RESPONSE TO NRCAN-04

ID:	NRCAN-04
Expert Department or Group:	Natural Resources Canada
Guideline Reference:	7.1.5 Project Setting and Baseline Conditions – Groundwater and Surface Water
EIS Reference:	Baseline Study Appendices 3, Attachment 3-D, Hydrogeology Baseline Report, Sections 3.2, 4.3. Chapter 6, Appendix 6A, Section 3.3, Appendix 2C Prefeasibility Geotechnical Report, Section 7.4
Context and Rationale:	The EIS Guidelines state that the EIS will present information in sufficient detail to enable the identification of how the project could affect the Valued Components and the analysis of those effects. Hydraulic conductivity in the overburden was assessed through single well response tests. The majority of these tests were completed in wells that were screened across the bedrock-overburden interface. A review of these tests indicate increased hydraulic conductivity with increased proportion of the screen within the bedrock (Section 4.3 of BSA 3D). These results, combined with the noted lower rock quality designation within the upper 5-10m of bedrock, appear to support a conceptualization of an upper, more permeable bedrock zone within the top 5-10m. Within the geological and groundwater models, the hydrostratigraphy of the bedrock has been classified into upper (0-20m), intermediate (20-120m), and deep (120-370m) bedrock units. These divisions do not appear to reflect the hydraulic conductivity data or the rock quality designation data, all of which point to higher hydraulic conductivity in the upper 5-10m. As shown on Figure 1, Section 7.4, Appendix 2C Prefeasibility Geotechnical Report, the packer testing data, while sparse, appears to show a lower uniform hydraulic conductivity for the remaining depth for the Marathon Pit and an increased hydraulic conductivity at depths greater than 350 m for the Leprechaun Pit. Single well response testing within the bedrock (MW5, MW6, and MW8) should not be relied upon to characterize bedrock hydraulic conductivity. In MW5, groundwater elevations were only displaced by 10cm, and only two observation points were used in the analysis. At MW6, and MW8, the rising head tests (completed second) yield hydraulic conductivity estimates that were at least an order of magnitude higher than the falling head tests (completed first). These results may indicate continued development of

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	these wells through testing. Results at these three wells may underestimate shallow bedrock hydraulic conductivity. Hydrostratigraphy implemented within the groundwater flow model is the main factor that controls the assessment of groundwater flow quantity and direction. Hydrostratigraphy should represent field observations to the extent possible. Failure to represent a conductive upper bedrock unit may result in an incorrect assessment of changes to surface water quantity and quality, which would be carried forward to the assessment of fish and fish habitat.
Information Request:	a. Update the geological and groundwater models to represent the observed hydrostratigraphy and measured hydraulic conductivity variations with depth. Implement variations in bedrock hydraulic conductivity with depth, only to the extent supported by hydraulic testing and rock quality designation. b. Reevaluate the single well response tests at MW5, MW6, and MW8 to determine if there is sufficient displacement and evaluate the potential for enhanced well development through the testing process. Update the conceptual model and parameterization as needed.
Response:	a. The geological and groundwater models presented in the EIS represent the observed hydrostratigraphy and measured hydraulic conductivity variations with depth. Further to the data used to support the models presented in the EIS, the results of additional packer testing completed in the area of the open pits are presented on Figure 17 (Terrane 2021). These plots indicate a decreasing trend of hydraulic conductivity with depth in the bedrock, which is consistent with the interpreted distribution of hydraulic conductivity in the shallow, intermediate, and deep bedrock units at the site. Also, additional hydraulic conductivity tests were completed in the shallow bedrock and overburden following submission of the EIS (Gemtec 2021) and are presented on Figure NRCan-04.1. These tests are generally limited to depths of less than 30 m below ground surface. As shown on NRCan-04.1, the hydraulic conductivity within the top 30 m from ground surface (or 20 to 25 m below top of bedrock) show a varied range of hydraulic conductivity from 1×10^{-7} m/s to 1×10^{-4} m/s. These data are consistent with those used to develop the geological and groundwater models presented in the EIS. The hydrostratigraphy used in the development of the geological and groundwater models presented in the EIS has been reviewed is considered appropriate, and this has been confirmed by additional data collected since completion of those models. Therefore, the geological

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	and hydrogeological models presented in the EIS are appropriate, and the models do not require updating at this time. b. Although the initial displacement for the hydraulic tests completed in wells MW5, MW6 and MW8 were small, the interpreted hydraulic conductivities from the original testing are consistent with the interpretations presented on Figure NRCan-04.1. The initial displacements observed in wells MW5, MW6 and MW8 may have been biased by the length of the screened interval that intersected the bedrock. However, in our experience, hydraulic conductivity estimates interpreted with low initial displacements represent the actual site conditions within an order of magnitude. Based on the additional data collected at the site, the interpreted hydrostratigraphy used in the geological and hydrogeological models presented in the EIS are appropriate, and do not require the models to be updated at this time. References: Gemtec Consulting Engineers and Scientists Limited (Gemtec). 2021. Feasibility-Level Site-Wide Geotechnical and Hydrogeological Investigations, Valentine Gold Project, Marathon Gold Corporation, Draft Report. Terrane Geoscience Inc. 2021. Feasibility Geotechnical Investigation: Marathon & Leprechaun Deposits. Prepared for Marathon Gold Corp.
Appendix:	None

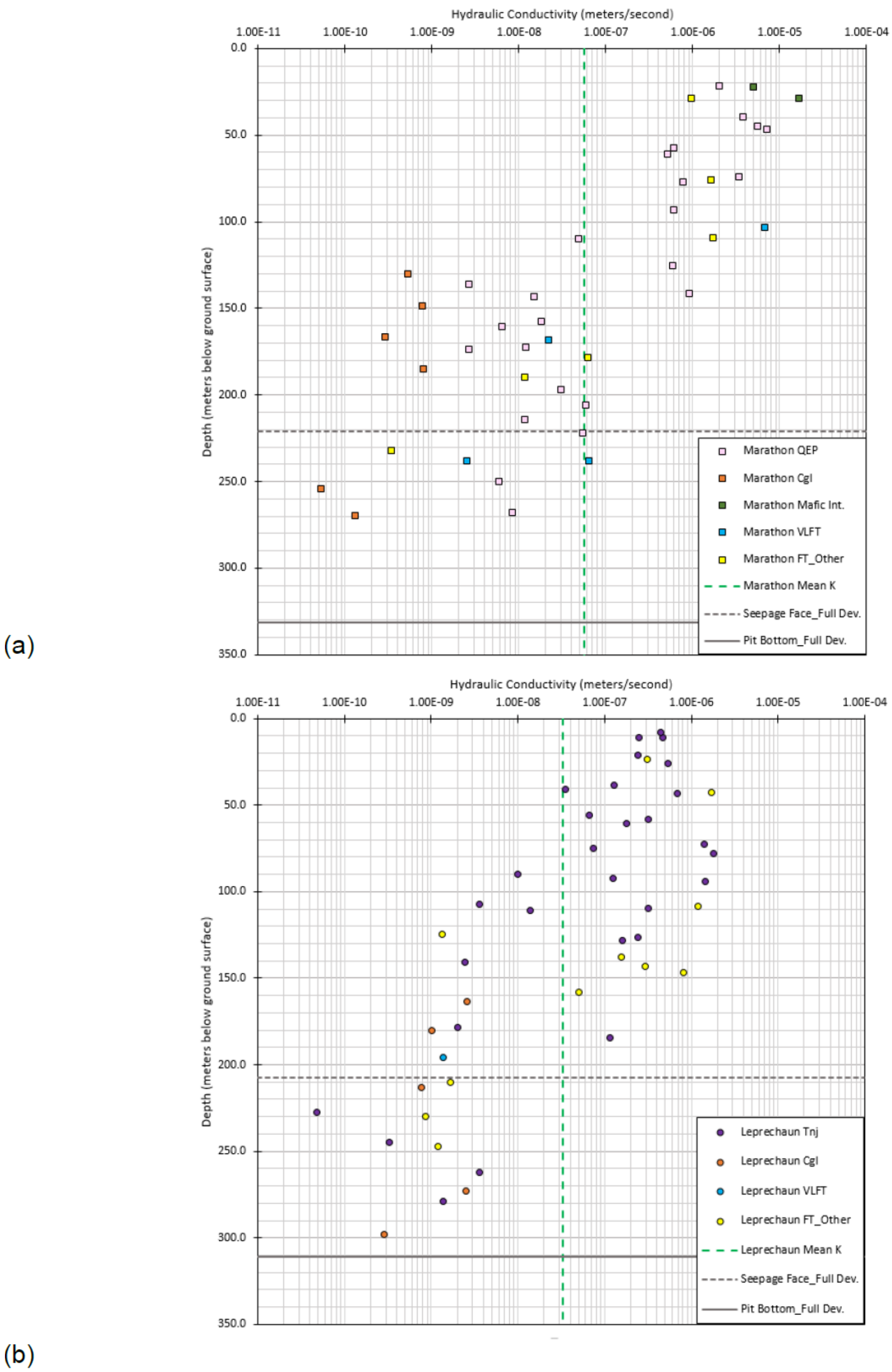

Figure 17 Hydraulic conductivity vs Depth by Rock Type and Structural Feature for (a) Marathon deposit, and (b) Leprechaun deposit

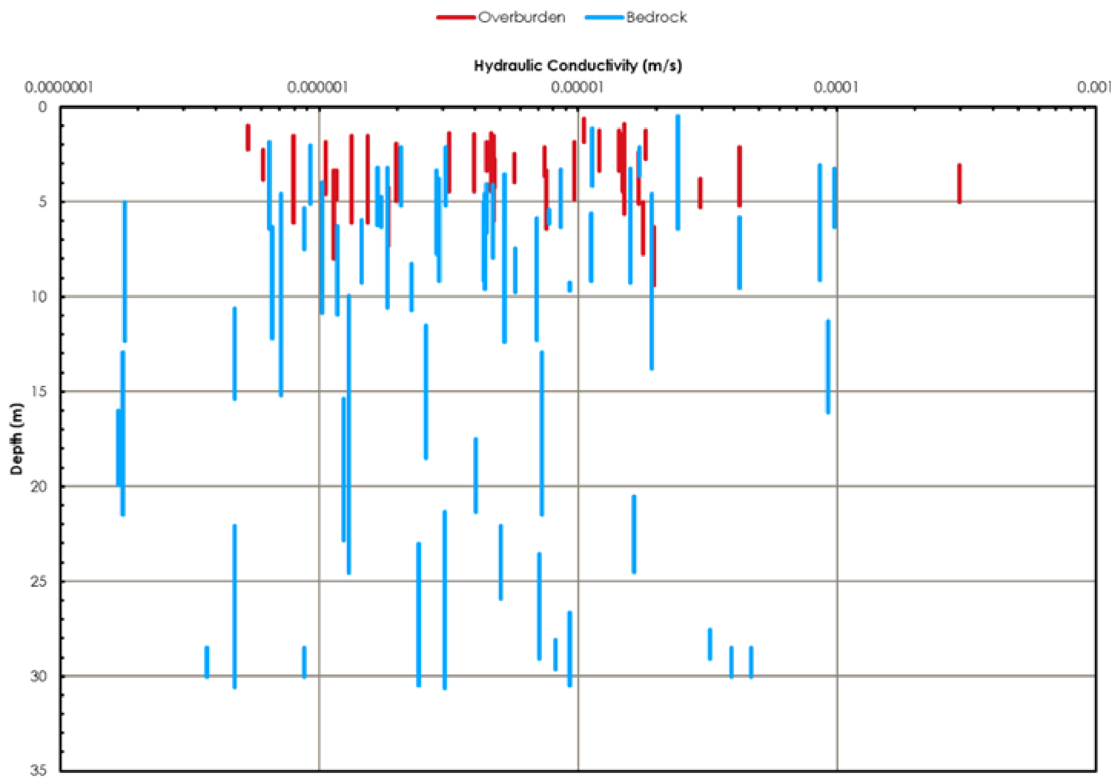

Figure NRCan-04.1 Interpreted Hydraulic Conductivity from Shallow Boreholes Using Data from Gemtec 2020 and 2021