21 September 2018

Assol Kubeisinova
Technical Advisor, NWB
P.O. Box 119
Gjoa Haven, NU X0B 1J0

RE: Issued for Construction Drawings Submission
Run of Mine Stockpile and Sedimentation Pond
Mary River Project - Type 'A' Water Licence 2AM-MRY1325 - Amend. No. 1

Please find attached transmission of the following drawings and documents in accordance with Part D, Item 2 of the Type 'A' Water Licence 2AM-MRY1325 (the Licence):

- Drawings
  - 300 – General Arrangement
  - 301 – Specifications
  - 310 – Access Road - Plan and Section
  - 311 – Access Road - Sections
  - 320 – Sedimentation Pond and Runoff Management Measures – Plan, Sections and Details
  - 321 – Sedimentation Pond and Runoff Management Measures – Sections and Details

- Design Brief
  - KM107 Stockpile Access Road and Runoff Management Designs

Please note that this Run of Mine (ROM) Stockpile infrastructure located at KM107 is included in the Final Environmental Impact Statement (FEIS), and is already considered in the scope of the Licence. Within the Licence the sedimentation pond has been identified as 'MS-07'. Construction of this facility does not require a Modification to the Licence. Minor updates to the *Surface Water and Aquatic Ecosystems Management Plan* and the *Fresh Water Supply, Sewage, and Wastewater Management Plan* will be required prior to operation of the facility. Implementation of the monitoring program associated with MS-07 will conform to the requirements of Schedule I of the Licence.

As this infrastructure was not included in the 2018 Work Plan or 2018 Work Plan Addendum, reclamation security for this specific activity is currently not in place. While a Work Plan addendum and security estimate could be pursued to address this gap, given the proximity to the 2019 Work Plan submission and ASR process, Baffinland believes reconciling this activity in the 2019 Work Plan is a suitable alternative. Therefore, this facility will be included in the 2019 Work Plan and associated 2019 Marginal Closure and Reclamation Financial Security Estimate. For reference, Baffinland has estimated the total reclamation

cost of this facility to be approximately $250,000. Additionally, as Baffinland has not executed the earthworks associated with the Milne Port Laydowns outlined in the 2018 Work Plan (with the exception of Laydown 7), Baffinland is over-bonded with respect to earthworks in 2018. As a result, in the event reclamation of the earthworks associated with the ROM Stockpile would be required prior to the end of 2018, adequate security would be in place to complete the reclamation.

Baffinland will prepare a Construction Summary Report within ninety (90) days following completion of this work, in accordance with Part D, Item 17 of the Licence.

We trust that this information meets the requirements under Part D of the Licence.

Regards,

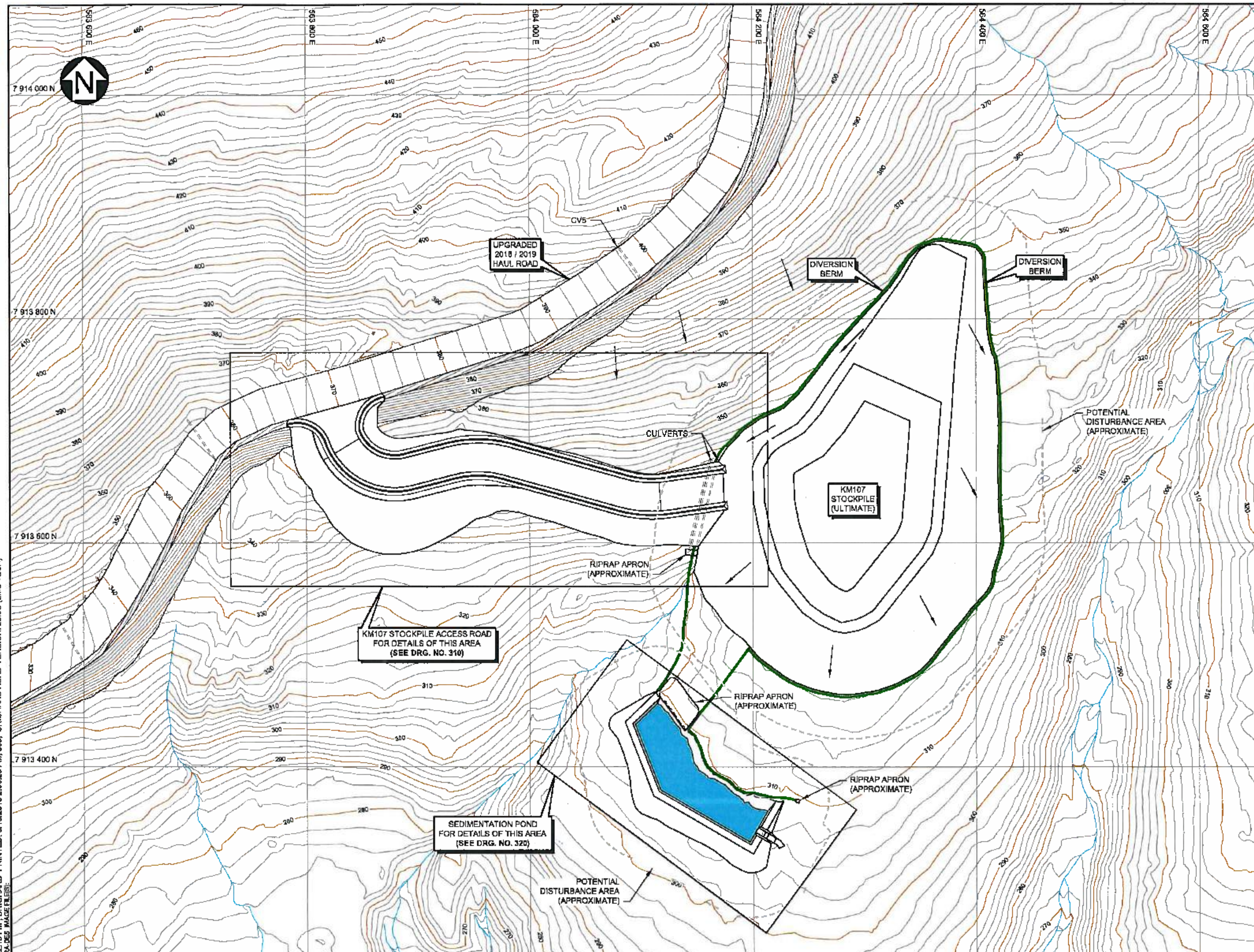
Christopher Murray
Environmental & Regulatory Compliance Manager

Attachments:
Attachment 1: For-Construction Drawings
Attachment 2: Design Brief

Cc:
Karén Kharatyan (Nunavut Water Board)
Fai Ndofor, Sean Joseph (Qikiqtani Inuit Association)
Ian Parsons, Bridget Campbell, Sarah Forté (Crown-Indigenous Relations and Northern Affairs Canada)
Solomon Amuno (Nunavut Impact Review Board)
Grant Goddard, Megan-Lord Hoyle, Timothy Ray Sewell, Simon Fleury (Baffinland)

Attachment No. 1

For Construction Drawings



LEGEND:

- WATER
- CULVERT
- DIVERSION BERM
- GENERAL FLOW DIRECTION
- POTENTIAL DISTURBANCE AREA (APPROXIMATE)

NOTES:

1. COORDINATE GRID IS UTM (NAD83) ZONE 17.
2. TOPOGRAPHY BASED ON INFORMATION PROVIDED BY EAGLE MAPPING (2008).
3. CONTOURS ARE IN METRES. CONTOUR INTERVAL IS 2 m.
4. DIMENSIONS AND ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE.
5. LOCATIONS OF CONSTRUCTION ITEMS MAY BE MODIFIED TO SUIT SITE CONDITIONS.
6. UPGRADED 2018 / 2019 HAUL ROAD AND KM107 STOCKPILE PROVIDED BY BAFFINLAND.
7. FINAL SLOPES SHALL BE TRIMMED TO THE LINES AND TOLERANCES INDICATED ON THE DRAWINGS AND IN THE TECHNICAL SPECIFICATIONS.
8. ALL INFRASTRUCTURE SHOWN IS PROPOSED UNLESS NOTED OTHERWISE.
9. THE DRAWING SHALL BE READ IN CONJUNCTION WITH THE CONTRACT DOCUMENTS AND APPLICABLE TECHNICAL SPECIFICATIONS.
10. FOUNDATION PREPARATION: PROVIDED THE AMOUNT OF ORGANICS AND UNSUITABLE MATERIAL ON THE GROUND IS NEGLIGIBLE, DISTURBANCE TO THE ORIGINAL GROUND (EXCAVATION, SCARIFYING, ETC.) SHOULD BE MINIMIZED SO AS NOT TO IMPACT CURRENT PERMAFROST CONDITIONS. ALTERNATIVE METHODS OF FOUNDATION PREPARATION MAY BE NECESSARY FOR SOME AREAS, AT THE DISCRETION OF THE OWNER'S REPRESENTATIVE. ALL FOUNDATIONS MUST BE MAINTAINED CLEAR OF SNOW, PONDED WATER AND ICE.

ISSUED FOR CONSTRUCTION

SCALE A: 40 20 0 40 80 120 160 200 m

PERMIT TO PRACTICE
KNIGHT PIESOLD LTD.

Signature ________

Date Sept. 19 /2018

PERMIT NUMBER: P 547

The Association of Professional Engineers, Geologists and Geophysicists of NWT/NU

REGISTERED PROFESSIONAL ENGINEER
K.E. HAWTON
LICENSEE
9/19/18
NWT/NU

Knight Piésold CONSULTING

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

KM107 STOCKPILE GENERAL ARRANGEMENT

DRG. NO.	DESCRIPTION
320	KM107 STOCKPILE - SEDIMENTATION POND AND RUNOFF MANAGEMENT MEASURES - PLAN, SECTION AND DETAILS
310	KM107 STOCKPILE - ACCESS ROAD - PLAN AND SECTION

REFERENCE DRAWINGS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED

REVISIONS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	18SEP'18	ISSUED FOR CONSTRUCTION	DMMD	MMD / SIR		

REVISIONS

P/A NO.	DRAWING NO.	REVISION
NB102-181/49	300	0

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XREF FILE(S): X-C-TOPO-MINE SITE; X-C-TOPO-INFRA; X-C-TOPO-INFRA-DES IMAGE FILES:

GEOSYNTHETICS:

CO-ORDINATION BETWEEN OWNER, ENGINEER AND CONTRACTOR

1. AFTER THE CONTRACTOR HAS COMPLETED PREPARING THE SUBGRADE SURFACE WHICH WILL LIE DIRECTLY BELOW THE GEOSYNTHETICS, THE CONTRACTOR, ENGINEER AND OWNER WILL VERIFY ACCEPTANCE BY SIGNING A FORM WHICH DESCRIBES THE EXTENT OF THE AREA. AT THAT TIME, THE CONTRACTOR ASSUMES RESPONSIBILITY OF PROTECTING THE APPROVED SURFACE, UNTIL IT IS COVERED WITH GEOSYNTHETICS.
2. ANY DAMAGE BY MECHANICAL MEANS CAUSED BY THE CONTRACTOR TO APPROVED SUBGRADE AREAS SHALL BE REPAIRED TO THE SATISFACTION OF THE ENGINEER AT THE EXPENSE OF THE CONTRACTOR. ANY DAMAGE CAUSED BY WEATHER TO APPROVED SUBGRADE AREAS SHALL BE REPAIRED TO THE SATISFACTION OF THE ENGINEER AT THE EXPENSE OF THE OWNER. ANY DAMAGE CAUSED BY WEATHER TO APPROVED SUBGRADE AREAS RESULTING FROM WIND EROSION OR POOR SURFACE RUNOFF CONTROL (E.G. ALLOWING SURFACE RUNOFF ONTO APPROVED AREAS) AS A RESULT OF OPERATIONS OF THE CONTRACTOR SHALL BE REPAIRED TO THE SATISFACTION OF THE ENGINEER AT THE EXPENSE OF THE CONTRACTOR.
3. AFTER INSTALLATION OF THE GEOSYNTHETICS AND FINAL QUALITY CONTROL MEASURES ARE COMPLETED BY THE CONTRACTOR, AREAS RECEIVING COVER MATERIAL SHALL BE CLEARLY IDENTIFIED AND THE ENGINEER SHALL BE NOTIFIED FOR GEOSYNTHETICS INSPECTION. UPON SIGNED ACCEPTANCE BY THE ENGINEER THAT THE GEOSYNTHETICS HAVE BEEN INSTALLED IN ACCORDANCE WITH THE SPECIFICATIONS, IT WILL BE AVAILABLE TO THE CONTRACTOR FOR PLACING THE COVER MATERIAL, WHERE APPLICABLE. AT THAT TIME THE CONTRACTOR WILL ASSUME RESPONSIBILITY FOR MAINTAINING THE CONDITION OF THE PORTION OF THE GEOSYNTHETICS UNTIL IT IS ADEQUATELY COVERED.
4. ANY DAMAGE TO PREVIOUSLY ACCEPTED GEOSYNTHETICS AS A RESULT OF THE CONTRACTOR'S OPERATION WILL BE REPAIRED TO THE SATISFACTION OF THE ENGINEER AT THE CONTRACTOR'S EXPENSE.
5. IN THE EVENT OF CONTRADICTION OR CONFLICT BETWEEN PARTIES MENTIONED ABOVE, QUESTIONS WILL BE TAKEN TO THE ENGINEER AND OWNER FOR FINAL DECISION.

SUBGRADE PREPARATION

1. SUBGRADE PREPARATION SHALL BE CARRIED OUT IN ACCORDANCE WITH THE MANUFACTURER'S SPECIFICATIONS AND INSTALLATION GUIDELINES.
2. SUBGRADE PREPARATION OVER ROCK SURFACES SHALL REQUIRE THE REMOVAL OF ANY PROTRUDING SURFACE SUCH THAT A SMOOTH GEOMEMBRANE SURFACE IS PROVIDED. NO OVERHANGS, PROTRUSIONS, OR LEDGES OF MORE THAN 0.1 m IN HEIGHT SHALL BE ACCEPTED.
3. PLACEMENT AND COMPACTION OF BEDDING OVER EXPOSED BEDROCK SURFACES SHALL BE CONDUCTED USING PLACEMENT AND COMPACTION METHODS TO SUIT THE SPECIFIC FIELD CONDITIONS. WHERE COMPACTION WITH A STANDARD VIBRATORY ROLLER IS NOT POSSIBLE, ALTERNATIVE COMPACTION EQUIPMENT MAY BE ACCEPTED. THE PLACEMENT AND COMPACTION METHODS MUST BE SUBMITTED TO THE ENGINEER FOR APPROVAL PRIOR TO THEIR IMPLEMENTATION.

DELIVERY, HANDLING AND STORAGE

1. DELIVERY, HANDLING AND STORAGE OF GEOSYNTHETICS MATERIAL SHALL BE IN ACCORDANCE WITH THE MANUFACTURER'S PRINTED INSTRUCTIONS.

GEOSYNTHETICS INSTALLATION

1. THE GEOMEMBRANE SHALL BE ATARFIL LLD, 40 mil, OR APPROVED EQUIVALENT. THE GEOTEXTILE SHALL BE TEXEL 100 P, 10 oz/yd², OR APPROVED EQUIVALENT AND SHALL BE PROVIDED IN INTIMATE CONTACT WITH THE GEOMEMBRANE.
2. THE GEOTEXTILE AND GEOMEMBRANE SHALL BE HANDLED IN SUCH A MANNER AS TO ENSURE THAT IT IS NOT DAMAGED IN ANY WAY. THE MATERIALS SHALL BE STORED INDOORS AT TEMPERATURES ABOVE 0 DEGREES CELSIUS PRIOR TO PLACEMENT. SHOULD THE CONTRACTOR DAMAGE THE GEOTEXTILE TO THE EXTENT THAT IT IS NO LONGER USABLE AS DETERMINED BY THESE SPECIFICATIONS OR BY THE ENGINEER, THE CONTRACTOR SHALL REPLACE THE GEOTEXTILE AS THEIR EXPENSE.
3. THE SUBGRADE UNDERLYING THE GEOTEXTILE SHALL BE APPROVED BY THE ENGINEER AND SHALL BE SMOOTH AND FREE OF RUTS OR PROTRUSIONS WHICH COULD DAMAGE THE GEOTEXTILE. THE GEOTEXTILE AND GEOMEMBRANE SHALL BE LAID FLAT AND SMOOTH SO THAT IT IS IN DIRECT CONTACT WITH THE SUBGRADE. THE GEOTEXTILE SHALL BE FREE OF TENSILE STRESSES, FOLDS AND WRINKLES SO THAT THE OVERLYING MATERIALS WILL NOT EXCESSIVELY STRETCH OR TEAR THE FABRIC. ON SLOPES STEEPER THAN 10H:1V, THE GEOTEXTILE SHALL BE LAID WITH THE MACHINE DIRECTION OF THE FABRIC PARALLEL TO THE SLOPE DIRECTION. ANCHORING OF THE TERMINAL ENDS OF THE GEOTEXTILE SHALL BE ACCOMPLISHED THROUGH THE USE OF ANCHOR TRENCHES, ANCHOR BERMS OR APRONS AT THE CREST AND TOE OF THE SLOPE. THE GEOTEXTILE SHALL BE PLACED DIRECTLY ON THE PREPARED SUBGRADE WITH SEAMS UPWARD AND SHALL EXTEND FOR A MINIMUM OF 0.9 m PAST THE DESIGNED SLOPE TOE.
4. UNLESS OTHERWISE NOTED INSTALLATION OF GEOSYNTHETICS SHALL BE IN ACCORDANCE WITH INTERNATIONAL ASSOCIATION OF GEOSYNTHETICS INSTALLERS - "GUIDELINES FOR INSTALLATION OF FACTORY FABRICATED HEAVY WEIGHT >0.64 mm (25 m11) THICKNESS FABRIC - SUPPORTED GEOMEMBRANES" (MARCH 2014), APPLICABLE GEOSYNTHETICS RESEARCH INSTITUTE STANDARDS, AND THE MANUFACTURER'S "QUALITY CONTROL MANUAL" (JANUARY 2017). GUIDELINES FOR INSTALLATION OF "FACTORY FABRIC - SUPPORTED GEOMEMBRANES" (MARCH, 2014; APPLICABLE .... MANUFACTURERS".
5. THE CONTRACTOR SHALL PROVIDE A WRITTEN GUARANTEE COVERING MATERIALS AND ALL WORKMANSHIP AS WELL AS DEGRADATION DUE TO ULTRAVIOLET LIGHT FOR EXPOSED AREAS. THE MATERIAL SHALL BE WARRANTED AGAINST MANUFACTURER'S DEFECTS FOR A PERIOD OF 5 YEARS FROM THE DATE OF INSTALLATION. THE INSTALLATION SHALL BE WARRANTED AGAINST DEFECTS IN WORKMANSHIP FOR A PERIOD OF 2 YEARS FROM THE DATE OF INSTALLATION.
6. THE GEOSYNTHETICS SHALL BE INSTALLED ON THE AREA SHOWN ON THE DRAWINGS OR AS DIRECTED BY THE ENGINEER.
7. PRIOR TO DEPLOYMENT OF THE GEOSYNTHETICS, THE CONTRACTOR, WITH THE OWNER AND ENGINEER SHALL INSPECT, CERTIFY, AND ACCEPT ALL SURFACES ON WHICH THE GEOTEXTILE AND GEOMEMBRANE IS TO BE PLACED TO ENSURE CONFORMANCE WITH THE SPECIFICATIONS. SURFACES NOT IN COMPLIANCE WITH THE SPECIFICATIONS SHALL BE RECTIFIED BY THE CONTRACTOR. ACCEPTANCE OF THE ANCHOR TRENCHES FOR PLACEMENT OF THE GEOMEMBRANE SHALL BE INCLUDED IN THE SURFACE PREPARATION ACCEPTANCE.
8. THE CONTRACTOR SHALL PROVIDE THE ENGINEER WITH A FINAL PANEL LAYOUT DRAWING, AND HARDCOPY FORMATS, AT LEAST ONE WEEK PRIOR TO PLACING THE GEOMEMBRANE. NO HORIZONTAL SEAMS ON A SLOPE WILL BE ACCEPTED. NO GEOSYNTHETICS SHALL BE INSTALLED WITHOUT PRIOR APPROVAL BY THE ENGINEER OF THE PROPOSED LAYOUT.
9. THE GEOSYNTHETICS WILL BE PLACED USING METHODS AND PROCEDURES THAT ENSURE A MINIMUM OF HANDLING. THE INSTALLER SHALL PROVIDE ADEQUATE TEMPORARY ANCHORING DEVICES TO PREVENT DAMAGE DUE TO WINDS.
10. THE GEOSYNTHETICS SHALL BE INSTALLED IN A RELAXED CONDITION AND SHALL BE FREE OF TENSION OR STRESS UPON COMPLETION OF THE INSTALLATION. ALL NECESSARY PRECAUTIONS, INCLUDING PROVISIONS FOR INSTALLING EXTRA MATERIAL, SHALL BE TAKEN TO AVOID TRAMPOLINING OF ANY GEOMEMBRANE WHICH MAY REMAIN EXPOSED.
11. SEAMS SHALL BE MADE BY LAPPING THE UPSLOPE MATERIAL OVER THE DOWNSLOPE MATERIAL WITH SUFFICIENT OVERLAP. A MINIMUM OF 1 m IS REQUIRED FROM THE TOE OF THE SLOPE TO ANY HORIZONTAL SEAM ON FLAT AREAS.
12. EXTREME CARE SHALL BE TAKEN BY THE CONTRACTOR IN THE PREPARATION OF THE AREAS TO BE WELDED. THE AREAS TO BE WELDED SHALL BE CLEANED AND PREPARED ACCORDING TO THE APPROVED PROCEDURES, AND ALL SHEETING SHALL BE WELDED TOGETHER BY THERMAL METHODS.
13. THE WELDING EQUIPMENT USED SHALL BE CAPABLE OF CONTINUOUSLY MONITORING AND CONTROLLING THE TEMPERATURES IN THE ZONE OF CONTACT WHERE THE MACHINE IS ACTUALLY FUSING THE GEOMEMBRANE MATERIAL, TO ENSURE CHANGES IN WEATHER CONDITIONS WILL NOT AFFECT THE INTEGRITY OF THE WELD.
14. NO "FISH MOUTHS" SHALL BE ALLOWED WITHIN THE SEAM AREA. WHERE "FISH MOUTHS" OCCUR, THE MATERIAL SHALL BE CUT, OVERLAPPED, AND EXTRUSION WELDED. ALL WELDS ON COMPLETION OF THE WORK SHALL BE TIGHTLY BONDED. ANY GEOMEMBRANE AREA SHOWING DISTRESS DUE TO EXCESSIVE SCUFFING OR PUNCTURE DURING INSTALLATION BE REPLACED OR REPAIRED AT THE CONTRACTOR'S EXPENSE.
15. THE CONTRACTOR SHALL TAKE INTO ACCOUNT THAT RAPID WEATHER CHANGES ARE VERY POSSIBLE, RESULTING IN DELAYS IN CONSTRUCTION OF FIELD SEAMS. JOINTING OF PANELS AND REPAIRS WILL ONLY BE PERMITTED UNDER WEATHER CONDITIONS ALLOWING SUCH WORK WITHIN THE WARRANTY LIMITS IMPOSED BY THE GEOMEMBRANE MANUFACTURER.

FIELD SEAM INSPECTION AND TESTING

1. A MAXIMUM EFFORT SHALL BE MADE TO INSTALL A PERFECT LINER SYSTEM. THIS MEANS THAT ALL SEAMS COMPLETED IN THE FIELD, PATCHES AND EXTRUSIONS SHALL BE INSPECTED, TESTED AND RECORDED.
2. A QUALITY CONTROL TECHNICIAN SHALL INSPECT EACH SEAM, MARKING HIS/HER INITIALS AND THE DATE INSPECTED AT THE END OF EACH PANEL. ANY AREA SHOWING A DEFECT SHALL BE MARKED AND REPAIRED IN ACCORDANCE WITH APPLICABLE GEOMEMBRANE REPAIR PROCEDURES.
3. ALL FIELD SAMPLING AND TESTING SHALL BE DONE BY THE CONTRACTOR AS APPROVED BY THE ENGINEER.
4. THE FIELD INSTALLATION TESTING PROGRAM SHALL CONSIST OF PERIODIC VISUAL OBSERVATIONS, CONTINUITY, AND STRENGTH TESTS. THESE INSPECTIONS AND TESTS ARE TO BE MADE ROUTINELY AND ARE REQUIRED REGARDLESS OF OTHER TYPES OF TESTING THAT MAY BE COMPLETED. THE INSTALLER SHALL PERFORM QUALITY CONTROL TESTING ACCORDING TO THE TYPES AND FREQUENCY INDICATED BELOW.
   - VISUAL OBSERVATIONS ARE TO BE MADE ROUTINELY AND SHALL INCLUDE THE FOLLOWING:
     - VISUALLY CHECK FIELD SEAMS FOR SQUEEZE OUT, FOOT PRINT, MELT AND OVERLAP
     - CHECK MACHINES FOR CLEANNESS, TEMPERATURE AND RELATED ITEMS.
     - ANY AREA OF THE SEAM OR PANEL SHOWING A DEFECT SHALL BE MARKED AND REPAIRED IN ACCORDANCE WITH THE APPLICABLE REPAIR PROCEDURES.
   - CONTINUITY TESTING IS REQUIRED FOR ALL FIELD SEAMS AND REPAIRED AREAS. INTER-SEAM PRESSURE OR "AIR TESTING" AND TESTING USING VACUUM BOX ARE CONSIDERED ACCEPTABLE METHODS FOR CONTINUITY TESTING. THE TEST PROCEDURE FOR INTER-SEAM PRESSURE OR AIR TESTING IS AS FOLLOWS:
     - SEAL BOTH ENDS OF THE SEAM TO BE TESTED BY APPLYING HEAT TO THE END OF THE SEAM UNTIL FLOW TEMPERATURE IS ACHIEVED. CLAMP OFF THE ENDS AND LET COOL.
     - INSERT A PRESSURE GAUGE/NEEDLE ASSEMBLY INTO THE END OF THE SEAM AND SEAL.
     - THE SEAM SHALL BE PRESSURIZED TO AN INITIAL START PRESSURE, MINIMUM 26 psi AND MAXIMUM 30 psi.
     - THE INITIAL START PRESSURE IS READ AFTER A 2-MINUTE RELAXING PERIOD, WHICH ALLOWS THE AIR TO REACH AMBIENT GEOMEMBRANE TEMPERATURE; THE ENDING PRESSURE IS READ AFTER 5 MINUTES.
     - THE ALLOWABLE PRESSURE DROP IS 3 psi LESS THAN THE INITIAL START PRESSURE.
     - THE RESULTS OF THE AIR TEST SHALL BE MARKED AT THE TEST LOCATION AND SHALL BE RECORDED BY THE CONTRACTOR. IF THE TEST FAILS, THE LOCATION OF THE LEAK SHALL BE FOUND AND REPAIRED AND RETESTED OR THE ENTIRE SEAM SHALL BE REPAIRED AND RETESTED.
   - THE TEST PROCEDURE FOR VACUUM BOX TESTING IS AS FOLLOWS:
     - MIX A SOLUTION OF LIQUID DETERGENT AND WATER AND APPLY AN AMPLE AMOUNT TO THE AREA TO BE TESTED. IF A SEAM CONTAINS EXCESS OVERLAP OR LOOSE EDGES IT IS TO BE TRIMMED BEFORE TESTING.
     - PLACE A TRANSLUCENT VACUUM BOX OVER THE AREA AND APPLY A SLIGHT AMOUNT OF DOWNWARD PRESSURE TO THE BOX TO THE SEAL TO THE GEOMEMBRANE.
     - APPLY A VACUUM (3 psi TO 5 psi) TO THE AREA. ANY LEAKS WILL BECOME VISIBLE BY LARGE BUBBLES AND SHALL BE REPAIRED.
5. STRENGTH TESTS ON SEAMS SHALL BE CARRIED OUT ON SAMPLE COUPONS CUT FROM THE INSTALLED GEOMEMBRANE IN ACCORDANCE WITH THE MANUFACTURER'S SPECIFICATIONS AND THE INTERNATIONAL ASSOCIATION OF GEOSYNTHETICS INSTALLERS "GUIDELINES FOR INSTALLATION OF FACTORY FABRICATED HEAVYWEIGHT > 0.64 mm (25 mil) THICKNESS FABRIC - SUPPORTED GEOMEMBRANES" (MARCH, 2014), APPLICABLE GEOSYNTHETICS RESEARCH INSTITUTE STANDARDS AND THE MANUFACTURER'S QUALITY CONTROL MANUAL.

AS-BUILT DOCUMENTATION

1. THE CONTRACTOR SHALL PROVIDE THE OWNER AND ENGINEER WITH COPIES OF ALL THE FABRICATION AND INSTALLATION TEST LOGS AND CONFORMANCE DATA INCLUDING:
   - GEOSYNTHETIC CERTIFICATION
   - DAILY PANEL PLACEMENT LOGS
   - AS-BUILT PANEL LAYOUT DRAWINGS
   - SEAM CONTROL LOGS
   - CONSTRUCTION REPAIR REPORT
2. IN ADDITION, THE CONTRACTOR SHALL SUBMIT AS-BUILT DRAWINGS SHOWING THE INSTALLED GEOMEMBRANE PANEL LAYOUT WITH EACH PANEL OR PORTION OF PANEL IDENTIFIED BY THE MANUFACTURER'S IDENTIFICATION NUMBER. THE EXTENT OF THE INSTALLED GEOSYNTHETICS AND LOCATIONS OF ALL TESTS SHALL BE IDENTIFIED ALONG WITH LOCATIONS OF ANY REPAIRS. THE AS-BUILT DRAWINGS SHALL BE MADE AVAILABLE ELECTRONICALLY TO THE OWNER AND ENGINEER IN A TIMELY FASHION AFTER THE WORK IS COMPLETE.

FILL MATERIALS:

MATERIAL PLACEMENT AND COMPACTION REQUIREMENTS

ZONE AND MATERIAL TYPE	PLACING AND COMPACTION REQUIREMENTS
ROAD EMBANKMENT FILL	MATERIAL SHALL BE WELL GRADED AND CONSIST OF HARD, DURABLE FRESH ROCKFILL FREE OF DELETERIOUS MATERIALS. ACCESS ROAD: MATERIAL TO BE PLACED BY TRUCK AND BULLDOZER STARTING AT THE EXISTING HAUL ROAD. COMPACTION TO BE ACHIEVED BY ROUTING HAULAGE TRAFFIC OVER THE ENTIRE SURFACE OF THE ROAD. SAFETY BERMS: MATERIAL TO BE PLACED AND NOMINALLY COMPACTED TO THE DIMENSIONS SHOWN ON THE DRAWINGS.
RIPRAP	RIPRAP SHALL BE WELL GRADED AND CLEAN, DURABLE AND ANGULAR IN SHAPE. FINE RIPRAP D_{50} = 75 mm; COARSE RIPRAP D_{50} = 200 mm. MATERIAL TO BE PLACED AND SPREAD IN MAXIMUM 150 mm LAYER (FINE RIPRAP) OR 400 mm LAYER (COARSE RIPRAP). PLACED TO FORM A TIGHTLY INTERLOCKING LAYER.
INTERMEDIATE BEDDING	MATERIAL SHALL CONSIST OF 32 mm MINIMUM CLEAN SAND AND GRAVEL FREE OF CLAY, LOAM, ORGANICS, AND OTHER DELETERIOUS MATERIAL. MATERIAL SHALL BE PLACED, SPREAD AND MOISTURE CONDITIONED IN MAXIMUM 200 mm LAYER AFTER COMPACTION FROM A MINIMUM OF 6 PASSES WITH A 10 TONNE SMOOTH DRUM ROLLER.
BERM FILL	MATERIAL SHALL CONSIST OF CLEAN, WELL GRADED, 150 mm MINUS PROCESSED ROCKFILL AND SHALL BE FREE OF CLAY, LOAM, ORGANICS, AND OTHER DELETERIOUS MATERIALS. SEDIMENTATION POND: PLACED AND SPREAD IN MAXIMUM 300 mm LAYERS AFTER COMPACTION. COMPACTION TO CONSIST OF MINIMUM 6 PASSES BY A 10 TONNE SMOOTH DRUM VIBRATORY ROLLER. DIVERSION BERMS: PLACED AND SPREAD IN MAXIMUM 200 mm LAYERS AFTER COMPACTION. NOMINAL COMPACTION.

NOTES:

1. THE DRAWING SHALL BE READ IN CONJUNCTION WITH THE ACCOMPANYING CONTRACT DOCUMENTS AND APPLICABLE TECHNICAL SPECIFICATIONS.
2. ROAD EMBANKMENT FILL TO BE USED FOR THE ACCESS ROAD AND SAFETY BERMS.
3. INTERMEDIATE BEDDING TO BE USED FOR ANCHOR TRENCH BACKFILL AND ANCHOR BERMS; BEDDING MATERIAL FOR GEOMEMBRANE, AND BEDDING AND BACKFILL FOR CULVERTS AND PIPES.
4. BERM FILL TO BE USED FOR THE SEDIMENTATION POND BERMS AND DIVERSION BERMS.
5. FILL MATERIALS USED FOR CONSTRUCTION SHALL NOT BE POTENTIALLY ACID GENERATING (PAG) OR METAL LEACHING (ML). THROUGHOUT CONSTRUCTION, ADEQUATE INSPECTION AND PERIODIC TESTING SHOULD BE CARRIED OUT TO DEMONSTRATE THE SUITABILITY OF THE FILL MATERIALS.
6. UNLESS OTHERWISE NOTED ALL MATERIALS SHALL CONSIST OF HARD, DURABLE FILL MATERIAL, FREE OF CLAY, LOAM, TREE STUMPS, ROOTS AND OTHER DELETERIOUS MATERIALS OR ORGANIC MATTER, AND CONTAIN NO MASSIVE ICE.

ISSUED FOR CONSTRUCTION

PERMIT TO PRACTICE
KNIGHT PIESOLD LTD.
Signature ________
Date Sept. 19/2018
PERMIT NUMBER: P 547
The Association of Professional Engineers, Geologists and Geophysicists of NWT/NU

REGISTERED PROFESSIONAL ENGINEER
K.E. HAWTON
LICENSEE
9/19/18
NWT/NU

Knight Piésold CONSULTING

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

KM107 STOCKPILE SPECIFICATIONS

P/A NO.	DRAWING NO.	REVISION
NB102-181/49	301	0

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	18SEP'18	ISSUED FOR CONSTRUCTION	DMMD	MMD / SIR		

REVISIONS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED

REVISIONS

DRG. NO.	DESCRIPTION

REFERENCE DRAWINGS

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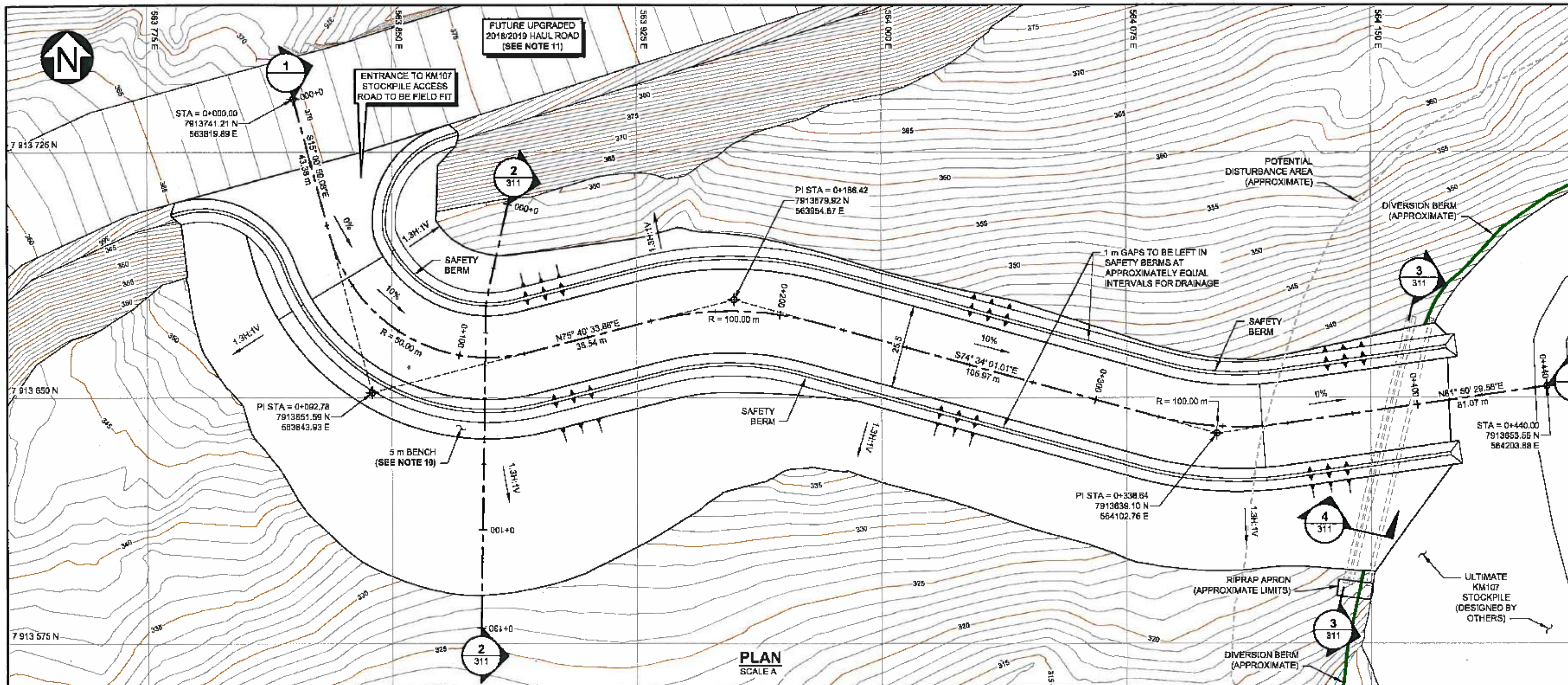
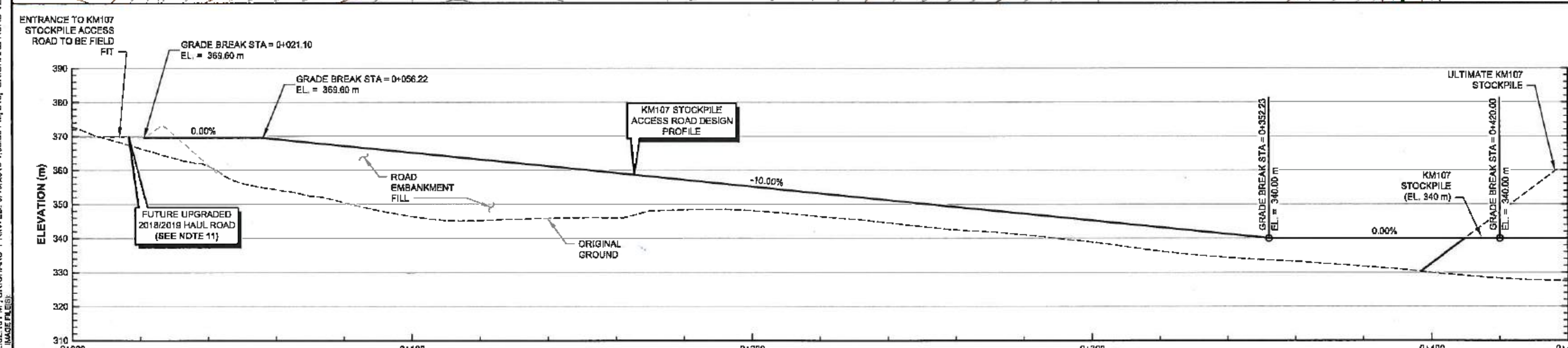


PLAN
SCALE A



1 SECTION
KM107 STOCKPILE ACCESS ROAD
SCALE A

LEGEND:

- CULVERT
- DIVERSION BERM
- ORIGINAL GROUND
- POTENTIAL DISTURBANCE AREA (APPROXIMATE)

NOTES:

1. COORDINATE GRID IS UTM (NAD83) ZONE 17.
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3. CONTOURS ARE IN METRES. CONTOUR INTERVAL IS 1 m.
4. DIMENSIONS AND ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE.
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8. FINAL SLOPES SHALL BE TRIMMED TO THE LINES AND TOLERANCES INDICATED ON THE DRAWINGS AND IN THE TECHNICAL SPECIFICATIONS.
9. LOCATIONS OF CONSTRUCTION ITEMS MAY BE MODIFIED TO SUIT SITE CONDITIONS.
10. FIVE METRE BENCH ON DOWNSTREAM SIDE OF THE ACCESS ROAD TO BE CONSTRUCTED BETWEEN CHAINAGES 0+035 TO 0+180.
11. FUTURE UPGRADED 2018/2019 HAUL ROAD PROVIDED BY BAFFINLAND AUGUST 2018.
12. ACCESS ROAD FILL SLOPES TO BE AT ANGLE OF REPOSE FOR ROAD EMBANKMENT FILL. 1.3H:1V HAS BEEN ASSUMED BASED ON MATERIAL PROPERTIES.

ISSUED FOR CONSTRUCTION

SCALE A 15 7.5 0 25 50 75 m

PERMIT TO PRACTICE
KNIGHT PIESOLD LTD.
Signature ______
Date Sept. 19 /2018
PERMIT NUMBER: P 547
The Association of Professional Engineers, Geologists and Geophysicists of NWT/NU

REGISTERED PROFESSIONAL ENGINEER
K.E. HAWTON
LICENSEE
9/19/18
NWT/NU

Knight Piésold CONSULTING

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

KM107 STOCKPILE ACCESS ROAD PLAN AND SECTION

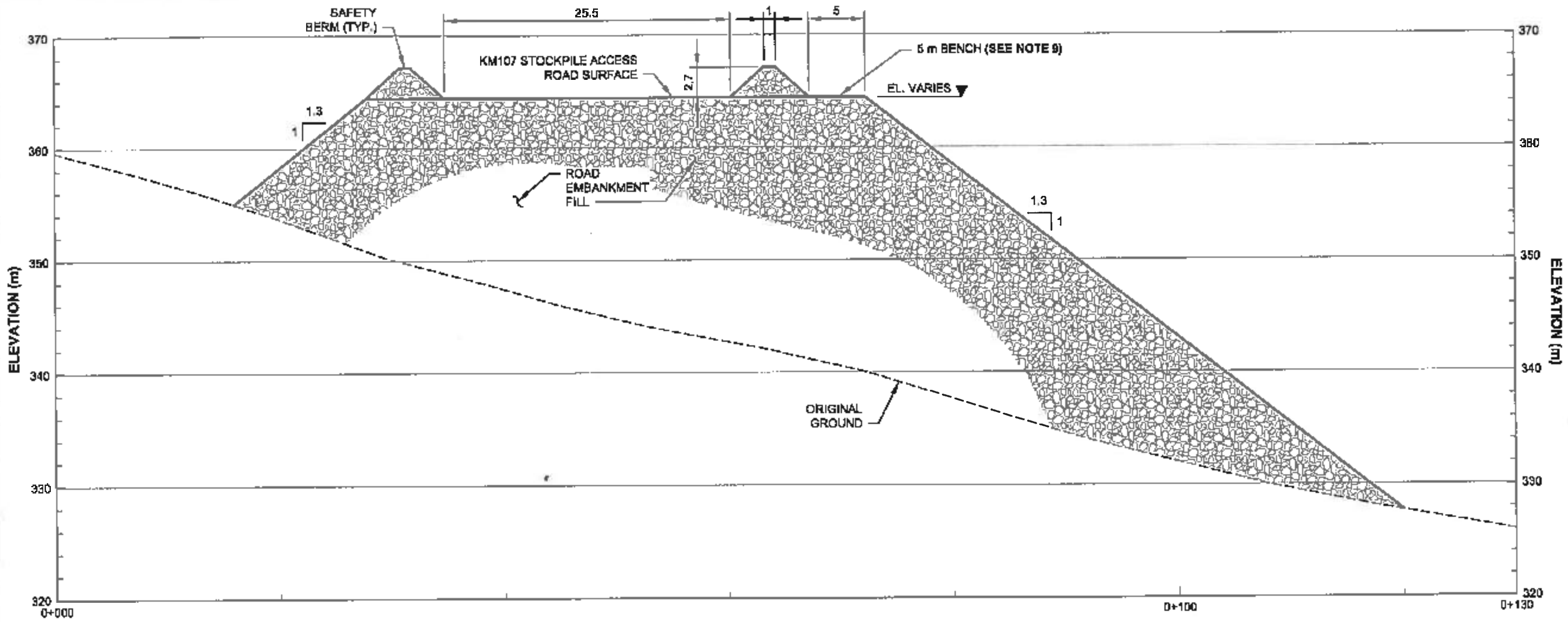
P/A NO.	DRAWING NO.	REVISION
NB102-181/49	310	0

REFERENCE DRAWINGS

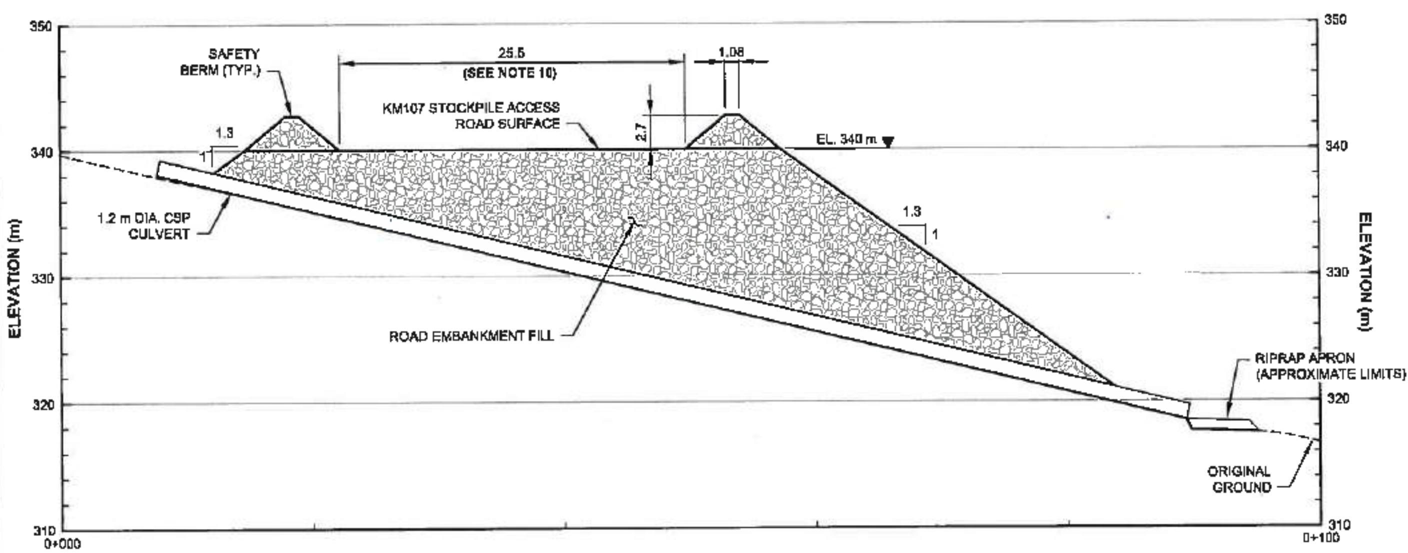
DRG. NO.	DESCRIPTION
311	KM107 STOCKPILE - ACCESS ROAD - SECTIONS

REVISIONS

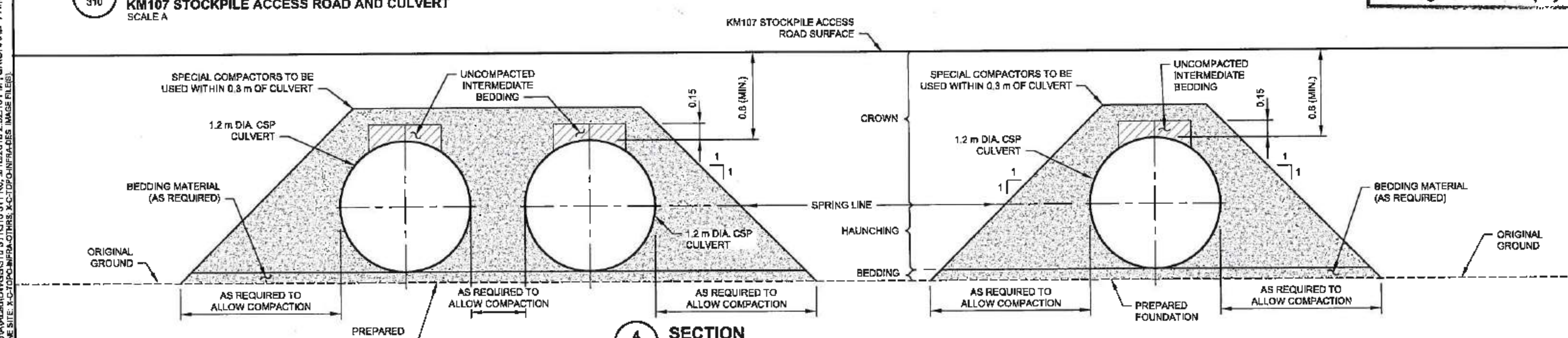
REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	18SEP'18	ISSUED FOR CONSTRUCTION	DMMD	MMD / SIR		



SECTION 2/310
KM107 STOCKPILE ACCESS ROAD
SCALE A



SECTION 3/310
KM107 STOCKPILE ACCESS ROAD AND CULVERT
SCALE A



SECTION 4/310
TYPICAL SECTION - KM107 STOCKPILE ACCESS ROAD CULVERTS
SCALE B

LEGEND:

- ROAD EMBANKMENT FILL
- UNCOMPACTED INTERMEDIATE BEDDING
- COMPACTED INTERMEDIATE BEDDING
- ORIGINAL GROUND

NOTES:

1. TOPOGRAPHY BASED ON INFORMATION PROVIDED BY EAGLE MAPPING (2006).
2. DIMENSIONS AND ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE.
3. ALL INFRASTRUCTURE SHOWN IS PROPOSED UNLESS NOTED OTHERWISE.
4. THE DRAWING SHALL BE READ IN CONJUNCTION WITH THE CONTRACT DOCUMENTS AND APPLICABLE TECHNICAL SPECIFICATIONS.
5. FOUNDATION PREPARATION: PROVIDED THE AMOUNT OF ORGANICS AND UNSUITABLE MATERIAL ON THE GROUND IS NEGLIGIBLE, DISTURBANCE TO THE ORIGINAL GROUND (EXCAVATION, SCARIFYING, ETC.) SHOULD BE MINIMIZED SO AS NOT TO IMPACT CURRENT PERMAFROST CONDITIONS. ALTERNATIVE METHODS OF FOUNDATION PREPARATION MAY BE NECESSARY FOR SOME AREAS, AT THE DISCRETION OF THE OWNER'S REPRESENTATIVE. ALL FOUNDATIONS MUST BE MAINTAINED CLEAR OF SNOW, PONDED WATER AND ICE.
6. FINAL SLOPES SHALL BE TRIMMED TO THE LINES AND TOLERANCES INDICATED ON THE DRAWINGS AND IN THE TECHNICAL SPECIFICATIONS.
7. LOCATIONS OF CONSTRUCTION ITEMS MAY BE MODIFIED TO SUIT SITE CONDITIONS.
8. FOR MATERIAL SPECIFICATIONS SEE DRG. NO. 301.
9. FIVE METRE BENCH ON DOWNSTREAM SIDE OF THE ACCESS ROAD TO BE CONSTRUCTED BETWEEN CHAINAGES 0+035 TO 0+180.
10. THE SECTION IS NOT PERPENDICULAR TO THE SLOPE.
11. ACCESS ROAD FILL SLOPES WILL BE AT ANGLE OF REPOSE FOR ROAD EMBANKMENT FILL. 1.3H:1V HAS BEEN ASSUMED BASED ON MATERIAL PROPERTIES.

PERMIT TO PRACTICE
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Signature [signature]
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ISSUED FOR CONSTRUCTION

SCALE A: 5 3 0 10 20 30 m
SCALE B: 0.5 0.25 0 0.5 1.0 1.5 2.0 2.5 m

REGISTERED PROFESSIONAL ENGINEER — K.E. HAWTON — LICENSEE — 9/19/18 — NWT/NU

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BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

KM107 STOCKPILE ACCESS ROAD SECTIONS

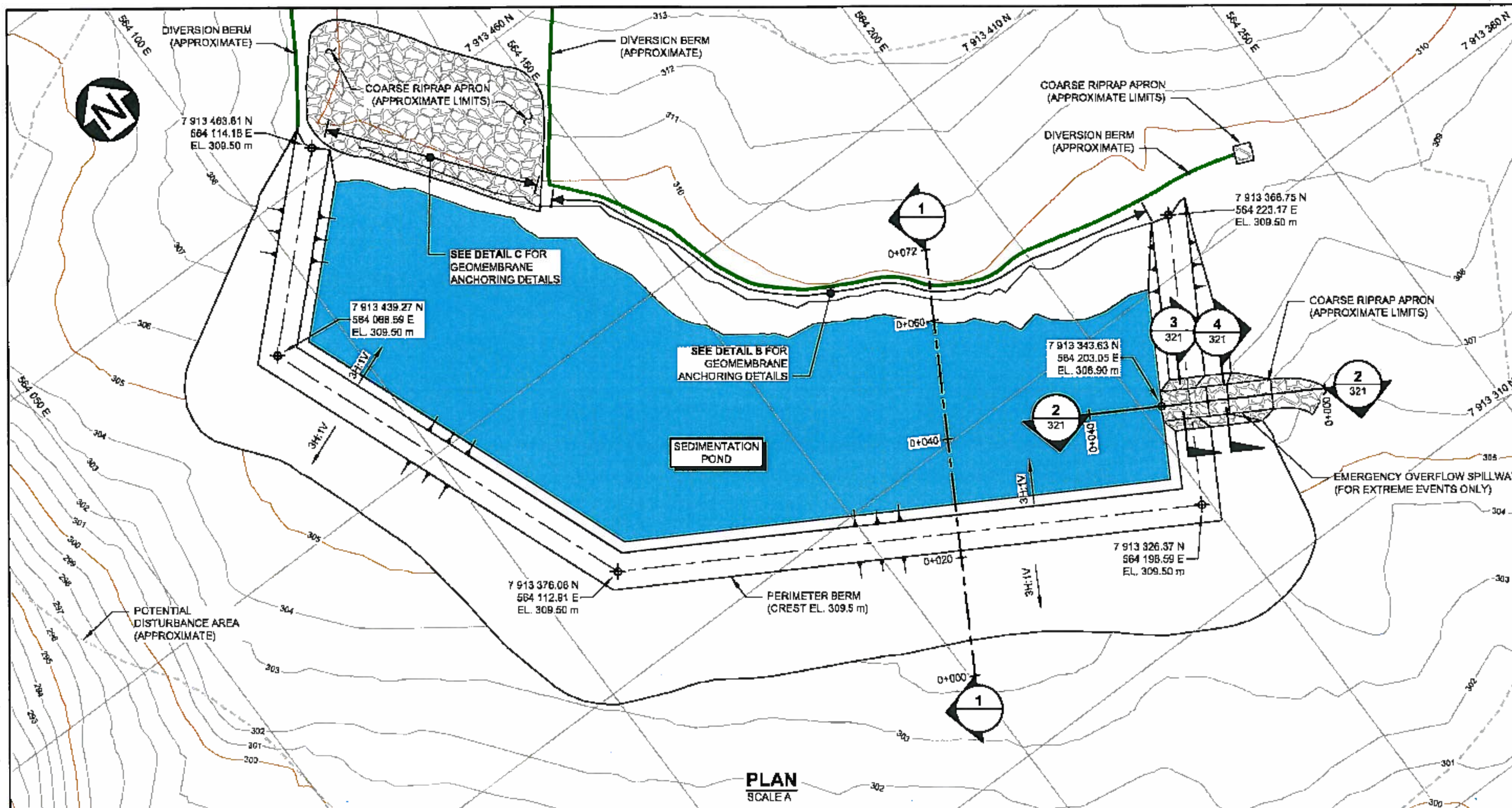
P/A NO.	DRAWING NO.	REVISION
NB102-181/49	311	0

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	18SEP'18	ISSUED FOR CONSTRUCTION	DMMD	MMD / SIR	[initials]	[initials]

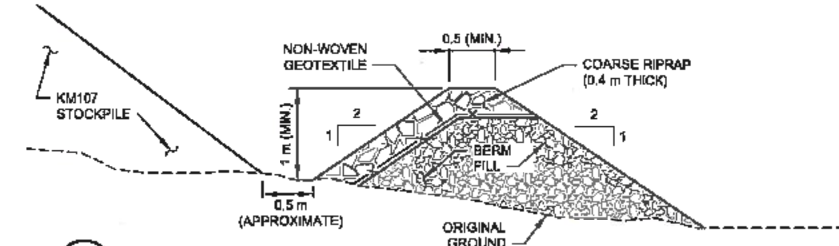
REVISIONS

DRG. NO.	DESCRIPTION
310	KM107 STOCKPILE - ACCESS ROAD - PLAN AND SECTION
301	KM107 STOCKPILE - SPECIFICATIONS

REFERENCE DRAWINGS



PLAN
SCALE A



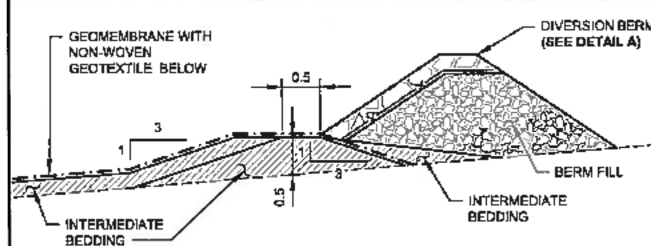
A DETAIL
TYPICAL DIVERSION BERM
NTS

LEGEND:

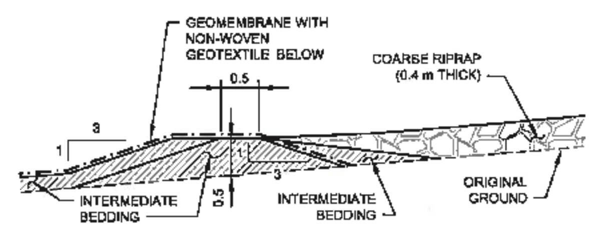
- WATER
- FINE RIPRAP
- COARSE RIPRAP
- BERM FILL
- INTERMEDIATE BEDDING
- GEOMEMBRANE WITH NON-WOVEN GEOTEXTILE ABOVE AND BELOW
- ORIGINAL GROUND
- DIVERSION BERM
- POTENTIAL DISTURBANCE AREA (APPROXIMATE)

NOTES:

1. COORDINATE GRID IS UTM (NAD83) ZONE 17.
2. TOPOGRAPHY BASED ON INFORMATION PROVIDED BY EAGLE MAPPING (2008).
3. CONTOURS ARE IN METRES. CONTOUR INTERVAL IS 1 m.
4. ALL INFRASTRUCTURE SHOWN IS PROPOSED UNLESS OTHERWISE NOTED.
5. DIMENSIONS AND ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE.
6. LOCATIONS OF CONSTRUCTION ITEMS MAY BE MODIFIED TO SUIT SITE CONDITIONS.
7. FOR MATERIAL AND GEOSYNTHETIC SPECIFICATIONS SEE DRG. NO. 301.
8. GEOMEMBRANE TO BE 40 mil ATARFIL LINEAR LOW DENSITY TEXTURED GEOMEMBRANE OR APPROVED EQUIVALENT AND TO BE INSTALLED AS PER THE MANUFACTURER'S SPECIFICATIONS.
9. NON-WOVEN GEOTEXTILE TO BE TEXEL 100P OR APPROVED EQUIVALENT WHEN PLACED ADJACENT TO GEOMEMBRANE. NON-WOVEN GEOTEXTILE TO BE 12 oz/yd^2 FOR ALL OTHER LOCATIONS. NON-WOVEN GEOTEXTILE TO BE INSTALLED AS PER THE MANUFACTURER'S SPECIFICATIONS.
10. ANCHOR TRENCH TO BE EXCAVATED TO THE APPROXIMATE LIMITS SHOWN (0.5 m x 0.5 m IN SECTION). FOLLOWING GEOTEXTILE AND GEOMEMBRANE INSTALLATION, TRENCH TO BE BACKFILLED WITH COMPACTED INTERMEDIATE BEDDING MATERIAL.
11. DOWNSTREAM SLOPE OF BERM TO BE TRIMMED AND NOMINALLY COMPACTED. UPSTREAM SLOPE OF BERM TO BE PREPARED FOR GEOSYNTHETICS INSTALLATION AS PER THE TECHNICAL SPECIFICATIONS.
12. EXCAVATION SLOPES ARE THE CONTRACTOR'S RESPONSIBILITY.
13. DIVERSION BERM TO BE GRADED AT 1% (MINIMUM) IN DIRECTION OF FLOW.
14. FOUNDATION PREPARATION: PROVIDED THE AMOUNT OF ORGANICS AND UNSUITABLE MATERIAL ON THE GROUND IS NEGLIGIBLE, DISTURBANCE TO THE ORIGINAL GROUND (EXCAVATION, SCARIFYING, ETC.) SHOULD BE MINIMIZED SO AS NOT TO IMPACT CURRENT PERMAFROST CONDITIONS. ALTERNATIVE METHODS OF FOUNDATION PREPARATION MAY BE NECESSARY FOR SOME AREAS, AT THE DISCRETION OF THE OWNER'S REPRESENTATIVE. ALL FOUNDATIONS MUST BE MAINTAINED CLEAR OF SNOW, PONDED WATER AND ICE.
15. THE DRAWING SHALL BE READ IN CONJUNCTION WITH THE CONTRACT DOCUMENTS AND APPLICABLE TECHNICAL SPECIFICATIONS.
16. FINAL SLOPES SHALL BE TRIMMED TO THE LINES AND TOLERANCES INDICATED ON THE DRAWINGS AND IN THE TECHNICAL SPECIFICATIONS.
17. RIPRAP TO BE CLEAN, DURABLE AND ANGULAR. RIPRAP TO BE TIGHTLY PLACED AND SPREAD IN MAXIMUM ROCK LAYERS.



B DETAIL
GEOMEMBRANE ANCHORING DETAIL
SCALE C



C DETAIL
GEOMEMBRANE ANCHORING DETAIL
SCALE C

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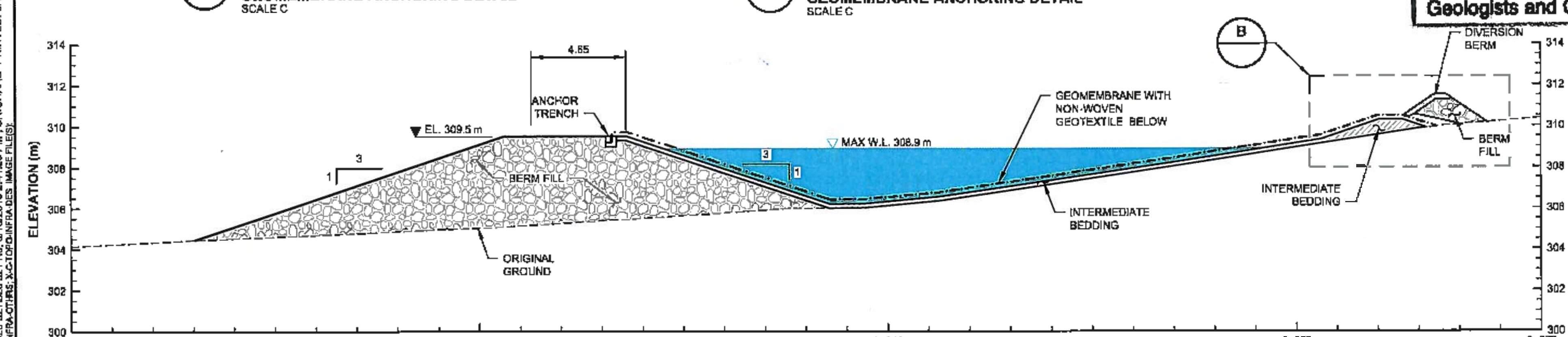


1 SECTION
SEDIMENTATION POND
SCALE B

ISSUED FOR CONSTRUCTION

SCALE A: 8 4 0 10 20 30 40 m
SCALE B: 3 1.5 0 5 10 15 m
SCALE C: 1 0.5 0 1 2 3 4 5 m

ORG. NO	DESCRIPTION
321	KM107 STOCKPILE - SEDIMENTATION POND AND RUNOFF MANAGEMENT MEASURES - SECTIONS AND DETAILS
301	KM107 STOCKPILE - SPECIFICATIONS

REFERENCE DRAWINGS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	18SEP'18	ISSUED FOR CONSTRUCTION	DMMD	MMD / SIR		

REVISIONS

Knight Piésold CONSULTING

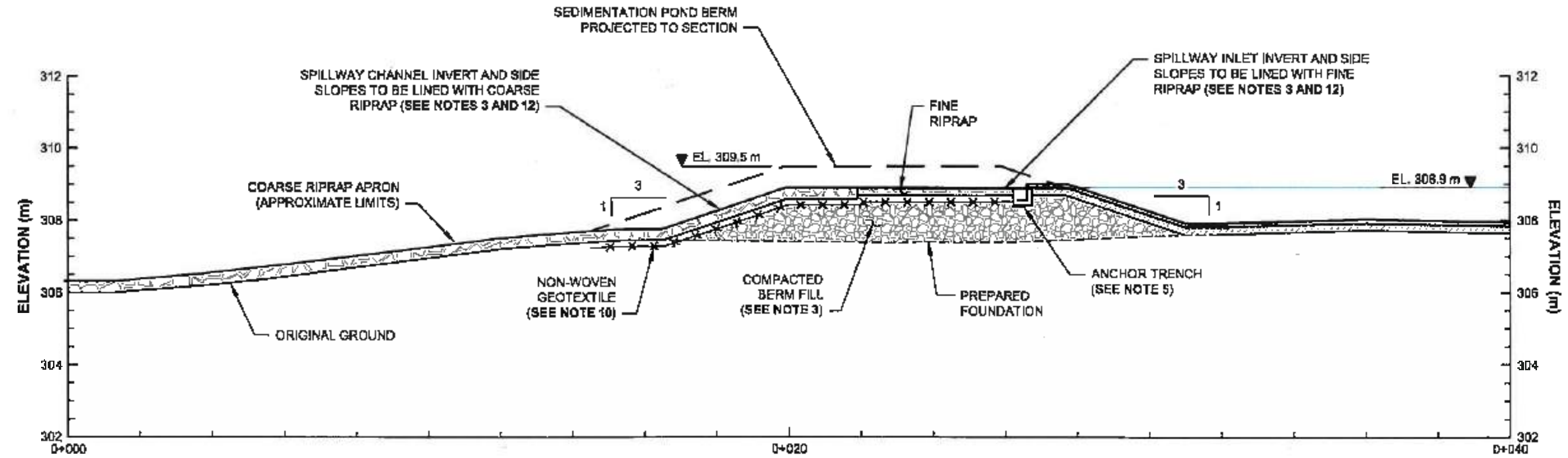
BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

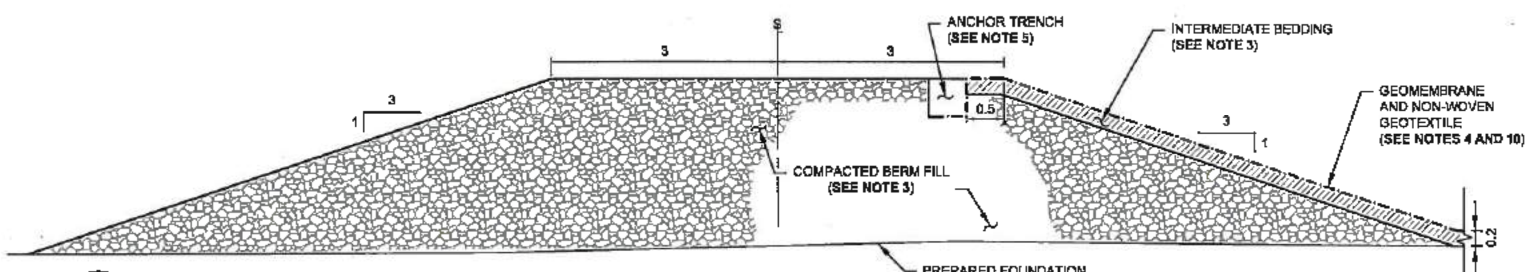
KM107 STOCKPILE
SEDIMENTATION POND AND RUNOFF MANAGEMENT MEASURES
PLAN, SECTION AND DETAILS

REGISTERED PROFESSIONAL ENGINEER
K.E. HAWTON
LICENSEE
9/19/18
NWT/NU

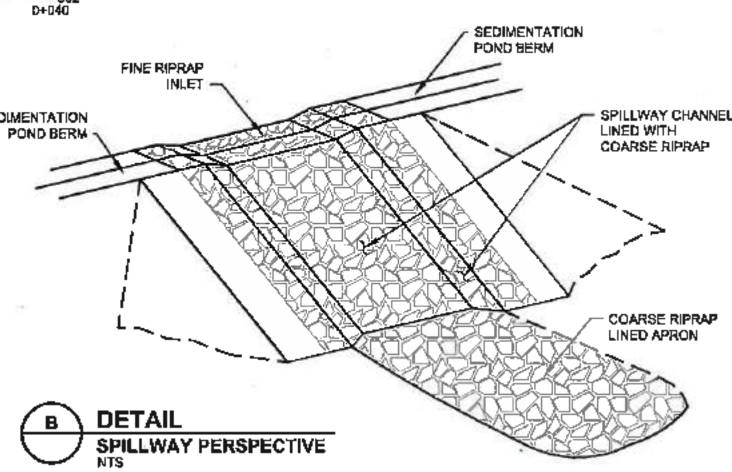
P/A NO.	DRAWING NO.	REVISION
NB102-181/49	320	0



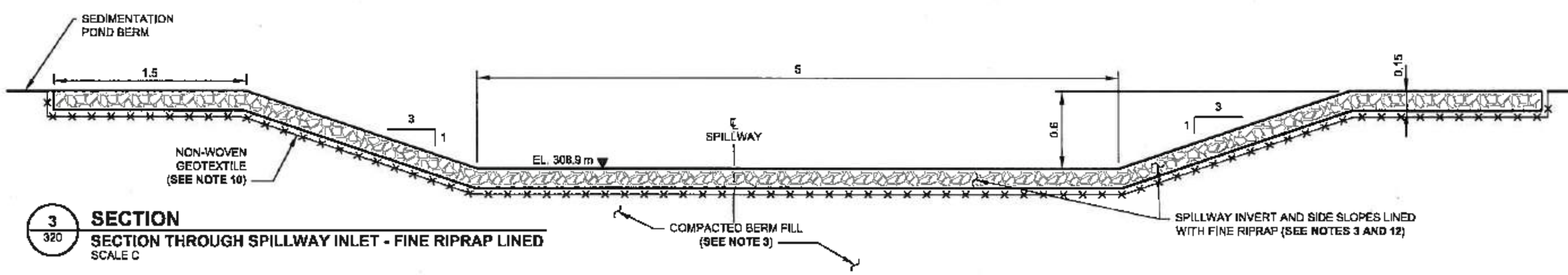
2 / 320 SECTION
SECTION THROUGH SPILLWAY
SCALE A



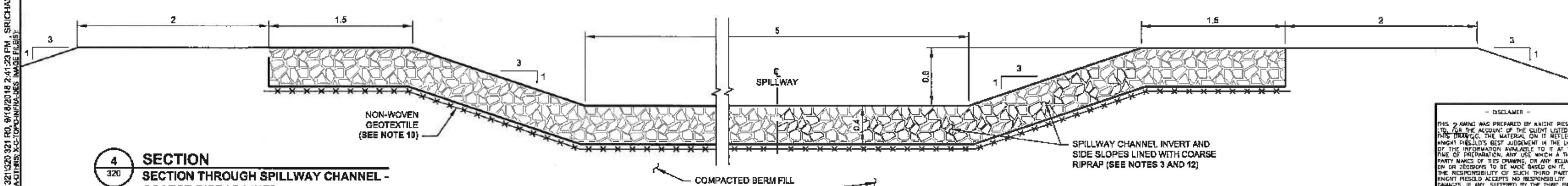
A DETAIL
TYPICAL PERIMETER BERM - GEOMEMBRANE INSTALLATION
SCALE B



B DETAIL
SPILLWAY PERSPECTIVE
NTS



3 / 320 SECTION
SECTION THROUGH SPILLWAY INLET - FINE RIPRAP LINED
SCALE C



4 / 320 SECTION
SECTION THROUGH SPILLWAY CHANNEL - COARSE RIPRAP LINED
SCALE C

LEGEND:

- BERM FILL
- FINE RIPRAP
- COARSE RIPRAP
- INTERMEDIATE BEDDING
- NON-WOVEN GEOTEXTILE
- GEOMEMBRANE WITH NON-WOVEN GEOTEXTILE ABOVE AND BELOW
- ORIGINAL GROUND
- PREPARED FOUNDATION

NOTES:

1. DIMENSIONS AND ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE.
2. LOCATION OF CONSTRUCTION ITEMS MAY BE MODIFIED TO SUIT SITE CONDITIONS.
3. FOR MATERIAL AND GEOSYNTHETIC SPECIFICATIONS SEE DRG. NO. 301.
4. GEOMEMBRANE TO BE 40 mil ATARFIL LINEAR LOW DENSITY TEXTURED GEOMEMBRANE OR APPROVED EQUIVALENT AND TO BE INSTALLED AS PER THE MANUFACTURER'S SPECIFICATIONS.
5. ANCHOR TRENCH TO BE EXCAVATED TO THE APPROXIMATE LIMITS SHOWN (0.5 m x 0.5 m IN SECTION). FOLLOWING GEOTEXTILE AND GEOMEMBRANE INSTALLATION, TRENCH TO BE BACKFILLED WITH COMPACTED INTERMEDIATE BEDDING MATERIAL.
6. DOWNSTREAM SLOPE OF BERM TO BE TRIMMED AND NOMINALLY COMPACTED. UPSTREAM SLOPE OF BERM TO BE PREPARED FOR GEOSYNTHETICS INSTALLATION AS PER THE TECHNICAL SPECIFICATIONS.
7. EXCAVATION SLOPES ARE THE CONTRACTOR'S RESPONSIBILITY.
8. FOUNDATION PREPARATION: PROVIDED THE AMOUNT OF ORGANICS AND UNSUITABLE MATERIAL ON THE GROUND IS NEGLIGIBLE, DISTURBANCE TO THE ORIGINAL GROUND (EXCAVATION, SCARIFYING, ETC.) SHOULD BE MINIMIZED SO AS NOT TO IMPACT CURRENT PERMAFROST CONDITIONS. ALTERNATIVE METHODS OF FOUNDATION PREPARATION MAY BE NECESSARY FOR SOME AREAS, AT THE DISCRETION OF THE OWNER'S REPRESENTATIVE. ALL FOUNDATIONS MUST BE MAINTAINED CLEAR OF SNOW, PONDED WATER AND ICE.
9. THE DRAWING SHALL BE READ IN CONJUNCTION WITH THE CONTRACT DOCUMENTS AND APPLICABLE TECHNICAL SPECIFICATIONS.
10. NON-WOVEN GEOTEXTILE TO BE TEXEL 100P OR APPROVED EQUIVALENT WHEN PLACED ADJACENT TO GEOMEMBRANE. NON-WOVEN GEOTEXTILE TO BE 12 oz/yd^2 FOR OTHER LOCATIONS. NON-WOVEN GEOTEXTILE TO BE INSTALLED AS PER MANUFACTURER'S SPECIFICATIONS.
11. FINAL SLOPES SHALL BE TRIMMED TO THE LINES AND TOLERANCES INDICATED ON THE DRAWINGS AND IN THE TECHNICAL SPECIFICATIONS.
12. RIPRAP TO BE CLEAN, DURABLE AND ANGULAR. RIPRAP TO BE TIGHTLY PLACED AND SPREAD IN MAXIMUM LAYERS, AS NOTED ON DRG. NO. 301.

PERMIT TO PRACTICE
KNIGHT PIESOLD LTD.
Signature ____
Date Sept. 19/2018
PERMIT NUMBER: P 547
The Association of Professional Engineers, Geologists and Geophysicists of NWT/NU

ISSUED FOR CONSTRUCTION

SCALE A: 2 1 0 2 4 6 8 10 m
SCALE B: 1 0.5 0 1 2 3 4 5 m
SCALE C: 0.5 0.25 0 0.5 1.0 1.5 2.0 2.5 m

REGISTERED PROFESSIONAL ENGINEER — K.E. HAWTON — LICENSEE — 9/19/18 — NWT/NU

Knight Piésold CONSULTING

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

KM107 STOCKPILE SEDIMENTATION POND AND RUNOFF MANAGEMENT MEASURES SECTIONS AND DETAILS

DRG. NO.	DESCRIPTION
320	KM107 STOCKPILE - SEDIMENTATION POND AND RUNOFF MANAGEMENT MEASURES - PLAN, SECTION AND DETAILS
301	KM107 STOCKPILE - SPECIFICATIONS

REFERENCE DRAWINGS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	19SEP'18	ISSUED FOR CONSTRUCTION	DMMD	MMD / SIR		

REVISIONS

P/A NO.	DRAWING NO.	REVISION
NB102-181/49	321	0

Attachment No. 2

Design Brief

Knight Piésold CONSULTING

September 18, 2018

Knight Piésold Ltd.
1650 Main Street West
North Bay, Ontario
Canada, P1B 8G5
T +1 705 476 2165
E northbay@knightpiesold.com
www.knightpiesold.com

Mr. Matt Brown
Mine Engineer
Baffinland Iron Mines Corporation
#300 - 2275 Upper Middle Road East
Oakville, Ontario
Canada, L6H 0C3

Dear Matt,

Re: KM107 Stockpile Access Road and Runoff Management Designs

1.0 INTRODUCTION

Baffinland Iron Mines Corporation (Baffinland) owns and operates the Mary River Project located on northern Baffin Island, Nunavut. As part of Baffinland's mining strategy, a long-term stockpile is required to stockpile run-of-mine material. Knight Piésold Ltd. (KP) has been retained to complete the design for the KM107 Stockpile Access Road (Access Road) and runoff management measures, including the Sedimentation Pond. This letter provides the detailed design for these structures.

2.0 SITE CONDITIONS, DESIGN CRITERIA AND MATERIALS

2.1 GENERAL

The design of the Access Road, Sedimentation Pond and runoff management measures, have been developed by KP based on the proposed KM107 Stockpile layout, preliminary Access Road layout and proposed Sedimentation Pond location as provided by Baffinland (dated June 27 and September 5, 2018). The KM107 Stockpile area is shown in plan view on Drawing 300. Additional details are provided on other drawings and in the sections below.

2.2 SITE CONDITIONS

KP has not visited the KM107 Stockpile area and as such is relying on Baffinland's input for site conditions. Baffinland has provided the following information relative to the site conditions:

- Topographical contours for the areas immediately adjacent to the KM107 Stockpile
- Design contours for the expanded Mine Haul Road (planned for next year)
- Stability Analysis for the Mine Haul Road (Golder, 2018a)
- Mine Haul Road Flow Mapping Imagery
- Crusher Pad Sedimentation Pond Expansion Detailed Design Brief (Golder, 2017)
- Waste Rock Facility (WRF) Pond Expansions Drainage System (Golder, 2018b)
- Mine Haul Road Drainage Improvement Project Detailed Design Report (Golder, 2016)

2.3 DESIGN CRITERIA

The project design criteria have been developed, and generally confirmed by Baffinland, based on discussions with Baffinland, the project RFP (Caserta, 2018), the Mary River Project Civil

Design Philosophy and Criteria (Hatch, 2013 and 2018), the Crusher Pad Sedimentation Pond expansion design (Golder Associates (Golder), 2017) and applicable guidelines and legislation including the following:

- The Mary River Project Water License (NWB, 2014)
- The Nunavut Mine Safety and Health Act (MSHA, 2011)
- The Nunavut Waters and Surface Rights Tribunal Act and Nunavut Waters Regulations (NWNSRTA, 2018)
- The Metal and Diamond Mining Effluent Regulations (MDMER, 2018)
- The *Fisheries Act* (2016)

The design criteria are summarized in Table 1.

2.4 MATERIALS

Baffinland has indicated that the materials used (or proposed to be used) to construct other structures at site, including the Haul Road (Golder, 2018a), Waste Rock Dump Sedimentation Pond (Golder, 2018b) and the Crusher Pad Sedimentation Pond (Golder, 2017) will be available for construction of the Access Road and runoff management measures, including the Sedimentation Pond. In general, all fill materials shall meet the following requirements:

- Fill materials used for construction shall not be potentially acid generating (PAG) or metal leaching (ML). Throughout construction, daily inspection should be carried out to verify the suitability of the fill materials.
- All materials shall consist of hard, durable fill material, free of clay, loam, tree stumps, roots and other deleterious materials or organic matter, and shell contain no ice

The material specifications are described as follows:

- Road Embankment Fill
  - To be used for the Access Road and safety berms
  - Material shall be well graded and shall consist of hard, durable, fresh rockfill
  - Access Road fill to be placed by truck and bulldozer starting at the existing Haul Road. Compaction to be achieved by routing haulage traffic over the entire surface of the road.
  - Safety berm fill to be placed and nominally compacted to the dimensions shown on the Drawings
- Berm Fill
  - To be used for the Sedimentation Pond berms and Diversion Berms
  - Material shall consist of clean, well graded, 150 mm minus processed rockfill
  - Sedimentation Pond berm fill to be placed and spread in maximum 300 mm thick layers after compaction. Compaction to consist of a minimum of 6 passes of a 10 tonne smooth drum vibratory roller.
  - Diversion Berms fill to be placed and spread in maximum 200 mm layers after compaction. Compaction to be nominal.
- Intermediate Bedding
  - To be used for anchor trench backfill, anchor berms, bedding material for geomembrane, and bedding and backfill for culverts
  - Material shall consist of 32 mm minus clean sand and gravel
  - Material to be placed, spread and moisture conditioned in maximum 200 mm layer after compaction from a minimum of 6 passes with a 10 tonne smooth drum vibratory roller

- Fine and Coarse Riprap
  - To be used for Sedimentation Pond spillway inlet and channel, and riprap aprons
  - Material shall consist of well graded, clean, durable and angular rockfill with a maximum particle size gradation not to exceed one and a half times the specified D50 value and minimal fines content
  - Fine Riprap to have a D50 of 75 mm
  - Coarse Riprap to have a D50 of 200 mm
  - Material to be placed and spread in maximum 150 mm layer (Fine Riprap) or 400 mm layer (Coarse Riprap), and placed to form a tightly interlocking layer

All materials shall be produced and sourced from an approved construction material source as required under Water License No. 2AM-MRY1325-Ammendment No. 1.

3.0 ACCESS ROAD DESIGN

3.1 GENERAL

The general layout for the Access Road is shown on Drawing 310. The Access Road will provide vehicular access from the Haul Road to the new KM107 Stockpile.

3.2 GEOMETRY

The Access Road has been designed to provide two-way access for a Caterpillar 793 haul truck (design vehicle) (CAT, 2013). The road cross section is shown on Drawing 311. The following design constraints have been incorporated in the road design:

- Road Width: The road surface is 25.5 m wide, equal to three times the width of the CAT 793 design vehicle (8.5 m) (Nunavut Mine Health and Safety Act (MHSA), 2011)
- Grade: The maximum grade is 10%
- Radius: The minimum radius for horizontal curves is 50 m

The entrance to the Access Road includes an approximately 40 m long section at 0% grade. This has been included in the design to provide a transition between the existing Haul Road and the -10% grade of the Access Road. The connection to the existing Haul Road will be field fit at the time of construction.

Vehicle safety berms are included on each side of the road. The geometry of the safety berms has been designed to meet the minimum requirements set by the MHSA (2011) and the project design criteria, and are described as follows:

- Height: 2.7 m
- Side Slopes: 1H:1V
- Crest Width: 1 m

The design criteria used for the Access Road are included in Table 1.

3.3 ROAD EMBANKMENT

The road embankment is planned to be constructed using Road Embankment Fill. The initial rockfill will be placed by dumping and pushing the material from the existing haul road. Subsequent rockfill will be dumped and pushed from the final design grade of the Access Road. Due to the required fill placement method, the side slopes will be developed at the angle of repose for the rockfill (approximately 37 degrees). As a result of the steep, high side slopes, the safety berms have been offset from the edge of the road to ensure that

the trafficable portion of the Access Road meets the minimum stability requirements. The stability assessment is discussed in Section 5.0. The minimum required offset from the outside edge of the safety berm ranges from 0 m for embankment heights up to 19 m high, to 5 m for the maximum embankment height. The safety berm offset is shown on Drawing 310. The final top surface of the Road Embankment Fill will be capped with aggregates to build a smooth running surface.

3.4 CULVERTS

Two culvert crossings (three culverts total) will be required through the eastern end of the Access Road embankment to convey the following:

- Diverted runoff, consisting of runoff from the area upstream of the Access Road to the natural environment (two culverts), including runoff from Culvert Crossing CV5 through the main Mine Haul Road
- Collected runoff from the western portion of the stockpile to the downstream Sedimentation Pond (one culvert)

The estimated catchment area reporting to each culvert crossing is approximately 133,000 m^2 and 25,000 m^2, respectively. Neither culvert crossing is assumed to be fish habitat.

The number of 1,200 mm diameter CSP culverts was determined for each culvert crossing based on the estimated peak flows. The peak flow for the diverted runoff is estimated as the sum of the flow for crossing CV5 (estimated by KP based on Golder, 2016) plus the peak flow determined by KP for the area between the Mine Haul Road, and the Access Road and stockpile resulting from the 1 in 200 year storm event. The peak flow for the collected runoff culvert was determined by KP based on the area of the western portion of the stockpile and the 1 in 200 year storm event.

Peak flows determined by KP for the culverts were obtained from flood routing models developed using the hydraulic profiling program HydroCAD® (2015). The peak flows were estimated according to the United States Soil Conservation Service (US SCS) rainfall-runoff modelling technique and applying a US SCS Type I distribution to the rainfall depth. Inputs into HydroCAD® (2015) included the rainfall depth, catchment areas, and SCS runoff curve number and basin response time (time of concentration) for each of the catchment areas.

The hydraulic capacity of individual culverts was determined by water flowing under inlet control with a ratio of the maximum upstream water level (above the invert of the culvert) to culvert diameter of approximately 1.4 (H/D = 1.4). That is for a culvert diameter equal to 1.2 m, and the upstream water level set at 1.7 m above the bottom of the culvert at peak flow. For an entrance projecting from fill condition, the entrance loss coefficient (Ke) was assigned a value of 1.0, the coefficient of discharge (C) a value of 0.546, and the loss coefficient (a) a value of 0.60.

It should be noted that any ice and snow accumulation in the culverts will need to be managed by “steaming” the culverts in accordance with current Baffinland practices to ensure the culverts are open to their full capacity prior to freshet. Culvert crossing locations and details are provided on Drawings 300, 310 and 311.

4.0 SEDIMENTATION POND DESIGN

4.1 GENERAL

The general layout for the Sedimentation Pond is shown on Drawings 300 and 320. The Sedimentation Pond will provide sediment control for runoff originating from the following catchment areas:

- The KM107 Stockpile area
- The pond itself
- The small area between the stockpile and the pond (where it can not be easily diverted around the pond)

This runoff will flow directly to the pond by gravity or be conveyed to the pond by perimeter Diversion Berms and a culvert under the Access Road. Runoff from upstream catchment areas, illustrated on Figure 1, will be diverted around the KM107 Stockpile and Sedimentation Pond.

4.2 PERIMETER BERM GEOMETRY AND LAYOUT

The Sedimentation Pond will be constructed as a perimeter berm along the northwest, southwest and southeast sides of the basin, while the northeast side of the pond will be delineated by the existing ground slope (see Drawing 320).

The perimeter berm will be constructed using compacted Berm Fill. The geometry of the perimeter berm is summarized as follows:

- Upstream Slope: 3H:1V
- Downstream Slope: 3H:1V
- Crest Width: 6 m

The basin of the pond and upstream slopes of the perimeter berm will be lined. The geomembrane liner will extend up the interior (upstream) slope of the perimeter berm (where present) and will be anchored at the crest, as indicated on the Drawings. Where there is no perimeter berm, a mound of Intermediate Bedding will be placed along the edge of the pond at approximate elevation 309.5 m and the geomembrane placed over the fill. Additional Intermediate Bedding will be placed over the edge of the geomembrane to anchor it in place. Coarse Riprap will then be placed over the Intermediate Bedding to minimize erosion where runoff from the stockpile area reports to the pond.

Where a Diversion Berm is present, the Diversion Berm will be constructed on top of the Intermediate Bedding as shown on the Drawings.

4.3 DAM CLASSIFICATION

The Sedimentation Pond is classified as a LOW consequence structure (CDA, 2007) based on the following criteria:

- There is no downstream population at risk
- There is no potential for loss of life
- The potential environmental losses are considered to be short term, and include erosion and sedimentation of downstream waterways (i.e. the Mary River)

- The potential economic losses are considered to be limited. There is no mine site infrastructure downstream of the Sedimentation Pond. Economic loses are likely to be limited to repairs of the affected structure.

The CDA recommends that LOW consequence dams be designed based an annual exceedance frequency of 1 in 100 years for flood and earthquake hazards.

The 1 in 200 year design storm event has been adopted for the design of the water management measures, including the Sedimentation Pond, based on the project design criteria (Hatch, 2013).

The peak ground acceleration for the 1 in 100 year earthquake event is 0.019g (NRC, 2015). The PGA is specified for Site Class C (NRCC, 2010) corresponding to firm ground with an average shear wave velocity of 450 m/s in the upper 30 m.

4.4 STORAGE CAPACITY

The Sedimentation Pond sizing has been developed for the following (from bottom to top):

- Temporary sediment storage up to a depth of approximately 0.5 m
- An operating water pond approximately 3,500 m^3 in volume to temporarily store runoff collected from the contributing catchment areas (see section 4.1) resulting from the 1 in 10 year, 24-hour rainfall event. This runoff volume was estimated by multiplying the total contributing catchment area by the rainfall depth by the relevant runoff coefficient of 0.9 for all contributing areas except the pond itself which has a runoff coefficient of 1.0.
- A flow depth of 0.3 m through the emergency overflow spillway which has been sized to safely convey the runoff resulting from the 1 in 200 year, 24-hour rainfall event
- A freeboard depth of 0.3 m

The Sedimentation Pond configuration has been developed assuming that the pond is empty when the 10 year rainfall event occurs.

The Sedimentation Pond has been designed to allow for some settling of total suspended solids (TSS) prior to the runoff being removed from the pond. The pond is sized to temporarily contain runoff resulting from the 1 in 10 year, 24-hour rainfall event, and has a L:W ratio of approximately 5:1 which aids in settling of suspended solids by reducing the potential for short-circuiting (British Columbia Ministry of Environment (BCMOE), 2015).

Design of the water transfer system needed to remove the collected runoff from the pond (below the spillway invert) is being completed by others. During operations, Baffinland will be responsible for ensuring that the discharge of collected runoff, to be sent to the Mary River, will be conducted in a controlled manner. Monitoring of discharge water quality, with respect to TSS must be conducted on a regular basis to ensure that water quality meets discharge requirements. If necessary, settling aids may be used to assist in the settling of solids prior to removal of water from the pond.

4.5 LINER

It is understood that Baffinland has contracted Western Tank and Lining Ltd. (Western) to supply and install the geomembrane liner and non-woven geotextile for the pond. Western is able to factory weld large panels, thereby limiting the number of field seams that are required during the winter months. Western has recommended a 40 mil Atarfil Liner Low Density (LLD) liner, to be manufactured and shipped with a 10 oz/yd^2 non-woven geotextile attached to the liner. The technical specifications for the LLD liner and the

non-woven geotextile are provided in Appendix A. KP understands that Western has recent experience installing the Atarfil LLD liner in cold conditions, as cold as -36 °C, and that the liner has cold crack resistance to -40 °C (C. Powell, Western Tank and Lining Ltd, personal communication, August 13, 2018). As such, the recommendations provided by Western are judged to be suitable for the Sedimentation Pond.

KP understands that the LLD liner and non-woven geotextile will be manufactured and shipped in intimate contact to support winter installation. Further, additional, heavier non-woven geotextiles are available on site and will be used, as necessary, to provide additional liner protection in problematic areas (M. Brown, Baffinland, personal communication, August 20, 2018).

A 0.2 m thick layer of Intermediate Bedding will be placed along the upstream slopes of the perimeter berm and over the basin to act as a bedding layer for the geomembrane liner. It will be necessary to closely monitor the geomembrane liner for leaks and holes, and to complete any necessary repairs promptly.

It is recommended that all geomembrane liners and non-woven geotextile be stored indoors at temperatures above 0 °C prior to installation in order to maintain workability. The geosynthetics specifications are provided on Drawing 301.

The design provided herein assumes that the upper surface of the geomembrane liner is exposed, consistent with our understanding of other sedimentation ponds on site. When a liner is left exposed, there is potential for degradation of the liner due to UV exposure and physical damage from ice in the pond or falling rock from the adjacent KM107 Stockpile. As such, the pond should only be drained below the spillway invert when there is no ice present.

4.6 SPILLWAY DESIGN

The Sedimentation Pond's emergency overflow spillway was sized to safely convey the peak flow resulting from the 1 in 200 year, 24-hour rainfall event following the project design criteria (Hatch, 2013). Similar to the peak flows for the culverts, the peak flow resulting from this event was estimated by applying an SCS Type I distribution to the design rainfall depth of 72 mm in HydroCAD® (2015).

The peak runoff flow was estimated as 0.74 m^3/s. In order to pass this flow, the spillway will need to have a minimum base width of 5 m and an inlet depth of 0.3 m.

The spillway will consist of a trapezoidal shaped inlet and channel to be constructed on the perimeter berm, at the location shown on Drawing 320. The spillway inlet will be lined with Fine Riprap, while the channel on the downstream slope of the perimeter berm will be lined with Coarse Riprap. Details are provided on Drawings 320 and 321. A riprap apron will be installed at the base of the spillway channel to dissipate energy as the runoff leaves the spillway. The peak flow estimated from HydroCAD® (2015) was used, with the Sedimentation Pond spillway section details developed in the flood routing model, to estimate the median particle size (D_{50}) of the riprap lining required to resist berm erosion and scour (Smith and Kells, 1995).

4.7 DIVERSION BERMS

In order to direct runoff originating within the KM107 Stockpile area to the Sedimentation Pond, a series of berms will be constructed around the perimeter of the stockpile. Additional berms will be constructed between the Sedimentation Pond and undisturbed upstream areas in order to divert runoff from those areas around the pond and to the environment. Construction of each berm will result in the formation of a channel between the berm and the stockpile, or the berm and the natural ground slope. Where existing ground

conditions permit, natural overburden material may be excavated to form part of the channel and any suitable excavated material used to form the berm.

The Diversion Berms were sized by treating the space between the berm's upstream slope and the stockpile slope (or the natural ground) as the two sides of a trapezoidal channel, with a base width of approximately 0.5 m. A freeboard depth of 0.3 m was included in the berm sizing to account for minor variations in the berm cross section and grade following construction.

The peak flows estimated from HydroCAD® (2015) were used in the flood routing model, with the typical Diversion Berm section details, to estimate the median particle size (D_{50}) of the riprap lining required to resist berm erosion and scour (Smith and Kells, 1995).

5.0 STABILITY

5.1 GENERAL

Limit equilibrium stability modelling was completed to evaluate the stability of the Access Road embankment and Sedimentation Pond berm under the expected loading and foundation conditions. Stability analyses were completed using SLOPE/W©, a two-dimensional Limit-Equilibrium slope stability program (Geo-Slope, 2018). The stability models incorporated the proposed embankment/berm configurations and the estimated strength of the foundation and fill materials. Three representative cross sections, shown on Figure 2, were evaluated based on the embankment/berm height and foundation conditions.

The following sections describe the loading conditions, materials and results of the stability analyses.

5.2 LOADING CONDITIONS AND TARGET FACTORS OF SAFETY

The stability models evaluated the following loading conditions:

- **Long Term, Static Loading**
  - *Access Road* - The stability models for the Access Road incorporated a fully loaded and stationary CAT 793 truck parked 1 m from the inside edge of the safety berm. The rear axle of the CAT 793 truck was modelled as a surcharge load 9 m wide and 1 m deep with an effective pressure of 265 kN/m^3.
  - *Sedimentation Pond* - The upstream slopes were evaluated with the water level at El. 307.0 m, corresponding to dead storage only. The downstream slopes were evaluated with the water level at El. 308.9 m corresponding to the maximum filling elevation.
- **Pseudo-Static Loading -** A horizontal seismic coefficient equal to the full PGA of 0.019g corresponding to the 1 in 100 year event was applied for the pseudo-static loading condition. Using this method, a FoS greater than 1.0 indicates that the slope is not sensitive to seismic loading. The water levels and surcharge loads applied to the long term, static loading analyses were adopted for the pseudo-static loading analyses.
- **Post-Earthquake Loading -** The fill and foundation materials are not expected to experience significant strength reduction following an earthquake event. As such, post-earthquake loading conditions were not evaluated and are considered to be identical to the long term, static loading conditions.

The Access Road will be constructed on a steep natural slope using material that is end dumped in thick lifts with minimal compaction. This method of fill placement will produce slopes that are at the angle of repose for the material and have a corresponding Factor of Safety (FoS) of 1.0. The slopes are expected to deform over time, and may exhibit surface sloughing and cracking. Winter construction will encourage aggregation of the permafrost into the Access Road and improve the overall stability, provided snow and ice is not encapsulated in the fill.

The stability analysis evaluated the trafficable road surface defined by the inside of the safety berms. The minimum FoS developed for the analysis are summarized in Table 2.

Table 2 Target Minimum FoS for the Access Road

Loading Condition	FoS
Long-Term, Static Loading	1.2
Pseudo-Static	1.0

The Sedimentation Pond is classified as a dam following the Canadian Dam Association Dam Safety Guidelines (CDA, 2007 and 2013). The recommended minimum FoS for embankment dams following the CDA Guidelines are summarized in Table 3:

Table 3 Recommended Minimum FoS for the Sedimentation Pond (CDA, 2007)

Loading Condition	FoS
Long-Term, Static Loading	1.5
Pseudo-Static	1.0
Post-Earthquake	1.2

5.3 MATERIALS AND PARAMETERS

Site investigations (KP, 2006) were previously completed upslope from the Haul Road. No site investigation data is available in the immediate vicinity of the Access Road or Sedimentation Pond. The upslope stratigraphy generally consists of the following geotechnical units:

- Glacial Till - consisting of silty Sand to well graded Gravel with some sand and trace silt. Cobbles and Boulders are common within this stratum and constitute up to approximately 20 percent of the soil mass in this stratum
- Bedrock - consisting predominately of highly fractured Gneiss and Gneissic Bedrock

This generalized stratigraphy has been adopted for the stability analysis. The thickness of the Glacial Till layer is not known and is expected to range from 0 m to greater than 10 m. The strength of the foundation is expected to increase with depth through the permafrost and into the bedrock. It is likely that the strength of the upper till layers within the active zone will control the stability of the embankments. As such, the stability models incorporate thick zones of Glacial Till and evaluated the FoS for potential slip surfaces through the Glacial Till layer only. The stability models assume that the Glacial Till consists of well graded Sand and Gravel, and that massive ice is not present.

The material parameters for the fill and foundation units were estimated based on typical correlations (Carter and Bentley, 2016) and recent analyses for the Haul Road Design (Golder, 2018a) and

are summarized in Table 4. The embankment fill in the stability models consists of Road Embankment Fill for the Access Road, and Berm Fill for the Sedimentation Pond.

The material parameters are estimated based on thawed conditions and do not include the potential strength contribution of the aggrading permafrost.

5.4 RESULTS

The results of the stability analyses are summarized in Table 5 and illustrated on Figures 3 to 6. The results indicate the following:

- Access Road:
  - The target FoS is achieved for all sections
  - The safety berm must be set back 5 m at the maximum slope height (Section 1). This setback is reduced to 0 m for slope heights of 19 m or less (Section 2).
  - The FoS for the zone extending from the inside of the safety berm to the outside edge of the slope is less than the target FoS and approaches unity at the edge of the slope. As such, sloughing and cracking may develop in this area and regular monitoring is required. Additional fill placement and ongoing grading may be necessary to maintain the design geometry of the Access Road.
- Sedimentation Pond: The computed FoS exceed the recommended values for all cases

Slow, steady creep of the Access Road and Sedimentation Pond embankments may occur if the ice rich materials or massive ice are present within the foundation soils. As such, regular monitoring is required to track the deformation and movement of the embankments, if any. Additional fill placement and surface grading may be necessary depending on the magnitude of the observed deformations.

6.0 CONSTRUCTION DETAILS

6.1 GENERAL

It is understood that construction of the Access Road, Sedimentation Pond and associated runoff management measures including berms and culverts, will be completed during the winter months to encourage aggradation of the permafrost and meet scheduling requirements. All construction materials must be maintained unfrozen and free of visible ice prior to placement. Geotextiles and geomembranes must be protected from UV exposure, and stored and handled in accordance with the manufacturer's recommendations. Snow must be removed from the footprint of the proposed structures prior to construction.

The locations and configurations of the Access Road, Sedimentation Pond and associated runoff management measures may change based on actual site conditions.

The following sections provide construction requirements and recommendations related to the Access Road, Sedimentation Pond and associated runoff management measures. Details, including material specifications and compaction requirements, are provided on the Drawings.

6.2 EROSION AND SEDIMENT CONTROL

Baffinland will employ a combination of sediment and erosion control measures as outlined in Baffinland's Environmental Protection Plan (Baffinland, 2016a), and Surface Water and Aquatic Ecosystems

Management Plan (Baffinland, 2016b), to address and manage sedimentation concerns during construction of access road, ore stockpile, diversion berms and sedimentation pond.

6.3 SURVEYING

Setting out details are provided on the Drawings for each of the structures. The structures will be located using suitably accurate surveying methods.

As-built surveys will be required following construction of each of the structures. The surveys will be sufficiently detailed to properly document the completed construction.

6.4 FOUNDATION PREPARATION

It is unknown whether the foundation soils are ice rich or contain massive ice. For the purposes of this design, we assume that the foundation materials are not ice rich and do not contain massive ice. Provided that the amount of organics and unsuitable material on the ground surface is negligible, disturbance to the original ground (excavation, scarifying, etc.) should be minimized so as to not impact current permafrost conditions. The foundations must be maintained clear of snow, ponded water and ice.

Alternative methods of foundation preparation may be necessary for areas with significant surface cover of organics, ice rich foundation soils or soils containing massive ice. If difficult ground conditions are anticipated in the area of the KM107 Stockpile based on Baffinland's past experience in the area or visual observations, drilling or test pitting could be completed to confirm the presence or absence of ice rich soils or massive ice.

The foundation must be approved and documented by the supervising Engineer prior to fill placement.

6.5 ACCESS ROAD

Due to steep terrain in the area of the Access Road, construction of the embankment in lifts will not be possible. The road embankment fill will be placed starting from the edge of the existing Haul Road. The fill material will be dumped and pushed with a bulldozer and is expected to be constructed to final grade in a single lift based on discussion with Baffinland. Due to the fill placement method, the road embankment crest width has been designed to be wider to account for the fill being placed at the angle of repose. Compaction will only be completed on the road surface by routing of the haulage traffic.

All haulage traffic must be kept off the area located under and outside of the vehicle safety berms for both construction and operation of the road. It is anticipated that this area will be constructed using a bulldozer.

There is potential for some settlement and cracking to develop in the Access Road as a result of the construction method and the planned winter construction. It will be necessary to closely monitor the Access Road during and following the first thaw. Additional fill placement may be necessary to mitigate cracking or deformation that develop.

6.6 CULVERTS

All culverts will be installed with their base projecting at least 0.5 m beyond the Access Road fill slope toe at each end. A minimum of 0.8 m of road fill material will be placed over the top of each culvert.

Site specific conditions have not been documented at the culvert locations, and as such, the culverts must be field fit based upon the typical culvert details shown on Drawing 311.

All culverts will be installed as shown on the drawings, according to the supplier's recommendations and in compliance with all applicable regulatory requirements.

6.7 SEDIMENTATION POND

Following foundation preparation, Berm Fill will be placed and compacted to construct the Sedimentation Pond perimeter berm. Intermediate Bedding will be placed over the compacted rockfill, and along the upstream slope, upstream part of the berm crest and over the floor of the pond. The integrated geomembrane and non-woven geotextile will be installed over the Intermediate Bedding layer. Details for the geosynthetics installation are shown on Drawing 301.

The spillway will be constructed as part of the pond perimeter berm construction. For the spillway, 12 oz/yd^2 non-woven geotextile (or approved equivalent) will be placed over the prepared foundation of the spillway inlet and channel invert and side slopes. Fine Riprap will be tightly placed over the geotextile along the spillway inlet invert and side slopes. Coarse Riprap will be tightly placed over the geotextile along the spillway channel invert and side slopes, and a Coarse Riprap apron will be tightly placed over the geotextile at the outlet of the spillway channel. Typical sections and details are provided on Drawings 320 and 321.

Prior to placement of the Intermediate Bedding layer, care must be taken to ensure that the final surface of the underlying prepared foundation is smooth and uniform. No angular particles or voids may be present. It is understood that additional geotextile is available on site. This additional geotextile shall be placed as necessary to provide a suitably smooth bedding layer for installation of the integrated geomembrane and non-woven geotextile.

The geomembrane installation details are provided on Drawings 301 and 320.

6.8 DIVERSION BERMS

Berm Fill will be placed and compacted to construct the Diversion Berms. Non-woven geotextile will be placed over the upstream slope of the berm and the crest, and Coarse Riprap will be placed over the non-woven geotextile to form a tightly interlocking layer. A typical Diversion Berm section is provided on Drawing 320.

6.9 MATERIALS AND QUANTITIES

A summary of materials and quantity estimates for the Access Road, Sedimentation Pond and runoff management measures is presented in Table 6. The materials and quantities are based on the drawings included herein. In general, quantities have been estimated using neat line measurements from the Drawings and are based on the typical sections and details provided on the Drawings. No contingencies have been included.

6.10 CONSTRUCTION QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

Technical specifications have been provided as notes and details on the attached drawings. The following additional information is provided with respect to Quality Assurance/Quality Control (QA/QC):

- It is assumed that a qualified Baffinland engineer will oversee and document construction of the Access Road, Sedimentation Pond and associated runoff management measures
- Geosynthetic materials and culverts will be installed as per the manufacturer's specifications and recommendations. The geosynthetics contractor will be responsible for performing and documenting the geosynthetics QC program.

- Qualified Baffinland personnel will be responsible for conducting the QC testing and inspections required on all placed and compacted fill materials

7.0 INSPECTIONS AND MAINTENANCE

KM107 Stockpile material placement and runoff management will need to be closely monitored during operation of the stockpile area, including use of the Access Road, and operation of the Sedimentation Pond and runoff management measures. The Sedimentation Pond will need to be emptied in a timely manner following a storm event or during freshet such that the pond is empty during normal operating conditions. Ongoing inspections and maintenance will be required to ensure that each of these structures are being operated as designed and that the Diversion Berms, culverts, and Sedimentation Pond water removal system and emergency overflow spillway are performing as designed. The recommended inspections are described below:

- Daily
  - Inspect the Access Road for any cracks, settlement or rutting of the road surface
  - Inspect the Safety Berms along the Access Road to ensure they are in good condition and have the design configuration
- Weekly During Non-Freezing Conditions
  - Inspect the water removal system from the Sedimentation Pond (designed by others) to ensure each component is performing as designed
  - Inspect the Sedimentation Pond to ensure the liner is in good condition, there are no visible holes or leaks, there is no erosion of the berms, and the berms and spillway are performing as designed
  - Inspect the Diversion Berms to ensure there is no erosion of the berms and that no material is blocking flow along the Diversion Berms
  - Inspect the Access Road culverts to ensure that there is no erosion or blockages, and the culverts are performing as designed
- Prior to Freshet, Following Freshet and After Any Large Storm Event
  - Inspect Access Road to ensure there is no erosion of fill materials
  - Inspect Access Road culverts to ensure the culverts are clear of snow and ice, and are performing as designed
  - Inspect the Diversion Berms to ensure there is no erosion of the berms and that no material is blocking flow along the Diversion Berms
  - Inspect the Sedimentation Pond to ensure the liner is in good condition, there are no visible holes or leaks, there is no erosion of the berms, and the berms and spillway are performing as designed
- Biannually
  - In accordance with Part D., Clause 18 of the Mary River Project Water License (NWB, 2014), "*inspections of earthworks and geological and hydrological regimes of the Project*" will be conducted "*biannually during the summer or as otherwise approved by the Board in writing. These inspections shall be conducted by a Geotechnical Engineer…*".

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8.0 CLOSING

We trust that this letter provides you with the information you require at this time. Please feel free to contact us if you require any additional information.

Yours truly,
Knight Piésold Ltd.

Prepared: FOR
Amy L. Adams, Ph.D., P.Eng., P.E.
Project Engineer

Prepared:
Deena Duff, P.Eng.
Senior Engineer

Prepared:
C.A. (Andy) Phillips, P.Eng.
Senior Engineer

Reviewed:
Kevin Hawton, P.Eng.
Specialist Engineer | Associate

REGISTERED PROFESSIONAL ENGINEER
K.E. HAWTON
LICENSEE
Sept 18/18
NWT/NU

PERMIT TO PRACTICE
KNIGHT PIESOLD LTD.
Signature
Date Sept 18/2018
PERMIT NUMBER: P 547
The Association of Professional Engineers, Geologists and Geophysicists of NWT/NU

Approval that this document adheres to Knight Piésold Quality Systems:

Attachments:

Table 1 Rev 0	Design Criteria
Table 4 Rev 0	Summary of Material Parameters for Slope Stability Analyses
Table 5 Rev 0	Summary of Slope Stability Results
Table 6 Rev 0	Schedule of Materials and Estimated Quantities
Figure 1 Rev 0	Estimated Catchment Areas
Figure 2 Rev 0	Slope Stability Section Locations
Figure 3 Rev 0	Slope Stability Results - Access Road - Section 1 - 36 m High Slope
Figure 4 Rev 0	Slope Stability Results - Access Road - Section 2 - 19 m High Slope
Figure 5 Rev 0	Slope Stability Results - Sedimentation Pond - Static, Long-Term Loading
Figure 6 Rev 0	Slope Stability Results - Sedimentation Pond - Pseudo-Static Loading
Drawing 300 Rev 0	General Arrangement
Drawing 301 Rev 0	Specifications

Drawing 310 Rev 0 Access Road - Plan and Section
Drawing 311 Rev 0 Access Road - Sections
Drawing 320 Rev 0 Sedimentation Pond and Runoff Management Measures - Plan, Section and Details
Drawing 321 Rev 0 Sedimentation Pond and Runoff Management Measures - Sections and Details
Appendix A Geomembrane and Non-Woven Geotextile Information

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Copy To: Chet Fong, Baffinland Iron Mines Corporation
Trevor Brisco, Baffinland Iron Mines Corporation

/ala

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TABLE 1

BAFFINLAND IRON MINES CORPORATION
MARY RIVER PROJECT

KM107 STOCKPILE
DESIGN CRITERIA

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Item No.	Item	Design Criteria	Reference
1.0	**GENERAL**		
1.1	Regulatory	• Water Licence No. 2AM-MRY1325 Amendment No. 1	NWB, 2014
		• Nunavut Mine Health and Safety Act and Regulations	MHSA, 2011
		• Nunavut Waters and Surface Rights Tribunal Act and Nunavut Waters Regulations	NWNSRTA, 2018
		Metal and Diamond Mining Effluent Regulations (MDMER)	MDMER, 2018
		• Fisheries Act	Fisheries Act, 2016
1.2	Guidelines and Reference	• Civil Design Criteria	Hatch, 2013
		• Canadian Dam Association Dam Safety Guidelines (2007, 2013)	CDA, 2007 & 2013
2.0	**WATER MANAGEMENT**		
2.1	General	• Runoff from the upstream catchment areas will be diverted around the KM107 Stockpile, through a culvert under the Access Road, and around the Sedimentation Pond	-
		• Meteoric water reporting to the KM107 Stockpile will be collected and temporarily stored in the Sedimentation Pond	-
		• A spillway in the Sedimentation Pond will convey excess runoff from the KM107 Stockpile	-
2.2	Design Storm Events	• Sedimentation Pond designed to provide temporary storage for runoff resulting from the 1 in 10 year, 24-hour storm event	Hatch, 2013
		• Ditches sized to convey flows resulting from the 1 in 200 year, 24-hour storm event	KP (based on Hatch, 2013)
		• Culverts sized to convey flows resulting from the 1 in 200 year, 24-hour storm event	KP (based on Hatch, 2013)
		• Emergency overflow spillway (Sedimentation Pond) sized to convey flows resulting from the 1 in 200 year, 24-hour storm event	Hatch, 2013
		• Storm events are rain only events; no snowfall or snowmelt is included	KP Estimate
2.3	Hydrological Parameters	• Catchment Areas:	
		o KM107 Stockpile: approximately 7.57 ha	Estimated from mapping provided by Baffinland
		o Upstream of KM107 Stockpile: approximately 8.73 ha	Estimated from mapping provided by Baffinland
		o Sedimentation Pond: approximately 1.22 ha	Estimated from mapping provided by Baffinland
		• Runoff Coefficients:	
		o KM107 Stockpile: 0.9	Hatch, 2013
		• Time of Concentration Method:	KP Estimate
		o KM107 Stockpile: Kirpich (1940)	-
		o Undisturbed/Upstream Areas: Hathaway (1945)	-
		• Rainfall Distribution: SCS Type I	KP Estimate
		• SCS Curve Number:	
		o KM107 Stockpile: 89	KP Estimate
		o Undisturbed/Upstream: 86	KP Estimate
2.4	Meteorological Parameters	• Return Period Rainfall Events:	
		o 1 in 10 year, 24-hour storm event: 41 mm	Hatch, 2013
		o 1 in 100 year, 24-hour storm event: 65 mm	Hatch, 2013
		o 1 in 200 year, 24-hour storm event: 72 mm	Hatch, 2013
2.5	Ditch Parameters	• Shape: Trapezoidal cross section	Hatch, 2013
		• Base Width: 0.5 m minimum	Hatch, 2013
		• Side Slopes: 2H:1V (soil)	Hatch, 2013 and Hatch, 2018
		• Grade: 0.2% minimum	Hatch, 2018
		• Depth: 0.3 m minimum	Hatch, 2013
		• Freeboard: 0.3 m	Hatch, 2013
		• Design Flood Event: 1 in 200 year, 24 hour	KP Estimate
		• Manning's "n" Value: 0.040 (riprap)	Hatch, 2013
2.6	Culvert Parameters	• Diameter: 600 mm (minimum).1200 mm culverts are typical	Hatch, 2013 and Hatch, 2018
		• Culvert Type: Corrugated Steel Pipe (CSP)	Hatch, 2013
		• Manning's "n" Value: 0.024 (CSP pipe)	Hatch, 2013
		• Grade: 1% minimum	KP Estimate
		• Head Above Culvert Invert: culvert diameter plus 0.5 m	KP, 2017
2.7	Diversion Berms	• Shape: Trapezoidal cross section	Hatch, 2013
		• Side slopes: 2H:1V	Hatch, 2018
		• Freeboard: 0.3 m	Hatch, 2018
		• Height: 1 m minimum (including 0.3 m freeboard)	Hatch, 2013
		• Top Width: 0.5 m	Hatch, 2013 and Hatch, 2018
3.0	**Construction Materials**		
3.1	Source	• Approved sources following Water Licence No. 2AM-MRY1325 Amendment No. 1	NWB, 2014
3.2	Quality	• Clean, free of debris and organics (see Drawing 301)	KP Estimate
3.3	Description	• Road Embankment Fill: Well graded; consisting of hard, durable, fresh rockfill	KP Estimate
		• Berm Fill: Well graded, 150 mm minus processed rockfill	KP Estimate
		• Intermediate Bedding: 32 mm minus sand and gravel, gradation as per Golder, 2018a	Golder, 2018a
		• Riprap: Maximum particle diameter not exceeding one and a half times the specified D_{50} value, well graded, with a fines content not exceeding 5%	KP Estimate (based on Golder, 2018a)
		o Fine Riprap: D_{50} of 75 mm	
		o Coarse Riprap: D_{50} of 200 mm	
4.0	**KM107 STOCKPILE**		
4.1	Geometry	• Footprint Area: 7.57 ha	Estimated from mapping provided by Baffinland
4.2	Condition	• Not lined; constructed on existing ground after clearing	Baffinland
5.0	**ACCESS ROAD**		
5.1	Design Vehicle	• Caterpillar (CAT) 793F Mining Truck	Baffinland
		• Truck Width: 8.6 m	Caterpillar, 2017
		• Tire Size: 50/80 R57	Caterpillar, 2017
		• Tire Diameter: 3.6 m	Michelin, 2018
		• Turning Circle Clearance Diameter: 33 m (radius: 16.5 m)	Caterpillar, 2017
5.2	Road Geometry	• Road Width: 3 times width of CAT 793 haul truck (one-way traffic)	Baffinland, 2018
		• Design Speed: 30 km/h	Hatch, 2013
		• Posted Speed: 20 km/h	Hatch, 2013
		• Minimum Horizontal Curve C/L Radius: 50 m	Hatch, 2013
		• Minimum Intersection Inner Radius: 30 m	Hatch, 2013
		• Minimum Cross Slope: 3%	Hatch, 2013
		• Maximum Road Grade: 10%	Hatch, 2013
5.3	Vehicle Safety Berms	• Berm Height: 3/4 of the diameter of the largest wheeled vehicle (CAT 793)	Nunavut Mine Health and Safety Regulations, Surface Haulage Roads, Section 1.143
		Berm Locations: All areas where drop off is greater than 3 m	Nunavut Mine Health and Safety Regulations, Surface Haulage Roads, Section 1.143
		• Side Slopes: 1H:1V	Hatch, 2013
5.4	Stability	• Factors of Safety:	
		o Static: 1.2	KP
		o Pseudo-Static: 1.0	KP
6.0	**SEDIMENTATION POND**		
6.1	Function	• Function: Runoff management and sedimentation control	Baffinland
6.2	Geometry	• Shape: Rectangular; L:W = approximately 5:1	KP Estimate; BCMOE (2015)
		• Pond Depth: 5 m maximum	Hatch, 2013
		• Berm Side Slopes: 3H:1V	Hatch, 2013
		• Berm Crest: 6 m	Golder, 2017
		• Freeboard: 0.3 m	Golder, 2017
		• Sediment Storage: approximately 0.5 m deep	KP Estimate
6.3	Liner	• Liner: required	Baffinland
		• Liner installation: Liner to be pre-welded in large panels by Western Tank and Lining Ltd.	Baffinland
		• Geomembrane Liner: Atarfil LLD, 40 mil	Baffinland
		• Non-Geotextile: Texel 100P, 10 oz/yd^2	Western Tank and Lining Ltd.
6.4	Dam Hazard Classification	• Potential loss of life: None - no downstream population	KP Estimate
		• Potential loss to Environmental and Cultural Values:	KP Estimate
		o Short Term - slope erosion and sedimentation of the Mary River	
		o Long Term - None	
		• Potential Economic Loss: Minimal, associated with repairs to the Sedimentation Pond itself	KP Estimate
		• Dam Hazard Classification: LOW	KP Estimate; CDA, 2013
6.5	Stability	• Factors of Safety:	
		o Static: 1.5	CDA, 2007 & 2013
		o Pseudo-Static: 1.0	CDA, 2007 & 2013
		o Post-Earthquake: 1.2	CDA, 2007 & 2013
6.6	Seismic Design Criteria	• 1 in 100 year event: 0.019g (based on Section 6.4)	CDA, 2013 & NRC, 2015

I:\1\02\00181\49\A\Data\Work Files\WF02 - Design Criteria Table\[Design Criteria Table 20180918.xlsx]Table

REV	DATE	DESCRIPTION	PREP'D	RVW'D
0	18SEP'18	ISSUED WITH LETTER NB18-00535	CAP/ALA	DMMD

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TABLE 4

BAFFINLAND IRON MINES CORPORATION
MARY RIVER PROJECT

KM107 STOCKPILE
SUMMARY OF MATERIAL PARAMETERS FOR SLOPE STABILITY ANALYSES

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Material	Unit Weight (kN/m^3)	Cohesion (kPa)	Effective Friction Angle (degrees)
Road Embankment Fill	21	0	37
Berm Fill	21	0	37
Glacial Till	19	0	34
Sediments	18	0	0
Bedrock	29	0	40

I:\1\02\00181\49\A\Data\Work Files\WF09 - Sedimentation Pond Stability\Rev 0\[Tables and Figures2.xlsm]Table 4

REV	DATE	DESCRIPTION	PREP'D	RVW'D
0	18SEP'18	ISSUED WITH LETTER NB18-00535	LB	JAB

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TABLE 5

BAFFINLAND IRON MINES CORPORATION
MARY RIVER PROJECT

KM107 STOCKPILE
SUMMARY OF SLOPE STABILITY RESULTS

Print Sep/18/18 11:25:07

Slope	Factor of Safety (FoS)			
	Static (Required)	Static (Achieved)	Pseudo-Static (Required)	Pseudo-Static (Achieved)
Access Road				
Section 1 - 36 m slope	1.2	1.2	1.0	1.2
Section 2 - 19 m slope	1.2	1.3	1.0	1.2
Sedimentation Pond				
Upstream	1.5	2.8	1.0	2.6
Downstream	1.5	2.4	1.0	2.3

I:\1\02\00181\49\A\Data\Work Files\WF09 - Sedimentation Pond Stability\Rev 0\[Tables and Figures2.xlsm]Table 5

NOTES:

1. STABILITY ANALYSES CARRIED OUT USING SLOPE/W© (GEO-SLOPE, 2018).
2. ACCESS ROAD SLOPES ARE 1.3H:1.0V; SAFETY BERMS ARE 2.7 m HIGH, WITH 1 m CREST WIDTH AND 1.0H:1.0V SIDE SLOPES.
3. DESIGN HAUL TRUCK LOAD ON THE ACCESS ROAD IS THE REAR AXLE OF A FULLY LOADED CAT 793. MODELLED AS A SURCHARGE LOAD 8.5 m WIDE, 1 m HIGH AT 265 kN/m^3.
4. SEDIMENTATION POND EMBANKMENT SIDE SLOPES ARE 3.0H:1.0V; CREST WIDTH IS 6 m.
5. MODELLED MAXIMUM DEAD STORAGE ELEVATION OF SEDIMENTS IN SEDIMENTATION POND IS 307 m; MAXIMUM POND ELEVATION IS 308.9 m.
6. SEISMIC COEFFICIENT OF 0.019g APPLIED TO ALL PSEUDO-STATIC ANALYSES (NRCAN, 2015).

REV	DATE	DESCRIPTION	PREP'D	RVW'D
0	18SEP'18	ISSUED WITH LETTER NB18-00535	LB	JAB

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TABLE 6

BAFFINLAND IRON MINES CORPORATION
MARY RIVER PROJECT

KM107 STOCKPILE
SCHEDULE OF MATERIALS AND ESTIMATED QUANTITIES

Print Sep/18/18 11:52:44

Item No.	Description	Unit	Estimated Quantity
SEDIMENTATION POND			
1	**Earthworks**		
1.1	**Sedimentation Pond Embankment and Basin**		
1.1.1	Prepare Foundation Area	m^2	11,500
1.1.2	Supply, Haul, Place and Compact - Berm Fill	m^3	13,000
1.1.3	Supply, Haul, Place and Compact - Intermediate Bedding	m^3	1,300
1.2	**Emergency Overflow Spillway**		
1.2.1	Prepare Spillway and Apron Areas	m^3	50
1.2.2	Supply, Haul, Place - Fine Riprap - Inlet	m^3	12
1.2.3	Supply, Haul and Place - Coarse Riprap - Channel and Apron	m^3	130
1.3	**Diversion Berms**		
1.3.1	Prepare Foundation Areas	m^2	4,500
1.3.2	Supply, Haul and Place - Berm Fill - Diversion Berms	m^3	2,600
1.3.3	Supply, Haul and Place - Coarse Riprap - Diversion Berms	m^3	1,020
	Subtotal Item 1.0		
2	**Geosynthetics**		
2.1	**Pond Lining**		
2.1.1	Supply and Install - 40 mil Atarifil LLD Geomembrane	m^2	7,400
2.1.2	Supply and Install - Texel 100 P 10 oz/yd^2 Non-Woven Geotextile	m^2	7,400
2.1.3	Supply and Install - 12 oz/yd^2 Non-Woven Geotextile	m^2	6,100
	Subtotal Item 2.0		
ACCESS ROAD			
3	**Earthworks**		
3.1	**Road Fill**		
3.1.1	Prepare Foundation Area	m^2	31,900
3.1.2	Supply, Haul and Place - Road Embankment Fill	m^3	279,900
3.1.3	Supply, Haul and Place - Intermediate Bedding	m^3	630
3.1.4	Supply, Haul and Place - Riprap - Culvert Apron	m^3	30
3.1.5	Supply and Install - Culverts (85 m in length)	each	3
3.2	**Safety Berms**		
3.2.1	Supply and Install - Road Embankment Fill	m^3	7,900
	Subtotal Item 3.0		

I:\1\02\00181\49\A\Data\Work Files\WF05 - Materials and Quantities\Rev 0\[Materials and Quantities Table .xlsm]Table M+ Q

NOTES:

1. MATERIAL QUANTITIES ARE BASED ON NEAT LINE MEASUREMENTS OF THE DRAWINGS AND DO NOT INCLUDE ANY CONTINGENCIES.

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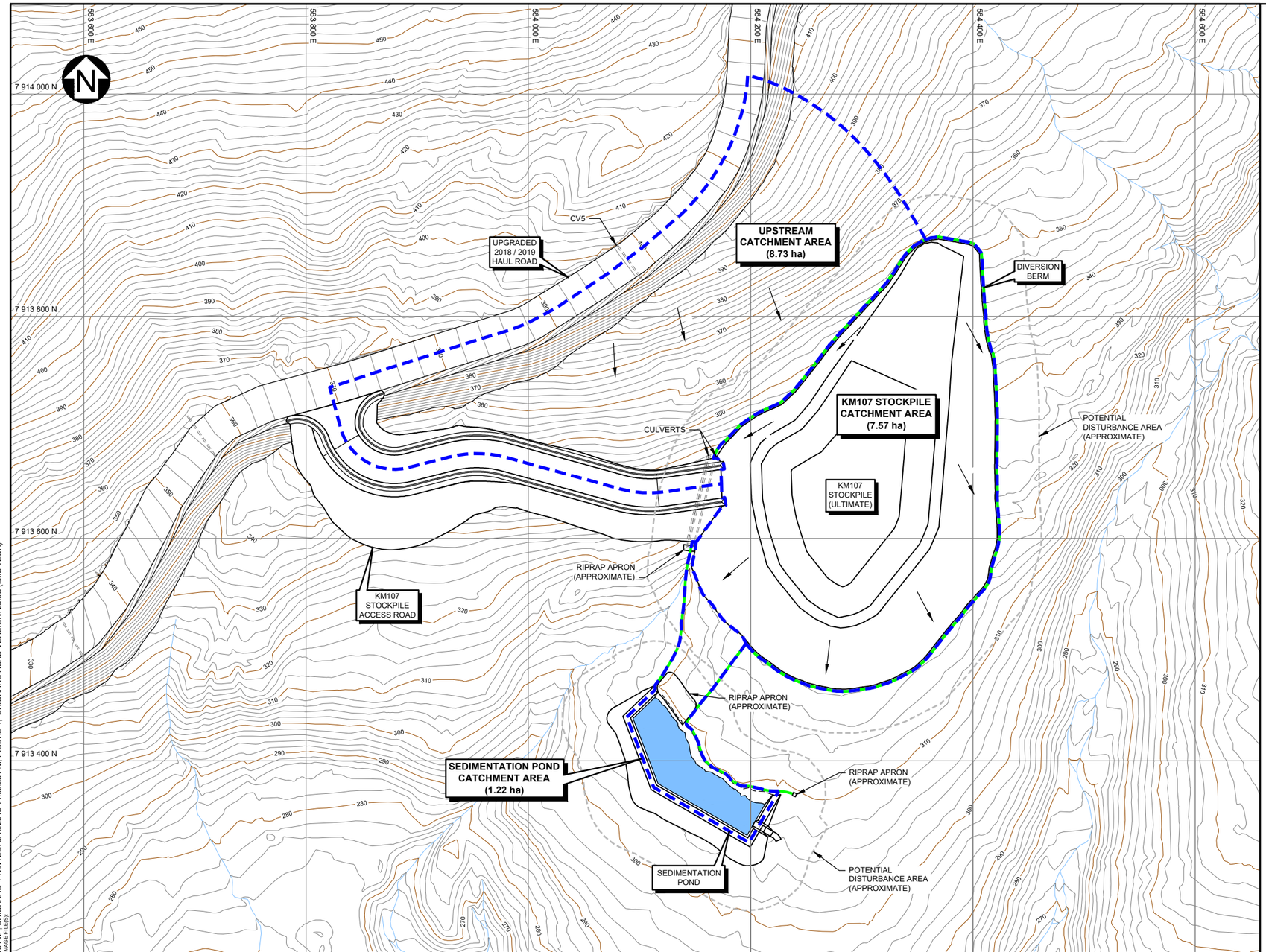

LEGEND:

- SEDIMENTATION POND
- CULVERT
- DIVERSION BERM
- ESTIMATED CATCHMENT AREA BOUNDARY
- GENERAL FLOW DIRECTION
- POTENTIAL DISTURBANCE AREA (APPROXIMATE)

NOTES:

1. COORDINATE GRID IS UTM (NAD83) ZONE 17.
2. TOPOGRAPHY BASED ON INFORMATION PROVIDED BY EAGLE MAPPING (2008).
3. CONTOURS ARE IN METRES. CONTOUR INTERVAL IS 2 m.
4. DIMENSIONS AND ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE.
5. LOCATIONS OF CONSTRUCTION ITEMS MAY BE MODIFIED TO SUIT SITE CONDITIONS.
6. UPGRADED 2018 / 2019 HAUL ROAD AND KM107 STOCKPILE PROVIDED BY BAFFINLAND.
7. ALL INFRASTRUCTURE SHOWN IS PROPOSED UNLESS NOTED OTHERWISE.

FOR INFORMATION ONLY

SCALE A 40 20 0 40 80 120 160 200 m

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED
0	18SEP'18	ISSUED WITH LETTER	DMMD	SIR	KEH

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

KM107 STOCKPILE ESTIMATED CATCHMENT AREAS

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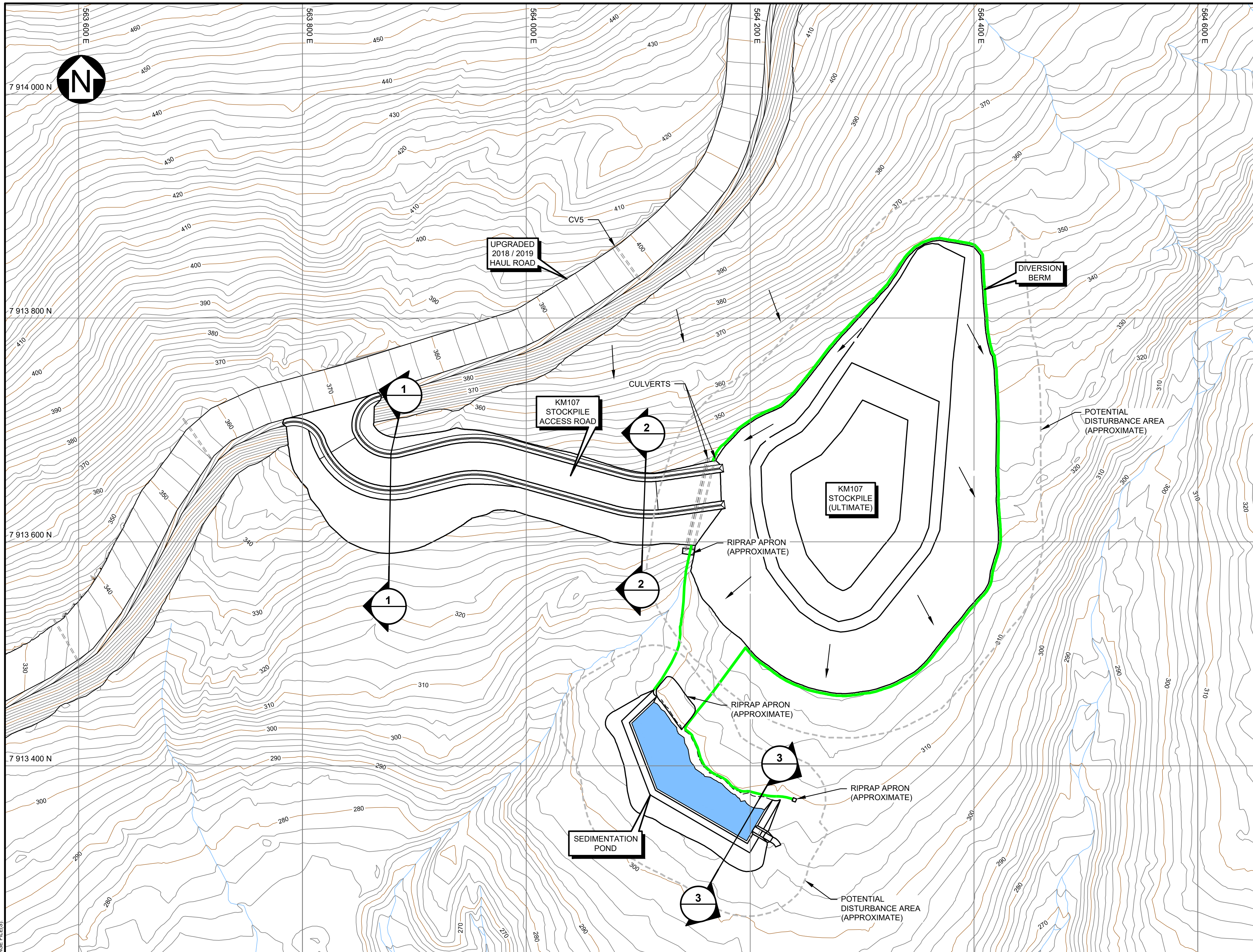
P/A NO. NB102-181/49 | REF NO. NB18-00535

FIGURE 1 | REV 0



LEGEND:

- WATER
- CULVERT
- DIVERSION BERM
- GENERAL FLOW DIRECTION
- POTENTIAL DISTURBANCE AREA (APPROXIMATE)

NOTES:

1. COORDINATE GRID IS UTM (NAD83) ZONE 17.
2. TOPOGRAPHY BASED ON INFORMATION PROVIDED BY EAGLE MAPPING (2008).
3. CONTOURS ARE IN METRES. CONTOUR INTERVAL IS 2 m.
4. DIMENSIONS AND ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE.
5. LOCATIONS OF CONSTRUCTION ITEMS MAY BE MODIFIED TO SUIT SITE CONDITIONS.
6. UPGRADED 2018 / 2019 HAUL ROAD AND KM107 STOCKPILE PROVIDED BY BAFFINLAND.
7. ALL INFRASTRUCTURE SHOWN IS PROPOSED UNLESS NOTED OTHERWISE.

FOR INFORMATION ONLY

SCALE A 40 20 0 40 80 120 160 200 m

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

KM107 STOCKPILE
SLOPE STABILITY SECTION LOCATIONS

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P/A NO.	REF NO.
NB102-181/49	NB18-00535

FIGURE 2 REV 0

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED
0	18SEP'18	ISSUED WITH LETTER	ALA	SIR	KEH

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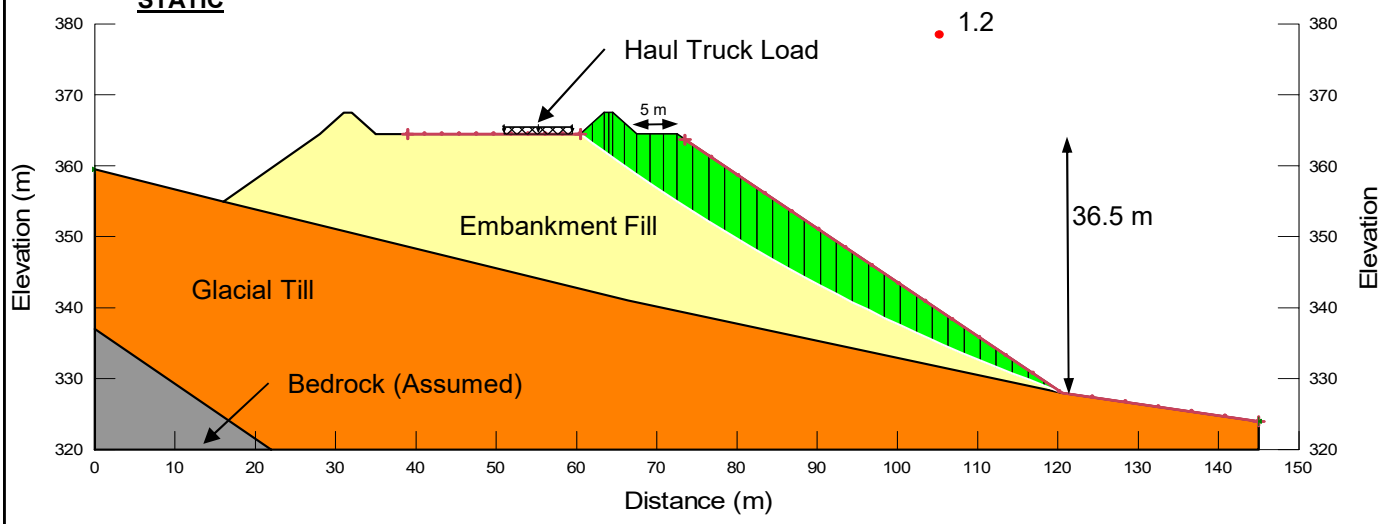
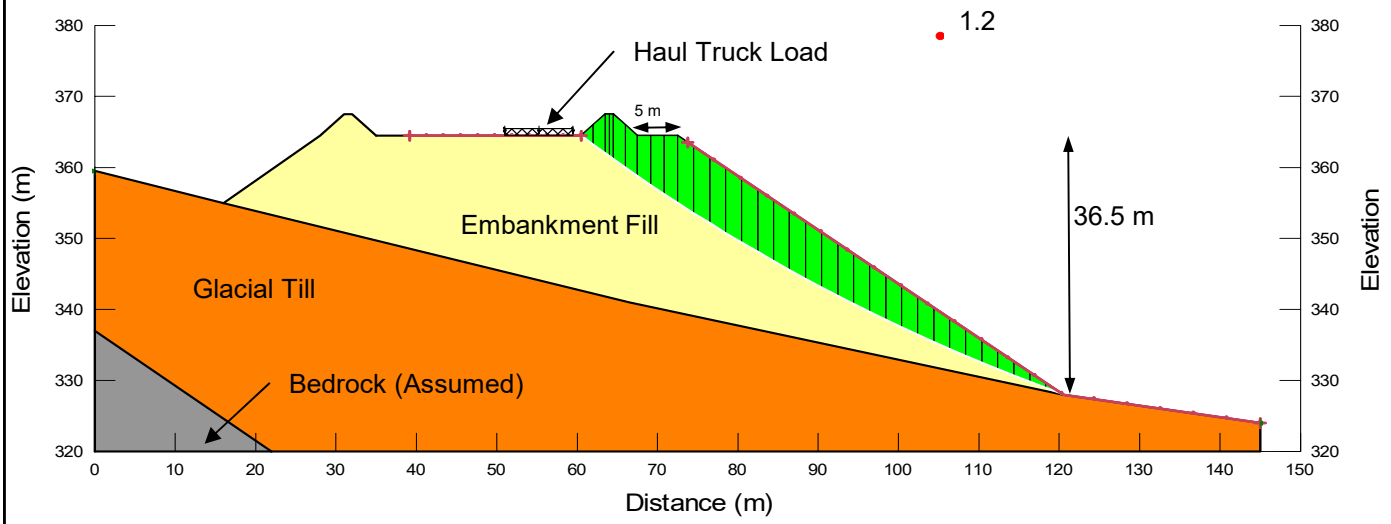


PSEUDO-STATIC



NOTES:

1. ACCESS ROAD SLOPES ARE 1.3H:1.0V.
2. SAFETY BERMS ARE 2.7 m HIGH, 1 m CREST WIDTH AND 1.0H:1.0V SIDE SLOPES.
3. A HORIZONTAL SEISMIC ACCELERATION CORRESPONDING TO A PGA OF 0.019g WAS APPLIED TO ALL PSEUDO-STATIC ANALYSES (NRCAN, 2015).
4. DESIGN HAUL TRUCK LOAD IS THE REAR AXLE OF A FULLY LOADED CAT 793. MODELLED AS A SURCHARGE LOAD 9 m WIDE, 1 m HIGH AT 265 kN/m^3.

REV	DATE	DESCRIPTION	PREP'D	RVW'D
0	18SEP'18	ISSUED WITH LETTER	JAB	ALA

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

SLOPE STABILITY RESULTS
ACCESS ROAD
SECTION 1 - 36 m HIGH SLOPE

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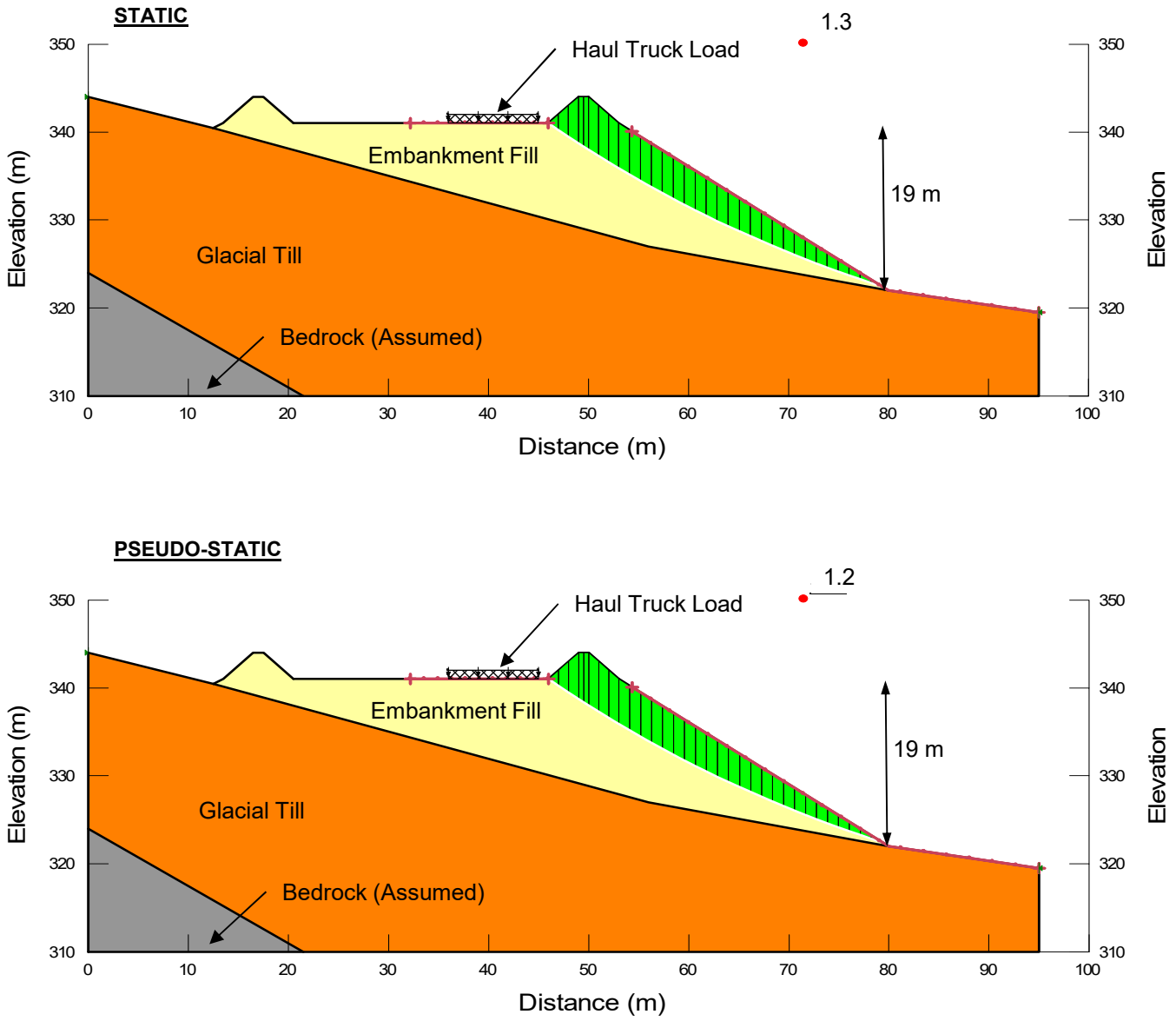
P/A NO. NB102-181/49

REF. NO. NB18-00535

FIGURE 3

REV 0



NOTES:

1. ACCESS ROAD SLOPES ARE 1.3H:1.0V.
2. SAFETY BERMS ARE 2.7 m HIGH, 1 m CREST WIDTH AND 1.0H:1.0V SIDE SLOPES.
3. A HORIZONTAL SEISMIC ACCELERATION CORRESPONDING TO A PGA OF 0.019g WAS APPLIED TO ALL PSEUDO-STATIC ANALYSES (NRCAN, 2015).
4. DESIGN HAUL TRUCK LOAD IS THE REAR AXLE OF A FULLY LOADED CAT 793. MODELLED AS A SURCHARGE LOAD 9 m WIDE, 1 m HIGH AT 265 kN/m^3.

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

SLOPE STABILITY RESULTS
ACCESS ROAD
SECTION 2 - 19 m HIGH SLOPE

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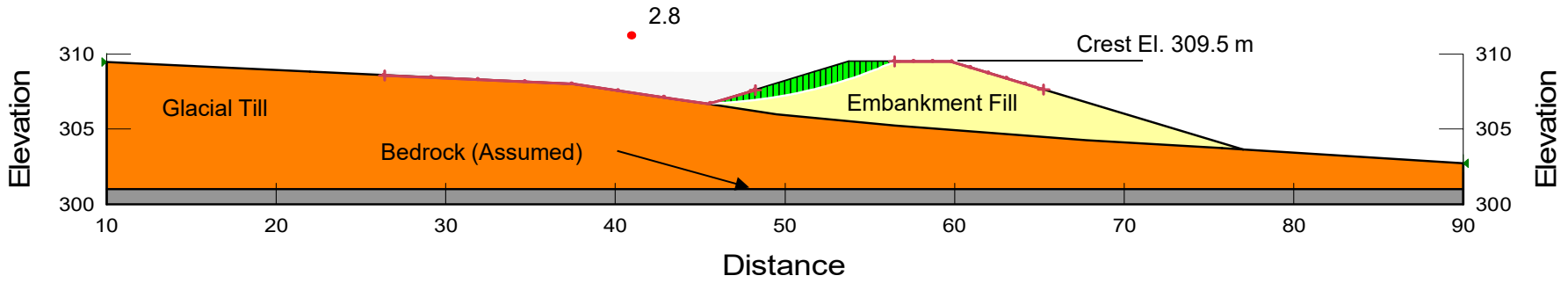
P/A NO. NB102-181/49 | REF. NO. NB18-00535

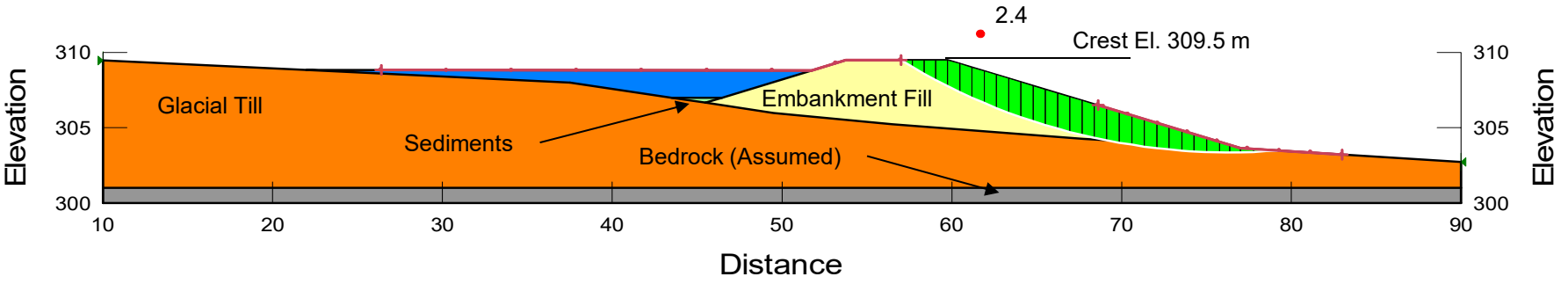
FIGURE 4 | REV 0

REV	DATE	DESCRIPTION	PREP'D	RVW'D
0	18SEP'18	ISSUED WITH LETTER	JAB	ALA

UPSTREAM SLOPE



DOWNSTREAM SLOPE



NOTES:

1. EMBANKMENT SIDE SLOPES ARE 3.0H:1.0V.
2. CREST WIDTH IS 6 m.

REV	DATE	DESCRIPTION	PREP'D	RVW'D
0	18SEP'18	ISSUED WITH LETTER NB18-00535	LB	JAB

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

SLOPE STABILITY RESULTS
SEDIMENTATION POND
STATIC, LONG-TERM LOADING

Knight Piésold CONSULTING

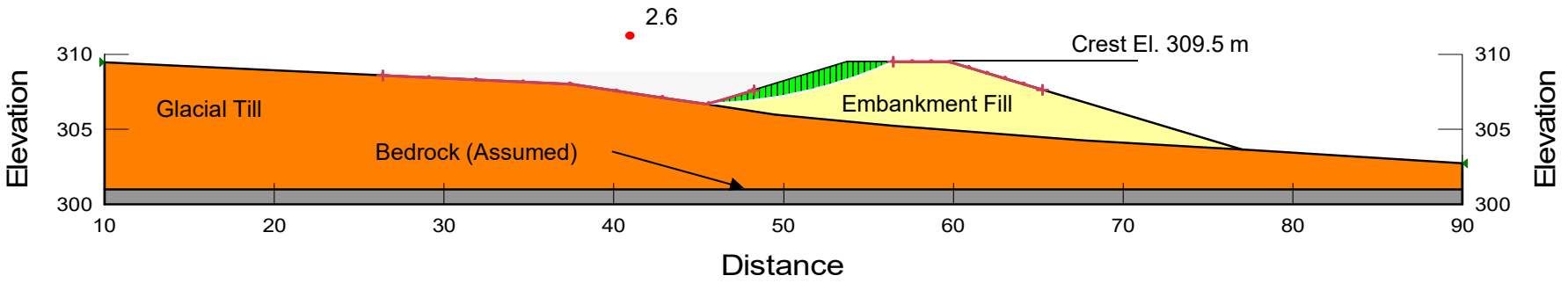
P/A NO. NB102-181/49

REF. NO. NB18-00535

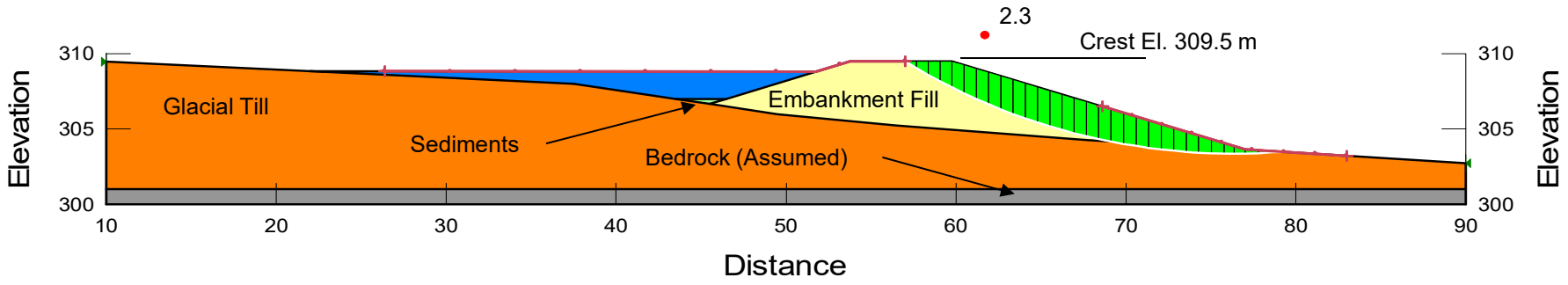
FIGURE 5

REV 0

UPSTREAM SLOPE



DOWNSTREAM SLOPE



NOTES:

1. EMBANKMENT SIDE SLOPES ARE 3.0H:1.0V.
2. CREST WIDTH IS 6 m.
3. A HORIZONTAL SEISMIC ACCELERATION CORRESPONDING TO A PGA OF 0.019g WAS APPLIED TO ALL PSEUDO-STATIC ANALYSES. (NRCAN, 2015).

REV	DATE	DESCRIPTION	PREP'D	RVW'D
0	18SEP'18	ISSUED WITH LETTER NB18-00535	LB	JAB

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

SLOPE STABILITY RESULTS
SEDIMENTATION POND
PSEUDO-STATIC LOADING

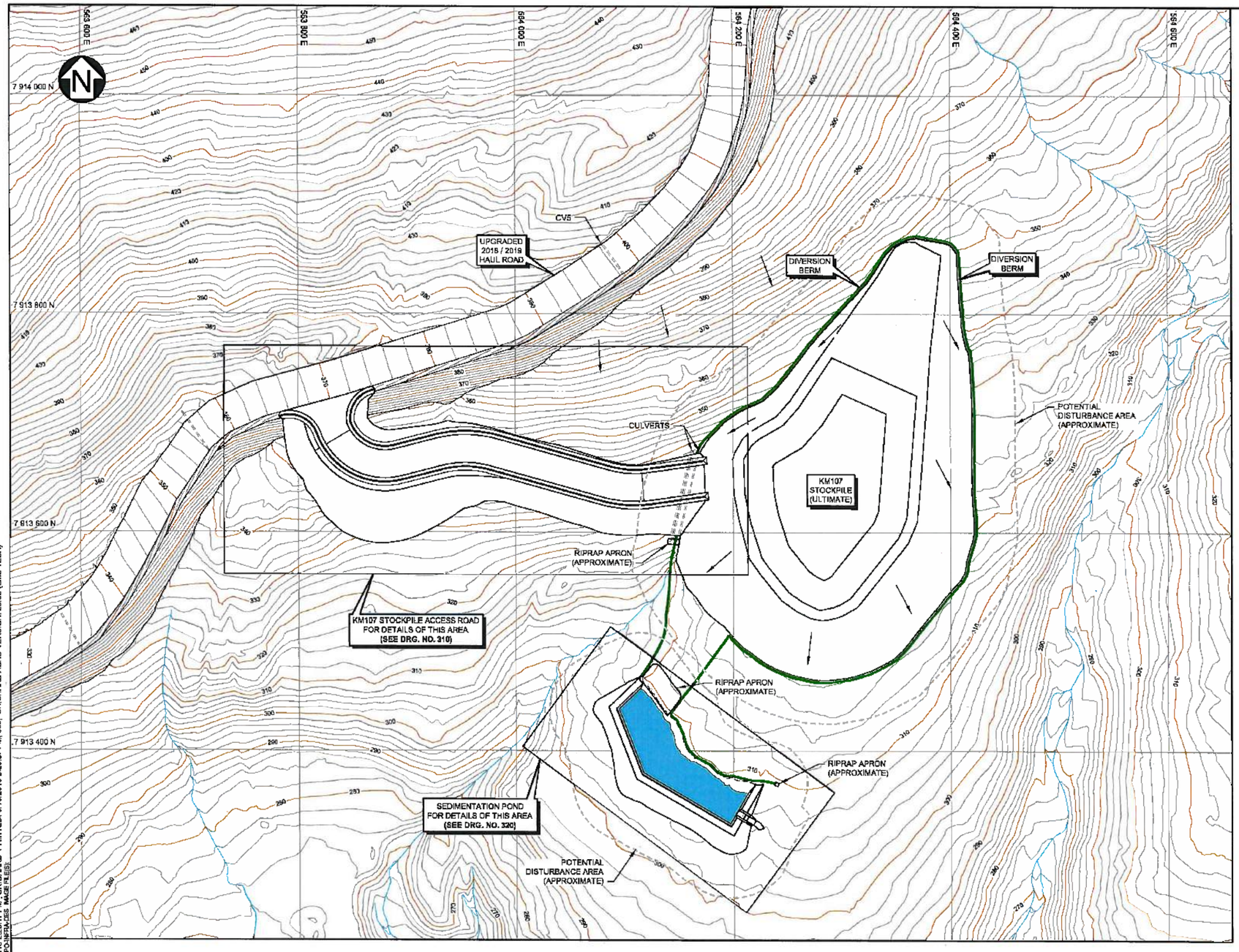
Knight Piésold CONSULTING

P/A NO. NB102-181/49

REF. NO. NB18-00535

FIGURE 6

REV 0



LEGEND:

- WATER
- CULVERT
- DIVERSION BERM
- GENERAL FLOW DIRECTION
- POTENTIAL DISTURBANCE AREA (APPROXIMATE)

NOTES:

1. COORDINATE GRID IS UTM (NAD83) ZONE 17.
2. TOPOGRAPHY BASED ON INFORMATION PROVIDED BY EAGLE MAPPING (2008).
3. CONTOURS ARE IN METRES. CONTOUR INTERVAL IS 2 m.
4. DIMENSIONS AND ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE.
5. LOCATIONS OF CONSTRUCTION ITEMS MAY BE MODIFIED TO SUIT SITE CONDITIONS.
6. UPGRADED 2018 / 2019 HAUL ROAD AND KM107 STOCKPILE PROVIDED BY BAFFINLAND.
7. FINAL SLOPES SHALL BE TRIMMED TO THE LINES AND TOLERANCES INDICATED ON THE DRAWINGS AND IN THE TECHNICAL SPECIFICATIONS.
8. ALL INFRASTRUCTURE SHOWN IS PROPOSED UNLESS NOTED OTHERWISE.
9. THE DRAWING SHALL BE READ IN CONJUNCTION WITH THE CONTRACT DOCUMENTS AND APPLICABLE TECHNICAL SPECIFICATIONS.
10. FOUNDATION PREPARATION: PROVIDED THE AMOUNT OF ORGANICS AND UNSUITABLE MATERIAL ON THE GROUND IS NEGLIGIBLE, DISTURBANCE TO THE ORIGINAL GROUND (EXCAVATION, SCARIFYING, ETC.) SHOULD BE MINIMIZED SO AS NOT TO IMPACT CURRENT PERMAFROST CONDITIONS. ALTERNATIVE METHODS OF FOUNDATION PREPARATION MAY BE NECESSARY FOR SOME AREAS, AT THE DISCRETION OF THE OWNER'S REPRESENTATIVE. ALL FOUNDATIONS MUST BE MAINTAINED CLEAR OF SNOW, PONDED WATER AND ICE.

ISSUED FOR CONSTRUCTION

SCALE A: 40 20 0 40 80 120 160 200 m

DRG. NO.	DESCRIPTION
320	KM107 STOCKPILE - SEDIMENTATION POND AND RUNOFF MANAGEMENT MEASURES - PLAN, SECTION AND DETAILS
310	KM107 STOCKPILE - ACCESS ROAD - PLAN AND SECTION

REFERENCE DRAWINGS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	18SEP'18	ISSUED FOR CONSTRUCTION	DMMD	MMD / SIR		

REVISIONS

Knight Piésold CONSULTING

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

KM107 STOCKPILE GENERAL ARRANGEMENT

P/A NO.	DRAWING NO.	REVISION
NB102-181/49	300	0

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GEOSYNTHETICS:

CO-ORDINATION BETWEEN OWNER, ENGINEER AND CONTRACTOR

1. AFTER THE CONTRACTOR HAS COMPLETED PREPARING THE SUBGRADE SURFACE WHICH WILL LIE DIRECTLY BELOW THE GEOSYNTHETICS, THE CONTRACTOR, ENGINEER AND OWNER WILL VERIFY ACCEPTANCE BY SIGNING A FORM WHICH DESCRIBES THE EXTENT OF THE AREA. AT THAT TIME, THE CONTRACTOR ASSUMES RESPONSIBILITY OF PROTECTING THE APPROVED SURFACE, UNTIL IT IS COVERED WITH GEOSYNTHETICS.
2. ANY DAMAGE BY MECHANICAL MEANS CAUSED BY THE CONTRACTOR TO APPROVED SUBGRADE AREAS SHALL BE REPAIRED TO THE SATISFACTION OF THE ENGINEER AT THE EXPENSE OF THE CONTRACTOR. ANY DAMAGE CAUSED BY WEATHER TO APPROVED SUBGRADE AREAS SHALL BE REPAIRED TO THE SATISFACTION OF THE ENGINEER AT THE EXPENSE OF THE OWNER. ANY DAMAGE CAUSED BY WEATHER TO APPROVED SUBGRADE AREAS RESULTING FROM WIND EROSION OR POOR SURFACE RUNOFF CONTROL (E.G. ALLOWING SURFACE RUNOFF ONTO APPROVED AREAS) AS A RESULT OF OPERATIONS OF THE CONTRACTOR SHALL BE REPAIRED TO THE SATISFACTION OF THE ENGINEER AT THE EXPENSE OF THE CONTRACTOR.
3. AFTER INSTALLATION OF THE GEOSYNTHETICS AND FINAL QUALITY CONTROL MEASURES ARE COMPLETED BY THE CONTRACTOR, AREAS RECEIVING COVER MATERIAL SHALL BE CLEARLY IDENTIFIED AND THE ENGINEER SHALL BE NOTIFIED FOR GEOSYNTHETICS INSPECTION. UPON SIGNED ACCEPTANCE BY THE ENGINEER THAT THE GEOSYNTHETICS HAVE BEEN INSTALLED IN ACCORDANCE WITH THE SPECIFICATIONS, IT WILL BE AVAILABLE TO THE CONTRACTOR FOR PLACING THE COVER MATERIAL, WHERE APPLICABLE. AT THAT TIME THE CONTRACTOR WILL ASSUME RESPONSIBILITY FOR MAINTAINING THE CONDITION OF THE PORTION OF THE GEOSYNTHETICS UNTIL IT IS ADEQUATELY COVERED.
4. ANY DAMAGE TO PREVIOUSLY ACCEPTED GEOSYNTHETICS AS A RESULT OF THE CONTRACTOR'S OPERATION WILL BE REPAIRED TO THE SATISFACTION OF THE ENGINEER AT THE CONTRACTOR'S EXPENSE.
5. IN THE EVENT OF CONTRADICTION OR CONFLICT BETWEEN PARTIES MENTIONED ABOVE, QUESTIONS WILL BE TAKEN TO THE ENGINEER AND OWNER FOR FINAL DECISION.

SUBGRADE PREPARATION

1. SUBGRADE PREPARATION SHALL BE CARRIED OUT IN ACCORDANCE WITH THE MANUFACTURER'S SPECIFICATIONS AND INSTALLATION GUIDELINES.
2. SUBGRADE PREPARATION OVER ROCK SURFACES SHALL REQUIRE THE REMOVAL OF ANY PROTRUDING SURFACE SUCH THAT A SMOOTH GEOMEMBRANE SURFACE IS PROVIDED. NO OVERHANGS, PROTRUSIONS, OR LEDGES OF MORE THAN 0.1 m IN HEIGHT SHALL BE ACCEPTED.
3. PLACEMENT AND COMPACTION OF BEDDING OVER EXPOSED BEDROCK SURFACES SHALL BE CONDUCTED USING PLACEMENT AND COMPACTION METHODS TO SUIT THE SPECIFIC FIELD CONDITIONS. WHERE COMPACTION WITH A STANDARD VIBRATORY ROLLER IS NOT POSSIBLE, ALTERNATIVE COMPACTION EQUIPMENT MAY BE ACCEPTED. THE PLACEMENT AND COMPACTION METHODS MUST BE SUBMITTED TO THE ENGINEER FOR APPROVAL PRIOR TO THEIR IMPLEMENTATION.

DELIVERY, HANDLING AND STORAGE

1. DELIVERY, HANDLING AND STORAGE OF GEOSYNTHETICS MATERIAL SHALL BE IN ACCORDANCE WITH THE MANUFACTURER'S PRINTED INSTRUCTIONS.

GEOSYNTHETICS INSTALLATION

1. THE GEOMEMBRANE SHALL BE ATARFIL LLD, 40 mil, OR APPROVED EQUIVALENT. THE GEOTEXTILE SHALL BE TEXEL 100 P, 10 oz/yd², OR APPROVED EQUIVALENT AND SHALL BE PROVIDED IN INTIMATE CONTACT WITH THE GEOMEMBRANE.
2. THE GEOTEXTILE AND GEOMEMBRANE SHALL BE HANDLED IN SUCH A MANNER AS TO ENSURE THAT IT IS NOT DAMAGED IN ANY WAY. THE MATERIALS SHALL BE STORED INDOORS AT TEMPERATURES ABOVE 0 DEGREES CELSIUS PRIOR TO PLACEMENT. SHOULD THE CONTRACTOR DAMAGE THE GEOTEXTILE TO THE EXTENT THAT IT IS NO LONGER USABLE AS DETERMINED BY THESE SPECIFICATIONS OR BY THE ENGINEER, THE CONTRACTOR SHALL REPLACE THE GEOTEXTILE AS THEIR EXPENSE.
3. THE SUBGRADE UNDERLYING THE GEOTEXTILE SHALL BE APPROVED BY THE ENGINEER AND SHALL BE SMOOTH AND FREE OF RUTS OR PROTRUSIONS WHICH COULD DAMAGE THE GEOTEXTILE. THE GEOTEXTILE AND GEOMEMBRANE SHALL BE LAID FLAT AND SMOOTH SO THAT IT IS IN DIRECT CONTACT WITH THE SUBGRADE. THE GEOTEXTILE SHALL BE FREE OF TENSILE STRESSES, FOLDS AND WRINKLES SO THAT THE OVERLYING MATERIALS WILL NOT EXCESSIVELY STRETCH OR TEAR THE FABRIC. ON SLOPES STEEPER THAN 10H:1V, THE GEOTEXTILE SHALL BE LAID WITH THE MACHINE DIRECTION OF THE FABRIC PARALLEL TO THE SLOPE DIRECTION. ANCHORING OF THE TERMINAL ENDS OF THE GEOTEXTILE SHALL BE ACCOMPLISHED THROUGH THE USE OF ANCHOR TRENCHES, ANCHOR BERMS OR APRONS AT THE CREST AND TOE OF THE SLOPE. THE GEOTEXTILE SHALL BE PLACED DIRECTLY ON THE PREPARED SUBGRADE WITH SEAMS UPWARD AND SHALL EXTEND FOR A MINIMUM OF 0.8 m PAST THE DESIGNED SLOPE TOE.
4. UNLESS OTHERWISE NOTED INSTALLATION OF GEOSYNTHETICS SHALL BE IN ACCORDANCE WITH INTERNATIONAL ASSOCIATION OF GEOSYNTHETICS INSTALLERS - "GUIDELINES FOR INSTALLATION OF FACTORY FABRICATED HEAVY WEIGHT >0.64 mm (25 m11) THICKNESS FABRIC - SUPPORTED GEOMEMBRANES" (MARCH 2014), APPLICABLE GEOSYNTHETICS RESEARCH INSTITUTE STANDARDS, AND THE MANUFACTURER'S "QUALITY CONTROL MANUAL" (JANUARY 2017). GUIDELINES FOR INSTALLATION OF "FACTORY FABRIC - SUPPORTED GEOMEMBRANES" (MARCH, 2014; APPLICABLE .... MANUFACTURERS".
5. THE CONTRACTOR SHALL PROVIDE A WRITTEN GUARANTEE COVERING MATERIALS AND ALL WORKMANSHIP AS WELL AS DEGRADATION DUE TO ULTRAVIOLET LIGHT FOR EXPOSED AREAS. THE MATERIAL SHALL BE WARRANTED AGAINST MANUFACTURER'S DEFECTS FOR A PERIOD OF 5 YEARS FROM THE DATE OF INSTALLATION. THE INSTALLATION SHALL BE WARRANTED AGAINST DEFECTS IN WORKMANSHIP FOR A PERIOD OF 2 YEARS FROM THE DATE OF INSTALLATION.
6. THE GEOSYNTHETICS SHALL BE INSTALLED ON THE AREA SHOWN ON THE DRAWINGS OR AS DIRECTED BY THE ENGINEER.
7. PRIOR TO DEPLOYMENT OF THE GEOSYNTHETICS, THE CONTRACTOR, WITH THE OWNER AND ENGINEER SHALL INSPECT, CERTIFY, AND ACCEPT ALL SURFACES ON WHICH THE GEOTEXTILE AND GEOMEMBRANE IS TO BE PLACED TO ENSURE CONFORMANCE WITH THE SPECIFICATIONS. SURFACES NOT IN COMPLIANCE WITH THE SPECIFICATIONS SHALL BE RECTIFIED BY THE CONTRACTOR. ACCEPTANCE OF THE ANCHOR TRENCHES FOR PLACEMENT OF THE GEOMEMBRANE SHALL BE INCLUDED IN THE SURFACE PREPARATION ACCEPTANCE.
8. THE CONTRACTOR SHALL PROVIDE THE ENGINEER WITH A FINAL PANEL LAYOUT DRAWING, AND HARDCOPY FORMATS, AT LEAST ONE WEEK PRIOR TO PLACING THE GEOMEMBRANE. NO HORIZONTAL SEAMS ON A SLOPE WILL BE ACCEPTED. NO GEOSYNTHETICS SHALL BE INSTALLED WITHOUT PRIOR APPROVAL BY THE ENGINEER OF THE PROPOSED LAYOUT.
9. THE GEOSYNTHETICS WILL BE PLACED USING METHODS AND PROCEDURES THAT ENSURE A MINIMUM OF HANDLING. THE INSTALLER SHALL PROVIDE ADEQUATE TEMPORARY ANCHORING DEVICES TO PREVENT DAMAGE DUE TO WINDS.
10. THE GEOSYNTHETICS SHALL BE INSTALLED IN A RELAXED CONDITION AND SHALL BE FREE OF TENSION OR STRESS UPON COMPLETION OF THE INSTALLATION. ALL NECESSARY PRECAUTIONS, INCLUDING PROVISIONS FOR INSTALLING EXTRA MATERIAL, SHALL BE TAKEN TO AVOID TRAMPOLINING OF ANY GEOMEMBRANE WHICH MAY REMAIN EXPOSED.
11. SEAMS SHALL BE MADE BY LAPPING THE UPSLOPE MATERIAL OVER THE DOWNSLOPE MATERIAL WITH SUFFICIENT OVERLAP. A MINIMUM OF 1 m IS REQUIRED FROM THE TOE OF THE SLOPE TO ANY HORIZONTAL SEAM ON FLAT AREAS.
12. EXTREME CARE SHALL BE TAKEN BY THE CONTRACTOR IN THE PREPARATION OF THE AREAS TO BE WELDED. THE AREAS TO BE WELDED SHALL BE CLEANED AND PREPARED ACCORDING TO THE APPROVED PROCEDURES, AND ALL SHEETING SHALL BE WELDED TOGETHER BY THERMAL METHODS.
13. THE WELDING EQUIPMENT USED SHALL BE CAPABLE OF CONTINUOUSLY MONITORING AND CONTROLLING THE TEMPERATURES IN THE ZONE OF CONTACT WHERE THE MACHINE IS ACTUALLY FUSING THE GEOMEMBRANE MATERIAL, TO ENSURE CHANGES IN WEATHER CONDITIONS WILL NOT AFFECT THE INTEGRITY OF THE WELD.
14. NO "FISH MOUTHS" SHALL BE ALLOWED WITHIN THE SEAM AREA. WHERE "FISH MOUTHS" OCCUR, THE MATERIAL SHALL BE CUT, OVERLAPPED, AND EXTRUSION WELDED. ALL WELDS ON COMPLETION OF THE WORK SHALL BE TIGHTLY BONDED. ANY GEOMEMBRANE AREA SHOWING DISTRESS DUE TO EXCESSIVE SCUFFING OR PUNCTURE DURING INSTALLATION BE REPLACED OR REPAIRED AT THE CONTRACTOR'S EXPENSE.
15. THE CONTRACTOR SHALL TAKE INTO ACCOUNT THAT RAPID WEATHER CHANGES ARE VERY POSSIBLE, RESULTING IN DELAYS IN CONSTRUCTION OF FIELD SEAMS. JOINTING OF PANELS AND REPAIRS WILL ONLY BE PERMITTED UNDER WEATHER CONDITIONS ALLOWING SUCH WORK WITHIN THE WARRANTY LIMITS IMPOSED BY THE GEOMEMBRANE MANUFACTURER.

FIELD SEAM INSPECTION AND TESTING

1. A MAXIMUM EFFORT SHALL BE MADE TO INSTALL A PERFECT LINER SYSTEM. THIS MEANS THAT ALL SEAMS COMPLETED IN THE FIELD, PATCHES AND EXTRUSIONS SHALL BE INSPECTED, TESTED AND RECORDED.
2. A QUALITY CONTROL TECHNICIAN SHALL INSPECT EACH SEAM, MARKING HIS/HER INITIALS AND THE DATE INSPECTED AT THE END OF EACH PANEL. ANY AREA SHOWING A DEFECT SHALL BE MARKED AND REPAIRED IN ACCORDANCE WITH APPLICABLE GEOMEMBRANE REPAIR PROCEDURES.
3. ALL FIELD SAMPLING AND TESTING SHALL BE DONE BY THE CONTRACTOR AS APPROVED BY THE ENGINEER.
4. THE FIELD INSTALLATION TESTING PROGRAM SHALL CONSIST OF PERIODIC VISUAL OBSERVATIONS, CONTINUITY, AND STRENGTH TESTS. THESE INSPECTIONS AND TESTS ARE TO BE MADE ROUTINELY AND ARE REQUIRED REGARDLESS OF OTHER TYPES OF TESTING THAT MAY BE COMPLETED. THE INSTALLER SHALL PERFORM QUALITY CONTROL TESTING ACCORDING TO THE TYPES AND FREQUENCY INDICATED BELOW.
   - VISUAL OBSERVATIONS ARE TO BE MADE ROUTINELY AND SHALL INCLUDE THE FOLLOWING:
   - VISUALLY CHECK FIELD SEAMS FOR SQUEEZE OUT, FOOT PRINT, MELT AND OVERLAP
   - CHECK MACHINES FOR CLEANNESS, TEMPERATURE AND RELATED ITEMS.
   - ANY AREA OF THE SEAM OR PANEL SHOWING A DEFECT SHALL BE MARKED AND REPAIRED IN ACCORDANCE WITH THE APPLICABLE REPAIR PROCEDURES.

   - CONTINUITY TESTING IS REQUIRED FOR ALL FIELD SEAMS AND REPAIRED AREAS. INTER-SEAM PRESSURE OR "AIR TESTING" AND TESTING USING VACUUM BOX ARE CONSIDERED ACCEPTABLE METHODS FOR CONTINUITY TESTING. THE TEST PROCEDURE FOR INTER-SEAM PRESSURE OR AIR TESTING IS AS FOLLOWS:
   - SEAL BOTH ENDS OF THE SEAM TO BE TESTED BY APPLYING HEAT TO THE END OF THE SEAM UNTIL FLOW TEMPERATURE IS ACHIEVED. CLAMP OFF THE ENDS AND LET COOL.
   - INSERT A PRESSURE GAUGE/NEEDLE ASSEMBLY INTO THE END OF THE SEAM AND SEAL.
   - THE SEAM SHALL BE PRESSURIZED TO AN INITIAL START PRESSURE, MINIMUM 28 psi AND MAXIMUM 30 psi.
   - THE INITIAL START PRESSURE IS READ AFTER A 2-MINUTE RELAXING PERIOD, WHICH ALLOWS THE AIR TO REACH AMBIENT GEOMEMBRANE TEMPERATURE; THE ENDING PRESSURE IS READ AFTER 5 MINUTES.
   - THE ALLOWABLE PRESSURE DROP IS 3 psi LESS THAN THE INITIAL START PRESSURE.
   - THE RESULTS OF THE AIR TEST SHALL BE MARKED AT THE TEST LOCATION AND SHALL BE RECORDED BY THE CONTRACTOR. IF THE TEST FAILS, THE LOCATION OF THE LEAK SHALL BE FOUND AND REPAIRED AND RETESTED OR THE ENTIRE SEAM SHALL BE REPAIRED AND RETESTED.

   - THE TEST PROCEDURE FOR VACUUM BOX TESTING IS AS FOLLOWS;
   - MIX A SOLUTION OF LIQUID DETERGENT AND WATER AND APPLY AN AMPLE AMOUNT TO THE AREA TO BE TESTED. IF A SEAM CONTAINS EXCESS OVERLAP OR LOOSE EDGES IT IS TO BE TRIMMED BEFORE TESTING.
   - PLACE A TRANSLUCENT VACUUM BOX OVER THE AREA AND APPLY A SLIGHT AMOUNT OF DOWNWARD PRESSURE TO THE BOX TO THE SEAL TO THE GEOMEMBRANE.
   - APPLY A VACUUM (3 psi TO 5 psi) TO THE AREA. ANY LEAKS WILL BECOME VISIBLE BY LARGE BUBBLES AND SHALL BE REPAIRED.
5. STRENGTH TESTS ON SEAMS SHALL BE CARRIED OUT ON SAMPLE COUPONS CUT FROM THE INSTALLED GEOMEMBRANE IN ACCORDANCE WITH THE MANUFACTURER'S SPECIFICATIONS AND THE INTERNATIONAL ASSOCIATION OF GEOSYNTHETICS INSTALLERS "GUIDELINES FOR INSTALLATION OF FACTORY FABRICATED HEAVYWEIGHT > 0.64 mm (25 mil) THICKNESS FABRIC - SUPPORTED GEOMEMBRANES" (MARCH, 2014). APPLICABLE GEOSYNTHETICS RESEARCH INSTITUTE STANDARDS AND THE MANUFACTURER'S QUALITY CONTROL MANUAL.

AS-BUILT DOCUMENTATION

1. THE CONTRACTOR SHALL PROVIDE THE OWNER AND ENGINEER WITH COPIES OF ALL THE FABRICATION AND INSTALLATION TEST LOGS AND CONFORMANCE DATA INCLUDING:
   - GEOSYNTHETIC CERTIFICATION
   - DAILY PANEL PLACEMENT LOGS
   - AS-BUILT PANEL LAYOUT DRAWINGS
   - SEAM CONTROL LOGS
   - CONSTRUCTION REPAIR REPORT
2. IN ADDITION, THE CONTRACTOR SHALL SUBMIT AS-BUILT DRAWINGS SHOWING THE INSTALLED GEOMEMBRANE PANEL LAYOUT WITH EACH PANEL OR PORTION OF PANEL IDENTIFIED BY THE MANUFACTURER'S IDENTIFICATION NUMBER. THE EXTENT OF THE INSTALLED GEOSYNTHETICS AND LOCATIONS OF ALL TESTS SHALL BE IDENTIFIED ALONG WITH LOCATIONS OF ANY REPAIRS. THE AS-BUILT DRAWINGS SHALL BE MADE AVAILABLE ELECTRONICALLY TO THE OWNER AND ENGINEER IN A TIMELY FASHION AFTER THE WORK IS COMPLETE.

FILL MATERIALS:

MATERIAL PLACEMENT AND COMPACTION REQUIREMENTS	
ZONE AND MATERIAL TYPE	PLACING AND COMPACTION REQUIREMENTS
ROAD EMBANKMENT FILL	MATERIAL SHALL BE WELL GRADED AND CONSIST OF HARD, DURABLE FRESH ROCKFILL FREE OF DELETERIOUS MATERIALS. ACCESS ROAD: MATERIAL TO BE PLACED BY TRUCK AND BULLDOZER STARTING AT THE EXISTING HAUL ROAD. COMPACTION TO BE ACHIEVED BY ROUTING HAULAGE TRAFFIC OVER THE ENTIRE SURFACE OF THE ROAD. SAFETY BERMS: MATERIAL TO BE PLACED AND NOMINALLY COMPACTED TO THE DIMENSIONS SHOWN ON THE DRAWINGS.
RIPRAP	RIPRAP SHALL BE WELL GRADED AND CLEAN, DURABLE AND ANGULAR IN SHAPE. FINE RIPRAP D_{50} = 75 mm; COARSE RIPRAP D_{50} = 200 mm. MATERIAL TO BE PLACED AND SPREAD IN MAXIMUM 150 mm LAYER (FINE RIPRAP) OR 400 mm LAYER (COARSE RIPRAP). PLACED TO FORM A TIGHTLY INTERLOCKING LAYER.
INTERMEDIATE BEDDING	MATERIAL SHALL CONSIST OF 32 mm MINIMUM CLEAN SAND AND GRAVEL FREE OF CLAY, LOAM, ORGANICS, AND OTHER DELETERIOUS MATERIAL. MATERIAL SHALL BE PLACED, SPREAD AND MOISTURE CONDITIONED IN MAXIMUM 200 mm LAYER AFTER COMPACTION FROM A MINIMUM OF 5 PASSES WITH A 10 TONNE SMOOTH DRUM ROLLER.
BERM FILL	MATERIAL SHALL CONSIST OF CLEAN, WELL GRADED, 150 mm MINUS PROCESSED ROCKFILL AND SHALL BE FREE OF CLAY, LOAM, ORGANICS, AND OTHER DELETERIOUS MATERIALS. SEDIMENTATION POND: PLACED AND SPREAD IN MAXIMUM 300 mm LAYERS AFTER COMPACTION. COMPACTION TO CONSIST OF MINIMUM 6 PASSES BY A 10 TONNE SMOOTH DRUM VIBRATORY ROLLER. DIVERSION BERMS: PLACED AND SPREAD IN MAXIMUM 200 mm LAYERS AFTER COMPACTION. NOMINAL COMPACTION.

NOTES:

1. THE DRAWING SHALL BE READ IN CONJUNCTION WITH THE ACCOMPANYING CONTRACT DOCUMENTS AND APPLICABLE TECHNICAL SPECIFICATIONS.
2. ROAD EMBANKMENT FILL TO BE USED FOR THE ACCESS ROAD AND SAFETY BERMS.
3. INTERMEDIATE BEDDING TO BE USED FOR ANCHOR TRENCH BACKFILL AND ANCHOR BERMS; BEDDING MATERIAL FOR GEOMEMBRANE, AND BEDDING AND BACKFILL FOR CULVERTS AND PIPES.
4. BERM FILL TO BE USED FOR THE SEDIMENTATION POND BERMS AND DIVERSION BERMS.
5. FILL MATERIALS USED FOR CONSTRUCTION SHALL NOT BE POTENTIALLY ACID GENERATING (PAG) OR METAL LEACHING (ML). THROUGHOUT CONSTRUCTION, ADEQUATE INSPECTION AND PERIODIC TESTING SHOULD BE CARRIED OUT TO DEMONSTRATE THE SUITABILITY OF THE FILL MATERIALS.
6. UNLESS OTHERWISE NOTED ALL MATERIALS SHALL CONSIST OF HARD, DURABLE FILL MATERIAL, FREE OF CLAY, LOAM, TREE STUMPS, ROOTS AND OTHER DELETERIOUS MATERIALS OR ORGANIC MATTER, AND CONTAIN NO MASSIVE ICE.

ISSUED FOR CONSTRUCTION

Knight Piésold CONSULTING

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

KM107 STOCKPILE SPECIFICATIONS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	18SEP'18	ISSUED FOR CONSTRUCTION	DMMD	MMD / SIR		

REVISIONS

DRG. NO.	DESCRIPTION

REFERENCE DRAWINGS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED

REVISIONS

P/A NO.	DRAWING NO.	REVISION
NB102-181/49	301	0

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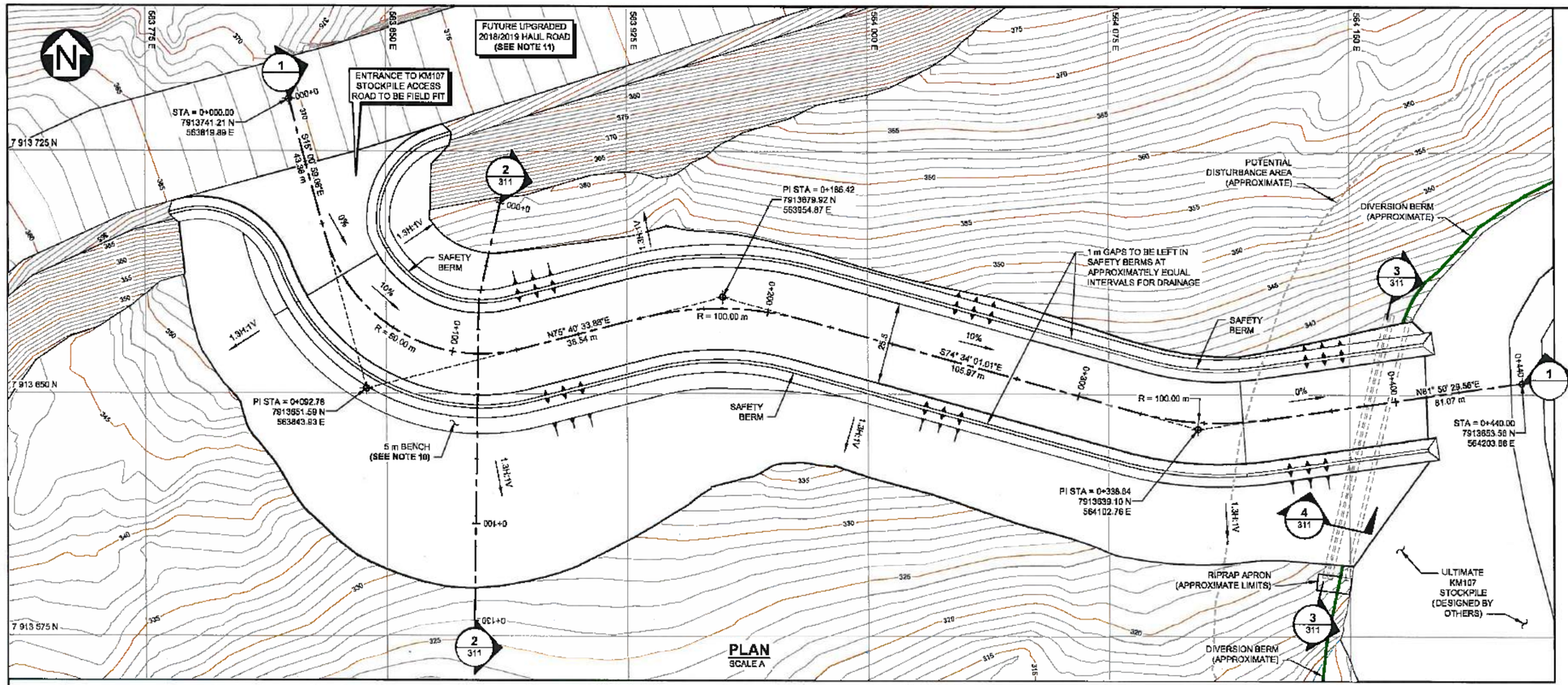
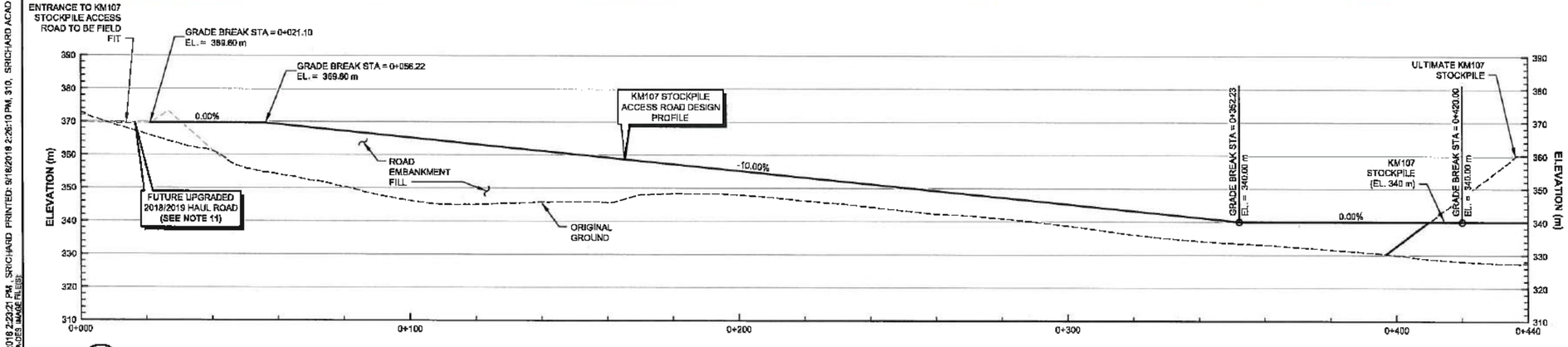


PLAN
SCALE A



1 SECTION
KM107 STOCKPILE ACCESS ROAD
SCALE A

LEGEND:

- CULVERT
- DIVERSION BERM
- ORIGINAL GROUND
- POTENTIAL DISTURBANCE AREA (APPROXIMATE)

NOTES:

1. COORDINATE GRID IS UTM (NAD83) ZONE 17.
2. TOPOGRAPHY BASED ON INFORMATION PROVIDED BY EAGLE MAPPING (2006).
3. CONTOURS ARE IN METRES. CONTOUR INTERVAL IS 1 m.
4. DIMENSIONS AND ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE.
5. ALL INFRASTRUCTURE SHOWN IS PROPOSED UNLESS NOTED OTHERWISE.
6. THE DRAWING SHALL BE READ IN CONJUNCTION WITH THE CONTRACT DOCUMENTS AND APPLICABLE TECHNICAL SPECIFICATIONS.
7. FOUNDATION PREPARATION: PROVIDED THE AMOUNT OF ORGANICS AND UNSUITABLE MATERIAL ON THE GROUND IS NEGLIGIBLE, DISTURBANCE TO THE ORIGINAL GROUND (EXCAVATION, SCARIFYING, ETC.) SHOULD BE MINIMIZED SO AS NOT TO IMPACT CURRENT PERMAFROST CONDITIONS. ALTERNATIVE METHODS OF FOUNDATION PREPARATION MAY BE NECESSARY FOR SOME AREAS, AT THE DISCRETION OF THE OWNER'S REPRESENTATIVE. ALL FOUNDATIONS MUST BE MAINTAINED CLEAR OF SNOW, PONDED WATER AND ICE.
8. FINAL SLOPES SHALL BE TRIMMED TO THE LINES AND TOLERANCES INDICATED ON THE DRAWINGS AND IN THE TECHNICAL SPECIFICATIONS.
9. LOCATIONS OF CONSTRUCTION ITEMS MAY BE MODIFIED TO SUIT SITE CONDITIONS.
10. FIVE METRE BENCH ON DOWNSTREAM SIDE OF THE ACCESS ROAD TO BE CONSTRUCTED BETWEEN CHAINAGES 0+035 TO 0+180.
11. FUTURE UPGRADED 2018/2019 HAUL ROAD PROVIDED BY BAFFINLAND AUGUST 2018.
12. ACCESS ROAD FILL SLOPES TO BE AT ANGLE OF REPOSE FOR ROAD EMBANKMENT FILL. 1.3H:1V HAS BEEN ASSUMED BASED ON MATERIAL PROPERTIES.

ISSUED FOR CONSTRUCTION

SCALE A 15 7.5 0 25 50 75 m

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MARY RIVER PROJECT

KM107 STOCKPILE ACCESS ROAD PLAN AND SECTION

PIA NO.	DRAWING NO.	REVISION
NB102-181/49	310	0

311	KM107 STOCKPILE - ACCESS ROAD - SECTIONS
ORG. NO.	DESCRIPTION

REFERENCE DRAWINGS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED

REVISIONS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	18SEP18	ISSUED FOR CONSTRUCTION	DMMD	MMD / SIR		

REVISIONS

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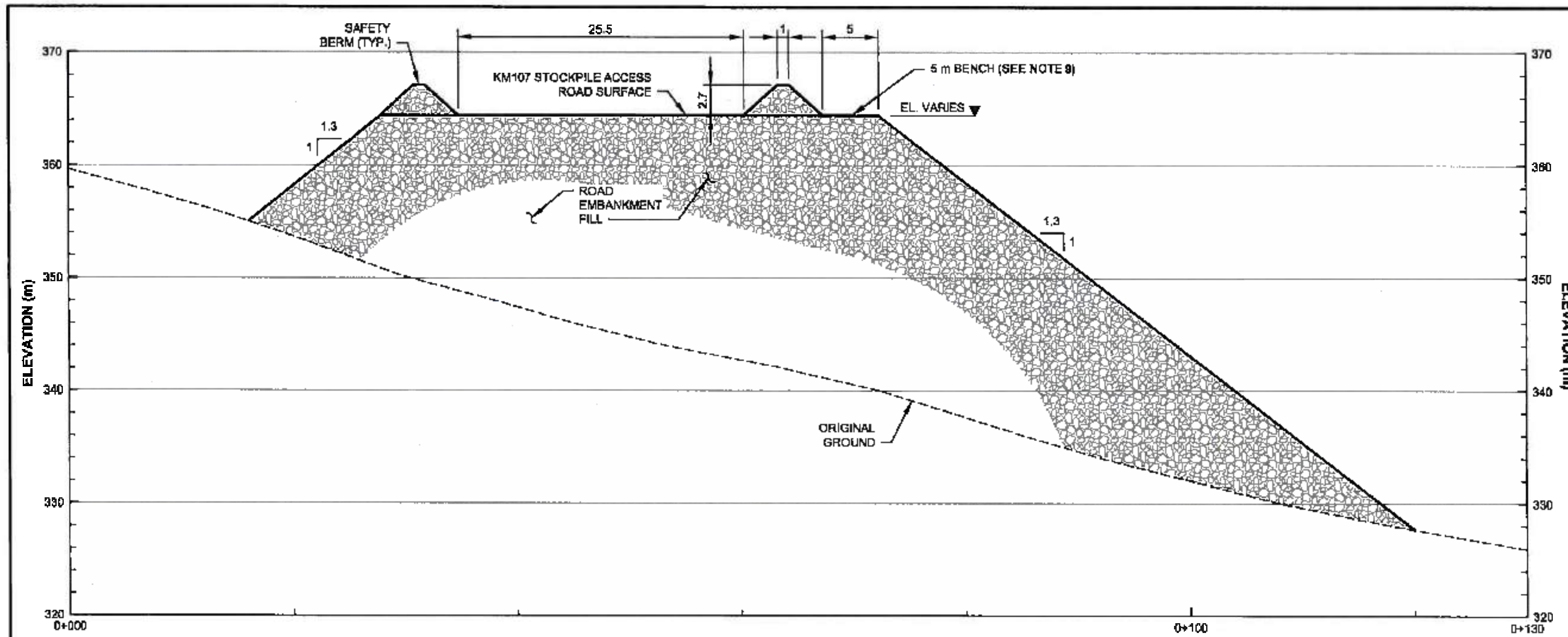
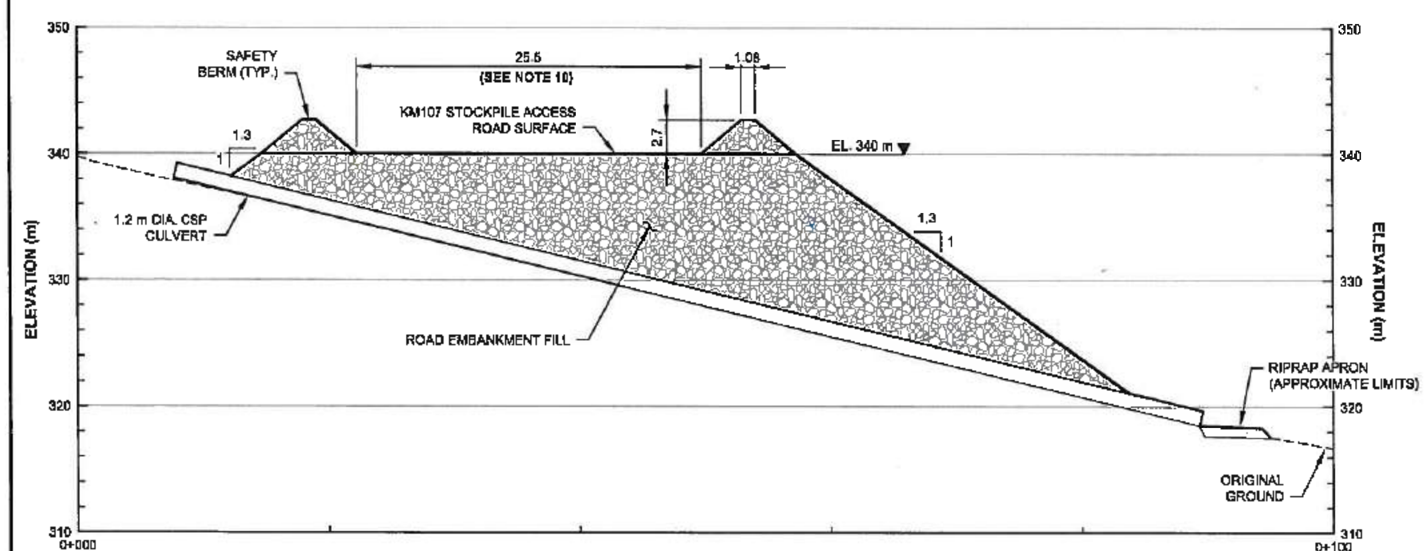
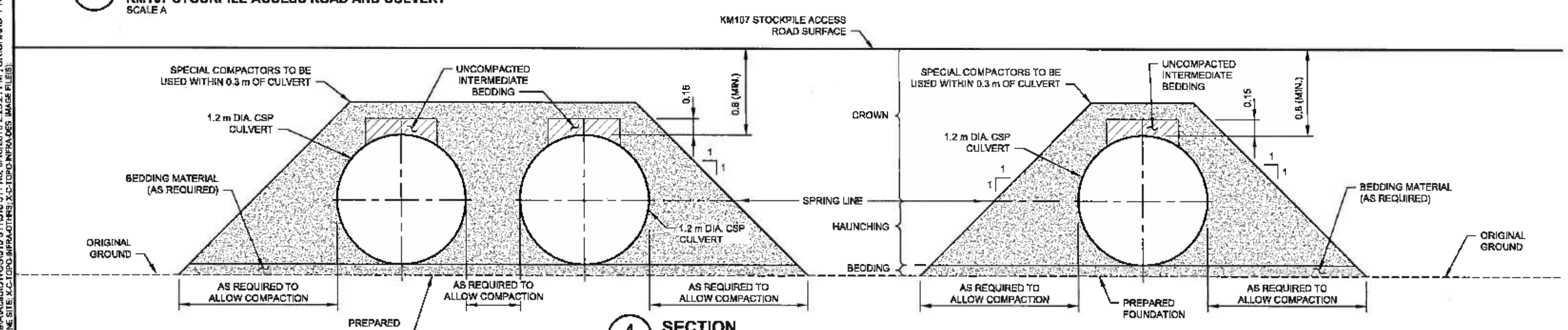


2 / 310 SECTION
KM107 STOCKPILE ACCESS ROAD
SCALE A



3 / 310 SECTION
KM107 STOCKPILE ACCESS ROAD AND CULVERT
SCALE A



4 / 310 SECTION
TYPICAL SECTION - KM107 STOCKPILE ACCESS ROAD CULVERTS
SCALE B

LEGEND:

- ROAD EMBANKMENT FILL
- UNCOMPACTED INTERMEDIATE BEDDING
- COMPACTED INTERMEDIATE BEDDING
- – – – – ORIGINAL GROUND

NOTES:

1. TOPOGRAPHY BASED ON INFORMATION PROVIDED BY EAGLE MAPPING (2008).
2. DIMENSIONS AND ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE.
3. ALL INFRASTRUCTURE SHOWN IS PROPOSED UNLESS NOTED OTHERWISE.
4. THE DRAWING SHALL BE READ IN CONJUNCTION WITH THE CONTRACT DOCUMENTS AND APPLICABLE TECHNICAL SPECIFICATIONS.
5. FOUNDATION PREPARATION: PROVIDED THE AMOUNT OF ORGANICS AND UNSUITABLE MATERIAL ON THE GROUND IS NEGLIGIBLE, DISTURBANCE TO THE ORIGINAL GROUND (EXCAVATION, SCARIFYING, ETC.) SHOULD BE MINIMIZED SO AS NOT TO IMPACT CURRENT PERMAFROST CONDITIONS. ALTERNATIVE METHODS OF FOUNDATION PREPARATION MAY BE NECESSARY FOR SOME AREAS, AT THE DISCRETION OF THE OWNER'S REPRESENTATIVE. ALL FOUNDATIONS MUST BE MAINTAINED CLEAR OF SNOW, PONDED WATER AND ICE.
6. FINAL SLOPES SHALL BE TRIMMED TO THE LINES AND TOLERANCES INDICATED ON THE DRAWINGS AND IN THE TECHNICAL SPECIFICATIONS.
7. LOCATIONS OF CONSTRUCTION ITEMS MAY BE MODIFIED TO SUIT SITE CONDITIONS.
8. FOR MATERIAL SPECIFICATIONS SEE DRG. NO. 301.
9. FIVE METRE BENCH ON DOWNSTREAM SIDE OF THE ACCESS ROAD TO BE CONSTRUCTED BETWEEN CHAINAGES 0+035 TO 0+180.
10. THE SECTION IS NOT PERPENDICULAR TO THE SLOPE.
11. ACCESS ROAD FILL SLOPES WILL BE AT ANGLE OF REPOSE FOR ROAD EMBANKMENT FILL. 1.3H:1V HAS BEEN ASSUMED BASED ON MATERIAL PROPERTIES.

ISSUED FOR CONSTRUCTION

SCALE A: 6 3 0 10 20 30 m
SCALE B: 0.5 0.25 0 0.5 1.0 1.5 2.0 2.5 m

Knight Piésold CONSULTING

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MARY RIVER PROJECT

KM107 STOCKPILE ACCESS ROAD SECTIONS

P/A NO.	DRAWING NO.	REVISION
NB102-181/49	311	0

REFERENCE DRAWINGS

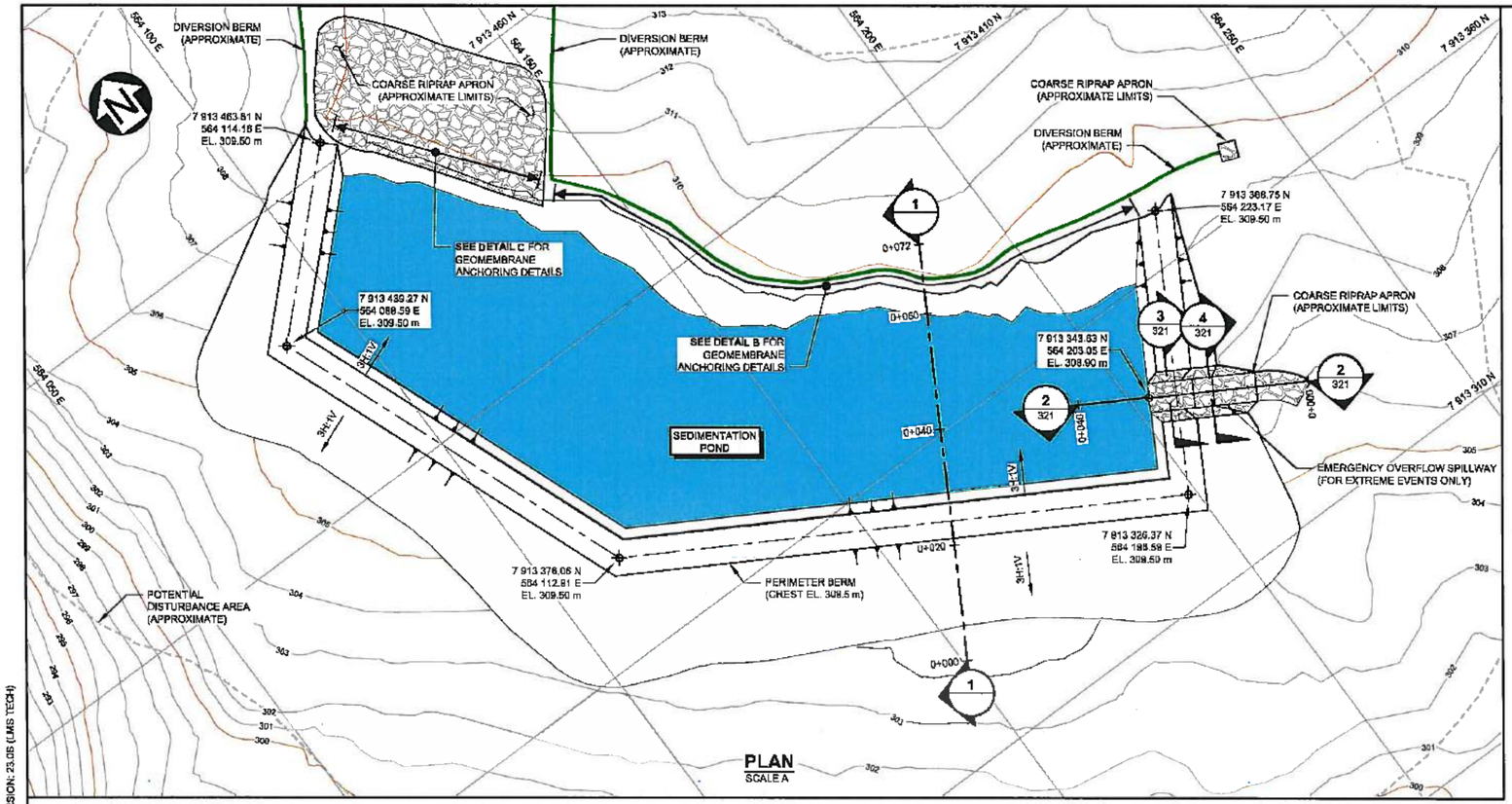
DRG. NO.	DESCRIPTION
310	KM107 STOCKPILE - ACCESS ROAD - PLAN AND SECTION
301	KM107 STOCKPILE - SPECIFICATIONS

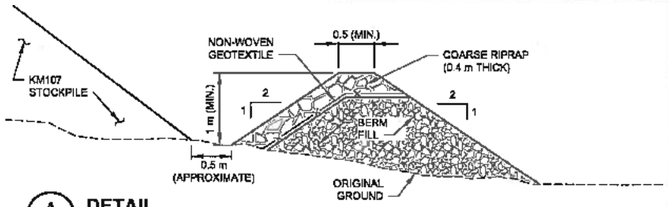
REVISIONS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED

REVISIONS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	18SEP'18	ISSUED FOR CONSTRUCTION	DMMD	MMD / SIR	[signature]	[signature]





A **DETAIL**
TYPICAL DIVERSION BERM
NTS

LEGEND:

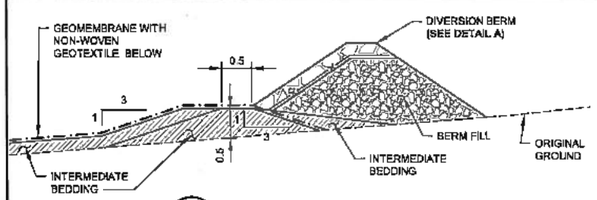
- WATER
- FINE RIPRAP
- COARSE RIPRAP
- BERM FILL
- INTERMEDIATE BEDDING
- GEOMEMBRANE WITH NON-WOVEN GEOTEXTILE ABOVE AND BELOW
- ORIGINAL GROUND
- DIVERSION BERM
- POTENTIAL DISTURBANCE AREA (APPROXIMATE)

NOTES:

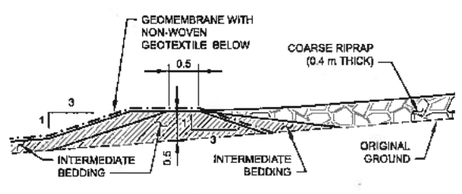
1. COORDINATE GRID IS UTM (NAD83) ZONE 17.
2. TOPOGRAPHY BASED ON INFORMATION PROVIDED BY EAGLE MAPPING (2008).
3. CONTOURS ARE IN METRES. CONTOUR INTERVAL IS 1 m.
4. ALL INFRASTRUCTURE SHOWN IS PROPOSED UNLESS OTHERWISE NOTED.
5. DIMENSIONS AND ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE.
6. LOCATIONS OF CONSTRUCTION ITEMS MAY BE MODIFIED TO SUIT SITE CONDITIONS.
7. FOR MATERIAL AND GEOSYNTHETIC SPECIFICATIONS SEE DRG. NO. 301.
8. GEOMEMBRANE TO BE 40 mil ATARFIL LINEAR LOW DENSITY TEXTURED GEOMEMBRANE OR APPROVED EQUIVALENT AND TO BE INSTALLED AS PER THE MANUFACTURER'S SPECIFICATIONS.
9. NON-WOVEN GEOTEXTILE TO BE TEXEL 100P OR APPROVED EQUIVALENT WHEN PLACED ADJACENT TO GEOMEMBRANE. NON-WOVEN GEOTEXTILE TO BE 12 oz/yd^2 FOR ALL OTHER LOCATIONS. NON-WOVEN GEOTEXTILE TO BE INSTALLED AS PER THE MANUFACTURER'S SPECIFICATIONS.
10. ANCHOR TRENCH TO BE EXCAVATED TO THE APPROXIMATE LIMITS SHOWN (0.5 m x 0.5 m IN SECTION). FOLLOWING GEOTEXTILE AND GEOMEMBRANE INSTALLATION, TRENCH TO BE BACKFILLED WITH COMPACTED INTERMEDIATE BEDDING MATERIAL.
11. DOWNSTREAM SLOPE OF BERM TO BE TRIMMED AND NOMINALLY COMPACTED. UPSTREAM SLOPE OF BERM TO BE PREPARED FOR GEOSYNTHETICS INSTALLATION AS PER THE TECHNICAL SPECIFICATIONS.
12. EXCAVATION SLOPES ARE THE CONTRACTOR'S RESPONSIBILITY.
13. DIVERSION BERM TO BE GRADED AT 1% (MINIMUM) IN DIRECTION OF FLOW.
14. FOUNDATION PREPARATION: PROVIDED THE AMOUNT OF ORGANICS AND UNSUITABLE MATERIAL ON THE GROUND IS NEGLIGIBLE, DISTURBANCE TO THE ORIGINAL GROUND (EXCAVATION, SCARIFYING, ETC.) SHOULD BE MINIMIZED SO AS NOT TO IMPACT CURRENT PERMAFROST CONDITIONS. ALTERNATIVE METHODS OF FOUNDATION PREPARATION MAY BE NECESSARY FOR SOME AREAS, AT THE DISCRETION OF THE OWNER'S REPRESENTATIVE. ALL FOUNDATIONS MUST BE MAINTAINED CLEAR OF SNOW, PONDED WATER AND ICE.
15. THE DRAWING SHALL BE READ IN CONJUNCTION WITH THE CONTRACT DOCUMENTS AND APPLICABLE TECHNICAL SPECIFICATIONS.
16. FINAL SLOPES SHALL BE TRIMMED TO THE LINES AND TOLERANCES INDICATED ON THE DRAWINGS AND IN THE TECHNICAL SPECIFICATIONS.
17. RIPRAP TO BE CLEAN, DURABLE AND ANGULAR. RIPRAP TO BE TIGHTLY PLACED AND SPREAD IN MAXIMUM ROCK LAYERS.

ISSUED FOR CONSTRUCTION

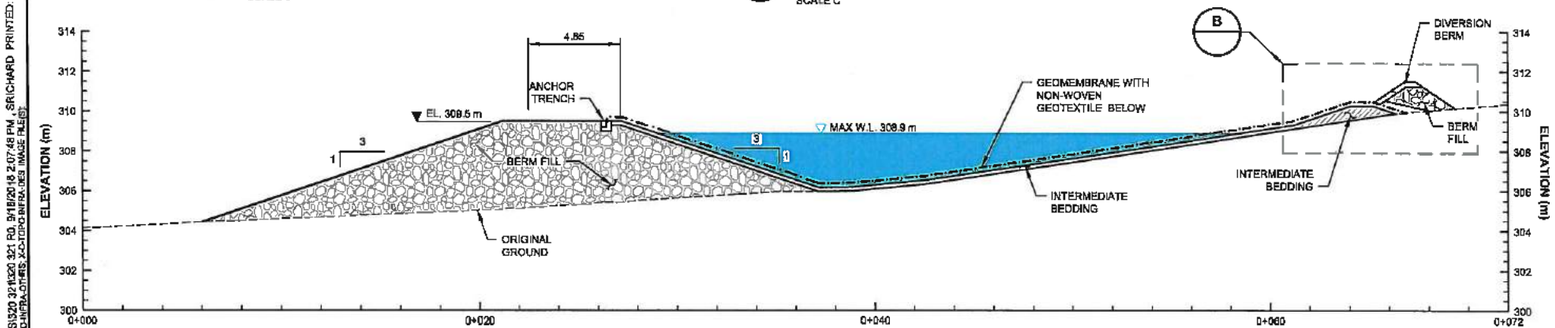
SCALE A: 8 4 0 10 20 30 40 m
SCALE B: 3 1.5 0 5 10 15 m
SCALE C: 1 0.5 0 1 2 3 4 5 m



B **DETAIL**
GEOMEMBRANE ANCHORING DETAIL
SCALE C



C **DETAIL**
GEOMEMBRANE ANCHORING DETAIL
SCALE C



1 **SECTION**
SEDIMENTATION POND
SCALE B

DRG. NO.	DESCRIPTION
321	KM107 STOCKPILE - SEDIMENTATION POND AND RUNOFF MANAGEMENT MEASURES - SECTIONS AND DETAILS
301	KM107 STOCKPILE - SPECIFICATIONS

REFERENCE DRAWINGS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED

REVISIONS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	18SEP'18	ISSUED FOR CONSTRUCTION	DMMD	MMD / SIR		

REVISIONS

Knight Piésold CONSULTING

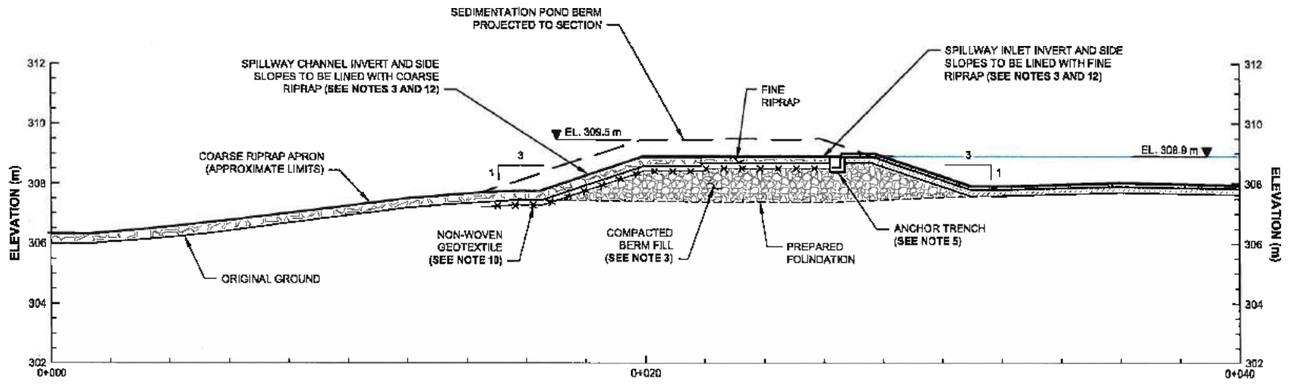
BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

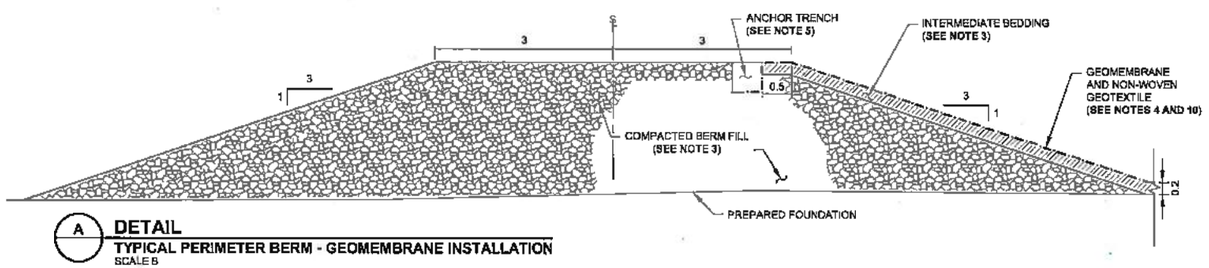
KM107 STOCKPILE SEDIMENTATION POND AND RUNOFF MANAGEMENT MEASURES PLAN, SECTION AND DETAILS

PIA NO.	DRAWING NO.	REVISION
NB102-181/49	320	0

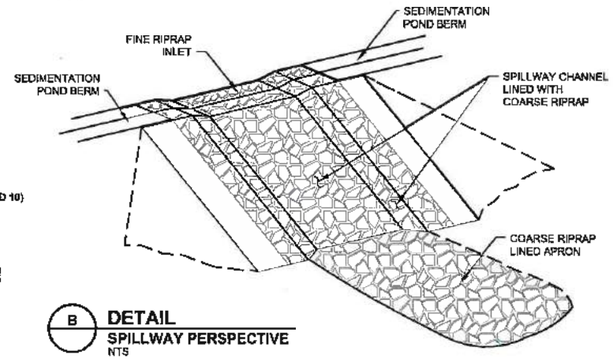
SAVED: I:\1\02\001\81\49\AA\acad\DWGS\320 321R0 321 R0_9\18\2018 2:07:46 PM, SRICHARD PRINTED: 9/18/2018 2:27:01 PM, 320, SRICHARD ACAD VERSION: 23.0S (LMS TECH)
XREF FILE(S): XC-TOPO-MINE SITE, XC-TOPO-INFRA-CNTRS, XC-TOPO-INFRA-DES IMAGE FILE(S):



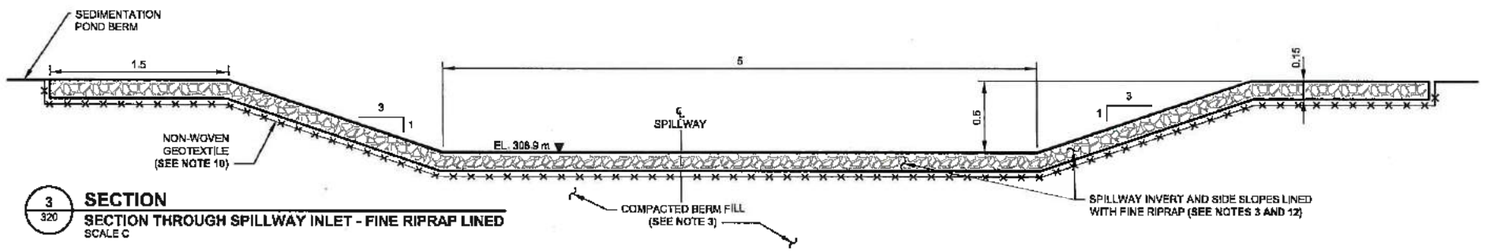
2/320 SECTION
SECTION THROUGH SPILLWAY
SCALE A



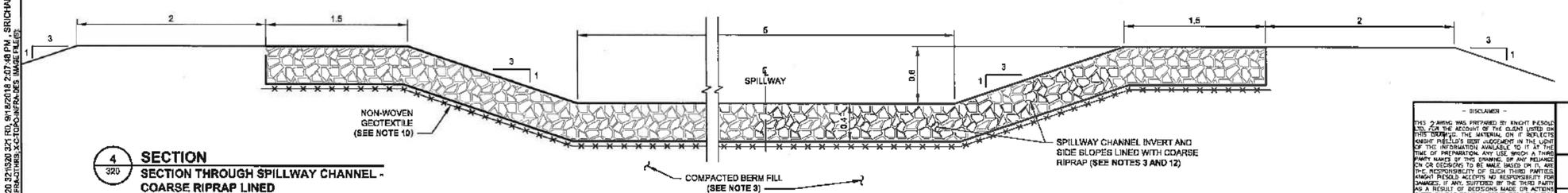
A DETAIL
TYPICAL PERIMETER BERM - GEOMEMBRANE INSTALLATION
SCALE B



B DETAIL
SPILLWAY PERSPECTIVE
NTS



3/320 SECTION
SECTION THROUGH SPILLWAY INLET - FINE RIPRAP LINED
SCALE C



4/320 SECTION
SECTION THROUGH SPILLWAY CHANNEL - COARSE RIPRAP LINED
SCALE C

LEGEND:

- BERM FILL
- FINE RIPRAP
- COARSE RIPRAP
- INTERMEDIATE BEDDING
- NON-WOVEN GEOTEXTILE
- GEOMEMBRANE WITH NON-WOVEN GEOTEXTILE ABOVE AND BELOW
- ORIGINAL GROUND
- PREPARED FOUNDATION

NOTES:

1. DIMENSIONS AND ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE.
2. LOCATION OF CONSTRUCTION ITEMS MAY BE MODIFIED TO SUIT SITE CONDITIONS.
3. FOR MATERIAL AND GEOSYNTHETIC SPECIFICATIONS SEE DRG. NO. 301.
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6. DOWNSTREAM SLOPE OF BERM TO BE TRIMMED AND NOMINALLY COMPACTED. UPSTREAM SLOPE OF BERM TO BE PREPARED FOR GEOSYNTHETICS INSTALLATION AS PER THE TECHNICAL SPECIFICATIONS.
7. EXCAVATION SLOPES ARE THE CONTRACTOR'S RESPONSIBILITY.
8. FOUNDATION PREPARATION: PROVIDED THE AMOUNT OF ORGANICS AND UNSUITABLE MATERIAL ON THE GROUND IS NEGLIGIBLE, DISTURBANCE TO THE ORIGINAL GROUND (EXCAVATION, SCARIFYING, ETC.) SHOULD BE MINIMIZED SO AS NOT TO IMPACT CURRENT PERMAFROST CONDITIONS. ALTERNATIVE METHODS OF FOUNDATION PREPARATION MAY BE NECESSARY FOR SOME AREAS, AT THE DISCRETION OF THE OWNER'S REPRESENTATIVE. ALL FOUNDATIONS MUST BE MAINTAINED CLEAR OF SNOW, PONDED WATER AND ICE.
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11. FINAL SLOPES SHALL BE TRIMMED TO THE LINES AND TOLERANCES INDICATED ON THE DRAWINGS AND IN THE TECHNICAL SPECIFICATIONS.
12. RIPRAP TO BE CLEAN, DURABLE AND ANGULAR. RIPRAP TO BE TIGHTLY PLACED AND SPREAD IN MAXIMUM LAYERS, AS NOTED ON DRG. NO. 301.

ISSUED FOR CONSTRUCTION

SCALE A 2 1 0 2 4 6 8 10 m
SCALE B 1 0.5 0 1 2 3 4 5 m
SCALE C 0.5 0.25 0 0.5 1.0 1.5 2.0 2.5 m

Knight Piésold CONSULTING

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

KM107 STOCKPILE SEDIMENTATION POND AND RUNOFF MANAGEMENT MEASURES SECTIONS AND DETAILS

P/A NO.	DRAWING NO.	REVISION
NB102-181/49	321	0

ORG. NO	DESCRIPTION
320	KM107 STOCKPILE - SEDIMENTATION POND AND RUNOFF MANAGEMENT MEASURES - PLAN, SECTION AND DETAILS
301	KM107 STOCKPILE - SPECIFICATIONS

REFERENCE DRAWINGS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED

REVISIONS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	18SEP'18	ISSUED FOR CONSTRUCTION	DMMD	MMD / SIR	[illegible]	[illegible]

REVISIONS

APPENDIX A

Geomembrane and Non-Woven Geotextile Information

(Pages A-1 to A-29)

ATARFIL LLD V1

Raw Material	Linear Low Density Polyethylene

ATARFIL LLD is a geomembrane manufactured from maximum quality linear low density polyethylene LLDPE resins, duly contrasted, that comply with the most rigurous requirements established for their use.
ATARFIL LLD contains 97,5% of pure polymer, and approximately 2,5% of Carbon Black, antioxidants and thermal stabilizers. The product does not contain plasticizers or fillers that can migrate over time.
The geomembrane **ATARFIL** LLD is manufactured under permanent quality controls.

Surface	Smooth	Colour	Black
		RAL Code	-

Raw Material Identification

Tested Property	Unit	Test Method	Value
Density of Raw Material	g/cm^3	ASTM D 792	0.915-0.926
Density of Geomembrane	g/cm^3	ASTM D 792	0.925-0.939
Melt Flow Index	g/10 min	ASTM D 1238 (190°C/2,16 Kg)	< 1,0
Carbon Black Content	%	ASTM D 4218	2,0 - 2,5
Carbon Black Dispersion	-	ASTM D 5596	Note (3)

Durability

Oxidative Induction Time (OIT) Standard OIT High Pressure OIT	min	ASTM D 3895 (200°C) ASTM D 5885	≥ 100 ≥ 400
Oven aging at 85°C HP O.I.T, % retained after 90 days	%	ASTM D 5721 ASTM D 5885	≥ 60
UV Resistance. HP OIT, % retained after 1600 hrs	%	ASTM D 5885	≥ 35

Functional Properties

Tested Property	Unit	Test Method	Value
Low Temperature Brittleness (tª: -40°C)	-	ASTM D 746	No cracks
Water Permeability	m^3/m^2·day	EN 14150	< 1·10^{-6}
Coefficient of Linear Thermal Expansion	1/K	ASTM D 696	2,15·10^{-4}
Water Absorption	%	ASTM D 570 (24h)	≤ 0,2
		ASTM D 570 (6 days)	≤ 1

Strength Characteristics Quality of Final Product

Tested Property	Unit	Test Method	Value					
Thickness	mils	ASTM D 5199	30	40	60	80	100	120
Tolerance	%		-10					
Mechanical Properties								
Tensile strength at Break[1]	lb/in	ASTM D 6693 (Type IV), lo 2 in	125 (108)	171 (148)	256 (222)	342 (296)	428 (371)	513 (445)
Elongation at Break	%		≥ 800					
Tear Resistance	lb	ASTM D 1004	≥ 15	≥ 21	≥ 32	≥ 43	≥ 53	≥ 64
Puncture Resistance	lb	ASTM D 4833	≥ 42	≥ 56	≥ 84	≥ 112	≥ 140	≥ 168
2% Modulus	lb/in	ASTM D 5323	≤ 1800	≤ 2400	≤ 3600	≤ 4800	≤ 6000	≤ 7200
Axi-Symmetric Break Resistance Strain	%	ASTM D 5617	≥ 30					
Dimensional Stability	%	ASTM D 1204 (100°C, 1h)	± 1.5					

PRESENTATION (Standard Sizes)

Parameter	Units	30	40	60	80	100	120
Roll width[4]	ft	19.7					
Roll Length[4]	ft	1,332	999	666	498	399	333
Surface	ft^2	26,240.4	19,680.3	13,120.2	9,810.6	7,860.3	6,560.1

280717

(1) Values indicated are medium. In brackets minimum values.
(2) Certificates belonging to the Environmental and Quality Integrated System of Atarfil.
(3) Carbon black dispersion (only near spherical agglomerates) for 10 different views: 9 in Categories 1 or 2 and 1 in Category 3.
(4) Roll lengths and widths have a tolerance of ±l%.

Headquarters: Ctra. de Córdoba, Km 429 - Complejo El Rey – E-18230 Atarfe – GRANADA – SPAIN – Tel.: +34 958 439 200 – Fax: +34 958 439 128
Middle East: P.O. Box 263 122 - Jebel Ali - DUBAI - U.A.E.
USA Branch: Telf: +1 7578483431
www.atarfil.com

TEXEL 100P

TECHNICAL DATASHEET

Product	Needle-punched nonwoven, short staple fibers
Composition	Polyester
Main function	Protection

Property	Test Method	Metric	Imperial
Physical			
Weigth (typical)	ASTM D5261	339 g/m²	10 oz/yd²
Thickness	ASTM D5199	2.4 mm	94.5 mils
Mechanical			
Trapezoid Tear	ASTM D4533	170 N	38 lbs
Grab Tensile	ASTM D4632	505 N	114 lbs
Grab Elongation	ASTM D4632	50 %	50 %
CBR Puncture	ASTM D6241	1 355 N	305 lbs
Dimensions			
Width	-	4.57 m	15 ft
Length	-	91.44 m	300 ft

All values are MARV.
Our quality management system is certified by ISO-9001 standard.
Our internal laboratory is certified by the Geosynthetic Accreditation Institute - Laboratory Accreditation Program (GAI-LAP).

According to our fibers suppliers, Polyester in general is considered highly UV resistant and much better than other fibers such as, nylon or polypropylene. Polyester is commonly used for UV exposure such as awnings or boat sails or rope. According once again to one of our fibers suppliers, it is generally known that polyester loses 10% of strength after two years of light exposure.

Please note this statement is only based on polyester fiber, not the needlepunched nonwoven structure which influences the residual tensile strength of the material. If this characteristic is critical, we highly recommend to perform a recognized UV exposure test based on ASTM-D4355 standard to estimate and validate the proposed material resistance to UV exposure.

Revision : 01-13-2016

Texel GEOSYNTHETICS

WESTERN TANK & LINING LTD.

YOUR CONTAINMENT **SPECIALISTS** SINCE **1985**

QUALITY CONTROL MANUAL

P.E. GEOMEMBRANE INSTALLATION
(Geo Textile)
(Draintube)
(Geo Composite)
(Geo Net)
(GCL)
(Petrogard 6)

WESTERN TANK & LINING LTD.

YOUR CONTAINMENT SPECIALISTS SINCE 1985

TABLE OF CONTENTS

INTRODUCTION

This manual details the practices and procedures used by Western Tank and Lining Ltd.'s crews during installation of PE liners to ensure a quality installation and to produce the quality control report. We also included Geotexile, Geonet, Geocomposite, and Draintube manual.

1. SUBGRADE PREPARATION

1.1 Requirements for Soil Subgrade

The Owner, General Contractor, or Earthworks Contractor shall be responsible for preparing and maintaining the subgrade in a condition suitable for installation of the liner unless specifically agreed otherwise. WTL and others install geosynthetic lining materials on earth surfaces prepared for liner installation by others. No liner shall be placed on surfaces not previously found acceptable by the WTL site supervisor. On projects installed by WTL, it is our practice to require written "Subgrade Surface Acceptance" documentation.

Surfaces to be lined shall be smooth and free of all rocks, stones, sticks, roots, sharp objects, or debris of any kind. No stones or other hard objects that will not pass through a 3/8" screen shall be present in the top 4" of the surfaces to be covered. All fill shall consist of well-graded material free of organics, trash, clay balls, sharp stones or any other deleterious material that may cause damage to the liner.

The surface should provide a firm, unyielding foundation for the membrane with no sudden, sharp or abrupt changes or break in grade.

The subgrade shall be compacted in accordance with design specifications but in no event below the minimum required to provide a firm unyielding foundation sufficient to permit the movement of vehicles and welding equipment over the subgrade without causing rutting or other deleterious effects. The subgrade shall have no sudden sharp or abrupt changes in grade, especially at pipes or concrete structures.

Typical preparation sequence involves trimming of the compacted excavation as smooth as possible with heavy equipment, hand raking and rock picking, and rolling of the surface with a smooth drum compactor. Rule of thumb for acceptable surface is "ready to lay sod". Under no circumstances will the integrity of the liner be compromised due to the presence of rocks, lumps, or incomplete subgrade preparation.

(1) **Surface Acceptance:** Upon request, Western Tank and Lining shall provide the Owner/Inspector with a written acceptance of the surface to be lined that day.

1.2 Geotextile Liner Cushion

In the event that suitable soils are not readily available at the construction site, soils containing smooth rocks up to 1-1/2 inches in diameter or angular rocks up to ¾ inches may be utilized if covered with geotextile cushion having a minimum weight of 8 oz/yd^2. The weight of geotextile selected will depend on the actual soil used, thickness of liner, and service life or design considerations, but may be as high as 16 oz/yd^2.

See Appendix A for installation procedures.

1.3 Geonet Drainage Layer

See Appendix B for installation procedures.

2. PLACING COVER SOILS ON TOP OF PE GEOMEMBRANES

Cover soils deployed over synthetic liners should be free of all sharp objects--sharp rocks, and sharp sticks. The stones present in the soil should be rounded and smooth and no larger than 3/4 inch in diameter. Cover materials should be deployed using bulldozers separated from the membrane by at least one foot of cover soil for the smallest size dozers, and at least 18 inches of cover soil separation for the larger size dozers. The spreading operation should begin with placement of a mound of soil such that as the dirt covers the liner, it must ascend up the mound and then down the mound suppressing the formation of wrinkles. The movement of the soil must have this vertical descent to it as the dirt is spread over the membrane, rather than be pushed horizontally across the membrane. This type of action will suppress the formation of wrinkles in the path of the cover soil as it is being spread over the membrane and avoid burying wrinkles in the liner. Alternatively, a front-end loader can be used to place the cover soil out ahead of the path of the dozer to minimize spreading of the dirt and suppress wrinkle formation. If these procedures are followed, there should be no threat of puncture to the membrane due to cover soil operations, and buried wrinkles should be minimized.

In the event that suitable soils are not readily available at the construction site, soils containing smooth rocks up to 1-1/2 inches in diameter or angular rocks up to ¾ inches may be utilized if a cushion geotextile having a minimum weight of 8 oz/yd^2. The weight of geotextile selected will depend on the actual soil used, thickness of liner, and service life or design considerations, but may be as high as 16 oz/yd^2.

The following are recommended procedures for placing of soil cover layers on top of HDPE Geomembrane liners using heavy equipment:

2.1 Liner Temperature

The liner must always be covered during the coolest portion of the day. As HDPE geomembrane is black and has a high coefficient of thermal expansion many "slack wrinkles" will form during sunlight hours. If the membrane is covered when it is warm these slack wrinkles will fold over or the slack will be displaced causing undue stresses on the liner.

2.2 Anchor Trenches

Anchor trenches should only be backfilled after the liner has undergone at least one nighttime contraction cycle after deployment and welding. The backfilling must take place when the membrane temperature is at its lowest - i.e. not at midday with the sun causing solar heating and expansion of the material.

2.3 Covering Sequence

When covering sloped areas, the covering must always proceed from the bottom of the slope to the top of the slope. This will avoid "dragging" the liner down the slope, which will stress the liner, of "sloughing" of the cover soils and heavy equipment.

2.4 Ground Pressure

No vehicles except balloon tire UTV's are allowed directly on the liner. Only low ground pressure equipment can be used near the leading edge of the soil cover. The depth of soil cover required under high ground pressure equipment will depend on the subbase, types of soils, and type of liner protection and must be determined by the project engineer.

2.5 Dozers

Dozers can be used to spread the cover material but cannot be the only method used at the leading edge of the cover material. Pushing with a dozer pushes membrane slack in front of the leading edge into a slack wave which will accumulate causing stresses in the liner. To avoid this an excavator or similar must be used to dump material in front of the leading edge and trap the liner slack before it accumulates.

2.6 Inspection

A responsible person must inspect the liner as the cover material is placed. If damage to the liner is noted it must be marked and cleaned by hand using a plastic shovel for repair.

3. LAYOUT PLAN & RECORD DRAWINGS

3.1 Layout Plan

Wherever possible a proposed layout plan will be prepared before mobilizing to the site. The layout plan will show:

(1) slope lines
(2) seams
(3) panel numbers and dimensions
(4) pipes of other penetration locations

3.2 Record Drawing

As installation progresses the following information will be recorded for the record drawing.

(1) changes to the layout plan's panels, seams and penetrations
(2) roll number for each panel
(3) locations and extrusion #'s of destructive tests, patches, repairs and extrusion beads
(4) seam numbers
(5) the approximate length of main panels

NOTE: The intent of the record drawing is to show the correct number and orientation of panels, seams and details and their approximate location. The locations are not surveyed as would be done for a true "asbuilt" drawing.

4. LINER DEPLOYMENT

Unloading, handling and deployment of the liner is completed using slings and axles without contacting the roll directly with heavy equipment to minimize the potential for damage to the liner.

Panels and seams are oriented parallel to the slope unless approved otherwise by Western Tank and Linings' design department for that particular application. The only vehicles allowed on the liner are low ground pressure ATV's.

As the liner is deployed the following quality control procedures will be performed:

(1) The roll number used is marked on the panel by the rollout crew.

(2) The panel number corresponding to the layout plan is marked on the panel by the rollout or Q.C. crews.

(3) A general visual inspection of the panel laid is performed by the rollout crew. A detailed visual inspection is performed by the Q.C. crew within 24 hrs. of deployment. Any defects in the sheet are circled with a permanent marker. A final visual inspection is performed at the completion of the installation.

(4) Any changes to the layout plan and any sheet defects are recorded on record drawings. Each sheet defect will also receive an extrusion number.

(5) No geomembrane materials shall be deployed if the material temperatures are lower than 0 degrees C (32 degrees F) unless otherwise approved by the Owners Represented. The specified minimum temperature for material deployment may be adjusted by the Owners Representative. Temperature limitations should be defined in the preconstruction meeting. Typically, only the quantity of geomembrane that will be anchored and seamed together in one day should be deployed

5. SEAM WELDING

5.1 Wedge Welding

To the maximum point practical all main seams will be produced using Western Tank and Linings' hot wedge welders. Once a wedge welder has passed a qualification weld (see 6.3) production seaming can proceed with the following quality control procedures performed and recorded on the attached wedge welder seamlog:

(1) The date, welder number, operator initials, welder speed, and sheet temperature will be recorded on the liner next to each seam with a permanent marker by the operator.

(2) The above information is recorded by a Q.C. technician.

(3) The operator cuts one specimen from the end of the weld and performs a "vice-grip peel test" (see 6.1.1) on both weld tracks at the end of each seam. The specimen must pass on both tracks before proceeding to the next seam. The tested specimen is left at the end of the seam for inspection by the Q.C. technician who records the result.

(4) The Q.C. technician cuts one specimen from the end of the seam and performs a tensometer peel test (see 6.1.2) on both tracks within 24 hrs. and records both values.

(5) The Q.C. technician performs the "Air Test" (see 6.2.2) on the completed seam as soon as possible and records the pressures and start and finish times.

(6) Any defects such as burnouts, single seams, etc. are marked on the liner by the operator and recorded and numbered on record drawings for extrusion repair.

(7) No geomembrane material shall be seamed when liner temperatures are less than 0 degrees C (32 degrees F) unless the following conditions are complied with:

1. Seaming of the geomembrane at material temperature below 0 degrees C (32 degrees F) if allowed if the Geomembrane installer can demonstrate to the Owner’s Representative, using pre-qualification test seams, that field seams comply with the project specifications, the safety of the crew is ensured, and the geomembrane material can be fabricated (i.e. pipeboots, penetrations, repairs. etc.) at subfreezing temperatures

2. The Geomembrane Installer shall submit to the Owner Presentative for approval, detailed procedures for seaming.

5.2 Extrusion Welding

Extrusion welding is used for penetration seals, detail welding, patches, butt seam “T” intersections and nip folds, capstrips, seam defects, and sheet defects or damage. Once an extrusion welder/operator combination has passed a qualification weld (see 6.3) extrusion welding can proceed with the following quality control procedures performed and recorded on the extrusion welding log.

(1) Each extrusion weld is given an identification number which is marked on the liner with a permanent marker and recorded on the record drawings. The section of extruding done on a butt seam may be marked using a single identification number from start to finish of that section.
(2) The date, operator and welder number is marked on the liner with a permanent marker by the extrusion crew and recorded by a QC technician.
(3) Each *extrusion weld is leak tested by vacuum testing (see 6.2.4) or in the case of butt seams (see 5.3) air tested or vacuum tested.
***NOTE:** Some extrusion welds cannot be leak tested due to the geometry; i.e. pipe boot sleeves or plate to pipe welds.
(4) Each extrusion weld is "pik tested" (see 6.2.5) to evaluate bond strength.
(5) Each extrusion weld is visually inspected for overgrind, heat distortion, thin bead, etc.
(6) Any welding defects found are marked and recorded for repair and retesting.

5.3 Butt Seams

Butt Seams (also known as "Tie-In Seams") are used to join main sections of liner that have seams oriented in more than one direction. Butt seams require a combination of wedge welding and extrusion welding to be leak free.
In general butt seams are not welded until the main sections of liner have undergone at least one thermal contraction cycle. Often additional slack is "built in" at the butt seams during wedge welding by using more than 6" of overlap. The overlap is measured and trimmed at cool times of the day.

A qualified wedge welder is used to weld the seam which is tested and documented according to 5.1 except that the "Air Test" must be performed after the extrusion welding is complete. A qualified extrusion welder is used to reinforce and seal the wedge weld at the nip folds and the "T" intersections on both tracks. Extrusion testing and documentation is as per 5.2 except that extrusion beads that pass the high pressure test are not vacuum tested. To the maximum point practical all butt seams will be high pressure air tested. If a section of seam is not high pressure tested it is vacuum tested for leaks.

6. WELD TEST PROCEDURES

6.1 Destructive Test Procedures

Destructive tests require cutting "coupons" from a trial weld or production weld or from the parent material for strength testing. If the coupon is cut from a production weld within the finished seam length or installed liner it requires a patch using extrusion welding. Western tank and Linings' philosophy is to minimize coupon cutouts requiring extrusion weld patches by using data from non-destructive testing, especially our "High Pressure Air Test", qualification weld destructive testing, and gathering production seam destructive test data from small coupons that are outside

the finished seam length (i.e. in the anchor trench or at the tie-in seams excess overlap).

6.1.1 Vice Grip Peel Test

Weld specimens cut perpendicular to the weld track(s) approximately 1 inch wide are tested for peel adhesion by placing one flap from each sheet of the weld into two vice grip sheet metal pliers and applying peel stress by levering the backs of the pliers against each other until break occurs. A Film Tear Bond and good visual appearance are the criterion for a pass. A Film Tear Bond indicates good fusion. Visually the break should be ductile with a consistent clean appearance; i.e. no unfused spots.

6.1.2 Tensometer Peel Test

Weld specimens are cut using a coupon cutter with 1" x 8" die. Care must be taken to cut the specimens perpendicular and centred on to the weld tracks. Specimens are placed in a field tensometer in the peel mode with the grips approximately 2 from either side of the weld and the specimen perpendicular to the jaws. Specimens are pulled at 2"/minute until break occurs (for both weld tracks for wedge welds). The peak load in pounds is displayed on the tensometer and recorded for determining acceptance. A Film Tear Bond is also required on all specimens. If some peel separation should occur the % incursion is determined by dividing the area of separation by the total weld area (nominally 2" x 1" = 2 in5) x 100.

NOTE: The peel strength is related to parent material break strength and should not be compared to parent material yield strength.

6.1.3 Tensiometer Tensile Test

Parent material tensile yield strength as well as weld tensile strength (also known as the shear test) and elongation are determined using a tensiometer. Specimens are cut using a coupon cutter with a 1" x 8" die.

The purpose of testing the parent material is to gauge the effects of field testing temperature (strengths will be higher at less than 20°C and lower at higher than 20°C). Parent material specimens are pulled at a speed of 2"/minute and an initial grip separation of 2" with the specimen perpendicular to the jaws. The initial peak load is recorded. The test is terminated after the initial peak load is reached. This test is only performed if the temperature effects on the test results are deemed significant.

When testing weld specimens the specimens must be cut perpendicular to the weld track(s) and placed in the tensometer square to the jaws. Also note that nicks in the cutter die can cause premature breaks. The specimens are marked at 1" outside the weld edge on both sides of the weld for grip placement. Testing speed is 2"/minute. The initial peak load is recorded and the distance the grips travel after the grips first pull tight is monitored. The % elongation is defined as the grip travel/1" x 100 (as almost all the elongation occurs on one side of the weld the initial gauge length is defined as 1" = the distance from the grip to the edge of the weld). The test is terminated after the minimum elongation specified has been achieved.

6.2 Non-destructive Testing

The following tests are performed to evaluate the continuity and bond strength of completed seams and detail welds in a non-destructive manner. The "High Pressure Air Test" and "Pick Test" can become destructive tests only if the weld bond strength is inferior. These tests can detect areas of poor strength that would not be located by other test procedures.

6.2.1 Visual Inspection

Visual inspections are performed by both the welder operators and the QC technicians. Wedge welds are inspected for burnouts, spinouts, single seams, inclusions, etc. Extrusion welds are inspected for overgrind, excessive heat distortion, thin bead, etc. Any welding defects found are marked on the liner and recorded on record drawings for repair and testing.

6.2.2 High Pressure Air Test

Purpose The air test was developed to provide a non destructive test to evaluate the bond strength of double wedge welded seams.

Description The pressurized air channel forms a tube which is then visually inspected. Areas of the seam with partial fusion will show up as a bulge or widening of the air channel, or a weld separation resulting in a complete loss of pressure.

Specification

(1) Pressurize the seam to a minimum of 30 psi

(2) Allow the pressure to stabilize for 5 minutes while performing a visual inspection.

(3) Record the pressure at the beginning and the end of the next 5 minutes. There should be no more than a 10% pressure drop.

Test Procedure

(1) Seal off both ends of the seam.

(2) Connect the WTL pressure gauge assembly to the air channel.

(3) Pressurize the air channel with a compressor to a minimum pressure of 30 psi

(4) Allow the pressure to stabilize in the air channel for 5 minutes. While the seam is pressurized perform a visual inspection of the air channel to look for bulges which would indicate incomplete fusion.

(5) There should be no more that 10% pressure drop for a period of 5 minutes.

(6) If a rapid pressure drop occurs, perform a visual inspection of the seam. If a flaw is detected in the seam, pressure test the seam on either side of the flaw. Record and repair the flaw using extrusion welding and test the extrusion weld using the vacuum test. If the entire weld is suspect, replace the weld.

(7) Record the results of the test on the seam log.

6.2.3 Vacuum Box Soap Test

The vacuum box test is used to check extrusion welds (or wedge welds that cannot be practically tested using the High Pressure Test) for leaks.

Vacuum Test Procedure

(1) Trim off any flaps on the wedge weld and coat the seam with a strong soap solution.
(2) Place the vacuum chamber over the test area and depressurize to 5 inches of mercury.
(3) Observe the weld inside the vacuum chamber. Any leaks will allow atmospheric pressure air from beneath the liner to enter the vacuum chamber. Soap bubbles will form at the leak.
(4) Mark any leaks that are found, repair and retest.
(5) Record the results of the test.

NOTE: Some extrusion welds such as at boots, etc. cannot be vacuum tested due to the geometry involved.

6.2.4 Pick Test

The pick test is used to evaluate the bond strength of extrusion welds. The test is performed by welder operators and QC technicians by prying at the edges of an extrusion weld using a blunt screwdriver. Areas of weakly bonded extrudate can be pried off the parent material. Any flaws are marked and recorded for repair and testing.

6.3 Welder Qualification Seams

Each welding machine for wedge welders, and each welder/operator combination for extrusion welding, produces qualification seams each day before starting production welding. Qualification seams are made using strips of material approximately 300 mm wide and are a minimum of 1 m long for extrusion welding and 3 m long for wedge welding. These seams are destructively tested and the results recorded on the welder qualification data sheets attached.

7. MINIMUM ACCEPTANCE CRITERIA

The following limits are the minimum acceptable for a completed installation.

7.1 Destructive Weld Testing

TEST		MINIMUM ACCEPTANCE CRITERIA				
Thermally Bonded Smooth and Textured High Density Polyethylene (HDPE) Geomembranes						
Vice Grip Peel Test		FTB (on both tracks for wedge welds)				
Material Thickness		30 mils	40 mils	60 mils	80 mils	100 mils
Peel Strength, lb/in	Wedge	45	60	91	121	151
	Extrusion	39	52	78	104	130
Peel Separation (Incursion)		- FTB for all specimens - Avg of 5 must be less than 25% - Single specimen test for production end coupon – less than 10%				
Shear Strength, lb/in (Wedge/Extrude)		57	80	120	160	200
Shear Elongation at break, %		50	50	50	50	50
Thermally Bonded Smooth and Textured Linear Low Density Polyethylene (LLDPE) Geomembranes						
Vice Grip Peel Test		FTB (on both tracks for wedge welds)				
Material Thickness		30 mils	40 mils	60 mils	80 mils	100 mils
Peel Strength, lb/in	Wedge	38	50	75	100	125
	Extrusion	34	44	66	88	114
Peel Separation (Incursion)		- FTB for all specimens - Avg of 5 must be less than 25% - Single specimen test for production end coupon – less than 10%				
Shear Strength, lb/in (Wedge/Extrude)		45	60	90	120	150
Shear Elongation at break, %		50	50	50	50	50

7.2 Non-Destructive Weld Testing

TEST	MINIMUM ACCEPTANCE CRITERIA
Visual Inspection	No unrepaired flaws.
Air Lance	Produce a steam of continuous air along the flap of the weld edge
High Pressure Air Test	No more than 10% pressure drop for 5 minutes at 1.0 PSI/mil thickness/inch of air channel width.
Vacuum Box Test	Produce up to 4 inches of Hg (2psi)
Pick Test	Non unbonded areas.
Each welder will produce a minimum of 1 qualification seam for each day that welder is used for production.	

8. MINIMUM TEST FREQUENCIES

The following test frequencies are the minimum required for a complete installation.

8.1 Wedge Weld Qualification Seams

TEST	FREQUENCY
Vice Grip Peel	2 specimens / qualification tested on both tracks
Tensiometer Peel	5 specimens / qualification tested on both tracks
Weld Tensile (Shear)	2 specimens / qualification

Each welder will produce a minimum of 1 qualification seam for each day that welder is used for production.

8.2 Extrusion Welder / Operator Qualification Seams

TEST	FREQUENCY
Vice Grip Peel	2 specimens / qualification
Tensiometer Peel	5 specimens / qualification
Weld Tensile (Shear)	2 specimens / qualification
Each welder will produce a minimum of 1 qualification seam for each day that welder is used for production.	

8.3 Wedge Weld Production Seams

TEST	FREQUENCY
Vice Grip Peel	1 specimen tested on both tracks / seam (except panel width cross seams). Specimen to be taken from the end of the seam – no repair patch required.
Visual Inspection	Full seam length.
Air Lance	Only used when the seam is welded with a full wedge assembly
High Pressure Air Test	Full length of all seams to the maximum point practical.
Vacuum Test	Only used where High Pressure Testing is impractical.

8.4 Extrusion Weld Seams or Beads

TEST	FREQUENCY
Visual Inspection	Full seam length.
Vacuum Test	Full seam length except for beads previously pressure tested which are not vacuum tested.
Pick Test	1 pick / lineal foot of seam.
High Pressure Air Test	Only applies to butt seam, “T’s”.

9. FAILED TEST PROCEUDRES

If a weld or seam fails one or more of the required tests the following procedures are performed.

TEST	FREQUENCY
Welder Qualification Seam	Adjust welder, reweld, and retest.

(wedge or extrusion)	
Visual Inspection and Vacuum Box Test	Mark liner, record defect, repair and retest. If the defect already has an extrusion number renumber as 47A (initial extrusion #47) for records.
Pick Test	Mark, record and repair as above. If the weld is suspect due to many flaws, cap or replace the weld.
High Pressure Air Test	Retest on either side of the defect. Mark, record and repair as above. If there are more bulges than 1/20' of seam length (average) replace the weld.
Production Wedge Weld Vice Grip Peel Test or Tensiometer Peel Test	If single specimen fails track along the seam and retest using 3 specimens. If 1 (or more) of the 3 specimens fail track along the seam and retest using 5 specimens (or replace the seam). If the 5 specimens test fails the acceptance criteria track to obtain a 5 specimen coupon that passes the acceptance criteria and repair the area to the passing sample or place the seam and retest.

10. PENETRATIONS

Any structures such as pipes, sumps, concrete, etc. that penetrate the liner require mechanical attachment and/or welding are an anchor point and can result in stresses on the liner under some conditions. For stress considerations and possibilities of leakage the number of penetrations should be minimized where practical. In addition, the final liner penetration detail should be considered during design and construction of the earthworks and piping. Please consult Western Tank and Lining during the design phase to optimize the end product. Attention to compaction around pipes or structures is a must to avoid shear or tensile forces on the liner due to subsidence. Western Tank and Lining takes careful consideration of penetration location during panel layout design, panel deployment, and slack incorporation.

10.1 HDPE Pipe

Where possible HDPE piping should be used for pipelines, or for the last section of pipe, penetrating the liner. For all but the highest molecular weight pipe resins (Drisco 8600), geomembrane and pipe resins are compatible for welding. Typical methods include cutting the HDPE pipe flush with the side slope and welding geomembrane or HDPE plate, directly to the pipe.

The resulting weld is more reliable than boots and does not require any steel banding or rubber gaskets. Pump out sumps can also be constructed of HDPE pipe or plate and welded directly to the liner.

10.2 Concrete

Sealing to concrete structures of pipe collars are accomplished with anchor bolts, clamping bar, and rubber gaskets. Clamping to vertical surfaces is not recommended. To ensure a complete seal, using horizontal (or flush with slope) concrete surfaces which are smooth and stringline flat. Rebar should be located away from the anchor bolt line or more than 4 inches below the surface. Concrete pipe collars should include anchor rings and/or waterstops on the pipe. Satisfactory pipe seals for many applications can be constructed using a concrete collar with waterstop and a liner to concrete clamp seal. Some applications involving new concrete are best handled using cast-in HDPE inserts.

10.3 Pipe Boots

Pipe boots can be field or factory fabricated from HDPE geomembrane and sealed to piping or round pilings using stainless steel bands and neoprene gaskets. A 90degree pipe boot is always preferred to a slope angle boot for a pipe entering near the bottom of a reservoir. Pipe boots should be avoided for horizontal pipes penetrating the sideslopes.

10.4 Corrugated Culverts

Corrugated Culverts should be avoided as the only method of sealing is a concrete collar with waterstop, but the waterstop is very difficult to construct.

10.5 Pipe Support Pilings

Pipe Support Pilings should be cylindrical concrete or pipe to facilitate boot seals. Rectangular or "I" beam shapes pose serious sealing problems and should be avoided.

11. SLACK INCORPORATION

Most HDPE liner installations require some slack incorporation due to the materials high coefficient of thermal expansion (approximately 1% / 75°C), solar heating that takes place during construction due to its black colour, and the minimum temperature the liner will see during its service life.

In general, exposed liners will require more slack than buried applications. In all cases slack incorporation is a compromise between too little slack which will result in bridging at corners or toes of slopes, or excessive stresses at fixed points during cold temperatures, and too much slack resulting in slack "wrinkles" that will fold over when covered with soils or fluids, with resultant stresses at the folds. Covered applications should be built to fit the subgrade at the temperature that the liner will be covered at. Exposed applications should be built so that no significant stresses are developed at the minimum service temperature.

The following techniques are used to "size" the liner:

(1) The main sections of liner must be allowed to undergo at least one thermal contraction cycle before the anchor trench is backfilled or the butt seams are welded or liner is covered.
(2) The butt seam(s) overlaps are measured and trimmed at the cool times (early morning or evening) of the day.
(3) If additional slack is required it can be placed at the anchor trench before backfilling or at the butt seams (or seams between fixed points) by using extra overlap.
(4) The project superintendent determines the amount of slack to be incorporated based on field experience, calculations, and the expected service life of the liner.

12. QUALITY CONTROL REPORT

A quality control report is produced after the project is completed. The report contains the following information:

(1) The manufacturing material certifications.
(2) The wedge welder and extrusion welder / operator qualification data sheets.
(3) The wedge welding and extrusion welding seam logs.

(4) The record drawing showing:
   a. approximate location of all panels and seams;
   b. the panel numbers;
   c. the seam numbers;
   d. the roll number used for each panel;
   e. the approximate lengths of main panels;
   f. the approximate location of all penetrations; and
   g. the extrusion weld number and approximate location of all extrusion weld patches, beads, and repairs.

13. STANDARD INSTALLATION WARRANTY

WESTERN TANK & LINING LTD.

12180 Vickers Way
Richmond, B.C., V6V-1H9
PHONE (604) 241-9487
FAX (604) 241-9485

WORKMANSHIP WARRANTY

PURCHASER/USER	
LOCATION OF INSTALLATION	
DESCRIPTION OF INTENDED USE	

WESTERN TANK & LINING LTD. (the "**Installer**") warrants to the party named above as the Purchaser/User ("**Purchaser**") that the tank and/or lining membrane system ("the "Liner System") as installed by the Installer will be free from installation-related defects for normal use in approved applications, on the terms and conditions set forth in this Workmanship Warranty (the "**Warranty**"). This Warranty shall be in effect from the above noted **Acceptance Date** for the above noted **Warranty Period**.

The term "**normal use**" means uses reasonably consistent with the above noted Description of Intended Use, and does not include, among other things, the exposure of the Liner System to harmful chemicals; abuse of the Liner System by machinery, equipment or people; excessive pressures or stresses from any source; subsurface or overburdened soil conditions; and total or differential soil settlements and the effect those settlements may have on the Liner System. The Purchaser acknowledges that the sale of the Liner System is for commercial or industrial use only.

This Warranty does **not** include damages or defects in the Liner System resulting from: (i) acts of God, casualty or catastrophe, including earthquakes, floods, weather, tornadoes, explosion, war, acts of any public authority, or any other cause beyond the Installer's reasonable control; (ii) faulty materials, or any defects in the workmanship, design or manufacturing of the materials comprising the Liner System; (iii) defects arising on account of third party action; (iv) defects arising from improper maintenance, use, repair, replacement or alteration of the Liner System by the Purchaser; (v) subsidence of the land around the Liner System; or (vi) surface defects in workmanship and materials apparent and accepted by the Purchaser at the date of delivery.

Any claim for an alleged breach of this *Warranty* must be made in writing, by registered mail or fax, to the President of the Installer at the address above within thirty (30) days of the Purchaser becoming aware of the alleged defect. If the Purchaser fails to deliver notice as required under this Warranty, the defect and all warranties shall be deemed to have been waived and the Purchaser will have no right of recovery against the Installer. Should defects within the scope of the above Warranty occur, the Installer will, at its option, repair or replace the Liner System or defective portion thereof. The Installer will have the right to inspect and determine the cause of any alleged defect in the Liner System and to take appropriate steps to repair or replace the Liner System if a defect exists for which the Installer is liable under the terms of this Warranty. The Installer will not be required to make such repairs and/or replacements until the Purchaser has ensured that the area surrounding the Liner System is clean, dry, and in an unencumbered condition, including without limitation free from all water, dirt, sludge, residuals, and liquids of any kind.

The Installer's liability under this Warranty shall in no event exceed the lesser of: (i) the replacement cost of the Liner System or defective portion thereof; or (ii) the total amount paid by the Purchaser to the Installer in respect of the Liner System. Further, under no circumstances shall the Installer be liable to the Purchaser or any other party for any special, direct, indirect, or consequential damages arising from any defect in the installation of the Liner System. This Warranty is given in lieu of all other possible warranties by the Installer in respect of the Liner System and by accepting delivery of the Liner System, the Purchaser waives all other such possible warranties, except those specifically given.

THE INSTALLER MAKES NO WARRANTY OF ANY KIND OTHER THAN AS EXPRESSLY SET OUT HEREIN, AND HEREBY DISCLAIMS ALL OTHER WARRANTIES, BOTH EXPRESSED AND IMPLIED, OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. THIS WARRANTY IS NOT EFFECTIVE AND THE INSTALLER IS NOT BOUND BY THE TERMS HEREOF UNTIL RECEIPT OF FULL AND FINAL PAYMENT FOR THE LINER SYSTEM FROM THE PURCHASER.

I hereby state I have read and understand the above and foregoing Warranty and agree to such by signing hereunder.

	PURCHASER/USER	WESTERN TANK & LINING LTD.
NAME		
SIGNATURE		
TITLE		
DATE (dd/mm/yy)		

APPENDIX "A"

GEOTEXTILES

Handling and Placement

All geotextiles shall be handled in a manner to ensure they are not damaged. The following special handling requirements shall be adhered to:

- On slopes, the geotextiles shall be secured in the anchor trench and then rolled down the slope when practical. In any event it should be deployed in such a manner as to continually keep the geotextile sheet in sufficient tension to reduce folds and wrinkles.

- In presence of wind, all geotextiles shall be weighted with sandbags or the equivalent.

- Geotextiles shall be cut using an approved cutter. If the material is being cut in place, special care must be taken to protect other geosynthetic materials from damage.

- Care shall be taken not to entrap stones or excessive dust that could damage the geomembrane, or generate clogging of drains or filters.

Seams and Overlaps

Geotextiles may be seamed by thermal bonding or by sewing.

- On slopes steeper than ten (10) horizontal to one (1) vertical, it is recommend that geotextiles be continuously seamed along the entire length of the panel. Geotextiles shall be overlapped approximately four (4") inches prior to seaming.

- On bottoms and slopes shallower than ten (10) horizontal to one (1) vertical, geotextiles can be either seamed, as indicated above or overlapped. If not thermally bonded the geotextile shall be overlapped a minimum of twelve (12") inches prior to seaming.

Repairs

Any holes or tears in the geotextile shall be repaired as follows:

- On Slopes - a patch made from the same geotextile shall be seamed into place.

- Horizontal Areas - a patch made from the same geotextile shall be spot seamed in place with a minimum of twelve (12") inches overlap in all directions.

APPENDIX "B"

GEONET

Handling and Placement

The geonets shall be handled in such a manner as to ensure the geonets are not damaged in any way.

- On slopes, the geonets shall be secured in the anchor trench and then rolled down the slope in such a manner as to continually keep the geonet sheet in tension. If necessary, the geonet shall be positioned by hand after being unrolled to minimize wrinkles. Geonets can be placed in the horizontal direction (i.e. across the slope) in some special locations (i.e. where extra layers are required or where slope is less than 10:1).

- Such locations shall be identified by the Design Engineer in the project drawings.

- Geonets shall not be welded to geomembranes. Geonets shall be cut using approved cutters, i.e. hook blade, scissors, etc. Care should be taken to prevent damage to underlying layers.

- Care must be taken not to entrap dirt in the geonet that could cause clogging of the drainage system, and/or stones that could damage the adjacent geomembrane.

Layering and Tying of Geonet

When several layers of geonets are installed, care should be taken to prevent the strands of one layer from penetrating the channels of the next layer. Adjacent geonets shall be joined according to the following requirements.

- Adjacent rolls shall be overlapped by at least four (4") inches and securely tied.

- Tying can be achieved by plastic fasteners. Tying devices shall be white or yellow for easy inspection. Metallic devices are not allowed.

- Tying shall be five (5') feet to ten (10') feet along the bottom, every five (5') feet along the slope every two (2') feet across the slope and at top of berm and into anchor trench at least with one (1') foot intervals.

- In the corners of the side slopes where overlaps between perpendicular geonet strips are required, an extra layer of geonet shall be unrolled along the slope, on top of the previously installed geonets, from top to bottom of the slope.

- When more than one layer of geonet is installed, overlaps must be staggered and layers tied together.

Repairs

Any holes or tears in the geonet shall be repaired by placing a patch extending two (2') feet beyond edges of the hole or tear. The patch shall be secured to the original geonet by tying every twelve (12") inches. If the hole or tear width across the roll is more than 50% the width of the roll, the damaged area shall be cut out and the two (2) portions of the geonet shall be joined.

APPENDIX "C"

GEOCOMPOSITE

Handling and Placement

All geocomposite shall be handled in a manner to ensure they are not damaged.

- On slopes, the geocomposite can be secured in the anchor trench and then rolled down the slope when practical. The geocomposite shall be deployed in a manner to continually keep the geocomposite sheet in sufficient tension to reduce folds and wrinkles.

- In the presence of high wind, all geocomposite shall be weighted with sandbags or the equivalent.

- Geocomposite shall be cut using an approved cutter. If material is being cut in place, special care should be taken to protect other geosynthetic materials from damage.

- Care should be taken not to entrap stones or excessive dust that could damage the geomembrane, or generate clogging of drains or filters.

Seams and overlaps

- Geocomposite shall be seamed by thermal bonding or by sewing.

- No horizontal seams shall be allowed on side slopes greater than 4H:1V. Owners Represented. The horizontal seams on side slopes greater than 4H:1V can be adjusted by the Owners Representative to utilize material to its entirety.

- Tying of the geonet shall be with plastic fasteners. Tying devices shall be white or yellow for easy inspection. Metallic devices are not allowed.

- Tying shall be every 1.5 m across the cell floor, every 1.5 m along the side slopes and every 750 mm at the top of berms and into anchor trenches. End to end joints on the cell floor shall be overlapped 600 mm. Tying shall be every 0.3 m across the end to end joint. All tying shall be covered with geotextile, sewn or heat bonded.

Repairs

The damage shall be observed, and if smaller than one (1) m by one (1) m, the geocomposite shall be repaired. If the tear or hole is larger, then the roll shall be cut to remove the damaged area, fasteners shall be used to attach the geonet with the geotextile being heat seamed. Minimum overlaps to be as specified.

- If the geonet is undamaged, and the geotextile is damaged, a patch of geotextile shall be placed. The geotextile patch shall be thermally bonded in place with a minimum of 300 mm overlap in all directions.

- If the geonet is damaged, the geonet shall be removed. A section of geonet shall be cut to replace the removed section. The geonet shall be tied to the existing geonet using plastic fasteners placed at least every 150 mm. A geotextile patch shall be placed over the repaired geonet section. The geotextile patch shall be thermally bonded in place with a minimum of 300 mm overlap in all directions.

APPENDIX "D"

GEOSYNTHETIC CLAY LINER (GCL)

Handling and Placement

All rolls GCL shall be handled in a manner to ensure they are not damaged.

- GCL rolls should be delivered to the working area of the site in their original packaging. Immediately prior to deployment, the packaging should be carefully removed without damaging the GCL. The orientation of the GCL should be in accordance with the Engineer's or manufacturer's recommendations.

- Proper equipment, spreader-bar and core-bar assembly and/or a forklift with stinger attachment shall be used during handling and deployment as per manufacturer's recommendations.

- Equipment which could damage the GCL shall not be allowed to travel directly on it. If the installation equipment causes rutting of the sub-grade, the sub-grade must be restored to its originally accepted condition before placement continues.

. The GCL shall be placed so that seams are parallel to the direction of the slope. Seams should be located at least 1 m from the toe and crest of slopes steeper than 4H:1V. The horizontal seams on side slopes greater than 4H:1V can be adjusted by the Owners Representative to utilize material to its entirety.

- Placement shall be from highest elevation to the lowest elevation to facilitate drainage in the event of precipitation unless the Engineer and or the Owners Representative assure that the subgrade is porous and free draining.

- All GCL panels should lie flat on the underlying surface, with minimal wrinkles and no folds, especially at the exposed edges of the panels. Panels shall be placed with non-woven side up.

- Only as much GCL shall be deployed as can be covered with soil, a geomembrane, or a temporary waterproof tarpaulin at the end of the working day.

- The GCL shall be placed in an anchor trench at the top of the slope as per the drawings. The front edge of the trench should be rounded so as to eliminate any sharp corners. Loose soil should be removed from the floor of the trench. The GCL should cover the entire trench floor, but not the rear trench wall.

Field Seams

- The GCL seams are constructed by overlapping their adjacent edges. Care should be taken to ensure that the overlap zone is not contaminated with loose soil or other debris. Supplemental bentonite is required in the overlap zone.

- The minimum dimension of the longitudinal overlap should be 225 mm. End-of-roll overlapped seams should be similarly constructed, but the minimum overlap should measure 600 mm.

- Seams at the ends of the panels should be constructed such that they are shingled in the direction of the grade to prevent the potential for runoff flow to enter the overlap zone.

- Where the GCL product requires bentonite-enhanced seams as recommended by the GCL manufacturer, bentonite-enhanced seams shall be constructed by overlapping adjacent panels as instructed above, exposing the underlying edge and then applying a continuous bead of granular sodium bentonite along a zone defined by the edge of the

underlying panel and the 150 mm line. The bentonite shall be applied at a minimum application rate of 0.4 kg/m. Where bentonite-enhanced seams are not required by the GCL product as recommended by the GCL manufacturer, GCL installer shall receive approval from the Engineer.

- GCL may be seamed by thermal bonding to prevent the movement of material while covering it with a geomembrane, covering it with soil or a temporary waterproof tarpaulin

Detail Work

- The GCL shall be sealed around penetrations and embedded structures embedded in accordance with the drawings.

- Cutting the GCL should be performed using a sharp utility knife. Frequent blade changes are required to avoid damage to the geotextile components of the GCL during the cutting process.

Repair

- If the GCL is damaged (torn, puncture, perforated, etc.) during installation, it may be possible to repair it by cutting a patch to fit over the damaged area. The patch shall be obtained from a new GCL roll or scrape peice and shall be cut to size such that minimum overlap of 300 mm (12 inches) is achieved around all of the damaged area. Dry bentonite or bentonite mastic should be applied around the damaged area prior to placement of the patch. It may be desirable to use an adhesive or heat bonded to affix the patch in place so it is not displaced during cover placement.

- Any solvent or adhesive in contact with the GCL must be approved by the Manufacturer.

APPENDIX "E"

DRAIN TUBE

Handling and Placement

Rolls of Draintube shall be handled in a manner to ensure they are not damaged.

- Draintube Drainage Geocomposite shall not be placed, seamed/joined, or repaired during periods of heavy precipitation, excessively high winds, or in areas of ponded water or excessive moisture.

- Draintube Drainage Geocomposite shall be installed in accordance with manufacturer's recommendations, and as shown on the Drawings and specified herein.

- Draintube Drainage Geocomposite shall be installed in the direction of the slope such that the pipe components are oriented with the intended flow direction (typically perpendicular to the contours) unless otherwise specified by the ENGINEER.

- The Draintube Drainage Geocomposite shall be kept clean prior to and during installation.

- Folds or excessive wrinkling of deployed Draintube Drainage Geocomposite shall be removed to the extent practicable.

- Installs shall exercise care not to entrap stones, excessive dust, or foreign objects in the material.

- Draintube Drainage Geocomposite shall be adequately weighted, using sand bags or equivalent until the subsequent soil or geosynthetic layer is placed. In the presence of wind, the sandbags or the equivalent shall be placed along the leading edge and removed once cover material is placed.

- If the project contains slopes steeper than 5 horizontal to 1 vertical, special care should be taken to use full length rolls from the top of the slope. If the roll length cannot cover entire slope, then the next roll should be situated towards the toe of the slope. The locations of horizontal connections of adjacent panels should be staggered at least 10 feet apart.

- Overlaps shall be singled down the slope and/or in the direction that backfilling will occur.

- If the project includes an anchor trench to secure the Draintube Drainage Geocomposite, then the panels shall be secured in the anchor trench as indicated on the Drawings.

Field Seams

Adjacent sheets of Draintube Drainage Geocomposite shall be overlapped as described below.

- Connections at along the side of the Draintube Drainage Geocomposite roll shall be overlapped 4 inches, and shall be secured using sewn seams, additional overlap, or welds (hot air or flame) [*ENGINEER to select one or more alternatives*].

- Connection at the leading or terminating edge of the Draintube Drainage Geocomposite shall be overlapped such that the upper geotextile layer can be rolled back 12 to 18 inches and the end of the next roll inserted into the opening. Pipes shall be connected either using a snap coupler fitting supplied by the geocomposite manufacturer or by overlapping the pipes by 12 to 18 inches [*ENGINEER to select the alternative*].

Connections to an interceptor drain and/or vacuum pipe shall conform to the Drawings and be at the direction of ENGINEER.

Repair

Prior to covering the deployed Draintube Drainage Geocomposite, each roll shall be inspected for damage.

- Any rips, tears or damaged areas on the geocomposite shall be removed and patched.

- If a section of pipe is damaged during installation, add a piece of undamaged pipe of the same diameter next to the damaged pipe, extending a minimum of 8 inches beyond each end of the damaged section of pipe.

- If the geotextile is ripped or torn, install an undamaged piece of the same material under the hole that extends a minimum of 6 inches beyond the hole in all directions to insure that protection of the geomembrane is maintained.

- If the area to be repaired is more than 50 percent of the width of the panel, then the damaged area shall be cut out and replaced with undamaged material. Damaged geotextile shall replaced by the same type of geotextile.

APPENDIX "F"

PETROGARD VI

Preparation

- Ensure subgrade is compacted and surface finished to not impair installed membrane.
- Subgrade to provide firm, unyielding surface with no sharp changes or abrupt breaks in grade. A smooth drum rolled surface is preferable.
- Ensure surfaces to be lined are smooth, free of foreign and organic material, sharp objects, or debris of any kind.
- If a suitable sub-grade is not available, then a cushion layer of clean sand or non woven geotextile shall be placed prior to liner placement.
- Excavate anchor trench to line, grade, and width indicated on drawings, prior to liner placement. Provide slightly rounded corners in the trench to avoid sharp bends in the geomembrane.
- Prepare mechanical attachments according to ASTM D6497 Standard Guide for Mechanical Attachment of Geomembrane to Penetrations or Structures.
- All concrete surfaces to which the liner will attach shall have “smooth trowel” finish. All the corners should have radius to a minimum 25mm as per the drawing.
- Compaction at pipe penetrations and areas of mechanical attachment will be inspected carefully as these are areas where differential settlement can occur.
- A certificate of subgrade acceptance will be prepared by the liner installation contractor prior to liner installation.

Handling and Placement

- Installation of the geomembrane shall be performed in a logical sequence.
- Place panels according to the drawings, the panel layout, and the label on each panel.
- Sufficient thermal slack shall be incorporated during placement to ensure that harmful stresses do not occur in service.
- Ensure personnel working on geomembrane do not use damaging footwear.
- Protect completed panels from damage; handle carefully to avoid damaging the liner.
- Equipment and methods used to unroll liner panels should not damage the prepared subgrade.
- Ballast used to prevent uplift by wind must not damage the geomembrane. A continuous load is recommended along the edges of panels to eliminate the risk of wind uplift.

Weather Conditions at Time of Installation

- Site welding may proceed at any temperature providing a suitable qualification weld can

be prepared at site conditions using the operator, equipment, and materials intended for the project.

- Installation of membrane in winds above 20 km/h can proceed only if the installer can demonstrate that the liner will not be at risk of damage.

- Do not install membrane during precipitation or in the presence of excessive moisture.

- Do not install in weather conditions that may be detrimental to the function of the membrane.

Qualification

- A qualification seam will be run prior to any field seams.

- A qualification seam is made with separate pieces of geomembrane using the same material and equipment that will be used for production welding.

- Machine conditions, and operator used for welding must be the same as those used for the qualification weld.

- Qualification seam must be tested in shear and peel, and meet the specified requirements for the material.

- A qualification seam must be rerun whenever the operator is changed, the equipment adjusted, or at least every 4 hours.

Seaming

- Cleaning solvents shall not be used unless product is approved by membrane manufacturer.

- Use water and rags for all cleaning. If soap is used for cleaning rinse with clean water and dry before welding.

- Over lap of a seam shall be a minimum of 150mm

- Technician shall record the machine number, date, technician initials and start the time of every wedge weld.

Destructive and Seam Testing

- Field seams will be sampled for testing in a way that does not compromise the installed liner One sample to be tested for every 150m of field seam

- Test samples are to be removed from the ends of seams, from the anchor trench, or other location that does not introduce a defect into the liner.

- Samples to be approximately 100 mm long to permit testing of one shear and two peel specimens (ASTM D6392).

- Test samples shall be taken with in 24hrs after seaming
    - Record date, location and pass/fail description

- Field seams must meet the specified requirements in peel and shear for the material.

- A written record will be maintained for all field seam tests.

All completed field seams will be 100% non-destructively tested using an air lance test (ASTM D4437 method 7.2).

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- Destructive Test Failure:
    - Cut out seam and re-weld; or,
    - Retrace welding path to <3 m> <<10 feet>> from location of failed test. Take sample for additional test. If passed - cap strip or extrusion weld between failed location and original failed location.

Repairs

- Inspect seams and non-seam areas for defects, holes, blisters, undispersed raw materials.
- Identify any sign of foreign matter contamination.
- Repair all through-thickness defects.
- Defective Seams: Cap strip or replace.
- Tears: Patch and seal round sharp ends of tears on slope or stressed area prior to patching.
- Repair blisters, large cuts and undispersed raw materials with patch.
- Secure Patches by Hot Air Welding:
    - Hot Air Welding
        - Hand hot air welding is permitted for patching liner.
        - Clean area to be patched.
        - Hand weld the patch with a hot air gun and suitable roller.
- Patches: Round or oval, of same geomembrane. Extend minimum 75 mm beyond the edge of the defect.
- Verification of Repairs: All repairs to be non-destructively tested using
    - Air Lance Test, ASTM D4437 Method 7.2
    - Vacuum Box Test ASTM D5641
- Redo failed repairs and re-test.
- Keep records of all repairs and the results of repair testing.

Cleaning solvents shall not be used unless product is approved by membrane manufacturer.
Use water and rags for all cleaning. If soap is used for cleaning rinse with clean water and dry before welding.