Appendix 24

Meadowbank 2022 Thermal Monitoring Report

MEADOWBANK PROJECT

Thermal Monitoring Report

Prepared by:
Agnico Eagle Mines Limited – Meadowbank Division

Version 4
January 2023

DOCUMENT CONTROL

Version	Date (YMD)	Section	Revision
1	2020-03-31	All	All
2	2021-01-25	All	All
3	2022-03-11	All	All
4	2023-01-20	All	All

INTRODUCTION

To observe the freeze back of the Tailings Storage Facility (TSF) and the Rockfill Storage Facilities (RSF's) at the Meadowbank Mine Project, a series of subsurface thermistors have been installed at strategic locations.

The purposes of the TSF thermistors are to monitor the Talik temperatures underneath the TSF as freezing progresses and to monitor the freezing of the tailings. The purpose of the thermistors in the RSF is to monitor the RSF temperature as freezing progresses. Appendix A of this report contains the updated data from each thermistor for 2022 as well as the location of the installed thermistors.

The thermistors data is reviewed periodically and as needed, and this will continue throughout the operational period as well as during closure. The results collected are to be used to compare the predicted thermal response of the facilities with the actual thermal response. This will allow adjustments to the Tailings Deposition Plan, the Waste Rock Management Plan and the Final Closure and Reclamation Plan.

INSTRUMENT SPECIFICATIONS

Each thermistor installed as part of the thermal monitoring plan must comply with the general specifications presented in Table 1.

Table 1: Thermistor Specifications

Items	Specifications
Accuracy	1 degree Celsius
Thermistor temperature range	-40 to 40 degrees Celsius
Method of cable termination	Amphenol connector and DAS direct connection
Cable termination enclosures	Weatherproof Animal resistant
Readout and data logger	Manual and DAS

THERMAL MONITORING OF THE TSF

The monitoring program objective for the TSF is to provide the data required to validate the predictions of freeze back within the tailings and for cover design purposes. The goals of the TSF North and South Cell cover systems and landforms are to ensure long-term landform stability, encourage TSF freeze-back into the surrounding permafrost, and maintain either subzero temperature or a high degree of saturation (>85%) in the tailings at all times. If it is determined by monitoring during operations that the tailings are freezing at lower rates than predicted, then mitigation procedures would be implemented.

An instrumentation plan for the TSF is planned to be developed to define the required instrumentation at closure once capping of the TSF is completed. The purpose of the performance monitoring system is to ensure that the cover performs as per its design intent.

The instruments installed in the North Cell TSF are located where tailings deposition was not planned to resume. No instruments are currently installed within the tailings of the South Cell but it is planned to install some to support the final design of the TSF landform cover.

As the TSF is reaching its final elevation, thermistors will be installed from the final tailings surface, and directly into the underlying bedrock.

THERMAL PERFORMANCE OF THE TSF

The thermistors are indicating that freeze back is occurring within the North Cell TSF.

Instruments located near the pond of water of the North Cell are showing a portion of unfrozen tailings at depth with frozen tailings in surface (with a 4-5 m active layer) and a progression of the freezing front advancing at depth. This is represented by yellow dot on Figure 1 (NC-16-1, NC-16-2, NC17-3, NC-17-2, NC-17-8). Instruments located away from the water pond show that the tailings and its foundation are entirely frozen with an active depth of 4-5 m. This is represented by red, green, and orange dot on Figure 1 (NC-17-1, NC17-4, NC-17-6, NC-17-7, NCIS-01 to NCIS-04).

Instruments installed below the capping shows that the active layer is contained within the rockfill showing the effectiveness of the capping concept. This is represented by a green dot on Figure 1 (NC-17-5).

SWD-01 shows a stable unfrozen situation in the foundation below the frozen tailings and capping.

SWD-03 indicates the return to a talik condition in the South Cell near Saddle Dam 3.

The thermal prediction of the tailings freeze-back made by Golder in 2008 indicated that for the more conservative scenario the entire tailings body would completely freeze back within a period of about 40 years after the end of operations with the freezing front advancing into the foundation beneath the tailings in the long term. The results are aligned with this modelling with most data showing a quicker freeze back than anticipated. Further discussion on these results and how they support the long-term performance of the tailings closure landform will be presented in the design document to be submitted as part of the FCRP.

THERMAL MONITORING PLAN OF THE RSF

Thermistors are currently installed within the Portage RSF.

Additional thermistors are planned to be installed within the Portage RSF and Vault RSF at closure. An instrumentation plan will be developed to define the required instrumentation at closure.

THERMAL REGIME OF THE RSF

Refer to the attached March 2022 memorandum by Okane for a detailed update and analysis on the available RSF thermal data, the work done so far on the cover design as well as a path forward in prevision of the submission of the final design of the cover as part of the FCRP. Work is ongoing for the final design of the cover as part of the FCRP.

The RSF thermal data for 2022 continues to follow the same trends explained in the Okane memorandum; the thermal data indicates that the RSF is continuing to freeze back but has not yet reached a state of equilibrium. Based on thermistor data, the depth of the active layer is approximately 3 m.

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Memorandum

To: Claude Gagné – Closure and Reclamation, Agnico Eagle Mines Limited

From: Lyndsey Thorson, Junior Engineer

Cc: Frederick Bolduc – Agnico Eagle Mines Limited; Dave Christensen – Okane Consultants

Our ref: 948-228-002 Rev0

Date: March 10, 2022

Re: **Meadowbank Portage RSF Landform Closure Strategy**

Agnico Eagle Mines Limited (Agnico Eagle) is looking to re-affirm or update the design of the Portage rock storage facility (RSF) landform so that the information can be presented in the Meadowbank Final Closure and Reclamation Plan (FCRP) which is due one year prior to closure. Okane previously completed thermal modelling of the Portage RSF and Agnico Eagle has requested support from Okane to increase the level of confidence on the RSF cover design.

Okane completed a review of the closure objectives, design basis, and modelling work done to support the Portage RSF cover system design, as well as regulator comment on the closure cover concept. Okane also completed review of studies and investigations completed by the Research Institute of Mines and Environment (RIME). A summary of information reviewed is enclosed in this memorandum including the milestones and estimated schedule to complete additional studies and investigations required prior to the submission of the FCRP.

Closure Cover System and Objectives

Description of Closure Cover System

The Portage RSF closure cover system consists of a 4 m non-potentially acid-generating (NPAG) cover system encapsuling potentially acid-generating (PAG) waste rock. The purpose of the cover system is to ensure geochemical stability of the Portage RSF by:

- Insulating the PAG waste rock from direct interaction with atmospheric forces; and
- Limiting oxidation by maintaining frozen conditions within the PAG waste rock.

The cover system also prevents runoff from contacting PAG waste rock material. To date, approximately 90% of the closure cover system has been constructed on the Portage RSF.

2019 Interim Closure and Reclamation Plan

As per the 2019 ICRP[1], the overarching closure objectives for rock storage facility (RSF) are as follows:

- The pile is physically and geotechnically stable for human and wildlife safety in the long-term: minimize erosion, thaw settlement, slope failure, collapse, or the release of contaminants or sediments;
- Build to blend in with current topography, be compatible with wildlife use, and/or meet future land use targets;
- Generation of poor water quality has been minimized, surface runoff and seepage water quality is safe for humans and wildlife; and
- Dust levels are safe for people, vegetation, aquatic life, and wildlife in the long-term.

Project Certificate Terms and Conditions

The third amendment of the Nunavut Impact Review Board (NIRB)'s Meadowbank Project Certificate [No.: 004] was issued by on December 21, 2018. The Project Certificate allows for the operation of the Meadowbank Mine including the Vault Expansion Project and the in-pit tailings disposal. With respect to the Portage RSF, the following terms and conditions are applicable:

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[1] SNC-Lavalin Inc. 2019. Meadowbank Interim Closure and Reclamation Plan (ICRP) - Update 2019 Final Report. Prepared for Agnico Eagle Mines Limited. May 2019.

15. *Cumberland shall within two (2) years of commencing operations re-evaluate the characterization of mine waste materials, including the Vault area, for acid generating potential, metal leaching and non-metal constituents to confirm FEIS predictions, and re-evaluate rock disposal practices by conducting systematic sampling of the waste rock and tailings in order to incorporate preventive and control measures into the Waste Management Plan to enhance tailing management during operations and closure. The results of the re-evaluations shall be provided to the NWB and NIRB's Monitoring Officer.*

79. *In addition to the NWB's requirements, the final Closure and Reclamation Plan shall require Cumberland to: b) Prevent continuing impacts from contaminants and wastes on the environment including those associated with acid rock drainage;*

Previous Regulating Agency Comment

Crown-Indigenous Relations and Northern Affairs Canada (CIRNAC) has raised several concerns regarding the closure cover system for the Meadowbank Portage RSF, *italicised* below with details as to how these concerns will be addressed prior to the FCRP submission.

Freeze back/Capping Thickness

"CIRNAC recommended that AEM include a meaningful discussion of the results from the thermal monitoring in the Annual Report. FEIS predictions should be compared with monitoring results and be clearly presented. AEM should present the updated modeling supporting their conclusions that the conceptual plans for thermal encapsulation of the Tailings Storage Facility (TSF) and the Waste Rock Storage Facility (WRSF) remain effective to prevent and control deleterious seepage over long term. Finally, if results show discrepancies from the predicted values, AEM should discuss the management actions that should be implemented to address the risk."

A detailed review of the thermal modelling for the Portage RSF closure cover system is presented in section *Design Basis Review*. Thermistor measurements and thermal model predictions are compared and analyzed in the *Performance Monitoring Data* section of this memorandum.

An adaptive monitoring trigger and action response plan (TARP) for the Portage RSF will be developed as part of an active scope of work with Okane, to be able to communicate the effectiveness of the cover system design to the regulator on a yearly basis (in operation and closure).

"CIRNAC recommended that AEM provide more information on the nature and extent of research efforts, results of the research and a discussion of how the proposed cover design has been influenced by these results."

The Research Institute of Mining and the Environment (RIME) has conducted several studies and investigations at the Meadowbank Portage RSF with respect to the thermal properties and regimes of the facility. These studies have been reviewed and summarized in the *RIME Studies and Investigations* section of this memorandum.

Progressive Reclamation

"CIRNAC recommended that future updates to the ICRP include more details on progressive reclamation at Meadowbank such as areas of Tailings Storage Facility (TSF) and Waste Rock Storage Facility (WRSF) facilities covered in the prior year, total areas covered to date, along with the volumes associated with these areas."

To date, approximately 90% of the closure cover system has been constructed on the Portage RSF. In response to 2019-2020 NIRB recommendations, Agnico Eagle has committed to include more details on progressive closure in the 2020 Annual Report. Relevant information to progressive closure can be found in Section 9.1 of the 2020 Annual Report and will continue to be updated annually. Details related to work completed and schedules of progressive reclamation is also included in the closure schedule presented in Appendix P of the ICRP which was updated in March 2020 and provided in the 2019 Annual Report in Appendix 55. Agnico Eagle is of the opinion that the last update March 2020 version fulfills the current request. Agnico Eagle is nevertheless committed to providing more details on the progressive closure in the next iteration of the Meadowbank ICRP.

WRSF Seepage Water Quality

"CIRNAC recommended that AEM confirm whether long-term modelling of seepage from the Meadowbank Waste Rock Storage Facilities (WRSFs) is of sufficient duration to characterize seepage after breakthrough. If not, CIRNAC recommends that AEM extend the temporal scope of its WRSF seepage modelling to ensure that potential seepage impacts after breakthrough are accurately characterized."

To support the landform water balance for the Portage WRSF, as part of an active scope of work Okane will document the inputs and assumptions from the thermal model. Such assumptions could include runoff estimates and distribution by zone of the WRSF and assumption on the potential for breakthrough seepage. This data will be used to model the water quality from the WRSF landform at closure (to demonstrate whether long-term water quality objectives will be met) as a future scope of work.

Thermistor Measurements for the Portage RSF

"CIRNAC recommended that AEM analyze the thermistor monitoring results against early thermal modelling predictions and update its Waste Rock and Tailings Management Plans if large discrepancies are observed between the monitoring results and model predictions."

Thermistor measurements and thermal model predictions are compared and analyzed in the *Performance Monitoring Data* section of this memorandum.

Thermal Performance of Meadowbank RSF Cover System

"CIRNAC notes that the WRSF cover concept for the Whale Tail Pit Project is generally similar to the concept used at the Meadowbank Gold Mine. The only notable difference is that thermal modelling for the Whale Tail Pit site determined that WRSF covers should have a total thickness of 4.7 m (4.2 m active freeze/thaw zone and a 0.5 m buffer). Modelling for the Whale Tail site also predicted that the freeze/thaw zone may penetrate deeper than the 4.7 m design thickness of the WRSF covers under the most conservative climate change scenario.

As part of an active scope of work, Okane will re-affirm or update the basis of design to demonstrate the effectiveness of the Meadowbank RSF cover concept to meet closure objectives based on the latest information available and integrating learnings from the Amaruq Project.

Design Basis Review

Summary of Thermal Modelling Inputs and Approach

The main objective of the initial numerical modelling exercise completed by Okane (2016) was to estimate the depth of the active layer (layer of materials undergoing freeze-thaw cycles from atmospheric forcing) within the Portage RSF and to confirm that the PAG waste rock will remain frozen, and oxidation rates greatly decreased, for the next 150 years under agreed upon climate change scenarios. One-dimensional (1D) and two-dimensional (2D) soil-plant-atmosphere (SPA), thermal and air flow modelling were completed, primarily to determine internal temperatures. Modelling was completed in three stages:

- development of a conceptual model to review available site data and provide initial estimates of performance and model inputs
- 1D and 2D calibration modelling to develop model inputs that can reasonably replicate measured temperatures within the Portage RSF. This modelling also provided validation that the model could be used to estimate future performance.
- 2D, 150-year climate change models were completed to estimate future performance of the Portage RSF assuming climate change followed either RCP4.5 or RCP6.0 climate change scenarios.

The conceptual model (Okane, 2016) at the time found/anticipated:

- The Portage RSF had not completely frozen at the time of its writing.
    - Thermistors installed in November of 2013 (RSF-3, RSF-5, and RSF-6), with the exception of RSF-4, did not equilibrate with the surrounding rock until May of 2014. The remaining thermistors were only just beginning to provide reliable data and were therefore excluded from informing the conceptual model and numerical modelling.
- The top 4 to 5 m of the Portage RSF were still thawing during summer, but its active layer was anticipated to decrease in thickness once permafrost fully formed.
- The northwest corner and north slope of the Portage RSF would have the coolest conditions and thinnest active zone, while the south slope is anticipated to be the area with the highest potential for a thicker active layer.

The 1D model was calibrated to thermistor RSF-3 for the period of January 1, 2013, to December 31, 2015, with a focus on the period following May of 2014 as review of the field data indicated that the RSF-3 thermistor had not equilibrated with the surrounding waste rock until then. The model simulated a cover system consisting of 0.3 m of crushed NPAG material overlying 3.7 m of NPAG material on top of the PAG rock. This configuration was used to mimic the impacts of material placement (dozer and truck traffic) on near surface cover system material. This trafficked layer is found on the plateau area, bench crests, and inter-bench slopes. The cover system on the inter-bench slopes will likely have slightly different properties as it is not trafficked and would likely not require the 0.3 m crushed NPAG layer used in modelling. As the thermistor strings used in calibration are exclusively located on the plateau or bench crests, the 0.3 m crushed NPAG layer was used in all modelling. A similar approach was used in previous cover system modelling (Okane, 2014) at Meadowbank. Once calibrated, the modelled temperature profiles were shown to match well with measured temperature data over the entire profile of RSF-3.

Following 1D calibration, two, 2D cross-sections, one running north-to-south and a second running northwest-to-southeast, were selected for additional model calibration. The material properties developed for the 1D model calibration were used as initial material properties for the 2D modelling, and then further adjusted to improve the comparison between the field measurements and model estimates.

Two dimensional (2D), 150-year models were completed using the north-to-south cross-section. The cross-section was simulated for two climate change scenarios: RCP4.5 and RCP6.0.

Thermal Modelling Results

The 2D, 150-year climate change models predicted:

- The maximum depth of the active zone would not extend below 4 m on any slope aspect assuming climate conditions follow the RCP4.5 trend.
- If climate conditions follow the RCP6.0 trend, the model predicts that the active layer will extend beyond the 4 m cover system currently in place for infrequent time periods, with the greatest depth being over 6 m on the plateau during a period of 664 days when the model predicted an active zone greater than 4 m.

These model results were reviewed by Okane (2019) to evaluate the accuracy of the thermal model by comparing the simulated results with field data collected from the thermistors in the Portage RSF since the modelling was completed in 2016. The key findings of the review and comparison of the Portage RSF monitoring and modelling programs were:

- Decreasing trends in the active zone depth were recorded at most thermistor locations.
- The thermal model predicted colder temperatures near surface compared to recorded near surface temperatures.
- Temperature trends becoming more consistent with simulated temperatures over time.
- The observed active zone was generally thicker on the north slope compared to the south slope. In the conceptual model, the south slope was anticipated to be the area with the highest potential for a thicker active zone.
- Comparison of site recorded net radiation to model input net radiation showed that the model underestimated net radiation by approximately 10-15% in the summer months.
- Snow depth was not recorded at the time on the RSF.

Hence, the confidence in the numerical model as a predictor of future conditions was estimated as moderate to high, with further increasing confidence if the trend towards consistency continued as expected.

Closure Approach at Similar Sites

A closure thermal cover system has also been proposed and investigated at Agnico Eagle's Amaruq site, specifically for the Whale Tail and IVR waste rock storage facilities (WRSFs). The intent of the WRSF design is to demonstrate the physical and chemical stability of the Whale Tail and IVR WRSFs while optimizing risk and cost for Agnico Eagle. The objective of the final cover system is to ensure that the overarching closure objective, specifically that water quality in the receiving environment be protected within permitted conditions, is met. The design basis of cover system design is to control mechanisms which result in the potential for poor water quality from the WRSF. These controls include:

- Limiting the depth of the yearly active (freeze-thaw) layer to limit the impacts on water quality;

- Promoting frozen conditions to limit acid generating reactions within the waste rock; and

- Promoting frozen conditions to limit mobilization of metal leaching and acid rock drainage (ML-ARD) products within the WRSF.

The thermal cover system for the waste rock storage facility (WRSF) is to be constructed of non-acid generating / non-metal leaching (NAG/NML) rockfill removed from the open pit as mining continues. The available NAG/NML materials are primarily classified as diorite and south greywacke, representing approximately 17% of the waste rock to be mined from the pit. A closure cover system (thermal cover) will be added (when practical as part of a progressive reclamation program) on the slopes and top surface of the WRSFs to encapsulate the potentially acid generating / metal leaching (PAG/ML) waste rock, limiting the effects on water quality. During operations, materials are classified as NAG/NML or PAG/ML based on sampled sulfur and arsenic concentrations).

The proposed cover system design thickness has been determined through modelling of the Whale Tail and IVR WRSFs, and monitoring efforts at the Portage WRSF. The Portage WRSF is a fully constructed and instrumented WRSF with a 4.0 m NAG/NML cover encapsulating PAG/ML waste rock. Review of thermal conditions at the Portage site indicate that the active zone depth in 2018 was between 0.6 and 4.9 m and is continuing to decrease over time.

Updated thermal modelling of the Amaruq WRSFs indicates that a thermal cover of NAG/NML material will limit the likelihood of risk associated with ML/ARD within the PAG/ML waste rock, by promoting frozen conditions in the Whale Tail and IVR WRSF. While thaw below the proposed cover system is expected, the likelihood of the thermal cover system thickness being insufficient, leading to unacceptable water quality in the receiver is expected to remain very low. This is due to the several factors, including:

- Low volumetric water content in the thawed waste rock, resulting in low likelihood of mobilization of seepage from waste rock;

- Lower pyrite oxidation rates within the thawed waste rock compared to the cover system material (as a result of consistent near-freezing temperatures within the waste rock) resulting in low to moderate likelihood of production of metal leaching and acid rock drainage (ML/ARD) products; and

- Limited volume of PAG/ML waste rock in the estimated thawed waste rock zone, resulting in low likelihood of production of ML/ARD products.

RIME Studies and Investigations

The Research Institute of Mines and Environment (RIME) has conducted a number of studies and investigations at Agnico Eagle's Meadowbank Mine and associated facilities. The following summarizes the articles pertaining to the Meadowbank facilities.

Resistance of a soapstone waste rock to freeze-thaw and wet-dry cycles: implications for use in a reclamation cover in the Canadian Arctic

Vincent Boulanger-Martel, Bruno Bussière, and Jean Côté

The durability of non-potentially acid-generating (NPAG) soapstone waste rock was investigated with respect to freeze-thaw and wet-dry cycles, to be used as a cover material for reclamation of tailings and waste rock storage facilities. No single methodology exists to accurately characterize a materials resistance to freeze/thaw and wet/dry cycles, so a series of index tests were chosen from existing literature to analyze pore space properties and static physical integrity.

Testing was completed on intact rock cores to determine the following physical properties:

- Dry mass;
- Dry density;
- Water adsorption index; and
- Apparent porosity.

Mechanical properties assessed included unconfined compressive strength (UCS), and Young's modulus (*E*) which omitted any weathering cycles, to represent initial conditions. The remaining samples were separated and tested under various weathering cycles, summarized in Table 1.

Table 1: Rock Core weathering analyses

Weathering Scenario	Number of Core Samples
Initial Conditions	9
20 freeze-thaw and 20 wet-dry cycles	18
80 freeze-thaw cycles	9
80 wet-dry cycles	9

Boulanger-Martel et al. (2020)

Experimental procedures were also performed on 10 rock slabs, modified from ASTM D5312-12 and ASTM D5313-12 to evaluate the resistance to freeze-thaw and wet-dry cycles. Unconfined freeze-thaw tests were conducted on waste rock aggregates to investigate the effects of freeze-thaw cycles on each grain-size fraction using procedures modified from the CSA A23.2-24A and MTO Ls-614 standards to match specific field conditions.

Results of the study indicate that the soapstone waste rock is resistant to freeze-thaw and wet-dry cycles, as well as to physical degradation. Based on site specific conditions, freeze-thaw cycles should be considered the primary weathering mechanism at Meadowbank Mine. Mass loss durability tests were also conducted on intact rock cores, rock slabs, and < 50-mm granular materials, which indicated the potential to release fine particles due to freeze-thaw weathering to be low. The soapstone waste rock is considered a suitable material for an insulation cover system at Meadowbank Mine.

Thermal behaviour and performance of two field experimental insulation covers to control sulfide oxidation at Meadowbank mine, Nunavut

Vincent Boulanger-Martel, Bruno Bussière, and Jean Côté

The proposed insulation cover for the Meadowbank mine TSF was validated *via* laboratory and field tests conducted on two instrumented experimental cells. The objectives of the study included:

- determining the materials main thermal and hydrogeological properties;
- identifying the maximum temperature for the safe storage of the Meadowbank tailings;
- assessing the thermal behaviour of 2 m and 4 m thick insulation covers after 4.5 years of monitoring; and
- assessing the in-situ performance of the cover systems with respect to limiting sulfide oxidation.

The TSF is divided into two deposition cells (North and South) where tailings are disposed of as a slurry. Grain sizes for the NPAG waste rocks range from fine particles to blocks (< 80 μm to <1 m) and is characterized by D10, D30, D50, D60, D90, and D100 values (Dx: diameter corresponding to x w/w % passing on the cumulative grain-size distribution curve) of 15, 90, 200, 250, 550, and 920 mm, respectively.

Thermal conductivity of solid particles was measured directly from intact rock cores and indirectly from two grain-size fractions using the water-saturated material thermal conductivity interpretation method. Saturated hydraulic conductivity was determined by performing constant-head permeability tests at low hydraulic gradients in a large high-density polyethylene (HDPE)column, and the water retention curve was determined from a column drainage test.

The relationship between tailings' reactivity and temperature (K_r - T) was investigated in a laboratory setting using oxygen consumption tests (OCT) to determine at which temperature the tailings' oxidation becomes negligible and thus establish a safe storage temperature for tailings.

Results indicated the temperature of the tailings was significantly influenced by the insulating properties of the cover material, and that maximum and minimum temperatures at the tailings-cover interface were influenced by the thickness of the cover. Below 0°C no reactivity was observed, and at 0°C, the laboratory measured Kr-T relationship indicated a reduction in Kr of 93-96% relative to ambient temperatures. Safe storage of the Meadowbank tailings is expected at a maximum temperature of 0°C (target temperature).

The 4 m thick cover maintained temperatures below 0 °C at the tailings-cover interface, whereas the 2 m thick cover resulted in temperatures above 0 °C on 94-124 days out of the year. The study recommends that insulation covers be designed thick enough to maintain temperatures below the target temperature at the tailings-cover interface in the long term. Materials and construction methods that promote high degrees of saturation should also be considered to help limit thaw depth and control sulfide oxidation.

Insulation covers with capillary barrier effects to control sulfide oxidation in the Arctic

Vincent Boulanger-Martel, Bruno Bussière, and Jean Côté

The performance of an insulation or thermal cover with capillary barrier effects (CCBEs) used for reclamation of a tailings storage facility (TSF) was investigated for the Meadowbank mine site in both a laboratory and field setting. The objectives of the insulation cover in a permafrost environment was to control the temperature and limit oxygen ingress of the potentially acid-generating (PAG) tailings.

Fine grained, compacted non-potentially acid-generating (NPAG) waste rock was evaluated as a potential candidate for construction of the moisture retention layer and was determined to be a suitable material as it has a low resistance to compaction; the waste rock easily breaks down into fine particles. The physical and hydraulic properties of both the cover NPAG and tailings materials were developed based on available samples, field collected data, and laboratory tests. Oxygen diffusion tests were also completed in the lab. A 2 m experimental cell was constructed in the field and monitored (temperature and unfrozen volumetric water content) for three and half years. The cover consisted of a 0.5 m layer protective layer of loose waste rock overlying a 0.5 m moisture -retaining layer and 1.0 m capillary break layer of loose waste rock atop approximately 15 m of tailings. Three monitoring stations were installed in the cell equipped with instrumentation to measure unfrozen volumetric water content and temperature.

The results of the investigation indicate that the active layer generally does not penetrate the PAG tailings. The maximum depth of thaw observed during the monitoring period was 15 to 25 cm into the tailings. This was typically observed in years with warmer summers, with 39 to 57 above 0°C depending on the year. The degree of saturation in the moisture retention layer was observed to remain high even when temperatures reach above 0°C.

During periods when the tailings are below 0°C, the oxidation reactions are limited. When above 0°C, oxidation reactions were limited by the amount of available oxygen able to pass through the moisture retention layer. The annual oxygen ingress through the moisture retention layer and into the tailings was calculated to be less than 2 mol/m^2/year.

Thermal conductivity of Meadowbank's mine waste rocks and tailings

Vincent Boulanger-Martel, Andrée Poirier, Jean Côté, and Bruno Bussière

A predictive thermal conductivity model was calibrated based on laboratory data to assess the thermal conductivity of solid particles and the unfrozen/frozen thermal conductivity as a function of saturation. Materials assessed include compacted NPAG waste rock, PAG waste rock, and tailings.

Thermal properties were assessed based on representative NPAG and PAG waste rocks samples that were sieved at 20 mm and further sub-divided into 0-1.25 mm and 1.25-5.00 mm sub-samples. Intact NPAG and PAG rock cores were sampled using a portable 4-in diamond core drill, and tailings samples were taken with a shovel from the TSF. The mineralogical compositions of all materials were quantified based on semi-quantitative X-ray diffraction (XRD) analyses.

The objective of the characterization program was to determine thermal conductivity (λ_s), obtain thermal conductivity measurements of the moist materials, and determine dry thermal conductivity (λ_{dry}). All results were interpreted to best fit the Côté and Konrad thermal conductivity model. Unfrozen and frozen thermal conductivities as a function of saturation for each material type were determined and summarized in Table 2.

Table 2: Thermal conductivity (λ_s) summary by material type

Material Type	Number of Samples	Degree of Saturation	Porosity	λ_s (W/m K)
Compacted NPAG	5	33 to 90%	0.19 to 0.21	4.80
PAG	2	21 and 67%	0.26 and 0.21	5.27
Tailings	3	46 to 89%	0.39 to 0.40	5.80

Additional testing was conducted on NPAG waste rocks to determine structural effects on thermal conductivity, in which λ_{dry} measurements were made on grain-size fractions 0-20mm and 0-1.25 mm.

Results of XRD analyses indicate that talc and chlorite are the primary minerals in all NPAG rock samples. Field and laboratory evidence showed that the NPAG waste rock has a relatively low resistance to compaction, resulting in breakage of particles which generates finer particles after compaction.

Thermal conductivity was found to increase with increasing saturation, and higher values were measured in the frozen state relative to those measured in the unfrozen state. No major structural effects on the thermal conductivity were identified.

Design, construction, and preliminary performance of an insulation cover with capillary barrier at Meadowbank Mine, Nunavut

Vincent Boulanger-Martel, Bruno Bussière, Jean Côté, and Patrice Gagnon

This study is a preliminary report which is appropriately detailed and summarized above in 'Insulation covers with capillary barrier effects to control sulfide oxidation in the Arctic.'

Thermal-Hydrological-Chemical Modeling of a Covered Waste Rock Pile in a Permafrost Region

Xueying Yi, Danyang Su, Bruno Bussière, and K. Ulrich Mayer

A reactive transport model was developed using the MIN3P-HPC software to understand the thermal-hydrological and chemical processes governing a covered waste rock pile under permafrost conditions located in Nunavut Canada.

Baseline studies in the area of the Meadowbank mine indicate that the average active layer in the region range from 1.3 m to 4 m. Thus, a cross section of a waste rock pile comprised of potentially acid generating material in encapsulated by a 4 m layer of non-potentially acid-generating (NPAG) material was used as the base case. The NPAG cover acts as a thermal or insulation cover in cold regions with the role of limiting the depth of thaw to the cover and thus maintaining permafrost conditions in the underlying PAG material. The base case scenario was modelled with a 4 m cover for a period of 50 years (2014 to 2064).

Site-specific hydraulic, thermal, and geochemical material properties measured through laboratory characterization and field investigations were incorporated into the model. A constant net infiltration rate was applied to the model on days when the air temperature was above freezing. Recharge due to snowmelt following the first month of spring thaw was also applied to the model. A sinusoidal air temperature function was developed based on observed average daily air temperatures between 2014 and 2017 and was applied to the model to capture the seasonal variability in thermal conditions. The main geochemical focus was placed on the generation of acid rock drainage and generation of heat from the oxidation of pyrite and carbonates (as a source of neutralization potential). It was assumed, based on previously studies completed at Meadowbank that below 0C, reactivity of waste rock is negligible.

Simulated temperatures were compared to measured temperatures collected from thermistors installed in the Portage RSF and generally show good agreement between the simulated and measured temperatures. However, simulated temperatures are generally lower than measured temperatures. Temperature fluctuations within the RSF lag the simulated air temperatures, but generally captures peaks and seasonal trends well. The model predicts average penetration of 10 to 15 m of the RSF. Generally, the temperature measurements of the RSF show warmer than modelled temperature at shallow depths particularly in the winter months due to the insulating effects of the snowpack.

The long-term thermal conditions for the base case scenario indicate that the zero-degree (0°C) isotherm remains within the 4 m NPAG cover system, indicating that frozen conditions are maintained in the PAG waste rock. Frozen conditions are maintained at the core of the pile.

It was noted that the model did not consider the following aspects that would be expected to affect the thermal regime within the RSF:

- heterogeneity of material properties
- wind effects;
- variations in cover thickness due to construction;
- preferential flow through large pores; and
- slope orientation.

Sensitivity analysis was conducted on infiltration rates; simulations included a reduced infiltration rate and an increased infiltration rate in addition to the base case. Increased saturation and ponding within the cover is observed under the increased infiltration rate. In addition, the saturation and basal seepage at the toe of the pile increases with increased infiltration. The magnitude of the laterally diverted flow increases with increasing net infiltration. The simulated results indicate that net infiltration does not have a significant impact on active layer thickness as similar flow patterns and locations and ice distributions are similar for all infiltration scenarios. Overall, it was observed that saturation, ponding, and seepage is a function of the net infiltration.

Additional sensitivity analysis was run on cover thickness, including simulations with a 2 m cover system and a 6 m cover system in addition to the base case 4 m cover. Under the 2 m cover thickness, the simulated active layer extending into the PAG waste rock. Similar to the 4 m cover thickness, for the 6 m cover thickness the zero-degree (0°C) isotherm the active layer remains within the cover system, nearing the interface of the NPAG and PAG materials.

The cover thickness and thus the resulting depth of the active layer are the main drivers affecting the geochemical processes within the RSF. For the no cover and 2 m cover scenarios, pyrite oxidation was observed in the summer months. The extent of the oxidation is greater in the no cover scenario as the entire active layer is within the PAG waste rock. The resulting loading of sulfates in basal drainage. In the 4 m and 6 m scenarios, minimal pyrite oxidation is observed as the PAG rock remains in a frozen state. As a result, basal drainage remains clean as no products of oxidation are generated.

Summary of Information of Interest

Following the review of the studies and investigations of the RIME, the following take-aways are provided below.

- NPAG waste rock is competent material for cover system construction as it is resistant to freeze-thaw and wet-dry cycles and physical degradation. As such, it would remain a physically stable cover system in closure.
- Use of an insulation thermal cover system in conjunction with a moisture retention layer can limit the oxidation reactions in tailings helping to develop and maintain frozen conditions as well as limit the amount of available oxygen.
- Thermal conductivity of NPAG waste rock was characterized through laboratory analyses. Thermal conductivity was found to increase with increasing saturation, and higher values were measured in the frozen state relative to those measured in the unfrozen state. No major structural effects on the thermal conductivity were identified.
- Thermal modelling completed by the RIME indicates that the active layer (temperatures above 0°C) is maintained with a 4 m NPAG cover system long term. This model considered the heat generated due to oxidation; however, climate change was not considered. The thermal model is in agreement with Okane’s thermal modelling results which considered climate change but not heat generation due to oxidation.

Performance Monitoring Data

Summary of Installed Instrumentation

Thermistor strings have been installed to monitor temperature and permafrost aggradation within the Portage RSF to monitor the temperature as freezing progresses. Nineteen (19) thermistor strings were installed in the Portage WRSF between 2012 and 2015 (Figure 1). A summary of thermistor strings installed in the RSF can be found in Table 3. The last reading for Thermistor string RSF-4 occurred on March 5, 2015 and is highlighted in Table 3

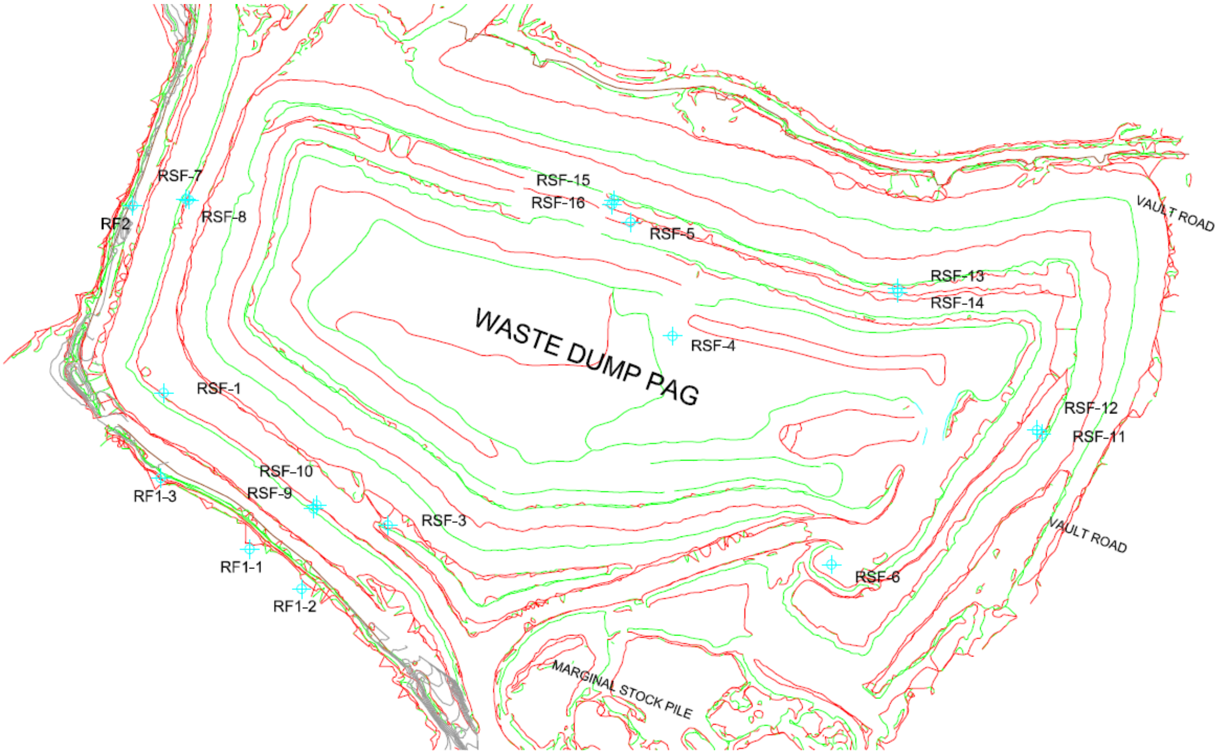

Figure 1: **Plan view of thermistor string monitoring locations at Portage RSF**[2]

Table 3: Summary of Thermistors Installed in Portage RSF between 2012 and 2020

Name	Easting	Northing	Elevation	Year Installed
RF1-1	638221.23	7215663.59	149.47	2012
RF1-2	638277.00	7215621.00	149.5	2012
RF1-3	638126.00	7215740.00	149.5	2013
RF-2	638096.00	7216032.00	149.83	2012
RSF-1	638129.00	7215831.00	172.8	2013
RSF-3	638369.59	7215689.20	173.99	2013
RSF-4	638675.00	7215892.00	210.21	2013
RSF-5	638629.81	7216014.00	193.02	2013
RSF-6	638845.40	7215647.00	197.79	2013
RSF-7	638153.00	7216039.00	173.5	2015
RSF-8	638156.00	7216038.00	173.85	2015

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[2] Okane Consultants, 2019. Thermal Model Review of Meadowbank Portage Waste Rock Storage Facility. 948-017-R-001 Rev2

RSF-9	638290.00	7215707.00	171.26	2015
RSF-10	638293.00	7215711.00	171.7	2015
RSF-11	639071.00	7215787.00	193.13	2015
RSF-12	639066.00	7215791.00	193.51	2015
RSF-13	638916.00	7215943.00	191.69	2015
RSF-14	638917.00	7215939.00	191.81	2015
RSF-15	638612.00	7216038.00	192.1	2015
RSF-16	638610.00	7216033.00	192.39	2015
RSF-17	638570.442	7215935.40	233.183	2020
RSF-18	638495.212	7216111.896	172.605	2020

2020 Instrumentation Install

Three RST Instruments thermistor strings installed in two drill holes installed by Agnico Eagle between October 18, 2020 and December 13, 2020 (Figure 2).

- TH-RSF-17, two installed in drill hole top and bottom
- TH-RSF-18

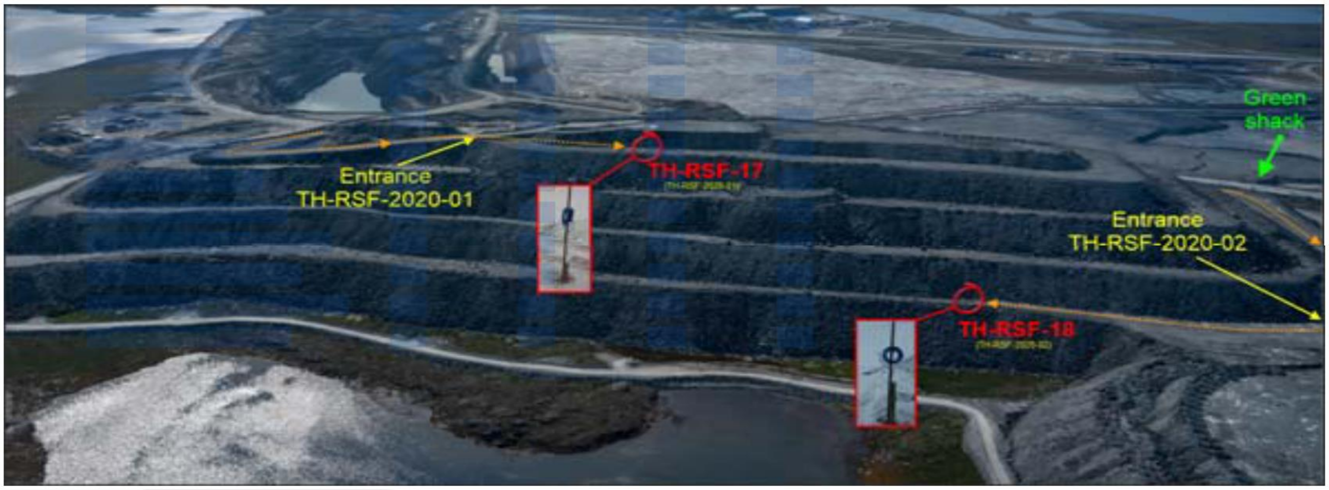

Figure 2: Locations of thermistors installed in 2020[3].

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[3] Agnico Eagle, 2020, Meadowbank Gold Mine Amaruq: 2020 Waste Rock Storage Facility Instrumentation.

Data collection began with the connection of thermistors to portable data loggers on December 12 and 13, 2020. Readings from the thermistors are recorded once a day at midnight. The data loggers are not linked to the data server as radio communication is not feasible due to the location on the RSF.

Agnico Eagle noted that 4 of 16 beads of the TH-RSF-18 thermistor string were damaged by grout freeze back and cable stretching during installation. It was also noted that this is a common problem and has been observed by Agnico Eagle at Meadowbank previously on several occasions.

Measured Thermal Regime of Portage RSF

The thermal regime was evaluated using the following thermistors: RSF-3 (south slope), RSF-5 (north slope), RSF-6 (south slope), RSF-8 (west slope), RSF-10 (south slope) RSF-11 (east slope), RSF-12 (east slope), RSF-15 (north slope), RSF-17, and RSF-18 due to the completeness of the data sets collected. The remaining thermistors had data gaps that restrict the usefulness of the data sets.

The results for the aforementioned thermistors show the continued gradual shallowing of the zero isotherm through repeated years of monitoring. This would indicate that the RSF is continuing to freeze back but has not yet reached a state of equilibrium. Based on thermistor data, the depth of the active layer is approximately 3 m.

Figure 3 and Figure 4 illustrate the thermal performance of the installed thermistors RSF-3 and RSF-15. The dashed line indicates the location of the thermal cover system. Additional figures of thermistor data are included in Appendix A.

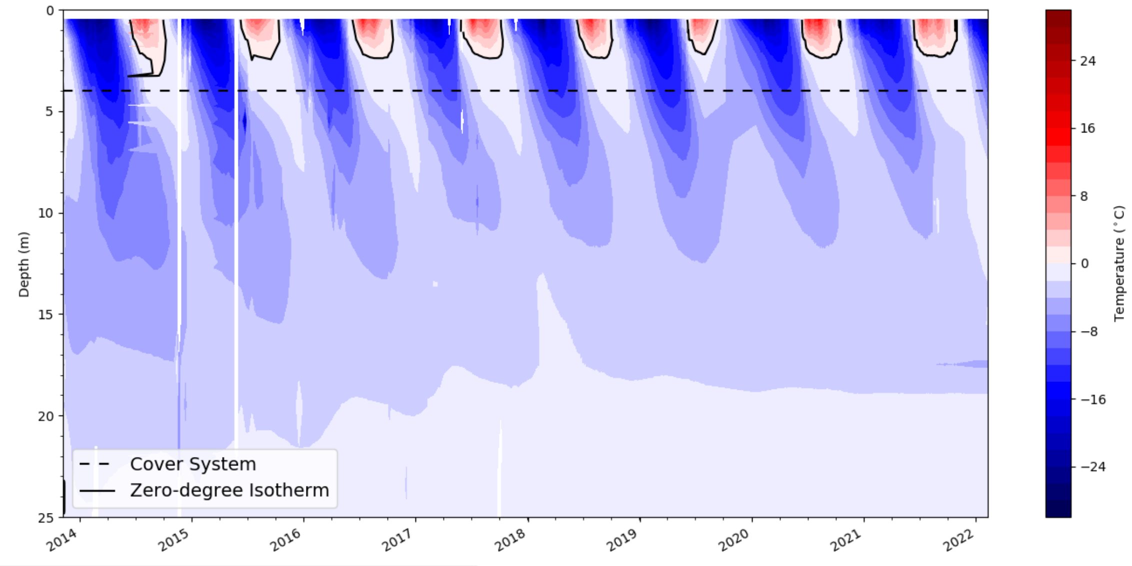


Figure 3: RSF-3 Thermistor String data between November 8, 2013 to February 8, 2022

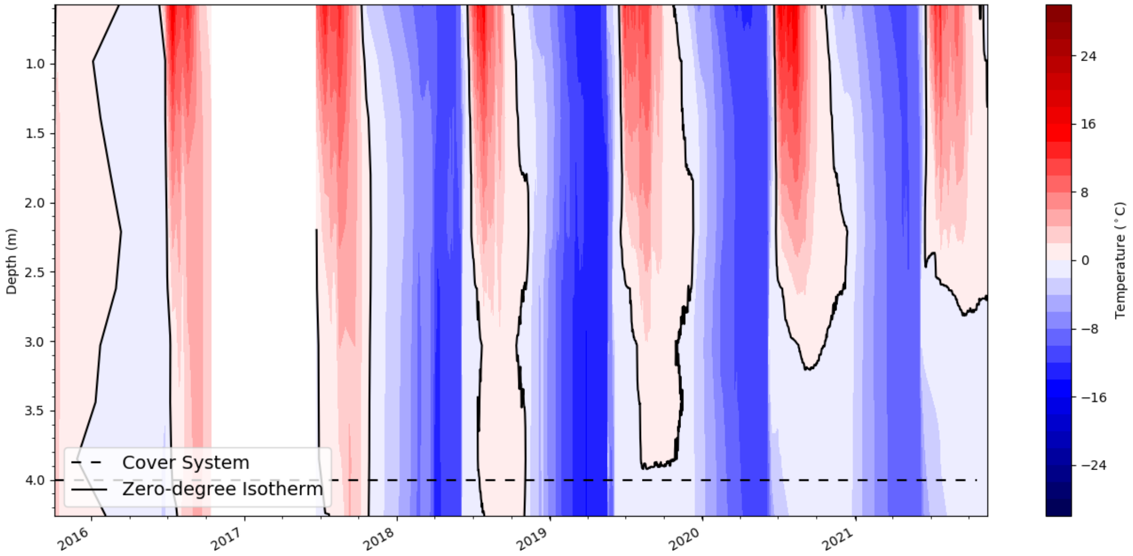


Figure 4: **RSF-15 Thermistor String between October 4, 2014 and November 13, 2021.**

Predicted Thermal Regime Comparison

Recorded temperature at a depth of approximately 4 m was compared to simulated thermal model temperatures for RCP4.5 and RCP6.0 to assess the accuracy of the thermal model. Recorded and simulated temperatures follow the same seasonal trends and have similar amplitudes of seasonal temperature fluctuations though recorded temperatures are generally higher than those simulated. Recorded temperatures indicate sensors are equilibrating during the initial years post-installation; therefore, analysis of recorded and simulated data will focus on the data starting in 2017.

Throughout the period of record, RCP4.5 simulations have underestimated temperatures at a depth of 4 m, though the magnitude of seasonal temperature changes are similar to recorded data. RSF-3 recorded temperature at a depth of 4 m reached a maximum of approximately 0°C in the summer versus predicted maximum temperatures of approximately -5°C. RSF-3, shown in Figure 5, was used to calibrate the thermal model in 2016.

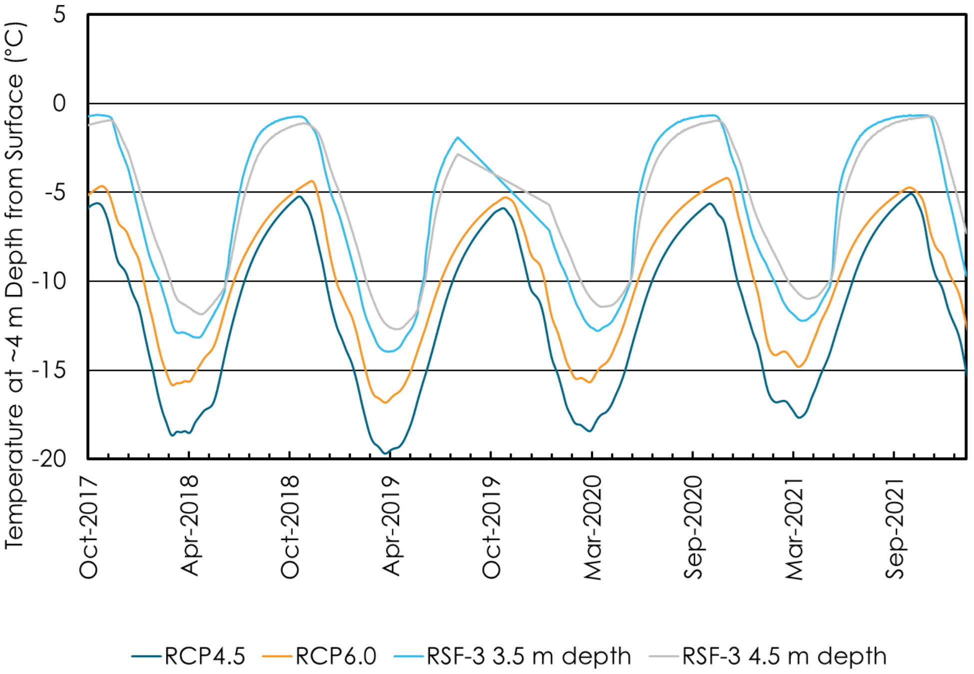


Figure 5: **RSF-3 measured temperature at 3.5 m and 4.5 m depth compared to model predicted temperature at 4 m depth.**

Figure 6 shows the general trends in recorded and simulated temperatures at a depth of ~4 m on northern facing slope locations. RSF-13 and RSF-14 are located on the eastern portion of the north slope while RSF-15, RSF-16 and RSF-5 are located on the western portion of the north slope (Figure 1). Simulated temperatures show a good match to RSF-13 and RSF-14, with similar active zone depths and seasonal trends. It should be noted that data was recorded for RSF-13 and RSF-14 until 2019 at which time it appears the thermistors were no longer functional.

RSF-5, RSF-15, and RSF-16 were all installed in the same vicinity on the north facing slope. Simulated temperatures were lower than those recorded at RSF-5 though the match appears to be improving in 2018-19 in terms of the amplitude of seasonal temperature fluctuation observed. RSF-16 recorded temperature has less amplitude of seasonal temperature fluctuations compared to RSF-5 and simulated results. The lower amplitude of seasonal temperature fluctuation at RSF-16 could be due to the deeper installation depth but also could be due to variability in cover system and waste rock materials, and moisture conditions. The cause of sharp changes in RSF-15 recorded temperatures is unknown and could potentially indicate sensor error; however, these sharp changes seem to be less pronounced with time.

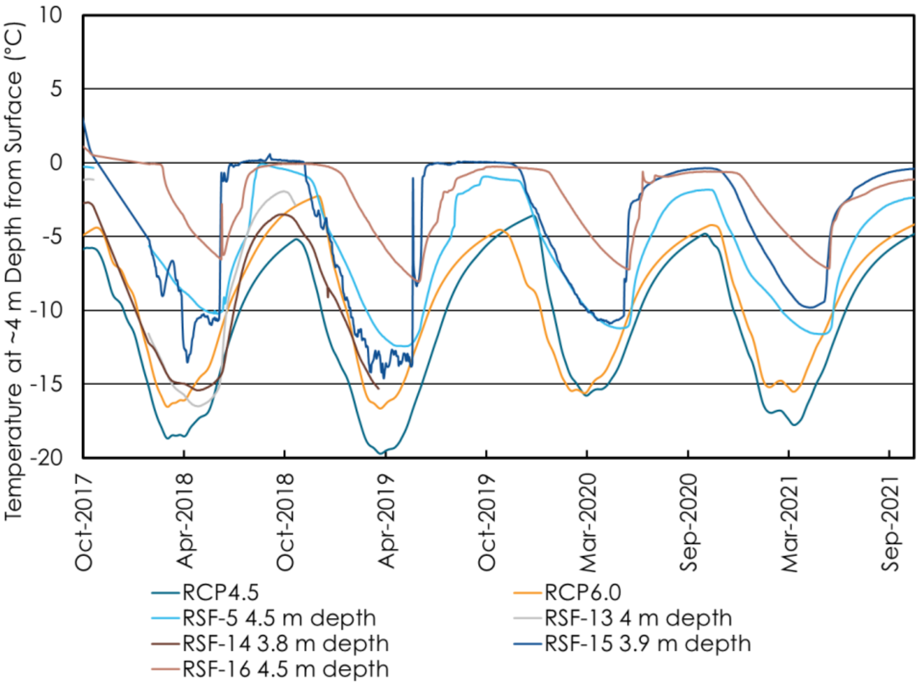


Figure 6: **Simulated temperature at 4 m depth compared to thermistor recorded temperatures near 4 m depth at north facing slope locations.**

Figure 7 shows the general trends in recorded and simulated temperatures at a depth of ~4 m on southern facing slope locations. Thermistors on the southern facing slope of Portage RSF generally measure higher temperatures and show less seasonal variation in temperature (generally a 10-degree difference from maximum to minimum temperatures) than simulated by the model (Figure 7).

RSF-9 and RSF-10 were installed in the same vicinity but measured a 4-degree difference in winter low temperatures (-9°C compared to -5°C). As mentioned for the north slope, the range in recorded temperatures at similar depths and location could potentially be due to variability in material properties and moisture conditions. A degree of heterogeneity is to be expected in an engineered cover system. Understanding the expected range of heterogeneity and the measured impacts of heterogeneity on moisture and temperature conditions can provide valuable data by which to calibrate sensitivity models and develop technical specifications for construction. Sensitivity modelling and an adequate quality assurance program during construction can limit the impact of risks associated with inherent material heterogeneity.

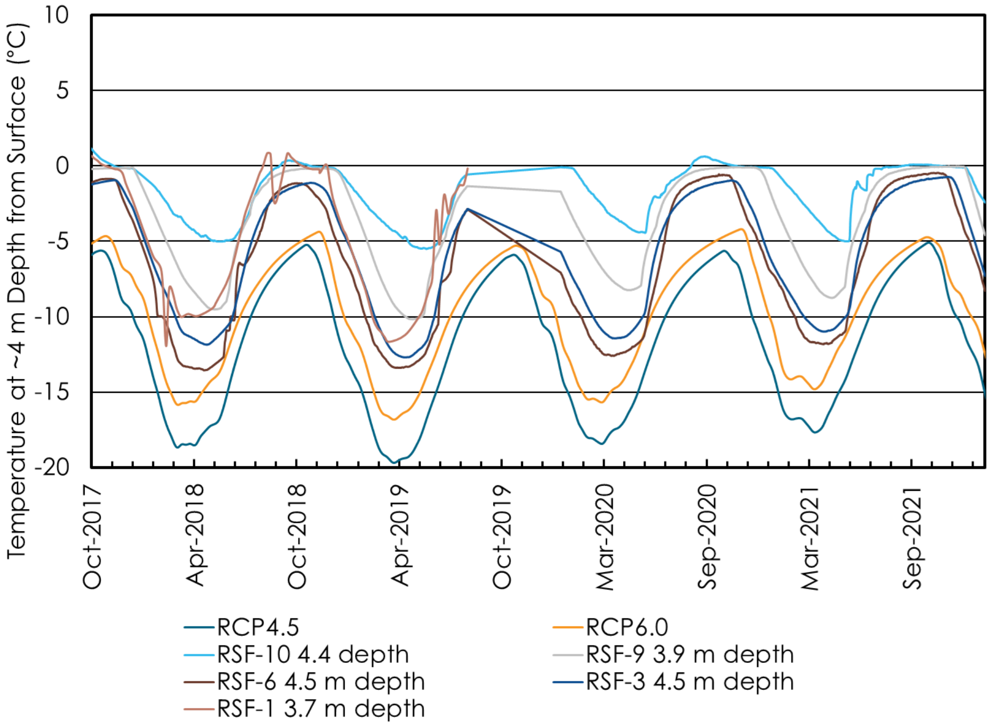


Figure 7: **Simulated temperature at 4 m depth compared to thermistor recorded temperatures near 4 m depth at south facing slope locations.**

Path to the Final Closure and Reclamation Plan

Conclusions about the performance of the closure cover system for Portage RSF to meet site objectives cannot be drawn based upon the results of thermal modelling alone. At Amaruq the design basis of the cover system acknowledges that performance should not just be measured by the depth of the active layer, it is the fulsome interaction of air and water in the intermittent non-frozen zones and the impacts (if any) that has on seepage and seepage water quality from the facility. Risk to water quality at Portage should be confirmed through incorporation of these results with an integrated site wide water and solute balance, as opposed to the depth of the active layer on its own.

Agnico Eagle is looking to re-affirm the design of the Portage RSF landform so that the information can be ultimately presented in the Meadowbank Final Closure and Reclamation Plan (FCRP) to be submitted in 2025. Based on the information presented here-in, the path forward (proposed studies and investigations) to the submission of the FRCP is presented in Table 4.

Table 4: Summary of the path forward and expected timelines for study

Milestone	Estimated Timeline	Description
Portage RSF Closure Landform Gap Analysis	Q1-Q2 2022	Review of existing investigations, studies, monitoring data to identify any uncertainties surrounding the design, and performance of the Portage RSF closure cover system.
Meadowbank Closure Gap Assessment	Q2-Q3 2022	Meadowbank closure plan gap assessment workshop will include different Agnico Eagle stakeholders (Permitting, Closure Director, key Superintendents) to identify any gaps in the current closure plan and align on any required updates.
Meadowbank Closure Research Plan	Q2-Q3 2022	Description of required research and study to be completed to close any identified gaps in the closure plan for Meadowbank prior to the submission of the FCRP.
Thermal Cover System Design Update	Q2-Q3 2022	Update design to demonstrate the effectiveness of the cover concept to meet closure objectives based on latest information available and to integrate learnings from the Amaruq project.
Monitoring Plan for Closure Landform	Q2-Q3 2022	An adaptive monitoring trigger and action response plan (TARP) will be developed to be able to communicate the effectiveness of the cover design on a yearly basis (in operation and closure).
Portage RSF Near Surface Monitoring Station (NSMS) Install	Q2-Q3 2022	Installation of near surface monitoring station on Portage RSF. NSMS will measure the near surface (<2 m depth) volumetric water content (VWC), temperature, matric suction, and provide field calibrated thermal and hydraulic material properties.
Landform Water Balance	Q2-Q3 2022	To support the landform water balance for the Portage WRSF, the inputs and assumptions from the thermal model update will be documented. This data will be used to ultimately model the water quality from the WRSF landform at closure (to demonstrate whether long-term water quality objectives will be met). Such assumptions could include runoff estimates and distribution by zone of the WRSF and assumption on the potential for breakthrough seepage.
Landform Water Quality	2023	A landform water quality analysis will be completed to demonstrate whether long-term water quality from the Portage RSF landform at closure will meet objectives.
Final Design of Portage RSF Cover System	2024-2025	Update thermal model and water balance WQ
Meadowbank FCRP	Q4 2025	Submission of FCRP for Meadowbank

We trust information provided in this memorandum is satisfactory for your requirements. Please do not hesitate to contact me at (306) 715 7029 or lthorson@okc-sk.com should you have any questions or comments.

Appendix A

Thermistor Data

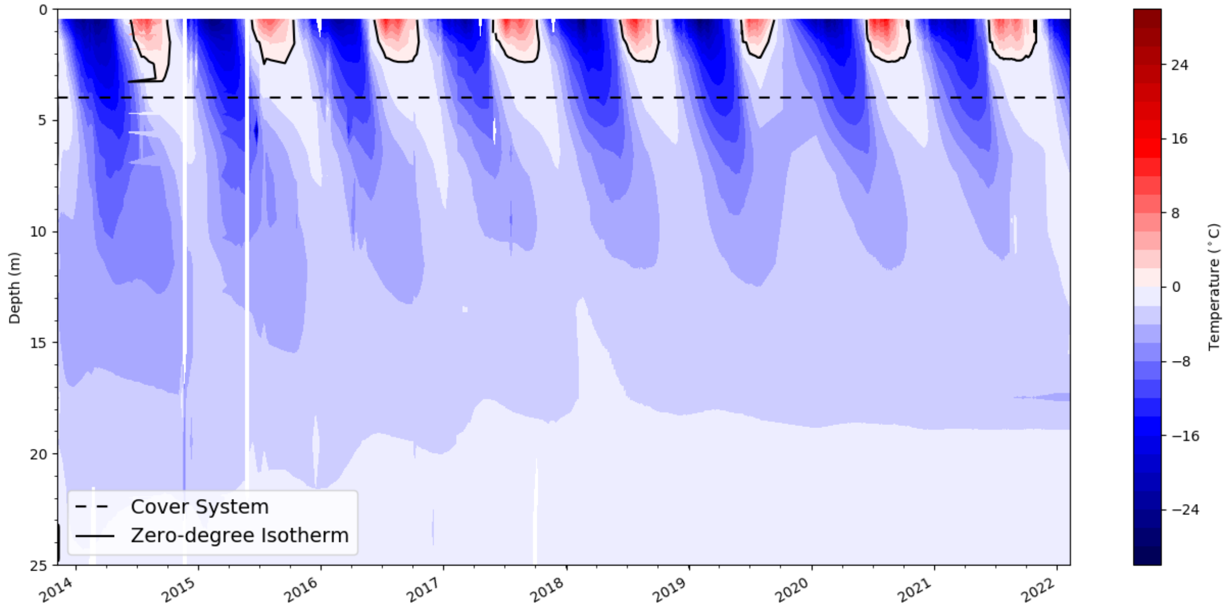


Figure A.1: RSF-3 Thermistor String data between 2014 and 2022

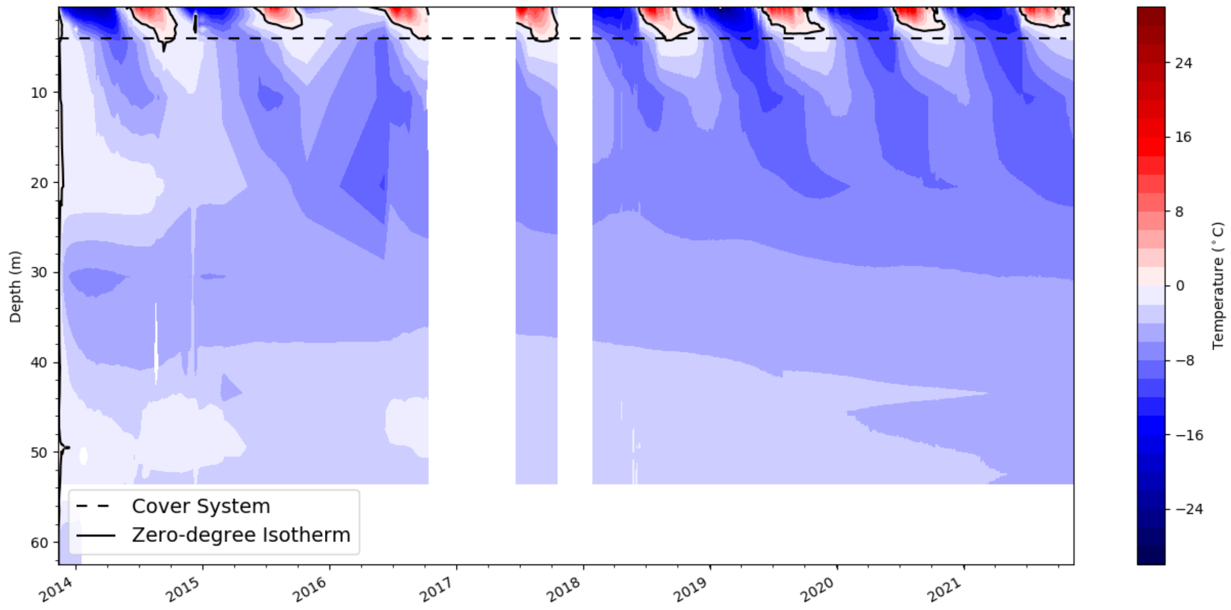


Figure A.2: RSF-5 Thermistor String data between 2014 and 2022

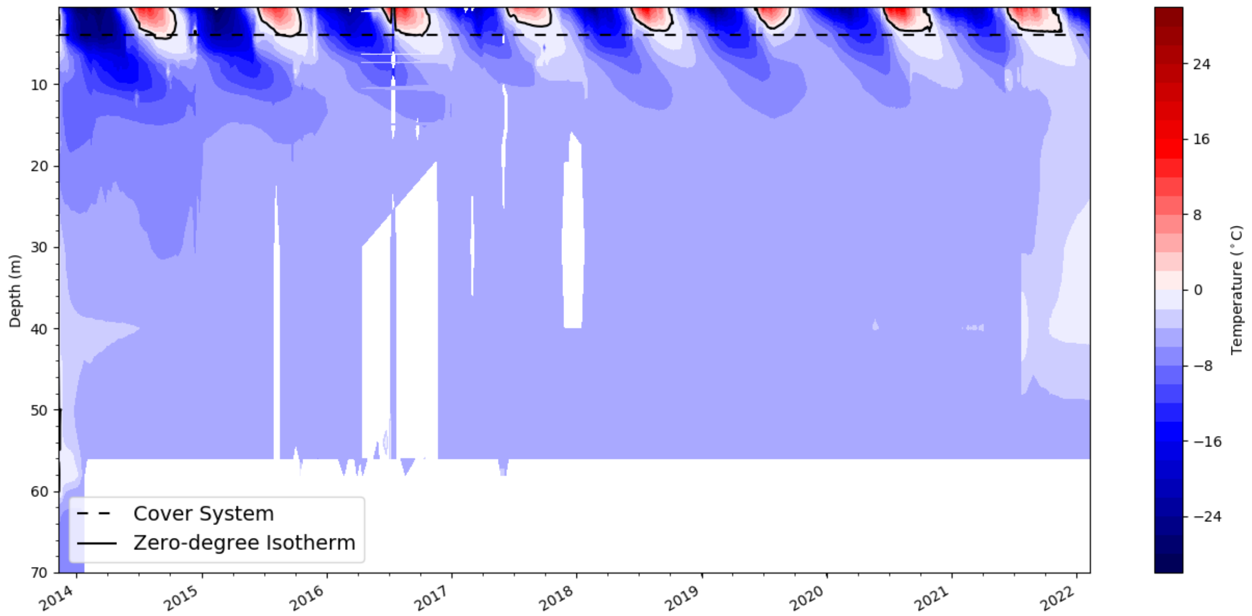


Figure A.3: RSF-6 Thermistor String data between 2014 to 2022

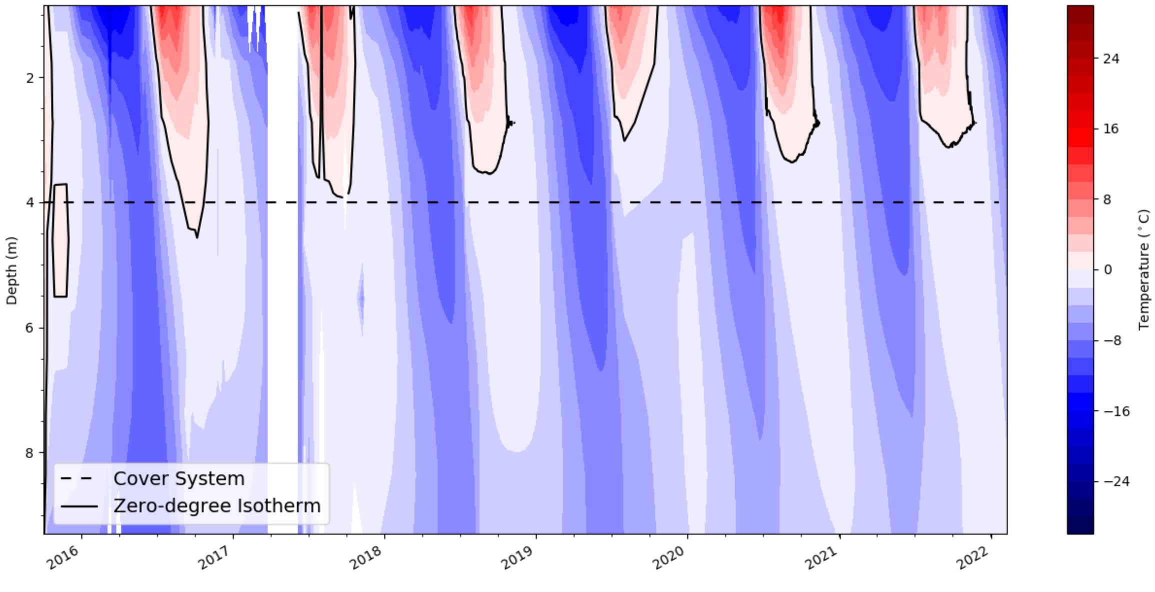


Figure A.4: RSF-8 Thermistor String between 2016 and 2022

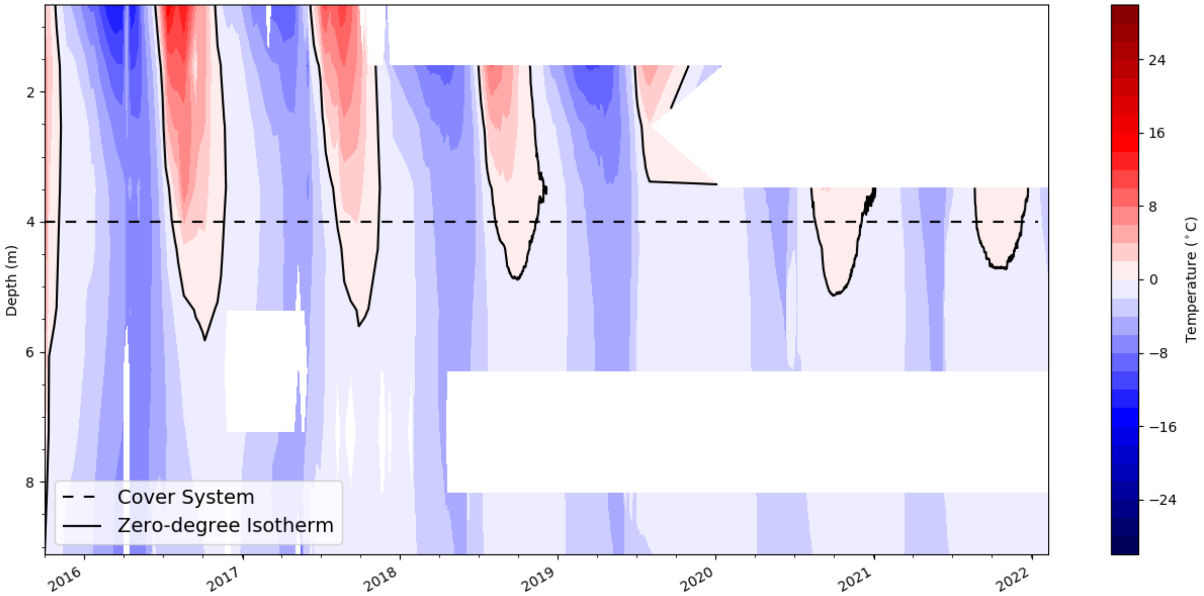


Figure A.5: RSF-10 Thermistor String between 2016 and 2022

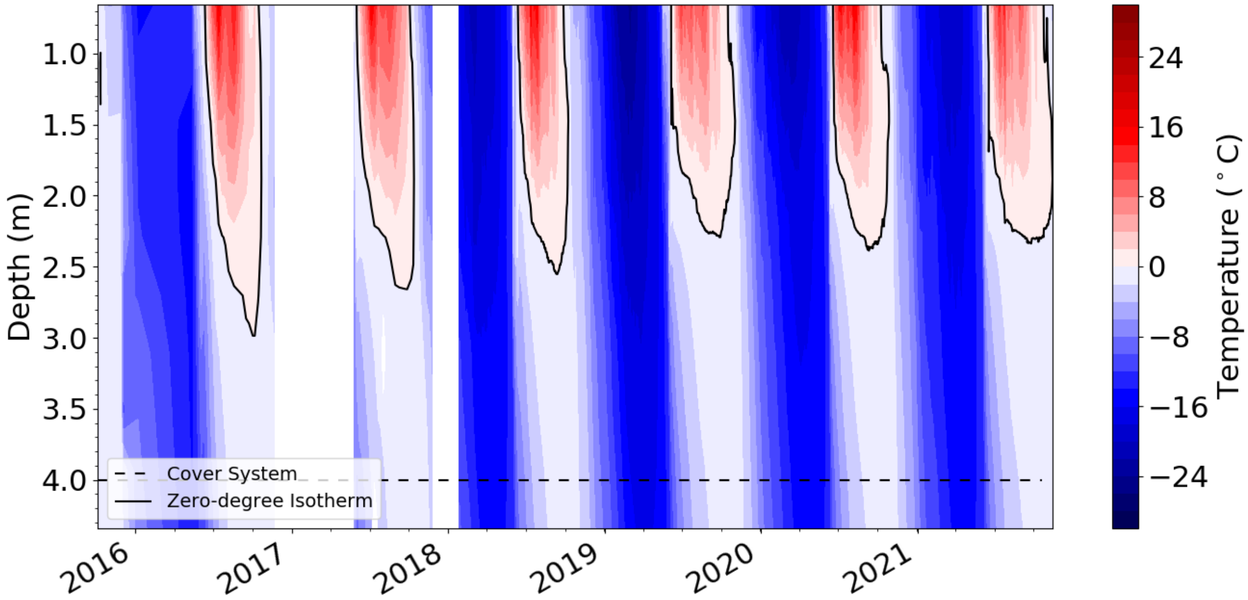


Figure A.6: RSF-11 Thermistor String between 2016 and 2022

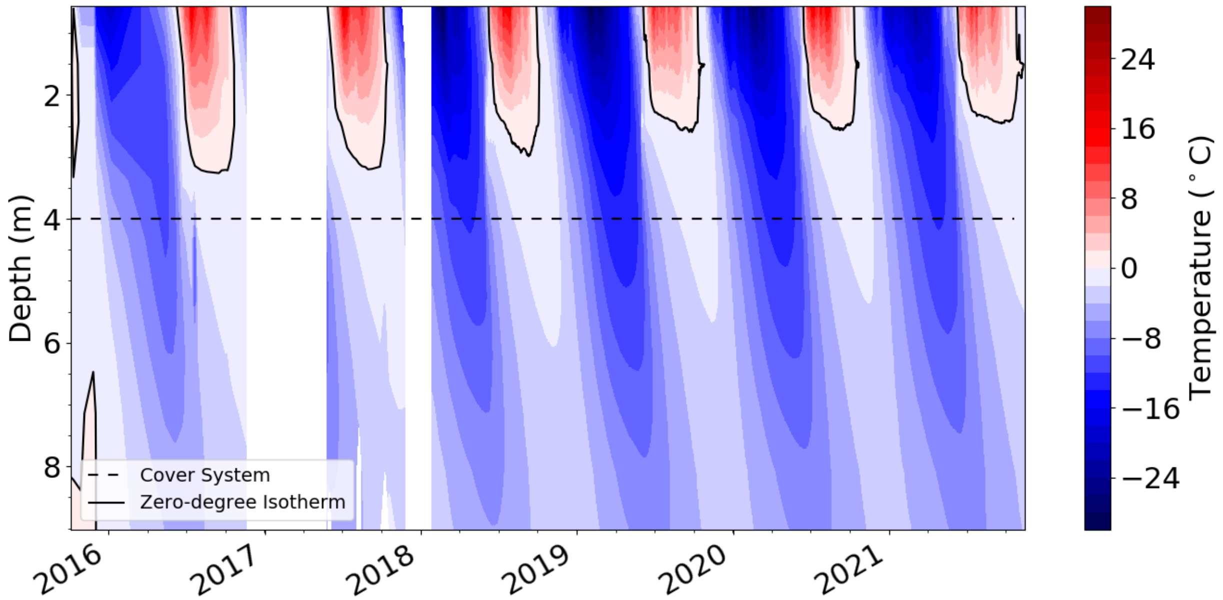


Figure A.7: RSF-12 Thermistor String between 2016 and 2022

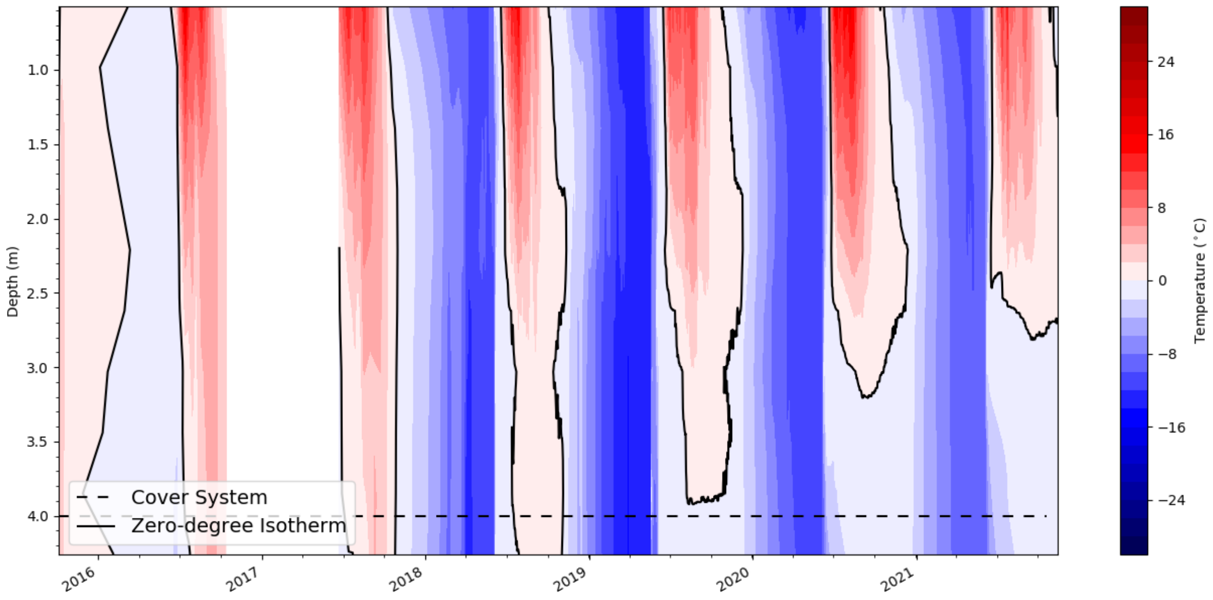


Figure A.8: RSF-15 Thermistor String between 2016 and 2022

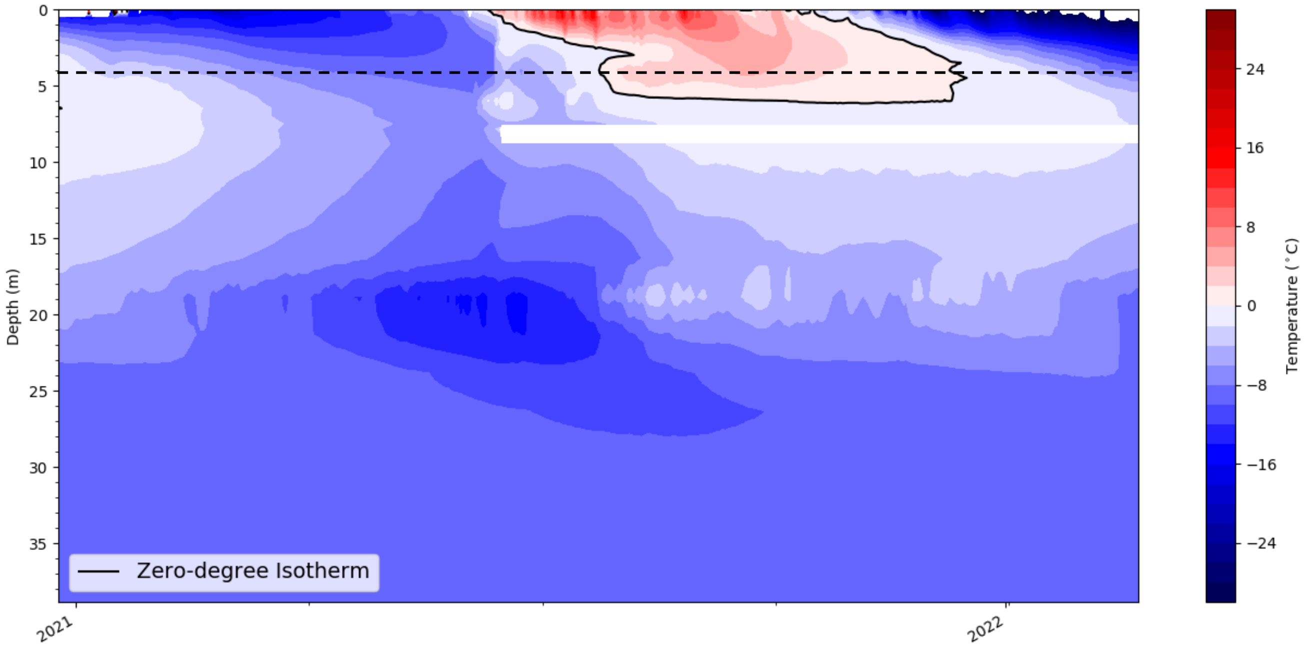


Figure A.9: RSF-17 Thermistor String between December 25, 2020 and February 22, 2022

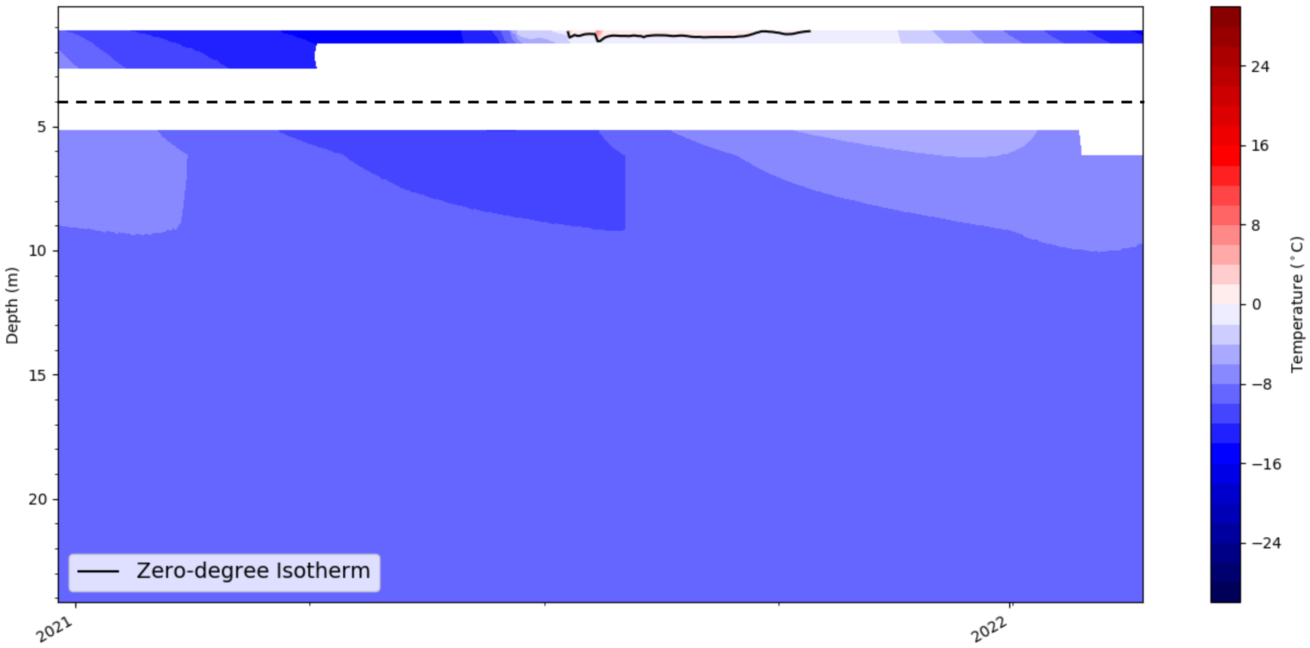
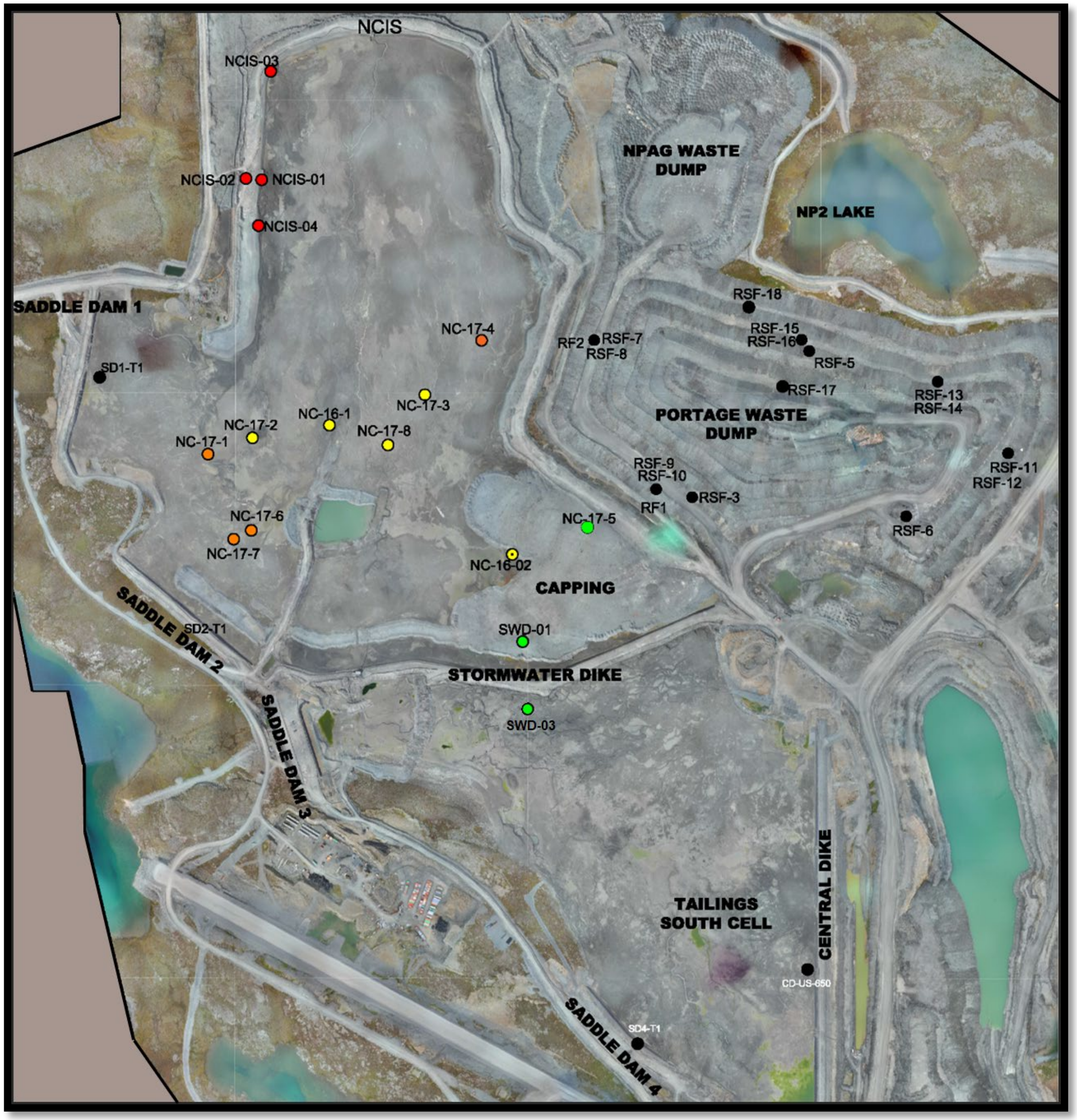
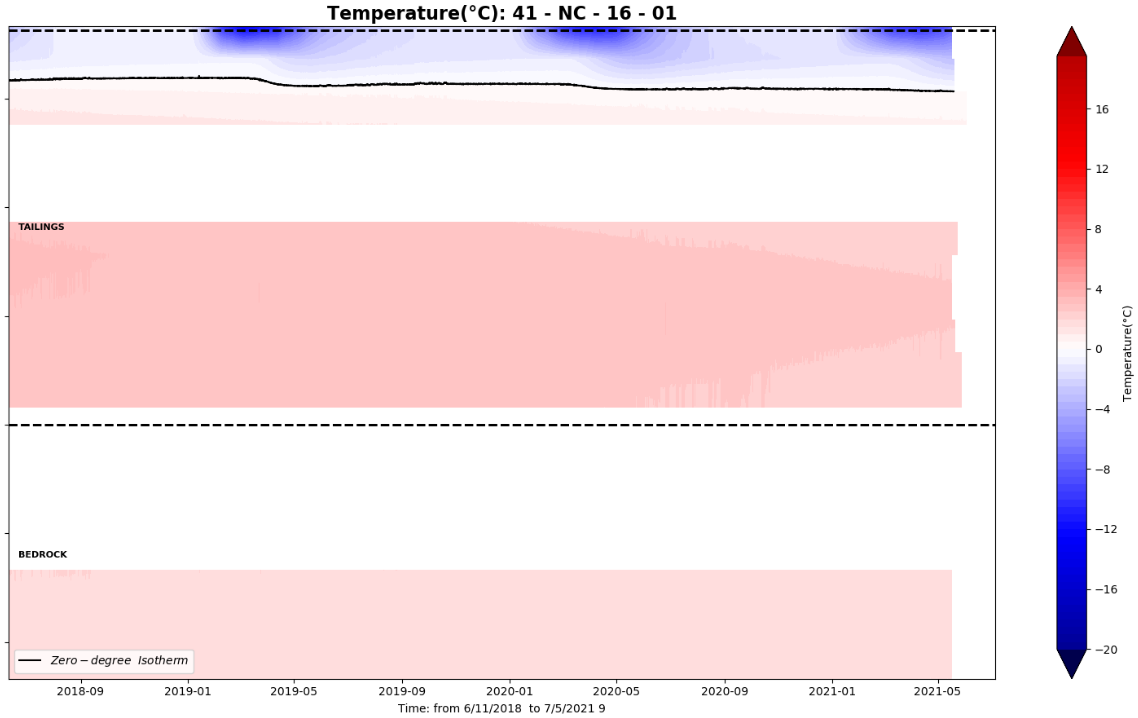


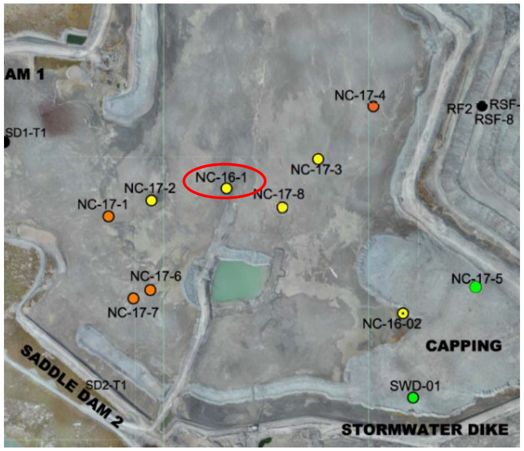
Figure A.10: RSF-18 Thermistor String between December 25, 2020 and February 22, 2022

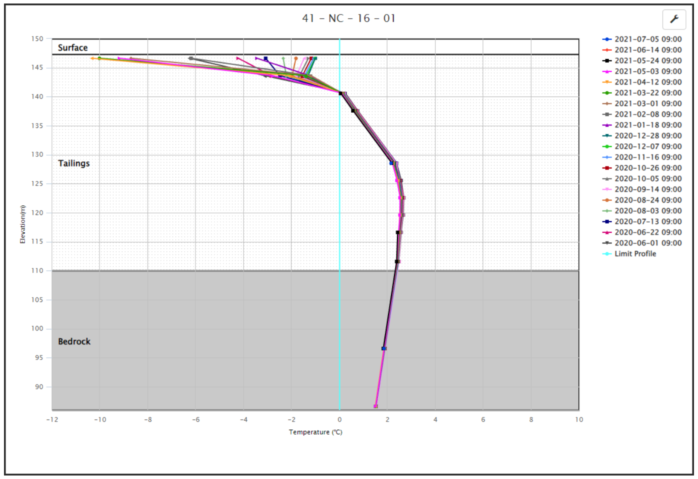

NCIS
NCIS-03
NCIS-02
NCIS-01
NCIS-04
NPAG WASTE DUMP
NP2 LAKE
SADDLE DAM 1
SD1-T1
RSF-18
RSF-15
RSF-16
RF2
RSF-7
RSF-8
RSF-5
RSF-17
RSF-13
RSF-14
NC-17-4
NC-17-3
NC-16-1
NC-17-2
NC-17-8
NC-17-1
PORTAGE WASTE DUMP
RSF-9
RSF-10
RSF-11
RSF-12
RSF-3
RF1
RSF-6
NC-17-6
NC-17-7
NC-17-5
NC-16-02
CAPPING
SADDLE DAM 2
SD2-T1
SWD-01
STORMWATER DIKE
SWD-03
SADDLE DAM 3
TAILINGS SOUTH CELL
CENTRAL DIKE
CD-US-650
SD4-T1
SADDLE DAM 4

Name	*Area*	*Easting (X)*	*Northing (Y)*	*Elevation (Z)*	*Azimuth*	*Dip*	*Installed*	*Active (Y) or (N)*
NC-16-01	NC	**637562.77**	**7215849.33**	**147.63**	--	-90	2016	N
NC-16-02	NC	**637969.22**	**7215561.87**	**148.33**	--	-90	2016	Y
NC-17-1	NC	**637290.00**	**7215823.00**	**148.10**	--	-90	2018	Y
NC-17-2	NC	**637391.00**	**7215823.00**	**147.61**	--	-90	2017	Y
NC-17-3	NC	**637775.00**	**7215917.00**	**147.65**	--	-90	2015	Y
NC-17-4	NC	**637901.00**	**7216038.00**	**148.48**	--	-90	2015	N
NC-17-5	NC	**638134.34**	**7215623.68**	**152.00**	--	-90	2015	Y
NC-17-6	NC	**637389.00**	**7215623.00**	**147.78**	--	-90	2015	Y
NC-17-7	NC	**637348.00**	**7215598.00**	**147.89**	--	-90	2015	Y
NC-17-8	NC	**637668.00**	**7215778.00**	**146.45**	--	-90	2015	Y
NCIS-01	NC	**637412.84**	**7216395.10**	**152.43**	--	-90	2018	Y
NCIS-02	NC	**637377.24**	**7216398.61**	**151.63**	--	-90	2018	Y
NCIS-03	NC	**637432.58**	**7216636.35**	**154.74**	--	-90	2018	Y
NCIS-04	NC	**637405.47**	**7216293.32**	**152.15**	--	-90	2018	Y
SWD-01	NC	**606778.00**	**7256254.00**	**162.00**	--	-90	2014	Y
SWD-03	SC	**638072.9**	**7215233.0**	**133**	--	-90	2014	Y
SD1-1	SD1	**637030.50**	**7215957.68**	**150.00**	--	Liner	2009	Y
SD2-1	SD2	**637290.00**	**7215420.00**	**150.00**	--	Liner	2012	Y
SD4-1	SD4	**638253.95**	**7214479.72**	**144.00**	--	Liner	2017	Y
CD-US 0+650	CD	**638626.00**	**7214639.00**	**126.40**	--	Liner	2015	Y
RSF-3	RSF	**638369.59**	**7215689.2**	**173.99**	--	-90	2013	Y
RSF-5	RSF	**638629.81**	**7216014.00**	**193.02**	--	-90	2013	N
RSF-6	RSF	**638845.40**	**7215647.00**	**197.79**	--	-90	2013	Y
RSF-7	RSF	**638153.00**	**7216039.00**	**173.50**	--	-55	2015	Y
RSF-8	RSF	**638156.00**	**7216038.00**	**173.85**	--	-70	2015	Y
RSF-9	RSF	**638290.00**	**7215707.00**	**171.26**	--	-55	2015	Y
RSF-10	RSF	**638293.00**	**7215711.00**	**171.70**	--	-70	2015	Y
RSF-11	RSF	**639071.00**	**7215787.00**	**193.13**	--	-55	2015	Y
RSF-12	RSF	**639066.00**	**7215791.00**	**193.51**	--	-70	2015	Y
RSF-13	RSF	**638916.00**	**7215943.00**	**191.69**	--	-55	2015	Y
RSF-14	RSF	**638917.00**	**7215939.00**	**191.81**	--	-80	2015	Y
RSF-15	RSF	**638612.00**	**7216038.00**	**192.10**	--	-55	2015	Y
RSF-16	RSF	**638610.00**	**7216033.00**	**192.39**	--	-70	2015	Y
RSF-17	RSF	**638570.442**	**7215935.4**	**233.183**	----	-90	2021	Y
RSF-18	RSF	**638495.212**	**7216111.896**	**172.605**	-	-90	2021	Y

NC-16-01

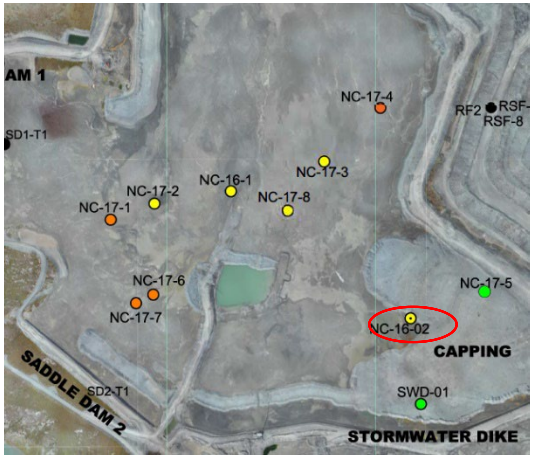


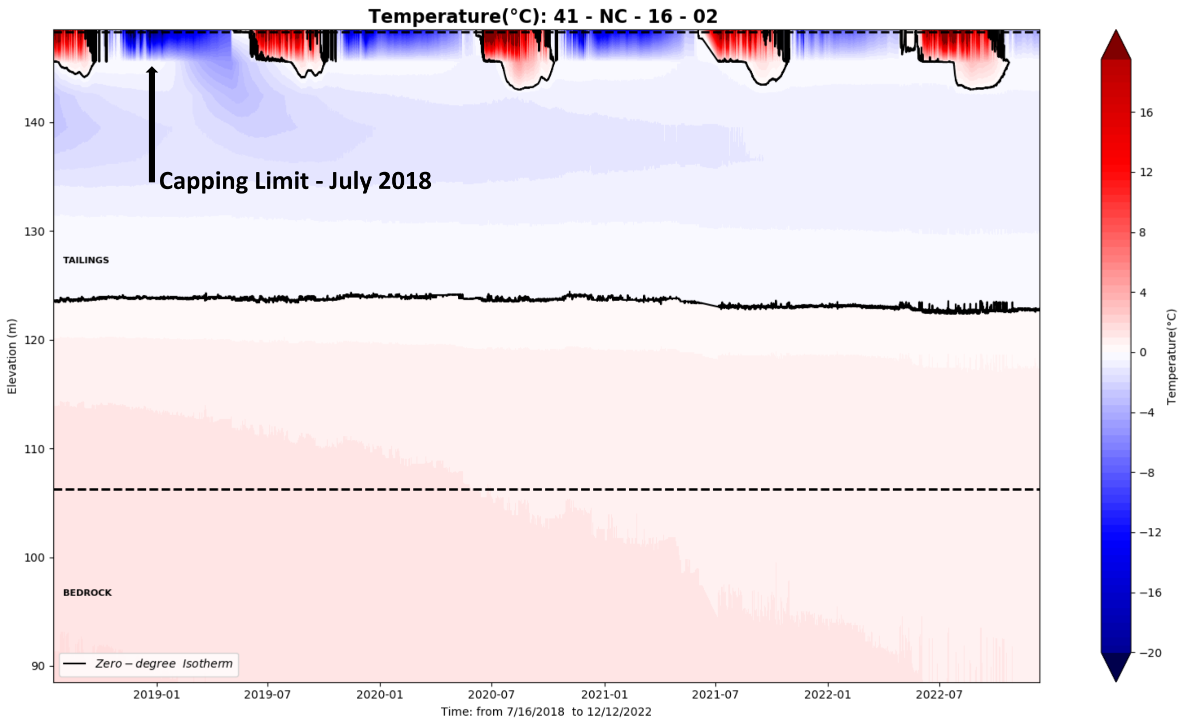


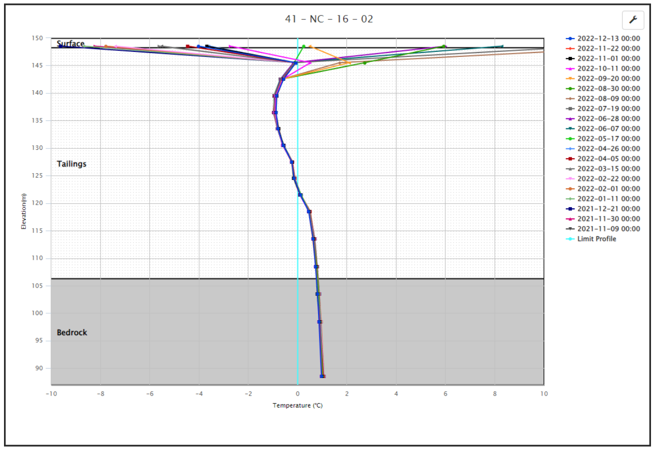


This instrument is broken and not sending anymore data.

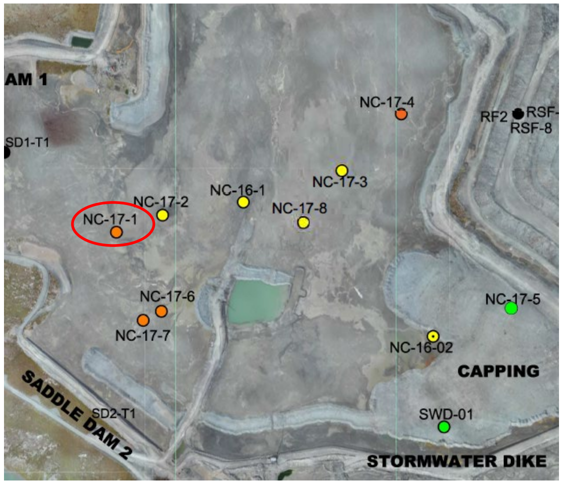
NC-16-02

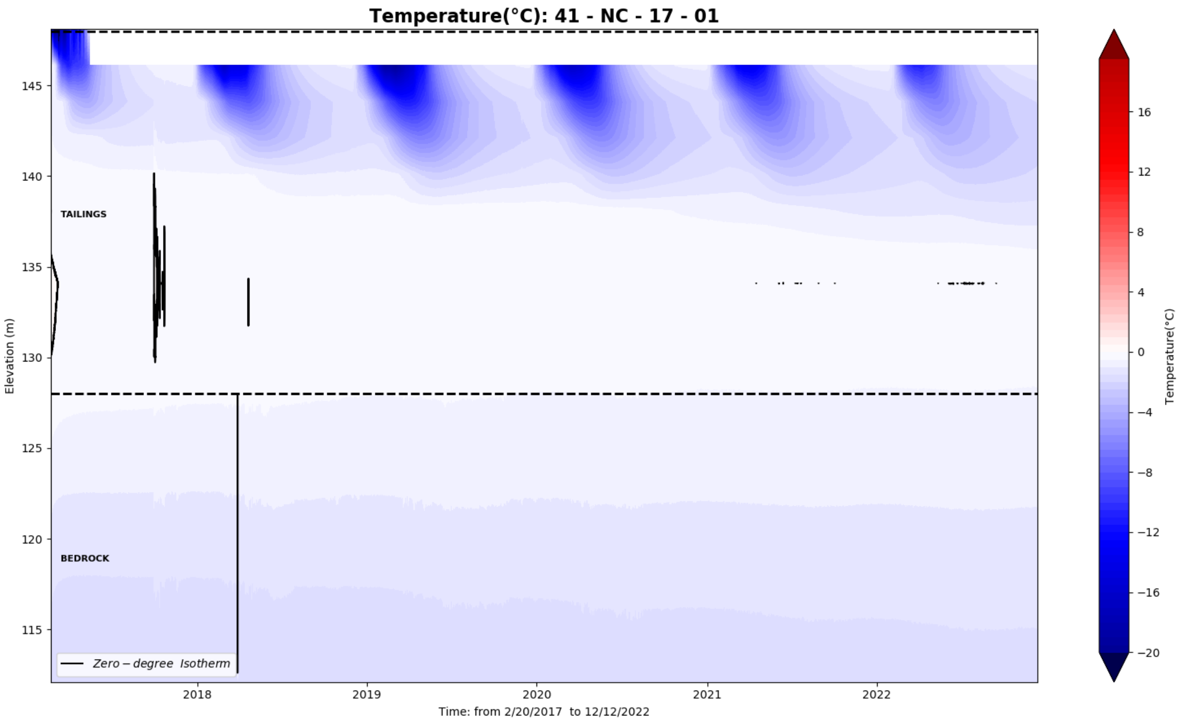

AM 1
SD1-T1
NC-17-4
RF2
RSF-
RSF-8
NC-17-3
NC-16-1
NC-17-2
NC-17-1
NC-17-8
NC-17-6
NC-17-7
NC-17-5
NC-16-02
CAPPING
SADDLE DAM 2
SD2-T1
SWD-01
STORMWATER DIKE

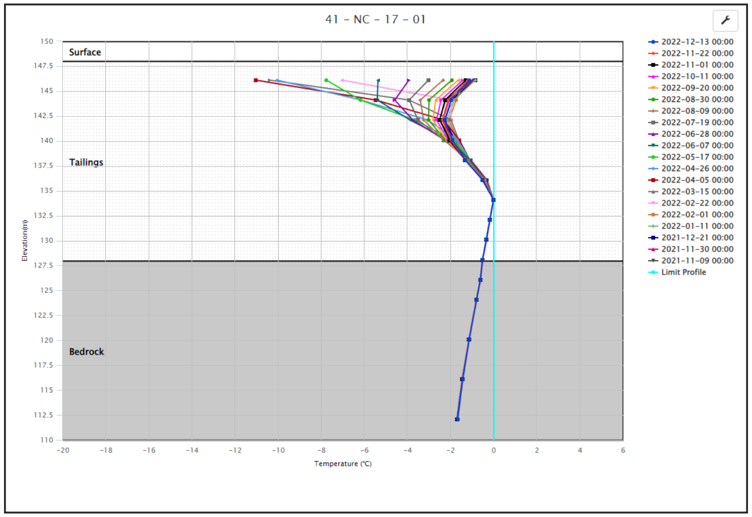

Temperature(°C): 41 - NC - 16 - 02
Capping Limit - July 2018
TAILINGS
BEDROCK
Zero – degree Isotherm
Elevation (m)
140
130
120
110
100
90
2019-01
2019-07
2020-01
2020-07
2021-01
2021-07
2022-01
2022-07
Time: from 7/16/2018 to 12/12/2022
Temperature(°C)
16
12
8
4
0
−4
−8
−12
−16
−20


41 – NC – 16 – 02
Surface
Tailings
Bedrock
Elevation(m)
150
145
140
135
130
125
120
115
110
105
100
95
90
Temperature (°C)
−10
−8
−6
−4
−2
0
2
4
6
8
10
2022-12-13 00:00
2022-11-22 00:00
2022-11-01 00:00
2022-10-11 00:00
2022-09-20 00:00
2022-08-30 00:00
2022-08-09 00:00
2022-07-19 00:00
2022-06-28 00:00
2022-06-07 00:00
2022-05-17 00:00
2022-04-26 00:00
2022-04-05 00:00
2022-03-15 00:00
2022-02-22 00:00
2022-02-01 00:00
2022-01-11 00:00
2021-12-21 00:00
2021-11-30 00:00
2021-11-09 00:00
Limit Profile

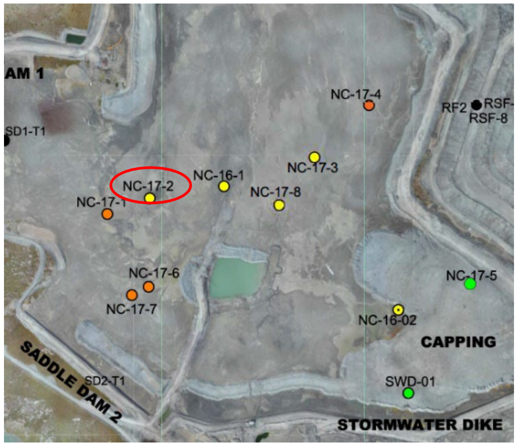
NC-17-01

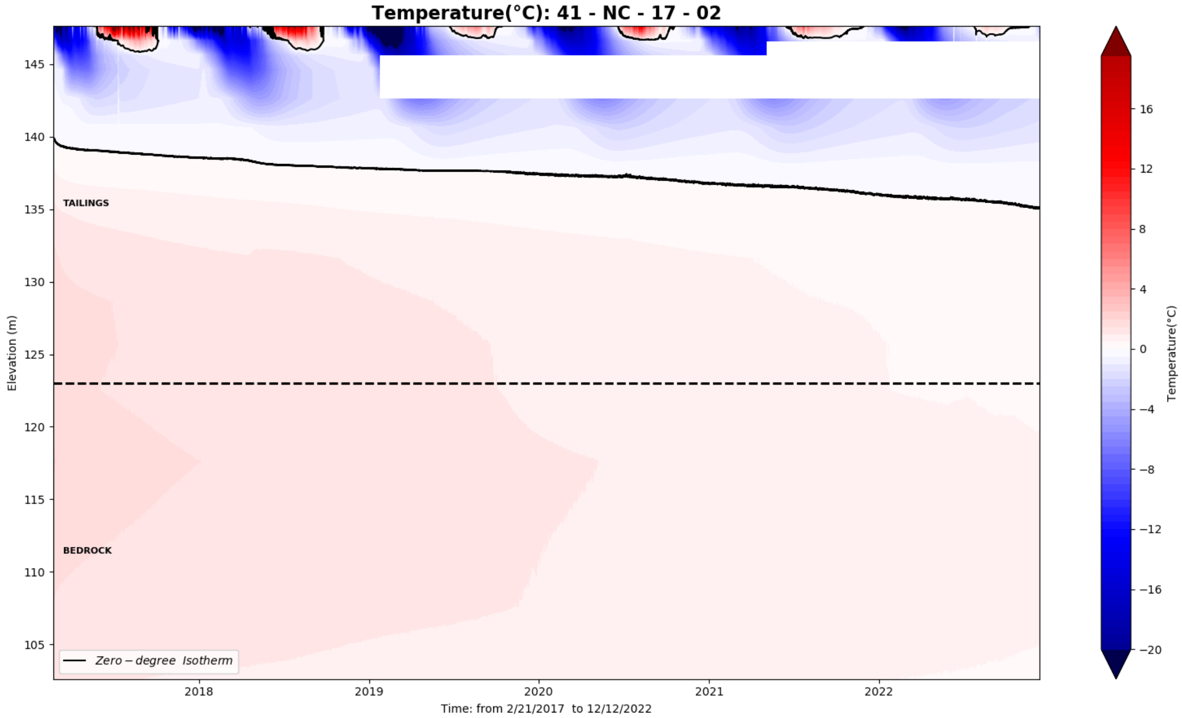

AM 1
SD1-T1
NC-17-4
RF2
RSF-
RSF-8
NC-17-3
NC-16-1
NC-17-2
NC-17-8
NC-17-1
NC-17-6
NC-17-7
NC-17-5
NC-16-02
CAPPING
SADDLE DAM 2
SD2-T1
SWD-01
STORMWATER DIKE

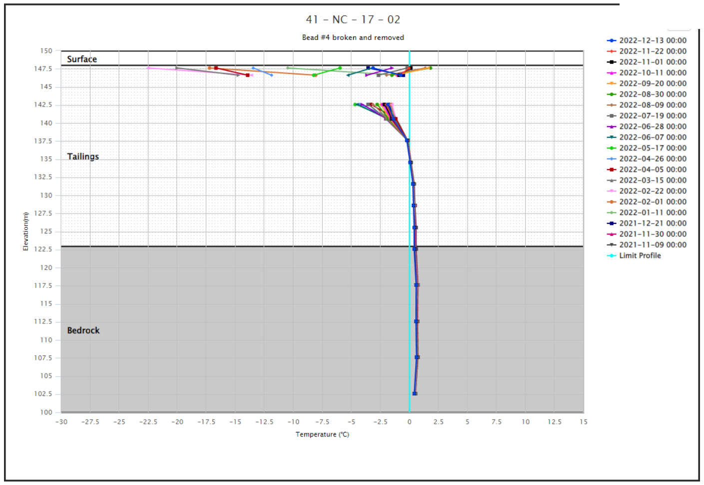

Temperature(°C): 41 - NC - 17 - 01
Elevation (m)
145
140
135
130
125
120
115
TAILINGS
BEDROCK
Zero – degree Isotherm
2018
2019
2020
2021
2022
Time: from 2/20/2017 to 12/12/2022
Temperature(°C)
16
12
8
4
0
−4
−8
−12
−16
−20


41 – NC – 17 – 01
Surface
Tailings
Bedrock
Elevation(m)
150
147.5
145
142.5
140
137.5
135
132.5
130
127.5
125
122.5
120
117.5
115
112.5
110
−20
−18
−16
−14
−12
−10
−8
−6
−4
−2
0
2
4
6
Temperature (℃)
2022–12–13 00:00
2022–11–22 00:00
2022–11–01 00:00
2022–10–11 00:00
2022–09–20 00:00
2022–08–30 00:00
2022–08–09 00:00
2022–07–19 00:00
2022–06–28 00:00
2022–06–07 00:00
2022–05–17 00:00
2022–04–26 00:00
2022–04–05 00:00
2022–03–15 00:00
2022–02–22 00:00
2022–02–01 00:00
2022–01–11 00:00
2021–12–21 00:00
2021–11–30 00:00
2021–11–09 00:00
Limit Profile

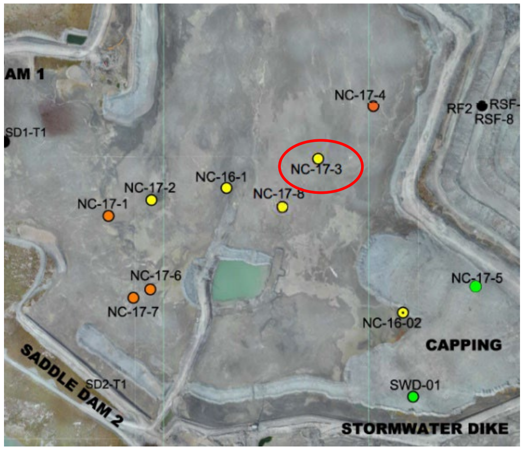
NC-17-02

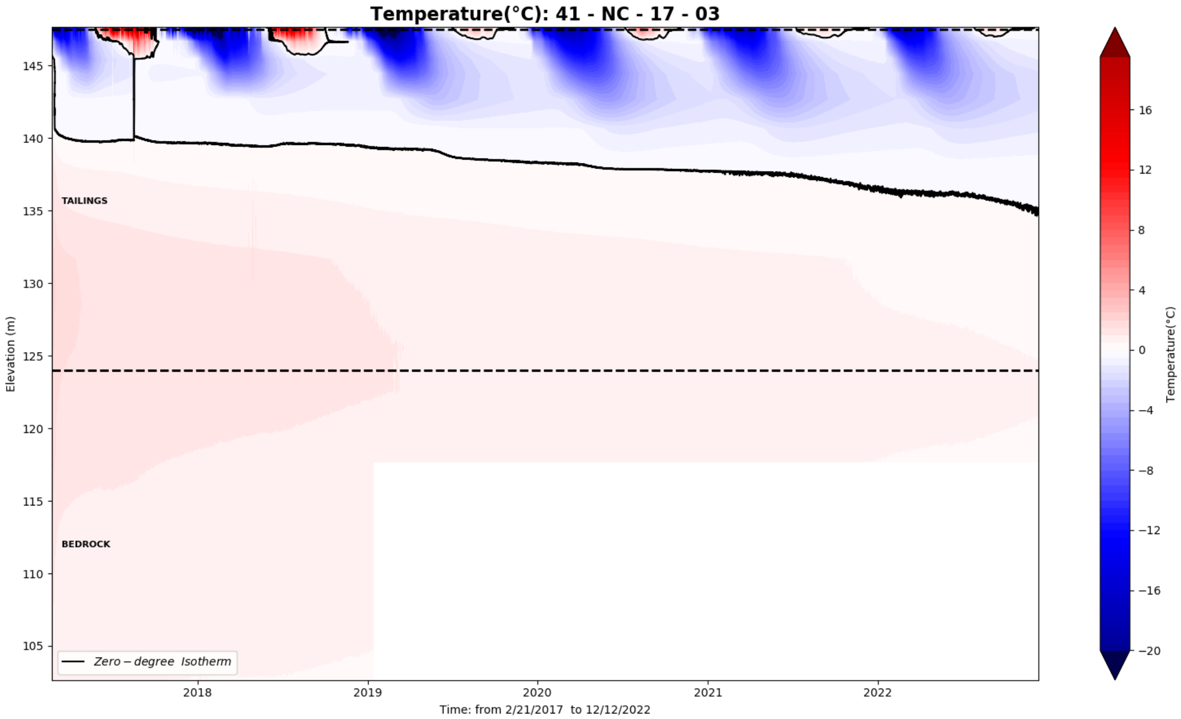

AM 1
SD1-T1
NC-17-4
RF2
RSF-
RSF-8
NC-17-3
NC-16-1
NC-17-2
NC-17-1
NC-17-8
NC-17-6
NC-17-7
NC-17-5
NC-16-02
CAPPING
SADDLE DAM 2
SD2-T1
SWD-01
STORMWATER DIKE

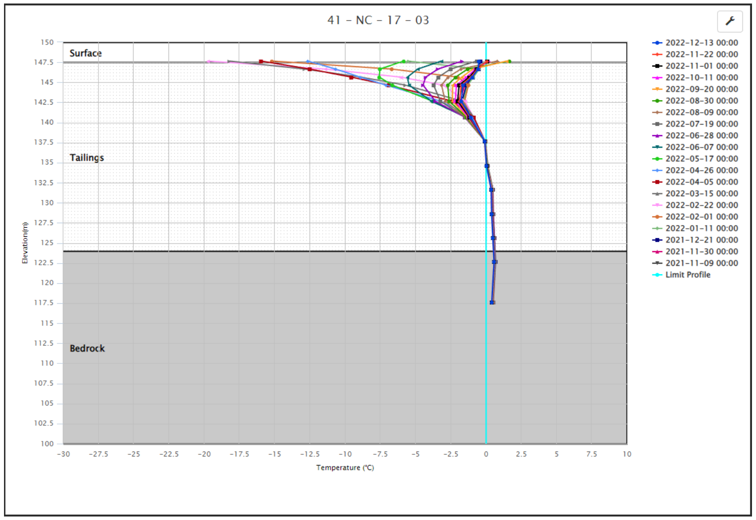

Temperature(°C): 41 - NC - 17 - 02
Elevation (m)
145
140
135
130
125
120
115
110
105
TAILINGS
BEDROCK
Zero – degree Isotherm
2018
2019
2020
2021
2022
Time: from 2/21/2017 to 12/12/2022
16
12
8
4
0
−4
−8
−12
−16
−20
Temperature(°C)


41 – NC – 17 – 02
Bead #4 broken and removed
Surface
Tailings
Bedrock
Elevation(m)
150
147.5
145
142.5
140
137.5
135
132.5
130
127.5
125
122.5
120
117.5
115
112.5
110
107.5
105
102.5
100
−30
−27.5
−25
−22.5
−20
−17.5
−15
−12.5
−10
−7.5
−5
−2.5
0
2.5
5
7.5
10
12.5
15
Temperature (°C)
2022-12-13 00:00
2022-11-22 00:00
2022-11-01 00:00
2022-10-11 00:00
2022-09-20 00:00
2022-08-30 00:00
2022-08-09 00:00
2022-07-19 00:00
2022-06-28 00:00
2022-06-07 00:00
2022-05-17 00:00
2022-04-26 00:00
2022-04-05 00:00
2022-03-15 00:00
2022-02-22 00:00
2022-02-01 00:00
2022-01-11 00:00
2021-12-21 00:00
2021-11-30 00:00
2021-11-09 00:00
Limit Profile

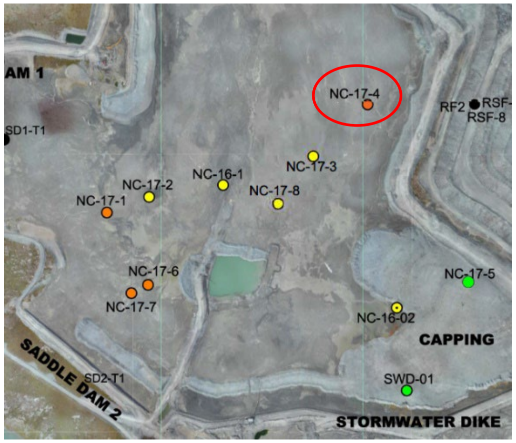
NC-17-03

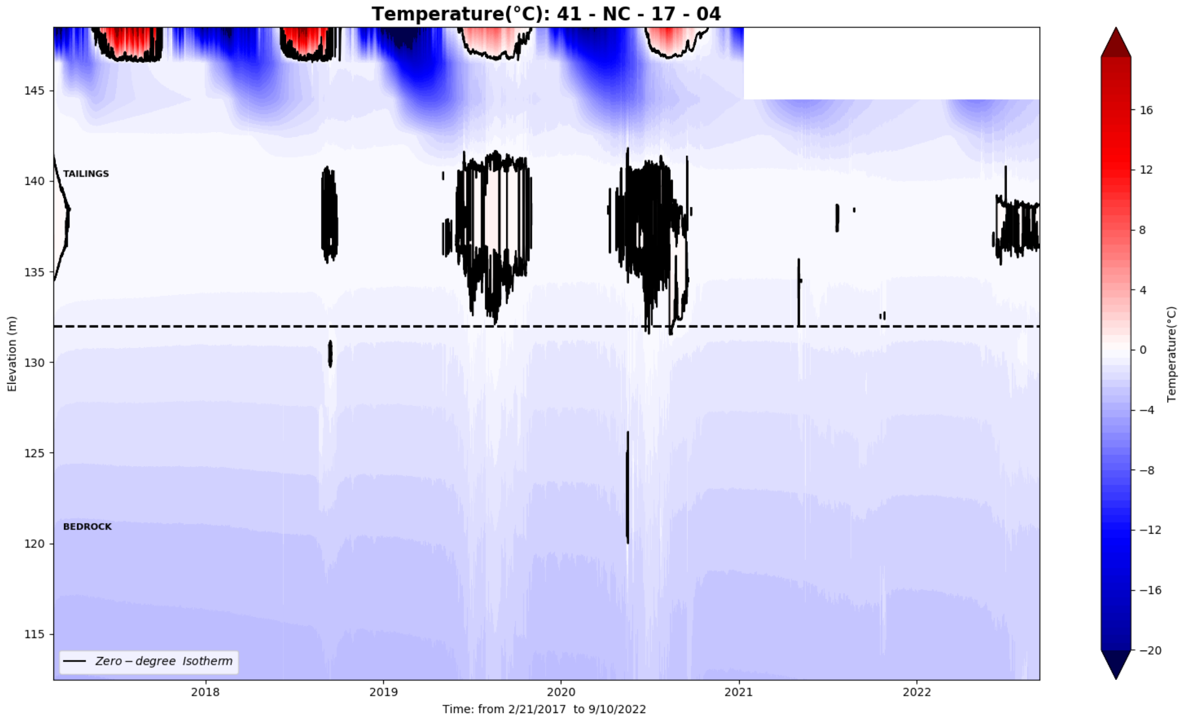

AM 1
SD1-T1
NC-17-4
RF2
RSF-
RSF-8
NC-17-3
NC-16-1
NC-17-2
NC-17-1
NC-17-8
NC-17-6
NC-17-7
NC-17-5
NC-16-02
CAPPING
SADDLE DAM 2
SD2-T1
SWD-01
STORMWATER DIKE

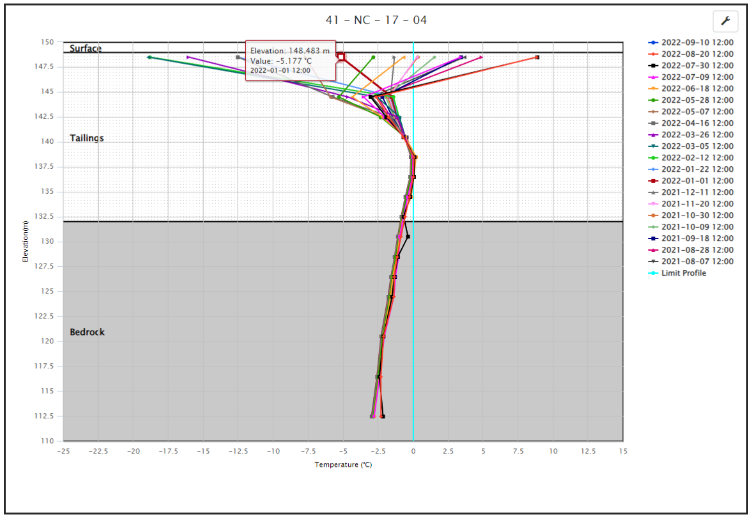

Temperature(°C): 41 - NC - 17 - 03
Elevation (m)
145
140
135
130
125
120
115
110
105
TAILINGS
BEDROCK
Zero – degree Isotherm
2018
2019
2020
2021
2022
Time: from 2/21/2017 to 12/12/2022
Temperature(°C)
16
12
8
4
0
−4
−8
−12
−16
−20


41 – NC – 17 – 03
Surface
Tailings
Bedrock
Elevation(m)
150
147.5
145
142.5
140
137.5
135
132.5
130
127.5
125
122.5
120
117.5
115
112.5
110
107.5
105
102.5
100
−30
−27.5
−25
−22.5
−20
−17.5
−15
−12.5
−10
−7.5
−5
−2.5
0
2.5
5
7.5
10
Temperature (°C)
2022–12–13 00:00
2022–11–22 00:00
2022–11–01 00:00
2022–10–11 00:00
2022–09–20 00:00
2022–08–30 00:00
2022–08–09 00:00
2022–07–19 00:00
2022–06–28 00:00
2022–06–07 00:00
2022–05–17 00:00
2022–04–26 00:00
2022–04–05 00:00
2022–03–15 00:00
2022–02–22 00:00
2022–02–01 00:00
2022–01–11 00:00
2021–12–21 00:00
2021–11–30 00:00
2021–11–09 00:00
Limit Profile

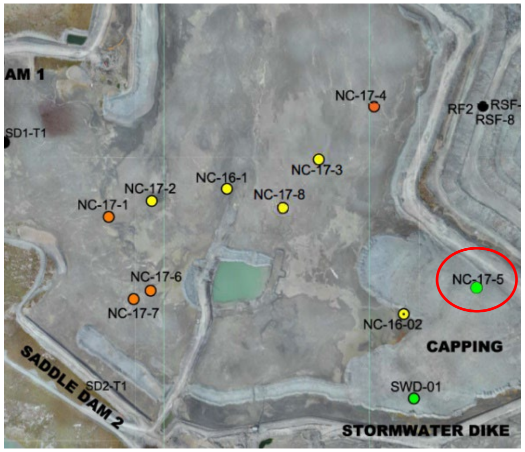
NC-17-04

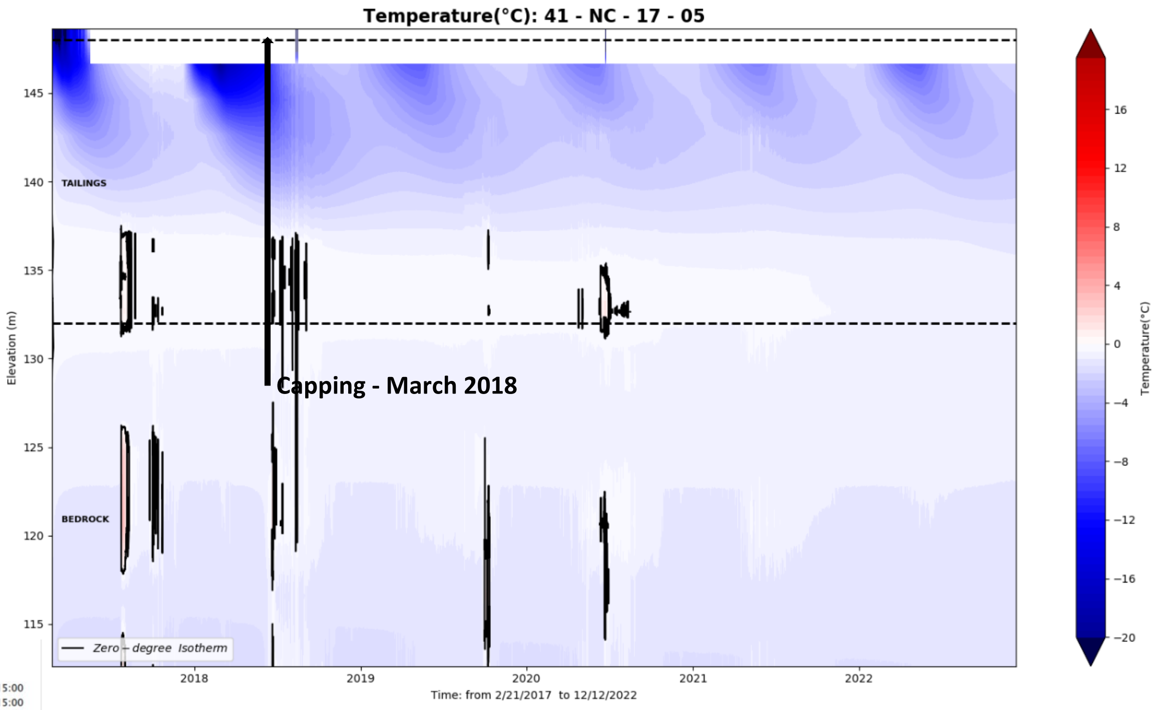

AM 1
NC-17-4
RF2
RSF-
RSF-8
SD1-T1
NC-17-3
NC-16-1
NC-17-2
NC-17-8
NC-17-1
NC-17-6
NC-17-5
NC-17-7
NC-16-02
CAPPING
SADDLE DAM 2
SD2-T1
SWD-01
STORMWATER DIKE

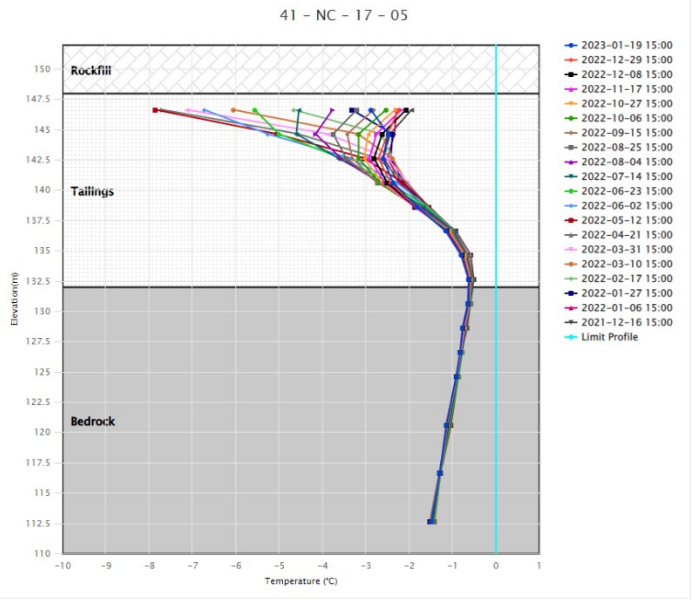

Temperature(°C): 41 - NC - 17 - 04
Elevation (m)
145
140
135
130
125
120
115
TAILINGS
BEDROCK
Zero – degree Isotherm
2018
2019
2020
2021
2022
Time: from 2/21/2017 to 9/10/2022
Temperature(°C)
16
12
8
4
0
−4
−8
−12
−16
−20


41 – NC – 17 – 04
Elevation: 148.483 m
Value: -5.177 °C
2022-01-01 12:00
Surface
Tailings
Bedrock
Elevation(m)
150
147.5
145
142.5
140
137.5
135
132.5
130
127.5
125
122.5
120
117.5
115
112.5
110
-25
-22.5
-20
-17.5
-15
-12.5
-10
-7.5
-5
-2.5
0
2.5
5
7.5
10
12.5
15
Temperature (°C)
2022-09-10 12:00
2022-08-20 12:00
2022-07-30 12:00
2022-07-09 12:00
2022-06-18 12:00
2022-05-28 12:00
2022-05-07 12:00
2022-04-16 12:00
2022-03-26 12:00
2022-03-05 12:00
2022-02-12 12:00
2022-01-22 12:00
2022-01-01 12:00
2021-12-11 12:00
2021-11-20 12:00
2021-10-30 12:00
2021-10-09 12:00
2021-09-18 12:00
2021-08-28 12:00
2021-08-07 12:00
Limit Profile

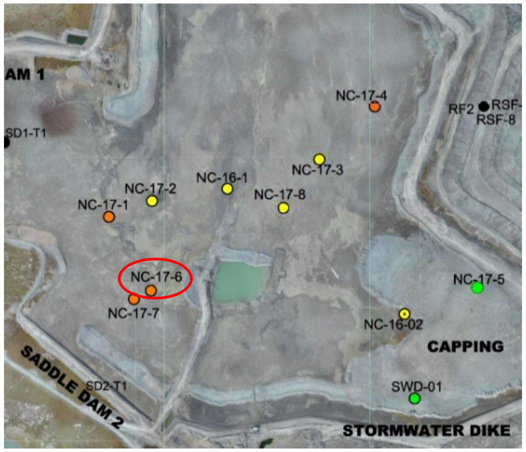
NC-17-05

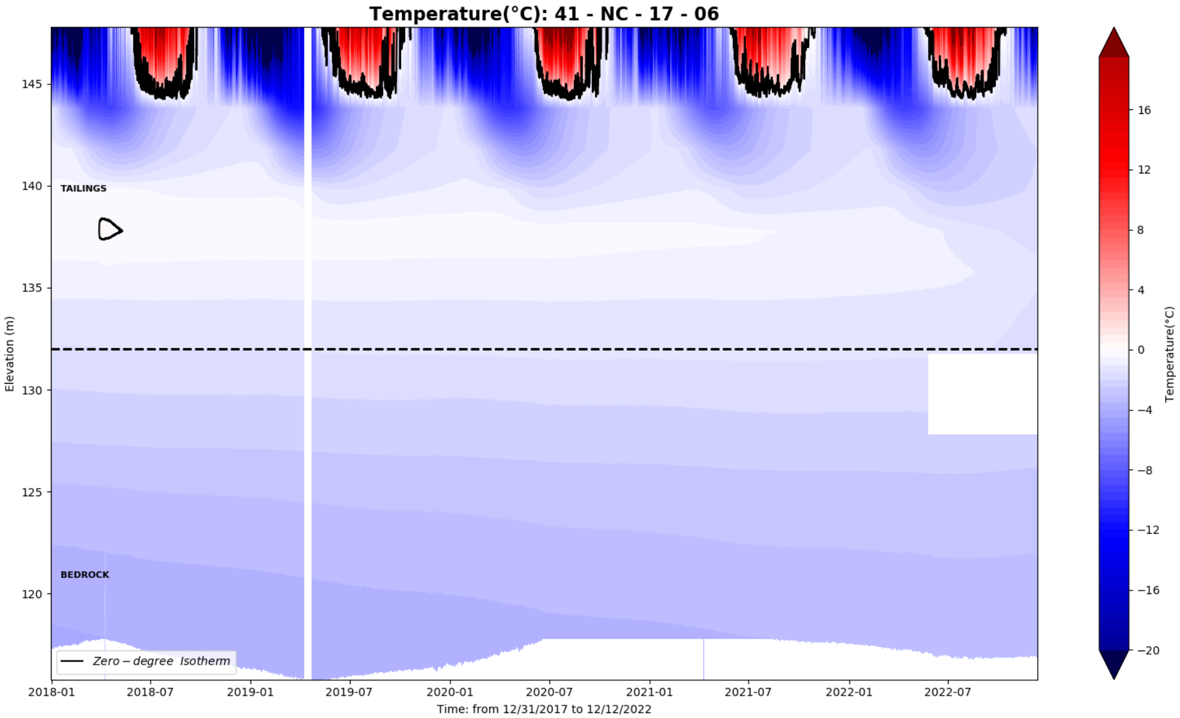

AM 1
SD1-T1
NC-17-4
RF2
RSF-
RSF-8
NC-17-3
NC-16-1
NC-17-2
NC-17-8
NC-17-1
NC-17-6
NC-17-7
NC-17-5
NC-16-02
CAPPING
SD2-T1
SADDLE DAM 2
SWD-01
STORMWATER DIKE

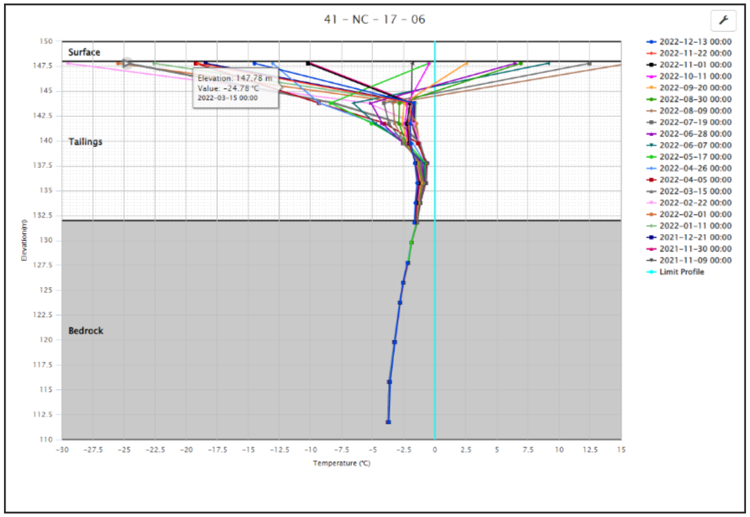

Temperature(°C): 41 - NC - 17 - 05
Elevation (m)
145
140
135
130
125
120
115
TAILINGS
BEDROCK
Capping - March 2018
Zero – degree Isotherm
2018
2019
2020
2021
2022
Time: from 2/21/2017 to 12/12/2022
Temperature(°C)
16
12
8
4
0
−4
−8
−12
−16
−20


41 - NC - 17 - 05
Rockfill
Tailings
Bedrock
Elevation(m)
150
147.5
145
142.5
140
137.5
135
132.5
130
127.5
125
122.5
120
117.5
115
112.5
110
−10
−9
−8
−7
−6
−5
−4
−3
−2
−1
0
1
Temperature (°C)
2023-01-19 15:00
2022-12-29 15:00
2022-12-08 15:00
2022-11-17 15:00
2022-10-27 15:00
2022-10-06 15:00
2022-09-15 15:00
2022-08-25 15:00
2022-08-04 15:00
2022-07-14 15:00
2022-06-23 15:00
2022-06-02 15:00
2022-05-12 15:00
2022-04-21 15:00
2022-03-31 15:00
2022-03-10 15:00
2022-02-17 15:00
2022-01-27 15:00
2022-01-06 15:00
2021-12-16 15:00
Limit Profile

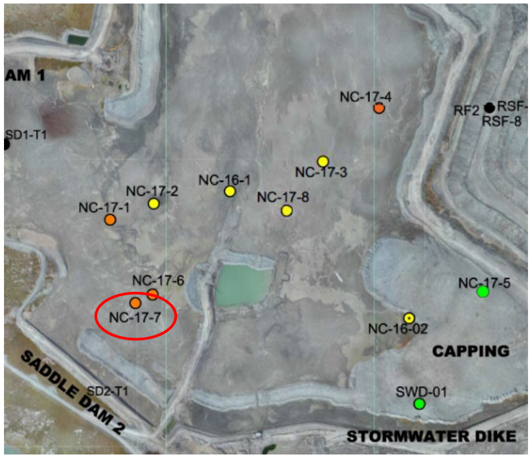
NC-17-06

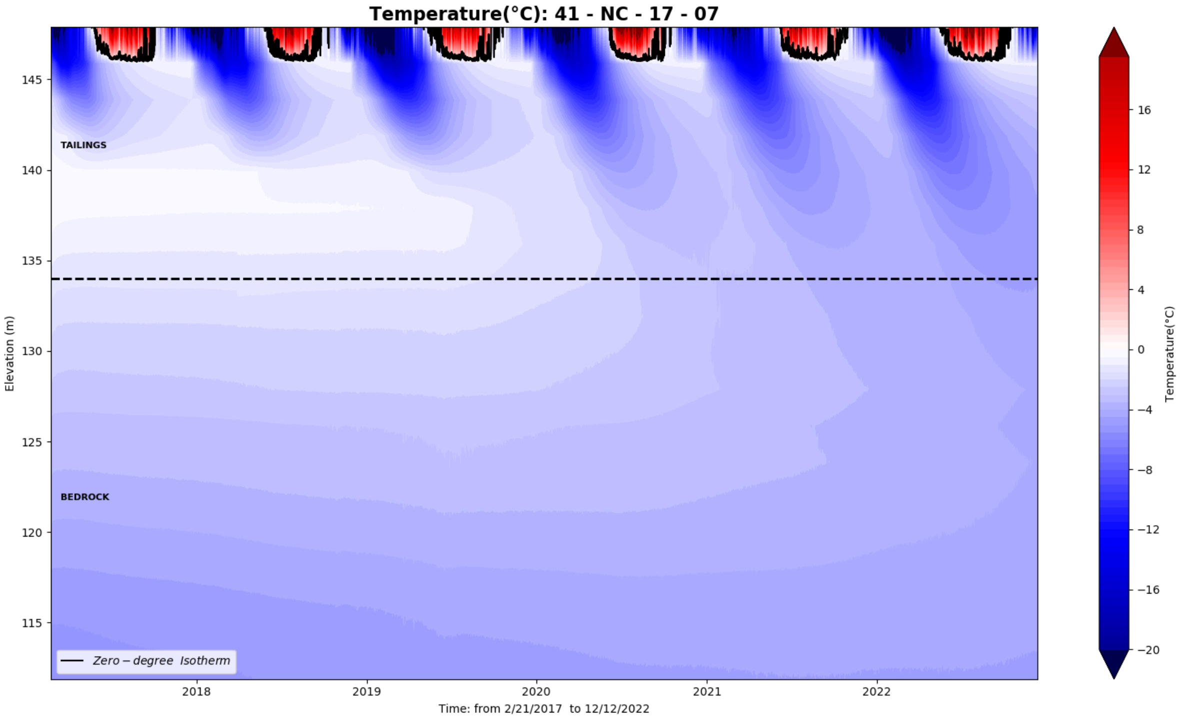

AM 1
SD1-T1
NC-17-4
RF2
RSF-
RSF-8
NC-17-3
NC-16-1
NC-17-2
NC-17-8
NC-17-1
NC-17-6
NC-17-7
NC-17-5
NC-16-02
CAPPING
SADDLE DAM 2
SD2-T1
SWD-01
STORMWATER DIKE

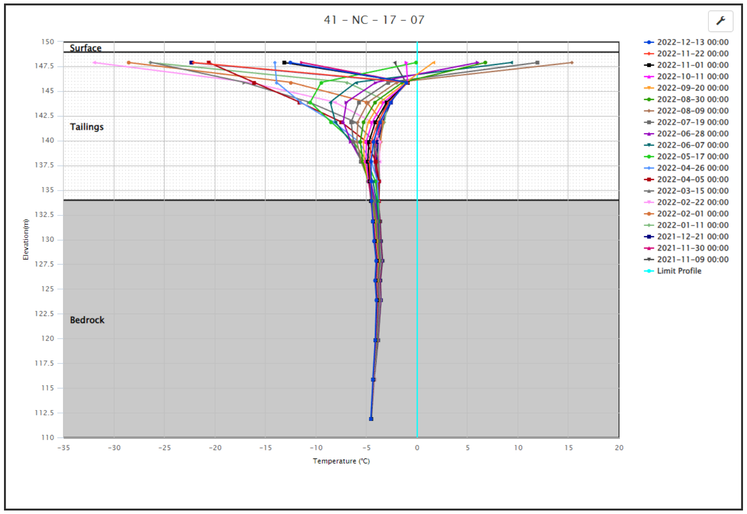

Temperature(°C): 41 - NC - 17 - 06
Elevation (m)
145
140
135
130
125
120
TAILINGS
BEDROCK
Zero – degree Isotherm
2018-01
2018-07
2019-01
2019-07
2020-01
2020-07
2021-01
2021-07
2022-01
2022-07
Time: from 12/31/2017 to 12/12/2022
Temperature(°C)
16
12
8
4
0
−4
−8
−12
−16
−20


41 – NC – 17 – 06
Surface
Tailings
Bedrock
Elevation(m)
150
147.5
145
142.5
140
137.5
135
132.5
130
127.5
125
122.5
120
117.5
115
112.5
110
-30
-27.5
-25
-22.5
-20
-17.5
-15
-12.5
-10
-7.5
-5
-2.5
0
2.5
5
7.5
10
12.5
15
Temperature (°C)
Elevation: 147.78 m
Value: -24.78 °C
2022-03-15 00:00
2022-12-13 00:00
2022-11-22 00:00
2022-11-01 00:00
2022-10-11 00:00
2022-09-20 00:00
2022-08-30 00:00
2022-08-09 00:00
2022-07-19 00:00
2022-06-28 00:00
2022-06-07 00:00
2022-05-17 00:00
2022-04-26 00:00
2022-04-05 00:00
2022-03-15 00:00
2022-02-22 00:00
2022-02-01 00:00
2022-01-11 00:00
2021-12-21 00:00
2021-11-30 00:00
2021-11-09 00:00
Limit Profile

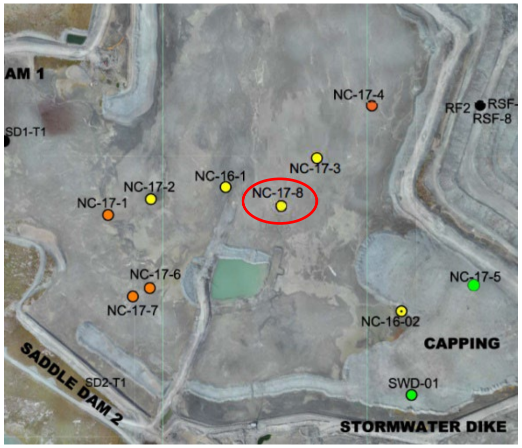
NC-17-07

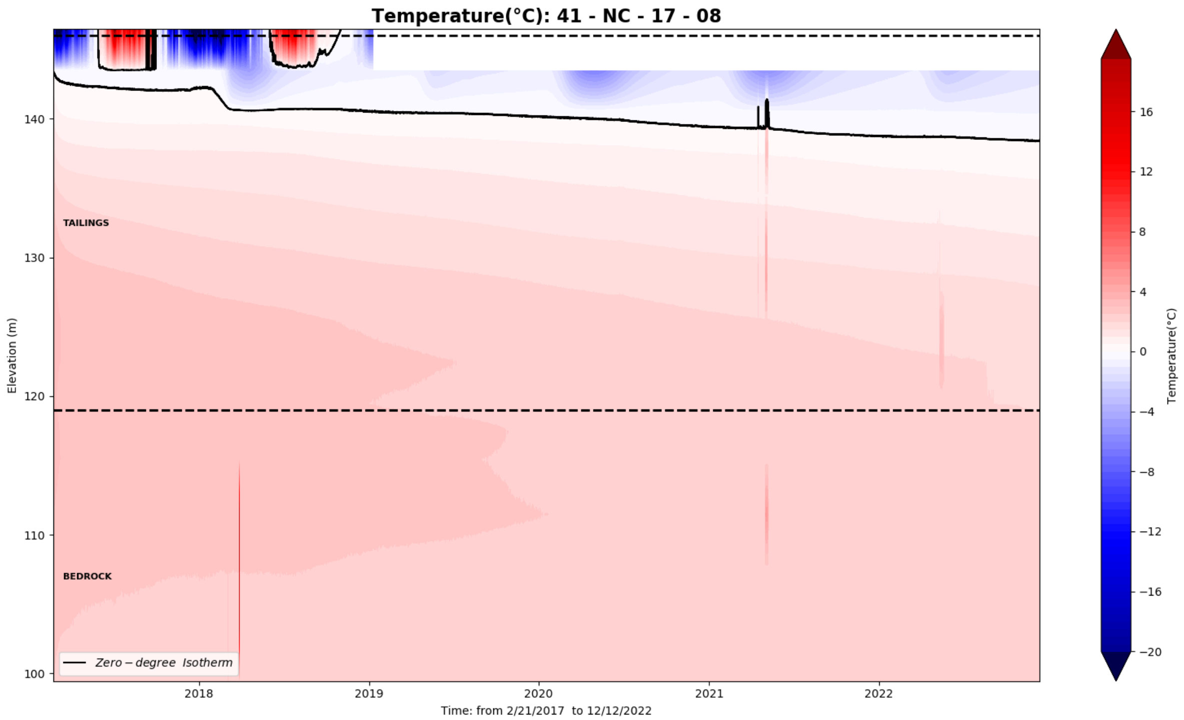

AM 1
SD1-T1
NC-17-4
RF2
RSF-
RSF-8
NC-17-3
NC-16-1
NC-17-2
NC-17-8
NC-17-1
NC-17-6
NC-17-7
NC-17-5
NC-16-02
CAPPING
SADDLE DAM 2
SD2-T1
SWD-01
STORMWATER DIKE

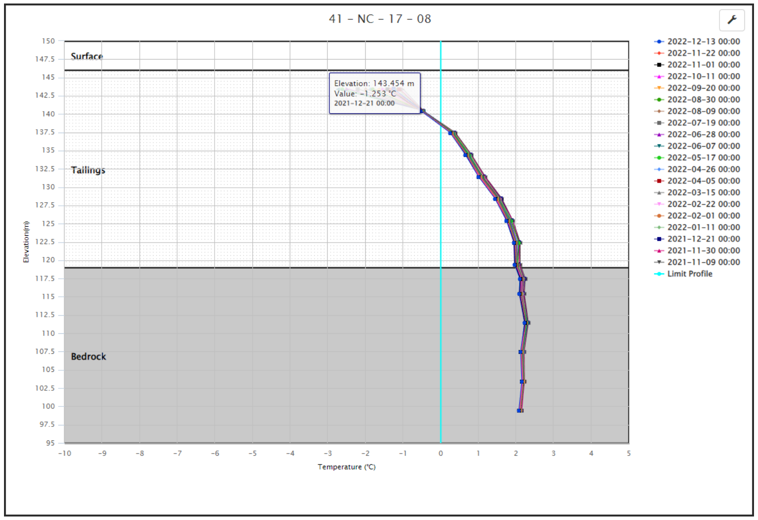

Temperature(°C): 41 - NC - 17 - 07
Elevation (m)
145
140
135
130
125
120
115
TAILINGS
BEDROCK
Zero – degree Isotherm
2018
2019
2020
2021
2022
Time: from 2/21/2017 to 12/12/2022
16
12
8
4
0
−4
−8
−12
−16
−20
Temperature(°C)


41 – NC – 17 – 07
Surface
Tailings
Bedrock
Elevation(m)
150
147.5
145
142.5
140
137.5
135
132.5
130
127.5
125
122.5
120
117.5
115
112.5
110
−35
−30
−25
−20
−15
−10
−5
0
5
10
15
20
Temperature (°C)
2022–12–13 00:00
2022–11–22 00:00
2022–11–01 00:00
2022–10–11 00:00
2022–09–20 00:00
2022–08–30 00:00
2022–08–09 00:00
2022–07–19 00:00
2022–06–28 00:00
2022–06–07 00:00
2022–05–17 00:00
2022–04–26 00:00
2022–04–05 00:00
2022–03–15 00:00
2022–02–22 00:00
2022–02–01 00:00
2022–01–11 00:00
2021–12–21 00:00
2021–11–30 00:00
2021–11–09 00:00
Limit Profile

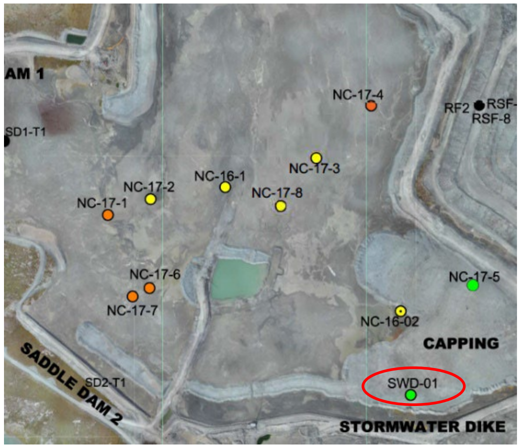
NC-17-08

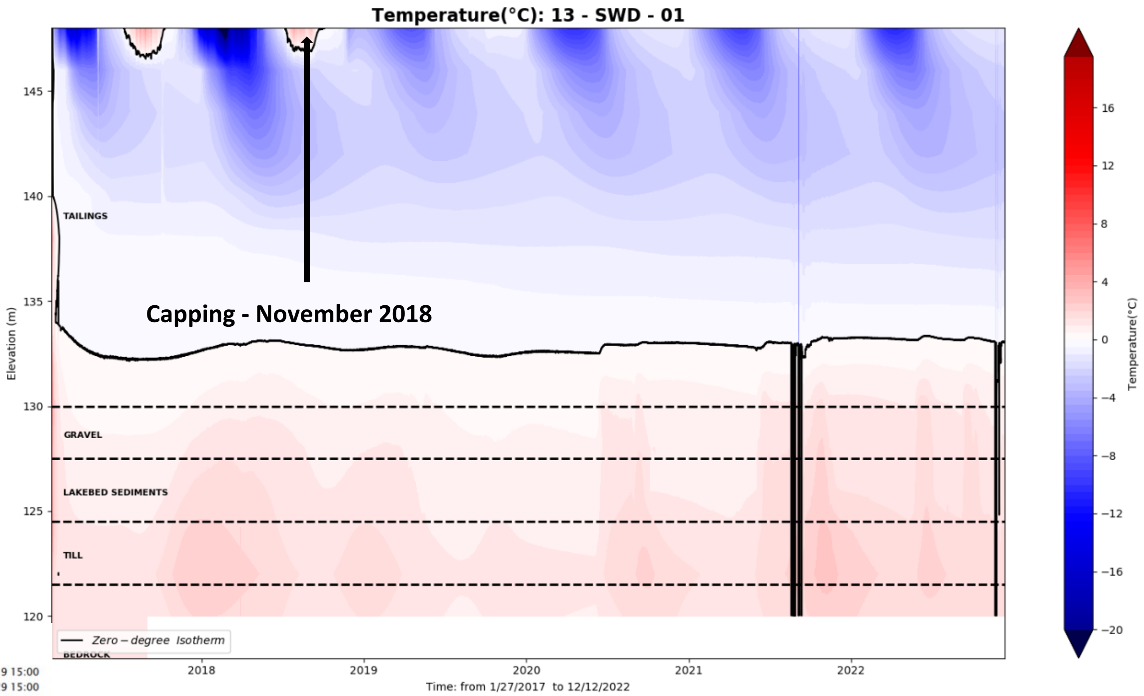

AM 1
SD1-T1
NC-17-4
RF2
RSF-
RSF-8
NC-17-3
NC-16-1
NC-17-2
NC-17-8
NC-17-1
NC-17-6
NC-17-7
NC-17-5
NC-16-02
CAPPING
SADDLE DAM 2
SD2-T1
SWD-01
STORMWATER DIKE

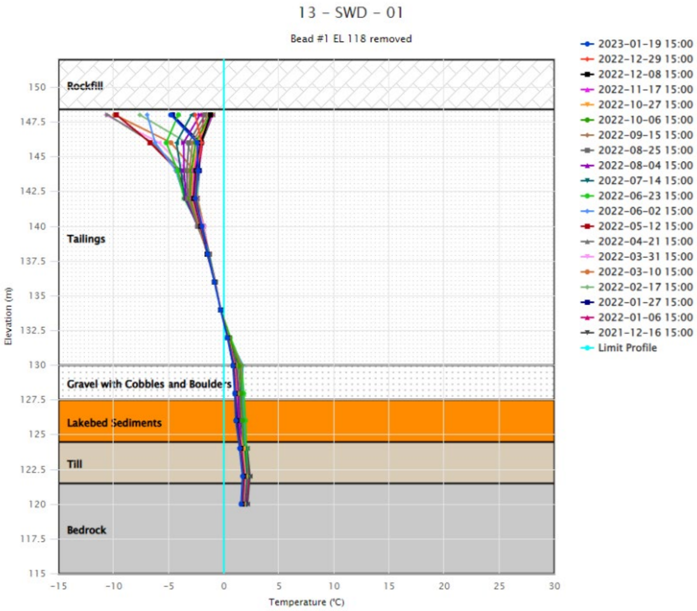

Temperature(°C): 41 - NC - 17 - 08
Elevation (m)
140
130
120
110
100
TAILINGS
BEDROCK
Zero – degree Isotherm
2018
2019
2020
2021
2022
Time: from 2/21/2017 to 12/12/2022
16
12
8
4
0
−4
−8
−12
−16
−20
Temperature(°C)


41 – NC – 17 – 08
Surface
Tailings
Bedrock
Elevation(m)
150
147.5
145
142.5
140
137.5
135
132.5
130
127.5
125
122.5
120
117.5
115
112.5
110
107.5
105
102.5
100
97.5
95
−10
−9
−8
−7
−6
−5
−4
−3
−2
−1
0
1
2
3
4
5
Temperature (°C)
Elevation: 143.454 m
Value: −1.253 °C
2021−12−21 00:00
2022−12−13 00:00
2022−11−22 00:00
2022−11−01 00:00
2022−10−11 00:00
2022−09−20 00:00
2022−08−30 00:00
2022−08−09 00:00
2022−07−19 00:00
2022−06−28 00:00
2022−06−07 00:00
2022−05−17 00:00
2022−04−26 00:00
2022−04−05 00:00
2022−03−15 00:00
2022−02−22 00:00
2022−02−01 00:00
2022−01−11 00:00
2021−12−21 00:00
2021−11−30 00:00
2021−11−09 00:00
Limit Profile

SWD-01

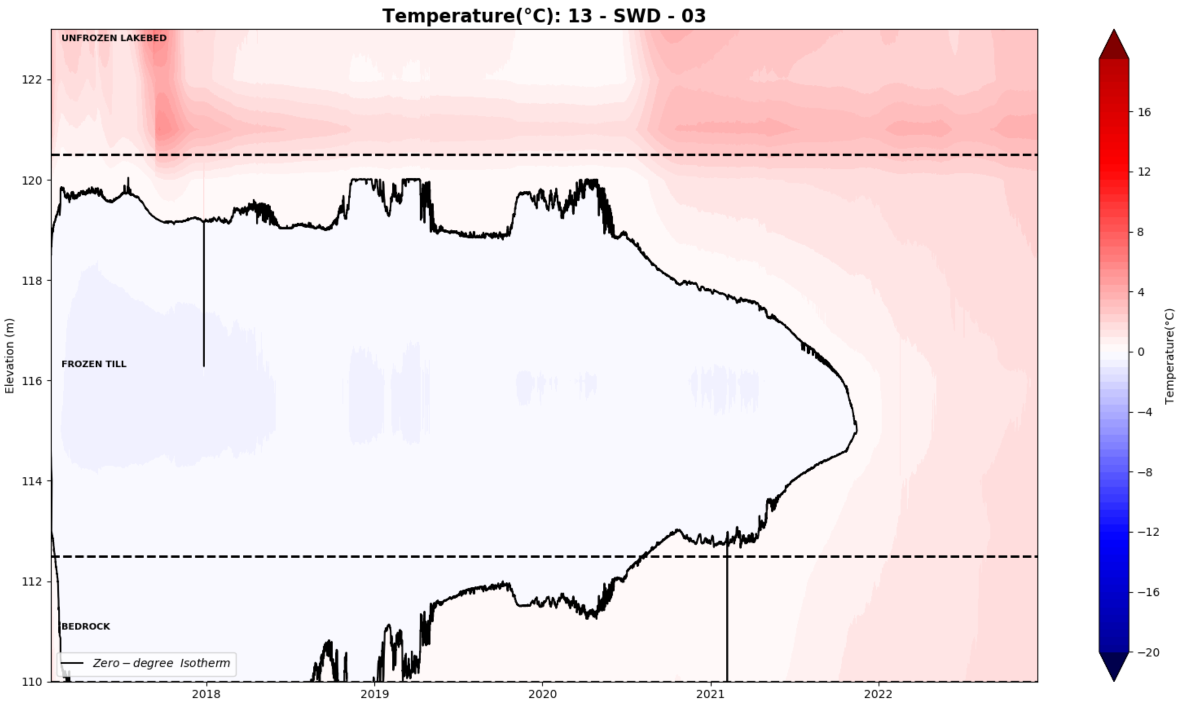

AM 1
NC-17-4
RF2
RSF-
RSF-8
SD1-T1
NC-17-3
NC-16-1
NC-17-2
NC-17-8
NC-17-1
NC-17-6
NC-17-5
NC-17-7
NC-16-02
CAPPING
SADDLE DAM 2
SD2-T1
SWD-01
STORMWATER DIKE

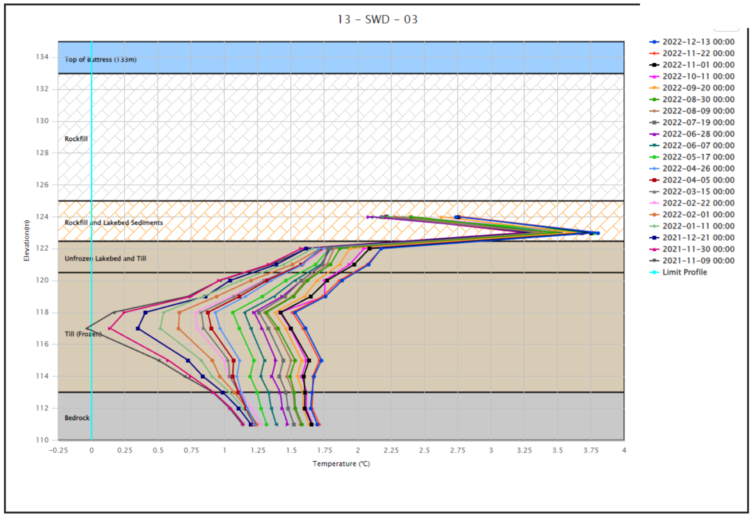

Temperature(°C): 13 - SWD - 01
Elevation (m)
145
140
135
130
125
120
TAILINGS
Capping - November 2018
GRAVEL
LAKEBED SEDIMENTS
TILL
BEDROCK
Zero – degree Isotherm
2018
2019
2020
2021
2022
Time: from 1/27/2017 to 12/12/2022
Temperature(°C)
16
12
8
4
0
−4
−8
−12
−16
−20


13 - SWD - 01
Bead #1 EL 118 removed
Elevation (m)
150
147.5
145
142.5
140
137.5
135
132.5
130
127.5
125
122.5
120
117.5
115
Rockfill
Tailings
Gravel with Cobbles and Boulders
Lakebed Sediments
Till
Bedrock
−15
−10
−5
0
5
10
15
20
25
30
Temperature (°C)
2023-01-19 15:00
2022-12-29 15:00
2022-12-08 15:00
2022-11-17 15:00
2022-10-27 15:00
2022-10-06 15:00
2022-09-15 15:00
2022-08-25 15:00
2022-08-04 15:00
2022-07-14 15:00
2022-06-23 15:00
2022-06-02 15:00
2022-05-12 15:00
2022-04-21 15:00
2022-03-31 15:00
2022-03-10 15:00
2022-02-17 15:00
2022-01-27 15:00
2022-01-06 15:00
2021-12-16 15:00
Limit Profile

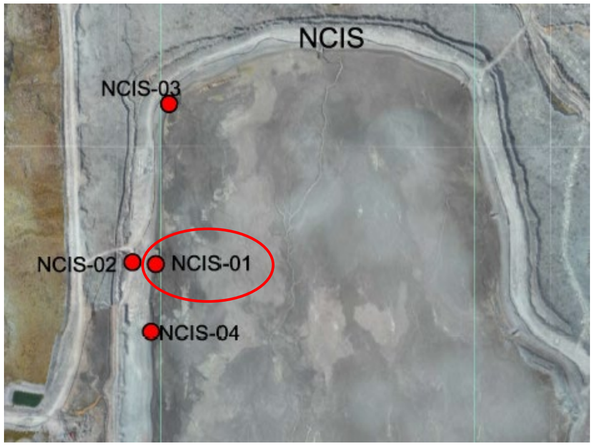
SWD-03

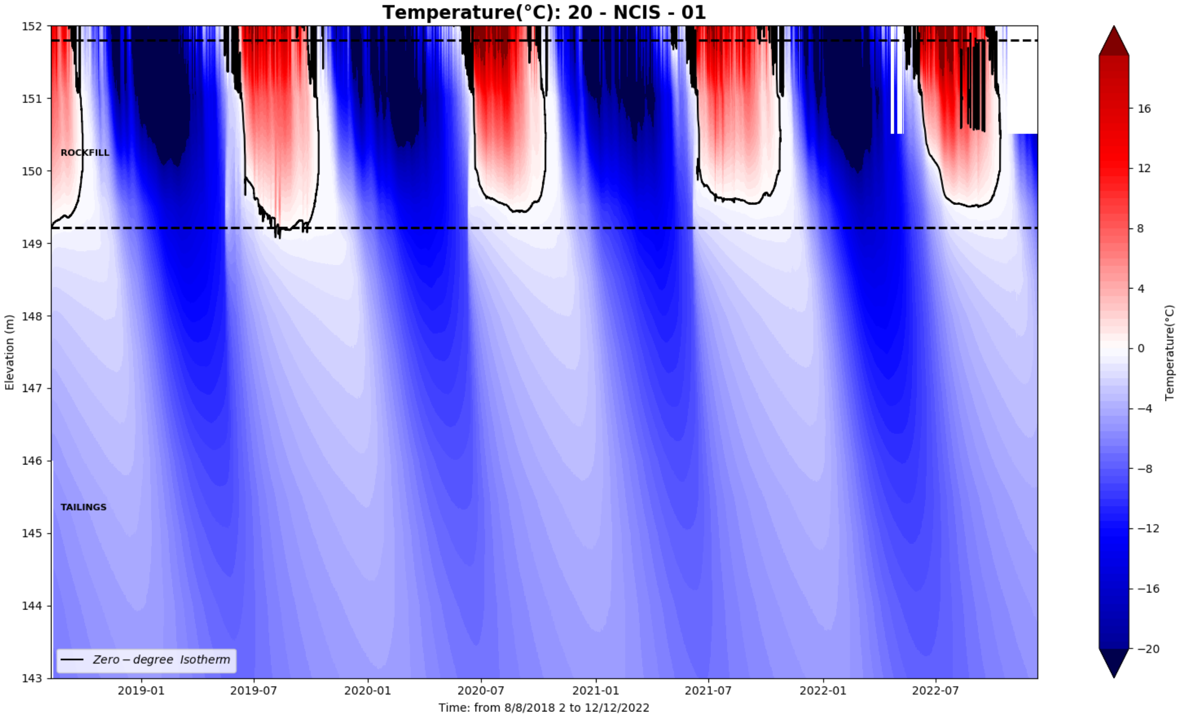

NC-17-2
NC-18-1
NC-17-3
NC-17-8
PORTAGE WASTE DUMP
RSF-9
RSF-10
RSF-3
RF1
NC-17-6
17-7
NC-17-5
NC-16-02
CAPPING
SWD-01
STORMWATER DIKE
SAD-03
SADDLE DAM 3

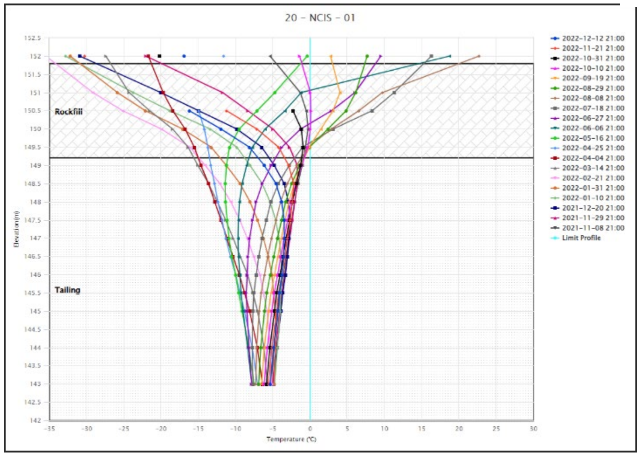

Temperature(°C): 13 - SWD - 03
UNFROZEN LAKEBED
FROZEN TILL
BEDROCK
Zero – degree Isotherm
Elevation (m)
122
120
118
116
114
112
110
2018
2019
2020
2021
2022
Time: from 1/27/2017 to 12/12/2022
16
12
8
4
0
−4
−8
−12
−16
−20
Temperature(°C)


13 – SWD – 03
Top of Buttress (133m)
Rockfill
Rockfill and Lakebed Sediments
Unfrozen Lakebed and Till
Till (Frozen)
Bedrock
Elevation(m)
134
132
130
128
126
124
122
120
118
116
114
112
110
−0.25
0
0.25
0.5
0.75
1
1.25
1.5
1.75
2
2.25
2.5
2.75
3
3.25
3.5
3.75
4
Temperature (°C)
2022–12–13 00:00
2022–11–22 00:00
2022–11–01 00:00
2022–10–11 00:00
2022–09–20 00:00
2022–08–30 00:00
2022–08–09 00:00
2022–07–19 00:00
2022–06–28 00:00
2022–06–07 00:00
2022–05–17 00:00
2022–04–26 00:00
2022–04–05 00:00
2022–03–15 00:00
2022–02–22 00:00
2022–02–01 00:00
2022–01–11 00:00
2021–12–21 00:00
2021–11–30 00:00
2021–11–09 00:00
Limit Profile

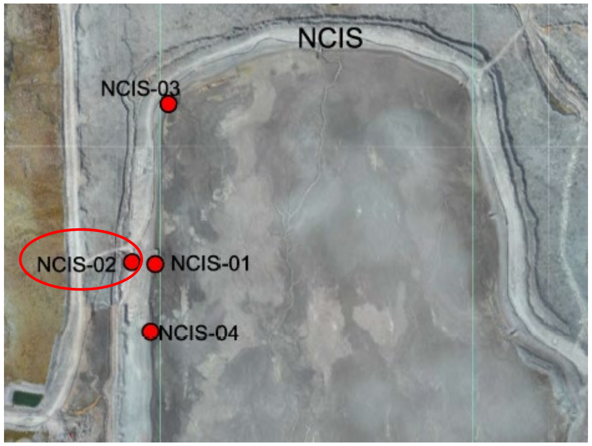
NCIS-01

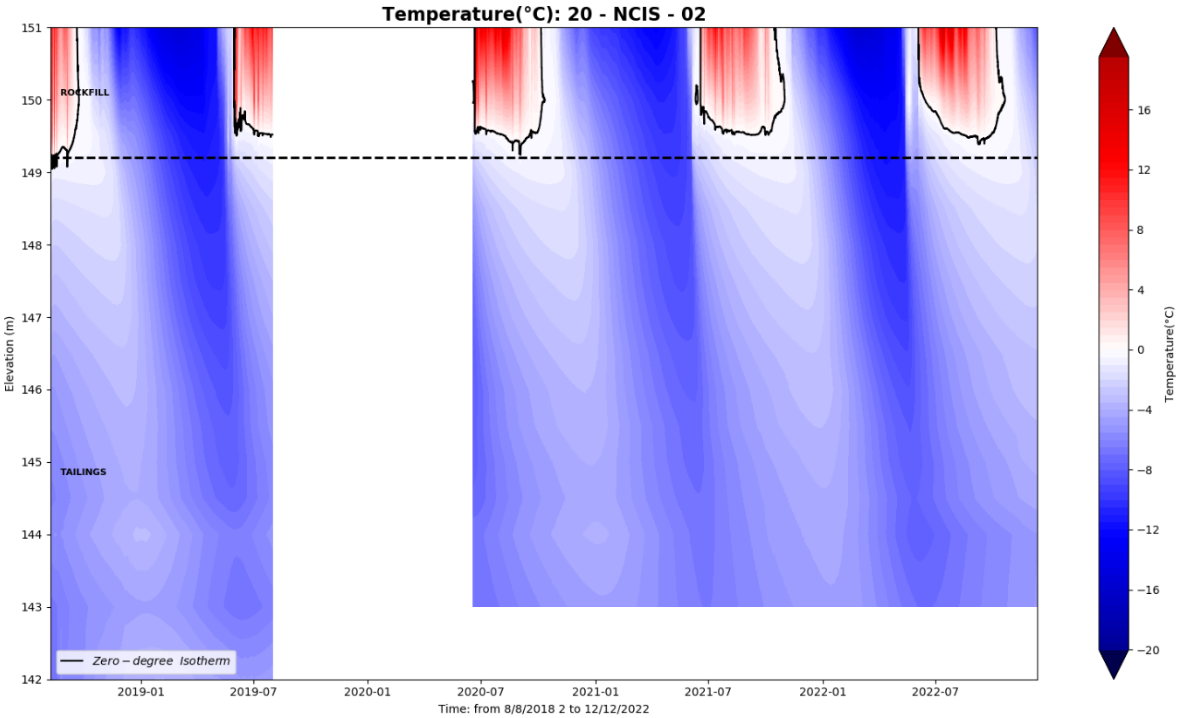

NCIS
NCIS-03
NCIS-02
NCIS-01
NCIS-04

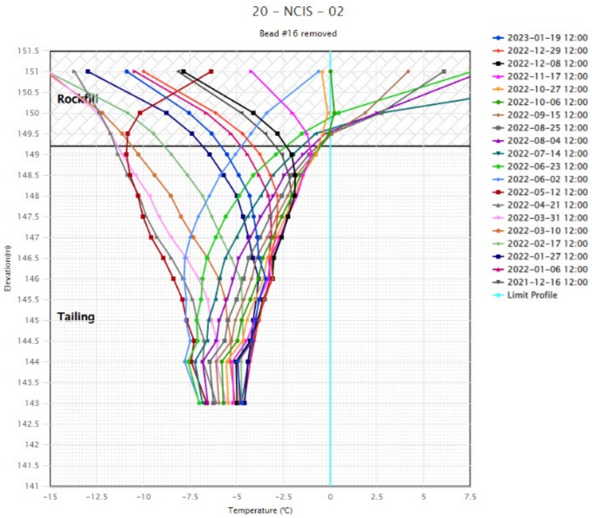

Temperature(°C): 20 - NCIS - 01
Elevation (m)
152
151
150
149
148
147
146
145
144
143
ROCKFILL
TAILINGS
Zero – degree Isotherm
2019-01
2019-07
2020-01
2020-07
2021-01
2021-07
2022-01
2022-07
Time: from 8/8/2018 2 to 12/12/2022
Temperature(°C)
16
12
8
4
0
−4
−8
−12
−16
−20


20 – NCIS – 01
Elevation(m)
152.5
152
151.5
151
150.5
150
149.5
149
148.5
148
147.5
147
146.5
146
145.5
145
144.5
144
143.5
143
142.5
142
Rockfill
Tailing
-35
-30
-25
-20
-15
-10
-5
0
5
10
15
20
25
30
Temperature (°C)
2022-12-12 21:00
2022-11-21 21:00
2022-10-31 21:00
2022-10-10 21:00
2022-09-19 21:00
2022-08-29 21:00
2022-08-08 21:00
2022-07-18 21:00
2022-06-27 21:00
2022-06-06 21:00
2022-05-16 21:00
2022-04-25 21:00
2022-04-04 21:00
2022-03-14 21:00
2022-02-21 21:00
2022-01-31 21:00
2022-01-10 21:00
2021-12-20 21:00
2021-11-29 21:00
2021-11-08 21:00
Limit Profile

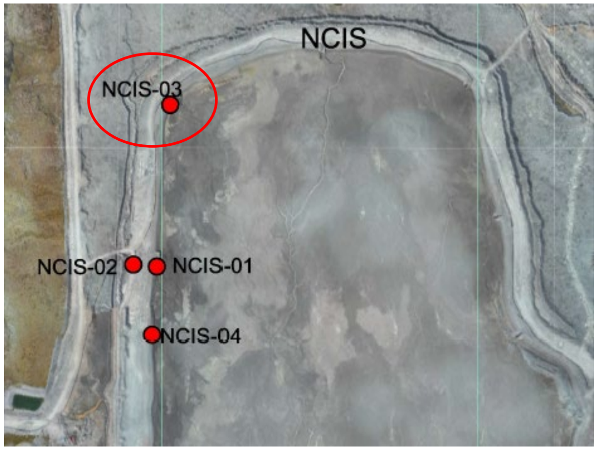
NCIS-02

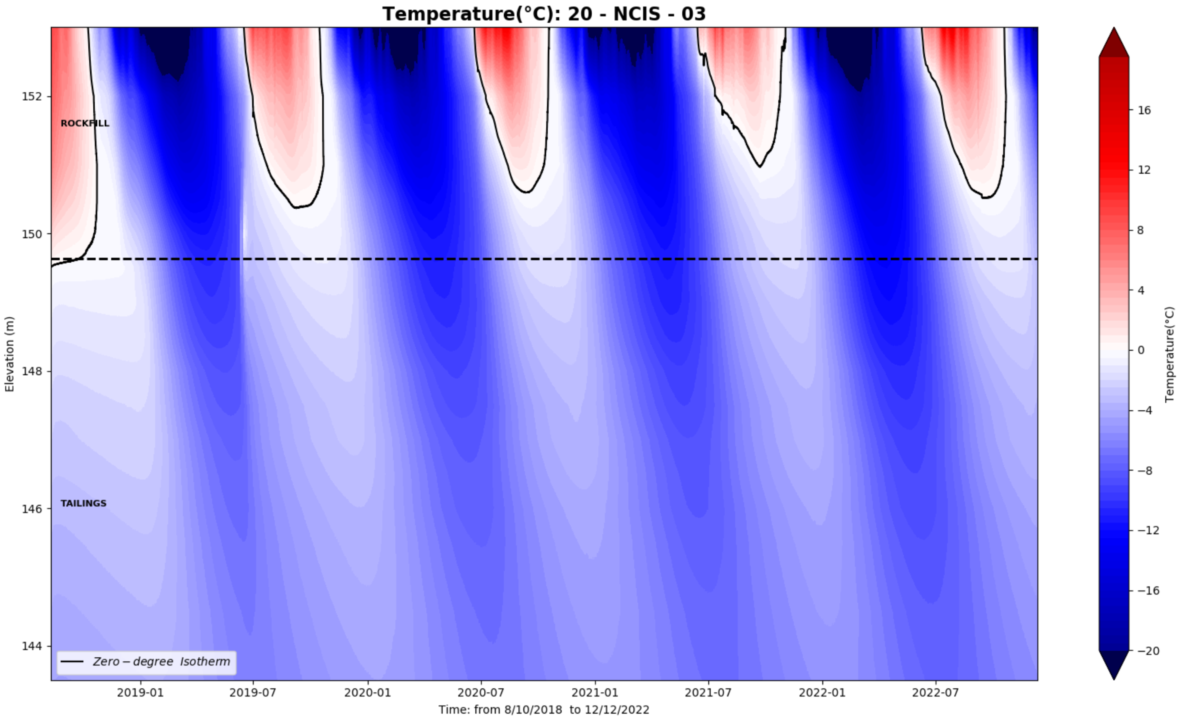

NCIS
NCIS-03
NCIS-02
NCIS-01
NCIS-04

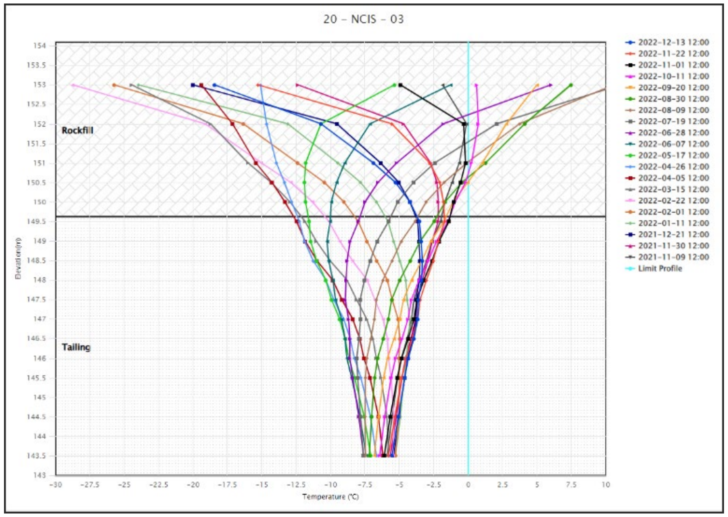

Temperature(°C): 20 - NCIS - 02
ROCKFILL
TAILINGS
Zero – degree Isotherm
Elevation (m)
151
150
149
148
147
146
145
144
143
142
2019-01
2019-07
2020-01
2020-07
2021-01
2021-07
2022-01
2022-07
Time: from 8/8/2018 2 to 12/12/2022
Temperature(°C)
16
12
8
4
0
−4
−8
−12
−16
−20


20 – NCIS – 02
Bead #16 removed
Rockfill
Tailing
Elevation(m)
151.5
151
150.5
150
149.5
149
148.5
148
147.5
147
146.5
146
145.5
145
144.5
144
143.5
143
142.5
142
141.5
141
−15
−12.5
−10
−7.5
−5
−2.5
0
2.5
5
7.5
Temperature (°C)
2023-01-19 12:00
2022-12-29 12:00
2022-12-08 12:00
2022-11-17 12:00
2022-10-27 12:00
2022-10-06 12:00
2022-09-15 12:00
2022-08-25 12:00
2022-08-04 12:00
2022-07-14 12:00
2022-06-23 12:00
2022-06-02 12:00
2022-05-12 12:00
2022-04-21 12:00
2022-03-31 12:00
2022-03-10 12:00
2022-02-17 12:00
2022-01-27 12:00
2022-01-06 12:00
2021-12-16 12:00
Limit Profile

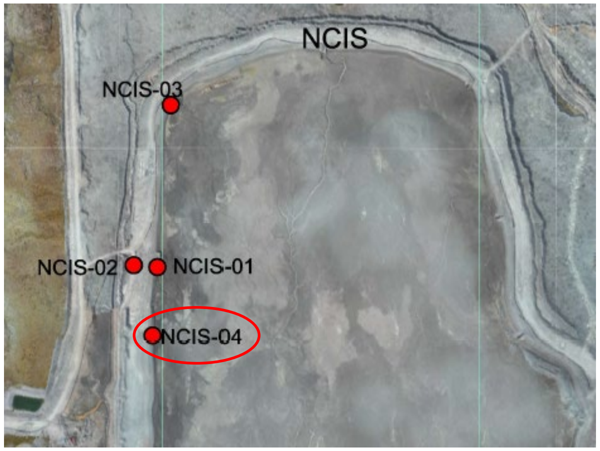
NCIS-03

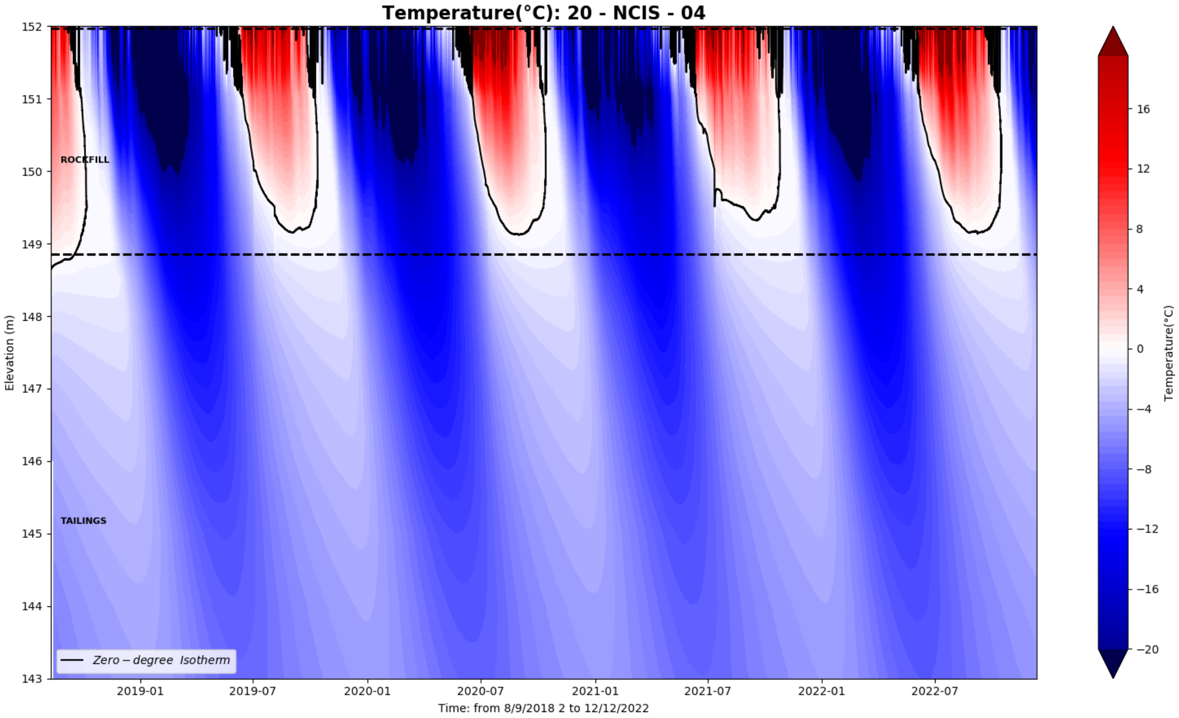

NCIS
NCIS-03
NCIS-02
NCIS-01
NCIS-04

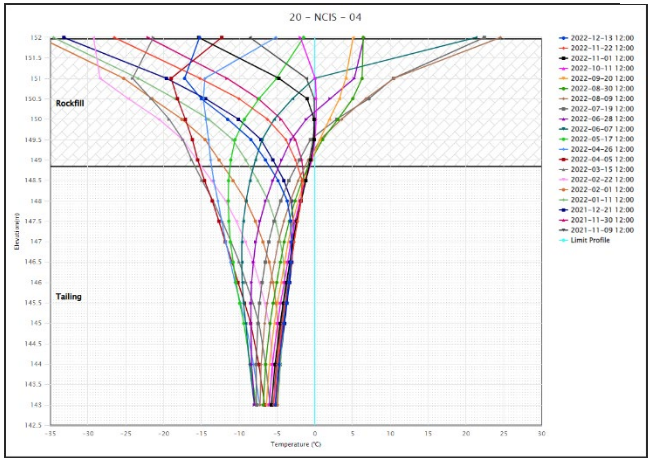

Temperature(°C): 20 - NCIS - 03
ROCKFILL
TAILINGS
Elevation (m)
152
150
148
146
144
Zero – degree Isotherm
2019-01
2019-07
2020-01
2020-07
2021-01
2021-07
2022-01
2022-07
Time: from 8/10/2018 to 12/12/2022
Temperature(°C)
16
12
8
4
0
−4
−8
−12
−16
−20


20 – NCIS – 03
Rockfill
Tailing
Elevation(m)
154
153.5
153
152.5
152
151.5
151
150.5
150
149.5
149
148.5
148
147.5
147
146.5
146
145.5
145
144.5
144
143.5
143
−30
−27.5
−25
−22.5
−20
−17.5
−15
−12.5
−10
−7.5
−5
−2.5
0
2.5
5
7.5
10
Temperature (°C)
2022-12-13 12:00
2022-11-22 12:00
2022-11-01 12:00
2022-10-11 12:00
2022-09-20 12:00
2022-08-30 12:00
2022-08-09 12:00
2022-07-19 12:00
2022-06-28 12:00
2022-06-07 12:00
2022-05-17 12:00
2022-04-26 12:00
2022-04-05 12:00
2022-03-15 12:00
2022-02-22 12:00
2022-02-01 12:00
2022-01-11 12:00
2021-12-21 12:00
2021-11-30 12:00
2021-11-09 12:00
Limit Profile

NCIS-04

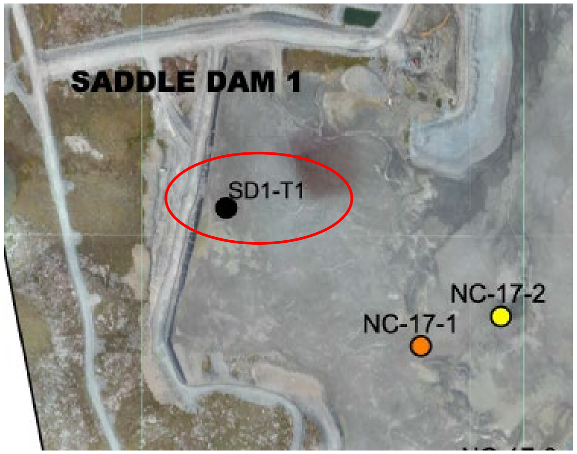

NCIS
NCIS-03
NCIS-02
NCIS-01
NCIS-04

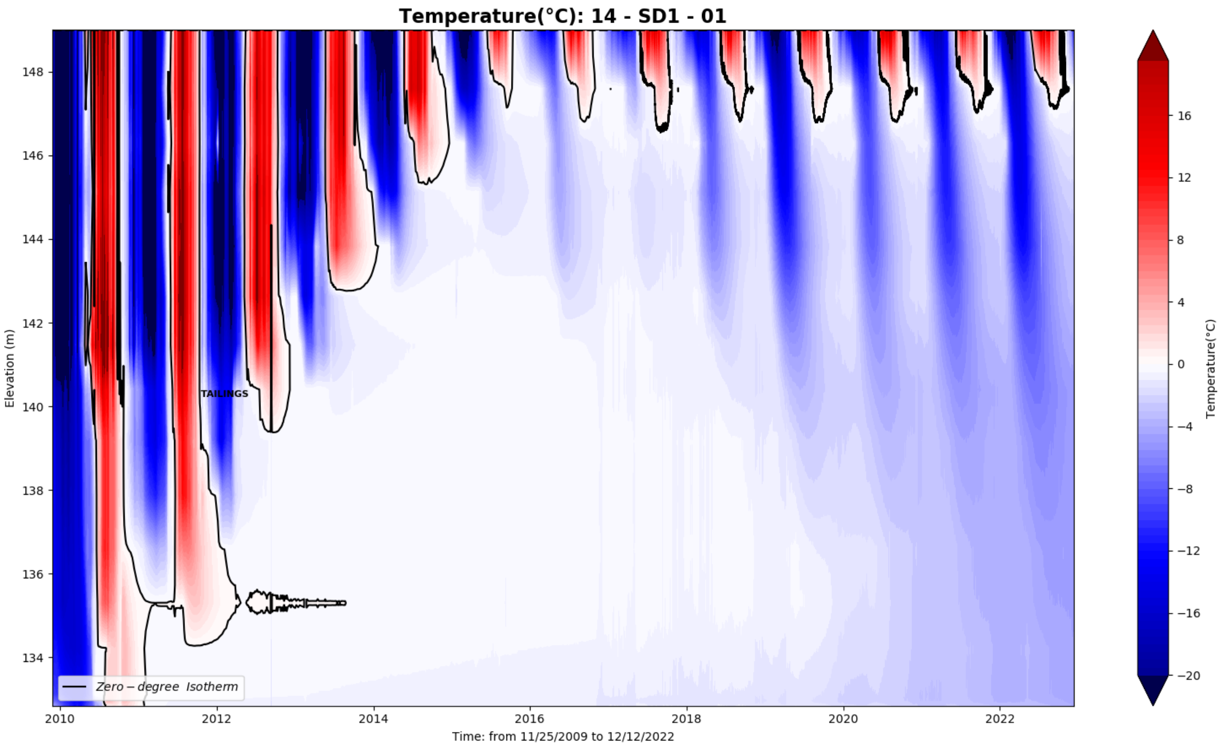

Temperature(°C): 20 - NCIS - 04
Elevation (m)
152
151
150
149
148
147
146
145
144
143
ROCKFILL
TAILINGS
Zero – degree Isotherm
2019-01
2019-07
2020-01
2020-07
2021-01
2021-07
2022-01
2022-07
Time: from 8/9/2018 2 to 12/12/2022
16
12
8
4
0
−4
−8
−12
−16
−20
Temperature(°C)

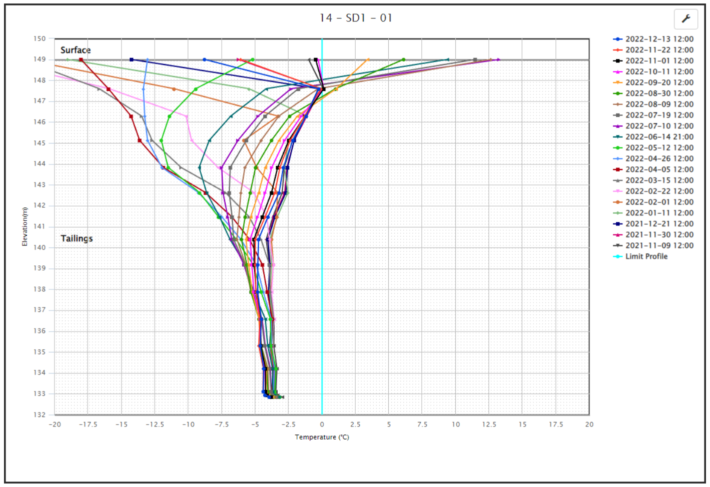

20 – NCIS – 04
Rockfill
Tailing
Elevation (m)
Temperature (°C)
152
151.5
151
150.5
150
149.5
149
148.5
148
147.5
147
146.5
146
145.5
145
144.5
144
143.5
143
142.5
-35
-30
-25
-20
-15
-10
-5
0
5
10
15
20
25
30
2022-12-13 12:00
2022-11-22 12:00
2022-11-01 12:00
2022-10-11 12:00
2022-09-20 12:00
2022-08-30 12:00
2022-08-09 12:00
2022-07-19 12:00
2022-06-28 12:00
2022-06-07 12:00
2022-05-17 12:00
2022-04-26 12:00
2022-04-05 12:00
2022-03-15 12:00
2022-02-22 12:00
2022-02-01 12:00
2022-01-11 12:00
2021-12-21 12:00
2021-11-30 12:00
2021-11-09 12:00
Limit Profile

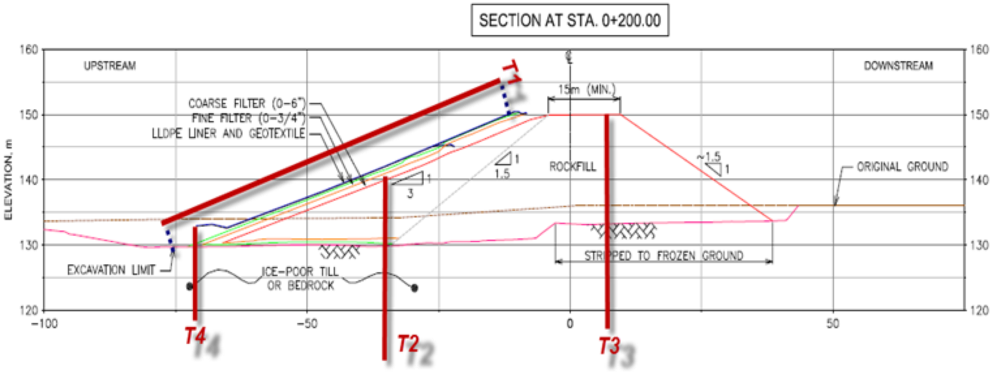
SD1-1

This instrument is along the liner.



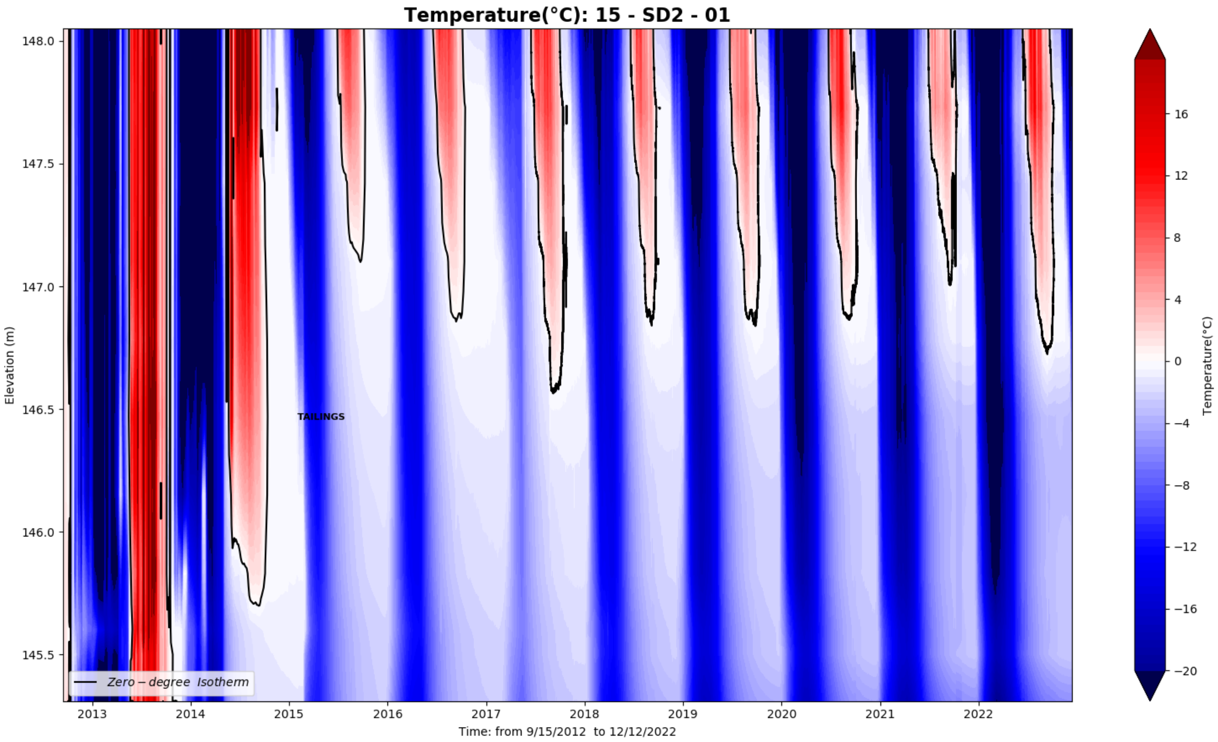


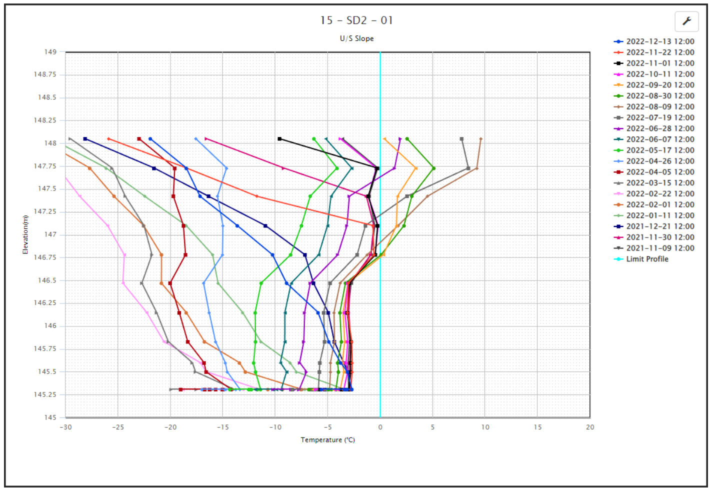


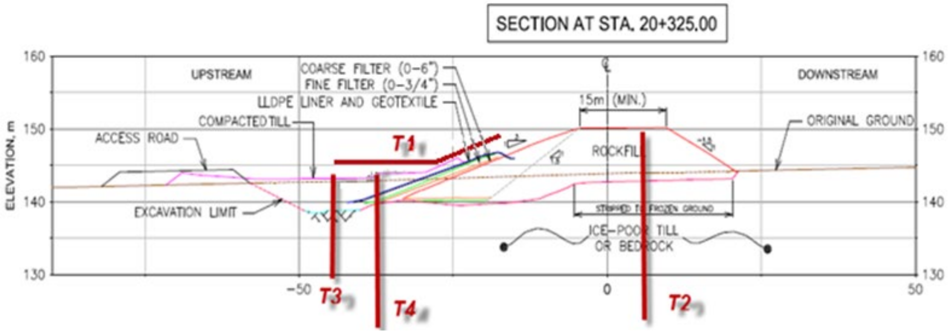


SD2-1

This instrument is along the liner.

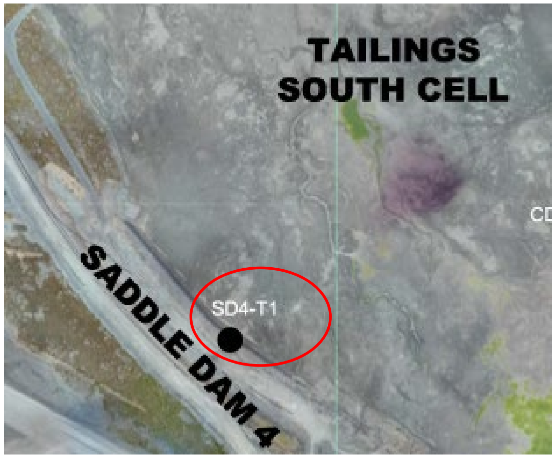


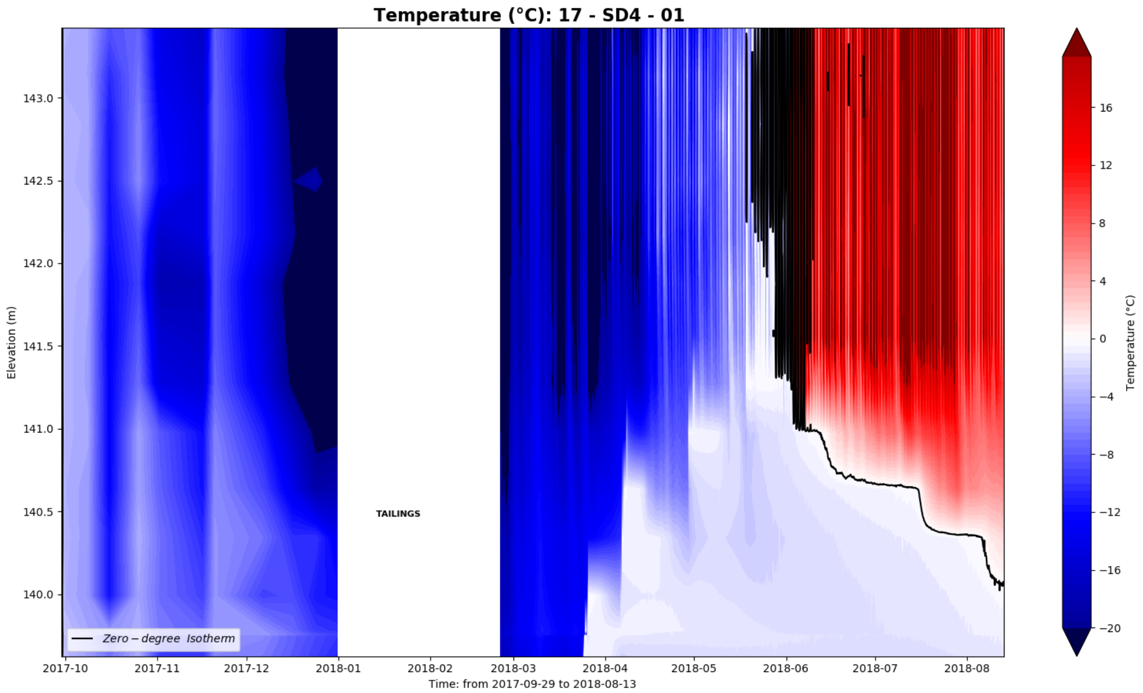


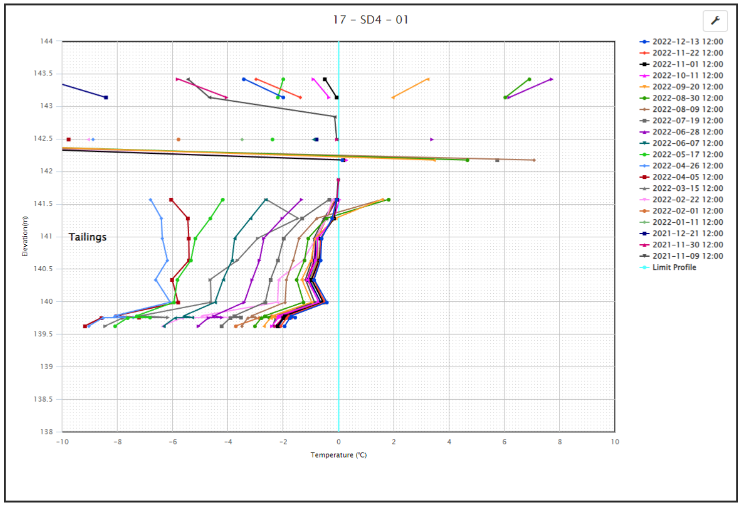


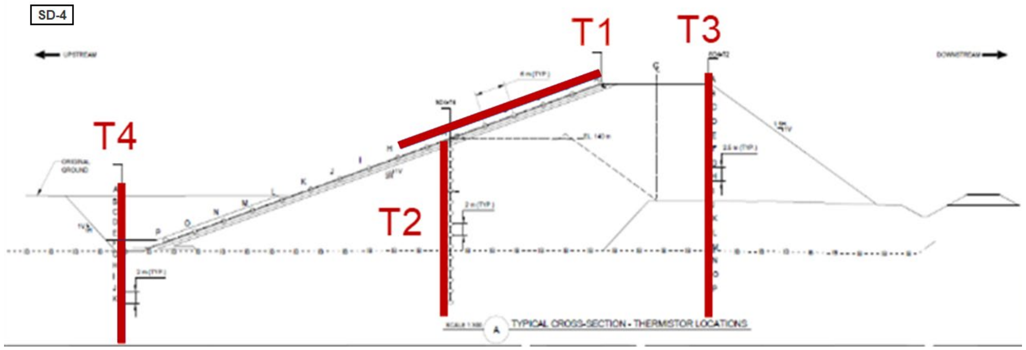
SD4-1

This instrument is along the liner.



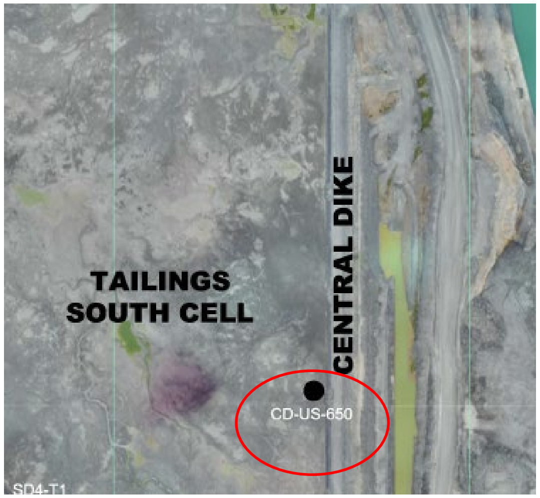


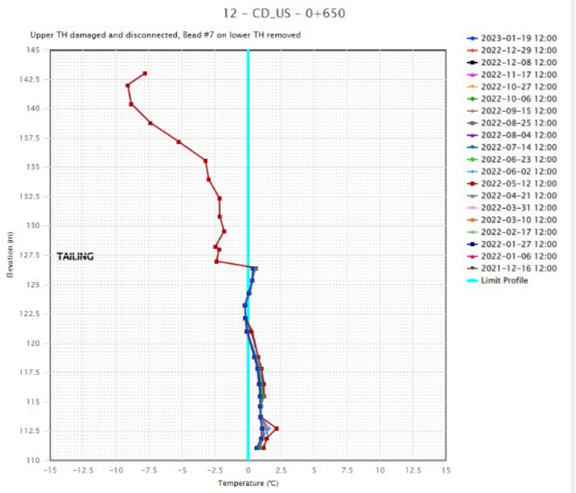


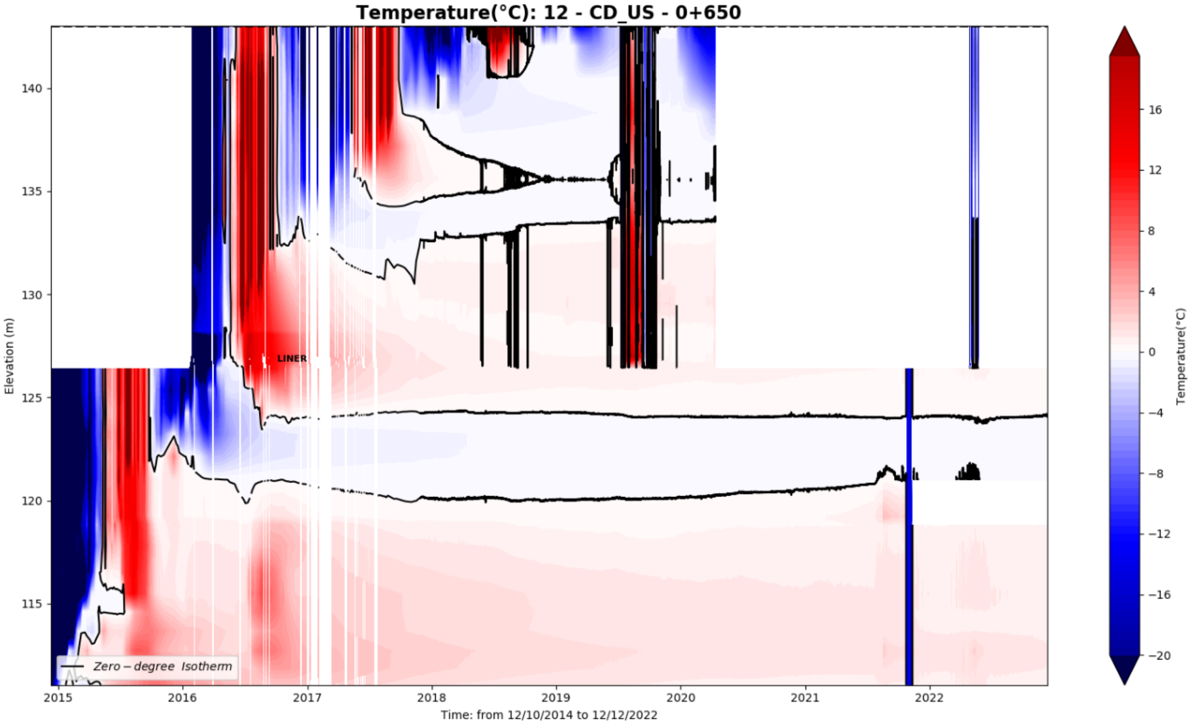


CD-US-0+650

This instrument is along the liner.

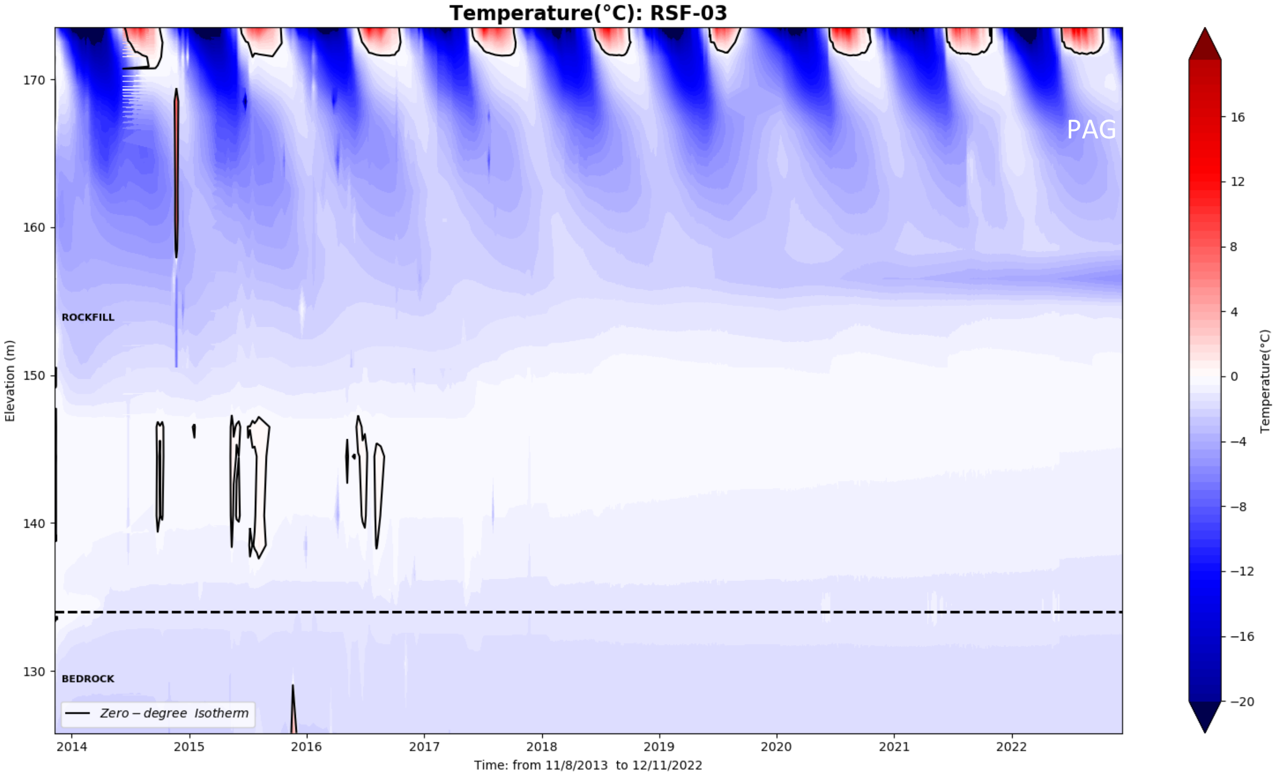






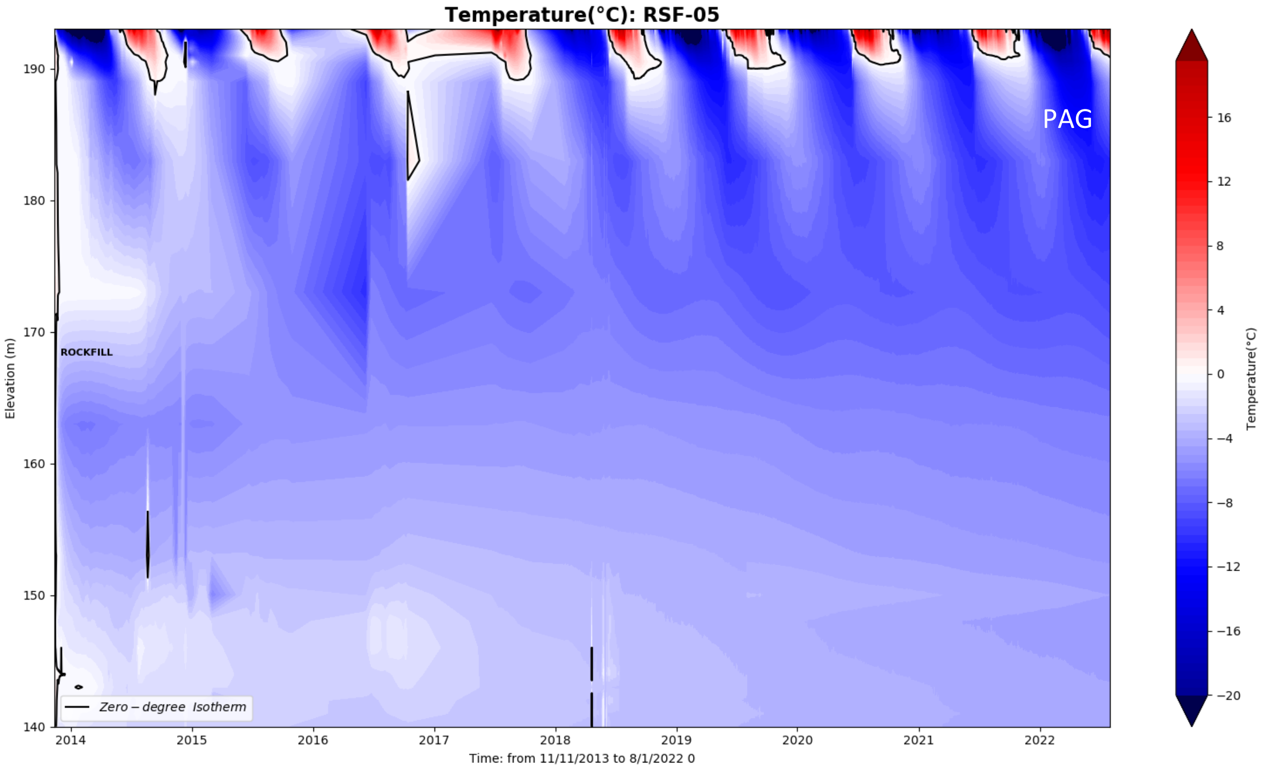
RSF-3


RSF-18
RF2
RSF-7
RSF-8
RSF-15
RSF-16
RSF-5
RSF-17
RSF-13
RSF-14
PORTAGE WASTE DUMP
RSF-9
RSF-10
RSF-3
RF1
NC-17-5
RSF-11
RSF-12
RSF-6

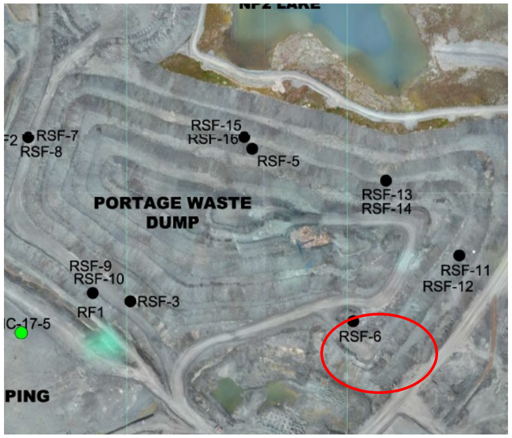

Temperature(°C): RSF-03
Elevation (m)
170
160
150
140
130
ROCKFILL
BEDROCK
PAG
Zero – degree Isotherm
2014
2015
2016
2017
2018
2019
2020
2021
2022
Time: from 11/8/2013 to 12/11/2022
Temperature(°C)
16
12
8
4
0
−4
−8
−12
−16
−20

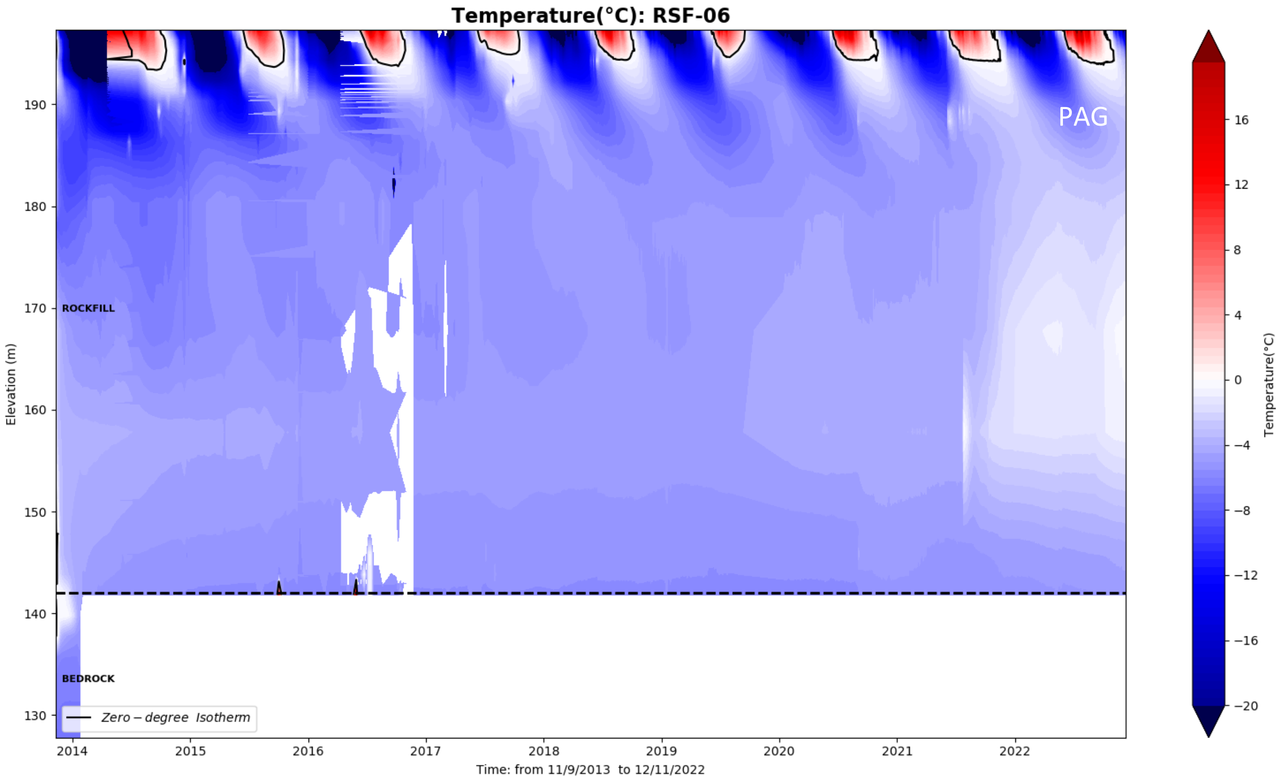
RSF-5

This instrument is broken and not sending data.



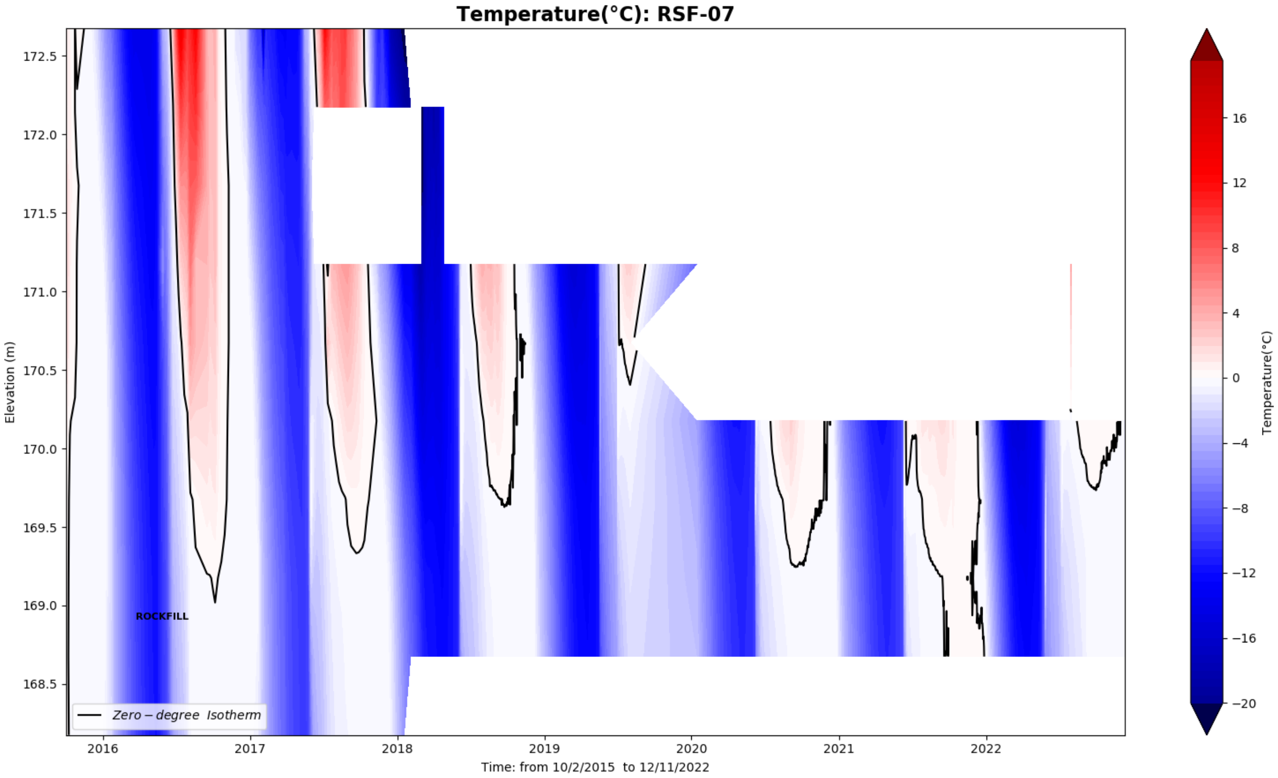
RSF-6


RSF-7
RSF-8
RSF-15
RSF-16
RSF-5
RSF-13
RSF-14
PORTAGE WASTE DUMP
RSF-9
RSF-10
RF1
RSF-3
RSF-11
RSF-12
RSF-6
PING


Temperature(°C): RSF-06
Elevation (m)
190
180
170
160
150
140
130
ROCKFILL
BEDROCK
PAG
Zero – degree Isotherm
2014
2015
2016
2017
2018
2019
2020
2021
2022
Time: from 11/9/2013 to 12/11/2022
Temperature(°C)
16
12
8
4
0
−4
−8
−12
−16
−20

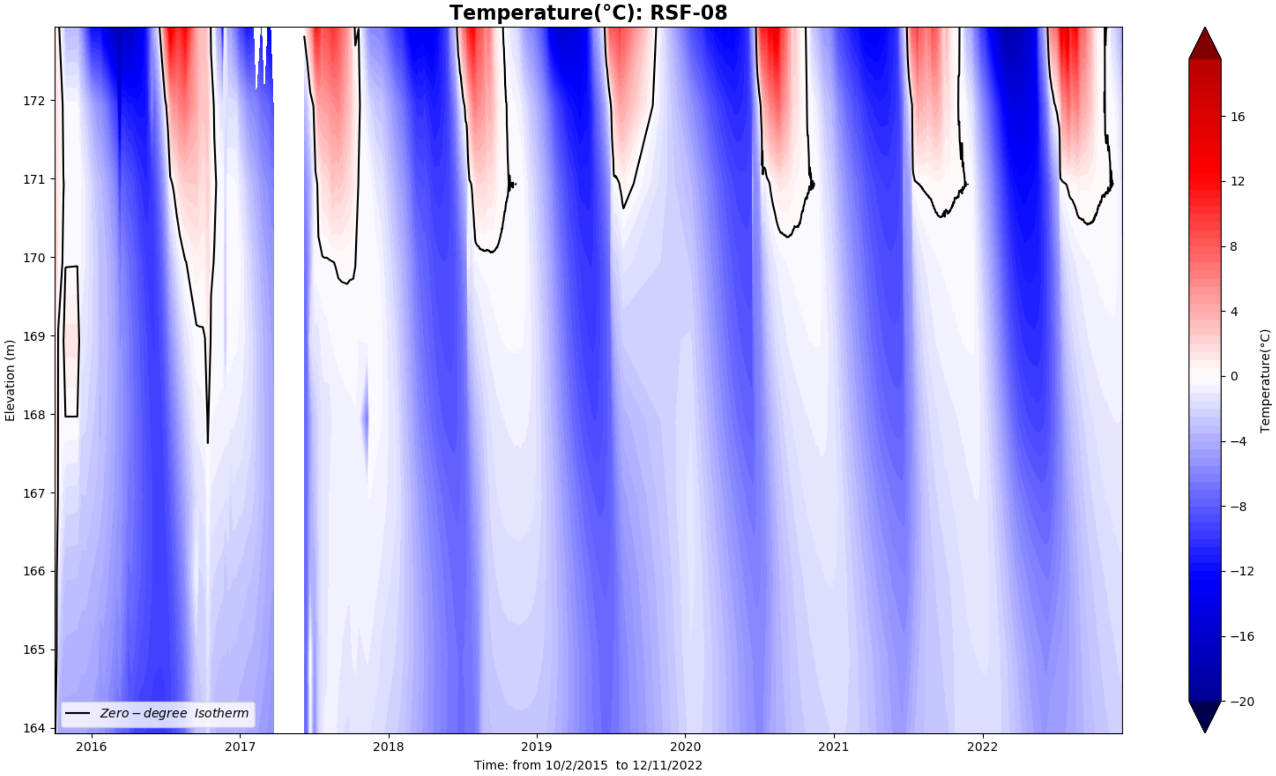
RSF-7

RSF-7 installed at a dip of -55°



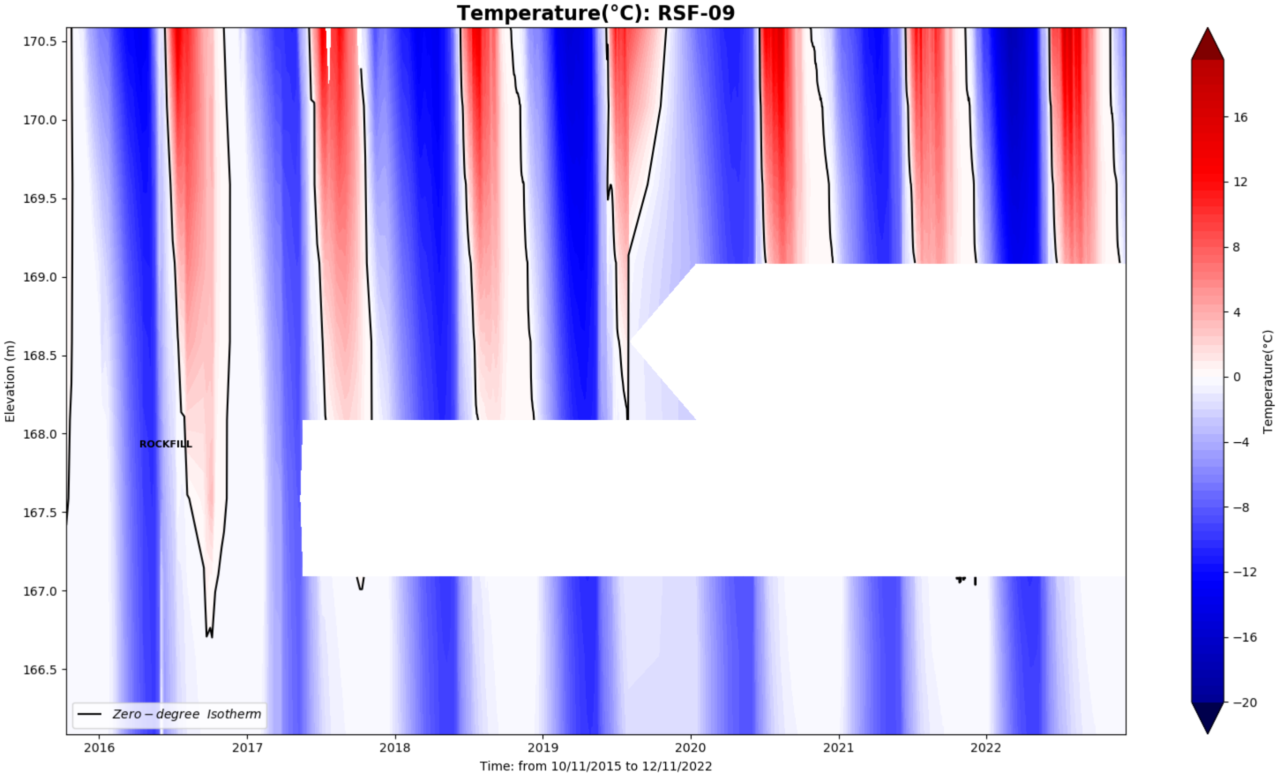
RSF-8

RSF-8 installed at a dip of -70°

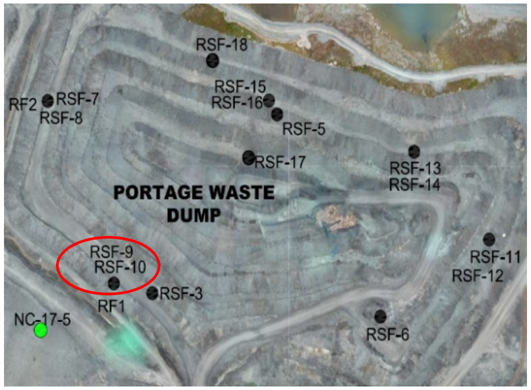


RSF-9

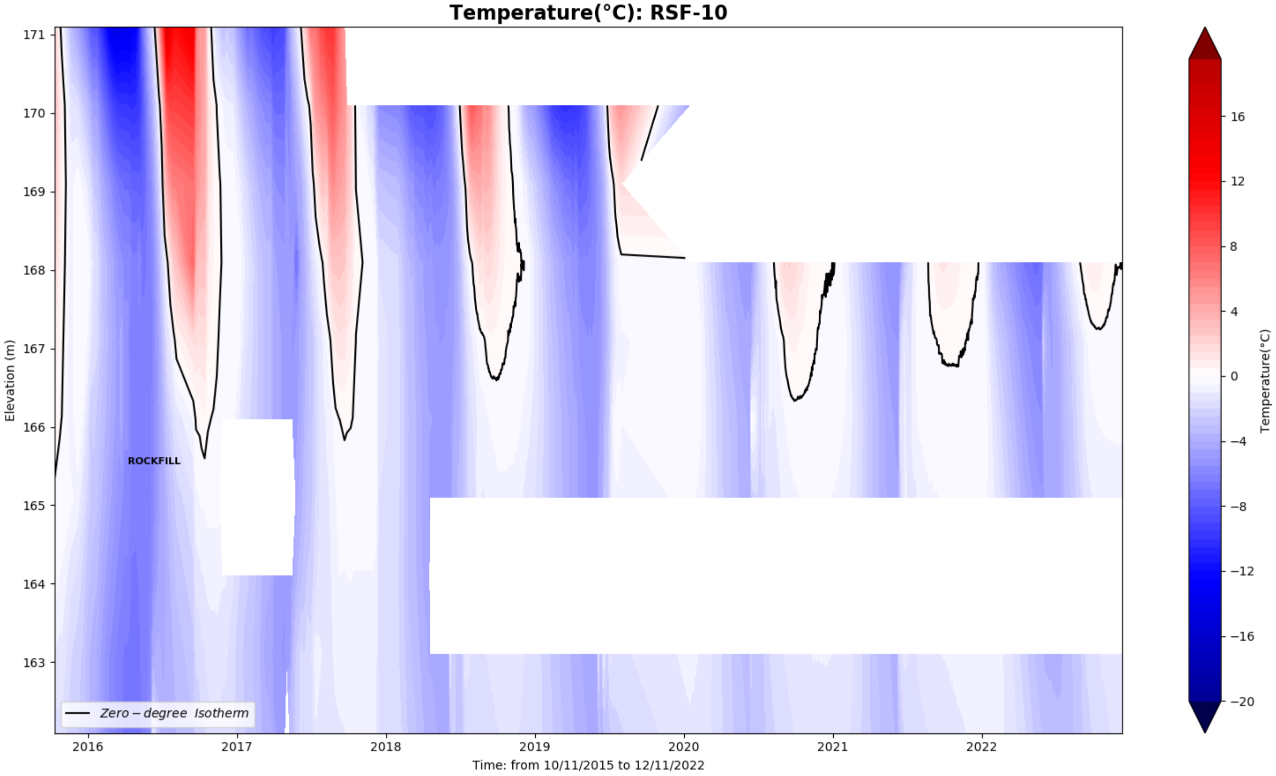
RSF-9 installed at a dip of -55°



RSF-10

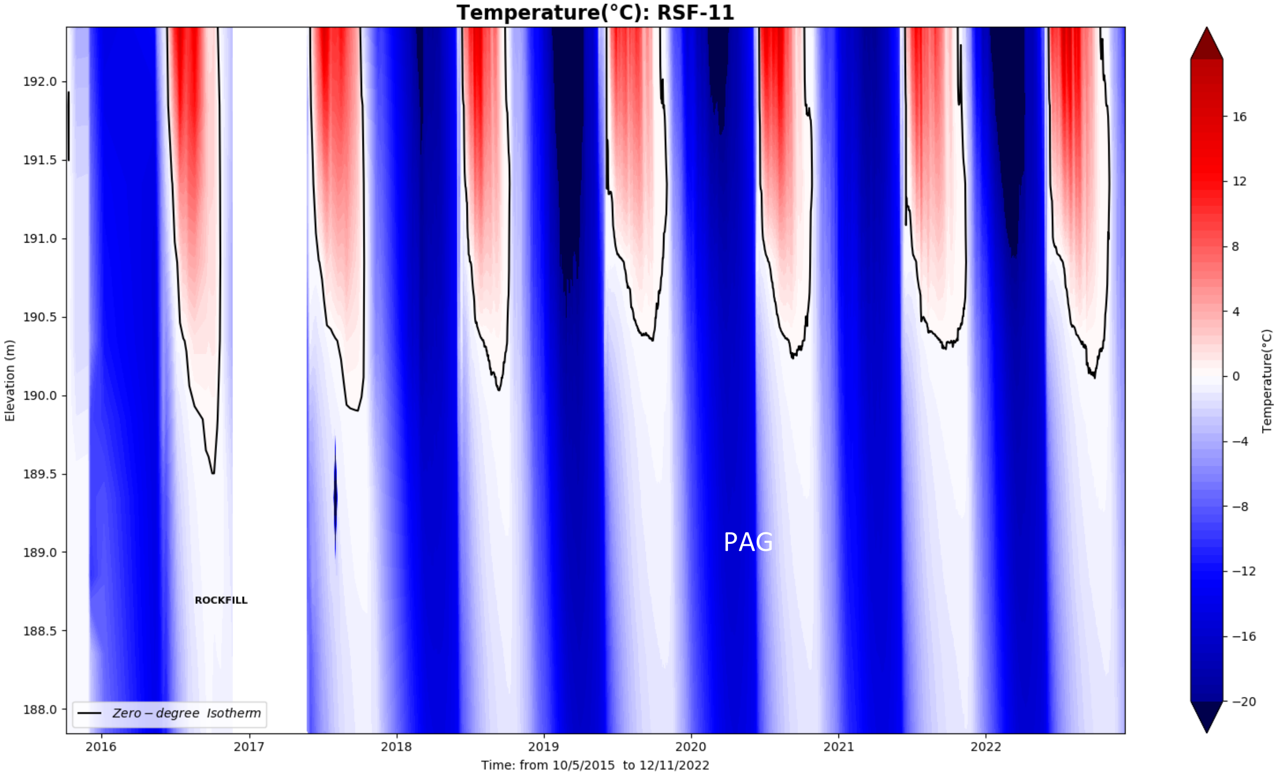


RSF-10 installed at a dip of -70°



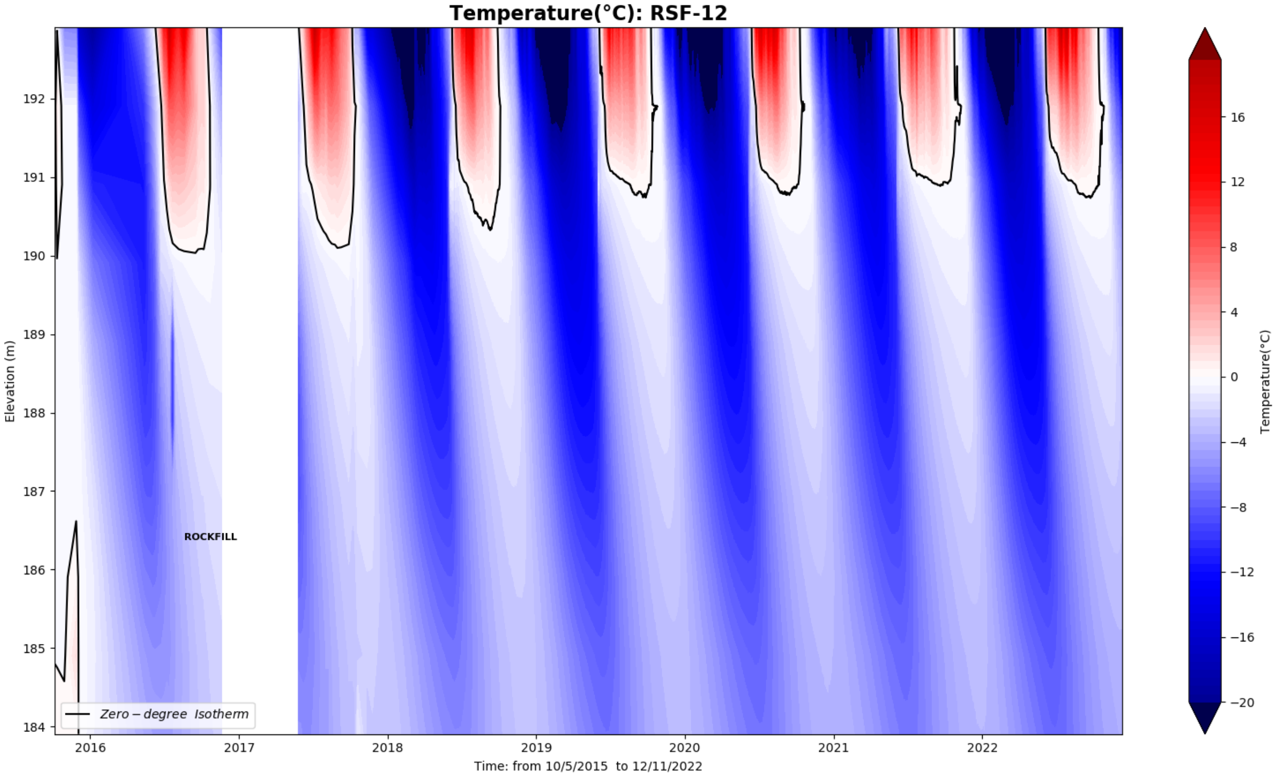
RSF-11

RSF-11 installed at a dip of -55°



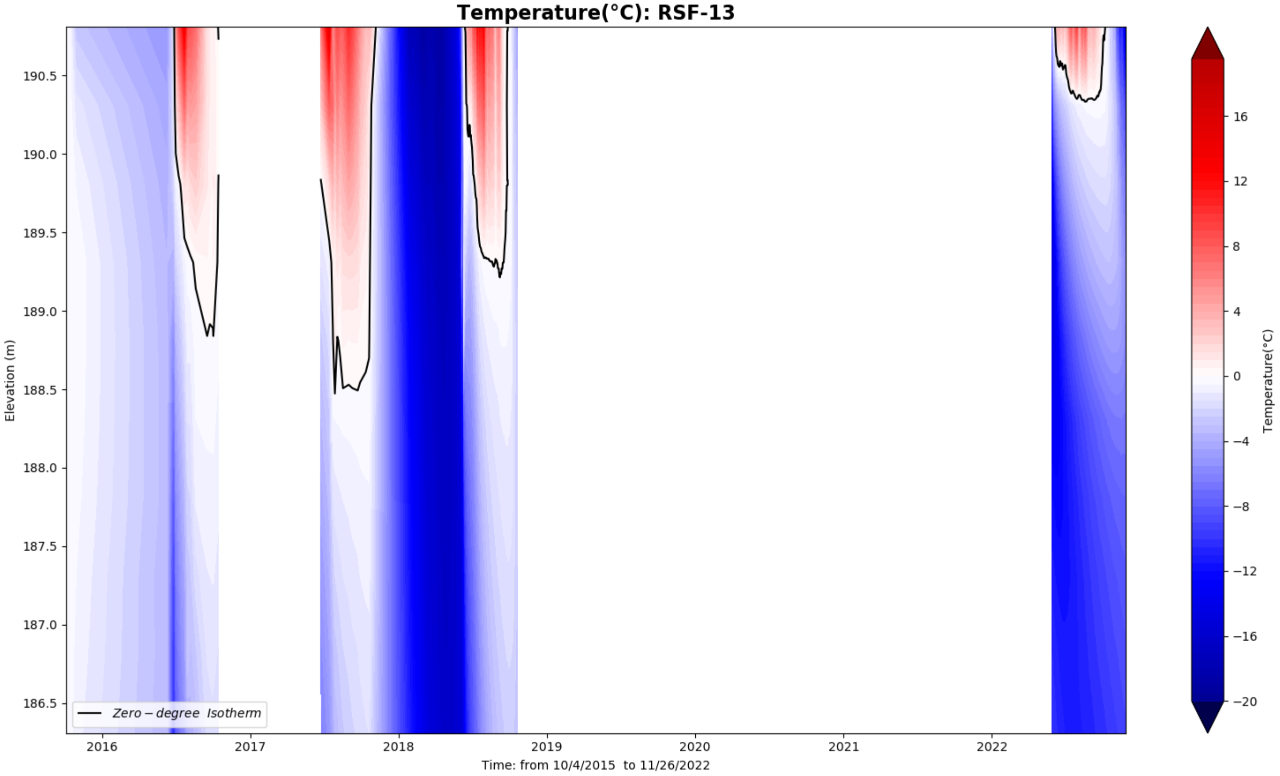
RSF-12

RSF-12 installed at a dip of -70°



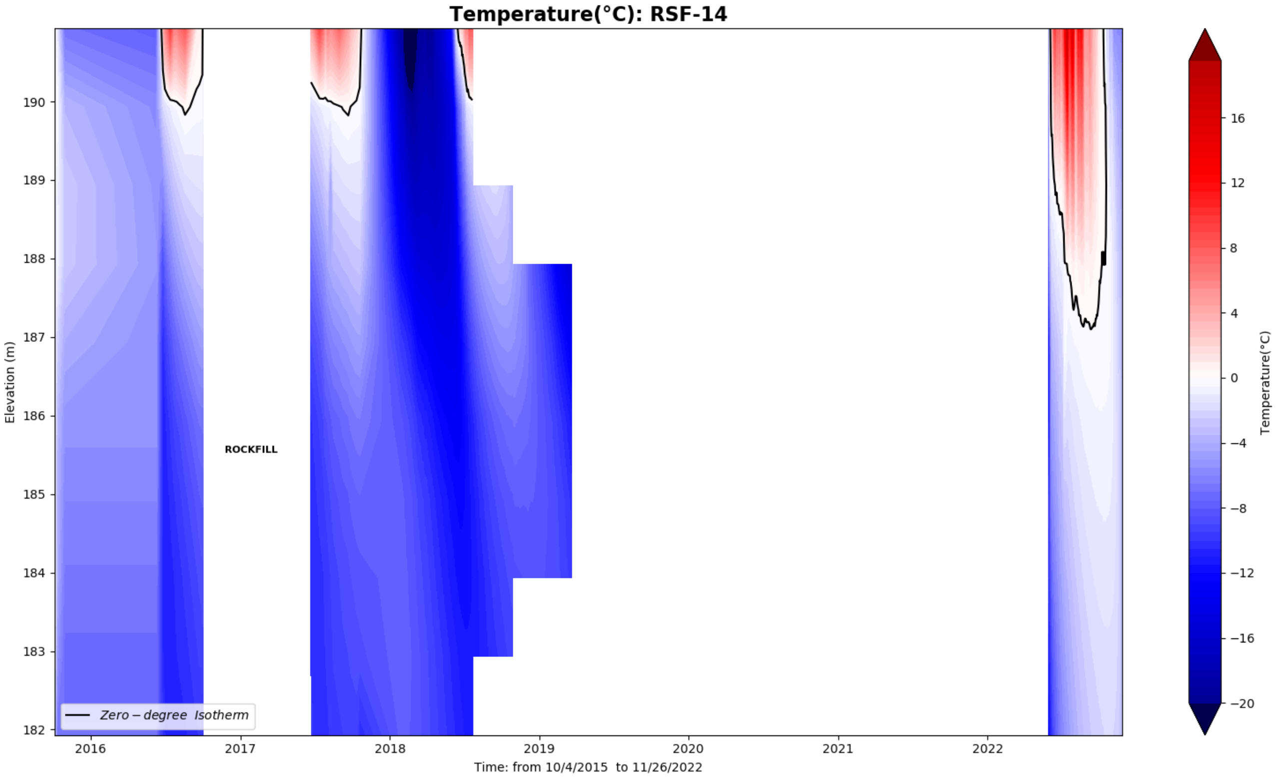
RSF-13


RSF-18
RF2
RSF-7
RSF-8
RSF-15
RSF-16
RSF-5
RSF-17
RSF-13
RSF-14
PORTAGE WASTE DUMP
RSF-9
RSF-10
RSF-11
RSF-12
RF1
RSF-3
NC-17-5
RSF-6

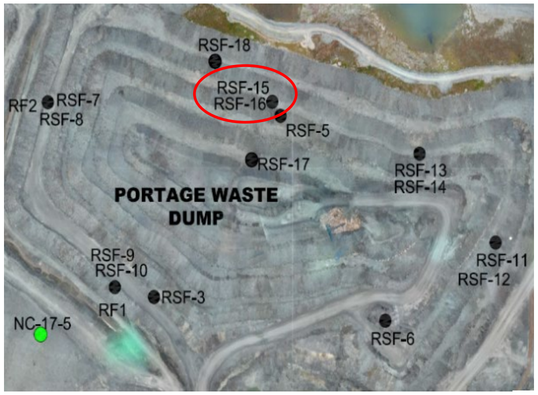

Temperature(°C): RSF-13
Elevation (m)
190.5
190.0
189.5
189.0
188.5
188.0
187.5
187.0
186.5
Zero – degree Isotherm
2016
2017
2018
2019
2020
2021
2022
Time: from 10/4/2015 to 11/26/2022
Temperature(°C)
16
12
8
4
0
−4
−8
−12
−16
−20

RSF-14

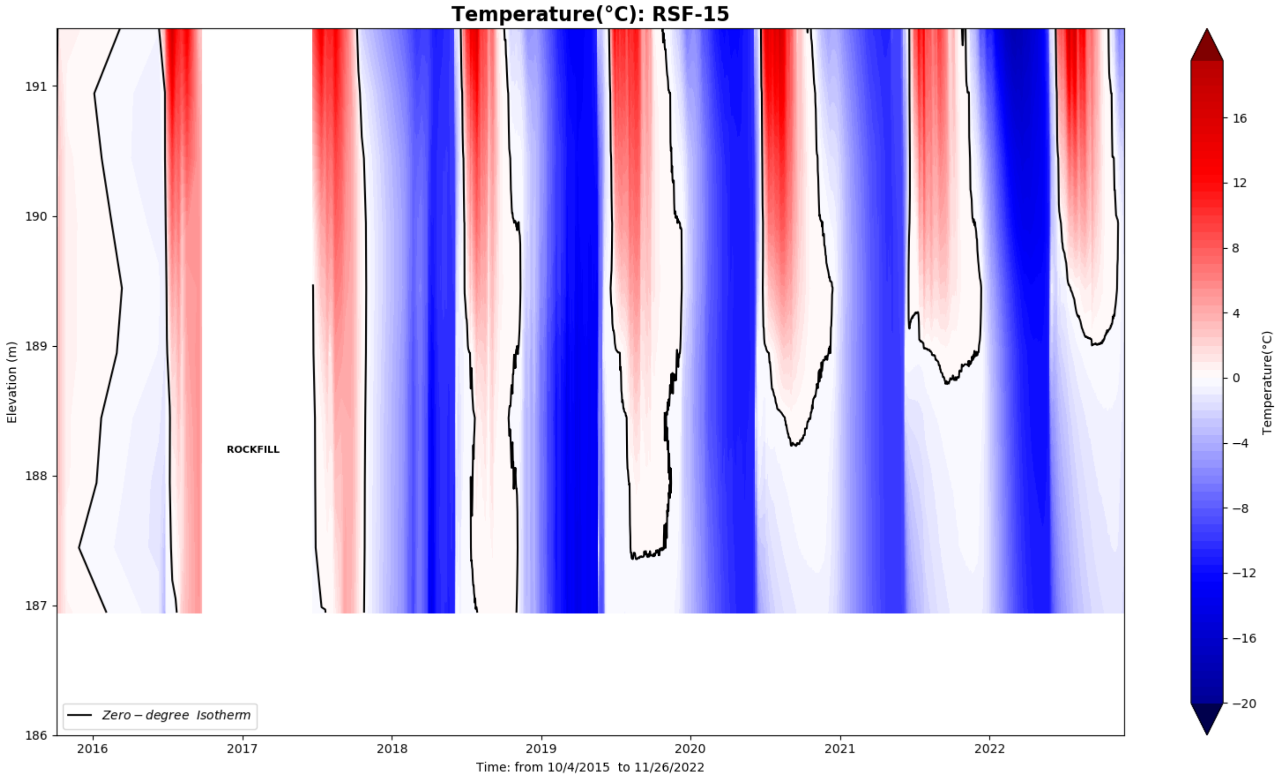

RSF-18
RSF-15
RSF-16
RF2
RSF-7
RSF-8
RSF-5
RSF-17
RSF-13
RSF-14
PORTAGE WASTE DUMP
RSF-9
RSF-10
RSF-3
RF1
RSF-11
RSF-12
NC-17-5
RSF-6


Temperature(°C): RSF-14
Elevation (m)
190
189
188
187
186
185
184
183
182
ROCKFILL
Zero – degree Isotherm
2016
2017
2018
2019
2020
2021
2022
Time: from 10/4/2015 to 11/26/2022
Temperature(°C)
16
12
8
4
0
−4
−8
−12
−16
−20

RSF-15

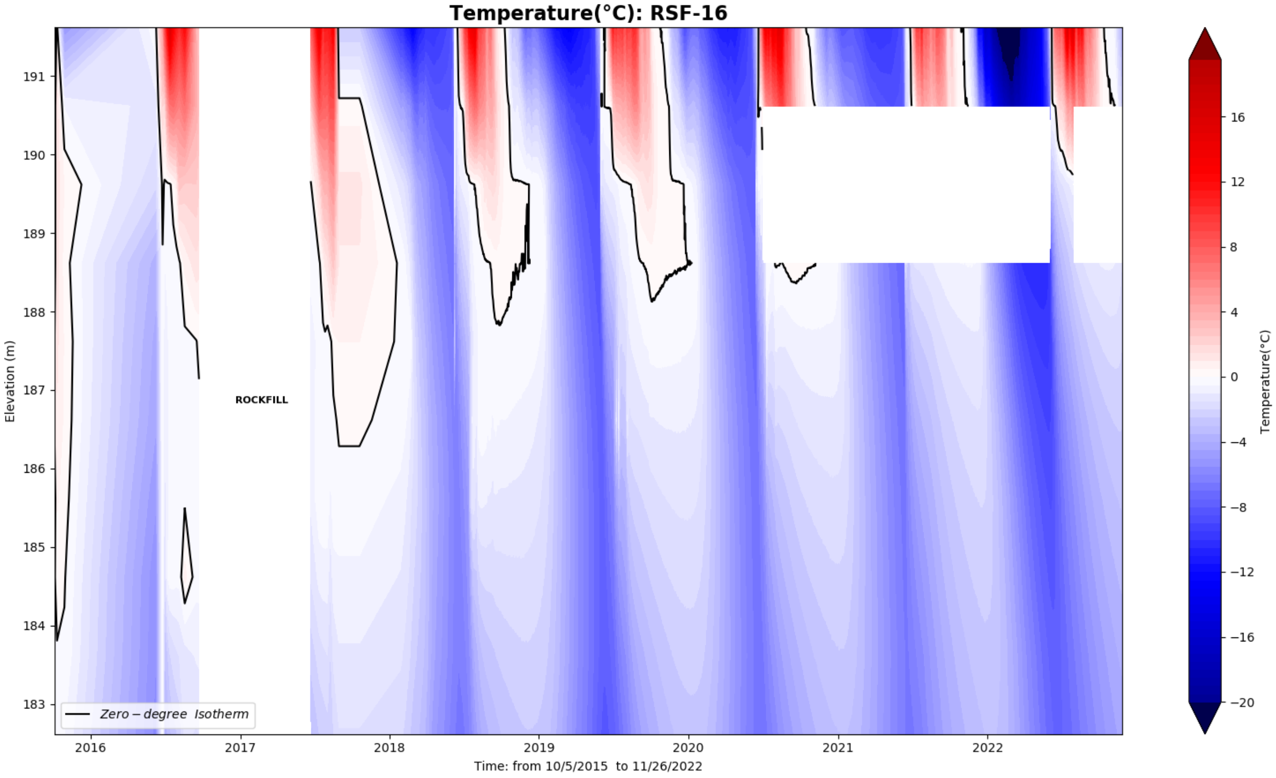


RSF-15 installed at a dip of -55°



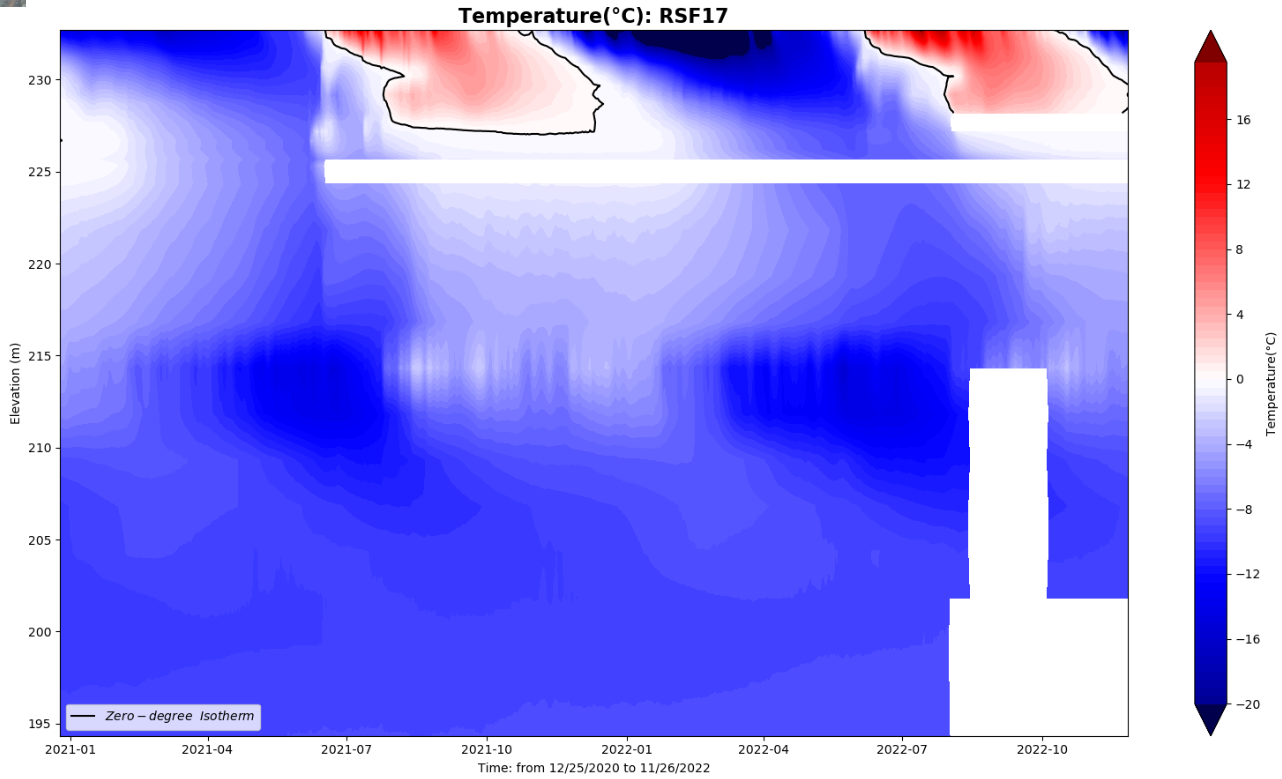
RSF-16

RSF-16 installed at a dip of -70°



RSF-17

RSF-17 installed at a dip of -90°



RSF-18

RSF-18 installed at a dip of -90°