Baffinland Iron Mines Corporation
Mary River Expansion Project

Geotechnical Recommendations for Stockpile Reclaim Tunnel & Crushing/Screening Plants

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To: Hatch Ltd. together with its affiliates, the “Consultant”

Re: Geotechnical Recommendations for Stockpile Reclaim Tunnel & Crushing/Screening Plants Report (and together with any subsequent revisions thereof, the “Report”) dated March 14, 2018 prepared by the Consultant for Baffinland Iron Mines Corporation (the “Client”), in respect of the design recommendations provided in this document.

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Dated: [insert current date]

[INSERT NAME OF REPORT RECIPIENT]

By:____

Name:

Title:

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1. Introduction

Hatch has been retained by Baffinland Iron Mines Ltd. (BIM) to assist on the design of a Bulk Material Handling (BMH) system at the Milne Inlet Port for the Mary River Expansion Project.

The BMH system consists of a rail car tippler located at the terminus of the mine-to-port railway, a indexer to push the rail car in the tippler, a loadout tunnel connecting with the tippler, a raw ore stockpile with embedded loadout tunnel, crushing and screening plants, and conveyor systems to transfer materials from the tippler through the crushing and screen plants to a longitudinal bucket-wheel stacker/reclaimer.

This memo provides geotechnical recommendations to improve the foundation bearing capacity by using rockfill pads for the footings of (1) the ore stockpile reclaim tunnel and (2) the crushing and screening plants. The settlement caused by the structure loads was assessed and is presented in this memo.

One requirement of the project is to respect the design elevation of the BMH system, excluding any option to raise the footing level. As such, the rockfill pad needs to be placed, at least partially, below the existing ground in a cut/backfill style, with the understanding that cutting into permafrost is not preferred from a technical point of view.

2. Geotechnical Site Information

The geotechnical site investigation plan and borehole profiles are illustrated in the Appendix A1.

2.1 General

Five (5) boreholes (BH 17-M010, BH 16-M010, BH 16-M011, BH 16-M012, and BH 16-M013) were drilled in the area vicinity of the stockpile reclaim tunnel and crusher/screening plants (see Appendix A2 for the borehole reports). In particular, the stockpile tunnel is located between boreholes BH 17-M010 and BH 16-M010. The crusher plant is close to BH 16-M011 and the screening plant is near BH 16-M013.

The subsurface conditions encountered at the site are highlighted as follows:

- The deposit at the site comprise a thin sandy layer overlying a thick silt deposit. Below this is likely a till layer as inferred from the findings in BH 17-M010.
- The sandy layer contains sand, with a varying amount of gravel, trace to some silt and trace cobbles. The thickness of the sandy layer varies from zero to about 3.5 m.
- The silt layer contains dominantly silt, trace to some fine sand, trace gravel, trace organics, with a thickness of 13.7 m at BH 17-M010. This layer likely a deltaic sediment sequence deposit. The frozen silt is general well bonded and contains trace thin ice lenses with a typical ice content from 20% to 40% by weight.

- A 1.4 m thick layer of ground ice was encountered from 1.0 m to 2.4 m depth in BH 16-M010. All other boreholes in this area did not encounter ground ice.
- A till layer (sand till with some silt and some gravel) was encountered in BH 17-M010 at a deep from 13.7 m to 16.7 m underlying the silt deposit. The till layer is well graded and has a relatively low ice content of about 8%.
- Bedrock was not encountered at this area during site investigation (the depth of the boreholes up to 16.7 m).

2.2 Subsurface Soil Interpretation – Silt Layer Thickness

The 13.7 m thickness of the silt layer was confirmed only in BH 17-M010. The other boreholes were all terminated within the silt layer and thus were not able to quantify the silt layer thickness.

As such, it is assumed that the silt layer has a thickness of 14 m as a base-case. A sensitivity check were performed for a thicker silt layer. A 20 m thick silt case was assessed for stockpile tunnel as it is about 40 m to 80 m away from BH 17-M010. A 28 m silt case (double of the 14 m) was evaluated for the crushing/screening plants, which is further away from BH 17-M010 (about 150 m to 400 m).

An interpretation of the sub-surface soil layers for design purposes is provided in Figure 2-1. Further investigation is recommended to confirm/verify the assumption for the thickness of the silt layer.

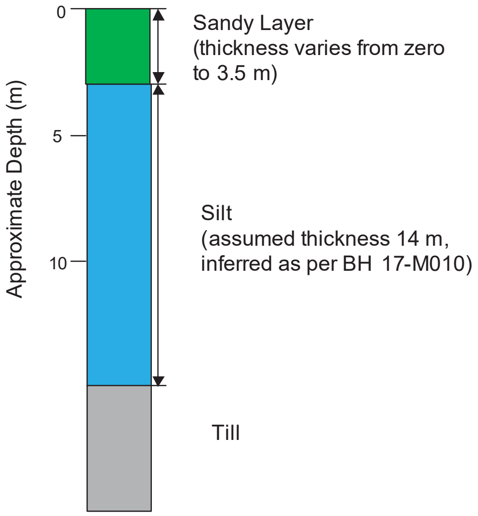


Figure 2-1: Interpreted Subsurface Soil Layers (Base Case)

(For the sites of the stockpile reclaim tunnel and crusher/screening plants)

3. Climatic Condition

The site is in a continuous permafrost zone with a mean annual air temperature of about -15° C, as per the mean monthly air temperature data from Pond Inlet, NU (1981-2010) extracted from the Government of Canada website. Climate information was summarized in Hatch Geotechnical Design Basis document (H353004-00000-229-210-0001, 2018). The global warming effect was taken into account according to the Intergovernmental Panel on Climate Change (IPCC) long term climate change studies. A temperature adjustment was applied considering global warming for the period spanning from 2010 to 2039 (see details in Hatch, 2018).

4. Stockpile Reclaim Tunnel

4.1 Structure

The stockpile over the ore reclaim tunnel is designed to be about 30 m high at the centre, measured from the top to the base of concrete footing and approximate 86 m in diameter for the footprint of the conical ore stockpile, as per the drawings shown in Appendix B1. Figure 4-1 illustrates a cross-section model of the ore stockpile and reclaim tunnel.

The key design inputs / assumptions for the tunnel footings are summarized as below:

- The thin-plate arch tunnel will be founded on a reinforced concrete strip footing with a width up to 6.4 m. The 6.4 m was conservatively used in the bearing capacity assessment and the calculated allowable bearing capacity applies for the smaller size footings. (Note: The drawing of BCSY-A-200 by tkIS shows the footing width of about 5 m and 6.4 m. The drawing of BCSY-K-203 by tkIS shows a footing size of about 3.5 m.)

- The unfactored bearing pressure (allowable bearing pressure) of foundation is 750 kPa (Foundation Loads and Design Criteria, tkIS response to Hatch RFI H353004-CM001-400-465-0045, Oct. 17, 2017, as attached in Appendix B1).

4.2 Foundation Design

The foundation for the tunnel footings consists of two components:

- 3 m thick crusher-run rockfill below the footing base.
- 150 mm thick insulation pad.

Figure 4-2 shows the conceptual configuration for the proposed rockfill foundation.

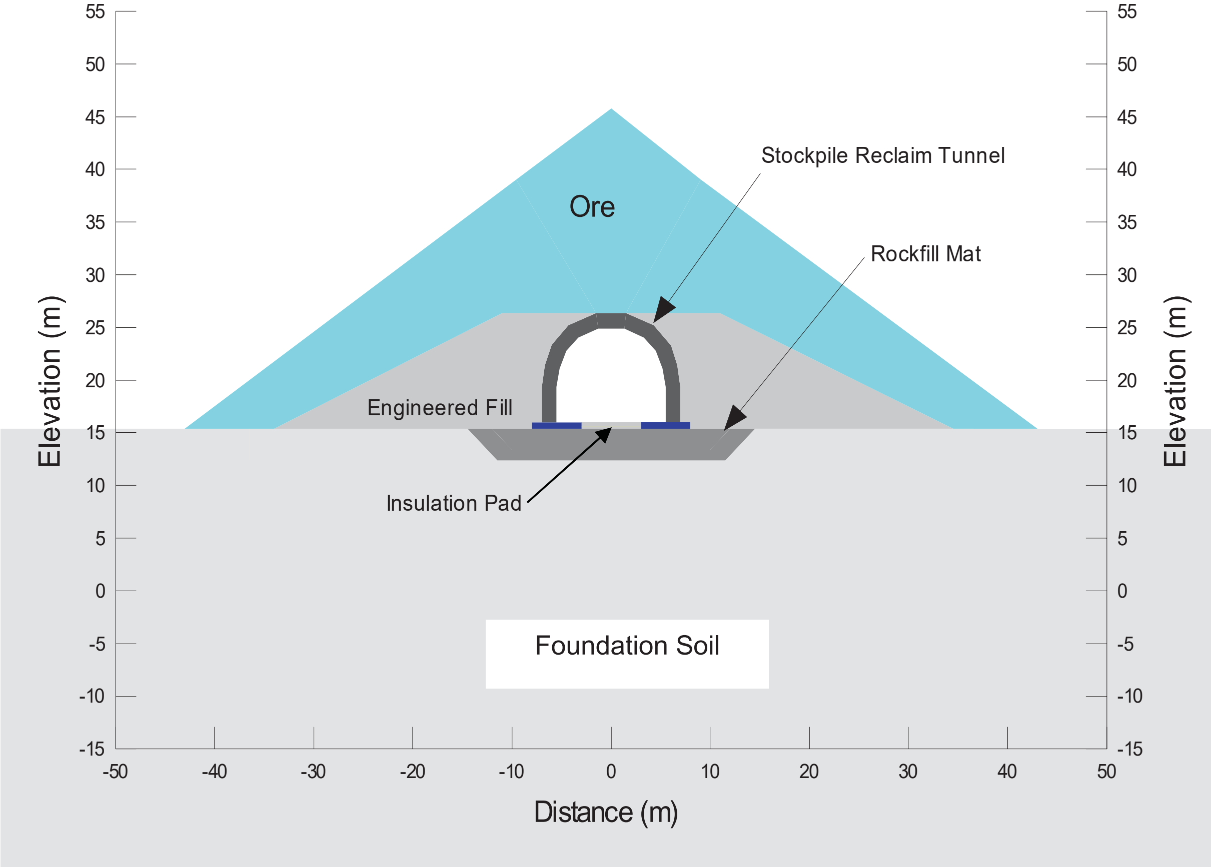
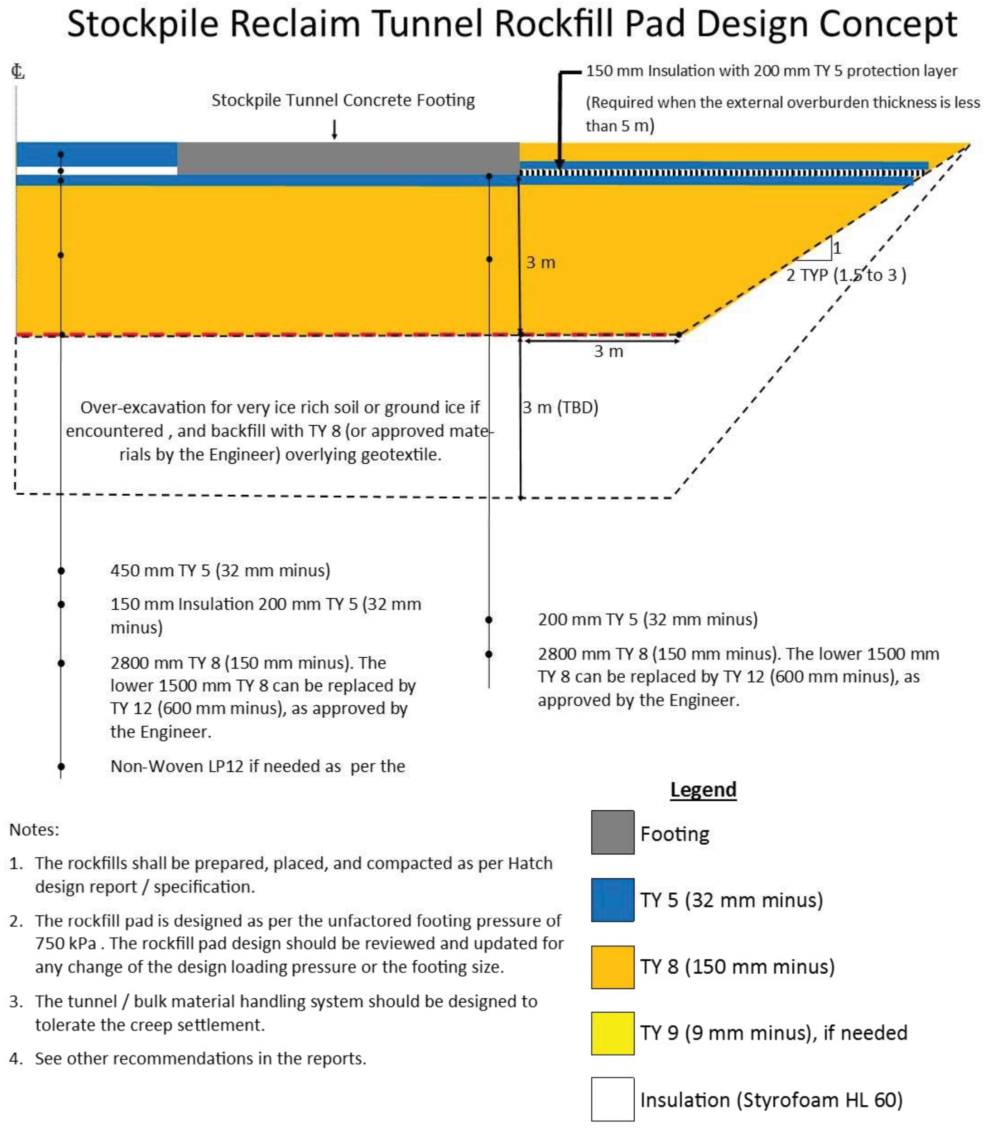


Figure 4-1: Illustration of Stockpile Reclaim Tunnel



Notes:

1. The rockfills shall be prepared, placed, and compacted as per Hatch design report / specification.
2. The rockfill pad is designed as per the unfactored footing pressure of 750 kPa . The rockfill pad design should be reviewed and updated for any change of the design loading pressure or the footing size.
3. The tunnel / bulk material handling system should be designed to tolerate the creep settlement.
4. See other recommendations in the reports.

Figure 4-2: Sketch of Rockfill Pad & Thermal Insulation

4.3 Bearing Capacity

The allowable bearing capacity of the tunnel foundation is estimated based on the following assumptions:

- A factor of safety of 2.5 is applied to the ultimate bearing capacity to obtain the allowable bearing capacity.
- The foundations will be constructed on an engineered rockfill pad. An internal friction angle of 40° and a cohesion of zero are assumed. The underlying soil (silt) has an internal friction angle of 30° and a cohesion intercept of zero. The other detailed parameters for the rockfill and underlying soil are listed in Appendix A4.
- The footing size of 6.4 m width is used for the bearing capacity check.
- The foundation bearing capacity was checked for the following scenarios:
  - (a) Bearing capacity of a two-layer foundation system with a top rockfill layer and an underlying native soil layer. The parameters for the rockfill and underlying soil are listed in Figure 4-2. A weighted average friction angle for the two-layer foundation is to be calculated as per the recommendation by Bowles (1988).

    $$\phi = \frac{d_1\phi_1 + (H - d_1)\phi_2}{H}$$

    Where the influence depth H = 0.5 x B x tan(45 + ϕ_1 /2), where ϕ_1 is the friction angle for the top layer, ϕ_2 for the bottom layer, d_1 is the thickness of the top layer, B is the footing width.
  - (b) Bearing capacity of the underlying soil. The bearing capacity will be checked in two sub-scenarios: (b1) bearing capacity as per friction shear strength (friction only) and (b2) bearing capacity as per frozen bonding strength (cohesion only).

Meyerhof's general bearing capacity equation (Das, 2007) was used to calculate the bearing capacity. Meyerhof's equation is (i.e. for zero cohesion):

$$q_u = qN_qF_{qs}F_{qd} + \gamma' BN_yF_{\gamma s}F_{\gamma d} \qquad \text{(Equation 1)}$$

where q is the surcharge load at the bottom of the foundation, N_q and N_y are bearing capacity factors, B is the foundation width, F_{qs} and F_{rs} are shape factors, and F_{qd} and F_{yd} are depth factors.

4.3.1 General

In a summary, the 3 m thick rockfill pad will satisfy the bearing capacity requirements, as summarized in the table below, given that the temperature of underlying permafrost is below minus 7°C (-7°C).

It is noted that the allowable bearing capacity in this section was estimated as per the ultimate limit state. The settlement analyses are presented in Section 4.5 to address the footing performance in the service limit state.

4.3.2 Scenario (a) – Two-Layer Foundation

Using Eqn. 1, the allowable bearing capacity of the two-layer system is 900 kPa, satisfying the required design load (750kPa).

4.3.3 Scenario (b1) – Underlying Soil (Friction Only)

This scenario checked the bearing capacity as per the friction angle of the silt (30 degree). The allowable bearing capacity is 1100 kPa, using the 2:1 stress distribution rule.

4.3.4 Scenario (b2) – Underlying Soil (Permafrost Bond Strength Only)

For frozen permafrost, the allowable bearing capacity below the footing is estimated to be 800 kPa, using (1) the 2:1 stress distribution rule and (2) the allowable permafrost bearing capacity of 560 kPa at a temperature below -7°C (see Ref. 5).

$$q_{allow} = 560kPa \times \lfloor (3m + B)/B \rfloor \approx 800\ kPa$$

4.3.5 Summary

The above analyses show that the calculated allowable bearing capacities for all three cases are higher than the required bearing pressure of 750 kPa and thus meets the bearing capacity requirement.

Table 4-1: Bearing Capacity Assessment Summary – Stockpile Reclaim Tunnel

Case	Case Description	Allowable Bearing Capacity (kPa)	Required Bearing Capacity (kPa)
Case A	Rockfill and Soil	900	750
Case B1	Underlying Soil (Friction Strength)	1100	750
Case B2	Underlying Soil (Permafrost Bond Strength)	800	750

4.4 Thermal Analyses

A thermal analyses were performed to investigate the temperature regime in the foundation below the tunnel. Appendix A3 summarizes the methodologies and details of the thermal analyse. Figure B2-1 presents the general material and boundary conditions for the stockpile reclaim tunnel.

(1) Case Without Insulation. Without insulation, the temperature of the underlying permafrost is about -3°C to -5°C to in the summer (see Figure B2-2 for the temperature contours 2 years after construction and Figure B2-3 for 20 years after construction). This does not satisfy the temperature requirement of -7°C in the previous section.

(2) Case With Insulation. In this case, insulation pad is used to control the temperature of permafrost of the underlying silty sand. With a 150 mm thick insulation pad, the temperature of underlying permafrost can be maintained to be below -7°C (see Figure B2-4 for the temperature contours 2 years after construction and Figure B2-5 for 20 years after construction), which satisfies the temperature requirement. It is noted that insulation

pad can not be placed directly below the footings as the high footing bearing pressure exceeds the allowable capacity of the insulation pad.

As such, a minimum 150 mm thick insulation pad is required to control the permafrost temperature below -7°C , which provides sufficient bearing capacity for the footing.

4.5 Settlement Analyses

The placement of ore stockpile and the tunnel will produce compression of the foundations and cause settlement including long-term creep. Deformation analyses were conducted to assess the deformation of the tunnel foundation. Appendix A4 summarizes the methodologies and parameters for the settlement analysis. Appendix B3 summarizes model configurations and results of the settlement analyses for the stockpile reclaim tunnel.

The following cases were analyzed for the stockpile reclaim tunnel:

- Case 1: An axisymmetric 2D model was used in the analyses to evaluate the settlement profile along the longitudinal direction of the tunnel. The axisymmetric model can account for the three-dimension (3D) effect of the conical shape for the ore stockpile. The tunnel configuration has to be simplified in the axisymmetric model to satisfy the requirement of an axisymmetric geometry.
- Case 2: A plane strain 2D model with the actual tunnel configuration was used to evaluate the settlement profile along the cross-section of the tunnel.
- Case 3: A plane strain 2D model with the simplified tunnel configuration was used to assess the impact of the simplified tunnel configuration, in comparison with the model with the actual tunnel configuration (Case 2).
- Case 4: An axisymmetric 2D model was used for a 20 m thick silt deposit instead of 14 m in Case 1, which is inferred from the silt as per BH 17-M010, about 40 m to 80 m away from the tunnel.

4.6 Settlement Results

A design settlement profile along longitudinal direction of the tunnel is recommended as shown in Figure 4-3. The design settlement is based on the analyses results of Case 4 (20 m silt case), which corresponds to about 1.5 times of the settlement of the Case 1 (14 m silt case). The results should be reviewed as per the findings of the on-going geotechnical investigation at the site.

The design settlement profile is the best-estimated settlement without the safety factor applied as the serviceability limit state assessment is performed using un-factored loads and corresponding un-factored settlement (Canadian Foundation Design Manual, 2006). 1

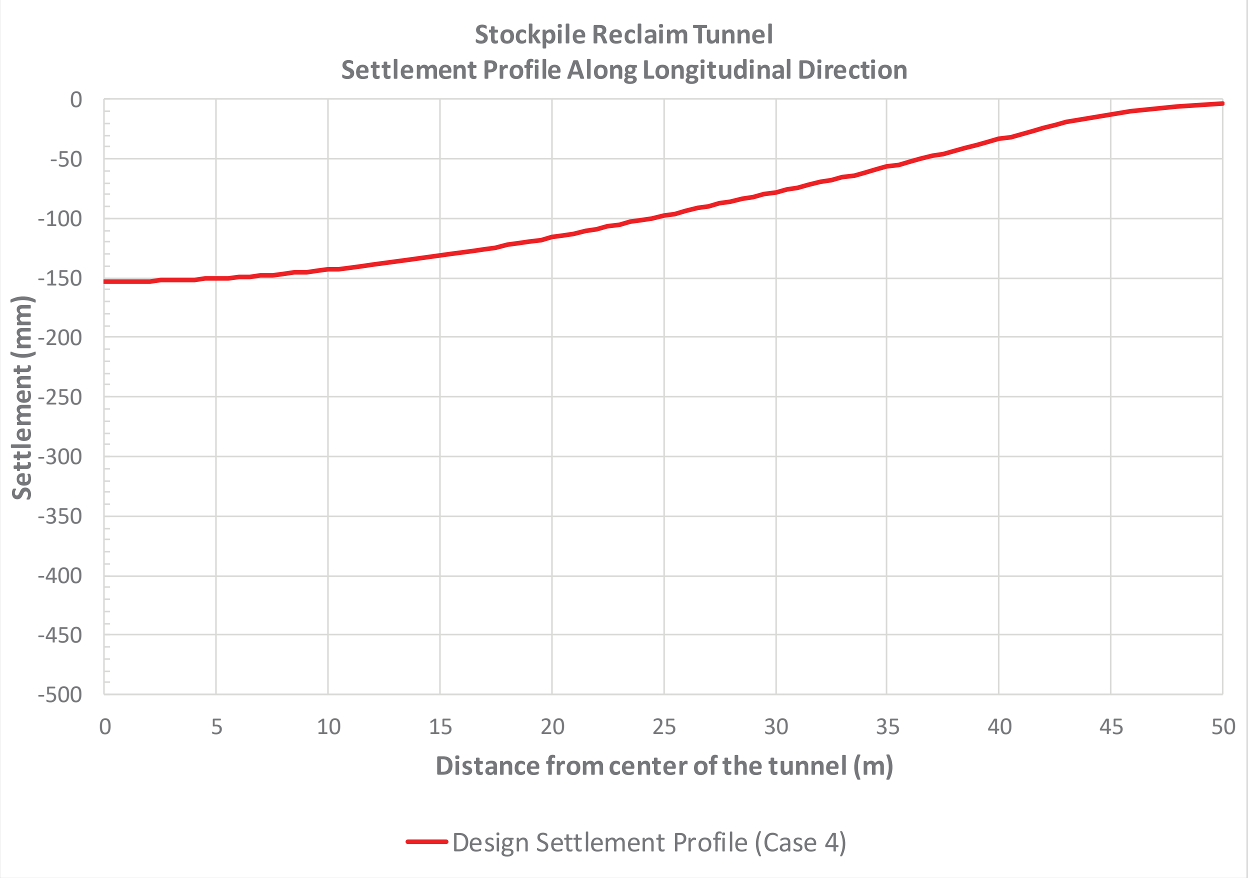


Figure 4-3: Settlement Profile along Longitudinal Direction – Stockpile Reclaim Tunnel

The following summarizes the results of all cases:

Case 1: Figure B3-1B shows the predicted vertical displacement along the longitudinal direction of the tunnel in axisymmetric model. The results show that the settlement is largest at the stockpile centre and gradually reduces approaching the toe of the stockpile. The total settlement at centre is about 110 mm.

Case 2: Figure B3-2B shows the predicted settlement displacement along the cross-section of the tunnel. As expected, the maximum settlement in Case 2 (about 130 mm) is higher than that of Case 1. The plane strain model in Case 2 tends to overestimate the settlement for a conical shape stockpile due to its inherent assumption of an infinite long model.

Case 3: Figure B3-3B shows the results of the plane strain model with a simplified tunnel configuration. Figure B3-5 presents a comparison between Case 2 and Case 3, showing Case 3 with the simplified tunnel configuration yields a similar and slightly larger settlement than Case 2 with the actual tunnel geometry. It shows that the simplification of tunnel configuration appears conservative in the settlement analysis. As such, the axisymmetric model with the simplified tunnel configuration is used as the base case to assess the settlement profile.

Case 4: Figure B3-4B presents the results from Case 4 as a sensitivity study for the silt thickness. It shows that the total settlement increases to about 150 mm for a 20 m thick silt deposit, approximately 50% higher than Case 1, as shown in Figure B3-6. It shows the foundation settlement is sensitive to the silt thickness. The elastic component of the total settlement is about 20 mm to 30 mm, which will occur during construction and initial ore placement. The creep settlement is expected to occur during the 20 year design life. Figure B3-7 provides an estimate of creep settlement versus time.

4.7 Monitoring/ Maintenance Program

A monitoring program is recommended to be carried out during the life of the project to track the performance of the stockpile and the reclaim tunnel and provide information for maintenance, if required. As part of maintenance program, surveys shall be performed twice a month during construction and may be reduced to a lower frequency during operation, depending on the actual performance. The design team should review the monitoring data on a regular basis.

The following provides a list of monitoring requirements. A detailed monitoring plan is beyond the scope of this report and should be developed separately.

1. Ground temperature cables: Two ground temperature cables (upper and lower) at each of two selected cross sections.
2. Survey inside the tunnel: four survey plate (two at the footing and two at the wall) at each of selected cross sections.
3. Surface survey points (survey monuments) on ground surface.
4. Temporary survey monuments: The survey monuments are to monitor the settlement after the tunnel installation and may be demobilised prior to the ore placement during operation.
5. Inclinometer/Thermistor (optional). This monitoring equipment may be required as per the review of the early stage monitoring data from the temperature cable and survey data.

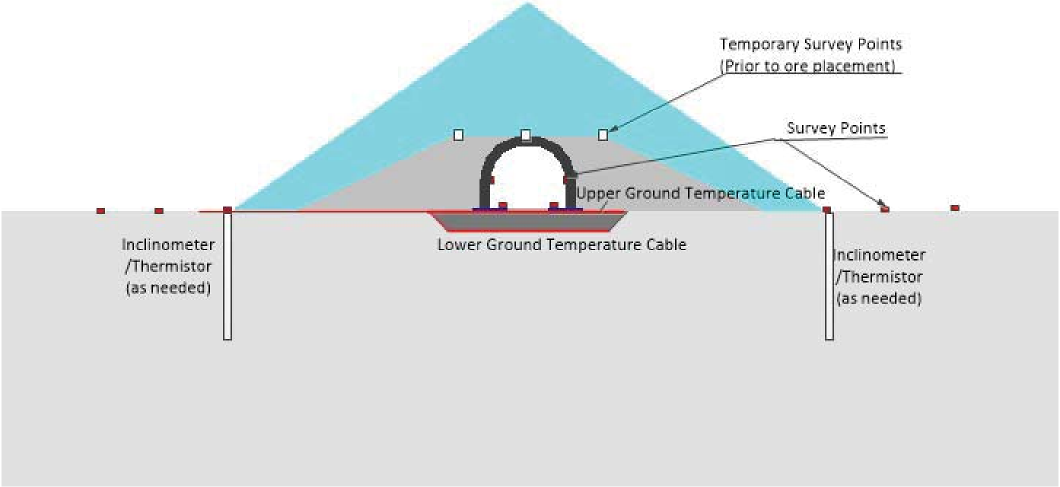


Figure 4-4: Monitoring Requirements

4.8 Assumptions and Limitations

The following presents the assumptions and limitations for the settlement analyses:

(1) The creep parameters for permafrost were estimated from the literature test data on the soil with similar properties (soil type, ice content, loading range, and temperature range). However, site-specific tests (laboratory or field tests) or model calibration using the monitoring data of the on-site facilities are required to verify and confirm these design parameters.

(2) Silt thickness is inferred as per the finding from BH 17-M010. Further investigation at the location of the structure is recommended to confirm/update this assumption.

(3) A low ice content till is below the silt layer in the borehole of BH 17-M010. Further investigation is recommended to confirm the depth and the properties of the till layer.

(4) It is understood that the tunnel footing information (load and size) may be not finalized. For any change of the footing load or footing size, the settlement/thermal analyses should be re-checked to ensure the sufficient bearing capacity and provide an update for the long-term settlement estimation.

(5) The tunnel structures are to be designed by a third party. The properties of tunnel structure assumed in the model are to be reviewed/updated as the tunnel design becomes finalized for a more accurate result.

4.9 Recommendations – Stockpile Reclaim Tunnel

1

4.9.1 Construction

The construction of the foundation is preferred to be carried out in cold seasons, i.e., late fall to early spring (i.e., November to April). The construction in warm seasons (June to September) should be avoided if possible as it may disturb/thaw the native permafrost. For stockpile reclaim tunnel foundation, the underlying soil consists of silt permafrost, which should be carefully managed during construction, particularly in warm seasons.

If the schedule doesn't allow a cold season construction, the foundation construction should be carefully planned and be executed in an efficient way to minimize the foundation base exposure time and the risk of disturbing permafrost. Detailed recommendations will be provided as per the construction. As minimum, the following should be considered in the construction planning.

1. Timely replacement to minimize the permafrost exposure. Leave the blasted permafrost soil in place as a thermal protection layer until the excavation/backfill construction is ready to carry out. Do not exposure the native permafrost for an extended period.
2. Stage the construction. Excavate and backfill in benched sections from one end to the other to minimize the exposure of the native permafrost.
3. Control water. Provide diversion ditches/berm, dewatering trench, and sump and pump equipment to effectively control water inflow during construction.
4. Schedule the construction in dry weeks.
5. The excavation slope may be further flattered. Sloughing of slope should be expected and a maintenance program should be carried out to address the issue.
6. A qualified engineer should be on site supervising the construction to ensure QA/QC.

4.9.2 Excavation

Temporary excavation is required for the rockfill foundation preparation. The cut and backfill should be carried out in cold seasons.

The overall slope of the temporary cut into the frozen permafrost is recommended to be 1.5 H:1 V or flatter. Insulation materials and locally flattening the slope will be required where ice and very ice-rich soil is encountered to protect the slope. Periodical inspection of the cut slope is required during construction.

Ground ice and very high ice rich soil, if encountered at the foundation base, shall be excavated and backfilled with compacted approved materials. Air drills or GPR surveys are recommended to be carried out after the exposure of the foundation to detect any ground ice / very ice rich soil below foundation base.

A qualified geotechnical engineer shall inspect and approve the foundation base prior to backfilling.

4.9.3 *Backfill*

The backfill materials should be free draining and non-frost susceptible to prevent the formation of ice lenses, which may cause frost action and significant damage to the footing and/or structure. Materials that are considered to be non-frost susceptible are with 0% to 1.5% particles by weight finer than 0.02 mm.

The rockfill pad materials should be crusher-run rockfills, satisfying the requirement of the project specifications and drawings. The recommended compaction requirements for the crusher-run rockfills, which may be used in the construction are provided below. Any ice or snow shall be removed efficiently during construction.

The rockfill placement and compaction for foundation shall be supervised by a full-time geotechnical engineer and the construction records should be retained for the lift thickness and compaction passes.

- TYPE 5 (crusher-run 32 mm minus material) or TYPE 3 (crusher-run 50 mm minus): the material must be placed in lifts not exceeding 200 mm and shall be compacted by minimum 5 passes of a minimum 15 ton vibratory roller with vibrations in the range of 1200 to 1500 vpm and the roller speed of about 2 mph (3.2 km/h). Alternatively the compaction should achieve a minimum of 100 percent of maximum dry density as determined by test method ASTM D698.
- TYPE 8 (crusher-run 150 mm minus): the rockfill must be placed in lifts not exceeding 500 mm. The placement shall avoid segregation and nesting of coarse particles. It shall be compacted by minimum 5 passes of a minimum 15 ton vibratory roller with vibrations in the range of 1200 to 1500 vpm and the roller speed of about 2 mph (3.2 km/h). Each lift must be “proof-rolled” prior to placing the subsequent lift.
- TYPE 12 (run-of-mine, typically 600 mm minus): the rockfill, if used, must be placed in lift not exceeding 1000 mm. The rockfill shall be compacted by minimum 5 passes of a minimum 15 ton vibratory roller with vibrations in the range of 1200 to 1500 vpm and the roller speed of about 2 mph (3.2 km/h). Alternative compactors such as heavy loaded rubber-tired haul trucks can only be used as per a written approval from the Engineer.

4.9.4 *Drainage*

Proper drainage is an important component to ensure a satisfactory performance of the structure.

(1) A positive and efficient drainage should be provided inside the tunnel to avoid any ponding water or ice accumulation. The drainage design should account for the potential settlement of the tunnel.

(2) Runoff collection and diversions systems should be provided to efficiently direct run off away from the structure. Grade the ground surface 2% away from the structure.

(3) During construction of rockfill pad, provide efficient sump / pump equipment to drain any runoff during construction as needed.

4.10 Summary and Conclusions

The following summarizes the key findings and recommendations:

- This report provides the foundation improvement measures consisting of a rockfill pad and insulation pads, providing a bearing capacity of 750 kPa for the tunnel footing size up to 6.4 m wide. The expected settlement is presented in this report. Hatch shared the preliminary settlement profile with the equipment supplier (tkIS) in January 2018 and understood that the settlement profile is manageable.
- It is noted that a geotechnical investigation is on-going to verify the assumed silt thickness. The settlement assessment performed in this report should be reviewed/updated as per the findings from the investigation program.
- Monitoring programs and inspections are recommended to verify the ground temperature and long-term displacement to ensure the satisfactory performance of the reclaim tunnel. The monitoring data will also provide useful information for maintenance purposes.
- Laboratory creep tests (and/or field tests) are recommended to verify the design creep parameters and the long-term bearing capacity for the permafrost.
- Pile foundation, as an alternative, should be used if the settlement is not acceptable for the structures. The pile foundations will have a much higher construction cost than the rockfill pad and thermal insulation option. Mat foundation can also be considered to improve the integrity of the tunnel structure and minimize the risk of the differential settlement in the cross-section direction.

5. Crushing/Screening Plants

5.1 Structure

This section summarizes the foundation configuration design for the crushing and screening plants.

The general arrangement of the structures and the site profiles are shown on the drawings in Appendix C1.

Figure 5-3 and Figure 5-4 shows the general layout of the crushing plant footings, as per Drawing No. 4853005 by tkIS. The following summarizes Hatch's understanding of the foundations:

- The crushing plant will have three 22 m long by 2.66 m wide pontoon-type footings. The centre-to-centre spacing of the footings is 6.6 m.
- The screening plant will have three 29 m long by 3 m wide pontoon-type footings. The centre-to-centre spacing of the footings is 6.4 m.

- The foundations will be constructed on an engineered rockfill pad. An internal friction angle of 40° and a cohesion of zero are assumed.
- The underlying soil (sand / silt) has an internal friction angle of 30° and a cohesion of zero.
- The expected loading pressure at the footing is about 350 kPa.
- The rockfill mat contains groundwater at the ground level during melt periods.
- A factor of safety of 3 is applied to the ultimate bearing capacity to obtain the allowable bearing capacity. The higher factor of safety is used for the crushing and screening plant considering the impact of vibration.
- For the crushing plant, the rockfill pad a 1 m high berm above the existing ground is required.
- For the screening plant, the rockfill pad a 0.4 m high berm above the existing ground surface is required.

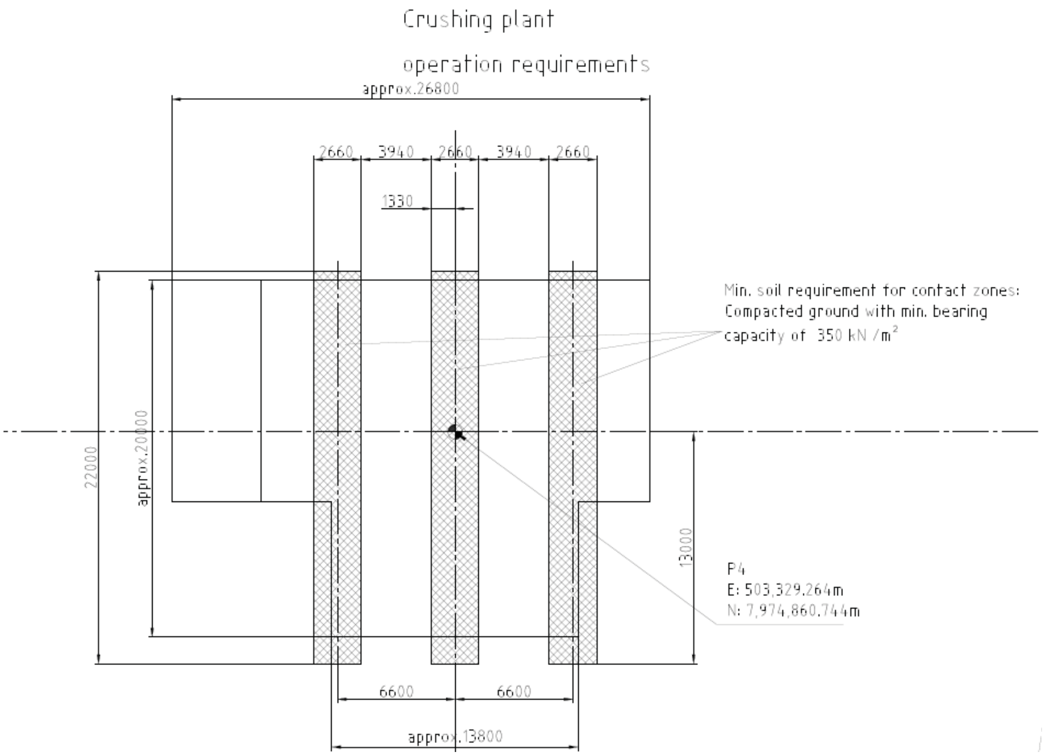


Figure 5-1: **General Layout of Crushing Plant**

(Information from Drawing No. 4853005, dated on July 07, 2017)

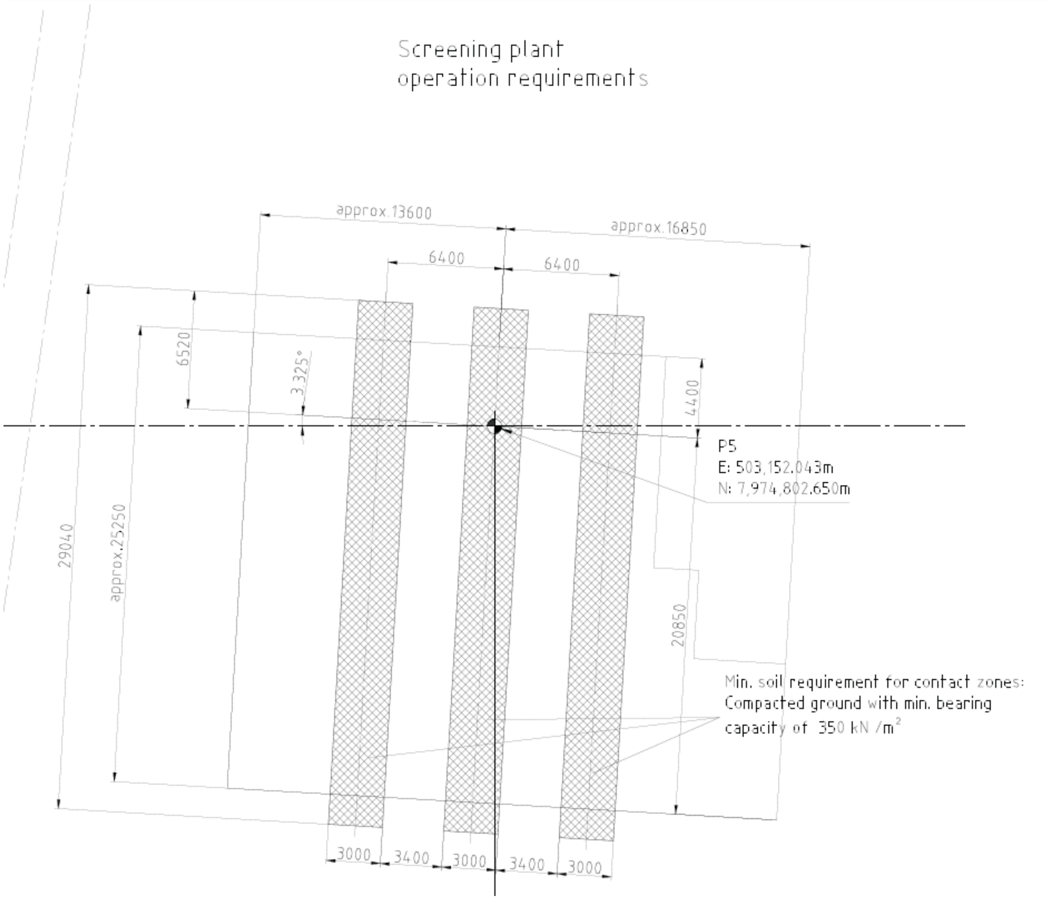


Figure 5-2: General Layout of Screening Plant

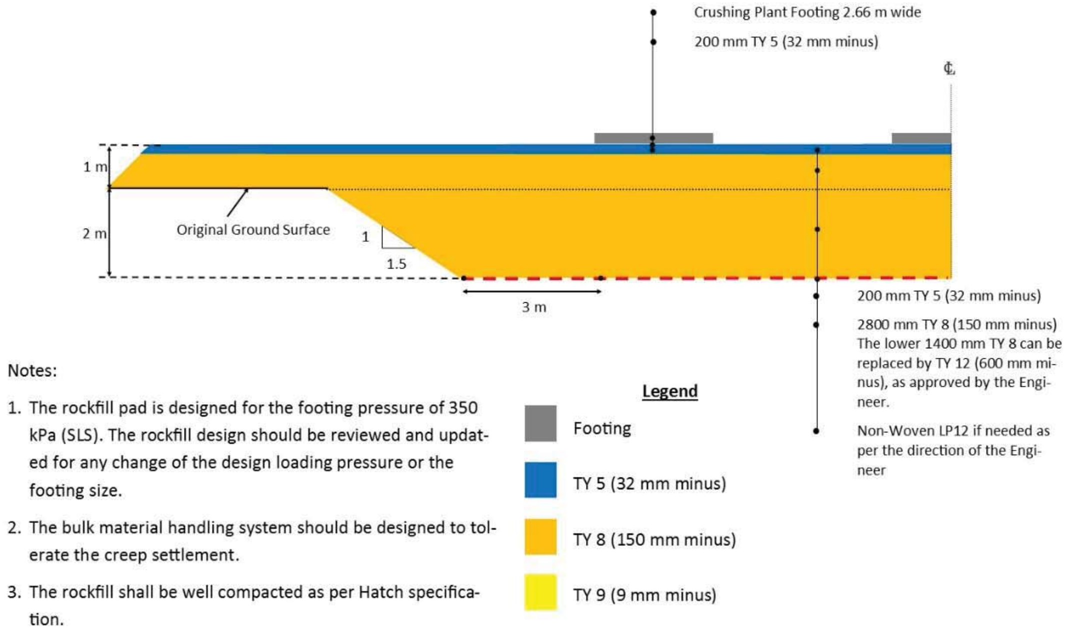
(Information from Drawing no. 4853005, dated on July 07, 2017)

5.2 Foundation Configurations

The rockfill foundation configurations for the crusher and screening plant are illustrated in the following figures.

- For the crushing plant site, the rockfill mat consists of a 1 m berm above ground surface and a 2 m cut and fill pad below ground surface.
- For the screening plant site, the rockfill mat consists of a 0.4 m berm above ground surface and a 2.6 m cut and fill pad below ground surface.

Figure 5-3 and Figure 5-4 show a preliminary configuration for the crushing plant and screening plant foundation respectively. The rockfill pads were designed to provide sufficient bearing capacity for the footing loads and to constrain the active zone within the rockfill. Insulation pad is not suitable to be used for the crushing and screening plant foundation considering the impact of vibration. Styrofoam HL requires a factor of safety of 5 to 10 for vibration loads and allows a very low bearing pressure from 40 kPa to 80 kPa for Styrofoam HL 60.



Notes:

1. The rockfill pad is designed for the footing pressure of 350 kPa (SLS). The rockfill design should be reviewed and updated for any change of the design loading pressure or the footing size.
2. The bulk material handling system should be designed to tolerate the creep settlement.
3. The rockfill shall be well compacted as per Hatch specification.

Legend

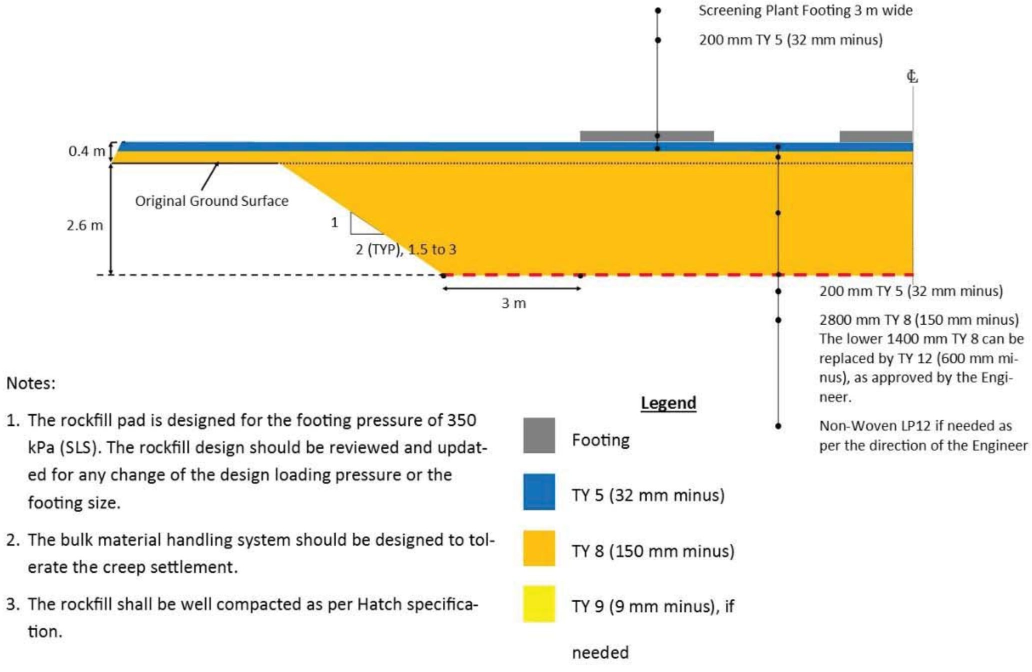
■ Footing

🟦 TY 5 (32 mm minus)

🟧 TY 8 (150 mm minus)

🟨 TY 9 (9 mm minus)

Figure 5-3: Foundation Configuration Sketch for Crushing Plant



Notes:

1. The rockfill pad is designed for the footing pressure of 350 kPa (SLS). The rockfill design should be reviewed and updated for any change of the design loading pressure or the footing size.
2. The bulk material handling system should be designed to tolerate the creep settlement.
3. The rockfill shall be well compacted as per Hatch specification.

Legend

■ Footing

🟦 TY 5 (32 mm minus)

🟧 TY 8 (150 mm minus)

🟨 TY 9 (9 mm minus), if needed

Figure 5-4: Foundation Configuration Sketch for Screening Plant

5.3 Bearing Capacity

The allowable bearing capacity for the crushing and screening plants was evaluated as per the three scenarios described in Section 4.3. The following table summarizes the calculated allowable bearing capacity, indicating that the proposed rockfill pad satisfies the bearing requirement:

Table 5-1: Bearing Capacity Assessment Summary Below Footings

Case	Case Description	Crushing Plant (kPa)	Screening Plant (kPa)	Required Bearing Capacity (kPa)
Case A	Rockfill and Soil	450	350	350
Case B1	Underlying Soil (Friction Strength)	>500	>500	350
Case B2	Underlying Soil (Permafrost Bond Strength)*	350	400	350

Note: *The bearing capacity below footings was estimated as per the allowable bearing capacity of underlying permafrost soil, i.e., 160 kPa at – 1°C temperature for the crushing plant and 200 kPa at – 1.5°C temperature for the screening plant (as per SNiP, 1988 with a factor of safety of 2.5).

5.4 Thermal Analyses

The thermal analyses were performed to investigate the temperature regime in foundation. Appendix A3 summarizes the methodologies and details of the thermal analyse. Figure C2-1 and Figure C2-6 presents the thermal model for the crushing plant and the screening plant respectively.

The temperature of the soil below rockfill pad is shown in Appendix C. The following summaries the results.

- The active zone is effectively restrained within the rockfill pad
- For the crushing plant, the underlying soil temperature ranges from -2°C to -1°C (see Figure C2-2 to Figure C2-3)
- For the screening plant, the underlying soil temperature ranges from -2°C to -1.5°C (see Figure C2-5 to Figure C2-6)
- The thaw settlement risk is considered low for the underlying permafrost, as the rockfill preserve the underlying permafrost below -1°C for both crushing and screening plants. The salinity measurement from BH 17-M010 is 3 ppt at 0.9 m depth and 13 ppt at 5 m depth, corresponding to a freezing point of -0.2°C and -0.7°C, respectively.

5.5 Settlement Analyses

The loads of crushing/screening plants will produce compression of the foundations and cause settlement including long-term creep. Deformation analyses were conducted to assess the foundation settlement. Appendix A4 summarizes the methodologies, and parameters of the analyses.

The following cases were analyzed:

- Case 1: A plane strain 2D model was used in the analyses to evaluate the settlement profile along the cross-section of the plant. The footing loads were modeled using surcharge. The stiffness of the plant is not available to Hatch and is thus conservatively ignored.
    - The subsurface configuration below the crushing plant consists of rockfill, sandy deposit to 3.5 m depth, 14 m thick silt, and till.
    - The subsurface configuration below the screening plant consists of rockfill, sandy deposit to 3 m depth, 14 m thick silt, and till.
- Case 2: This case is same with Case 1 except for the 28 m thick silt deposit instead of 14 m in Case 1.

5.6 Settlement Results

The design total settlement profiles along cross-sections are shown in Figure 5-5 and Figure 5-6 for crushing and screening plants respectively. It is noted that the settlement analyses assumes a flexible structure. For a rigid structure, the footing settlement is factored by a structure-rigidity settlement coefficient of 0.93 (Das, 1999). As such, the design total settlements are about 80 mm and 100 mm for the crushing plant and the screening plant respectively assuming a rigid structure.

The design settlement profile is the best-estimated settlement without the safety factor applied as the serviceability limit state assessment is performed using un-factored loads and corresponding un-factored settlement (Canadian Foundation Design Manual, 2006). 1

The total settlement includes both the elastic and creep settlement components. The elastic settlement due to the plants' self-weight will occur during installation and construction.

Appendix C3 summarizes the model configuration and the results of the settlement analyses.

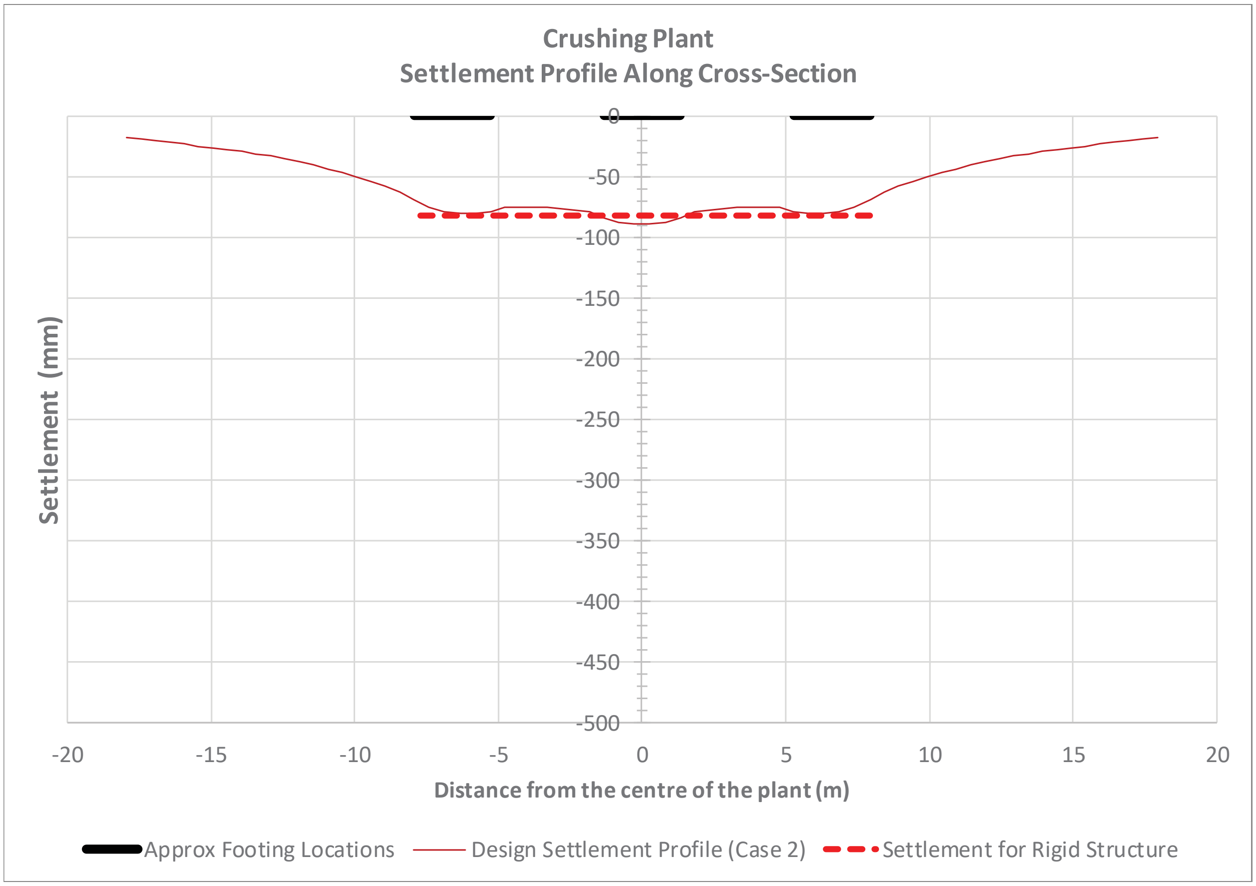


Figure 5-5: Settlement Profile in Cross-Section – Crushing Plant

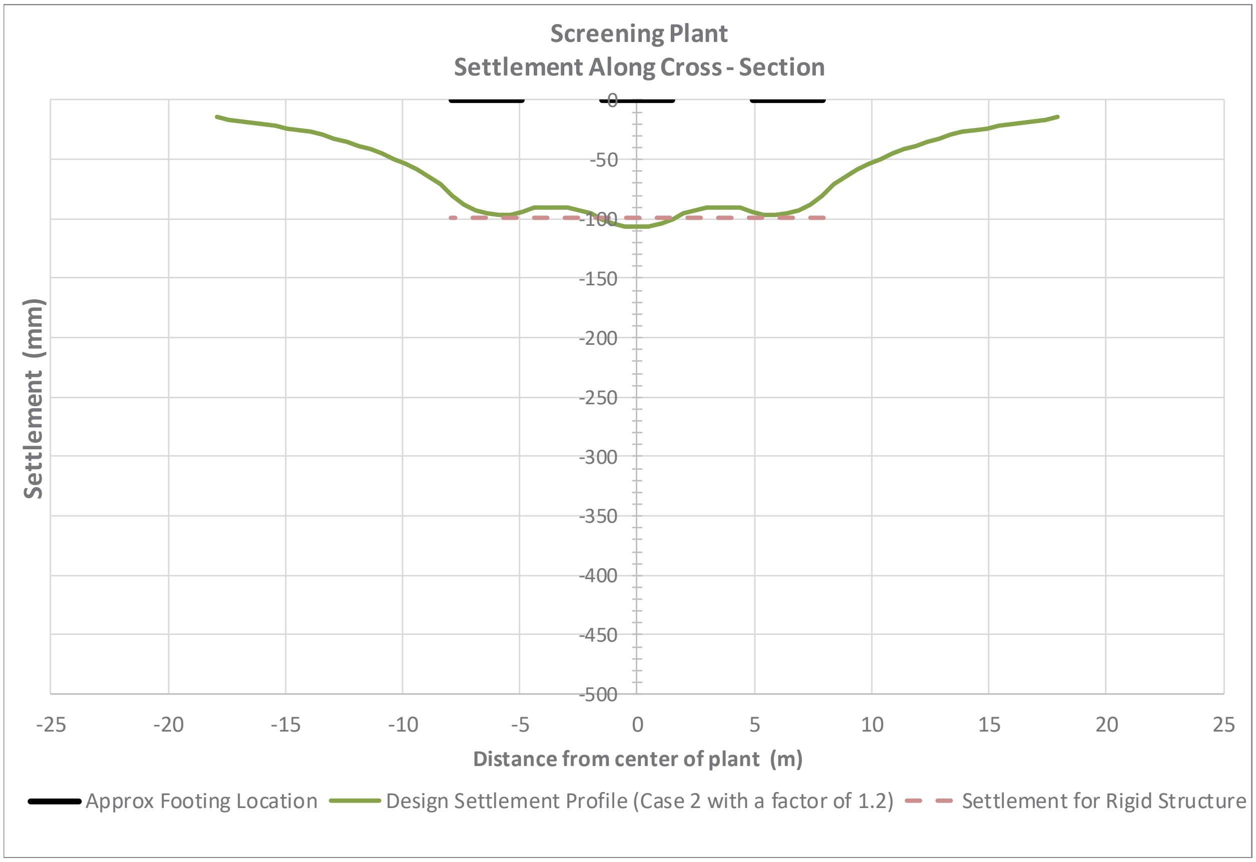


Figure 5-6: Settlement Profile in Cross-Section – Screening Plant

5.6.1 *Crushing Plant Settlement*

The total settlement contour of the crushing plant is shown in Figure C3-2 and Figure C3-3 in Appendix C3 for Case 1 and Case 2, respectively.

1. The total settlement below the footings ranges from 60 mm to 70 mm for Case 1, as shown in Figure C3-4.
2. The elastic (instantaneous) component is about 10 mm to 20 mm. This component will occur during installation/construction.
3. The creep settlement below the footings for Case 1 is about 40 to 50 mm.
4. The thicker silt layer (28 m) in Case 2 yield a larger footing settlement ranging from 80 mm to 90 mm, about 30% more than Case 1 with a 14 m thick silt layer.
5. The creep settlement versus time is shown in Figure B3-7, where the settlement is assumed in a power-law relationship with time, where the exponent ranges from 0.3 to 1.

5.6.2 Screening Plant Settlement

The settlement of the screening plant is shown in Figure C3-6 to Figure C3-8 for Case 1 and Case 2. The calculated settlement magnitude for the screening plant is very similar to those for the crushing plant. The design settlement profile for the screening plant was developed by applying a ratio of 1.2 to the calculated settlement, considering the more uncertainty of the silt layer due to the further distance of the screening plant (400 m) to the borehole BH 17-M010 than that (150 m) for the crusher plant.

5.7 Monitoring Program

A monitoring program is preferred to keep track the settlement performance of the plants. The monitoring program will consist of survey points marked on the footings of the plants.

5.8 Assumptions and Limitations

The following presents the assumptions and limitations for the settlement analyses:

- The creep parameters for permafrost were estimated from the literature test data on similar permafrost (soil type, ice content, loading range, and temperature range). However, site-specific tests (lab or field tests) or model calibration using the monitoring data of the on-site facilities are required to verify and confirm these design parameters.
- Silt thickness of 14 m is inferred as per the finding from BH 17-M010. Further investigation at the location of the structure is recommended to confirm/update this assumption.
- A low ice content till is expected below the silt layer in the borehole of BH 17-M010. Further investigation is recommended to confirm the depth and the properties of the till layer.
- The footing loads were simulated as surcharges in the finite element model (equivalent to the flexible footing). The calculated settlement from the model is conservative. The stiff frame structure would yield a more uniform and less settlement.
- The impact of vibration to the settlement of permafrost has not been well studied in literature. The settlement factor was used to account for the uncertainties.

5.9 Recommendations – Crushing/Screening Plants

The recommendations for foundation construction, excavation, backfill and drainage in Section 4.9.1 are applicable for the crushing/screening plants' foundation.

5.10 Design Update

1

A design update was shown in Figure 5-7 and Figure 5-8 consisting an insulation layer added below the footings.   It is noted that the insulation pad can not be placed directly below the footing to avoid damage of the insulation under the dynamic loads (consequently creep settlement).

The main objective of the insulation layer is to protect the permafrost It also helps raise the permafrost line near the native soil to block the potential water inflow. The conclusions of the settlement and thermal analyses remains valid for the updated configuration.

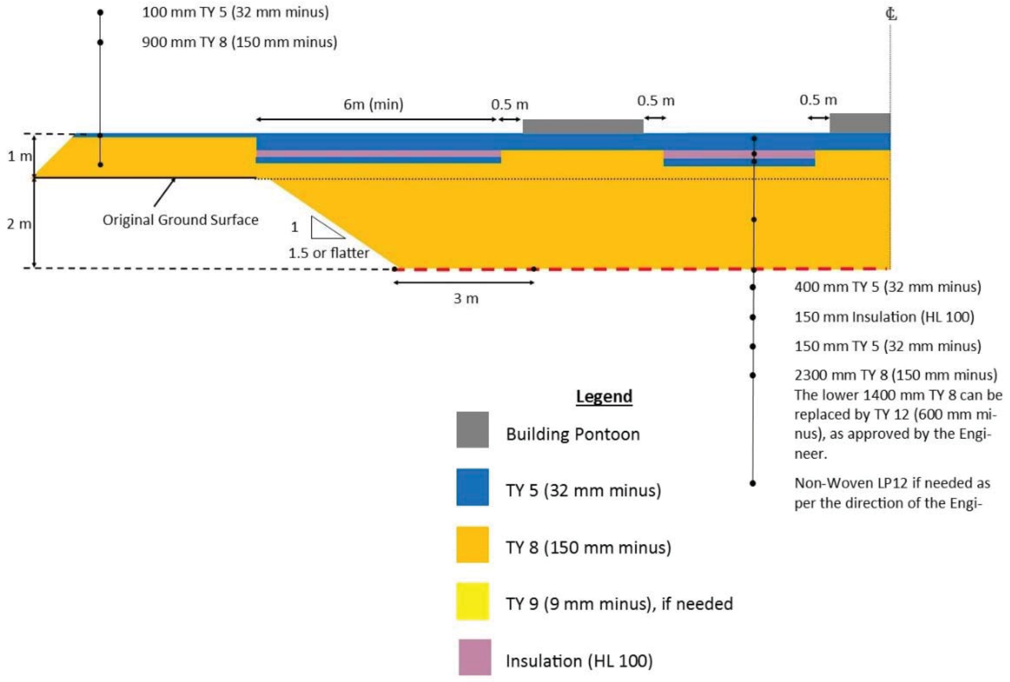


Figure 5-7: Foundation Configuration Sketch for Crushing Plant (updated)

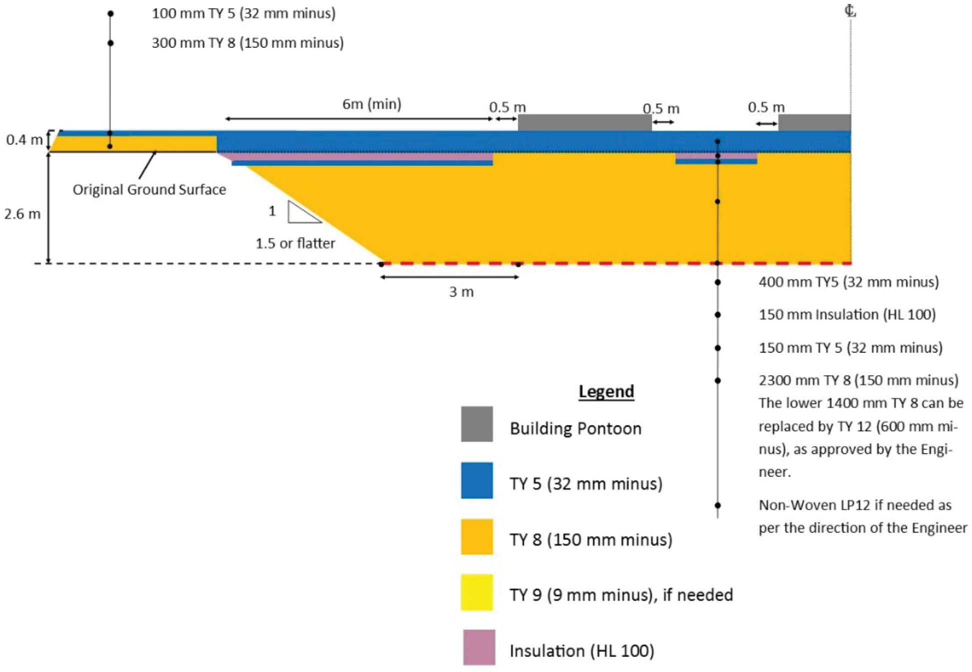


Figure 5-8: Foundation Configuration Sketch for Screening Plant (updated)

5.11 Summary and Conclusions

The following summarizes the key findings and recommendations:

- The foundation improvement consists of a rockfill pad, providing a bearing capacity of 350 kPa for the footings of the crushing and screening plants.
- The expected settlement is presented in this report. The bulk material handling system should be designed to mitigate the estimated settlement. A staged installation may be considered to mitigate the settlement by taking advantage of the waiting time from the plant installation and the installation of the tie-in component connecting to the conveyor system.
- It is noted that a geotechnical investigation are on-going to verify the assumed silt thickness. The settlement assessment performed in this report should be reviewed/updated as per the findings from the investigation program.
- Monitoring programs and inspections are required to track the long-term displacement to ensure the satisfactory performance of the structures. The monitoring data will also provide useful information for maintenance purposes.
- Laboratory creep tests (and/or field tests) are recommended to verify the design creep parameters and the long-term bearing capacity for the permafrost.

- Pile foundation (e.g., adfreeze piles), as an alternative, should be used if the settlement is not *acceptable* for the structures. The pile foundations likely have a much higher construction cost than the rockfill pad and insulation pad option.

6. References

1. *Hatch, 2012, "Geotechnical Data Report -Infrastructure" (ref H337697-0000-15-1240004, Rev. C), April 05,2012.*
2. *Hatch, 2016, "Geotechnical Criteria for Building Foundations at Milne Inlet", H352004-0000-229-078-0001, Rev.O, Dec. 15,2016.*
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9. *Canadian Geotechnical Society, 2006, "Canadian Foundation Engineering Manual", Forth Edition.*
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11. *International Permafrost Association, 2005, "Glossary of Permafrost", The Arctic Institute of North America, The University of Calgary.*
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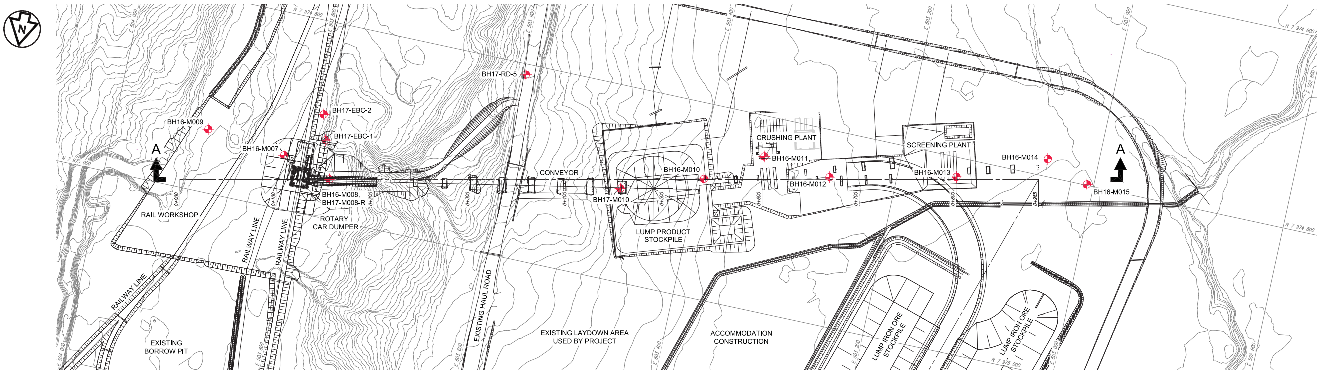
13. *Tsytovich, N.A., Kronik, Ya.A., Markin, K.F., Aksenov, V.I. Physical and Mechanical Properties of Saline Soils. Proc. 2nd International Conference on Permafrost (1973), Yakutsk, USSR Contributin, U.S. National Academy of Sciences, pp. 238-2*
14. SNiP 1988. Base and Foundations On The Permafrost Soil. 2.02.04-88. USSR State Building And Construction Committee, Moscow.

Appendix A1

Geographical Profile

DWG. No.



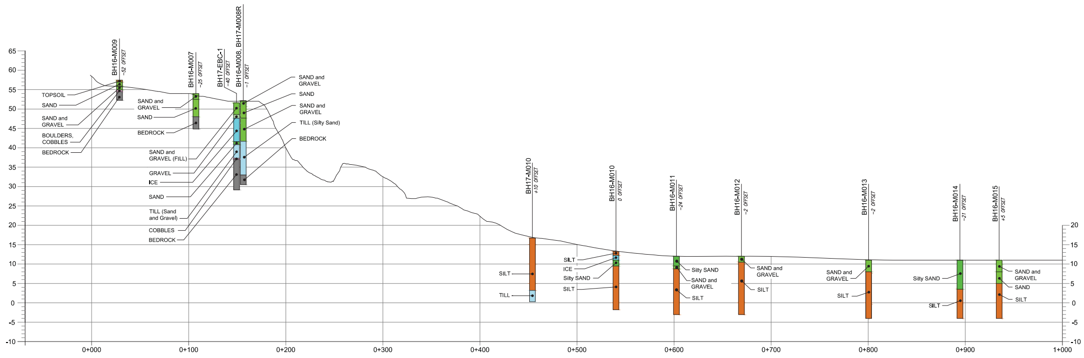
PLAN

0 50 100 150 200 METRES

SCALE: 1:2000

NOTE

PROCESSING LINE LAYOUT UPDATED LAST ON FEBRUARY 6TH., 2018



LEGEND

🟫	TOPSOIL
🟧	SILT
🟩	Silty SAND
🟩	SAND
🟩	SAND & GRAVEL
🟦	TILL
🟦	ICE
🟪	BOULDERS, COBBLES
⬛	BEDROCK

SECTION A-A

1:2000 HORIZONTAL 0 50 100 150 200 METRES

1:500 VERTICAL 0 10 20 30 40 50 METRES

DRAWING No.	DRAWING TITLE
REFERENCE DRAWINGS	

NAME

SIGNATURE

ENG REG NUMBER

REVISION DATE

ORIGINAL DATE

REGISTERED PROFESSIONAL

No.	DESCRIPTION	BY	CHK'D	DATE
REVISIONS				

HATCH

ROLE	NAME	SIGNATURE	DATE
DRAFTSPERSON	T BEREKOWSKI	NR	26/01/2018
DESIGNER		NR	
CHECKER			2018-02-07
DESIGN COORD.			
RESP. ENG.	G QU		
LEAD DISC. ENG.			
ENG. MANAGER			
PROJ. MANAGER			

DRAWING APPROVAL STATUS: INTERNAL REVIEW

Baffinland

BAFFINLAND EXPANSION 12 MTPA MINE OPTION
PRE FEASIBILITY STUDY

PORT SITE
PROCESSING LINE
GEOLOGICAL PROFILE

SCALE	DWG. No.	REV
1:2000 OR AS NOTED	H352034-GEOSKT-229-292-0011	A1

$TIME$
$USERNAME$
$DATE$
$FILE$

Appendix A2

Borehole Data

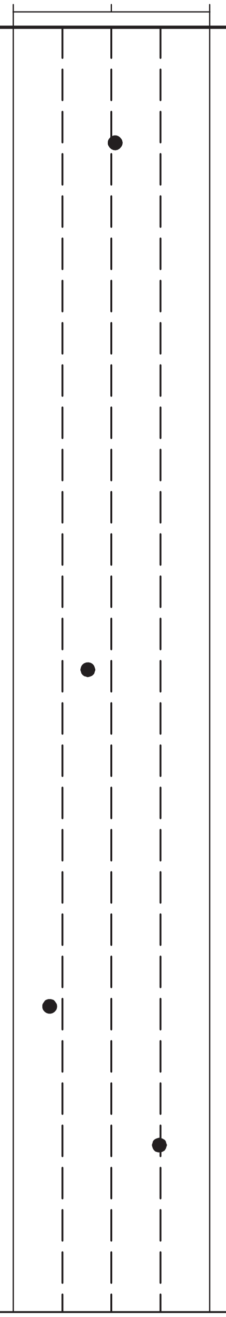
HATCH

BOREHOLE REPORT

BH17-10

Sheet 1 of 2

Client: Baffinland Iron Mines
Project: Mary River Expansion Study Stage 2
Location: Transfer Conveyor
Project No.: H353004
Datum: NAD 83
Platform: 0
Easting: 503,476.0 m
Northing: 7,974,905.0 m
Surface Elevation: 17.00 m
Bottom Elevation: 0.28 m
Total Depth: 16.7 m
Contractor: Boart Longyear
Rig Type/ Mounting: MiniSonic Rig
Date Logged: 10/29/2017
Logged By: R.S
Driller: Brent McAndrew
Hole Diameter (mm): 100 mm
Date Reviewed: 1/18/2018
Reviewed By: G.Q



Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Frozen Soil Description	Recovery	Sample Type	Field Water Content	Percent Gravel	Percent Sand	Percent Fines	Liquid Limit	Plastic Index	Other Tests
						SILT with Sand, trace Gravel up to 80 mm, brown, unfrozen to 1.6 m, occasional ice lenses up to 4 mm thick.	Nbe - Vs									
	16.0	1.0								26	10	42	48			
	15.0	2.0														
	14.0	3.0														
	13.0	4.0														
	12.0	5.0								19	10	35	55			
	11.0	6.0														
	10.0	7.0														
						SILT, trace to some Sand, trace Organics, thin layers, brown to greyish-brown with occasional thin black seam, frozen with some thin ice lenses from 10.3 to 10.6 m.	Nbe trace Vs			9	8	36	56			
	9.0	8.0														
										37	0	1	99			
	8.0	9.0														
	7.0	10.0														

Notes: BH colar elevation is estimated fro Lidar information.

BOREHOLE REPORT

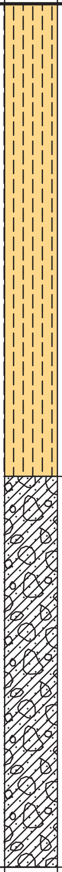
BH17-10

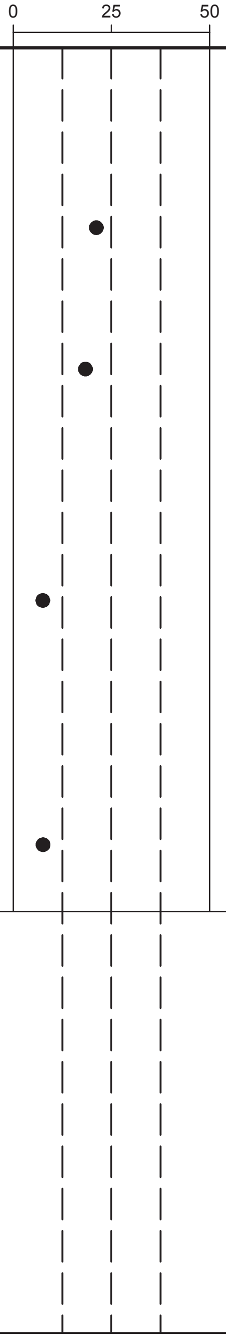
Sheet 2 of 2

Client:	Baffinland Iron Mines	**Project No.:**	H353004
Project:	Mary River Expansion Study Stage 2	**Datum:**	NAD 83
Location:	Transfer Conveyor	**Platform:**	0

Easting:	503,476.0 m
Northing:	7,974,905.0 m
Surface Elevation:	17.00 m
Bottom Elevation:	0.28 m
Total Depth:	16.7 m
Logged By:	R.S
Reviewed By:	G.Q

Contractor: Boart Longyear
Rig Type/ Mounting: MiniSonic Rig
Date Logged: 10/29/2017
Driller: Brent McAndrew
Hole Diameter (mm): 100 mm
Date Reviewed: 1/18/2018





Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Frozen Soil Description	Recovery	Sample Type	Moisture Content Profile	Field Water Content	Percent Gravel	Percent Sand	Percent Fines	Liquid Limit	Plastic Index	Other Tests
						SILT, trace to some Sand, trace Organics, thin layers, brown to greyish-brown with occasional thin black seam, frozen with some thin ice lenses from 10.3 to 10.6 m. *(Continued)*	Nbn trace Vs *(Continued)*										
	6.0	11.0															
										●	21	0	2	98			
	5.0	12.0															
										●	18	0	30	70			
	4.0	13.0															
						TILL, Sand, some Silt, some Gravel rounded to sub angular, well graded, biege to light grey, frozen.	Nbn										
	3.0	14.0															
										●	8	15	69	16			
	2.0	15.0															
	1.0	16.0															
										●	8	13	60	27			
						To Target Depth. **Drillhole BH17-10 terminated at 16.7m.**											
	0.0	17.0															
	-1.0	18.0															
	-2.0	19.0															
	-3.0	20.0															

Notes: BH colar elevation is estimated fro Lidar information.

BAFFINLAND GINT LIBRARY_REV2.GLB Log ICE BOREHOLE MILNE PORT SUPPLIMENTARY BOREHOLES.GPJ <<DrawingFile>> 25/01/2018 11:53

HATCH BOREHOLE REPORT

BH16-M008

Sheet 1 of 3

Client: Baffinland Iron Mines

Project: Mary River Expansion Study Stage 2

Location: Milne Port Train Unloading

Project No.: H352034

Datum: NAD83

Platform: Ground

Contractor: Boart Longyear

Rig Type/ Mounting: MiniSonic Rig

Date Logged: 10/4/2016

Driller: E.Beachamp

Hole Diameter (mm): 96

Date Reviewed: 2/10/2017

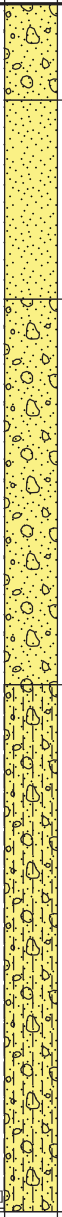
Easting:	503,771.0 m
Northing:	7,974,959.0 m
Surface Elevation:	52.00 m
Bottom Elevation:	30.66 m
Total Depth:	21.3 m
Logged By:	UK
Reviewed By:	SH/WH

Elevation (m)	Depth (m)
50.0	2.0
48.0	4.0
46.0	6.0
44.0	8.0
42.0	10.0
40.0	12.0
38.0	14.0
36.0	16.0
34.0	18.0
32.0	20.0

Water: Unobserved due to Permafrost

Method: Vibracore

Casing: H-Casing [18.8]



Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Frozen Soil Description
SANDY GRAVEL: Rounded to sub angular gravel, coarse grained sand, well graded	Nf
SAND: Coarse to fine grained	Nf
3.00 m to 4.60 m: Some SILT	Nbn
SAND and GRAVEL: Coarse grained sand	Nf
6.90 m to 7.60 m: Zone of inferred cobbles	
SILTY SAND, some GRAVEL: Fine to coarse, subangular gravel	Nbn
12.20 m to 12.60 m: GRAVELLY SILTY SAND	
13.80 m to 15.40 m: SILTY SAND	
Start of Coring at 18.8m. Continued on Rock Core Log sheet.	

Recovery | Sample Type | Moisture Content Profile 0 | Other Tests

Notes:

HATCH LIBRARY V1.02.GLB Log ICE BOREHOLE RAIL ALIGNMENT ALL_WITH ICE LOG_REV 3.GPJ <<DrawingFile>> 21/02/2018 10:19

BOREHOLE REPORT

BH16-M009

Sheet 1 of 2

Client: Baffinland Iron Mines
Project: Mary River Expansion Study Stage 2
Location: Milne Port Train Unloading

Project No.: H352034
Datum: NAD83
Platform: Ground

Easting: 503,904.0 m
Northing: 7,974,935.0 m
Surface Elevation: 57.50 m
Bottom Elevation: 52.32 m
Total Depth: 5.2 m
Logged By: MR
Reviewed By: SH/WH

Contractor: Boart Longyear
Driller: Samuel Flynn
Rig Type/ Mounting: MiniSonic Rig
Hole Diameter (mm): 96
Date Logged: 10/4/2016
Date Reviewed: 2/10/2017

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Frozen Soil Description	Recovery	Sample Type	Moisture Content Profile 0	Other Tests
Unobserved due to Permafrost			Vibracore	H-Casing		ORGANICS: Organic soil					
						GRAVELLY SAND: Light brown to grey, angular to subgranular gravel, medium to coarse grained sand	Nf				
	55.5	2.0				SAND and GRAVEL: Grey to light brown, Fine to coarse grained sand, angular to subangular gravel	Nbn				
				[3.7]		Inferred BOULDERS with SAND: Coarse to fine grained sand					
	53.5	4.0				***Start of Coring at 3.7m.*** ***Continued on Rock Core Log sheet.***					
	51.5	6.0									
	49.5	8.0									
	47.5	10.0									
	45.5	12.0									
	43.5	14.0									
	41.5	16.0									
	39.5	18.0									
	37.5	20.0									

Notes:

HATCH

BOREHOLE REPORT

BH16-M010

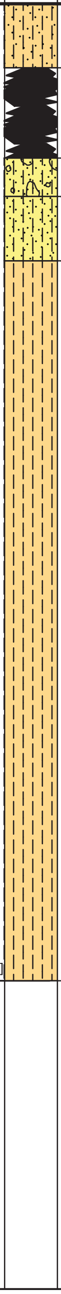
Sheet 1 of 1

Client: Baffinland Iron Mines
Project: Mary River Expansion Study Stage 2
Location: Milne Port Crusher

Project No.: H352034
Datum: NAD83
Platform: Ground

Easting: 503,394.0 m
Northing: 7,974,877.0 m
Surface Elevation: 13.30 m
Bottom Elevation: -1.90 m
Total Depth: 15.2 m
Logged By: MR
Reviewed By: SH/WH

Contractor: Boart Longyear
Driller: Michael Scott
Rig Type/ Mounting: MiniSonic Rig
Hole Diameter (mm): 96
Date Logged: 12/9/2016
Date Reviewed: 2/10/2017



Water	Elevation (m)	Depth (m)	Method	Casing	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Frozen Soil Description	Recovery	Sample Type	Moisture Content Profile	Field Water Content	Percent Gravel	Percent Sand	Percent Fines	Liquid Limit	Plastic Index	Other Tests
			Vibrocore	H-Casing	SILT, some SAND: Brown, moist	Vc										
					ICE: Soft, white, cloudy texture	ICE				28	0	16	84			
	11.3	2.0														
					GRAVELLY SILTY SAND: Light brown and grey	Nf										
					SILT and SAND: Organic silt, brown, moist	Vx										
	9.3	4.0														
					SILT, trace SAND: Organic, dark grey to brown, moist	Vx				100	0	4	96			
										32						
	7.3	6.0														
						Nbn										
						Nf										
	5.3	8.0														
						Vx										
	3.3	10.0														
						Nf										
	1.3	12.0														
						Nbn										
						Nf										
	-0.7	14.0														
				[15.2]												
					To Target Depth. **Drillhole BH16-M010 terminated at 15.2m.**											
	-2.7	16.0														
	-4.7	18.0														
	-6.7	20.0														

Notes:

HATCH

BOREHOLE REPORT

BH16-M011

Sheet 1 of 1

Client: Baffinland Iron Mines

Project: Mary River Expansion Study Stage 2

Location: Milne Port Crusher

Project No.: H352034

Datum: NAD83

Platform: Ground

Easting: 503,339.0 m

Northing: 7,974,868.0 m

Surface Elevation: 12.00 m

Bottom Elevation: -3.20 m

Total Depth: 15.2 m

Logged By: MR

Reviewed By: SH/WH

Contractor: Boart Longyear

Driller: Michael Scott

Rig Type/ Mounting: MiniSonic Rig

Hole Diameter (mm): 96

Date Logged: 12/4/2016

Date Reviewed: 2/10/2017

Elevation (m)	Depth (m)
10.0	2.0
8.0	4.0
6.0	6.0
4.0	8.0
2.0	10.0
0.0	12.0
-2.0	14.0
-4.0	16.0
-6.0	18.0
-8.0	20.0

Method: Vibrocore

Casing: H-Casing [15.2]

Moisture Content Profile: 0

Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Frozen Soil Description	Field Water Content	Percent Gravel	Percent Sand	Percent Fines	Liquid Limit	Plastic Index	Other Tests
SILTY SAND: Light brown, moist	Nf							
	Nbn	16	0	68	32			
	Nf							
	Nbn							
SAND and GRAVEL: Light brown, moist, subangular gravel	Vx	10						
SILT, trace SAND: Dark grey, moist	Nbe							
	Vc							
	Nf							
	Nf							
	Nf							
	Nbn							
	Nbn							
	Nbn							

To Target Depth.

Drillhole BH16-M011 terminated at 15.2m.

Notes:

HATCH LIBRARY V1.02.GLB Log ICE BOREHOLE RAIL ALIGNMENT ALL_WITH ICE LOG_REV 3.GPJ <<DrawingFile>> 21/02/2018 10:19

HATCH

BOREHOLE REPORT

BH16-M012

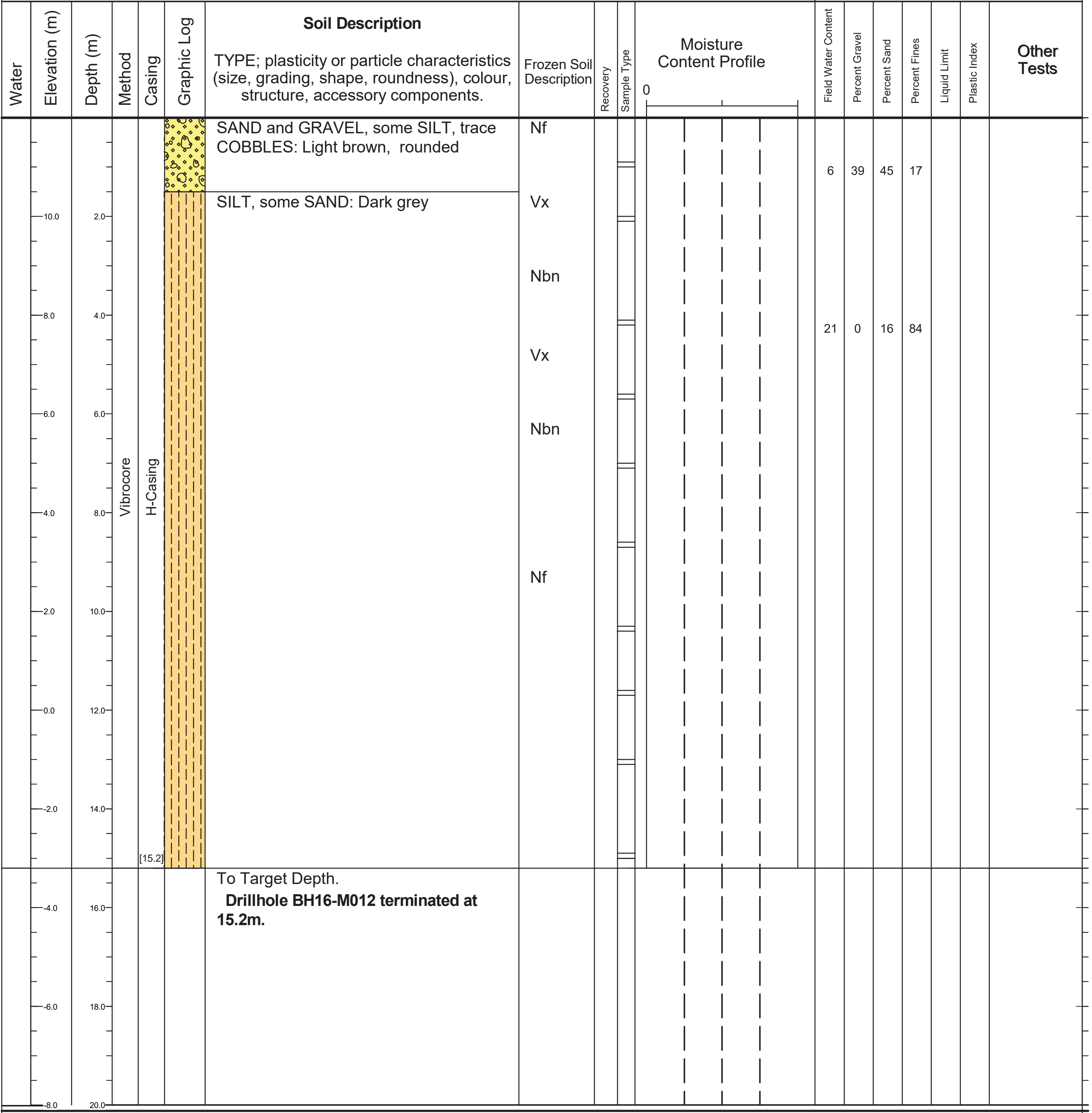
Sheet 1 of 1

Client: Baffinland Iron Mines
Project: Mary River Expansion Study Stage 2
Location: Milne Port Generator

Project No.: H352034
Datum: NAD83
Platform: Ground

Easting: 503,268.0 m
Northing: 7,974,848.0 m
Surface Elevation: 12.00 m
Bottom Elevation: -3.20 m
Total Depth: 15.2 m
Logged By: MR
Reviewed By: SH/WH

Contractor: Boart Longyear
Rig Type/ Mounting: MiniSonic Rig
Date Logged: 12/8/2016
Driller: Michael Scott
Hole Diameter (mm): 96
Date Reviewed: 2/10/2017



Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Frozen Soil Description	Field Water Content	Percent Gravel	Percent Sand	Percent Fines	Liquid Limit	Plastic Index	Other Tests
SAND and GRAVEL, some SILT, trace COBBLES: Light brown, rounded	Nf	6	39	45	17			
SILT, some SAND: Dark grey	Vx							
	Nbn							
		21	0	16	84			
	Vx							
	Nbn							
	Nf							
To Target Depth. **Drillhole BH16-M012 terminated at 15.2m.**								

Notes:

HATCH

BOREHOLE REPORT

BH16-M013

Sheet 1 of 1

Client: Baffinland Iron Mines
Project: Mary River Expansion Study Stage 2
Location: Milne Port Screening

Project No.: H352034
Datum: NAD83
Platform: Ground

Easting: 503,140.0 m
Northing: 7,974,820.0 m
Surface Elevation: 11.00 m
Bottom Elevation: -4.20 m
Total Depth: 15.2 m
Logged By: MR
Reviewed By: SH/WH

Contractor: Boart Longyear
Driller: Michael Scott
Rig Type/ Mounting: MiniSonic Rig
Hole Diameter (mm): 96
Date Logged: 12/5/2016
Date Reviewed: 2/10/2017

Water	Elevation (m)	Depth (m)	Method	Casing	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Frozen Soil Description	Recovery	Sample Type	Moisture Content Profile 0	Field Water Content	Percent Gravel	Percent Sand	Percent Fines	Liquid Limit	Plastic Index	Other Tests
			Vibrocore	H-Casing	Organic soil and GRAVEL											
					GRAVELLY SAND, some SILT: Light brown, medium to coarse grained sand, rounded to subangular gravel	Vx				25	32	48	20			
					SILT, some SAND: Dark grey	Vc				21	5	33	61			
						Nf										
						Nbn										
						Nf Nbn										
						Nf										
						Nbn Nf										
						Nbn										
				[15.2]	To Target Depth. **Drillhole BH16-M013 terminated at 15.2m.**											

Elevation (m)	Depth (m)
9.0	2.0
7.0	4.0
5.0	6.0
3.0	8.0
1.0	10.0
-1.0	12.0
-3.0	14.0
-5.0	16.0
-7.0	18.0
-9.0	20.0

Notes:

BOREHOLE REPORT

BH16-M014

Sheet 1 of 1

Client: Baffinland Iron Mines

Project: Mary River Expansion Study Stage 2

Location: Milne Port Tail Pulley

Project No.: H352034

Datum: NAD83

Platform: Ground

Easting: 503,052.0 m

Northing: 7,974,782.0 m

Surface Elevation: 11.00 m

Bottom Elevation: -4.20 m

Total Depth: 15.2 m

Logged By: MR

Reviewed By: SH/WH

Contractor: Boart Longyear

Rig Type/ Mounting: MiniSonic Rig

Date Logged: 12/5/2016

Driller: Michael Scott

Hole Diameter (mm): 96

Date Reviewed: 2/10/2017

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	**Soil Description** TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Frozen Soil Description	Recovery	Sample Type	Moisture Content Profile 0	Field Water Content	Percent Gravel	Percent Sand	Percent Fines	Liquid Limit	Plastic Index	Other Tests
			Vibrocore	H-Casing		GRAVELLY SILTY SAND: Grey to brown, angular to subangular gravel	Nf										
											6	22	52	26			
	9.0	2.0															
						SILTY SAND: Grey	Nbn										
	7.0	4.0															
											21	0	78	22			
	5.0	6.0															
							Nf										
							Nbn										
						SILT, some SAND: Dark grey, fine grained sand	Nf										
	3.0	8.0															
							Nbn										
							Nf										
	1.0	10.0															
	-1.0	12.0															
							Nbn										
	-3.0	14.0															
				[15.2]													
						To Target Depth. **Drillhole BH16-M014 terminated at 15.2m.**											
	-5.0	16.0															
	-7.0	18.0															
	-9.0	20.0															

Notes:

HATCH BOREHOLE REPORT

BH16-M015

Sheet 1 of 1

Client:	Baffinland Iron Mines	**Project No.:**	H352034
Project:	Mary River Expansion Study Stage 2	**Datum:**	NAD83
Location:	Milne Port Tail Pulley Alt.	**Platform:**	Ground
Contractor:	Boart Longyear	**Rig Type/ Mounting:**	MiniSonic Rig
Driller:	Michael Scott	**Hole Diameter (mm):**	96
Date Logged:		**Date Reviewed:**	2/10/2017

Easting:	503,007.0 m
Northing:	7,974,799.0 m
Surface Elevation:	11.00 m
Bottom Elevation:	-4.20 m
Total Depth:	15.2 m
Logged By:	MR
Reviewed By:	SH/WH

Water	Elevation (m)	Depth (m)	Method	Casing	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Frozen Soil Description	Recovery	Sample Type	Moisture Content Profile 0	Field Water Content	Percent Gravel	Percent Sand	Percent Fines	Liquid Limit	Plastic Index	Other Tests
			Vibrocore	H-Casing	SAND and GRAVEL, trace SILT, trace COBBLES: Light brown to grey, fine to coarse grained sand, rounded gravel	Nf				1	32	59	10			
	9.0	2.0														
					SAND, trace SILT: Light brown, fine to coarse grained sand,	Nf										
	7.0	4.0								14	15	71	14			
	5.0	6.0														
					SILT, some SAND: Dark grey to brown	Nbn										
						Nf										
	3.0	8.0														
	1.0	10.0														
	-1.0	12.0								24						
	-3.0	14.0														
				[15.2]						27						
					To Target Depth. **Drillhole BH16-M015 terminated at 15.2m.**											
	-5.0	16.0														
	-7.0	18.0														
	-9.0	20.0														

Notes:

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BOREHOLE REPORT

BH17-EBC-1

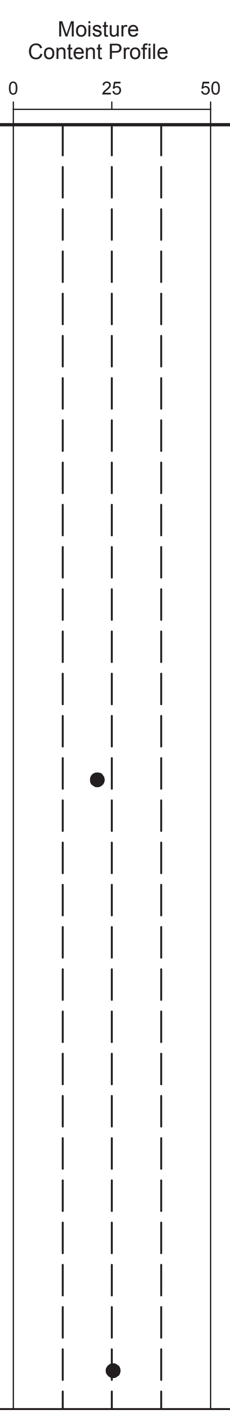
Sheet 1 of 4

Client: B.I.M
Project: Mary River Expansion Study Stage 2
Location: Rail Indexer Foundation
Project No.: H353004
Datum: NAD 83
Platform: Ground
Easting: 503,783.4 m
Northing: 7,974,920.8 m
Surface Elevation: 51.59 m
Bottom Elevation: 29.92 m
Total Depth: 21.7 m
Contractor: Boart Longyear
Rig Type/ Mounting: MiniSonic Rig
Date Logged: 9/19/2017
Logged By: R.S
Driller: Brent McAndrew
Hole Diameter (mm): 100 mm
Date Reviewed: 1/26/2018
Reviewed By: G.Q

Elevation (m)	Depth (m)
50.6	1.0
49.6	2.0
48.6	3.0
47.6	4.0
46.6	5.0
45.6	6.0
44.6	7.0
43.6	8.0
42.6	9.0
41.6	10.0

Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Frozen Soil Description	Field Water Content
FILL, Sand and Gravel. Material placed to create level drilling platform.	Unfrozen	
GRAVEL with Silt, brown and grey, frozen.	Unfrozen	
ICE, clear.	ICE	
SAND, fine to medium, brown, frozen.	Nbn	21
ICE, clear, trace silt, trace fine sand, grey.	ICE	
SAND, fine to medium, trace silt, light brown, frozen with a trace thin ice lenses.	Nbn-Vs	25

Moisture Content Profile



Notes:

HATCH

BOREHOLE REPORT

BH17-EBC-1

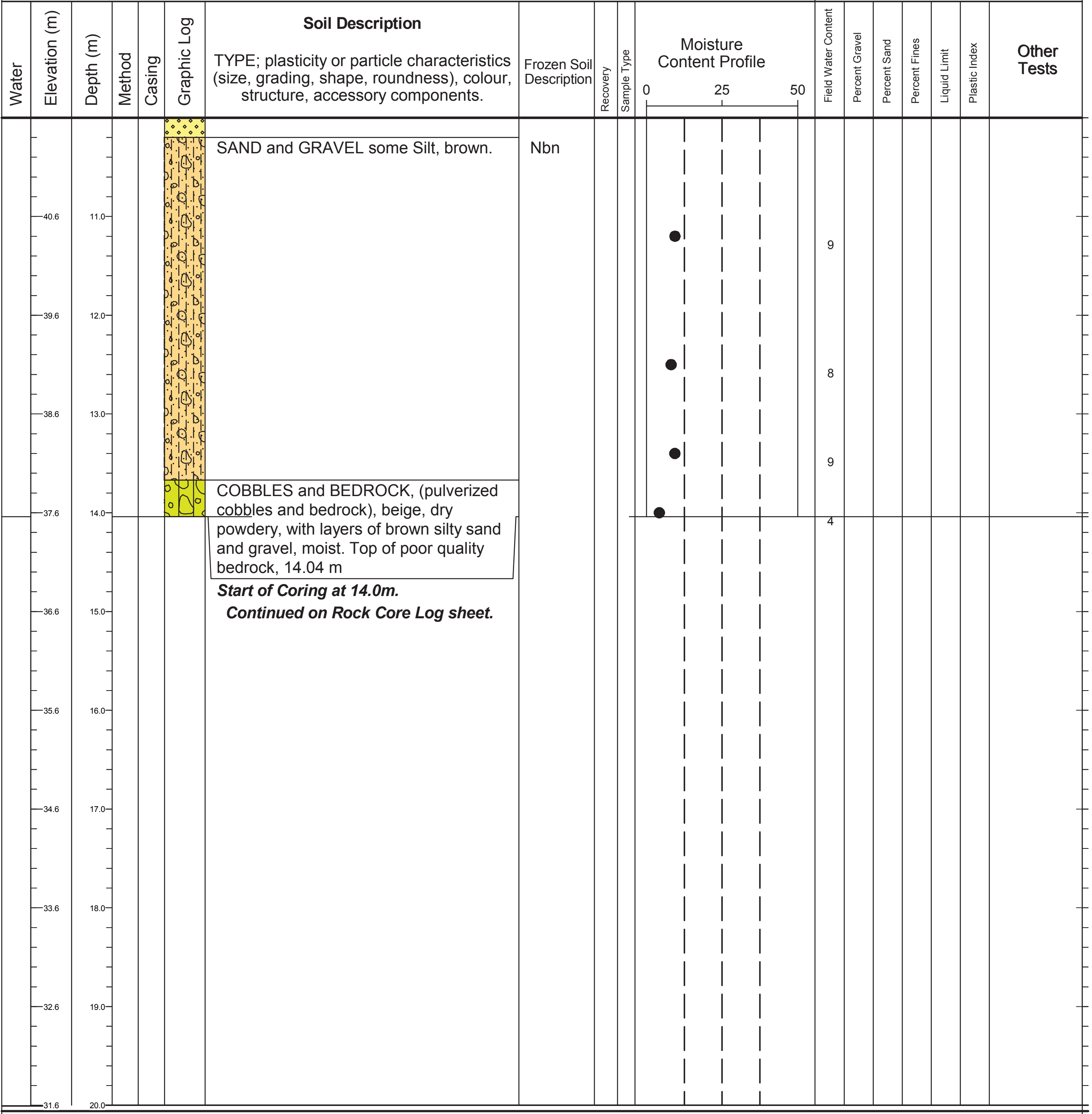
Sheet 2 of 4

Client: B.I.M
Project: Mary River Expansion Study Stage 2
Location: Rail Indexer Foundation

Project No.: H353004
Datum: NAD 83
Platform: Ground

Easting: 503,783.4 m
Northing: 7,974,920.8 m
Surface Elevation: 51.59 m
Bottom Elevation: 29.92 m
Total Depth: 21.7 m
Logged By: R.S
Reviewed By: G.Q

Contractor: Boart Longyear
Driller: Brent McAndrew
Rig Type/ Mounting: MiniSonic Rig
Hole Diameter (mm): 100 mm
Date Logged: 9/19/2017
Date Reviewed: 1/26/2018



SAND and GRAVEL some Silt, brown.

COBBLES and BEDROCK, (pulverized cobbles and bedrock), beige, dry powdery, with layers of brown silty sand and gravel, moist. Top of poor quality bedrock, 14.04 m

Start of Coring at 14.0m.

Continued on Rock Core Log sheet.

Notes:

HATCH

BOREHOLE LOG

ROCK CORE FORMAT

BH17-EBC-1

Sheet 3 of 4

Client: B.I.M

Project: Mary River Expansion Study Stage 2

Location: Rail Indexer Foundation

Project No.: H353004

Datum: NAD 83

Platform: Ground

Easting: 503,783.4 m

Northing: 7,974,920.8 m

Surface Elevation: 51.59 m

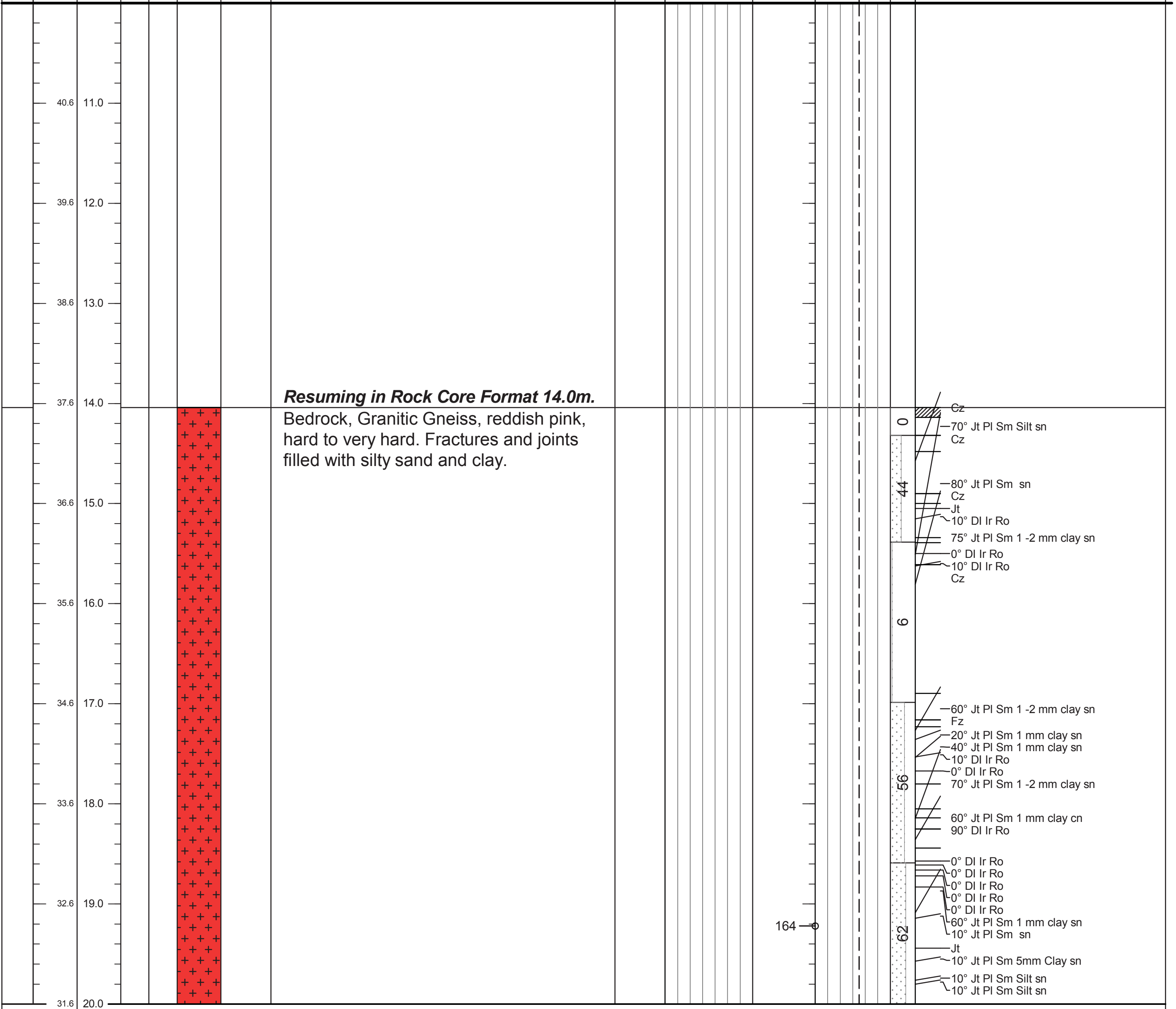
Bottom Elevation: 29.92 m

Total Depth: 21.7 m

Contractor: Boart Longyear **Rig Type/ Mounting:** MiniSonic Rig **Bearing:** N/A **Date Logged:** 9/19/2017 **Logged By:** R.S

Driller: Brent McAndrew **Hole Diameter (mm):** 100 mm **Plunge:** Vertical **Date Checked:** 1/26/2018 **Reviewed By:** G.Q

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Geological Unit	**Rock Description** ROCK TYPE; Grain size, texture and fabric, colour, general defect conditions, minor constituents.	Weathering/ Cementation	Estimated Strength EH VH H M L VL EL	$Is_{(50)}$ [UCS] MPa	Defect Spacing mm 2000 600 200 [100] 60 20	RQD %	



Resuming in Rock Core Format 14.0m.

Bedrock, Granitic Gneiss, reddish pink, hard to very hard. Fractures and joints filled with silty sand and clay.

Notes:

BOREHOLE LOG

ROCK CORE FORMAT

BH17-EBC-1

Sheet 4 of 4

Client:	B.I.M	**Project No.:**	H353004
Project:	Mary River Expansion Study Stage 2	**Datum:**	NAD 83
Location:	Rail Indexer Foundation	**Platform:**	Ground

Easting:	503,783.4 m
Northing:	7,974,920.8 m
Surface Elevation:	51.59 m
Bottom Elevation:	29.92 m
Total Depth:	21.7 m
Logged By:	R.S
Reviewed By:	G.Q

Contractor:	Boart Longyear	**Rig Type/ Mounting:**	MiniSonic Rig	**Bearing:**	N/A	**Date Logged:**	9/19/2017
Driller:	Brent McAndrew	**Hole Diameter (mm):**	100 mm	**Plunge:**	Vertical	**Date Checked:**	1/26/2018

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Geological Unit	**Rock Description** ROCK TYPE; Grain size, texture and fabric, colour, general defect conditions, minor constituents.	Weathering/ Cementation	Estimated Strength EH VH H M L VL EL	Is(50) [UCS] MPa	Defect Spacing mm 2000 600 200 **[100]** 60 20	RQD %	
							Bedrock, Granitic Gneiss, reddish pink, hard to very hard. Fractures and joints filled with silty sand and clay. *(Continued)*					66	85° Jt Pl Sm Silt sn 85° Jt Pl Sm Silt sn 85° Jt Pl Sm Silt sn 85° Jt Pl Sm Silt sn 85° Jt Pl Sm 1 mm clay sn 85° Jt Pl Sm Silt sn 85° Jt Pl Sm Silt sn 85° Jt Pl Sm Silt sn 85° Jt Pl Sm Silt sn 85° Jt Pl Sm Silt sn 85° Jt Pl Sm Silt sn 10° Cz Ir Ro Silt
	30.6	21.0											
							To Target Depth. **Drillhole BH17-EBC-1 terminated at 21.7m.**						10° Dl Ir Ro Silt 10° Dl Ir Ro Silt 10° Dl Ir Ro Silt 10° Dl Ir Ro Silt
	29.6	22.0											
	28.6	23.0											
	27.6	24.0											
	26.6	25.0											
	25.6	26.0											
	24.6	27.0											
	23.6	28.0											
	22.6	29.0											
	21.6	30.0											

Notes:

BOREHOLE REPORT

BH17-EBC-2

Sheet 1 of 4

Client: B.I.M

Project: Mary River Expansion Study Stage 2

Location: Rail Indexer Foundation

Project No.: H353004

Datum: NAD 83

Platform: Ground

Easting: 503,790.9 m

Northing: 7,974,895.2 m

Surface Elevation: 54.05 m

Bottom Elevation: 32.21 m

Total Depth: 21.8 m

Contractor: Boart Longyear

Rig Type/ Mounting: MiniSonic Rig

Date Logged: 9/24/2017

Logged By: R.S

Driller: Brent McAndrew

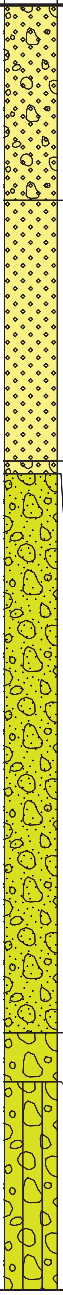
Hole Diameter (mm): 100 mm

Date Reviewed: 1/26/2018

Reviewed By: G.Q

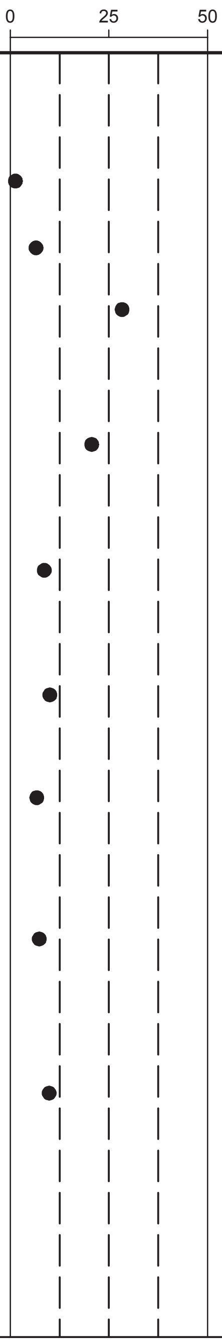
Elevation (m)	Depth (m)
53.1	1.0
52.1	2.0
51.1	3.0
50.1	4.0
49.1	5.0
48.1	6.0
47.1	7.0
46.1	8.0
45.1	9.0
44.1	10.0

Graphic Log



Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Frozen Soil Description
SAND and GRAVEL with Silt and Cobbles. Gravel is well graded up to 75 mm, cobbles infered from pulveriszed, dry, beige rock flour. Sand is brown. Unfrozen.	Unfrozen
SAND trace Silt ,fine to medium, brown, frozen, (ice poor soil)	Nbn
SAND and GRAVEL, medium sand to medium gravel, angular, brown, frozen. (ice poor soil)	Nbn
GRAVEL with Sand trace Silt. Fine sand to coarse gravel, angular, brown and beige, frozen (ice poor soil)	Nbn
GRAVEL with Silt, brown and grey, frozen. (ice poor soil)	Nbn
COBBLES and GRAVEL some Silt, trace Sand.	

Moisture Content Profile



Depth (m)	Field Water Content
1.0	1
	6
2.0	28
3.0	21
4.0	9
5.0	10
	7
	7
	10

Water | Method | Casing | Recovery | Sample Type | Percent Gravel | Percent Sand | Percent Fines | Liquid Limit | Plastic Index | Other Tests

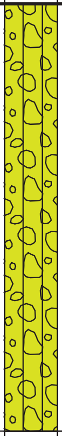
Notes:

HATCH BOREHOLE REPORT

BH17-EBC-2

Sheet 2 of 4

Client:	B.I.M
Project:	Mary River Expansion Study Stage 2
Location:	Rail Indexer Foundation
Project No.:	H353004
Datum:	NAD 83
Platform:	Ground
Easting:	503,790.9 m
Northing:	7,974,895.2 m
Surface Elevation:	54.05 m
Bottom Elevation:	32.21 m
Total Depth:	21.8 m
Contractor:	Boart Longyear
Rig Type/ Mounting:	MiniSonic Rig
Date Logged:	9/24/2017
Logged By:	R.S
Driller:	Brent McAndrew
Hole Diameter (mm):	100 mm
Date Reviewed:	1/26/2018
Reviewed By:	G.Q

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	**Soil Description** TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Frozen Soil Description	Recovery	Sample Type	Moisture Content Profile 0 25 50	Field Water Content	Percent Gravel	Percent Sand	Percent Fines	Liquid Limit	Plastic Index	Other Tests
						COBBLES and GRAVEL some Silt, trace Sand. *(Continued)*											
	43.1	11.0															
	42.1	12.0															
	41.1	13.0															
						Start of Coring at 13.3m. ***Continued on Rock Core Log sheet.***											
	40.1	14.0															
	39.1	15.0															
	38.1	16.0															
	37.1	17.0															
	36.1	18.0															
	35.1	19.0															
	34.1	20.0															

Notes:

HATCH

BOREHOLE LOG

ROCK CORE FORMAT

BH17-EBC-2

Sheet 3 of 4

Client: B.I.M

Project: Mary River Expansion Study Stage 2

Location: Rail Indexer Foundation

Project No.: H353004

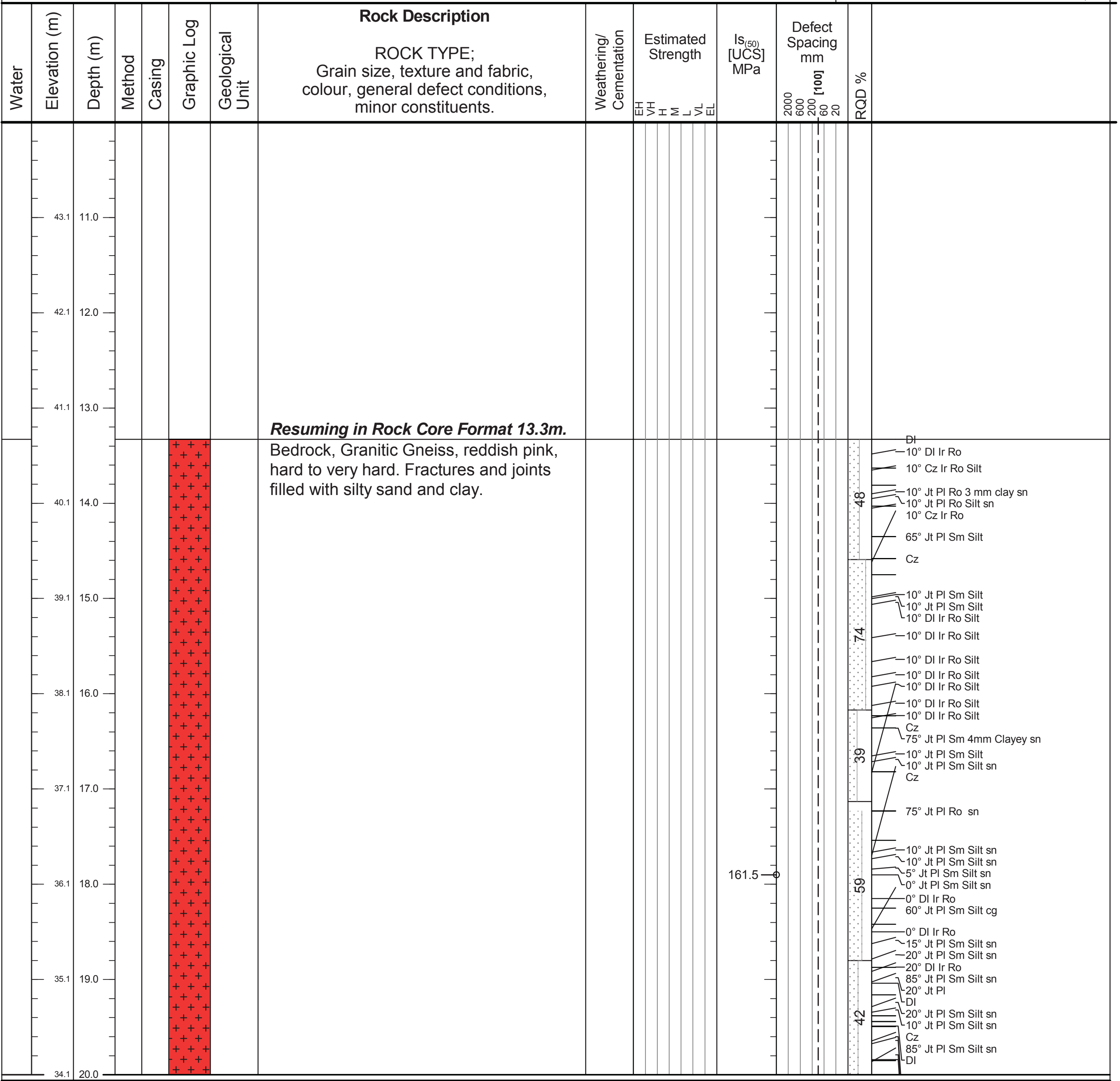
Datum: NAD 83

Platform: Ground

Easting:	503,790.9 m
Northing:	7,974,895.2 m
Surface Elevation:	54.05 m
Bottom Elevation:	32.21 m
Total Depth:	21.8 m
Logged By:	R.S
Reviewed By:	G.Q

Contractor: Boart Longyear **Rig Type/ Mounting:** MiniSonic Rig **Bearing:** N/A **Date Logged:** 9/24/2017

Driller: Brent McAndrew **Hole Diameter (mm):** 100 mm **Plunge:** Vertical **Date Checked:** 1/26/2018



Resuming in Rock Core Format 13.3m.

Bedrock, Granitic Gneiss, reddish pink, hard to very hard. Fractures and joints filled with silty sand and clay.

Notes:

HATCH

BOREHOLE LOG

ROCK CORE FORMAT

BH17-EBC-2

Sheet 4 of 4

Client:	B.I.M	**Project No.:**	H353004
Project:	Mary River Expansion Study Stage 2	**Datum:**	NAD 83
Location:	Rail Indexer Foundation	**Platform:**	Ground

Easting:	503,790.9 m
Northing:	7,974,895.2 m
Surface Elevation:	54.05 m
Bottom Elevation:	32.21 m
Total Depth:	21.8 m
Logged By:	R.S
Reviewed By:	G.Q

Contractor:	Boart Longyear	**Rig Type/ Mounting:**	MiniSonic Rig	**Bearing:**	N/A	**Date Logged:**	9/24/2017
Driller:	Brent McAndrew	**Hole Diameter (mm):**	100 mm	**Plunge:**	Vertical	**Date Checked:**	1/26/2018

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Geological Unit	**Rock Description** ROCK TYPE; Grain size, texture and fabric, colour, general defect conditions, minor constituents.	Weathering/ Cementation	Estimated Strength EH VH H M L VL EL	$Is_{(50)}$ [UCS] MPa	Defect Spacing mm 2000 600 200 **[100]** 60 20	RQD %	
	33.1	21.0					Bedrock, Granitic Gneiss, reddish pink, hard to very hard. Fractures and joints filled with silty sand and clay. *(Continued)*					42 42	85° Jt Pl Sm Silt sn 20° Jt Pl Sm Silt sn 15° Jt Pl Sm Silt sn 30° Jt Pl Sm Silt sn 0° Dl Ir Ro 85° Jt Pl Sm Silt sn 0° Dl Ir Ro 20° Jt Pl Sm Silt sn 15° Jt Pl Sm Silt sn 25° Dl Ir Ro 10° Jt Pl Sm Silt sn Cz 5° Jt Pl Sl vn Cz 0° Dl Ir Ro
	32.1	22.0					To Target Depth. **Drillhole BH17-EBC-2 terminated at 21.8m.**						0° Dl Ir Ro 0° Dl Ir Ro 0° Dl Ir Ro 0° Jt Pl Ro Silt sn 0° Jt Pl Ro Silt sn 0° Jt Pl Ro Silt sn 0° Jt Pl Ro Silt sn 0° Dl Ir Ro
	31.1	23.0											
	30.1	24.0											
	29.1	25.0											
	28.1	26.0											
	27.1	27.0											
	26.1	28.0											
	25.1	29.0											
	24.1	30.0											

Notes:

BOREHOLE REPORT

BH17-M008-R

Sheet 1 of 4

Client: B.I.M

Project: Mary River Expansion Study Stage 2

Location: Rail Indexer Foundation

Project No.: H353004

Datum: NAD 83

Platform: Ground

Easting: 503,772.0 m

Northing: 7,974,960.0 m

Surface Elevation: 52.00 m

Bottom Elevation: 30.01 m

Total Depth: 22.0 m

Contractor: Boart Longyear

Rig Type/ Mounting: MiniSonic Rig

Date Logged: 9/17/2017

Logged By: R.S

Driller: Brent McAndrew

Hole Diameter (mm): 100 mm

Date Reviewed: 1/26/2018

Reviewed By: G.Q

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Frozen Soil Description	Recovery	Sample Type	Moisture Content Profile 0 25 50	Field Water Content	Percent Gravel	Percent Sand	Percent Fines	Liquid Limit	Plastic Index	Other Tests
						NO SAMPLES TAKEN IN OVERBURDEN. Avanced and sonic tube to refusal to begin diamond coring bedrock.											
	51.0	1.0															
	50.0	2.0															
	49.0	3.0															
	48.0	4.0															
	47.0	5.0															
	46.0	6.0															
	45.0	7.0															
	44.0	8.0															
	43.0	9.0															
	42.0	10.0															

Notes: Redrill of BH16-M008. Elevation is approximate.

BOREHOLE REPORT

BH17-M008-R
Sheet 2 of 4

Client:	B.I.M	**Project No.:**	H353004
Project:	Mary River Expansion Study Stage 2	**Datum:**	NAD 83
Location:	Rail Indexer Foundation	**Platform:**	Ground

Easting:	503,772.0 m
Northing:	7,974,960.0 m
Surface Elevation:	52.00 m
Bottom Elevation:	30.01 m
Total Depth:	22.0 m
Logged By:	R.S
Reviewed By:	G.Q

Contractor: Boart Longyear **Rig Type/ Mounting:** MiniSonic Rig **Date Logged:** 9/17/2017

Driller: Brent McAndrew **Hole Diameter (mm):** 100 mm **Date Reviewed:** 1/26/2018

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	**Soil Description** TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Frozen Soil Description	Recovery	Sample Type	Moisture Content Profile 0 25 50	Field Water Content	Percent Gravel	Percent Sand	Percent Fines	Liquid Limit	Plastic Index	**Other Tests**
						NO SAMPLES TAKEN IN OVERBURDEN. Avanced and sonic tube to refusal to begin diamond coring bedrock. *(Continued)*											
	41.0	11.0															
	40.0	12.0															
	39.0	13.0															
	38.0	14.0															
	37.0	15.0															
	36.0	16.0															
	35.0	17.0															
						Start of Coring at 17.4m. ***Continued on Rock Core Log sheet.***											
	34.0	18.0															
	33.0	19.0															
	32.0	20.0															

Notes: Redrill of BH16-M008. Elevation is approximate.

HATCH

BOREHOLE LOG

ROCK CORE FORMAT

BH17-M008-R

Sheet 3 of 4

Client: B.I.M

Project: Mary River Expansion Study Stage 2

Location: Rail Indexer Foundation

Project No.: H353004

Datum: NAD 83

Platform: Ground

Easting: 503,772.0 m

Northing: 7,974,960.0 m

Surface Elevation: 52.00 m

Bottom Elevation: 30.01 m

Total Depth: 22.0 m

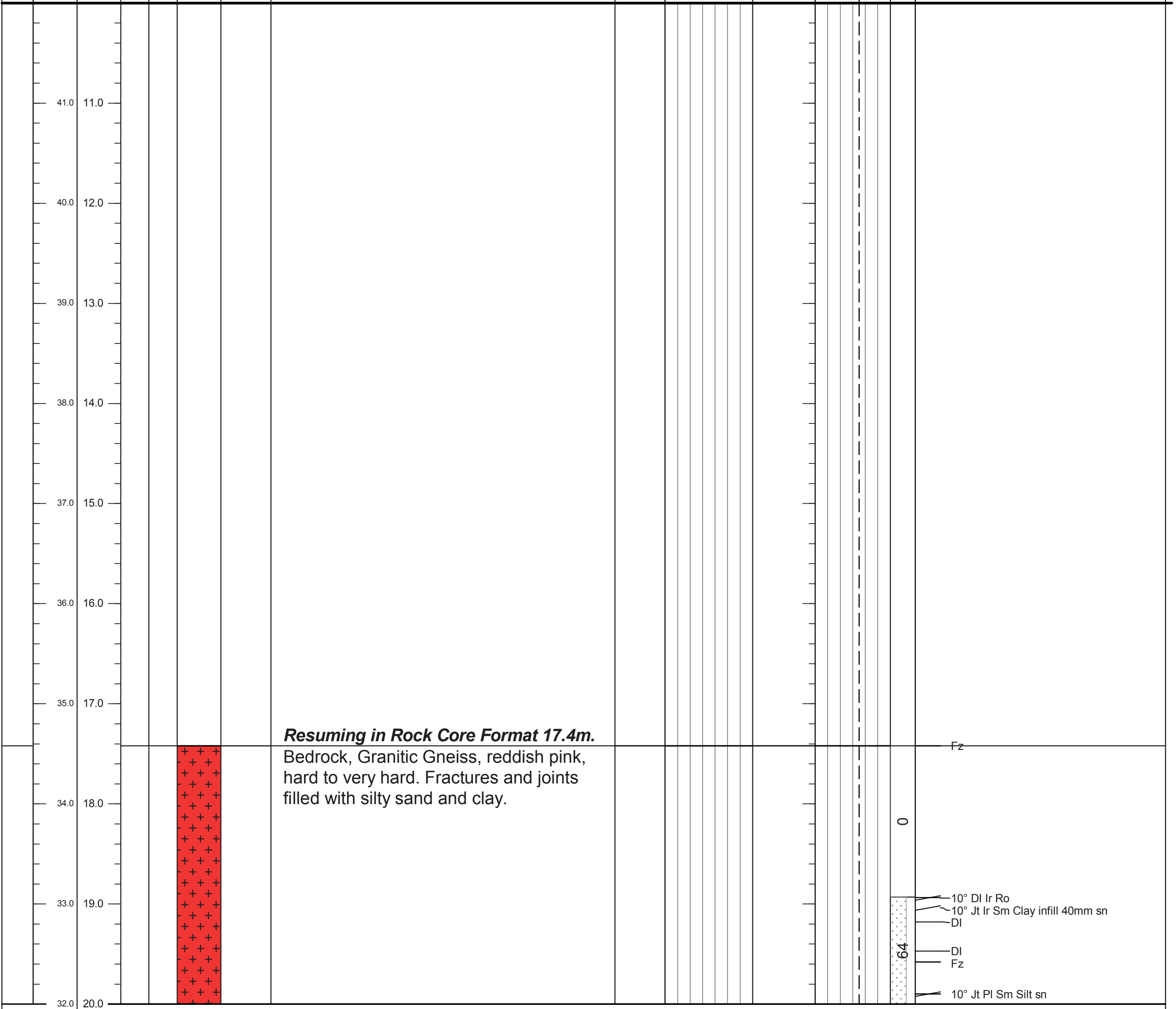
Logged By: R.S

Reviewed By: G.Q

Contractor: Boart Longyear **Rig Type/ Mounting:** MiniSonic Rig **Bearing:** N/A **Date Logged:** 9/17/2017

Driller: Brent McAndrew **Hole Diameter (mm):** 100 mm **Plunge:** Vertical **Date Checked:** 1/26/2018

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Geological Unit	**Rock Description** ROCK TYPE; Grain size, texture and fabric, colour, general defect conditions, minor constituents.	Weathering/ Cementation	Estimated Strength EH VH H M L VL EL	Is(50) [UCS] MPa	Defect Spacing mm 2000 600 200 [100] 60 20	RQD %



Resuming in Rock Core Format 17.4m.
Bedrock, Granitic Gneiss, reddish pink, hard to very hard. Fractures and joints filled with silty sand and clay.

Notes: Redrill of BH16-M008. Elevation is approximate.

BOREHOLE LOG

ROCK CORE FORMAT

BH17-M008-R

Sheet 4 of 4

Client:	B.I.M	**Project No.:**	H353004
Project:	Mary River Expansion Study Stage 2	**Datum:**	NAD 83
Location:	Rail Indexer Foundation	**Platform:**	Ground

Easting:	503,772.0 m
Northing:	7,974,960.0 m
Surface Elevation:	52.00 m
Bottom Elevation:	30.01 m
Total Depth:	22.0 m
Logged By:	R.S
Reviewed By:	G.Q

Contractor: Boart Longyear **Rig Type/ Mounting:** MiniSonic Rig **Bearing:** N/A **Date Logged:** 9/17/2017

Driller: Brent McAndrew **Hole Diameter (mm):** 100 mm **Plunge:** Vertical **Date Checked:** 1/26/2018

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Geological Unit	**Rock Description** ROCK TYPE; Grain size, texture and fabric, colour, general defect conditions, minor constituents.	Weathering/ Cementation	Estimated Strength EH VH H M L VL EL	$Is_{(50)}$ [UCS] MPa	Defect Spacing mm 2000 600 200 [100] 60 20	RQD %	
	31.0	21.0			+ + +		Bedrock, Granitic Gneiss, reddish pink, hard to very hard. Fractures and joints filled with silty sand and clay. *(Continued)*			57.9 46.1 94.8		64 68	10° Dl Ir Ro 10° Dl Ir Ro 10° Dl Ir Ro 10° Dl Ir Ro 30° Jt Pl Sm Silt sn 10° Dl Ir Ro 10° Dl Ir Ro 10° Jt Cu Sm Silt sn 45° Dl Ir Ro 0° Dl Ir Ro 10° Jt Ir Ro Silt sn 50° Jt Ir Ro Silt sn 0° Dl Ir Ro 0° Jt Ir Sm Silt sn 10° Dl Ir Ro
	30.0	22.0					To Target Depth. **Drillhole BH17-M008-R terminated at 22.0m.**						
	29.0	23.0											
	28.0	24.0											
	27.0	25.0											
	26.0	26.0											
	25.0	27.0											
	24.0	28.0											
	23.0	29.0											
	22.0	30.0											

Notes: Redrill of BH16-M008. Elevation is approximate.

Appendix A3

Thermal Analyses Methodology

Appendix A3

Thermal Analyses

Two-dimensional finite element modelling, with commercially available software (Temp/W), was used to predict the thermal regime for the tunnel foundation.

The air temperature is based on the mean monthly air temperature from Pond Inlet, NU (1981-2010) extracted from the government of Canada website, see Figure A-3-1.

The global warming effect was taken into account according to the Intergovernmental Panel on Climate Change (IPCC) long term climate change studies. A temperature adjustment was applied considering to global warming for the period spanning from 2010 to 2039 (Hatch 2018).

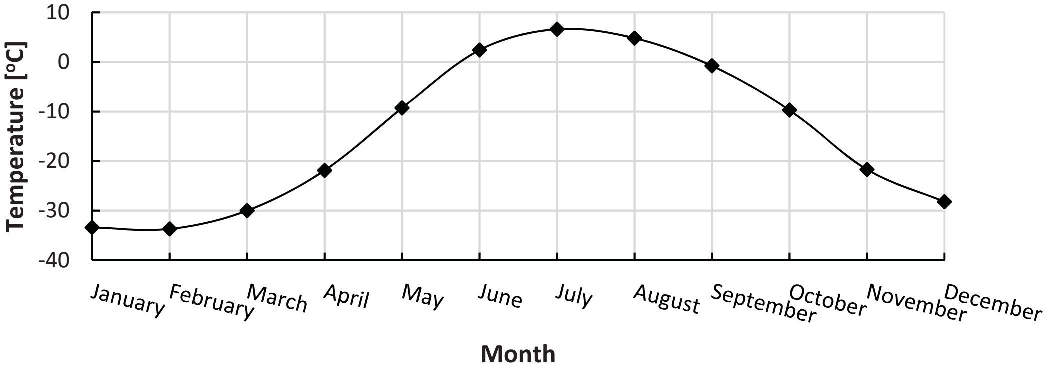


Figure A-3-1: Mean Monthly Temperatures for Pond Inlet, NU (1981-2010)

Surface boundary conditions at the site were obtained based on the n-factors which was used to correlate air temperatures to ground surface temperatures during cold seasons (n_f) and thaw seasons (n_t). Values of n_t and n_f used in the analysis were summarized in Table A-3-1 Typically, n_f is less than 1 considering the impact of snow accumulation/insulation over ground surface during winter while n_t is more than 1 considering the impact of radiation.

Inside the tunnel, the n factor of 1 was used assuming that the ground surface temperature is same as the air temperature. It is noted that in summer the air temperature in the tunnel could be colder than the air temperature outside while in winter, the inside air temperature in the tunnel becomes is likely warmer than the outside air temperature. There is no sufficient data/study to quantify the two opposite effects. As such, this study assumed that the air temperature in tunnel is same.

The available thermistor data from the Mary River site (Hatch, 2012) indicate that ground temperature reaches equilibrium (at -10° C) below 15m depth, thus the bottom boundary was assumed to be 15m below the ground surface, with a constant temperature of -10° C.

The construction of the tunnel foundation is set in April, 2019.

The results are shown in the figures in this appendix.

Table A-3-1: N-factors to be Used in Modelling

Material	N – factors	
	Freezing (n_f)	Thawing (n_t)
Native Sand	0.7	1.2
Native Silt	0.5	1.2
Rockfill / Granular Backfill	0.8	1.5
Tunnel Inside Boundary	1	1

Appendix A4

Settlement Analyses Methodology

Appendix A4

Settlement Analyses

Two-dimensional finite element modelling, with commercially available software (Sigma/W), was used to predict the displacement.

Figure A-4-1 and Table A-4-2 shows the engineering parameters for unfrozen soil, frozen silt and frozen till used in the analyses.

In the model, the creep deformation was modeled using a long-term strength envelope and equivalent long-term deformation modulus (see details in Hatch 2018).

For the soil beyond structures/facilities, the following simplified soil profile was used as per the warmest envelope from the thermistor monitoring data (see the figure below).

a. 0 m to 3 m depth: Soil in Active Zone*

b. 3 m to 7 m depth: Frozen Soil (above - 7° C)

c. Below 7 m depth: Frozen Soil (below - 7° C)

Note: * The properties of the unfrozen soil was used for the soil between 2 m to 3 m depth as a conservative assumption.

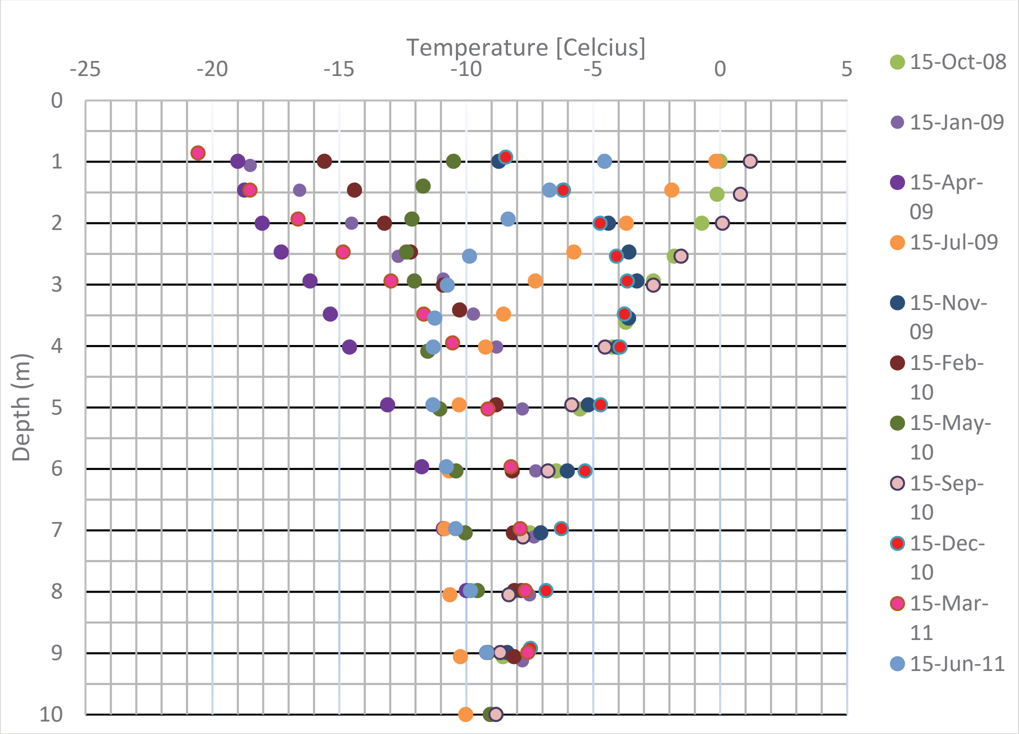


Figure: A-1: Temperature Profiles containing Numerical and Recorded Data Overlain

(Thermistor data from BH2007-10, reported by Knight Piesold, 2008)

Table A-4-1: General Design Parameters

Materials	Elastic Young's Modulus	Poisson's Ratio	Unit Weight	Strength Parameters	
	Es, (MPa)		kN/m^3	c' (kPa)	ϕ' (Degrees)
Ore	30	0.33	26	0	40°
Engineered Fill (compacted crushed rockfill)	70	0.33	22	0	40°
Rockfill	70	0.33	22	0	40°
Native Silt	8 (unfrozen condition)	0.33	18	0	30°
Native Sand	15 (unfrozen condition)	0.33	18	0	32°

Table A-4-2: Design Parameters for Frozen Silty Permafrost

Temperature	Long-term Deformation Modulus	Poisson's Ratio	Unit Weight	Strength Parameters For Creep Analyses (20-year design life)	
	Ec, (MPa)		kN/m^3	c'_{LT} (kPa)	ϕ'_{LT}
Above - 7° C	22	0.33	18	0	30°
Below -7° C	44	0.33	18	0	30°

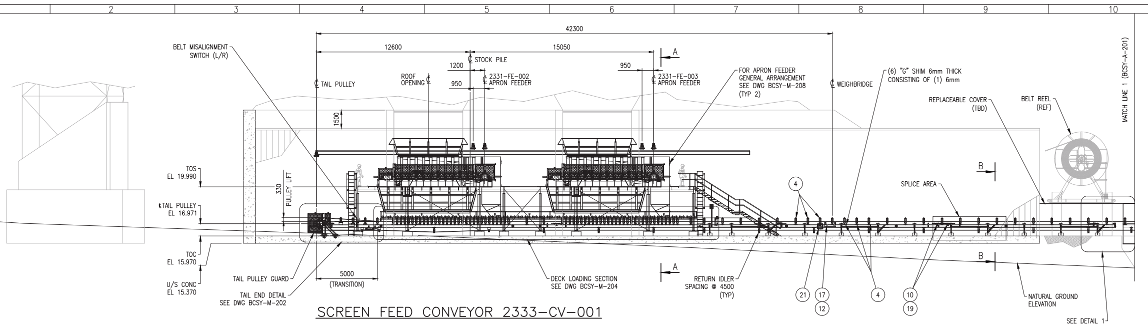
Note: The underlying till material is considered very stiff in its hard frozen state (< - 7°C) with a high deformation modulus of 1,000 MPa.

Table A-4-3: Design Parameters for Frozen Sandy Permafrost

Temperature	Long-term Deformation Modulus	Poisson's Ratio	Unit Weight	Strength Parameters For Creep Analyses (20-year design life)	
	Ec, (MPa)		kN/m^3	c'_{LT} (kPa)	ϕ'_{LT}
Above - 7° C	80	0.33	18	0	32°
Below -7° C	160	0.33	18	0	32°

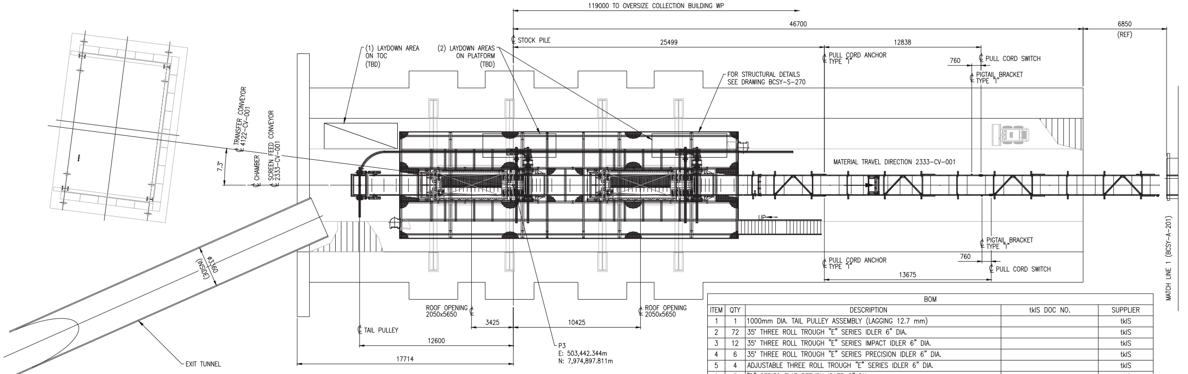
Note: The underlying till material is considered very stiff in its hard frozen state (< - 7°C) with a high deformation modulus of 1,000 MPa.

Appendix B1
Stockpile Reclaim Tunnel Drawings



SCREEN FEED CONVEYOR 2333-CV-001
TAIL END ELEVATION VIEW

SCALE 1:150



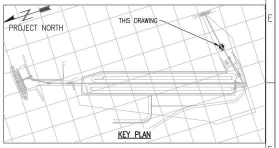
SCREEN FEED CONVEYOR 2333-CV-001
TAIL END PLAN VIEW

SCALE 1:150

REFERENCE DRAWING	
DRAWING NO.	TITLE
BCSY-A-201	SCREEN FEED CONVEYOR 2333-CV-001 GENERAL ARRANGEMENT SHEET 2
BCSY-M-200	SCREEN FEED CONVEYOR 2333-CV-001 DATA SHEET
BCSY-M-202	SCREEN FEED CONVEYOR 2333-CV-001 TAIL END DETAIL
BCSY-M-204	SCREEN FEED CONVEYOR 2333-CV-001 APRON FEEDER DECK LOADING SECTION
BCSY-M-208	SCREEN FEED CONVEYOR 2333-CV-001 APRON FEEDER G.A.
BCSY-S-270	RECLAIM CHAMBER – STEEL STRUCTURE SUPPORTING AF'S STRUCTURE PLAN & ELEVATION
BCSY-T-111	SCALE DECK SECTION STANDARD DETAILS
BCSY-T-114	PULL CORD SWITCH MOUNTING BRACKET
BCSY-T-120	STRUCTURAL SUPPORT TYPICAL CONNECTION DETAILS

NOTES

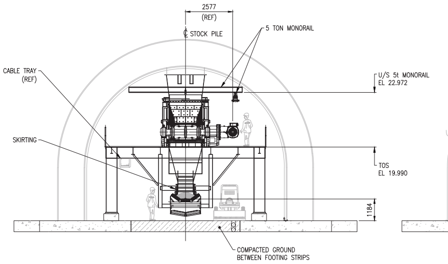
1. ALL DIMENSIONS ARE IN [mm] & ELEVATIONS ARE IN [m].
2. FOR GENERAL FABRICATION NOTES, SEE FABRICATION SPECIFICATION BCSY-S-002.
3. ANY BOLTS NOT LISTED IN BILL OF MATERIALS ARE IN STEEL FABRICATORS SCOPE OF SUPPLY.
4. FOR ALL BOLTED CONNECTIONS, SEE FABRICATION SPECIFICATION BCSY-S-002 SECTION 6.3 UNO.
5. ADDITIONAL BILL OF MATERIAL ITEMS SHOWN ON DRAWINGS BCSY-M-202 & BCSY-M-204.
6. FOR WEIGHBRIDGE DETAILS SEE DRAWING BCSY-T-111.
7. FOR PULLCORD & PIGTAIL BRACKETS SEE DRAWING BCSY-T-114.
8. FOR STRINGER CONNECTION DETAILS SEE DRAWING BCSY-T-120.



KEY PLAN

BOM				
ITEM	QTY	DESCRIPTION	tkIS DOC NO.	SUPPLIER
1	1	1000mm DIA. TAIL PULLEY ASSEMBLY (LAGGING 12.7 mm)		tkIS
2	72	35° THREE ROLL TROUGH "E" SERIES IDLER 6" DIA.		tkIS
3	12	35° THREE ROLL TROUGH "E" SERIES IMPACT IDLER 6" DIA.		tkIS
4	6	35° THREE ROLL TROUGH "E" SERIES PRECISION IDLER 6" DIA.		tkIS
5	4	ADJUSTABLE THREE ROLL TROUGH "E" SERIES IDLER 6" DIA.		tkIS
6	3	"D" SERIES FLAT RETURN IDLER 5" DIA.		tkIS
7	11	"D" SERIES V-RETURN 10 IDLER 5" DIA.		tkIS
8	1	"D" SERIES INVERTED V-RETURN 10 IDLER 5" DIA.		tkIS
9	1	"MARTIN" 54" BELT V-PLOW, C/W (2) 24" LG 1/8" SS. RESTRAINING CABLE		tkIS
10	4	"THERMO RAMSEY" PULL CORD – SAS NEMA TYPE-4X		tkIS
11	1	"THERMO RAMSEY" 60-12 SPEED SENSOR		tkIS
12	1	"THERMO RAMSEY" 10-20 WEIGHBRIDGE C/W 9101 MICROTECH SCALE INTEGRATOR		tkIS
13	2	"CONVEYOR COMPONENTS COMPANY" TA-5 BELT ALIGNMENT CONTROL SWITCH		tkIS
14	2	"CONVEYOR COMPONENTS COMPANY" DB-500 BELT RIP DETECTOR		tkIS
15	1	"AXIS COMMUNICATIONS" T98A-VE MEDIA CONVERTER CABINET A SERIES C/W MOUNTING PLATE & MOUNT T91A67		tkIS
16	8	1 1/2-6 UNC HEAVY HEX BOLTS, NUTS & FLAT WASHERS		tkIS
17	4	3/4-10 x 60 UNC HEAVY HEX BOLTS, NUT, FLAT WASHER, & BEVELED WASHER		tkIS
18	40	5/8-11 x 51 UNC HEAVY HEX BOLTS, NUTS & FLAT WASHERS		tkIS
19	22	3/8-16 x 45LG UNC HEX BOLTS, NUTS & FLAT WASHERS		MECH. ERECTOR
20	8	3/8-16 x 38LG UNC HEX BOLTS, NUTS & FLAT WASHERS		MECH. ERECTOR
21	4	5/16-18 x 32LG UNC HEX BOLTS, NUTS & FLAT WASHERS		MECH. ERECTOR
22	6	12-24 x 25LG PHILIPS PAN HEAD MACHINE SCREWS, HEX NUT & FLAT WASHERS		MECH. ERECTOR
23	51.7m	"MARTIN" APRON SEAL, SINGLE SKIRTING XHD		tkIS
24	51.7m	"MARTIN" HD ANGLE CLAMP WELDMENT W/ QUICK-RELEASE CLAMP & HARDWARE		tkIS

CLIENT DRAWING NUMBER:
E353004-CM001-240-270-0002-0001



SECTION A-A

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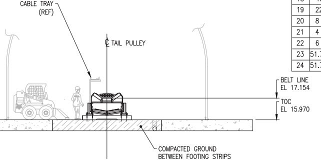

SECTION B-B

SCALE 1:100

PRELIMINARY

tkIS (Canada) Inc.

Tolerances for machined surfaces ISO 2768 part 1/2 Tolerance classification m/K

Tolerances for welded constructions ISO 13920 Tolerance classification B/F

Surface ISO 1302

Scale AS SHOWN

Weight kg

Bill of Material

Material

	Date (YY-MM-DD)	Name
Drawn	17-01-17	A. ZHAN
Checked	17-01-23	S.STUPAR
Designed		
Approved	17-01-31	I. MRLJIC

Index	Revision	Date (YY-MM-DD)	Name	Checked
E	ISSUED FOR RFQ	17-08-31	M.E.	R.V.
D	ISSUED FOR RFQ	17-08-02	M.E.	R.V.
C	ISSUED FOR REVIEW	17-06-13	A.Z.	G.R.
B	ISSUED FOR PROPOSAL	17-05-17	A.Z.	R.G.
A	ISSUED FOR BID	17-02-03	A.Z.	S.S.

BAFFINLAND IRON MINES – MARY RIVER EXPANSION PROJECT

SCREEN FEED CONVEYOR 2333-CV-001
GENERAL ARRANGEMENT SHEET 1

thyssenkrupp

Drawing-Ident No. BCSY-A-200

CH.

Key-No.

Size A1

Sheet

CAD

Sheets

Origin:

Supercedes:

Superceded by:

PLOT DATE: 7 September 2017 FILE: G:\BAF\BCSY\DRAWINGS\TEMPORARY ARCHIVE\BCSY-A-200_E.DWG

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DRAWING NO.	TITLE
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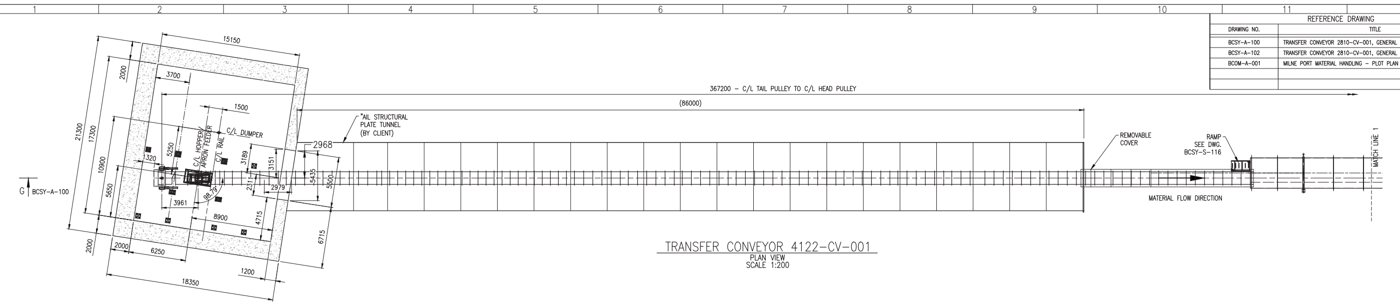
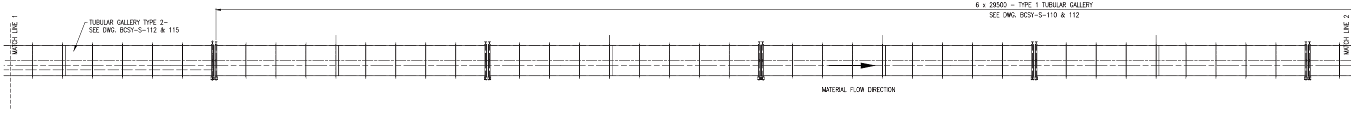
BCSY-A-102	TRANSFER CONVEYOR 2810-CV-001, GENERAL ARRANGEMENT SHEET 3
BCOM-A-001	MILNE PORT MATERIAL HANDLING – PLOT PLAN



TRANSFER CONVEYOR 4122-CV-001

PLAN VIEW
SCALE 1:200



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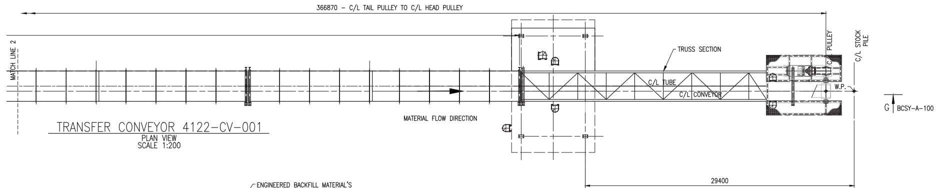

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PLAN VIEW
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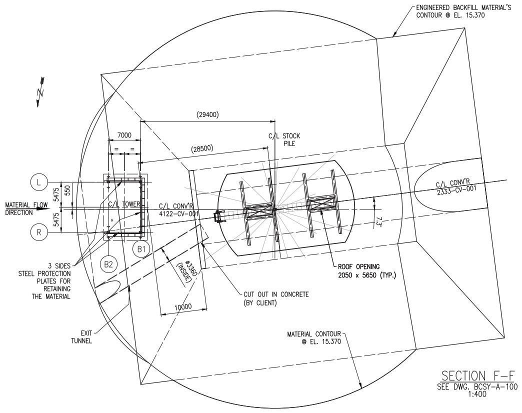

SECTION F–F

SEE DWG. BCSY-A-100
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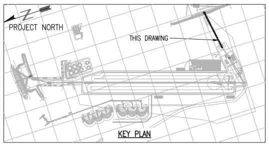


KEY PLAN

HATCH Vendor/Contractor Document Review

Doc Number	E353004-CM001-240-270-0001-0002	SUB	02
Date Received			

Review Grade	Next Submittal Status
☐ **C1** - Proceed to next submission & status ☐ **C2** - Proceed with exceptions as noted to next submission & status	☐ Certified ☐ As-Built
☐ **C3** - Do not proceed. Revise as noted & resubmit **Next Submittal Date:**	☐ Internal Review ☐ Certified/☐ As-Built
☐ **C4** - No further submission required - Complete (select status below) ☐ Certified Final ☐ Final ☐ Cancelled ☐ Superseded	

Package Engineer: Name, signature and date

Reviewed only for general conformity with the specifications. Acceptance by the engineer does not warrant or represent that the information contained on this drawing/document is either accurate or complete. The sole responsibilty for correct design, details & dimensions shall remain with the party submitting the drawing/document.

PRELIMINARY

CLIENT DRAWING NUMBER:
E353004–CM001–240–270–0001–0002

tkIS (Canada) Inc.

Tolerances for machined surfaces	ISO 2768 part 1/2 Tolerance classification m/K		Tolerances for welded constructions	ISO 13920 Tolerance classification B/F	
Surface ISO 1302			Scale AS SHOWN	Weight kg	
Bill of Material			Material		
	Date (YY-MM-DD)	Name	BAFFINLAND IRON MINES – MARY RIVER EXPANSION PROJECT		
Drawn	17-05-08	J. ANDRIC	TRANSFER CONVEYOR 4122-CV-001		
Checked	17-05-08	S. STUPAR	GENERAL ARRANGEMENT SHEET 2		
Designed					
Approved	17-05-08	I. MRLJIC			
thyssenkrupp			Drawing-Ident No. BCSY-A-101	CH.	Key-No. / Size A1 / Sheet 2
				CAD	3 Sheets
Origin:		Supercedes:	Superceded by:		

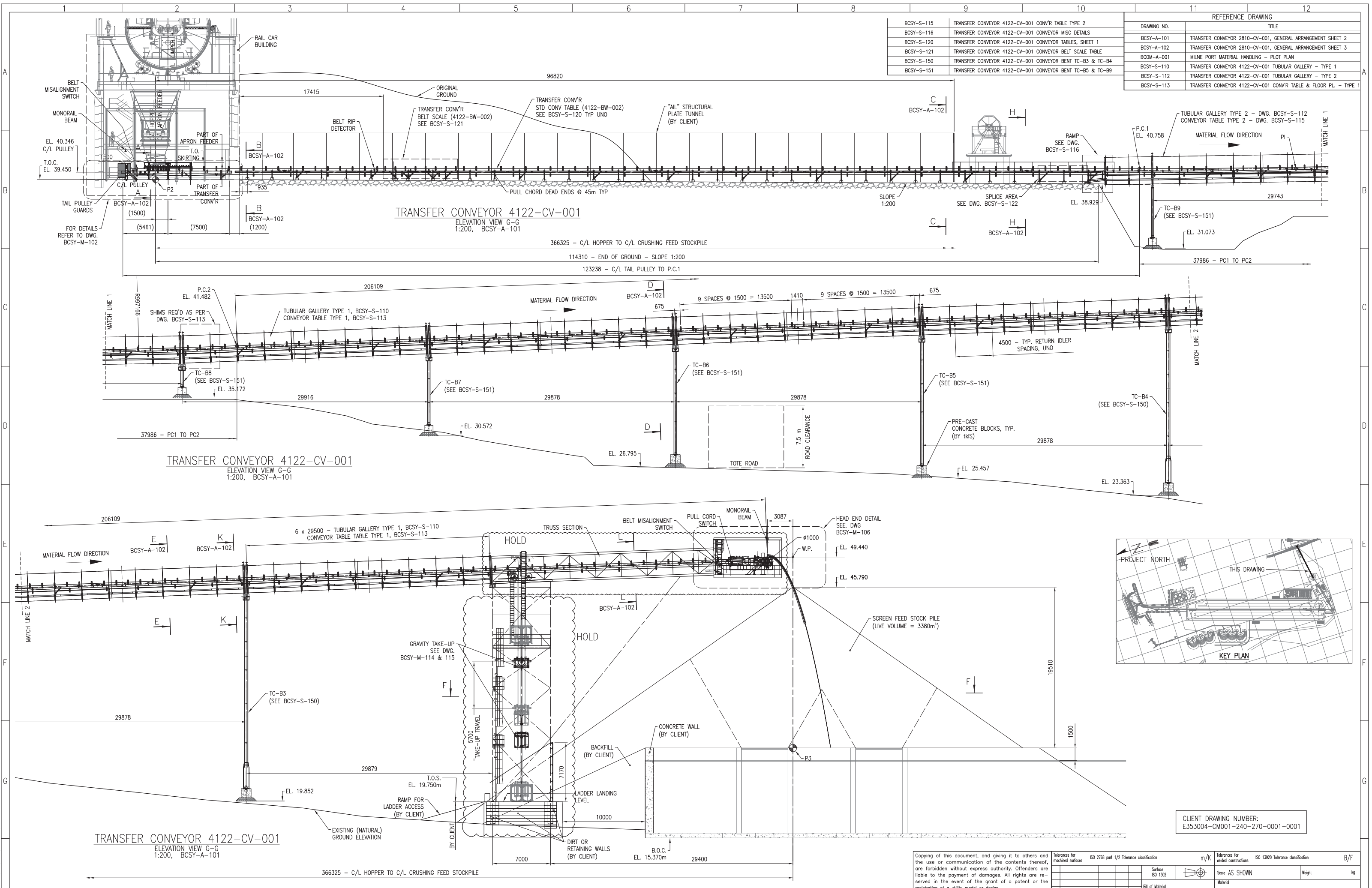
Index	Revision	Date (YY-MM-DD)	Name	Checked
B	ISSUED FOR QUOTATION	17-08-31	J.A.	E.G.N.
A	ISSUED FOR REVIEW	17-06-14	J.A.	E.G.N.

PLOT DATE: 31 August 2017 FILE: G:\BAF\BCSY\DRAWINGS\TEMPORARY ARCHIVE\BCSY-A-100-102_B.DWG

BCSY-S-115	TRANSFER CONVEYOR 4122-CV-001 CONV'R TABLE TYPE 2
BCSY-S-116	TRANSFER CONVEYOR 4122-CV-001 CONVEYOR MISC DETAILS
BCSY-S-120	TRANSFER CONVEYOR 4122-CV-001 CONVEYOR TABLES, SHEET 1
BCSY-S-121	TRANSFER CONVEYOR 4122-CV-001 CONVEYOR BELT SCALE TABLE
BCSY-S-150	TRANSFER CONVEYOR 4122-CV-001 CONVEYOR BENT TC-B3 & TC-B4
BCSY-S-151	TRANSFER CONVEYOR 4122-CV-001 CONVEYOR BENT TC-B5 & TC-B9

REFERENCE DRAWING

DRAWING NO.	TITLE
BCSY-A-101	TRANSFER CONVEYOR 2810-CV-001, GENERAL ARRANGEMENT SHEET 2
BCSY-A-102	TRANSFER CONVEYOR 2810-CV-001, GENERAL ARRANGEMENT SHEET 3
BCOM-A-001	MILNE PORT MATERIAL HANDLING – PLOT PLAN
BCSY-S-110	TRANSFER CONVEYOR 4122-CV-001 TUBULAR GALLERY – TYPE 1
BCSY-S-112	TRANSFER CONVEYOR 4122-CV-001 TUBULAR GALLERY – TYPE 2
BCSY-S-113	TRANSFER CONVEYOR 4122-CV-001 CONV'R TABLE & FLOOR PL. – TYPE 1



PRELIMINARY

CLIENT DRAWING NUMBER:
E353004-CM001-240-270-0001-0001

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tkIS (Canada) Inc.

Tolerances for machined surfaces ISO 2768 part 1/2 Tolerance classification m/K

Tolerances for welded constructions ISO 13920 Tolerance classification B/F

Surface ISO 1302

Scale AS SHOWN

Weight kg

Bill of Material

Material

	Date (YY-MM-DD)	Name
Drawn	17-01-23	J. ANDRIC
Checked	17-01-23	S. STUPAR
Designed		
Approved	17-01-23	I. MRLJIC

BAFFINLAND IRON MINES – MARY RIVER EXPANSION PROJECT

TRANSFER CONVEYOR 4122-CV-001
GENERAL ARRANGEMENT SHEET 1

Index	Revision	Date (YY-MM-DD)	Name	Checked
B	ISSUED FOR QUOTATION	17-09-01	J.A.	E.G.N.
A	ISSUED FOR REVIEW	17-06-14	J.A.	E.G.N.

thyssenkrupp

Drawing-Ident No. BCSY-A-100

CH.

Key-No.

Size A1

Sheet 1

CAD

3 Sheets

Origin:

Supercedes:

Superceded by:

PLOT DATE: 1 September 2017 FILE: G:\BAF\BCSY\DRAWINGS\TEMPORARY ARCHIVE\BCSY-A-100-102_B.DWG

Request for Information - to Contractor

RFI Number: 0045

Subject: Foundation Loads and Design Criteria

Revision: 0

Originator: Deena Naidoo

Package CM001

Discipline CSA

Project: H353004

Date Submitted: 12 October 2017

Required Response Date 17 October 2017

Information Required

Please provide

1. Design criteria (total and differential settlement requirements)
2. Design loads/pressures
3. Footing sizes/designs

For the following areas

a. Crusher and crusher services buildings
b. Screening building
c. Primary Stockpile Tunnel
d. Reclaim Tunnel
e. Reclaimer Berm
f. All piled foundations

Answer/Response (Use Additional Sheets As Required)

See attached response.

Hatch Project Engineer	Signature Digitally signed by Naidoo, Deena DN: CN="Naidoo, Deena" Location: Mississauga Reason: I am approving this document Contact Info: +16473837855 Date: 2017.10.12 11:03:48-04'00'	Date: 12/10/2017
Hatch Area Manager	Signature	Date
Contractor Representative	Signature Laurent Foulonneau Digitally signed by Laurent Foulonneau DN: cn=Laurent Foulonneau, c=CA, email=laurent.foulonneau@thyssenkrupp.com Date: 2017.11.17 18:19:13 -07'00'	Date

tk IS response to Hatch RFI H353004-CM001-400-465-0045

Crusher and screen buildings

Maximum differential settlement between any two adjacent pontoons: 10 mm.
Maximum total settlement without major rework to equipment: 10 mm
Design loads/pressure: minimum unfactored bearing pressure: 350 kPa per drawing 4853005 under pontoon.
Footing size: See drawing 4853005, BCRU-K-002 and BSCR-K-001

Crusher services building

See tk IS response to Hatch RFI H353004-CM001-400-465-0055

Primary stock pile tunnel;

- Total settlement shall not exceed 20 mm
- Differential settlement of footing along the length of the tunnel: 1/1000
- Differential settlement between footings at any transverse section: 50 mm for the tunnel / 6 mm for the apron feeder structure
- Unfactored bearing pressure: 750 KPa

Footing size: see drawings BCSY-A-200 and BCSY-K-203

Reclaim tunnel

- We do not make a distinction between the primary stock pile tunnel & the reclaim tunnel. Both areas would have the same criteria.

Reclaimer berm

- For total and differential settlement see attached drawing 4935166. Tolerances indicating on these drawings are for installation and operation tolerances.
- For load information and layout please refer to attached drawings 4500001466-B07-0001-001, E353004-CM001-240-272-4006 and E353004-CM001-230-272-4007-0001.

Piled foundation

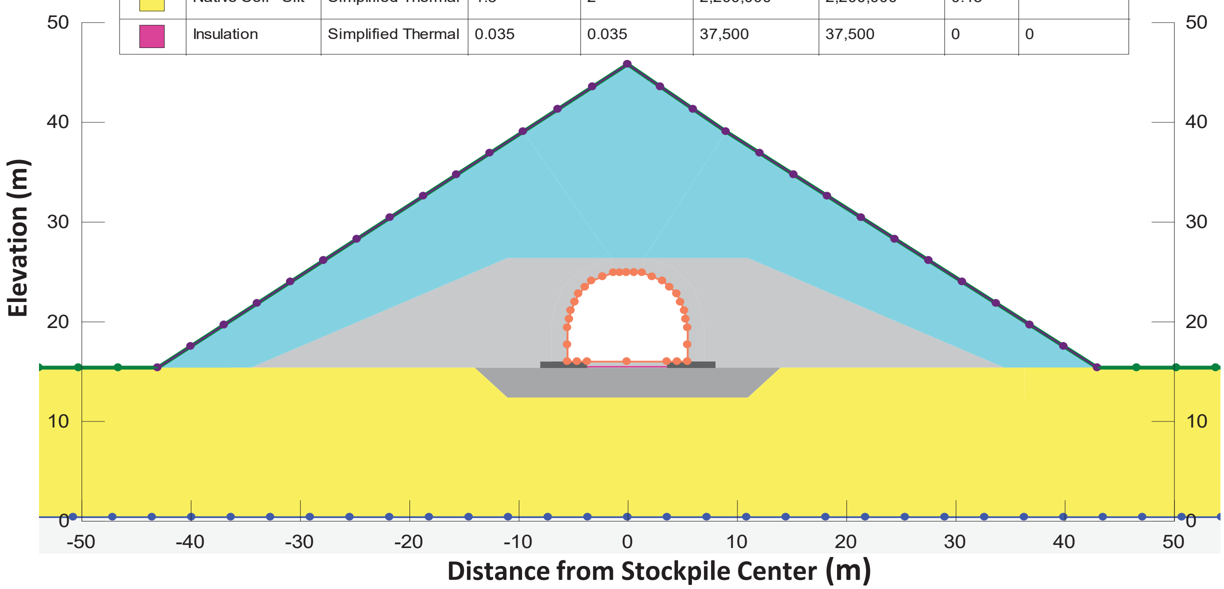
-Total and differential settlement =0 mm
-Capacity adequate for the provided loads. See tk IS foundation load drawings.
-Note that spring constants for each foundation are required to confirm foundation loads.

Appendix B2

Thermal Analyses – Stockpile Reclaim Tunnel

File Name: Stockpile Tunnel _Thermal_Michael_3m_depth_ipcc.gsz
Date: 2/13/2018
Directory: P:\REDLEAF\335458\SPECIALIST_APPS\02 Marry River\02 Stockpile Tunnel\GEO Model\Thermal\Michael thermal models and plots\Stockpile\

Color	Name	Model	Unfrozen Thermal Conductivity (J/sec/m/°C)	Frozen Thermal Conductivity (J/sec/m/°C)	Unfrozen Volumetric Heat Capacity (J/m³/°C)	Frozen Volumetric Heat Capacity (J/m³/°C)	Vol W/C (m³/m³)	Initial Temperature (°C)
🟦	Pre-Crushed Ore	Simplified Thermal	3	4.5	3,000,000	2,400,000	0.036	0
⬜	Engineered Fill	Simplified Thermal	3	4.5	3,000,000	2,400,000	0.036	0
▨	Rockfill Pad	Simplified Thermal	3	4.5	3,000,000	2,400,000	0.036	-3
⬛	Concrete	Simplified Thermal	1.5	1.5	2,000,000	2,000,000	0.024	-3
🟨	Native Soil - Silt	Simplified Thermal	1.3	2	2,200,000	2,200,000	0.45	
🟪	Insulation	Simplified Thermal	0.035	0.035	37,500	37,500	0	0



Job number	353004		
Ref	Stockpile Tunnel		
By	Lk	0	28-Feb-18
Revision		A	28-Feb-18

Mary River Expansion Project

Thermal Model

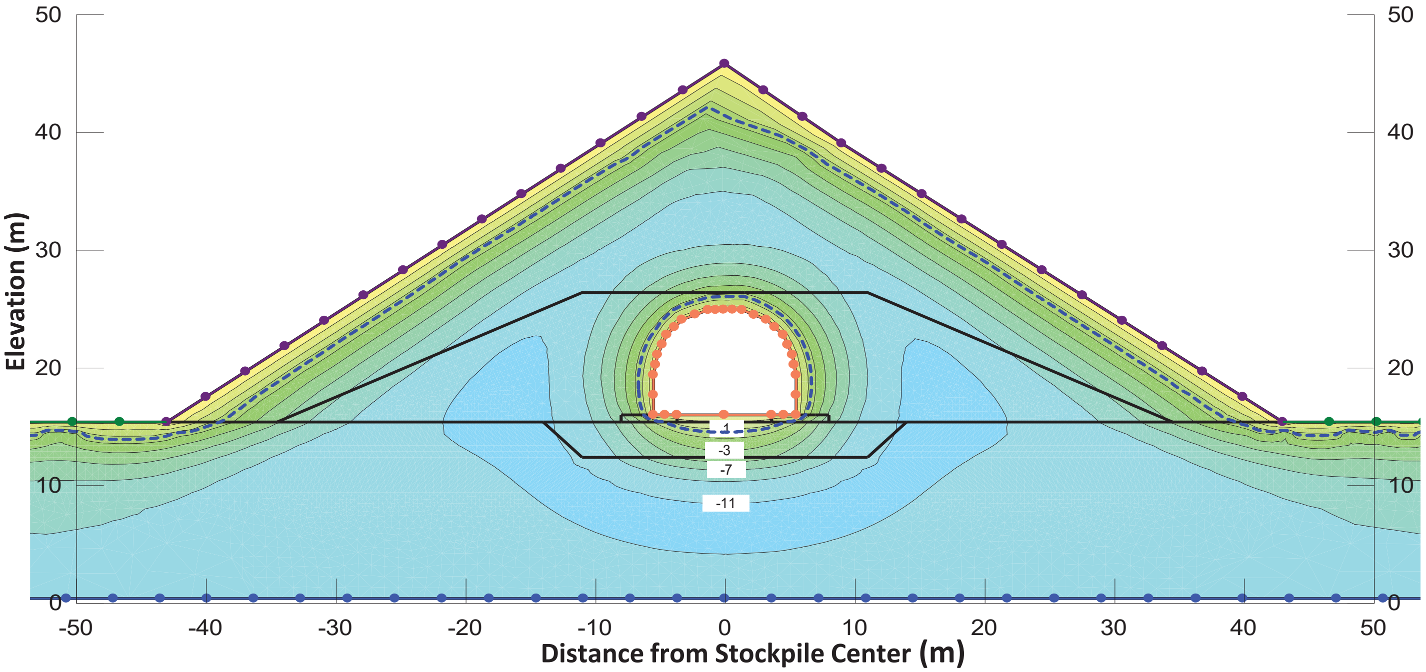
HATCH

BIM

Milne Inlet Port

FIGURE B2-1

File Name: Stockpile Tunnel _Thermal_Michael_3m_depth_ipcc.gsz
Date: 2/13/2018
Directory: P:\REDLEAF\335458\SPECIALIST_APPS\02 Marry River\02 Stockpile Tunnel\GEO Model\Thermal\Michael thermal models and plots\Stockpile\



Job number	353004			**Mary River Expansion Project**	**BIM**
Ref	Stockpile Tunnel			**No Insulation** **Temperature Contour In Summer** **(2 yr after construction)**	**Milne Inlet Port**
By	Lk	0	28-Feb-18		
Revision		A	28-Feb-18		**FIGURE B2-2**

HATCH

File Name: Stockpile Tunnel _Thermal_Michael_3m_depth_ipcc.gsz
Date: 2/13/2018
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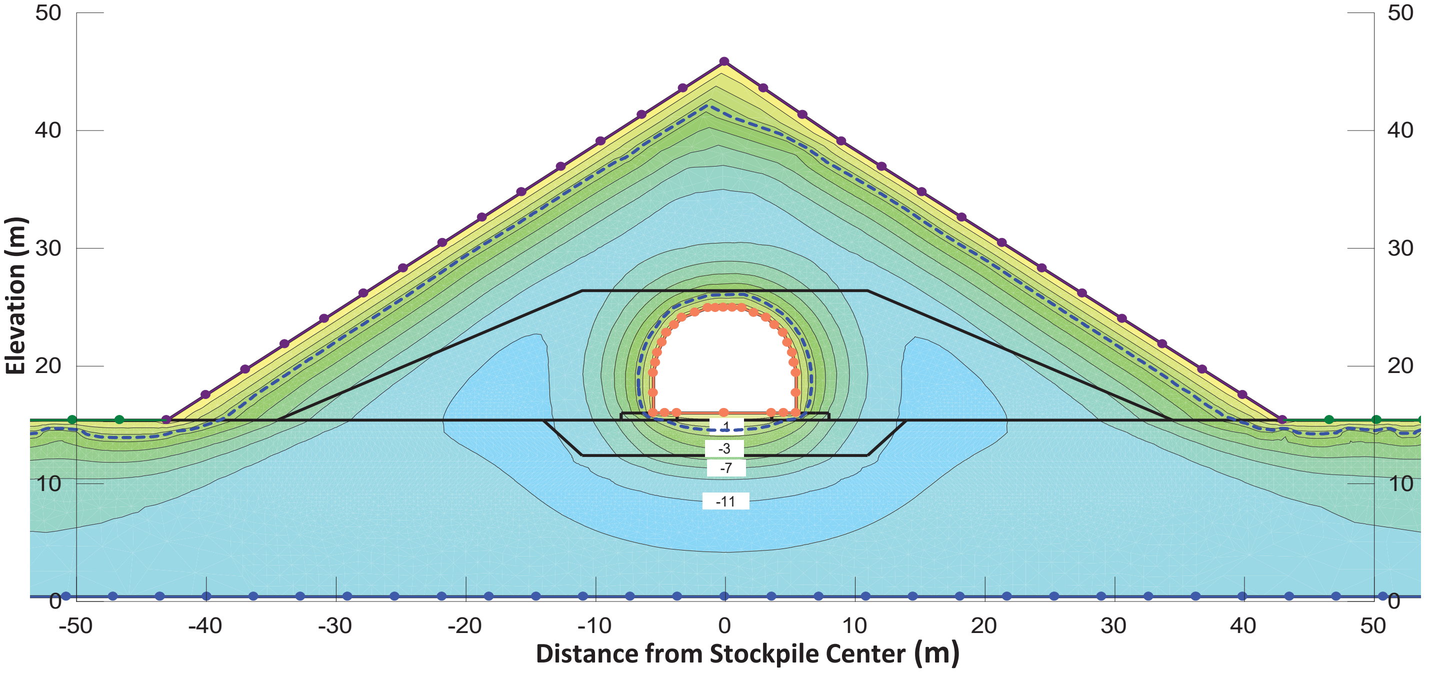
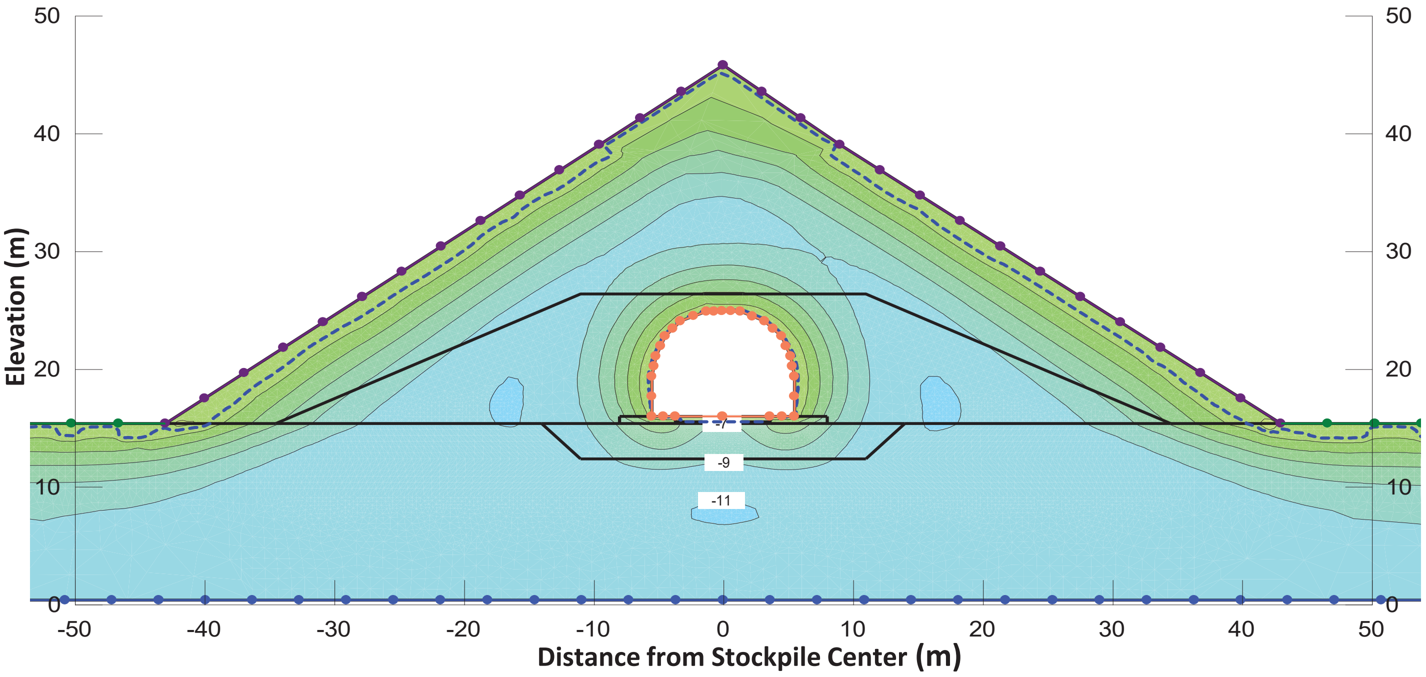


Job number	353004		Mary River Expansion Project	HATCH	BIM
Ref	Stockpile Tunnel		No Insulation Temperature Contour In Summer (20 yr after construction)		Milne Inlet Port
By	Lk	0	28-Feb-18		
Revision	A	28-Feb-18			FIGURE B2-3

File Name: Stockpile Tunnel _Thermal_Michael_3m_depth_ipcc.gsz
Date: 2/13/2018
Directory: P:\REDLEAF\335458\SPECIALIST_APPS\02 Marry River\02 Stockpile Tunnel\GEO Model\Thermal\Michael thermal models and plots\Stockpile\



Job number	353004		**Mary River Expansion Project**	**BIM**
Ref	Stockpile Tunnel		**Insulation** **Temperature Contour In Summer** **(2 yr after construction)**	**Milne Inlet Port**
By	Lk	0	28-Feb-18	
Revision		A	28-Feb-18	**FIGURE B2-4**

HATCH

File Name: Stockpile Tunnel _Thermal_Michael_3m_depth_ipcc.gsz
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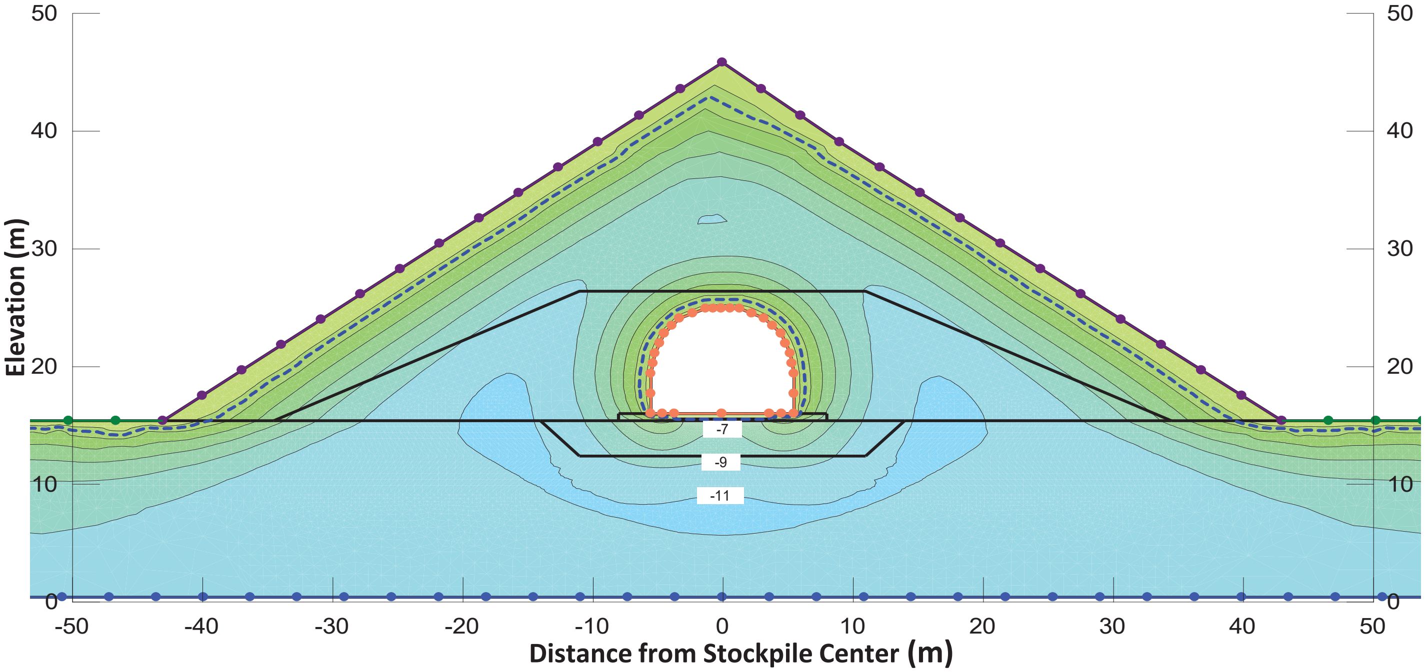


Job number	353004			**Mary River Expansion Project**	HATCH	**BIM**
Ref	Stockpile Tunnel			**Insulation** **Temperature Contour In Summer** **(20 yr after construction)**		**Milne Inlet Port**
By	Lk	0	28-Feb-18			
Revision		A	28-Feb-18			**FIGURE B2-5**

Appendix B3

Settlement Analyses – Stockpile Reclaim Tunnel

Color	Name	Model	Effective Young's Modulus (E') (kPa)	Cohesion' (kPa)	Phi' (°)	Poisson's Ratio	Unit Weight (kN/m³)
🟦	Pre-Crushed Ore	Elastic-Plastic (Effective)	25,000	0	40	0.33	26
⬜	Granular Engineering Fill	Elastic-Plastic (Effective)	70,000	0	40	0.33	22
🟨	Native Silt	Elastic-Plastic (Effective)	7,000	0	30	0.33	18
🟧	Frozen Silt (E=22 mPa)	Elastic-Plastic (Effective)	22,000	0	30	0.33	18
🟥	Frozen Silt (E=44 mPa)	Elastic-Plastic (Effective)	44,000	0	30	0.33	18
⬛	Steel Reinforced Structure	Linear Elastic (Effective)	30,000,000			0.2	20
🟫	Till	Elastic-Plastic (Effective)	1,000,000	0	35	0.33	22
🟦	Concrete	Linear Elastic (Effective)	30,000,000			0.2	24
⬛	Rockfill Foundation	Elastic-Plastic (Effective)	70,000	0	40	0.33	22

Job number	353004		
Ref	Stockpile Tunnel		
By	LK	0	04-Mar-18
Revision		A	04-Mar-18

Mary River Expansion Project

Material Properties

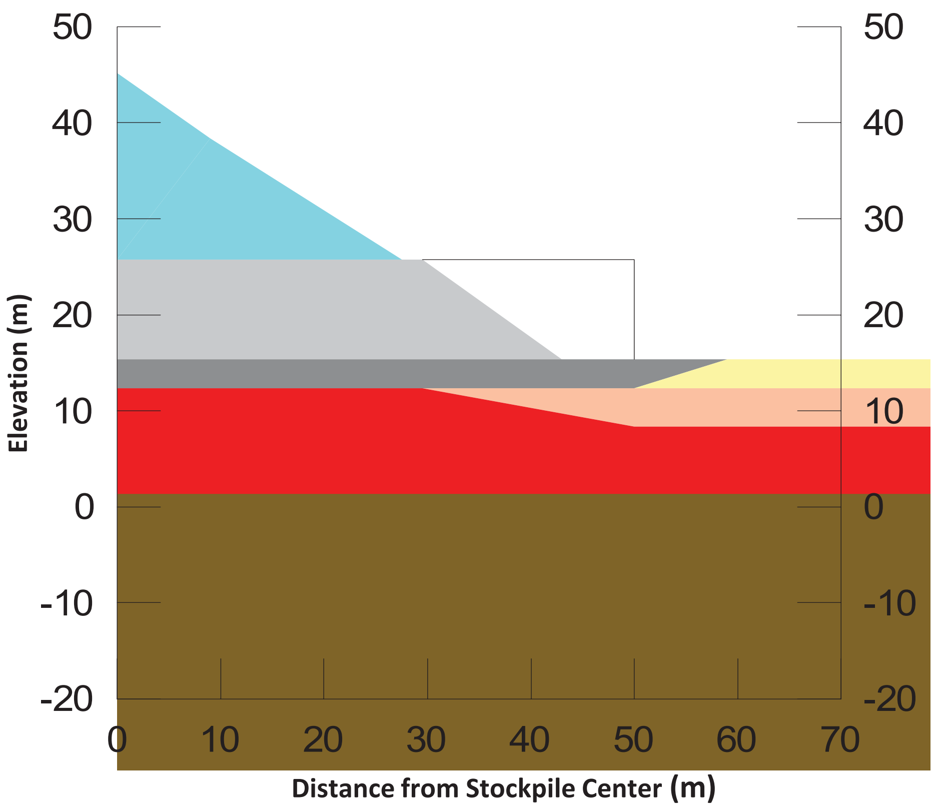
HATCH

Baffinland Iron Mines Corporation

Milne Inlet Port

FIGURE B3-1

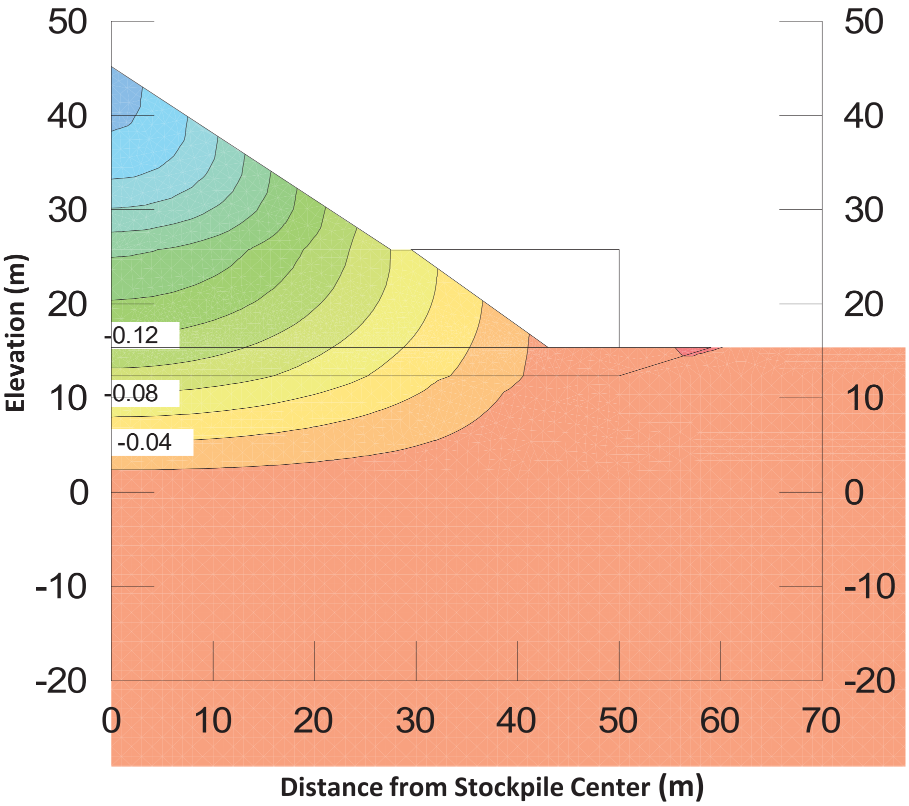
File Name: Axisymmetric Model 3m Pad.gsz
Date: 2/26/2018
Directory: P:\REDLEAF\335458\SPECIALIST_APPS\02 Marry River\02 Stockpile Tunnel\GEO Model\Stockpile Tunnel Model\14m Till Depth\3 m Foundation\



Color	Name
🟦	Pre-Crushed Ore
⬜	Granular Engineering Fill
🟨	Native Silt
🟧	Frozen Silt (E=22 mPa)
🟥	Frozen Silt (E=44 mPa)
🟫	Till
⬛	Rockfill Foundation

Job number	353004			**Mary River Expansion Project**	HATCH	**Baffinland Iron Mines Corporation**
Ref	Stockpile Tunnel			**Case 1**		**Milne Inlet Port**
By	LK	0	04-Mar-18			
Revision		A	04-Mar-18			**FIGURE B3-1A**

File Name: Axisymmetric Model 3m Pad.gsz
Date: 2/26/2018
Directory: P:\REDLEAF\335458\SPECIALIST_APPS\02 Marry River\02 Stockpile Tunnel\GEO Model\Stockpile Tunnel Model\14m Till Depth\3 m Foundation\



Job number	353004			Mary River Expansion Project	HATCH	Baffinland Iron Mines Corporation
Ref	Stockpile Tunnel			Case 1 - Results		Milne Inlet Port
By	LK	0	04-Mar-18			
Revision		A	04-Mar-18			FIGURE B3-1B

File Name: Plane Strain Unfilled_C=0.gsz
Date: 2/26/2018
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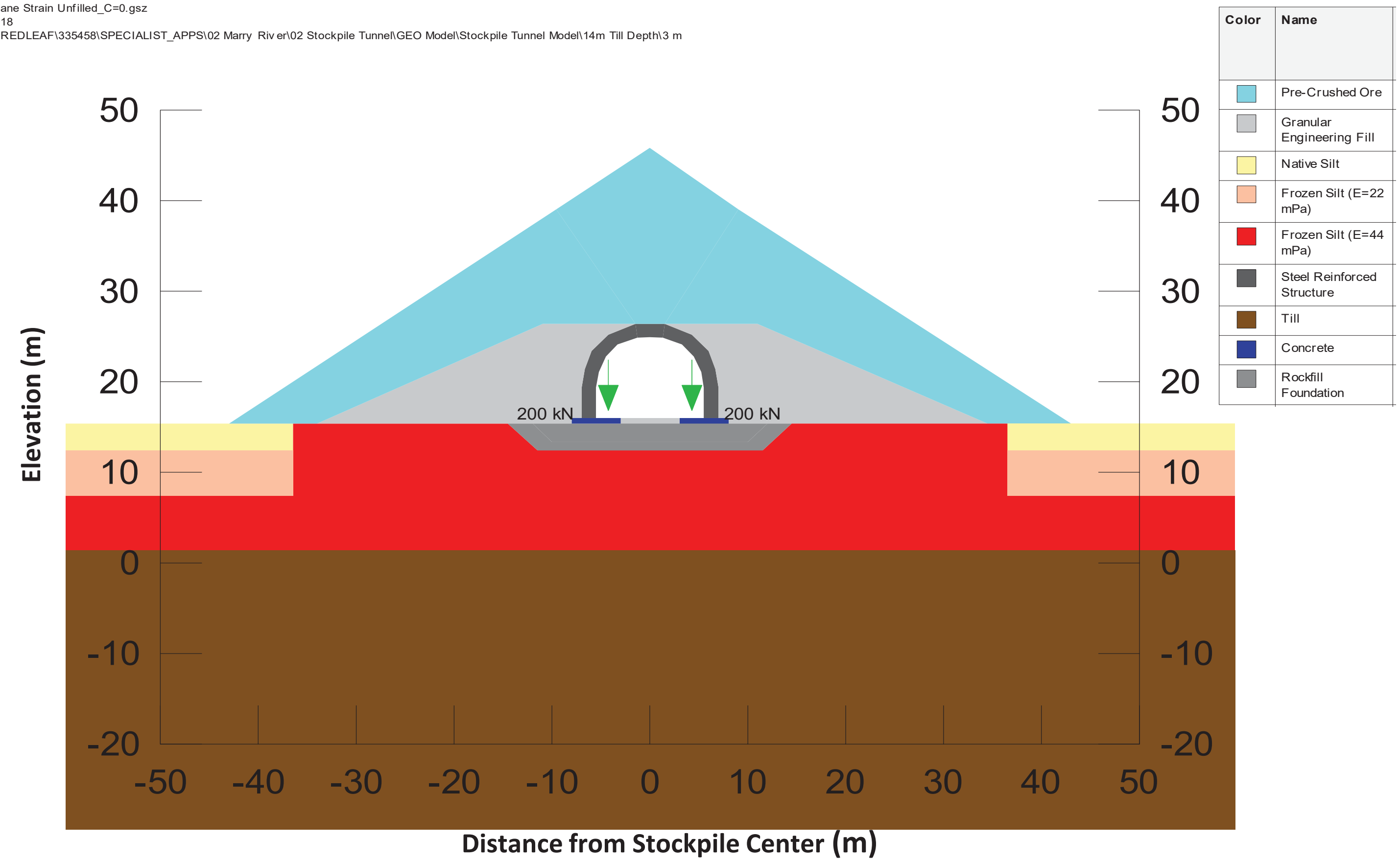
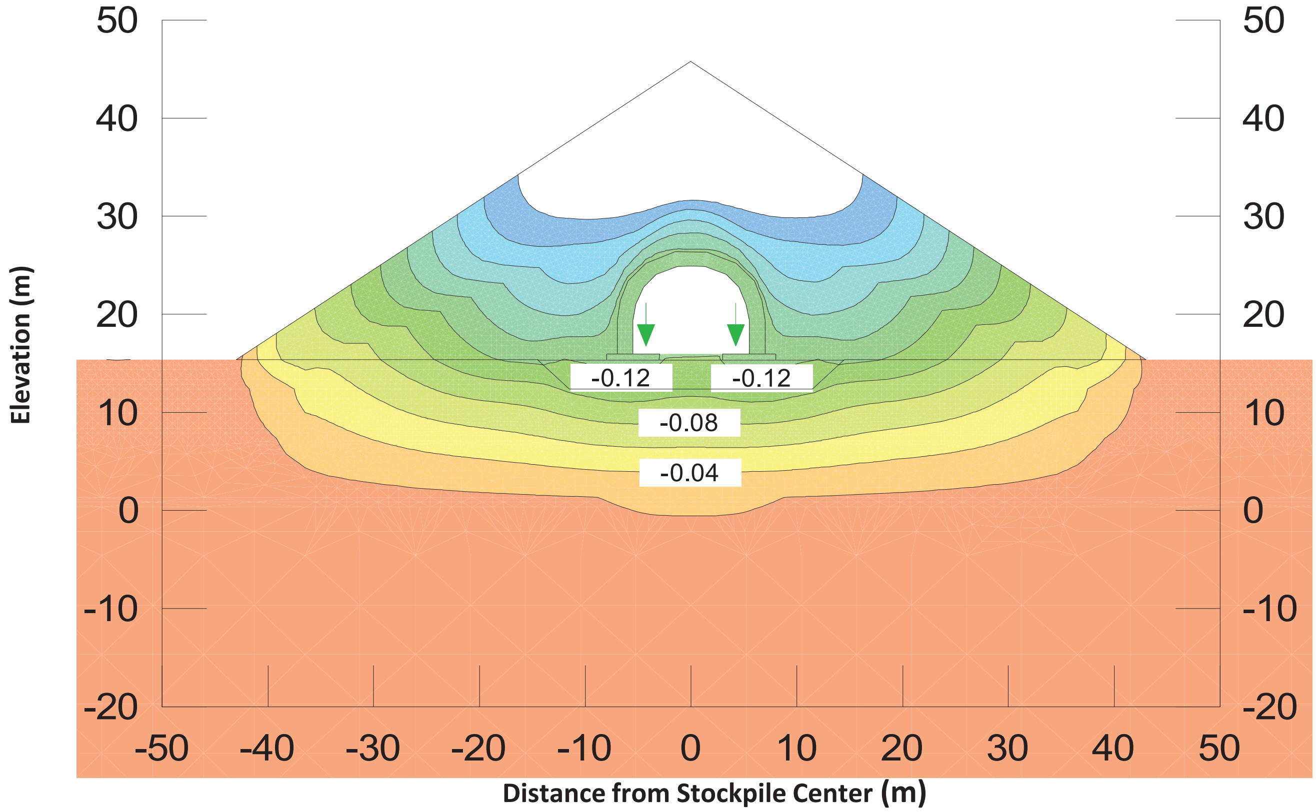


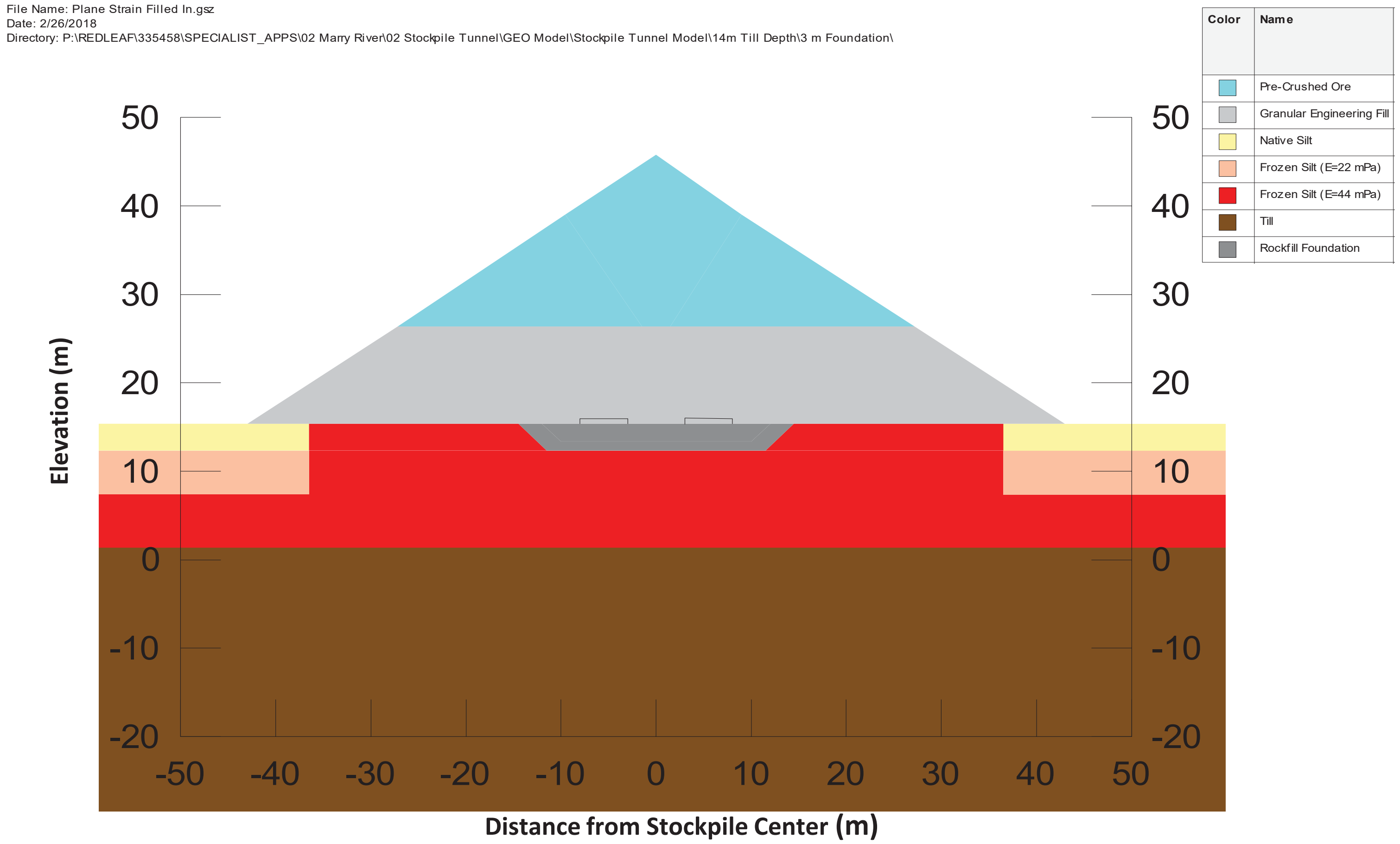
Note: The load of 200 kN was estimated from the maximum of the average loads of each steel frame segment (Reference: Drawing E3530004-CM001-2200272-0015.

Job number	353004		Mary River Expansion Project	HATCH	Baffinland Iron Mines Corporation
Ref	Stockpile Tunnel		Case 2		Milne Inlet Port
By	LK	0	04-Mar-18		
Revision	A	04-Mar-18			FIGURE B3-2A

File Name: Plane Strain Unfilled_C=0.gsz
Date: 2/26/2018
Directory: P:\REDLEAF\335458\SPECIALIST_APPS\02 Marry River\02 Stockpile Tunnel\GEO Model\Stockpile Tunnel Model\14m Till Depth\3 m Foundation\



Job number	353004		**Mary River Expansion Project**	HATCH	**Baffinland Iron Mines Corporation**
Ref	Stockpile Tunnel		**Case 2 - Results**		**Milne Inlet Port**
By	LK	0	04-Mar-18		
Revision	A	04-Mar-18			**FIGURE B3-2B**



File Name: Plane Strain Filled In.gsz
Date: 2/26/2018
Directory: P:\REDLEAF\335458\SPECIALIST_APPS\02 Marry River\02 Stockpile Tunnel\GEO Model\Stockpile Tunnel Model\14m Till Depth\3 m Foundation\

Job number	353004			Mary River Expansion Project	**Baffinland Iron Mines Corporation**
Ref	Stockpile Tunnel			**Case 3**	**Milne Inlet Port**
By	LK	0	04-Mar-18		
Revision		A	04-Mar-18		**FIGURE B3-3A**

File Name: Plane Strain Filled In.gsz
Date: 2/26/2018
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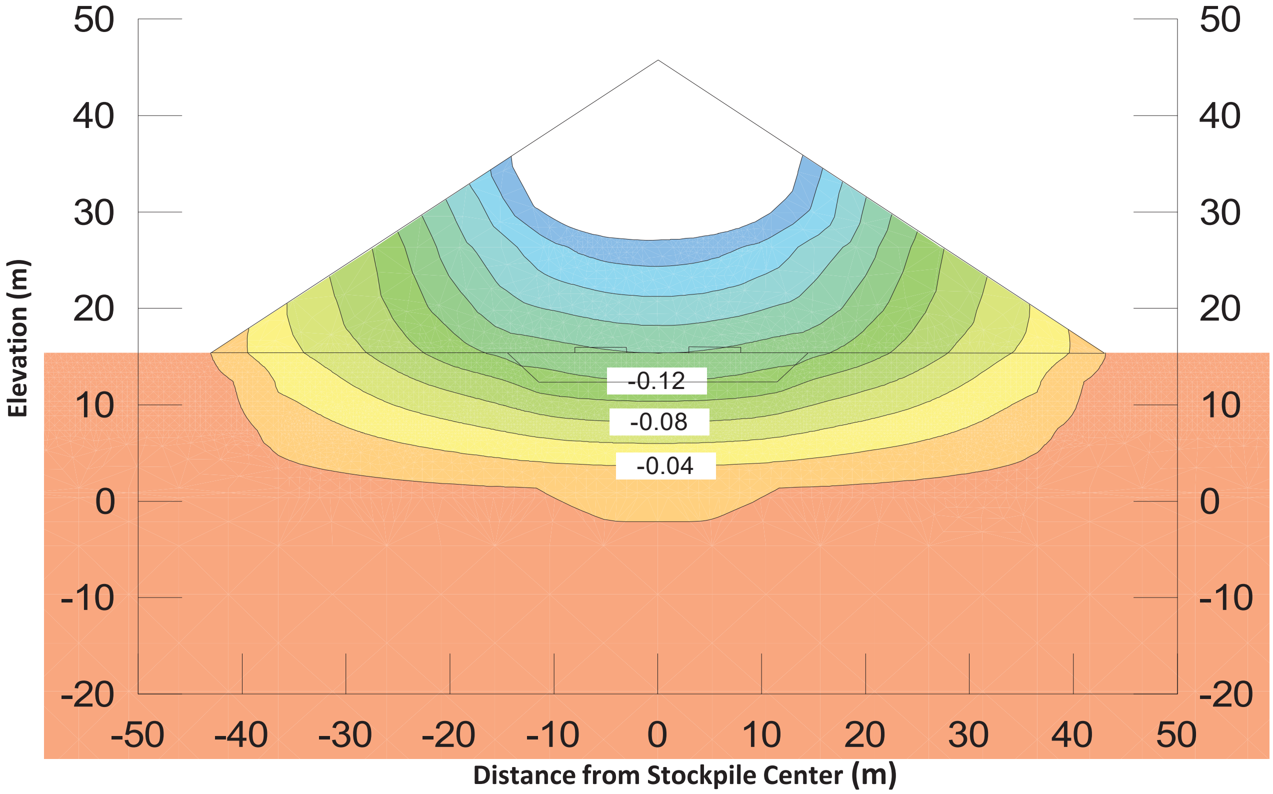

Job number	353004			Mary River Expansion Project	HATCH	Baffinland Iron Mines Corporation
Ref	Stockpile Tunnel			Case 3 - Results		Milne Inlet Port
By	LK	0	04-Mar-18			
Revision		A	04-Mar-18			FIGURE B3-3B

Fig B3-3B | 3/4/2018 10:22 AM | P:\REDLEAF\335458\SPECIALIST_APPS\02 Marry River\02 Stockpile Tunnel\GEO Model\Stockpile Tunnel Model\Summary\Footing Settlement Rev 4.xlsx

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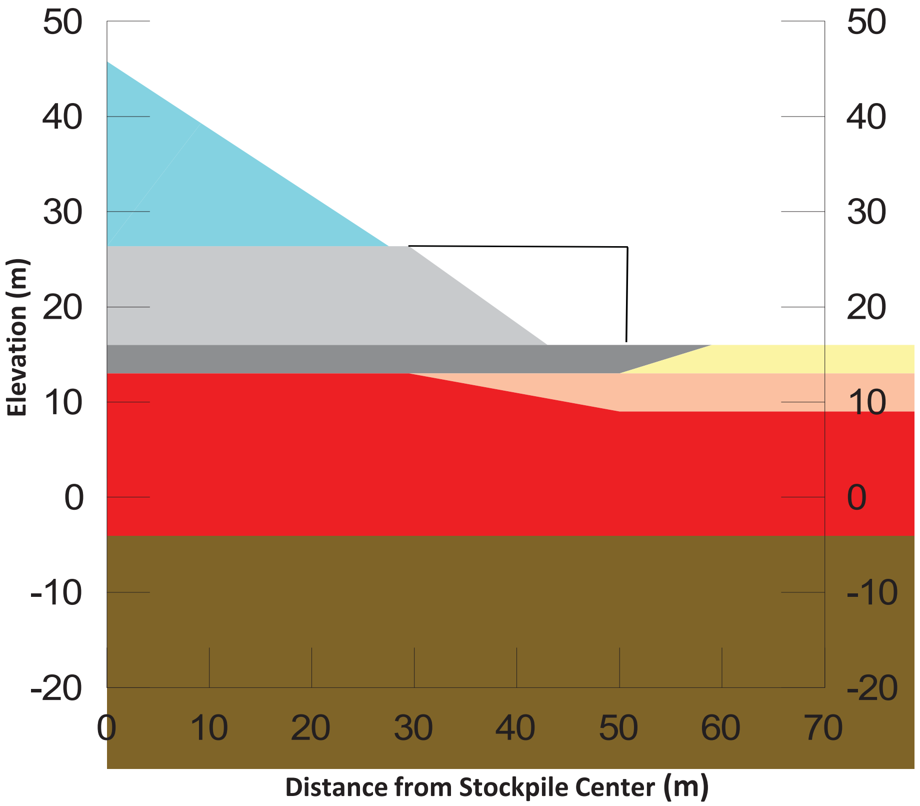
Date: 2/26/2018
Directory: P:\REDLEAF\335458\SPECIALIST_APPS\02 Marry River\02 Stockpile Tunnel\GEO Model\Stockpile Tunnel Model\20m Till Depth\3m Foundation\

Color	Name
🟦	Pre-Crushed Ore
⬜	Granular Engineering Fill
🟨	Native Silt
🟧	Frozen Silt (E= 22mPa)
🟥	Frozen Silt (E=44 mPa)
🟫	Till
⬛	Rockfill Foundation



Job number	353004	Mary River Expansion Project
Ref	Stockpile Tunnel	Case 4
By	LK	0	04-Mar-18
Revision	A	04-Mar-18

HATCH

Baffinland Iron Mines Corporation

Milne Inlet Port

FIGURE B3-4A

File Name: Axisymmetric Model 3m Pad.gsz
Date: 2/26/2018
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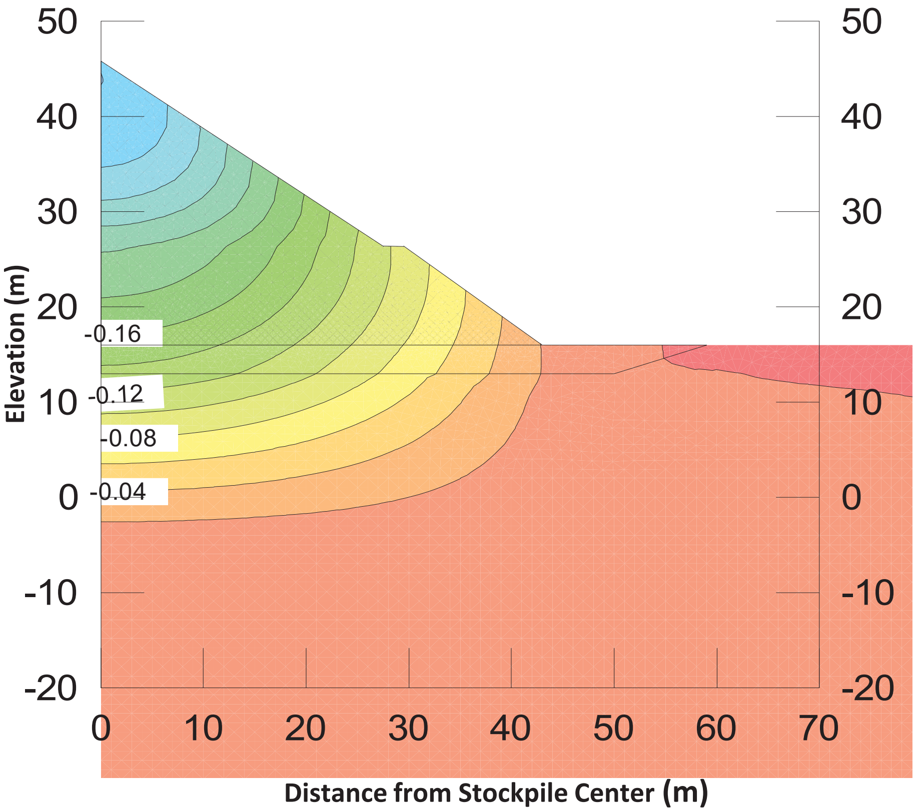
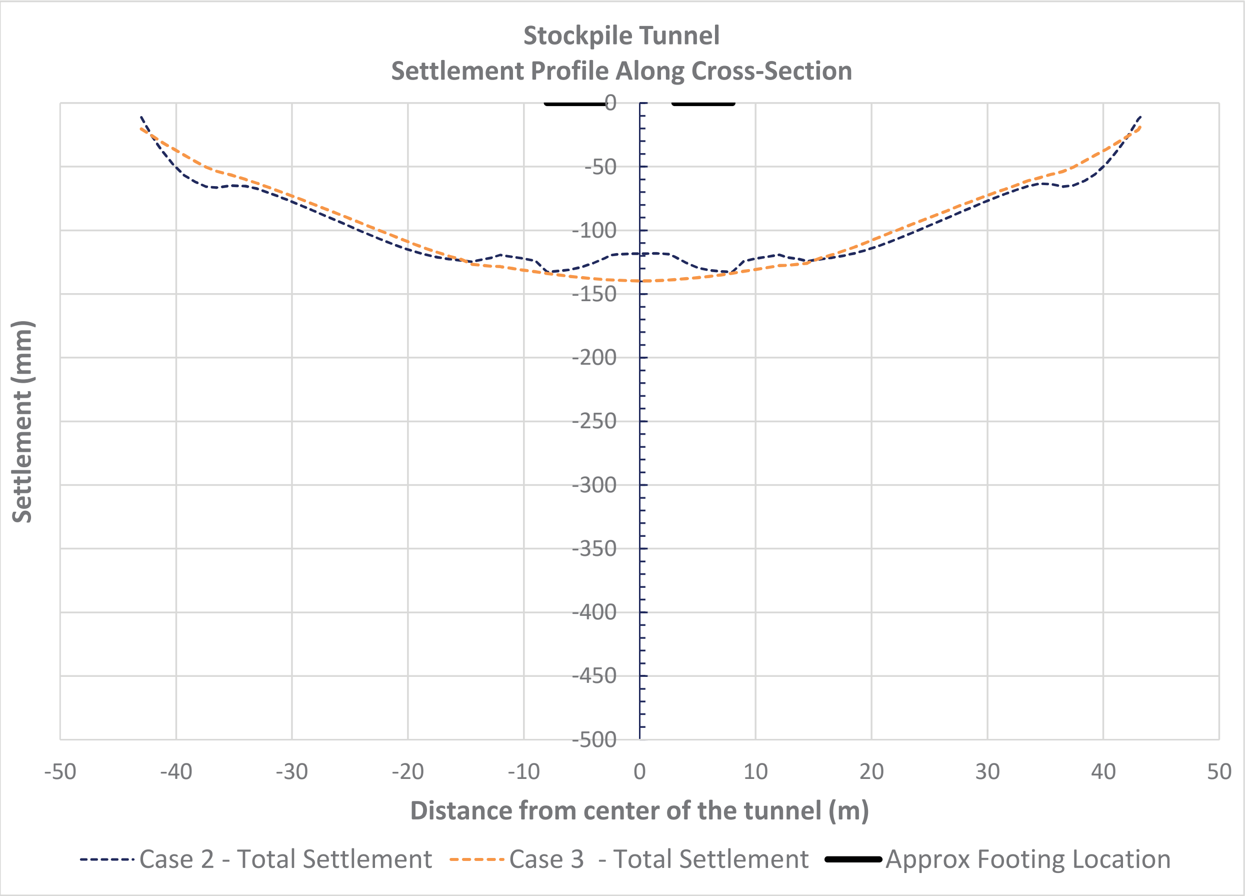
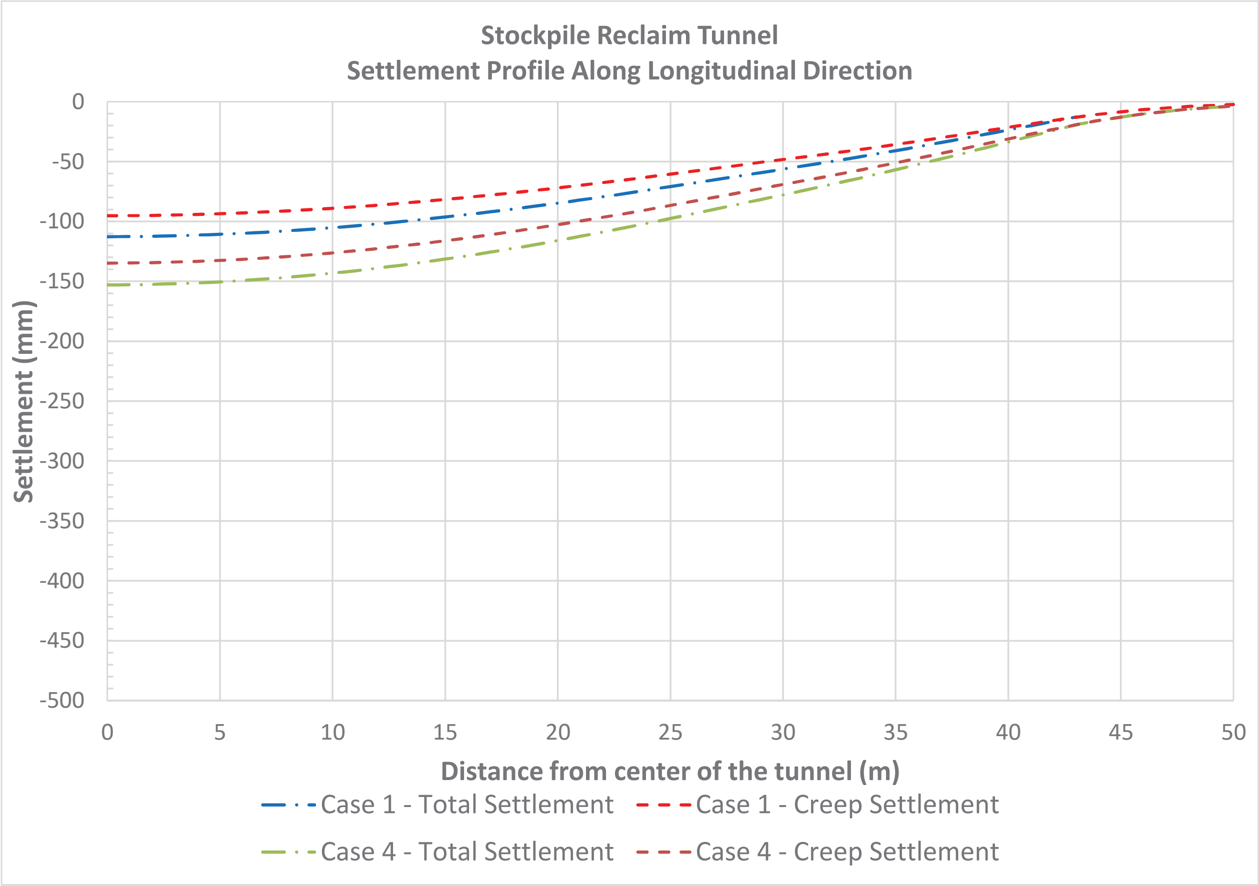


Job number	353004		Mary River Expansion Project	HATCH	Baffinland Iron Mines Corporation
Ref	Stockpile Tunnel		Case 4 - Results		Milne Inlet Port
By	LK	0	04-Mar-18		
Revision	A	04-Mar-18			FIGURE B3-4B

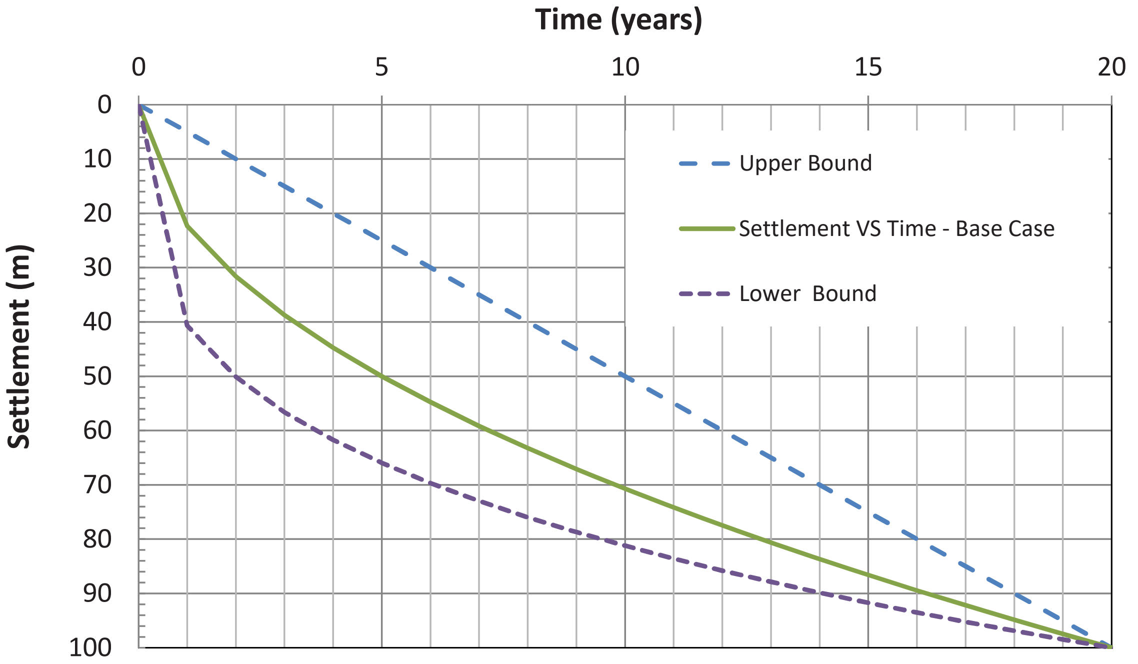
Fig B3-4B | 3/4/2018 10:22 AM | P:\REDLEAF\335458\SPECIALIST_APPS\02 Marry River\02 Stockpile Tunnel\GEO Model\Stockpile Tunnel Model\Summary\Footing Settlement Rev 4.xlsx



Job number	353004	**Mary River Expansion Project**	HATCH	**Baffinland Iron Mines Corporation**
Ref	Stockpile Tunnel	**Comparison of Case 2 and Case 3**		**Milne Inlet Port**
By	LK 0 04-Mar-18			
Revision	A 04-Mar-18			**FIGURE B3-5**



Job number	353004		**Mary River Expansion Project**	HATCH	**Baffinland Iron Mines Corporation**
Ref	Stockpile Tunnel		**Comparison of Case 1 (14 m silt) and Case 4 (20 m silt)**		**Milne Inlet Port**
By	LK	0	04-Mar-18		
Revision		A	04-Mar-18		**FIGURE B3-6**

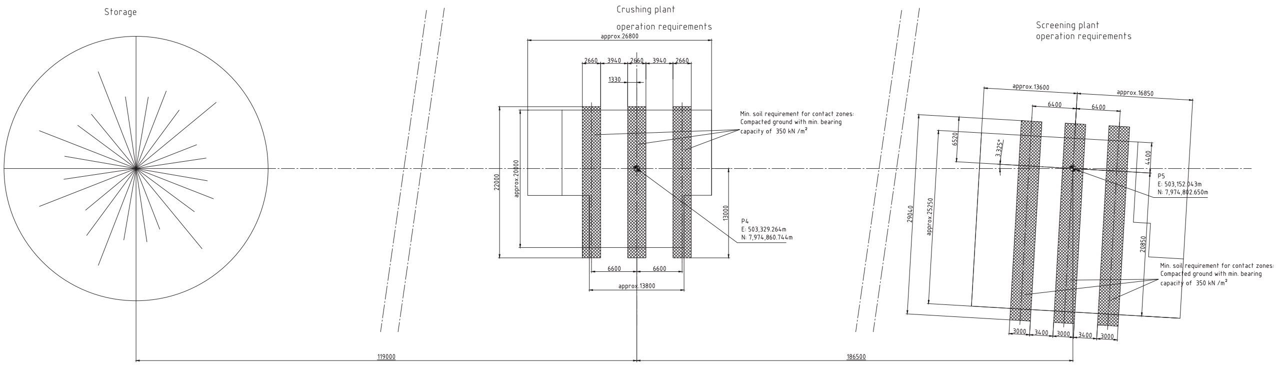


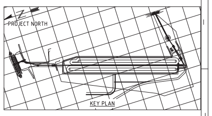
Job number	353004			Mary River Expansion Project	Baffinland Iron Mines Corporation
Ref	Stockpile Tunnel			Creep Settlement Versus Time	Milne Inlet Port
By	LK	0	04-Mar-18		
Revision		A	04-Mar-18		FIGURE B3-7

Fig B3-7 | 3/4/2018 10:22 AM | P:\REDLEAF\335458\SPECIALIST_APPS\02 Marry River\02 Stockpile Tunnel\GEO Model\Stockpile Tunnel Model\Summary\Footing Settlement Rev 4.xlsx

Appendix C1
Crushing/Screening Plant Drawings

REFERENCE DRAWING	
DRAWING NO.	TITLE





CLIENT DRAWING NUMBER:
E353004-CM001-220-272-0009

thyssenkrupp Industrial Solutions
Beckum, Germany

BAFFINLAND IRON MINES – MARY RIVER EXPANSION PROJECT

	Datum	Name	Abt.
Bearb.	23.05.2017	Tholema	
Gepr.	24.05.2017	Lunau	
Statik			
Sichtv.			

Maßstab/Scale 1:100

FOOTPRINT DRAWING

SEMIMOBILE CRUSHING AND
SCREENING PLANT

Zust.	Änderung/Revision	Datum	Name	Gepr.
03	revised	07.07.2017	THOLEMA	Hoelscher
02	screening plant	21.06.2017	THOLEMA	Hoelscher

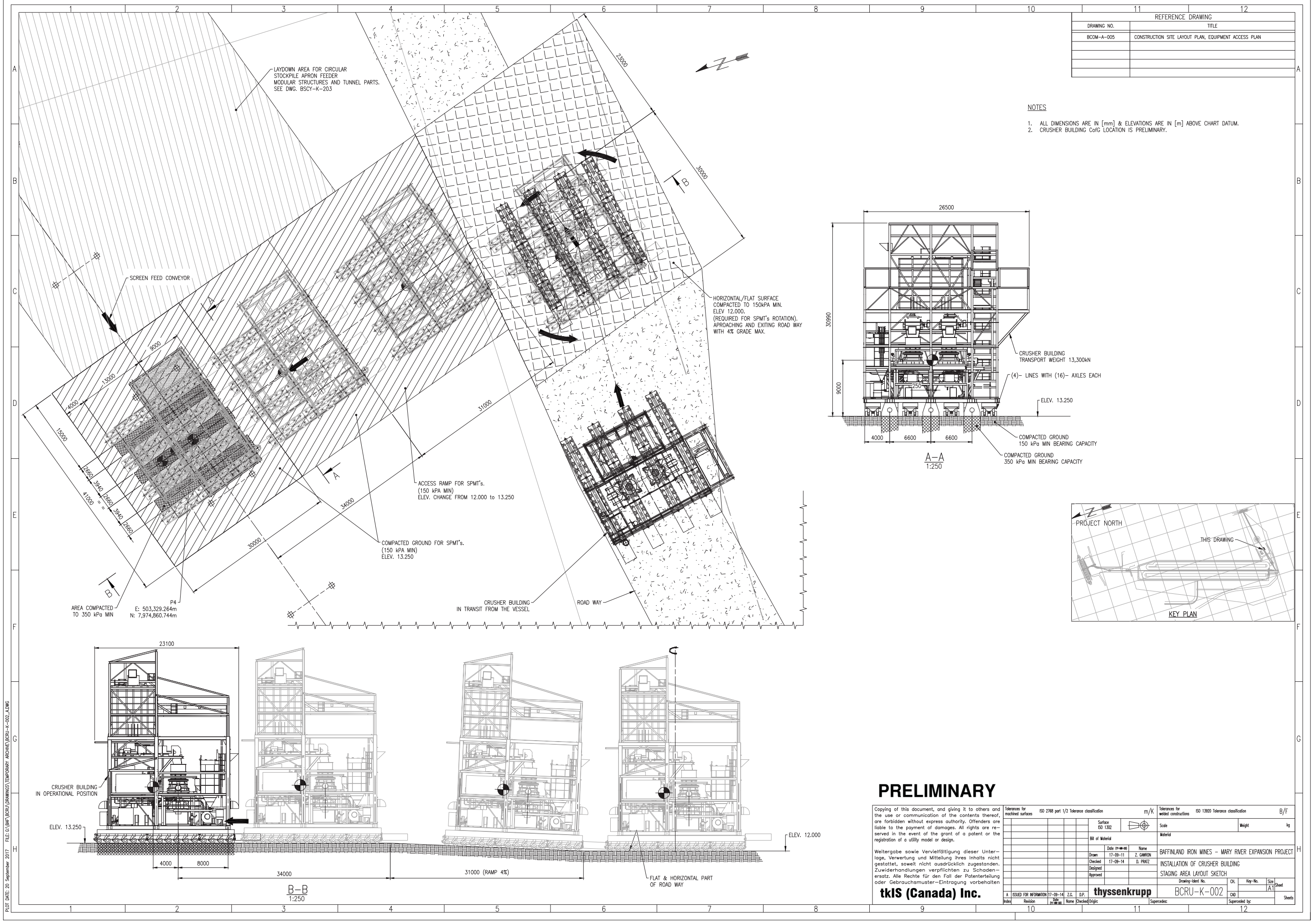
thyssenkrupp

Zeichnung-Ident Nr./Drawing-Ident No.: 4853005
CH.
Schlüssel-Nr.
F 0
Blatt Sheet 1
CAD Zeichnung10
1 Blätter Sheets
Urspr.
Ers.f.:
Ers.d.:

REFERENCE DRAWING	
DRAWING NO.	TITLE
BCOM-A-005	CONSTRUCTION SITE LAYOUT PLAN, EQUIPMENT ACCESS PLAN

NOTES

1. ALL DIMENSIONS ARE IN [mm] & ELEVATIONS ARE IN [m] ABOVE CHART DATUM.
2. CRUSHER BUILDING CofG LOCATION IS PRELIMINARY.



PRELIMINARY

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tkIS (Canada) Inc.

Tolerances for machined surfaces ISO 2768 part 1/2 Tolerance classification m/K
Tolerances for welded constructions ISO 13920 Tolerance classification B/F
Surface ISO 1302
Scale
Weight kg
Bill of Material
Material

	Date (YY-MM-DD)	Name
Drawn	17-09-11	Z. GAWRON
Checked	17-09-14	D. PRATZ
Designed		
Approved		

BAFFINLAND IRON MINES – MARY RIVER EXPANSION PROJECT
INSTALLATION OF CRUSHER BUILDING
STAGING AREA LAYOUT SKETCH

Index	Revision	Date (YY-MM-DD)	Name	Checked
A	ISSUED FOR INFORMATION	17-09-14	Z.G.	D.P.

thyssenkrupp
Drawing-Ident No. BCRU-K-002
CH.
Key-No.
Size A1
Sheet
CAD
Sheets
Origin:
Supercedes:
Superceded by:

PLOT DATE: 20 September 2017 FILE: G:\BAF\BCRU\DRAWINGS\TEMPORARY ARCHIVE\BCRU-K-002_A.DWG

REFERENCE DRAWING	
DRAWING NO.	TITLE
BCOM-A-005	CONSTRUCTION SITE LAYOUT PLAN, EQUIPMENT ACCESS PLAN

NOTES

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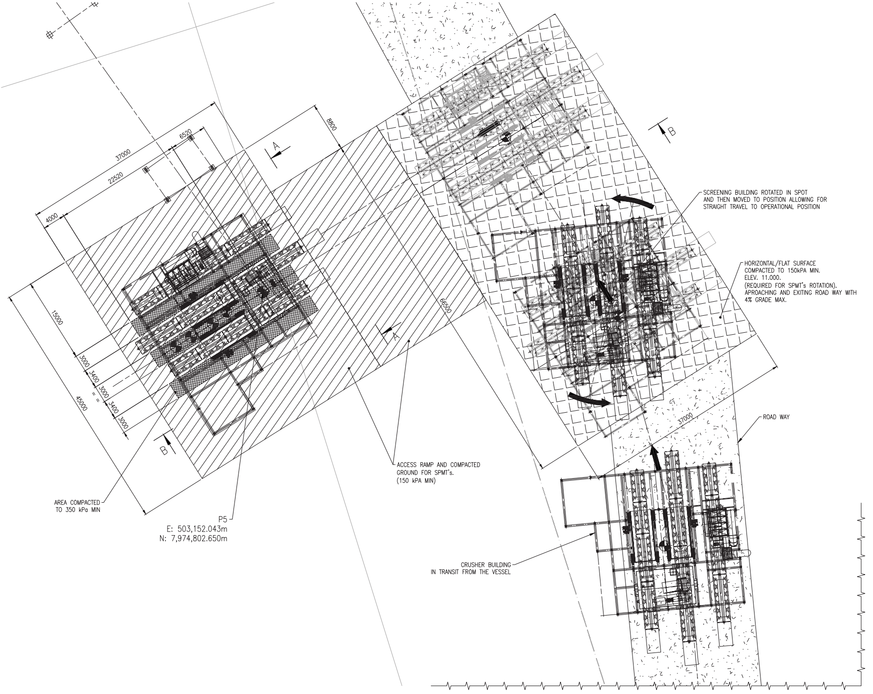
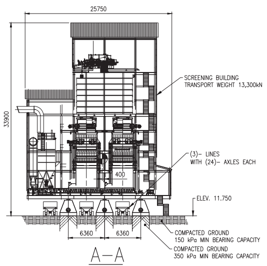
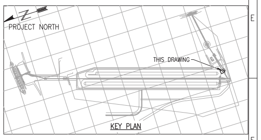
2. SCREENING BUILDING CofG LOCATION IS PRELIMINARY.

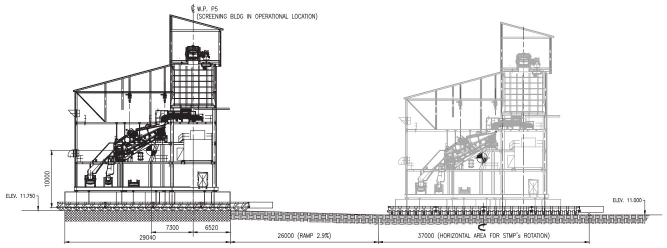




A–A
1:300



KEY PLAN



B–B
1:300

PRELIMINARY

tkIS (Canada) Inc.

Tolerances for machined surfaces	ISO 2768 part 1/2 Tolerance classification	m/K	
Tolerances for welded constructions	ISO 13920 Tolerance classification	B/F	
Surface ISO 1302		Scale	Weight kg
Bill of Material		Material	
	Date (YY-MM-DD)	Name	
Drawn	17-09-13	Z. GAWRON	
Checked	17-09-14	D. PRATZ	
Designed			
Approved			

Index	Revision	Date (YY-MM-DD)	Name	Checked
A	ISSUED FOR INFORMATION	17-90-15	Z.G.	D.P.

BAFFINLAND IRON MINES – MARY RIVER EXPANSION PROJECT

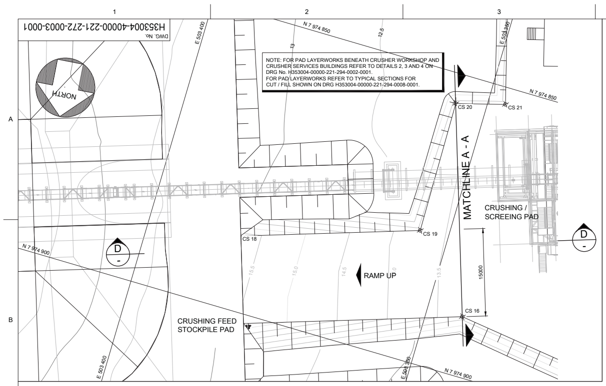
INSTALLATION OF SCREENING BUILDING
STAGING AREA LAYOUT SKETCH

thyssenkrupp

Drawing-Ident No.	CH.	Key-No.	Size	Sheet
BSCR-K-001			A1	
	CAD			Sheets

Origin: | Supercedes: | Superceded by:

DWG. No.
H353004-40000-221-272-0003-0001



NOTE: FOR PAD LAYERWORKS BENEATH CRUSHER WORKSHOP AND CRUSHER SERVICES BUILDINGS REFER TO DETAILS 2, 3 AND 4 ON DRG No. H353004-00000-221-294-0002-0001.
FOR PAD LAYERWORKS REFER TO TYPICAL SECTIONS FOR CUT / FILL SHOWN ON DRG H353004-00000-221-294-0008-0001.

PLAN ON CRUSHING AND SCREENING PAD (CONTINUED)

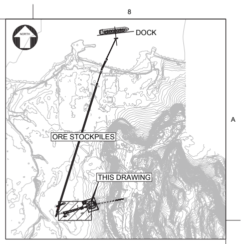
SCALE 1:250

CRUSHING / SCREENING PAD SETTING OUT COORDINATES

POINT	E	N	EL
CS 1	503 134.854	7 974 761.678	11.750
CS 2	503 130.468	7 974 778.250	11.750
CS 3	503 159.469	7 974 785.926	11.750
CS 4	503 158.738	7 974 788.688	11.750
CS 5	503 129.737	7 974 781.013	11.650
CS 6	503 117.711	7 974 826.448	11.750
CS 7	503 167.326	7 974 834.407	11.750
CS 8	503 176.793	7 974 798.639	11.750
CS 9	503 133.291	7 974 787.125	11.750
CS 10	503 123.824	7 974 822.894	11.750
CS 11	503 171.182	7 974 840.603	11.650
CS 12	503 231.834	7 974 867.437	11.987
CS 13	503 243.866	7 974 872.760	12.054
CS 14	503 288.263	7 974 892.403	12.300
CS 15	503 300.304	7 974 895.763	13.250
CS 16	503 343.849	7 974 889.864	13.250
CS 17	503 381.020	7 974 902.049	15.530
CS 18	503 384.323	7 974 887.346	15.750
CS 19	503 354.927	7 974 877.710	13.697
CS 20	503 355.215	7 974 855.121	13.250
CS 21	503 347.008	7 974 852.880	13.250
CS 22	503 354.910	7 974 823.939	12.950
CS 23	503 361.180	7 974 800.976	12.712
CS 24	503 321.980	7 974 790.273	12.851
CS 25	503 293.351	7 974 782.456	12.814
CS 26	503 279.816	7 974 832.027	12.300
CS 27	503 262.774	7 974 827.516	12.187
CS 28	503 249.416	7 974 823.981	12.098
CS 29	503 197.029	7 974 810.116	11.750
CS 30	503 204.939	7 974 780.227	11.750
CS 31	503 161.668	7 974 777.634	11.627
CS 32	503 181.256	7 974 791.541	11.692
CS 33	503 294.419	7 974 869.857	12.300
CS 34	503 306.463	7 974 873.203	13.250
CS 35	503 312.779	7 974 850.071	13.250

CRUSHING / SCREENING PAD SETTING OUT COORDINATES

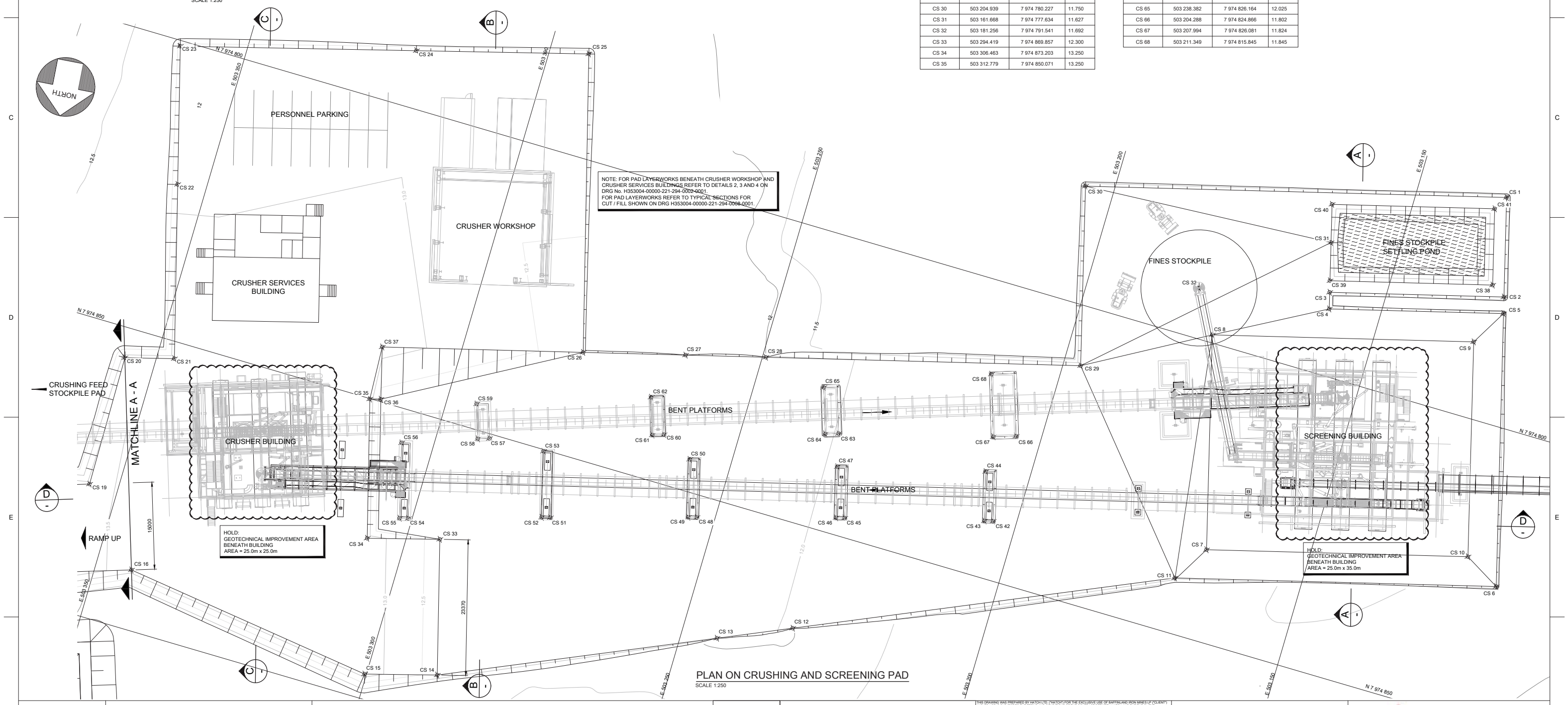
POINT	E	N	EL
CS 36	503 310.946	7 974 849.570	12.300
CS 37	503 313.250	7 974 840.876	13.199
CS 38	503 132.913	7 974 776.829	11.750
CS 39	503 159.981	7 974 783.993	11.750
CS 40	503 163.348	7 974 771.274	11.750
CS 41	503 136.276	7 974 764.122	11.750
CS 42	503 203.941	7 974 840.032	11.816
CS 43	503 205.391	7 974 840.415	11.824
CS 44	503 207.562	7 974 832.209	11.827
CS 45	503 228.598	7 974 846.706	11.963
CS 46	503 230.048	7 974 847.089	11.973
CS 47	503 232.293	7 974 838.604	11.986
CS 48	503 253.032	7 974 853.777	12.115
CS 49	503 254.482	7 974 854.161	12.122
CS 50	503 257.027	7 974 844.540	12.143
CS 51	503 277.205	7 974 860.909	12.225
CS 52	503 278.655	7 974 861.293	12.232
CS 53	503 281.564	7 974 850.295	12.261
CS 54	503 300.626	7 974 867.928	12.300
CS 55	503 302.077	7 974 868.311	12.300
CS 56	503 305.392	7 974 855.779	12.300
CS 57	503 291.106	7 974 850.790	12.300
CS 58	503 293.007	7 974 851.413	12.300
CS 59	503 294.876	7 974 845.712	12.300
CS 60	503 262.487	7 974 841.695	12.172
CS 61	503 264.387	7 974 842.318	12.181
CS 62	503 266.411	7 974 836.142	12.196
CS 63	503 233.704	7 974 833.050	11.995
CS 64	503 235.890	7 974 833.766	12.010
CS 65	503 238.382	7 974 826.164	12.025
CS 66	503 204.288	7 974 824.866	11.802
CS 67	503 207.994	7 974 826.081	11.824
CS 68	503 211.349	7 974 815.845	11.845



KEY PLAN

NOTES:

1. LIDAR SURVEY PROVIDED BY PHOTSAT (2016).
2. CO-ORDINATE GRID IS SHOWN IN UTM (NAD83), ZONE 17 AND IS METERS.
3. CONTOURS ARE IN METERS. THE CONTOUR INTERVAL IS 0.5m.
4. ALL DIMENSIONS SHOWN ARE IN METERS.



NOTE: FOR PAD LAYERWORKS BENEATH CRUSHER WORKSHOP AND CRUSHER SERVICES BUILDINGS REFER TO DETAILS 2, 3 AND 4 ON DRG No. H353004-00000-221-294-0002-0001.
FOR PAD LAYERWORKS REFER TO TYPICAL SECTIONS FOR CUT / FILL SHOWN ON DRG H353004-00000-221-294-0008-0001.

HOLD:
GEOTECHNICAL IMPROVEMENT AREA
BENEATH BUILDING
AREA = 25.0m x 25.0m

HOLD:
GEOTECHNICAL IMPROVEMENT AREA
BENEATH BUILDING
AREA = 25.0m x 35.0m

PLAN ON CRUSHING AND SCREENING PAD

SCALE 1:250

DRAWING No.	DRAWING TITLE
H353004-40000-221-272-0002-0001	CRUSHING FEED STOCKPILE PAD - LAYOUT PLAN
H353004-40000-221-273-0002-0001	CRUSHING AND SCREENING PAD - PAD CROSS SECTIONS
BCSY-A-300	THYSSENKRUPP - OVERSIZE COLLECTION CONVEYOR 2333-CV-002 - SHEET 1
BCSY-A-202	THYSSENKRUPP - SCREEN FEED CONVEYOR 2333-CV-001 - SHEET 3

REFERENCE DRAWINGS

REG. PROFESSIONAL

NOT FOR CONSTRUCTION

No.	DESCRIPTION	BY	CHK'D	DATE
A	CLIENT REVIEW	IHB	FH	19/01/2018

REVISIONS

HATCH

ROLE	NAME	SIGNATURE	DATE
DRAFTSPERSON	I BARNARD	NR	
DESIGNER	I BARNARD	NR	
CHECKER	F HUGO		
DESIGN COORD.	R GOOSEN		
RESP. ENG.	R HALIM		
LEAD DISC. ENG.	A GROBBELAAR		
AREA MANAGER	V LAVRIC		
ENG. MANAGER	D STANGER		
CLIENT			

DRAWING APPROVAL STATUS: Client Review

Baffinland

BAFFINLAND IRON MINES LP
MARY RIVER EXPANSION PROJECT

PORT SITE
CRUSHING AND SCREENING PAD
LAYOUT PLAN

SCALE 1:250 OR AS NOTED

DWG. No. H353004-40000-221-272-0003-0001

REV A

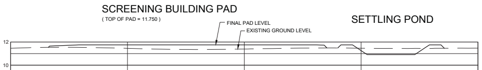
SHEET SIZE: E

$TIME$
$USERNAME$
$DATE$
$FILE$

DWG. No.
H353004-40000-221-273-0003-0001

SCALES:
HORIZONTAL 1:250
VERTICAL 1:125

DATUM 10.000

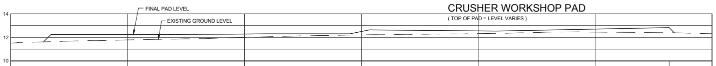


CENTRE LINE (CL)		11.750	11.750	11.260	
GROUND LEVELS ON CL	11.461	11.452	11.391	11.460	11.470
DISTANCE (m)	0	20	40	60	80

CROSS SECTION A - A

SCALES:
HORIZONTAL 1:250
VERTICAL 1:125

DATUM 10.000

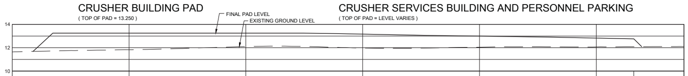


CENTRE LINE (CL)		12.244	12.283	12.494	12.548	12.703	12.829	
GROUND LEVELS ON CL	11.510	11.781	11.994	12.206	12.319	12.447	12.392	12.309
DISTANCE (m)	0	20	40	60	80	100	113	120

CROSS SECTION B - B

SCALES:
HORIZONTAL 1:250
VERTICAL 1:125

DATUM 10.000



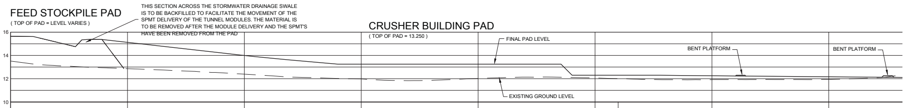
CENTRE LINE (CL)		13.250	13.250	13.166	12.994	12.830	12.766	
GROUND LEVELS ON CL	11.642	11.830	12.103	11.977	12.050	12.073	12.085	12.108
DISTANCE (m)	0	20	40	60	80	100	106	115

NOTE: FOR PAD LAYERWORKS REFER TO TYPICAL SECTIONS SHOWN FOR CUT / FILL AND UNDER BUILDINGS ON DRG No. H353004-00000-221-294-0008-0001

CROSS SECTION C - C

SCALES:
HORIZONTAL 1:250
VERTICAL 1:125

DATUM 10.000



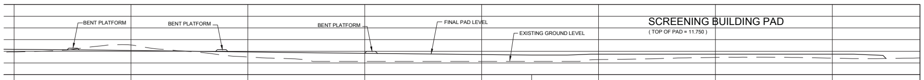
THIS SECTION ACROSS THE STORMWATER DRAINAGE SWALE IS TO BE BACKFILLED TO FACILITATE THE MOVEMENT OF THE SPMT DELIVERY OF THE TUNNEL MODULES. THE MATERIAL IS TO BE REMOVED AFTER THE MODULE DELIVERY AND THE SPMT'S HAVE BEEN REMOVED FROM THE PAD

CENTRE LINE (CL)		15.125	13.997	13.250	13.250	12.300	12.300	12.254	12.166
GROUND LEVELS ON CL	13.517	12.864	12.391	11.972	12.016	12.060	12.003	11.922	11.941
DISTANCE (km)	0.000	0.020	0.040	0.060	0.080	0.100	0.104	0.120	0.140

CROSS SECTION D - D

SCALES:
HORIZONTAL 1:250
VERTICAL 1:125

DATUM 10.000



CENTRE LINE (CL)	12.166	12.069	11.941	11.826	11.722	11.678	11.750	11.750	11.750	
GROUND LEVELS ON CL	11.941	12.540	11.507	11.130	11.130	11.130	11.292	11.475	11.412	11.427
DISTANCE (km)	0.140	0.160	0.180	0.200	0.220	0.229	0.240	0.260	0.280	0.295

CROSS SECTION D - D (CONTINUED)

DRAWING No.	DRAWING TITLE
H353004-00000-221-294-0008-0001	STANDARD DRAWINGS - TYPICAL PAD, DITCH AND BERM SECTIONS
H353004-40000-228-272-0004-0001	CRUSHING AND SCREENING PAD - SETTLING POND LAYOUT
H353004-40000-221-272-0003-0001	CRUSHING AND SCREENING PAD - LAYOUT PLAN

REFERENCE DRAWINGS

REG. PROFESSIONAL

NOT FOR CONSTRUCTION

No.	DESCRIPTION	BY	CHK'D	DATE
A	CLIENT REVIEW	IHB	FH	19/01/2018

REVISIONS

HATCH

ROLE	NAME	SIGNATURE	DATE
DRAFTSPERSON	I BARNARD	NR	
DESIGNER	I BARNARD	NR	
CHECKER	F HUGO		
DESIGN COORD.	R GOOSEN		
RESP. ENG.	R HALIM		
LEAD DISC. ENG.	A GROBBELAAR		
AREA MANAGER	V LAVRIC		
ENG. MANAGER	D STANGER		
CLIENT			

DRAWING APPROVAL STATUS: Client Review

Baffinland

BAFFINLAND IRON MINES LP
MARY RIVER EXPANSION PROJECT

PORT SITE
CRUSHING AND SCREENING PAD
PAD CROSS SECTIONS

SCALE 1:250 OR AS NOTED

DWG. No. H353004-40000-221-273-0003-0001

REV A

SHEET SIZE: E

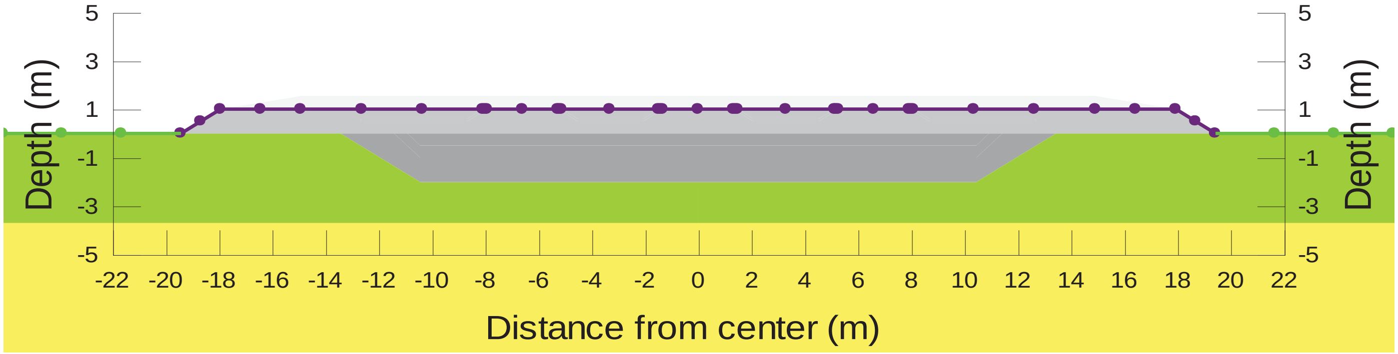
$TIMES$
$USERNAMES$
$DATES$
$FILES$

Appendix C2

Thermal Analyses – Crushing/Screening Plant

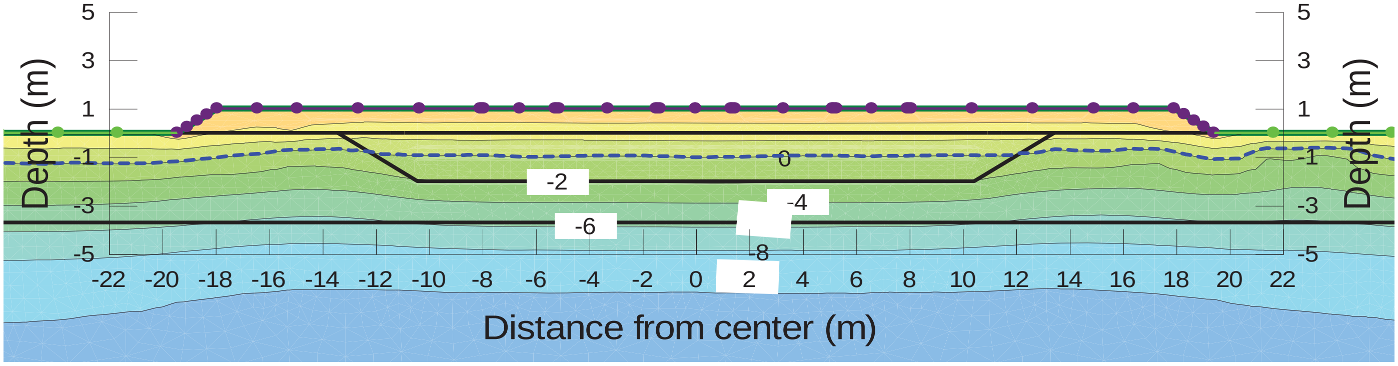
File Name: Crusher Plant updated V2.gsz
Name: Base Crusher Plant - 2m Foundation
Date: 3/28/2018
Directory: P:\REDLEAF\335458\SPECIALIST_APPS\02 Marry River\03 Crusher Buildings\Thermal models\

Color	Name	Model	Unfrozen Thermal Conductivity (J/sec/m/°C)	Frozen Thermal Conductivity (J/sec/m/°C)	Unfrozen Volumetric Heat Capacity (J/m³/°C)	Frozen Volumetric Heat Capacity (J/m³/°C)	Vol W/C (m³/m³)	Initial Temperature (°C)
⬜	Rockfill above ground	Simplified Thermal	3	4.5	3,000,000	2,400,000	0.036	0
◼	Rockfill Pad	Simplified Thermal	3	4.5	3,000,000	2,400,000	0.036	-3
🟨	Silt	Simplified Thermal	1.3	2	2,200,000	2,200,000	0.45	
🟩	Sand	Simplified Thermal	2	3	2,600,000	2,600,000	0.255	



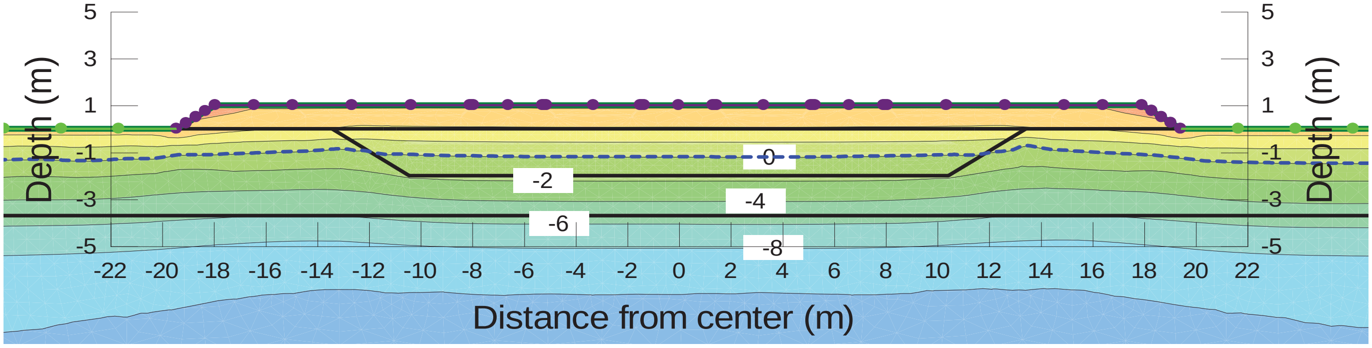
Job number	353004		Mary River Expansion Project	HATCH	BIM
Ref	Crusher Building		Thermal Model - No Insulation		Milne Inlet Port
By	Lk	GQ	10-Apr-18		
Revision	A	10-Apr-18			FIGURE C2-1

File Name: Crusher Plant updated V2.gsz
Name: Base Crusher Plant - 2m Foundation
Date: 3/28/2018
Directory: P:\REDLEAF\335458\SPECIALIST_APPS\02 Marry River\03 Crusher Buildings\Thermal models\



Job number	353004		Mary River Expansion Project	HATCH	BIM
Ref	Crusher Building		No Insulation Temperature Contour In Summer (2 yr after construction)		Milne Inlet Port
By	Lk	GQ	10-Apr-18		
Revision	A	10-Apr-18			FIGURE C2-2

File Name: Crusher Plant updated V2.gsz
Name: Base Crusher Plant - 2m Foundation
Date: 3/28/2018
Directory: P:\REDLEAF\335458\SPECIALIST_APPS\02 Marry River\03 Crusher Buildings\Thermal models\



Job number	353004		
Ref	Crusher Building		
By	Lk	GQ	10-Apr-18
Revision	A		10-Apr-18

Mary River Expansion Project

No Insulation
Temperature Contour In Summer
(10 yr after construction)

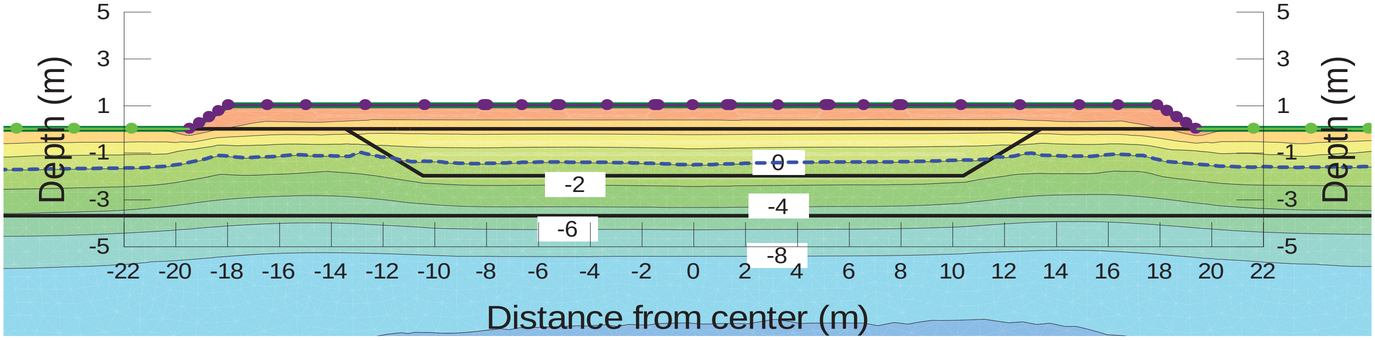
HATCH

BIM

Milne Inlet Port

FIGURE C2-3A

File Name: Crusher Plant updated V2.gsz
Name: Base Crusher Plant - 2m Foundation
Date: 3/28/2018
Directory: P:\REDLEAF\335458\SPECIALIST_APPS\02 Marry River\03 Crusher Buildings\Thermal models\



Job number	353004		
Ref	Crusher Building		
By	Lk	GQ	10-Apr-18
Revision	A		10-Apr-18

Mary River Expansion Project

No Insulation
Temperature Contour In Summer
(20 yr after construction)

HATCH

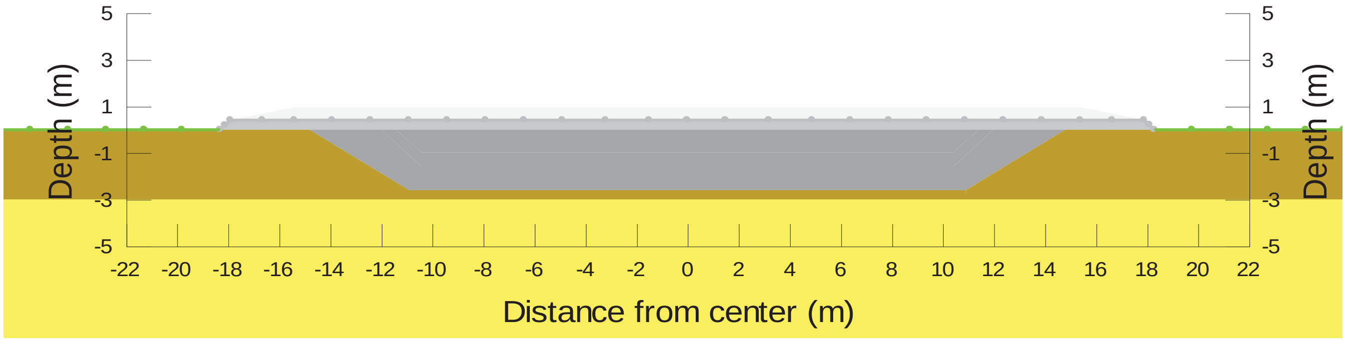
BIM

Milne Inlet Port

FIGURE C2-3B

File Name: Screening Plant_thermal_updated.gsz
Name: May start date (2.6m pad)
Date: 3/28/2018
Directory: P:\REDLEAF\335458\SPECIALIST_APPS\02 Marry River\03 Crusher Buildings\Thermal models\

Color	Name	Model	Unfrozen Thermal Conductivity (J/sec/m/°C)	Frozen Thermal Conductivity (J/sec/m/°C)	Unfrozen Volumetric Heat Capacity (J/m³/°C)	Frozen Volumetric Heat Capacity (J/m³/°C)	Vol W/C (m³/m³)	Initial Temperature (°C)
⬜	Rockfill above ground	Simplified Thermal	3	4.5	3,000,000	2,400,000	0.036	0
⬛	Rockfill Pad	Simplified Thermal	3	4.5	3,000,000	2,400,000	0.036	-3
🟨	Silt	Simplified Thermal	1.3	2	2,200,000	2,200,000	0.45	
🟫	Sand and Gravel	Simplified Thermal	2	3	2,600,000	2,600,000	0.255	



Job number	353004		
Ref	Screening Building		
By	Lk	GQ	10-Apr-18
Revision	A	10-Apr-18	

Mary River Expansion Project

Thermal Model - No Insulation

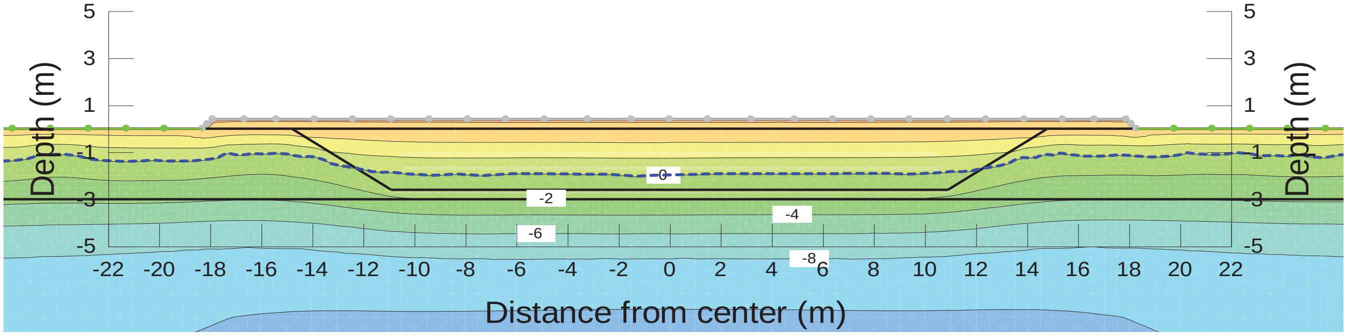
HATCH

BIM

Milne Inlet Port

FIGURE C2-4

File Name: Screening Plant_thermal_updated.gsz
Name: May start date (2.6m pad)
Date: 3/28/2018
Directory: P:\REDLEAF\335458\SPECIALIST_APPS\02 Marry River\03 Crusher Buildings\Thermal models\



Job number 353004
Ref Screening Building
By Lk GQ 10-Apr-18
Revision A 10-Apr-18

Mary River Expansion Project

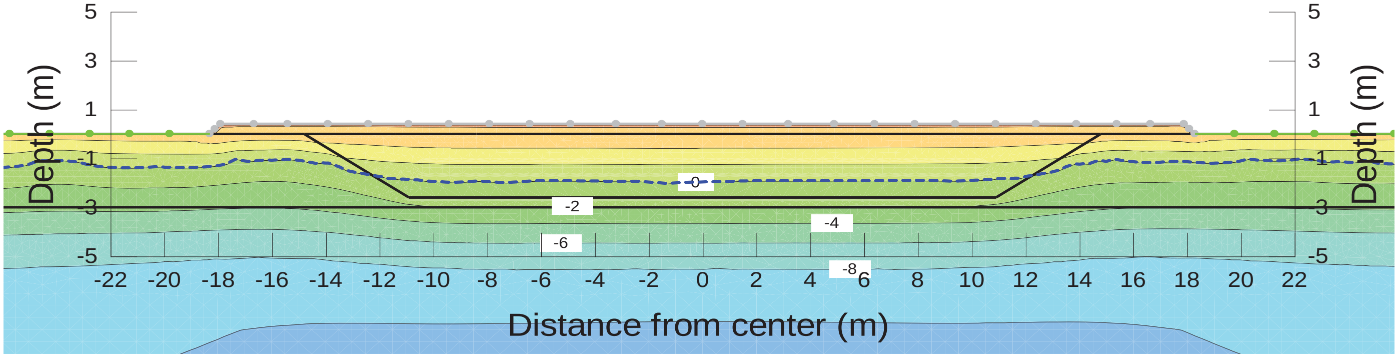
No Insulation
Temperature Contour In Summer
(2 yr after construction)

BIM

Milne Inlet Port

FIGURE C2-5

File Name: Screening Plant_thermal_updated.gsz
Name: May start date (2.6m pad)
Date: 3/28/2018
Directory: P:\REDLEAF\335458\SPECIALIST_APPS\02 Marry River\03 Crusher Buildings\Thermal models\



Job number	353004		
Ref	Screening Building		
By	Lk	GQ	10-Apr-18
Revision	A		10-Apr-18

Mary River Expansion Project

No Insulation
Temperature Contour In Summer
(10 yr after construction)

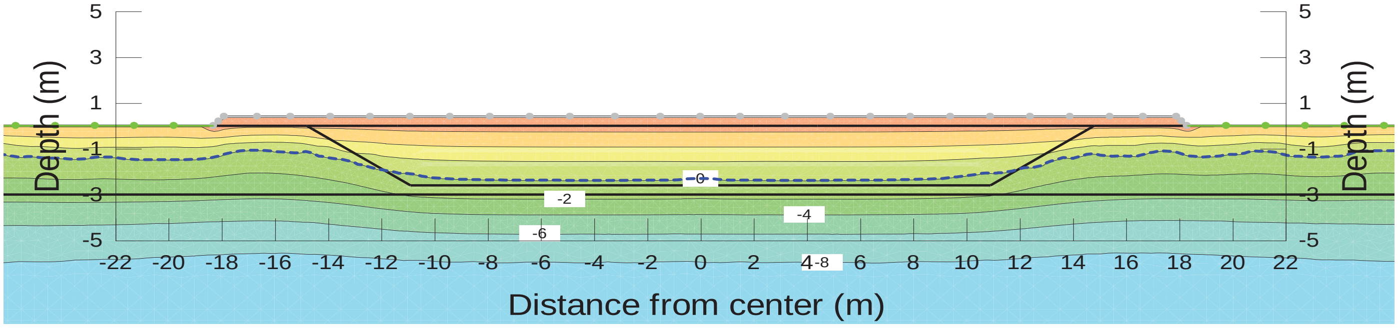
HATCH

BIM

Milne Inlet Port

FIGURE C2-6A

File Name: Screening Plant_thermal_updated.gsz
Name: May start date (2.6m pad)
Date: 3/28/2018
Directory: P:\REDLEAF\335458\SPECIALIST_APPS\02 Marry River\03 Crusher Buildings\Thermal models\



Job number 353004
Ref Screening Building
By Lk GQ 10-Apr-18
Revision A 10-Apr-18

Mary River Expansion Project

No Insulation
Temperature Contour In Summer
(20 yr after construction)

HATCH

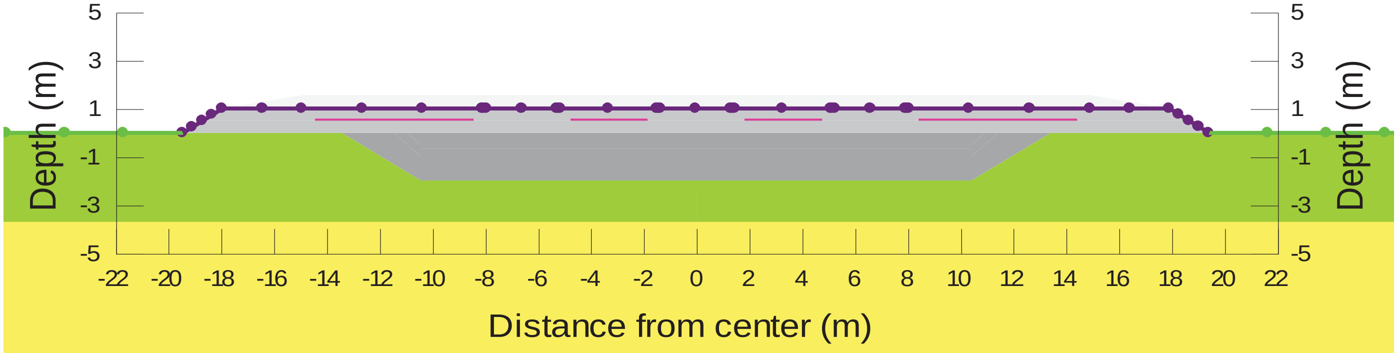
BIM

Milne Inlet Port

FIGURE C2-6B

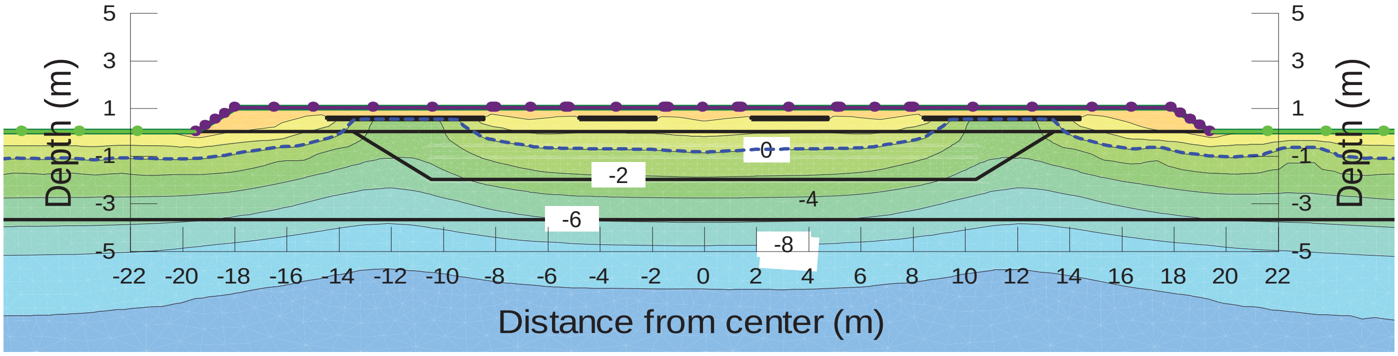
File Name: Crusher Plant updated V2.gsz
Name: Base Crusher Plant - 2m Foundation - 150 mm Insulation in Found
Date: 3/29/2018
Directory: P:\REDLEAF\335458\SPECIALIST_APPS\02 Marry River\03 Crusher Buildings\Thermal models\

Color	Name	Model	Unfrozen Thermal Conductivity (J/sec/m/°C)	Frozen Thermal Conductivity (J/sec/m/°C)	Unfrozen Volumetric Heat Capacity (J/m³/°C)	Frozen Volumetric Heat Capacity (J/m³/°C)	Vol W/C (m³/m³)	Initial Temperature (°C)
⬜	Rockfill above ground	Simplified Thermal	3	4.5	3,000,000	2,400,000	0.036	0
⬛	Rockfill Pad	Simplified Thermal	3	4.5	3,000,000	2,400,000	0.036	-3
🟨	Silt	Simplified Thermal	1.3	2	2,200,000	2,200,000	0.45	
🟪	Insulation	Simplified Thermal	0.035	0.035	37,500	37,500	0	0
🟩	Sand	Simplified Thermal	2	3	2,600,000	2,600,000	0.255	



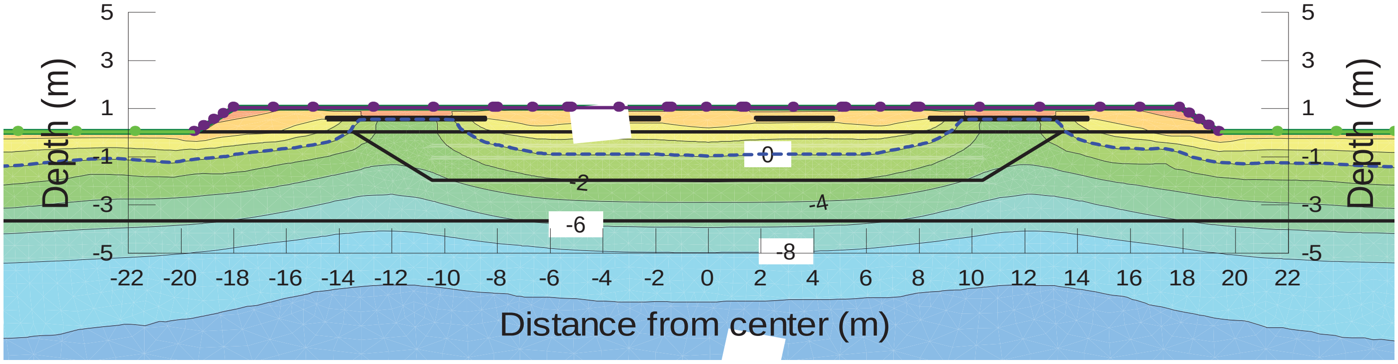
Job number	353004			**Mary River Expansion Project**	HATCH	**BIM**
Ref	Crusher Building			**Thermal Model - Modified Insulation Geometry**		**Milne Inlet Port**
By	Lk	GQ	10-Apr-18			
Revision		A	10-Apr-18			**FIGURE C2-7A**

File Name: Crusher Plant updated V2.gsz
Name: Base Crusher Plant - 2m Foundation - 150 mm Insulation in Found
Date: 3/29/2018
Directory: P:\REDLEAF\335458\SPECIALIST_APPS\02 Marry River\03 Crusher Buildings\Thermal models\



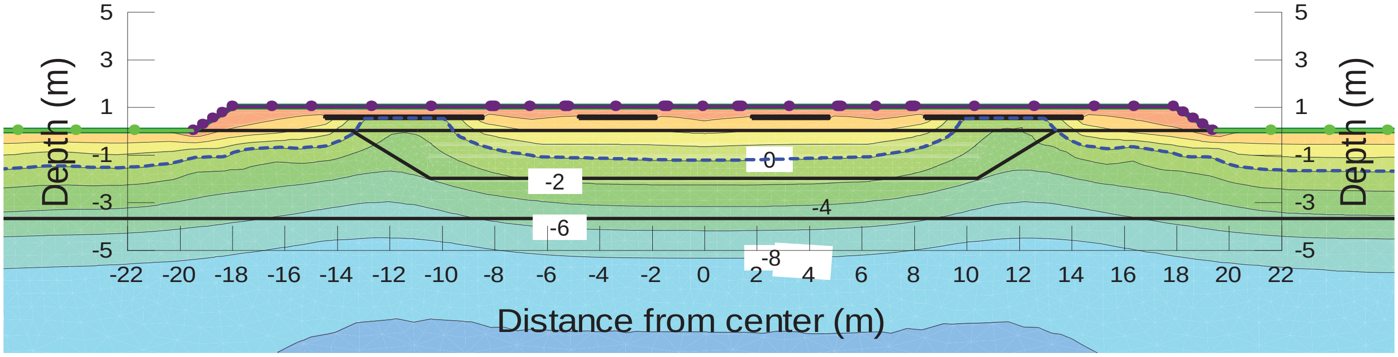
Job number	353004			**Mary River Expansion Project**	**BIM**
Ref	Crusher Building			**Modified Insulation Geometry** **Temperature Contour In Summer** **(2 yr after construction)**	**Milne Inlet Port**
By	Lk	GQ	10-Apr-18		
Revision		A	10-Apr-18		**FIGURE C2-7B**

File Name: Crusher Plant updated V2.gsz
Name: Base Crusher Plant - 2m Foundation - 150 mm Insulation in Found
Date: 3/29/2018
Directory: P:\REDLEAF\335458\SPECIALIST_APPS\02 Marry River\03 Crusher Buildings\Thermal models\



Job number	353004			**Mary River Expansion Project**	**BIM**
Ref	Crusher Building			**Modified Insulation Geometry Temperature Contour In Summer (10 yr after construction)**	**Milne Inlet Port**
By	Lk	GQ	10-Apr-18		
Revision		A	10-Apr-18		**FIGURE C2-7C**

File Name: Crusher Plant updated V2.gsz
Name: Base Crusher Plant - 2m Foundation - 150 mm Insulation in Found
Date: 3/29/2018
Directory: P:\REDLEAF\335458\SPECIALIST_APPS\02 Marry River\03 Crusher Buildings\Thermal models\



Job number	353004		
Ref	Crusher Building		
By	Lk	GQ	10-Apr-18
Revision		A	10-Apr-18

Mary River Expansion Project

Modified Insulation Geometry
Temperature Contour In Summer
(20 yr after construction)

HATCH

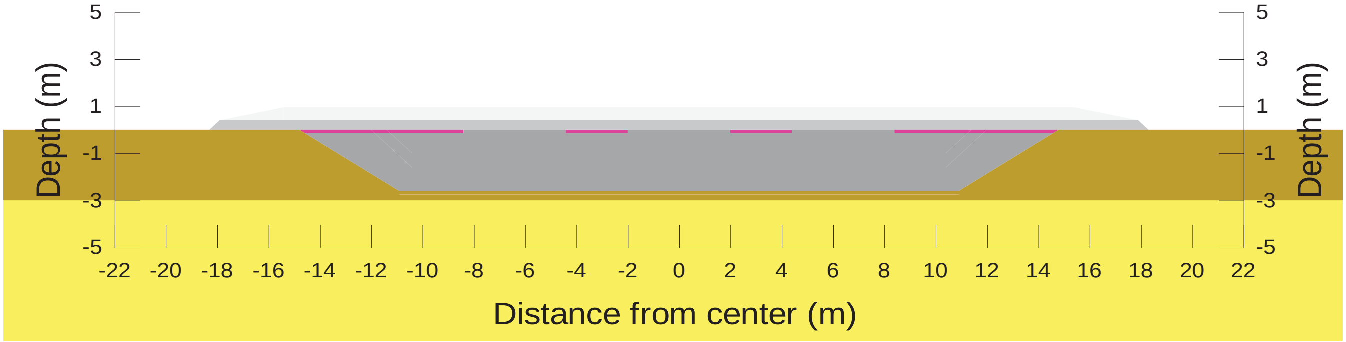
BIM

Milne Inlet Port

FIGURE C2-7D

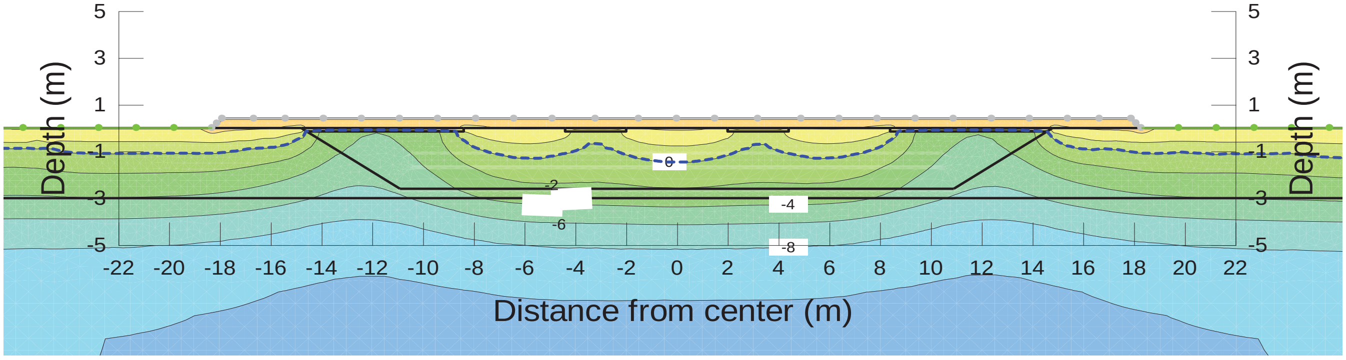
File Name: Screening Plant_thermal_updated.gsz
Name: May (2.6 m Pad) + Insulation in Found
Date: 3/28/2018
Directory: P:\REDLEAF\335458\SPECIALIST_APPS\02 Marry River\03 Crusher Buildings\Thermal models\

Color	Name	Model	Unfrozen Thermal Conductivity (J/sec/m/°C)	Frozen Thermal Conductivity (J/sec/m/°C)	Unfrozen Volumetric Heat Capacity (J/m³/°C)	Frozen Volumetric Heat Capacity (J/m³/°C)	Vol W/C (m³/m³)	Initial Temperature (°C)
⬜	Rockfill above ground	Simplified Thermal	3	4.5	3,000,000	2,400,000	0.036	0
◼	Rockfill Pad	Simplified Thermal	3	4.5	3,000,000	2,400,000	0.036	-3
🟨	Silt	Simplified Thermal	1.3	2	2,200,000	2,200,000	0.45	
🟪	Insulation	Simplified Thermal	0.035	0.035	37,500	37,500	0	0
🟫	Sand and Gravel	Simplified Thermal	2	3	2,600,000	2,600,000	0.255	



Job number	353004			Mary River Expansion Project	HATCH	BIM
Ref	Screening Building			Thermal Model - Modified Insulation Geometry		Milne Inlet Port
By	Lk	GQ	10-Apr-18			
Revision		A	10-Apr-18			FIGURE C2-8A

File Name: Screening Plant_thermal_updated.gsz
Name: May (2.6 m Pad) + Insulation in Found
Date: 3/28/2018
Directory: P:\REDLEAF\335458\SPECIALIST_APPS\02 Marry River\03 Crusher Buildings\Thermal models\



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<tr><td colspan="2">Ref</td><td colspan="2">Screening Building</td><td rowspan="3">Modified Insulation Geometry
Temperature Contour In Summer
(2 yr after construction)</td><td rowspan="2">Milne Inlet Port</td></tr>
<tr><td>By</td><td>Lk</td><td>GQ</td><td>10-Apr-18</td></tr>
<tr><td colspan="2">Revision</td><td>A</td><td>10-Apr-18</td><td>FIGURE C2-8B</td></tr>
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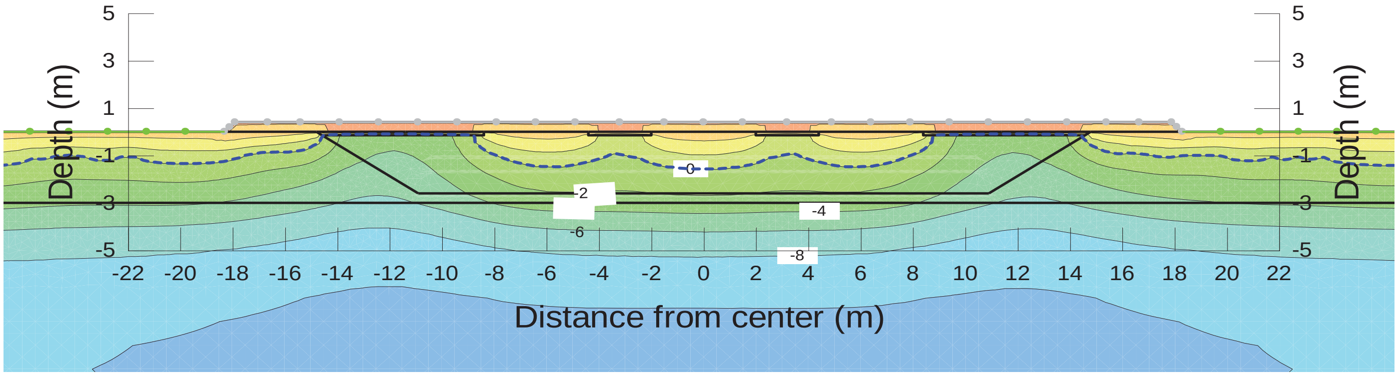
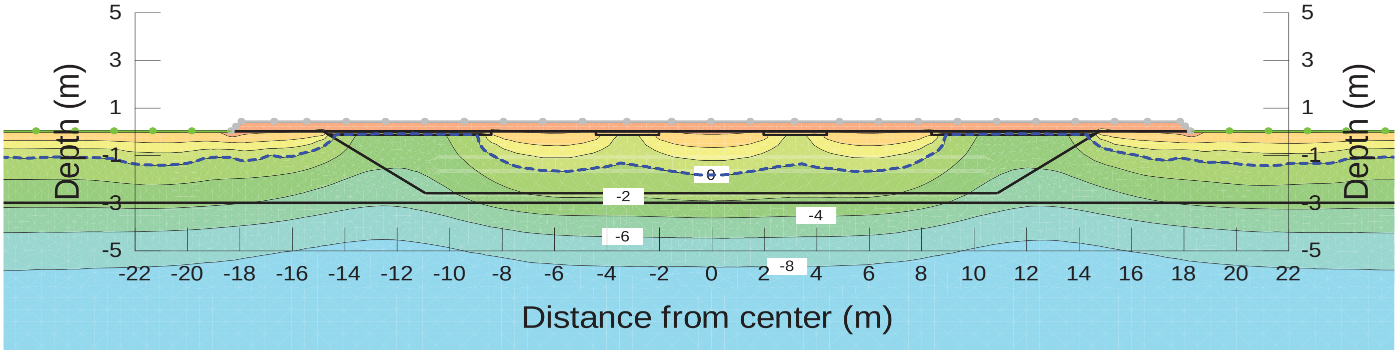
File Name: Screening Plant_thermal_updated.gsz
Name: May (2.6 m Pad) + Insulation in Found
Date: 3/28/2018
Directory: P:\REDLEAF\335458\SPECIALIST_APPS\02 Marry River\03 Crusher Buildings\Thermal models\



Job number	353004		**Mary River Expansion Project**	HATCH	**BIM**
Ref	Screening Building		**Modified Insulation Geometry** **Temperature Contour In Summer** **(10 yr after construction)**		**Milne Inlet Port**
By	Lk	GQ	10-Apr-18		
Revision	A		10-Apr-18		**FIGURE C2-8C**

File Name: Screening Plant_thermal_updated.gsz
Name: May (2.6 m Pad) + Insulation in Found
Date: 3/28/2018
Directory: P:\REDLEAF\335458\SPECIALIST_APPS\02 Marry River\03 Crusher Buildings\Thermal models\



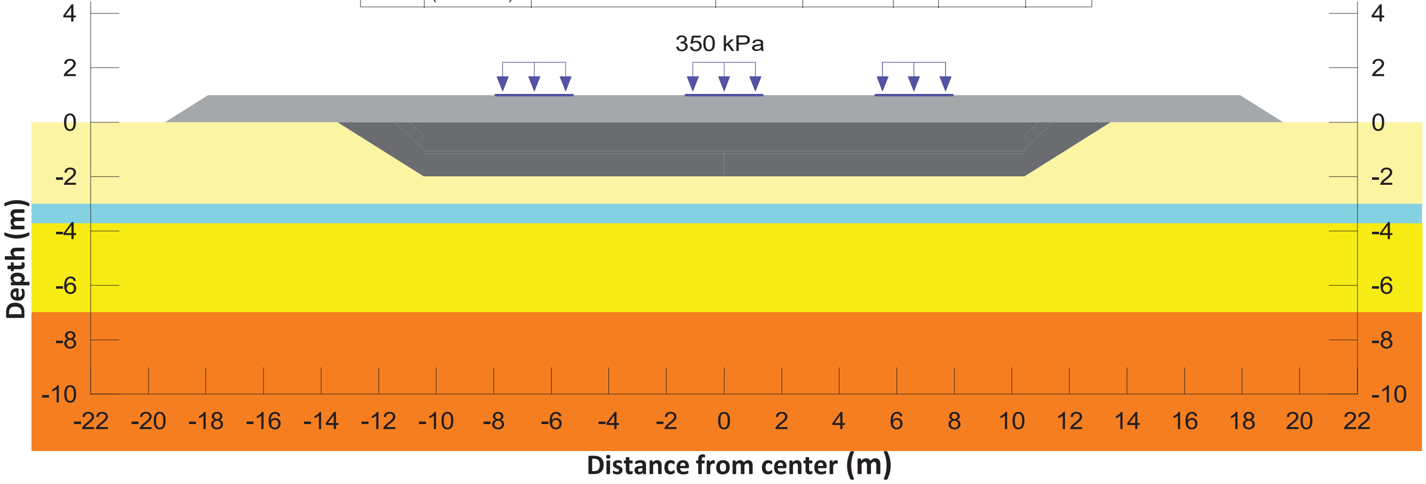
Job number	353004			**Mary River Expansion Project**	HATCH	**BIM**
Ref	Screening Building			**Modified Insulaton Geometry Temperature Contour In Summer (20 yr after construction)**		**Milne Inlet Port**
By	Lk	GQ	10-Apr-18			
Revision		A	10-Apr-18			**FIGURE C2-8D**

Appendix C3

Settlement Analyses – Crushing/Screening Plant

File Name: Crusher Plant Various Foundations.gsz
Name: Load/Deformation 2m Foundation - Constructed
Date: 2/22/2018
Directory: P:\REDLEAF\335458\SPECIALIST_APPS\02 Marry River\03 Crusher Buildings\Settlement\Geo Models\

Color	Name	Model	Effective Young's Modulus (E') (kPa)	Cohesion' (kPa)	Phi' (°)	Poisson's Ratio	Unit Weight (kN/m³)
⬜	Rockfill	Elastic-Plastic (Effective)	70,000	0	40	0.33	22
⬛	Rockfill Foundation	Elastic-Plastic (Effective)	70,000	0	40	0.33	22
🟨	Native Sand	Elastic-Plastic (Effective)	15,000	0	32	0.33	18
🟧	Frozen Silt (E=44 mPa)	Elastic-Plastic (Effective)	44,000	0	30	0.33	18
🟫	Till	Elastic-Plastic (Effective)	1,000,000	0	35	0.33	22
🟨	Frozen Silt (E=22 mPa)	Elastic-Plastic (Effective)	22,000	0	30	0.33	18
🟦	Frozen Sand (E=80 mPa)	Elastic-Plastic (Effective)	80,000	0	32	0.33	18



Job number	353004		
Ref	Crusher Building		
By	Lk	0	04-Mar-18
Revision		A	04-Mar-18

Mary River Expansion Project

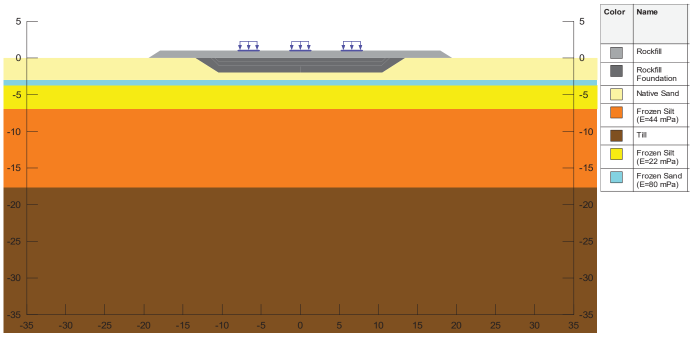
Settlement Model

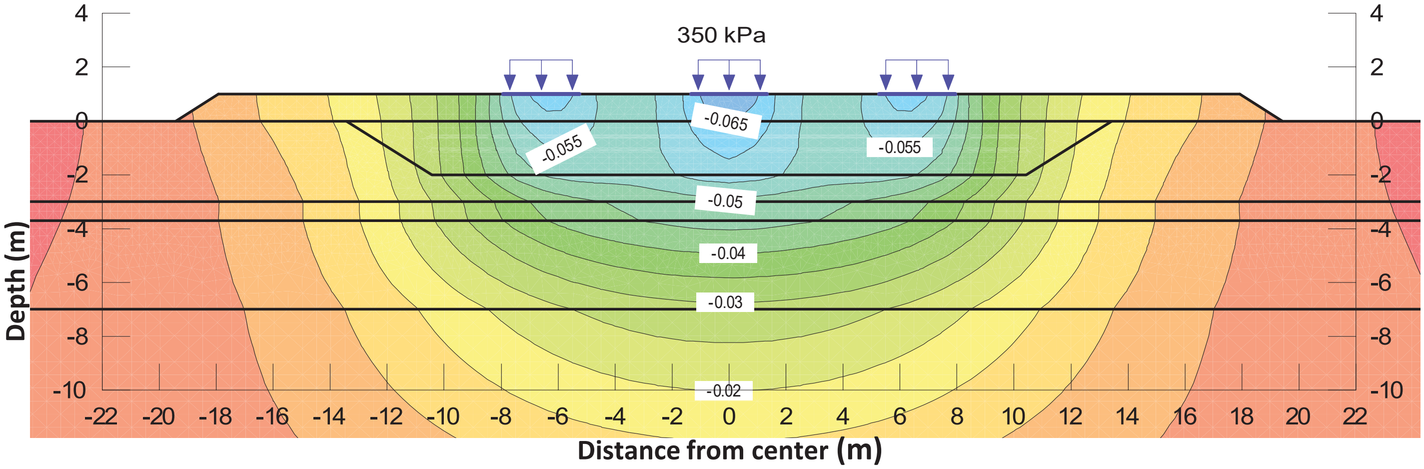
BIM

Milne Inlet Port

FIGURE C3-1

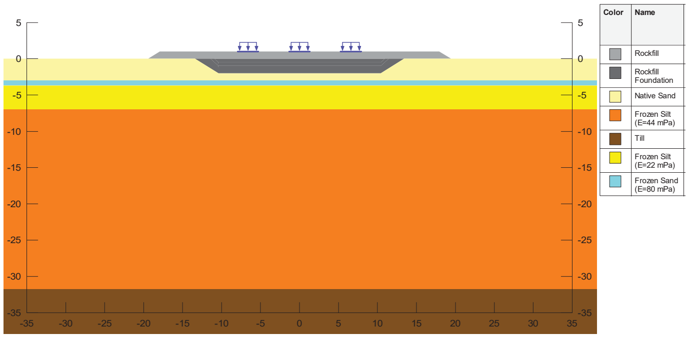
File Name: Crusher Plant Various Foundations.gsz
Name: Load/Deformation 2m Foundation - Constructed
Date: 2/22/2018
Directory: P:\REDLEAF\335458\SPECIALIST_APPS\02 Marry River\03 Crusher Buildings\Settlement\Geo Models\

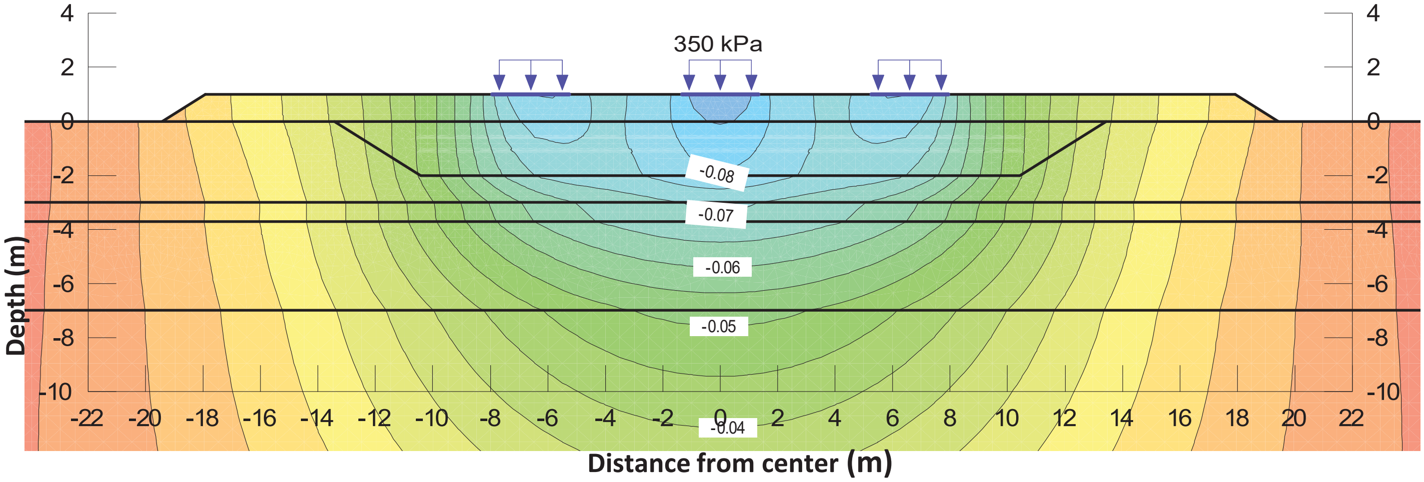




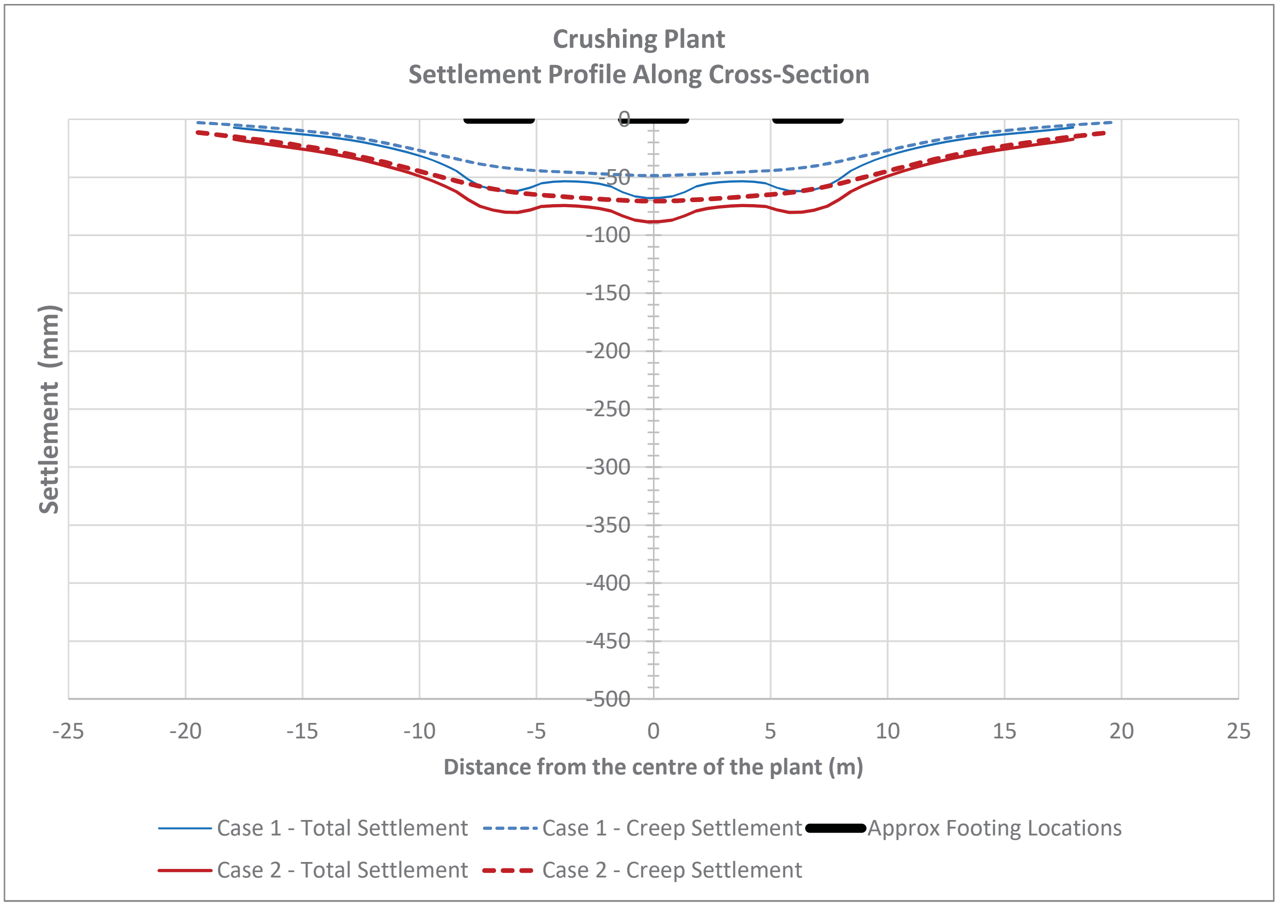
Job number	353004			**Mary River Expansion Project**	HATCH	**BIM**
Ref	Crusher Building			**Case 1 Results**		**Milne Inlet Port**
By	Lk	0	04-Mar-18			
Revision		A	04-Mar-18			**FIGURE C3-2**

File Name: Crusher Plant Various Foundations.gsz
Name: Load/Deformation 2m Foundation - Constructed Silt 28 m
Date: 2/22/2018
Directory: P:\REDLEAF\335458\SPECIALIST_APPS\02 Marry River\03 Crusher Buildings\Settlement\Geo Models\





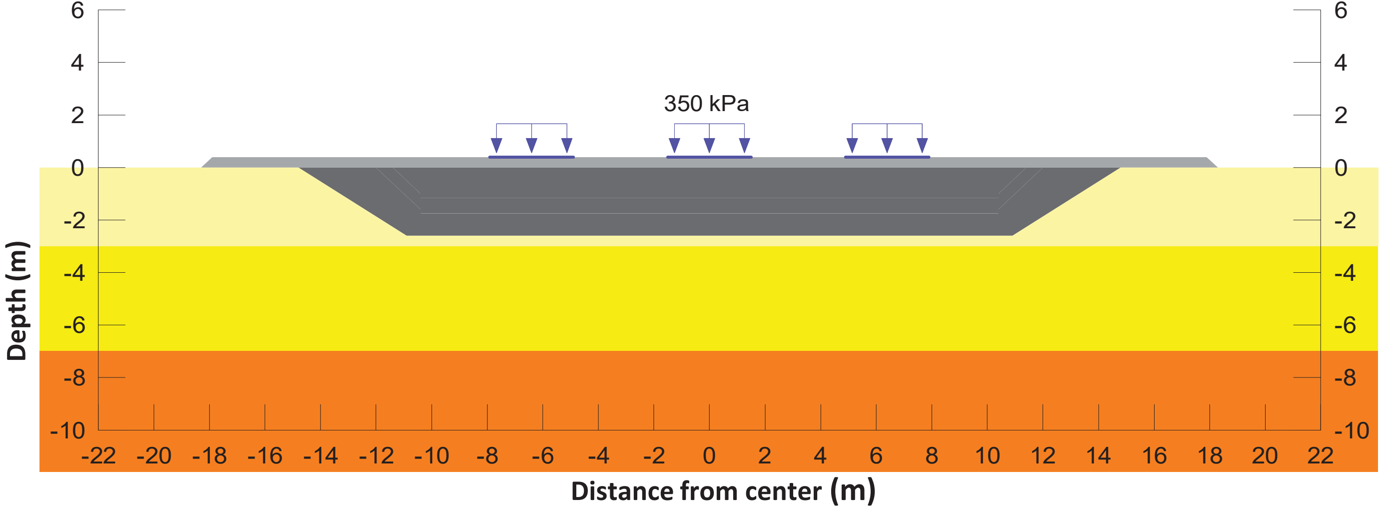
Job number	353004			Mary River Expansion Project	BIM
Ref	Crusher Building			Case 2 Results	Milne Inlet Port
By	Lk	0	04-Mar-18		
Revision		A	04-Mar-18		FIGURE C3-3



Job number	353004			**Mary River Expansion Project**	**HATCH**	**BIM**
Ref	Crusher Building			**Settlement Profile Summary**		**Milne Inlet Port**
By	Lk	0	04-Mar-18			
Revision		A	04-Mar-18			**FIGURE C3-4**

File Name: Screening Plant.gsz
Name: Load/Deformation 2.6m Foundation - Constructed
Date: 2/23/2018
Directory: P:\REDLEAF\335458\SPECIALIST_APPS\02 Marry River\03 Crusher Buildings\Settlement\Geo Models\

Color	Name	Model	Effective Young's Modulus (E') (kPa)	Cohesion' (kPa)	Phi' (°)	Poisson's Ratio	Unit Weight (kN/m³)
▨	Rockfill	Elastic-Plastic (Effective)	70,000	0	40	0.33	22
■	Rockfill Foundation	Elastic-Plastic (Effective)	70,000	0	40	0.33	22
□	Native Sand	Elastic-Plastic (Effective)	15,000	0	32	0.33	18
🟧	Frozen Silt (E=44 mPa)	Elastic-Plastic (Effective)	44,000	0	30	0.33	18
🟫	Till	Elastic-Plastic (Effective)	1,000,000	0	35	0.33	22
🟨	Frozen Silt (E=22 mPa)	Elastic-Plastic (Effective)	22,000	0	30	0.33	18



Job number 353004
Ref Screening Buildings
By Lk 0 04-Mar-18
Revision A 04-Mar-18

Mary River Expansion Project

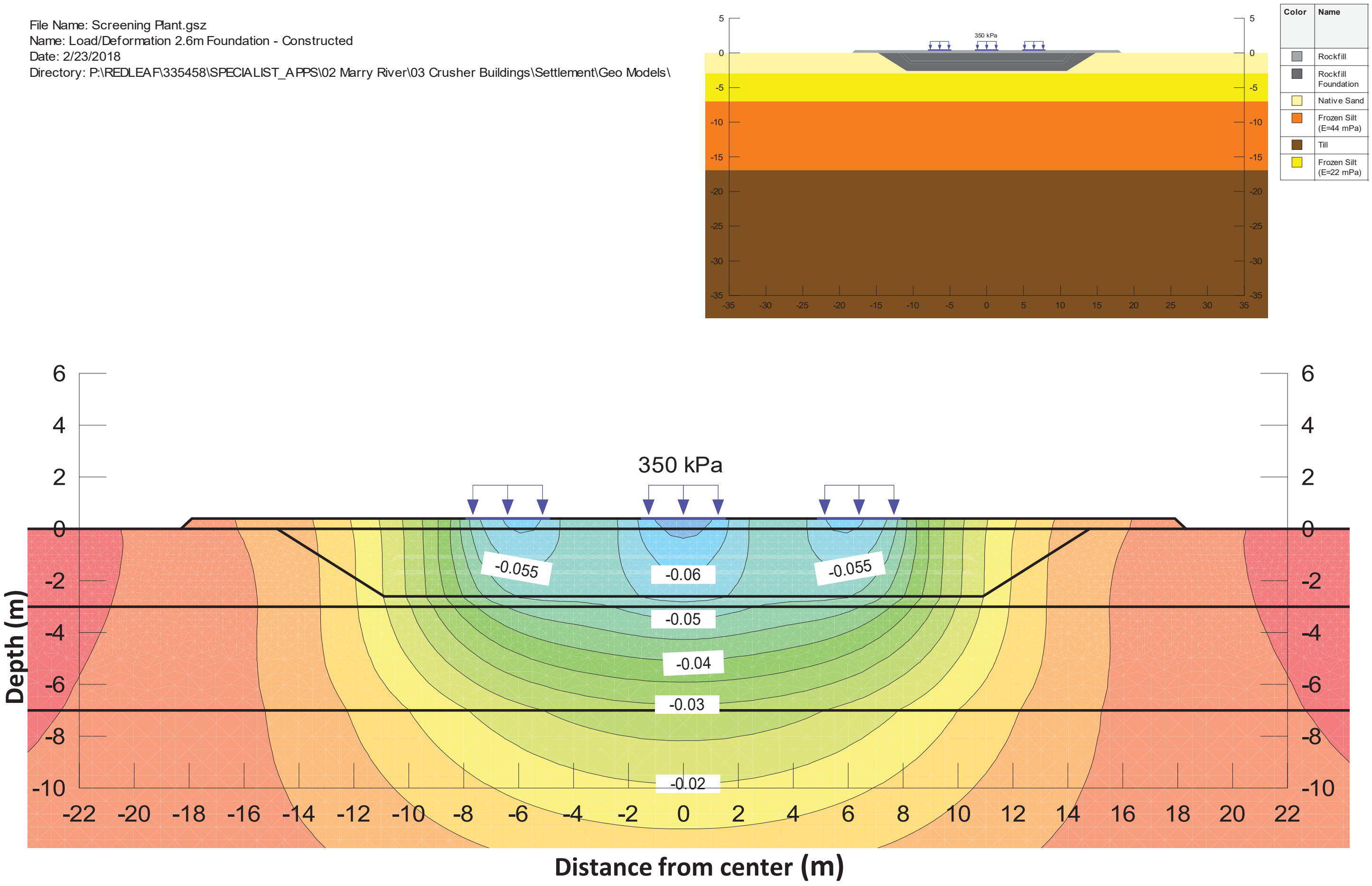
Settlement Model

HATCH

BIM

Milne Inlet Port

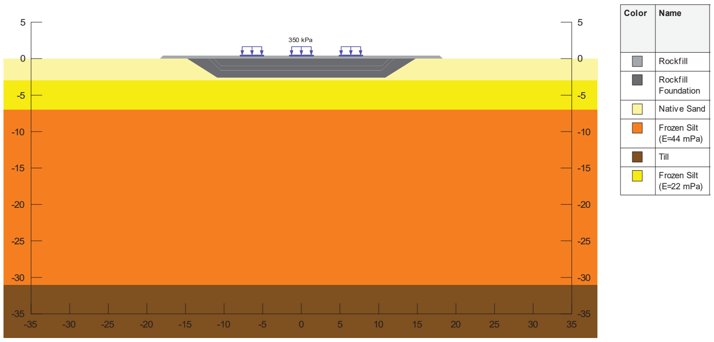
FIGURE C3-5

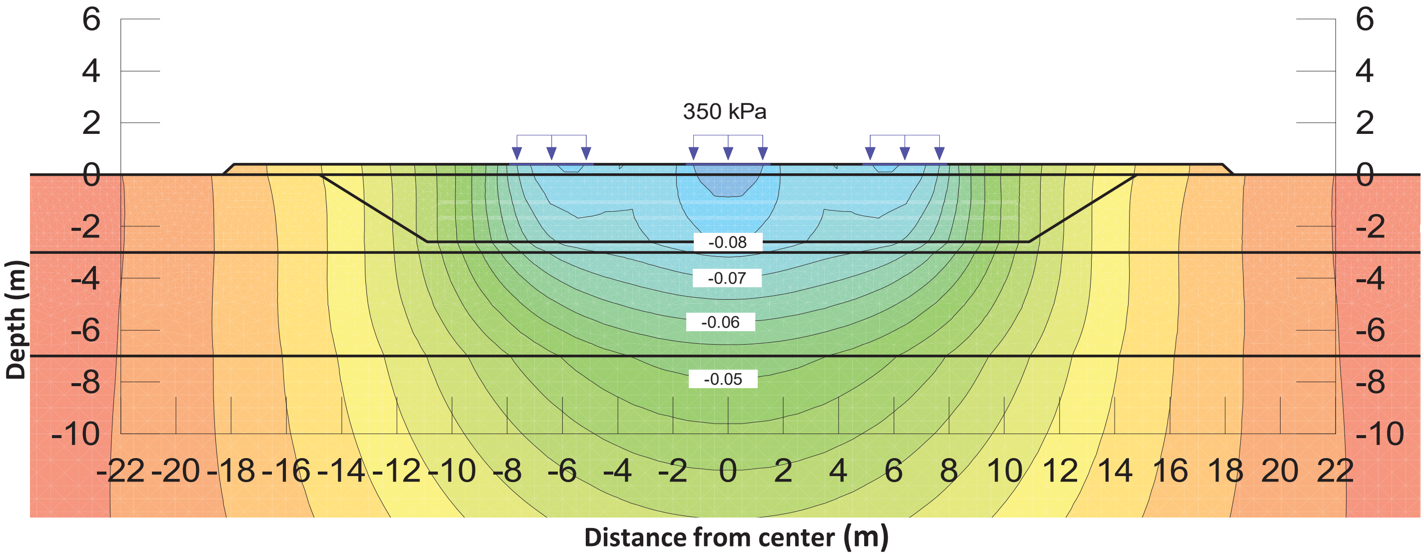


File Name: Screening Plant.gsz
Name: Load/Deformation 2.6m Foundation - Constructed
Date: 2/23/2018
Directory: P:\REDLEAF\335458\SPECIALIST_APPS\02 Marry River\03 Crusher Buildings\Settlement\Geo Models\

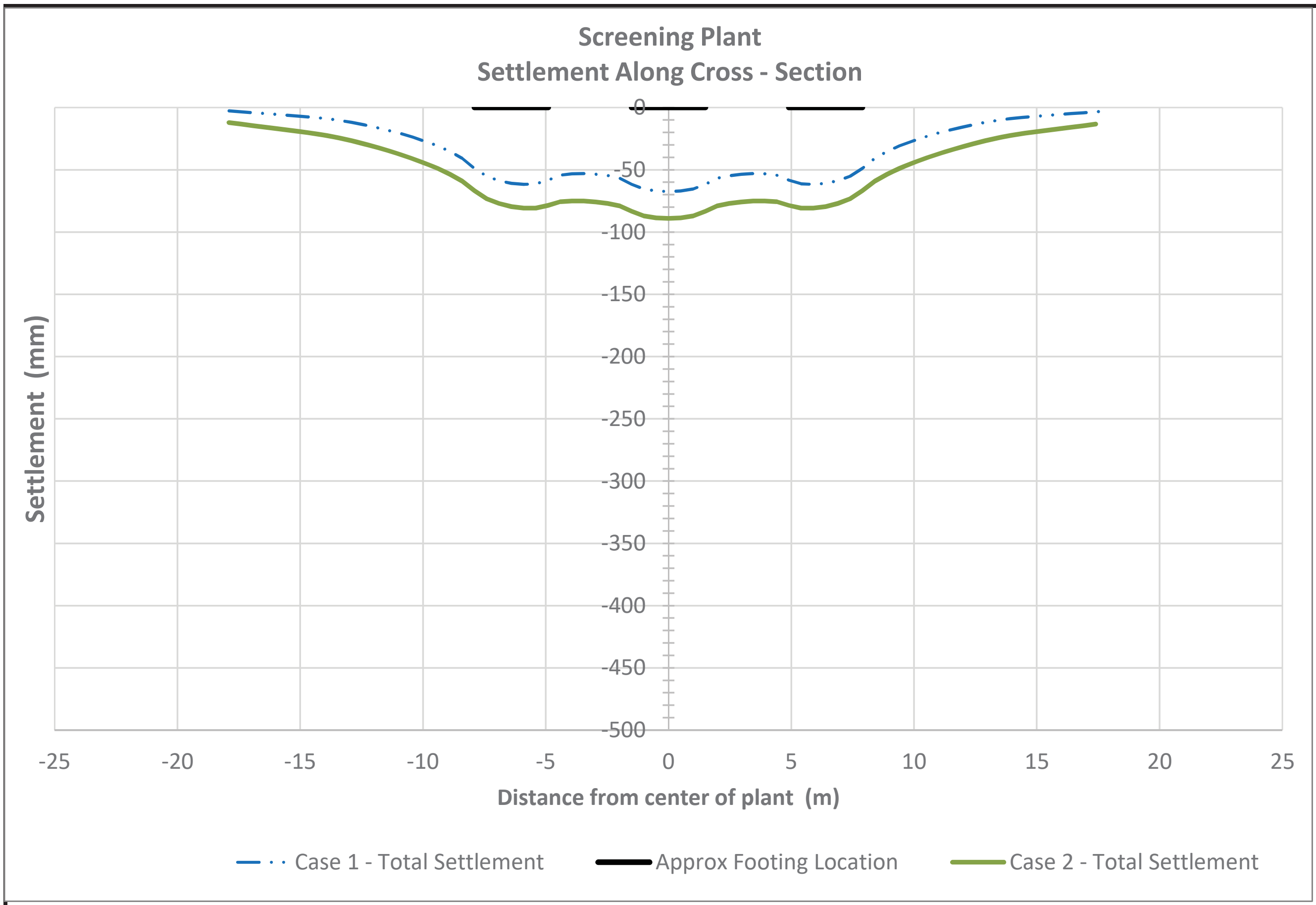
Job number	353004			**Mary River Expansion Project**	HATCH	**BIM**
Ref	Screening Buildings			**Case 1 Results**		**Milne Inlet Port**
By	Lk	0	04-Mar-18			
Revision		A	04-Mar-18			**FIGURE C3-6**

File Name: Screening Plant.gsz
Name: Load/Deformation 2.6m Foundation - Constructed - Silt 28 m
Date: 2/23/2018
Directory: P:\REDLEAF\335458\SPECIALIST_APPS\02 Marry River\03 Crusher Buildings\Settlement\Geo Models\





Job number	353004			**Mary River Expansion Project**	**BIM**
Ref	Screening Buildings				**Milne Inlet Port**
By	Lk	0	04-Mar-18	**Case 2 Results**	
Revision		A	04-Mar-18		**FIGURE C3-7**



Job number	353004			**Mary River Expansion Project**	HATCH	**BIM**
Ref	Screening Buildings			**Settlement Profile Summary**		**Milne Inlet Port**
By	Lk	0	04-Mar-18			
Revision		A	04-Mar-18			**FIGURE C3-8**