LUPIN MINES INCORPORATED

2020 Updated Final Closure and Reclamation Plan

Technical Comment Responses

Submitted to:

Nunavut Water Board
PO Box 119
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Submitted by:

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On behalf of:
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Contents

1.0 INTRODUCTION

On February 28, 2020, the Nunavut Water Board (NWB or Board) issued the Type A Water Licence 2AM-LUP2032 (Licence), with approval of the Licence from the Minister of Crown Indigenous Relations and Northern Affairs on 9 April 2020. The Licence requires Lupin Mines Incorporated (LMI) in accordance with Part I, Item 2, to submit to the Board for review within ninety (90) days of approval of the Licence, an updated Final Closure and Reclamation Plan (FCRP, Ver1), to address relevant comments and recommendations provided by intervening parties and the Board during the review process for the Application.

Technical review submissions were received from Crown Indigenous Relations and Northern Affairs Canada (CIRNAC) and Environment and Climate Change Canada (ECCC), SteveJan Consultants Inc on behalf of the Kitikmeot Inuit Association (KIA) on or before February 16, 2021.

In response to the submissions, LMI has provided this document, which includes the response from LMI to each of the comments as presented including references and attachments where necessary.

As state above, the updated FRCP was to address relevant comments and recommendations provided by intervening parties and the Board during the review process for the Application for Renewal/Amendment that occurred in 2018/2019. The “review process” was finalized upon issuance and approval of the Licence by the Minister on April 9, 2020.

While LMI has answered all applicable comments in their previous submission, dated February 1, 2021, in direct response to the FCRP. LMI suggests that CIRNAC and SteveJan Consultants Inc. (on behalf of the KIA) are requesting additional information outside of what was required for the updated FCRP in accordance with the Licence issued by the Board 2AM-LUP2032 Part I, Item 2.

Specifically, CIRNAC and KIA are raising issues already resolved by LMI as confirmed by the NWB on November 2, 2020, with regards to conditions in the water licence, Part E, Items 25, 26 and 27. In addition LMI notes, a majority of the comments being raised again are in regards to items that were resolved during the FCRP application process prior to issuance and approval of the Licence.

LMI is progressing with the closure work at the Lupin Mine site based on the approved FCRP but are now being requested to justify the approved FCRP. Any comments on the updated FCRP being reviewing to ensure LMI updated the plan to address all the relevant comments, recommendations from intervening parties and the Board are provided with a response below. LMI has also pointed out where items have already been resolved and approved.

2.0 ENVIRONMENT AND CLIMATE CHANGE CANADA (ECCC)

Interested Party:	ECCC	**Technical Comment No:**	1
Subject/Topic:	Tailings Containment Area		

Reference:

- Section 3.3.1 and App H-9

Detailed Review Comment by Party (November 12, 2020):

The Proponent stated, "the 2016 and 2017 cover performance data indicated that the cover active layer (thaw depth) ranged from 1.0 m to 1.5 m, and varied between reporting years and TCA locations. Furthermore, the Proponent stated, as of 2017, there remained approximately 123,500 m2 to cover in Cell 5 and 86,000 m2 to cover in Cell 3. Covering of Cell 5 resumed in 2018. Approximately 19,136 m3 of esker material was placed in Cell 5 during 2018 to cover exposed tailings. An area of approximately 104,500 m2 remains to be covered in Cell 5 and approximately 86,000 m2remains to be covered in Cell 3, for a total area of approximately 190,500 m2 remaining to be covered within the Tailings Containment Area.

Based on the above statements, ECCC is of the view that the active layer (thaw depth) is thicker or deeper than the cover thickness of 1 m, implying that the thaw depth will penetrate beyond the cover into the tailings, which may thaw causing potential oxidation of sulphide content that will result in Acid Rock Drainage (ARD)/Metal Leaching (ML).

Although the Stantec Technical Memo (Appendix H-9) concluded, Oxidized tailings were not observed within the test pits. In general, the water quality results from 2002 and 2019 are comparable. Based on these observations and measurements, the cover appears to be functioning as permitted, test pit 1 photograph shows frozen tailings at 1.3m depth (August 24-25, 2019), and test Pit 2 photograph shows water seeping into the test pit at 1.3m depth. These photographs show that the thaw penetrated beyond the cover into the tailings. Therefore, ECCC recommends that the proponent implement a monitoring and mitigation program to detect and remediate any ARD/ML issues should that occur.

Request or Recommendation by Party (November 12, 2020):

ECCC recommends that the proponent have a mitigation plan to address acidic leachates that may occur should the tailings begin to thaw and produce acidic leachate.

LMI Response (February 1, 2021):

The active layer at Lupin is deeper than 1 m, which is why Lupin moved away from a permafrost encapsulation tailings closure technology and towards a store-and-release tailings cover technology, as explained in the approved FCRP (LMI, 2017). The store-and-release cover limits oxygen ingress into the tailings and any associated ARD generation.

ECCC Comment/Recommendation (February 16, 2021):

In their response, the Proponent indicates that the store-and-release cover will limit oxygen ingress into the tailings; however, it does not completely eliminate oxygen ingress into the tailings. Therefore, ECCC recommendation for a monitoring program just in case the store-and-release cover systems does not completely eliminate the chance of ARD generation is still valid.

LMI RESPONSE (March 17, 2021):

LMI is addressing this recommendation in their Post Closure Monitoring Plan (PCMP), currently being discussed with ECCC, CIRNAC and the KIA, to be submitted to the NWB on April 9, 2020.

3.0 CROWN-INDIGENOUS RELATIONS AND NORTHERN AFFAIRS CANADA (CIRNAC)

Interested Party:	CIRNAC	**Technical Comment No:**	New 1A
Subject/Topic:	Introduction		

Reference:

- n/a

Detailed Review Comment by Party (February 16, 2021):

In general, LMI's responses do not address CIRNAC's comments and many defer integrating information until version 2 of the FCRP. Therefore, CIRNAC's general recommendation is for the Nunavut Water Board to defer approval of the plan until interveners have been able to review version 2 of the FCRP. Version 2 of the FCRP is expected to be submitted at the end of March 2021, with the 2020 Annual Report for water licence 2AM-LUP2032.

CIRNAC is concerned with LMI's repeated deferral of our requests for information which would allow for the evaluation of the potential effectiveness of their proposed reclamation strategies. The remainder of this letter is separated into two sections, the first regarding information which CIRNAC has been requesting since the water licence renewal process and the second section contains specific replies to each of LMI's responses. Both sections have been developed with the support of Arcadis Canada Inc.

LMI RESPONSE (March 17, 2021):

First, LMI would clarify with CIRNAC, the FCRP was approved by the Minister on approval of the Licence on April 9, 2020. The updated FCRP subject to "review" by the NWB to ensure it is updated to address relevant comments, recommendations provided by intervening parties and the Board during the review process for the Application. Given the licence was issued in February 2020 the updated FCRP for "review" would include comments, recommendations etc. from July 2018 to February 2020 and is not required to include comments/recommendations following approval of the Licence to confirm compliance with Board direction and the condition of the water licence, Part I, Item 2 which states:

> The Licensee shall, within ninety (90) days of approval of the Licence, submit to the Board for review, an updated *Final Closure and Reclamation Plan*, to address relevant comments and recommendations provided by intervening parties and the Board during the review process for the Application.

During the water licence amendment renewal/FCRP application approval process LMI responded to all information requests. LMI and CIRNAC resolved all issues prior to the end of the Public Hearing, with exception of security. LMI and CIRNAC resolved three items by way of an agreement on what additional information they would require and an agreed up statement was provided at the Public Hearing. These three items resulted in Part E, Items 25, 26 and 27 in the approved water licence. CIRNAC also made the following statement at the public hearing: "At this time, I'd like to state that our presentation had been completed before the latest submissions by Lupin Mines and our discussions with them up until midnight yesterday, so some of the issues we're going to present, they have responded, and we have resolved them. There's only one issue that's not completely resolved."

Secondly, LMI acknowledges that compliance is also required to other terms and conditions of the licence to address additional specific issues raised during the review process. The Licence is structured in such a way as to capture any updates to approved plans in subsequent Annual Reports as such any issued raised and resolved through acceptance or confirmation from the NWB in 2020 would be addressed in the 2020 annual report due to the NWB on March 31, 2021.

In conclusion, LMI is surprised to hear that CIRNAC's believes that LMI has not been addressing their comments and LMI respectfully disagrees with this statement. LMI believes that CIRNAC and LMI have worked cooperatively and effectively during the application review process and subsequently following approval of the licence amendment/renewal. The items CIRNAC is indicating they believe were deferred to be integrated into an updated version of the FCRP were in regards to Terms and Conditions in the water licence which were still being addressed when the updated FCRP was submitted to NWB for review and was not a part of the condition for the updated FCRP under Part I, Item 2.

Interested Party:	CIRNAC	**Technical Comment No:**	New 1B
Subject/Topic:	Introduction		

Reference:

- n/a

Detailed Review Comment by Party (February 16, 2021):

Missing information on reclamation methodologies

Specifics on reclamation methods and designs are necessary to evaluate if they will be adequate for long term physical and chemical stability of the site. CIRNAC has been requesting further details since the water licence renewal process initiated in 2019. As LMI did not provide the information during the renewal process, the renewed licence included three conditions to provide some of the missing information within 60 days of licence issuance. These are Part E, Item 25 for design details of the waste rock dome design, Part E, Item 26 for geotechnical details on TCA Dams K & M, and Part E, Item 27 for preliminary design cover for newly exposed tailings.

The Board provided CIRNAC with the opportunity to review three technical memos submitted by LMI covering these three topics. LMI's response to our comments was that the information requested would be integrated into the FCRP revision. The revision number was not specified, which has led to confusion. Our October 30, 2020 reply to the Board's question on whether these responses satisfactory was that we would review the FCRP, as at the time we believed it integrated the missing information. On November 2, 2020, the Board distributed a letter stating it had reviewed the memos and found: "*the information functional and generally satisfying Part E, Items 25, 26, and 27 of Water Licence 2AM-LUP2032.*"

Though the Board is generally satisfied, CIRNAC is seeking details on how the site will be reclaimed. Below is a summary on the information CIRNAC considers to be missing from what was to be provided under Part E Items 25, 26 and 27 of the water licence. The lists for Items 25 and 27 are a re-iteration of comments submitted on August 25, 2020, as well as comments regarding Item 26.

Further details on these concerns are presented in Annex A. CIRNAC's general recommendation is for LMI to provide sufficient information to answer these questions in revision 2 of the FCRP.

I. Information provided for Item 25 "dome design" is insufficient to provide confidence in long term erosion protection and cover stability. Concerns include:

   a. lack of detailed grading information for top of "dome";

   b. lack of design information on storm / freshet flows;

   c. no protection against rill erosion on long 10% slope surfaces;

   d. lack of runoff channels from discharge chutes;

   e. potential for toe erosion from discharge chute runoff flows;

   f. lack of specific notes to address construction constraints that need to be addressed before cover can be placed;

g. failure to show where materials to be removed prior to cover placement are located; and

h. failure to show locations of shaft, crown pillar area, that will be buried under the dome.

II. Information provided for Item 26 "additional geotechnical details" includes a series of 15 drawings and our concerns are summarized as:

a. no detailed information or specifications are provided with respect to the work to be performed on the embankment slopes;

b. no information is provided with respect to the "compacted fill" to be placed on the dams as shown on dam section drawings;

c. section drawings show no erosion control measures related for the dam slopes and no armouring or rip rap for any dam work;

d. it is unclear how the embankment fill will be placed in horizontal layers and adequately compacted to ensure long term stability;

e. there is no information on the closure work on the west end of the M dam as extends beyond the N dam M dam intersection;

f. the is no information on how any potential closure works on the N dam will be carried out if needed or how they will confirm that works are not needed; and

g. there is no discussion of logistics of dewatering Pond 2 and impacts on schedule and work if water level is not lowered before work on the dams is scheduled.

III. Information provided for Item 27 "cover design for potential exposed tailings" is still insufficient to allow for general approval of approach. Based on information provided, LMI should be required to submit details on any new exposed tailings encountered (e.g. potential exposed tailings as may be encountered in Pond 2 between the 480 m contour and the toe of the M&N dams) and provide specific information on proposed approach prior to carrying out any work on the tailings. (Note that there is a potential logistical / timing issue with respect to covering future exposed tails after dewatering if dewatering is the last step of the reclamation of the reclamation.)

Further details on these concerns are presented in Annex A. CIRNAC's general recommendation is for LMI to provide sufficient information to answer these questions in revision 2 of the FCRP.

LMI RESPONSE (March 17, 2021):

LMI refers CIRNAC to CIRNAC 1A (above) for LMI position and context applicable to issues raised in CIRNAC 1B.

In regards to Part E, Items 25, 26 and 27 and CIRNAC's understanding that new information was integrated into the updated FCRP, LMI's responses to CIRNAC did not advise that any new information was included in the updated FCRP during the reviewing process for Part E, Items 25, 26 and 27. Any reference to the FCRP was referring to information already provided in the approved FCRP (dated July 2018). LMI advised as a courtesy in their closing comments that they had submitted the updated FCRP to the NWB (and had been sent out by the NWB for review) specifically stating "as required under Part 1, Item 2 and that it was an update to the Final Closure and Reclamation Plan, to address relevant comments and recommendations provided by intervening parties and the Board during the review process for the Application." LMI pointed out documents already reviewed by CIRNAC during the application review process and as a courtesy confirmed those documents were

included with the updated FCRP as required. LMI committed to providing construction drawings, which is required by the water licence, for review as recommended by CIRNAC that would address their unresolved comments and CIRNAC advised that “CIRNAC appreciates the commitment by LMI to provide the construction drawings to the Nunavut Water Board as required by the water licence. CIRNAC looks forward to reviewing these construction drawings.”

LMI considers Part E, Items 25, 26, 27 resolved as per CIRNAC’s confirmation on Oct 30, 2020 and the NWB’s letter on November 2, 2020. These items will be included in the updated FCRP addendum filed with the Annual Report as per the water licence.

LMI has an approved FCRP and they have fulfilled the required water licence conditions under Part E, Items 25, 26 and 27, so respectfully LMI will not be responding to the items above or presented in Annex A.

Interested Party:	CIRNAC	**Technical Comment No:**	1
Subject/Topic:	Integration of comments responses to the FCRP		

Reference:

- n/a

Detailed Review Comment by Party (November 17, 2020):

The R1 version of the FCRP has had editorial updates made throughout the document. In addition, various sections have been updated to provide comments and specific references and responses to questions from CIRNAC and other parties, as per commitments made to the NWB at the technical meeting and/or the public hearing.

The material R1 additions to the FCRP relate to references made to, and the inclusion of the Technical Memoranda provided by LMI in its various responses and commitments. CIRNAC has reviewed these documents previously and provided comments on them. While in some cases, LMl's responses have addressed CIRNAC's concerns, in other cases additional information was (is required) to address issues raised by CIRNAC with respect to these Technical Memoranda. CIRNAC also notes that the R1 FCRP does not include any references to the NWB Conditions 25, 26, 27 that resulted from the Public Hearing of January 2020 Type A 2AM-LUP2032 issued on 28 February 2020 and approved on 9 April 2020.

Request or Recommendation by Party (November 17, 2020):

CIRNAC recommends that:

i) LMI create a disposition table listing all issues raised by the lntervenors at the technical and management meetings, along with LMI commitments, responses and technical memos, plus intervenor review comments on LMl's submission and remaining concerns raised by lntervenors with respect to the LMI responses provided to date.

ii) LMI update the R1 FCRP to include information related to Conditions 25, 26, and 27 of the approved Water Licence 2AM-LUP2032.

LMI Response (February 1, 2021):

i) The Type A Water Licence Part J, Item 2 required LMI to incorporate commitment, responses and associated technical memos into an updated FCRP as provided by LMI through submission of FCRP Rev1, submitted on September 28, 2020. Technical Memorandum were submitted to the NWB in compliance with specific terms and conditions (i.e., Part E) are already a part of the NWB registry. LMI would refer CIRNAC to the NWB Reasons for Decision that provides a list of submissions and correspondence in Appendix D.

iii) LMI notes the technical review of information related to Water Licence 2AM-LUP2032 Part E, Item 25, 26 & 27 was only concluded by the NWB on 2 November 2020. LMI will provide an updated Rev2 of the FCRP in the 2020 Annual Report due 31 March 2021.

Request or Recommendation by Party (February 16, 2021):

CIRNAC recommended the licensee incorporate to the FCRP I) a disposition table listing issues, commitments, and responses, II) information provided for Part E, Items 25, 26 & 27 of the water licence. LMI commits to the second request for revision 2 of the FCRP. CIRNAC recommends that both a disposition table and information pertaining to licence conditions Part E, Items 25, 26 & 27 be included in revision 2, and that interveners be an opportunity to review revision 2 when it is provided.

LMI RESPONSE (March 17, 2021):

LMI will endeavour, time permitting to include a disposition table listing issues, commitments and responses in the 2020 Annual Report or in any event the 2021 Annual Report.

As required by the Licence, information from Part E, Items 25, 26 and 27 addressed in 2020 will be included as an addendum to the 2020 Annual Report.

Interested Party:	CIRNAC	**Technical Comment No:**	2
Subject/Topic:	Schedule Updates		

Reference:

- n/a

Detailed Review Comment by Party (November 17, 2020):

The FCRP Rev 1 (August 2020) includes Table 14 which provides a schedule that was prepared on March 2019. This schedule needs to be updated to remove items that are no longer valid (e.g., includes line items that refer to work to be done under Care and Maintenance) and include all activities agreed to by LMI including such items/activities as follows:

- Construction of water management structures related to "dome";
- Stabilization and erosion protection of tailings dams (M, K, etc.);
- Removal for placement in tailings cells, or cover in place, existing or future exposed tailings (after dewatering); and,
- Construction of water management features (drainage swales and discharge structures) in tailings cells.

In addition to the above, the March 2019 schedule does not reflect the actual works carried out in 2019 or 2020. It would be helpful if LMI can provide a more detailed and updated schedule that includes all actions to be undertaken, links with LMl's RECLAIM estimate and milestones, and illustrates actual verses planned progress as well as any proposed future schedule revisions. This update to the FCRP will provide a better understanding of the state of the closure works and scheduled revisions/adjustments LMI may be proposing going forward.

Request or Recommendation by Party (November 17, 2020):

CIRNAC recommends that LMI provide a more detailed and updated schedule for the reclamation works consistent with the work completed as reflected in the Security Reduction requests of 2020. The updated schedule should include the original 2019 proposed project schedule timelines as shown in the R1 FCRP, the actual work carried out to the end of 2020, and any proposed revisions to the schedule going forward. The schedule should be updated to include line items for all activities committed to by LMI.

LMI Response (February 1, 2021):

LMI is committed to compliance and submission of the Annual Report on March 31, 2021 to reflect works completed in 2020 and will include in accordance with Schedule B, Item 1, Part m) a summary of any abandonment and reclamation work completed during the year and an outline of any work anticipated for the next year.

Request or Recommendation by Party (February 16, 2021):

CIRNAC recommended the FCRP include a detailed and updated work schedule. LMI is committing to provide this information with the Annual Report. This does not address our concern, as the work schedule included in the current version of the FCRP is inaccurate and out of date. CIRNAC recommends version 2 of the FCRP include an updated and accurate work schedule.

LMI RESPONSE (March 17, 2021):

LMI will provide an updated 2021 proposed work schedule in the Annual Report or as soon as finalized for implementation.

Interested Party:	CIRNAC	**Technical Comment No:**	3
Subject/Topic:	Removal of contaminated Materials from Mill Site Area Prior to Consolidating Waste Rock and Construction Dome Cover		

Reference:

- n/a

Detailed Review Comment by Party (November 17, 2020):

The R1 FCRP states that approximately 16,000 m3 heavily arsenic impacted soils and 35,200 m3 of PHC impacted soils (S4.3.2.3, p 4-6) exist on site that will require active management and disposal.

On page 4-9 in regard to arsenic impacted soils LMI states; *"The heavily arsenic impacted shallow material will be ex-situ remediated using conventional techniques (i.e., excavators, haul trucks, and dozers) and will be excavated and disposed of within the shafts or open crown pillars for isolation."*

On the same page in regard to the PHC impacted soils LMI states that; *"35,200 m3 of PHC impacted soil has been identified at 13 historical maintenance, fueling, and fuel storage locations across the Site (Golder 2017a). These locations include: the STF and Powerhouse, the Mill and Office Emergency Tanks, the Main Tank Farm Loaders, the Main Tank Farm Bedding Sand, the Emergency Powerhouse, the South Burn Pit, the Landfill, the RTL Shop, the North Burn Pit, the Incinerator, Cold Storage #1, the Former Airstrip Fuelling Area, and the former Ball Field. This material will be ex-situ remediated using conventional techniques (i.e., excavators, haul trucks, and dozers) and disposed of in the shafts or open crown pillars."*

No drawings were provided in the R1 FCRP document identifying the location and extent of the areas with heavily impacted arsenic or PHCs requiring excavation. In the absence of a drawing providing this information it is difficult to confirm that all of these impacted materials have been removed from these locations before consolidating the waste rock at the mill site.

Request or Recommendation by Party (November 17, 2020):

CIRNAC recommends that LMI provide a detailed site plan that identifies the location and estimated extent of heavily impacted arsenic soils, and PHC impacted soils that are expected to be excavated and placed underground. CIRNAC also requests that LMI clarify how it will confirm that these materials have been removed prior to waste rock re- grading and cover placement.

LMI Response (February 1, 2021):

Further to the ESA completed in 2006 and updated in the 2017 Updated Phase 1 & II Environmental Site Assessment completed by Golder, a detailed site plan indicating the locations of heavily impacted arsenic soils and PHC impacted soils that will be excavated and disposed underground is attached (Figure 1). The extents of the excavations will be determined in the field through the completion of field screening and confirmatory soil sampling. LMI will confirm the removal of these materials through the implementation of the contaminated soils quality assurance / quality control (QA/QC) plan outlined in Appendix C2 of the Post Closure Monitoring Plan due to the NWB on 9 April 2021 in accordance with Part J, Item 13 of the Licence.

Request or Recommendation by Party (February 16, 2021):

CIRNAC requested a detailed site plan with location and estimated extent of arsenic and petroleum hydrocarbon (PHC) impacted soils, as well as information on the method for confirming contaminated materials removal prior to further work. The licensee has provided a figure with test pit locations, indicating which ones have exceedances. This map does not estimate potential extents, does not indicate which exceedances are for arsenic or PHC, and has no indication of potential depth of contamination. Furthermore LMI deferred answering how they will confirm removal of contaminated materials until April 9, 2021, when the Quality Assurance/Quality Control (QA/QC) Plan of the Post Closure Monitoring Plan is to be submitted. To address CIRNAC's concerns, the location and extents of arsenic and PHC impacted soils need to be integrated in the closure plan as they will have to be remediated. We recommend this information be added to version 2 of the FCRP, as well as a method for confirming removal of contaminated materials, since it forms part of the reclamation work and needs to be completed prior to post closure monitoring.

LMI RESPONSE (March 17, 2021):

The two ESA's (Morrow, 2006 and Golder, 2017) provide a thorough compilation of all data known on the nature and extent of soil contamination in the mill area. Table 29 in the 2017 Updated Phase 1 & 2 Environmental Site Assessment completed by Golder provides an explicit estimate of the potential volumes, including the exceedances for arsenic and PHC, and indicates the potential areas and depths of contamination for PHCs. Remediation was carried out in 2020 or will be completed in 2021 at each of the exceedance test pits shown on the figure. The final extents and volumes of the excavations will be determined in the field through the completion of field screening and confirmatory soil sampling as per the approved FCRP.

The August 2020 QA/QC Plan, was intended to be filed with the updated FCRP but did not get placed on the NWB ftp site. (We can only assume the email did not go through as there were a large number of documents filed with the updated FCRP.) A copy of the August 2020 QA/QC Plan is attached to this document, and has been resubmitted to the NWB and is currently out for review by interested parties. An updated draft version, dated February 2021, has been provided to CIRNAC, and will be submitted with the draft PCMP on April 8, 2021.

Attachment(s):

- Figure 1 – Locations of Contaminated Soils to be Excavated (19136158-0005-CM-0001-B-SIZE) (with February 1, 2021 responses)
- August 2020 QA/QC (with March 17, 2021 response)

Interested Party:	CIRNAC	**Technical Comment No:**	4
Subject/Topic:	Crown Pillar Stabilization and Disposal of Materials Underground		

Reference:

- n/a

Detailed Review Comment by Party (November 17, 2020):

Discussion of closure of the underground and placement of material into the underground is found in the Executive Summary 5a) and Section 4.3.2.4 Underground Workings, and in Figures 6, 13, and 14. Review of these sections notes that on page 4- 14 LMI states the Preferred Reclamation activities will; *"modify the previous plan for the West Zone disposal as shown on Figure 14. The modified plan would address the void areas and increase the storage capacity. Instead of developing additional drop raises in the remaining crown pillar for disposal, the new plan would be to blast down the remaining crown pillar, creating an open slope trench approximately 260 m in length and approximately 72 m deep".*

Consistent with these statements, on page 4-15 Synthesis of Preferred Activities into a Reclamation Plan, LMI states that *"The remaining West Zone crown pillar will be collapsed to provide additional disposal capacity and to prevent future post-closure stability problems. The main haulage shaft, fresh air raise, and the exhaust raise will be completely backfilled to prevent access. Site materials and equipment, waste rock, and hydrocarbon contaminated soils will be disposed of in these areas".*

Upon review of the R1 FCRP Figures 6, 13, and 14, CIRNAC identified the following:

•Figure 6 notes that it provides a Site Plan showing the West Zone and provides some notes on open depths and a "ramp" in the areas referred to as WZ Crown Pillar Pit and WZ Underground Disposal Key Cross Section Locations (5).

Request or Recommendation by Party (November 17, 2020):

CIRNAC recommends that LMI provide more detailed discussions and plans related to the following:

- How surface openings and the open stope will be filled.
- How long-term subsidence of fill materials will be avoided.
- The information provided to the Mines Inspector with respect to final closure of surface openings.

LMI Response (February 1, 2021):

i) The updated FCRP Rev1 submitted on September 28, 2020, confirms that the surface openings and the open stope will be completely filled. Waste materials will be dumped beside the openings and then progressively dozed into the openings.

ii) As shown on Figure 10, the entire west zone crown pillar area will fall within the footprint of the waste rock "dome". As shown on Figure 6, the ground surface elevation along the open crown pillar generally varies between Elev. 502 and 501 m, with lower elevations on the north end. Comparing this to the dome grading plan (TM of June 8, 2020 in response to condition E-25) shows that the total cover over the crown pillar

(including the 1 m esker cover) will generally be about 4 m. It is expected that most of the fill subsidence will occur while the dome is being constructed and so it will be accommodated in the final grading. Any long-term subsidence can be corrected by placing additional esker material in the subsidence area to bring it back up to grade. A small volume of esker material will be stockpiled on the dome for this purpose.

iii) The information provided to the Mines Inspector on June 29 was confirmed and provided to the NWB in response to CIRNAC similar question related to the technical review of term and condition Part E, Item 25.

Request or Recommendation by Party (February 16, 2021):

CIRNAC recommended the licensee include a more detailed discussion on how the surface openings and the open stope would be filled, and how long term subsidence of fill material would be avoided. The licensee has responded "*the surface openings and the open stope will be completely filled. Waste materials will be dumped beside the openings and then progressively dozed into the openings.*" As well, they state they expect subsidence to occur during construction, so that it could be accommodated during final grading. This information is not sufficiently detailed to evaluate the likelihood of its effectiveness. For example, does the "progressive dozing into the openings" involve pushing end-dumped material over the opening edge with the bulldozer, or will the fill be placed in lifts, allowing the bulldozer to track over and compact the material? The method used will have an incidence on the likelihood of subsidence. CIRNAC recommends LMI include the information requested in version 2 of the FCRP.

CIRNAC also recommended the documents provided to the Mines Inspector with respect to final closure of the surface openings be shared, as presently we only have a copy of the authorization letter. Documents referred to in the authorization letter which we would like to see are:

- 2020-06-25 Drilling and Blasting Plan Approval;
- West Zone Crown Pillar Blast Locations – Plan view; and
- M8277 Break-Away Drill and Blast – Lupin Mine Closure – West Zone Pilla…[*sic*].

LMI RESPONSE (March 17, 2021):

LMI will include the information requested as committed in Part E, Item 25, to provide the addition information with the construction drawings.

Please find attached the requested approved documents by the Mines Inspector.

Attachment(s):

- Drill-Blast Execution Plan Crown Pillar Blasting June 2020
- West Zone Crown Pillar Blast Locations – Plan view; and
- M8277 Break-Away Drill and Blast – Lupin Mine Closure – West Zone Pillar

Interested Party:	CIRNAC	**Technical Comment No:**	5
Subject/Topic:	Long Term Stability of Dome Cover and Erosion Stopes		

Reference:

- n/a

Detailed Review Comment by Party (November 17, 2020):

Since the development of the draft FCRP, CIRNAC has expressed concerns regarding the long-term effectiveness and erosion stability of the proposed dome cover and water management systems. Prior to the Public Hearing of January 2020, LMI replied through a series of discussions and the Technical Memos included in Appendix H-8 (Technical Memorandum in Appendix H-8 regarding Conceptual Design for the Waste Rock "Dome" at Lupin Mine for response to TM/PHC Commitment No.5 (Golder, 2019d).

Pursuant to the Public Hearing, in response to Condition 25 of the Water Licence, Golder provided a Technical Memorandum dated 8 June 2020 that included a brief discussion on the "Dome" Design Objective and two "Not for Construction" drawings; one provided a Plan View drawing of the proposed dome, and the other provided two cross sections through the proposed "dome" along with typical details of the proposed drainage chutes, and the crest perimeter berm.

CIRNAC appreciated LMI's submission of the additional information in the Technical Memorandum and subsequently provided review comments to the NWB for LMI consideration. CIRNAC notes that the 8 June 2020 memo and drawings from LMI were not included in the R1 FCRP document.

Request or Recommendation by Party (November 17, 2020):

CIRNAC recommends that the R1 FCRP be updated to include:

- The contents of the 8 June 2020 Golder Technical Memorandum responding to Condition 25 requirements.
- CIRNAC concerns on the "dome" design related to long term erosion, as expressed in CIRNAC comments on the Condition 25 Submissions as dated 25 August 2020.
- Any further design details that LMI may have generated since June 2020 with respect to the "dome" design.

LMI Response (February 1, 2021):

LMI notes the technical review of information related to Water Licence 2AM-LUP2032 Part E, Item 25, 26 & 27 was only concluded by the NWB on 2 November 2020 wherein, NWB confirms that it has completed its review of the above mentioned Technical Memorandums and related submissions, and finds the information functional and generally satisfying Part E, Items 25, 26, and 27 of Water Licence 2AM-LUP2032. Refer to document titled 201102 2AM0LUP2032 Part E, Item 25, 26, 27-ODDE.pdf at ftp://ftp.nwb-oen.ca/registry/2%20MINING%20MILLING/2A/2AM%20-%20Mining/2AM-LUP2032%20LMI/3%20TECH/E%20WASTE%20DISP/

LMI will provide an updated Rev2 of the FCRP in the 2020 Annual Report due 31 March 2021. The updated FCRP Rev1 was submitted to the NWB on September 28, 2020.

Request or Recommendation by Party (February 16, 2021):

CIRNAC recommended information LMI submitted in a technical memo on June 8, 2020 regarding conceptual design for the waste rock “dome” be integrated into the FCRP. Furthermore CIRNAC requested that our concerns raised on August 25, 2020 be addressed and any further details or modifications for these reclamation works developed since June 2020 be provided. LMI has committed to doing so in revision 2 of the FCRP, which CIRNAC will review once received.

LMI RESPONSE (March 17, 2021):

LMI considers this item resolved.

Interested Party:	CIRNAC	**Technical Comment No:**	6
Subject/Topic:	TCA - Embankment Stabilization and Erosion		

Reference:

- n/a

Detailed Review Comment by Party (November 17, 2020):

Condition 26 is a Licence condition generated with respect to addressing the concerns expressed and the request for additional information by Intervenors to clarify the nature and extent of long term stabilization and closure works at the TCA, and in particular as related to K and M dam repairs and long term stability and erosion control.

By way of a Technical Memorandum from Stantec dated 8 June 2020, LMI provided a substantial information package that included design notes, specifications, and a series of drawings (plans, sections, profiles, and details) related to the proposed closure works for the TCA area. Specifically, the package included 15 drawings: 1 Design Specification drawing, 4 Cell 5 drawings; 4 Cell 3 drawings; 3M Dam drawings; and 3 K Dam drawings.

CIRNAC notes that the 8 June 2020 memo and drawings were not included in the R1 FCRP document.

Request or Recommendation by Party (November 17, 2020):

CIRNAC recommends that the R1 FCRP be updated to include:

- The contents of the 8 June 2020 Stantec Technical Memorandum responding to Condition 26 requirements.
- Any further revisions or details that LMI may have generated since June 2020 with respect to the closure works at the TCA.

LMI Response (February 1, 2021):

LMI notes the technical review of information related to Water Licence 2AM-LUP2032 Part E, Item 25, 26 & 27 was only concluded by the NWB on 2 November 2020. LMI will provide an updated Rev2 of the FCRP in the 2020 Annual Report due 31 March 2021. The updated FCRP Rev1 was submitted to the NWB on September 28, 2020.

Request or Recommendation by Party (February 16, 2021):

CIRNAC recommended the design notes, specifications and drawings for long term stabilization and closure work at the tailings containment area including Dams K & M provided in a June 8, 2020 technical memo for Part E, Item 26 of the licence, be incorporated into the FCRP. Additionally CIRNAC requested any further details or modifications for these reclamation works developed since June 2020. LMI has committed to doing so in revision 2 of the FCRP, which CIRNAC will review once received.

LMI RESPONSE (March 17, 2021):

LMI considers this item resolved.

Interested Party:	CIRNAC	**Technical Comment No:**	7
Subject/Topic:	TCA - N Dam and Potentially Exposed Tailings		

Reference:

- n/a

Detailed Review Comment by Party (November 17, 2020):

Figure 11 of the R1 FCRP shows that a tailings cover is to be placed in the area contained by the N Dam. No other reference is made to work at the N Dam or covering of the N Dam tailings in the R1 FCRP document.

Appendix H-03 TCA Dam Stability Review Rev 0 dated 14 November 2020, includes modeled cross sections of the N Dam (Fig 30, 31, and 32) as part of the geotechnical stability analysis. Given that the downstream embankment of the N Dam was mostly underwater in 2019 it is unclear how the profile was generated.

LMI's provision of additional TCA details in the 8 June 2020 Stantec Technical Memorandum and drawing package addresses the N Dam tailings cover in Drawing 002 Cell 5 Closure, Plan View - in which Note 3 states that topographic and bathymetric surveys were not available due to ponded water, that dewatering is required before cover placement, and that the contractor is to adjust cover placement to ensure a 1 m cover thickness. The drawings do not clearly indicate water flow management in this area, e.g., will there be an outlet from this area, and if so where and how it will be constructed.

Request or Recommendation by Party (November 17, 2020):

CIRNAC recommends that LMI provide additional information with respect to the contour information used in the N Dam Safety analysis as well as on the final contour elevations and associated water management for the N Dam containment area.

LMI Response (February 1, 2021):

Dam N profiles were generated using the bathymetric survey information as outlined in the FCRP Technical Memorandum: 2AM-LUP2032 related Technical Meeting Commitment No.6 Response – Geotechnical Review on the long-term stability of the TCA Dams (Refer to Updated FCRP, Appendix H_03). Based on currently available information, Cell N cover will be shaped to shed water and does not require an outlet.

Request or Recommendation by Party (February 16, 2021):

CIRNAC requested the contour information used in the N Dam Safety analysis and the final contour elevations and associated water management for the N Dam containment area be shared. The licensee indicated which contour information they used to generate N Dam profiles, and indicated "*Cell N cover will be shaped to shed water and does not require an outlet*." Plans for the shape of the Cell N cover are not in the FCRP, and CIRNAC recommends they be included for future review.

LMI RESPONSE (March 17, 2021):

Cell N is included in the approved TCA Closure Plan, and will be covered as per the approved TCA Closure Plan with minimum 1 m of esker and sloped for passive drainage. LMI will provide the contour information in the updated FCRP addendum being submitted with the Annual Report on March 31, 2021.

Interested Party:	CIRNAC	**Technical Comment No:**	8
Subject/Topic:	Financial Security - Section 7		

Reference:

- n/a

Detailed Review Comment by Party (November 17, 2020):

In regard to Financial Security, Section 7 has been significantly altered to remove discussion of fonner liability estimate and other related information. The R1 FCRP makes reference to LMl's January 2020 RECLAIM estimate of $23,463,049; the release framework and milestones; states that $6,549,072 was released to LMI in April 2020, and that the new letter of credit approved 9 June 2020 is in the amount of $19,558,231. CIRNAC appreciates inclusion of this current detail, and observed no discussion on the difference in security held and LMl's RECLAIM estimate value less the released amount ($2,644,254). This may lead to confusion when parties review the RECLAIM model to evaluate reduction of security and the amount of security still being held.

Request or Recommendation by Party (November 17, 2020):

CIRNAC recommends that LMI provide a brief discussion on the difference in security held and LMl's RECLAIM estimate value less the released amount.

LMI Response (February 1, 2021):

In January of 2020, the security for 2AM-LUP1520 was $26,107,303. LMI's revised RECLAIM estimate submitted in January 2020 was in the amount of $23,463,049. The NWB decision when approving the renewed/FRCP water licence 2AM-LUP2032 was to keep the security the same, being $26,107,303. In April of 2020 LMI obtained a release in the amount of $6,549,072 leaving the total security at $19,558,231. In October of 2020 LMI obtaining another release in the amount of $4,984,477 leaving the total security of January 2021 at $14,573.754.

Request or Recommendation by Party (February 16, 2021):

CIRNAC requested the licensee provide a discussion on the security estimate values. LMI has provided the requested information in their reply and CIRNAC recommends they incorporate these up to date figures in their FCRP.

LMI RESPONSE (March 17, 2021):

LMI will incorporate these figures in the updated FCRP addendum.

4.0 KITIKMEOT INUIT ASSOCIATION (KIA)

Interested Party:	KIA	**Technical Comment No:**	New 1A
Subject/Topic:	Introduction		

Reference:

1. Introduction

Detailed Review Comment by Party (February 15, 2021):

It is hoped that LMI can consider the comments made in this report as well as those likely to be provided by the other commentors of the FCRP (namely BlueStar, CIRNAC and ECCC) in their preparation of the updated FCRP, including a new Post-Closure Monitoring Plan, and the Annual Report of site activities which are all dur for submission to the NWB by March 31, 2021.

Request or Recommendation by Party (February 15, 2021): n/a

LMI RESPONSE (March 17, 2021):

LMI will consider the comments in their preparation of the updated FCRP addendum. Noting the Annual Report and updated Plans are due March 31, 2021 but the PCMP is not due for submission until April 9, 2021. If approved any updated versions of the PCMP's would need to be filed with the Annual Reports on March 31 of each year.

Interested Party:	KIA	**Technical Comment No:**	New 1B
Subject/Topic:	Introduction		

Reference:

Layout of the Report

Detailed Review Comment by Party (February 15, 2021):

This report will address the 36 comments provided by LMI on the KIA (SJCI) review of the FCRP.

Comments also include items considered unresolved to previous KIA comments on the LMI responses to Conditions included in Part E, Items 25, 26 & 27 of the new Water License (2AM-LUP2032) as well as the text from the Conclusions and Recommendations sections of the latest (Nov.15, 2020) SJCI report.

Request or Recommendation by Party (February 17, 2021): n/a

LMI RESPONSE (March 17, 2021):

Part E, Item 25, 26 and 27 have already been resolved, whereby the NWB issued LMI a letter advising that these condition had been satisfied on November 2, 2020, as well as a letter from the KIA to the NWB confirming LMI's responses are acceptable dated August 12, 2020.

LMI confirms that where applicable comments will be included as addendum to the FCRP with the 2020 Annual Report due to the Board March 31, 2021 as required by the current water licence.

Interested Party:	KIA	**Technical Comment No:**	3
Subject/Topic:	Previous KIA Comments on New Water License Conditions		

Reference:

- Item 27

Detailed Review Comment by Party (November 17, 2020):

A range of methodologies are available for dealing with pockets of tailings located outside of the tailings cells, or currently below the water cover in the TCA water ponds, although the FCRP is relying on a limited selection of these, namely cover-in-place(based on Stantec Technical Memorandum dated June 8, 2020). This may not be the best long-term methodology. However, LMI states the civil works contract for this has already been awarded and thus there is no change possible. This is not correct. It would be in LMI's best interest in employing the best methods and ones which in the end will have the best long-term results.

Uncertainties: KIA had questioned the uncertainty of there being adequate volumes and quality of esker material that are being proposed to cover significant portions of the site as engineered cover. LMI provided a response stating "... LMI does confirm that there are more than adequate volumes of esker material to carry out the required closure and reclamation activities". A blanket statement does not provide adequate assurance.

Request or Recommendation by Party (November 17, 2020):

i) LMI should provide a listing of all the outlying or yet to be exposed deposits of tailings material and provide a thorough alternatives assessment for all the individual areas with the best solution for each then determined.

ii) LMI should provide an estimate of the total volume of acceptable quality esker materials required to complete the reclamation program and the timeline on the esker material being extractable(i.e., a methodology) to be employed due to the pile's frozen permafrost state.

LMI Response (February 1, 2021):

i) A technical memo, Commitment Part E Item 27 Response, outlining a conceptual cover was completed as part of the FCRP.

ii) Currently, the borrow area is approximately 422,000 m2. Assuming an annual thaw depth of at least 1.5 m, at least 633,000 m3 of esker is readily available for use and adequate for closure application. The esker landform is very extensive and there would be room to expand the borrow pit within the Lupin Surface Lease.

Request or Recommendation by Party (February 15, 2021):

The first point has not been answered; specifically a full inventory of outlying and yet to be exposed tailings and best remediation plans have not been provided. The second point concerning the timely availability of sufficient esker material has been answered.

LMI RESPONSE (March 17, 2021):

Part E, Items 27 have been resolved as per the NWB letter date November 2, 2020 as well as a letter from the KIA to the NWB confirming LMI's responses are acceptable date August 12, 2020. CIRNAC advised they were satisfied on October 30, 2020.

A full inventory of yet to be exposed tailings cannot be completed until the water in the TCA is lowered to final closure elevations. If tailings are exposed while lowering the TCA to closure elevations, LMI has addressed that contingency as part of the technical memo Commitment Part E, Item 27 Response, outlining a conceptual cover design that will be refined according to specific site conditions.

Interested Party:	KIA	Technical Comment No:	4
Subject/Topic:	General Comments of FCRP		

Reference:

- n/a

Detailed Review Comment By Party (November 17, 2020):

i) Significant portions of the new FCRP have not been updated since the 2018 document. A number of tasks proposed for work to be undertaken in 2018 and 2019 after the 2018 FCRP was issued are still included in the 2020 text with the same estimated dates of when the work was to be undertaken. It does not look professional and is confusing. The 2018 Plan was prepared by Golder Associates. The 2020 Plan, although in the same format as the earlier Plan, does not show it as being a Golder product. The Plan was likely updated by LMI, who did not do as thorough an editing as would have been done by Golder.

ii) LMI considered the estimated 450,000m3 of contaminated soils, comprising 35,200 m3 PHC-contaminated & 418,000 m3 As-contaminated soils(Ref: FCRP Sec. 4.3.2.3)too large a volume for ex-situ remediation or on-site remediation using methods such as PHC-landfarming or consolidating and covering due to their volumes and time constraints (i.e., wanting to have active reclamation work completed within 2-3 years) (Ref: FCRP Sec. 4.3.2.3). Instead, a risk-based plan has been provided for removing 16,300 m3 of highly As-contaminated soils (Ref: FCRP Sec. 4.3.2.3) into the crown pillar and covering it with esker material layer and for the remainder (As-and PHC-contaminated soils) the Plan is to cover these areas in-situ with esker material covers. Also, the FCRP does not provide any conclusions on the success or failure to date of the small site landfarm that was established in 2017 with an initial volume of 500m3 of PHC-contaminated soils.

iii) The FCRP proposes a program of covering areas of contaminated soils with an esker material although the use of several different methodologies would likely provide a better long term solution and one which ultimately will require less long-term monitoring and the possible need for later interventions if acceptable long-term levels are not reached. The FCRP is basing this plan on a flow sheet decision matrix (Stantec 2020) which does not provide sufficient detail to adequately assess the numerous areas on site which need to be dealt with individually and which in the end may be best suited to one of several different remediation methodologies. (i.e., the toolbox should not consist of just one tool, as is being proposed).

iv) The FCRP relies on a significant quantity of acceptable quality esker material to be used as an engineered cover for all the required areas. The document does not provide an estimate of how much material will be required and whether there are sufficient volumes available, be it at the Fingers Lake location or from elsewhere, and if not what the back-up plan may be.

Request or Recommendation by Party (November 17, 2020): n/a

LMI Response (February 1, 2021)

i) The FCRP Rev0 was approved by the NWB on issuance of the Type A Water Licence and subsequent approval of the Licence by the Minister. LMI was requested by the NWB to update the approved FCRP Rev0

to address relevant comments and recommendations provided by intervening parties and the Board during the review process for the Application which concluded in January 2020 not to complete a comprehensive revision of the approved Plan.

ii) The remedial strategy for contaminated soils consists of the excavation and underground disposal of the heavily arsenic impacted soils (16,300 m^3) and the petroleum hydrocarbon (PHC) impacted soils (35,200 m^3). The remainder of the arsenic contaminated soils (401,700 m^3) will be consolidated within the central mill area, graded to a dome shape, and covered with 1.0 m of esker material. There are no conclusions on the success or failure of the pilot landfarm as this remedial strategy was abandoned shortly after construction of the pilot landfarm. This strategy was abandoned due to the significant volume of PHC impacted soils and the impracticability to bio-remediate this volume of soil over a short timeframe (2 to 3 year closure period).

iii) The list of remedial alternatives considered for the contaminated soils is provided in Table 15 of the FCRP. The HHERA confirmed that the selected remedial strategy is sufficiently protective of human health and the environment (refer to Section 6.2 of the FCRP).

iv) Refer to Technical Comment Response KIA-TC-03 (iii). An estimate of the quantities required were provided to Mr. Jann (via LMI's response to the KIA on July 31, 2020 – filed on the NWB FTP site). On August 12, 2020 the KIA responded, "The LMI Response is considered acceptable."

Request or Recommendation by Party (February 17, 2021):

The first point was not answered; it dealt with the lack of updating the FCRP to reflect work done at the site over the past 2 years (i.e., 2018 and 2019) prior to issuance of the 2020 FCRP. It is understood that a comprehensive revision, with new or revised plans was not requested but the updated document should acknowledge work undertaken since the previous FCRP was issued.

Table 15 and Section 6.2 of the FCRP do not provide an itemized evaluation of the various remediation options for all the areas of contaminated soils on site.

LMI RESPONSE (March 17, 2021):

Work completed in 2018 and 2019 has been filed with the 2018 and 2019 Annual Reports. LMI will fulfill the requirement to update the FCRP under Schedule B, Item K: Where applicable, revisions as Addendums, with an indication of where changes have been made, for Plans, Reports, and Manuals as related to the 2020 Annual Report due March 31, 2021 (still under development)

Table 15 identifies the available remediation options and the subsequent paragraphs in Section 4.3.2.3 provide the rationale for the selection of the contaminated soils remediation option (i.e., a combination of ex situ remediation and covering). It should be noted that all soils contaminated with PHC, lead nitrate, cyanide and arsenic (above 4,000 mg/kg) will be ex situ remediated and disposed into the crown pillar. Table 17 provides the estimated volumes of these materials. After the ex situ remediation is completed, the remaining waste rock in the designated areas of the mill site will be consolidated and covered.

The SJCI comment that the FCRP is basing this plan on a flow sheet decision matrix is incorrect. The decision matrix was originally discussed, an ultimately dismissed, in regard to exposed tailings in the TCA, not soils in the mill area. There is possibly some confusion surrounding soils vs exposed tailings.

Following an earlier submission concerning this item under Part E, Item 27(exposed tailings), the KIA advised on August 12, 2020 that LMI's response was considered acceptable and followed up with a letter from the NWB that this condition has been satisfied on November 2, 2020. CIRNAC advised they were satisfied on October 30, 2020.

Interested Party:	KIA	**Technical Comment No:**	5
Subject/Topic:	Detailed Comments of FCRP		

Reference:

- n/a

Detailed Review Comment by Party (November 17, 2020):

A number of references are made to the use of Discovery Mining Services (DMS) to undertake and/or to oversee others completing a number of the ongoing tasks at the site, namely site monitoring during the Active and Passive Phases of the reclamation and closure work at the site. No information is provided on how the arrangement between LMI and DMS will work. There is no information provided on whether DMS or LMI will be submitting ongoing reporting to NWB and others.

The Plan includes minimal updating of the reclamation work done at the site since the earlier 2018 DRAFT FCRP was submitted. In multiple places in the 2020 document, reclamation work that has been undertaken to the end of 2017 is mentioned, and any work for 2018 and 2019 and beyond is mentioned as work yet to done.

The text states it expects continuing licensing of the FCRP to take 10 months from the date the document was submitted; with the FCRP dated August 2020 (Ref: Executive Summary Item 8.) suggesting approvals may not be in place until mid-year 2021. The text goes on to say that concurrent with the ongoing permitting it will begin implementing the closure tasks at the site. Does this suggest active closure work has already begun at the site? Was a winter road utilized in early 2020 to mobilize heavy equipment and supplies to the site? (Note: This section refers to plans to begin implementation of reclamation activities in 2018).The previous request (above) covers this point.

Request or Recommendation by Party (November 17, 2020):

i) An overview on the arrangement between LMI and DMS should be provided.

ii) LMI should update the August 2020 FCRP to be current and updated showing work completed to the end of 2019 and proposed future work to fulfill the Plan.

LMI Response (February 1, 2021)

i) All permits, authorization and licenses are issued to LMI. LMI is responsible for compliance of all permits, authorizations, licences and/or directives under applicable legislation and regulations. The arrangement between LMI and Discovery Mining Services as with any other consultants engaged in support of remediation at the site are private contracts and not subject to public review.

ii) & iii) LMI is committed to compliance and submission of the Annual Report on March 31, 2021 to reflect works completed in 2020 and will include in accordance with Part m) a summary of any abandonment and reclamation work completed during the year and an outline of any work anticipated for the next year, including a revised schedule.

Request or Recommendation by Party (February 17, 2021):

Thank you for your clarification concerning LMI being responsible for all work on site.

The comment remains that during preparation the new FCRP should be checked for accuracy concerning dates and updating what dates are considered to be in the past and what is in the future (similar to KIA T.C. No. 4, referenced above).

LMI RESPONSE (March 17, 2021):

Pls see comment above for KIA T.C 4.

Interested Party:	KIA	**Technical Comment No:**	7
Subject/Topic:	Detailed Comments of FCRP		

Reference:

- Section 2.1.2

Detailed Review Comment By Party (November 17, 2020):

Sec 2.1.2 Climate: The text references others' work in stating that the mean annual temperature at the site will increase by about 4 to5'C over the next century. It then goes on to discuss the range of climate and temperature changes that may occur. This re-affirms the need to build significant conservatism into the design of civil structures at the site (TCA dams, spillways, engineered covers, etc.) due to the uncertainty as to long-term climate at the site.

Request or Recommendation by Party (November 17, 2020):

n/a

LMI Response (February 1, 2021)

A technical memorandum, 2AM-LUP Technical Meeting Commitment Number 12 Response – Risk Assessment on Two Dams in the Lupin Tailings Containment Area, outlining the stability of the dams was provided as part of the FCRP.

Request or Recommendation by Party (February 17, 2021):

A general comment was made in the SJCI T.C. concerning the conservatism in the reclamation plans being required due to the risk of temperature rises due to climate change. This topic is also covered in KIA T.C. No. 27 and is still considered valid.

LMI RESPONSE (March 17, 2021):

Thank you for your comment.

Interested Party:	KIA	**Technical Comment No:**	14
Subject/Topic:	Detailed Comments of FCRP		

Reference:

- Section 6.2.4

Detailed Review Comment By Party (November 17, 2020):

Section 6.2.4 Regulatory Review: The text mentions the commitment to a new Post Closure Monitoring Plan and then goes on to describe the ERA and HHERAs that were conducted. These are not typical components of a Regulatory Review section in a Mine Closure Plan. This section should provide a brief overview of the mandated regulatory review process in Nunavut (but to not repeat what was detailed near the beginning of the FCRP), what was the regulatory review process utilized for this project (history to date, current status and future expectations), and what the outcomes were from the company going through the process.

Request or Recommendation by Party (November 17, 2020): n/a

LMI Response (February 1, 2021)

In Nunavut, Type A Water Licences subject to final closure (i.e., Nanisivik Mine and Polaris Mine) and subsequently Lupin under specific conditions and commitments in response to intervening parties to include within the final closure plans requirements for a Human Health and Ecological Risk Assessment.

The regulatory review process is clearly defined by the NWB Guidance documents found on the NWB ftp site at the following: ftp://ftp.nwb-oen.ca/other%20documents/NWB%20GUIDES/ and the full regulatory review process for the LMI's renewal/FCRP approval application is detailed as part of the NWB Licence Decision located on the NWB FTP site. Given these transparent processes defined by the NWB a summary of the process duplicated within the FCRP is not warranted.

A high-level summary of the project history is provided in the FCRP Rev 1 Table 12: Summary of Progressive Reclamation and Post Operation Activities. Specific to closure requirement defined in previous Type A water Licence are summarized in Appendix B. The current status and future expectation will be outlined in the annual reports to as required under Schedule B of the Type A Water Licence.

Request or Recommendation by Party (February 17, 2021):

The LMI response discusses the significance of the HHERA and mentions where the Regulatory Review process has been discussed in the NWB Guidance document and that it is outlined elsewhere within the FCRP. That is all acceptable, however the reasoning as to why this section of the FCRP goes into the details of responding to several CIRNAC comments about the ERA and later the HHERA is unclear, and as stated in the KIA T.C. is not typical of what would be in such a section of a mine closure plan. The section would typically discuss the regulatory review process.

LMI RESPONSE (March 17, 2021):

LMI thanks you for your comment. Part I, Item 2 states:

> The Licensee shall, within ninety (90) days of approval of the Licence, submit to the Board for review, an updated *Final Closure and Reclamation Plan*, to address **relevant comments and**

recommendations provided by intervening parties and the Board during the review process for the Application.

The section was added to comply with the NWB direct request.

Interested Party:	KIA	**Technical Comment No:**	15
Subject/Topic:	Detailed Comments of FCRP		

Reference:

- Section 7.0

Detailed Review Comment By Party (November 17, 2020):

Section 7 Financial Security: The text does not conform to the standard Financial Security sections seen in mine closure plans.

Typically this section would outline the basis of the security approach used in this cost estimation, how the estimated detailed closure costs were determined, the basis of what cost estimating model is being used and why, major and minor assumptions in the closure tasks and their costs, references back to the closure plan tasks describing costing aspects of those undertakings. Additionally, because the costing is based on the rudimentary RECLAIM Model a section needs to describe all the assumptions that went into the individual line items (i.e., the effort required, the unit cost used, etc.) that might otherwise be included directly in a more detailed model but are not with the RECLAIM model.

The text refers to Appendix G in which 3 sub-sections include the RECLAIM costing, milestones for determining when tasks are considered to have been completed in order to qualify for return of security for that item and a joint LMI/CIRNAC Security Reduction Framework document.

The focus of this section in the FCRP is on security refunds; what the milestones are to confirm specific tasks have been completed. how LMI can apply for security refunds, and ensuring the agencies release the funds in a timely manner. A discussion on how securities are to be returned is a subject that is dealt with in Appendix G-3 and should not form the basis of this section in the FCRP.

The 5% continency allowance included in the RECLAIM costing (app. G-1) is significantly lower than should be accepted for a large project with a number of uncertainties and with costing based on a very rudimentary spreadsheet program. This is worsened by the Framework presented in App. G-2 for giving the company credit for completed tasks. That table does not align with typical return of securities criteria as is used in jurisdictions the author has experience with, namely BC, the Yukon and Ontario.

It would be interesting to map out the likely reduction in Financial Security being held with the currently planned work schedule and what funds will be left at various future milestone dates. A reasonable financial provision should be in place after completion of the Active Phase, due to the uncertainty of how long monitoring may need to continue until final equilibrium acceptable values and closure criteria are reached, as well as for the possible need for maintenance work, and finally for the possible need for interventions to address deficiencies. No information is provided to ensure there will be sufficient security in place towards the end of the Active Phase should a deficiency arise through the Post-Closure Monitoring and Maintenance Phase.

Request or Recommendation by Party (November 17, 2020):

The FCRP should provide rationale as to how the 5% Contingency Allowance for the Closure Plan cost estimate was determined.

LMI Response (February 1, 2021)

The NWB within guidance documentation, terms and conditions of specific water licence and decision related to the Lupin Mine site and NWB accepted guidance for mine closure in Nunavut (i.e., Nunavut Reclamation Policy (INAC 2002)) as well a precedent for success mine closures in Nunavut (i.e., Nanisivik, Polaris) the use of Reclaim is the current accepted standard. The process for establishing security requirements has evolved over the Life of the project and is critically assessed repeatedly throughout the LOM during each Type A water licence renewal/amendment process (i.e., the process recently undertaken in 2019, concluding in Q1 2020 on issuance of the current licence) or as stipulated in the specific terms and conditions related to security of any current or previous water licence for the project.

Our reclaim estimate was 5% but based on accepted security by the NWB under 2AM-LUP2032 it is currently 29.58%. The water licence approval set the security amount at $26,107,303, which exceeds the FCRP estimate by $2,644,254, so the effective contingency is over 29% of direct capital costs.

The RECLAIM estimate in Appendix G provides an allowance of $1,139,442 for Post-Closure Monitoring and Maintenance, additional work and indirect costs, which would remain in place at the end of the Active stage.

Request or Recommendation by Party (February 17, 2021):

The LMI response mentions that the financial security in place is currently ~29% of the latest cost estimate and not the 5% stated in the RECLAIM cost estimate and referred to in the SJCI Technical Comment. The original comment still applies.

The 5% contingency shown on the RECLAIM summary page is only on the Direct Costs and does not include the Indirect Costs which amount to a slightly higher total cost than the Direct Costs, being ~$10.8M and ~$12.2M for the Direct and Indirect costs. The 29% number LMI is referring in their response has more to do with the stepped reduction of security being held as the closure plan continues to evolve and reclamation work on site is being completed and refunds are being awarded back to LMI, rather than the overall contingency allowance being placed on implementing the entire closure plan. The Summary Sheet also states the contingency is lower due to having a firm bid for the civil works component of the closure plan. However, a number of the required closure components and their costs will likely be beyond the scope of the current civil works contract (although the author has no knowledge of the contract's full scope of work) including the various add-ons such as project management, permitting, taxes, insurances, bonding, engineering, as well as active phase and later post-closure monitoring programs, etc.

The comment about the claimed 5% figure (actually $538K on a Total Direct and Indirect Costs Estimate of $22.9M, i.e., 2.3%) being insufficient is still considered valid.

And it is likely the cost estimate for the Post Closure Monitoring Program (now at $1.139M) will need to adjusted after the updated PCMP is issued and then following review and incorporation of comments, approved.

LMI RESPONSE (March 17, 2021):

Security negotiations and agreement for mechanisms moving forward have been approved by the NWB and CIRNAC Minister under water licence 2AM-LUP2032 (Refer to Part C and Schedule C). The Licence Terms and Conditions allow for updates and any future changes and an updated RECLAIM estimate will be provided to the NWB.

Interested Party:	KIA	**Technical Comment No:**	17
Subject/Topic:	Detailed Comments of FCRP Supporting Documents		

Reference:

- Appendix H-01 - Decision Matrix Memo Rev. C, Jan 2020 (App. H-01)

Detailed Review Comment By Party (November 17, 2020):

The Decision Matrix is intended to put forward the alternative methodologies to deal with the contaminated areas of the site. However, the document presents a bias from the beginning in favor of the cover-in-place methodology. A number of the arguments in favor of this methodology have similar issues as with the cover-in-place approach (e.g., having to get access to bad material for removal, it being the same as for gaining access to place a cover. Relocation and consolidation of tailings elsewhere has been done in a large number of other mines, ...}. Arguments concerning LMI having a closure work schedule and civil contractor already in place, the additional work involved in undertaking a relocation and placement elsewhere are not valid, if that approach has significant benefits.

Hydraulic methods (i.e., hydraulic monitoring) can be done with full containment of runoff waters and is likely the best method to remove shallow areas of contaminated materials, especially over uneven bedrock area. The TCA has a large area of water covered cells as well as dry cells (including several that are yet to be completely covered) that the material could be pumped to, especially as the current plan involves a period of unknown duration for allowing water quality within the TCA to come to acceptable and long-term equilibrium levels prior to switching to the long-term passive water flow-through system for the facility.

Contaminants mixed within soft lakebed sediments are more difficult to deal with. In this case, a number of options are available and should have been considered. They would probably be very local-deposit specific, but could include methods such as 1) leave in place (e.g., if already established with a natural soil cover and vegetation), 2) cover in place, 3) treat in place, 4) hydraulic removal(dredging or hydraulic monitoring), or5)through physical removal(possibly assisted by cutting in wicking channels where contained water can be drained from the area, making access onto the area with heavy machinery doable), as well as a number of other methods.

A site-wide assessment of all the areas of potential concern and alternative closure methodologies should have been provided to adequately determine the best solutions for all the areas.

With the proposed cover-in-place method, the document does not address the issue of ultimate degradation of the esker material cover over time(through freeze-thaw cycles, cracking, wicking of contaminants up into the cover, formation of erosion gullies, etc.)that will degrade the performance of the cover and may lead to downstream water quality effects as well as localized sediment transport through erosive forces across the covers.

Finally, the report suggests Active Monitoring will demonstrate that the proposed methodology will be successful. But it does not mention the possibility of failure and the need to evaluate alternative remedial measures, which would be better done now rather than in the future when a problem is realized and with more limited resources available.

Request or Recommendation by Party (November 17, 2020): n/a

LMI Response (February 1, 2021)

These topics are addressed in a technical memo, Commitment Part E Item 27 Response, providing a conceptual cover design for known exposed tailings at the northern corner of Cell 4.

Request or Recommendation by Party (February 17, 2021):

The author stands by the comments presented in the text of the submitted T.C. There are a number of methodologies that should have been considered for each of the areas being evaluated (i.e., more than just the two mentioned in the Stantec report, or the one selected (i.e., cover in place) as the one to use throughout).

LMI RESPONSE (March 17, 2021):

This has been resolved under Part E, Item 27, whereby the NWB issued LMI a letter advising that this condition had been satisfied on November 2, 2020, as well as letter from the KIA to the NWB confirming LMI's responses are acceptable date August 12, 2020. CIRNAC advised they were satisfied with responses on October 30, 2020.

Interested Party:	KIA	Technical Comment No:	20
Subject/Topic:	Detailed Comments of FCRP Supporting Documents		

Reference:

- Appendix H-03 - Geotechnical Review on the Long-Term Stability of TCA Dams Rev. 0, Nov 2019 (App. H-03)

Detailed Review Comment By Party (November 17, 2020):

This report was issued in fulfill Technical Commitment 6. The author is not a geotechnical engineer and as a result cannot comment on the detailed engineering aspects of this geotechnical review on the long-term stability of the TCA dams. However, a number of general comments are presented below;

The Design Basis and Criteria section states that permafrost is assumed to remain at current levels. Is this considered adequate?

From previous documentation it is understood that neither Cells 3 nor 5 have yet been completely covered with the esker material cover. It is not known which areas of these cells are yet to be covered and whether these areas are the areas where proposed re-grading of the surfaces is proposed as shown in Figures 2 & 3 of the Appendix.

The report shows the proposed surface contouring to be undertaken across Cells 3 & 5 to have any surface water flow into the channels and then towards the outflow structures. Is the “New Tailings Cover” in these cells working with the proposed esker material and not the tailings, before a cover is placed over the areas, or does it suggest existing tailings will be excavated/re-sloped before the 1.0m esker material cover is placed?

Should the non-woven geotextile in the proposed outflow structures in Dams J & L not have bedding material placed against it rather then the 0.5m thick Boulder Armor with a D50 of 250mm?

The slope stability analyses shown in the Figures (Nos.A.1 to A.32) provide results for all the dams including the current as-built configurations and final re-sloped scenarios for Dams K & M. But all the analyses are undertaken with the current permafrost level at a depth of 2m below ground surface.

Request or Recommendation by Party (November 17, 2020):

i) Based on estimates of average annual temperature rises of 4-5’C by the year 2100 LMI should confirm that modelling only undertaken at current permafrost levels is considered sufficient.

ii) LMI should confirm whether the drainage channels being installed in the tailings cells are being cut into tailings or the cover layer.

iii) LMI should provide the basis by which using just the one depth of permafrost in the dams is considered sufficient.

LMI Response (February 1, 2021)

i) The technical risk assessment memorandum, 2AM-LUP Technical Meeting Commitment Number 12 Response – Risk Assessment on Two Dams in the Lupin Tailings Containment Area, provided in support of the FCRP considers conditions with and without permafrost.

ii) The cover extents are outlined in the construction drawings. No bedding is required as the geotextile is intended to be a separator and does not require protection.

iii) The technical risk assessment memorandum, 2AM-LUP Technical Meeting Commitment Number 12 Response – Risk Assessment on Two Dams in the Lupin Tailings Containment Area, provided in support of the FCRP considers conditions with and without permafrost.

Request or Recommendation by Party (February 17, 2021):

The text of App. H-03 – Design Basis and Criteria states "...Permafrost was assumed to remain at its current level…" The question remains as to why the long-term stability analyses undertaken herein did not consider lowered top of permafrost levels in the dams in the long-term (up to year 2100) as was determined in the Climate Model (App. H-02) in all the scenarios modelled.

LMI RESPONSE (March 17, 2021):

LMI provided a risk assessment on the impact of the permafrost on the dam stability in the Public Hearing Commitment #12 response, Appendix H-12. Appendix H-03 referred to by SJCI was resolved with CIRNAC during the public hearing with LMI's agreement to provide additional information which became condition Part E, Item 26 under the water licence. Condition Part E, Item 26 was resolved on November 2, 2020 by the NWB, the KIA considered LMI's responses acceptable on August 12, 2020 and CIRNAC was satisfied with LMI's responses on October 30, 2020. Appendix H-12 was resolved with ECCC during the application process with a commitment to monitoring in the Post Closure Monitoring Plan. LMI has incorporated this into the draft PCMP.

Interested Party:	KIA	Technical Comment No:	21
Subject/Topic:	Detailed Comments of FCRP Supporting Documents		

Reference:

- Appendix H-06 - Coupled Thermal-Seepage Modelling of the Esker Cover for the Waste Rock "Dome", Oct 2019 (App. H-06)

Detailed Review Comment By Party (November 17, 2020):

Section 3.3 -Material Properties: The text mentions that thermal and hydraulic properties of the different materials being assessed in the models (i.e., the esker material and waste rock) were unavailable and were therefore assumed or estimated by the modellers. This likely makes for a deficiency as to the validity (or accuracy) of the model outputs.

The report then states the ground was assumed to remain saturated and frozen for most of the model duration although elsewhere it is stated that it thaws in late summer.

Section 4.1 & 4.2 -Model Results for Current and Long-Term Scenarios: This section states the active layer will be subject to seasonal freeze and thaw and this zone of infiltration will move downward from a depth of 2.7-3 m currently and then down to 4 m below surface in the long-term scenario. In Section 5 –Conclusions: The text states that the infiltration through the esker layer will increase over time and that climate change considered there would be.

Field trials should have already been undertaken with the monitoring used to determine the optimal cover for the waste rock dome, prior to the facility being built. However, the opportunity for this has passed and now the proposed design needs to be constructed. To be able to predict it will meet long term closure objectives it should be built with several instrumented data collection sites from within and below the covers, supplemented by regular visual inspections

Request or Recommendation by Party (November 17, 2020):

LMI should provide a confirmation of the validity of the model results with the modellers use of typical values for similar (i.e., in-house) materials rather than actual materials from the site.

LMI should provide rationale as to why the modelling assumed the ground to be saturated and frozen through the entire length of the modelling runs.

"...an increase in percolation rates at the base of the esker [layer] from 16% to between 22 and 25%...It is recommended that supplemental thermistor strings and, if possible, construction and monitoring of field trials be implemented before the final cover is constructed. The use of field trials typically brings several technical and financial advantages and provides valuable information to refine the cover design and optimize performance..."

LMI Response (February 1, 2021)

As described, the thermal properties were estimated using referenced state-of-practice methods that are incorporated in the TEMP/W software package. Likewise, the hydraulic properties of the esker (k and SWCC) were estimated from the average grain size using referenced standard practice methods.

The thermal modelling shows that thawing of the natural ground is slight and occurs only at the end of the summer for the Year 2100 case. This simplifying assumption simply means that all of the infiltration is assumed to flow through the waste rock layer.

The commitment has been made to install 4 thermistor strings into the waste rock dome and to monitor them as per the PCMP. The esker cover will be constructed in 2021, so there will not be any opportunity to carry out field trials in advance; however, the thermistor strings will document the thermal performance.

Request or Recommendation by Party (February 17, 2021):

The Technical Comments still apply. The report text states "… thermal and hydraulic properties of the different materials in the models were not available and were therefore assumed or estimated…" The output of the modelling using "state-of-practice methods" can only be as good as the inputs.

Section 4.2 of the Golder report states that the model results suggest the depth of seasonal freeze and thaw would deepen from 2.7 m under current conditions to about 4m at the end of the century. It is not as stated in the LMI response "…thawing of the natural ground is slight and occurs only at the end of the summer for the Year 2100 case…" It is not natural ground that is of concern in this case but rather the "dome".

The report authors Golder Associates recommended the benefit of using field trials before the final cover is constructed, if possible. Realizing construction of the esker cover (over the filled waste rock "dome") is due for construction

LMI RESPONSE (March 17, 2021):

This item was resolved at the Public Hearing and LMI has made a commitment to install 4 thermistor strings into the waste rock dome and to monitor them as per the draft PCMP. The results of the monitoring are expected to show actual depths of thaw that are consistent with those predicted in the modelling.

Interested Party:	KIA	**Technical Comment No:**	22
Subject/Topic:	Detailed Comments of FCRP Supporting Documents		

Reference:

- Appendix H-07 - TCA Waste Rock Review, Aug 2019 (App. H-07)

Detailed Review Comment By Party (November 17, 2020):

The report was commissioned to fulfill Technical Commitments Nos.3 & 4, as requested by CIRNAC. The report refers significantly on a 2005 URS assessment of waste rock at the site.

It is unknown why Dam3 was not sampled for ABA parameters in the 2005 program. It is a perimeter dam containing Cells 1 & 2 of tailings within the TCA. The one dam flagged as a potential concern in Table 1 is Dam 5 which is also a perimeter dam. But both of these dams have not had, nor are planned to have any new exposures of their dam slopes and thus are unlikely to have any new generation of ML/ARD seepages. Most of the other samples shown in Table 1 returned acceptable NP/MPA numbers. One of possible concern is Dam 2 with a NP/MPA of 1.03, as it is a perimeter dam and it will have its upstream face freshly exposed as the water level against it is to be dropped from elev. 483.0 to 480.0 m, as part of the closure plan. Depending on the type of rock that comprises the upstream face of the dam, ML/ARD generation from the dam material could become a long-term issue for consideration.

Commitment No. 3 also asked for a review of other waste rock areas on the site (roadways, etc.). The report provides very little assessment of any other work undertaken in these areas including it using 2017 Golder ESA results, except for a mention in the Conclusions and referring back to the TCA but not the other areas of concern across the site.

Otherwise, based on Stantec's assessment and the dams all being in the order of 25 years in age and by all apparent indications (by others), the dams are functioning without ML/ARD issues and the report significantly addresses this issue.

Request or Recommendation by Party (November 17, 2020): n/a

LMI Response (February 1, 2021)

Thank you for your comment.

Request or Recommendation by Party (February 17, 2021):

The Technical Comment still stands concerning the potential of long-term ML/ARD from the upstream face of Dam 2 (depending on the type of rock that comprises the upstream (i.e., soon to be unsaturated zone of the dam) as the water level is lowered by 3 m (and the permafrost level drops) for closure of the TCA and that this dam should have been included in the assessment as an example of a dam whose state may change with closure being implemented.

LMI RESPONSE (March 17, 2021):

At the Public Hearing CIRNAC advised that this item was resolved as LMI committed to post closure monitoring. The draft PCMP is currently being discussed with ECCC, CIRNAC and the KIA, to be submitted to the NWB on April 9, 2020 as per the water licence condition.

Interested Party:	KIA	**Technical Comment No:**	25
Subject/Topic:	Detailed Comments of FCRP Supporting Documents		

Reference:

- Appendix H-09 - TCA Cover Rev. 0, Oct 2019(App. H-09)

Detailed Review Comment By Party (November 17, 2020):

The report was commissioned to fulfill Technical Commitments No. 10, as requested by CIRNAC. Test pits were excavated at two locations within the TCA, in Cells 1 and 2. A location map of the 2 cells within the TCA should have been provided showing where the test pits were excavated and where the 7 standpipes are located. The report compares water levels and water quality in 7 standpipes in Cell 1 collected in 2002 and 2019. No mention is made of why water quality from only 5 of the 7 standpipes is provided. The report concludes that there was a saturated layer of cover material above the tailings and that there was no evidence of oxidized tailings in the two test pits and that the water quality results in 2002 and 2019 are comparable. No mention is made why there wasn't comparable data (i.e., 2002 & 2019 water levels and water quality comparison) provided for Cell 2.

Request or Recommendation by Party (November 17, 2020):

LMI Response (February 1, 2021)

The 5 standpipes that were sampled in 2019 were the same 5 that were sampled in 2002. There are no standpipes in Cell 2.

Request or Recommendation by Party (February 17, 2021):

Although the referenced Stantec report provides some interesting results, the issues raised in the KIA T.C. have not been addressed in the LMI response; specifically why were only 5 of 7 standpipes sampled from Cell 1 and why was a test pit dug in Cell 2 if there were no adjacent standpipes.

LMI RESPONSE (March 17, 2021):

This work was carried out as a commitment requested by ECCC (not CIRNAC as noted under the KIA comment). This item was resolved during the public hearing d with ECCC recommendation that the monitoring be included in the post-closure monitoring plan. LMI has included this request in the draft PCMP.

Interested Party:	KIA	**Technical Comment No:**	26
Subject/Topic:	Detailed Comments of FCRP Supporting Documents		

Reference:

- Appendix H-04.4 - APEC 2017 (App. H-04.4)

Detailed Review Comment By Party (November 17, 2020):

This one-page map of the site is titled Areas of Potential Environmental Concern and is dated Oct. 17, 2017. As was the case with the earlier Golder drawing (see 5.2.7, above) this drawing makes no reference to an accompanying report where results of all the sampling locations are presented, which is presumably the 2017 Phase 1 & 2 Environmental Site Assessment report. It is unknown why this figure is a part of the supporting documents for this 2020 review of the FCRP but the ESA report is not.

Request or Recommendation by Party (November 17, 2020): n/a

LMI Response (February 1, 2021)

Refer to LMI response herein to KIA-TC-23

Request or Recommendation by Party (February 17, 2021):

This is another example of where a one-page site map has been extracted from a significant supporting document without the accompanying relevant information. It is unfortunate that LMI includes these drawings without support (even a full listing of what is on the map and possibly the associated interpretation from the report), and that the onus is on the reader to find the full report to enable a proper evaluation of the drawing details and its significance.

LMI RESPONSE (March 17, 2021):

The map was included as a request by CIRNAC and referenced the corresponding document. A link to the updated ESA has been provided to SJCI in our previous response. The Lupin Mine has been a project/mine in operation since the 80's and has a significant amount of history and associated documentation. Therefore, LMI provided a reference document with links to all the various relevant documents located on the NWB ftp site, which was included with the Application for the FCRP (including the referred to ESA) named Table A - List of Plans Document for the readers ease of use when reviewing the FCRP application and related documents.

ftp://ftp.nwb-oen.ca/registry/2%20MINING%20MILLING/2A/2AM%20-%20Mining/2AM-LUP2032%20LMI/1%20APPLICATION/2019%20Renewal_Amendment/180727%202AM-LUP1520%202%20Table%20A_List_Plans_Documents-IMLE.pdf

Interested Party:	KIA	**Technical Comment No:**	27
Subject/Topic:	Detailed Comments of FCRP Supporting Documents		

Reference:

- Appendix H-02 - Climate Model Rev. 0, Oct 2019 (App. H-02)

Detailed Review Comment By Party (November 17, 2020):

The report was commissioned to fulfill Technical Commitments No. 13, as requested by CIRNAC. The purpose of the modelling was to assess the potential for long-term permafrost thaw of frozen tailings dams under three climate warming scenarios, these simulating three emission scenarios (Low (LES), medium (AES) and high (HES)).The report concluded that the LES and AES did not result in long-term progressive permafrost thaw in the TCA dams. The LES and AES were considered to be more realistic climate models than the HES, based on data from the second half of the 20thcentury in Canada. The HES predicted that there would be long-term progressive permafrost thawing which would result in a permafrost thaw depth of 14 m below ground surface by the year 2100. It states long-term progressive permafrost thaw is expected to begin in the latter quarter of the 21st century. However, it did not provide any numerical estimates for the permafrost thaw depth for the "more realistic" AES and LES methods for the year 2100.

Request or Recommendation by Party (November 17, 2020):

LMI should provide the AES and LES numerical estimates of the permafrost thaw depth for the year 2100.

LMI Response (February 1, 2021)

Numerical estimates for the permafrost thaw depths for the AES and LES were provided in the 2AM-LUP Technical Meeting Commitment Number 13 Response - Lupin Mine Tailings Containment Area Dams Thermal Modelling Results document.

Request or Recommendation by Party (February 17, 2021):

The report suggests that the AES and LES scenarios are the "more realistic" ones of the three (for predicting the potential for long-term permafrost thawing in the frozen tailings dams), but the Conclusions section of the report only specify what the depth would be with the HES scenario. It should have included the predicted depths from the other two scenarios to enable a comparison. The LMI response suggests the information can be found in another follow-up document or in their response to the KIA request. This information should have been provided in the original report.

Graphical results shown in the report indicate increasing depths of permafrost thaw for all three scenarios over the years 1995 to 2100 time frame (i.e., -2.3 m to -4.0 m for AES, -2.3 m to -2.8 m for LES, and -2.3 m to -14.0 m for HES).

LMI RESPONSE (March 17, 2021):

LMI believes they addressed SJCI comment. Noting this item was resolved at the Public Hearing. To clarify, SJCI commented that the commitment was requested by CIRNAC but the commitment was made by LMI to ECCC during the technical meetings in 2019. During the public hearing ECCC advised that they considered this item resolved based on responses and clarifications received from the LMI.

Interested Party:	KIA	**Technical Comment No:**	28
Subject/Topic:	Detailed Comments of FCRP Supporting Documents		

Reference:

- Appendix H-11 - Geophysics Rev. 0, Oct 2019(App. H-11)

Detailed Review Comment By Party (November 17, 2020):

The report was commissioned to fulfill Technical Commitments No. 11, as requested by ECCC. The request was for geophysical surveys to be undertaken of two selected dams. However, it is unclear which dams were being requested for surveying. LMI selected Dams 3D and 4 and stated the reasons they were selected was because they had thermistors already installed in them and that they represented one internal and one external dam.

The purpose was to assess whether there were any thawed ice core sections in the dams that could lead to seepages through the dams. The Stantec cover letter introduced the commitment and outlines the subcontractor's task. The cover letter does not provide conclusions on the work undertaken by Aurora Geosciences Ltd. The Aurora report also makes no specific conclusions but rather provides results and interpretations that seem to suggest both dams have continuous ice cores, as per design.

Request or Recommendation by Party (November 17, 2020):

Stantec should clarify the results and especially the conclusions of the Aurora work to confirm the acceptable conditions of the frozen dam cores, as they were the party that made the commitment and they commissioned the work.

LMI Response (February 1, 2021)

ECCC allowed LMI to select which dams to survey. The Aurora Geoscience report concluded that permafrost was encountered at a similar depth as indicated by the nearby thermistor data.

Request or Recommendation by Party (February 17, 2021):

The KIA T.C. is still valid as neither the Aurora detailed report or the Stantec cover letter make any specific conclusions to answer the initial goal of the ECCC request of confirming the condition of the frozen cores. The LMI response states that the Aurora report found the levels of the permafrost to be similar to that of the nearby thermistors. The Aurora report does not include a "Conclusions" section but rather has an "Interpretation and Results" section which amongst other findings indicated a 120 m long depressed zone in Dam 3D. No anomalies were found for Dam 4. The Aurora report does not compare the levels from their testing to that of the thermistors.

LMI RESPONSE (March 17, 2021):

This item was resolved at the Public Hearing with ECCC recommendation that monitoring of the dams extend beyond the five-year period and for monitoring to be included in the PCMP. LMI has included this request in the draft PCMP.

Interested Party:	KIA	Technical Comment No:	29
Subject/Topic:	Detailed Comments of FCRP Supporting Documents		

Reference:

- Appendix H-10 - Decision Matrix Rev. 0, (App. H-10)

Detailed Review Comment By Party (November 17, 2020):

The report was commissioned to fulfill Technical Commitments No. 8, as requested by CIRNAC. The purpose of the document was to provide proposed plans on how to deal with tailings or other contaminants which become exposed as a result of lowering the water levels in the TCA tailings ponds. A single flowsheet decision matrix was presented in the document. The flowsheet oversimplified the options review in that it suggested either covering contaminated areas or relocating all of the contaminated materials into Cell 3 and/or 5. It presented a bias towards cover-in-place, and not excavating and relocation, nor any other commonly used methods. In fact, a number of different methods may be most effective for the overall TCA, as each contaminated area should be evaluated separately and the methods that work best for each situation should be employed across the entire TCA facility (and the site).

Request or Recommendation by Party (November 17, 2020): n/a

LMI Response (February 1, 2021)

As noted in Commitment Part E Item 27 Response, the Decision Matrix is no longer being used.

Request or Recommendation by Party (February 17, 2021):

The KIA T.C. concerning the overly simplified flowsheet that was the decision matrix for selecting the optimal remediation plans for exposed contaminants above TCA closure water levels still applies. However, it is reassuring to see that the LMI Response states the Decision Matrix is no longer being used. However, a reference to that being stated in Commitment Part E Item 27 Response (LMI letter to NWB dated July 9, 2020) could not be found as the LMI Response states.

LMI RESPONSE (March 17, 2021):

LMI's response stated "As stated in Commitment Part # Item 27 Response, the Decision Matrix is no longer in use." This response was provided by LMI in a letter to NWB on July 31, 2020 that the decision matrix was discussed with the regulatory bodies during the renewal licence/FCRP approval process which resulted in the condition under Part E. Item 27. During the public hearing, as part of the application process (see public hearing transcripts on the NWB ftp site and LMI Comments on CIRNAC on Commitments), CIRNAC and LMI agreed that the decision tree matrix would no longer be used but committed to what resulted as condition Part E, Item 27 of the current water licence.

This item has been resolved under Part E, Item 27, whereby the NWB issued LMI a letter on November 2, 2020 advising that this condition had been satisfied. The KIA advised the NWB on August 12, 2020 that they considered LMI's responses acceptable. CIRNAC advised the NWB on October 30, 2020 that they are satisfied with LMI's responses.

Interested Party:	KIA	**Technical Comment No:**	33
Subject/Topic:	LMI Commitments to undertake Future Work		

Reference:

- n/a

Detailed Review Comment By Party (November 17, 2020):

i) Due date unknown: The Conclusions section of FCRP supporting document Appendix H-5 (Golder 2019) mentions that additional geochemical characterization of waste rock will continue using samples collected from the site in August 2019. It is unknown whether the results of this additional sampling have been published and if so, has it already been considered in follow-up water quality modelling and what were its results, or whether it recommended that any additional work is warranted?

ii) Due date Feb 28, 2021:-An updated and expanded Post-Closure Monitoring Plan (PCMP) to be provided within one year of new Water License issuance. This Plan is to incorporate regulatory review comments, where applicable, results of other inputs such as the HHERA and the new Water License 2AM-LUP2032 (Ref: FCRP Sec. 3.2.1).

iii) Due date unknown: A QA/QC program for remediation of contaminated soils on the site is to be issued out for comments before the remedial activities commence (Ref: FCRP Sec. 4.3.2.3).The text mentions several aspects of such a program and states that additional details will be provided in the new PCMP.

iv) Due date unknown: Engineering drawings and specifications are to be provided to contractors handling the relocation and isolation of the waste rock and a QA/QC program will be developed that will ensure the program is undertaken satisfactorily (Ref: Sec.4.3.2.7).

v) Due date unknown: An intrusive hazardous materials assessment (including building materials) is to be completed prior to any demolition activities (Ref: Sec. 4.3.2.9).

vi) Due date -During final reclamation and closure planning: Sec. 4.3.2.10 of the FCRP states that a risk assessment will be undertaken to evaluate the likelihood of adverse ecological or environmental effects from the future use of the property.

vii) Due date unknown: Sec 4.3.2.13 of the FCRP states that engineering drawings and technical specifications will be prepared for the two spillway types required for the TCA, one being the internal dam spillways required immediately and the other being the two final spillways over dam Nos.J & 1A required for the post-closure passive water system envisioned for the TCA.

viii) 2021: FCRP Table 20 includes a number of locations where new geotechnical instrumentation will be installed, and a number of locations where existing non-functioning instrumentation is to be replaced.

Request or Recommendation by Party (November 17, 2020): n/a

LMI Response (February 1, 2021)

i) The measured geochemistry of the various seepage samples were used as the source term for the water quality model. (Refer to Appendix C of the HHERA submitted in response to Commitment No. 1 from the Technical Meeting/Pre-Hearing Conference).

ii) Under water licence 2AM-LUP2032 condition Part J, Item 13 states, "The Licensee shall, within one (1) year following the **approval** of the Licence, submit to the Board for approval a Post Closure Monitoring Plan in accordance with requirements in Schedule J." The water licence was approved by the Minister on April 9, 2020 and therefore the due date is April 9, 2021 not February 28, 2021, as this was the date of issuance not approval. LMI can confirm the Post Closure Monitoring Plan (PCMP) currently under development will provide analyses and interpretation of site monitoring data and outline contingency plan should results suggest the need for additional steps. LMI notes the Type A Water licence Schedule J requires LMI during the development of the PCMP and subsequently during post closure monitoring to consult with community members and organizations in Kugluktuk and will include in the Annual Report referred to in Part B, Item 2, and provided to the Board, a summary of these community consultations. LMI intends to begin consultation on the Draft PCMP in Q1 2020.

iii) LMI confirms a QA/QC program for remediation of contaminated soils on the site is included in the PCMP. Refer to item (ii) above. A QA/QC program was prepared before soils remediation began in August 2020.

iv) LMI confirms a QA/QC program, engineering drawings will be provided as needed for handling, relocation, and management of waste rock.

v) An assessment for hazardous materials was carried out by Arctic Response in 2012. A more detailed intrusive assessment for asbestos was carried out by Golder Associates in 2017 and removed from the security estimate in 2018. Hazardous waste is being dealt with in accordance with the licence and GN requirements.

vi) This section will be updated to confirm as per Section 6.2 of the FCRP Rev 1 (August 2020) that LMI has completed an HHERA for the Lupin Mine/mill site (Golder, 2019c). The HHERA was submitted and reviewed by interested parties prior to issuance and approval of the Licence is on the NWB Registry for the Project at the following link: ftp://ftp.nwb-oen.ca/registry/2%20MINING%20MILLING/2A/2AM%20-%20Mining/2AM-LUP2032%20LMI/2%20ADMIN/4%20HEARINGS/2%20HEARING/2019%20Amendment%20Renewal/

vii) Assuming that monitoring within the TCA indicates that water quality objectives are met, the engineering drawings and specifications will be provided at least 60 days prior to construction in accordance with the Licence.

viii) Clarification of on-site monitoring including geotechnical instrumentation will be provided in the PCMP. Refer to item (ii) above.

Request or Recommendation by Party (February 17, 2021):

Item iii) The text states the QA/QC program was to have been issued out for comments prior to commencement of the remedial activities. The LMI response agrees that it will be included in the updated PCMP but then goes on to say that these activities were started in August 2020. Was the program issued out for comments before it was initiated?

Item v) The KIA T.C. was referring to text in the 2020 FCRP (i.e., Sec 4.3.2.,9 Hazardous Building Materials) with LMI stating "…An intrusive building materials assessment will be completed prior to any demolition activities…" (i.e., after the two reported assessments of 2012 and 2017). Thus, the T.C. has not been answered. And it is likely this item (or a more limited version of it) should be added back into the security estimate, as the LMI response states that costing for undertaking a hazardous materials assessment was removed in 2018.

LMI RESPONSE (March 17, 2021):

See response to CIRNAC T.C. 3 above in regards to the QA/QC Plan

Security has already been approved under water licence 2A-LUP2032. An updated FCRP addendum will be submitted with the 2020 Annual Report due March 31, 2021.

Lupin Mines Incorporated

A wholly owned indirect subsidiary of Mandalay Resources Corporation

Lupin Mine Site

Nunavut, Canada

Water Quality Monitoring Plan and Water and Soil Quality Assurance/ Quality Control Plan

(Care and Maintenance)

August 2020

Lupin Mines Incorporated
Mandalay Resources Corporation
76 Richmond Street East, Suite 330
Toronto, Ontario M5C 1P1

Document Control

Revision No.	Date	Details	Author	Approver
1.0	30/03/2013	Replaces Care and Maintenance Plan – *Sampling Procedure: Tailings Containment Area and Sewage Lakes Disposal Facility*, March 2012 Replaces the *Environmental Laboratory Quality Assurance / Control Plan*, Prepared: March 1993, Revised: December 1995 Update contact and general information Revised to include bioassay sample requirements	D. Vokey	W. Osborne
2.0	18/03/2016	Updated to reflect new water licence Added Landfill and Landfarm facility requirements Updated parameters and frequency of testing for all stations Added provisions for the annual sampling of the interior ponds of the TCA Updated contact and general information Updated UTM coordinates for sample stations to agree with those shown on the figures. Corrected reference to ammonia as NH_3 not NH_4 (NH_4 is ammonium) Updated laboratory accreditations Provided additional direction for the discharge from the sewage and TCA added	SRK	K. Lewis
3.0	14/08/2020	Updated to reflect new water licence Updated parameters and frequency of testing for all stations Updated laboratory accreditations Added QA/QC for Soils	Golder	K. Lewis

Executive Summary

Lupin Mines Incorporated (LMI), a wholly owned indirect subsidiary of Mandalay Resources Corporation (Mandalay), has prepared this Monitoring Plan.

A review of the Plan takes place and revisions are submitted as necessary with the annual report. The current Type A Water Licence 2AM-LUP2032 (Water Licence) for the Lupin Gold Mine (Lupin or the Lupin Mine or the Site) is valid until February 27, 2032.

Executive Summary Inuktitut

Awaiting translation – to be provided as soon as possible

Executive Summary Inuinnaqtun

Awaiting translation – to be provided as soon as possible

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Appendices

1 Introduction

Lupin Mines Incorporated (LMI), a wholly owned indirect subsidiary of Mandalay Resources Corporation (Mandalay), has prepared this Water Quality Monitoring Plan and Quality Assurance / Quality Control Plan (the Plan).

An annual review of the Plan takes place and revisions are submitted as necessary with the Annual Report to the Nunavut Water Board (NWB). The current Type A Water Licence 2AM-LUP2032 (Water Licence) for the Lupin Gold Mine (Lupin or the Lupin Mine or the Site) is valid until February 27, 2032.

1.1 Project and Company Information

Mandalay is a Canadian based company focused on producing assets in Australia, Chile and Sweden, a development project in Chile and the exploration and development of the past-producing Lupin Gold Mine and the Ulu gold project, both located in Nunavut, Canada.

Mandalay purchased Elgin Mining Inc., which owns LMI and the Lupin Mine, in September 2014. Lupin was in operation from 1982 to 2005 with temporary suspensions of activities between January 1998 and April 2000, and again between August 2003 and March 2004. The mine resumed production in March 2004 until February 2005.

Lupin Mine is currently in Closure and Reclamation with final reclamation and closure of on-site facilities being conducted in accordance with the *Final Closure and Reclamation Plan* and the *Closure and Reclamation Plan for the Tailings Containment Area.* Progressive reclamation will be implemented during the Closure and Post Closure Phase in accordance with *Care and Maintenance Plan* for the Project. Surface exploration is conducted under Water Licence 2BE-LEP1217. All camp infrastructure required for the surface exploration program currently exists at the Lupin Mine

Company:	LMI
Project:	Lupin Mine, Nunavut
Company Address:	Suite 330, 76 Richmond Street East, Toronto, ON M5C 1P1 Telephone: 778-386-7340
Email:	klewis@elginmining.com
Attention:	Karyn Lewis, General Administration
Effective date:	14 Aug 2020
Distribution List:	
Karyn Lewis	General Administration
Discovery Mining Services	Site Contractor
Golder Associates	Site Consultant
SRK Consulting	Site Consultant

Additional copies of this Plan are available from General Administration. This Plan will be posted in key locations at the Site, and all employees and contractors will be made aware of its contents.

1.2 Site Location

The Lupin Mine is located in the Kitikmeot Region, Nunavut, 400 km north of Yellowknife, Northwest Territories and 285 km southeast of Kugluktuk, Nunavut. The airport serving this Site is at 65°46'00" N and 111 14'41" W. The Site is on the western shore of Contwoyto Lake, approximately 60 km south of the Arctic Circle (Figure 1).

1.3 Environmental and Sustainable Development Policy

Lupin Mine Incorporated (LMI) is committed to maintaining a safe, clean, compliant and respectful work environment. LMI looks to our employees, contractors and managers to adopt and grow a culture of social responsibility and environmental excellence. Together we achieve this by:

- Promoting environmental stewardship in all tasks. Nothing is too important that it cannot be done in a clean and responsible manner. We strive towards maintaining a zero-incident work place.
- Recognizing that we have a shared responsibility as stewards of the environment in which we operate. We will not walk away from a non-compliant act.
- Identifying, managing and mitigating environmental, business and social risks in an open, honest and transparent manner.
- Planning our work so it is done in the cleanest possible manner and executing work according to plan.
- Continually improving environmental and operational performance by setting and reviewing achievable targets.
- Providing appropriate and necessary resources in the form of training, personnel and capital, including that required for closure planning and reclamation.
- Managing our materials and waste streams, maintaining a high degree of emergency response preparedness and minimizing our operational footprint to maintain environmental protection at all stages of project development.
- Procuring goods and services locally, where available, and favouring suppliers with environmentally and socially responsible business practices.
- Seeking to understand, learn from and mitigate the root causes of environmental incidents and near misses when they do occur.
- Employing systems and technology to achieve compliance, increase efficiency and promote industry best practices in development, operations and environmental stewardship.
- Working with stakeholders to identify and pursue opportunities for sustainable social and economic development and capacity building.
- Conducting early and ongoing stakeholder engagement relevant to the stage of project and mine development and operation.
- Recognizing diversity in the workplace and building meaningful relationships with all stakeholders in a timely, collaborative and transparent manner.

Through implementation of this policy, LMI seeks to earn the public's trust and be recognized as a respectful and conscientious employer, neighbor, and environmental steward.

1.4 Purpose and Scope

The purpose of this Plan is to identify water quality and soils monitoring requirements for the Site and minimize the impacts of potential sampling and analytical errors by providing a set of standardized procedures for sampling, analysis and reporting. These procedures are to be implemented by any personnel involved in monitoring for the purpose of regulatory compliance or internal environmental management.

The Plan documents Quality Assurance (QA) and Quality Control (QC) procedures for the Lupin Mine Monitoring Program as required by Type A Water Licence 2AM-LUP2032 Part J, Items 5, 6 and 7. The Plan also documents QA/QC procedures for the Lupin Mine Monitoring Program as required by the *Metal and Diamond Mine Effluent Regulations* (MDMER) under the *Fisheries* Act Part 2 Division 1 Item 11 and Part 2 Division 2 Items 12(1) and (2), 14(1), (2), and (3), 17(1) and (2), and 19(3) as well as Schedule 4 and 5.

QA/QC planning has been developed in accordance with the Crown-Indigenous Relations and Northern Affairs Canada (CCIRNAC), *Quality Assurance (QA) and Quality Control (QC) Guidelines for use by Class 'A' Licensees in meeting SNP Requirements and for Submission of a QA/QC Plan*, July 1996 which defines QA and QC as follows:

Quality Assurance: is the system of activities designed to better ensure that quality control is done effectively.

Quality Control: is the use of established procedures to achieve standards of measurement for the three principal components of quality: precision, accuracy and reliability.

This Plan outlines field sample collection procedures including sampling requirements and methods; field sample identification, preservation and transport procedures; field sampling quality control measures; analytical laboratory information; and reporting requirements.

2 Field Sampling

2.1 Sample Collection

2.1.1 Sampling Station Locations, Requirements and Parameters

Sampling station locations, requirements, and parameter analyses are set out in the Type A Water Licence 2AM-LUP2032 Table 1 of Schedule J and in the MDMER Part 2 Division 2 Items 12 thru 18 and Schedules 4 and 5. In addition, LMI's site monitoring program includes the collection of additional samples to assess the progression of water quality and the performance of or need for treatment measures.

Generally, samples are required from the following locations:

- Freshwater intake at Contwoyto Lake,
- Tailings Containment Area (TCA):
    - Annual characterization samples;
    - Prior to discharge;
    - During discharge;
    - Reference areas; and
    - Downstream exposure areas,
- Sewage Lakes Disposal Facility,
- Bulk Fuel Storage Facility
- Landfarm Facility, and
- Landfill Facility.

The monitoring requirements outlined in the Water Licence and MDMER effluent monitoring requirements are outlined in Table 2.1. Water sampling under the Environmental Effects Monitoring Program of the MDMER will accompany any planned discharges from the TCA. Monitoring guided by LMI's initiative are also outlined.

A sample event schedule is also provided in Table 2.2 which outlines the Water Licence and MDMER effluent monitoring requirements as well as field monitoring and QC sample requirements (see Section 3 of this Plan for more details about QC monitoring). LMI's routine sampling initiatives are also listed. This table is intended to serve as a guide to on-site personnel with sampling responsibilities.

Regulatory authorities are to be notified of planned discharge events. Table 2.3 provides the notification schedule.

Table 2.1: Sample collection requirements

Station ID	Location Description	Parameters												Frequency
		Field[a]	Conventional[b]	Metals and Mercury	Nutrients[c]	Cyanide	Ra-226	Anions and TP[d]	Fecal Coliform	BOD, TKN and ortho-phosphorus[e]	BTEX and O&G[f]	Bioassay		
												Acute[g]	Sublethal[h]	
LUP-01	Freshwater Intake from Contwoyto Lake	X	X	X	-	-	-	-	X	-	-	-	-	Annually
LUP-10	Pond 2 discharge at Dam 1A	X	X	X	-	X	-	-	-	-	-	-	-	Daily during periods of discharge
		X	X	X	X	X	X	-	-	-	-	-	-	Weekly
		X	X	X	X	X	X	X	-	-	-	X	-	Monthly (no less than one month Intervals) commencing with the first day of decant
		X	X	X	X	X	X	X	-	-	-	X	X	Once per calendar quarter
LUP10a (LUP-102)	Internal station in TCA Pond 2, approximately 100 m upstream from siphon intake	X	X	X	X	X	X	-	-	-	-	X	-	Once prior to initiation of decant and once prior to termination of decant
LUP-11	Mine-water discharge at automatic sampler in the mill	-	-	-	-	-	-	-	-	-	-	-	-	Not Active
LUP-12	Mill tailings taken at the mill	-	-	-	-	-	-	-	-	-	-	-	-	Not Active
LUP-14	Decant structure from the Sewage Lakes Disposal Facilities	X	X	X	X	-	-	-	X	X	-	-	-	First day of discharge and then monthly thereafter during periods of flow
LUP-15	Discharge from TCA Pond 1 (east pond) into TCA Pond 2 (west pond)	-	-	-	-	-	-	-	-	-	-	-	-	Not Active

Table 2.1: Sample collection requirements

Station ID	Location Description	Parameters												Frequency
		Field[a]	Conventional[b]	Metals and Mercury	Nutrients[c]	Cyanide	Ra-226	Anions and TP[d]	Fecal Coliform	BOD, TKN and ortho-phosphorus[e]	BTEX and O&G[f]	Bioassay		
												Acute[g]	Sublethal[h]	
LUP-16	TCA Pond 2 at center	-	-	-	-	-	-	-	-	-	-	-	-	Not Active
LUP-17	TCA Pond 2 upstream of Station LUP-10	-	-	-	-	-	-	-	-	-	-	-	-	Not Active
LUP-19	East end of Seep Creek in Dam 2 Lake	-	-	-	-	-	-	-	-	-	-	-	-	Not Active
LUP-20	West end of Seep Creek before discharge into Unnamed Lake	X	X	X	X	X	X	-	-	-	-	-	-	Weekly during discharge from the Tailings Containment Area, commencing with the first day of decant
LUP-21	North end of Concession Creek before discharge into Unnamed Lake	X	X	X	X	X	X	-	-	-	-	-	-	Weekly during discharge from the Tailings Containment Area, commencing with the first day of decant
		X	X	X	X	X	X	X	-	-	-	-	-	Four times per year
LUP-22	Inner Sun Bay near center and midway between end of peninsula and west shore	X	X	X	X	X	X	-	-	-	-	-	-	Weekly at mid-depth, commencing one (1) week prior to discharge from the Tailings Containment Area and concluding two (2) weeks after cessation of the discharge

Table 2.1: Sample collection requirements

Station ID	Location Description	Parameters												Frequency
		Field[a]	Conventional[b]	Metals and Mercury	Nutrients[c]	Cyanide	Ra-226	Anions and TP[d]	Fecal Coliform	BOD, TKN and ortho-phosphorus[e]	BTEX and O&G[f]	Bioassay		
												Acute[g]	Sublethal[h]	
LUP-24	Inner Sun Bay at mid-way point in narrows	X	X	X	X	X	X	-	-	-	-	-	-	Weekly at mid-depth, commencing one (1) week prior to discharge from the Tailings Containment Area, and concluding two (2) weeks after cessation of the discharge and when bioassay sample is collected at LUP-10 just prior to termination of decant
		X	X	X	X	X	X	X	-	-	-	-	-	Four times per year
LUP-25	Outer Sun Bay (Total Rather than specific metals)	X	X	X	X	X	X	-	-	-	-	-	-	Weekly at mid-depth, commencing one (1) week prior to discharge from the Tailings Containment Area, and concluding two (2) weeks after cessation of the discharge
LUP-26	Contwoyto Lake in bay east of water intake	-	-	-	-	-	-	-	-	-	-	-	-	Inactive
LUP-27	Bulk Fuel Storage Facility	X	X	X	X	-	-	-	-	-	X	-	-	Once prior to discharge and weekly during periods of discharge
LUP-28	Discharge from the Landfarm Facility.	X	X	X	X	-	-	-	-	-	X	-	-	Once prior to discharge and weekly during periods of discharge

Table 2.1: Sample collection requirements

Station ID	Location Description	Parameters												Frequency
		Field[a]	Conventional[b]	Metals and Mercury	Nutrients[c]	Cyanide	Ra-226	Anions and TP[d]	Fecal Coliform	BOD, TKN and ortho-phosphorus[e]	BTEX and O&G[f]	Bioassay		
												Acute[g]	Sublethal[h]	
LUP-29	Landfarm Facility Monitoring Well – Up gradient	X	X	X	X	-	-	-	-	-	X	-	-	Monthly during periods of observed flow – June through September
LUP-30a	Landfarm Facility Monitoring Well – Down gradient	X	X	X	X	-	-	-	-	-	X	-	-	Monthly during periods of observed flow – June through September
LUP-30b	Landfarm Facility Monitoring Well – Down gradient	X	X	X	X	-	-	-	-	-	X	-	-	Monthly during periods of observed flow – June through September
LUP-31	Seepage from the Landfill Facility	X	X	X	X	-	-	-	-	-	X	-	-	Monthly during periods of observed flow
LUP-32	Landfill Facility Monitoring Well – Up gradient	X	X	X	X	-	-	-	-	-	X	-	-	Monthly during periods of observed flow – June through September
LUP-33a	Landfill Facility Monitoring Well – Down gradient	X	X	X	X	-	-	-	-	-	X	-	-	Monthly during periods of observed flow – June through September
LUP-34b	Landfill Facility Monitoring Well – Down gradient	X	X	X	X	-	-	-	-	-	X	-	-	Monthly during periods of observed flow – June through September
LUP-35	Seepage from the Landfill Facility	X	X	X	X	-	-	-	-	-	X	-	-	Monthly during periods of observed flow – June through September

Table 2.1: Sample collection requirements

Station ID	Location Description	Parameters												Frequency
		Field[a]	Conventional[b]	Metals and Mercury	Nutrients[c]	Cyanide	Ra-226	Anions and TP[d]	Fecal Coliform	BOD, TKN and ortho-phosphorus[e]	BTEX and O&G[f]	Bioassay		
												Acute[g]	Sublethal[h]	
LUP-36[i]	Demolition Landfill Facility Monitoring Well – Up gradient	X	X	X	X	-	-	-	-	-	X	-	-	Monthly during periods of observed flow – June through September
LUP-37a[i]	Demolition Landfill Facility Monitoring Well – Down gradient	X	X	X	X	-	-	-	-	-	X	-	-	Monthly during periods of observed flow – June through September
LUP-37b[i]	Demolition Landfill Facility Monitoring Well – Down gradient	X	X	X	X	-	-	-	-	-	X	-	-	Monthly during periods of observed flow – June through September
LUP-EL-01	East Lake near shoreline near the potential seepage inputs	X	X	X	-	-	-	-	-	-	-	-	-	Twice-yearly: Once in freshet and once in late open-water season, ensuring that baseline samples are collected prior to construction of the waste rock dome.
LUP-BL-01	Boot Lake near shoreline near the potential seepage inputs	X	X	X	-	-	-	-	-	-	-	-	-	Twice-yearly: Once in freshet and once in late open-water season, ensuring that baseline samples are collected prior to construction of the waste rock dome.
LUP-LSL-01	Lower Sewage Lake near shoreline near the potential seepage inputs	X	X	X	-	-	-	-	-	-	-	-	-	Twice-yearly: Once in freshet and once in late open-water season, ensuring that baseline samples are collected prior to construction of the waste rock dome.

Table 2.1: Sample collection requirements

Station ID	Location Description	Parameters												Frequency
		Field[a]	Conventional[b]	Metals and Mercury	Nutrients[c]	Cyanide	Ra-226	Anions and TP[d]	Fecal Coliform	BOD, TKN and ortho-phosphorus[e]	BTEX and O&G[f]	Bioassay		
												Acute[g]	Sublethal[h]	
LUP-SP-01 to LUP-SP-XX[j]	Seeps from the Waste Rock Dome, Locations of observed seepage or flow from waste rock pile	X	X	X	-	-	-	-	-	-	-	-	-	Twice-yearly: Once in freshet and once in late open-water season
LUP-TCA-01 to LUP-TCA-XX[j]	Seeps from the Tailings Containment Area (TCA), Locations of observed seepage or flow from waste rock pile	X	X	X	-	-	-	-	-	-	-	-	-	Twice-yearly: Once in freshet and once in late open-water season

Notes:

(a) pH, conductivity, temperature and dissolved oxygen (receiving environment only).

(b) pH, conductivity, total suspended solids, alkalinity, hardness.

(c) Total ammonia, nitrate, and nitrite.

(d) Chloride and sulphate. TP = Total Phosphorus.

(e) Biochemical Oxygen Demand, Total Kjedahl Nitrogen and ortho-phosphorus.

(f) Benzene, toluene, ethyl benzene, xylene, and Oil and Grease.

(g) Acute Toxicity Testing: Rainbow Trout and *Daphnia Magna*.

(h) Sublethal Toxicity Testing for Fathead Minnows, *Ceriodaphnia dubia*, *Lemna minor* and *P. subcapitata*.

(i) Monitoring requirements are as per Water Licence, but are not applicable because the Demolition Landfill is not planned for construction.

(j) Seep sampling locations will be added to the post-closure monitoring program as new seeps are documented.

Table 2.2: Sampling event schedule.

Sampling Events	Station	Samples and Parameters	Quality Control[(1)]
TAILINGS CONTAINMENT FACILITY			
Annually	LUP-10a (LUP-102) LUP-POND1 LUP-CELL4 LUP-CELL5	Field pH, temperature, conductivity	1 field duplicate
		pH, TSS, hardness	
		Total Metals	
		Dissolved Metals	
One month prior to discharge	LUP-10a (LUP-102)	Field pH, temperature, conductivity	-
		pH, conductivity, TSS, alkalinity, hardness,	
		NO_2, NO_3, NH_3	
		Total Metals and Hg	
		CN (total cyanide)	
		^{226}Ra	
Upon receipt of results meeting discharge criteria (expect pH) and not less than two weeks prior to discharge	LUP-10a (LUP-102)	Field pH, temperature and conductivity	-
		Static pass/ fail Bioassay with pH adjustment[(2)]	
One week prior to discharge	Pond 2 (various locations and depths)	Field pH, temperature conductivity	1 field duplicate or field blank
		Field pH, temperature, and conductivity (Daily)	
	LUP-22, 24, 25 (at mid-depth)	pH, conductivity, TSS, alkalinity, hardness	
		Total Metals and Hg	
		NO_2, NO_3, NH_3	
		CN	
Daily during discharge	LUP-10	Field pH, temperature, and conductivity	1 field duplicate or field blank per week
		Field observation of visual sheen	
		flow rate m^3	
		pH, conductivity, TSS, alkalinity, hardness	
		CN	
		Total Metals and Hg	

Table 2.2: Sampling event schedule.

Sampling Events	Station	Samples and Parameters	Quality Control[1]
First day of discharge (in addition to daily sampling)	LUP-10	NO_2, NO_3, NH_3	1 field duplicate or field blank
		Total Metals and Hg	
		MDMER Bioassays: LC50	
		^{226}Ra	
	LUP-20, 21 (surface), LUP-22, 24, 25 (at mid-depth)	Field pH, temperature, conductivity, dissolved oxygen	
		pH, conductivity, TSS, alkalinity, hardness	
		Total Metals and Hg	
		NO_2, NO_3, NH_3	
		CN	
	LUP-21 (surface), LUP-24 (at mid-depth)	Anions and Total Phosphorus	
Weekly during discharge (in addition to daily sampling)	LUP-10	NO_2, NO_3, NH_3	1 field duplicate or field blank
		^{226}Ra	
	LUP-20, 21 (surface), LUP-22, 24, 25 (at mid-depth)	pH, conductivity, TSS, alkalinity, hardness	
		Total Metals and Hg	
		NO_2, NO_3, NH_3	
		CN	
		^{226}Ra	
Monthly during discharge (in addition to daily and weekly sampling	LUP-10	MDMER Bioassay LC50 and sublethal[3]	1 field duplicate or field blank
	LUP-21 (surface), LUP-24 (at mid-depth)	Total Hg	
		Field dissolved oxygen	
		Anions and Total Phosphorus	

Table 2.2: Sampling event schedule.

Sampling Events	Station	Samples and Parameters	Quality Control[(1)]
Just before the bioassay sample at LUP- 102 prior to termination of decant	LUP-21 (surface), LUP-24 (at mid- depth)	pH, conductivity, TSS, alkalinity, hardness	1 field duplicate or field blank
		Total Metals and Hg	
		NO_2, NO_3, NH_3	
		CN	
		^{226}Ra	
Last day of discharge	LUP-10a (LUP-102)	Static Pass/ Fail Bioassay	-
		Field pH, temperature, conductivity and dissolved oxygen	
		pH, TSS, alkalinity, hardness	
		Total Metals and Hg	
		CN	
		NO_2, NO_3, NH_3	
		^{226}Ra	
Weekly for two weeks following termination of discharge	LUP-22, 24, 25 (at mid-depth)	pH, TSS, alkalinity, hardness	1 field duplicate or field blank
		Total Metals	
		NO_2, NO_3, NH_3	
		CN	
SEWAGE LAKES DISPOSAL FACILITY			
Three weeks prior to discharge	LUP-14	Field pH, temperature, conductivity	1 field duplicate
		Field observation for visual sheen	
		pH, conductivity, TSS, alkalinity, hardness	
		Total Metals and Hg	
		NO_2, NO_3, NH_3, TKN, TP, OPO4	
		BOD5	
		Fecal Coliforms	
Daily during discharge		Field flow rate in m^3	-
		Field pH, temperature, conductivity	
		Field observation for visual sheen	

Table 2.2: Sampling event schedule.

Sampling Events	Station	Samples and Parameters	Quality Control[(1)]
First day of discharge and Monthly thereafter [(2)] (in addition to daily sampling)		pH, TSS, alkalinity, hardness	1 field duplicate or field blank
		Total Metals and Hg	
		BOD5	
		Fecal Coliforms	
		NO_2, NO_3, NH_3, TKN, TP, OPO4	
FRESHWATER INTAKE FACILITY			
Daily during intake	LUP-01	Field flow rate in m^3	-
Annually		Field pH, temperature, conductivity	
		pH, conductivity, TSS, conductivity	
		Total Metals and Hg	
		Fecal Coliforms	
BULK FUEL STORAGE FACILITY			
One week prior to discharge (RUSH 48 hour turnaround for sample results are to be requested of the laboratory)	LUP-27	Field pH, temperature, conductivity	1 field duplicate
		Field observation for visual sheen	
		pH, conductivity, TSS, hardness, alkalinity	
		Total Metals and Hg	
		Total Oil and Grease	
		BTEX	
		NO_2, NO_3, NH_3	
Daily during discharge		Field flow rate in m^3	-
		Field pH, temperature, conductivity	
		Field observation for visual sheen	
Weekly during discharge (in addition to daily testing)		pH, conductivity, TSS, hardness, alkalinity	1 field duplicate or field blank
		Total Metals and Hg	
		Total Oil and Grease	
		BTEX	
		NO_2, NO_3, NH_3	

Table 2.2: Sampling event schedule.

Sampling Events	Station	Samples and Parameters	Quality Control[(1)]
LANDFARM			
Monthly during discharge during periods of observed flow – June through September	LUP-28, LUP-29, LUP- 30a, LUP-30b	pH, conductivity, TSS, hardness, alkalinity	1 field duplicate or field blank
		Total Metals and Hg	
		Total Oil and Grease	
		BTEX	
		NO_2, NO_3, NH_3	
LANDFILL FACILITY			
Monthly during discharge during periods of observed flow – June through September	LUP-31, LUP-32, LUP- 33a, LUP-33b	pH, conductivity, TSS, hardness, alkalinity	1 field duplicate or field blank
		Total Metals and Hg	
		NO_2, NO_3, NH_3	

Notes:

(1) Duplicate and Blank samples must be collected for approximately every ten (10) field samples collected across the range of parameters. At least one duplicate must be submitted per sample shipment.

(2) Samples are to be collected on the morning of the next plane departure after discharge commences where hold time restraints apply.

(3) Twice per year. Nautilus Environmental should be advised that the dilution series for *Ceriodaphnia* and *Lemna* should be adjusted prior to sublethal testing.

Table 2.3: Discharge notification schedule.

Discharge Event	Schedule	Action Required
TAILINGS CONTAINMENT AREA	30 days prior to MDMER Bioassay	Provide notice to Environment and Climate Change Canada (ECCC) of planned sample date.
	10 days prior to discharge	Provide notice to the CIRNAC inspector, include analytical results and estimated volume of discharge.
LOWER SEWAGE LAKE	10 days prior to discharge	Provide notice to the CIRNAC inspector, include analytical results and estimated volume of discharge.
BULK FUEL STORAGE FACILITY	10 days prior to discharge	Provide notice to the CIRNAC inspector and estimated volume of discharge (1). Analytical results will be provided upon receipt and no discharge to occur prior to CIRNAC acknowledgment of receipt.

Note:

(1) Discharge from the bulk fuel storage facilities needs to commence as soon as possible when water starts accumulating in the spring.

Active monitoring (sampling) station locations as shown in Figure 2.1 are clearly identified in the field with permanent stakes and appropriate signage.

Samples must always be collected from the same locations, unless the sampling locations are relocated at the request of the designated CIRNAC Inspector or sampling location modifications are approved in writing by the NWB. The following Table 2.4 summarizes the current UTM coordinates of the active sampling locations:

Table 2.4: Lupin Mine sampling locations using the UTM NAD85, Zone 12N coordinates

Monitoring Station No.	Description	UTM Northing	UTM Easting
LUP-01	Freshwater intake from Contwoyto Lake	7294933	490030
LUP-10	TCA Pond 2 discharge at Dam 1A	7289689	485843
LUP-102 (Station 102)	Approximately 100 m upstream from the siphon intake in TCA Pond 2	7289875	486196
LUP-14	Decant structure from the Sewage Lakes Disposal Facilities	7293013	490187
LUP-20	West end of Seep Creek before discharge into Unnamed Lake	7290197	480149
LUP-21	North end of Concession Creek before discharge into Unnamed Lake	7290217	479841
LUP-22	Inner Sun Bay near centre midway between end of peninsula and west shore	7291715	479160
LUP-24	Inner Sun Bay near narrows	7293125	478989
LUP-25	Outer Sun Bay	7293770	478330
LUP-27	Bulk Fuel Storage Facility	7293609	489072
LUP-28	Discharge from the Landfarm Facility	TBD	TBD
LUP-29	Landfarm Facility monitoring well – upgradient	TBD	TBD
LUP-30a	Landfarm Facility monitoring well – downgradient	TBD	TBD

Table 2.4: Lupin Mine sampling locations using the UTM NAD85, Zone 12N coordinates

Monitoring Station No.	Description	UTM Northing	UTM Easting
LUP-30b	Landfarm Facility monitoring well – downgradient	TBD	TBD
LUP-31	Seepage from the Landfill Facility	TBD	TBD
LUP-32	Landfill Facility monitoring well – upgradient	TBD	TBD
LUP-33a	Landfill Facility monitoring well – downgradient	TBD	TBD
LUP-33b	Landfill Facility monitoring well – downgradient	TBD	TBD
LUP-EL-01	East Lake near shoreline near the potential seepage inputs	7293910	490496
LUP-BL-01	Boot Lake near shoreline near the potential seepage inputs	7294246	488593
LUP-LSL-01	Lower Sewage Lake near shoreline near the potential seepage inputs	7293164	489874

2.1.2 Field Measurements and Field Log Book

Where required by the monitoring program, pH, temperature, conductivity and dissolved oxygen of water is measured and recorded in the field directly from the water body being sampled wherever possible. Where it is not possible to take field measurements directly from the water body, the measurements can be taken from the sample bottle.

The pH and conductivity meters must be calibrated in advance of each day's sampling activities according to the manufacturer's instructions, using fresh standard calibration solutions. Any discrepancies must be recorded in the Field Log Book along with the sampling data; however recorded field measurements must not be altered due to calibration issues. Refer to the pH and conductivity meter manuals for instructions regarding how to calibrate and take measurements with the particular devices.

Details of all sampling activities are recorded in the Field Log Book including:

- Date and time of each sample collected,
- Sampling location visited,
- Weather conditions and air temperature,
- Flow rates where applicable,
- Integrity of sample location and water observations,
- Samples collected at each location including identification number (see Section 2.2), whether the sample will be submitted for analysis, and type of analysis as well and sample preservation measures,
- Sample depth where applicable, and
- Field measurements (i.e. pH, conductivity, temperature, dissolved oxygen) as well as any calibration discrepancies with the field meters.

Immediately following field activities, an electronic copy of the Field Log data must be made. Field log entries in the Field Log Book must not be altered; pages must not be removed; space or pages left blank must be labeled as such and crossed with a diagonal line; and errors must be crossed out, not erased.

2.1.3 Sample Containers

Sample container sizes and materials of construction depend upon the parameter(s) to be analyzed. A summary of sample container requirements for various parameters is provided in Table 2.5 (Section 2.3 of this Plan).

All water quality sample containers will be prepared and supplied by the contracted laboratory. Only clean, unused containers should be used to limit contamination and preservation errors. Samples analyzed for fecal coliform tests must be contained in bottles provided by the laboratory to ensure that the bottle is sterilized prior to use. Toxicity samples are to be collected in food grade containers, such as water jugs or buckets. The food grade containers must be thoroughly cleaned and rinsed and then triple rinsed with the sample water prior to being filled.

2.1.4 Sampling Methods

Water quality sampling methods are as follows:

- Record details of the sampling activity and field measurements in the Field Log Book (see Section 2.1.2 for details).
- In the field, disposable nitrile sampling gloves must be worn during handling of all the bottles and equipment.
- Triple rinse sample bottles with the source water prior to sample collection, except for those bottles with preservative already added by the laboratory (i.e., BTEX), as well as those bottles for Oil and Grease or Fecal Coliform analysis.
- Collect samples off-shore as much as possible without disturbing bottom sediments.
- When collecting samples from flowing bodies of waters (i.e. stream, creeks):
    - The sample must be collected as close as possible to the middle of the flowing water body. To prevent the stirring up of sediment, use a container attached to a pole extension. Otherwise, if wading into the stream is unavoidable, wait for the sediment to settle or flow away before collecting the sample.
    - When rinsing, plunge the sample bottle into the flowing water toward the current allowing it to fill at a depth of approximately half the stream depth. If the stream depth is too shallow to collect a clean sample without disturbing sediment or too shallow to fill the bottle completely, use a smaller bottle and transfer the water to the larger sample bottle.
    - Empty rinse water downstream of the sample locations so as not to disturb sediments.
- When collecting samples from surface water bodies (ponds, lakes) follow the same procedures as above for flowing bodies of water, ensuring that subsequent samples are collected at the same location, and by plunging the sample bottle into the water to a depth of about six (6) inches below the water surface.

- Sample bottles must be filled with room left for preservative addition and mixing. Add preservatives after filling as directed by the laboratory (unless the bottle was provided pre- loaded with preservatives by the laboratory).
- Record field measurements (pH, temperature, conductivity, dissolved oxygen) and any deviations from the sample collection method in the Field Log Book.

2.2 Sample Identification

All water samples must be provided with a unique sample identification number based on the following example:

Example: LUP-22-200801-50

LUP-22 Refers to the monitoring station.

130801 Refers to the date that the sample was collected (yy/mm/dd). In this example the date the sample was collected was August 1, 2020.

50 Refers to the depth in centimeters from surface which the same was collected. If the depth of the sample is not applicable do not include the suffix.

Sample labels including at a minimum: sample identification number, location, date, and parameters for analyses should be prepared as much as possible before entering the field for the sampling event with a waterproof, non-smear pen. Then, sample labels, bottles and preservatives should be packed, preferably in a cooler to maintain constant temperature, for transport to the field.

Sample bottle labels must be clearly and consistently labeled prior to being sent to the external laboratory with the following information:

- Company name,
- Site name,
- Sample Station Number,
- Sample Number,
- Sample Date and Time, and
- Analysis required.

Quality Control (QC) samples (i.e., field blanks, trip blanks, duplicates) are provided with unique sample identification numbers and note of the sample as a QC sample is recorded in the Field Log Book.

2.3 Sample Preservation

Water quality samples must be preserved, either by laboratory issued chemical preservative or temperature control, immediately following sample collection to ensure that the quality of the water sample remains similar to the source water. The following Table 2.5 summarizes the required containers, preservatives, and holding times for each parameter as outlined in ALS Sample Collection pocket Guide, Version 2 and additional information provided directly by ALS staff.

Table 2.5: Required sample containers, preservation, holding times, and sample volumes for analysis of specific parameters.

Parameter	Container Type	Preservative	Holding Time
pH [1,5]	500 mL plastic	4° C	0.25 hours
TSS [1]	500 mL plastic	4° C	7 days
Conductivity [1,5]	500 mL plastic	4° C	28 days
Total Metals and Hardness [4]	80 mL plastic	3 mL 1:3 Nitric Acid	6 months
Mercury	40 mL glass vial	2 mL Hydrochloric acid	28 days
Radium226	0.5 – 1 L plastic	6 mL 1:3 Nitric Acid	6 months
Cyanide (Total or WAD (low level))	60 mL plastic	3 mL 6N Sodium Hydroxide	14 days
Alkalinity [1]	500 mL plastic	4° C	14 days
Total Ammonia	100 mL amber glass with septa cap	1 mL 1:1 Sulphuric Acid	28 days
Nitrogen, Nitrate and Nitrite	500 mL plastic	4° C	28 days
Kjeldahl or Organic Nitrogen	100 mL amber glass with septa cap	1 mL 1:1 Sulphuric Acid	28 days
Total Phosphorus	100 mL amber glass with septa cap	1 mL 1:1 Sulphuric Acid	28 days
Ortho Phosphate[1]	500 mL plastic	4° C	2 days
BOD5 [1]	500 mL plastic	500 mL plastic	2 days
Fecal Coliforms	250 mL sterilized plastic	Sodium Thiosulphate	30 hours
Oil and Grease	2 x 250 mL amber glass	2 mL 1:1 H2SO4	28 days
BTEX [2,3]	2 x 40 mL glass vials	Sodium Bisulphate or Thiosulphate	14 days
Daphnia magna (pass/fail, LC50) [6]	2 x 20 L carboy	4° C	5 days
Rainbow Trout (pass/ fail, LC50) [7]		4° C	5 days
Fathead Minnows (sublethal)	3 x 20 L carboy	4° C	5 days
C. dubia (sublethal)		4° C	5 days
L. minor (sublethal)		4° C	5 days
P. subcapitata (sublethal)		4° C	5 days

Notes:

(1) Parameters may be analyzed from a single unpreserved bottle.

(2) 40 mL glass vials must be filled with no headspace. May contain preservative. Do not pre-rinse with sample. If sample is chlorinated use thiosulphate preservative.

(3) All volatile organics in water (chlorinated aromatics, BTEX, volatile organics, THMs and halogenated aliphatics) can be analyzed from the same set of vials. Consult ALS whether 2 or 3 vials are required.

(4) If field filtering is not possible, or poses unacceptable risks for sample contamination, then send the samples unfiltered to and unpreserved to the laboratory as soon as possible.

(5) Testing in the field is recommended.

(6) For Daphnia Magna (LC50), require 2 L minimum volume. For Daphnia Magna (Pass/Fail), require 1 L minimum volume.

(7) For Rainbow Trout (LC50), 2 x 20 L bladder and 40 L minimum volume required. For Rainbow Trout (Pass/Fail), 1 x 20 L bladder and 20 L minimum volume required.

2.4 Sample Transportation

Sample integrity will be preserved from the time of sample collection to completion of delivery to the laboratory by limiting exposure of samples to heat, light, and agitation.

Sample bottles will be packed standing upright and immobile in a new or laboratory issued portable cooler. Samples suspected of elevated contaminant levels, such as a sewage sample, will be shipped separately from clean samples. All samples will be stored and transported at 10°C to 1°C in the coolers with ice packs and the cooler will be securely closed prior to shipping. Samples will be shipped as soon as possible following sample collection with appropriate transportation instructions such as "refrigerate" and "do not freeze".

2.5 Chain of Custody Forms

A Chain of Custody Form containing the following information is completed by the sampler for every cooler shipment of samples:

- Company name and contact information,
- Analytical laboratory name, address , and contact person,
- Invoicing instructions,
- Report format requested,
- Project information,
- Sampler's name,
- Sample identification number, time and date of sampling, sample type, and analyses requested,
- Any special instructions, and
- Name of person releasing the shipment as well as date and time of release. Each person relinquishing and receiving the samples, including the courier, must sign the Chain of Custody form.

Each cooler shipped must have a Chain of Custody form indicating those samples contained in the particular cooler. Chain of Custody forms should be enclosed in a Ziploc bag to protect them from possible water damage during shipment.

One copy of the Chain of Custody form is included with the shipment and one copy must remain at the mine site for recording keeping. An example of the Chain of Custody Form is provided in Appendix A.

3 Water Field Quality Control

3.1 Trip or Travel Blanks

Travel blanks are supplied and shipped by the laboratory to test for possible contamination that might arise during the handling, transport, or storage of the samples. The identity of these samples must be recorded in the Field Log Book.

One travel blank must be submitted per sample shipment.

3.2 Duplicates or Replicates

Duplicate or replicate sampling is the collection of more than one sample for a given analysis at a given location to test the validity of sampling procedures and laboratory methodology. Duplicates are collected, handled, and analysed using the same procedures applied to routine samples. Duplicates are submitted to the laboratory with a unique (fictitious) identifier to prevent association of the paired samples. The identity of these samples must be recorded in the Field Log Book.

Duplicate samples must be collected for approximately every ten (10) field samples collected across the range of parameters. At least one duplicate must be submitted per sample shipment.

4 Laboratory Analyses

ALS Environmental laboratories (ALS) located in Yellowknife, NWT performs the required environmental analyses for the Lupin Mine, with the exception of MDMER toxicity testing which is completed by Nautilus Environmental in Calgary, AB.

ALS is accredited by the Canadian Association for Laboratory Accreditation Inc. (CALA) and conforms to the requirements of ISO/IEC Standard 17025. Attached in Appendix B is a copy of the ALS Yellowknife laboratory scope of accreditation. The scope of accreditation of all ALS laboratories is available from their website at:

https://www.alsglobal.com/en/myals/downloads

Nautilus Environmental is accredited by the CALA to conduct acute lethality and Daphnia magna monitoring tests and conforms to the requirements of ISO/IEC Standard 17025. Nautilus Environmental should be advised that the dilution series for *Ceridodaphnia* and *Lemna* should be adjusted prior to sublethal testing. Attached in Appendix B is a copy of the Nautilus Environmental Burnaby laboratory scope of accreditation.

All analyses are conducted in accordance with methods prescribed in the current edition of Standard Methods for the Examination of Water and Wastewater including regular QA/QC during the analysis of field samples including a program of method blanks, laboratory control samples, instrument calibration samples, matrix spikes, and duplicates.

5 Reporting

All analytical results will be forwarded in electronic format from ALS to LMI for data collection and management. Upon receipt, LMI will review the results to identify any anomalies. Anomalous results will be either re-analyzed by the laboratory or new samples will be collected to confirm the analytical results.

Any analytical results that indicate exceedance of regulatory criteria will be reported to the appropriate agencies including the NWB and the CIRNAC inspector.

Part J Item 10 of the Lupin Mine Water Licence requires LMI to include in its Annual Report (due March 31st), all data, monitoring results and information required by Part J of the Water Licence. Under the MDMER effluent monitoring reporting of all tests and monitoring conducted during each quarter is to be reported not later than 45 days after the end of a quarter. A report summarizing the previous calendar year is also required under the MDMER to Environment and Climate Change Canada (due March 31st).

To facilitate the required annual reporting, LMI prepares written monthly reports supported by laboratory analyses results table summaries and quality assurance review. Each monthly report includes the following:

- A description of the sample activities undertaken,
- Description of the existing conditions at each sampling station,
- Tabular summary of analytical lab result including the results of the quality control samples (travel blank, field blank, duplicate samples), and
- Interpretation of the analytical lab results including comparison of the results with water licence criteria and assessment of the reliability of the results.
- Within the annual report, the acceptability of samples will be evaluated qualitatively by examination of the trip blanks and field duplicate sample data. Reproducibility of samples will be expressed as relative percent difference (RPD):

$$RPD = 100 * ((X_1 – X_2) / (X_1 + X_2) / 2)$$

Where X_1 is the original sample concentration, X_2 is the duplicate sample concentration, and X_1-X_2 denotes the absolute value of the difference between these two concentrations.

Quality Assurance/Quality Control Plan for Soils at the Lupin Mine

The purpose of this document is to provide a quality assurance (QA) / quality control (QC) plan for the remediation of contaminated soils at Lupin Mine (the Site). This QA/QC plan for contaminated soils outlines the field screening and confirmatory sampling program for the remediation of contaminated soils that will be required as part of Site closure. The objective of this QA/QC plan is to confirm that the contractor successfully remediates the areas of contaminated soils and meets the intent of the design.

The remediation of contaminated soils will require a field QA/QC plan to confirm compliance with the established remedial criteria. The QA/QC program will include four primary components:

- Field layout and remedial excavation.
- Field screening.
- Confirmation sampling.
- Reporting.

6. Field Layout and Remedial Excavations

The excavation of contaminated soils will be initially defined in the field based on the locations of test pits where contaminated soils were identified as part of the 2006 Phase I and II ESA (Morrow 2006) and the 2017 Phase I and II ESA Update (Golder 2017a). The layout of the locations of the planned remedial excavations will be surveyed in the field and the locations will be verified prior to remedial work commencing.

The remedial excavations of contaminated soils will be monitored, and the type and quantity of excavated material will be documented as remedial activities advance. Visual observations will initially be used to identify the limits of contaminated materials and a photographic log of remedial activities will be maintained. The advancement of remedial activities will be tracked and compared with the design estimates of remedial volumes and excavation limits.

7. Field Screening

Soil samples will be screened to obtain "real-time" field data to guide the remedial activities and to enable the collection of a subset of confirmatory samples for laboratory analysis. Field screening techniques such as portable combustible gas instruments (CGIs) and x-ray fluorescence (XRF) instruments are widely used during remediation activities. Although these field tools do not replace the collection of confirmation laboratory analysis, they provide complimentary data to support field decisions with respect to soil excavation and will be used to verify soil quality compliance.

The CGI and XRF instruments must be calibrated by the equipment supplier prior to shipment to the Site. Afterwards, regular "bump" tests of the CGI instrument should be completed according to the manufacture's instructions. As part of the daily field screening, field notes should be collected which include the following information:

- Date of field screening.
- Weather conditions.
- Excavation and field screening sample identifications.
- Field screening sample depths.
- Field screening concentrations.

The following sections summarize the field screening instruments and methodologies for the primary contaminants of concern: PHCs and total arsenic.

7.1. Petroleum Hydrocarbons (PHCs)

Field screening of PHCs will consist of a combination of visual assessment of staining and the use of a portable CGI. The presence of residual volatile hydrocarbons within soil affected by weathered diesel and fuel oil is likely low and it is therefore expected that field screening for PHCs may not be highly effective. The portable CGI measures concentrations of volatile hydrocarbons from soil in either the parts per million (ppm) or percentage Lower Explosive Limit ranges. The unit will be calibrated to a reference gas, typically operated in methane elimination mode.

Discrete soil samples will be collected from the walls and base of the remedial excavations following the definition of the potential limits. The frequency of discrete field screening will be determined on an excavation by excavation basis based upon the lateral and vertical extents. If bedrock or permafrost is encountered below PHC contaminated soil, discrete soil samples will be collected if possible. However, if ex-situ screening can not be completed due to terrain limitations, a visual assessment of the bedrock or permafrost surface will be completed and documented.

Discrete soil samples will be collected in the field from the excavation or the excavator bucket depending on the depth of the excavation and applicable health and safety requirements. Samples will be stored in re-sealable plastic bags and allowed to acclimatise to room temperature for approximately 15 minutes. The CGI probe is then inserted into the bag for measurement of combustible vapours. It is anticipated that field screening results using the CGI will generally fall into two categories:

- Field screening data indicates a high likelihood of a below applicable criteria confirmation laboratory result. Field screening data should include CGI readings less than 50 ppm and no staining or olfactory indications of contamination observed.
- Field screening data characterized by elevated CGI readings exceeding 50 ppm and/or significant staining or olfactory indications of contamination observed indicates a low likelihood of a below applicable criteria confirmation laboratory result.

It is recognized that the interpretation of field screening data will evolve as correlations between laboratory and field screening results become established. The results of the field screening program will be used to identify sample locations designated for confirmatory sampling.

7.2. Total Arsenic

Field screening of total arsenic will be completed using a portable XRF instrument, which allows for the detection of mg/kg concentrations of a wide spectrum of metals within soil. The XRF instrument will be used to estimate total arsenic concentrations in the field and the results will be used to determine whether additional excavation is required or if confirmatory soil sampling may be initiated. The XRF is a radiation source and requires health and safety training for use as well as specific Transport Canada documentation associated with land and air transport.

Upon completion of the remedial excavations, it is assumed that residual soil will be present along the base and walls of the excavations. As a result, once the potential limits of the remedial excavations are encountered, detailed field screening of the walls and bases will be completed using discrete samples collected on a grid pattern. Discrete soil samples (approximately 250 ml in size) will be collected directly from the excavation or bucket of the excavator depending on the depth of the excavation and applicable health and safety requirements. Samples will be collected such that minimal organic material and/or gravel-sized fragments are present in order to minimize interference with the XRF. Three methods will be used to complete the XRF field screening:

- Unprocessed ex-situ method. This method involves sample placement in thin walled plastic bags. No sample processing (i.e., drying, sieving, or blending) will occur. Measurements are taken in a trailer located on-site with the instrument mounted to a stand.
- Processed ex-situ method. This method requires sample preparation (i.e., drying, sieving, and blending) and compaction/placement in XRF sample cups. Measurements are also taken in an on-site trailer with instrument mounted to stand.
- In-Situ “point and shoot” method. This method involves collecting in-field readings of total arsenic concentrations from soil remaining on bedrock terrain or permafrost exposed during remedial activities. Although this method is generally not considered to provide as accurate of results as the ex-situ methods, it will be used to assess soil quality in bedrock terrain or permafrost where sample collection for ex-situ screening methods is not considered feasible.

The majority of the discrete soil samples will be field screened using the unprocessed ex-situ method in order to reduce the time and effort required to prepare each sample. If a discrete sample is observed to be frozen or have excessive moisture, that sample will need to be field screened using the processed ex-situ method as moisture content will interfere with the XRF readings. For each of the methods, a minimum of three readings will be taken per sample using the XRF. These three readings will be collected sequentially and averaged to produce a single screening value. The frequency of discrete field screening will be determined on an excavation by excavation basis and will be based on the final extents of the excavation.

The results of the field screening program will be used to either: (i) temporarily suspend excavation activities and proceed with confirmatory sampling; or (ii) continue remedial excavation activities. The field screening results will be used to predict expected compliance with the applicable criteria, whereas the confirmatory sampling analytical data will be used to verify compliance with the applicable criteria. It is recognized that the interpretation of field screening data will evolve as correlations between laboratory and field screening results become established. It is anticipated that field screening results using the XRF will generally fall into three categories:

- Field screening data indicates a high likelihood of a below applicable criteria confirmation laboratory result.
- Field screening result is marginally below the applicable criteria, suggesting the confirmation laboratory result may be just below or above the applicable criteria.
- Field screening data indicates a low likelihood of a below applicable criteria confirmation laboratory result.

Table 7.1 summarizes the planned strategy for the interpretation of the XRF field screening results.

Table 7.1: Strategy for Interpretation of XRF Field Screening Results

XRF Screening Result	Strategy
Less than 50% of arsenic “hotspot” value (<2,000 mg/kg total arsenic)	Proceed with confirmatory sample collection
Between 50% to 100% of arsenic “hotspot” value (2,000 mg/kg to 4,000 mg/kg total arsenic)	Proceed with limited additional remedial work and field screening
Greater than 100% of arsenic “hotspot” value (>4,000 mg/kg total arsenic)	Continue with remedial work and field screening

7.3. Confirmation Sampling

Confirmatory sampling will be completed throughout the remedial works for the purposes of verifying the contaminant concentrations prior to proceeding with backfilling activities. It is expected that the field screening results for both the CGI and XRF will correlate with the laboratory results. However, this correlation will be assessed following the collection of approximately 100 sample pairs.

The analytical testing program will focus on verifying contaminant concentrations at the limits of remedial excavations and thereby confirming compliance with the remedial objectives. Discrete soil samples,

selected based on field screening results, will be submitted to an accredited analytical laboratory for chemical analysis. Discrete confirmatory soil samples will be collected within a grid pattern from the walls and bases of the excavations. The frequency of confirmatory soil sample submission will be determined on an excavation by excavation basis and will consider the lateral extents of the excavation. However, the generally frequency for confirmatory soil sampling will consist of a maximum confirmatory soil sampling grid pattern of 10 m by 10 m (CCME 2016).

7.4. Sample Collection and Handling

Confirmatory samples will be collected for laboratory analysis of either benzene, toluene, ethylbenzene, xylenes (BTEX), and PHC Fractions F1 through F4 or total arsenic. All samples will be collected directly from the excavator bucket and will be gathered using dedicated Terracore samplers and/or a putty knife. All samples will be handled using dedicated nitrile gloves and sampling equipment will be decontaminated using Liquinox and distilled water between sample locations. The confirmatory samples will be placed within laboratory supplied sample containers. Samples for analysis of BTEX and PHC Fractions F1 through F4 will be placed into two 40 mL vials pre-charged with methanol for field preservation and one 125 mL jar, while samples for analysis of total arsenic will be placed in sealable plastic bags. Afterwards the samples will be placed in coolers with ice packs in order to limit the loss of volatile compounds.

7.5. Sample Labelling

Samples must be clearly and consistently labeled using a waterproof, non-smear pen prior to being sent to the laboratory with the following information:

- Company name.
- Site name.
- Sample identification.
- Sample date and time.
- Analysis required.

7.6. Sample Transportation

Sample integrity will be preserved from the time of sample collection to completion of delivery to the laboratory by limiting exposure of samples to heat, light, and agitation. The sample containers will be packed standing upright and immobile in a new or laboratory issued portable cooler. Samples suspected of elevated contaminant levels will be shipped separately from clean samples. All samples will be stored and transported at 10°C to 1°C in the coolers with ice packs and the cooler will be securely closed prior to shipping. Samples will be shipped as soon as possible following sample collection with appropriate transportation instructions such as “refrigerate” and “do not freeze”.

7.7. Chain of Custody Forms

A Chain of Custody (CoC) form containing the following information must be completed by the sampler for every cooler shipment of samples:

- Company name and contact information.
- Analytical laboratory name, address, and contact person.
- Invoicing instructions.
- Report format requested.
- Project information.
- Sampler's name.
- Sample identification number, time and date of sampling, sample type, and analyses requested.
- Any special instructions.
- Name of person releasing the shipment as well as date and time of release.

Each person relinquishing and receiving the samples, including the courier, must sign the CoC form. Each cooler shipped must have a CoC form indicating those samples contained in the particular cooler. CoC forms should be enclosed in a Ziploc bag to protect them from possible water damage during shipment. One copy of the CoC form is included with the shipment and one copy must remain at the Site for recording keeping.

8. Duplicate Samples

Duplicate or replicate sampling is the collection of more than one sample for a given analysis at a given location to test the validity of sampling procedures and laboratory methodology. Duplicates are collected, handled, and analyzed using the same procedures applied to the parent samples. Duplicate soil samples will be collected at an approximate 10% frequency. The location of the duplicate soil samples will be recorded in the field notebook. The duplicate soil samples will be submitted to the laboratory with a unique (fictitious) identifier to prevent association of the paired samples and should be stored and handled the same as the parent samples. At least one duplicate soil sample should be submitted per sample shipment.

9. Laboratory Analysis

ALS Environmental Laboratories (ALS) located in Yellowknife, Northwest Territories will perform the required environmental analyses for the confirmatory samples. ALS is accredited by the Canadian Association for Laboratory Accreditation Inc. (CALA) and conforms to the requirements of ISO/IEC Standard 17025. The scope of accreditation of all ALS laboratories is available from their website at: https://www.alsglobal.com/en/myals/downloads

Should results of the laboratory analysis confirm contaminant concentrations below the applicable remedial objectives, the limits of the remedial excavations will be documented, and backfilling activities will commence. However, should the results identify contaminant concentrations exceeding the applicable remedial objectives, additional excavation will be required, and new samples will be collected

from the revised excavation limits for field screening and confirmatory sampling. This process will continue until the analytical results from all soil samples confirm the contaminant concentrations are below the applicable remedial objectives.

10. Reporting

Throughout the remedial works, daily reports will be produced which will include the following information:

- Date and hours worked.
- Weather and other notable site conditions.
- Daily construction activities completed.
- Daily monitoring activities completed.
- Drawings showing excavation extents and sample locations.
- Field screening concentrations.
- Samples submitted for confirmation sampling.
- Select photographs of the daily work.

In addition, on a weekly basis, field data, field notes, and photographs will be scanned and uploaded to an electronic server for ease of retrieval. As analytical results are received from the laboratory, the results will be communicated by e-mail to the contractor, client, and any other relevant parties.

At the conclusion of the contaminated soils remedial works, a closure report will be produced for LMI. This report will document the results of the remedial excavation activities and will include a description and summary of the remedial works, a summary of the field screening concentrations, a comparison of the results of the confirmatory soil sample analyses to the applicable criteria, and a discussion of the results. The report will also include tables summarizing the analytical results and figures outlining the Site features, excavation extents, confirmatory sampling locations, and analytical results. The report will also include appendices with select photographs of the daily work and copies of the laboratory certificates of analysis.

Legend

Project Location

Coordinate System: NAD_1983_UTM_Zone_12N

Map Sources/Notes:
Various Canadian Government Websites - Feb 2012

0 60 120 240 360 480 600 Km

1:15,000,000

Approved By: SH
Project No.: LUP
Prepared By: PW
Date Revised: 21 Mar 2012

File Name: Lup-12-10-01-LocationMap-A.mxd

Project: **Lupin Project**
Location: Kitikmeot Region, Nunavut, Canada

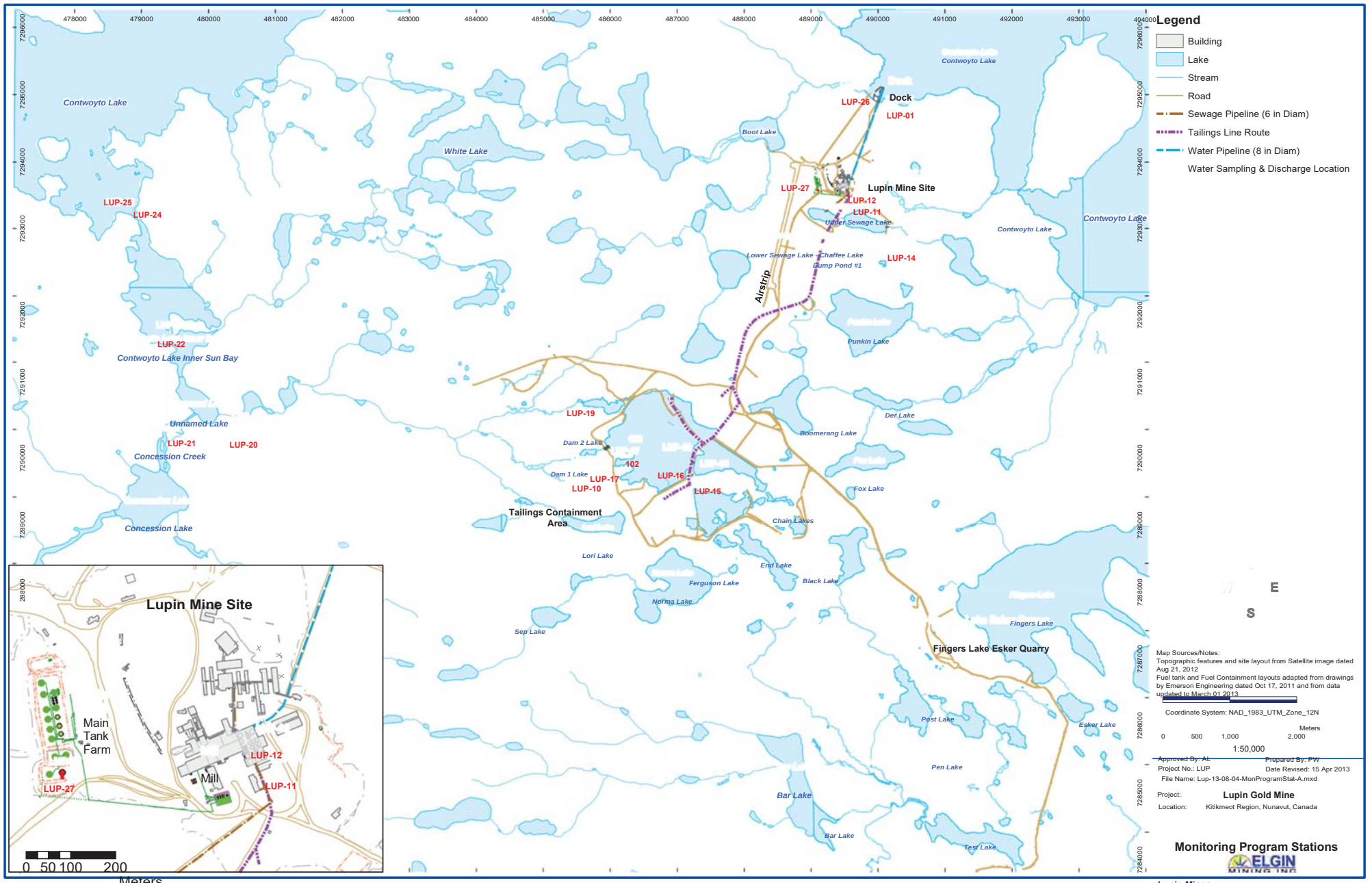
Lupin Mine Annual Report - Water Licence 2AM-LUP0914

Location Map - Lupin Mine

Lupin Mines Incorporated

ELGIN MINING INC.

Figure: 1
Rev: 120321


Legend
Building
Lake
Stream
Road
Sewage Pipeline (6 in Diam)
Tailings Line Route
Water Pipeline (8 in Diam)
Water Sampling & Discharge Location
Lupin Mine Site
Dock
LUP-01
LUP-26
LUP-27
LUP-12
LUP-11
LUP-14
LUP-25
LUP-24
LUP-22
LUP-21
LUP-20
LUP-19
LUP-17
LUP-16
LUP-15
LUP-10
102
Tailings Containment Area
Airstrip
Contwoyto Lake
Boot Lake
White Lake
Upper Sewage Lake
Lower Sewage Lake
Chaffee Lake
Dump Pond #1
Punkin Lake
Contwoyto Lake Inner Sun Bay
Unnamed Lake
Concession Creek
Concession Lake
Dam 2 Lake
Dam 1 Lake
Der Lake
Boomerang Lake
Fox Lake
Chain Lakes
Lori Lake
End Lake
Ferguson Lake
Black Lake
Norma Lake
Sep Lake
Fingers Lake
Fingers Lake Esker Quarry
Esker Lake
Post Lake
Pen Lake
Bar Lake
Test Lake
Main Tank Farm
Mill
0 50 100 200
Meters
Map Sources/Notes:
Topographic features and site layout from Satellite image dated Aug 21, 2012
Fuel tank and Fuel Containment layouts adapted from drawings by Emerson Engineering dated Oct 17, 2011 and from data updated to March 01 2013
Coordinate System: NAD_1983_UTM_Zone_12N
0 500 1,000 2,000
Meters
1:50,000
Approved By: AL
Prepared By: PW
Project No.: LUP
Date Revised: 15 Apr 2013
File Name: Lup-13-08-04-MonProgramStat-A.mxd
Project: Lupin Gold Mine
Location: Kitikmeot Region, Nunavut, Canada
Monitoring Program Stations
ELGIN MINING INC.
Lupin Mines Incorporated
Figure:
Rev:
130415

Appendix A: Chain of Custody

Chain of Custody (COC) / Analytical Request Form

www.alsglobal.com

Canada Toll Free: 1 800 668 9878

Affix ALS barcode label here
(lab use only)

COC Number:

Page of

Report To	Contact and company name below will appear on the final report
Company:	Lupin Mines Inc.
Contact:	Karyn Lewis
Phone:	
	Company address below will appear on the final report
Street:	76 Richmond Street, Suite 330
City/Province:	Toronto ON
Postal Code:	M5C 1P1

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☐ EDD (DIGITAL)
Quality Control (QC) Report with Report ☐ YES ☐ NO
☐ Compare Results to Criteria on Report - provide details below if box checked
Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax: k.lewis@mandalayresources.com
Email 2: erichard@golder.com
Email 3: jim.mckinley@stantec.com

Select Service Level Below - Contact your AM to confirm all E&P TATs (surcharges may apply)

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)
- **4 day [P4-20%]** ☐
- **3 day [P3-25%]** ☐
- **2 day [P2-50%]** ☐

EMERGENCY
- **1 Business day [E - 100%]** ☐
- **Same Day, Weekend or Statutory holiday [E2 -200%** ☐
  (Laboratory opening fees may apply)]

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Invoice To	Same as Report To ☑ YES ☐ NO
	Copy of Invoice with Report ☑ YES ☐ NO
Company:	
Contact:	k.lewis@mandalayresources.com

Invoice Distribution

Select Invoice Distribution: ☐ EMAIL ☑ MAIL ☐ FAX
Email 1 or Fax:
Email 2:

Project Information

ALS Account # / Quote #: Q80133
Job #:
PO / AFE:
LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center: PO#
Major/Minor Code: Routing Code:
Requisitioner:
Location:

ALS Lab Work Order # (lab use only):

ALS Contact: Oliver Gregg **Sampler:**

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

NUMBER OF CONTAINERS

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Conventional (pH, EC, Alk-Tot, hardness, TS	Nutrients (Nitrate, Nitrite and total ammonia)	Total Metals + Hg	Cyanide	Radium-226	Acute Toxicity Daphnia magna	Acute Toxicity Rainbowm Trout	Major Ions	Phosphorus (colorimetric)	Sublethal Toxicity - Fathead Minnows	Sublethal Toxicity - Ceridaphinia dubia	Sublethal Toxicity - Lemna minor	Sublethal Toxicity - P. subcapitata		**SAMPLES ON HOLD**	**SUSPECTED HAZARD (see Special Instructions)**
	LUP-10			Effluent	R	R	R	R	R	R	R	R	R	R	R	R	R			

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?
☐ YES ☑ NO

Are samples for human consumption/ use?
☐ YES ☐ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐
Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐
Cooling Initiated ☐

INITIAL COOLER TEMPERATURES ºC				FINAL COOLER TEMPERATURES ºC			

SHIPMENT RELEASE (client use)		
Released by:	Date:	Time:

INITIAL SHIPMENT RECEPTION (lab use only)		
Received by:	Date:	Time:

FINAL SHIPMENT RECEPTION (lab use only)		
Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCT 2018 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form**.

Appendix B: Scope of Accreditations

Canadian Association for Laboratory Accreditation Inc.

Certificate of Accreditation

ALS Environmental (Vancouver)
ALS Canada Ltd.
8081 Lougheed Highway
Suite 100
Burnaby, British Columbia

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017.
This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated April 2017).

Accreditation No.:	A1719
Issued On:	December 12, 2018
Accreditation Date:	January 3, 2005
Expiry Date:	June 11, 2021

President & CEO

CALA
Canadian Association for
Laboratory Accreditation Inc.

CALA Directory of Laboratories

Membership Number: 1719
Laboratory Name: ALS Environmental (Vancouver)
Parent Institution: ALS Canada Ltd.
Address: 8081 Lougheed Highway Suite 100 Burnaby BC V5A 1W9
Contact: Ms. Helenita Franco
Phone: (604) 253-4188
Fax: (604) 253-6700
Email: quality.vancouver@alsglobal.com

Standard: Conforms with requirements of ISO/IEC 17025
Clients Served: All Interested Parties
Revised On: June 18, 2020
Valid To: June 11, 2021

Scope of Accreditation

Air (Inorganic)
Dustfall - Air [Dustfall] (227)
VA-TM-1039; ASTM D1739-98 and BC MOE LABORATORY MANUAL
GRAVIMETRIC
Fixed Dustfall
Total Dustfall
Total Insoluble Dustfall
Total Soluble Dustfall

Air (Inorganic)
Mercury - Air [Dustfall] (271)
NA-TM-1005, NA-TP-2012, VA-TP-2063; modified from BC MOE LABORATORY MANUAL and EPA 1631E
COLD VAPOUR AAS - DIGESTION
Mercury

Air (Inorganic)
Metals - Air [Dustfall] (224)
NA-TM-1002, NA-TP-2007, VA-TP-2063; modified from BC MOE LABORATORY MANUAL and EPA 6020B
ICP/MS - DIGESTION
Aluminum
Antimony
Arsenic
Barium
Beryllium
Bismuth
Boron

† "OSDWA" indicates the appendix is used for the analysis of Ontario drinking water samples, which is subject to the rules and related regulations under the Ontario "Safe Drinking Water Act" (2002).

The list of tests and measurement capabilities for which a laboratory is accredited can change at any time due to circumstances such as scope extensions, voluntary withdrawal of tests by the laboratory and suspension. Scopes are published by the CALA via the Internet at http://www.cala.ca/cala_directories.html

Calcium
Chromium
Cobalt
Copper
Lead
Lithium
Magnesium
Manganese
Molybdenum
Nickel
Potassium
Selenium
Silver
Sodium
Strontium
Thallium
Tin
Uranium
Vanadium
Zinc

Air (Inorganic)
Total Particulates - Air [Filter, Particulate] (035)
VA-TM-1041; modified from ASTM D2009-65 and BC WORKERS COMPENSATION BOARD STANDARDS (BCWCB) 1150
GRAVIMETRIC
Respirable Dust
Total Particulate Matter

Air (Organic)
Volatile Organic Compounds (VOC) - Air (206)
VA-TM-1109; modified from EPA TO-17
GC/MS
1,1-Dichloroethane
1,1-Dichloroethylene
1,1-Dichloropropene
1,1,1-Trichloroethane
1,1,1,2-Tetrachloroethane
1,1,2-Trichloroethane
1,1,2-Trichlorotrifluoroethane
1,1,2,2-Tetrachloroethane
1,2-Dibromo-3-chloropropane (DBCP)
1,2-Dibromoethane (Ethylene dibromide)
1,2-Dichlorobenzene
1,2-Dichloroethane
1,2-Dichloropropane
1,2,3-Trichlorobenzene
1,2,3-Trichloropropane

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1,2,4-Trichlorobenzene
1,2,4-Trimethylbenzene
1,3-Butadiene
1,3-Dichlorobenzene
1,3-Dichloropropane
1,3,5-Trimethylbenzene
1,4-Dichlorobenzene
2-Butanone (Methyl ethyl ketone, MEK)
2-Chlorophenol
2-Chlorotoluene
2-Hexanone (Methyl butyl ketone, MBK)
2-Propanol (Isopropyl alcohol)
2,2-Dichloropropane
4-Chlorotoluene (p-Chlorotoluene)
4-isopropyltoluene (p-Cymene)
4-Methyl-2-pentanone (MIBK)
Acetone (2-Propanone)
Benzene
Biphenyl (1,1-Biphenyl)
Bromobenzene
Bromochloromethane
Bromodichloromethane
Bromoform
Bromomethane
Carbon disulfide
Carbon tetrachloride
Chlorobenzene
Chloroethane (Ethyl Chloride)
Chloroethene (Vinyl chloride)
Chloroform
Chloromethane (Methyl chloride)
cis-1,2-Dichloroethylene
cis-1,3-Dichloropropene
Cyclohexane
Decane
Dibromochloromethane
Dibromomethane
Dichlorodifluoromethane
Dichloromethane (Methylene Chloride)
Ethyl acetate
Ethylbenzene
Hexachlorobutadiene
Isopropylbenzene (Cumene)
m,p-Xylene
Methyl tert-butyl ether (MTBE)
Methylcyclohexane

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n-Butylbenzene
n-Heptane
n-Hexane
n-Octane
n-Propylbenzene
Naphthalene
o-Xylene
sec-Butylbenzene
Styrene
tert-Butylbenzene
Tetrachloroethylene
Toluene
trans-1,2-Dichloroethylene
trans-1,3-Dichloropropene
Trichloroethylene
Trichlorofluoromethane

Air (Organic)
Volatile Organic Compounds (VOC) - Air (207)
VA-TM-1109; modified from EPA TO-17
GC/FID
F1: C6-C10
F2: C10-C16
Total Volatile Organic Compounds (TVOC): >C10-C12
Total Volatile Organic Compounds (TVOC): >C12-C16
Total Volatile Organic Compounds (TVOC): >C6-C8
Total Volatile Organic Compounds (TVOC): >C8-C10
Volatile Hydrocarbons (VH): C6-C13

Dust (Inorganic)
Soluble Anions - Dustfall (255)
NA-TM-1001, VA-TM-1039; modified from BC MOE LABORATORY MANUAL and EPA 300.0 and SM 4110
ION CHROMATOGRAPHY
Chloride
Nitrate

Food
Arsenic Speciation - Food [Egg, Fresh Fruit, Meat, Processed Food, Vegetables] (236)
NA-TM-1002, NA-TP-2007, VA-TM-1082; modified from CFIA SOM-DAR-CHE-053-04 and EPA 6020A
HPLC - ICP/MS
Arsenate (As(V))
Arsenite (As(III))
Arsenobetaine (AsB)
Arsenocholine (AsC)
Dimethylarsinic acid (DMA)
Monomethyl arsenate (MMA)

Food (Inorganic)
Methyl mercury - Seafood (272)
NA-TM-1002, VA-TM-1088; modified from FDA METHOD 4.8
HPLC - ICP/MS
Methyl mercury

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Oil (Organic)
Total Polychlorinated Biphenyls (PCB) - Oil (080)
VA-TM-1118, VA-TP-2116; modified from EPA 3620C and EPA 3660B and EPA 3665A and EPA 600/4-81-045 and EPA 8082A
GC/ECD
Aroclor 1016
Aroclor 1221
Aroclor 1232
Aroclor 1242
Aroclor 1248
Aroclor 1254
Aroclor 1260
Aroclor 1262
Aroclor 1268
Total PCB

Paint (Inorganic)
Lead - Paint (261)
NA-TM-1002, NA-TP-2004; modified from EPA 200.2 and EPA 6020B
ICP/MS - DIGESTION
Lead

Soil (Inorganic)
Acidity - Solids [Soil] (257)
VA-TM-1053, VA-TM-1074; modified from MEND REPORT 1.20.1 and SM 2320 B
TITRIMETRIC - SHAKEFLASK EXTRACTION
Acidity

Soil (Inorganic)
Alkalinity - Solids [Soil] (258)
VA-TM-1053, VA-TM-1074; modified from MEND REPORT 1.20.1 and SM 2320 B
TITRIMETRIC - SHAKEFLASK EXTRACTION
Alkalinity

Soil (Inorganic)
Anions - Solids [Leachate] (256)
NA-TM-1001, VA-TM-1078; modified from BC MOE LABORATORY MANUAL and EPA 300.0 and SM 4110
ION CHROMATOGRAPHY (IC) - FIXED RATIO EXTRACTION
Chloride
Chloride
Sulphate
Sulphate (Sulfate)

Soil (Inorganic)
Leachable Anions - Solids [Soil] (244)
NA-TM-1001, VM-TM-1074; modified from EPA 300.1 and MEND REPORT 1.20.1
IC - SHAKEFLASK EXTRACTION
Bromide
Chloride
Fluoride
Nitrate as Nitrogen
Nitrite as Nitrogen
Sulphate (Sulfate)

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The list of tests and measurement capabilities for which a laboratory is accredited can change at any time due to circumstances such as scope extensions, voluntary withdrawal of tests by the laboratory and suspension. Scopes are published by the CALA via the Internet at http://www.cala.ca/cala_directories.html

Soil (Inorganic)
Leachable Metals - Solids [Soil] (247)
NA-TM-1002, NA-TP-2007, VA-TM-1074; modified from EPA 6020B and MEND REPORT 1.20.1
ICP/MS - SHAKEFLASK EXTRACTION
Aluminum
Antimony
Arsenic
Barium
Beryllium
Bismuth
Boron
Cadmium
Calcium
Chromium
Cobalt
Copper
Iron
Lead
Lithium
Magnesium
Manganese
Molybdenum
Nickel
Phosphorus
Potassium
Selenium
Silicon
Silver
Sodium
Strontium
Thallium
Tin
Uranium
Vanadium
Zinc

Soil (Inorganic)
pH - Solids [Soil] (250)
VA-TM-1074; modified from MEND REPORT 1.20.1 and SM 4500-H
pH METER-Shake flask Extraction
pH

Soil (Microbiology)
Fecal (Thermotolerant) Coliforms - Solids [Soil] (245)
VA-TM-1200; modified from EPA 1680
MOST PROBABLE NUMBER
Fecal (Thermotolerant) Coliforms

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Solids (Inorganic)
Acid Volatile Sulphide (AVS) - Solids [Soil] (230)
VA-TM-1021; modified from EPA 821-R-91-100
COLORIMETRIC - EXTRACTION
Acid Volatile Sulfides

Solids (Inorganic)
Anions - Solids [Soil] (148)
NA-TM-1001, VA-TP-2066; modified from EPA 300.1 and SM 4110 B and SOIL SAMPLING & METHODS OF ANALYSIS CHAPTER 15
IC-SATURATED EXTRACTION
Bromide
Chloride
Fluoride
Nitrate-N
Nitrite
Sulphate

Solids (Inorganic)
Conductivity - Solids [Soil] (147)
VA-TM-1053, VA-TP-2066; modified from SM 2510 B and SOIL SAMPLING & METHODS OF ANALYSIS CHAPTER 15
METER - SATURATION EXTRACTION
Conductivity

Solids (Inorganic)
Cyanide - Solids [Soil] (213)
NA-TM-1003, VA-WI-3019; modified from BC MOE LABORATORY MANUAL and ISO 14403 and ON MOECC E3015 and SM 4500-CN- I
AUTO COLOR - DISTILLATION-EXTRACTION
Cyanide (SAD)
Cyanide (WAD)

Solids (Inorganic)
Cyanide - Solids [Soil] (214)
NA-TM-1003, VA-WI-3019; modified from ASTM 7237 and BC MOE LABORATORY MANUAL and ON MOECC E3015
AUTO COLOR/GAS DIFFUSION-EXTRACTION
Cyanide, Free

Solids (Inorganic)
Flashpoint - Solids [Ash] (264)
VA-TM-1090; modified from ASTM D93-15
PENSKE-MARTEN CLOSED CUP
Flashpoint

Solids (Inorganic)
Leachable Mercury - Solids [Soil] (270)
NA-TM-1005, NA-TP-2012, VA-TM-1074; modified from MEND REPORT 1.20.1
COLD VAPOUR AA - SPECTROMETRIC SHAKE FLASK EXTRACTION
Mercury

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The list of tests and measurement capabilities for which a laboratory is accredited can change at any time due to circumstances such as scope extensions, voluntary withdrawal of tests by the laboratory and suspension. Scopes are published by the CALA via the Internet at http://www.cala.ca/cala_directories.html

Solids (Inorganic)
Leachable Mercury - Solids [Waste] (267)
NA-TM-1005, NA-TP-2012, VA-TM-1071; modified from BC MOE ENVIRONMENTAL MANAGEMENT ACT HAZARDOUS WASTE REGULATION (EMA/HWR) and EPA 1631E
CVAAS-MELP EXTRACTION
Mercury

Solids (Inorganic)
Leachable Mercury - Solids [Waste] (268)
NA-TM-1005, NA-TM-1700, NA-TP-2012; modified from EPA 1311 (PREPARATION) and EPA 1631E (ANALYSIS)
COLD VAPOUR AA - TCLP EXTRACTION
Mercury

Solids (Inorganic)
Leachable Metals - Solids (121)
VA-TM-1066, VA-TM-1071, VA-TP-2072; modified from BC MOE ENVIRONMENTAL MANAGEMENT ACT HAZARDOUS WASTE REGULATION (EMA/HWR) and EPA 6010D
ICP/OES- MLEP EXTRACTION
Arsenic
Barium
Boron
Cadmium
Chromium
Copper
Lead
Selenium
Silver
Uranium
Zinc

Solids (Inorganic)
Leachable Metals - Solids (122)
NA-TM-1700, VA-TM-1066, VA-TP-2072; modified from EPA 1311 (PREPARATION) and EPA 6010D (ANALYSIS)
ICP/OES - EXTRACTION - TCLP
Antimony
Arsenic
Barium
Beryllium
Boron
Cadmium
Calcium
Chromium
Cobalt
Copper
Iron
Lead
Magnesium
Nickel
Selenium

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The list of tests and measurement capabilities for which a laboratory is accredited can change at any time due to circumstances such as scope extensions, voluntary withdrawal of tests by the laboratory and suspension. Scopes are published by the CALA via the Internet at http://www.cala.ca/cala_directories.html

Silver
Thallium
Vanadium
Zinc
Zirconium

Solids (Inorganic)
Leachable Metals - Solids [Soil] (235)
NA-TM-1002, NA-TM-1700, NA-TP-2007; modified from BC PROTOCOL 13 (ANALYSIS) and EPA 1311 (PREPARATION) and EPA 6020B (ANALYSIS)
ICP/MS - Extraction - TCLP
Antimony
Arsenic
Barium
Beryllium
Boron
Cadmium
Calcium
Chromium
Cobalt
Copper
Iron
Lead
Magnesium
Nickel
Selenium
Silver
Thallium
Uranium
Vanadium
Zinc
Zirconium

Solids (Inorganic)
Mercury - Solids [Soil] (269)
NA-TM-1005, NA-TP-2004, NA-TP-2012; modified from BC MOE LABORATORY MANUAL, SALM (PREPARATION) and EPA 1631E (ANALYSIS) and EPA 200.2 (ANALYSIS)
COLD VAPOUR AAS - DIGESTION
Mercury

Solids (Inorganic)
Metals - Solids [Soil] (152)
NA-TM-1002, NA-TP-2004, NA-TP-2007; modified from BC MOE LABORATORY MANUAL, SALM (PREPARATION) and EPA 200.2 (ANALYSIS) and EPA 6020B (ANALYSIS)
ICP/MS - DIGESTION
Aluminum
Antimony
Arsenic
Barium
Beryllium
Bismuth

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The list of tests and measurement capabilities for which a laboratory is accredited can change at any time due to circumstances such as scope extensions, voluntary withdrawal of tests by the laboratory and suspension. Scopes are published by the CALA via the Internet at http://www.cala.ca/cala_directories.html

Boron
Cadmium
Calcium
Chromium
Cobalt
Copper
Iron
Lead
Lithium
Magnesium
Manganese
Molybdenum
Nickel
Phosphorus
Potassium
Selenium
Silver
Sodium
Strontium
Thallium
Tin
Titanium
Uranium
Vanadium
Zinc
Zirconium

Solids (Inorganic)
Metals - Solids [Soil] (153)
VA-TM-1066, VA-TP-2066, VA-TP-2072; modified from EPA 6010D and SOIL SAMPLING & METHODS OF ANALYSIS CHAPTER 15
ICP/OES - SATURATION EXTRACTION
Calcium
Magnesium
Potassium
Sodium

Solids (Inorganic)
Methyl Mercury - Solids [Soil] (173)
VA-TM-1062; modified from EPA 1630
P&T - GC - CVAFS - EXTRACTION
Methyl mercury

Solids (Inorganic)
Moisture - Solids [Soil] (089)
NA-TM-1200; CCME CWS PETROLEUM HYDROCARBONS IN SOIL - TIER 1 METHOD
GRAVIMETRIC
Percent Moisture

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Solids (Inorganic)
Oil and Grease - Solids [Soil] (239)
VA-TM-1125; modified from BC MOE LABORATORY MANUAL
GRAVIMETRIC - EXTRACTION
Mineral Oil and Grease

Solids (Inorganic)
Paint Filter - Solids [Paint] (262)
VA-TM-1055; modified from EPA 9095B
FILTRATION
Paint Filter (Free Liquid)

Solids (Inorganic)
Percent Saturation - Solids [Saturated Paste] (149)
VA-TP-2066; modified from SOIL SAMPLING & METHODS OF ANALYSIS CHAPTER 15
GRAVIMETRIC - SATURATED PASTE
Percent Saturation

Solids (Inorganic)
pH - Solids [Soil] (120)
VA-TM-1078, VA-TP-2066; modified from SM 4500-H+ B and SOIL SAMPLING & METHODS OF ANALYSIS CHAPTER 15
METER - SATURATION EXTRACTION
pH

Solids (Inorganic)
pH - Solids [Soil] (169)
VA-TM-1078; modified from BC MOE LABORATORY MANUAL and SM 4500-H+ B
METER - FIXED RATIO EXTRACTION
pH

Solids (Inorganic)
Simultaneously Extracted Metals (SEM) - Solids [Soil] (228)
NA-TM-1005, NA-TP-2011, NA-TP-2012, VA-TM-1021; modified from EPA 1631E and EPA 821-R-91-100
CVAFS - SEM EXTRACTION
Mercury

Solids (Inorganic)
Simultaneously Extracted Metals (SEM) - Solids [Soil] (229)
VA-TM-1021, VA-TM-1066, VA-TP-2072; modified from EPA 6010D and EPA 821-R-91-100
ICP/OES - SEM EXTRACTION
Arsenic
Cadmium
Copper
Lead
Nickel
Zinc

Solids (Inorganic)
Waste Oil - Solids (123)
VA-TM-1111; BC MOE LABORATORY MANUAL
GRAVIMETRIC - EXTRACTION
Waste Oil Content

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Solids (Organic)
Extractable Hydrocarbons - Solids [Soil] (184)
NA-TM-1106, NA-TP-2106; modified from BC MOE LABORATORY MANUAL and EPA 3570
GC/FID - EXTRACTION (COLD SHAKE)
EPH C10-C19 (sg)
EPH C19-C32 (sg)
Extractable Petroleum Hydrocarbons (EPH): C10-C19
Extractable Petroleum Hydrocarbons (EPH): C19-C32

Solids (Organic)
Glycols - Solids [Soil] (156)
VA-TM-1113; modified from EPA 8015B
GC/FID - EXTRACTION
Diethylene glycol
Ethylene glycol
Propylene glycol
Triethylene glycol

Solids (Organic)
Organochlorine (OC) Pesticides - Solids [Soil] (079)
VA-TM-1121, VA-TP-2117; modified from EPA 3540C and EPA 3630C and EPA 3660B and EPA 8081B
GC/ECD - EXTRACTION
2,4'-DDD (o,p'-DDD)
2,4'-DDE (o,p'-DDE)
2,4'-DDT (o,p'-DDT)
4,4'-DDD (p,p'-DDD)
4,4'-DDE (p,p'-DDE)
4,4'-DDT (p,p'-DDT)
4,4'-Methoxychlor (p,p'-Methoxychlor)
Aldrin
alpha-BHC
alpha-Chlordane
beta-BHC
beta-HCH (beta-Hexachlorocyclohexane (b-HCH, b-BHC, beta-BHC, beta-Hexachlorocyclohexane)
cis-Nonachlor
Dieldrin
Endosulfan I (a-Endosulfan)
Endosulfan II (b-Endosulfan)
Endosulfan Sulfate
Endrin
gamma-Chlordane
Heptachlor
Heptachlor epoxide
Lindane (gamma-BHC)
Mirex
Oxychlordane
trans-Nonachlor

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Solids (Organic)
Petroleum Hydrocarbons (PHC) - Solids [Soil] (189)
NA-TM-1100, NA-TP-2100; modified from ALBERTA ENVIRONMENT INTERPRETATION, SEPT 2003 and CCME CWS PETROLEUM HYDROCARBONS IN SOIL - TIER 1 METHOD (DEC 2000 NO. 1310)
GC/FID - TUMBLER EXTRACTION
F2: C10-C16
F3: C16-C34
F4: C34-C50

Solids (Organic)
Petroleum Hydrocarbons (PHC) - Solids [Soil] (190)
NA-TM-1100; modified from ALBERTA ENVIRONMENT INTERPRETATION, SEPT 2003 and CCME CWS PETROLEUM HYDROCARBONS IN SOIL - TIER 1 METHOD (DEC 2000 NO. 1310)
GRAVIMETRIC - TUMBLER EXTRACTION
F4: Gravimetric
F4G-SG: Gravimetric Heavy Hydrocarbons - Silica

Solids (Organic)
Phenols - Solids [Soil] (071)
VA-TM-1122, VA-TP-2113; modified from EPA 3570 and EPA 8270D and KNAPP 1979
GC/MS - EXTRACTION
2-Chlorophenol
2-Methylphenol (o-Cresol)
2,3-Dichlorophenol
2,3,4-Trichlorophenol
2,3,4,5-Tetrachlorophenol
2,3,4,6-Tetrachlorophenol
2,3,5-Trichlorophenol
2,3,5,6-Tetrachlorophenol
2,3,6-Trichlorophenol
2,4-Dichlorophenol + 2,5-Dichlorophenol
2,4-Dimethylphenol
2,4,5-Trichlorophenol
2,4,6-Trichlorophenol
2,6-Dichlorophenol
3-Chlorophenol
3,4-Dichlorophenol
3,4,5-Trichlorophenol
3,5-Dichlorophenol
4-Chloro-3-methylphenol
4-Chlorophenol
4-Methylphenol (p-Cresol)
m-Cresol
Pentachlorophenol
Phenol

Solids (Organic)
Polycyclic Aromatic Hydrocarbons (PAH) - Solids [Soil] (185)
NA-TM-1106, NA-TP-2103; modified from EPA 3570 and EPA 8270D
GC/MS - EXTRACTION (COLD SHAKE)
2-Methylnaphthalene

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Acenaphthene
Acenaphthylene
Anthracene
Benzo(a)anthracene
Benzo(a)pyrene
Benzo(b,j)fluoranthene
Benzo(g,h,i)perylene
Benzo(k)fluoranthene
Chrysene
Dibenzo(a,h)anthracene
Fluoranthene
Fluorene
Indeno(1,2,3 - cd)pyrene
Naphthalene
Phenanthrene
Pyrene
Quinoline

Solids (Organic)
Total Polychlorinated Biphenyls (PCB) - Solids [Soil] (112)
VA-TM-1119, VA-TP-2116; modified from EPA 3570 and EPA 3620C and EPA 3660B and EPA 3665A and EPA 8082A
GC/ECD - EXTRACTION
Aroclor 1016
Aroclor 1221
Aroclor 1232
Aroclor 1242
Aroclor 1248
Aroclor 1254
Aroclor 1260
Aroclor 1262
Aroclor 1268
Total PCB

Solids (Organic)
Volatile Hydrocarbons (VH) - Solids [Soil] (202)
NA-TM-1102, NA-TP-2102; modified from BC MOE LABORATORY MANUAL and CCME CWS PETROLEUM HYDROCARBONS IN SOIL - TIER 1 METHOD and EPA 5021A
GC/FID - HEADSPACE
F1: C6-C10
VH: C6-C10

Solids (Organic)
Volatile Organic Compounds (VOC) - Solids (263)
NA-TM-1102, VA-TM-1126; modified from EPA 1311 (PREPARATION) and EPA 8260C (ANALYSIS)
GC/MS - HEADSPACE - TCLP
1,1-Dichloroethene
1,2-Dichlorobenzene
1,2-Dichloroethane
1,4-Dichlorobenzene
Benzene

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Bromodichloromethane
Bromoform
Carbon tetrachloride
Chlorobenzene
Chlorodibromomethane
Chloroethene (Vinyl chloride)
Chloroform
Dichloromethane (Methylene Chloride)
Ethylbenzene
m,p-Xylene
Methyl ethyl ketone
o-Xylene
Tetrachloroethylene
Toluene
Trichloroethylene

Solids (Organic)
Volatile Organic Compounds (VOC) - Solids [Soil] (201)
NA-TM-1102, NA-TP-2102; modified from EPA 5021A and EPA 8260C
GC/MS - HEADSPACE
1,1-Dichloroethane
1,1-Dichloroethylene
1,1,1-Trichloroethane
1,1,1,2-Tetrachloroethane
1,1,2-Trichloroethane
1,1,2,2-Tetrachloroethane
1,2-Dichlorobenzene
1,2-Dichloroethane
1,2-Dichloropropane
1,2,4-Trimethylbenzene
1,3-Dichlorobenzene
1,3,5-Trimethylbenzene
1,4-Dichlorobenzene
4-Isopropylbenzene
Benzene
Bromodichloromethane
Bromoform
Carbon tetrachloride
Chlorobenzene
Chlorodibromomethane
Chloroethane (Ethyl Chloride)
Chloroethene (Vinyl chloride)
Chloroform
Chloromethane (Methyl chloride)
cis-1,2-Dichloroethylene
cis-1,3-Dichloropropene
Dichloromethane

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Ethylbenzene
Ethylene Dibromide
Isopropylbenzene (Cumene)
m,p-Xylene
Methyl t-butyl ether
n-Propylbenzene
Naphthalene
o-Xylene
Styrene
Tetrachloroethylene
Toluene
trans-1,2-Dichloroethylene
trans-1,3-Dichloropropene
Trichloroethylene
Trichlorofluoromethane

Swab (Organic)
Total Polychlorinated Biphenyls (PCB) - Solids [Swab] (249)
VA-TM-1120, VA-TP-2116; modified from EPA 3620C and EPA 3660B and EPA 3665A and EPA 8082A
GC/ECD - EXTRACTION
Aroclor 1016
Aroclor 1221
Aroclor 1232
Aroclor 1242
Aroclor 1248
Aroclor 1254
Aroclor 1260
Aroclor 1262
Aroclor 1268

Tissue (Inorganic)
Ashfree - Tissue (259)
VM-TM-1051; modified from SM 10300
GRAVIMETRIC
Ash-free weight

Tissue (Inorganic)
Lipid Content - Tissue (241)
VA-TM-1112; modified from EPA 3570 and EPA 8290A
GRAVIMETRIC
Lipid Content

Tissue (Inorganic)
Methyl Mercury - Tissue (172)
VA-TM-1062; modified from EPA 1630
P&T - GC - CVAFS - DIGESTION
Methyl mercury

Tissue (Inorganic)
Moisture - Tissue (090)
VA-TM-1087; modified from PUGET SOUND PROTOCOLS
GRAVIMETRIC
Percent Moisture

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Tissue (Inorganic)
Selenium Speciation - Tissue (253)
NA-TM-1002, NA-TP-2007, VA-TM-1085; CFIA METHOD SOM-DAR CHE-053-04
HPLC - ICP/MS
Selenium (IV)
Selenium (VI)
SelenoMethionine

Tissue (Inorganic)
Total Mercury - Tissue (266)
NA-TM-1005, NA-TP-2006, NA-TP-2012; modified from EPA 1631E and EPA 200.3
COLD VAPOUR AA - SPECTROMETRIC
Mercury

Tissue (Inorganic)
Total Metals - Tissue (100)
NA-TM-1002, NA-TP-2006, NA-TP-2007; modified from EPA 200.3 and EPA 6020A
ICP/MS - DIGESTION
Aluminum
Antimony
Arsenic
Barium
Beryllium
Bismuth
Boron
Cadmium
Calcium
Cesium
Chromium
Cobalt
Copper
Iron
Lead
Lithium
Magnesium
Manganese
Molybdenum
Nickel
Phosphorus
Potassium
Rubidium
Selenium
Silver
Sodium
Strontium
Sulphur (Sulfur)
Tellurium
Thallium
Tin

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Titanium

Uranium

Vanadium

Zinc

Zirconium

Urine (Inorganic)
Creatinine - Biomaterials [Urine] (234)
VA-TM-1052; THERMO DRI CREATININE-DETECT SPECIMEN VALIDITY TEST
COLORIMETRIC

Creatinine

Urine (Organic)
Arsenic Speciation - Biomaterials [Urine] (233)
NA-TM-1002, NA-TP-2007, VA-TM-1081; modified from CDC METHOD ID ITU003B, 2004 and EPA 6020A
HPLC-ICPMS

Arsenate (As(V))

Arsenite (As(III))

Arsenobetaine (AsB)

Dimethylarsinic acid (DMA)

Monomethyl arsenate (MMA)

Total Arsenic Species

Total Inorganic Arsenic

Total Inorganic Arsenic and Methylated Metabolites

Water (Inorganic)
Acidity - Water (219)
VA-TM-1053; modified from SM 2310
TITRIMETRIC

Acidity

Water (Inorganic)
Alkalinity - Water (001)
VA-TM-1053; modified from SM 2320 B
TITRIMETRIC

Alkalinity (pH 4.5)

Alkalinity-Bicarbonate

Alkalinity-Carbonate

Alkalinity-Hydroxide

Phenolphthalein Alkalinity

Water (Inorganic)
Ammonia - Water (208)
VA-TM-1024; JOURNAL OF ENVIRONMENTAL MONITORING (2005) SECTION 7, P. 37-42
AUTO-FLUORESCENCE

Ammonia

Water (Inorganic)
Anions - Water (026)
NA-TM-1001; modified from EPA 300.1
IC

Bromide

Chloride

Fluoride

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Nitrate

Nitrate plus Nitrite

Nitrite

Sulfate

Water (Inorganic)
Arsenic - Water (232)
NA-TM-1002, NA-TP-2007, VA-TM-1086; modified from USGS Water Resources Investigation Report 02-4144
HPLC - ICPMS

Arsenate (AsV)

Arsenite (ASIII)

Arsenobetaine (AsB)

Dimethylarsinic acid (DMA)

Monomethyl arsenate (MMA)

Total Arsenic Species

Total Inorganic Arsenic

Total Inorganic Arsenic and Methylated Metabolites

Water (Inorganic)
Biochemical Oxygen Demand (BOD) - Water (027)
VA-TM-1032; modified from SM 5210 B
D.O. METER

BOD (5 day)

CBOD (5 day)

Soluble Biological Oxygen Demand (SBOD)

Water (Inorganic)
Carbon - Water (091)
VA-TM-1037; modified from SM 5310 B
IR - COMBUSTION

Inorganic Carbon

Organic Carbon

Total Carbon (TC)

Water (Inorganic)
Chemical Oxygen Demand (COD) - Water (028)
VA-TM-1033; modified from SM 5220 D
COLOR - DIGESTION

COD

Water (Inorganic)
Chlorophyll A - Water (220)
VA-TM-1038, VA-TP-2011; modified from EPA 445.0
FLUORIMETRY

Chlorophyll a

Water (Inorganic)
Colour - Water (015)
VA-TM-1004; modified from BC MOE Laboratory Manual and SM 2120 C
COLORIMETRIC

Apparent Colour

True Colour

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Water (Inorganic)
Conductivity - Water (004)
VA-TM-1053; modified from SM 2510 B
CONDUCTIVITY METER
Conductivity (25˚C)

Water (Inorganic)
Cyanide - Water (209)
NA-TM-1003; modified from ISO 14403 and SM 4500-CN- I
AUTO COLOR - DISTILLATION
Cyanide (SAD)
Cyanide (WAD)

Water (Inorganic)
Cyanide - Water (210)
NA-TM-1003; modified from ASTM D7237
AUTO COLOR (GAS DIFFUSION)
Cyanide, Free

Water (Inorganic)
Dissolved Ferrous Iron - Water (242)
VA-TM-1046, VA-TP-2009; modified from SM 3500-FE
COLORIMETRIC - FILTRATION
Ferrous Iron

Water (Inorganic)
Dissolved Metals - Water (032)
NA-TM-1002, NA-TP-2002, NA-TP-2007; modified from EPA 6020B and SM 3030 B
ICP/MS - FILTRATION
Aluminum
Antimony
Arsenic
Barium
Beryllium
Bismuth
Boron
Cadmium
Calcium
Cesium
Chromium
Cobalt
Copper
Gallium
Gold
Indium
Iron
Lanthanum
Lead
Lithium
Magnesium
Manganese
Molybdenum

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Nickel
Niobium
Phosphorus
Potassium
Rhenium
Rubidium
Selenium
Silicon
Silver
Sodium
Strontium
Sulphur (Sulfur)
Tantalum
Tellurium
Thallium
Thorium
Tin
Titanium
Tungsten
Uranium
Vanadium
Yttrium
Zinc
Zirconium

Water (Inorganic)
Dissolved Metals - Water (036)
NA-TP-2002, VA-TM-1066, VA-TP-2072; modified from EPA 6010D and SM 3030 B
ICP/OES
Aluminum
Antimony
Arsenic
Barium
Beryllium
Bismuth
Boron
Cadmium
Calcium
Chromium
Cobalt
Copper
Iron
Lead
Lithium
Magnesium
Manganese
Molybdenum

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Nickel
Phosphorus
Potassium
Selenium
Silicon
Silver
Sodium
Strontium
Thallium
Tin
Titanium
Vanadium
Zinc

Water (Inorganic)
Mercury - Water (136)
NA-TM-1005, NA-TP-2002, VA-TP-2068; modified from EPA 1631E
CVAFS - BrCl DIGESTION
Mercury

Water (Inorganic)
Mercury - Water (265)
NA-TM-1005, NA-TP-2002, NA-TP-2012; modified from EPA 1631E
COLD VAPOUR AA - SPECTROMETRIC
Mercury

Water (Inorganic)
Methyl Mercury - Water (192)
VA-TM-1062; modified from EPA 1630
P&T GC-CVAFS-DISTILLATION
Methyl mercury

Water (Inorganic)
Nitrogen - Water (217)
VA-TM-1047, VA-WI-3046; modified from SM 4500-P J
AUTO COLOR - DIGESTION
Total Dissolved Nitrogen
Total Nitrogen

Water (Inorganic)
Oil and Grease - Water (061)
NA-TM-1107; modified from EPA 1664
GRAVIMETRIC - EXTRACTION
Mineral Oil and Grease
Total Oil and Grease

Water (Inorganic)
pH - Water (018)
VA-TM-1053; modified from SM 4500-H+ B
pH METER
pH

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Water (Inorganic)
Phosphorus - Water (179)
VA-TM-1025, VA-TP-2009, VA-WI-3046; modified from SM 4500-P B and SM 4500-P E
COLOR - DIGESTION (AUTOCLAVE)
Phosphate
Total Dissolved Phosphorus
Total Phosphorus

Water (Inorganic)
Reactive Silica - Water (008)
VA-TM-1018; modified from SM 4500-SIO2 D
COLORIMETRIC
Reactive Silica

Water (Inorganic)
Selenium Speciation - Water (252)
NA-TM-1002, NA-TP-2007, VA-TM-1084; Spectrochimica Acta Part B60 (2005) 633-641
HPLC - ICP/MS
Selenium (IV)
Selenium (VI)
SelenoMethionine

Water (Inorganic)
Solids - Water (016)
NA-TM-1004, VA-TM-1009, VA-TM-1050; modified from SM 2540 B and SM 2540 C and SM 2540 D and SM 2540 E
GRAVIMETRIC
Fixed Suspended Solids
Total Dissolved Solids
Total Solids (TS)
Total Suspended Solids
Volatile Suspended Solids

Water (Inorganic)
Sulphide - Water (010)
VA-TM-1020; modified from SM 4500-S2- D
COLOR
Sulphide

Water (Inorganic)
Thiocyanate - Water (014)
VA-TM-1029; modified from SM 4500-CN- M
COLOR
Thiocyanate

Water (Inorganic)
Total Kjeldahl Nitrogen (TKN) - Water (211)
VA-TM-1044; modified from SM 4500-NORG D
AUTO FLUORESCENCE - DIGESTION
Dissolved Kjeldahl Nitrogen
Total Kjeldahl Nitrogen

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Water (Inorganic)

Total Metals - Water (031)

NA-TM-1002, NA-TP-2001, NA-TP-2007; modified from EPA 200.2 and EPA 6020B

ICP/MS - DIGESTION

- Aluminum
- Antimony
- Arsenic
- Barium
- Beryllium
- Bismuth
- Boron
- Cadmium
- Calcium
- Cesium
- Chromium
- Cobalt
- Copper
- Gallium
- Gold
- Indium
- Iron
- Lanthanum
- Lead
- Lithium
- Magnesium
- Manganese
- Molybdenum
- Nickel
- Niobium
- Phosphorus
- Potassium
- Rhenium
- Rubidium
- Selenium
- Silicon
- Silver
- Sodium
- Strontium
- Sulphur (Sulfur)
- Tantalum
- Tellurium
- Thallium
- Thorium
- Tin
- Titanium
- Tungsten

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Uranium
Vanadium
Yttrium
Zinc
Zirconium

Water (Inorganic)
Total Metals - Water (041)
NA-TP-2001, VA-TM-1066, VA-TP-2072; modified from EPA 6010D and SM 3030 E
ICP/OES - DIGESTION
Aluminum
Antimony
Arsenic
Barium
Beryllium
Bismuth
Boron
Cadmium
Calcium
Chromium
Cobalt
Copper
Iron
Lead
Lithium
Magnesium
Manganese
Molybdenum
Nickel
Phosphorus
Potassium
Selenium
Selenium
Silicon
Silver
Sodium
Strontium
Thallium
Tin
Titanium
Vanadium
Zinc

Water (Inorganic)
Turbidity - Water (020)
VA-TM-1011; modified from SM 2130 B
TURBIDIMETRIC
Turbidity

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Water (Inorganic)
UV Absorbance and Transmittance - Water (254)
VA-TM-1042, VA-TP-2011; modified from SM 5910 B
SPECTROPHOTOMETRIC
UV Absorbance
UV Transmittance

Water (Microbiology)
Coliforms - Water (145)
NA-TM-1300; modified from SM 9223 B
MOST PROBABLE NUMBER (ENZYME SUBSTRATE)
Escherichia coli
Fecal (Thermotolerant) Coliforms
Total Coliforms

Water (Microbiology)
Enterococci - Water (186)
VA-TM-1203; modified from SM 9230 C
MEMBRANE FILTRATION (mENTEROCOCCUS)
Enterococci

Water (Microbiology)
Escherichia coli (E. coli) - Water (240)
VA-TM-1201; modified from SM 9222 G
MEMBRANE FILTRATION (mFC/NA-MUG)
Escherichia coli

Water (Microbiology)
Fecal (Thermotolerant) Coliforms - Water (029)
VA-TM-1200; modified from SM 9221 E
MOST PROBABLE NUMBER
Fecal (Thermotolerant) Coliforms

Water (Microbiology)
Fecal (Thermotolerant) Coliforms - Water (030)
VA-TM-1201; modified from SM 9222 D
MEMBRANE FILTRATION (mFC)
Fecal (Thermotolerant) Coliforms

Water (Microbiology)
Heterotrophic Plate Count (HPC) - Water (126)
NA-TM-1301; modified from SM 9215 B
POUR PLATE (PLATE COUNT AGAR)
Heterotrophic Plate Count (HPC)

Water (Microbiology)
Pseudomonas aeruginosa - Water (187)
VA-TM-1204; modified from SM 9213 E
MEMBRANE FILTRATION (mPAC)
Pseudomonas aeruginosa

Water (Microbiology)
Total Coliforms - Water (142)
VA-TM-1200; modified from SM 9221 B
MOST PROBABLE NUMBER
Total Coliforms

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Water (Microbiology)
Total Coliforms - Water (143)
VA-TM-1201; modified from SM 9222 B
MEMBRANE FILTRATION (mENDO)
Total Coliforms

Water (Organic)
Extractable Petroleum Hydrocarbons (EPH) - Water (251)
NA-TM-1112, VA-TP-2127, VA-TP-2129; BC MOE LABORATORY MANUAL
GC/FID - EXTRACTION
EPH C10-C19 (sg)
EPH C19-C32 (sg)
Extractable Petroleum Hydrocarbons (EPH): C10-C19
Extractable Petroleum Hydrocarbons (EPH): C19-C32
Total Extractable Hydrocarbons (TEH): C10-C30

Water (Organic)
Glycols - Water (155)
VA-TM-1113; modified from EPA 8015C
GC/FID - EXTRACTION
Diethylene glycol
Ethylene glycol
Propylene glycol
Triethylene glycol

Water (Organic)
Petroleum Hydrocarbons (PHC) - Water (238)
NA-TM-1112, NA-TP-2100; modified from CCME CWS PETROLEUM HYDROCARBONS IN SOIL - TIER 1 METHOD and EPA 3511
GC/FID - EXTRACTION
F2: C10-C16
F3: C16-C34
F4: C34-C50

Water (Organic)
Phenols - Water (059)
VA-TM-1101, VA-TP-2113; modified from BC MOE LABORATORY MANUAL and EPA 3510C and EPA 8270D
GC/MS - EXTRACTION
2-Chlorophenol
2-Methylphenol (o-Cresol)
2,3-Dichlorophenol
2,3,4-Trichlorophenol
2,3,4,5-Tetrachlorophenol
2,3,4,6-tetrachlorophenol
2,3,5-Trichlorophenol
2,3,5,6-Tetrachlorophenol
2,3,6-Trichlorophenol
2,4-Dichlorophenol
2,4-Dimethylphenol
2,4,5-Trichlorophenol
2,4,6-trichlorophenol
2,6-Dichlorophenol

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3-Chlorophenol
3,4-Dichlorophenol
3,4,5-Trichlorophenol
3,5-Dichlorophenol
4-Chloro-3-methylphenol
4-Chlorophenol
4-Methylphenol (p-Cresol)
m-Cresol
Pentachlorophenol
Phenol

Water (Organic)
Polycyclic Aromatic Hydrocarbons (PAH) - Water (237)
NA-TM-1112, VA-TP-2128; modified from EPA 3511 and EPA 8270D
GC/MS - EXTRACTION
1-Methylnaphthalene
2-Methylnaphthalene
Acenaphthene
Acenaphthylene
Acridine
Anthracene
Benzo(a)anthracene
Benzo(a)pyrene
Benzo(b,j)fluoranthene
Benzo(g,h,i)perylene
Benzo(k)fluoranthene
Chrysene
Dibenzo(a,h)anthracene
Fluoranthene
Fluorene
Indeno(1,2,3 - cd)pyrene
Naphthalene
Phenanthrene
Pyrene
Quinoline

Water (Organic)
Resin and Fatty Acids - Water (212)
VA-TM-1105, VA-TP-2114; modified from EPA 3510C and EPA 8270D
GC/MS/LIQUID-LIQUID EXTRACTION
12-Chlorodehydroabietic acid
14-Chlorodehydroabietic acid
Abietic acid
Arachidic acid
Behenic acid
Dehydroabietic acid
Dichlorodehydroabietic acid
Dodecanoic acid (Lauric acid)
Hexadecanoic acid (Palmitic acid)

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Isopimaric acid + Palustric acid
Levopimaric acid
Lignoceric acid
Linoleic acid
Linolenic acid (Octadecadienoic acid)
Myristic acid (Tetradecanoic Acid)
Neoabietic acid
Oleic acid
Pimaric acid
Sandaracopimaric acid
Stearic acid (Octadecanoic acid)

Water (Organic)
Total Polychlorinated Biphenyls (PCB) - Water (115)
VA-TM-1115, VA-TP-2116; modified from EPA 3510C and EPA 3620C and EPA 3660B and EPA 3665A and EPA 8082A
GC/ECD - EXTRACTION
Aroclor 1016
Aroclor 1221
Aroclor 1232
Aroclor 1242
Aroclor 1248
Aroclor 1254
Aroclor 1260
Aroclor 1262
Aroclor 1268
Total PCB

Water (Organic)
Volatile Hydrocarbons (VH) - Water (197)
NA-TM-1102; modified from BC MOE LABORATORY MANUAL and CCME CWS PETROLEUM HYDROCARBONS IN SOIL - TIER 1 METHOD and EPA 5021A
GC/FID - HEADSPACE
F1: C6-C10
Volatile Hydrocarbons (VH): C6-C10

Water (Organic)
Volatile Organic Compounds (VOC) - Water (196)
NA-TM-1102, NA-TP-2102; modified from EPA 5021A and EPA 8260C
GC/MS - HEADSPACE
1,1-Dichloroethane
1,1-Dichloroethylene
1,1,1-Trichloroethane
1,1,1,2-Tetrachloroethane
1,1,2-Trichloroethane
1,1,2,2-Tetrachloroethane
1,2-Dichlorobenzene
1,2-Dichloroethane
1,2-Dichloropropane
1,2,4-Trimethylbenzene
1,3-Dichlorobenzene

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1,3,5-Trimethylbenzene
1,4-Dichlorobenzene
4-isopropyltoluene (p-Cymene)
Acetone (2-Propanone)
Benzene
Bromodichloromethane
Bromoform
Carbon tetrachloride
Chlorobenzene
Chlorodibromomethane
Chloroethane (Ethyl Chloride)
Chloroform
Chloromethane (Methyl chloride)
cis-1,2-Dichloroethylene
cis-1,3-Dichloropropene
Dichloromethane
Ethylbenzene
Ethylene Dibromide
Isopropylbenzene (Cumene)
m,p-Xylene
Methyl ethyl ketone
Methyl isobutyl ketone (MIBK)
Methyl t-butyl ether
n-Propylbenzene
Naphthalene
o-Xylene
Styrene
Tetrachloroethylene
Toluene
trans-1,2-Dichloroethylene
trans-1,3-Dichloropropene
Trichloroethylene
Trichlorofluoromethane
Vinyl chloride

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CALA
Canadian Association for
Laboratory Accreditation Inc.

CALA Directory of Laboratories

Membership Number: 2800
Laboratory Name: Nautilus Environmental-Calgary
Parent Institution: Nautilus Environmental Company Inc.
Address: #4, 6125 12th St. S.E. Calgary AB T2H 2K1
Contact: Ms. Tamara Pomeroy
Phone: (403) 253-7121
Fax: (403) 252-9363
Email: tamara@nautilusenvironmental.ca; tanya@nautilusenvironmental.ca

Standard: Conforms with requirements of ISO/IEC 17025
Clients Served: All Interested Parties
Revised On: September 12, 2019
Valid To: November 25, 2021

Scope of Accreditation

Solids (Toxicology)
Chironomids - Solids [Sediment] (013)
WTR-ME-026; EPS 1/RM/32
SURVIVAL AND GROWTH
Freshwater midge Chironomus dilutus (formerly Chironomus tentans) (10d)

Solids (Toxicology)
Hyalella azteca - Solids [Sediment] (014)
WTR-ME-021; EPS 1/RM/33
SURVIVAL AND GROWTH
Freshwater Amphipod Hyalella Azteca (14d)

Water (Microbiology)
Microcystins - Water (058)
WTRQ-ME-016; ENZYME-LINKED IMMUNOSORBENT ASSAY FOR THE CONGENER-INDEPENDENT DETERMINATION OF MICROCYSTINS & NODULARINS IN WATER SAMPLES
ELISA
Microcystins

Water (Toxicology)
Ceriodaphnia dubia - Water (006)
WTR-ME-018; EPS 1/RM/21
SURVIVAL AND REPRODUCTION
Ceriodaphnia dubia

Water (Toxicology)
Daphnia magna - Water (002)
WTR-ME-015; EPS 1/RM/11 and EPS 1/RM/14
ACUTE LETHALITY (SURVIVAL)
Daphnia LC50 (48 h)

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Daphnia Single Concentration (48h)

Water (Toxicology)
Fathead Minnow - Water (007)
WTR-ME-046; EPS 1/RM/22
GROWTH AND SURVIVAL
Fathead minnow (Pimephales promelas)

Water (Toxicology)
Hyalella azteca - Water (059)
WTR-ME-065; EPS 1/RM/33
SURVIVAL AND GROWTH
Hyalella azteca

Water (Toxicology)
Lemna minor - Water (017)
WTR-ME-030; EPS 1/RM/37
GROWTH INHIBITION
Freshwater macrophyte (Lemna minor)

Water (Toxicology)
Microtox - Water (003)
SOIL-ME-001; EPS 1/RM/24
BIOLUMINESCENCE
Microtox IC50 (15 min)

Water (Toxicology)
Pseudokirchneriella subcapitata - Water (008)
WTR-ME-034; EPS 1/RM/25
GROWTH INHIBITION
Freshwater alga (Pseudokirchneriella subcapitata)

Water (Toxicology)
Rainbow Trout - Water (001)
WTR-ME-041; EPS 1/RM/13 and EPS 1/RM/9
ACUTE LETHALITY (SURVIVAL)
Single Concentration (96h)
Trout LC50 (96 h)

Water (Toxicology)
Rainbow Trout [pH Stabilization] - Water (057)
WTR-ME-062; EPS 1/RM/13 and EPS 1/RM/50
ACUTE LETHALITY (pH STABILIZATION)
Single Concentration (96h)
Trout LC50 (96h)

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CALA
Canadian Association for Laboratory Accreditation Inc.

CALA Directory of Laboratories

Membership Number: 2635
Laboratory Name: Taiga Environmental Laboratory
Parent Institution: Government of Northwest Territories (GNWT)
Address: P.O. Box 1320 4601 - 52nd Avenue Yellowknife NT X1A 2L9
Contact: Mr. Bruce Stuart
Phone: (867) 767-9235
Fax: (867) 920-8740
Email: bruce_stuart@gov.nt.ca; taiga@gov.nt.ca; Glen_hudy@gov.nt.ca

Standard: Conforms with requirements of ISO/IEC 17025
Clients Served: All Interested Parties
Revised On: December 11, 2019
Valid To: March 5, 2022

Scope of Accreditation

Solids (Inorganic)
Moisture - Solids [Soil] (030)
TEL007; CCME CWS PETROLEUM HYDROCARBONS IN SOIL - TIER 1 METHOD
GRAVIMETRIC
Percent Moisture

Solids (Organic)
BTEX - Solids [Soil] (072)
TEL038; modified from EPA 502.2 and EPA 5030B and EPA 602
GC/MS - PURGE AND TRAP
Benzene
Ethylbenzene
m,p-Xylene
o-Xylene
Toluene

Solids (Organic)
Purgeable Hydrocarbons - Solids [Soil] (074)
TEL056; CCME CWS PETROLEUM HYDROCARBONS IN SOIL - TIER 1 METHOD
GC/FID - PURGE AND TRAP
F1: C6-C10

Water (Inorganic)
Alkalinity - Water (066)
TEL060:PC TITRATE; modified from SM 2320 A and SM 2320 B
AUTO TITRIMETRIC
Alkalinity (pH 4.5)

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Water (Inorganic)
Ammonia Nitrogen - Water (089)
TEL068; modified from SM 4500-NH3 G
COLORIMETRIC - DISCRETE
Ammonia

Water (Inorganic)
Anions - Water (059)
TEL055; modified from SM 4110 B
ION CHROMATOGRAPHY
Chloride
Fluoride
Nitrate
Nitrite
Sulfate

Water (Inorganic)
Biochemical Oxygen Demand (BOD) - Water (004)
TEL019; modified from SM 5210 A and SM 5210 B
D.O. METER
BOD (5 day)
CBOD (5 day)

Water (Inorganic)
Carbon - Water (029)
TEL033; modified from SM 5310 B
INFRARED
Organic Carbon

Water (Inorganic)
Cations - Water (042)
TEL055; modified from SM 4110 B
ION CHROMATOGRAPHY
Calcium
Magnesium
Potassium
Sodium

Water (Inorganic)
Chemical Oxygen Demand (COD) - Water (061)
TEL016; modified from SM 5220 D
REFLUX - COLORIMETRIC
COD

Water (Inorganic)
Colour - Water (063)
TEL051; modified from SM 2120 C
SPECTROPHOTOMETRIC
Apparent Colour
True Colour

Water (Inorganic)
Conductivity - Water (068)
TEL059:PC TITRATE; modified from SM 2510 B
AUTO CONDUCTIVITY METER
Conductivity (25˚C)

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Water (Inorganic)
Dissolved Metals - Water (013)
TEL035; modified from EPA 200.8
ICP/MS
Aluminum
Antimony
Arsenic
Barium
Beryllium
Boron
Cadmium
Cesium
Chromium
Cobalt
Copper
Iron
Lead
Lithium
Manganese
Molybdenum
Nickel
Rubidium
Selenium
Silver
Strontium
Thallium
Tin
Titanium
Uranium
Vanadium
Zinc

Water (Inorganic)
Mercury - Water (080)
TEL062; modified from EPA 245.7
ATOMIC FLUORESCENCE
Mercury

Water (Inorganic)
Oil and Grease - Water (060)
TEL024: HEM; modified from EPA 1664A (REVISION A)
GRAVIMETRIC - EXTRACTION
Total Oil and Grease

Water (Inorganic)
pH - Water (067)
TEL058:PC TITRATE; modified from SM 4500-H+ A and SM 4500-H+ B
AUTO - pH METER
pH

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Water (Inorganic)
Phosphate - Water (087)
TEL069; modified from SM 4500-P F
COLORIMETRIC - DISCRETE
Phosphate

Water (Inorganic)
Reactive Silica - Water (090)
TEL070; modified from SM 4500-SI F
COLORIMETRIC - DISCRETE
Reactive Silica

Water (Inorganic)
Solids - Water (011)
TEL008, TEL009; modified from SM 2540 C and SM 2540 D
GRAVIMETRIC
Total Dissolved Solids
Total Suspended Solids

Water (Inorganic)
Total and Dissolved Nitrogen - Water (086)
TEL066; modified from ASTM D5176-91 and ISO 11905
PYROLYSIS - CHEMILUMINESCENCE
Dissolved Nitrogen
Total Nitrogen

Water (Inorganic)
Total and Dissolved Phosphorus - Water (088)
TEL069; modified from SM 4500-P F
COLORIMETRIC - DISCRETE
Dissolved Phosphorus
Total Phosphorus

Water (Inorganic)
Total Metals - Water (054)
TEL035; modified from EPA 200.8
ICP/MS
Aluminum
Arsenic
Barium
Beryllium
Boron
Cadmium
Cesium
Chromium
Cobalt
Copper
Iron
Lead
Lithium
Manganese
Mercury
Molybdenum

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Nickel
Rubidium
Selenium
Silver
Strontium
Thallium
Tin
Titanium
Uranium
Vanadium
Zinc

Water (Inorganic)
Turbidity - Water (028)
TEL006; modified from SM 2130 B
NEPHELOMETRY
Turbidity

Water (Microbiology)
Coliforms - Water (045)
TEL053; modified from IDEXX QUANTI-TRAY
MOST PROBABLE NUMBER (QUANTI-TRAY)
Escherichia coli
Total Coliforms

Water (Microbiology)
Fecal (Thermotolerant) Coliforms - Water (041)
TEL017; modified from SM 9222 D
MEMBRANE FILTRATION (mFC)
Fecal (Thermotolerant) Coliforms

Water (Microbiology)
Fecal Streptococci - Water (055)
TEL053; modified from IDEXX QUANTI-TRAY
MOST PROBABLE NUMBER (QUANTI-TRAY)
Fecal streptococci

Water (Organic)
BTEX - Water (070)
TEL037:BTEX; modified from EPA 502.2 and EPA 5030B and EPA 602
GC/MS - PURGE AND TRAP
Benzene
Ethylbenzene
m,p-Xylene
o-Xylene
Toluene

Water (Organic)
Extractable Hydrocarbons - Water (085)
TEL067; modified from EPA 3510C and EPA 3630C and SM 6010
GC/FID - SOLID PHASE EXTRACTION
C10-C50

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Water (Organic)
Purgeable Hydrocarbons - Water (084)
TEL044; modified from EPA 5030 and EPA 8000 and EPA 8015 and EPA 8260B
GC/FID - PURGE AND TRAP
C6-C10

Water (Organic)
Trihalomethanes (THM) - Water (077)
TEL039:THM; modified from EPA 502.2 and EPA 5030B and EPA 602
GC/MS - PURGE AND TRAP
Bromodichloromethane
Bromoform
Chlorodibromomethane
Chloroform

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BREAK-AWAY DRILLING & BLASTING LTD.

| P.O. Box 2104 | Yellowknife | NT | X1A | 2P6 | Phone/Fax: 867-766-7945 |

2020 Drill/Blast Execution Plan – Nahanni Construction (Lupin Mine Site)
Crown Pillar Blasting

WORK EXECUTION PLAN

OBJECTIVE: To drill and blast Crown pillars with 100% control of flyrock to eliminate personal injury, equipment and property damage (Refer to Explotech Lupin Mine West Zone Crown Pillar Blast Design)

Factors:

- #Holes per blast	Approximately 8 - 110
- Pattern size	Thick crown pillars 2 meters x 4 meters diced. Thin crown pillars 2.3 meters x 6 meter staggered
- Hole size	5.25 inch
- Depth of hole	18 meters – 19 meters
- Load	Anfo with 1 lb. stick of dynamite for a booster
- Detonators	25/500 millisecond Handi-dets with 42 mm/sec delays/jumpers
- Powder factor	Approximately 1.8-2 kilograms per cubic meter
- Collar	Minimum 3.4 meters
- Stemming	Every hole to be stemmed with ¾ inch crush (supplied by Nahanni)

Proposed Work Areas:

- Blast# 1 – Thick crown pillars 8 meters long (Approx. 8 holes)
- Blast# 2 – Thin crown pillar 47 meters long (Approx. 38 holes)
- Blast# 3 – Thick crown pillars 20 meters long (Approx. 26 holes)
- Blast# 4 – Thin crown pillar 130 meters long (Approx. 110 holes) May be 2 blasts
- Blast# 5 – Thick crown pillars 16 meters long (Approx. 23 holes)
- Blast# 6 – Thick crown pillars 8 meters long (Approx.8 holes)
- Blast# 6 – Thin crown pillars 10 meters long (Approx. 8 holes)

Work to start on Blast# 1, and then move to #2, #3, #4, #5 and then #6 last

1) Applicable areas to be cleared of all snow, trees, boulders and debris prior to drilling. Dewatering of open trenches may need to be done,

2) We would start with site orientation, identify the danger zone (blast zone) and implement a safety plan to protect the public, workers, equipment and property.

3) We anticipate working 7 days per week, 12 hours per day, starting the project on Mid July, 2020, with 1 drill drilling for 2-3 days before blasting starts to provide 8 meter buffer between drilling and loading operations (mines regulations requirement).

4) Prior to working in the area, we would drill and install 3.5" steel posts 0 .6 -0 .9 meters back from all open face ever 3 – 4 meters and run cable from post to post, and flag with danger marker tape. We would also do this in the areas of the trench that are filled with overburden (ramp area) as we are uncertain of the stability of this area.

5) Blasting to start 3 days behind drill or once we have established an 8 meter buffer.

6) We anticipate drilling 5-6 holes per drill, per shift; approximately 100 meters per drill shift.

7) We anticipate blasting 1-3 shots per week; approximately 8-110 holes per blast.

8) Blast patterns and timing to be evaluated after Blast#1 and Blast#2 and if changes are required they will first be approved by the proper authorities before proceeding

Implemented Restrictions:

After review of Hazards, we will implement these restrictions to minimize the impact on the personnel working in the area.

- ✓ Safety fence/barrier to be installed prior to drill and blasting
- ✓ Blasting plan to be reviewed after blast # 1, any changes if required need to be approved by appropriate authorities
- ✓ Maximum of 110 holes per blast
- ✓ No blasting shall occur later than ½ hour after sunset
- ✓ Blasting to take place within the estimated timeframe specified on each posted pre-blast notification. Notifications to be delivered 24 hrs. prior to blasting. If we cannot blast within the time specified, we will phone the following contacts to relay the actual (revised) blast time:

    1) Site Safety
    2) Mine Manager
    3) Gord Peckford (Nahanni)

Summary of Execution:

- Daily toolbox meetings will occur to identify any hazards and to review the events of each day. ***Reminder that appropriate PPE is required 'at all times' when outside camp.***
- Vehicle inspections to be completed and logbooks filled out at the beginning of each shift.
- Supervisor to ensure caution is taken when placing water pump and discharge hose over blast rock.
- The Supervisor shall ensure the Drillers have clear instructions on safely maneuvering the terrain. Prior to setting up the drills/equipment, a daily inspection and walk-around procedure must be completed.
- The Blaster will pick up powder and then proceed to the blast site following all procedures and regulations. Any vehicles transporting explosives to site will ensure proper paper work filled out prior to leaving magazine site
- Helpers/Blaster to check all holes we anticipate loading in blast to ensure they are loadable. If they find any holes that need to be re-drilled, this happens before loading starts. The loading of blastholes will start at the face, always working away from the face. This way, if for some reason something blocks one of the holes, it can be re-drilled. ***For no reason whatsoever will any equipment be walked over top of a loaded blasting pattern.***
- We will start with a smaller blast (8 holes); ensuring we have control of the work site and to ensure the surrounding area is safe. Then, we will increase the number of holes in each blast until we get to where the blasting mats are utilized without compromising safety, always keeping personnel and equipment safety in mind.

- After all holes are loaded, they will be tied-in, directing the shot to the open face. Under the Blaster's direction, the Equipment Operator will lay the blasting mats on loaded holes, maintaining an overlap of 0.5 – 1.0 meter on all sides. Each blasting mat will be to anchor to a anchor post by cable to prevent mat from falling in trench after blast.

- Blasting announcements to be made as per blasting schedule a minimum of 24 hours prior to the start of blasting activity. Refer to 'Implemented Restrictions', on pg. 2 for blast schedule revision procedure on actual blast day.

- All personnel are required to call in on Mine Site radio channel to notify Break-Away Supervisors of intent to enter and leave blast area. Break-Away to ensure a Supervisor is on site that will monitor the radio for people trying to access site.

- Once the blasting mats are in place, guards will proceed to their designated area as per Supervisor's instructions. The Supervisor will call in the 10 minute radio announcement/warning with verification from Nahanni Supervisor and Site Safety Equipment (drills, excavator and trucks), will vacate the blast zone (approximately 200 meters from blast site). Once the Supervisor verifies all guards are in place and that the blast area is clear of all equipment and personnel, the 2 minute radio announcement is made followed by 12 short horn bursts. The Supervisor then authorizes the Blaster to fire the shot if/when safe to do so.

- After the shot is fired and the smoke has cleared, the Blaster will check the blast area to ensure entire shot has fired. Once the shot is clear, the Blaster will sound a 15 second *'All Clear'* horn. All posted guards are released and the men/equipment can resume work. The excavator will move blasting mats away from next blast area, stacking them in piles not exceeding 10 mats high.

- After blasting mats are removed, all holes in the next blast will be checked to ensure they are loadable. Any blastholes that are not clear to load will be re-drilled before any loading commences.

- Drills shall always maintain minimum distance of 8 meters from the loading area.

- At the end of each shift, park all equipment in an area where it can be safely serviced and refueled. The Blaster shall return all unused explosives to the appropriate magazines and conduct a product inventory.

- Park all vehicles in a safe manner.

- Blasting activity results will be reviewed on a daily basis to address any concerns, if any, from the previous day. Policies and procedures to be reviewed on a regular basis at toolbox meetings.

- The areas of concern to be addressed in site safety plan are as follows:

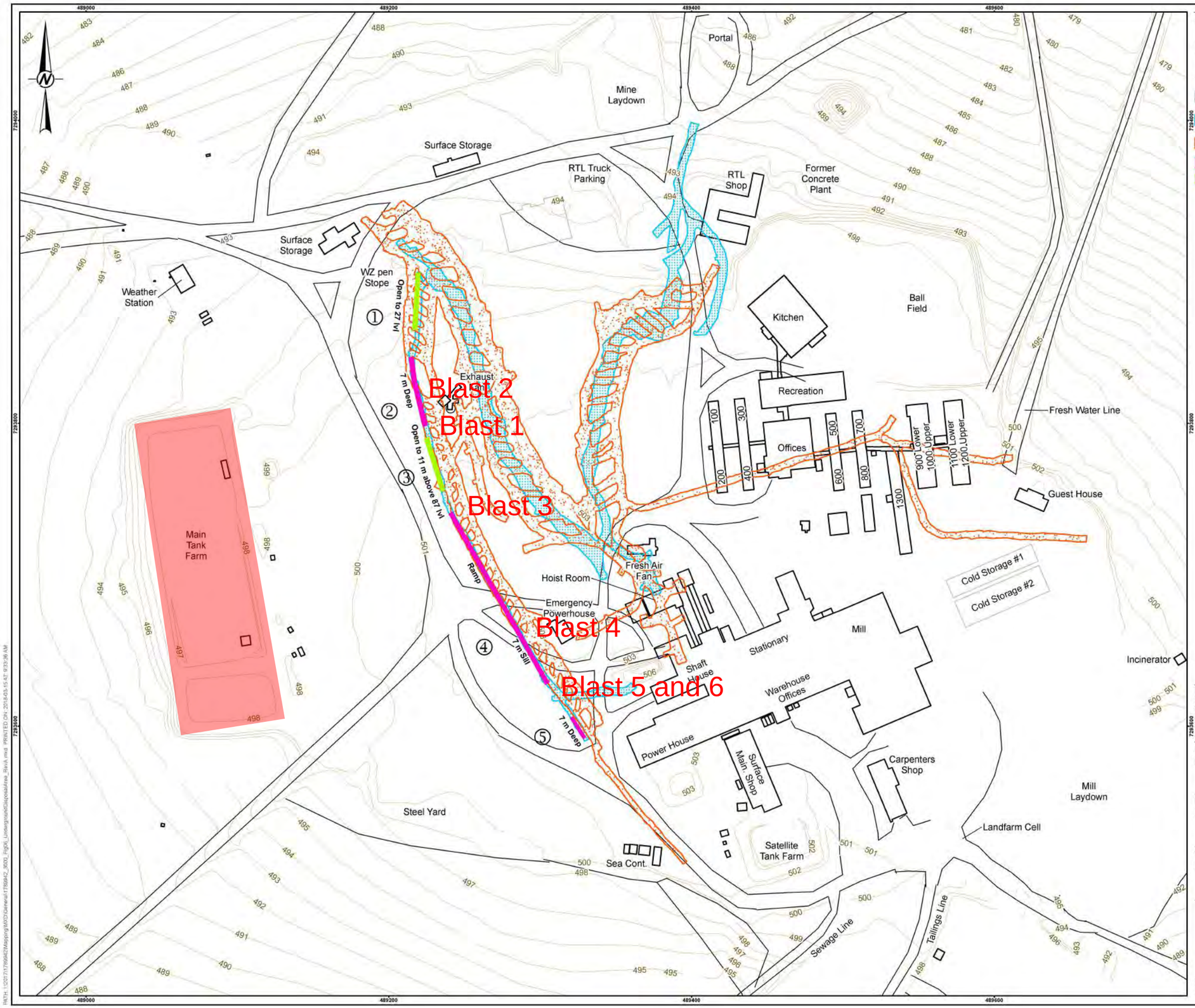
    I. Spills
    II. Flyrock
    III. Property Damage
    IV. Personal Injury
    V. Equipment Damage
    VI. Public Safety

Proposed Loads:

Location	Maximum Load	Station #	Precautions
Blast 1, 8 holes	75 kgs per delay	Area 2	Test blast, Decking required
Blast 2, 44 holes	85 kgs per delay	Area 2	Test blast, No decking required
Blast 3, 26 holes	75 kgs per delay	Area 4	Adjustments made if required from Blast

			#1 results, Decking required
Blast 4, 116 holes	95 kgs per delay	Area 4	Adjustments made if required from Blast #2 results, no decking required
Blast 5, 20 holes	75 kgs per delay	Area 5	Decking required
Blast 6, 16 holes	100 kgs per delay	Area 5	Decking in 8 holes and no decking in 8 holes

Comments:



LEGEND

① WZ UNDERGROUND DISPOSAL KEY CROSS-SECTION LOCATION

CONTOUR

INFRASTUCTURE FOOTPRINT

27 LEVEL ORE DRIFT PROJECTION

87 LEVEL ACCESS DRIFT PROJECTION

WZ CROWN PILLAR PIT

WZ OPEN STOPE

0 50 100

1:2,500 METRES

REFERENCE(S)

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DATUM: NAD83 PROJECTION: UTM ZONE 12

CLIENT

MANDALAY RESOURCES CORPORATION

PROJECT

LUPIN MINE CLOSURE

TITLE

UNDERGROUND MINE WORKING PLAN

LUPIN MINES INCORPORATED

YYYY-MM-DD	2018-01-25
DESIGNED	NORWEST CORP.
PREPARED	AA
REVIEWED	
APPROVED	

PROJECT NO.	CONTROL	REV.	FIGURE
1789942	3000	0	6

EXPLOTECH

Specialists in Explosives, Blasting and Vibration
Consulting Engineers

February 20, 2020

Break-Away Drilling and Blasting Ltd.
P.O. Box 2104
Yellowknife, NT
X1A 2P6

Attention: Mr. Roger Mann

Subject: Lupin Mine Closure, Kitikmeot Region, Nunavut.
West Zone Crown Pillar Blast Design Options

Dear Mr. Mann,

In response to your request, Explotech Engineering Ltd. (Explotech) has reviewed the provided documentation to assess blast design options for the planned explosive removal of the remaining West Zone Crown Pillar Stope as part of the Lupin Mine Closure project in Kitikmeot Region, Nunavut. This report summarizes our analysis and subsequent recommendations based exclusively on a document review and discussions with project personnel. We note that no site visit has been undertaken as part of this analysis.

1.0 Site Environs, Sensitive Structures and Existing Conditions

Based on discussions with Break-Away Drilling and Blasting Ltd. (Break-Away) project personnel, we understand the blasting is occurring in a largely vacant and remote area with the vast majority of remaining equipment or structures being abandoned and/or scheduled for decommission. The single notable exemption are fuel tanks located approximately 140m to the West of the West Zone Pillar Stope (refer to red highlighted tank farm area in the attached appendices).

With reference to these tanks, it is our understanding that they do not represent a necessary design constraint in terms of limiting ground vibrations or air overpressure, however, they cannot be impacted with flyrock or debris from the blast. Furthermore, we understand the physical scale of these tanks is such that they cannot be easily hoarded or shielded from the blast with a temporary barrier such as stacked sea cans.

Across the existing West Zone Pillar Stope, we can categorize the following three (3) existing conditions for the established crown pillar:

- *Thin Crown Pillars*: The sections defined by Explotech as the *Thin Crown Pillars* are the three (3) particular sections along the length of the West Zone Pillar Stope that have been formed through previous rock excavation which effectively established a 4m wide open trench ranging in depth from 13.2m to 14.2m below surface. Beneath that open trench is a thin crown pillar ranging between 3.2m to 4.6m in depth. The exact methodology of blasting these thin sections are detailed in Section 2.1 below.

- *Thick Crown Pillars:* The sections defined by Explotech as the *Thick Crown Pillars* are the three (3) particular sections along the length of the West Zone Pillar Stope that are full depth crown pillars which are traversable on surface. The crown pillar depths of these three (3) sections range between 17.4m to 18.2m. The exact methodology of blasting these sections are detailed in Section 2.2 below.

- *Open Stopes:* The completely open section defined on the Working Plan drawing as *Open Stopes* near the center of the West Zone Stope will be fundamental in providing a face for vertical relief in the proposed blasting sequence (detailed in Section 3.0 below).

2.0 Blasting Design Parameters

Given the significant range of elements to consider for drilling, loading and blasting the *Thin Crown Pillars* compared to the *Thick Crown Pillars*, their respective design parameters are detailed individually below.

2.1 Thin Crown Pillar Blast Design

For the *Thin Crown Pillar* sections, the existing open trench ranging in depth from 13.2m to 14.2m restricts the ability to directly drill or load into the thin crown pillar. Accordingly, the drill and blast design encompasses a step back from the stope edges on surface to drill and strategically load explosives functionally designed to fracture and continuously separate the rock mass connecting the thin crown pillar and stope walls.

Visually detailed in the attached appendices, Explotech proposes establishing perimeter drill lines with a 1m true burden off the existing stope faces. Note that true burden is defined as the burden relative to the crown pillar or thinnest section of stope wall which is not necessarily the same as burden measured at surface (i.e. surface burden). Based on the provided details, drill hole depths will range between 19.4m to 19.9m across the West Zone Stope in order to establish boreholes extending approximately 2m below the bottom of the various sections of thin crown pillar. These holes will be spaced at 2.3m for the trial blast and shall be laid out so that they are staggered on opposing stope faces to better distribute explosive energies. Boreholes will be established using 133mm (5.25”) diameter drill bits.

In terms of proposed loading parameters, ANFO (0.85g/cc) will be loaded in each borehole such that the explosive column continuously extends from 2m below to 2m above the thin crown pillar. The extension of the explosive column above and below the crown pillar has been established to both compensate for field condition inconsistencies between drilled depths and survey information, as well as sufficiently generate a cavity in the stope wall to reduce the risk that rock hangs or binds following detonation. Based on provided drawings detailing the thin crown pillar thickness ranging from 3.2m to 4.6m, explosive column loads will respectively range from 7.2m to 8.6m, resulting in between 85kg to 101.5kg of explosives per blasthole. Holes will be primed with cast boosters appropriately sized for a 133mm diameter blasthole and double primed if utilizing NONEL detonators in order to maximize the probability of a complete and thorough detonation. Finally, collars ranging between 11.2m and 12.2m will be required utilizing 3/4” clearstone or a suitable substitute based on material available on the remote site.

There are numerous potential options for the inter-hole timing of blast holes along these thin sections of crown pillar. For the initial trial blast, holes shall be detonated on a single hole per standard 25ms timing. Holes should alternate between opposing sides of the stope in order to separate the crown pillar from the stope walls in a linear progression from the front to the back of each blast. Observed results from the trial blast(s) may necessitate alterations in the timing for subsequent, larger blast sections (refer to proposed blasting sequence detailed in Section 3.0 below).

2.2 Thick Crown Pillar Blast Design

For the *Thick Crown Pillar* sections, we understand that the surface topography of the crown pillar is traversable and thus the crown pillar can be drilled and loaded directly on surface in a traditional methodology. Accordingly, these holes will be drilled from surface and loaded with multiple explosive decks which will be initiated sequentially from bottom to top in order to project the vast majority of blast energies and fragmentation into the existing stope below.

Visually detailed in the attached appendices, Explotech proposes establishing the perimeter drill lines directly above the existing stope walls below. The layout pattern will also include dice holes placed along the centerline of the crown pillar aimed to push explosive energies towards the midpoint of the stope and significantly fragment the crown pillar to reduce the risk of large boulders binding inside the stope following detonation. Based on the provided details, drill hole depths will range between 17.4m to 18.2m across the West Zone Pillar Stope in order to establish boreholes terminating at the approximate elevation for the bottom of the various sections of thick crown pillar. Boreholes will again be drilled using 133mm (5.25”) diameter drill bits.

In terms of proposed loading parameters, each borehole will consist of three (3) separate explosive charges, one inert deck and both a bottom and surface collar. A description of the loading design, as referenced starting at the bottom of the borehole, is as follows;

- A 1m bottom collar, established either with a hole plug or by terminating the drill hole within approximately 1m of the bottom of the crown pillar. Note that the bottom collar holds the singular purpose of supporting the weight of the borehole contents until detonation.
- A 6m explosive column of ANFO (70.9kg) loaded above the bottom collar.
- A 2m inert deck separating the two (2) ANFO column loads. The inert deck will be formed by a potential combination of hole plugs, expandable foam or suitable stemming materials. This inert deck must be sufficient to retain the upper portion of borehole contents for the brief time period between initiating the bottom and top ANFO explosive columns.
- A 5m to 5.8m explosive column of ANFO (59.1kg to 68.5kg) loaded above the inert deck. Exact quantity of ANFO in the upper column of each borehole will be established based on the overall hole depth and maintaining a 3.4m surface collar
- A 3.4m surface collar of suitable stemming material. This large surface collar is intended to push the majority of explosive energy from the upper ANFO column downwards and reduce potential of upwards projected flyrock. Note that inside the 3.4m surface collar will be a satellite charge of one (1) 100mm diameter cartridge (approx. 9kg) intended to fracture the remaining cap rock to collapse the remaining pillar without risking an excessive flyrock potential.

Each ANFO deck will be primed with cast boosters appropriately sized for a 133mm borehole and double primed if utilizing NONEL detonators in order to maximize the probability of a complete and thorough detonation. The satellite charge can be directly primed with a detonator if utilizing a detonator sensitive emulsion, otherwise must be primed with a single cast booster.

For the inter-hole timing of blast holes, all thick crown pillar blasts should lead off with a dice hole. This will continually establish a crater along the centerline of the crown pillar which should push the majority of explosive energies from the subsequent perimeter holes inwards. Timing for the explosive decks must be initiated from bottom to top (i.e. three separate detonation events per borehole). The exact timing between each ANFO deck and the subsequent satellite charge should be timed sufficiently to allow rock swell and movement into the open stope. We anticipate this will require more than the standard 25ms timing and thus either NONEL jumper detonators or NONEL LP detonators can be used to extend inter-deck timing. Observed results from the trial blast(s) may necessitate alterations in the timing for subsequent for larger blast sections (refer to proposed blasting sequence detailed in Section 3.0 below).

While the designs detailed above provide parameters to guide initial blasting operations onsite, Break-Away personnel must be prepared to adjust the drilling pattern, change explosives types, and implement controlled blasting techniques such as decking or utilizing multiple lifts in order to adapt to site conditions following observations from the trial blasts.

3.0 Blast Sequence

As demonstrated in the attached appendices, the proposed blast sequence involves a minimum of six (6) blasts, staged to best utilize open relief along existing or established vertical faces.

Blast 1: A short section of *Thick Crown Pillar* to the immediate North of the central *Open Stope*. Timing sequence will project material towards the existing open space to the South. Note that Blast 1 will be considered the trial blast for the *Thick Crown Pillar* design parameters.

Blast 2: A short section of *Thin Crown Pillar* at the Northern most end of the West Zone Pillar Stope. Timing sequence will project material towards the open space generated by Blast 1. Note that Blast 2 will be considered the trial blast for the *Thin Crown Pillar* design parameters

Blast 3: A *Thick Crown Pillar* section to the immediate South of the central *Open Stope*. Timing sequence will project material towards the open space to the North.

Blast 4: A longer section of *Thin Crown Pillar* to the South of Blast 3. Timing sequence will project material towards the open space generated by Blast 3. Note that observed results from Blast 2 will dictate if Blast 4 necessitates a division into multiple separate blasts to avoid a backup of blast energies which risks hanging or binding rock after detonation.

Blast 5: A *Thick Crown Pillar* section to the South of Blast 4. Timing sequence will project material towards the open space generated by Blast 4. It is not anticipated that this longer *Thick Crown Pillar* section can be taken in a single blast without risking rock fragmentation issues. Accordingly, the exact division between Blast 5 and Blast 6 will be decided based on observed results from Blast 1 and Blast 3.

Blast 6: The remaining *Thick Crown Pillar* from Blast 5 and a short *Thin Crown Pillar* section at the Southern most end of the West Zone Pillar Stope. Timing sequence will project material towards the open space generated by Blast 5. As noted above, the exact division between Blast 5 and Blast 6 will be decided based on observed results from Blast 1 and Blast 3.

The blast sequence detailed above provides initial guidance for blasting operations. Observations from the trial blasts will dictate the appropriate scale of each blast in order to safely and efficiently complete the necessary excavation.

4.0 Flyrock

Flyrock is the term used to define rocks which are projected from the blast area by the force of the explosion. This action is a predictable and necessary component of a blast and requires that every blast have an exclusion zone established within which no persons or property which may be harmed are permitted.

While we understand that personnel and equipment can be sufficiently evacuated to a safe area on the Lupin Mine site, the proximity of the fuel tanks necessitates that flyrock is sufficiently controlled to within approximately 140m of the West Zone Stope.

4.1 Theoretical Horizontal Flyrock Calculations

Flyrock occurs when explosives in a hole are poorly confined by the stemming or rock mass and the high pressure gas breaks out of confinement and launches rock fragments into the air. The three primary sources of fly rock are as follows:

- **Face burst:** Lack of confinement by the rock mass in front of the blast hole results in fly rock in front of the face.
- **Cratering:** Insufficient stemming height or weakened collar rock results in a crater being formed around the hole collar with rock projected in any direction.
- **Stemming Ejection:** Poor stemming practice can result in a high angle throw of the stemming material and loose rocks in the blast hole wall and collar.

The horizontal distance flyrock can be thrown (L_H) from a blast hole is determined using the expression:

$$L_H = \frac{V_o^{\,2} Sin2\theta_0}{g} \qquad [1]$$

where: V_o = launch velocity (m/s)

θ_0 = launch angle (degrees)

g = gravitational constant (9.8 m/s^2)

The theoretical maximum horizontal distance fly rock will travel occurs when θ_0 = 45 degrees, thereby yielding the equation:

$$L_{H\max} = \frac{V_o^{\,2}}{g} \qquad [2]$$

The normal range of launch velocity for blasting is between 10m/s - 30m/s. To calculate the launch velocity of a blast the following formula is used:

$$V_o = k\left(\frac{\sqrt{m}}{B}\right)^{1.3} \quad [3]$$

where: k = a constant
m = charge mass per meter (kg/m)
B = burden (m)

By combining equations 2 and 3 and taking into account the different sources of fly rock, the following equations can be used to calculate the maximum fly rock thrown from a blast:

Face burst: $$L_{H\max} = \frac{k^2}{g} * \left(\frac{\sqrt{m}}{B}\right)^{2.6}$$

Cratering: $$L_{H\max} = \frac{k^2}{g} * \left(\frac{\sqrt{m}}{SH}\right)^{2.6}$$

Stemming Ejection: $$L_{H\max} = \frac{k^2}{g} * \left(\frac{\sqrt{m}}{SH}\right)^{2.6} Sin2\theta$$

where: θ = drill hole angle
L_{hmax} = maximum flyrock throw (m)
m = charge mass per meter (kg/m)
B = burden (m)
SH = stemming height (m)
g = gravitational constant
k = a constant

The range for the constant k is 13.5 for soft rocks and 27 for hard rocks. For the Lupin Mine site, an estimated rock hardness factor of 20 has been utilized.

4.2 Thick Crown Pillar Sections - Flyrock Estimation

With a typical surface topography, flyrock calculations can reasonably estimate the maximum theoretical flyrock distances based on the proposed designs. It is of note for these calculations that the bottom ANFO column is largely irrelevant from a flyrock perspective as that material will be almost entirely projected downwards and horizontally into the open stope. Accordingly, flyrock potential is focused on both the upper ANFO column and the satellite charge of a 100mm packaged emulsion product.

Upper ANFO Column

- For a 133mm borehole loaded with ANFO (0.85g/cc) to a collar of 3.4m, the maximum theoretical horizontal distance for **cratered flyrock or stemming ejection** would be **42m**. *Note that cratered rock can be projected 360 degrees around a blast hole (i.e. to the North, East, South and West).*
- Similarly, for the same loaded borehole the maximum theoretical horizontal distance for **face burst flyrock** would be **168m**. *Note, face burst rock would be projected from the vertical face of the blast hole (i.e. primarily to the North or South depending on blast orientation).*

Satellite Charge

- For a 133mm borehole loaded with 100mm packaged emulsion (1.20g/cc) to a collar of minimum 1.8m, the maximum theoretical horizontal distance for **cratered flyrock or stemming ejection** would be **170m**. *Note that cratered rock can be projected 360 degrees around a blast hole (i.e. to the North, East, South and West).*
- Similarly, for the same loaded borehole the maximum theoretical horizontal distance for **face burst flyrock** would be **129m**. *Note, face burst rock would be projected from the vertical face of the blast hole (i.e. primarily to the North or South depending on blast orientation).*

Given these theoretical estimations, it is anticipated that a double layer of blast mats will be required to reduce the potential flyrock distance within the necessary 140m containment zone. Rubber tire blast mats can be placed directly on top of the *Thick Crown Pillar*, however, without securing mats in place they would likely

only provide a single time use if the crown pillar collapses as planned. Accordingly, it is Explotech's recommendation to chain the mats together and anchor them back to secured points outside of the immediate stope area to ensure they can be retrieved afterwards.

4.3 Thin Crown Pillar Sections - Flyrock Estimation

The unique surface dynamics of the thin crown pillar sections are quite atypical with the narrow open air trench and thus, calculating a reliable estimation for the maximum theoretical flyrock distance is not possible. That said, we can be certain that no cratered or stemming ejection flyrock will be generated at the surface of these particular perimeter holes given the 11.2m to 12.2m collars in each borehole. However, a risk of flyrock still exists based on the upper 2m of the ANFO column loads as they will be exposed above the top elevation of the existing thin crown pillar. Given that the explosive charges will detonate over 11m down a narrow, 4m wide open air trench, the opportunity for flyrock will be dramatically reduced compared to a surface blast.

In order to mitigate the risk of flyrock projection, Explotech recommends partially backfilling the open air trench with approximately 2m of loose fill material, ideally of a consistency similar to sand. The suggested 2m of material will cover the upper 2m of explosive charge which will substantially absorb excess explosive energy. We note that it may be difficult to judge material placement given the 11 to 12m elevation difference between surface and the top of the crown pillar, however, it is important to not place an excessive amount of loose fill on top of the crown. The explosive design for the thin crown pillar section requires relatively even breakage across the entire height of the crown pillar and choking any rock movement at the top of the crown can drastically alter the explosive's behaviour. Similarly, substantial material weight on top of the crown pillar can affect the anticipated reaction of the rock material as it shears off the stope walls and collapses into the open stope below.

In addition to the 2m of backfilled material, it is recommended to leverage a common shaft blasting technique where mats are placed above a temporary superstructure to provide a second source of mitigation and ensure the mats

remain in place after the blast has detonated. In the case of a 4m wide open stope, any available steel plates or beams at least 6m long could create a temporary support structure which sufficiently extends the gap between stope walls. Placing double layered mats on top that structure should ensure the mats could be repeatedly used while still largely mitigating the energy of projected material.

The flyrock mitigation detailed above provide a template for mitigating risk during the initial trial blasts. Observations from the trial blasts will dictate the appropriate use of flyrock mitigation methods for subsequent blasts.

5.0 Conclusion

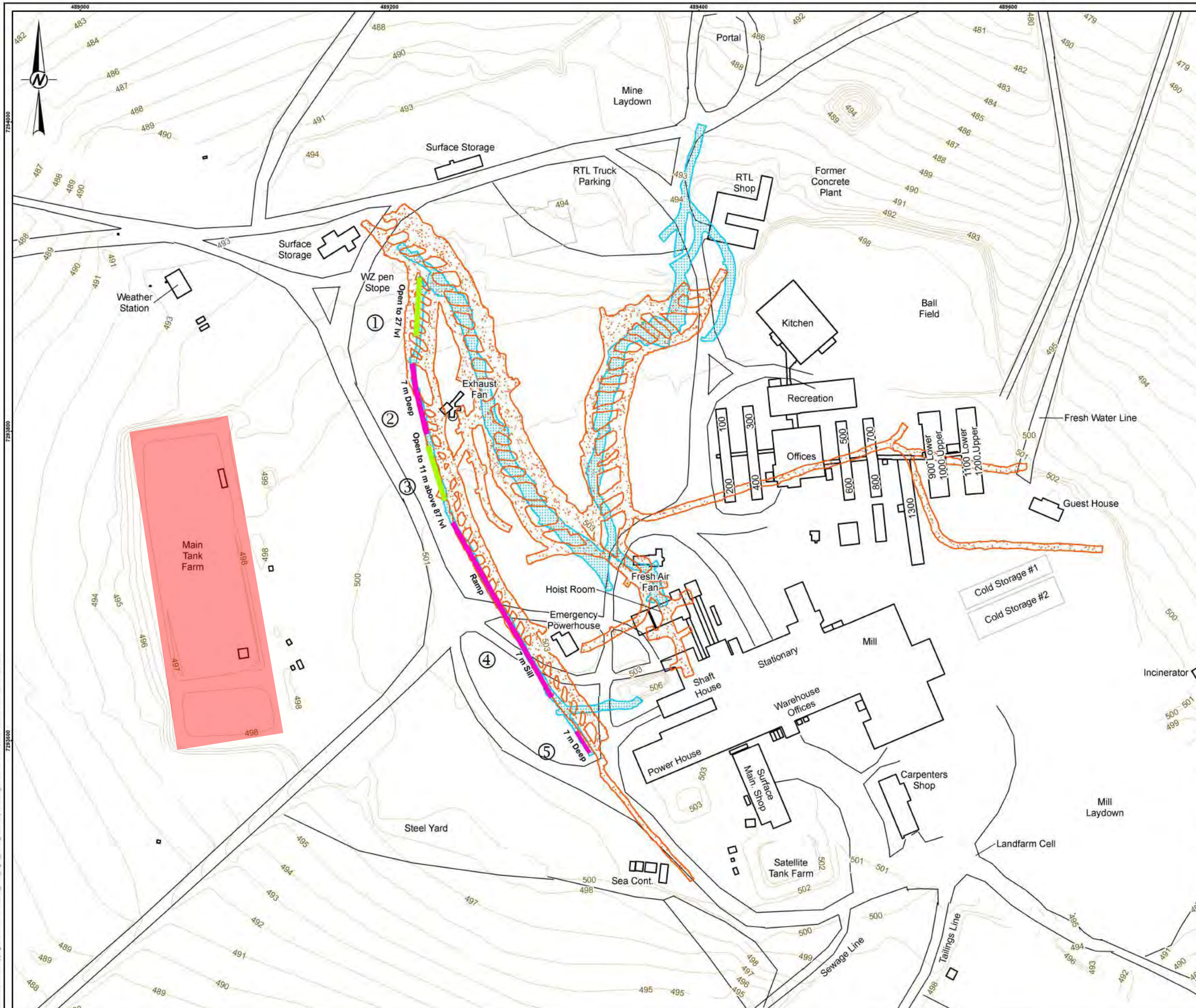
The blast parameters described within this report will provide a good basis for the West Zone Pillar Stope blasting operations proposed for the Lupin Mine Closure project in Kitikmeot Region, Nunavut. Initial designs may require modification based on observed fragmentation and flyrock results. However, it is Explotech's opinion that blasting operations can be carried out safely and within the guidelines recommended herein.

We trust the above provides the requested insight and information. Should you require any clarification or additional information, we remain available as necessary.

Kindest regards,

Mitch Malcomson, P.Eng. (ON)
Explotech Engineering Ltd.

Rob Cyr, P. Eng
Explotech Engineering Ltd.



LEGEND

① WZ UNDERGROUND DISPOSAL KEY CROSS-SECTION LOCATION

CONTOUR

INFRASTUCTURE FOOTPRINT

27 LEVEL ORE DRIFT PROJECTION

87 LEVEL ACCESS DRIFT PROJECTION

WZ CROWN PILLAR PIT

WZ OPEN STOPE

0 50 100

1:2,500 METRES

REFERENCE(S)

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DATUM: NAD83 PROJECTION: UTM ZONE 12

CLIENT

MANDALAY RESOURCES CORPORATION

PROJECT

LUPIN MINE CLOSURE

TITLE

UNDERGROUND MINE WORKING PLAN

LUPIN MINES INCORPORATED

YYYY-MM-DD	2018-01-25
DESIGNED	NORWEST CORP.
PREPARED	AA
REVIEWED	
APPROVED	

PROJECT NO.	CONTROL	REV.	FIGURE
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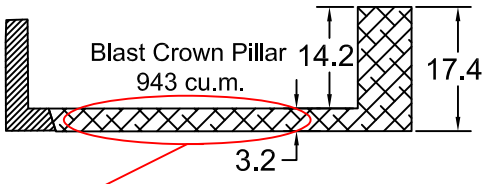
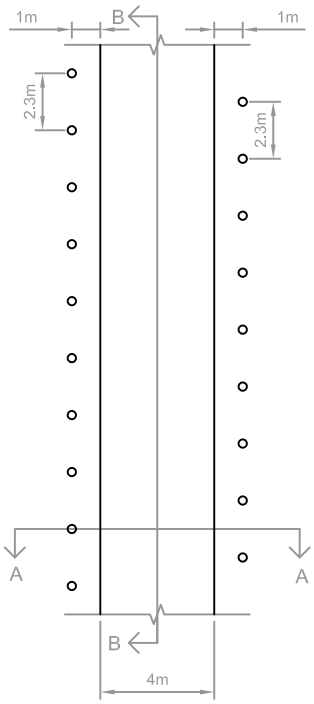
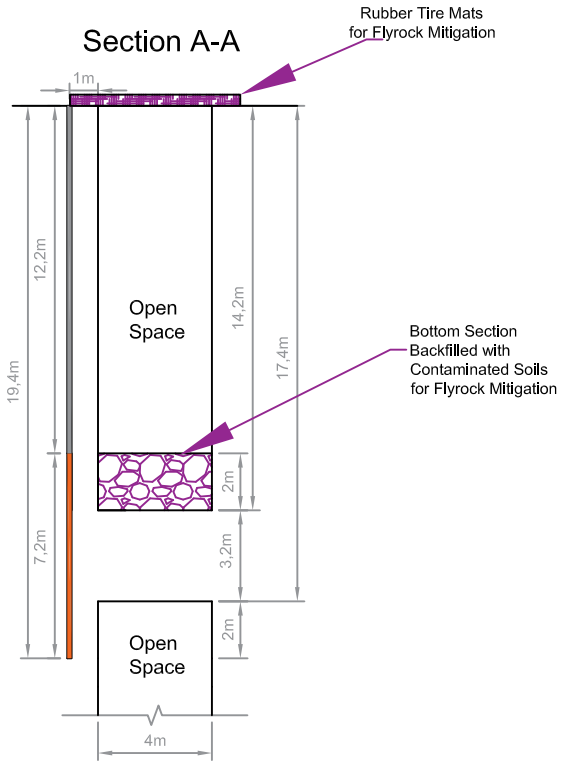






Loading Characteristics

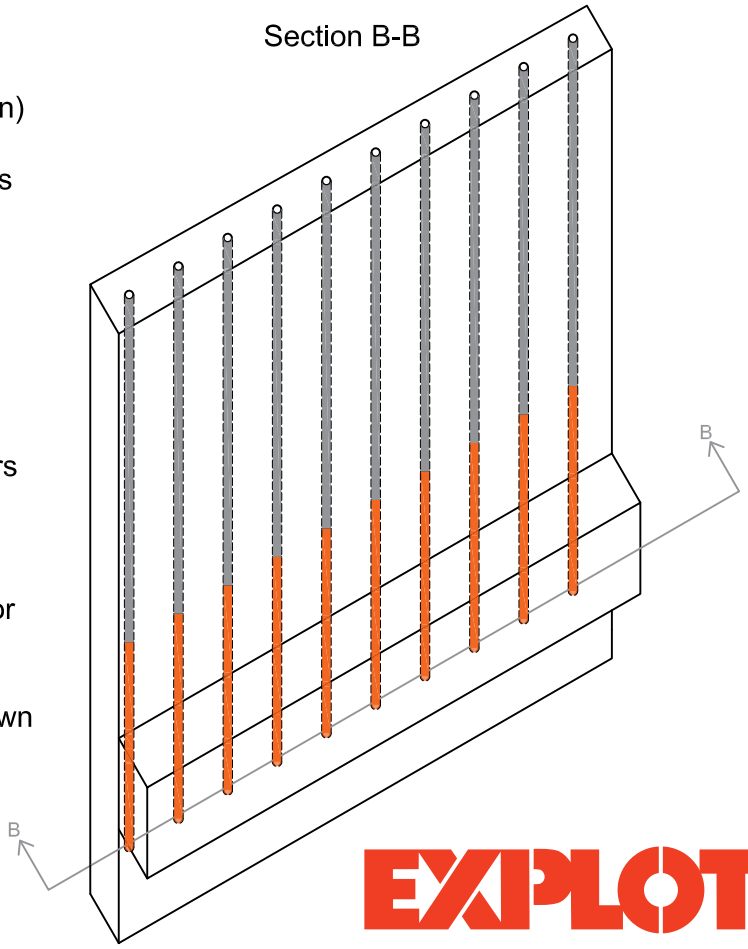
- ~1m Burden from Face (True Burden)
- 2.3m Line Spacing between Holes
- Holes Staggered on Opposing Faces

- 133mm Hole Diameter
- 19.4m Hole Depth (incl. Subdrill)
- 12.2m Collar
- 7.2m Explosive Column

- ANFO Loaded (0.85g/cc)
- Double Primed with Two (2) Boosters
- NONEL Detonators
- ~85kg per hole

- Approximate Average Powder Factor for Explosive Column of **2.6**
  - (85kg)/(7.2m*2m*2.3m)
- Approximate Powder Factor for Crown Pillar Section of **1.7**
  - (37.8kg)/(3.2m*3m*2.3m)

Section B-B



EXPLOTECH

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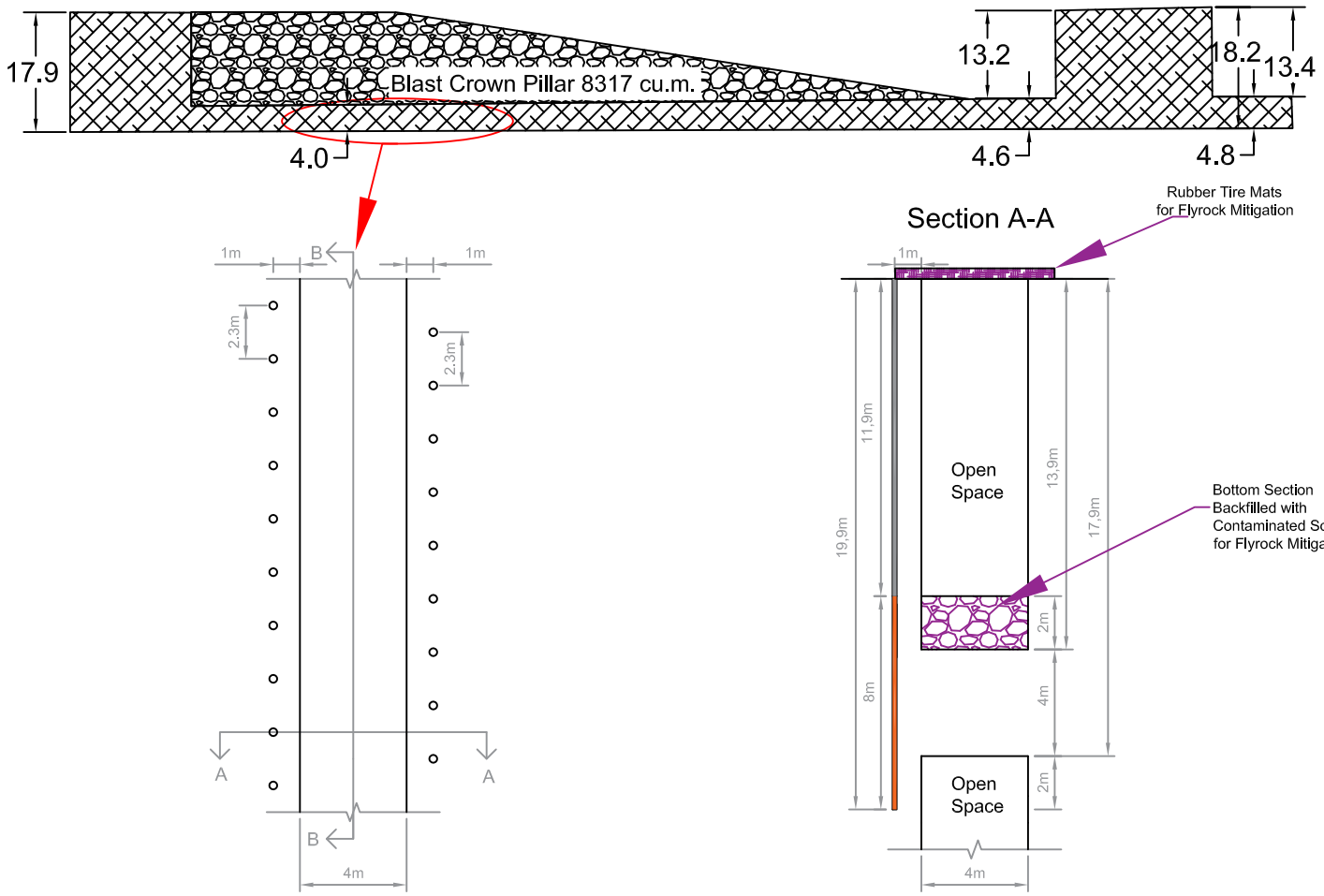


Loading Characteristics

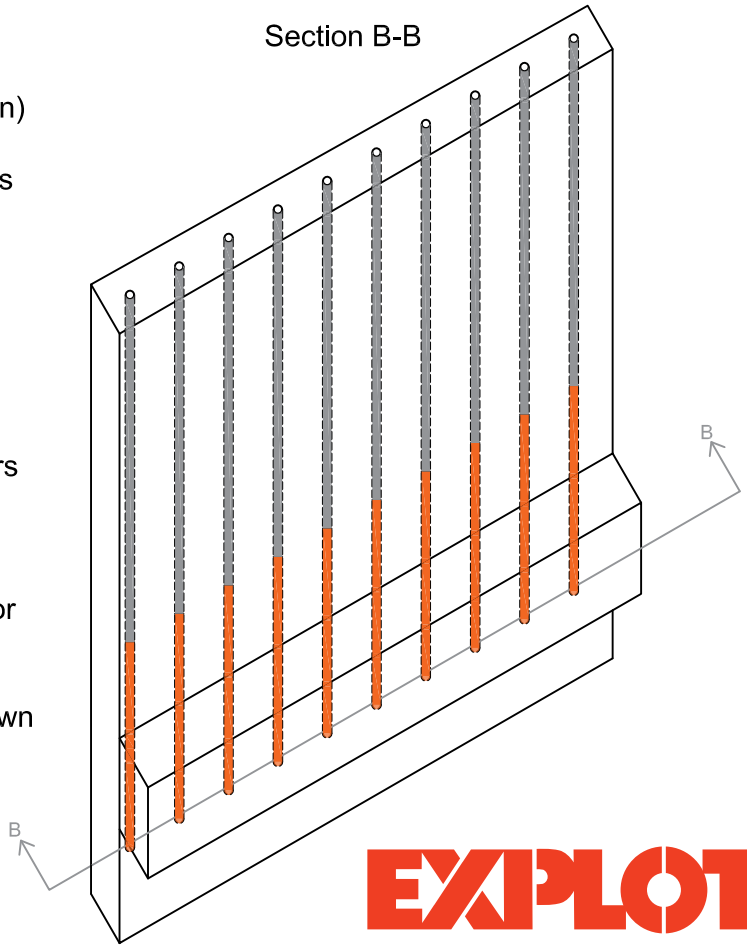
- ~1m Burden from Face (True Burden)
- 2.3m Line Spacing between Holes
- Holes Staggered on Opposing Faces

- 133mm Hole Diameter
- 19.9m Hole Depth (incl. Subdrill)
- 11.9m Collar
- 8m Explosive Column

- ANFO Loaded (0.85g/cc)
- Double Primed with Two (2) Boosters
- NONEL Detonators
- ~94.5kg per hole

- Approximate Average Powder Factor for Explosive Column of **2.6**
  - (94.5kg)/(8m*2m*2.3m)
- Approximate Powder Factor for Crown Pillar Section of **1.7**
  - (47.2kg)/(4m*3m*2.3m)

Section B-B



EXPLOTECH

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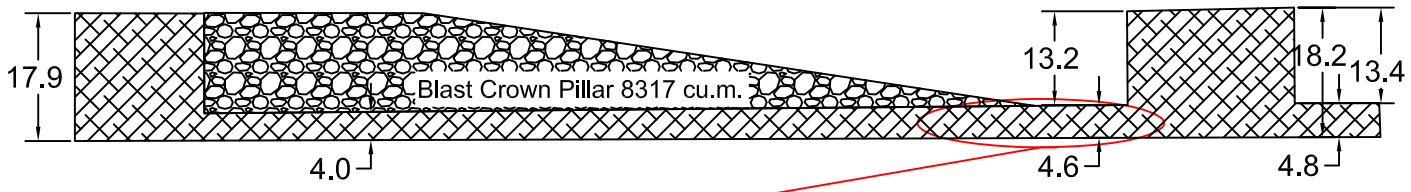
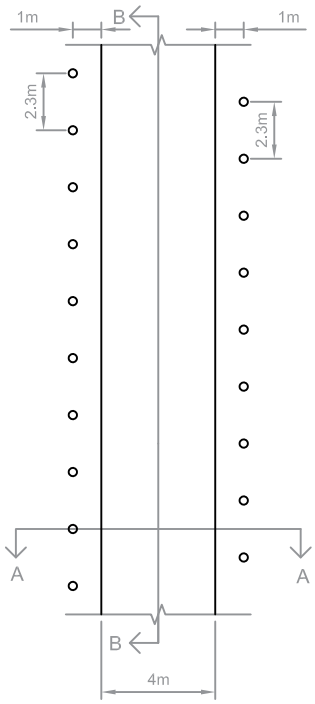
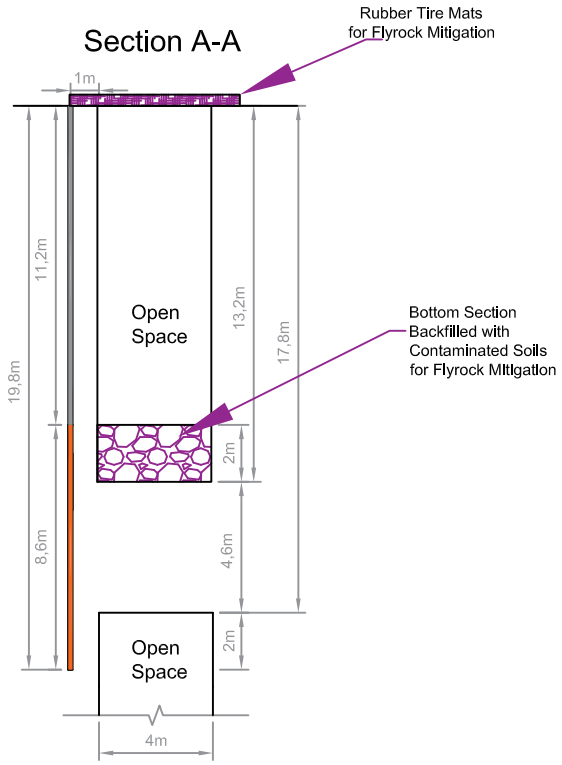




Section A-A



Loading Characteristics

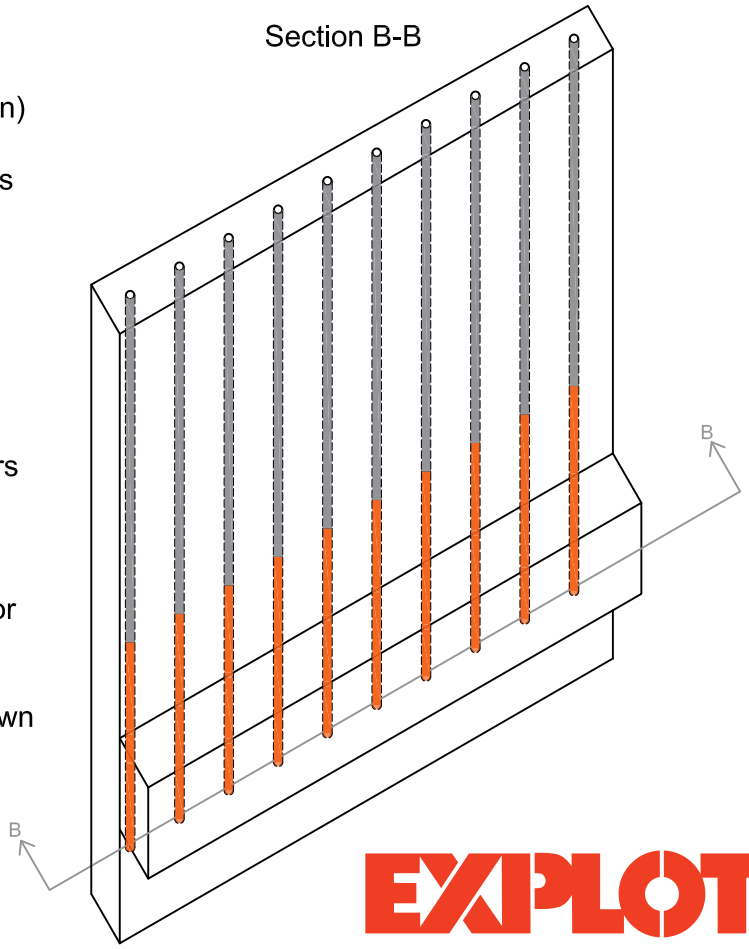
- ~1m Burden from Face (True Burden)
- 2.3m Line Spacing between Holes
- Holes Staggered on Opposing Faces

- 133mm Hole Diameter
- 19.8m Hole Depth (incl. Subdrill)
- 11.2m Collar
- 8.6m Explosive Column

- ANFO Loaded (0.85g/cc)
- Double Primed with Two (2) Boosters
- NONEL Detonators
- ~101.5kg per hole

- Approximate Average Powder Factor for Explosive Column of **2.6**
  - (101.5kg)/(8.6m*2m*2.3m)
- Approximate Powder Factor for Crown Pillar Section of **1.7**
  - (54.3kg)/(4.6m*3m*2.3m)

Section B-B



EXPLOTECH

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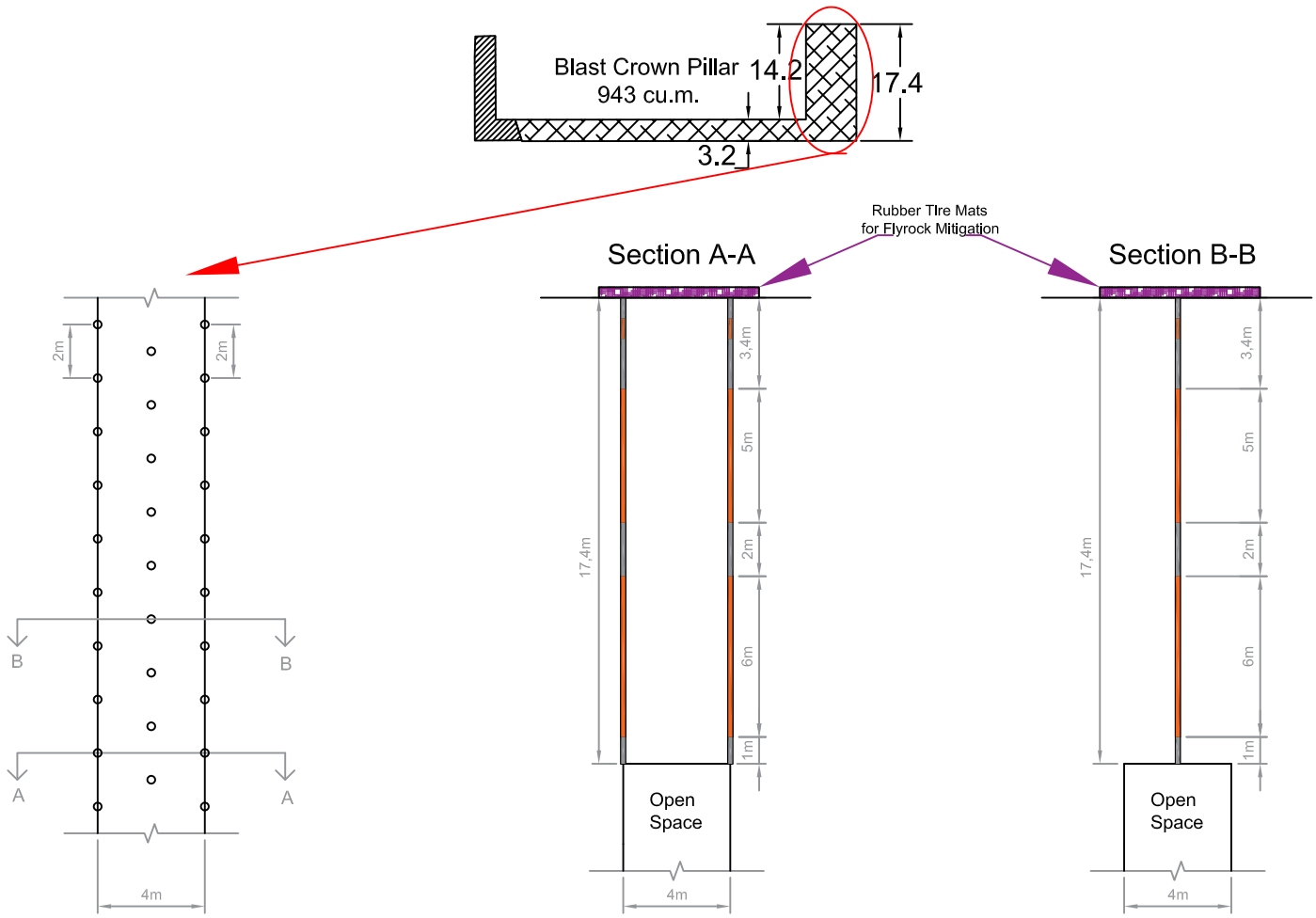


Loading Characteristics

- 2m x 4m Dice Pattern
- 133mm Hole Diameter
- 17.4m Hole Depth (incl. Subdrill)
- Three Explosive Decks, Three Inert Decks
- Initiated Bottom Deck First, then Middle Deck, then Top Deck Satellite Charge

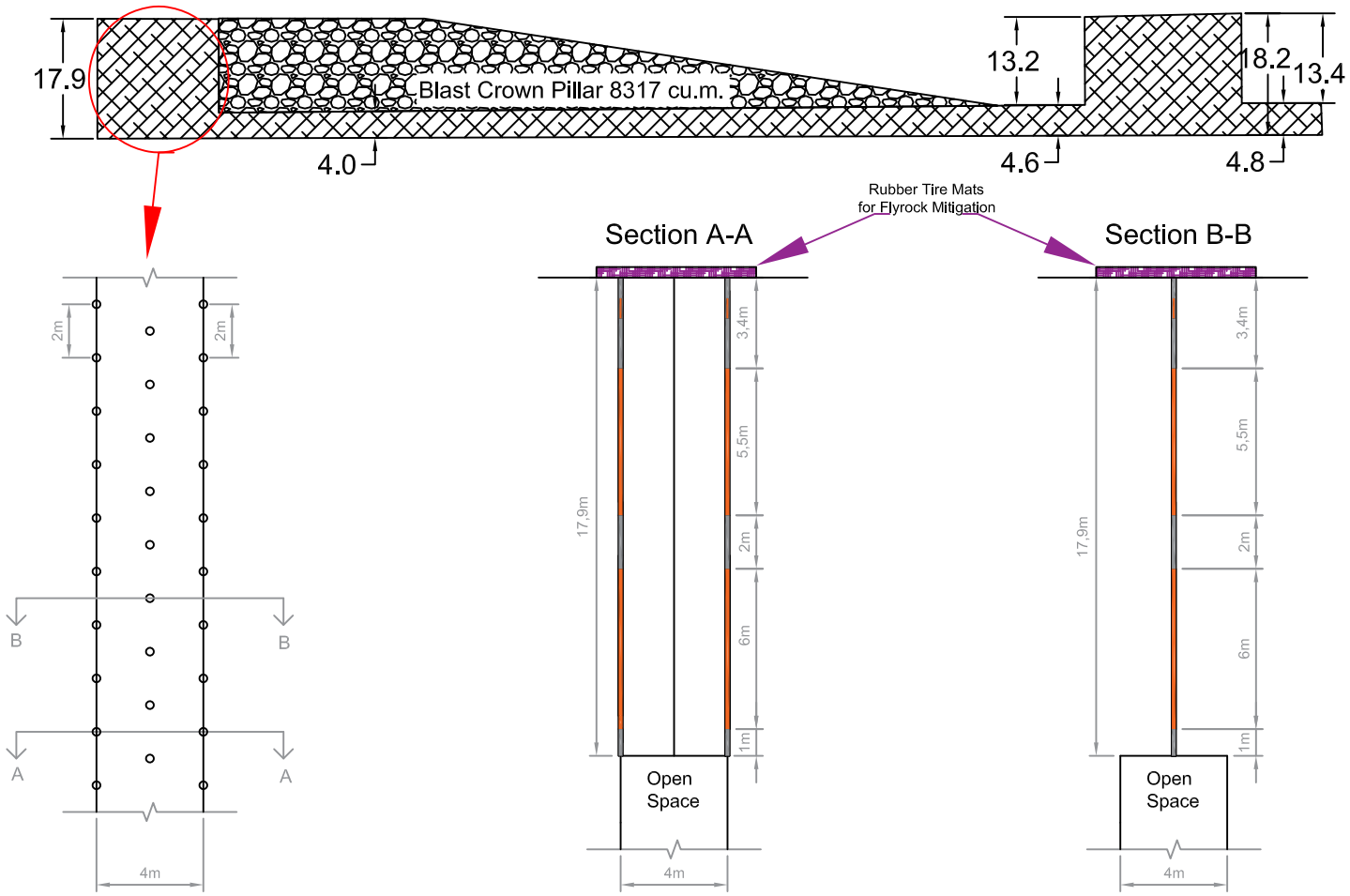
- Loading Design (Referenced from Bottom of Hole
  - 1m Bottom Collar (Plug)
  - 6m ANFO Load (70.9kg)
  - 2m Inert Deck (Plug or Stemming)
  - 5m ANFO Load (59.1kg)
  - 3.4m Surface Collar with a Satellite Charge of One (1) 100mm diameter cartridge (approx. 9kg)

- ANFO explosive decks Double Primed with Two (2) Boosters
- NONEL Detonators
- ~139.0kg per hole

- Approximate Powder Factor for Production Holes is **2.00**
  - (139kg)/(17.4m*2m*2m)

EXPLOTECH

NTS



Loading Characteristics

- 2m x 4m Dice Pattern
- 133mm Hole Diameter
- 17.9m Hole Depth (incl. Subdrill)
- Three Explosive Decks, Three Inert Decks
- Initiated Bottom Deck First, then Middle Deck, then Top Deck Satellite Charge

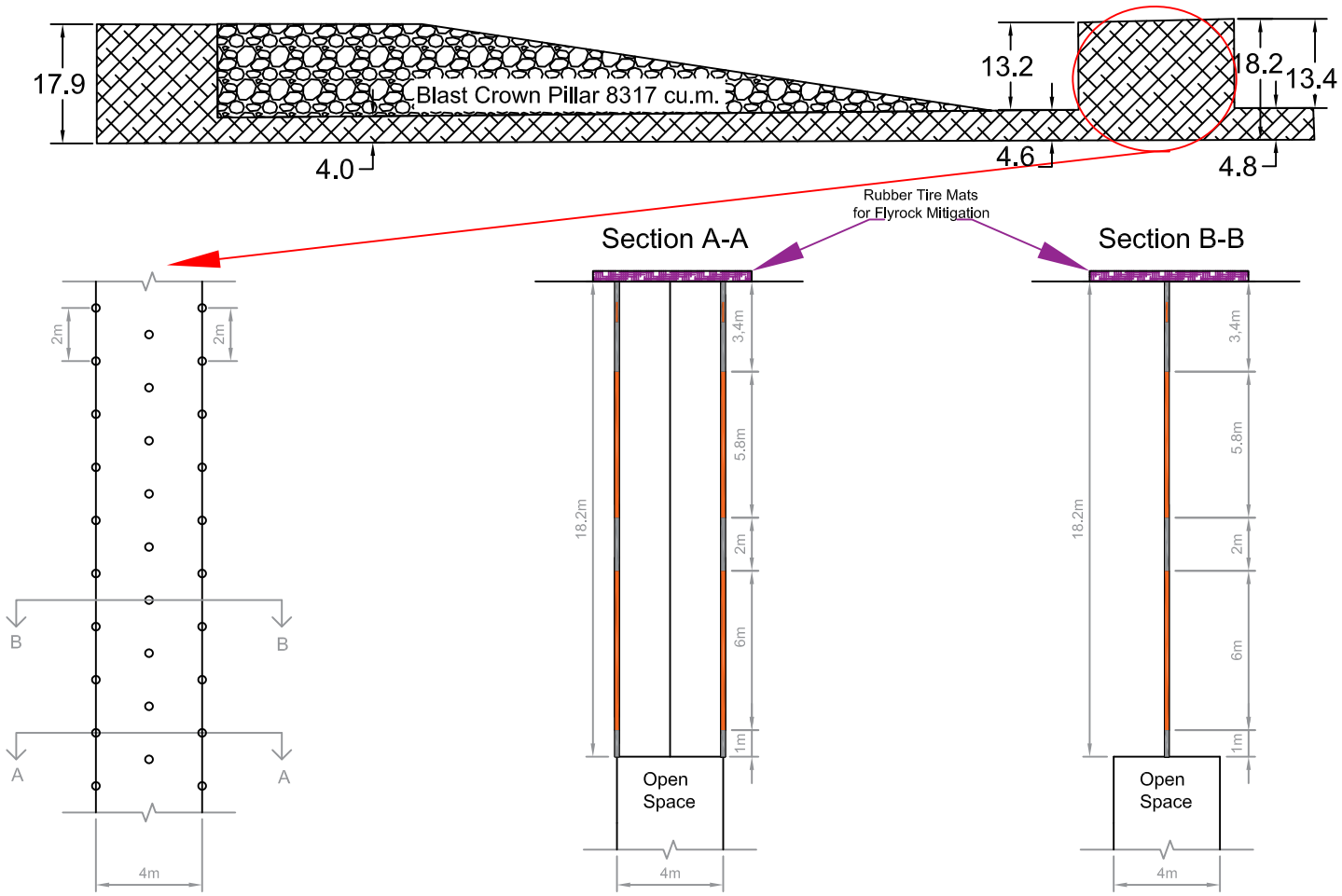
- Loading Design (Referenced from Bottom of Hole
  - 1m Bottom Collar (Plug)
  - 6m ANFO Load (70.9kg)
  - 2m Inert Deck (Plug or Stemming)
  - 5.5m ANFO Load (65kg)
  - 3.4m Surface Collar with a Satellite Charge of One (1) 100mm diameter cartridge (approx. 9kg)

- ANFO explosive decks Double Primed with Two (2) Boosters
- NONEL Detonators
- ~144.9kg per hole

- Approximate Powder Factor for Production Holes is **2.02**
  - (144.9kg)/(17.9m*2m*2m)

EXPLOTECH

NTS



Loading Characteristics

- 2m x 4m Dice Pattern
- 133mm Hole Diameter
- 18.2m Hole Depth (incl. Subdrill)
- Three Explosive Decks, Three Inert Decks
- Initiated Bottom Deck First, then Middle Deck, then Top Deck Satellite Charge

- Loading Design (Referenced from Bottom of Hole
  - 1m Bottom Collar (Plug)
  - 6m ANFO Load (70.9kg)
  - 2m Inert Deck (Plug or Stemming)
  - 5.8m ANFO Load (68.5kg)
  - 3.4m Surface Collar with a Satellite Charge of One (1) 100mm diameter cartridge (approx. 9kg)

- ANFO explosive decks Double Primed with Two (2) Boosters
- NONEL Detonators
- ~148.4kg per hole

- Approximate Powder Factor for Production Holes is **2.04**
  - (148.4kg)/(18.2m*2m*2m)

EXPLOTECH

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Blast Sequence