TECHNICAL MEMORANDUM

DATE July 10, 2017 **REFERENCE No.** 1774579-124-TM-Rev0-2500

TO Ryan Vanengen
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COMMITMENT 39: WHALE TAIL PIT PROJECT WASTE ROCK STORAGE FACILITY COVER THERMAL ASSESSMENT

1.0 INTRODUCTION

Agnico Eagle Mines Limited – Meadowbank Division (Agnico Eagle) is proposing to develop Whale Tail Pit and Haul Road Project (Project), a satellite deposit located on the Amaruq property, to continue mine operations and milling at Meadowbank Mine.

The Amaruq property is a 408 km^2 site located on Inuit Owned Land approximately 150 km north of the hamlet of Baker Lake and approximately 50 km northwest of Meadowbank Mine in the Kivalliq Region of Nunavut. The deposit will be mined as an open pit (i.e., Whale Tail Pit), and ore will be hauled to the approved infrastructure at Meadowbank Mine for milling. There are four phases to the development: one year of construction, three years of mine operations, eight years of closure, and the post-closure period.

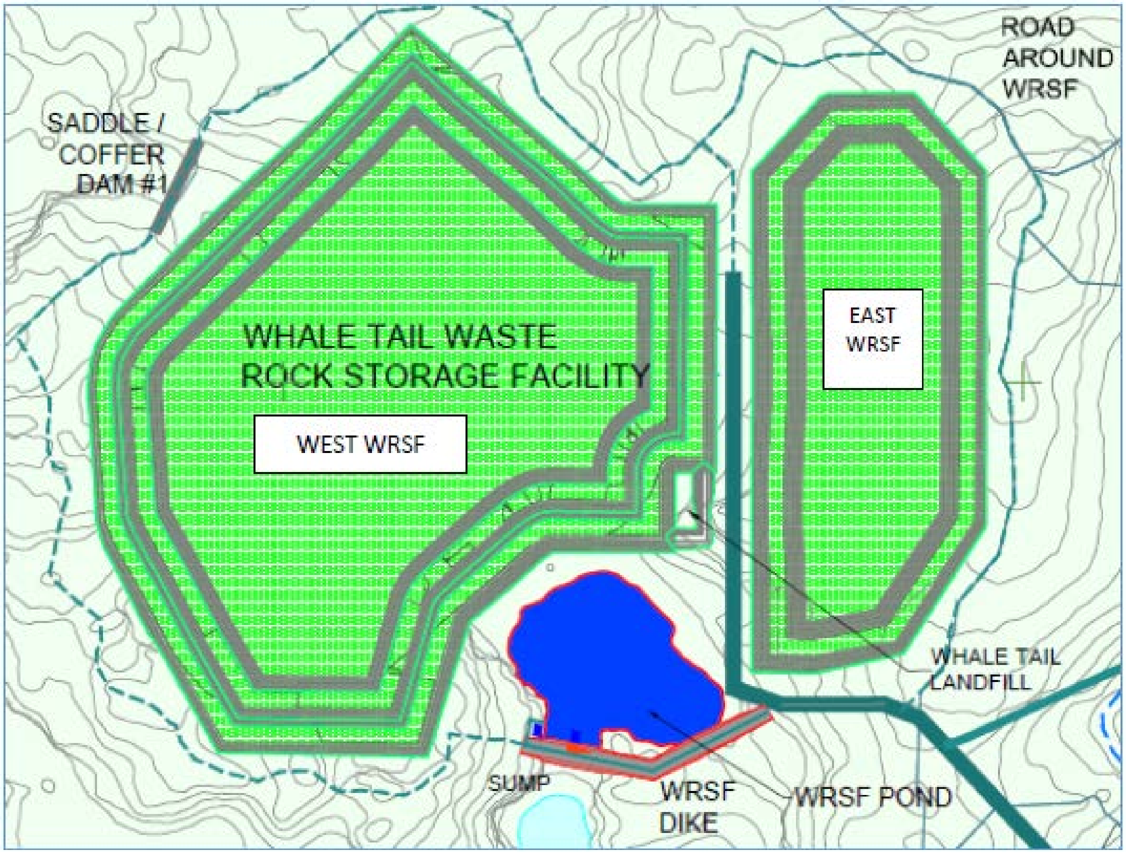
One area, located north-west of the open pit, has been identified as the Whale Tail Waste Rock Storage Facility (WRSF), consisting of West WRSF and East WRSF (Figure 1). Waste rock and overburden will be trucked to the Whale Tail WRSF until the end of mine operations, with distribution according to the operations schedule. Waste rock and overburden will be co-disposed together in one of the two piles constituting the Whale Tail WRSF area.

Geochemical behaviour of waste rock and overburden is presented in Agnico Eagle (2016) and Golder (2017a).

Closure of the Whale Tail WRSF will begin when practical as part of the progressive reclamation program. As part of the Whale Tail Pit – Waste Rock Management Plan (Agnico Eagle 2017a), the Whale Tail WRSF will be covered with non-potentially acid generating and non-metal leaching (NPAG/NML) waste rock to promote freezing as a control strategy against acid generation and migration of contaminants.

This thermal assessment was carried out as answer to the technical comments INAC-TRC #1 (April 2017) and NRCan3 (April 2017) and pre-hearing commitment #39 from the Nunavut Water Board. This technical memorandum incorporates information from the Meadowbank Mine WRSF monitoring program, provides a description of the future projected monthly mean temperature for Whale Tail Pit Project site and input to determine the thickness of NPAG/NML rock that would be required to maintain the PAG/ML materials frozen below the active layer under selected climate change conditions.

Figure 1: Whale Tail WRSF (screen capture from drawing 6108-600-210-003)



2.0 BACKGROUND

The Whale Tail Pit Project is located in the zone of continuous permafrost. Based on measurements of ground temperatures (Knight Piésold 2015), the depth of permafrost at the mine site is estimated to be in the order of 425 m outside of the influence of waterbodies. The depth of the permafrost and active layer will vary based on proximity to the lakes, overburden thickness, vegetation, climate conditions, and slope direction. The typical depth of the active layer is 2 m in this region of Canada. The typical permafrost ground temperatures at the depths of zero annual amplitude (typically at the depth of below 15 m) is approximately -8.0°C in the areas away from lakes and streams. The geothermal gradient measured is 0.02°C/m (Knight Piésold 2015). Late-winter ice thickness on freshwater lakes is approximately 2.0 m. Ice covers usually appear by the end of October and are completely formed in early November. The spring ice melt typically begins in mid-June and is complete by early July.

A further review on site thermistor data was carried out by Golder during the thermal assessment for the Whale Tail Lake, with a summary of the thermal conditions presented in Golder (2017b).

Based on site investigation data, soils in the project area are typically medium to coarse grained glacial till and colluvium with high coarse fragment content overlying bedrock at shallow depths. Review of existing data indicates the soil thicknesses varying from about 1 to 12 m in the WRSF area. Underlying the soil, bedrock in the area generally consists of a stratigraphic sequence of greywacke, komatiite, and ultramafics, with varying thicknesses.

Between 2018 and 2021, Agnico Eagle plans to deposit a total of 61.48 million dry tonnes of waste rock (e.g., Golder 2017a), in two piles constituting the Whale Tail WRSF (Figure 1).

The answer to the technical comments INAC-TRC #1 and NRCan3 proposed the use of the East WRSF (Figure 1) as contingency source to store NPAG/NML waste rock. This material will be used to complete the top cover of the WRSF after the operation but can also be used to increase the thickness of the cover on the slopes in the eventuality the active layer is deeper than currently expected.

3.0 CLIMATE DATA AND CLIMATE CHANGE SCENARIOS

A summary of air temperatures at the project site and Baker Lake is shown in Table 1. A mean annual air temperature of -11.3°C was obtained for the site based on Golder (2016a). Climate normal for Baker Lake between 1981 and 2000 shows a mean annual air temperature of -11.2°C. As climate data for Baker Lake in the year of 2000 shows the same mean annual air temperature of -11.2°C, a series of daily climate data over the year were further assessed for the purpose of estimating ground surface temperatures required as input for the thermal model (refer to Section 4.3). Figure 2 shows the 2000 climate data set including maximum and minimum daily air temperatures, maximum and minimum daily air relative humidity, mean daily wind speed and daily total precipitation.

Future climate projections from the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5) provided by the Canadian Climate Data and Scenarios (CCDS) interface were analyzed to determine representative concentration pathways (RCP) scenarios for the project. Detailed analyses were presented in a technical memorandum included in Attachment 1.

The following two climate change scenarios were used for the WRSF thermal modelling, representing projected air temperatures increases over 100 years:

- Scenario RCP 4.5 - increases ranging from 1.9°C to 6.1°C for mean monthly temperatures over 100 years, with an average of 3.6°C.
- Scenario RCP 6.0 - increases ranging from 3.2°C to 8.5°C for mean monthly temperatures over 100 years, with an average of 5.3°C.

The projected mean monthly air temperatures after 100 years for the two scenarios are shown in Table 1.

Table 1: Mean Monthly Air Temperatures

Month	Whale Tail Project (Golder 2016a)	Baker Lake Climate Normal (1981 to 2010)	Baker Lake (2000)	Projected After 100 year Climate Change (RCP 4.5)	Projected After 100 year Climate Change (RCP 6.0)
Unit	°C	°C	°C	°C	°C
January	-31.3	-31.2	-29.9	-26.7	-24.6
February	-31.1	-31.0	-28.3	-27.4	-25.4
March	-26.3	-26.2	-23.9	-23.2	-21.6
April	-17.0	-17.0	-19.0	-15.0	-13.7
May	-6.4	-6.3	-5.3	-4.3	-2.9
June	4.9	4.8	2.3	6.7	8.1
July	11.6	11.6	13.0	14.0	15.5
August	9.8	9.8	11.1	13.0	14.5
September	3.1	3.1	2.3	6.8	8.2
October	-6.5	-6.4	-7.6	-1.3	0.2
November	-19.3	-19.3	-19.6	-13.2	-10.9
December	-26.8	-26.5	-29.1	-21.2	-18.7
Average	**-11.3**	**-11.2**	**-11.2**	**-7.7**	**-5.9**

4.0 THERMAL MODELLING

The active layer is defined as the upper portion of permafrost subject to annual cycles of freezing and thawing. The depth of the active layer can vary depending on material type and water content, presence or absence of vegetation, proximity to water bodies, and specific topographic aspects.

To assess depths of the active layer in the West WRSF area, transient one-dimensional (1D) thermal modelling was carried out using the finite element program TEMP/W, a component of the software package GeoStudio 2007 (Version 7.23), developed by GEO-SLOPE international Ltd. (GEO-SLOPE 2010). This section presents the modelling scenarios, criteria, assumptions, material properties, boundary conditions, initial conditions, and results.

4.1 Scenarios and Assumptions

Based on review of the West WRSF layout provided by Agnico Eagle, these model scenarios were developed:

- WRSF including waste overburden – under climate change scenario RCP 4.5
- WRSF including waste overburden – under climate change scenario RCP 6.0
- WRSF without waste overburden – under climate change scenario RCP 4.5
- WRSF without waste overburden – under climate change scenario RCP 6.0

The models have included the following conditions of WRSF development:

- Waste rock deposition operations between June 2018 and December 2021, which was modelled with half-year increments.
- The Whale Tail WRSF was modelled to an average height of 50 m.
- The waste overburden was assumed to be a layer of 3 m thick for the southeast area.

- For all scenarios, the WRSF was modelled for 100 years (January 2022 to December 2122) after closure under the two climate change conditions.

Figure 3 shows the model configurations for the scenarios with and without waste overburden.

This thermal assessment has these assumptions and limitations:

- No calibration was carried out in the modelling exercise.

- No convective heat transfer mechanism due to air or water flow was considered. Only thermal conduction with phase change was considered.

  Although convection is the main gas transport mechanism for waste pile (MEND 2012; Lefebvre et al. 2001) the source of heat in a waste pile is identified as sulphide minerals (Wels et al. 2003). Currently, kinetic testing conducted on waste rock over the period of 70 to 90 weeks and show no sign of sulphide mineral oxidation nor acidification (low sulphate, low conductivity, neutral pH). Mineral depletion calculations show that acidic conditions could develop after more than a decade in the field (Golder Geochemistry Report: FEIS Appendix 5-E). This period of time is likely underestimated because it does not consider the buffering capacity afforded by the other waste rock with which it will be mixed in the pile, slower sulphide mineral oxidation kinetics at lower temperature, and the eight months of freezing conditions and lower rock to liquid ratio in the field that slows the rate of buffering mineral dissolution. As comparison, Meadowbank Portage WRSF contains approximately 50% of PAG waste rock (vs. 27% expected in the Whale Tail WRSF) and pH remains neutral (6.9 to 7.8) and sulphate production low (35 to 165 mg/L). Therefore, although convection may be present it is expected to have a minor influence on the thermal conditions in the waste rock.

- No freezing point depression due to pore-water salinity was considered in the model.

  Using the Westbay facility (Golder 2016b) the calculated total dissolved solids (TDS) content of groundwater samples collected from the talik below Whale Tail Lake at a depth between 276 m and 392 m ranges between 3198 mg/L and 4042 mg/L (0.3% to 0.4%). The salinity in the Canadian Shield generally increases with depth (Frape and Fritz 1987) and as the open pit is planned to end at a depth of approximately 130 m, the TDS content is expected to have limited influence on the freezing point of pore-water.

4.2 Material Properties

Waste rock is typically unsaturated, with varying water contents. Typically, the surface portion of each lift would have finer particles compared to lower portions in the end-dumping construction method, and would have higher water contents according to Fala et al. (2005). The waste rock properties have considered an average water content for both upper and lower portions of waste rock.

According to available information from the project, the WRSF foundation consists of till underlain by bedrock. The upper 30 m of bedrock at the site is generally weathered and would have a higher porosity and water content.

Thermal properties for the different materials were estimated based on Meadowbank Project experience presented in Golder (2017b), and/or were assumed based on literature and experience with similar materials. Table 2 presents the thermal properties used in the models.

Table 2: Material Thermal Properties Used in the Models

Material	In-situ Vol. Water Content (m^3/m^3)	Porosity	Saturation (%)	Thermal Conductivity (W/m-°C)		Volumetric Heat Capacity (MJ/m^3-°C)		Source and Reference
				Frozen	Unfrozen	Frozen	Unfrozen	
Waste Rock	0.058	0.29	20	1.3	1.2	1.5	1.7	Estimated based on Meadowbank Project experience
Waste Overburden	0.285	0.3	95	1.7	1.4	1.9	2.4	Assumed
Foundation Till	0.3	0.3	100	1.8	1.5	2.0	2.5	Golder (2017b)
Weathered Bedrock (0 to 30 m depth)	0.05	0.05	100	2.9	2.9	2.1	2.1	Assumed
Bedrock (>30 m depth)	0.01	0.01	100	3.0	3.0	2.0	2.0	Golder (2017b)

W/m-°C = Watts per metre per degree Celsius; MJ/m^3-°C = million Joules per cubic metre per degree Celsius.

4.3 Boundary Conditions

4.3.1 Ground Surface Temperature Estimation

The monthly ground surface temperature function was a key input to the thermal model. The function was estimated through numerical modelling using climate data from Baker Lake for the year 2000 as reference, and through review of existing thermistor data for the Whale Tail site between September 2015 and September 2016. Table 3 presents a summary of these ground surface temperatures. Based on this information, a ground surface temperature function was defined for the site by adjusting the climate normal air temperatures using a range of multiplier n-factor values between 0.75 and 1.3. Figure 4 shows the ground surface temperature function used in the model as the upper boundary condition during the operations between 2018 and 2021 and the calculated ground average monthly temperatures after 100 years with consideration to climate change. During the 100-year model period, the projected monthly temperature increases for the two climate change scenarios are applied to the baseline ground surface temperature function. The 100-year ground surface temperature functions for the RCP 4.5 and 6.0 scenarios are shown in Figures 5 and 6, respectively, and were used in the model for the post-closure upper boundary conditions.

Table 3: Mean Monthly Air Temperatures

Month	Computed Average Ground Surface Temperature based on 2000 climate data	Thermistor AMQ15-306* (2015 to 2016)	Thermistor AMQ15-324* (2015 to 2016)	Thermistor AMQ15-349A* (2015 to 2016)	Proposed Ground Surface Temperatures for Modelling
	average between 0 and 0.1 m depth	**0.4 m above ground**	**0.4 m below ground**	**0.9 m below ground**	
Unit	°C	°C	°C	°C	°C
January	-21.4	-22.2	-14.9	-18.6	-23.4
February	-20.0	-26.5	-19.1	-21.7	-23.3
March	-17.1	-23.2	-17.8	-20.9	-19.7
April	-13.6	-18.7	-15.9	-18.8	-12.8
May	-3.9	-5.0	-10.1	-9.9	-4.7
June	3.0	5.6	3.2	-0.8	3.6
July	13.1	13.2	13.8	7.1	15.1
August	10.1	9.8	10.6	7.7	12.7
September	1.4	*2.2***	*2.5***	*4.2***	3.4
October	-6.5	-6.5	-3.9	-2.3	-4.8
November	-13.9	-11.4	-6.9	-10.0	-14.5
December	-20.4	-19.4	-10.8	-17.4	-19.9
Average	**-7.4**	**-8.5**	**-5.8**	**-8.5**	**-7.3**

* thermistor data available two readings per day; monthly average from the top thermistor node; refer to Golder (2017b) for thermistor locations.

** incomplete September data – available 4 to 6 days of readings only.

4.3.2 Geothermal Gradient

A geothermal heat flux of 0.048 J/sec was applied to the models as the lower boundary condition based on the assumed bedrock thermal conductivity of 3.0 W/m-°C and a geothermal gradient of 0.016°C/m (Golder 2017b).

4.4 Initial Thermal Conditions

The following initial ground thermal conditions and initial material temperatures were assumed for the models.

- Ground surface temperature of -7.3°C.
- Initial waste rock and waste overburden material temperatures assumed as 15°C in summer and 5°C in winter.

4.5 Model Results

The 1D model results indicated that the WRSF will freeze back progressively after closure. The estimated time for complete freeze-back of the entire pile (excepting the active layer) is estimated to be between 24 and 25 years after the end of operations (Table 4). The temperature profiles for post-closure conditions for the four model scenarios are shown in Figures 7 and 8. Review of the profiles of each scenario indicates both upwards and downwards freezing directions, with conditions as summarized below:

- At 1 year after the end of operations, the pile would be generally unfrozen.
- At 5 years after the end of operations, the pile would freeze to about 17 m below the surface. Portions of the pile between heights of about 7 and 33 m remain unfrozen, with near zero temperatures likely associated

with the pore-water in the waste rock (i.e. water delays the freezing progress due to additional latent heat required to achieve phase change).

- At 10 years after the end of operations, the pile would freeze to about 20 m below the surface. The unfrozen portion in the pile reduces in thickness, being located between heights of about 11 m and 30 m, with near zero temperatures.
- At 15 years after the end of operations, the pile would freeze to about 23 m below the surface. The unfrozen portion reduces to be between heights of about 17 and 27 m, with near zero temperatures.
- At 20 years after the end of operations, the pile would freeze to about 26 m below the surface. The unfrozen portion is limited to heights between about 20 and 24 m, with near zero temperatures.
- At 24 years after the end of operations, the pile would freeze completely.
- After completion of freezing-back, the pile temperatures would continue to decrease with time.

After completion of the freeze-back process, the depth of active layer evolves over time. The active layer depth at selected years after the end of operations are summarized in Table 4. The waste overburden layer appears to have minor impact on the active layer depths during early years after closure, compared to the scenarios without the waste overburden layer. The maximum depth of the active layer is estimated to occur in September to October of each year. The October thermal conditions of the WRSF at selected years shown in Figures 7 and 8 indicate the approximate active layer depth. With the impact of climate change, a warming trend of the waste rock temperatures can be noticed in the plots. With RCP 4.5 and RCP 6.0, the active layer would reach approximately 3 m 100 years after the end of operations.

Table 4: Summary of Active Layer Depths after the End of Operations

WRSF Scenarios	**Climate Change Scenarios**	**Time to Freeze Back after end of Operations**	**Active Layer Depth (m)**			
		Years	**25 Years (2047)**	**50 Years (2072)**	**75 Years (2097)**	**100 Years (2122)**
With waste overburden	RCP 4.5	~ 24.1	2.2	2.5	2.8	2.8
	RCP 6.0	~ 24.6	2.7	2.8	2.8	3.3
Without waste overburden	RCP 4.5	~ 24.2	2.3	2.4	2.7	2.8
	RCP 6.0	~ 24.3	2.5	2.7	2.8	3.3

5.0 MEADOWBANK DATA

Meadowbank operators installed thermistors at different locations on the Portage WRSF in 2013 to monitor the freeze-back of the waste rock and measure the performance of the NPAG cover. Field thermal data has been measured since the time and reported yearly in the Annual reports (Agnico Eagle 2017b). Results indicated an active layer depth of less than 4 m in most of the areas of the WRSF. Specifically, the thermistors show that the waste rock remains below 0 (zero) Celsius degrees all year long at a depth range between 2 and 5.5 m. This monitoring is ongoing and will continue to inform WRSF closure at Meadowbank and Whale Tail Pit.

6.0 SUMMARY AND RECOMMENDATIONS

For the Whale Tail Pit Project WRSF, Golder has carried out a 1D thermal modelling study to evaluate freeze-back times and estimate changes in depth of the active layer with consideration to climate change. The purpose of the modelling was to provide input to the design of a cover for the WRSF aimed at maintaining the PAG/ML waste rock frozen.

The waste rock pile is expected to freeze progressively in both upward and downward directions. The upper portion of the pile is expected to freeze to 17 m (excluding variation in the near-surface active layer) below the surface in 5 years and to 26 m in 20 years. The unfrozen portion within the pile will decrease with time. The WRSF is expected to freeze back completely within 25 years after the end of operations, and sustain frozen conditions except for the active layer. With the impact of climate change, the depth of active layer is expected to increase with time. The estimated active layer depth 100 year after operations is computed to be in the order of 3 m for the scenarios modelled.

Based on the results presented in this study, the following conclusions and recommendations are provided.

- Based on RCP 6.0 modelled results, the selected active layer for design is 3.3 m.
- With a contingency buffer of 0.5 m, a cover thickness of 3.8 m using NPAG/NML waste rock is recommended.
- The Whale Tail Pit WRSF capping model results are consistent with Meadowbank WRSF thermistor monitoring.
- As per the Operational ARD/ML Sampling and Testing Plan (Agnico Eagle 2016b), verify waste rock geochemical properties during the mine operations.
- As per the Whale Tail Pit – Waste Rock Management Plan (Agnico Eagle 2017a), install thermistors at different locations within the Whale Tail Pit WRSF to monitor the temperatures throughout the mine operations; selected locations should address the potential active layer variations due to sun and dominant wind expositions as well as effect of slope vs. plateau. Recorded thermal data will feed the final cover design.
- Prior to closure, calibrate and update the thermal model based on the thermistor data and further material properties collected from the site.
- As recommended by INAC, plan a contingency NPAG/NML waste rock dump with material sourced from the south wall push-back (e.g., Golder 2017a), that would allow an increase of the cover thickness on the entire surface of the WRSF. Based on Meadowbank observations (see Section 5.0), some areas of the WRSF may need a thicker cover. It is suggested to use the East WRSF (Figure 1) as contingency NPAG/NML waste rock dump.

7.0 CLOSURE

The reader is referred to the Study Limitations, which follows the text and forms an integral part of this technical memorandum.

We trust this document satisfies you current requirements. If you have any questions or require further assistance, please do not hesitate to contact the undersigned.

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Attachments: Study Limitations
Figures 1 to 7
Attachment 1: Technical Memorandum - Monthly Mean Air Temperature Projections for Whale Tail Pit Project, Nunavut

REFERENCES

Agnico Eagle (Agnico Eagle Mines Limited). 2016a. Whale Tail FEIS Volume 5, Appendix 5-E. Evaluation of the Geochemical Properties of Waste Rock, Ore, Tailings, Overburden and Sediment from the Whale Tail Pit and Road Aggregate Materials.

Agnico Eagle. 2016b. Meadowbank Division FEIS Volume 8, Appendix 8-E.5 Operational ARD-ML Sampling and Testing Plan – Whale Tail Pit Addendum. June 2016.

Agnico Eagle. 2017a. Meadowbank Division, Whale Tail Volume 8, Appendix 8-A.1 Whale Tail Pit – Waste Rock Management Plan. Version 1. January 2017

Agnico Eagle Mines Ltd. 2017b. Meadowbank Gold Project 2016 Annual Report, Prepared for: Nunavut Water Board, Nunavut Impact Review Board, Fisheries and Oceans Canada, Indigenous and Northern Affairs Canada, Kivalliq Inuit Association.

Fala, O., Molson J., Aubertin, M., and Bussière, B 2005. Numerical Modelling of Flow and Capillary Barrier Effects in Unsaturated Waste Rock Piles, Mine Water and the Environment 24: 172–185.

Frape S.K. and P. Fritz. 1987. Geochemical Trends for Groundwaters from the Canadian Shield. In: Saline Water and Gases in Crystalline Rock. GAC Special Paper 33. Edited by P. Fritz and S.K. Frape, 19 – 38.

GEO-SLOPE (GEO-SLOPE International Ltd.). 2010. Thermal Modeling with TEMP/W 2007. An Engineering Methodology. Fourth edition. GEO-SLOPE International Ltd., Calgary. February 2010.

Golder (Golder Associates Ltd.) 2016a. Water Management and Water Balance Related to Amaruq Exploration Portal/Ramp Program, Quarry and Advanced Underground Exploration and Bulk Sample, Amaruq Exploration Site, Nunavut. Golder Doc. No. 069-1665859 Ver 0. Prepared for Agnico Eagle Mines Ltd. Submitted 15 November 2016.

Golder. 2016b. Groundwater Quality Investigation, Amaruq, Nunavut. Golder Reference No. Doc 080. 1649355. Prepared for Agnico Eagle Mines Ltd. Submitted 15 November 2016.

Golder. 2017a. Addendum to Agnico Eagle Mines Whale Tail FEIS Appendix 6-H. Sensitivity Analyses on Water Quality Modelling in Support of Responses to Technical Commitments 30, 36, 37 and 42 and Intervenor Comments ECCC #15 And INAC-TRC #3 and #5, on the Water License A Application to the Nunavut Water Board. July 10, 2017. Golder Reference No. 1658927/6100/6130 Doc.125

Golder (Golder Associates Ltd.) 2017b. Whale Tail Lake Thermal Assessment. Golder Reference No. 1665859-085-TM-Rev0-5100. Prepared for Agnico Eagle Mines Ltd. Submitted 22 February 2017.

Lefebvre, R., Hockley, D., Smolensky, J., and Gélinas, P. (2001). Multiphase transfer processes in waste rock piles producing acid mine drainage 1: Conceptual model and system characterization, Journal of Contaminant Hydrology, 52, 137–164.

Knight Piesold. 2015. Agnico Eagle Mines Ltd.: Meadowbank Division – Whale Tail Pit – Permafrost and Hydrogeological Characterization. Submitted 24 November 2015.

MEND 2012. Cold Regions Cover System Design Technical Guidance Document, MEND Report 1.61.5c.

Wels, C., Lefebvre, R., and Robertson, A.M. 2003. An Overview of Prediction and Control of Air Flow in Acid-Generating Waste Rock Dumps, 6th ICARD, Cairns, QLD, 12 - 18 July 2003, 639–650.

STUDY LIMITATIONS

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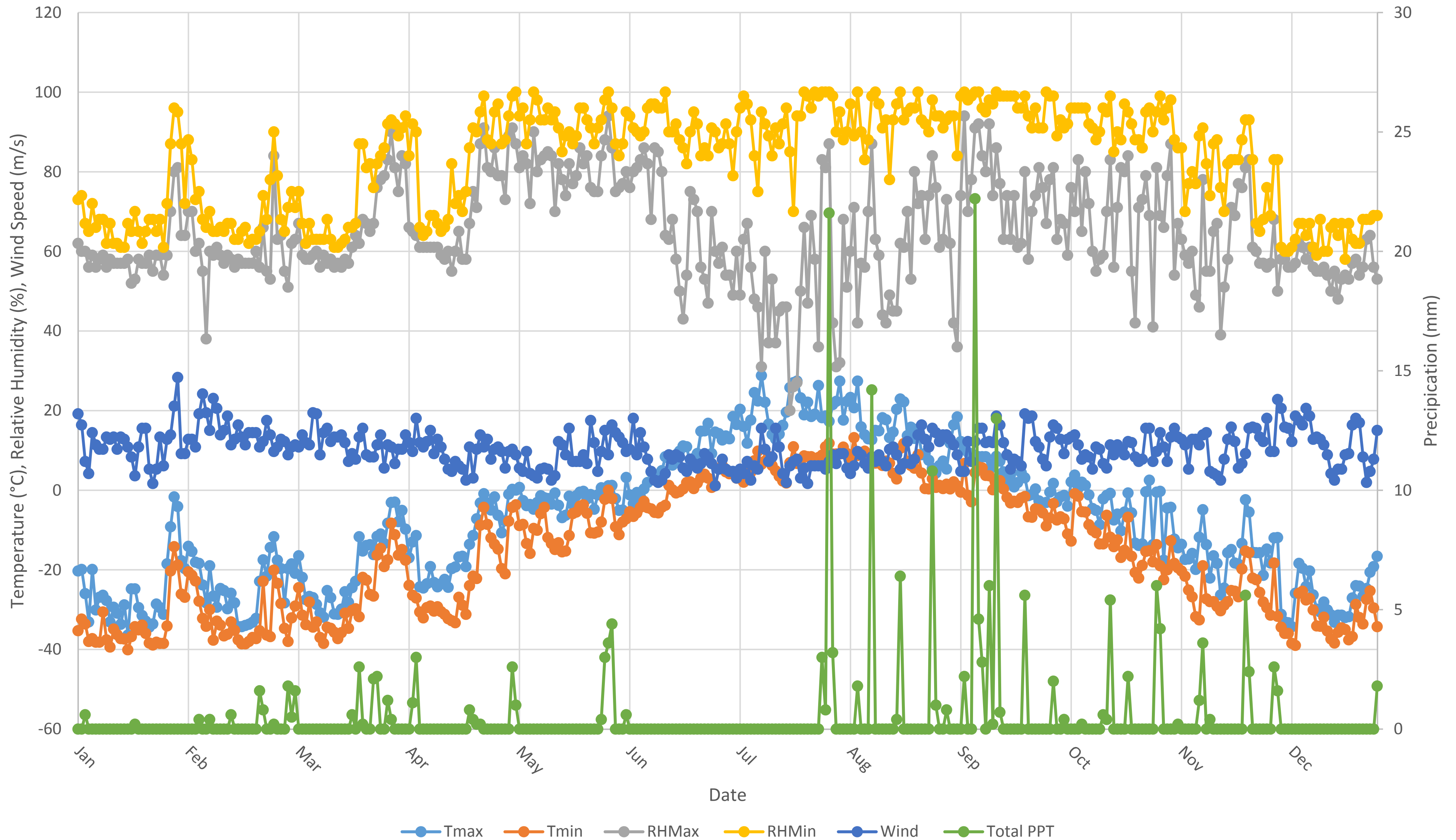
FIGURES



Notes:

1. Sourced from Baker Lake weather station #2300500

CLIENT
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WHALE TAIL PIT PROJECT
NUNAVUT CANADA

PROJECT
WHALE TAIL WASTE ROCK STORAGE FACILITY THERMAL ASSESSMENT

CONSULTANT
Golder Associates

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PREPARED	DSW
DESIGN	DSW
REVIEW	SO
APPROVED	DC

TITLE
BAKER LAKE 2000 CLIMATE DATA

PROJECT No.	Phase./Task	Rev.	Figure
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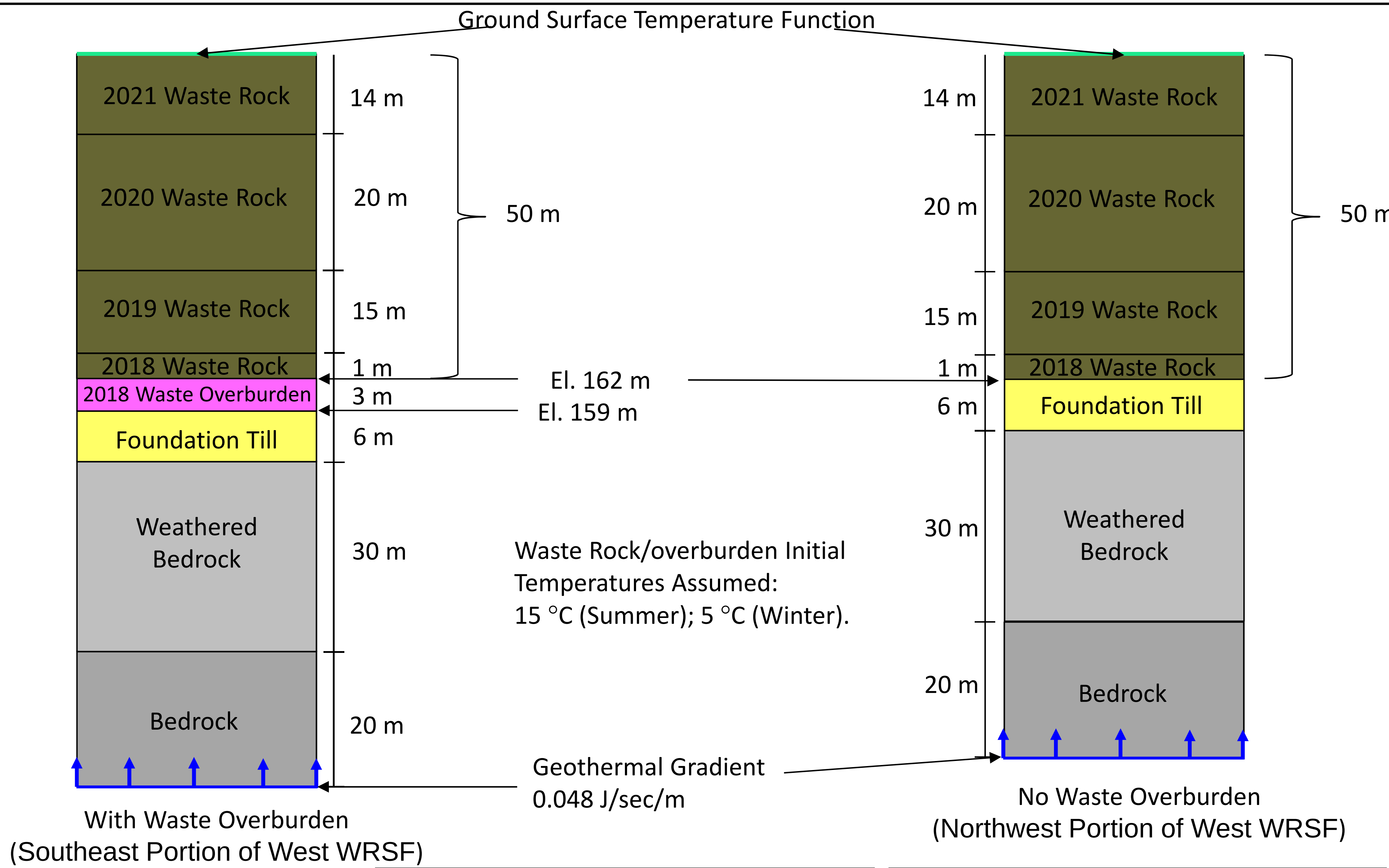

Notes:

1. Drawing not to scale.
2. Annual temperature function based on estimated monthly ground surface temperatures for analysis from 2018 to 2021. From 2022 to 2122 this function models the predicted climate change for two cases RCP 4.5 and RCP 6.0.

CLIENT
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WHALE TAIL PIT PROJECT
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YYYY-MM-DD	2017-06-27
PREPARED	DSW
DESIGN	DSW
REVIEW	SO
APPROVED	DC

PROJECT
WHALE TAIL WASTE ROCK STORAGE FACILITY THERMAL ASSESSMENT

TITLE
1D MODEL SCHEMATICS

PROJECT No.	Phase./Task	Rev.	Figure
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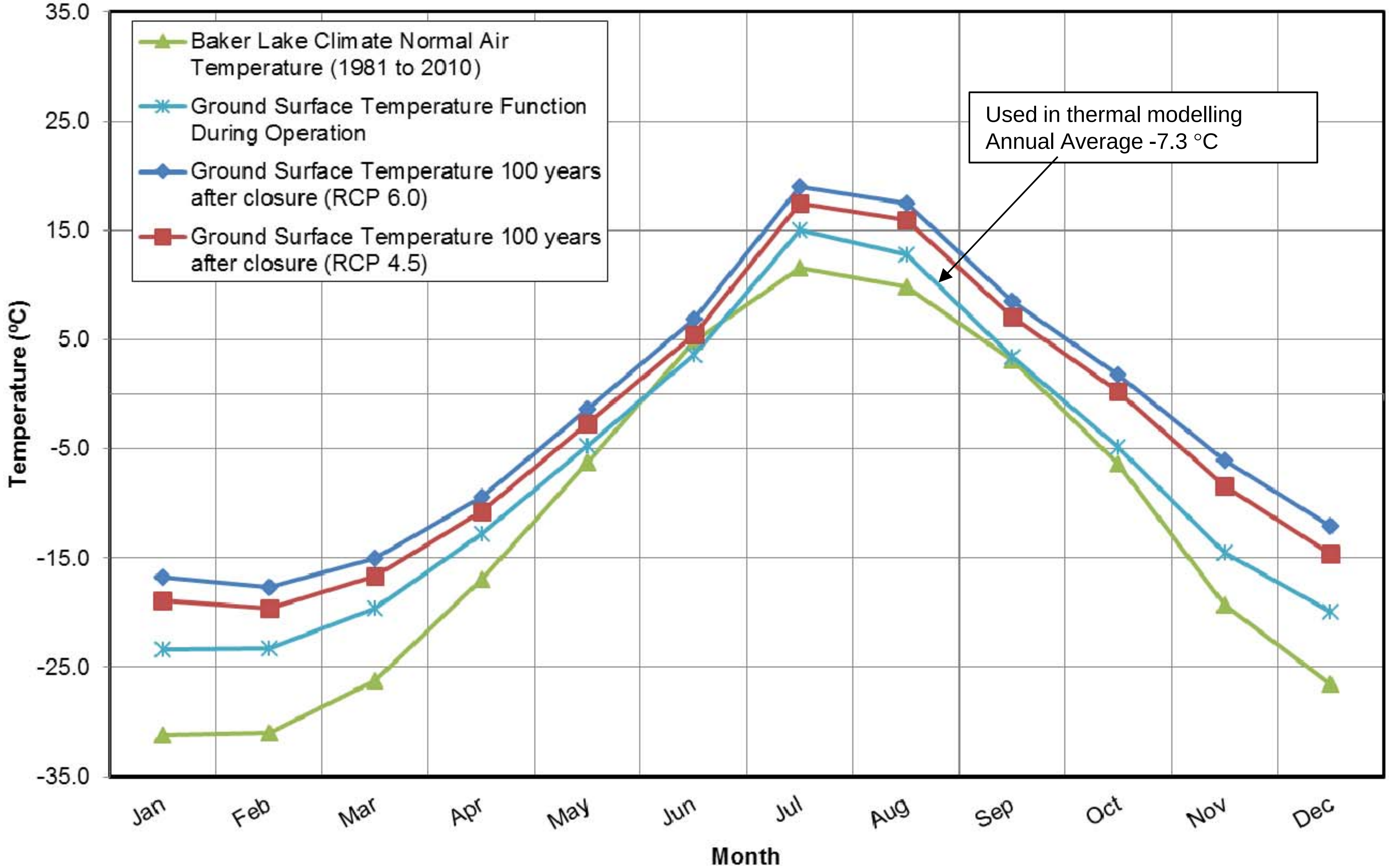

CLIENT	PROJECT
AGNICO EAGLE MINES LIMITED WHALE TAIL PIT PROJECT NUNAVUT CANADA	WHALE TAIL WASTE ROCK STORAGE FACILITY THERMAL ASSESSMENT

CONSULTANT		
Golder Associates	YYYY-MM-DD	2017-06-27
	PREPARED	DSW
	DESIGN	DSW
	REVIEW	SO
	APPROVED	DC

TITLE
GROUND SURFACE TEMPERATURE FUNCTION DURING OPERATIONS

PROJECT No.	Phase./Task	Rev.	Figure
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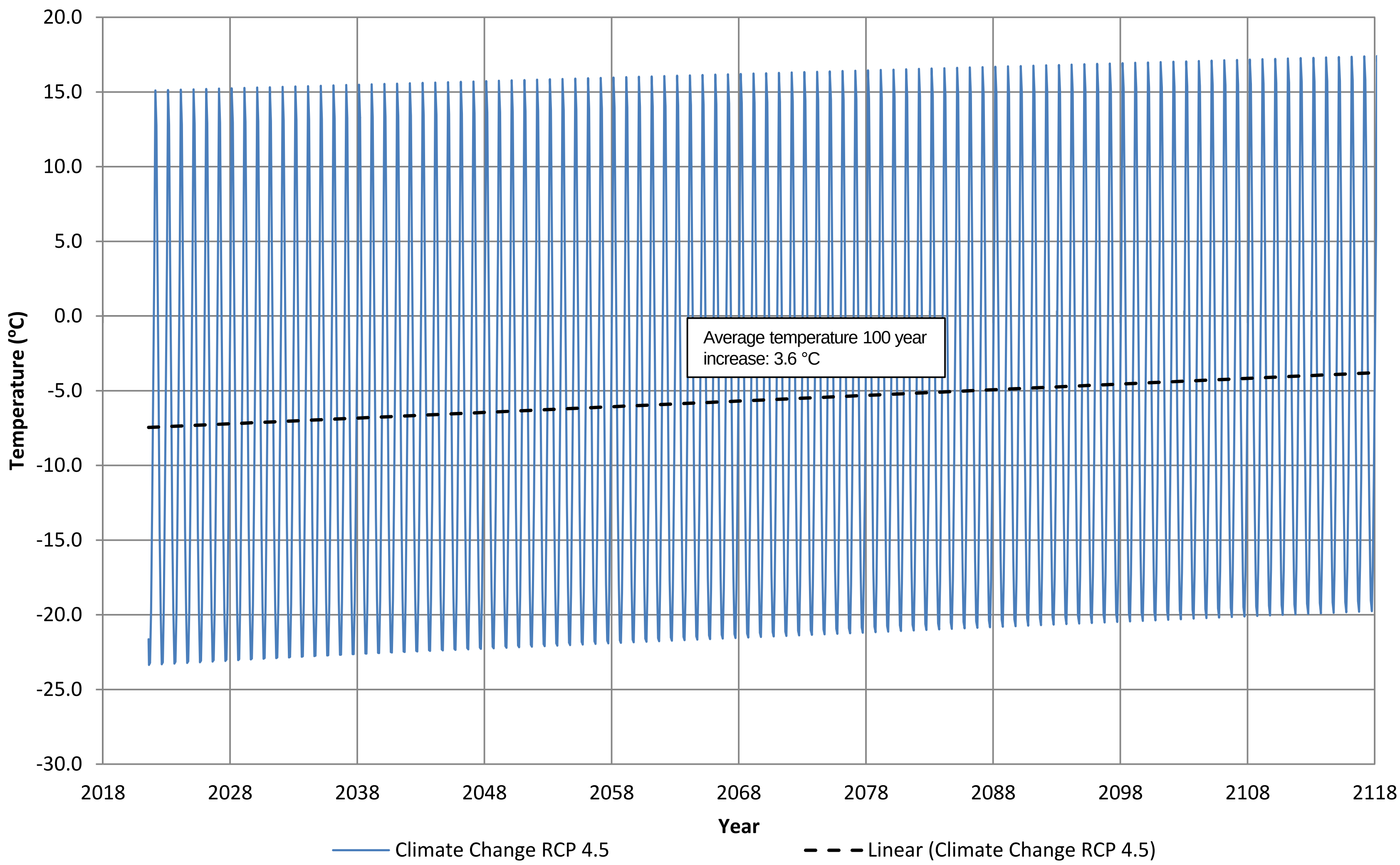
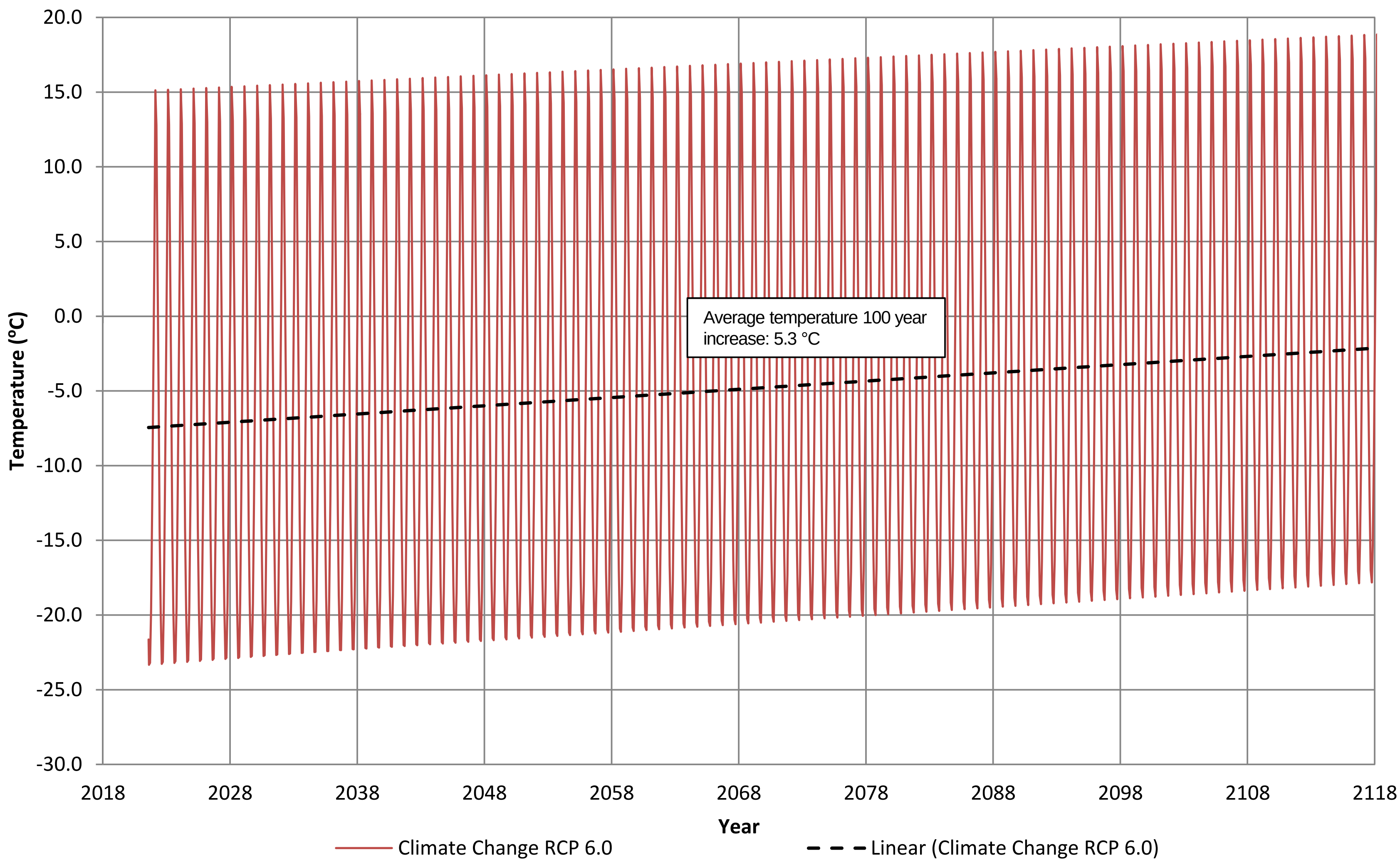


Notes:

1. Data provided in monthly intervals.
2. RCP – Representative Concentration Pathways

CLIENT	AGNICO EAGLE MINES LIMITED WHALE TAIL PIT PROJECT NUNAVUT CANADA
PROJECT	WHALE TAIL WASTE ROCK STORAGE FACILITY THERMAL ASSESSMENT
CONSULTANT	Golder Associates
YYYY-MM-DD	2017-06-27
PREPARED	DSW
DESIGN	DSW
REVIEW	SO
APPROVED	DC
TITLE	**100 YEAR CLIMATE CHANGE PROJECTIONS RCP 4.5 – GROUND SURFACE TEMPERATURE**
PROJECT No.	1774579
Phase./Task	2500
Rev.	0
Figure	5



Notes:
1. Data provided in monthly intervals.
2. RCP – Representative Concentration Pathways

CLIENT
AGNICO EAGLE MINES LIMITED
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NUNAVUT CANADA

PROJECT
WHALE TAIL WASTE ROCK STORAGE FACILITY THERMAL ASSESSMENT

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-06-27
PREPARED	DSW
DESIGN	DSW
REVIEW	SO
APPROVED	DC

TITLE
100 YEAR CLIMATE CHANGE PROJECTIONS RCP 6.0 – GROUND SURFACE TEMPERATURE

PROJECT No.	Phase./Task	Rev.	Figure
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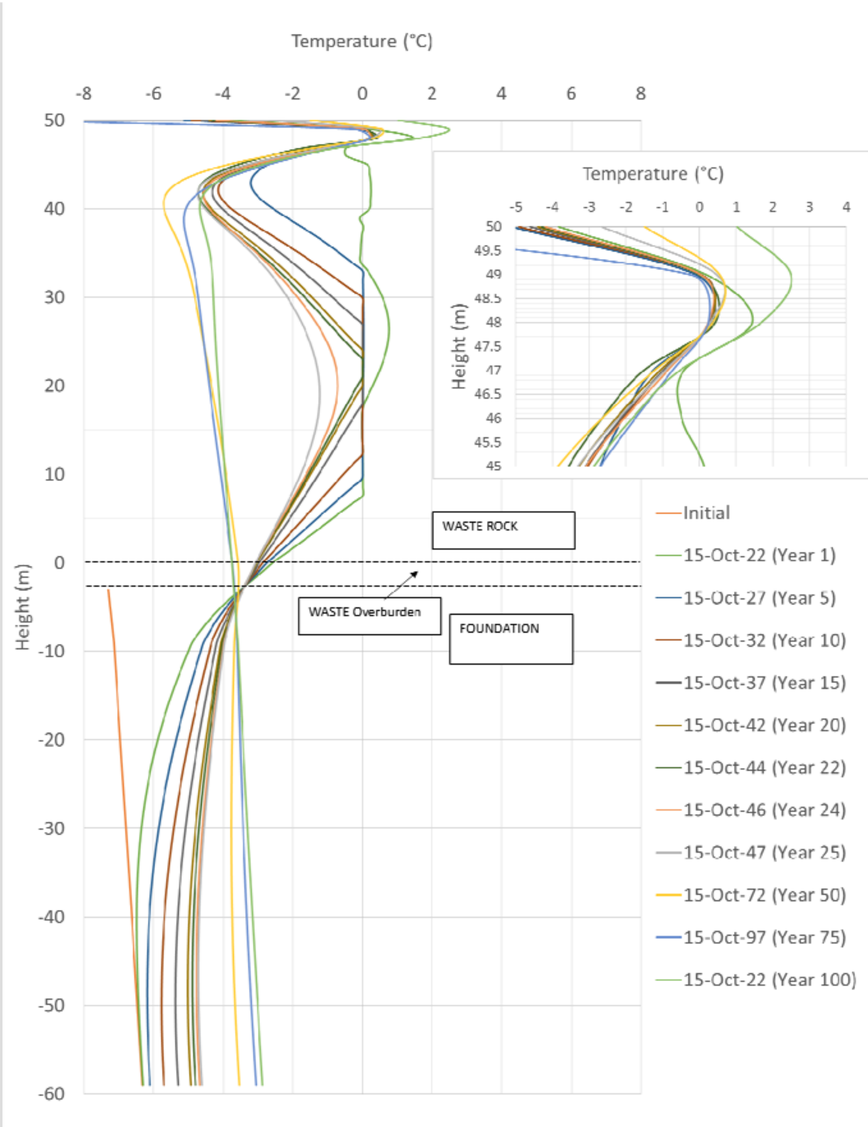
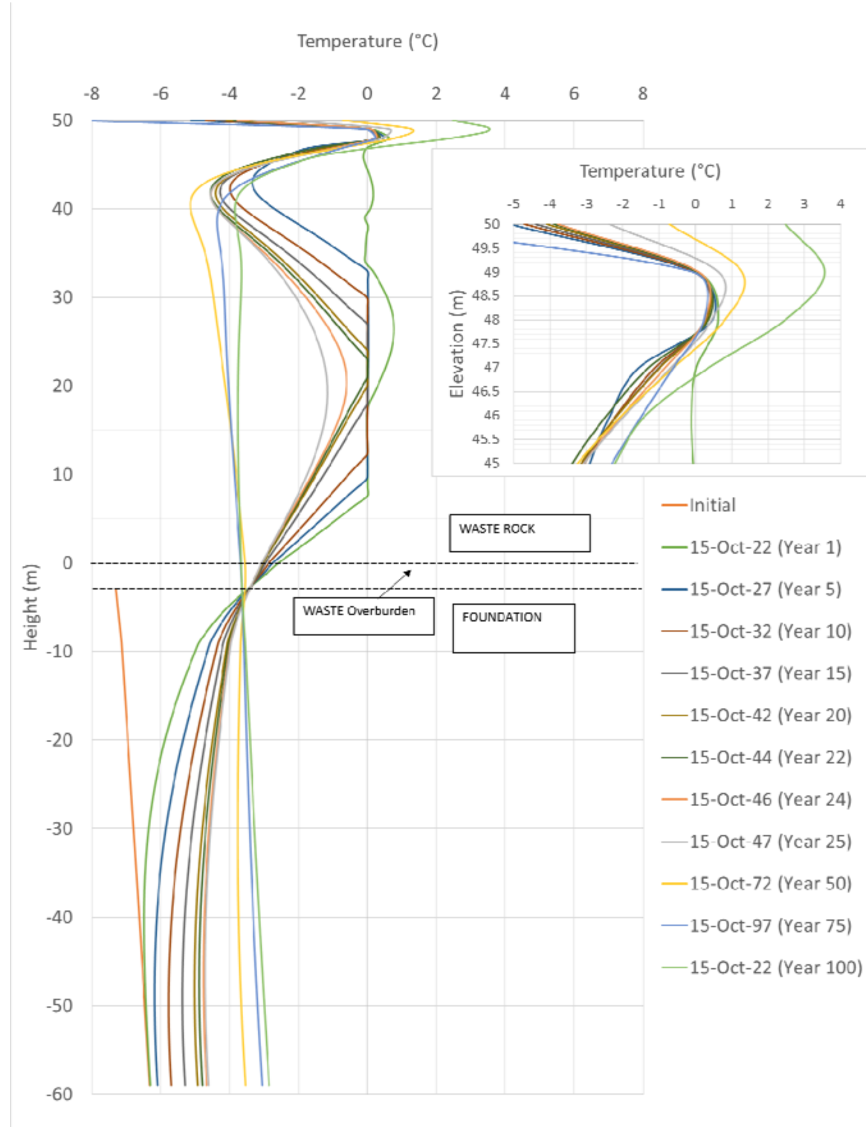


CLIMATE CHANGE RCP 4.5



CLIMATE CHANGE RCP 6.0

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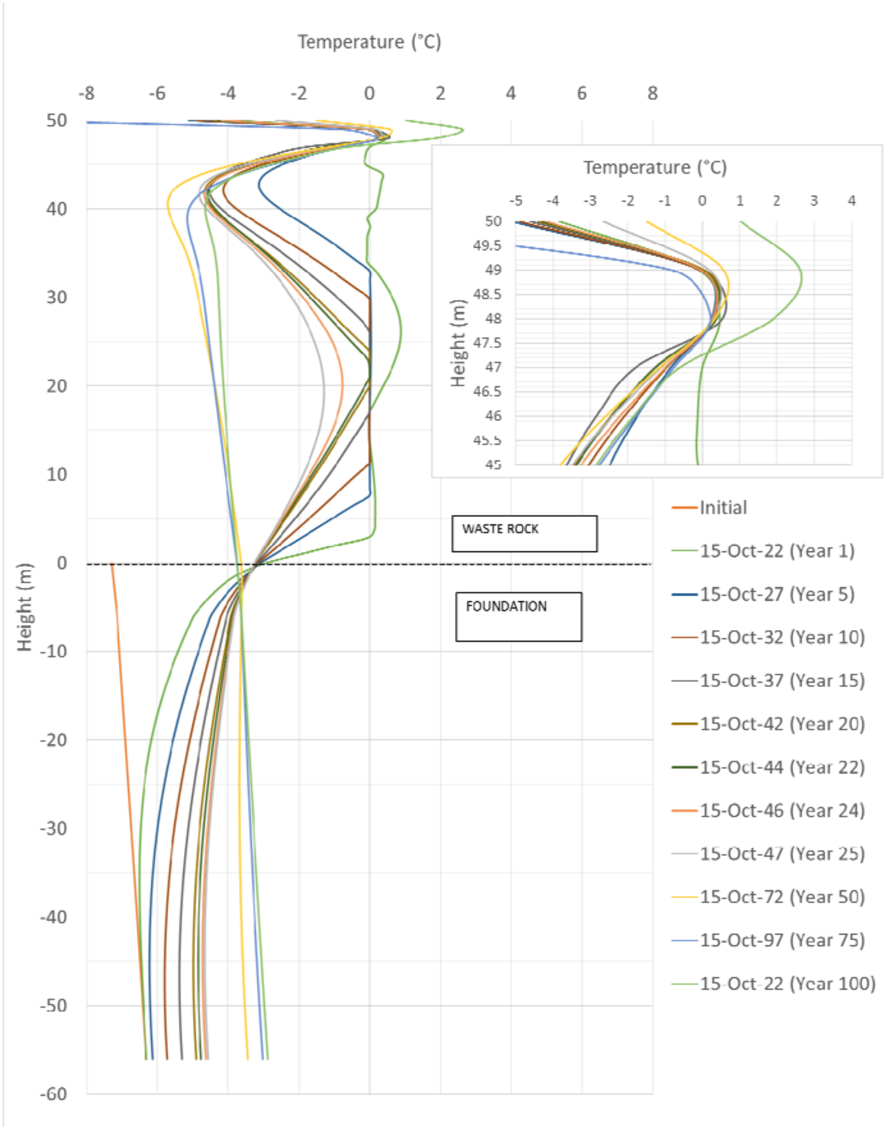
Golder Associates

YYYY-MM-DD	2017-06-27
PREPARED	DSW
DESIGN	DSW
REVIEW	SO
APPROVED	DC

TITLE
TEMPERATURE PROFILES FOR WRSF – WITH WASTE OVERBURDEN
YEARS AFTER END OF OPERATIONS

PROJECT No.	Phase./Task	Rev.	Figure
1774579	2500	0	7



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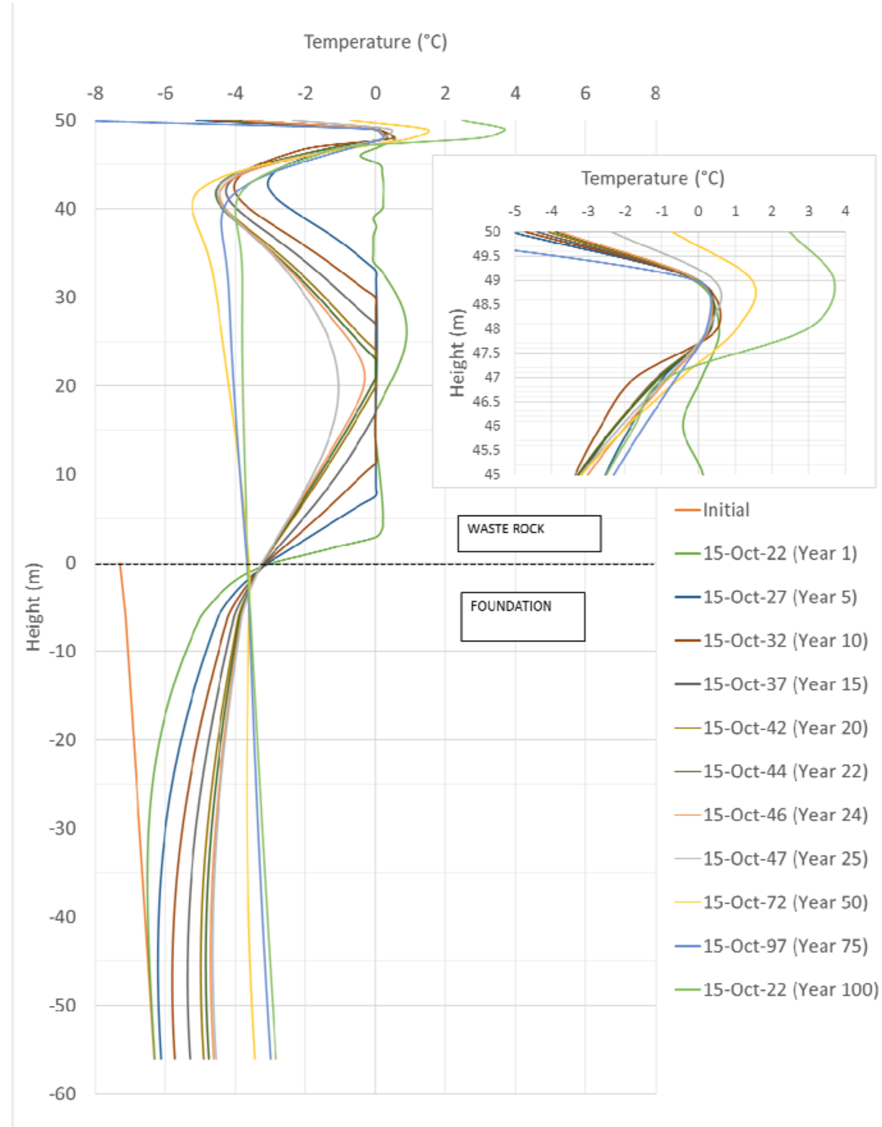


CLIMATE CHANGE RCP 6.0

CLIENT
AGNICO EAGLE MINES LIMITED
WHALE TAIL PIT PROJECT
NUNAVUT CANADA

PROJECT
WHALE TAIL WASTE ROCK STORAGE FACILITY THERMAL ASSESSMENT

CONSULTANT

Golder Associates

YYYY-MM-DD	2017-06-27
PREPARED	DSW
DESIGN	DSW
REVIEW	SO
APPROVED	DC

TITLE
TEMPERATURE PROFILES FOR WRSF – WITHOUT WASTE OVERBURDEN YEARS AFTER END OF OPERATIONS

PROJECT No.	Phase./Task	Rev.	Figure
1774579	2500	0	8

ATTACHMENT 1

Technical Memorandum - Monthly Mean Air Temperature Projections for Whale Tail Pit Project, Nunavut

TECHNICAL MEMORANDUM

DATE July 6, 2017 **PROJECT No.** 1774579-2500-rev0

TO Ryan Vanengen
Agnico Eagle Amaruq Permitting Lead
François Petrucci
Agnico Eagle Study Manager

FROM Janya Kelly and Sean Capstick **EMAIL** jkelly@golder.com; scapstick@golder.com

MONTHLY MEAN AIR TEMPERATURE PROJECTIONS FOR WHALE TAIL PIT PROJECT, NUNAVUT

This technical memorandum provides a description of the future projected monthly mean temperature for the Whale Tail Pit Project, Nunavut. The analysis is based on publicly available information of current climate observations from Environment Canada and future climate projections from the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5) provided by the Canadian Climate Data and Scenarios (CCDS) interface. The methodology used to analyze the available current climate data and future climate projections is outlined in the sections below, as well as the limitations associated with the analysis. The monthly future climate projections are provided based on the time periods requested by the project team and outlined in the proposal, namely:

- current climate (1981 through 2010)
- the 2080s (2071 through 2099)

1.0 METHODOLOGY

To understand how the climate has been changing, and may change in the future, climate trends were analyzed by describing the current climate using available long-term (30-year) data from 1981 through 2010 and discussing the range of future climate projections (2071 through 2099; 2100 being not available for all models in the ensemble).

Describing the current climate in the region surrounding the project involved selection of the most representative climate station and documenting the current climate. The current climate conditions were defined using climate normals data, which are long-term (usually 30-year) averages of observed climate data. The standard period recommended by Environment Canada for establishing climate normals is a 30-year period from 1981 through 2010.

The projected ranges of future climate were described using the outputs from general circulation models (GCMs) accepted by the IPCC for various emission scenarios developed by the IPCC. The GCM projections are accessed for the project area using the Canadian Climate Data and Scenarios (CCDS) (CCDS 2015). The CCDS provides multiple emissions scenarios for multiple models to provide an indication of the range of possible future climate conditions.

1.1 Climate Station Selection

For the purposes of this assessment, selection of climate station was based on specific recommendations from Environment Canada's Canadian Climate Change Scenarios Network (CCCSN), which is the predecessor to CCDS and was previously the Government of Canada's interface for distributing global climate change scenarios and adaptation research. This network provides useful guidance for selecting a climate station to represent an area of interest and how climate data should be used when calculating trends (CCCSN 2009). These CCCSN criteria were selected for consideration:

- length of record (minimum 30 years of data)
- availability of a continuous record
- proximity to the area of interest

In addition to utilizing the CCCSN criteria, the study team also considered the following selection factors to identify the station(s) that best represent the Project site meteorologically:

- age of observations compared to the currently accepted normal period
- latitude
- elevation of station
- geographic siting

The climate assessment completed for the project used daily data from one climate station, namely Baker Lake A (Climate ID 2300500; Environment Canada 2017), to describe current climate conditions. Baker Lake A climate station is the only station close to the project that provides a complete dataset within the desired normal period (1981 through 2010).

1.2 Future Climate Change

As an international body, the IPCC provides a common source of information relating to emission scenarios, provides third-party reviews of models, and recommends approaches to document future climate projections. In 1988, the IPCC was formed by the World Meteorological Organization and the United Nations Environment Program to review international climate change data. The IPCC is generally considered to be the definitive source of information related to past and future climate change as well as climate science. Periodically, the IPCC issues assessment reports summarizing the most current state-of-climate science. The Fifth Assessment Report (AR5) (IPCC 2013) represents the most current complete synthesis of information regarding climate change.

1.2.1 Approach for Describing Future Climate

Climate modeling involves the mathematical representation of global land, sea, and atmosphere interactions over a long period of time. These GCMs have been developed by various government agencies, but they share a number of common elements described by the IPCC (IPCC 2013). The IPCC does not run the models, but acts as a clearinghouse for the distribution and sharing of the model forecasts.

Future climate projection data for Baker Lake (i.e., for the appropriate GCM grid square) were extracted from the CCDS interface (CCDS, 2015) for all available GCMs (30) and the three representative concentration pathways (RCP 2.6, RCP 4.5 and RCP 8.5 – detailed in section below) in the Intergovernmental Panel on Climate Change

(IPCC) Fifth Assessment Report (AR5). The model projections were summarized for magnitude of change from the climate regime baseline for the period from 2071 through to 2099 (denoted as 2080s).

In order to graphically represent the individual model output in a comparable and meaningful way, the data must have a consistent baseline. For each model, the change in temperature and precipitation was calculated relative to the respective modelled baseline values, which are unique to each model. This change was then imposed onto the historic climate baseline for Baker Lake.

Given the large grid size of a GCM projection, as described below, the data are representative of area averages and are not necessarily representative of a specific location contained within the grid box. Murdock and Spittlehouse (2011) recommend that analyses involving GCM projections be based on descriptions of future climate that have been presented in the context of change from the accepted baseline period (i.e., the models use the 1961 through 1990 period as the baseline). Since the models may have an absolute bias, the predicted future climate is compared to the predicted baseline using the same model. Also, because the models are most effective at describing projections of change, projected changes from a modeled baseline are typically described as a deviation from baseline, either in degrees Celsius (°C) for temperature, or percent (%) for precipitation. The resulting change from the modeled baseline can then be used to estimate the future climate conditions in the context of the actual current climate for the project.

The current climate was analyzed for the period from 1981 through 2010, a normal period different than the model baseline of 1986 through 2005 from AR5. Additionally, AR5 focuses on far term projections for the period from 2081 through 2100. However, as the CCDS interface provides model projections for the historical period from 1900 through 2005, as well as the future projections from 2006 through 2100, the appropriate years from the AR5 dataset were selected to match the desired current and future climate time periods. Climate projections, in the form of a deviation from the current climate baseline, were calculated for the desired future period relevant to the project.

1.2.2 General Circulation Models

Climate simulations produced by these general circulation models vary because each model uses a different combination of algorithms to describe and couple the earth’s atmospheric, oceanic, and terrestrial processes. The GCMs used in this analysis have been validated against observations, and the interpretation of their results have been peer-reviewed by the IPCC and others. Rather than selecting a single model, the climate change projections from all available models from AR5 (i.e., 90 unique sets of modeling results) using the CCDS interface were included in the analysis, unless otherwise specified for project-specific scenarios. This ensemble approach was used to delineate the probable range of results and better capture the actual outcome (an inherent unknown).

In the case of climate models, projections are not made at a location, but for a series of grid cells in the scale of hundreds of km in size. The CCDS interface provides gridded global GCM projections. For this assessment, the climate projections for the closest grid square to the Baker Lake were extracted from the gridded AR5 model projections provided by CCDS.

1.2.3 Climate Scenarios

Global climate models require extensive inputs in order to characterize the physical processes and social development paths that could alter climate in the future. In order to represent the wide range of the inputs possible to global climate models, the IPCC have established a series of representative concentration pathways (RCPs) that help define the future levels of radiative forcing of the atmosphere. The IPCC identifies four scenarios

(Table 1), the pathways are named after the radiative forcing projected to occur by 2100. These RCPs have been described by Van Vuuren et. al. (2011).

Table 1: Characterization of Representative Concentration Pathways

Name	Radiative Forcing in 2100	Characterization
RCP 8.5	8.5 W/m²	Increasing greenhouse gas emissions over time, with no stabilization, representative of scenarios leading to high greenhouse gas concentration levels.
RCP 6.0	6.0 W/m²	Total radiative forcing is stabilized shortly after 2100, without overshoot. This is achieved through the application of a range of technologies and strategies for reducing greenhouse gases.
RCP 4.5	4.5 W/m²	Total radiative forcing is stabilized shortly after 2100, without overshoot. This is achieved through a reduction in greenhouse gases over time through climate policy.
RCP 2.6	2.6 W/m²	"Peak and decline" scenario where the radiative forcing first reaches 3.1 W/m² by mid-century and returns to 2.6 W/m² by 2100. This is achieved through a substantial reduction in greenhouse gases over time through stringent climate policy.

Note: Summarized from Van Vuuren et al. 2011.

For this scope of work, selected RCPs have been grouped into two unique scenarios for the project:

- Scenario 1: ensemble of all RCP 4.5 and RCP 8.5 model runs considered representative of a RCP 6.0 scenario.
- Scenario 2: ensemble of all RCP 4.5 model runs.

RCP 4.5 is representative of intermediate emissions levels with greenhouse gas reduction and RCP 8.5 is representative of high emissions levels with no reduction in greenhouse gas emissions. The blend of RCP 4.5 and RCP 8.5 is considered representative of a future with intermediate to high emissions levels, where there have been some reductions in greenhouse gas emissions but not as ambitious as those required by RCP 4.5. The range of projections for Scenario 1 very likely covers the range of projections from RCP 6.0.

1.2.4 Understanding Climate Projections and Their Limitations

General circulation models have inherent limitations that are important to bear in mind when evaluating variability and the rate of climate change, (i.e., when comparing future projections to historical observations). These limitations are dependent on the research institution's approach to overcoming model uncertainty. Since no one model or climate scenario can be viewed as completely accurate, the IPCC recommends that climate change assessments use as many models and climate scenarios as possible. For this reason, the multi-model ensemble approach described above was used to account for these uncertainties and limitations.

1.2.4.1 Spatial Scales

Due to limitations on computing power, the GCM outputs are limited to grid cells of 1° to 2.5° (approximately 110 to 275 km) and a small number of vertical layers in both the atmosphere and the ocean. These grid cells represent a mathematically defined '*region*' rather than a specific geographic location and are different for many models. Although the appropriate grid cells were selected to represent the Project location, and the data extracted from the appropriate grid cell, this scale is much larger than that of most weather processes such as convective thunderstorms. In addition, local changes in topography cannot be represented at this scale.

Temporally, the GCM simulations are run at monthly time scales, and only monthly average temperature and precipitation are available as outputs.

1.2.4.2 Unpredictable Events

Climate model simulations represent average conditions and typically do not consider the influence of inherently unpredictable stochastic or episodic events (e.g., volcanic eruptions, earthquakes, tsunamis). In other words, events of a certain magnitude tend to occur at a certain frequency; however, their actual magnitude and timing is unknown and currently not predictable within a specific GCM's outputs.

Although large events are rare, they have the potential to invalidate climate model projections both globally and regionally. For example, the 1991 eruption of Mount Pinatubo is well known to have decreased the average planetary surface temperature by approximately 1˚C for at least one year; this change represents a significant offset to predictions of approximately 3˚C of warming over the next century. The Pinatubo eruption ranks as a "6 out of 8" on the logarithmic-based volcanic explosivity index, and events such as Pinatubo have return periods on the order of 100 years. Larger events have return periods of 1,000 years or more; however, their plumes can reach altitudes of greater than 40 km and inject sufficient amounts of sulphur into the stratosphere to suppress global temperature from years to decades (Robock et al. 2009).

1.2.4.3 Changes to Collective Understanding of the Processes

The earth's system processes and feedbacks are very complex, and therefore have to be approximated in GCM model simulations. In these instances, mathematical parameterizations of these processes are required to reduce the computational burden within the simulations. Each of these independent processes that drive climate change can be assigned a rank based on the current level of scientific understanding (LOSU). The contribution of aerosols in the GCMs is an example of this uncertainty. Aerosols were ranked as very low LOSU in the 2001 IPCC report and were upgraded to a medium-to-low LOSU in the 2007 IPCC report (Forster et al. 2007).

In addition, new discoveries can change the inputs to the GCMs and the interrelationship of these drivers within each GCM. For example, the 1988 discovery of *Prochlorococcus* spp. (cyanobacteria), the most abundant photosynthetic organism (i.e., a photosynthetic picoplankton) in the ocean, led to a change in the understanding of ocean biology, the carbon cycle, and atmospheric carbon dioxide (CO_2) (Chisholm et al. 1988). Similarly, the 2001 discovery of ubiquitous atmospheric N_2-fixation by the marine cyanobacterium *Trichodesmium* spp. (i.e., also called sea sawdust) changed the understanding of the effects of ocean biology and our understanding of the earth's nitrogen cycle (Berman-Frank et al. 2001).

2.0 CLIMATE PROJECTIONS FOR BAKER LAKE

The following tables and figures summarize the magnitude of model-projected changes during the 2080s from the historic climate scenario. Figures 1 and 2 depict the monthly mean projected air temperatures in Baker Lake for the 2080s for the Scenarios 1 and 2. Scenarios 1 and 2 are described in Section 1.2.3, above. The figures also show a dashed line, which represents the mean of all the modelled projections. The solid line in the figures represents the monthly observed climate scenario based on data from 1981 through to 2010. The figures show a noticeable increase between the historic and projected monthly temperature means, for both scenarios.

Figure 1: Model Projected Temperatures in Baker Lake for the 2080s – Scenario 1

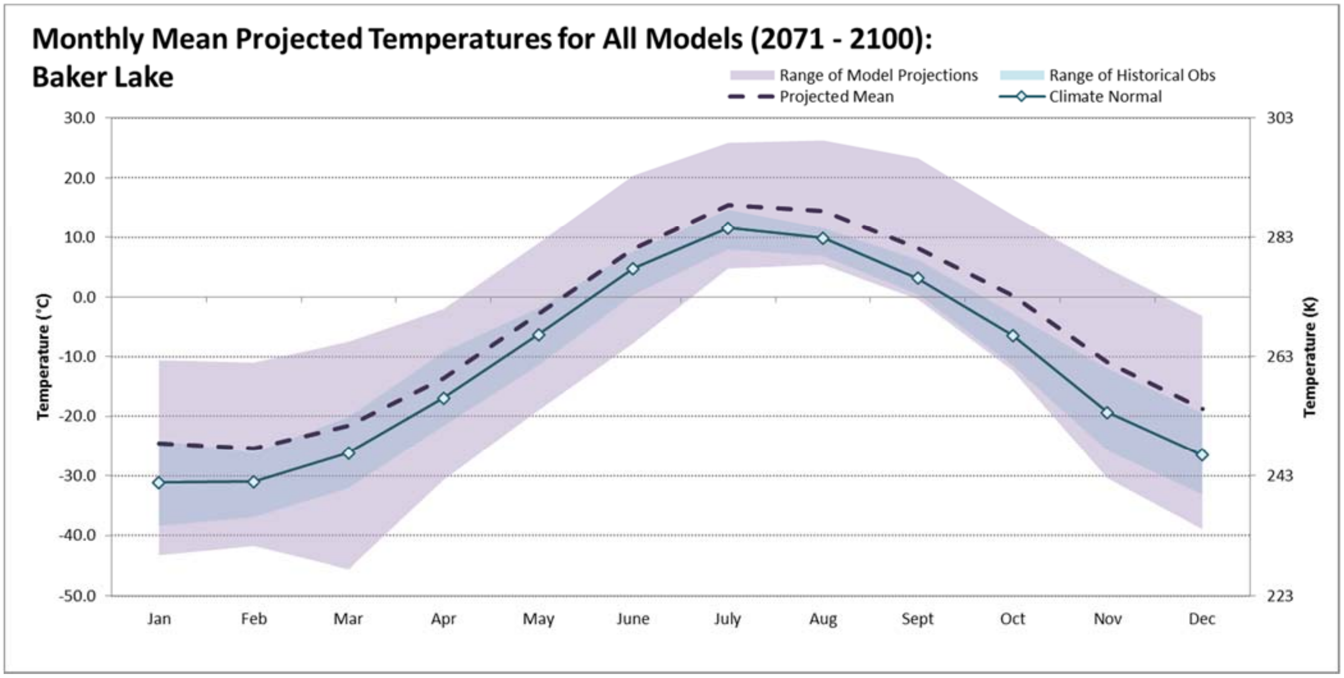
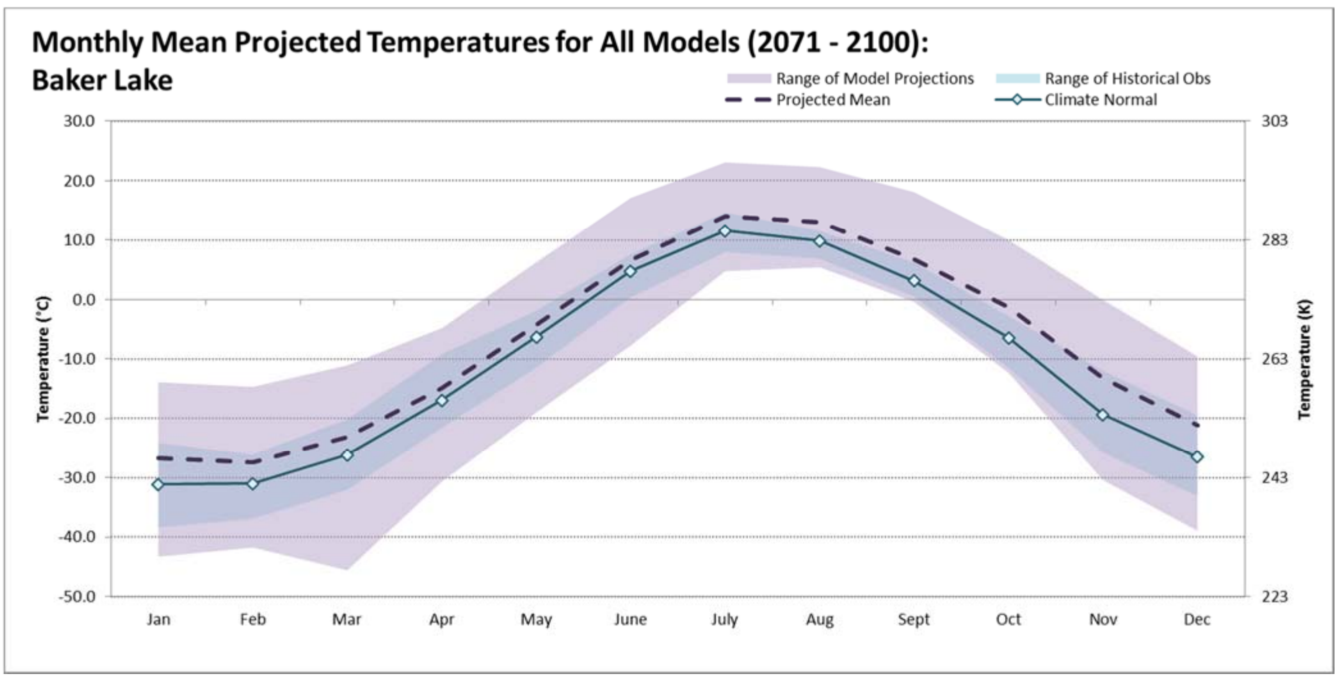


Figure 2: Model Projected Temperatures in Baker Lake for the 2080s - Scenario 2



The difference between the historic climate scenario and the projected mean for the 2080s is shown in Tables 1 for both scenarios. Overall, the model projected means are greater than the observed climate regime, showing an increase in temperature. The largest differences in temperature are during the colder months (October through February), with the smallest difference during the late Spring and early Summer (April through June). Scenario 1 shows larger warming in the future compared to Scenario 2. It is likely, under either scenario, that warming will be greater during the colder months than during the warmer months in Baker Lake.

Table 2: Model Projected Mean and Current Climate Normal for Baker Lake for the 2080s

Month	Mean Air Temperature [°C]					
	Scenario 1			Scenario 2		
	Current Climate Normal[1]	Projected Mean	Difference	Current Climate Normal[1]	Projected Mean	Difference
January	-31.2	-24.6	6.6	-31.2	-26.7	4.4
February	-31.0	-25.4	5.5	-31.0	-27.4	3.6
March	-26.2	-21.6	4.5	-26.2	-23.2	3.0
April	-17.0	-13.7	3.2	-17.0	-15.0	2.0
May	-6.3	-2.9	3.5	-6.3	-4.3	2.0
June	4.8	8.1	3.3	4.8	6.7	1.9
July	11.6	15.5	3.9	11.6	14.0	2.4
August	9.8	14.5	4.7	9.8	13.0	3.2
September	3.1	8.2	5.1	3.1	6.8	3.7
October	-6.4	0.2	6.6	-6.4	-1.3	5.1
November	-19.3	-10.9	8.5	-19.3	-13.2	6.1
December	-26.5	-18.7	7.8	-26.5	-21.2	5.3

Note: Refers to historic climatic conditions for the 1981 to 2010 period.

The following tables, Tables 3 and 4, describe the variation in the future projections in more detail for both scenarios. The minimum, maximum and mean for each month, along with selected percentiles and the standard deviation about the mean are provided. As shown in the tables, the colder winter months (November through March) show the largest variation in projections.

Table 3: Model Projections Statistics for Baker Lake for the 2080s – Scenario 1

Month	Temperature [°C]										
	Min	5%	10%	50%	75%	90%	95%	99%	Max	Mean	Std Dev
January	-43.1	-33.9	-32.0	-24.4	-20.6	-17.4	-15.6	-12.9	-10.4	-24.6	5.5
February	-41.6	-34.0	-32.0	-25.4	-21.7	-19.0	-17.3	-14.4	-10.8	-25.4	5.1
March	-45.4	-28.8	-27.1	-21.6	-18.6	-16.0	-14.5	-11.7	-7.3	-21.6	4.4
April	-30.5	-20.4	-18.4	-13.5	-11.3	-9.1	-7.7	-5.2	-1.9	-13.7	3.8
May	-18.8	-9.8	-7.8	-2.9	-0.4	2.2	3.6	6.2	9.2	-2.9	4.0
June	-7.6	-0.8	2.8	8.4	11.0	13.3	14.7	17.3	20.5	8.1	4.4
July	4.9	10.2	11.1	15.3	17.8	19.9	21.1	23.8	26.0	15.5	3.4
August	5.6	9.6	10.5	14.2	16.6	18.9	20.4	23.3	26.4	14.5	3.3
September	-0.2	3.2	4.2	7.6	10.0	13.1	15.3	20.3	23.5	8.2	3.7
October	-12.2	-5.9	-4.7	-0.2	2.7	6.0	8.2	10.8	13.9	0.2	4.2
November	-30.3	-19.8	-17.7	-10.8	-7.0	-4.0	-2.4	-0.1	4.9	-10.9	5.3
December	-38.8	-28.4	-26.2	-18.5	-14.4	-11.4	-9.8	-7.5	-3.0	-18.7	5.6

Table 4: Model Projections Statistics for Baker Lake for the 2080s – Scenario 2

Month	Temperature [°C]										
	Min	5%	10%	50%	75%	90%	95%	99%	Max	Mean	Std Dev
January	-43.1	-35.0	-33.3	-26.5	-23.1	-20.2	-19.0	-16.3	-13.7	-26.7	5.0
February	-41.6	-35.6	-33.4	-27.2	-24.1	-21.2	-19.6	-17.1	-14.5	-27.4	4.8
March	-45.4	-30.2	-28.4	-23.1	-20.4	-18.1	-16.8	-14.2	-10.9	-23.2	4.1
April	-30.5	-21.5	-19.4	-14.6	-12.8	-10.9	-9.7	-8.0	-4.7	-15.0	3.5
May	-18.8	-10.7	-8.8	-4.1	-2.3	0.1	1.4	3.5	6.4	-4.3	3.5
June	-7.6	-2.1	1.0	7.1	9.1	11.3	12.7	15.0	17.3	6.7	4.1
July	4.9	9.6	10.5	13.9	15.9	17.7	18.6	20.3	23.2	14.0	2.8
August	5.6	8.9	9.7	12.8	14.7	16.6	17.7	19.9	22.5	13.0	2.7
September	-0.2	2.3	3.3	6.2	8.2	11.8	13.6	16.1	18.2	6.8	3.2
October	-12.2	-6.9	-5.7	-1.9	0.6	4.8	6.1	8.7	10.2	-1.3	3.9
November	-30.3	-21.7	-19.6	-13.5	-9.7	-6.2	-4.7	-2.3	0.1	-13.2	5.0
December	-38.8	-29.6	-27.9	-21.2	-17.7	-14.3	-13.0	-11.2	-9.4	-21.2	5.1

3.0 LIMITATIONS

3.1 Standard of Care:

Golder Associates Ltd. (Golder) has prepared this memorandum in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering and science professions currently practicing under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this report. No other warranty, expressed or implied is made.

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The Client and Approved Users acknowledge that the nature of the work undertaken is stochastic with substantial inherent uncertainly around any given datum points. The latter also acknowledge that the uncertainty associated with any projections or forecasts is increases with the duration of the projected period and is subject to future developments or intervening acts which may manifest in the interim period. The uncertainty surrounding the future climate projections is discussed in Section 1.2.5.

The information in this memorandum was prepared using published data and information, technical journals, articles as well as professional judgment and experience. No sampling or fieldwork was conducted in the course of this work.

4.0 CLOSURE

This technical memorandum provides the future climate projections for the monthly mean temperature for Baker Lake Inlet (and by extension for the Whale Tail Pit Project) for the 2080s (2071 through 2099) for Scenario 1 (RCP 4.5 and RCP 8.5) considered representative of a RCP 6.0 scenario and Scenario 2 (RCP 4.5). The analysis methodology for creating the projections was also provided, along with the limitations associated with using the climate projections.

GOLDER ASSOCIATES LTD.

Janya Kelly, PhD
Air Quality Specialist

Sean Capstick, BSc
Principal, Project Director

5.0 REFERENCES

Berman-Frank, I. P. Lundgren, Y.B. Chen, H. Kupper, Z. Kolber, B. Bergman, P. Falkowski. 2001. Segregation of Nitrogen Fixation and Oxygenic Photosynthesis in the Marine Cyanobacterium Trichodesmium. Science. 294: 1534-1537.

Canadian Climate Change Scenarios Network (CCSN). 2009. Canadian Climate Change Scenarios Network Workshop, Environment Canada, Toronto, Ontario.

Canadian Climate Data and Scenarios (CCDS). 2015. Available at http://ccds-dscc.ec.gc.ca/?page=main. Accessed July, 2015.

Chisholm, SW, R.J. Olson, E.R. Zettler, R. Goericke, J.B. Waterbury, N.A. Welschmeyer, NA. 1988. A Novel Free-Living Prochlorophyte Abundant in the Oceanic Euphotic Zone. Nature. 334:340-343. July 28, 1988. ISBN 0028-0836.

Environment Canada. 2017. Historical Climate Data. Available at http://climate.weather.gc.ca/. Accessed May 2017.

Forster, P., V. Ramaswamy, P. Artaxo, T. Berntsen, R. Betts, D.W. Fahey, J. Haywood, J. Lean, D.C. Lowe, G. Myhre, J. Nganga, R. Prinn, G. Raga, M. Schulz and R. Van Dorland. 2007. Changes in Atmospheric Constituents and in Radiative Forcing. In: Climate Change. 2007. The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

IPCC. 2013. Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1535 pp.

Murdock, T.Q. and D.L. Spittlehouse. 2011. Selecting and Using Climate Change Scenarios for British Columbia. Available at http://www.pacificclimate.org/resources/publications. Accessed July 24, 2014.

Robock, A., C.M. Ammann, L. Oman, D. Shindell, S. Levis, G. Stenchikov. 2009. Did the Toba volcanic eruption of ~74 ka B.P. produce widespread glaciation, J. Geophys. Res., 114, D10107, doi:10.1029/2008JD011652.

Van Vuuren et. al. 2011. The representative concentration pathways: an overview, Climatic Change (2011) 109:5–31, DOI 10.1007/s10584-011-0148-z