StrataGold Corporation

# EAGLE GOLD PROJECT

## HEAP LEACH FACILITY FOUNDATION IMPROVEMENT PLAN

*2017-01*

JUNE 2017

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# 1 INTRODUCTION

## 1.1 OVERVIEW

StrataGold Corporation (SGC) is developing the proposed Eagle Gold Project (the Project), located in north-central Yukon, as shown in Figure 1.1-1. The Project is located 45 km north of Mayo, and 15 km northwest of Elsa in the Yukon Territory and is in an area of discontinuous permafrost where ground ice conditions are typically heterogeneous.

The mine will extract gold within a heap leach facility (HLF). The Eagle Gold Project Heap Leach Facility Design Report, referred to hereafter as HLF Design Report (BGC 2017a) incorporates a construction plan, which specifies the following for preparing the HLF foundation:

> *Several conditions could affect the performance of the HLF foundation; however, when properly identified the conditions can be mitigated. For occurrences of permafrost, over-excavation with suitable compacted fill replacement is specified. The grading plan for the HLF accounts for removal of known ice-rich materials within the footprint of the facility. However, during the course of construction, additional ice-rich material may be encountered and will be removed.*

This plan describes the methods for identifying, classifying and removing ice-rich material within the foundation of the HLF, and supplements the general methodologies, concepts and methods described in the Frozen Material Management Plan (FMMP) (SGC 2017). Further, this plan was developed in response to specific conditions, outlined in the Type A Water Use Licence QZ14-041 and the Quartz Mining License QML-0011, that require a detailed foundation improvement plan for the HLF to improve and clarify the methodologies for successfully identifying and removing ice-rich frozen ground within the footprint of the HLF during construction. Specifically, the licence conditions are as follows:

*QZ14-041*

*148. The Licensee shall develop and submit 30 days prior to Development Phase of the Project a foundation improvement plan for the HLF. The foundation improvement plan shall include:*

- *a. A specific definition of what constitutes Ice-Rich Soils within the HLF by consideration of moisture content, ice content and distribution, soil type and structure, and required performance of thawed soils within the limits of the HLF;*
- *b. A plan to locate and remove Ice-Rich Soils from the footprint of the heap facility; and*
- *c. The means, where required, of improving and confirming the improvement of the heap foundation soils to achieve accepted stiffness and liquefaction resistance.*

*149. Where the means of locating Ice-Rich Soils will result in disturbance of in-situ foundation soils a means of ensuring the disturbance is corrected or is not significant in terms of the performance of the foundation shall be identified.*

Further, the licence stipulates other conditions relevant to HLF foundation preparation:

*63. All Ice-Rich Soil shall be removed from the footprint of the HLF in accordance with the HLF foundation improvement plan (clause 148).*

*64. With the exception of the HLF embankment and the area of the Events Pond, all loose or unsuitable materials in the area of the HLF shall be removed as directed by a suitably qualified Professional Engineer.*

*65. At the location of the HLF embankment, all soils shall be excavated to Type 3 bedrock or better. Bedrock types are as defined on page 16 of Exhibit 1.3.9.*

*66. At the location of the Events Pond, loose surficial soils shall be removed to at least a depth of 3m.*

QZ14-041 defines "Ice-Rich Soil" as:

> *…in the context of Engineered Structures, seasonally frozen or perennially frozen overburden or weathered bedrock that contains sufficient frozen moisture that if thawed the soil or weathered bedrock material would be subject to adverse volumetric changes due to draining of excess pore water or low shear strength due to excess pore pressure generated by the insufficient drainage of the excess pore water. In this definition, what constitutes adverse volumetric changes or low shear strength is to be specifically determined based on the required performance of the materials within the Engineered Structure they are located.*

*QML-011 - Schedule C, Part 2:*

*1.6 (b) the Licensee shall provide a detailed foundation improvement plan for the heap leach facility, 30 days prior to construction, including:*

*i. removal of all ice rich material;*

*ii. With the exception of the HLF embankment and the Events Pond, removal of all loose or unsuitable materials as directed by a suitably qualified engineer.*

*iii. where the means of locating ice-rich soil results in disturbance of in-situ foundation soils, ensure disturbance is corrected or not significant in terms of foundation performance;*

*iv. excavation of foundation to Type 3 bedrock or better at the location of the HLF embankment;*

*v. installation of geotechnical equipment to monitor performance.*

QML-0011 does not provide a specific definition for what constitutes "ice rich material"; however, the primary concern for the material is clear in the definition of "ice-rich soil" provided in QZ14-041, thus the condition to remove all "ice rich material" in QML-0011 is interpreted to be identical to condition 63 from QZ14-041.

To ensure consistency with the regulatory approvals issued for the Project, Engineer, as used in this document, is defined as a Professional Engineer licensed under the Engineering Profession Act, R.S.Y. 2002, c.75 to practice in Yukon.

## 1.2 SCOPE

Foundation preparation for the HLF includes removing vegetation and loose or unsuitable materials including ice rich soils, and grading to prepare a suitable foundation for the construction of the HLF. Several conditions could affect the performance of the HLF foundation; and when properly identified the conditions can be mitigated. For occurrences of ice rich soils, over excavation with suitable fill replacement will be completed.

In the area of the HLF embankment, the foundation and abutment areas will be excavated to bedrock (Type 3 rock or better) to remove any poorly consolidated or ice rich material that could shift or settle upon loading the foundation with the embankment and crushed ore.

This foundation improvement plan accounts for the identification and removal of ice-rich materials and loose or unsuitable materials within the footprint of the HLF, followed by placement of compacted fill, where required to establish appropriate grade The removal of ice-rich material in the subgrade is required to enhance the stability of the HLF embankment and ore stack. This plan also describes the excavation of materials to Type 3 bedrock in the area of the HLF embankment.

Thus, the scope of this document includes the development of a field guide for identifying ice-rich frozen soils, loose or unsuitable materials, and Type 3 bedrock during construction to comply with licence conditions. This document provides the field methods for identifying these material types during construction and provides practical recommendations for removal measures, as well as potential techniques to thaw ice-rich soils, with the goal to improve the HLF foundation conditions.

1) Identify and remove topsoil and loose or unsuitable materials,
2) For the HLF embankment, excavate to Type 3 bedrock,
3) Identify and remove ice-rich soils, and
4) Final subgrade and foundation preparation.

Technical specifications and the Construction Quality Assurance Plan for the construction of the HLF are provided in the HLF Design Report and provide further details on the requirements and procedures necessary to complete the construction of earthworks, geosynthetics, and pipework for the HLF. Detailed description of the project, the heap leach facility and a summary of ground ice conditions can be found in BGC (2012, 2017b) and SGC (2017).

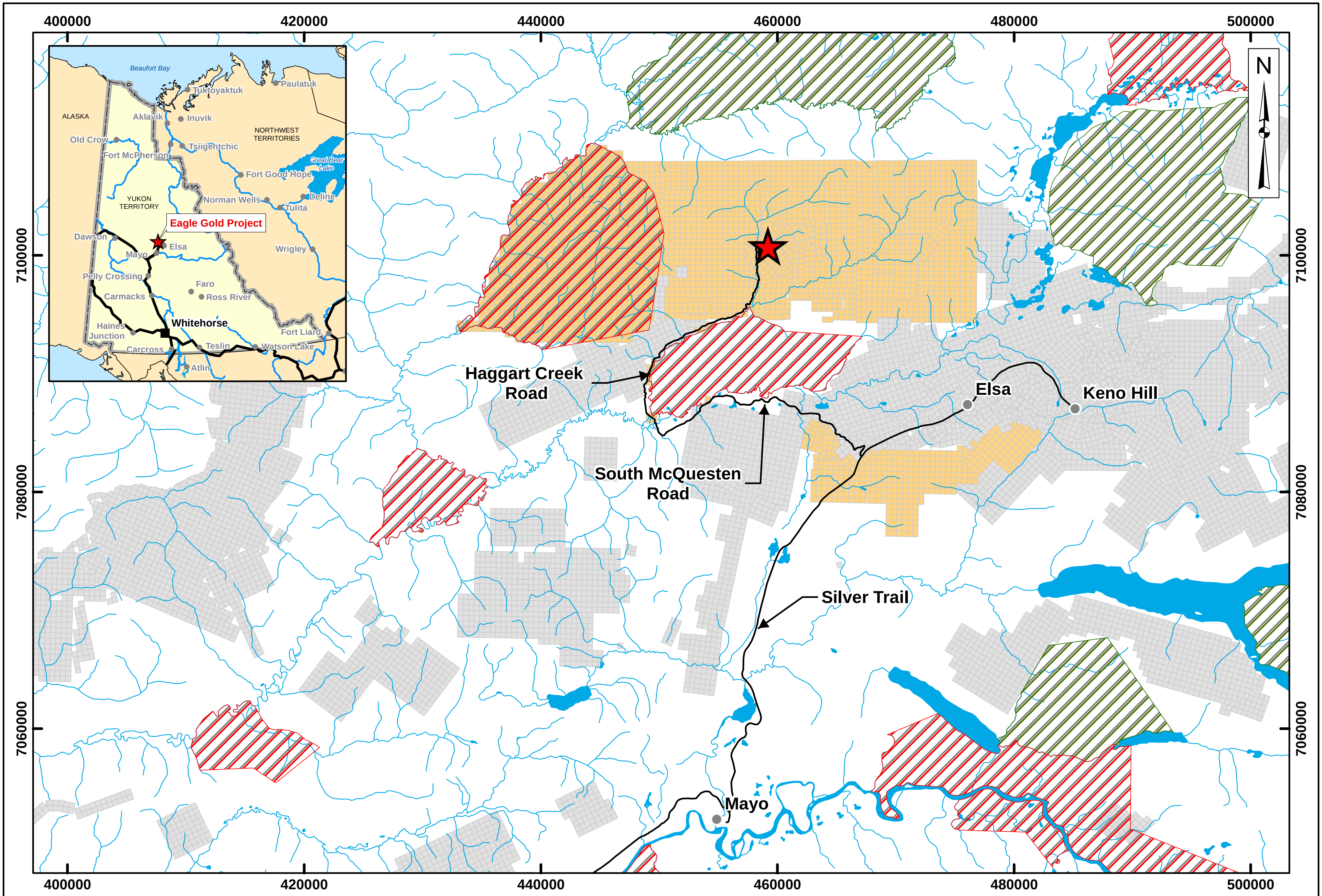
## 1.3 DEFINITIONS

Practical definitions for key terms are summarized in below. Additional and more expanded definitions can be found in Appendix A and SGC 2017.

**Table 1.3-1: Practical Definitions**

| Term | Definition / Description |
|---|---|
| Permafrost | Ground that remains at or below 0°C for at least two consecutive years. |
| Warm Permafrost | Permafrost at temperatures between -1°C and 0°C. |
| Frozen Ground | Soil or rock containing ice; this can be seasonal (winter frost) or permanent (permafrost). |

| Term | Definition / Description |
|---|---|
| Ice Rich Soils | Frozen Ground that contains excess ice, where the volumetric ice content is greater than 10%. |
| Active Layer | Layer on top of the permafrost that thaws in the summer and freezes in the winter. |
| Excess Ice | Volume of ice is larger than volume of soil's unfrozen pore space. |
| Loose or unsuitable materials | Ash, boulder or gravel zones, soft saturated zones, highly organic zones, drilling mud pits, or rock fragments greater than 150 mm in size |
| Type 3 bedrock | The first "rock-like" material underlying overburden materials, defined as highly or less weathered rock (i.e. W4 or better, that is highly weathered, but not completely weathered and part of the overburden), with intact strength greater than R0 (i.e. minimum UCS strength 1 MPa). It is expected that Type 3 rock can be excavated with normal excavating equipment |




Legend:

- Eagle Gold Project
- Town / Village
- Road
- Watercourse
- Category A Settlement Land
- Category B Settlement Land
- StrataGold Claims
- Other Claims

StrataGold Corporation

0 3 6 12 Kilometres

| Projection: | Drawn By: | EAGLE GOLD PROJECT YUKON TERRITORY |
|---|---|---|
| NAD 83 Zone 8N | HC | |
| Date: 2017/06/01 | Figure: 1.1-1 | General Site Location |

# 2 STEP 1 - IDENITFY AND REMOVE TOPSOIL AND LOOSE OR UNSUITABLE MATERIALS

The natural ground surface will be cleared, grubbed and stripped or all organic and unsuitable materials generally 3m outside of the limits of the HLF. Clearing and grubbing will include the removal of vegetation and roots and stripping includes the removal of topsoil, defined as soil of any gradation or degree of plasticity that contains significant quantities of visually identifiable organics (e.g., vegetable matter, sod, roots, or humus) as determined by the Engineer. The thickness of organics (in most cases equal to the depth of the topsoil) to be removed will vary across the site and will be determined by the Engineer based on the character and thickness of material encountered. Clearing, grubbing and stripping will generally be conducted as a single operation.

For preparation of the HLF foundation subgrade, all organic soils will be removed, exposing the underlying colluvium. It is assumed that additional removal of loose native colluvium and weathered bedrock may be required, as described in section 3, to provide a suitable subgrade for the placement of the liner and the ore in areas beyond the HLF embankment.

# 3 STEP 2 - EXCAVATION TO TYPE 3 BEDROCK

In the area of the HLF embankment, excavation to Type 3 bedrock (or better) will be completed. Bedrock at the Project site is subdivided into three broad categories - Type 1, Type 2 and Type 3. Type 3 bedrock consists of highly weathered metasedimentary rock that has a confined compressive strength of 1 to 5 MPa. Type 3 bedrock is the lowest quality rock mass that is considered to behave as rock (rather than as a soil) and can be recognized on the basis of evident preserved fabric of the parent rock within the highly weathered rock mass and requires moderate effort to excavate with heavy excavators. Identification of Type 3 bedrock will be identified by suitable qualified construction personnel under the supervision of the Engineer.

# 4 STEP 3 - IDENTIFY AND REMOVE ICE RICH SOILS

## 4.1 INTRODUCTION

As stated in the design report (BGC 2017a) and the FMMP, ice-rich soils in permafrost, when thawed and generating excess pore pressures, can result in soil instabilities and therefore, it is critical to identify and remove any ice-rich soils in the foundation of the HLF prior to liner construction and stacking. On the other hand, if the frozen ground does not contain excess ice (no ice-rich soils) and is thaw stable, there is negligible impact on the stability of the ground upon thaw.

The management strategies for frozen soils as per the FMMP are listed in Table 4.1-1. These strategies are provided for information purposes as the management strategies for the HLF, described herein, have been specifically refined (simplified) for the HLF.

**Table 4.1-1: Management Strategies for Frozen Soils**

| Material Classification Type | Frozen Material Type | Strategy | Management Description |
|---|---|---|---|
| I | Fine and/or coarse-grained colluvial/alluvial soils or weathered bedrock with little or no ice content | Used as fill or stockpiled for closure | Used as general fill or if excess to a local fill requirement stored for reclamation. |
| II | Coarse-grained sands and gravels with zones of variable ice content | Used as fill | Exposed and readily thawed and drained, and then used as general fill within embankments and platforms. |
| III | Fine-grained soils with relatively thin zones (lenses) of low proportions of “excess ice” | Stockpiled for closure | Separated and co-disposed with other nonfrozen soils within stockpiles to be used for reclamation. |
| IV | Fine-grained silty and clayey soils with relatively thick lenses of highly visible “excess ice” | To IROSA* | Segregated at excavation site based on prior field data/ information, and additional observations during excavations. Excavated and hauled to IROSA located in the Haggart Creek valley. |
| V | Small quantities of ice-rich soils (fine or coarse) | Locally stored | Disposed of adjacent to excavation sites where thawing and drainage can be managed locally rather than hauled to the IROSA. |

* IROSA: ice-rich overburden storage area

## 4.2 GROUND ICE IDENTIFICATION METHODS

The primary goal of the HLF foundation preparation work will be to identify whether ice-rich soils exist in the foundation subgrade, and then if it does, since all ice-rich soil shall be removed from the footprint of the HLF (as per Condition #63), further classify it into the appropriate frozen soil type so it can be removed from the HLF footprint and managed accordingly. The identification and management of ice-rich soils can involve up to four steps that would include, in order:

1) Visual observations
2) Test pit excavations, where no visible ice was identified
3) Shallow auger drilling where test pitting was not conclusive
4) Increased density of test pitting and/or drilling

### 4.2.1 Initial Visual Observations of Subgrade

After completing the first two steps, the ground will then be inspected for the presence of ice and classification of the material (following the system described in Table A-1), to determine if additional excavation may be necessary. The first observations in the field will be made using surficial grab-samples approximately every 25 m immediately upon excavation and exposure of the layer.

Because of the licence condition that all ice rich soil be removed from the HLF footprint, and cannot be used as fill in the footprint, the frozen material management classification for this plan is simplified. While ice rich soil is defined by CAN/BNQ (Standards Council of Canada) as soil with greater than 15% ice content, this plan conservatively uses 10%.

If ground ice is visible, and the soil is predominantly fine-grained with visible ice laterally continuous between observation points and the ice lensing is greater than 1mm, and/or the volumetric ice content is estimated to be more than 10%, the material is classified as Type IV. This material is considered to be ice rich soil and is excavated and hauled to the IROSA.

If ground ice is visible, the soil is fine or coarse grained with isolated pockets between observation points with ice lensing less than 1mm, and/or the volumetric ice content is estimated to be less than 10%, the material is classified as Type I/II/III. This material, for the purposes of the HLF foundation, is not considered ice rich soil and will only be excavated and hauled to the Reclamation Stockpiles if in the opinion of the Engineer it is necessary.

If ground ice is not visible and the soil is predominantly fine-grained, the temperature of the sample shall be taken and the sample manually warmed in the field. If the soil is <0 C and then excess water forms upon warming, the soil is classified as Type III. This material, for the purposes of the HLF foundation, is not considered ice rich soil and will only be excavated and hauled to the Reclamation Stockpiles if in the opinion of the Engineer it is necessary.

If ground ice is not visible, the soil is fine or coarse-grained and the sample shows little moisture or remains intact upon warming, it is Type II, and this material, for the purposes of the HLF foundation, is not considered ice rich soil and will remain in-situ and/or can be used as fill within the HLF footprint.

### 4.2.2 Subsequent Invasive Investigations

Since the required subgrade excavation depth may be thin, it is possible that the excavation required for foundation preparation does not reach to the permafrost table. Therefore, ice-rich or thaw unstable soil that is not visible on the exposed subgrade cannot be excluded, so additional investigations will be conducted to demonstrate the absence of ice rich soils at depth (i.e., to a depth of 6 m below the initial subgrade). With respect to outside the HLF embankment foundation area, test pits using a large excavator will be excavated to Type 3 bedrock or, if bedrock is not encountered, to a depth of at least 6 m below the initial excavated subgrade. Due to the heterogeneous nature of the ground, investigations at 100 m x 100 m spacing will be completed while foundation preparation is being carried out. Samples will be visibly inspected as described above and classified accordingly. Test pits should be properly backfilled and compacted using non-frost susceptible and ice-free fill material.

Shallow auger drilling, which will only be carried out at locations where test pit excavation is not successful (i.e., did not reach 6 m below the initial excavated subgrade). The locations and density of boreholes in an area will be determined in the field under the supervision of the Engineer, but in general, will be used to supplement and refine the test pitting findings. The ground ice inspection boreholes are expected to reach competent bedrock but also to be not deeper than 6 m.

All observations from site should be supervised by an engineering professional with experience in ground ice characterization.

Where adjacent test pitting and augering show conflicting results, additional test pitting and/or augering will be completed in the intervening zones to resolve any issues related to identifying lateral extent of ice-rich soil.

## 4.3 GROUND ICE REMOVAL TECHNIQUES

### 4.3.1 Excavation

Excavating ice-rich soils, in particular coarse colluvium, is challenging due to the high strength of the frozen material at temperatures below mainly -1°C, as the amount of unfrozen water in the ground becomes negligible.

The frozen ground can be broken using a ripper tooth attached to a large dozer or an excavator. Once broken, the pieces of ice rich soil can be loaded and hauled with excavator and haul trucks to the reclamation stockpile or hauled to the IROSA. As described above, the goal of excavating will be to excavate to Type 3 bedrock in the area of the embankment (as per Condition 65), and if ice-rich soil is present, excavate to below the extent of ice-rich soil.

As stripping and excavating of the active layer and the permafrost advances, ground thawing is initiated at the new surfaces. These newly thawed conditions can result in surficial soil sliding and slumping, and cause non-trafficable condition for heavy equipment, necessitating the use of rig mats, or additional fill.

To evaluate the foundation conditions and demonstrate the absence of ice-rich soil in the foundation area, the subgrade will be visually monitored, following stripping, under the supervision of the Engineer. The monitoring will focus on visually identifying signs of subsidence and water surfacing. If ice-rich soil is present under the excavated subgrade and it is exposed to warming during the summer, the ground would start to thaw, settle and water would be visible at the surface. Depending on the time of the year, this would be visible within days following the excavation. The presence of ice rich soil in shallow ground can also be noted if runoff shows a daily pattern. In the absence of snow melt, increase in runoff at the bottom of HLF construction areas towards the end of day can be related to the melting of ground ice.

### 4.3.2 Thawing

In addition to ripping ice rich soils, it is also possible to allow the exposed subgrade to thaw naturally during the summer. The thickness of the ground layer that thaws during a summer depends on the surface, ground and climate conditions. The vegetation forms the main insulating layer within the footprint of the HLF. By clearing the vegetation and stripping the active layer, ground ice containing permafrost is exposed to the atmosphere. Judging from the ground temperature data available (BGC 2012b) thaw depths between 2 m and 3 m can be expected for the area in one summer, where ice-rich soil is present. While natural thawing of ice-rich soils is generally not practical during preparation of the HLF subgrade due to time constraints, it may prove useful in some areas where the ice content is low (< 10%) and sporadically located (i.e. non ice rich soils), and the subgrade area can be exposed for the summer prior to development. The steps for natural thawing operations would include as follows:

- Strip vegetation and organic layer prior to summer;
- Expose frozen surface to atmosphere;
- Excavate any thawed ground at the end of the period or by end of summer.

Independent of the thawing method used, controlling surficial melt water runoff, sediment transport and potential soil instabilities that occur upon ground thawing will be necessary. This will be achieved by digging dewatering trenches or installing drainage pipes that provide a controlled drainage system as well as potential sediment transport. Running or standing water on permafrost subgrades will be avoided.

# 5 FINAL FOUNDATION PREPARATION

The first excavation pass will then be undertaken to the lines and grades as specified by the Engineer. During final grade preparation, there may still be areas left with pockets of loose or unsuitable materials. Under the direction of the Engineer, these loose or unsuitable materials will be removed. Unsuitable materials may include ash, boulder or gravel zones, soft saturated zones, highly organic zones or drilling mud pits.

The evaluation methods for loose or unsuitable materials will depend on the location and the materials that will be placed over the subgrade. The evaluation methods may include proof-rolling with a loaded dump truck or similar pneumatic-tired equipment to ensure that the surface is firm and smooth. Probing with a metal rod may also be performed.

Soft or yielding areas delineated by the evaluation methods described above that cannot be stabilized by compacting under the supervision of the Engineer will be removed and replaced with site grading fill. If deemed necessary by the Engineer, the treated areas will be re-evaluated by test pitting such that the cut face is clearly visible so that they can be examined and logged by the Engineer. After the re-evaluation has been completed, the test pit locations will be backfilled with the excavated material and compacted in layers to the surface to the satisfaction of the Engineer.

Once the foundation area has been managed to mitigate instances of loose or unsuitable materials or ice rich soils, and in the HLF embankment area confirmation that Type 3 bedrock is exposed, the Engineer will be notified and a final inspection will be undertaken to determine the appropriate method of treatment for the ground surface prior to the placement of the embankment and underdrain system. The methods of treatment that will be utilized may include trimming and shaping the surface, scarifying, moisture conditioning, or compacting of any area where fill material was placed.

# 6 REFERENCES

ASTM D4083-89. 2016. Standard Practice for Description of Frozen Soils (Visual-Manual Procedure).

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# APPENDIX A

## Definitions

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## DEFINITIONS

Key terms used in this document are defined below (see also SGC 2017). These definitions are needed, because those terms may be used differently in different documents as there is often not a clear definition available.

### Permafrost

Permafrost is defined as a layer of soil or rock, including ice or organic material, if present, at some depth beneath the surface, in which the temperature has been continuously below 0°C. It exists where summer heating fails to reach the base of the layer of frozen ground. According to Muller (1947), the temperature has to remain at or below freezing for at least 2 consecutive years. It is important to note that permafrost is solely defined via a temperature and a time condition and there is no requirement for the presence of ice. As such, and because of the freezing point depression that can exist in natural soils, permafrost does not automatically imply that the ground is frozen, i.e. containing ground ice (cf. Frozen Ground).

### Frozen Ground / Material

Frozen Ground, in contrast to permafrost, is soil or rock in which part or all of the pore water has turned into ice. It is related to the state of the pore water and not the temperature. It does further not relate to time. Typically, there is a differentiation between seasonal and permanently frozen ground. Seasonal frozen ground is frozen for no longer than a couple of months, typically only during the winter. In a permafrost environment, the moist soil in the active layer, the shallow ground that freezes in winter and thaws in summer, would be seasonally frozen ground whereas the frozen ground in the permafrost, is permanently frozen ground. Seasonally frozen ground is also present outside the permafrost zones.

### Ground Ice

Ground Ice is the general term referring to all types of ice contained in freezing and frozen ground. According to ASTM D4083-89(2016), frozen ground can be described using three main classes: i) ice; ii) visible ground ice; and iii) non-visible ground ice.

### Excess Ice

Excess ice is the volume of the ice in the ground which exceeds the total pore volume that the ground would have under natural unfrozen conditions.

### Ice-Rich Frozen Soil

Currently, there is no formal definition of Ice-Rich Frozen Soil or Ground that is commonly used for cold regions geotechnical design. CAN/BNQ (2017), for example, defines ice-rich frozen ground when the volumetric ice content is between 15 and 50%. Additional descriptors are as follows:

- Pure ice (100% volumetric ice content);
- Soil-poor ice (< 100% to >75% volumetric ice content);
- Soil-rich ice (> 50% to ≤75% volumetric ice content);
- Ice-rich soil (> 15% to ≤50% volumetric ice content);
- Ice-poor soil (≤ 15% volumetric ice content).

Eagle Gold Classification for Management of Frozen Material (or Ground)

Following Eagle Gold's Frozen Material Management Plan (SGC, 2017) five material types based on soil properties (grain sizes and their distribution), percentage of ice, and the lateral extent of ice-bearing soils (or frozen ground) are differentiated in the table below.

**Field Identification and Classification of Frozen Soils (Table 3.2-1 in SGC 2017).**

| Classification with respect to HLF Foundation Improvement Plan | Material Classification Type | Frozen Material Type Guidelines for Field Classification | | | | |
|---|---|---|---|---|---|---|
| | | Soil Properties | USCS Soil Types | Lateral Extent of Ice-bearing soils | % of Ice | Ice-Bearing Lense or Layer Thickness |
| Non ice rich soil | I | Fine and/or coarse-grained colluvial or alluvial soils, or weathered bedrock | GW, GP, GM, GC, SW, SP, SM, SC, ML, CL, MH and CH | Limited to isolated zones (<5-10% of exposure), not laterally continuous | Little (< 5%) or no ice content | Lenses less than 0.5 m thick and separated by > 1.0 m of non-ice-bearing material |
| | II | Coarse-grained sands and gravels (> 50% retained on No. 200 (0.075 mm) sieve) | GW, GP, GM, GC, SW, SP, SM and SC | Limited to isolated zones (< 20% of exposure), not laterally continuous | zones of variable ice content - up to 10% excess ice | Relatively thin lenses < 0.5 m thick |
| | III | Fine-grained soils (> 50% silts and clays) | ML, CL, MH and CH | Limited to isolated zones (<5-10% of exposure), not laterally continuous | low proportions (<5-10%) of "excess ice" | relatively thin (< 0.5 to 1.0 m thick) zones (lenses) |
| Ice rich soils | IV | Fine-grained soils (> 50% fines) | ML, CL, MH and CH | Laterally continuous throughout exposure; multiple lenses | Readily visible (>10%) "excess ice" | with relatively thick (> 1 m) lenses |
| | V | Small quantities of ice-rich soils (fine or coarse) | GW, GP, GM, GC, SW, SP, SM, SC, ML, CL, MH and CH | Overall volume is less than 10% of potential fill area | Variable ice content - up to 20% excess ice | Relatively thin zones (lenses) < 1.0 m thick |