Alamos Gold Inc.

Lynn Lake Gold Project
Environmental Impact Statement

Federal IR Responses Round 3
Final Submission

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Introduction

The Impact Assessment Agency of Canada (the Agency) provided the third round (Round 3) of Information Requests (IRs) on July 15, 2022, for the Lynn Like Gold Project Environmental Impact Statement (EIS) submitted by Alamos Gold Inc. (Alamos) on May 25, 2020. Upon review of the EIS and Alamos' responses to the Round 1 and Round 2 Information Requests, the Agency and federal authorities identified areas where additional information would be required. The Agency directed that this additional information is necessary to determine whether the Project is likely to cause significant adverse environmental effects and to inform the Agency's preparation of the Environmental Assessment (EA) Report under the *Canadian Environmental Assessment Act, 2012* (CEAA 2012).

Alamos confirms that each of the seven IRs provided in Round 3 have been fully addressed and answered as clearly and succinctly as possible. A fulsome response to each IR is provided in the following sections in reference to the original request. Where required to complete the response, attachments have been provided in Appendix A.

Alamos has followed the Agency's direction and has considered the following while responding to the Information Requests:

- The context and rationale for the required information for every question.
- Applied a precautionary approach, given that some of the detailed engineering may not be complete at this time.
- Provided additional information (wherever possible) to assuage uncertainty and to provide clearly defined, detailed follow-up program measures, including proposed further mitigation and adaptive management measures.
- Presented complete or summarized information and discussion within the IR responses, rather than limited responses with references to applicable reports.

Alamos trusts that this package provides the Agency with all of the required information to conclude the technical review phase.

RESPONSE TO IAAC-R3-01

ID:	**IAAC- R3-01**
Expert Department or Group:	Natural Resources Canada – Technical Review of Round 2 Information Request Responses
Context and Rationale:	The Environmental Impact Statement (EIS) Guidelines require Alamos Gold Inc. (the Proponent) to provide an appropriate hydrogeologic model for the Lynn Lake Gold Project (the Project) area, which discusses the hydrostratigraphy and groundwater flow systems. The model should include the delineation of key stratigraphic and hydrogeological boundaries and the physical properties of the hydrogeological units. The Proponent is also required to perform a sensitivity analysis to test model sensitivity to climatic variations (e.g., the effects of variation in precipitation has on recharge rates) and hydrogeologic parameters (e.g., hydraulic conductivity). In the EIS, the Proponent indicated that groundwater wells used in the calibration of the groundwater model extended to a maximum total depth of 80 metres for the Gordon site and 30 metres for the MacLellan site. In its response to IAAC-R2-62, the Proponent notes that, despite the fact that hydraulic conductivity tests have not been completed within the deep bedrock unit at the Gordon site or within the lower 100 metres of the deep bedrock unit at the MacLellan site, the gaps in information and the related uncertainty associated with the limited testing of deep bedrock units have been addressed through calibration of the groundwater model. Natural Resources Canada (NRCan) noted that calibration of the groundwater model would not be sufficiently sensitive to the deep bedrock units and potentially the intermediate bedrock units, and that the sensitivity analysis did not address uncertainty regarding the hydraulic conductivity of the lower 90% of the open pit at the MacLellan site and the lower 50% of the open pit at the Gordon site. In its response to IAAC-R2-62, the Proponent noted that packer testing was conducted at the Gordon site to support their conclusions with respect to the hydraulic conductivity of the deep bedrock unit. NRCan noted concerns that, as packer testing has not been completed for the MacLellan site, no hydrostratigraphic information is available for the lower 100 metres of bedrock. The results of the sensitivity analysis presented in response to IAAC-R2-62 demonstrate that the groundwater assessment for the MacLellan site is sensitive to the hydraulic conductivity assigned to the intermediate and deep bedrock units within the numerical model, which is represented as Rock Quality Designation (RQD). As the model is sensitive to the parameterization of these units and no data is available, further information regarding the site- specific relationship between RQD and hydraulic conductivity is required to address the uncertainty within the model and provide confidence in the quantity of groundwater that would be intercepted by the open pit, the extent of drawdown associated with open pit dewatering, and the direction, timing, and quantity of seepage from the mine rock storage areas (MRSAs) at the Gordon and MacLellan sites. Further, although increasing the hydraulic conductivity of the lower bedrock unit has a negative effect on the calibration of the model, as noted in the Proponent's response to IAAC-R2-62, improved calibration may be achieved with adjustment of the recharge parameterization. To reduce uncertainty in the assessment of effects to groundwater for the MacLellan site, an updated sensitivity analysis in which recharge, intermediate bedrock hydraulic conductivity, and deep bedrock hydraulic conductivity are adjusted is required. This information is required to support the Impact Assessment Agency of Canada's (Agency) understanding of potential Project effects to fish and fish habitat, Indigenous

ID:	**IAAC- R3-01**
	Peoples, and other valued components (VCs) that may be affected by changes in groundwater and, through groundwater-surface water interactions, surface water quality and quantity.
Information Request:	a. Provide a plot showing the site-specific relationship between RQD and hydraulic conductivity for the Gordon and MacLellan sites. b. Using the existing model, provide an updated sensitivity analysis for the MacLellan site in which recharge, intermediate bedrock hydraulic conductivity, and deep bedrock hydraulic conductivity are adjusted. Should an upper limit on recharge limit the calibration of the model, present site-specific evidence for the recharge limit. i. If needed, revise the effects assessment for all relevant VCs to account for the results of the sensitivity analysis.
Response:	a. It is not possible to plot RQD versus hydraulic conductivity on a graph as the RQD measurements on the borehole logs that have corresponding hydraulic conductivity data are presented graphically and it is difficult to understand the length of the run and the corresponding RQD measurement to create an accurate graph. Regardless, a direct relationship between RQD and hydraulic conductivity of the given tested bedrock intervals is unlikely to be clearly defined, as it is the relationship of RQD of the overall bedrock with depth that controls the ability to transmit water which is explained herein. RQD is a measure of the degree of jointing or fracture in a rock mass, measured as a percentage of the drill core in lengths of 10 cm. For the MacLellan site, the RQD was logged across 17,238 core runs from boreholes that extended to depths of 1,173 m below top of bedrock. As presented in Figure IAAC-R3-01-1 (Attachment IAAC-R3-01), the RQD of the shallow 10 m of bedrock is generally more variable than the RQD measured greater than 10 m. For example, the range of RQD (as measured by the 50th percentile) is 63% for the shallow bedrock (0 to 10 m below the top of bedrock surface), 89% for the upper bedrock (10 m to 50 m below the top of bedrock), and greater than 90% for the intermediate and deep bedrock (greater than 50 m below the top of bedrock). A clear decreasing trend in RQD with depth is observed in the borehole data at the MacLellan site. Over 85 hydraulic conductivity tests were completed within boreholes that extended to depths up to 256 m below the top of bedrock at the MacLellan site. The hydraulic conductivity of bedrock with depth below top of bedrock is presented in Figure IAAC-R3-01-2. As shown in Figure IAAC-R3-01-2 (Attachment IAAC-R3-01), the hydraulic conductivity of the bedrock decreases with increasing depth. The hydraulic conductivity of bedrock at less than 10 m below the top of bedrock ranges over 5 orders of magnitude from $1x10^{-8}$ to $1x10^{-3}$ m/s whereas at depths greater than 50 m below the top of bedrock the hydraulic conductivity ranges over two orders of magnitude and is consistently less than $1x10^{-7}$ m/s. The decreasing trend in RQD with depth provides an indication of the degree of jointing or fracture in the overall bedrock and the graph illustrates that the fracturing becomes less frequent with depth. Less fracture with depth means the potential for interconnectedness of the fractures at depth is less and groundwater has limited opportunities to flow. Therefore, it is the overall trend of RQD in bedrock with depth that is relevant as opposed to the individual measurement in the given borehole that was tested. This concept is illustrated on the GTM-15-04 borehole log provided in Attachment IAAC-R3-01, where RQD over the bedrock interval from 53 m to 70 m below ground surface is as low as 65% yet the

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	hydraulic conductivity of the tested interval was on the lower end of the estimated values at $1x10^{-8}$ m/s. A low RQD with low hydraulic conductivity at these depths indicate that despite the presence of fractures, the fractures are not well connected within bedrock which limits the overall flux through the bedrock and resulting in a lower estimated value of hydraulic conductivity for that tested interval. There is no available hydraulic test data for the bedrock interval from 256 m to 350 m, which represents the lower portion of the groundwater flow model. However, there are 551 measurements of RQD across this bedrock interval and the geological formation is consistent with the hydraulically characterized bedrock interval of the intermediate and deep model layers. Given that the bedrock from 256 m to the base of the model domain at 350 m is the same geological formation and has the same overall trend of decreasing RQD with depth as the hydraulically tested intervals of deep and intermediate bedrock, it is reasonable to assume similar hydraulic properties. b. including i. The sensitivity of the model to recharge and hydraulic conductivity of intermediate and deep bedrock were completed as individual sensitivity runs and are summarized as follows: - Sensitivity of model results to recharge were presented in Section 5.4.2.3 of Hydrogeology Assessment: MacLellan Site – Technical Modelling Report (Volume 5, Appendix G of the EIS). - Sensitivity of the model results to hydraulic conductivity of intermediate and deep bedrock model layers were presented in response to IAAC-R2-62. Using the same methodology, an assessment of the sensitivity of the MacLellan groundwater model to hydraulic conductivity of the intermediate and deep bedrock as well as recharge was completed in one model run representing the end of operation. The results of this scenario were compared with the average annual end-of-mine inflow rates to the open pit as well as the fate (quantity and timing) of seepage from the tailings management facility (TMF). In sensitivity scenario 1, the hydraulic conductivity of the intermediate and deep bedrock was increased by an order of magnitude and the recharge rate was increased by 25% compared to the base case as summarized in Table IAAC-R3-01-1 (Attachment IAAC-R3-01). The results of the sensitivity scenario for the end of operation (pit fully dewatered with no seepage collection systems) are summarized in the following tables, figures, and maps presented in Attachment IAAC-R3-01 with comparison to the base case: - Table IAAC-R3-01-1: Summarizing groundwater inflow to the open pit for the sensitivity scenario compared to base case - Table IAAC-R3-01-2: Summarizing fate of seepage from the TMF and MRSA for the sensitivity scenario compared to the base case - Table IAAC-R3-01-3: Summary of residual between observed and predicted water levels for the sensitivity scenario and base case - Map IAAC-R3-01-1: Simulated water table drawdown for sensitivity scenario - Map IAAC-R3-01-2: Particle tracks from TMF and MRSA for sensitivity scenario. After increasing the hydraulic conductivity of deep and intermediate bedrock by an order of magnitude, the upper, intermediate, and deep bedrock are all assigned equivalent hydraulic conductivities from $2x10^{-7}$ m/s to $1x10^{-7}$ m/s. Consequently, from 10 m to 350 m depth (97%) of the vertical model domain, the modelled hydrostratigraphic unit and hydraulic conductivity are equivalent. The sensitivity scenario does not reflect the field data as indicated in response to IAAC-R3-01A,

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	in which a distinct trend of decreasing hydraulic conductivity with depth is shown with field testing of bedrock at depths greater than 10 m having a hydraulic conductivity of less than $1x10^{-7}$ m/s. Therefore, we caution the use of the results of sensitivity scenario 1 as it does not reflect the available field data collected as part of baseline studies for the MacLellan site. In the base case scenario, the results of groundwater flow modelling of the MacLellan site show groundwater recharges at high elevations and flows through the upper bedrock layers to discharge in areas of lower elevation. Groundwater flow into intermediate and deep bedrock is limited as the hydraulic conductivity of the deeper bedrock is lower and there is no where for groundwater to flow, or discharge, in the deeper system. This concept of groundwater flow is consistent with literature descriptions of hydrogeology of the Canadian Shield (Toth 1963; Sykes et al 2009). Toth's (1963) model of local, intermediate, and regional flow systems has been an accepted model of groundwater flow in areas of low hydraulic conductivity such as the Canadian Shield. Toth (1963) demonstrates mathematically, for where there is topographic relief across a drainage basin, the predominant flow pathway for recharge is local with a downward gradient located under the highest topography and an upward gradient located under the lowest topography across the site. This regional flow pattern means up to 90 percent of the total recharge does not penetrate the intermediate to deep flow systems. Further research by Sykes et al (2009) on large scale groundwater flow in the Canadian Shield indicates that intermediate and regional flow may not be prevalent and shallow flow to a depth of tens of metres dominates the overall water balance with the length of flow paths being relatively short. Both Toth (1963) and Sykes et al (2009) indicate the heads are highly correlated with surface topography such that the transition from zones of groundwater recharge to zones of discharge occurs over distances that can be relatively short. Precipitation at Lynn Lake Airport is 478 mm per year. Recharge applied in the base case model is 120 mm per year, which is 25% of precipitation. Hydrometric monitoring at the MacLellan site included reporting the 15-minute minimum flow measured in 2016 at five different hydrometric stations (Hydrology Baseline Technical Data Report, Volume 4, Appendix G, of the EIS). Assuming the 15-minute minimum flow is reflective of base flow and accounting for the catchment area, the estimated recharge at the MacLellan site ranges from 64 mm/year to 136 mm/year. In addition, Singer & Cheng (2002) estimated recharge to seven river basins in northern Ontario that have similar climate and depositional environment to Lynn Lake and indicated the range of recharge to be 27 mm/year to 82 mm/year. Recharge applied in sensitivity scenario 1 is 150 mm per year, which is 31% of precipitation. This far exceeds the range indicated by Singer & Cheng (2002) and indications of recharge at the MacLellan site based on field data. Increasing recharge beyond this rate would further deviate from the conceptual model for the region and site-specific measurements. Consequently, the rate applied in sensitivity scenario 1 is an upper bound and likely exceeds actual recharge. In sensitivity scenario 1, because the hydraulic conductivity of the model is consistent across the vertical domain and recharge is increased, groundwater flows further into the intermediate and regional flow systems (intermediate and deep bedrock) as opposed to flowing through the local or shallow bedrock system and discharging to nearby surface water features as in the base case. The deep groundwater flow is highlighted in Table IAAC-R3-01-2, which shows that a 33% of

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	recharge from the TMF and 31% of recharge from the MRSA does not discharge to surface water whereas in the base case the seepage from the TMF and MRSA discharged to local surface water features. Table IAAC-R3-01-3 presents the observed versus predicted water levels for the base case and sensitivity scenario 1. The average residual of the difference between the observed and predicted water levels increases from 0.95 m in the base case to 8.9 m in sensitivity scenario 1. For the majority of locations, the predicted water level elevation decreased, meaning the overall water table was flatter than the base case. This is further indication that recharge was driven further into the intermediate and deep bedrock as opposed to discharging to nearby surface water features. In addition, the water table was no longer a reflection of topography which is inconsistent with the conceptual model of hydrogeology for the MacLellan site that is based on field investigations and supported by literature (Toth 1963; Sykes et al 2009). Further, given the recharge rate assigned in sensitivity scenario 1 represents an upper bound for recharge for the region, the decrease in water levels across the model demonstrate increasing recharge cannot offset the increase in hydraulic conductivity. Consequently, this is further indication that the hydraulic conductivity used to represent the intermediate and deep bedrock in sensitivity scenario 1 is too high. The base case MacLellan groundwater flow model was calibrated with recharge and hydraulic conductivity of the groundwater flow model layers used as calibration parameters. The hydraulic conductivity of the bedrock was allowed to vary within the estimated range based on field data using PEST to estimate the hydraulic conductivity that results in an acceptable fit between measured and simulated water levels and baseflow. As indicated above, the modeled hydraulic conductivity of sensitivity scenario 1 is not consistent with the field characterization of the MacLellan site which consistently shows a decreasing trend of hydraulic conductivity with depth below top of bedrock. By increasing the recharge rate and the hydraulic conductivity of the intermediate and deep bedrock layers the effects of the Project on the receiving environment are reduced as recharge is driven deeper into the bedrock. The results of sensitivity scenario 1 are not a reflection of the conceptual model of the MacLellan site, which is based on field data. In addition, the predicted effects are a less conservative assessment of the effects of the Project on the receiving environment compared to the base case presented in the EIS/EA. Consequently, there is no further assessment of sensitivity scenario 1 warranted. **References:** Singer, S.N. and C.K. Cheng. 2002. An Assessment of the Groundwater Resources of Northern Ontario. Hydrogeology of Ontario Series (Report 2). Environmental Monitoring and Reporting Branch; Ministry of the Environment. Sykes, J.F., S.D. Normani, M.R. Jensen, and E.A. Sudicky. 2009. Regional-scale groundwater flow in a Canadian Shield setting. Canadian Geotechnical Journal. V. 46, pp. 813-827. Toth, J. 1963. A theoretical analysis of groundwater flow in small drainage basins. Journal of Geophysical Research. V. 68, no. 16, pp. 4795-4812.
Attachment:	Appendix A, Attachment IAAC-R3-01

RESPONSE TO IAAC-R3-02

ID:	**IAAC- R3-02**
Expert Department or Group:	Environmental and Climate Change Canada – Technical Review of Round 2 Information Request Responses
Context and Rationale:	The EIS Guidelines require the Proponent to predict changes to surface water quality and quantity associated with the Project. In its response to IAAC-R2-18, the Proponent stated that discharge loadings from the Sewage Treatment Plant are expected to meet federal and provincial effluent criteria. Environment and Climate Change Canada (ECCC) noted that some contaminants that may be present in effluents (e.g., phosphorus, coliforms) are not regulated under existing federal regulations. Additional information regarding discharge loadings is required to demonstrate that treatment of wastewater in the Sewage Treatment Plant will render effluent loadings negligible and will not affect aquatic productivity in the receiving environment, including the Keewatin River. This information is required to support the Agency's understanding of potential effects to fish and fish habitat, Indigenous Peoples, and other VCs that may be affected by changes to surface water quality.
Information Request:	a. Provide the Sewage Treatment Plant intended effluent target levels for total suspended solids, biological oxygen demand, ammonia, phosphorus, and coliforms, if available. b. Provide an estimate of the environmental loadings in effluents from the Sewage Treatment Plant during each Project phase and describe changes to productivity that may occur in the receiving environment due to effluent discharges. c. If discharges, environmental loadings, and changes in productivity did not inform the effects assessment, revise the effects assessments for all relevant VCs to include this information.
Response:	a. As described in the response to IAAC-R2-18, the proposed sewage treatment system design will not be finalized until Project approvals are received but will be finalized prior to the permitting phase. The sewage treatment system will be suited for use in remote northern locations making use of existing technologies which may include, but are not limited to, biological treatment. A description of the sewage treatment plant that Alamos is currently evaluating for use at the Lynn Lake Gold Project is provided below. This sewage treatment system is a secondary biological wastewater treatment system that uses a fixed film technology to reduce biological oxygen demand (BOD), total suspended solids (TSS), ammonia, and phosphorous. To do this, the system uses hundreds of thin, circular, high density polyethylene disks (i.e., the media), mounted on a rotating horizontal shaft. Bacteria present in the wastewater attach and multiply on the rotating media, forming a thin layer of biomass and a thin layer of wastewater in the air which facilitates the absorption of oxygen. This aerated layer of bacteria is then resubmerged into the wastewater where it metabolizes organic matter from the wastewater, producing the required effluent quality. As the film starts to grow, excess biomass is sloughed off by shearing forces caused by the media rotation. The rotating action of the media also keeps the solids in suspension. This sewage treatment plant also includes a coagulant dosing system and a tertiary filtration system for removal of total phosphorous.

ID:	**IAAC- R3-02**
	Sewage from the Gordon site will be collected in septic tanks and trucked to the MacLellan Sewage Treatment Plant for treatment. Therefore, only one sewage treatment system will be used for the Project with only one effluent location, the Keewatin River. The sewage treatment plant at the MacLellan site will be modular so that it can be expanded to treat higher sewage volumes or to treat any parameters that monitoring shows to be exceeding Manitoba Water Quality Standards, Objectives, and Guidelines (MWQSOG) for industrial wastes (see below). Also, the Project design includes the ability to divert treated sewage effluent to the Tailings Management Facility (TMF) should treated sewage not meet provincial standards or objectives at any time, during any mine phase. The sewage treatment plant will be designed such that effluent concentrations are below the limits outlined in the MWQSOG under *The Water Protection Act* (Manitoba). These include the following MWQSOG Tier I Water Quality Standards: - TSS: 25 mg/L - Carbonaceous BOD: 25 mg/L - Total phosphorous (TP): 1 mg/L - Fecal Coliform Bacteria (FCB): 200 colony forming units/100 ml The MWQSOG Tier II – Water Quality Objectives for ammonia is water temperature and pH dependent. Therefore, effluent from the sewage treatment plant will also meet the seasonally variable ammonia water quality objective throughout the year. b. As indicated in the response to IAAC-R2-18, construction is the mine phase when the on-site work force is expected to be largest (i.e., 400 people). Therefore, maximum loading rates for BOD, TSS, TP, FCB, and ammonia can be conservatively calculated as the product of the MWQSOG Tier I Water Quality Standards or Tier II Water Quality Objectives (ammonia only), the maximum per person waste production rate of 250 Litres/person/day, and the maximum number of people on site. Based on these assumptions, the maximum daily effluent discharge flow rate is 100 m^3/day (i.e., 100,000 L/day) and the maximum daily loadings during construction are calculated to be: - 2,500,000 mg/day BOD - 2,500,000 mg/day TSS - 100,000 mg/day TP - 200,000,000 colony forming units/day FCB - 848,000 mg/day ammonia (assuming a 30-day Tier II Water Quality Objective for ammonia of 8.48 mg/L based on a pH of 6.5 and a maximum water temperature of 25°C in the Keewatin River) Potential changes in primary productivity due to the daily maximum TP and maximum ammonia loading calculated above are expected to be negligible in the Keewatin River once the sewage treatment effluent is fully mixed with water in the Keewatin River. This is because the maximum sewage treatment plant discharge volume during construction (i.e., 100 m^3/day) would constitute <0.05% of the Keewatin River discharge in all months of the year during average flow conditions and during 1:25 dry year conditions (see table provided in the response to IAAC-R2-18). The Keewatin River is mesotrophic based on TP concentrations measured in water quality samples collected in 2015 and 2016 (mean TP concentration = 18 μg/L; range 12 μg/L to 24 μg/L) and the Canadian Council of Ministers of the

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	Environment (CCME) (2004) TP trigger ranges (i.e., mesotrophic: 10 to 20 µg/L TP). However, the Keewatin River is oligotrophic based on total nitrogen concentrations (i.e., ammonia, nitrite/nitrate, total Kjeldahl nitrogen) in samples collected in these same years (mean TN concentration = 0.45 mg/L; range 0.3 mg/L to 0.6 mg/L) and the classification system proposed by Alexander and Smith (2006). Therefore, it is likely that primary productivity in the Keewatin River is more nitrogen-limited than phosphorus limited. This is supported by the ratio of inorganic nitrogen to inorganic phosphorus in the Keewatin River during the open-water growing season which ranged between 2.7 and 5.5 in 2015 and 2016; N:P ratios <7 are nitrogen-limited (Jarvie et al. 1998). While ammonia additions have the greatest potential to change the trophic status of the Keewatin River downstream of the sewage treatment plan effluent pipe, periphyton (i.e., attached algae) require both nitrogen and phosphorus for growth. Therefore, the effects of the potential maximum ammonia and total phosphorus loadings from the sewage treatment plant on the Keewatin River are assessed below. The average total nitrogen concentration in the Keewatin River would need to increase by 0.25 mg/L to change trophic state from oligotrophic (i.e., <0.7 mg/L TN) to mesotrophic (i.e., >0.7 mg/L to 1.5 mg/L) based on the nitrogen trigger range developed by Alexander and Smith (2006). During the month with the lowest average discharge (April), the Keewatin River has a total nitrogen load of 2,558 mg/sec (i.e., product of average total nitrogen concentration in Keewatin River [0.48 mg/L] and average April discharge [5,329 L/s]) or 221,011,200 mg/day. Therefore, the maximum ammonia load from the sewage treatment plant during construction, during the lowest flow month in the Keewatin River, would contribute <1% more nitrogen to the river per day [848,000 mg ammonia/day from wastewater discharge ÷ 221,011,200 mg total nitrogen/day in Keewatin River = 0.4%]. This increase is highly unlikely to increase the total nitrogen concentration in the river above the lower 0.7 mg/L total nitrogen trigger limit for mesotrophic rivers. TP triggers for rivers were refined in a study conducted for the CCME by Gartner Lee (2006). In this study, TP triggers were developed using an Ontario dataset, but the triggers are applicable to rivers across Canada because the data set included a wide range of naturally occurring TP levels. Based on the Gartner Lee study (2006), the Keewatin River is oligotrophic (i.e., TP concentration <25 µg/L). While the TP trigger ranges are most applicable to lakes, CCME (2004) suggests that, if additions of TP do not cause exceedances of the applicable baseline TP trigger ranges, then the TP concentrations in rivers should not be increased by more than 50% above baseline to avoid potentially adverse effects. Therefore, average TP concentrations would need to increase by 2 µg/L or 7 µg/L to exceed the baseline TP trigger range based on the CCME (2004) and Gartner Lee (2006) criteria and by at least 9 µg/L to increase by at least 50% of baseline. During the month with the lowest average discharge (April), the Keewatin River has a TP load of 96 mg/second (i.e., product of average TP concentration in Keewatin River [0.018 mg/L] and average April discharge [5,329 L/s]) or 8,294,400 mg/day. Therefore, the maximum TP load from the sewage treatment plant during construction, during the lowest flow month in the Keewatin River, would contribute only about 1% more TP to the river per day [100,000 mg TP/day from wastewater discharge ÷ 8,294,400 mg TP/day in Keewatin River = 1.2%]. This increase is highly unlikely to increase the TP concentration in the river such that it would exceed the upper baseline TP trigger range of 20 µg/L, as defined by the CCME

ID:	**IAAC- R3-02**
	(2004), or the upper baseline total trigger range of 25 µg/L as defined by Gartner Lee (2006), even in the lowest flow months of the year. c. Potential changes in primary productivity due to discharge of treated sewage to the Keewatin River were not included in the water quality modeling (because design details had not been finalized) but they were considered generally in the effects assessment (Chapters 9 and 10 of the EIS). The potential for cumulative effects of nutrient loading from the sewage treatment plant with other community-based sewage treatment plants and cottage septic fields was also assessed. It is Alamos' opinion that the surface water quality and fish and fish habitat effects assessments do not need to be updated because, as the information provided above indicates, the potential for changes in primary productivity (and associated eutrophication effects) due to increases in nutrient loadings to the Keewatin River from the sewage treatment plant is negligible; ammonia and TP loadings from the sewage treatment plant are too small (even when using conservative assumptions for loadings based on the Tier I and Tier II Water Quality Standards) compared to the volume of the Keewatin River (and the baseline nitrogen and phosphorus concentrations) to have any measurable effect once water from the sewage treatment plant is fully mixed. Mixing would be enhanced in the river by installing a diffuser on the sewage treatment plant effluent pipe and/or locating the sewage treatment plant immediately upstream of a cascade or riffle. **References:** Alexander, R.B. and R.A. Smith. 2006. Trends in the nutrient enrichment of U.S. Rivers during the late 20th century and their relation to change in probable stream trophic conditions. Limnol. Oceanog. 51:639-654. Canadian Council of Ministers of the Environment (CCME). 2004. Phosphorus: Canadian Guidance Framework for the Management of Freshwater Systems. Canadian Water Quality Guidelines for the Protection of Aquatic Life. Ottawa, ON. Dodds, W.K., J.R. Jones, and E.B. Welch. 1998. Suggested classification of stream trophic state: distributions of temperate stream types by chlorophyll, total nitrogen, and phosphorus. Wat. Res. 32(5):1455-1462. Gartner Lee. 2006. Development of Ecoregion-based phosphorus guidelines for Canada: Ontario as a case study. A report prepared for Water Quality Task Group of the Canadian Council of Minsters of the Environment by Gartner Lee Limited, Markham, Ontario. Jarvie, H.P., Whitton, B.A. and Neal, C. (1998) Nitrogen and Phosphorus in East Coast British River: Speciation, Sources and Biological Significance. Science of the Total Environment, 210-211, 79-109.
Attachment:	No

RESPONSE TO IAAC-R3-03

ID:	**IAAC- R3-03**
Expert Department or Group:	Environment and Climate Change Canada – Technical Review of Round 2 Information Request Responses
Context and Rationale:	The EIS Guidelines require the Proponent to describe potential effects to surface water and groundwater as a result of the Project, including changes to surface water and groundwater quality. In its response to IAAC-R2-30, the Proponent discussed fertilizer amendments as a potential pit lake treatment option for the removal of contaminants from surface water, should monitoring indicate that surface water quality in the pit lakes during the decommissioning/closure and post closure phases is not adequate for release to the surrounding environment. ECCC noted that it is unclear whether fertilizer amendments could potentially contribute to increased concentrations and loadings of nutrients in nearby waterbodies, which may contribute to eutrophication. In its response to IAAC-R2-26, the Proponent stated that the screening criteria for parameters of potential concern was applied to predicted water quality concentrations in receiving waterbodies at the Gordon and MacLellan sites as whole waterbody concentrations. ECCC noted that the Canadian Council of Ministers of the Environment (CCME) refers to total phosphorus within its guidance framework for the measurement of phosphorous in surface water and specifies total phosphorus threshold ranges based on the baseline trophic status of waterbodies. ECCC noted that it is unclear whether the potential effects (e.g., trophic status changes, eutrophication, oxygen depletion) of increased phosphorus loadings as a result of the Project were taken into consideration in the effects assessment. This information is required to support the Agency’s understanding of potential effects to fish and fish habitat, migratory birds, Indigenous Peoples, and other VCs that may be affected by changes to surface water quality.
Information Request:	a. Clarify if the use of fertilizer amendments as a pit lake treatment option could potentially result in elevated nutrient levels or loadings in surface water in the pit lakes that would potentially be released to the surrounding environment and identify all other potential sources of phosphorus loadings associated with the Project. b. Describe the baseline trophic status of waterbodies that may receive Project effluents or that may experience increased phosphorus loadings as a result of the Project and describe how the Project may affect these waterbodies (e.g., trophic status changes, eutrophication, oxygen depletion), including consideration of total phosphorus concentrations and loadings. i. If potential increases in nutrient levels and environmental loadings associated with the use of fertilizer amendments and other Project-related phosphorus sources were not taken into account in the effects assessment for the Project, revise the effects assessment for surface water quality and any related VCs to account for potential effects.
Response:	a. Use of fertilizer amendments as a treatment option could result in elevated nutrient levels in the pit lake at the MacLellan site and in the downstream receiving environment during years in which fertilizer amendments are used

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	if the rate or timing of fertilizer application results in more nutrients entering the water than can be taken up by the phytoplankton community. This potential effect exists because fertilizer amendments involve the addition of nutrients, such as phosphorus and nitrogen, to the pit lake to achieve the desired objective of increasing phytoplankton production and the subsequent sequestration of metals in the bottom sediments. As the phytoplankton grow, they incorporate metals from the water column into their tissues. As these phytoplankton die, the metals incorporated into their tissues are sequestered in the sediments in the bottom of the lake if the pit is deep enough to be permanently stratified; the pit at the MacLellan site will be ~350 m deep at the conclusion of mining is expected to permanently stratify once filled with water. This biological process reduces the concentration of dissolved metals in the water column. As an example of their potential effectiveness, Dessouki et al. (2005) found statistically significant declines in the surface water concentrations of arsenic, cobalt, copper, manganese, nickel, and zinc as phosphorus loads increased in mesocosm experiments in Cluff Lake (Saskatchewan). The potential effect of eutrophication in lakes and rivers downstream of the open pits was not considered in the EIS because use of fertilizer amendments was considered only as a contingency measure should water quality monitoring in the open pits show that metal concentrations are higher, or trending higher, than applicable federal or provincial water quality guidelines or applicable science-based environmental benchmarks (if baseline water quality exceeds applicable guidelines) while the pits are filling with water. In such a scenario, various contingency treatment options would be evaluated, including fertilizer amendments, but also engineered covers for mine rock dumps, engineered wetlands, or other industry standard methods. If fertilizer amendments are identified as the preferred treatment option, Alamos would conduct laboratory bench testing, field bin testing, and predictive treatment water quality modelling (including pit lake modelling to predict density and/or temperature induced stratification) during closure prior to full-scale fertilizer amendments of the pit lakes. This work would include investigation of methods to optimize fertilizer amendments (e.g., dosage rates and timing of fertilizing, scheduling discharge) to limit effects and assessment of potential effects of phosphorous additions on the trophic status (i.e., eutrophication potential) in the pit lakes and downstream receiving environment. Pit filling at the Gordon and MacLellan sites is predicted to take 11 years and 21 years, respectively. Given these durations, Alamos is confident that there will be sufficient time to determine if water quality in the open pits would require treatment and, if so, what the best treatment approach would be. If fertilizer amendments were found to be the best treatment option, the optimum amendment rates and nutrient loadings would be calculated based on pit volume, pit water quality, and fertilizer nutrient concentrations to reduce metal concentrations while limiting potential for downstream eutrophication. At the MacLellan site, potential sources of phosphorous during construction and operation are: 1) discharge from the collection pond that receives runoff and seepage from overburden, mine rock, ore stockpiles; 2) excess water from the tailings management facility (in 1:25 wet years or wetter only); and 3) effluent from the sewage treatment plant. Effluent from the sewage

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	treatment plant is the only potential source of phosphorus during active closure. In post-closure, the only potential source of phosphorus is discharge from the open pit once it is full of water and discharging to the tributary KEE3-B1 and the Keewatin River. At the Gordon site, potential sources of phosphorous during construction and operation are: 1) groundwater interceptor wells; 2) discharge from the collection pond that receives runoff and seepage from overburden, mine rock, and ore stockpiles; and 3) contact water pumped from the pit. During active closure, the only potential source of phosphorus is from the groundwater interceptor wells. In post-closure, the only potential source of phosphorus is discharge from the open pit once it is full of water and discharging to Farley Lake. b. An unnamed tributary of the Keewatin River (KEE3-B1) would be the immediate downstream receiving environment for water from the open pit at the MacLellan site during post-closure. This tributary drains to the Keewatin River upstream of the confluence with the Lynn River. The combined water from the Keewatin River (including water from the open pit) and the Lynn River drain to Cockeram Lake. No total phosphorus or chlorophyll a concentration data are available for tributary KEE3-B1. However, the headwater lake of tributary KEE3-B1 (i.e., East Pond) is meso-eutrophic (mean total phosphorus concentration = 29 µg/L; range 11 µg/L to 112 µg/L; mean chlorophyll a concentration = 4.3 ug/L; range 1.0 ug/L to 14.5 ug/L) according to the CCCE (2004) total phosphorus trigger ranges. Therefore, tributary KEE3-B1 is likely also meso-eutrophic. Based on total phosphorus concentrations in water samples collected in 2015 and 2016 (mean total phosphorus concentration = 18 µg/L; range 12 µg/L to 24 µg/L) and chlorophyll a concentration (mean = 0.5 µg/cm2; range 0.1 µg/cm2 to 1.5 µg/cm2) in periphyton samples collected in 2016, the Keewatin River is mesotrophic according to the CCCE (2004) total phosphorus trigger ranges. Based on total phosphorus concentrations and chlorophyll a concentration in surface water samples collected during the open-water seasons in 2015 and 2016, Cockeram Lake is mesotrophic (mean total phosphorus = 13 µg/L; range 5 µg/L to 24 µg/L; mean chlorophyll a concentration = 1.9 ug/L; range 0.6 ug/L to 5.0 ug/L) according to the CCCE (2004) total phosphorus trigger ranges. Phytoplankton production in lakes and periphyton production in rivers is a photosynthetic process controlled by the availability of essential nutrients (i.e., phosphorus, nitrogen, organic carbon), water temperature, and sunlight. Each essential nutrient is cycled near instantaneously between the water, sediments, and the photosynthetic organisms and, because each nutrient is critical to photosynthesis, it is the nutrient with the lowest concentration in the water column that typically limits primary production at any given time. Nutrient enrichment, and subsequent increases in primary productivity (i.e., eutrophication), can negatively affect fish and other aquatic biota in lakes by increasing bacterial decomposition in the bottom water and sediments when the phytoplankton die, thereby reducing dissolved oxygen concentrations in the water column. While this same negative effect can also occur in rivers, the flowing water in a river limits the geographic extent of the effect to areas downstream of the nutrient additions and the magnitude of the effect is

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	typically smaller than in lakes due to the continuous downstream cycling of nutrients instead of accumulation of nutrients in a lake's standing water. At the MacLellan site, elevated concentrations of total aluminum, arsenic, cadmium, copper, and fluoride are predicted to occur in tributary KEE3-B1 once the pit is full of water and is discharging to the downstream receiving environment. If fertilizer amendments are identified as the best option for reducing metal concentrations in the open pit, changes in trophic status and associated decreases in dissolved oxygen concentrations in the Keewatin River and Cockeram Lake are not expected to occur. This contention is based on the following: 1) A Fertilizer Management Plan would be developed in the years while the open pit is filling, and this plan would prescribe the rate of fertilizer application necessary to achieve the desired metal reduction goals while limiting the potential for excess nutrients or oxygen depleted water from discharging from the pit. At the appropriate nutrient concentrations and application rates, it is expected that most of the nutrients added to the pit would be taken up by phytoplankton and settle out in the pit lake, reducing the potential receiving environment effects downstream. 2) The MacLellan pit is expected to take approximately 21 years to fill with water. This duration provides an opportunity to add fertilizer amendments in numerous years (if necessary) and to monitor metals, nutrient, and dissolved oxygen concentrations in the water column before and after treatment. This would allow the opportunity to refine the Fertilizer Management Plan as necessary and time to reduce metals concentrations in the water column so that fertilizer amendments are not needed once the pit is full and discharging to the downstream receiving environment 3) Chlorophyll a concentrations decreased significantly in the upper 5 m of the water column and increased significantly at depths greater than 5 m within 32 days in an open pit treated with various phosphorus additions, with the greatest change occurring at the highest concentration of phosphorus additions (Dessouki et al. (2005). This indicates that the sequestration of metals in the bottom of the open pit at MacLellan will be relatively quick. 4) Discharge from tributary KEE3-B1 will constitute <1% of the total discharge volume of the Keewatin River in average, dry, and wet flow conditions during post-closure. Therefore, any elevated nutrient concentrations in tributary KEE3-B1 will be quickly diluted with water from the Keewatin River. So, while there is a potential for increased nutrient concentrations in tributary KEE3-B1, Alamos would not expect there to be any measurable change in nutrient concentrations or trophic state in the Keewatin River or in Cockeram Lake. 5) Cockeram Lake is shallow (mean depth <3 m) with its outlet in a direct line on the opposite side of the lake from the inlet. This morphology makes the lake function more like a river widening than like a deep lake and likely results in a relatively short water retention time. This reduces the potential for eutrophying nutrients to accumulate in the water column. Farley Lake would be the downstream receiving waterbody for outflow from the open pit at the Gordon site once the pit has filled with water. Water from Farley Lake flows downstream to Swede Lake and Ellystan Lake. Based on total phosphorus concentrations and chlorophyll *a*

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	concentration in surface water samples collected during the open-water seasons in 2015 and 2016, Farley Lake is mesotrophic (mean total phosphorus = 23 µg/L; range 12 µg/L to 58 µg/L; mean chlorophyll a concentration = 3.2 ug/L; range 0.4 ug/L to 9.9 ug/L) and Swede Lake is mesotrophic (mean total phosphorus = 19 µg/L; range 12 µg/L to 30 µg/L; mean chlorophyll a concentration = 3.9 ug/L; range 0.9 ug/L to 7.5 ug/L). Eutrophication is unlikely to occur in the open pit, Farley Lake, or any other lake downstream of the Gordon site. This is because the water quality model does not predict concentrations for any metal to exceed water quality guidelines and 120% of baseline concentrations in the open pit or Farley Lake during any mine phase, including post-closure when the open pit would discharge to the lake. Therefore, the need for any type of mitigation measure for elevated metals in the open pit is considered low. i. For the reasons explained above, it is Alamos' opinion that the surface water quality assessment, and all dependent effects assessments, do not need to be revised to include the potential for eutrophication of lakes and rivers downstream of the open pits. **References:** Canadian Council for Ministers of the Environment (CCME). 2004. Canadian Water Quality Guidelines for the Protection of Aquatic Life. Phosphorus: Canadian Guidance Framework for the Management of Freshwater Systems. Dessouki, TCE, JJ Hudson, BR Neal, MJ Bogard. 2005. The effects of phosphorus additions on the sedimentation of contaminants in a uranium mine pit-lake. Water Research vol. 39 (13): pp 3055-3061. Dodds, W.K. 2006. Eutrophication and trophic state in rivers and streams. Limnol. Oceanogr. 51(1):671-680 Wetzel, R. 2001. Limnology: lake and river ecosystems. Third Edition Academic Press. Cambridge, MA, USA.
Attachment:	No

RESPONSE TO IAAC-R3-04

ID:	**IAAC-R3-04**
Expert Department or Group:	Environment and Climate Change Canada – Technical Review of Round 2 Information Request Responses
Context and Rationale:	The EIS Guidelines require the Proponent to describe potential effects to surface water and groundwater as a result of the Project, including changes to surface water and groundwater quality. In its response to IAAC-R2-12 and IAAC-R2-75, the Proponent stated that seepage from the ore stockpiles, MRSAs, Tailings Management Facility (TMF), and other Project infrastructure would be captured by seepage collection ditches and contact water collection ponds or through open pit dewatering during operation and would be collected in the pit lakes during decommissioning/closure and post-closure. ECCC noted concerns that, once dewatering and seepage collection is halted at the end of operation, particle tracking has shown that contaminants from source areas may lead to several waterbodies, including Farley Lake and Minton Lake at the Gordon and MacLellan sites, respectively. Depending on local recharge rates, the local hydrogeological context, and whether the sources of contamination remain present upon closure of the Project, dilution estimates may have been overestimated, which may result in exceedances of surface water quality guidelines. It is unclear how contamination of groundwater will be prevented once dewatering of the open pit and seepage collection ceases. The Proponent stated that during closure of the mine, once ore stockpiles are depleted, ore stockpile areas would be rehabilitated to eliminate sources of contamination. It is not clear what methods of rehabilitation would be used for the ore stockpiles. This information is required to support the Agency's understanding of potential effects to fish and fish habitat, migratory birds, and other VCs that may be affected by changes to surface water quality.
Information Request:	a. Clarify if removal of the ore stockpiles would result in residual contamination, including mineralized materials, at the Gordon and MacLellan sites after operation and how the presence of these contaminants may affect groundwater quality, surface water quality, and related VCs. i. If these effects were not considered in the effects assessments for VCs, revise all relevant effects assessments to account for the potential effects described in a). b. Describe how groundwater contamination from Project infrastructure, including the ore stockpiles, MRSAs, and TMF, and the subsequent transport and discharge of groundwater contaminants to surface waterbodies will be mitigated or prevented during decommissioning/closure and post-closure. Ensure the results of the updated sensitivity analysis referenced in IAAC-R3-01 is considered. i. Describe the approach planned for rehabilitation of the ore stockpiles after the ore is depleted.
Response:	a. The ore is a valuable resource and so Alamos intends to process ore that is extracted from the open pit. During closure, the remaining ore in the ore stockpiles will be sent to the mill for processing. Once processing is complete, the pad for the ore stockpiles will be grade scraped to remove residual material which will be

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	placed within the tailings management facility (TMF). Therefore, there is no residual impact of the ore stockpile on the receiving environment predicted for closure. i. As there is no residual impact of the ore stockpile on the receiving environment, no revision to the effects assessment is required. b. Mitigation of and the effect of the ore stockpile on the receiving environment in closure is described in response to IAAC-R3-04a. The mitigation of and the effect of the mine rock storage areas (MRSA) and the TMF on the receiving environment in closure are described in the Environmental Impact Statement (EIS) and summarized in Table 20B-1 of Volume 3, Chapter 20 of the EIS. Some of the key mitigation measures for the TMF and MRSA are described below. Mitigation measures that may commence in the operation phase of mine life and where the effect of the mitigation measure extends into the closure phase of mine life are included in the summary below. - Limiting the construction footprint to the extent possible to reduce the potential for reductions in groundwater recharge and limit the number of watersheds overprinted by the PDA. - Designing the MRSAs to increase the amount of runoff and reduce the amount of infiltration through the MRSAs, thereby reducing the recharge and loading to groundwater. - Installing contact water collection ditches around the MRSA and TMF to collect toe seepage and groundwater recharge from these Project components. The collection ditches will be decommissioned in closure once water quality meets requirements for discharge to the environment. - Operating the TMF as a non-discharging facility during operation through decommissioning and active closure. - Constructing non-contact water ditches upslope of MRSA and TMF to reduce contact water volumes. - Designing the TMF dams for long term stability so no additional re-grading of the side slopes will be required at closure. - Placing a cover on the tailings surface at closure to limit acid generating reactions and the migration of contaminants and to prevent wind and runoff erosion of the tailings. - Developing and implementing surface water and groundwater monitoring programs in closure to validate predicted effects of the TMF and MRSA on the receiving environment. The surface water and groundwater monitoring programs will include a component of adaptive management to alert to changing conditions beyond that predicted in the EIS to allow the implementation of mitigation measures, if necessary. The above mitigation measures were considered, as appropriate, in the assessment of effects on groundwater as presented in the EIS. Therefore, no further assessment of mitigation measures is required. Please refer to the response to IAAC-R3-01 for the results of the requested sensitivity scenario. The results of the sensitivity analyses indicated that groundwater recharge may flow deeper into bedrock with less recharge discharging to nearby surface water features. It was also noted that the sensitivity scenario did not represent the field data and therefore results should be viewed with caution. The sensitivity analysis in IAAC-R3-01 were less conservative than that modeled in the EIS, which suggested greater seepage from mine infrastructure would discharge to nearby

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	surface water features and therefore the mitigation measures presented in the EIS remain valid. Seepage collection ditches will not be decommissioned until water quality meets requirements for discharge to the environment. When no longer required, the seepage collection ditches will be re-contoured to restore the original drainage course to the extent possible and to enhance the area for natural re-vegetation. The surface water and groundwater monitoring program will inform the trends in water quality through the operation and closure phases of mine life. The monitoring programs include an adaptive management component to alert to changing conditions that would allow the implementation of additional mitigation measures, if required, in a timely manner. For example, in closure, contact water will be sent to the open pit to expedite pit filling. Pit filling is anticipated to occur over a period of 21 years at the MacLellan site and 11 years at the Gordon site, which during the majority of this time the horizontal hydraulic gradient (and thus flow direction) will remain toward the open pits. Should the contact water quality within the collection ditches or seepage from mine components not be consistent with that in the EIS or meet the requirements for discharge to the environment, then additional mitigation measures will be evaluated during the filling of the open pit where contact water is collected during the active closure phase and may be implemented prior to pit lake discharge. i. Please see response to a. above which describes the approach planned for rehabilitation of the ore stockpiles after the ore is depleted.
Attachment:	No

RESPONSE TO IAAC-R3-05

ID:	**IAAC- R3-05**
Expert Department or Group:	Environment and Climate Change Canada – Technical Review of Round 2 Information Request Responses
Context and Rationale:	The EIS Guidelines require the Proponent to document the assumptions that underlie any models used, the quality of the data, and the degree of certainty of the predictions obtained. The Proponent is also required to describe the baseline conditions for surface water, including hydrological regimes. In the EIS, the Proponent noted that the TMF would be 75% capped following operation, leaving a standing pond in the remaining area. ECCC noted that it is unclear whether a standing pond is necessary to maintain anoxic conditions in the tailings (i.e., prevent acid rock drainage and metal leaching) and to prevent wind erosion of tailings and dispersal of contaminants during the decommissioning/closure and post-closure phases. In the EIS, the Proponent acknowledged that, under climate change scenarios, summer precipitation would likely be reduced, temperatures may increase, and the risk of drought in the Regional Assessment Area (RAA) may become more extreme. ECCC noted concerns that, should a standing pond be required to maintain the safety of the TMF, the effects of climate change on temperature and precipitation patterns in the RAA may increase the risk of adverse effects to the environment from the TMF in the decommissioning/closure and post-closure phases if this pond cannot be maintained. In its response to IAAC-R2-71, the Proponent indicated that the water balance model for the Project assumed a uniform distribution of precipitation over a consecutive 25-year period under three scenarios (i.e. dry, average, and wet), and the results were assessed against current baseline conditions. The reference period for the monthly mean values was from 1980 to 2010. ECCC indicated that the assumption of constant precipitation distribution and the prorating of each month to obtain the wet and dry scenarios precluded consideration of short-term droughts, which could result in deviations from the reference period. Further, ECCC noted that the evaporation estimates used in the model are from 2002 and are therefore likely outdated and do not account for increased temperatures associated with climate change in future years during the Project's expected operation and decommissioning/closure phases. Additional information is required to determine the validity of the outcomes of the water balance model and to understand the risks that may be posed by the TMF in the decommissioning/closure and post-closure phases if a standing pond cannot be naturally maintained. This information is required to support the Agency's understanding of potential Project effects to fish and fish habitat, Indigenous Peoples, and other VCs that may be affected by changes to surface water quality and air quality.
Information Request:	a. Clarify whether a standing pond in the TMF is required to maintain anoxic conditions in the tailings and/or prevent dry tailings during the decommissioning/closure and post-closure phases. b. Describe any potential risks or adverse effects to VCs that may occur should maintenance of a standing pond not be possible. c. Describe how drier summer months and increased evaporation from climate change would affect the water balance model compared to the assumption of a uniform distribution of precipitation. Describe how this may contribute to

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<tr><td>ID:</td><td>IAAC- R3-05</td></tr>
<tr><td></td><td>effects to VCs discussed in part b.
i. If the precipitation and evaporation inputs used in the water balance model may contribute to uncertainty with respect to the vulnerability of the TMF to climate change:
a. reassess the closure phase water balance for the TMF; and
b. discuss the new risk of dry tailings in the decommissioning/closure phase given the new water balance data.</td></tr>
<tr><td>Response:</td><td>a. A standing pond in the TMF is not required to maintain anoxic conditions in the tailings and/or prevent dry tailings during the decommissioning/closure and post-closure phases. As discussed in the Conceptual Closure Plan (Chapter 23, Appendix 23B of the Environmental Impact Statement), the supernatant pond is being retained through part of the Project closure phases to serve as a sediment trap. It will be drained prior to Permanent Closure.
b. Since a standing pond in the TMF is not required to maintain anoxic conditions, there are no potential risks or adverse effects to VCs should maintenance of a standing pond not be possible.
c. As previously discussed in IAAC-R2-71, the range of scenarios already modelled account for a wider range in annual precipitation than is expected according to the Climate Atlas for Lynn Lake under RCP 8.5 (high carbon future scenario). The Climate Atlas results for the period 2021-2050 are that annual precipitation ranges from 411mm – 523mm – 643mm (low-mean-high). The annual precipitation conditions included in the water balance model were 344mm – 478mm – 655mm (25-year dry – average – 25-year wet). The range in annual precipitation scenarios modelled in the water balance model is greater than the predicted range in annual precipitation from the climate models. Overall, precipitation is expected to increase according to the information available from ECCC. Our understanding regarding the change in evaporation in the area is less certain.
To clarify, the evaporation data presented in the EIS covers the period of 1971-2006, not 2002 as mentioned.
Recent research regarding the understanding of long-term trends of evaporation in Canada by Li et al. (2020), shows that for the ecozone where the Project is located, long-term trends in potential evaporation (1979-2016) are not statistically significant at the 95% confidence interval as a result of increased humidity, which translates into decreased potential evaporation. The assumption that increased evaporation is significant for the area is not necessarily true given the current research.
The water balance modelling process compares results under existing and future conditions. Uncertainty with respect to holding the distribution constant over time provides a clearer picture of project effects as it isolates the project effects from external forcing conditions. The uncertainty with downscaling global climate models to sub grid areas and with the potential changes to evaporation related to climate change would create more uncertainty in the results.
i. including a. and b. Since the presence of a standing pond in the TMF is not required for long-term stability (see responses to a. and b. above), there is no need to re-assess the results. Additionally, it is Alamos' opinion that additional uncertainty would be introduced by varying the</td></tr>
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	distribution of precipitation and evaporation. **References:** Li, Z., Wang, S. and Li, J., 2020. Spatial variations and long-term trends of potential evaporation in Canada. *Scientific reports*, *10*(1), pp.1-14.
Attachment:	No

RESPONSE TO IAAC-R3-06

ID:	**IAAC- R3-06**
Expert Department or Group:	Environment and Climate Change Canada – Technical Review of Round 2 Information Request Responses
Context and Rationale:	The EIS Guidelines require the Proponent to describe changes to groundwater, surface water, and fish and fish habitat as a result of the Project, and, where there is uncertainty about effects outcomes, the Proponent is required to describe the follow-up and monitoring program that will be implemented and adaptive management measures that will be applied. In its response to IAAC-R2-04, the Proponent indicated that the Aquatics Effects Monitoring Plan for the Project would include monitoring of mercury concentrations in fish tissues. The threshold that would be used to indicate when adaptive management measures are required was defined as: concentrations in the exposure area that are greater than 0.5 milligrams/kilogram wet weight mercury (i.e., equivalent to the Manitoba Water Quality Standards, Objectives, and Guidelines Regulation tissue residue guideline for human consumption) and statistically higher than mercury concentrations in fish tissue in the reference area. ECCC noted concerns that the proposed fish tissue concentration threshold of greater than 0.5 milligrams/kilogram total mercury is 15 times higher than the methylmercury tissue residue guideline established by the CCME and no rationale was provided to support the proposed threshold. It is unclear whether the proposed mercury concentration threshold selected would provide an early indication of Project-related effects to fish and Indigenous Peoples from mercury exposure. This information is required to support the Agency's understanding of potential effects to fish and fish habitat and Indigenous Peoples, including current use and Indigenous health conditions.
Information Request:	a. Provide a rationale to support the proposed fish tissue mercury concentration threshold selected, including how the proposed threshold would provide an early indication of Project-related effects to fish and Indigenous Peoples. b. If baseline fish tissue mercury concentrations are not comparable to reference area levels, consider defining the threshold using comparisons to baseline levels and use detection of upward trends in mercury concentrations to trigger adaptive management measures.
Response:	a. As the reviewer correctly notes, preliminary thresholds for adaptive management for fish tissue concentrations were identified in Table IAAC-R2-04-1 as "mercury concentrations in exposure areas that are >0.5 mg/Kg wet weight and statistically higher than mercury concentrations in fish tissue in reference areas". This is the Manitoba Water Quality Standards, Objectives, and Guidelines (MWS 2011) guideline for the protection of human consumers of fish and is based on the Health Canada "Maximum Levels for Chemical Contaminants in Foods" (MLCCF) for the protection of humans. However, the response to IAAC-R2-48 provides a list of available tissue quality guidelines that fish tissue data from "exposure sites" and "reference sites" would be compared (and potentially used as trigger thresholds for adaptive management) and includes the Canadian Council of Minister's of Environment (CCME 2000) methylmercury tissue residue guideline for the

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	protection of wildlife consumers of aquatic biota (0.033 mg/Kg wet weight). This information was inadvertently excluded from Table IAAC-R2-04-1. Health Canada's MLCCFs are established to reduce the risk of exposure to contaminants in foods eaten by people. Exposure is affected by the concentration of the chemical in food and the amount of food consumed with the chemical in it. Therefore, even if the concentration of a chemical exceeds a guideline it may not pose a health risk to humans if the amount of food eaten by a person with the chemical is small. For example, it is estimated that a 76 Kg person would need to eat at least 25 grams of northern pike muscle tissue per day from lakes near the Lynn Lake Gold Project to reach the mercury intake level that poses a risk to human health from mercury. The CCME's (2000) methylmercury tissue guideline was derived from the lowest "reference concentration" (RC) for mammalian and avian consumers of fish. Specifically, this RC was derived from the ratio between the lowest observable adverse effect level (LOAEL) for the most sensitive bird species (mallard duck) and the bird species with the highest food intake rate (FI) to body weight (BW) ratio (Wilson's storm petrel), a species that consumes almost its entire body weight each day. Use of Wilson's storm petrel's FI/BW ratio has the potential to result in bioaccumulation of more methylmercury than species that consume much less than their body weight each day (CCME 2000) and, therefore, is conservative. A similar RC for methylmercury, the toxic form of mercury, in humans is not available. Mercury concentrations in fish are not expected to increase due to the Project (i.e., mercury was not identified as a parameter of potential concern in any waterbody downstream of the Project and the Project will not result in flooding of any upland areas, a known cause of methylmercury increases in fish tissue in northern Manitoba). However, Alamos understands Indigenous Nations' concerns that mercury concentrations in tissues from fish species that community members typically eat (e.g., northern pike, walleye) are currently higher than the CCME (2000) methylmercury tissue residual guideline for the protection of wildlife consumers of aquatic biota (0.033 mg/Kg wet weight) in lakes near the Project (assuming that total mercury concentrations in fish are comprised entirely of methylmercury). This includes lakes downstream of the Gordon and MacLellan sites and unaffected reference lakes, indicating that mercury concentrations in fish tissues are naturally elevated in the region. Total mercury and methylmercury will be analyzed from fish tissues collected at all "exposure sites" and "reference sites" at the MacLellan and Gordon sites (see Table IAAC-R2-48-1). This will allow Alamos to compare results to both tissue residue guidelines accurately. Given that fish tissue mercury concentrations in tissues from large-bodied fish species already exceed the CCME (2000) methylmercury tissue residue guideline for the protection of wildlife consumers, Alamos agrees that this guideline is not suitable as a trigger threshold for adaptive management. b. In its response to IAAC-R2-48, Alamos described the statistical analyses that would be used to determine if changes in fish tissue concentrations were occurring due to the Project. In summary, it states, "Statistically significant differences, greater than a Critical Effect Size (CES) of ±25%, between fish tissue concentration in fish collected from "impact" and "control" sites will be determined using Analysis of Covariance (ANCOVA) using fork length as a covariate. Alternatively, trend analysis will be used to determine if there are statistically

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	significant differences between the slopes of the regression lines representing the change in fish tissue concentrations at "impact" and "control" sites through time". This latter analysis will allow the statistical comparison of fish tissue mercury concentrations at "impact" sites before, during, and after mining. Use of the federal CES with the ANCOVA and/or trend analysis would provide the analytical methods to define a fish tissue trigger threshold that the reviewer has suggested in lieu of an available federal or provincial tissue guideline that would be sensitive enough to trigger adaptive management in a timely manner.
Attachment:	No

RESPONSE TO IAAC-R3-07

ID:	**IAAC- R3-07**
Expert Department or Group:	Environment and Climate Change Canada – Technical Review of Round 2 Information Request Responses
Context and Rationale:	The EIS Guidelines require the Proponent to identify and justify the spatial and temporal boundaries for the cumulative effects assessment for each VC selected, and to describe potential Project effects to the atmospheric environment, including noise levels, riparian, wetland, and terrestrial environments, and how changes to the environment caused by the Project will affect Indigenous Peoples. In its response to IAAC-R2-51, the Proponent indicated that the 95% upper confidence limit (UCLM) prediction for dustfall and metal accumulation in soil within the Local Assessment Areas (LAA) was used to assess potential risks of direct exposure via soil and country foods in the cumulative effects assessment. However, as noted in the Proponent's response to IAAC-R2-86, the baseline dustfall rate used in the Human Health Risk Assessment (HHRA) was a mean calculated from the 2016 sampling dataset as opposed to the 95% UCLM. Health Canada noted concerns that the use of mean dustfall rates in the HHRA may not be protective of human health at receptor locations. This information is required to support the Agency's understanding of potential effects to Indigenous Peoples and other VCs that may be affected by changes to the atmospheric, riparian, wetland, and terrestrial environments.
Information Request:	a. Clarify whether the prediction of dustfall and metal accumulation in soil within the LAAs was based on the 95% UCLM or mean values based on baseline sampling for both the HHRA and the cumulative effects assessment. i. If the values used are different, provide a rationale for the approach used. ii. Discuss whether the values used are protective of human receptors, including Indigenous Peoples, under current and future use scenarios. iii. If values used are not protective of human receptors, provide a revised assessment for Indigenous health conditions and other relevant VCs using the most conservative value.
Response:	a. For clarity, the baseline dustfall deposition rate of 0.99 g/m^2/30-days (i.e., single year mean) discussed in IAAC-R2-86 was not an input into the Human Health Risk Assessment (HHRA). Measured 30-day dustfall is an air quality parameter that describes total particulate deposition to soil. The approach used (mean of measured average dustfall at the seven monitoring stations) is consistent with accepted practice for the assessment of ambient air quality. For human health, concentrations of total particulate in air (i.e., $PM_{2.5}$) are more appropriate for the assessment of human health effects via inhalation, while assessment of speciated deposition (i.e., metals deposition) to soil is used to assess the potential health risks associated with oral exposure pathways (i.e., ingestion and dermal contact with soil, and ingestion of terrestrial country foods). Measured concentrations in soil and country foods are considered representative of baseline conditions, including the potential effects of historical deposition of metals. As noted in IAAC-R2-51, and

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	Table 4-33 of the Human Health and Ecological Risk Assessment Technical Modelling Report, the 95% upper confidence limits of the mean (UCLMs) of measured soil concentrations were used as baseline soil concentrations and the 95% UCLMs for each type of vegetation were used as the baseline vegetation concentrations. These 95%UCLMs for soil and vegetation were used to predict baseline concentrations in wild meat. To assess the potential project-related effects associated with dustfall, 95% UCLMs of metals deposition (wet + dry) were used to estimate potential project-related metals accumulation in soil. The 95% UCLMs were based on the predicted total metals deposition associated with operation at the MacLellan and Gordon sites at each of the receptor locations. As shown in IAAC-IR2-51, predicted future concentrations of metals in soil reflect the accumulation of project-related depositions and baseline concentrations of metals in soil. As a result, these predicted metal concentrations in soil are considered appropriate for use in the assessment of cumulative effects to soil from historical activities and project-related effects. These predicted future metal concentrations in soil were used in combination with baseline concentrations of metals in terrestrial country foods to predict future concentrations of metals in terrestrial country foods in the HHRA. With respect to cumulative effects, potential human health risks associated with past and present projects (e.g., not operating, closed or decommissioned facilities) and physical activities (i.e., residential, industrial, commercial and natural environment) in the local assessment area have been captured in the baseline assessment of existing human health risks. As such, the contribution of present projects and activities are considered in the assessment of the future case (in the HHRA) and the Project residual effects (Section 17.4). Residual effects arising from past, present, and reasonably foreseeable future activities would have the same exposure pathways as those arising from the Project (Section 17.4.3) and would have the potential to result in a cumulative increase in human health risks. Changes in air quality could result in changes in potential inhalation health risks and, as a result of contaminant deposition to soil, changes in health risks associated with direct contact with and ingestion of soil, and changes in terrestrial country food quality. As noted in the Environmental Impact Statement, the cumulative effects assessments for air quality (Chapter 6, Section 6.5.1) concluded that the potential for cumulative effects from the Project and other reasonably foreseeable projects was considered negligible. In the absence of cumulative effects of the Project and other projects and activities on air quality, there is no potential for cumulative effects on human health from the Project and other reasonably foreseeable projects via soil and terrestrial country foods. i. Baseline and predicted concentrations of metals in soil and terrestrial country foods are based on 95% UCLMs – either through direct measurement (baseline soil, baseline vegetation) or predicted using modelling (future case soil, future case vegetation, baseline and future case wild meat). ii. The values used in the HHRA are considered protective of human receptors, including Indigenous Peoples, under current and future use scenarios. The assessment of potential risks associated with direct contact exposures to soil

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	and harvesting of terrestrial country foods was based on the 95% UCLM predictions of metal deposition and accumulation in soil within the LAA. This assumption was applied across the LAA and assumed that metal uptake into vegetation and wild meat would be the same across the LAA. This approach over predicts direct exposures to metals in soil and through the consumption of country foods harvests within the LAA and from beyond the LAA by attributing 95% UCLM dust fall and metal accumulation in areas of the LAA removed from the Gordon and MacLellan PDAs where dust fall will be lower than the predicted 95% UCLM values. In addition, by assuming that 100% of the country foods harvested by Indigenous and non-Indigenous receptors come from within the LAA, this approach reduces the uncertainties associated with apportioning country food consumption between areas with different deposition and metal accumulations. Even with these conservative estimates, the predicted changes in metals concentrations in soil were less than 1%, with the exception of arsenic: arsenic concentrations in soil in the MacLellan Region are predicted to increase from 1.58 mg/kg to 2.05 mg/kg, which are still well below the CCME guideline of 12 mg/kg. iii. Based on the above, the values used are protective of human receptors and no revisions are necessary.
Attachment:	No

Appendix A ATTACHMENTS

ATTACHMENT IAAC-R3-01

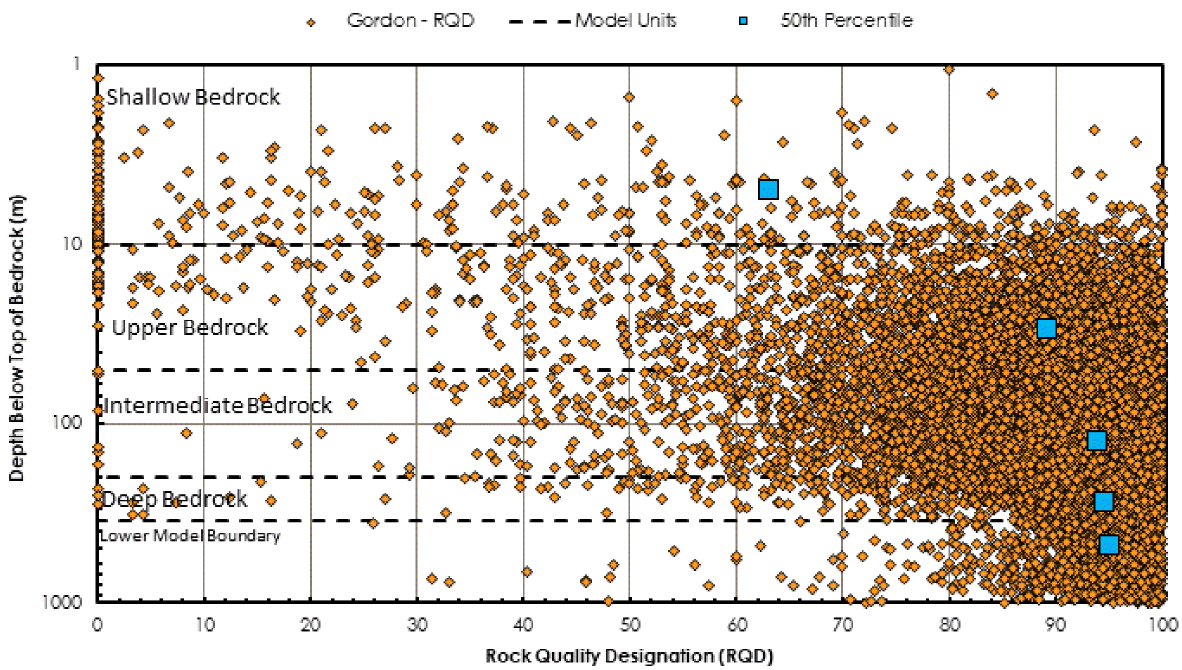


Figure IAAC-R3-01-1 **MacLellan Site Rock Quality Designation with Depth Below Top of Bedrock Relative to Groundwater Flow Model Layers**

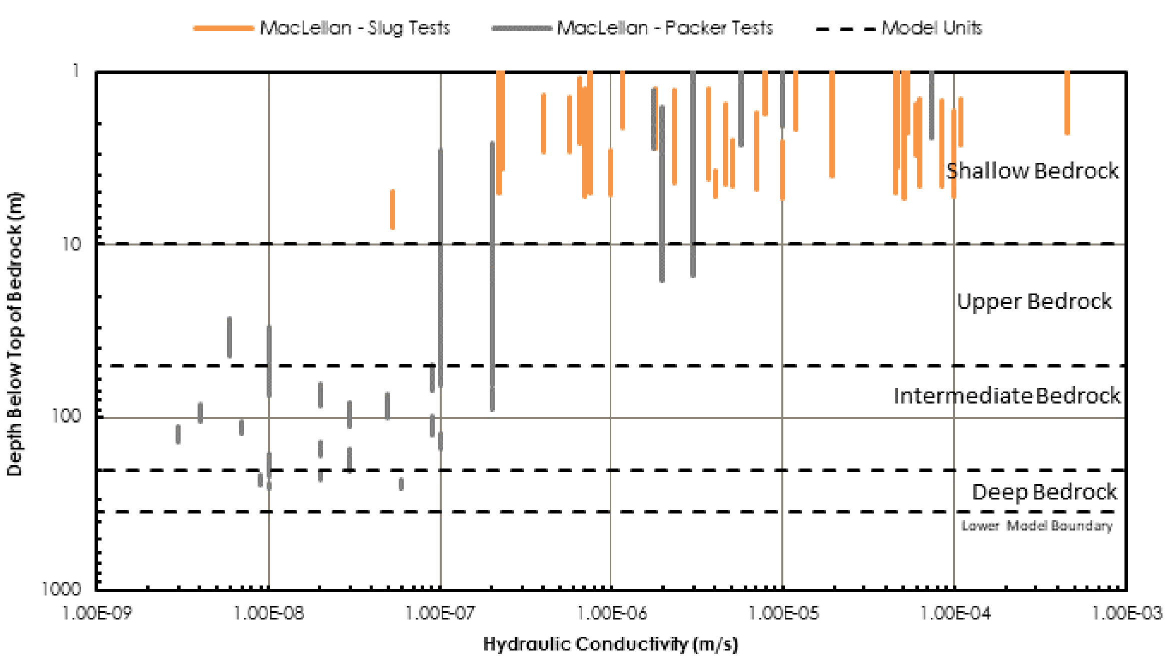


Figure IAAC-R3-1-2 **MacLellan Site Horizontal Hydraulic Conductivity of Bedrock with Depth Below Top of Bedrock Relative to Groundwater Flow Model Layers**

Table IAAC-R3-01-1 MacLellan Site Intermediate and Deep Bedrock Hydraulic Conductivity and Recharge Sensitivity Scenario – Predicted Open Pit Inflow at End of Operation

Scenario	Hydraulic Conductivity (m/s)				Recharge (mm/yr)	Total Pit Inflow (m^3/s)
	Shallow Bedrock	Upper Bedrock	Intermediate Bedrock	Deep Bedrock		
Base Case	8.1×10^{-6}	2.0×10^{-7}	3.4×10^{-8}	1.3×10^{-8}	120	0.22
1	8.1×10^{-6}	2.0×10^{-7}	2.0×10^{-7}	1.3×10^{-7}	150	0.14

Table IAAC-R3-01-2 MacLellan Site Intermediate and Deep Bedrock Hydraulic Conductivity and Recharge Sensitivity Scenario – Predicted Fate of Seepage from TMF at End of Operation (no seepage collection ditches)

Source	Receptor	Base Case				Sensitivity Scenario 1 – Increased Intermediate and Deep Bedrock Hydraulic Conductivity and Increased Recharge			
		Discharge (m^3/s)	Travel Time (years)			Discharge (m^3/s)	Travel Time (years)		
			Minimum	Mean	Maximum		Minimum	Mean	Maximum
TMF	Subsurface Seepage to Fen	7.3E-5	1	129	1,226	n/a	n/a	n/a	n/a
	Keewatin River	2.3E-4	130	1,302	32,869	1.8E-4	3	8	18
	Watercourse connecting Payne Lake and Keewatin River (Kee3-Pay1)	1.2E-4	140	210	326	1.8E-4	2	11	340
	Minton Lake	1.1E-3	3	4,447	29,497	5.6E-4	2	10	38
	Open Pit	3.0E-4	178	11,364	48,415	1.4E-3	<1	4	18
	Tributary of Keewatin River (Kee3-B1)	3.0E-3	1	327	5,268	3.0E-4	<1	5	22
	Cockeram Lake	8.2E-5	108,755	196,541	368,155	n/a	n/a	n/a	n/a
	Payne Lake	n/a	n/a	n/a	n/a	6.8E-4	2	5	62
	Seepage to Intermediate Flow System	n/a	n/a	n/a	n/a	1.6E-3	n/a	n/a	n/a
MRSA	Keewatin River	6.5E-5	94	310	3,189	n/a	n/a	n/a	n/a
	Tributary of Keewatin River (Kee3-B1)	1.3E-3	3	81	1,853	4.7E-4	<1	2	43
	Minton Lake	4.5E-3	20	754	8,376	3.0E-3	<1	9	84
	Open Pit	1.3E-3	18	603	46,397	1.2E-3	<1	2	43
	Cockeram Lake	8.0E-6	131,865	132,155	132,445	n/a	n/a	n/a	n/a
	Subsurface Seepage to Fen	n/a	n/a	n/a	n/a	3.1E-4	<1	14	47
	Seepage to Intermediate Flow System	n/a	n/a	n/a	n/a	2.2E-3	n/a	n/a	n/a

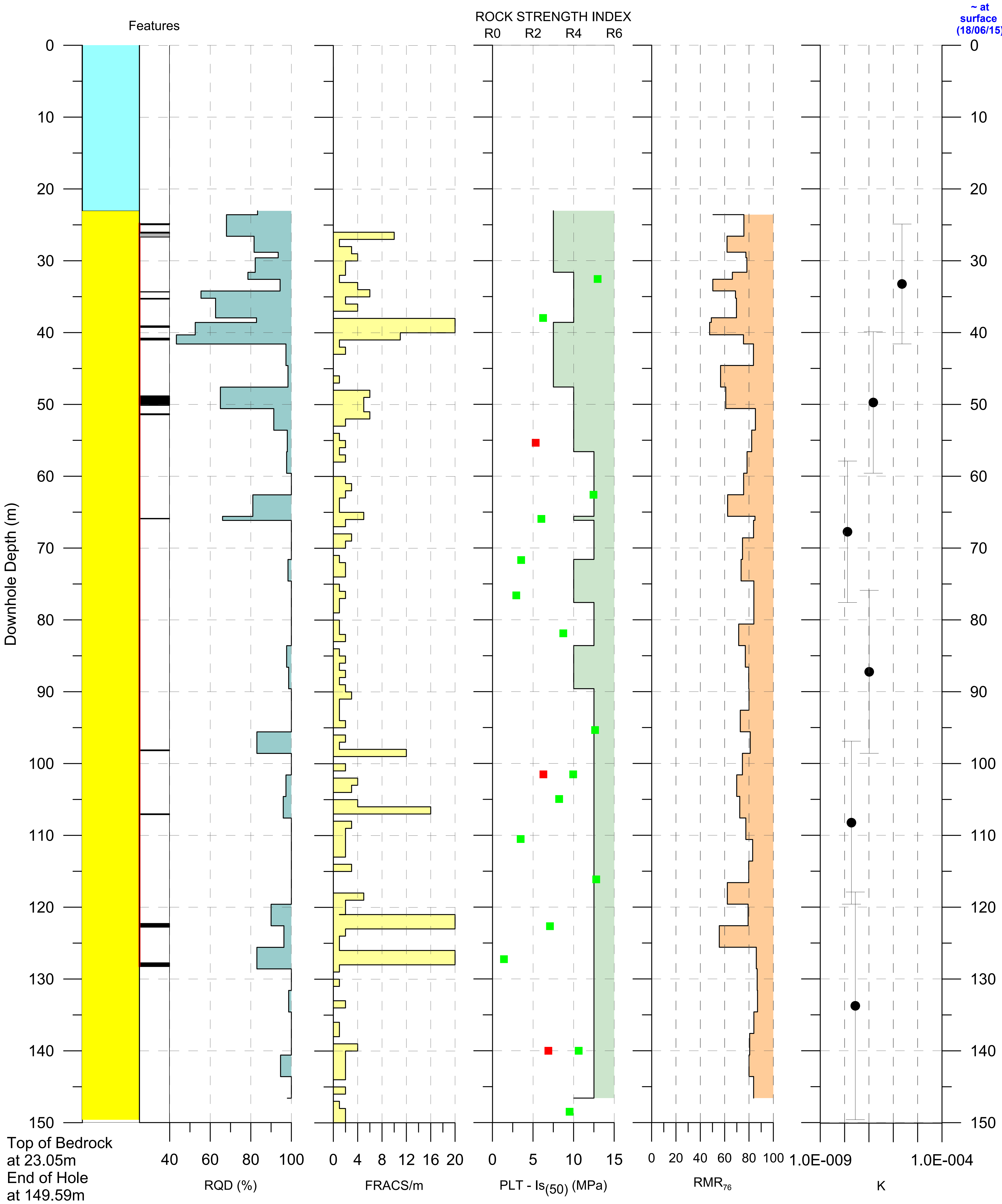
Notes:
n/a – not applicable

Table IAAC-R3-01-3 MacLellan Site Water Level Residuals and Statistics for Base Case Calibration Compared to Intermediate and Deep Bedrock Hydraulic Conductivity and Recharge Sensitivity Scenario

Monitoring Well	Base Case – Calibrated Model			Scenario 1 – Intermediate and Deep Bedrock Hydraulic Conductivity and Recharge		
	Average Annual Water Level Target (m amsl)	Simulated Average Annual Water Level Target (m amsl)	Residual (m)	Average Annual Water Level Target (m amsl)	Simulated Average Annual Water Level Target (m amsl)	Residual (m)
MWM01A	343.89	343.68	-0.21	343.89	346.49	2.6
MWM02A	349.91	350.10	0.19	349.91	348.9	-1.01
MWM02B	349.48	350.03	0.55	349.48	348.92	-0.56
MWM04	349.92	342.75	-7.17	349.92	322.38	-27.54
MWM05A	332.16	332.72	0.56	332.16	330.57	-1.59
MWM05B	332.11	332.68	0.57	332.11	330.95	-1.16
MWM06A	331.27	331.64	0.37	331.27	330.87	-0.4
MWM06B	331.51	331.67	0.16	331.51	330.91	-0.6
MWM09A	344.61	337.57	-7.04	344.61	>384.61	>40
MWM09B	345.01	337.57	-7.44	345.01	>385.01	>40
MWM10A	327.47	326.87	-0.60	327.47	325.87	-1.6
MWM10B	327.77	326.77	-1.00	327.77	325.84	-1.93
GBHM01B	333.93	334.74	0.81	333.93	>373.93	>40
GBHM03A	336.46	336.60	0.14	336.46	299.8	-36.66
GBHM05A	330.71	331.98	1.27	330.71	319.71	-11
GBHM05B	330.7	332.00	1.30	330.7	319.98	-10.72
GBHM06A	344.28	335.93	-8.35	344.28	>384.28	>40
GBHM07	-	-	-	342.14	347.61	5.47
GBHM08	351.34	349.18	-2.16	351.34	346.55	-4.79
GBHM09A	346.22	343.83	-2.39	346.22	322.47	-23.75
GBHM10A	338.61	339.57	0.96	338.61	307.96	-30.65
GBHM10B	338.20	339.68	1.48	338.2	308.15	-30.05
GBHM12	335.64	340.14	4.50	335.64	339.13	3.49
GBHM13A	343.21	343.61	0.40	343.21	344.23	1.02
GBHM13B	343.21	343.50	0.29	343.21	344.48	1.27
		Average:	-0.95		Average:	-8.10

Northing (m): 6307765
Easting (m): 381436
Elevation (m.a.s.l.): 336

Azimuth: 180°
Inclination: 60°



LITHOLOGY

- Biotite Chlorite Amphibole Schist (M3b)
- Overburden (OVB)

FEATURES

- BROKEN CORE
- LOST CORE
- INFERRED FAULT/SHEAR

PLT

- INTACT AXIAL PLT
- INTACT DIAMETRAL PLT
- FOLIATION PLT

- GROUNDWATER LEVEL

Golder Associates

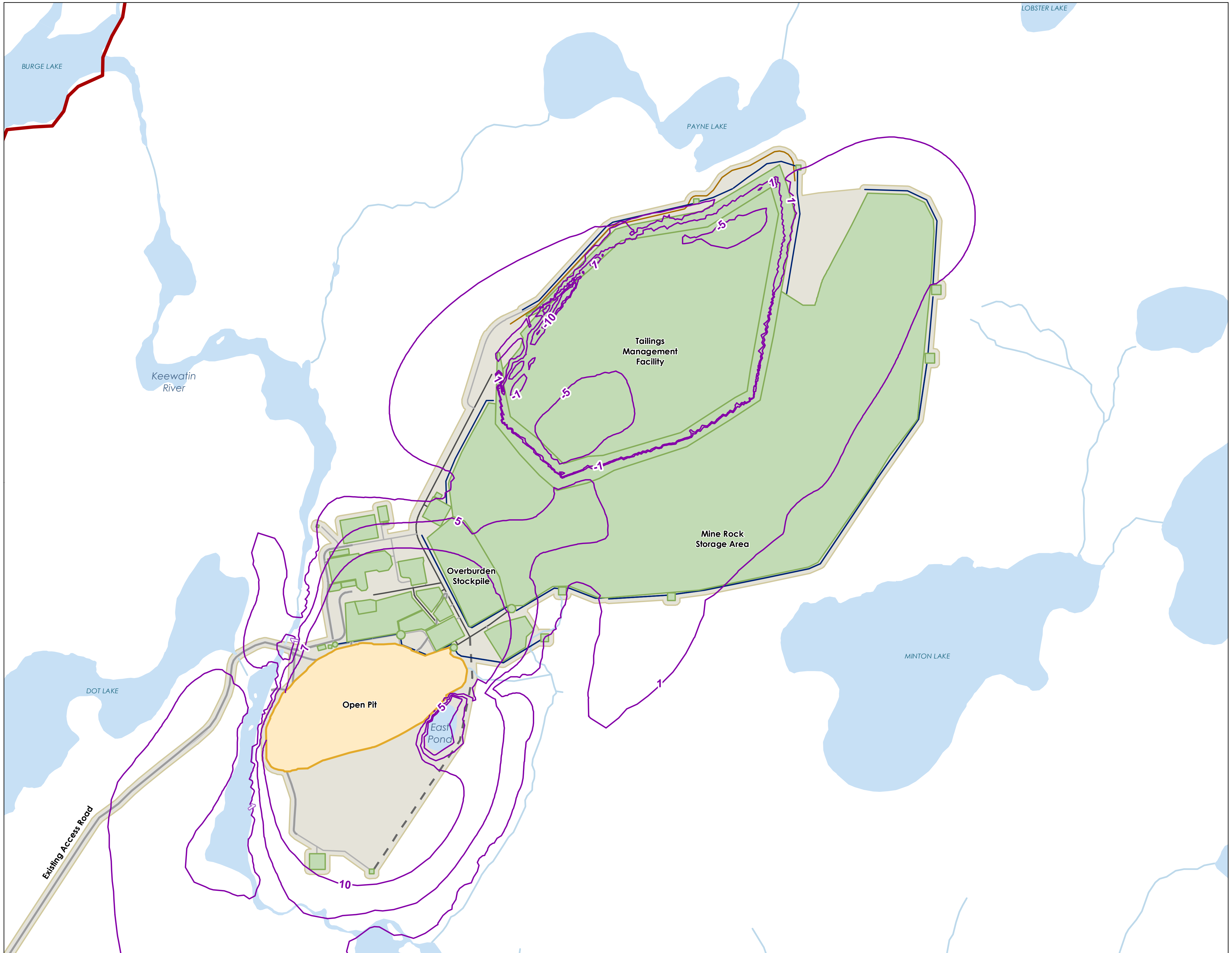
Project No. 1418706

Alamos: McLellan

HISTOGRAM SUMMARY PLOT
GTM-15-04

Date: January 2016
DRAWN/REV: AB/LC

FIGURE A4



Project Infrastructure
- Project Development Area
- Proposed Open Pit
- Potential Infrastructure
- Drainage Ditch
- Existing Access Road
- Access Road
- Haul Road
- Inplant Road
- Toe Road
- Future Access Road

Study Area
- Study Area
- Groundwater Drawdown Contour (m)

Landbase
- Existing Access Road
- Waterbody

N

0 0.5 1 Kilometres
1:25,000 (At original document size of 11x17)

Notes
1. Coordinate System: NAD 1983 UTM Zone 14N
2. Base Data Sources: Government of Manitoba and Government of Canada.
3. Project Infrastructure features provided by QPit and Ausenco.

Project Location
Lynn Lake,
Manitoba

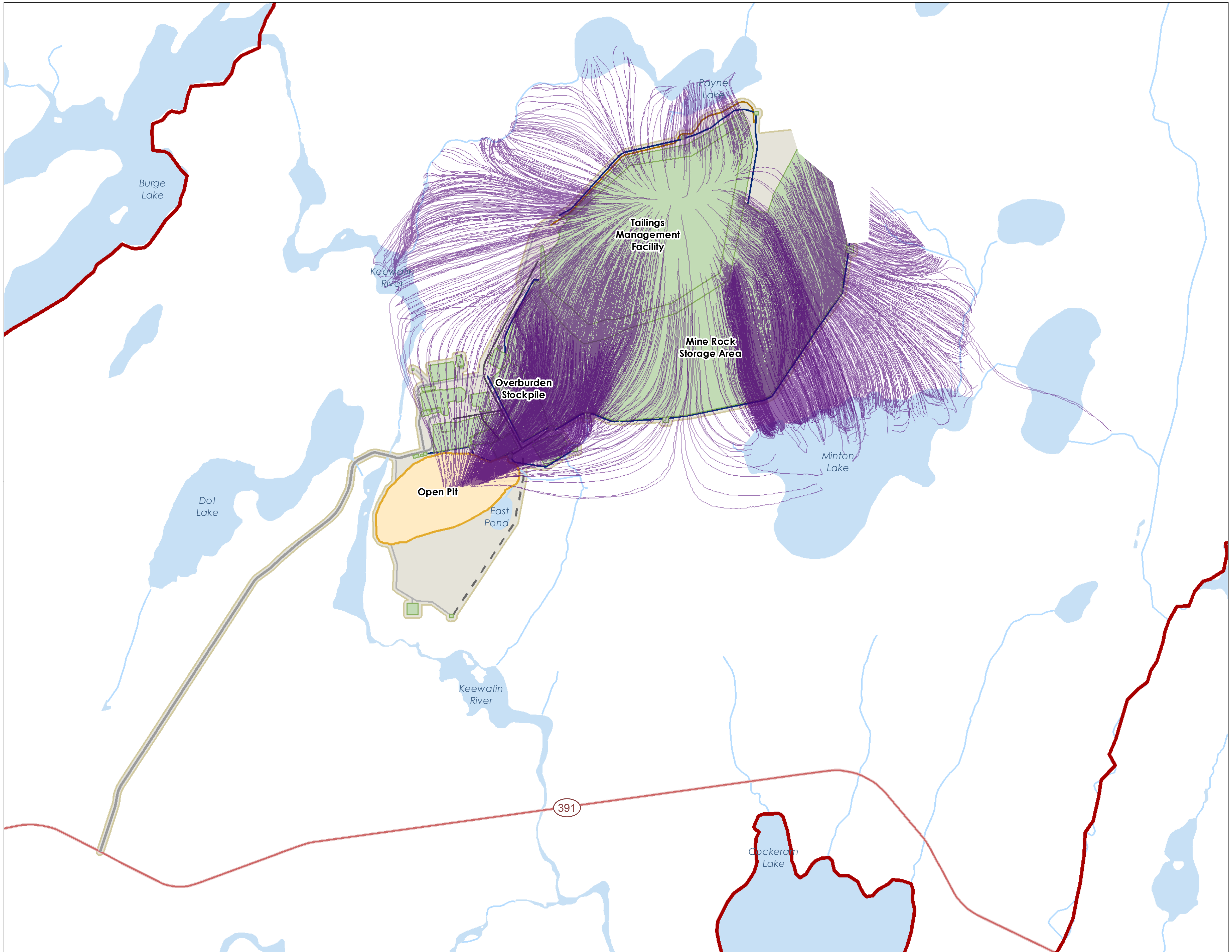
Prepared by AC on 2022-07-26
Technical Review by MF on 2022-07-26

Client/Project
111473012-REVB

ALAMOS GOLD INC.
Lynn Lake Gold Project

Map No.
IAAC-R3-01-1

Title
Simulated Water Table Drawdown at End of Operation - MacLellan (not including contact water collection ditches) - Sensitivity Scenario 1



Stantec

Project Infrastructure

- Project Development Area
- Proposed Open Pit
- Potential Infrastructure
- Access Road
- Haul Road
- Inplant Road
- Toe Road
- Future Access Road

Study Area

- Study Area
- Particle Tracks

Landbase

- Highway
- Existing Access Road
- Watercourse
- Waterbody

N

0 0.5 1 Kilometres

(At original document size of 11x17)
1:35,000

Notes

1. Coordinate System: NAD 1983 UTM Zone 14N
2. Base Data Sources: Government of Manitoba and Government of Canada.
3. Project Infrastructure features provided by QPit and Ausenco.

Project Location
Lynn Lake, Manitoba

Prepared by JH on 2022-07-22
Technical Review by MF on 2022-07-22

Client/Project 111473012
ALAMOS GOLD INC.
Lynn Lake Gold Project

Map No.
IAAC-R3-01-2

Title

Particle Traces from the TMF to the Receiving Environment - End of Operation - MacLellan (no contact water collection ditches) Sensitivity Scenario 1

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