Technical Memorandum

DATE 8 June 2020 **Project No.** 19136158

TO Karyn Lewis
Lupin Mines Inc.

CC

FROM Ken Bocking **EMAIL kbocking@golder.com**

WATER LICENCE CONDITION PART E-25 - DESIGN FOR THE WASTE ROCK "DOME" AT LUPIN MINE

1.0 INTRODUCTION

Lupin Mine's Type "A" water licence No. 2AM-LUP2032 received ministerial approved on April 9, 2020. Condition 25 in Part E of the Licence requires that:

> *The licencee shall, within sixty (60) days following the approval of the licence, submit to the Board for review, a Technical Memorandum that provides design details on the Waste Rock Dome, including, but not limited to the following:*
>
> *a. Cardinal direction cross sections and slopes;*
> *b. Details on drainage systems and conceptual water features; and*
> c. *Erosion control measures and cover stabilization of the dome.*

This Technical Memorandum provides a response to Condition 25.

2.0 WASTE ROCK DOME DESIGN

2.1 Design Objective

The objective of the Waste Rock Dome is to reduce loadings from seepage from the waste rock to the surface water receivers around the mine site. This will be done by limiting the contact between the waste rock and surface runoff (as opposed to limiting oxygen flux into the waste rock) by:

1) consolidating the waste rock to reduce its overall surface area; and

2) constructing a cover over the waste rock that sheds non-contact water and reduces infiltration into the waste rock.

As discussed in the Final Closure and Reclamation Plan (Golder, 2018),

> *"…waste rock will be removed from some areas (generally around the perimeter of the mine mill area). The waste rock will be excavated, transported and then some of the excavated waste rock will be disposed of into the shafts, open crown pillars or the landfill. The remainder of the excavated waste rock*

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> *will be relocated into the central area and used to grade the surface of the waste rock that is being left in place. …. The surface of the waste rock will be contoured to drain freely and then it will be capped with 1.0 m cover of esker material."*

Under equilibrium conditions, the volume of seepage that emerges from the edges of the waste rock will be equal to the volume of water that infiltrates into the top surface. Under the current conditions with relatively flat uncovered waste rock across the mine/mill site, the current infiltration is estimated to be about 70% of the annual average precipitation. Golder (2019a) provided an evaluation of the thermal and seepage performance of the planned esker cover over the Waste Rock Dome. It was estimated that, for current climate conditions, the cover system would reduce the infiltration into waste rock to about 16% of the annual average precipitation. It was also estimated that the infiltration would increase to about 25% of average annual precipitation if climate warming of 4.95 °C was to occur. On a unit area basis, this is estimated to be about 23% or 36% respectively of the infiltration that currently occurs.

A Human Health and Environmental Risk Assessment (HHERA) (Golder, 2019c) concluded that

> *"… the measures outlined in the FCRP are sufficiently protective of human health and the environment with respect to soil and groundwater; however additional measures should be considered with respect to ARD impacted seepage from the proposed esker-covered waste rock dome and potential reductions in pH in Boot Lake and East Lake. Water quality monitoring is recommended to assess the current conditions, provide data to evaluate the conservatism of the water quality model and to confirm the conclusion of negligible/low risks to aquatic life from metals."*

2.2 Design Drawings

The design of the proposed Waste Rock Dome is shown on the attached Drawings 1 and 2. Drawing 1 shows the proposed footprint of the Waste Rock Dome, together with the locations of the runoff management features. Drawing 2 provides cross-sections through the Waste Rock Dome as well as typical details of features to manage runoff and control erosion.

The topography shown on Drawing 1 is taken from mapping that was completed by Stantec Consulting between August 23 and 25, 2019. The existing Machine Shop will be used to support the ongoing closure work; it will not be demolished until after the closure construction is completed. To enable this, the Machine Shop was left outside of the footprint of the Waste Rock Dome. The design surface shown provides capacity for about 269,000 m^3 of imported waste rock. If less capacity is required, a lower top surface elevation will be used while maintaining the grades and drainage pattern shown.

For clarity, the vertical scale on the cross-sections on Drawing 2 has been exaggerated 5 times relative to the horizontal scale. The dashed line represents the current ground surface, estimated following the removal of the existing buildings. The cross-section shows the placement of imported waste rock (relocated from areas outside of the dome) over the top of existing waste rock in the mine/mill area pad.

The top surface of the dome, with its 1.0 m thick esker cover, will be graded at a minimum cross-slope of about 1.6% to enhance the shedding of clean runoff. To match the dome into the topography, the perimeter of the dome will be sloped at 10H:1V. The 1.6% top slope is designed to be gentle enough to avoid erosion of the esker cover material. To prevent erosion on the 10H:1V sideslopes, runoff will be directed down erosion protected chute

structures. Low perimeter berms will be constructed on the edge of the top surface to direct the runoff into the chutes.

The design footprint area of the Waste Rock Dome is estimated at about 16 hectares. Two additional “islands” of covered waste rock will exist at the expanded landfill (about 4 hectares) and at the plugged adit (about 1 hectare). The total area of covered waste rock of about 21 hectares is 30% less than the 30 hectare dome area that was assumed in the water quality model (Golder, 2019b) as input for the HHERA, so the actual volume of leachate produced should be proportionately less.

3.0 CLOSURE

We trust that this technical memorandum meets your present requirements. If you have any questions, please do not hesitate to contact the undersigned.

GOLDER ASSOCIATES LTD.

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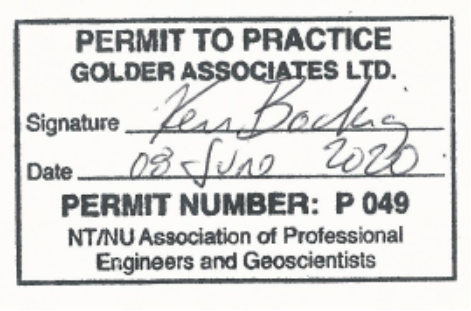
Dionne Filiatrault, PEng (Nu/NT)
Project Manager

KAB/DF/md

Attachments: Drawing 1: Proposed Waste Rock Dome Plan
Drawing 2: Proposed Waste Rock Dome Sections and Details

https://golderassociates.sharepoint.com/sites/107254/project files/6 deliverables/condition e 25-tm-dome design/19136158-rev0-condition e 25-tm-dome design_08 june 2020.docx



REFERENCES:

Golder Associates Ltd. (2018), Lupin Mine Site, Final Closure and Reclamation Plan, July 2018, (Document 180727 2AM-LUP 1520 5_0 Final_Closure _Reclamation _Plan Ver.0)

Golder Associates Ltd. (2019a), Coupled Thermal-Seepage Modelling for Performance Evaluation of the Esker Cover for the Waste Rock “Dome” at Lupin Mine, Technical Memorandum, October 15, 2019.

Golder Associates Ltd. (2019b), Closure Geochemical Source Term and Seepage Water Quality Model for Performance Evaluation of the Esker Cover for the Waste Rock “Dome” at Lupin Mine, Technical Memorandum, October 15, 2019.

Golder Associates Ltd. (2019c), Human Health and Ecological Risk Assessment, Lupin Mine, Nunavut, Report, October 2019.

ATTACHMENTS

Drawing 1: Proposed Waste Rock Dome Plan

Drawing 2: Proposed Waste Rock Sections and Details

PLAN
SCALE 1:1,500 m

LEGEND

- EXISTING GROUND SURFACE CONTOUR (1 m INTERVAL)
- PROPOSED WASTE ROCK COVER CONTOUR (2 m INTERVAL)
- PERIMETER BERM
- DRAINAGE CHUTE
- STILLING BASIN

NOTE(S)

1. THE SUBGRADE UNDER THE DOME AREA IS TO BE PREPARED IN ACCORDANCE WITH THE WATER LICENCE AND WITH THE FINAL CLOSURE AND RECLAMATION PLAN (FCRP) BEFORE IMPORTED WASTE ROCK OR COVER MATERIALS ARE PLACED.
2. THE FOLLOWING MATERIALS SHALL BE REMOVED FROM THE EXISTING SUBGRADE BEFORE IMPORTED WASTE ROCK IS PLACED: DEMOLITION WASTE, PETROLEUM HYDROCARBON CONTAMINATED SOILS, ARSENIC "HOT SPOTS", SOIL OR ROCK MATERIALS IMPACTED WITH CYANIDE OR LEAD NITRATE AND ANY HAZARDOUS WASTE.
3. FLOOR SLABS LEFT IN PLACE IN THE SUBGRADE SHALL BE PUNCTURED WITH A HOE RAM BEFORE WASTE ROCK AND/OR COVER MATERIALS ARE PLACED ON TOP.
4. THE CROWN PILLAR OPENINGS AND MINE SHAFTS ARE TO BE FILLED BEFORE WASTE ROCK IS PLACED ON TOP.
5. NO IMPORTED WASTE ROCK SHALL BE PLACED ON THE PREPARED SUBGRADE UNTIL THE SUBGRADE PREPARATION HAS BEEN APPROVED BY THE ENGINEER.
6. IMPORTED WASTE ROCK OR ESKER COVER MATERIALS SHALL NOT BE PLACED ON TOP OF SNOW OR ICE.
7. THE DESIGN SURFACE SHOWN PROVIDES CAPACITY FOR ABOUT 269,000 m^3 OF IMPORTED WASTE ROCK. IF LESS CAPACITY IS REQUIRED, A LOWER TOP SURFACE ELEVATION SHALL BE USED WHILE MAINTAINING THE GRADES AND DRAINAGE PATTERN SHOWN.
8. TOPOGRAPHY BEYOND THE TOE OF WASTE ROCK DOME IS EXISTING TOPOGRAPHY BEFORE RELOCATION OF WASTE ROCK.
9. EXISTING MACHINE SHOP TO BE LEFT IN PLACE TO SUPPORT CLOSURE CONSTRUCTION.

REFERENCE(S)

1. EXISTING GROUND SURFACE TOPOGRAPHY FROM STANTEC, SURVEYED AUGUST 23 TO 25, 2019.
2. COORDINATES ARE IN METRES TO UTM NAD83, NRCS ZONE 12N.
3. FOR PLAN VIEW OF EXPANDED LANDFILL REFER TO DRAWING 19136158-0001-1.

0 50 100
1:1,500 METRES

NOT FOR CONSTRUCTION

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
A	2020-06-08	ISSUED FOR REVIEW	DB	MR	KAB	KAB

SEAL

CLIENT
LUPIN MINES INCORPORATED

CONSULTANT
GOLDER

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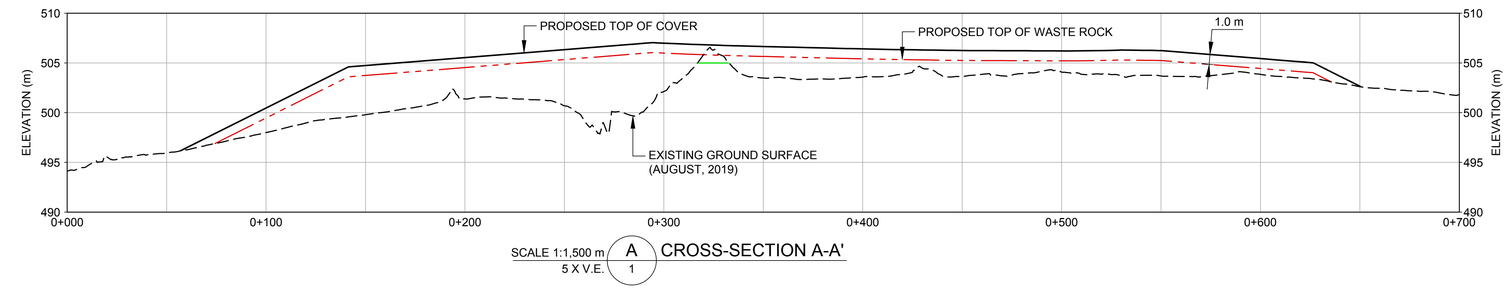
PROJECT
WASTE ROCK DOME DESIGN
LUPIN MINE CLOSURE
NUNAVUT, CANADA

TITLE
PROPOSED WASTE ROCK DOME

PROJECT NO.	CONTROL	REV.		DRAWING
19136158	0002	A	1 of 2	1

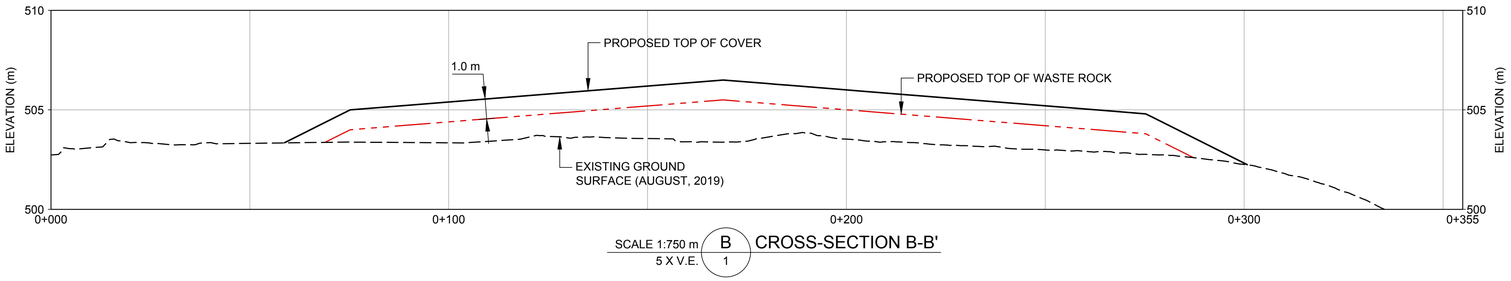
IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

0 25 mm



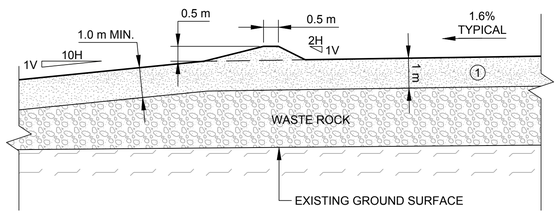
SCALE 1:1,500 m
5 X V.E.

A-1 CROSS-SECTION A-A'

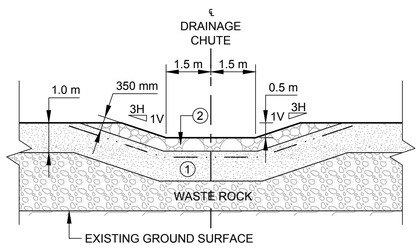


SCALE 1:750 m
5 X V.E.

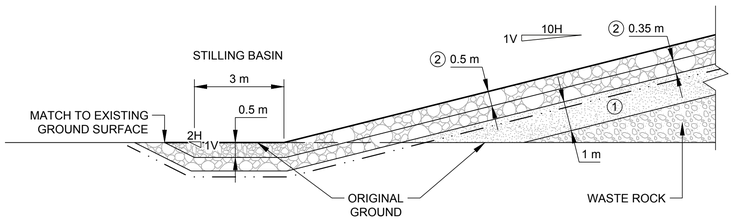
B-1 CROSS-SECTION B-B'



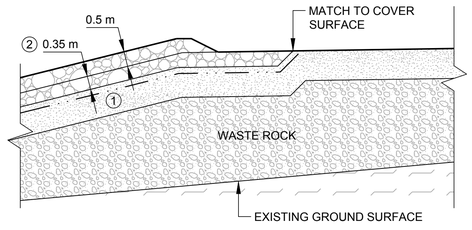
TYPICAL DETAIL OF PERIMETER BERM
N.T.S.



DRAINAGE CHUTE TYPICAL CROSS-SECTION
N.T.S.



DRAINAGE CHUTE TYPICAL PROFILE
N.T.S.



LEGEND

- PROPOSED TOP OF COVER IN SECTION
- PROPOSED TOP OF WASTE ROCK IN SECTION
- PROPOSED BASE REGRADE
- EXISTING GROUND SURFACE (AUGUST, 2019)

MATERIAL ZONATION

- 1 — ESKER SAND AND GRAVEL
- 2 — 10 kg EROSION PROTECTION
- NON-WOVEN GEOTEXTILE

NOTE(S)

1. REFER TO DRAWING 1 FOR LOCATIONS OF CROSS-SECTIONS, PERIMETER BERMS, DRAINAGE CHUTES AND STILLING BASINS.
2. GEOTEXTILE TO BE NON-WOVEN NEEDLE-PUNCHED MINIMUM 350 g/m^2.
3. 10 kg EROSION PROTECTION TO HAVE D_{50} OF 190 mm MINIMUM AND MAXIMUM SIZE 350 mm.

REFERENCE(S)

1. EXISTING GROUND TOPOGRAPHY FROM STANTEC, SURVEYED AUGUST 23 TO 25, 2019.

0 20 40
1:500 METRES

0 25 50
1:750 METRES

NOT FOR CONSTRUCTION

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LUPIN MINE CLOSURE
NUNAVUT, CANADA

TITLE
PROPOSED WASTE ROCK DOME SECTIONS AND DETAILS

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