Baffinland

Attachment 7

Mine Haul Road Construction Memorandum

To: Chris Murray, Michael Anderson and Dick Matthews

From: Chris Teske

Cc: Adam Gyorffy, Cody Gagne, Wayne Rogers

Date: January 23, 2018

Re: Nuluujaak Pit Haul Road Construction

Summary:

The Mine Operations department is planning to perform some significant road construction during 2018 and 2019.

The first project is to construct a new road to access the Nuluujaak pit starting at approximately KM108. This road will travel up the East face of the mountain and will be in use for all four phases of the pit.

The second project is widening the entire existing mine haul road to allow for double lane 793 haul truck traffic. This entails widening the existing road from KM104 to KM110 by approximately 8.5 m on average.

This document outlines the proposed designs with particular focus on water control and management.

New Pit Access Road:

The new pit access road, as seen in Figure 1, will travel up from KM108 and meet the pit near the south mining face. The planned construction starts at the 620 elevation and will work down towards KM108 where it will intersect with the existing mine haul road. This will significantly increase production capacity by decreasing the ore haul cycle time as well as improving site safety by providing a secondary access road to the pit.

The road design specifics are as follows:

- 1,400 m in length @ approx. 10% gradient
- Starting from 620 masl going to 485 masl
- Minimum 25 m road width – required for dual lane 793 traffic
- Crowned at 4.5% from center
- 3 m high berm on down-hill side
- ~275,000 m^3 fill, 27,000 m^3 cut
- ~75,000m^2 of disturbed area

The water management structures being implemented with the road are as follows:

- 1 m deep ditch on up-hill side
- 2 rock cut ditch sections, 785 m long and 285 m long for upper and lower sections respectively (As per rock cut ditch design - Appendix B)
- 1 connecting ditch section 400 m long (As per standard ditching design – Appendix B)
- 1 twinned culvert installed to allow the existing mine haul road ditch to flow under the new access road (As per standard twinned culvert design – Appendix A)

With the aforementioned water management structures being constructed, the volume and flow of water will not change once it has reached downstream of the mine haul road. As can be seen in Figure 2, any water that is being diverted due to the new pit access road, will be directed into the existing mine haul road ditch and distributed to the mine haul road culverts. The main discharge points for this water will be the culverts located at KM107 and KM106.5.

Mine Haul Road Widening:

The existing mine haul road is designed to enable dual lane 777 mine haul truck traffic, however in mid Q4 2018 two larger 793 mine haul trucks will be deployed. In 2019 an additional four 793 haul trucks are scheduled to arrive. In order to facilitate this larger hauling equipment, the mine haul road must be widened from the existing 18.3 m minimum width up to 25 m minimum width. The design can be seen in Figure 3.

The road widening specifics are as follows:

- 6,200 m in length of road widening @ approx. 10% gradient
- Includes
    - Entirety of the existing mine haul road for ~ 5,500 m
    - 2 access roads to crusher for ~500 m
    - Single lane access to maintenance shop for ~ 200 m
- Minimum 25 m road width – required for dual lane 793 traffic
- Crowned at 4.5% from center
- 3 m high berm on down-hill side
- All widening on downslope side of road
- Maximum of 10 m offset from existing road centerline
- ~550,000 m^3 fill, 2,000 m^3 cut (cut due to moving existing road side berms)

The water management structures being implemented with the road widening are as follows:

- Maintain existing mine haul road ditch
- Build up current running surface where existing ditch depth is insufficient (> 1 m deep)
- Extend 6 sets of existing twinned culverts (As per standard twinned culvert design – Appendix A)
- Possibility to extend old culverts if found to still be functional (As per standard culvert design)
- Upgrade outflow structures of existing culverts (As per standard culvert design – Appendix A)

Widening of the existing haul road will not change the volume or flow of downstream water courses. There are no additional culverts being installed, and any extensions are to existing culverts only. This

project will allow for upgrading to the outflow structures of the culverts which will improve dispersion of surface water and unloading of sediment from the contact water.

Construction Schedule:

Construction schedules have been devised for both the new pit access road and the mine haul road widening. These schedules are preliminary and are dependent on approvals to begin construction.

New Pit Access Road:

Table 1 displays the monthly quantities for cut and fill as well as the anticipated timing of installing the twinned culvert for the new pit access road. The fill quantities shrink as the construction progresses due to increasing haul cycle times. The twinned culvert is installed during the month of September to avoid any significant flow of surface water through the construction area.

Construction of the road will be completed using the existing mining fleet. Fill material will be clean, non-acid generating rock sourced from Phase 2 of the Nuluujaak Pit. Culvert installation may be performed in house or through contractor, depending on resource availability at the time.

Table 1: New Pit Access Road Construction Schedule.

Month	Cut (m^3)	Fill (m^3)	Culvert Installation
Jul-18	10,000	60,000	-
Aug-18	10,000	55,000	-
Sep-18	7,000	50,000	2
Oct-18	-	45,000	-
Nov-18	-	40,000	-
Dec-18	-	25,000	-
Total	**27,000**	**275,000**	**2**

Crushed aggregate will be required for the following:

1. Capping of the running surface
2. Installation of the culverts
3. Lining of the ditch

Quantities of aggregate required for each project are still to be determined.

Mine Haul Road Widening

Table 2 displays the monthly fill quantities as well as the anticipated timing of extending the twinned culvert for the mine haul road widening. The fill quantities shrink as the construction progresses due to increasing haul cycle times. The culvert extensions will be installed during the summer months, following the completion of freshet which will help avoid any significant flow of surface water through the construction area. All downstream water dissipation structures will be constructed in conjunction with the culvert extensions.

Construction of the road will be completed primarily with the new 793 haul truck fleet arriving in Q4 of 2018. If required, existing 777 haul equipment will be utilized to maintain construction schedule. Construction will start at KM110 and progress downward to continually allow for dual lane 793 traffic. Fill material will be clean, non-acid generating rock sourced largely from Phase 2 of the Nuluujaak Pit. Other sources of clean, non-acid generating material may be utilized to supplement Phase 2 waste. Culvert extensions and construction of dissipation structures will be performed by a third party contractor.

Table 2: Mine Haul Road Widening Construction Schedule

Month	Fill (m^3)	Culvert Extension
Jan-19	80,000	-
Feb-19	75,000	-
Mar-19	70,000	-
Apr-19	60,000	-
May-19	50,000	-
Jun-19	40,000	4
Jul-19	30,000	4
Aug-19	30,000	4
Sep-19	30,000	-
Oct-19	30,000	-
Nov-19	30,000	-
Dec-19	25,000	-
Total	**550,000**	**12**

Crushed aggregate will be required for the following:

1. Capping of the running surface
2. Extension of the culverts
3. Downstream water dissipation
4. Lining of the mine haul road ditch (if required)

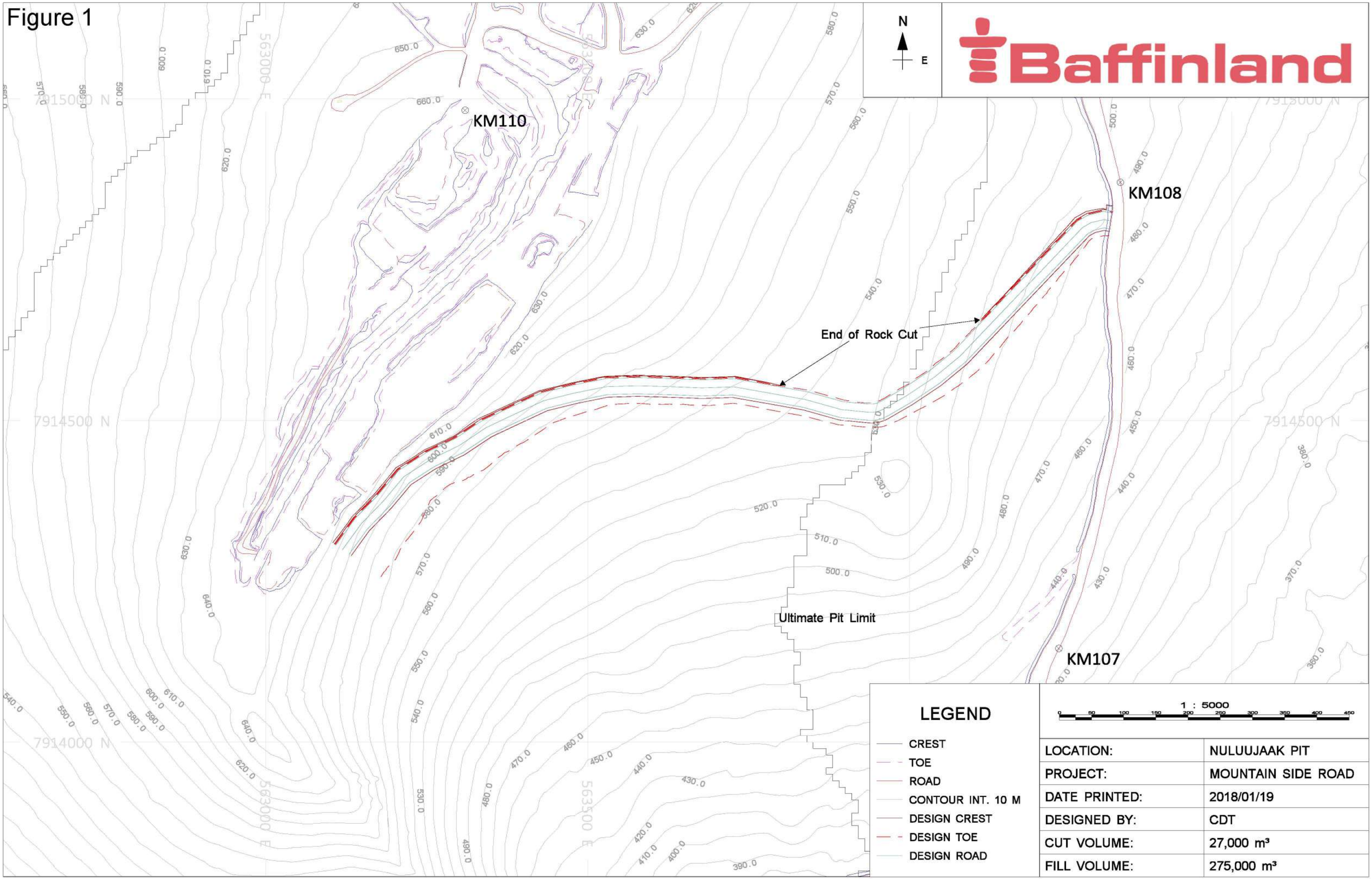
Quantities of aggregate required for each project are still to be determined.

Conclusions:

The new pit access road will be constructed starting in July 2018 through to December 2018 and will require 275,000 m^3 of fill material and 27,000 m^3 of cut. There will be a contact water ditch constructed to divert all water to the existing mine haul road ditch where it will be dispersed at the KM107 and KM106.5 culverts. There will be no changes to existing downstream flow patterns.

The entire mine haul road widening will start in January 2019 through to December 2019 and will require 550,000 m^3 of fill material. The existing mine haul road ditch will continue to be the primary water control mechanism for contact water. The existing 6 twinned culverts will be extended and the downstream dissipation structures will be constructed to accommodate the extensions.

Figure 1



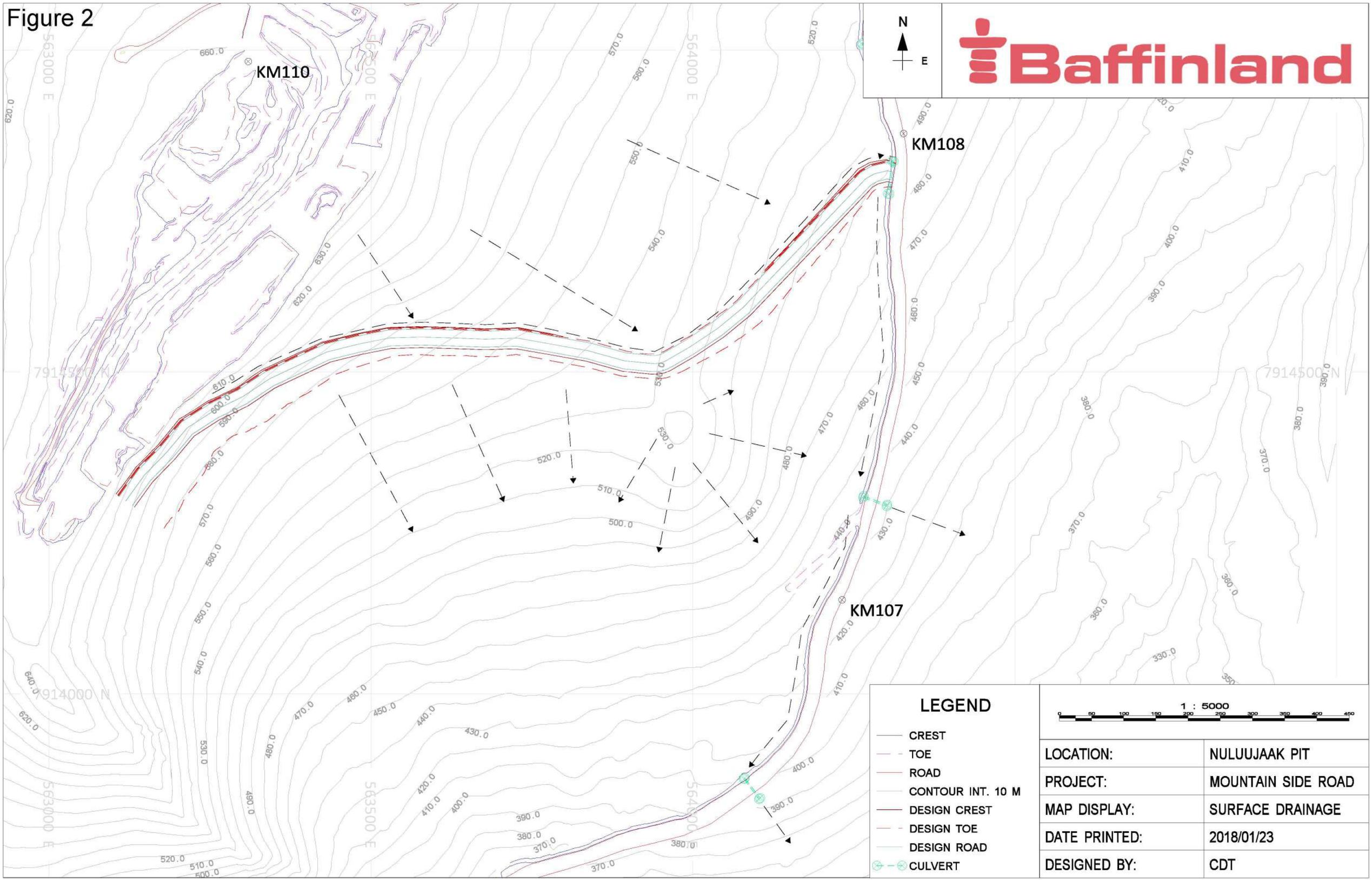
LEGEND

- CREST
- TOE
- ROAD
- CONTOUR INT. 10 M
- DESIGN CREST
- DESIGN TOE
- DESIGN ROAD

1 : 5000

LOCATION:	NULUUJAAK PIT
PROJECT:	MOUNTAIN SIDE ROAD
DATE PRINTED:	2018/01/19
DESIGNED BY:	CDT
CUT VOLUME:	27,000 m³
FILL VOLUME:	275,000 m³

Figure 2



LOCATION:	NULUUJAAK PIT
PROJECT:	MOUNTAIN SIDE ROAD
MAP DISPLAY:	SURFACE DRAINAGE
DATE PRINTED:	2018/01/23
DESIGNED BY:	CDT

Figure 3

N

E

Baffinland

562000 E

562500 E

7915500 N

7915000 N

7914500 N

7914000 N

7913500 N

7913000 N

7912500 N

KM109

KM110

KM108

KM107

KM106

KM104

KM105

LEGEND

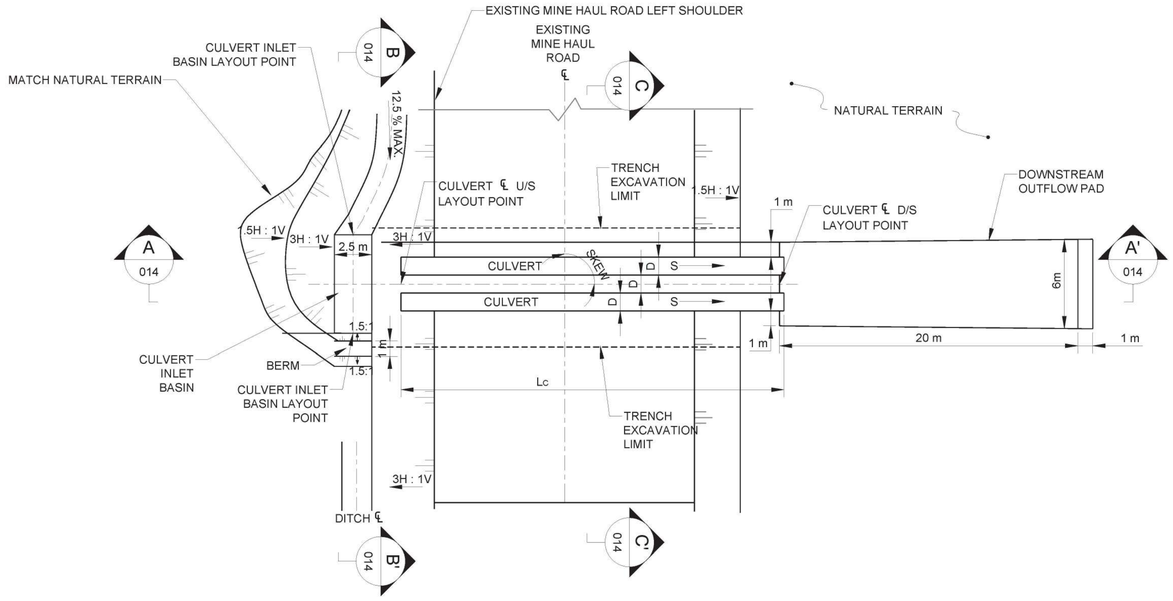
- CREST
- TOE
- ROAD
- CONTOUR INT. 10 M
- DESIGN CREST
- DESIGN TOE
- DESIGN ROAD
- CULVERT

1 : 10000

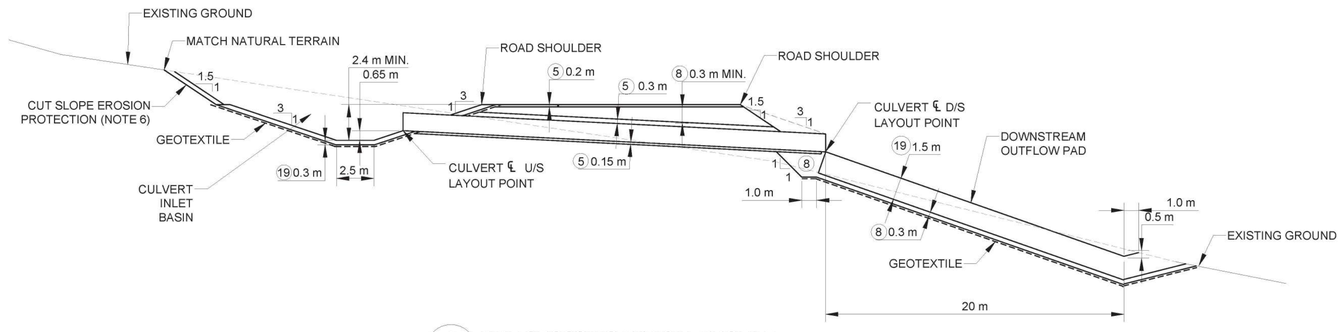
0 100 200 300 400 500 600 700 800 900 1000 1100 1200

LOCATION:	NULUUJAAK PIT
PROJECT:	MINE HAUL ROAD
DATE PRINTED:	2018/01/23
DESIGNED BY:	CDT
CUT VOLUME:	2,000 m³
FILL VOLUME:	550,000 m³

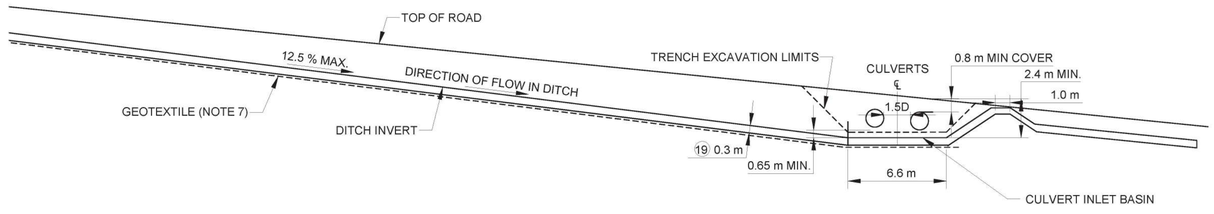
Appendix A



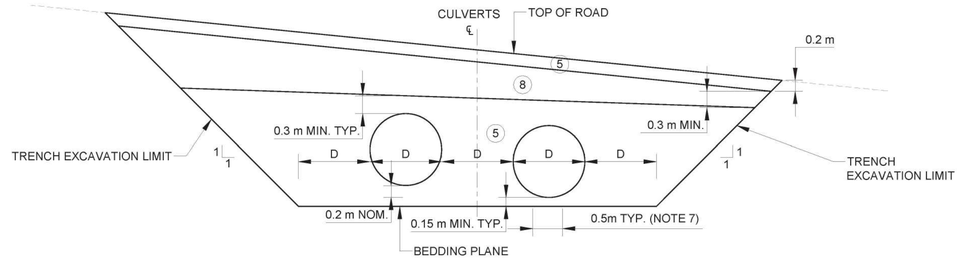
PIPE CROSSING PLAN VIEW
SCALE 1:200



SCALE 1:200 A 014 PIPE CROSSING TYPICAL PROFILE



SCALE 1:200 B 014 CULVERT INLET BASIN TYPICAL PROFILE



SCALE 1:50 C 014 PIPE CROSSING TYPICAL SECTION

LEGEND

5	JAW RUN
8	SCREENED MATERIAL
19	EROSION PROTECTION (NOTE 10)

NOTES

1. THE INFORMATION PRESENTED ON THIS DRAWING IS INTENDED TO CONVEY THE PIPE CROSSING CONSTRUCTION DETAILS.
2. FILL MATERIALS SHALL BE HANDLED, SORTED, PLACED AND COMPACTED AS SHOWN ON THE DRAWINGS, DESCRIBED IN THE SPECIFICATIONS AND TO THE SATISFACTION OF THE OWNER'S REPRESENTATIVE WITH INPUT FROM THE GEOTECHNICAL ENGINEER.
3. CULVERT LAYOUT POINTS MAY BE ADJUSTED BY THE OWNER'S REPRESENTATIVE BASED ON FIELD CONDITIONS ENCOUNTERED.
4. CULVERT SKEW MAY BE ADJUSTED BY THE OWNER'S REPRESENTATIVE BASED ON ENCOUNTERED FIELD CONDITIONS.
5. THE USE OF GEOTEXTILE MAY BE REQUIRED. THE USE OF GEOTEXTILE WILL BE AS SHOWN ON THE DRAWINGS OR AT THE DIRECTION OF THE OWNER'S REPRESENTATIVE WITH INPUT FROM THE GEOTECHNICAL ENGINEER.
6. REFER TO DWG. 016 FOR CUT SLOPE EROSION PROTECTION TYPICAL DETAILS.
7. BEDDING TO BE SHAPED TO RECEIVE PIPE.
8. CULVERT INLET BASIN IS PROVIDED TO ALLOW FOR ACCUMULATION OF LARGE DEBRIS TO PREVENT BLOCKAGE OF THE CULVERT. IF THE OWNER REQUIRES SEDIMENTATION BASINS THE BASE OF THE PONDS AND LENGTHS OF THE PONDS SHOULD BE EXTENDED.
9. IT IS RECOMMENDED THAT THE EROSION PROTECTION OF THE DOWNSTREAM OUFLOW PAD BE EXTENDED TO A WATERBODY CAPABLE OF CONVEYING THE CONCENTRATED FLOW TO PREVENT EROSION OF THE NATURAL SOILS.
10. THE INDICATED EROSION PROTECTION ROCK SIZE IS SMALLER THAN REQUIRED FOR THE SELECTED 1:10 YEAR DESIGN FLOW. THIS IS IN RECOGNITION OF THE AVAILABLE MATERIAL AND AT THE OWNER'S REQUEST. RIPRAP BLOCKS COULD MOBILIZE EVEN DURING FREQUENT FLOOD EVENTS, WHICH MIGHT IMPACT SIGNIFICANTLY THE OPERATION OF THE DRAINAGE SYSTEM. REGULAR MAINTENANCE WILL BE REQUIRED. FUTURE IMPROVEMENTS (I.E. REPLACEMENT OF EROSION PROTECTION WITH MATERIAL WITH LARGER ROCK SIZES, PLACEMENT OF GABION MATS) ARE RECOMMENDED.
11. LAYOUT POINTS OF THE CULVERT CENTRELINE IS REFERENCED TO THE CENTRELINE BETWEEN THE PIPES AT THE LOWEST CULVERT INVERT ELEVATION.
12. REFER TO DWG. 002 FOR ADDITIONAL NOTES.

CULVERT SCHEDULE

CULVERT ID	FISH BEARING (Y/N)	NUMBER OF PIPES	DIAMETER, D (mm)	LENGTH L_c, (m)	TYPE	CULVERT CL LAYOUT AT UPSTREAM (NOTE 11)			CULVERT CL LAYOUT AT DOWNSTREAM (NOTE 11)			SLOPE, S (%)	SKEW (°)
						NORTHING	EASTING	U/S INV. ELEV.	NORTHING	EASTING	D/S INV. ELEV.		
CV1	N	2	1200	32.3	CSP	7912808.9	563134.1	258.19	7912779.3	563147.1	256.58	5	90
CV2	N	2	1200	40.0	CSP	7913333.0	563337.8	300.80	7913301.4	563320.7	298.32	9	-
CV3	N	2	1200	31.9	CSP	7913525.7	563577.9	329.49	7913500.1	563597.0	327.90	5	90
CV4	N	2	1200	35.4	CSP	7913699.8	563696.8	354.50	7913674.8	563721.8	352.73	5	90
CV5	N	2	1200	34.9	CSP	7913868.0	564076.9	396.94	7913840.3	564098.0	395.20	5	90
CV6	N	2	1200	36.5	CSP	7914310.7	564268.6	436.61	7914300.1	564303.4	434.54	5	90
CV7	N	2	1200	43.0	CSP	7914985.8	564274.8	502.94	7914996.3	564316.4	500.79	5	90

CULVERT INLET BASIN DETAILS

CULVERT INLET BASIN ID	SETOUT POINT ID	NORTHING (m)	EASTING (m)	ELEVATION (m)
B- CV1	B1	7912810.8	563129.7	257.54
	B2	7912813.4	563135.7	254.54
B- CV3	B3	7913526.9	563572.9	328.84
	B4	7913530.9	563578.1	328.84
B- CV4	B5	7913700.4	563691.5	353.85
	B6	7913705.0	563696.2	353.85
B- CV5	B7	7913869.4	564071.7	396.29
	B8	7913873.4	564077.0	396.29
B- CV6	B9	7914308.8	564263.9	435.96
	B10	7914315.0	564266.0	435.96
B- CV7	B11	7914981.7	564271.9	502.29
	B12	7914988.1	564270.3	502.29

0 2 4
1:50 METRES

0 10 20
1:200 METRES

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2016-04-01	ISSUED FOR CONSTRUCTION	TDR	MJT	MJT	PMB
A	2016-03-18	ISSUED FOR CLIENT REVIEW	TDR	MJT	MJT	PMB

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PROJECT
MARY RIVER PROJECT
MINE HAUL ROAD
DRAINAGE IMPROVEMENT PROJECT

TITLE
PIPE CROSSING TYPICAL DETAILS AND CULVERT SCHEDULE

PROJECT NO.	PHASE	REV.	14 of 17	DRAWING
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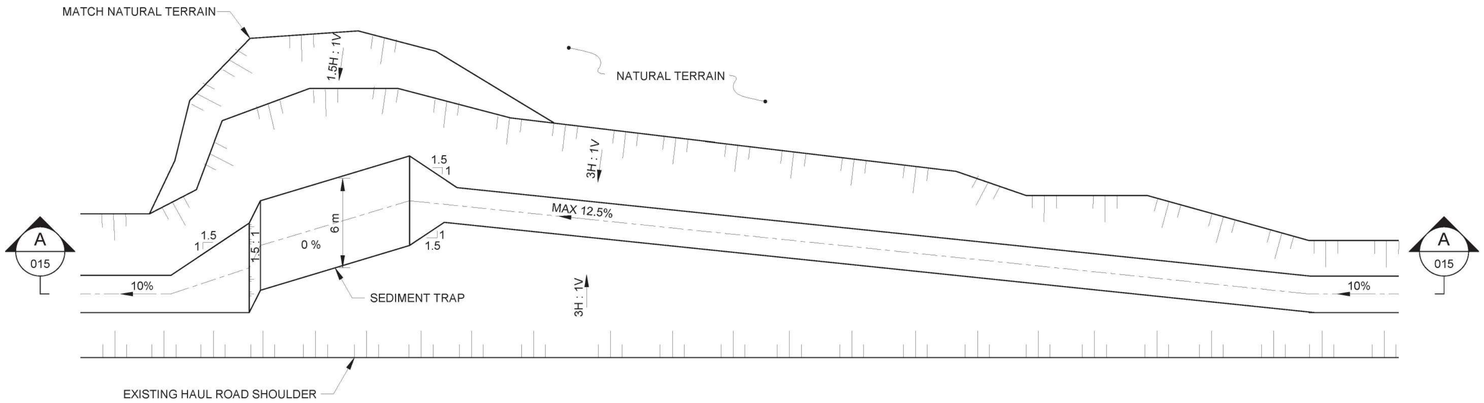
Appendix B



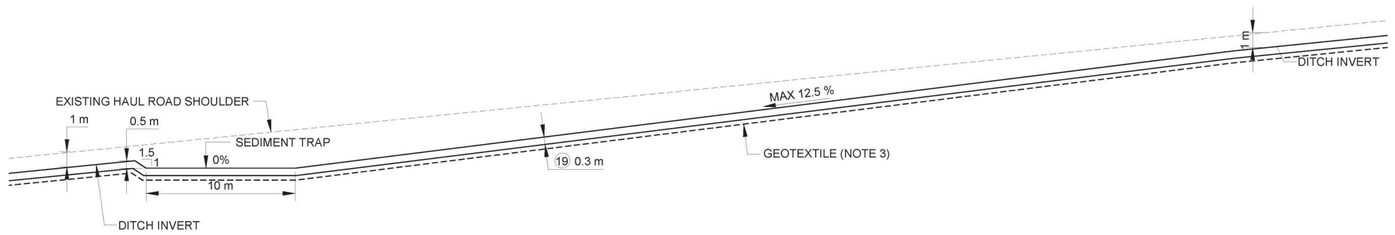
SEDIMENT TRAP - PLAN VIEW
SCALE 1:200

LEGEND

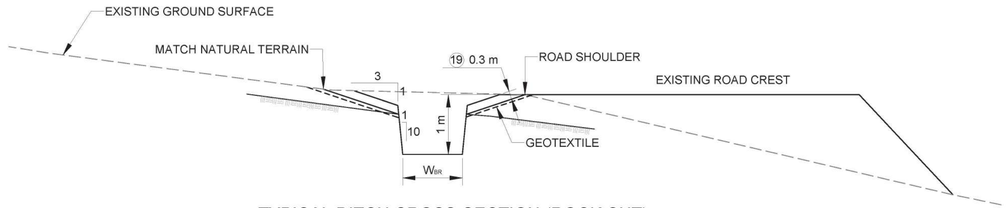
19 EROSION PROTECTION (NOTE 7)

NOTES

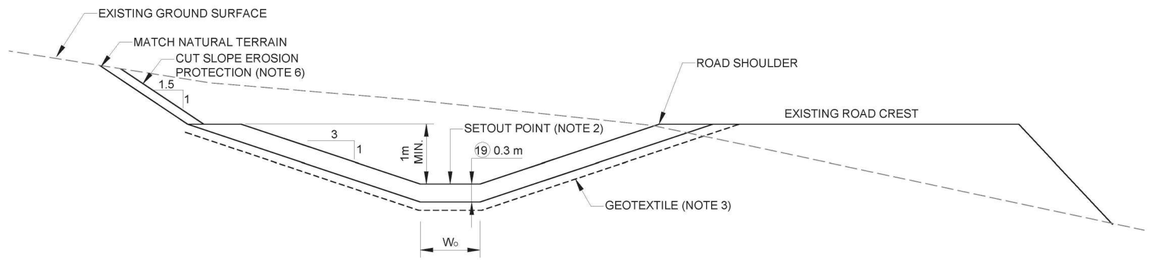
1. THE INFORMATION PRESENTED ON THIS DRAWING IS INTENDED TO CONVEY THE SEDIMENT TRAP DETAILS AND THE DITCH DETAILS.
2. REFER TO DWG. 017 FOR DITCH INVERT SETOUT POINTS.
3. THE USE OF GEOTEXTILE MAY BE REQUIRED. THE USE OF GEOTEXTILE WILL BE AS SHOWN ON THE DRAWINGS OR AT THE DIRECTION OF THE OWNER'S REPRESENTATIVE WITH INPUT FROM THE GEOTECHNICAL ENGINEER.
4. CONSTRUCTION OF THE POTENTIAL SEDIMENT TRAPS AND ASSOCIATED STEEPENED DITCH SECTIONS WILL BE AS DIRECTED BY THE OWNER'S REPRESENTATIVE. IT IS EXPECTED THAT THESE SEDIMENT TRAPS WILL BE CONSTRUCTED IN THE LATER PHASES OF CONSTRUCTION.
5. CONSTRUCTION OF THE DRAINAGE SWALE IS REQUIRED BETWEEN STATIONS 103+750 AND 105+240 ONLY IF THE NATURAL DRAINAGE TOWARDS THE EAST IS INSUFFICIENT. CONSTRUCTION OF THE DRAINAGE SWALE WILL BE AS DIRECTED BY THE OWNER'S REPRESENTATIVE. REFER TO DWGS. 003, 004 AND 005 FOR THE APPROXIMATE LOCATION.
6. REFER TO DWG 016 FOR CUT SLOPE EROSION PROTECTION TYPICAL DETAILS.
7. THE INDICATED EROSION PROTECTION ROCK SIZE IS SMALLER THAN REQUIRED FOR THE SELECTED 1:10 YEAR DESIGN FLOW. THIS IS IN RECOGNITION OF THE AVAILABLE MATERIAL AND AT THE OWNER'S REQUEST. RIPRAP BLOCKS COULD MOBILISE EVEN DURING FREQUENT FLOOD EVENTS, WHICH MIGHT IMPACT SIGNIFICANTLY THE OPERATION OF THE DRAINAGE SYSTEM. REGULAR MAINTENANCE WILL BE REQUIRED. FUTURE IMPROVEMENTS (I.E. REPLACEMENT OF EROSION PROTECTION WITH MATERIAL WITH LARGER ROCK SIZES, PLACEMENT OF GABION MATS) ARE RECOMMENDED.
8. REFER TO DWG. 002 FOR ADDITIONAL NOTES.



SCALE 1:200 A 015 SEDIMENT TRAP (NOTE 4)



TYPICAL DITCH CROSS-SECTION (ROCK CUT)
SCALE 1:50



TYPICAL DITCH CROSS-SECTION (OVERBURDEN)
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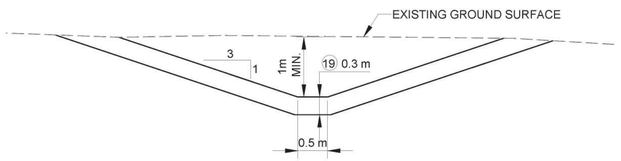

TYPICAL POTENTIAL DRAINAGE SWALE CROSS-SECTION (NOTE 5)
SCALE 1:50

DITCH DETAILS

DITCH ID	START STATION	END STATION	BASE WIDTH IN OVERBURDEN, W_o (m)	BASE WIDTH IN BEDROCK, W_{BR} (m)
DITCH 1	105+270	106+190	2.5	3.5
DITCH 2	106+190	106+397	2.5	3.5
DITCH 3	106+397	106+815	2.5	4.0
DITCH 4	106+815	107+362	0.5	1.5
DITCH 5	107+362	108+014	2.5	4.0
DITCH 6	108+014	108+724	2.5	4.5
DITCH 7	108+953	109+744	1.5	3.0
RAMP 1 DITCH	-	-	1.0	1.0
RAMP 2 DITCH	-	-	1.0	1.0
RAMP 3 DITCH	-	-	1.5	3.0

0 2 4
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PROJECT
MARY RIVER PROJECT
MINE HAUL ROAD
DRAINAGE IMPROVEMENT PROJECT

TITLE
DITCHES AND SEDIMENT TRAPS TYPICAL DETAILS

PROJECT NO.	PHASE	REV.		DRAWING
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