2018 Lupin Mine Tailings Area Inspection Report

Annual Geotechnical Inspection of the Tailings Containment Area

November 16, 2018

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Sign-off Sheet

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1.0 INTRODUCTION

Lupin Mines Incorporated (LMI) retained Stantec Consulting (Stantec) to complete the annual geotechnical dam inspection at the Lupin Mine tailings containment area (TCA). The Lupin Mine site is currently under care and maintenance status and operates under the Nunavut Water License 2AM-LUP1520 (NWB 2015) for LMI. LMI is a wholly-owned indirect subsidiary of Mandalay Resources.

The Lupin Mine is located on the northwest shore of Contwoyto Lake, approximately 400km northeast of Yellowknife, Northwest Territories (Figure 1). The site consists of a mill, camp and support facilities, fuel storage, airstrip, and the TCA (Figure 2). A detailed view of the mill site is provided in Figure 3 and of the TCA in Figure 4.

The water license explicitly requires an annual geotechnical inspection to be completed for the TCA perimeter dams, TCA reclamation covers, including a quantitative assessment of any seepage from the TCA (NWB 2015). Stantec has provided a qualified person to conduct the geotechnical inspection to fulfill the requirements listed in Part E, Item 6 of the water license, which stipulates the following:

“The tailings containment area shall be constructed, operated and maintained to engineering standards such that:

- A minimum freeboard of 1.0 metre shall be maintained at all times or as recommended by a geotechnical engineer and as approved by the Board in writing;
- Seepage from the Tailings Containment Area is minimized;
- Any seepage that occurs is collected and returned immediately to the Tailings Containment Area;
- Erosion of constructed facilities is addressed immediately;
- The solids fraction of the mill tailings shall be permanently contained within the Tailings Containment Area or underground as backfill.
- Implement measures to ensure that the Tailings Containment Area is adequately covered or managed, including the use of approved binding agents, so as to prevent windblown tailings from impacting other areas of the project site;
- During care and maintenance, inspection shall be carried out on a bi-weekly basis during the freshet (approx. May and June), and monthly during the reminder of the open water period (approx. July – October) of the following:
  - Collection and return of seepage in Dam 2;
  - Water levels in ponds 1 and 2, and cells 3 and 5;
  - General surface erosion and anomalies on dams; and,
  - Tension crack in Dam M. If water level in the ponds rise, then inspection shall be carried out bi-weekly during the open water season (approx. May – October);
  - Records of these inspection shall be kept for review upon the request of an Inspector, or as otherwise approved by the Board. More frequent inspections shall be performed at the requested of an Inspector.
  - More frequent inspections shall be performed at the requests of an Inspector;
  - An inspection of the Tailings Containment Area shall be carried out annually during ice free, open water condition by a geotechnical Engineer. The Engineer’s report shall be submitted to the Board within sixty (60) days following the inspection and shall include a cover letter from the Licensee outlining an implementation plan to respond to the Engineer’s recommendations.”

This report summarizes Stantec's observations of the TCA's condition in 2018 and presents our recommendations. Previous annual inspections, safety reviews, and risk assessments with respect to the TCA made available to Stantec include:

- Inspection Report from 2017 by Norwest Corporation;
- Inspection Report from 2016 by Norwest Corporation;
- Inspection Report from 2012-2015 by SRK Consulting;
- 2015 Dam Safety Review Report by SRK Consulting; and,
- 2012 TCA Risk Assessment and Water Quality Review by SRK Consulting.

While the annual inspection is carried out to satisfy the license requirements, the format and methodology used are in accordance to the best engineering practice using the Inspection and Maintenance of Dams Safety Guidelines issued by the Province of British Columbia, Water Management Branch (BCWMB 2011) and the Mining Association of Canada (MAC) Guidelines.

1.1 PROJECT DESCRIPTION

1.1.1 Location and Access

The Lupin Mine is only assessible by air or winter road. The air access is serviced by a gravel runway, capable of handling large aircraft such as Hercules C-130 and Boeing 737 jets. Charter flights are typically deployed from Yellowknife for worker rotation and re-supply during the open water seasons. When the mine was in operation, it used the Tibbitt to Contwoyto Winter Road to resupply the mine. This winter road currently ends at the Ekati Diamond Mine and has not been extended to the Lupin Mine since 2005, when the mine went into care and maintenance status.

1.1.2 History and Current Status

Currently the Lupin Mine is in care and maintenance status and licensed accordingly. Mining operations ceased in 2005. Current care and maintenance operations include, but are not limited to, earthwork maintenance, water treatment and discharge as needed, water quality monitoring, and waste management as needed.

1.1.3 Site Infrastructure

The mine site consists of the following main structures: mill site, camp and support facilities, fuel storage, airstrip, and tailings containment area (TCA).

- The mill site included an underground hoist and wheelhouse, ball mill, concentrator, and a paste backfill plant (now decommissioned).
- The camp and support facilities included multiple wings of accommodations for workers, an office building, recreation facilities, cool and warm storage, generators, sewage lagoons and dams, and waste management facilities. Gravel roads are in place to connect the facilities.
- Fuel storage includes the main tank farm that contains diesel fuel for annual operation, along with fuel for aircraft. Fuel is pumped to a satellite tank farm as needed for equipment fueling and power generation to minimize the risk of spillage and accidents from using the large fuel tanks at the main farm.
- The airstrip is a gravel runway that can accommodate aircraft up to the size of a Boeing 737 jet.

- The TCA consists of a number of frozen core dams that provide a closed system for tailings and water treatment. Tailings are contained in a number of cells and progressive reclamation is ongoing and has now been completed at several cells. Water treatment is carried out using Pond 1 as a holding pond for effluent, treating the water in a plant, and then using Pond 2 as a polishing pond to allow the solids to precipitate prior to discharge to the environment. Details of the TCA configuration are described in Section 2 of this report.

1.2 CLIMATE

Stantec evaluated the climate data from an automated weather station known as Lupin (CWIJ) available in the Weather Underground database (WU 2016). Intermittent climate data is also available from the Environment Canada database under station Lupin CS Climate ID 230N002. The climate data evaluation was done from May 2005 to April 2017. The climate data evaluation was not updated in 2018 as the data was not made publicly available. The evaluation results indicate the station reported an annual mean temperature of -13°C. The average winter temperature, from October to April, was around -21°C. The average summer temperature, from May to September, was around 8°C. Annual total precipitation was averaged to be around 592mm, where the data does not differentiate between snow and rain. The mean wind direction was south-southeast, with average wind speed of 16km/h and high of 50km/h.

1.3 SITE GEOLOGICAL CONDITIONS

The Lupin Mine is located in the Archean metaturbidite sequence of the Contwoyto Formation. The rocks have been subjected to both regional and contact metamorphism, including deformations and intrusions.

The area was glaciated, and experienced isostatic rebound after the melt. The glaciers and runoff from the melt washed out the erodible soils and formed lakes in low lying areas. The easily erodible glaciolacustrine and glacio-fluvial sands were reworked and displaced by the meltwater and resulted in the outcrops present with thin soil veneers, abandoned beaches and esker formations (Kinross 2005). Where bedrock is not present at the surface, the overburden typically consists of coarse grained glacial till which is intermittently covered by glaciolacustrine and glacial-fluvial deposits. The till is a silty sand with gravel and boulders, with low plasticity and ice depending on the depth.

1.4 PERMAFROST AND DAM GEOTECHNICAL CONDITIONS

The site is within a continuous permafrost region. The active layer is observed to be variable between the depth of 1m to 3m based on available data. During operation, scheduled monitoring was completed of all instrumentation, recording water levels, water quality and production volumes. This monitoring program was reduced accordingly during the care and maintenance period and is now carried out when work is being done on site. Thermistors are installed in several dams and in the tailings cover to monitor their performance. Some of the thermistors are no longer functional or damaged beyond repair. The remaining thermistors are read at least once annually during the geotechnical inspection and more often when site access allows. The thermistor readings indicate that permafrost remains within the dams and reclaimed tailings, and the readings are consistent with historical variation and limits.

2.0 TAILINGS CONTAINMENT AREA DAMS

The tailings produced are primarily comprised of amphibole and quartz, which account for 80% of the volume. Pyrrhotite and arsenopyrite make up an additional 17%. The tailings have been shown through various studies to have a potential for acid generation (Kinross 2005). All of the tailings are contained within the TCA.

The Lupin Mine TCA consists of eight (8) perimeter dams and nine (9) internal dams. The perimeter dams are Dam 1A, 1B, 1C, and Dams 2 through 6. The internal dams are Dam 3a through 3e, Dams J through N, and the Divider Dykes. Combinations of the perimeter dams and internal dams form Tailings Cell 1 through 5 for containment. As the progressive reclamation is being completed, some of the internal dams (3a, 3b, 3c, 3e) are incorporated into the cover and are no longer considered as individual dams. Currently, Cells 1 and 2 are completely reclaimed, while Cell 3 is approximately 80% covered and Cell 5 is approximately 70% covered. About 84% of the entire tailings area is reclaimed with at least 1m of sand/gravel cover. No new tailings have been produced since 2005 when the site went into care and maintenance status.

All dams are constructed from esker sands and gravels, with the perimeter dams incorporating a geosynthetic liner for seepage control. All the perimeter dams are designed as frozen core dams founded on permafrost. Generally, the perimeter dams ranged in height from 1 to 8 metres. The internal dam heights range from 6 to 12 metres.

The care and maintenance procedures for water management, direct runoff and seepage from Cell 3 into Cell 4. The water in Cell 4 then flows through the Divider Dykes either though the control structure or seepage into Pond 1. Cell 5 runoff is pumped directly into Pond 1. The pond 1 water level is managed by siphoning water into Pond 2. Water treatment is carried out by treating the water in-situ in Pond 2, by adding lime to raise the pH. Precipitates from this treatment are deposited in Pond 2. The treated water in Pond 2 is siphoned into the environment in accordance with the Water License requirements (NWB 2015). Pond 2 does not have any flood overflow structures, such as a spillway or a control gate, to manage the water level. All water is retained, and discharge is restricted until water quality meets the discharge requirement outlined in the Water License (NWB 2015).

2.1 DAM CONSEQUENCE CLASSIFICATIONS

Stantec utilized the Canadian Dam Association Guidelines (CDA 2014) to classify the consequence classification of each dam. The CDA consequence classifications are shown in

Table 2.1.

The dam consequence classifications of the dams based on Norwest’s 2017 inspection are outlined in

Table 2.2. These consequence classifications are in line with the classifications outlined in the 2015 Dam Safety Review (SRK 2015).

An emergency preparedness plan (EPP) is noted by the DSR (SRK 2015) to be in place and deemed appropriate for care and maintenance status. Stantec did not review the EPP. Due to the lack of transportable tailings, permanent population, or infrastructure downstream of the perimeter dams, a detailed inundation study is deemed non-applicable.

Table 2.1: CDA Dam Consequence Classifications

Dam Class	Population at Risk(1)	Incremental Losses		
		Loss of Life(2)	Environmental and Cultural Values	Infrastructure and Economics
Low	None	0	• Minimal short-term loss; • No long-term loss	Low economic losses Area contains limited infrastructure or services
Significant	Temporary only	Unspecified	• No significant loss or deterioration of fish or wildlife habitat • Loss of marginal habitat only • Restoration or compensation in kind highly possible	Losses to recreational facilities, seasonal workplaces, and infrequently used transportation routes
High	Permanent	10 or fewer	• Significant loss or deterioration of important fish or wildlife habitat • Restoration or compensation in kind highly possible	High economic losses affecting infrastructure, public transportation, and commercial facilities
Very High	Permanent	100 or fewer	• Significant loss or deterioration of critical fish or wildlife habitat • Restoration or compensation in kind possible but impractical	Very high economic losses affecting important infrastructure or services (e.g. highway, industrial facility, storage facilities for dangerous substances)
Extreme	Permanent	More than 100	• Major loss of critical fish or wildlife habitat • Restoration or compensation in kind impossible	Extreme losses affecting critical infrastructure or services (e.g. hospital, major industrial complex, major storage facilities for dangerous substances)

Note 1. Definition for population at risk:
None - There is no identifiable population at risk, so there is no possibility of loss of life other than through unforeseeable misadventure. **Temporary** - People are only temporary in the dam-breach inundation zone (e.g. seasonal cottage use, passing through on transportation routes, participating in recreational activities). **Permanent** - The population at risk is ordinarily located in the dam-breach inundation zone (e.g. as permanent resident); three consequence classes (high, very high, extreme) are proposed to allow for more detailed estimate of potential loss life (to assist in decision-making if the appropriate analysis is carried out).
Note 2. Implication for loss of life:
Unspecified - The appropriate level of safety required at a dam where people are temporarily at risk depends on the number of people, the exposure time, the nature of their activity, and other conditions. A higher class could be appropriate, depending on the requirements. However, the design flood requirement, for example, might not be higher if the temporary population is not likely to be present during the flood season.

Table 2.2: Lupin TCA Dam Consequence Classifications

Dam		Consequence Classification	Rationale
Perimeter Dams	1A	Significant	Release of water that might not meet discharge criteria into the environment
	1B	Significant	Release of water that might not meet discharge criteria into the environment
	1C	Significant	Release of water that might not meet discharge criteria into the environment
	2	Significant	Release of water that might not meet discharge criteria into the environment
	3	Low	No free-standing water; Stable reclaimed tailings with very limited impact consequence upon failure
	4	Significant	Release of water that might not meet discharge criteria into the environment
	5	Low	No free-standing water; Stable reclaimed tailings with very limited impact consequence upon failure
	6	Low	No free-standing water; Stable reclaimed tailings with very limited impact consequence upon failure
Internal Dams	3D	Low	Any release of effluent or tailings are contained within the TCA
	J	Low	Any release of effluent or tailings are contained within the TCA
	K	Low	Any release of effluent or tailings are contained within the TCA
	L	Low	Any release of effluent or tailings are contained within the TCA
	M	Low	Any release of effluent or tailings are contained within the TCA
	N	Low	Any release of effluent or tailings are contained within the TCA
	Divider Dykes	Low	Any release of effluent or tailings are contained within the TCA

3.0 2018 TCA INSPECTION

3.1 GENERAL

Mr. Alvin Tong, PEng., a Senior Geotechnical Engineer with Stantec, conducted the geotechnical inspection on the 13th and 14th of September 2018. Detailed visual inspection was completed on all TCA components, along with readings of instrumentation. Mr. Dave Vokey, representative of LMI, was on site for communication and organization, but did not accompany Stantec on the inspection.

The weather during inspection was below freezing and overcast with periods of flurries. Detailed inspection and photograph logs are provided in Appendix A.

The general observations indicated that the perimeter dams are in stable condition. The divider dykes and Dam K should be considered for maintenance and repairs and Stantec communicated this to Mr. Vokey on site. The pond 2 water level was significantly lower than last year's level due to water treatment, with a freeboard upwards of 3.5m at the perimeter dams.

Since the inspection in September, LMI continued to lower the water level in Pond 2 until late September, due to discharge from water treatment, thus the freeboard should have now increased slightly.

3.2 INSTRUMENTATION

3.2.1 Thermistors

Thermistors were installed in the TCA between 1995 and 2004 to monitor the performance of the dams and tailings covers. From the existing records, there were thirteen thermistors installed in the dams, but only seven of them are currently functional. Of the seven functioning thermistors, five are in the perimeter dams and two are in the internal dams. There are an additional seven thermistors installed in the reclaimed tailings cover, but three of them do not have calibration data on record to evaluate the results. This report focuses on the thermistor readings from dams, using the thermistor readings from the cover for reference and comparison.

The thermistors were read monthly during operation up until 2006, and then read semi-annually during care and maintenance. Not all the functioning thermistors were read consistently throughout the care and maintenance period. To provide a point of reference in this report, selected data series between August and September, from year 2010 to 2018, are shown for comparison, while maximum values are calculated from the entire series from the first available records to 2018.

For the perimeter dams, the five functioning thermistors are less than 20m deep. The five thermistor readings are shown in the figures below. The data suggests the 2018 readings are within the historical variations, taking into account annual climatic variations and time of reading. Generally, the active layer (thaw zone) ranges from 2m to 3m depth, as interpolated by the 0°C gradient line. The largest historical variation in the given data set is approximately 2.2°C (between -2.5°C and -4.7°C) in Dam 2 (D2-00-02n) at the depth of 6m.

Figure 3-1: Thermistor Reading for Dam 1A

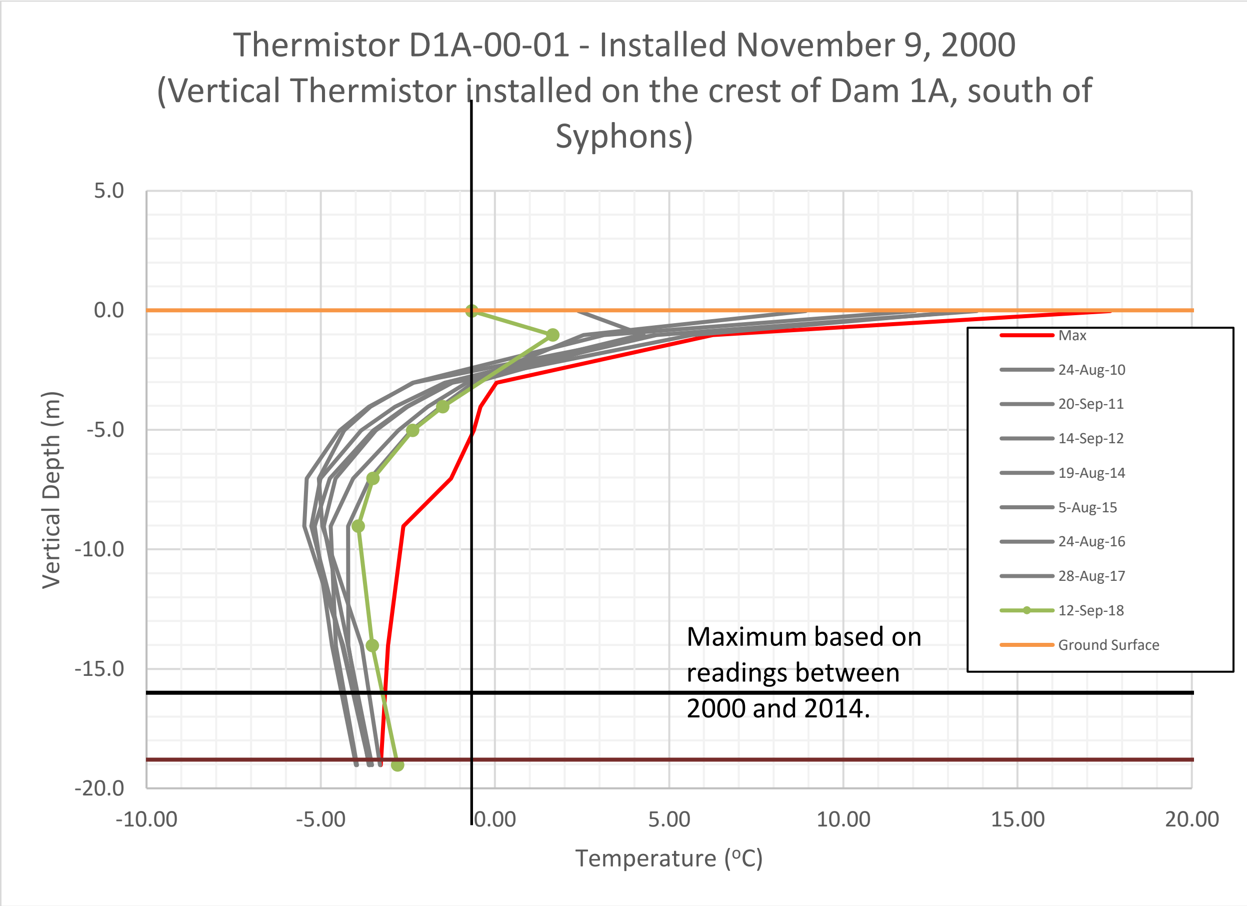


Figure 3-2: Thermistor Reading for Dam 2

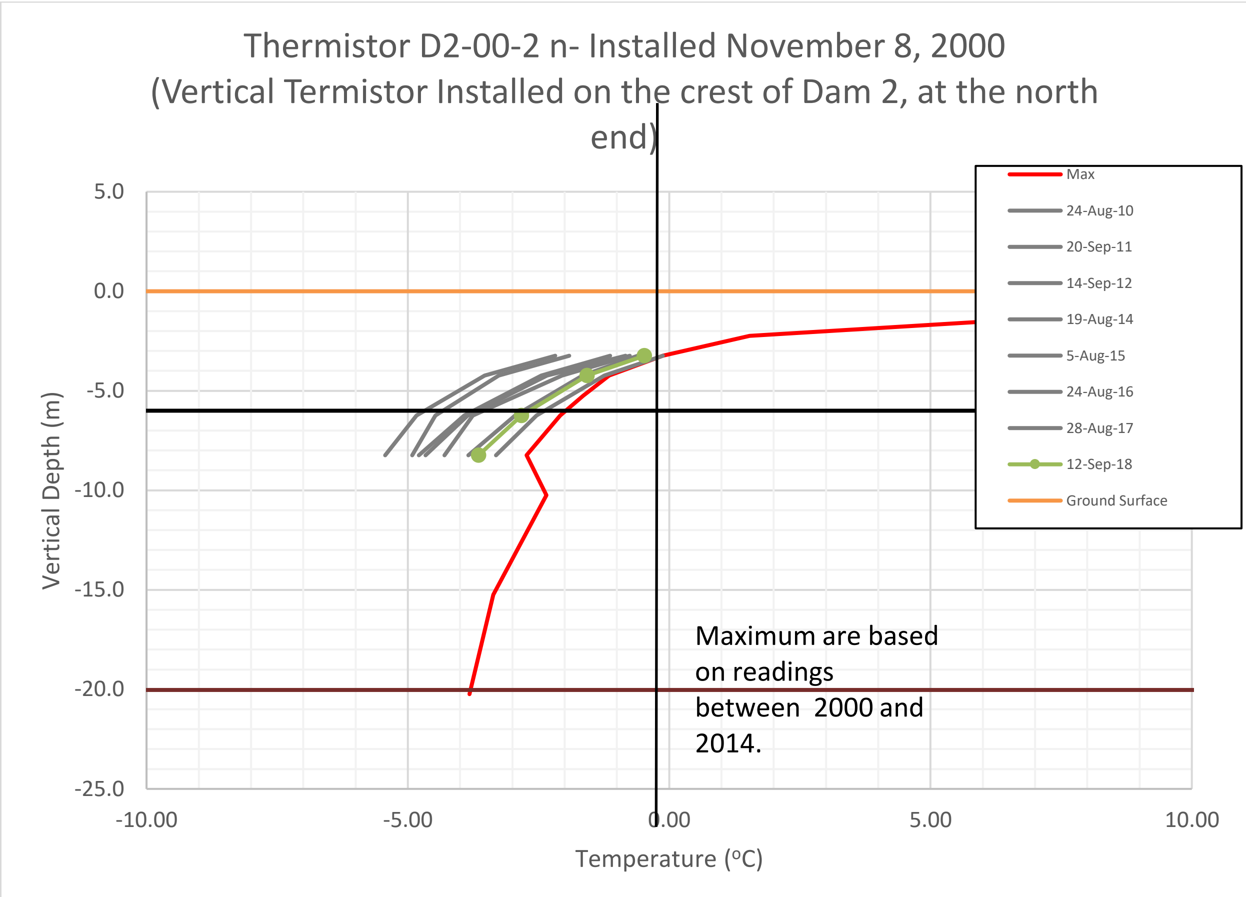


Figure 3-3: Thermistor Reading for Dam 4-1

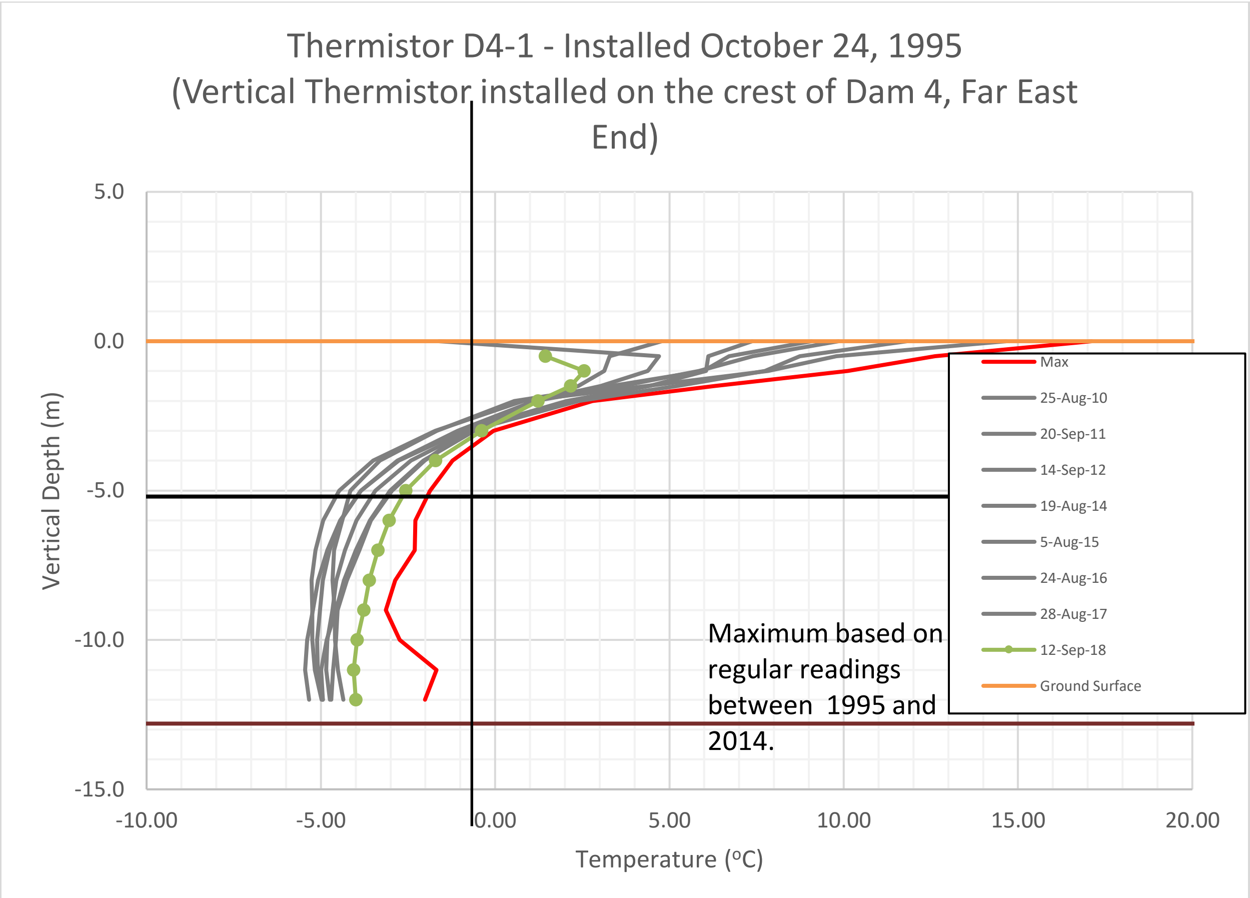


Figure 3-4: Thermistor Reading for Dam 4-3

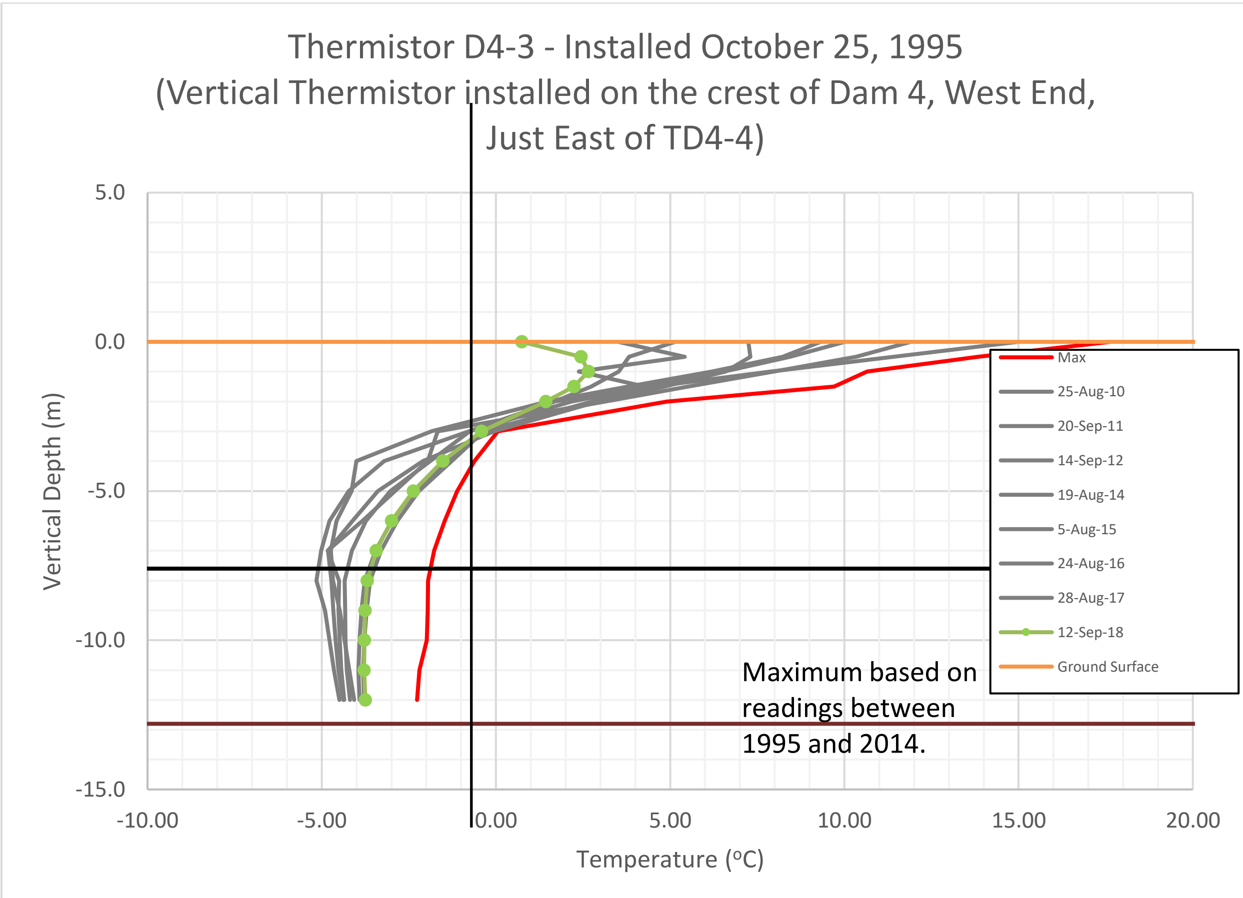
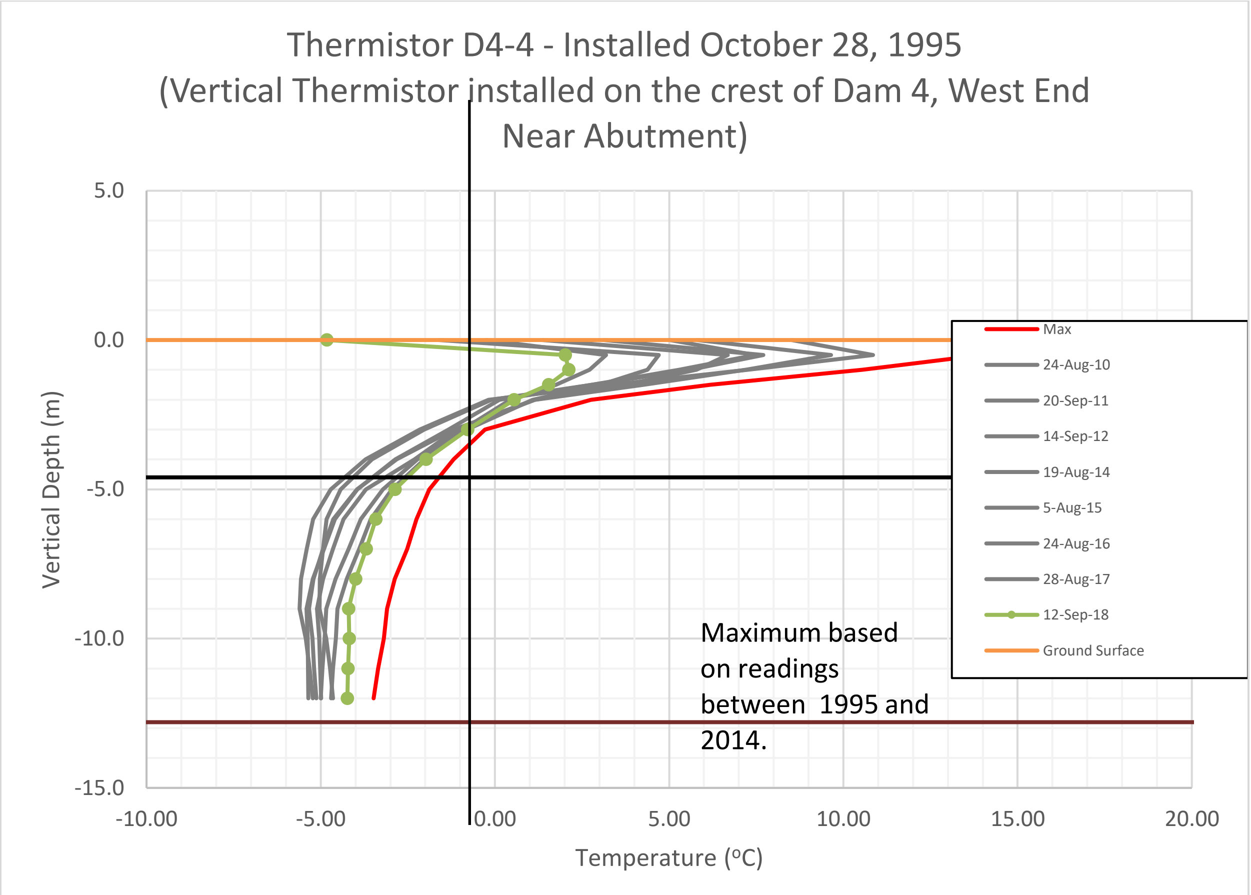


Figure 3-5: Thermistor Reading for Dam 4-4



For the internal dams, the two functional thermistors are also less than 20m deep. These were not monitored as rigorously as the ones installed in the perimeter dams, and only have recent data between 2014 and 2017. The two thermistor readings are shown in the figures below. The active layer is observed to be between 2m to 3m, as interpolated by the 0°C gradient line. The variations between the data set are less than 2°C and generally occur below the historical maximum.

Figure 3-6: Thermistor Reading for Dam 3D

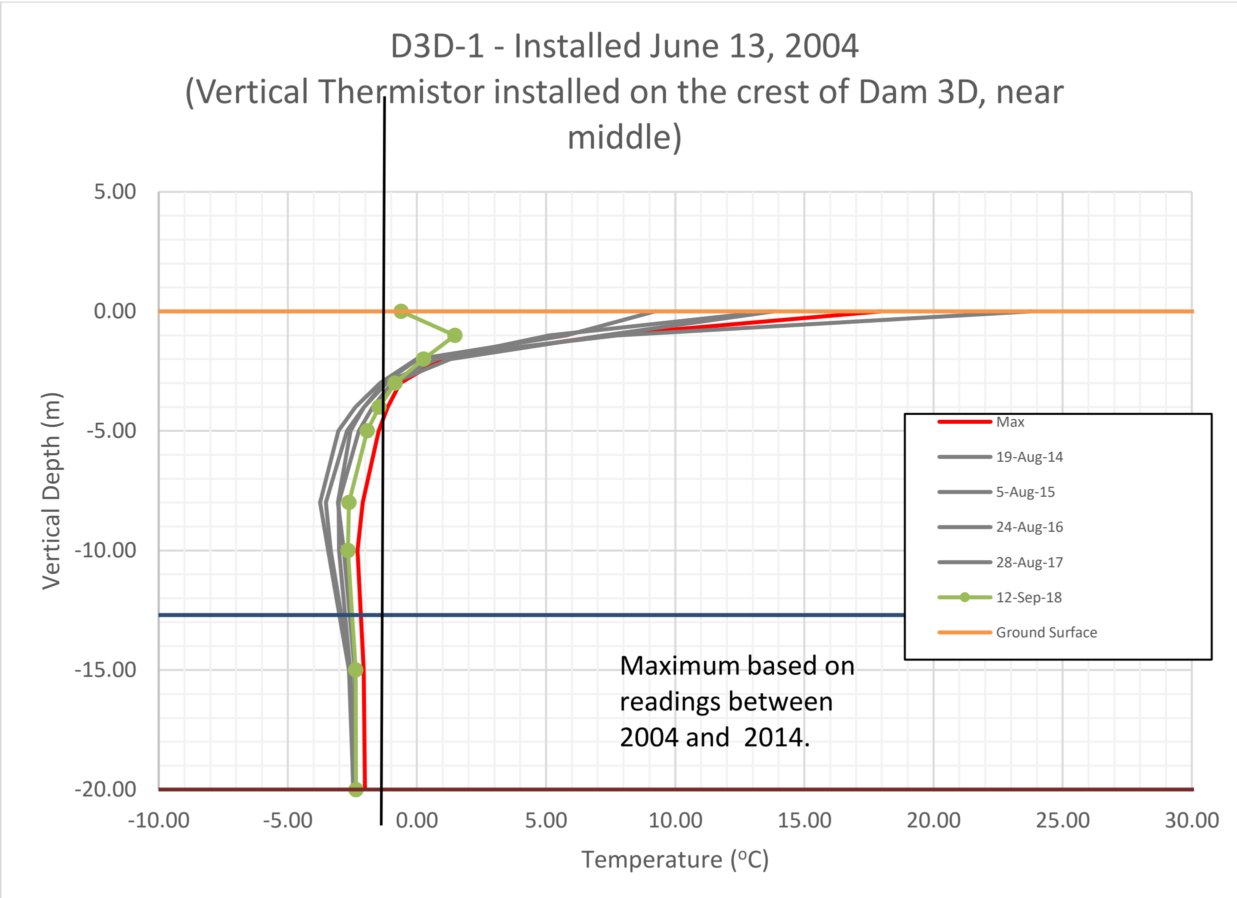
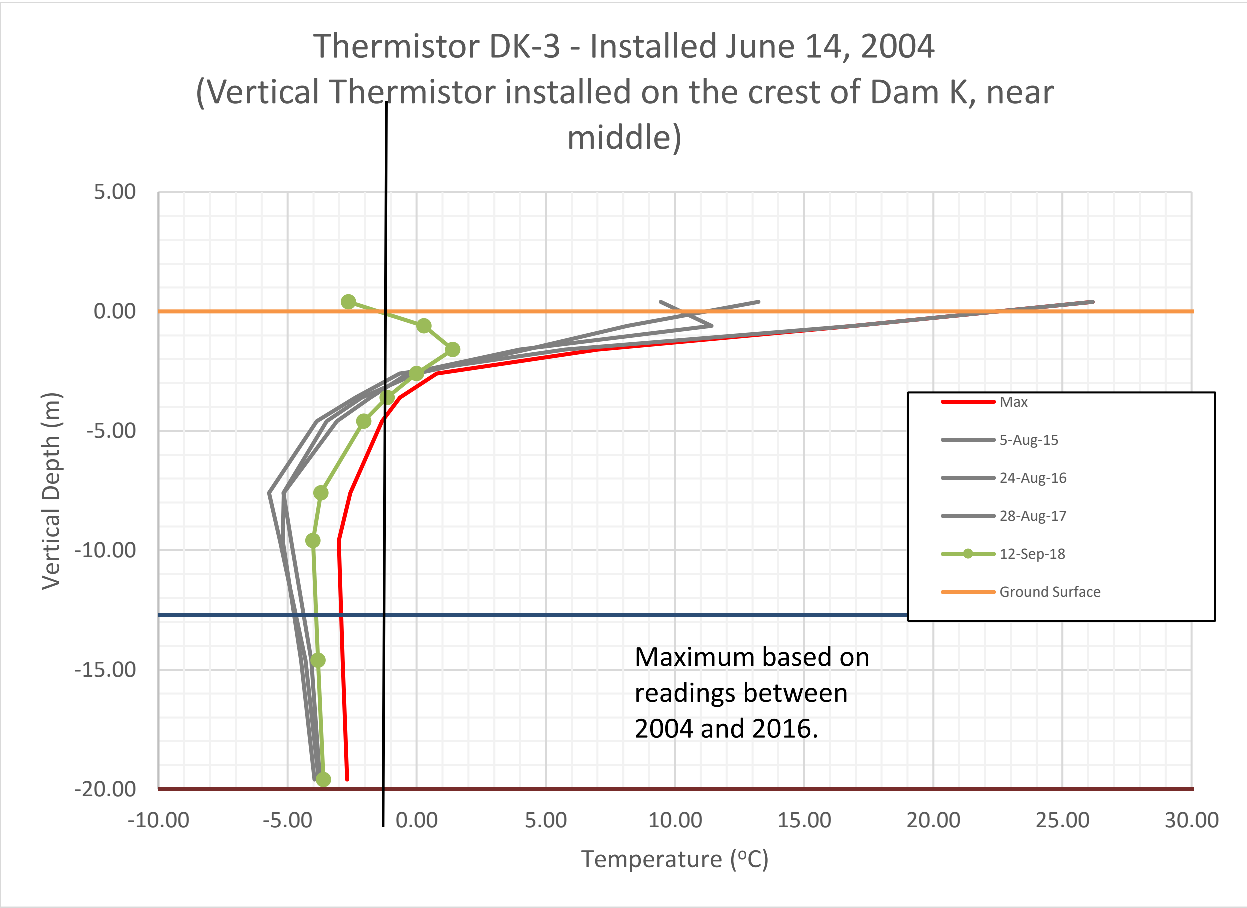


Figure 3-7: Thermistor Reading for Dam K



Readings from the four thermistors in the tailings cover are not presented in this report. The results are comparable to the readings from the dams. All the observed larger temperature variations remained below 0°C and well below the active layer. The observed active layer depths remain consistent with the site recorded data and information provided by national research (Penner 1983). The thermistor readings indicate that the frozen cores within the monitored dams are frozen below the active layer and are performing well.

3.2.2 Moisture Sensors

To provide insight into the performance of the cover, volumetric moisture sensors were installed in the Cell 2 and Cell 3 covers in 2018. The intent of the sensor readings is to define the degree of saturation throughout the year at the depths near the cover and tailings contact. The sensors are TEROS-12 VWC sensors that measure volumetric water content, temperature and electric conductivity. The sensor readings are set to read once every 12 hours and the readings are recorded by dataloggers. Cell 2 and 3 each have one string of five sensors in installed within the cover (C2VWC and C3VWC). The sensors are spaced 0.2m apart and installed between 1m to 1.5m below the cover surface. The initial sets of readings will be available in the new year.

3.3 TCA PERIMETER DAMS

The perimeter dams (Dam 1A through Dam 6) were observed to be in stable condition, although some erosion was observed on the dam slopes from either surface runoff or wave action below the high water mark (HWM). While most of the surface erosion was observed to be minor, repair work should be considered on the downstream face of Dam 1A and some areas along Dam 4. The rest of the dams should be monitored and repaired as needed, to prevent the erosion from becoming worse and creating preferential surface flow paths.

Previous annual inspections noted seepage from the northern toe buttress of Dam 2 into the seepage collection pond adjacent to Dam 2 Lake. This seepage was not observed during this inspection due to winter conditions, but a small amount of open water was present in the seepage collection pond. It is assumed that a small, undetermined amount of leakage is continuing.

The observed freeboard at the perimeter dams was more than 3.5m. This well exceeds the minimum requirement of 1m freeboard as stated in the water license. Dam 1B, 1C, Dam 5 and Dam 6 do not have water on the upstream face of the dams.

3.4 INTERNAL DAMS

All of the internal dams have some erosion on their downstream slopes, associated with either surface runoff or wave action at the HWM. Dam 3D also has some crest erosion from the surface runoff. Dam J and Dam L both have wave action erosion at the HWM that has reduced their crest widths. Maintenance should be considered to repair the erosion on the slopes of Dam 3D, Dam J and Dam L.

Dam K has experienced considerable undercutting at the toe from Pond 2 wave action. There are five large erosion gullies at the downstream crest from overland flow over the cover. These gullies are sufficiently wide and deep that the permafrost within the structure could be compromised. This area should be prioritized for repairs in the next construction season.

Dam M was repaired with a reinforcement buttress and crest surface backfill in 2016 (Norwest 2016). The toe of the buttress has experienced some wave erosion at the HWM. The water level has been lowered following water treatment and discharge and the buttress toe are now currently protected by the original riprap armor as per original construction. Repair should be considered for the toe erosion when practicable.

Dam N was observed to be in stable condition, but with only 0.5m freeboard between it and Pond 2. This was communicated with LMI site personnel, and the need to increase the freeboard to 1m to meet water license requirement was highlighted. It was agreed that the water behind Dam N would be lowered after water treatment operations when practicable. Dam N and its contents were submerged in previous years and this did not appear to have had any adverse impact on its geotechnical stability. The reduced freeboard does not create any geotechnical and environmental concerns as Dam N and its contents are contained within Pond 2.

The northern section of the divider dykes at the east end of Cell 4 is in poor condition, while the southern section has been repaired. Signs of erosion, cracks, and sloughing were noted on the upstream and downstream sides of both dykes. Deformations have created an uneven crest and reduced its width to approximately 2m in some areas. The south divider dyke has experienced sufficient sloughing to create a low spot with a freeboard of around 1m. The slopes of the dykes vary between 2H:1V to 1H:1V in some areas that is caused by undercutting and sloughing.

4.0 RECOMMENDATIONS

Table 4.1 summarizes the observations and recommendations from the 2018 inspection, together with the findings from the 2017 inspection for comparison.

Table 4.1: Inspection Observation and Recommendations

Inspection Item	2018 Inspection			2017 Inspection	
	Estimated Freeboard (m)	Observation	Recommendations	Observations	Recommendations
Perimeter Dams					
Dam 1A	3.6	Minor erosion on slopes with some deep erosion gullies	Repair deep erosion gullies.	Minor erosion on slopes with some deep erosion gullies	Repair deep erosion gullies.
Dam 1B	N/A[(1)]	Pond 2 water wa approximately 50m upstream from the dam.	Surface maintenance, e.g. grading and backfilling.	Minor erosion in the slopes.	Surface maintenance, e.g. grading and backfilling.
Dam 1C	N/A[(1)]	Pond 2 water was approximately 100m upstream from the dam.	Surface maintenance e.g. grading and backfilling.	Minor erosion in the slopes.	Surface maintenance e.g. grading and backfilling.
Dam 2	3.2	Minor erosion in the slopes. Seepage was not observed due to weather conditions. The seepage is assumed to be ongoing as a small amount of open water was found in the seepage collection pond.	Surface maintenance e.g. grading and backfilling. Monitor the seepage and pump back into Pond 2 as necessary.	Minor erosion in the slopes. Seepage at northern abutment estimated at 1L/min. Seepage was collected and pumped back into Pond 2.	Surface maintenance e.g. grading and backfilling. Monitor the seepage and pump back into Pond 2 as necessary.
Dam 3	No water is impounded by this dam	Minor erosion in the downstream slope.	Surface maintenance e.g. grading and backfilling.	Minor erosion in the downstream slope.	Surface maintenance e.g. grading and backfilling.
Dam 4	3.6	Minor erosion in the slopes and wave erosion at HWM. Geogrid was not observed due to	Surface and toe maintenance e.g. grading and backfilling.	Minor erosion in the slopes. Historical exposed geogrid at the east abutment in	Surface maintenance e.g. grading and backfilling. Monitor the exposed geogrid

Inspection Item	2018 Inspection			2017 Inspection	
	Estimated Freeboard (m)	Observation	Recommendations	Observations	Recommendations
		snow cover on the ground.		similar condition as observed previously.	for changes and deformations.
Dam 5	N/A(1)	Pond 2 water is approximately 50m upstream from the dam. Minor erosion on surface.	Surface maintenance e.g. grading and backfilling.	Minor erosion in the slopes.	Surface maintenance e.g. grading and backfilling.
Dam 6	N/A(1)	Ponding in a natural low at the south abutment. Erosion gullies in the downstream slope.	Surface maintenance e.g. grading and backfilling. Monitor the ponded water level in the south abutment.	Ponding in a natural low at the south abutment. Erosion gullies in the downstream slope.	Surface maintenance e.g. grading and backfilling. Monitor the ponded water level in the south abutment.
Internal Dams					
Dam 3D	No water is impounded by this dam	Minor erosion in the slopes.	Surface and slope maintenance e.g. grading and backfilling.	Minor erosion in the slopes.	Surface and slope maintenance e.g. grading and backfilling.
Dam J	1.1(2)	Over steepened slope due to erosion and reduced crest width in some sections.	Repair the eroded slope and crest with compacted sand and gravel.	Erosion gullies on slopes. Over steepened slope due to erosion and reduced crest width in some sections.	Repair the eroded slope and crest with compacted sand and gravel.
Dam K	N/A(1)	Erosion at HWM and five large erosion gullies in the downstream crest. Near vertical slope at the eroded toe.	Prioritize the repair the eroded gullies at the crest and toe, and armor the slope up to the HWM with boulders to limit further erosion. Repair should be done while the Pond 2 water level is lowered for access.	Erosion at HWM and erosion gullies in the downstream crest. Near vertical slope at the eroded toe.	Repair the eroded gullies at the crest and toe, and armor the slope up to the HWM with boulders to limit further erosion. Monitor the crest for cracks and sloughing until repairs are completed. Repair should be done while the Pond 2 water level is lower for access.
Dam L	1.5(2)	Erosion in the crest and slopes.	Repair the eroded upstream slope, crest and armor the downstream toe for protection.	Erosion in the crest and slopes.	Repair the eroded slope and armor the toe for protection. Monitor the water level in Cell 3 and manage as necessary.

Inspection Item	2018 Inspection			2017 Inspection	
	Estimated Freeboard (m)	Observation	Recommendations	Observations	Recommendations
Dam M	2.5	Minor erosion at the downstream toe above the riprap protection	Repair the eroded toe areas.	Tension cracks have been excavated and backfilled, and over steepened slopes have been buttressed and armored at the toe.	Monitor the repair for erosion and settlements.
Dam N	0.5[(2)]	Minor wave action erosion at HWM.	Monitor the water level behind Dam N and lower the water when practicable to yield minimum 1m freeboard.	Minor wave action erosion at HWM.	Monitor the water level behind Dam N and manage it as necessary to yield minimum 1m freeboard.
Divider Dykes	0.4[(2)]	Erosion, sloughing and cracks along upstream and downstream of the northern portion of the dyke. Uneven crest level and reduced crest width.	Second priority to complete the repair to the northern section	Erosion, sloughing and cracks along upstream and downstream of the northern portion of the dyke. Uneven crest level and reduced crest width.	Repair has been done to the southern section of the dyke. Complete similar repair to the northern section

Notes: 1. Water is not adjacent to the dam to determine available freeboard.

2. Freeboard at the lowest point of the dam and below the minimum requirement stated in the Water License (NWB 2015).

4.1 MITIGATION FOR DAM K TOE AND CREST EROSION

The Dam K toe has significant erosion below the HWM from the wave action in Pond 2. The erosion has undercut the toe of the dam and created near vertical slopes in several areas. The downstream crest has five significant erosion gullies cause by surface overflow from the cover. These gullies are sufficiently wide and deep that the slopes of the dam and permafrost condition within the structure could be compromised. Initial maintenance and repair should be completed to replace the eroded material at the toe with compacted sand and gravel armored with boulders/riprap for wave protection. Once the repair at the toe is complete, loose crest material should be removed and additional compacted fill should be place in lifts to repair the erosion gullies. All the proposed work should be endorsed by the Engineer-of-Record prior to commencement.

The water level in Pond 2 was lowered in 2017 following water treatment and discharge. LMI should consider the timing and planning of the repair work in 2019 when the Pond 2 water level is still below the eroded zone at the toe.

4.2 MAINTENANCE AND REPAIRS PRIORITIES

Of the repairs and maintenance recommended in Table 3, the following repairs should be prioritized:

1. Repair the erosion gullies and toe at Dam K. Repair the eroded toe at Dam K with compacted sand and gravel to restore the original design configuration and armor the repaired toe with boulders/riprap for wave protection. Once that is completed, remove any loose crest material and repair the crest with compacted sand and gravel.

2. Repair the northern section of the Divider Dykes with compacted sand and gravel to restore the original design configuration, including side slopes, a leveled crest and armoring up to the HWM, as directed by the Engineer-of-Record.

3. Monitor the water level behind Dam N and lower the water level to maintain a minimum 1m freeboard.

After the completion of the priority repairs, LMI should consider carrying out the following repairs:

- Monitor the seepage at Dam 2 and manage it as necessary by pumping the seepage back into Pond 2.

- LMI is currently monitoring and managing the water in Cell 5 as part of the cover construction work. This monitoring and water management should continue to prevent damage to newly repaired Dam M.

- General repairs on surface and slope erosion at the HWM.

All observations and records from monitoring should be included in the annual inspection report and should be sent to Stantec and the Engineer-of-Record for review.

5.0 REFERENCES

Canadian Dam Association (CDA) 2014. Technical Bulletin, Application of Dam Safety Guidelines to Mining Dams, 2014.

Nunavut Water Board (NWB) 2015. Nunavut Water License 2AM-LUP1520, issued to Lupin Mines Incorporated, May 2015.

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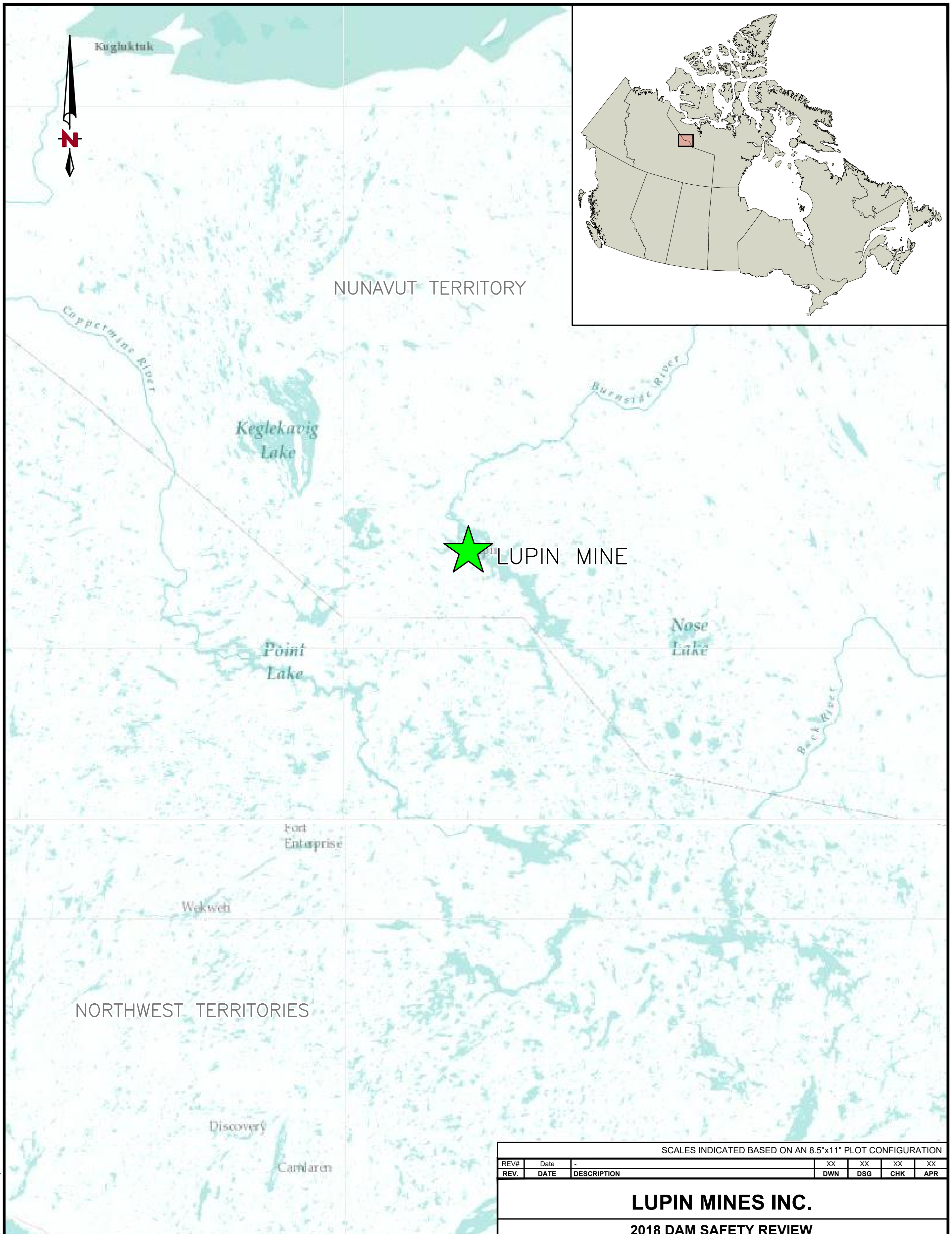


0 50 100 km

SCALES INDICATED BASED ON AN 8.5"x11" PLOT CONFIGURATION

REV#	Date	-	XX	XX	XX	XX
REV.	DATE	DESCRIPTION	DWN	DSG	CHK	APR

LUPIN MINES INC.

2018 DAM SAFETY REVIEW

SCALE:	AS SHOWN
DATE:	2016-10-20
CO-ORD. SYS.:	UTM-NAD83-12
DRW'N BY:	KM
DSG'N BY:	--
REV'D BY:	AT
APP'D BY:	SE

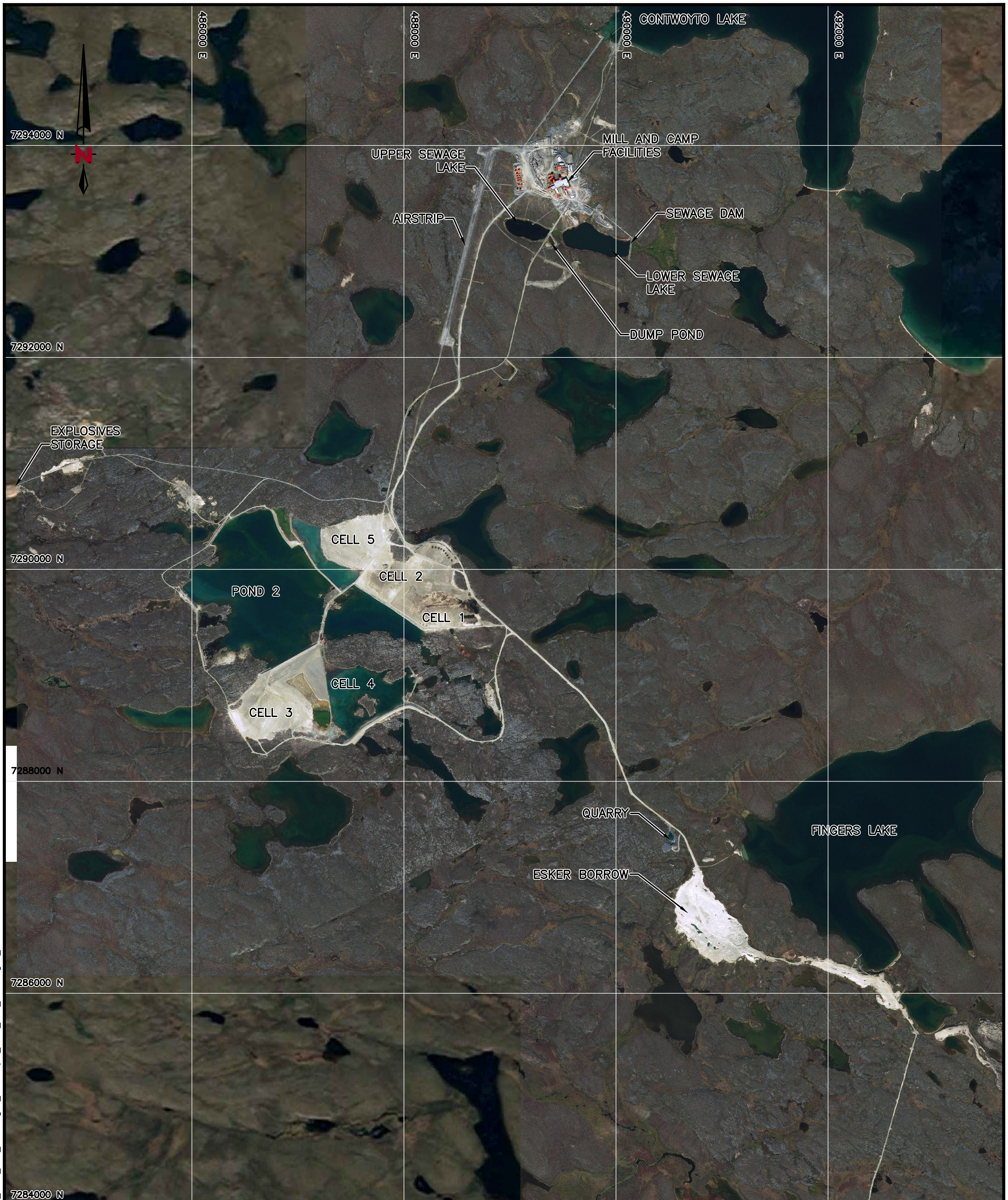
SITE LOCATION

Stantec

PROJECT NO.:	FIG. NO.:	REV.:
129500082	1	A

DATE: 9/29/2017 TIME: 16:00:20 PLOT SCALE: 1:3.872

FILENAME: □\924-2_DSI\DISC\DRAFTING\01.SITE LOCATION.DWG
XREF FILE(S):
IMAGE FILE(S): Lupin-Site Lo□ation-N Lupin-Site Lo□ation-S



1000m 500 0 1000 2000 3000m

SCALE 1:50,000

SCALES INDICATED BASED ON AN 8.5"x11" PLOT CONFIGURATION

REV#	Date	-	XX	XX	XX	XX
REV.	DATE	DESCRIPTION	DWN	DSG	CHK	APR

LUPIN MINES INC.

2018 DAM SAFETY REVIEW

SCALE:	AS SHOWN
DATE:	2016-10-20
CO-ORD. SYS.:	UTM-NAD83-12
DRW'N BY:	KM
DSG'N BY:	--
REV'D BY:	AT
APP'D BY:	SE

SITE OVERVIEW

Stantec

PROJECT NO.:	FIG. NO.:	REV.:
129500082	2	A

DATE: 9/29/2017 TIME: 16:03:34 PLOT SCALE: 1:3.872

FILENAME: □\924-2_DSI\DSI\DRAFTING\02.SITE OVERVIEW.DWG
XREF FILE(S):
IMAGE FILE(S): Lupin-NE Lupin-NW Lupin-SW lupin_mine_wv2_2012aug21_north lupin_mine_wv2_2012aug21_south

SCALES INDICATED BASED ON AN 8.5"x11" PLOT CONFIGURATION

100m 0 100 200 400m

SCALE 1:6000

REV#	Date	-	XX	XX	XX	XX
REV.	DATE	DESCRIPTION	DWN	DSG	CHK	APR

LUPIN MINES INC.

2018 DAM SAFETY REVIEW

SCALE:	AS SHOWN
DATE:	2016-10-20
CO-ORD. SYS.:	UTM-NAD83-12
DRW'N BY:	KM
DSG'N BY:	--
REV'D BY:	AT
APP'D BY:	SE

MILL SITE AND SUPPORT FACILITY PLAN

Stantec

PROJECT NO.:	FIG. NO.:	REV.:
129500082	3	A

FILENAME: □\924-2_DSI\DISC\DRAFTING\03.MILL SITE AND SUPPORT FACILITY.DWG
XREF FILE(S):
IMAGE FILE(S): lupin_mine_wv2_2012aug21_north

DATE: 9/29/2017 TIME: 16:06:18 PLOT SCALE: 1:3,872

DATE: 11/16/2018 TIME: 16:31:12 PLOT SCALE: 1:3,872

LEGEND

THERMISTORS STATUS

- ACTIVELY MONITORED
- DAMAGED
- MONITORED DURING DSR-NO CALIBRATION DATA
- UNLOCATED-LOCATION ESTIMATED FROM HISTORICAL MAP
- VOLUMETRIC WATER CONTENT SENSOR STRINGS

500m 0 500 1000m

SCALE 1:20,000

SCALES INDICATED BASED ON AN 8.5"x11" PLOT CONFIGURATION

REV#	Date	-	XX	XX	XX	XX
REV.	DATE	DESCRIPTION	DWN	DSG	CHK	APR

LUPIN MINES INC.

2018 DAM SAFETY REVIEW

SCALE:	AS SHOWN
DATE:	2016-10-20
CO-ORD. SYS.:	UTM-NAD83-12
DRW'N BY:	KM
DSG'N BY:	--
REV'D BY:	AT
APP'D BY:	SE

TAILINGS CONTAINMENT AREA

Stantec

PROJECT NO.:	FIG. NO.:	REV.:
129500083	4	A

FILENAME: V:\1295\ACTIVE\129500082\DISC\DRAFTING\04.TAILINGS CONTAINMENT AREA.DWG
XREF FILE(S):
IMAGE FILE(S): lupin mine wv2 2012aug21 north lupin mine wv2 2012aug21 south

Appendix A Photographic Log

Photo 1: Looking northwest at the downstream slope of Dam 1A

Photo 2: Looking northwest at the crest of Dam 1A

Photo 3: Looking northwest at the upstream slope of Dam 1A

Photo 4: Looking south at the upstream slope of Dam 1B.

Photo 5: Looking south at the downstream slope of Dam 1B.

Photo 6: Looking east at the edge of Pond 2 to the upstream slope of Dam 1B.

LMI	Lupin Mine Incorporated
	2018 Dam Safety Inspection

Site Inspection Photograph Log for Dam 1A and 1B

Stantec | PN: 129500082 | FIGURE 1 | REV. A

Photo 7: Looking south at the crest of Dam 1C

Photo 8: Looking south at the upstream slope of Dam 1C.

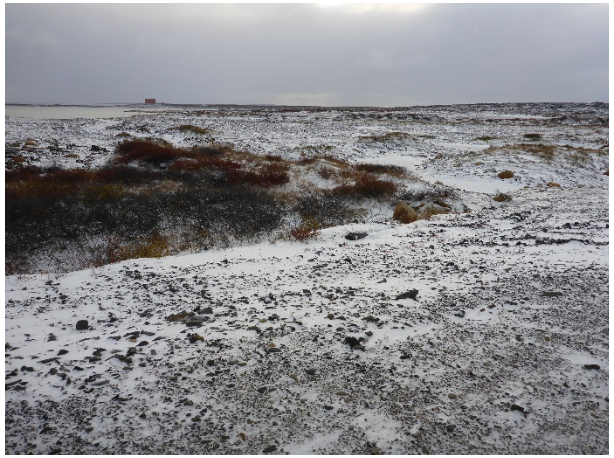


Photo 9: Looking east at the edge of Pond 2 from the upstream slope of Dam 1C.

Photo 10: Looking southwest at the upstream slope of Dam 2.

Photo 11: Looking southwest at the downstream slope of Dam 1 with the seepage collection pond.

Photo 12: The small amount of open water at the seepage collection pond.

LMI	Lupin Mine Incorporated
	2018 Dam Safety Inspection

Site Inspection Photograph Log for Dam 1C and 2

Stantec	PN: 129500082	FIGURE 2	REV. A

Photo 13: Looking northwest at the surface ditch along Dam 3.

Photo 14: Looking northwest at the crest of Dam 3.

Photo 15: Looking northeast at the surface ditch spillway on Dam 3.

LMI	**Lupin Mine Incorporated**
	2018 Dam Safety Inspection

Site Inspection Photograph Log for Dam 3

Stantec	PN: 129500082	FIGURE 3	REV. A

Photo 16: Looking east from the west abutment at the upstream slope of Dam 4

Photo 17: Looking east from the west abutment at the downstream slope of Dam 4

Photo 18: Looking east at the upstream slope of Dam 4.

Photo 19: Looking south at an erosion gully near the east abutment of Dam 4.

LMI	**Lupin Mine Incorporated** **2018 Dam Safety Inspection**
Site Inspection Photograph Log for Dam 4	
Stantec	PN: 129500082 FIGURE 4 REV. A

Photo 20: Looking south at the crest of Dam 5

Photo 21: Looking south at the downstream slope of Dam 5.

Photo 22: Looking southwest at one of the erosion gullies at the downstream crest of Dam 5.

Photo 23: Looking east at the crest of Dam 6

Photo 24: Looking east at the downstream slope of Dam 6.

LMI	**Lupin Mine Incorporated** **2018 Dam Safety Inspection**		
Site Inspection Photograph Log for Dam 5 and 6			
Stantec	PN: 129500082	FIGURE 5	REV. A

Photo 25: Looking south at the upstream crest of Dam J, adjacent to Pond 1.

Photo 26: Looking south at the downstream crest of Dam J adjacent to Pond 2.

Photo 27: Looking south at the eroded downstream slope of Dam J.

Photo 28: Looking southeast from the west abutment at the downstream slope of Dam 3D.

Photo 29: Looking southeast from the west abutment at the downstream crest of Dam 3D.

Photo 30: Looking northwest from the east abutment at the downstream crest of Dam 3D.

LMI	**Lupin Mine Incorporated**
	2018 Dam Safety Inspection

Site Inspection Photograph Log

for Dam 3D and J

Stantec | PN: 129500082 | FIGURE 6 | REV. A

Photo 31: Looking southwest from the east abutment of the eroded toe at Dam K

Photo 31: Looking northwest at one of the five erosion gullies along the upstream crest of Dam K

Photo 32: Looking northwest, down toward the toe at one of the five erosion gullies along the upstream crest of Dam K

Photo 33: Looking northwest at another one of the five erosion gullies along the upstream crest of Dam K

Photo 34: Looking southwest from near the east abutment along the downstream crest of Dam K at the erosion gullies.

LMI	**Lupin Mine Incorporated**
	2018 Dam Safety Inspection
Site Inspection Photograph Log for Dam K	

Stantec | PN: 129500082 | FIGURE 7 | REV. A

Photo 35: Looking north at the Dam L crest from the south abutment.

Photo 36: Looking north at the downstream slope of Dam L from the south abutment.

Photo 37: Looking south at the Dam L downstream slope.

Photo 38: A string of 5 sensors mount on post, spaced 20cm apart waiting in preparation for installation.

Photo 39: Close up of one of the sensors with the probe exposed.

Photo 40: Installation of the sensor string at the tailings and cover contact, 1m below cover surface.

LMI	**Lupin Mine Incorporated**
	2018 Dam Safety Inspection

Site Inspection Photograph Log

for Dam L and VWC Installation

Stantec	PN: 129500082	FIGURE 8	REV. A

Photo 41: Looking northwest at the reinforcement buttress at Dam M.

Photo 42: Looking southeast at the reinforcement buttress of Dam M.

Photo 43: Looking southwest at the riprap armor at the toe of reinforcement buttress.

Photo 44: Looking north at the upstream crest of Dam M with the ongoing cover construction in the background.

Photo 45: Looking north at the downstream slope of Dam N with Pond 2.

Photo 46: Looking north at the crest of Dam N and ponding water with less than 1m freeboard.

LMI	**Lupin Mine Incorporated** **2018 Dam Safety Inspection**

Site Inspection Photograph Log

for Dam M and N

Stantec | PN: 129500082 | FIGURE 9 | REV. A

Photo 47: Looking north at the repaired upstream slope and crest of the southern divider dyke.

Photo 48: Looking north at the culvert intake at the divider dyke.

Photo 49: Looking west at the culvert discharge at the divider dyke.

Photo 50: Looking north at the eroded crest slopes and sloughed crest of northern divider dyke.

LMI	**Lupin Mine Incorporated** **2018 Dam Safety Inspection**

Site Inspection Photograph Log for Divider Dykes

Stantec	PN: 129500082	FIGURE 10	REV. A