Tote Road

DATE	REV.	STATUS	PREPARED BY	CHECKED BY	APPROVED BY	APPROVED BY
2013-04-02	0	Approved for Use	J. Toloviski	R. Nusink	S. Perry	D. Matthews

Table of Contents

1. General

1.1 Introduction

1.1.1 This document outlines the Design Criteria that shall govern the design for the Tote road associated with the Early Revenue Phase (ERP) of the Mary River Project located on Baffin Island, Nunavut.

1.2 Jurisdictional Authority

1.2.1 The road will be operated and maintained by Baffinland (BIM) during the life of the ERP of the project as a private, controlled-access road.

1.2.2 Other users may be permitted to use the road, at the discretion of BIM, and at their own risk.

1.3 Project Scope Definition

1.3.1 The Early Revenue Phase has been planned as a means to achieve early production at a rate of 3.5 Mtpa with reduced upfront capital cost requirements. Infrastructure and equipment have been designed and selected for the purposes of a relatively small operation and it is this design basis which is fundamental to achieving the low capital cost included within the proposed development strategy. The mining area will be developed in an area of the open pit with a low stripping ratio, high iron grade and acceptable grades of deleterious elements. The existing road to the open pit Mine will be upgraded to serve as the Haul Road from the pit to the crusher. Mining equipment will be sized to suit the relatively small production rate.

1.3.2 The existing 98.5 km Tote Road will be upgraded to enable year round trucking of iron ore from Mary River to Milne Inlet using 12 axle tractor B-train with 140 metric tonne-capacity side dumping B-Train trailer-sets as are currently operated in other northern mining operations such as the Red Dog mine in Alaska. Although year round haulage is planned, it has been assumed that there will be 35 road haulage days lost per year due to soft road conditions and road repairs/maintenance during the freshet, as well as poor visibility and drifting snow during winter. These assumptions reduce the required standards for road and water crossing design, hence cost and construction duration. An ore stockpile will be constructed at Milne Inlet to receive ore on a year round basis. The stockpile will be located as close to the ship loader as possible in order to reduce conveyor costs. Mobile stacking and reclaim equipment will be used, except for a fixed reclaim conveyor that will be installed from the stockpile to the ship loader.

1.4 Project Objectives

1.4.1 The objective of the project is to provide a reliable, all-season transport system to move approximately 3.5 million tonnes per year of iron ore from the Mary River mine site to the Milne Inlet port. The transport system will also be used to support the Mary River mine site operation with the transport of fuel, supplies, equipment, waste and personnel.

1.5 Acronyms

ERP	Early Revenue Phase
ROW	Right-of-way
TAC-ATC	Transportation Association of Canada
BIM	Baffinland Iron Mines

1.6 Project Language

The project language will be Canadian English.

1.7 Road Classification

The road will be classified as a Temporary Resource Road for permitting purposes.

1.8 Design Context

The Design Criteria of the road will be based on a "best practices" approach as set out in the Transportation Association of Canada, current design requirements for Low Volume Roads.[1]

1.9 Scope

1.9.1 The criteria in this document apply to the civil engineering design for the following road within the project limits:

- **Tote Road** including 98.5km (approximate) of upgrading existing road and an additional 7km (approximate total) within the Milne Port area and Mine site.

1.10 Safety

1.10.1 The consideration of personnel safety in all stages of the design, construction and operation is paramount. Prime consideration shall be given to safety and reliability to:

- Maximize health and safety for all personnel using the road.
- Minimize environmental impacts during construction and operation.
- Maximize the security of equipment.
- Maximize continuity of service (i.e. minimize time road is out of service).

1.11 Units of Measure

1.11.1 The International System (SI) will be used as the project standard.

1.12 Limits of Project

1.12.1 The project limits of this component are from the Milne Inlet new stock pile area to Mine Site crusher pad.

[1]Transportation Association of Canada (TAC) Manual of Geometric Design Standards for Canadian Roads; 2011

1.12.2 This includes construction of a 2.5km (approximate) road, following the new alignment down the hill to the new stock pile area at Milne Inlet.

1.13 Assumptions and Exclusions

1.13.1 The design criteria for the Tote Road are based on the following assumptions:

1. The primary usage of this road is for round-trip truck-transporting of iron ore from the mine site to a small marine facility at Milne Inlet, that will subsequently be transported to market by sea during the three month open water season (July to October). All other usage is secondary to this.
2. The preferred design speed identified by BIM for the Tore road is 65km/h and the design vehicle is 12 axle tractor B-train with 140 metric net payload and GVW=190t. The design speed and vehicle define geometric design criteria for safe operation. Where these geometric design criteria cannot be met, due to site conditions imposed by impacts to permafrost topography and cost, BIM have provided minimum acceptable geometric design criteria. A corresponding design and posted speed have been identified in Geometric Design Criteria – Table 5-1
3. Refer to Section 5.2 for Design Vehicle.
4. The road will be operated and maintained by BIM as a private, controlled-access road during the life of the Early Revenue Phase of the Mary River Project – five (5) years.
5. The design life for the Early Revenue Phase of the project for the purposes of evaluating the project investment is five (5) years.
6. Other users will be permitted to use the road at the discretion of BIM, and at their own risk.
7. The road will be classified as a Temporary Resource Road for permitting purposes.
8. The road will have a prepared granular running surface (“pavement”). There will be no asphalt or concrete wearing course, and therefore no pavement markings will be used.
9. Operators of the crushed iron ore transport fleet will be based in the Mary River area. They will operate on the basis of two (2) single round-trips per shift (approx. 400km in total), under normal conditions.

2. References and Acronyms Design Codes, Standards, and Regulations

2.1.1 Unless specifically stated elsewhere, roads shall be designed in accordance with this Criteria read along with applicable sections of the latest revisions of the codes, specifications, and standards listed below. If there is any conflict between this Criteria and other relevant design standards, the following shall apply in descending order of precedence:

1. This Design Criteria.
2. Mine Health and Safety Act.
3. All applicable federal, territorial and local laws and regulations.
4. *Canada Geometric Design Guide for Canadian Roads; TAC – ATC; 2011.*
5. *Developing and Managing Transportation Infrastructure in Permafrost Regions, TAC-ATC; 2010.*
6. *Northern Land Use Guidelines: Access Roads and Trails, Indian and Northern affairs Canada; Volume 5; 2010.*
7. *British Columbia MoT, Supplement to TAC Geometric Design Guide, MoT Section 900, June 2007.*
8. *A Policy on Geometric Design of Highways and Streets; AASHTO, 2004.*
9. Fisheries Act (Canada).
10. Ontario MoE, *Stormwater Management Planning and Design Manual*, 2003.

2.1.2 In addition, the design must comply with all laws and regulations of local authorities; in the event of conflicting requirements, the most stringent shall govern as confirmed with the Engineer.

2.2 Other Regulations

2.2.1 All applicable federal, provincial and local laws and regulations apply to the Mary River Project: Early Revenue Phase:

INAC	Indian and Northern Affairs Canada
OSHA	Occupational Safety and Health Administration
OSHR	Occupational Health and Safety Regulations
NBCC	National Building Code of Canada
NFPA	National Fire Protection Association
CFEM	Canadian Foundation Engineering Manual
MNR	Ontario Ministry of Natural Resources
MOE	Ontario Ministry of the Environment
MSHA	Mine Safety and Health Administration Handbook Number PH99-I-4.

2.3 Other Project Design Criteria

2.3.1 This Design Criteria shall be read in conjunction with other documents which may already exist or will be developed as the project proceeds. These documents include the following:

- H349000-1000-07-122-0001 Environmental Design Criteria
- H349000-1000-10-122-0001 Civil Design Criteria

2.4 Reference Documents

2.4.1 Reference will be made to the following documents when reading these criteria:

- BIM-Engineering Scope - Tote Road.
- Bulk Sampling Program (Knight Piesold, 2010).
- Hydrology Baseline Report (Knight Piesold, Feb. 2012).
- Tote Road As-built Summary; (Knight Piesold, Dec. 2009.

3. Current Conditions of the Road

3.1.1 The Tote Road was originally a winter-only road. It was upgraded to a temporary all-season road under the 2008 Bulk Sample Program. This all-season capability will be maintained during the construction period of the Mary River project.

3.1.2 The road was constructed directly on the existing tundra. The foundation of the road consists generally of an active zone ranging from 1-2 m in thickness overlaying permafrost which is sometimes ice-rich.

3.1.3 The alignment of the road is curvilinear. The existing road cross-section (width) varies from 8 m to 10 m. The road narrows to a single lane at bridge and culvert crossings.

3.1.4 In terms of vertical alignment, adverse grades can reach as high as 18%, with sharp changes in vertical alignment at crests and sags (low “K” values).

3.1.5 Regarding horizontal alignment, there are at least 22 locations were the curve radii are less than 50 m.

3.1.6 There are several locations where the road winds (tight radius curves) to ascend adverse grades. In total, there are at least 12 locations, with a total length approximately 6 km, that are identified as geometrically-deficient (narrow cross-section; steep grade; inadequate stopping sight distance; sequences of substandard horizontal curves; and/or constructed/topped with loose, very silty material).

3.1.7 There are over 400 culverts along the route, many of which are undersized and have negative slopes (totalling approximately 1,052 linear metres with 150 mm diameter; and 470 linear metres with 300 mm diameter). The culverts require maintenance each spring (8-10 weeks per yr) to remove accumulated silt and debris Refer to section 5.15 - Culverts for further details.

3.1.8 There are over 100 small roadside borrow pits, and three (3) major borrow pits, along the route.

3.1.9 There are four bridges along the route currently in active use. Constructed using sea containers stacked side-by-side; these installations will require replacement with modular bridges to accommodate the loaded weight of the proposed design vehicle.

4. Functional Requirements

4.1.1 Upgrades to the Tote Road will be minimized wherever possible, in consideration of the project life and budget, to meet the structural, geometric, operational, and safety requirements defined by the road-haul design vehicle, and the iron ore road-haul operation, as proposed.

4.1.2 Where feasible, site-specific or more general exceptions to the base design criteria may be proposed to reduce the scope and scale of the upgrade, and to control construction cost. Design exceptions may prove tolerable, provided operating and safety requirements can be otherwise satisfied through the introduction of lower-cost mitigating measures. Exceptions will be reviewed in detail and approved by BIM.

4.1.3 Whenever design exceptions are considered, an explicit safety and operational analysis shall be conducted, so as to understand what increment of safety and or productivity is being surrendered, to satisfy other competing project demands.

4.1.4 Passing meets between opposing vehicles will require a minimum of 9.2 metres of clear roadway cross-section on tangent sections, and additional width in horizontal curves, to account for off-tracking. Minimum stopping sight distance will also need to be provided.

4.1.5 Vehicle dimensions and manoeuvring capabilities will be used to examine the existing horizontal alignment, and identify areas of deficiency.

4.1.6 Where design exceptions are to be considered, possible mitigating measures for low cost alternatives to ensure geometric compliance include:

- Advance curve warning signs; advisory speed tabs.
- Road-edge delineators.
- Chevron alignment signs placed around the outside of speed-restricted curves.

4.1.7 Aspects of the vertical alignment, including: adverse grades; sharp sags, which may adversely impact vehicle control; and sharp crests, which limit stopping sight distance; will be examined for improvement opportunities to increase stopping sight distance and allow for higher relative operating speeds.

4.1.8 The Tote Road design criteria will not necessarily match the site preparation design criteria. To ensure a smooth transition from tote road to access roads at the Mary River site, where conflicts occur, the most stringent parameter will be applied.

4.1.9 Modifications shall generally be undertaken using fill material. No excavation shall be permitted without approval by BIM.

5. Design Requirements

5.1 Road Alignment

5.1.1 One of the main elements of the Early Revenue Phase of the Mary River Project will be the Tote Road which will serve as a link and the permanent access from the Milne Inlet site to the Mine Site. Once constructed, it will be used to transport supplies, equipment, personal, and crushed iron ore between Milne Inlet and the Mine Site during its operation phase.

5.1.2 The beginning of the proposed road corridor is presently anticipated to be at the "T"-intersection near the lay down area at the Milne Inlet site, following the existing Tote Road south for approximately 98 km and ending at the Mine Site crusher area.

5.1.3 The proposed upgrades to the road will be confined within a 60m right-of-way corridor, extending from the existing roadway's centerline out 30m to either side.

5.2 Design Vehicle

5.2.1 The design vehicle proposed is a tractor pulling a side-dumping B-train trailer-set. The gross loaded curb weight of this vehicle, for design purposes, is 190 t, of which 140 t is payload. The vehicle will have twelve (12) axles, as follows:

- A conventional steering axle.
- A tridem (3) set of drive axles (conventional duals, planetary drives).
- A quad (4) axle-set with conventional duals supporting the lead trailer.
- A quad (4) axle-set with conventional duals supporting the second trailer.

5.2.2 The tractor-to-trailer connection, and the trailer-to-trailer connection, will be of a pin-and-fifth-wheel type.

5.2.3 The vehicle will be loaded to equalize individual axle-loads to the greatest extent possible. Assuming a GLVW of 190 t, and six (6) tonnes carried on the tractor steering-axle, individual axle loads will be approximately 16.8 t per axle. This information, along with vehicle dimensions (attached), the operating speed proposed (55 km/h), and the average daily traffic volumes proposed (75-80 round-trips per day – loaded in one direction only), will be used to develop bridge and pavement design recommendations.

5.3 Design Speed (DS)

5.3.1 The design speed is determined by the functional classification of the roadway, and the intended operating speed of traffic upon it, as per industry best practices. The design speed is set at 10-20 km/h above the posted speed limit.

5.3.2 Where road conditions and design require the implementation of a reduced design speed, suitable advanced advisory traffic control measures shall be employed.

5.4 Horizontal Curves

5.4.1 Taking into consideration that the design vehicle adopted has a substantially-higher center of gravity than a passenger car, the minimum horizontal curve radius for the Tote Road are calculated taking into account the following:

- Roll-over speed.
- Lateral friction on granular surface.
- Planned cross-fall (for drainage), and potential for an uneven driving surface due to settlement, frost-heave, or traffic wear.

5.5 Stopping Sight Distance

5.5.1 Design and operational criteria for stopping sight distance as given in geometric design standards are based on passenger car braking distances on wet pavement (either asphalt or concrete), even and clean road surfaces, and tires that are worn but in good condition. Stopping site distance for the design vehicle is calculated to take into account the following:

- Peak braking coefficient of friction on gravel surface.
- Specified braking performance of the design vehicle (i.e. ABS).
- Specified tire wear limits.
- Calculated braking distance.
- Standard reaction time, as defined by design standards.

5.6 Widening in Horizontal Curves

5.6.1 Circular curves with R ≤ 1,000 m may need be widened to account for high-speed off-tracking. Widening when included, will be uniform for the entire circular curve length. Such designed curves shall be checked for all design vehicles using software AutoTURN™ by TransSoft Solution. In order to ensure smooth traffic operations, a 1.0 m clearance shall be provided between opposing vehicles and incorporated into the total roadway width.

5.7 Vertical Curves

5.7.1 In geometric design standards minimum recommended parametric value K for vertical curves is established for passenger cars. For crest vertical curves it is typically assumed that the longer stopping sight distance required for commercial vehicles is offset by the higher driver eye position in trucks.

5.7.2 K values apply to vertical crest and to vertical sag curves. Within limits, vertical sag curves represent an area where a design exception may be introduced with limited adverse safety effects on lower-speed, low-volume roads.

5.8 Roadside

5.8.1 In tangent sections, the minimum roadside clear zone for a design speed of 65 km/h, at Average Annual Daily Traffic (AADT) volume of less than 750 vehicles-per-day, is three (3) metres. Adjustment of clear zone distances is required on horizontal curves.

5.8.2 Fixed objects within the clear zone will be removed, relocated, made traversable, or made crashworthy. Bridge parapet walls will be protected with guide rail approach and leaving treatments.

5.8.3 Surplus material that is not suitable for roads' substructure can be used for flattening of slopes on embankments that are higher than 3.0 m. Such slopes shall be 4:1 or flatter. If there is no surplus material available, other measures to enhance safety by making the roadside forgiving (e.g. by installation of safety barrier) but which minimize potential for snow accumulation may be considered.

5.9 Pullouts

5.9.1 Most narrow resource roads have pull-outs built alongside the main driving surface. Pullouts are being used where slow moving vehicles impact the Level of Service and cause unacceptable truck-platooning. Pullouts should be used to avoid long no-passing sections.

5.9.2 Pullouts should be considered on long uphill grades when a truck climbing lane cannot be built and where speed reductions of at least 20 km/h bellow the posted speed are encountered.

5.9.3 Minimum Pullout width is 4 m. This is shoulder widening. Parking should be prohibited in the pullout area. The minimum width is to avoid pavement degradation by off-tracking or wide vehicle. Pavement design should be as per travel lanes.

5.10 Escape Lanes

5.10.1 Where long descending grades exceeds 5%, evaluate the road geometry to determine if a clearly identified emergency runaway lane(s) or retardation barriers at suitable location, capable of bringing a runaway vehicle to a controlled stop will be required.

5.10.2 The location of the escape ramp depends on terrain, length of grade, and roadway geometrics. Desirable locations include before a critical curve, near the bottom of a grade, or before a stop. It is desirable that the ramp leave the roadway on a tangent. The angle of departure for the ramp should be small, usually five (5) degree or less.

5.10.3 The alignment of the escape ramp should be tangent on very flat curvature to minimize the driver's difficulty in controlling the vehicle.

5.10.4 The length of an escape ramp depends on speed, grade, and type of design used. The minimum length is 65 m.

5.10.5 The width of each escape ramp depends on needs of the individual situation. It is desirable for all the ramp to be wide enough to accommodate more than one vehicle. The desirable width of an escape ramp to accommodate two out-of-control vehicles is 12 m and the minimum is 8 m.

5.10.6 The surfacing material used in the arrester bed should be clean, not easily compacted, and have a high coefficient of rolling resistance. Arrester bed should be constructed with a minimum aggregate depth of 1 m.

5.10.7 The principal determinations as to the need should be the safety of the other traffic on the roadway, the operator of the out-of-control vehicle, and the residents along or at the bottom of the grade. Long descending grades allow high vehicle speeds to be reached, and truck brakes can overheat and fail through extensive use.

5.10.8 The ramps are often built before a critical change in the curvature of the road, or before a place that may require the vehicle to stop, such as before an intersection in a populated area. Escape lanes have good potential for intercepting and stopping runaway haulage vehicles.

5.11 Barriers

5.11.1 Berms (or other barrier devices specifically approved by BIM) are required where a drop off of at least 3m exists.

5.11.2 Berms shall be placed as ¾ the height of the largest tire of vehicles using the road.

5.12 Geometric Design Criteria

5.12.1 The following table summarize the geometric design criteria:

Table 5-1: Tote Road: Early Revenue Phase – Mary River Project

Parameter	Id	Unit	Desirable Value (TAC-ATC)	Minimum Value (BIM)	Design Speed	Posted Speed
Design Classification	-	-	Rural / Local Resource Road			
Design Vehicle			12 Axle B-Train Side Dump(GVW=190t)			
Design Speed			65km/h (unless otherwise noted)			
Posted Speed			55km/h (unless otherwise noted)			
Rolling Friction	F_r	-	0.320			
Min Stopping Sight Distance	Ssd	[m]	100[4]			
Max Tangent Length	L	[m]	N/A			
Max Tangent Length Between In Curves In The Same Direction	L	[m]	N/A			
Lateral Friction	F_l	-	0.150			
Min Radius	R_{min}	[m]	160		65km/h	55km/h
				55	30km/h[4]	20km/h[4]
Min Radius For Reverse Crown	R_{rc}	[m]	1750			
Min Radius For Normal Crown	R_{nc}	[m]	2500			
Min K Factor – Crest	-		13		65km/h	55km/h
				4	40km/h	30km/h
Min K Factor – Sag	-		9		65km/h	55km/h
				8	40km/h	30km/h
Min Vertical Curve Length	L_{vc}	[m]	Ds=65			
Max Grade	G_{max}	[%]	6-12	10		
Min Grade	G_{min}	[%]	0.05			
Max Cross Fall	E_{max}	[m/m]	0.04	0.02		
Normal Cross Fall	E	[m/m]	-0.03	-0.02		
Total Platform Width	B	[m]	9.2			
Lane Width	W	[m]	2 @ 3.7			
Shoulder Width (to midpoint Rnd)	W_{sh}	[m]	0.4			
Shoulder Rounding	Rnd	[m]	0.5 [1]			
Min Fore Slope	N	-	3:1	1.5:1		
Min Clear Zone (Tangent)	Cz	[m]	3			
Min R.O.W. Width	Row	[m]	60	60		
Min Turning Radius [3]	R'	[m]	14			
Advisory Speed Limits	As	[km/h]	TBD [4]			

[1] *Where steel beam barrier is proposed shoulder rounding will be 1.0 m*

[2] *Minimum ditch grade is 0.3%*

[3] *For centre of axle*

[4] *For sub-standard horizontal curves (if any) advisory speed limits will be confirmed by ball-bank test upon completion of construction.*

[5] *For centre of axle*

[6] *Typical Tote Road Cross Section –Figure 5-1: Typical Tote Road Cross Section.*

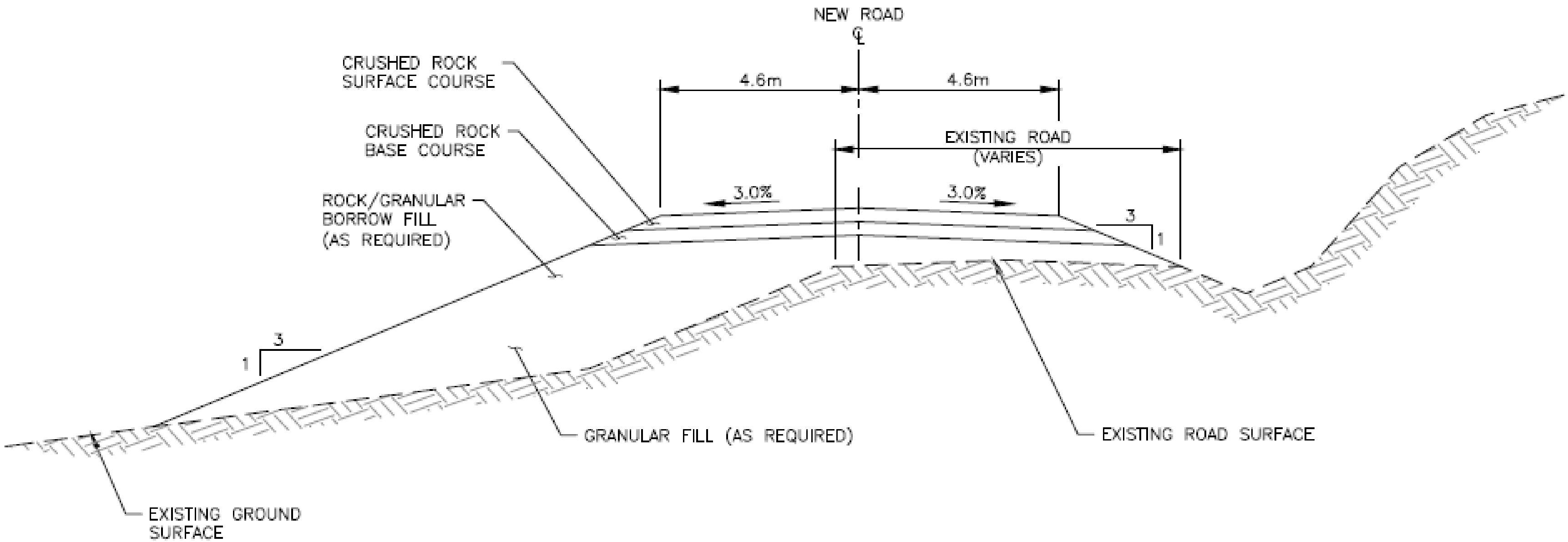

Figure 5-1: Typical Tote Road Cross Section

5.13 Exceptions

5.13.1 Where necessary, minimum values or design exceptions will be applied and suitable mitigating measures will be recommended on a case-by-case basis.

5.13.2 Mitigating measures, where applied, shall be approved by BIM.

5.14 Drainage

5.14.1 Wherever a section of the existing road requires upgrading, the need to install roadside ditches will be evaluated.

5.14.2 Generally cuts to accommodate drainage will be avoided and only permitted in a case by case basis and with prior approval by BIM. Where ditches are required and approved, they will be designed as per design requirements below. Where natural cross fall of existing grade is impacted by road embankment and ponding is expected, relief culverts will be detailed to allow water to follow its natural surface flow.

5.14.3 Roadside ditches, with desirable 0.5 m depth (minimum 0.3m) and 1.5H:1V side slopes will be provided where necessary, with prior approval by BIM. The ditch shape will be either triangular or trapezoidal, depending upon the amount of flow the ditch is anticipated to carry.

5.14.4 Drainage controls consist primarily of culverts, bridges and open ditches. In flat areas, roads can be crowned so that runoff drains to either side of the right-of-way, leaving the surface dry. In areas with longitudinal slopes less than 4%, roads should be outsloped so that the downslope side of the road is slightly lower than the upslope side to ensure effective drainage across the road. In steep (longitudinal slopes greater than 4%) or wet areas, water will be channelled into drainage control structures designed to carry greater volumes, such as ditches and cross drains.

5.14.5 Controlling drainage involves design aspects or structures that keep the road dry, including stream crossings. A detailed understanding of natural drainage patterns will assist in designing drainage control structures that will be appropriately sized for expected flows and will follow natural drainage erosive sheet flow. Rapid runoff from slopes is also a concern, especially on south or west-facing slopes where snowmelt is more rapid.

5.14.6 Where ponding is likely to occur, culverts shall be included to allow overland flow through road embankments.

5.14.7 Roadside ditches will be designed in accordance with the criteria given in Table 5-2.

Table 5-2: Design Requirements for Roadside Ditches for Conveyance of Flow

Parameter	Id	Unit	Standard Value	Desirable Value
Max Back Slope	N_{bs}	-	2:1	3:1
Min Longitudinal Grade	$G_{d,Min}$	[%]	0.3	
Bottom Width	Bd	[m]	0	1.0
Min Depth: Normal Ditch [1] Ditch At Toe Of Fore Slope	D_n	[m]	 0.50 0.25	
Min Distance From Ditch Invert to top of Road Sub-Base	D_{sb}	[m]	0.3	0.5

[1] *Road At Level Or In Cut*

5.14.8 Culvert crossings will be designed with a minimum 0.5 m headwater freeboard from design flow peak stage to the edge of the shoulder.

5.15 Culverts

5.15.1 There are over 400 culverts generally ranging from 150 mm to 1200 mm in diameter are already in place, many of which are undersized and have negative slopes (approximately 1,052 m with 150 mm diameter and 470 m with 300 mm diameter). The culverts require maintenance each spring (8-10 weeks per yr). 38 new culverts were installed during 2009 and approximately 200 m of culverts were installed during 2010. 30 culverts were installed during 2011 and 54 culverts were upgraded. 45 new culverts were installed in 2012 and 96 were upgraded.

5.15.2 Cover above culverts shall be checked for the proposed design loading conditions to ensure a minimum depth is provided.

5.15.3 As stated in section 4.1.4, a minimum road width of 9.2m shall be provided. However, to allow for future potential widening, culverts (including extensions where necessary) shall be designed and installed to support a road width of 10.0m.

5.15.4 The existing culverts will not be checked for their hydraulic capacities, as it is assumed that current maintenance works have acted on the (hydraulically) undersized sections. Wherever a road upgrading interferes with the existing culverts, those will be extended and/or replaced retaining the same hydraulic capacity.

5.16 Permafrost

5.16.1 Some areas of potentially frozen ground contain significant amounts of ground ice. Disturbance of these areas should be avoided due to the potential for melting and ground subsidence, potentially leading to soil erosion, instability of engineered structures and loss of habitat.

5.17 Snow Drifting

5.17.1 In areas where the roadway has a high risk of snow drifting, the following measures to minimize accumulation and provide adequate storage are to be considered:

1. Where it is not required to accommodate a water crossing, elevating the road profile by up to 2 m above the adjacent land.
2. In fill sections, making side slopes 4:1 or flatter.
3. In cut sections, making ditches deeper than 0.5 m and wider than 1.0 m (as practical).

5.18 Signage

5.18.1 For signage and traffic delineation information refer to ERP Operations Strategy (to be confirmed).

5.19 Aggregate Sources (Borrow Pits)

5.19.1 The number, location and available volumes of borrow sources within the corridor have a significant impact on the cost of the road. Where feasible, aggregate to construct and maintain the proposed Tote Road will be derived from sources within the proposed ROW.

5.19.2 Further investigation is underway to determine the potential aggregate sources along the proposed ROW.

5.19.3 Fill material will be required over the life of the resource road due to and especially for the continual maintenance of the road surface.