6.4.2 The following general rules shall apply to the geometric design of the project roads:

- Roadway grades shall not exceed the maximum grades specified in Table 6-1, except for short ramps which shall be considered on a case-specific basis.
- Signage shall be provided for speed and caution at steep horizontal and/or vertical curves, and where the design criteria can□t be met.
- Light poles, traffic signs and shoulder barriers (safety berms or guardrails), shall be placed at the outer edges of the roads, as required.

6.5 Pavement Design

6.5.1 The design of pavement structures requires information such as the expected pavement service life, design vehicle traffic volume, loads, and geotechnical information such as soil type and California Bearing Ratio (CBR).

6.6 Pavement Thickness

6.6.1 For the project internal site roads, the subgrades shall be prepared via cut/fill activities prior to pavement installation/placement. If the height of the subgrade fill is less than 600 mm, Type 8 (150 mm minus) material shall be used. If the height of the subgrade fill is greater than 600 mm, Type 12 Run-of-□uarry and/or suitable earth fill material shall be used. The voids of each layer of Type 12 material shall be filled with rock fragments prior to placement of the next layer. 1

6.6.2 The following minimum internal site road pavement thicknesses shall be used throughout the project:

- 300 mm, Type 8 (150 mm minus) subbase.
- 100 mm, Type 5 (32 mm minus) base/surface course for low speed light vehicle traffic roads and low speed B-Train traffic roads. 1
- 200 mm, Type 5 (32 mm minus) base/surface course for medium to high speed B-Train traffic roads. 1

6.6.3 The following minimum haul road pavement thicknesses shall be used throughout the project:

- 300 mm, Type 8 (150 mm minus) subbase.
- 300 mm, Type 8 (150 mm minus) base.
- 200 mm, Type 5 (32 mm minus) base/surface course. 1
- ~~900 mm, Type 12 Run-of-Mine structural subgrade (varies depending on the actual site conditions).~~ 1

6.6.4 The ramp and earthworks pad leading down to the sea lift from the laydown area, including the designated turnaround area at the beach within the Milne Port shall contain the following pavement thickness:

- 300 mm, Type 8 (150 mm minus) subbase.
- 200 mm, Type 5 (32 mm minus) base/surface course. 1
- ~~100 mm Type 3 (19 mm minus) wearing course.~~ 1

6.6.5 *Pavement Service Life*

6.6.5.1 The service life of the site pavements, prior to any structural rehabilitation work being required, shall be 5 years, unless noted otherwise for specific items.

6.6.6 *Design Vehicles, Traffic Volume and Load*

6.6.6.1 Vehicle types have been selected for the project roads based on the expected usage and transportation requirements of the area (Section 6.3).

6.6.6.2 All pavement, slabs, bridges, trenches, trench covers and underground installations accessible to trucks shall be designed to withstand the load associated with an HS 20-44 wheel load or its equivalent, as defined by the American Association of State Highway and Transportation Officials (AASHTO) under Standard Specification for highway bridges. However, within areas of special equipment operation, this shall be considered as per the actual vehicle loading.

6.7 Parking

6.7.1 Parking areas shall be designed to accommodate their intended use. In general, all parking areas shall be surfaced with granular materials.

6.7.2 Vehicle parking area design shall adhere to the following:

- The area shall be graded to direct stormwater away from the parking. 1
- Alignment and gradients shall be coordinated with the grading plans to control drainage.
- Walking distance from parking areas shall be kept to a minimum.
- Barrier-free parking spaces as well as walkways shall be provided according to the applicable regulations.
- Designated turnaround areas shall be provided at dead ends.
- Parking lot design criteria shall be as shown in Table 6-2.

Table 6-2: Parking Lot Design Criteria

Topic	Criteria
Gradient	Maximum 5□ Minimum 0.5□ Optimum 2□
Cross Slope	Maximum 5□ Minimum 2□ Optimum 3□
Pavement Structure	300 mm Type 8 (150 mm minus) subbase 1 100 mm Type 5 (32 mm minus) base/wearing surface course 1 ~~50mm wearing course~~
Parking Stall Dimensions	Driving Lane • Width 7.5 m Standard

Topic	Criteria
	• Depth 6 m • Width 2.75 m Barrier-free • Depth 6 m • Width 3.5 m • Access Aisle Width 1.5 m

6.8 Signage

6.8.1 Traffic control signs and road edge markers shall be provided as required to ensure safe movement in and about the site.

6.8.2 Direction and information signs for both vehicle and pedestrian traffic shall be provided for parking areas, restricted areas, shipping and receiving.

6.8.3 Primary identification signs shall be free-standing and sited according to the applicable standards as listed in Section 4.3.

6.8.4 Other signs shall be free-standing, fence-mounted or wall-mounted.

6.8.5 Security signs shall be provided at the sites and along the site property boundaries.

6.8.6 Signs for the site access roads shall be compliant with the local traffic regulations.

6.8.7 Signs shall be lighted, if deemed necessary.

6.8.8 All signs and pavement markings (if applicable) shall be well maintained during the construction and operational periods.

6.9 Bollards

6.9.1 Bollards, if required, shall be provided at building entrances and around hazardous areas such as tanks and transformers. Bollards shall be 1.2 m high, 150 mm diameter schedule 40 CS pipes. 1

6.9.2 Bollards shall be filled with concrete.

6.9.3 Bollards shall be painted and coated such that they provide clear reflection off of vehicle headlights.

6.10 Shoulder Barriers (Safety Berms/Guardrails)

6.10.1 Shoulder barriers (earth safety berms or guardrails) shall be provided where a 3.0 m or more drop-off exists at the edge of roads. 1

~~6.10.2~~ ~~Shoulder barriers shall be installed where the horizontal distance from the edge of a travelled lane to an obstruction is less than 1.0 m~~ 1

6.10.3 Earth/safety berms for the Mine Haul Road from the open pit to the crusher pad and from the crusher pad to the maintenance building shall have heights of 2.0 m, and side slopes of 1H:1V. 1

6.10.4 Safety berms for the internal roads shall have heights of 1.0 m and side slopes of 1H:1V. 1

6.10.5 Discontinuous openings shall be provided in berms at maximum 25 m spacing for drainage and snow clearance, with openings smaller than half the blade width of vehicles constructing or maintaining the berms. 1

6.10.6 Runaway vehicle collision berms or escape lanes shall be provided in accordance with industry requirements as described in the Nunavut MHSA.

6.11 Utility Berms

6.11.1 Utility Berms shall travel along the project roadways to the greatest extent possible, shall be of trapezoidal cross-sections, shall be minimum 0.6 m high from the road edge or the existing ground, and shall have maximum fill side slopes of 1.5H:1V, as validated by the geotechnical engineer. They shall be constructed with the use of 300 mm of granular Type 8 (150 mm minus) and 100 mm of granular Type 5 (32 mm minus) material. If the height of the subgrade fill is less than 600 mm, Type 8 (150 mm minus) fill shall be used. If the height of the subgrade fill is greater than 600 mm, Type 12 Run-of-□uarry and/or suitable earth fill material shall be used. The voids of each layer of Type 12 material shall be filled prior to placement of the next layer. The top width of utility berms will depend on the pipe and cable duct sizes. Utility berms shall cross roadway intersections through utility sleeves. After crossing the intersections, they shall resume the alignments within the utility berms. 1

7. Stormwater Management System

7.1 Internal Surface Drainage

7.1.1 The general criteria for the site internal stormwater management system are described below.

- All interior site grading and roads shall be designed to provide continuous overland flow without erosion to a drainage ditch system.
- All drainage ditches should be of trapezoidal cross sections, where possible. 1
- Ditches shall be designed to convey a 1 in 25 year flood event.
- Provision must be made to ensure that there is a safe flow path for events up to the 1 in 100 year event, such that the runoff will not flood key mining areas, cause significant erosion, pick up excessive contaminants or cause other significant problems.
- Ditch freeboard, minimum depth, minimum width, side slope, longitudinal slope and maximum permissible velocities shall be as per Table 7-2.
- Minimum set back distance of structures from top of drainage ditch slopes shall be 3 m.
- Roof and yard drainage shall be collected in open ditches.

- Rip rap shall be provided at locations throughout the storm drainage system which are susceptible to erosion, including ditch sections subject to high-velocities (greater than 1.5 m/s), sections of super critical flow, ditch outlets, storm sewers outfalls, and culverts inlets and outlets.
- If the ditch is in rock, no rip rap is required.
- Energy dissipaters shall be used where the flow velocities may reach values high enough to cause severe erosion or hydraulic jumps.

7.2 External Surface Drainage

Criteria for drainage of the external area are as follow:

- Runoff from undisturbed areas surrounding the mine site shall be collected in perimeter ditches and diverted around and/or through the site perimeter.
- To the extent possible, these perimeter ditches shall be designed to discharge at locations that best retain the characteristics of the existing (i.e. pre-development) natural drainage patterns.
- Diversion ditches shall be designed to convey the 1 in 100 year flood event.
- Ditch freeboard, minimum depth, minimum width, side slope, longitudinal slope and maximum permissible velocities shall be as per Table 7-2.

7.2.1 Peak Flow Estimation

- **For catchment areas greater than 0.5 km^2:** 1

Runoff peak flow estimation shall be based on the following equations developed by Knight Pi□sold Consulting:

$□_2 = 1.1\ A^{0.79}$

$□_5 = 1.7\ A^{0.77}$

$□_{10} = 2.0\ A^{0.76}$

$□_{25} = 2.6\ A^{0.75}$

$□_{100} = 3.5\ A^{0.73}$

$□_{200} = 3.9\ A^{0.73}$

Where:

□=peak flow instantaneous flow in m^3/s

A = drainage area in km^2 (0.5 km^2 ≤ A ≤ 1000 km^2)

- **For catchment areas less than 0.5 km^2:** 1

The Rational Method shall be used for peak flow estimation, as follows:

□ = 0.28 CIA

Where:

□ = peak instantaneous flow in m^3/s

A = drainage area in km^2

C = runoff coefficient = 0.90 (for all drainage areas except the Milne Port Ore Stockpile footprint, for which C = 0.0, as per BIM's instructions). 1

I = rainfall intensity corresponding to the time of concentration (mm/hr), estimated using Table 7-1 below.

- Time of Concentration shall be computed with the modified Kirpich equation:

$T_c = 0.06628 (L^{0.77}/S^{0.385})$

Where:

T_c = time of concentration (hours)

L = main channel length (km)

S = main channel slope (m/m)

Minimum T_c = 10 min

7.3 Rainfall Intensity

7.3.1 Table 7-1 displays the Intensity-Duration-Frequency data which shall be used for peak flow runoff approximation, developed by Knight Piesold consulting:

Table 7-1: Rainfall Intensity (mm/h)

Duration	2 yrs	5 yrs	10 yrs	15 yrs	20 yrs	25 yrs	50 yrs	100 yrs	200 yrs
5 min	9.5	12.0	14.0	15.1	15.9	16.5	18.3	20.1	22.0
10 min	7.2	9.0	10.5	11.3	11.9	12.4	13.7	15.1	16.5
15 min	6.0	7.5	8.7	9.4	9.9	10.3	11.4	12.6	13.7
30 min	5.0	6.3	7.3	7.9	8.3	8.6	9.5	10.5	11.4
1 hr	4.0	5.2	6.1	6.6	7.0	7.3	8.1	9.0	9.9
2 hr	3.0	3.9	4.6	5.0	5.2	5.5	6.1	6.8	7.4
6 hr	2.0	2.7	3.3	3.6	3.9	4.0	4.6	5.1	5.7
12 hr	1.3	1.8	2.2	2.4	2.6	2.7	3.1	3.4	3.8
24 hr	1.0	1.4	1.7	1.9	2.0	2.1	2.4	2.7	3.0

7.3.2 Figure 7-1 displays the 200 year design storm distribution:

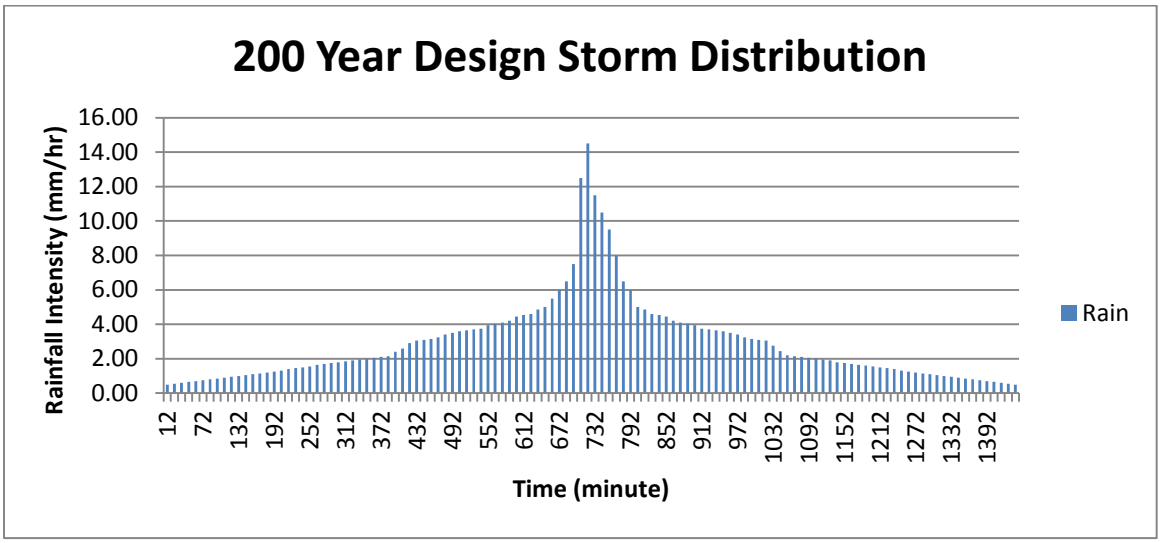

Figure 7-1: 200 Year Storm Distribution

7.3.3 The 200 year 24-hour balanced storm depth is 71 mm.

7.4 Sedimentation Ponds

7.4.1 Sedimentation ponds shall only be provided at the Milne Port Ore Stockpile area, Mine Site Crushing and Screening area and the Mine Site Waste Rock Drainage area. For all other areas, including infrastructure facility pads, laydown areas and roads, the water is considered to be clean and no sedimentation ponds shall be provided. 1

7.4.2 The general design criteria for the project sedimentation ponds are as follow:

- Ponds shall be sized based on 1 in 10 year, 24 hour design storm volumes. 1
- Runoff coefficient to estimate runoff shall be 0.9 for all drainage areas except the Milne Port Ore Stockpile footprint, for which the runoff coefficient shall be 0.0 as per BIM's instructions. 1
- Sedimentation shall be for Total Suspended Solids (TSS) ≤ 30 mg/l for a single sample and TSS ≤ 15 mg/l for the monthly average.
- Sedimentation ponds shall contain emergency overflow weirs of sufficient capacity to safely convey a 1 in 200 year return period storm event or the Probable Maximum Flood (PMF), maximum wind-induced waves, or unexpected operational difficulties. 1
- Emergency overflow weirs shall be designed to handle applicable design storms, such that the pond high water level does not increase past the set freeboard elevation. 1
- Emergency overflow weirs shall be designed as broad-crested weirs with rip rap. 1
- Gabion mattresses shall be provided at the downstream locations of emergency overflow weirs as energy dissipation measures to protect against erosion. 1
- The following broad-crested weir capacity flow equation shall be used for sizing the Project emergency overflow weirs:

□ = $CLH^{3/2}$ Where: 1

□ = Peak instantaneous flow (m^3/s)

C = Weir discharge coefficient

L = Width of weir (m)

H = Depth of flow (m), measured 2.5H upstream of the weir discharge point

- Deep sedimentation ponds shall be avoided as much as possible. Sedimentation pond depths shall be kept to less than 5 m, to avoid non-compliant TSS removal/efficiency and other safety concerns. 1
- Berm/embankment side slopes for the ponds shall be 3H:1V. 1
- Mine Site Ore Crushing and Screening and Waste Rock Drainage sedimentation ponds shall be lined and the discharge from the ponds shall be controlled. 1
- Milne Port Ore Stockpile pond(s) can be lined/unlined and depending on its impact to the environment and permafrost as well as geotechnical stability, the discharge from the pond(s) can be controlled/uncontrolled. 1
- Ponds with storage volumes greater than 30,000 m3 and heights exceeding 2.5 m shall be classified as dams and shall meet the dam safety requirements as per the Canadian Dam Association□s Dam Safety Guidelines (CDA 2007). 1

7.5 Off-Spec and Treated Effluent Ponds

7.5.1 The off-spec effluent pond at the Milne Port shall be sized based on the storage requirements specified in the event that the sewage treatment plant does not meet effluent discharge criteria and/or the system halts operations due to technical difficulties. 1

7.5.2 The treated effluent pond at the Mine Site shall be sized based on the requirements for 10 months storage of treated sewage generated at the Mine Site during the period in which the body of water receiving the discharge (i.e. Mary River) is frozen. 1

7.5.3 The ponds shall have minimum freeboards of 0.3 m. 1

7.5.4 The ponds shall have side slopes of not steeper than 3H:1V.

7.5.5 The effluent ponds shall be lined.

7.6 Culverts and Roadside Ditches

7.6.1 Drainage ditches and culverts for all internal/access roadways and vehicle access points shall be designed to convey the runoff peak flow from a 1 in 25 year return period storm, such that the inlet headwater level does not exceed the bottom of the road subbase. Their analysis and design shall consider design flow, culvert size and material, entrance structure layout, outlet structure layout and erosion protection.

7.6.2 Drainage ditch design shall also be subject to the criteria stated in Table 7-2.

Table 7-2: Drainage Ditch and Culvert Design Criteria

Maximum permissible flow velocity in ditch without rip rap (m/s)		1.5
Minimum ditch and culvert slope (□)		0.3
Minimum freeboard for ditch (mm)		300
Minimum ditch depth for internal roads and other areas (mm)		300
Minimum ditch bottom width for internal roads and other areas (mm)		500
Minimum rock ditch depth for haul road (mm)		500
Minimum ditch bottom width for haul road (mm)		1000
Ditch side slopes (H:V)	Rock	1:4
	Soil	2:1
Minimum culvert diameter (mm)		500

~~7.6.3 All culverts shall have 50 mm diameter steam pipes welded at the top inner sides for prevention of water from freezing.~~

7.6.4 Loading over culverts and pipes shall be in accordance with AASHTO HS 20-44, except for areas of special equipment operation, which shall consider actual vehicle loading. The minimum cover for culverts shall be 600 mm, or as required by the differing specific design vehicle.

7.6.5 Fish-bearing culverts shall be minimum 1,000 mm diameter and only one pipe shall be embedded by 10□ of the pipe diameter.

7.6.6 All culverts shall be Corrugated Steel Pipe (CSP).

7.6.7 Apply Manning□s n values as per the following:

- n = 0.025 for gravel ditches
- n = 0.040 for rip rap ditches
- n = 0.024 for all CSP pipe.

7.7 Drainage Interceptor/Collector Berms

7.7.1 Drainage berms diverting overland flow from the waste rock drainage area to the sedimentation ponds shall be a minimum of 1.0 m high with 1.5H:1V side slopes and 0.5 m top width.

7.7.2 Rip rap and other energy dissipation measures shall be provided to protect against erosion.