exiting the Jay Pit was accounted for in the water quality model.
Vertical Exaggeration of three is shown.

PROJECT
DOMINION DIAMOND EKATI CORPORATION
JAY PROJECT
NORTHWEST TERRITORIES, CANADA

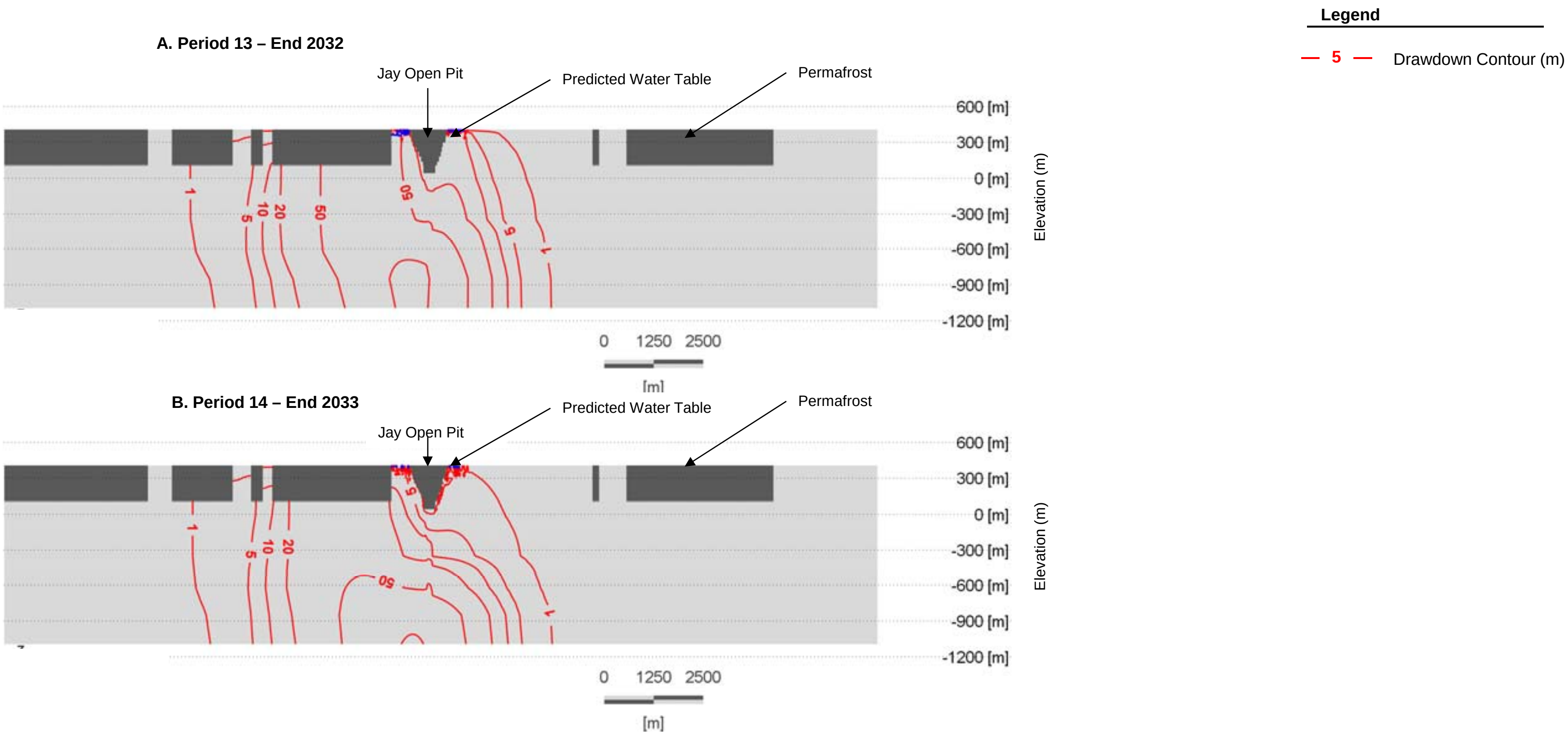
TITLE
PREDICTED DRAWDOWN AND TDS
2029 TO 2031– REASONABLE ESTIMATE
CASE - HYDROGEOLOGICAL MODEL

Golder Associates

PROJECT	1419751		FILE No.
DESIGN	CB	20/05/2015	SCALE AS SHOWN REV 0
CADD	CB	20/05/2015	**FIGURE: 4**
CHECK	DC	21/05/2015	
REVIEW	DC	21/05/2015	

A. Period 13 – End 2032

B. Period 14 – End 2033



Note
Transport was not simulated in the groundwater model beyond the third quarter of 2031 as the model predicted net outflow from the pit after this period.
The TDS of water exiting the Jay Pit was accounted for in the water quality model.
Vertical Exaggeration of three is shown.

PROJECT	DOMINION DIAMOND EKATI CORPORATION JAY PROJECT NORTHWEST TERRITORIES, CANADA			
TITLE	**PREDICTED DRAWDOWN AND TDS 2032 TO 2033 – REASONABLE ESTIMATE CASE - HYDROGEOLOGICAL MODEL**			
Golder Associates	PROJECT	1419751	FILE No.	
	DESIGN	CB	20/05/2015	SCALE AS SHOWN REV 0
	CADD	CB	20/05/2015	**FIGURE: 5**
	CHECK	DC	21/05/2015	
	REVIEW	DC	21/05/2015	

References:

Vandenberg, J. M.K. Herrell, J. Faithful, A.M. Snow, J. LaCrampe, C. Bieber, S. Dayanni and V. Chisholm. Multiple Modeling Approach for the Aquatic Effects Assessment of a Proposed Northern Diamond Mine Development. Mine Water and the Environment. DOI 10.1007/s10230-015-0337-5.