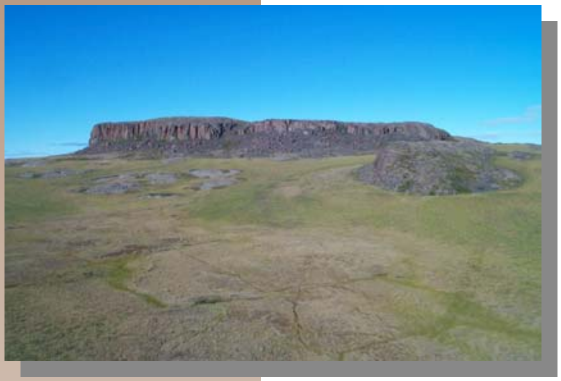
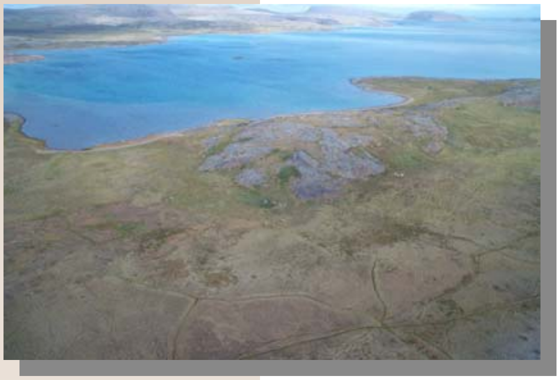
Design of the Surface Infrastructure Components Doris North Project, Hope Bay, Nunavut, Canada





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SRK Project No. 1CM014.008.420

October 2006

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1 Introduction

This report presents the geotechnical design of select surface infrastructure components for the Doris North Project owned by Miramar Hope Bay Limited (MHBL). This report has been prepared as part of the Water Licence Application to the Nunavut Water Board (NWB). The following documents form part of the designs presented in this report, and should therefore be read in conjunction with this document:

- SRK Consulting (2006a). Design of the Tailings Containment Area, Doris North Project, Hope Bay, Nunavut, Canada. Report submitted to MHBL, October.

- SRK Consulting (2006b). Technical Specifications for Tailings Containment Area and Surface Infrastructure Components, Doris North Project, Hope Bay, Nunavut, Canada. Report submitted to MHBL, October.

The drawings referenced in this report form part of a set of engineering drawings completed for the Tailings Containment Area (TCA) and surface infrastructure designs for the Doris North Project, and are bound as a separate volume:

- SRK Consulting (2006c). Engineering Drawings for Tailings Containment Area and Surface Infrastructure Components, Doris North Project, Hope Bay, Nunavut, Canada. Drawings submitted to MHBL, October.

This report includes information about the design, operation, monitoring, maintenance and construction of the following permanent surface infrastructure components, as illustrated in Dwg. G-02:

- Jetty.
- Roads, including road turnouts, culverts and caribou crossings.
- Pads for laydown areas, mill, camp, explosives storage facility, pump house, and temporary waste rock pile.
- Airstrip and apron.
- Fuel transfer station and fuel tank farm.
- Float plane dock.
- Bridge.
- Surface water management structures such as the sedimentation pond.
- Pollution control management structures such as the pollution control pond.
- Landfill and landfarm.

SRK has completed geotechnical designs of the facilities only. Ancillary facilities such as pumps, piping or any services are not part of the SRK Consulting (Canada) inc. (SRK) scope of work. Furthermore, any structures to be placed on the pads covered by this design report are outside the SRK scope of work. Where these structures are mentioned they are for information only, such that the design concepts can be clearly understood.

2 Project Area Description

2.1 Location and Access

The Doris North Project is located approximately 400 km east of Kugluktuk and 160 km southwest of Cambridge Bay in the West Kitikmeot Region of the Territory of Nunavut. The project location is shown on Dwg. G-01.

Access to the site is by air (float planes in the summer, and an ice airstrip in the winter); with an annual barge sealift re-supply in Roberts Bay during the open water season.

2.2 Regional Geology

The Doris North Project is in the faulted Bathurst Block, forming the northeast portion of the Slave Structural Province, a geological sub-province of the Canadian Shield. The region is underlain by the late Archean Hope Bay Greenstone belt, which is seven to 20 km wide and over 80 km long in a north-south direction. The belt is mainly comprised of mafic metavolcanic (mainly meta-basalts) and meta-sedimentary rocks that are bound by Archean granite intrusives and gneisses. The greenstone package has been deformed during multiple events, and is transected by major north-south trending shear zones that appear to exert a significant control on the occurrence of mineralization, particularly where major flexures are apparent and coincident with antiforms.

2.3 Sesimicity

A site specific seismic hazard assessment was done by the Geological Survey of Canada, according to the procedures documented in Adams and Halchuck (2003). Peak ground accelerations and velocities for various annual probabilities of exceedence were determined and are listed in Table 2.1.

Table 2.1: Probabilistic seismic ground motion analysis at the Doris North Project site

Annual Probability of Exceedence	Return Period (Years)	Peak Ground Acceleration (g)	Peak Ground Velocity (cm/sec)
0.01	100	0.014	0.033
0.005	200	0.018	0.039
0.0021	475	0.023	0.049
0.0010	1,000	0.028	0.060
0.0004*	2,475	0.059	-

*The 1:2,475 return period data is not site specific to the Doris North Project area, but are for Kugluktuk.

The Doris North Project falls within the “stable” zone of Canada. This region has too few earthquakes to define reliable seismic source zones. However, international experience suggests that large earthquakes can occur anywhere in Canada, although the probability is very low.

Within this "stable" zone, the project area falls in acceleration zone 1 (Z_a = 1) and experiences zonal accelerations of 0.05 g. The velocity zone in which the area falls is zone 0 (Z_v = 0) which corresponds to zonal velocities of 0.05 m/s. These zonal classifications are the lowest zones classified on the seismic hazard maps of Canada (Adams and Halchuck 2003).

2.4 Climate

Baseline climate data for the project was collected at the Boston and Windy camps during exploration (August 1993 thru 2003, with some interruptions). This site specific data combined with data from three longer-term regional weather stations operated by Environment Canada (Lupin, Cambridge Bay, and Kugluktuk) were used to develop annual climate profiles for the Doris North site.

The Doris North site has a low arctic ecoclimate with a mean annual temperature of -12.1^{o}C with winter (October to May) and summer (June to September) mean daily temperature ranges of -50^{o}C to +11^{o}C and -14^{o}C to +30^{o}C, respectively; and mean precipitation ranges from 94 mm to 207 mm, with only about 40% falling as rain. Annual lake evaporation (typically occurring between June and September) is about 220 mm.

Wind speed data reported for the Boston area (Rescan 2001) indicates predominant wind directions ranging from northwest to northeast, with wind speed in the order of 5 to 7.5 m/s. Calm conditions (wind speed below 1 m/s) occur about 6 to 9% of the time.

2.5 Permafrost

The Doris North site is underlain by continuous permafrost that has been estimated to extend to depths in the order of 550 m (SRK 2005a). This permafrost depth is based on a 200 m deep drill hole (SRK-50, see Dwg. G-04) where the mean surface temperature is about -6.3 °C and the geothermal gradient is 11.4 °C km^{-1}. The geothermal gradient in the upper 100 m appears to be isothermal or slightly negative. For comparison, the deep ground temperature profile measured at the Boston Camp, 60 km south of the site, also suggested a similar permafrost depth, about 560 m (EBA 1996; Golder 2001). The mean annual surface temperature is however colder at –10 °C and the geothermal gradient is higher at 18 °C km^{-1}. The difference in the ground temperature profiles at these two sites can be attributed to different surface conditions and the thermal conductivity of the ground at depth. The geothermal gradient measured at the Doris North site is probably representative of the conditions at Tail Lake.

Temperature data collected around Tail Lake indicates that the active layer in the marine clay/silt soils appears to be about 0.5 m, while the sand deposit has an active zone no greater than 2 m. The depth of zero annual amplitude varies between 11 and 17 m. The ground temperatures at the depth of zero annual amplitude are generally in the range of -9 to -7 °C.

2.6 Hydrology

The Doris North Project is located primarily in the Doris Lake outflow drainage basin. Tail Lake basin, part of the Doris basin, is the Projects TCA. Peak flows typically occur in June during snowmelt. A second smaller peak may occur from rainfall in late August or early September. The streams in the study area are usually frozen with negligible flow from November until May. The mean flow from June to October for Tail, Doris and Little Roberts Lake outflows are about 0.03, 0.85, and 1.73 m^3/s, respectively (AMEC 2003).

2.7 Hydrogeology

The permafrost underlying the Project site is generally impervious to groundwater movements. Groundwater movement will only occur in the shallow active layer (0.5 m to 2.0 m) during its seasonal thaw period. There is no hydraulic connection between the taliks beneath Tail and Doris Lakes, as has been demonstrated though a series of deep drill holes (SRK 2005b).

3 Design Criteria and Assumptions

3.1 Design Basis

The Doris North Project will have an operating life of two years, followed by an active decommissioning phase of about two years, for a total design life for most of the surface infrastructure of about four years. This Project is the first phase of development for MHBL in the Hope Bay Belt, and although MHBL is actively pursuing towards better definition of any future development phases, MHBL would like to develop the Doris North Project in such a way that the site disturbance is minimized, and that the total capital investment is not disproportionate to the current Project scope. Therefore, the designs presented in this report are somewhat unconventional as compared to other gold mines, although no compromises are made with respect to safety or environmental protection.

3.2 Foundation Conditions

3.2.1 Geotechnical Investigations

Site specific foundation investigations have been carried out at the Doris North site to identify foundation conditions. These site investigations can be summarized as follows:

- EBA completed six onshore and four offshore drill holes in Roberts Bay in 1997, about 2 km northwest of the jetty location selected for the Doris North Project. Two thermistor strings were installed in onshore holes (EBA 1997).
- SRK completed two drill holes in September 2002 in the vicinity of the mill site (SRK 2005c).
- Fifteen drill holes were installed in the winter of 2003, and included holes at the mill site, the beach laydown area, the airstrip location, the explosives storage facility location, along the secondary and primary road alignments as well as adjacent Doris Creek where the bridge abutments are to be constructed. Eight of these holes were completed with thermistor installations (SRK 2005c).
- Four drill holes were completed through the sea-ice in Roberts Bay at the Jetty location in the winter of 2004 SRK (2005d).
- A Nilcon vane-shear apparatus was used to test in-situ shear strength of the jetty foundation soils through the sea-ice in April 2005. A total of six borings was completed as part of this investigation (SRK 2005e).
- In April 2006 seven additional drill holes was completed at the jetty to obtain in-situ samples of the marine soils for strength characterization. This work is summarized in SRK (2006d), which has been included as Appendix B to this report.

In addition to these geotechnical investigations specifically focussed on the surface infrastructure components, there has also been a large number of characterization carried out for the design of the

TCA, as documented in SRK (2006a). The foundation conditions within the TCA boundaries appear identical to those under the surface infrastructure components (with the exception of the jetty), and therefore all the information is relevant. Dwg. G-04 presents a complete summary of all geotechnical drill holes completed at the Doris North site.

3.2.2 Jetty

The jetty will be about 103 m long, and will for the most part be in water less than 2 m deep; however, the jetty terminus will be in water over 5 m deep. Sea ice approximately 2 m thick develops in the winter and freezes to the bottom of the seabed for at least the first 55 m of the jetty. The drilling results confirm sub-ocean permafrost to at least this location, consisting of a 3 to 5 m thick layer of frozen marine silt and clay over 6 to 9 m of sand and gravel.

The remainder of the jetty foundation consist of unfrozen marine silt and clay, 8 to 12 m thick. In-situ and laboratory strength testing confirms that the marine sediments have peak shear strengths between 14 and 28 kPa, increasing gradually in strength with depth. These overburden soils overly competent basalt bedrock.

3.2.3 Other Areas

The onshore surface infrastructure foundation soils generally consist of sand, marine silts and clays of medium plasticity, ranging between 5 and 15 m thick. Permafrost conditions are present everywhere, with ground ice generally about 25%. The marine clays tend to contain saline pore water, with salinities equivalent to that of sea water. The underlying bedrock is generally competent basalt.

3.3 Hydraulic Design

Storm water conveyance systems will be designed for the 1:100 year recurrence interval storm event of 24-hour duration. This event has a magnitude of 65.5 mm. Storm water and pollution control containment ponds will be designed for this storm event taking into consideration 6-hour pumping cycles, with one operational stand-by pump available at all times.

3.4 Design Earthquake

The Doris North site is not seismically active, falling within the lowest seismic hazard rating category for Canada. No special seismic design standards have been adopted for the surface infrastructure components. All structural fill will be placed with angle of repose side slopes, which is about 40^{o} for the parent basalt bedrock.

3.5 Borrow Materials

Air photo interpretation, supported by the field investigations has confirmed that local marine clay silt and borrow deposits could be developed. The clays and silts would however not be of much use given the type of construction to be carried out, and although the sand could be useful as concrete aggregate, the complications associated with developing a soil borrow pit in a permafrost environment makes development of these sources undesirable.

Therefore, all construction materials for the Doris North Project will be crushed and processed material from one of four quarry sites identified on the site, as indicated on Dwg. G-02. The locations of these quarries have been based on ease of development and proximity to the construction areas. Geochemical analyses have confirmed that rock from each of these quarries would be suitable for use as a construction material, including concrete aggregate (SRK 2006e).

Development of the rock quarries does not require disturbance of the surrounding permafrost, with the exception of either winter road access, or an all-weather road. The rock quarries do not contain massive ice or ground ice and will be developed through conventional drill-and-blast techniques. The rock mass is competent, and conventional hard-rock bench design parameters is envisioned, consisting of 3 to 5 m high benches blasted with 80^o wall slopes. Bench setback will be between 3 to 5 m. These parameters will be adjusted as needed based on observed rock quality once quarry development starts.

During quarry development and operation, surface water management will consist of an upstream diversion berm to prevent runoff from outside of the quarry footprint from entering the area, as well as a downstream containment berm to contain surface runoff within the quarry footprint. The quarry base will have a low spot where this water can collect without affecting quarry operations.

3.6 Construction Materials

Nine different material classes have been defined for use in the Doris North Project. Grain size distribution envelopes for each of these classes are presented in Dwg. G-05. The material classes relevant to the designs presented in this report can be summarized as:

- Riprap – for use as erosion protection where needed.
- Run of quarry – for use as bulk fill.
- Select grade – for use as a filter or transition layer between the run of quarry and surfacing material.
- Surfacing material – for use as a traffic layer, or a liner protection layer.
- Drainage gravel – for use as a liner protection material.

Complete Specifications (SRK 2006b) regarding these materials are presented the in Project Technical Specifications document. All these materials will be produced on site at one or more locations. Appendix E contains preliminary summary of quarry material quantities for the Project.

Three synthetic products are listed to be used consistently with the natural construction materials. These are:

- 1.4 mm (57 mil) textured HDPE liner for containment in the fuel transfer station, fuel tank farm and the pollution control pond.
- 385 g/m^2 non-woven geotextile for protection of the HDPE liner.

- 40 x 40 mm bi-axial polypropylene geogrid as a structural support layer at the base of the jetty.

3.7 Minimum Pad Thickness

Appendix D contains details of a thermal calculation that was carried out to determine the minimum granular pad fill thickness for the Doris North Project. For the most important structures such as the fuel tank farm and the mill and crusher foundations, a fill foundation will not suffice and these structures will be founded on competent bedrock. For less important structures such as the airstrip and the camp, the minimum pad thickness will be 2 m, whilst for regular structures such as the roads and other simple pads, the minimum fill thickness will be 1 m.

These pad thicknesses are not sufficiently thick that the active layer will necessarily remain completely within the fill material. Settlement of the pads and roads are therefore expected. The monitoring and maintenance procedures document in this report will ensure that such settlement can be managed adequately.

3.8 Diversion of Natural Drainage Paths

No natural streams or rivers will be diverted to accommodate mine infrastructure. Furthermore, none of the surface infrastructure (with the exception of the TCA) will interfere with any natural drainage system, fish bearing or otherwise, other than diffuse natural runoff. Water from upslope areas will be naturally diverted around the pads and road alignments. Ponding will be prevented by installing culverts at those locations where water would have been flowing seasonally if the infrastructure had not been in place.

The only permanent stream crossing affected by the Doris North Project is Doris Creek, and at that location a clear span bridge will be constructed.

4 Design of Surface Infrastructure Components

4.1 Jetty

Annual re-supply for the Project will be via barges from Hay River, NT. The barges typically arrive at Roberts Bay mid to late August every year. A jetty will be constructed, such the barges can be directly offloaded without having to beach the barge. The jetty will therefore only be used for a period of two to three weeks every year. The jetty will only be used for the two years of mining, plus another two years of active decommissioning. Subsequent to active decommissioning the jetty will no longer be required, since further annual re-supply volumes are expected to be small and will be done via sealift to the existing barge landing site used for exploration in the Hope Bay Belt.

Due to the short design life of the jetty, and the complex foundation conditions, MHBL is satisfied to construct a jetty that will require annual maintenance. Therefore, the jetty has been designed to a substantially lower standard than would normally be required for a similar structure, and MHBL is prepared to accept the risks and consequences that this design criteria has. The risks include damage to the jetty due to large waves, storm surges and sea ice. Furthermore, annual settlement and frost heave could result in damage to the jetty. MHBL is however prepared to implement the necessary maintenance measures, to ensure safe operation of the jetty when the time requires.

The physical consequences of damage to the jetty include addition of construction rock and an increased jetty footprint. Operational consequences for these damages include delays to the offloading of the barges, with associated increased operational costs for the mine.

Design criteria for the jetty are summarized in Table 4.1, and detailed drawings of the jetty are presented as Dwg. J-01, J-02 and J-03. Appendix C contains detailed calculations for the jetty bearing capacity.

MHBL had committed to the NIRB that a new detailed bathymetric survey of the jetty area will be undertaken to determine whether there is sufficient water depth to allow the jetty to shortened. This survey was carried in the summer of 2006, and confirmed that the original design of a 103 m long jetty is appropriate. The complete bathymetric survey report is included as Appendix A.

Table 4.1: Summary of jetty design criteria

Design Component	Design Criteria
Vessel	Barge NT 1500 Series: 1,886 tonne dead weight; 76.2 m LOA; 17.1 m Beam; 0.97 m minimum freeboard; 3.05 m Draft
Vehicles	Integrated Tool Carrier (TC-28) = 11,412 kg Wheel Loader Komatsu WA500-3; operating weight = 31,000 kg (Supplied by NTCL for off-loading only (Provisions for unloading mill modules for the mine at the jetty have not been included; these modules will be offloaded at the existing barge landing site)
Tides	Tide levels in Melville Sound (north of the site), as listed below, are taken from Canadian Hydro-graphic Service Chart 7780. EHWL and ELWL are based on tides at Cambridge Bay. Tides are referenced to local Chart datum Extreme High Water Level (EHWL) = 0.5 m Higher High Water Level, Large Tide (HHWL) = 0.2 m Higher High Water Level, Mean Tide = 0.2 m Mean Water Level (MWL) = 0.0 m Lower Low Water Level, mean Tide = -0.1 m Lower Low Water Level, Large Tide (LLWL) = -0.1 m Extreme Low Water Level (ELWL) = -0.3 m This tide data is consistent with site specific data reported in Golder (2005) and Frontier Geosciences (2003)
Jetty Working Platform	Minimum Water Depth: Established to provide a minimum of 1 m keel offset for the Series 1500 barge below LLWL (i.e. minimum water depth of 4.05 m) Deck Height: Established to provide 1.0 m of freeboard above the HHWL
Roadway Width	6 m
Barge Ramp	Barges are supplied with a 25 ft long ramp to span between the barge and the jetty structure. The maximum recommended grade of the ramp is 6%
Jetty Terminus Work Area	NTCL requires only 6 m of work space to offload the barges; however, they prefer a berthing face of at least 20 m wide. Barge unloading can be from barges orientated laterally or longitudinally to the jetty
Wave Conditions	Largest waves from North, with maximum wave height = 0.9 m Maximum sustained storm surge = 0.7 m
Geotechnical Parameters	Existing Seabed: Unfrozen and frozen Silt and Clay; Saturated unit weight = 18 kN/m^3; Peak Shear Strength = 15 kPa Existing Seabed: Frozen Sand and Gravel; Saturated unit weight = 18 kN/m^3 Engineered Fill: Rock fill; Unit weight = 19.62 kN/m^3
Mooring Hardware	Moorings are designed for a one day per month exceedance wind gust of 82 km/h; During periods of higher wind speeds, the barge shall not be at berth Mooring lines and hardware must manage individual loads of 30 tonnes

4.2 Roads, Turnouts and Caribou Crossings

All-weather roads are required to link the surface infrastructure components of the Doris North Project. Complete engineering drawings of the road alignments and profiles are provided in drawings S-15 to S-26, and the road sections can be summarized as follows:

- North primary road (6 m wide and 1,179 m long); link between the jetty to the northern end of the airstrip (Dwg. S-15).
- South primary road (6 m wide and 2,400 m long); link between the southern end of the airstrip and the road junction leading to the tank farm and camp (Dwg. S16 and S-17).
- Secondary road (5 m wide and 5,470 m long); link between the South Dam and the junction leading to the float plane dock and the camp (Dwg. S-18 to S-20).
- Explosives storage facility access road (6 m wide and 306 m long); link between the south primary road and the explosives storage facility (Dwg. S-22).
- Landfill/landfarm access road (6 m wide and 143 m long); link between the south primary road and the landfill/landfarm (Dwg. S-22).
- Fuel tank farm access road (6 m wide and 171 m long); link between the south primary road and the fuel tank farm (Dwg. S-23).
- Camp access road (6 m wide and 548 m long); link between the south primary road and the camp and mill pads (Dwg. S-23).
- Portal access road (6 m wide and 506 m long); link between the camp pad and the portal (Dwg. S-24).
- Float plane dock access road (6 m wide for 265 m, and 20 m wide for 160 m); link between the float plane dock and the mill pad (Dwg. S-24).
- Decant access road (5 m wide and 378 m long); link between the secondary road and the decant location (Dwg. S-25).
- Tail Lake discharge access road (5 m wide and 191 m long); link between the secondary road and the tailings slurry discharge point (Dwg. S-25).
- Spillway access road (5 m wide and 65 m long); link between the secondary road and the North Dam (Dwg. S-26).

The roads will be constructed with a minimum fill thickness of 1 m to cover micro-relief and protect the permafrost. Typical roadway cross sections are illustrated in Dwg. S-17 and S-20. All roads have been designed for single lane traffic only. Road turnouts are strategically placed to allow safe passing. The largest design vehicle is a CAT-988 loader. Sections of the secondary road, as well as some of the access roads will share traffic with pipelines. No physical separation of the pipeline corridors has been provided. Primary road turnouts are 4 m wide and 30 m long (Dwg. S-11). Secondary turnouts are 7.5 m wide as illustrated in Dwg. T-13.

Caribou crossings will be provided at all road junctions, major bends and at regular intervals along stretches of the road where no junctions are present. The final locations of the crossings will be inspected by local elders and additional crossings will be added if deemed necessary. The crossings are 10 m wide and the approach ramps have a minimum grade of 5H:1V, as illustrated in Dwg. S-10.

4.3 Airstrip and Apron

The design aircraft is the De Havilland Twin Otter and the Dornier 228. The airstrip will be equipped with lights for night use and with instrumentation necessary to support Instrument Flight Rules (IFR) flights. Minimum airstrip design parameters were supplied by Arctic Sunwest and Summit Air in Yellowknife, NT.

The airstrip will be constructed by widening a 914 m long section of the primary road to 23 m (Dwg. S-03). The airstrip is not located in an optimum location with respect to the prevailing northwest winds. The charter companies have flown mock approaches to this airstrip and are satisfied that it would be safe to use, provided there is good visibility and light to moderate winds. MHBL is aware that the airstrip location as designed may result in plane and/or crew change delays.

A 40 m x 17 m apron for vehicle parking, an emergency power generator, fuel storage and emergency shelter will be constructed adjacent to the southern end of the airstrip. This apron will also provide ample room to allow the design aircraft to turn around. A similar apron is not required at the north end of the runway, as both design aircraft are capable of making a 180^{o} turn on the airstrip.

A typical cross-section through the airstrip, as well as a longitudinal profile is illustrated in Dwg. S-03. The minimum gradient along the airstrip is 0%, while maximum gradient is 1.5%.

Transport Canada (1993) requires the following lights and instrumentation for an airstrip of this size to allow night time use with a non-precision approach system:

- One illuminated wind direction indicator with a maximum height of 7.5 m. The wind direction indicator will be centrally located along the longitudinal dimension of the airstrip, approximately 60 m from the edge of the airstrip.
- A simple Approach Lighting System (ALS) consisting of a minimum of five white lights, 90 m apart, installed on the extended centerline of the airstrip over 450 m on each end and two lights abeam of the airstrip threshold.
- Low intensity white airstrip edge lights, in two parallel rows equidistant from the centerline, uniformly spaced no greater than 60 m apart.
- Airstrip threshold lights consisting of six white lights at each end, configured to operate with the airstrip edge lights.
- Airstrip end lights consisting of two groups of three red lights each, mounted in a line at right angles to the airstrip axis, not more than 3 m from the end of the airstrip.

If necessary MHBL will consider constructing a winter airstrip on Doris Lake every year capable of landing a Lockheed C-130/L-100 Hercules. This airstrip will also require lights and IFR instrumentation. This airstrip will be designed and constructed by a specialist contractor, according to guidelines supplied by First Air in Yellowknife, NT.

4.4 Culverts

The surface infrastructure requires no permanent stream crossings, and therefore all culverts will only convey seasonal melt or rainwater. The culverts are expected to be operational as long as the roads are used, and are installed at low points along the road and at specified seasonal drainage paths.

The culverts are 900 mm diameter corrugated steel pipes in compacted fill. Hydraulic design suggests that smaller culverts may be used; however, to allow easy access for installation of the steam pipes, the culvert sizes have been increased. There shall be a minimum of 0.5 m fill cover over the culvert. The road surface shall be raised to accommodate this with a minimum 5H:1V approach ramp over the culverts. The culvert will extend a minimum 1 m beyond the toe of the slope of the fill, as illustrated in Dwg. S-11.

Steam will be used to thaw out the culverts prior to spring. To facilitate this, there will be a 51 mm outside diameter steel pipe laid inside along the longitudinal axis of the culvert. The steel pipe will have a 1.5 m stick-up vertically from the upstream end of the culvert for steam delivery.

4.5 Bridge and Bridge Abutments

Doris Creek is at least 7 m wide in the area where the secondary road must cross under normal flow conditions. Since Doris Creek is a fish bearing water body, and is defined as navigable water, the crossing will be by means of a free span bridge. A pre-fabricated modular steel bridge will be assembled on two rock fill abutments such that the minimum bridge deck height above Doris Creek will be 4.1 m. The stream bank-full width (i.e. the ordinary high water mark) of Doris Creek at the crossing location is about 15 m. This is therefore the minimum distance that the abutment toes can be apart.

The bridge design vehicle is a fully loaded CAT-740 haul truck. The bridge will have a 75 tonne capacity and measure 7.3 m wide by 32 m long. A firm specializing in the design and manufacture of steel modular bridges was subcontracted to provide SRK with a suitable bridge design.

The bridge will rest on two pre-cast concrete sills, and will be anchored at the ends by two pre-cast concrete wing walls. These concrete members are also designed by the specialist firm. The concrete members will be founded on the rock fill abutments. In order to accommodate the bridge deck, the abutments will be 10 m wide, and the minimum fill thickness of the abutments beneath the concrete sills will be 2.5 m, to ensure the active layer remain within the fill material.

The approach ramps leading up to the bridge deck will have a maximum slope of 5H:1V and due to the height of the abutment, there will be guard rails along the entire ramp length. Dwg. S-12 provides more details of the design.

4.6 Beach Laydown Area

A laydown area for temporary storage of bulk ammonium nitrate, equipment and other supplies will be constructed 100 m inshore from the high-tide level immediately adjacent to the north primary road. This is a self-imposed buffer distance adopted by MHBL.

The pad has been sized based on an estimate of annual supplies provided by MHBL. The 100 m x 60 m pad will be at least 1 m thick, and will have a minimum grade of 0.5% to allow shedding of surface runoff. This is illustrated in Dwg. S-01 and S-02.

Following development of Quarry #1, the quarry itself will be considered for use as a laydown area. If exposed rock is suitable and competent, and sufficient space is available, consideration will be given using the quarry instead of, or in addition to the beach laydown area.

4.7 Pump House Pad

A 10 m x 10 m pump house pad, 1 m thick will be constructed immediately adjacent the secondary road, en route to the decant location. A building will be erected on this pad to house the control systems for the reclaim and decant water pipeline systems. The pump house shall have its own spill containment measures built in, primarily associated with fuel spills for pumps and motors.

4.8 Explosives Storage Facility

The explosives storage requirements for the Doris North Project consist of; (1) 38,000 kg of explosives, (2) 39,000 detonators, and (3) peak annual supply of bulk ammonium of 700,000 kg. The prefabricated on-site AN/FO mixing plant will produce a maximum amount 10,000 kg at any one time. For design purposes the total amount of mixed product was assumed to be 20,000 kg which includes the weight of mixed explosives and half the weight of ammonium nitrate in the mixing plant building.

MHBL will subcontract explosives storage, mixing, transportation and handling to an outside specialist contractor. SRK has prepared a foundation pad layout in accordance with the requirements stipulated by the specialist contractor. The layout satisfies the rules and regulations governing the storage and mixing of explosives (NRCan 1995). The minimum distance requirements for the explosives storage facility are as follows:

- D1 = not applicable
- D2 = 50 m
- D3 = not applicable
- D4 = 170 m
- D5 = not applicable
- D6 = not applicable
- D7 = 465 m
- D8 = not applicable

For the purposes of the minimum distance requirements, the primary road has been classified as a lightly travelled road based on the following:

- The road is used to haul goods from the annual sea-lift to the camp lay-down area (a couple of weeks every year)
- Fuel is only hauled along this road for a 2 week period every summer
- The road is used to transport personnel from the airstrip to the camp (3 to 4 scheduled flights a week)
- Explosives will be hauled to the mine along this roadway
- The transportation of explosives shall be in accordance with the Explosives Act.

The actual explosives and detonator magazines will be Type 4 prefabricated magazines, contained within sea cans. The mixing plant will also be a pre-manufactured facility contained within a sea can. These sea cans will be installed on six 1 m thick rock fill pads, linked together with roads, as illustrated in Dwg. S-04. Barrier berms between pads provide the necessary safety buffers.

4.9 Fuel Transfer Station

The fuel storage demand for the project is 7.5 million litres per year, as defined by MHBL. Fuel will annually be shipped to site via barge. The barge company will supply a pump and floating fuel line to pump fuel to a shore manifold in the fuel transfer station. Fuel trucks will haul fuel from the fuel transfer station to the tank farm, operating round the clock for a two week period after the barge arrives.

The fuel transfer station will be located across the road from the beach laydown area (Dwg. S-01 and S-02). The station will consist of a lined containment facility measuring about 32 m by 16 m. The containment area has been sized to retain at least 110% of the capacity of the largest fuel truck at 40,000 L. In reality the containment volume is significantly larger, as a result of constructability restraints. Ramps for the fuel trucks will be located at opposite ends of the station, allowing for drive-through access. Access ramps will have a maximum grade of 5H:1V.

The bulk fill under the lined area will be at least 1 m thick. The containment area will be graded such that there is s single collection sump. Spill containment will be provided by an HDPE liner sandwiched between two geotextiles, and covered with a protective layer of surfacing material.

At any time when water is contained in the sump (i.e. surface runoff or melt water), it would be subjected to water quality testing, and if deemed clean would be pumped out onto the tundra. If this water is contaminated it would be pumped into a water truck and disposed of in Tail Lake.

4.10 Fuel Tank Farm

The tank farm has been designed in accordance with all appropriate standards and regulations, both with respect to containment requirements and minimum distances. The 7.5 million litres of fuel storage for the Project will be within five steel tanks each measuring 14.8 m in diameter and 9.8 m high (information supplied by MHBL).

Spill containment will be in a bermed and lined area. The minimum required containment capacity is 100% of the volume of the largest single fuel tank (1,500 m^3) plus 10% of cumulative volume of all additional tanks (600 m^3). A minimum containment berm height of 0.8 m is required to meet this criterion. The containment area must be sloped towards a single collection sump.

To minimize the risk of fuel spills, tanker trucks will be loaded and unloaded via a manifold located within the confines of the tank farm. An access ramp with a maximum grade of 5H:1V will be constructed for this purpose.

The tank farm must be constructed on a precision blasted bedrock surface, to completely remove any risk of foundation settlement. A nominal levelling layer of crushed material will be placed before proceeding with the spill containment layers. Spill containment will be provided by an HDPE liner sandwiched between two geotextiles, and covered with a protective layer of surfacing material. Dwg. S-05 and S-06 presents the facility design.

4.11 Mill and Camp Pads

Pads are required to house the ore stockpile, mill building, crusher building, mill reagent storage, power plant, light vehicle refuelling station, workshop, camp, kitchen, offices, dry, sewage treatment plant, potable water treatment plant, environmental laboratory and first aid station. The mill and crusher buildings cannot withstand any differential settlement, and as a result a precision blasted pad will be cut into bedrock to facilitate construction of these facilities. A nominal layer of surfacing material will be placed on the bedrock surface to provide a smooth and graded surface for civil construction. Based on surface topography, the final mill pad size (about 75 m x 250 m), will allow room over and above the mill and crusher, for the ore stockpile (about 10,000 tonnes, or 15 days of mill feed), the mill reagent storage area and the power plant. Dwg. S-07 and S-08 provides details of these areas.

All other facilities will be erected on a 2 m thick rock fill pad measuring about 60 m x 150 m. Both pads will be graded such that all surface water runoff and melt water will drain into the sedimentation pond located immediately downstream of the camp pad. The mill and crusher buildings will be covered and will have self contained sumps in the event of spills. The ore stockpile area will be graded to drain towards the pollution control pond immediately downstream of the temporary waste rock pile.

The construction and operation details of the mill surface civil facilities to be erected on the pads are not part of the SRK scope of work; however, for completeness a brief summary of the elements of these facilities as it pertains to this design is presented below:

Service complex (workshop): The workshop and storeroom (service complex) will measure about 30 m x 50 m. The storeroom will house tools and equipment required for service and maintenance of the underground fleet. The workshop floor will be a concrete bunded structure with sumps to collect spillage or wash water. These sumps will be emptied into the tailings feed line and pumped to Tail Lake.

Service complex (wash bay): Mining equipment and other surface and underground vehicles will be washed prior to maintenance in a dedicated wash bay to be located in the service complex. Wash water for this activity will come from the site's fresh water supply tank. The wash bay will be equipped with a sump to collect the dirty water, and will also be equipped with a divider to allow light hydrocarbons to be collected from the surface using oil adsorbent materials. There will be provision to remove the mud through conventional settling which will be sent to the mill tailings pump box for co-disposal with the tailings solids. The wash bay system will be equipped with equipment to allow heavier hydrocarbons to be removed from the wastewater using cyclone action and to facilitate some recycle of the wash water.

Mill reagent storage area: Mill reagents will be shipped and stored in 6.1 m x 2.4 m sea containers. A storage area measuring about 45 m x 42 m will be provided immediately adjacent the mill building for storing 20 containers, single stacked, 2 m apart. The mill reagent storage area has been sized based on the number of containers required to supply the mill for one year, as provided by MHBL.

Mill laydown area: An additional laydown area for equipment and supplies will be provided on the mill pad.

Power supply: All mine power for the mill and camp pads will be generated on site using four diesel generators. The generators will be installed in a permanent building measuring approximately 384 m^2. This building will be constructed in close vicinity to the mill and crusher buildings on the mill pad. Remote power at the TCA, fuel transfer station and the airstrip will be by small local portable diesel generators.

Camp and first aid station: The 175-person camp will be a combination of skid mounted units linked together via Arctic Corridors. Accommodation will consist of single rooms with attached bathrooms. The kitchen and recreation facilities will be an additional five skid mounted modular units joined to the rest of the camp via the Arctic Corridor. The first aid station will be located in a separate modular unit connected to the rest of the facilities.

Offices, dry complex and environmental laboratory: The offices will consist of two combined modular units, the environmental laboratory will be one unit, and the dry complex will be four combined units. All these units will be linked to the main camp via Arctic Corridors.

Sewage treatment: Sewage treatment will consist of a modular packaged biological treatment plant that will be brought to site fully assembled within two skid mounted 12.2 m x 2.4 m containers. The treatment plant will have a treatment capacity of 68.6 m^3/day. The camp wastewater is collected in a grinder pump lift station and discharged to the solids settling tank, housed within the unit. Clarified raw sewage overflows to the equalizing tanks that feed the extended aeration bioreactors.

Each bioreactor consists of an aerated primary side and a clarifier cone. Wastewater will enter the primary aerated side and will be mixed with the existing water by means of a bubble aeration system. The clarification cone separates developed solids from the treated wastewater, allowing solids to settle back into the aerated side of the tank. This action reduces the amount of total solids and improves treatment. Treated effluent will be collected in a discharge/recycle tank for delivery into the tailings line.

Mine water supply: Potable water, fire suppression water and up to 67% of the mill water will be supplied from Doris Lake. A single insulated and heat traced 4" diameter HDPE pipeline will be used to pump water to storage tanks at the mill pad. Details of the fresh-water intake in Doris Lake are provided on Dwg. T-11 and T-12. Potable water will be treated in a packaged plant installed in a 12.2 m x 2.4 m container and will consist of sand filtration followed by ultra violet light and/or chlorination treatment.

4.12 Float Plane Dock

A float plane dock will be constructed at Doris Lake. The dock will be a pre-fabricated modular unit, designed and manufactured by a specialist contractor. The modular unit can be dragged on shore during freeze-up.

The dock has been designed to allow offloading of supplies from a Twin Otter plane using a Bobcat forklift. The plane requires 7.5 m of berthing face against the dock, and a minimum water depth of 1.5 m when fully laden. Based on the most recent Doris Lake bathymetry (Appendix A), the dock would have to be 25 m long to ensure compliance with the design plane berthing requirements. To ensure sufficient buoyancy of the dock, as well as a safe working platform, the minimum width will be 4 m. Dock buoyancy will be provided via sealed HDPE pontoons. The dock will be held in place via six permanently installed bollards. These bollards will be embedded in bedrock. Complete dock design details are provided on Dwg. S-09.

4.13 Temporary Waste Rock Pile Pad

Temporary storage for about 135,000 tonnes of waste rock is required. Some of the waste rock is potentially acid generating, and as a result MHBL will return it all as underground backfill. However, until the waste rock is used as backfill, a temporary waste rock pile will be constructed on a 1 m thick pad of clean run of quarry rock immediately downstream of the mill pad (Dwg. S-07 and S-08).

This will allow for easy dumping and reloading of any waste rock without a risk of damage to the underlying permafrost. Immediately downstream of the pad, a pollution control pond will be constructed to ensure complete containment of all surface runoff and melt water from the temporary waste rock pile and the ore stockpile. Berms strategically located along the edges of the pad will ensure complete containment.

4.14 Pollution Control Pond

The pollution control pond is designed to contain all surface runoff and melt water from the ore stockpile and the temporary waste rock pile. The pond is designed for full containment of the 1:100 year storm event of 24-hour duration, plus an additional freeboard of 0.3 m.

Containment is provided, at least to the full supply level of 35.7 m by an HDPE liner sandwiched between two geotextiles (Dwg. S-07 and S-08). A protective cover layer is placed over the liner. No emergency spillway is provided, since it is intended that pumping out of this facility be initiated whenever there is at least one hour of pumping capacity in the pond. The pond pumps are designed to completely empty the pond within six hours.

4.15 Sedimentation Pond

The sedimentation pond is designed to retain all surface water runoff and melt water from the remaining areas of the mill and the entire camp pad. The hydraulic design criteria are identical to that for the pollution control pond.

The sedimentation pond is not lined (Dwg. S-07 and S-08). An emergency overflow is provided for the pond in the form of an outflow culvert located at the pond full supply level of 35.7 m.

4.16 Landfill

Non-combustible and non-hazardous waste will be disposed of in a landfill that will be constructed in a portion of the rock quarry immediately west of the camp (Quarry #2). A surface area of at least 100 m x 100 m will be dedicated to the landfill as illustrated in Dwg. S-13 and S-14. The landfill will be completely hydrologically isolated via a set of containment and barrier berms. The landfill surface will be graded towards a single sump to allow pump out of clean water directly onto the tundra, or contaminated water to a tanker and then on to Tail Lake. The landfill will be fenced and access will be via lockable vehicle gate.

Waste oil will be burned on site in a dedicated waste oil burner specifically designed for that purpose. Unused explosives will be burned or destroyed on site and unused chemicals as well as any other hazardous material will be disposed of in an appropriate manner.

4.17 Landfarm

The landfarm has been designed by others (AMEC 2006). SRK prepared engineering drawings in accordance with the information stipulated in AMEC (2006). The landfarm will be completely within the quarry development used for the landfill, as illustrated in Dwg. S-13 and S-14.

5 Operation and Maintenance Procedures

5.1 Jetty

5.1.1 Operation

Operation of the jetty will be according to the following procedures:

- As soon as the sea-ice is melted, the jetty will be inspected, and the annual maintenance to be carried out on the jetty will be defined and carried out in anticipation of the barge arrival in mid to late August (see next section for a description of what this maintenance will entail).
- Carry out a bathymetric survey of the approach channel to the jetty terminus, as confirmation to the barge company that there are no hazards present.
- The blast mats which are used as fenders against the jetty terminus will be installed.
- The buoys housing the floating mooring lines will be reconnected and the floating mooring lines will be attached to the shore anchor blocks and the buoys.
- When the barges arrive they will be pushed alongside the jetty terminus by the tugboat and the mooring lines will be connected. The barges will normally be berthed abeam; however, should conditions require the barge can be berthed along its bow or stern.
- A ramp supplied by the barging company, will be deployed, and supplies will be offloaded onto the jetty terminus by a loader supplied by the barge company. MHBL will use their own loader to transport these supplies to the beach laydown area.
- Once the barges has left, the mooring lines, buoys and blasting mats will be retrieved and stored in the beach laydown area until the next operating season.
- If strong winds or large waves are present, barge offloading will be temporarily terminated.

MHBL will be the only official user of the jetty. MHBL does however acknowledge that local communities may make use of the jetty whilst it is in operation. Access to the jetty will not be restricted unless MHBL is of the opinion that the jetty is not safe to use.

5.1.2 Maintenance

It is expected that the jetty will continue to undergo differential settlement over its lifetime, although the rate of settlement will likely exponentially decrease as time progresses. Considering the fact that the jetty will only be in use for two to three weeks in any year, this differential settlement can be managed with a program of annual maintenance that will consist of the following:

- As soon as the sea-ice has melted, the jetty surface will be surveyed and visually inspected by a qualified person, experienced with the design and intent of the jetty. The results of the survey and visual inspection will be used to determine how much settlement has occurred, and how much new rock fill would have to be added to return the jetty to its design operating standard (i.e. maintaining a safe trafficking surface with at least 1 m freeboard above the HHWL).

- For planning purposes, SRK recommends stockpiling sufficient additional fill material for about 0.5 m settlement every year, for the four year design life of the jetty. This amounts to a rock fill allowance of about 350 m^3 per year.
- Depending on the location and quantity of maintenance fill placement every year, silt curtains may have to be deployed around the construction area to ensure containment of suspended sediments that may be mobilized as a result of fill ravelling down onto the soft marine foundation.

In addition to the settlement maintenance described above, there are a number of other routine maintenance components for the jetty:

- Every year, prior to the arrival of the barge, the barge operator requires that a bathymetric survey of the channel leading up to the jetty terminus be carried out, to ensure that there are no sub ocean hazards.
- The coverage of this bathymetric survey should be extended to include the jetty footprint, since this data will be useful in tracking the settlement progress, as well as provide advance warning if there are any shoreline processes which may affect the jetty performance.
- All mooring hardware must be inspected prior to the arrival of the barge, and any equipment that show signs of wear, damage or corrosion must be replaced or repaired.

5.2 Roads, Turnouts and Caribou Crossings

5.2.1 Operation

Generally operation of the roads, turnouts and caribou crossings does not require any special consideration, outside of what would normally be considered applicable from a safety perspective. MHBL will set road and traffic rules, and will enforce these as necessary. All roads are for the sole use of MHBL; however, MHBL acknowledges that the roads will be used by the local communities if and when the pass through the area. Some specific operational issues are as follows:

- Considering the fact that the road design does not include a safety berm, MHBL must take all necessary precautions to post appropriate warning signs along the roads to advise road users of any potential hazards along the way. Strict enforcement of the speed limit is also recommended.
- If necessary, MHBL may apply water to the road surfaces in the summer months as a dust suppression agent. The water will be drawn directly from Doris Lake, and will be deployed by a tanker truck. No chemical dust suppressants will be used.
- Winter snow clearing will be done using a snow cat, or some other suitable equipment. The snow will be pushed off the side of the road, always towards the downstream side where practical. Care must be taken not to block culverts or instrument clusters.

- Generally no winter de-icing agents will be used. If ice makes the roads impassable, friction methods will be used such as application of pea-gravel as opposed to application of salt.
- Many of the roads share space with pipelines. MHBL should take all necessary precautions to ensure that road users are aware of where these pipelines are at all times.

5.2.2 Maintenance

Road maintenance will be an ongoing task, and will consist of the following components:

- During the summer months, the road and turnout surfaces, as well as the caribou crossings must be regularly visually inspected for signs of settlement, potholes, ruts or any standing water. Should any of these signs be detected, maintenance should be carried out using a conventional road grader using standard road grading procedures for gravel topped roads. The grader must first roughen up the surface, re-shape the crown and remove any ruts and/or potholes. Periodically new topping gravel may have to be placed on the surface to fill in voids such as potholes or undue settlement, or to re-shape the road crown. MHBL should prepare stockpiles of surfacing material expressly for this purpose during the initial construction phase.
- Winter road maintenance entails predominantly snow removal. Snow removal must be done with due care to avoid removal of any road surfacing material with the snow. Stockpiling of snow must be done in such a fashion that no large ponds will be created during the spring melt. The caribou crossings do not have to be cleared of snow; however, snow removed from the roads may not be stockpiled on the caribou crossings.
- During all maintenance activity, MHBL will have to take special precautions to ensure that the pipelines sharing some of the road alignments are not damaged.

5.3 Airstrip and Apron

5.3.1 Operation

The airstrip will primarily be used for crew changes; however, some equipment re-supply will also be done by air. Operating procedures associated with the airstrip are as follows:

- Since the airstrip doubles as the main road between the jetty and the camp, it will be necessary to stop all road traffic when aircraft are on the airstrip. MHBL will develop and put in place a protocol to manage this aspect.
- During winter months the airstrip must be cleared of snow prior to any landing taking place. No stockpiling of snow is allowed on the airstrip or apron, and should where practical be on the downstream side of the airstrip and not be higher than the airstrip grade.
- Routine checks must be carried out to ensure that the approach lighting system (ALS) is in complete working condition.
- Routine checks must be carried out to ensure that the IFR instrumentation has valid calibration certificates, and are in working condition.

- Depending on re-supply requirements, MHBL may construct a winter airstrip on Doris Lake. The design and construction of such an airstrip will be done by, and under the supervision of a specialist contractor. The size of the airstrip will be dependant on the re-supply needs, but may include landing of fully laden Hercules C-130 aircraft.
- All aircraft landing at the site will be charter planes, and will have a quick turnaround time. Therefore no de-icing equipment will be provided on site.

5.3.2 Maintenance

Airstrip and apron maintenance will be similar to that required for the roads. One additional maintenance requirement however entails continuous inspection of the ALS. MHBL must take all necessary precautions to identify the locations of all lights associated with the ALS, and special care must be taken so as not to damage these lights during snow removal or summer surface levelling and repair.

5.4 Culverts

5.4.1 Operation

There are no culverts at the Doris North site that allow passage of permanent streams, and there is no permanent aquatic life present at any of the culvert locations. All culverts will only have flow during the spring thaw, and possibly during heavy precipitation events.

The only period when any work is required on the culverts are at the onset of spring. At that time snow must be removed from the up and downstream end of each culvert opening and each culvert must be physically inspected to confirm if there is any indication of ice blockage. If ice blockage is present, steam will be used to thaw the culvert.

5.4.2 Maintenance

Maintenance of the culverts is limited to the following:

- Regular visual inspection to ensure that there are no objects that would obstruct the free flow of water through the culverts.
- If any culvert settlement has occurred, the amount of settlement must be documented and if necessary the culvert will have to be excavated, removed and re-installed to the original invert level after backfilling the settlement void with a competent material.
- If any wild life takes up habitat in a culvert, the animal will have to be relocated by appropriate specialists.

5.5 Simple Pads (Camp, Mill, Beach Laydown Area, Explosives Storage Facility, Pump House Pad and Temporary Waste Rock Pile Pad)

5.5.1 Camp and Mill Pads Operation

The camp and mill pads will house all the processing and accommodation facilities for the Project. As far as the geotechnical design is concerned, there are no special operating procedures associated with these pads, other than snow clearing. From a water management aspect the following operational procedures apply:

- The mill, crusher and workshop will be in individually enclosed buildings and will have self contained sumps to contain any spills. Emptying of these sumps will depend on the nature of the spill, and may be returned to the mill, be pumped to Tail Lake, or even send to the landfarm.
- The ore stockpile and the temporary waste rock pile are considered to be “dirty” water areas, and all runoff from these locations will be directed to the pollution control pond. Water in this pond must be tested, and if deemed unsuitable for general discharge, it will be pumped to Tail Lake.
- The remaining surface areas of the camp and mill pads are generally considered “clean” surfaces; however, all runoff and melt water from these pads will be collected in the sedimentation pond. Once suspended matter has settled, and if the water quality in the pond is deemed acceptable, this water will be pumped out onto the tundra. If the water quality is not deemed to be of acceptable quality it will either be used as mill make-up water or pumped to Tail Lake.

5.5.2 Beach Laydown Area Operation

Prior to arrival of the re-supply barges, the beach laydown area will be cleared as much as practical by transporting all surplus materials to the mill laydown area. This is to provide sufficient room for storage of the new products. Winter snow clearing of the beach laydown area is recommended in case supplies have to be retrieved.

5.5.3 Explosives Storage Facility Operation

Two types of explosives will be used on site; (1) stick explosives, and (2) AN/FO. The stick explosives, detonator cords and detonators will be stored in pre-fabricated magazines, placed directly on the fill foundations. The AN/FO will be mixed on site in a plant housed in a sea can. Bulk Ammonium Nitrate in one tonne tote bags will be mixed with diesel fuel to manufacture AN/FO prills in 25 kg bags. Explosives manufacturing will be done in batch form, based on demand, typically manufacturing enough explosives for a three week period at any one time.

Explosives manufacturing will be done by an appropriately qualified and certified outside contractor, in accordance with all relevant federal, territorial and local laws and regulations.

5.5.4 Pump House Pad Operation

The pump house pad and the building erected on it require no special operating procedures, other than snow clearing.

5.5.5 Temporary Waste Rock Pile Pad Operation

The purpose of the temporary waste rock pile pad is to preserve the permafrost such that waste rock can be stockpiled and reloaded during any season of the year. Therefore, other than ensuring that the section of the pile receiving waste rock is clear of snow, there are no special operating requirements for this pad.

5.5.6 Temporary Waste Rock Pile Construction

Actual construction of the waste rock pile is not part of the surface infrastructure design scope of work; however, for completeness, the waste rock pile construction methodology will briefly summarized here to assist in understanding the design principles.

During mine development a peak of 135,000 tonnes of waste rock will require temporary storage, prior to all being returned underground (there is however capacity to store at least 200,000 tonnes of waste rock on the temporary pad). Total waste rock storage space will only be required for a period of 32 months. The waste rock pile will be constructed in lifts, each a maximum of 5 m high. Secondary lifts will not be benched. Pile side slopes will be angle of repose. Peak waste rock deposition rate will be approximately 545 tonnes per day.

The overall waste rock pile will be less than 50 m in height, it will contain less than 1 million tonnes of waste, it will have an overall compound slope of 40^o, and it will be constructed in lifts less than 25 m in height, at a rate significantly less than 25 m^3/linial metre of crest per day. Furthermore, the pile will be moderately confirmed by natural topography and will be constructed from strong and durable waste. Percolation of water through the dump is expected to be limited, since freezing in the dump will likely occur rapidly. Based on all these considerations, the temporary waste rock pile can be classified as being in Stability Class I, according to Table 5.2, page 70, in the British Columbia Mine Waste Rock Pile Research Committee’s manual on Mined Rock and Overburden Piles (BCMWRPRC 1991). For such piles the failure hazard is classified as negligible and the design can be based on basic reconnaissance and baseline data such as is available for this site.

5.5.7 Maintenance for Simple Pads

Maintenance for the simple pads discussed in the preceding sections is similar to that described for the roads. Where ruts, potholes or settlement areas are observed, they must be in filled or levelled using standard grading equipment. Special care must be taken to ensure that there are no areas of standing water on the pads, and especially under heated buildings, inspections must be carried out to confirm that the active layer thickness has not increased.

The highwall slopes of the mill pad must be inspected by a qualified person every year to ensure that the face remain stable. Special care must be taken to inspect the state of permafrost degradation (if any) that may have occurred in the overburden cut slopes at the top of the highwall. Any measures to ensure the stability of the slopes must be carried out as part of the regular site maintenance program, and may include rock bolting the highwall, or re-armouring the overburden slopes.

5.6 Fuel Transfer Station and Fuel Tank Farm

5.6.1 Operation

Fuel barges will be moored at the jetty, or possibly anchored some distance offshore. The barge company will supply a floating fuel line and a pump (located on the barge) to offload fuel. The floating fuel lines will be connected to a shoreline manifold inside the fuel transfer station. Fuel trucks will drive into the fuel transfer station and will be filled via the shoreline manifold. The fuel trucks will then transport the fuel to the fuel tank farm from where pumps will transfer the fuel to one of the five primary fuel tanks. This fuel transfer will continue around the clock for a period of about two weeks until the barges are empty.

Standard operating procedures associated with the fuel transfer station and the fuel tank farm is as follows:

- MHBL will develop and put in place a fuel transfer protocol, which will be strictly enforced.
- Both the fuel transfer station and the tank farm will be kept clear of any snow, ice or water throughout the year.
- Prior to pumping of any water from the sumps, the water shall be tested, and if there are any signs of contamination, the water will be pumped to the mill for re-use, or to Tail Lake for disposal.
- Regular visual inspections must be undertaken specifically focussing on the liner integrity. Should there be any signs of liner damage, all fuel transfer must be halted until the necessary liner repairs have been carried out.

5.6.2 Maintenance

Fuel transfer station and fuel tank farm maintenance can be summarized as follows:

- Prior to arrival of the fuel barge, all pumping hardware must be inspected, and any components that show signs of wear, damage or corrosion must be repaired or replaced.
- The fuel transfer station and the fuel tank farm must be completely cleared of any snow, ice or water.
- The facilities must be inspected, and if there are any signs of settlement that may put undue stress on the liner, the cover must be excavated, the liner over the settlement area must be cut away and the settlement must be filled in. The liner must then be repaired or replaced as appropriate, and the cover material replaced.

5.7 Float Plane Dock

5.7.1 Operation

The float plane dock operating procedures are as follows:

- The dock will only be used during the open water season.
- When freeze-up starts the dock will be dragged on shore and winterised for storage.
- When the lake ice has disappeared, the dock will be inspected before re-floating and attaching it to the permanent bollards.
- Once floating, the deck will be inspected to ensure that it is in safe working condition.
- Float planes will be able to berth against the dock along any of its three faces.
- Care must be taken when clearing snow from the dock access road, that the dock which has been stored for the winter is not damaged.

5.7.2 Maintenance

Dock maintenance entails a detailed pre-season inspection of all components of the dock to check for wear, damage or corrosion. Any such components must either be repaired or replaced prior to re-floating of the dock.

5.8 Bridge and Bridge Abutments

The bridge abutments are rock fill structures that will require the same operational and maintenance procedures as those listed for the roads. Some additional maintenance aspects of the bridge include:

- Annually, the bridge and the safety guard rails along the approach to the bridge must be thoroughly inspected for wear, damage and corrosion. All deficiencies must be replaced or repaired as necessary as soon as practical. If in the opinion of the inspector there is a safety concern, the bridge will be decommissioned until the repairs have been carried out.

5.9 Pollution Control and Sedimentation Ponds

5.9.1 Operation

The pollution control pond will capture all surface runoff and melt water from the ore stockpile and the temporary waste rock pile. Pumps will convey the water in this pond to Tail Lake, or return it to the mill for re-use. The sedimentation pond will capture all surface runoff and melt water from the remainder of the mill pad and the camp pad.

Both ponds have been sized to contain the 1:100 year, 24-hour duration storm event (assuming no flood attenuation and 100% runoff), plus 0.3 m of freeboard. Pumps will be sized to allow complete draining of the ponds in 6 hours.

Once there is sufficient water in the pollution control pond to allow at least 1 hour of continuous pumping, the pumps will be switched on. Water will be pumped from the sedimentation pond, only after there is visual evidence that any suspended matter has settled, and a water quality sample had been taken and analysed. However, no ponded water is allowed in the sedimentation pond for more than 48 hours at any given time. This is to ensure that the permafrost integrity is maintained.

5.9.2 Maintenance

Maintenance tasks for the two ponds are as follows:

- Immediately before freeze-up, both ponds must be pumped dry to allow sufficient storage capacity when the melt starts.
- Throughout the winter the ponds may remain snow filled; however, before freeze-up a path to the pumping sumps must be cleared.
- Regular visual inspections must be made specifically focussing on the liner integrity. Should there be any signs of liner damage, repairs must be carried out as soon as possible.

5.10 Landfill

5.10.1 Operation

Landfill operating procedures will be as follows:

- All non-hazardous garbage will be deposited in a “cell” of the landfill. The size of these cells will vary depending on the specific disposal needs.
- At least once every three months, any open cells will be closed by covering them with a nominal layer of surfacing material, and a new cell will be started.
- Winter cells must be kept small such that a minimum amount of snow will be captured when the cell is closed. Care must be taken to remove as much snow as possible from the cell before closing it.
- At all times surface runoff and melt water must be directed to a single low point where suspended matter can settle out before pumping the water either onto the tundra, or to Tail Lake, depending on its water quality.

5.10.2 Maintenance

Landfill maintenance items are as follows:

- Snow clearing.
- Visual inspection to confirm that the water containment and diversion berms are in working condition.
- The highwall slopes of the camp pad must be inspected by a qualified person every year to ensure that the face remain stable. Special care must be taken to inspect the state of permafrost degradation (if any) that may have occurred in the overburden cut slopes at the top of the highwall. Any measures to ensure the stability of the slopes must be carried out as

part of the regular site maintenance program, and may include rock bolting the highwall, or re-armouring the overburden slopes.

5.11 Landfarm

SRK produced engineering drawings of the landfarm in accordance with a design by AMEC (2006). Their design document provides operational and maintenance procedures for the landfarm and will not be repeated here.

6 Construction

6.1 General

With the exception of the jetty, the sensitive permafrost environment requires that all the surface infrastructure fill material be placed during the winter months when the ground is completely frozen. Once the primary foundation fill has been put in place construction of ancillary facilities on these pads are no longer season dependant, provided construction equipment does not have to go onto the tundra.

Mobilization of all construction equipment will be via barges from Hay River, NT. All equipment, plant, materials, fuel and explosives will be mobilized to Hay River by June 30, 2007 at the latest. The barges will arrive at Roberts Bay by mid to late August 2007, and the barges will be offloaded at the existing barge landing site used for exploration in the Belt. The Contractor will winterise the equipment in anticipation of the crew mobilization that will occur in December 2007, when construction will start.

This design report outlines the basic principles of construction; however, complete details are provided in the Technical Specifications (SRK 2006b) that should be read together with this report. These Specifications also contain the necessary information relating to the Quality Control and Quality Assurance (QC/QA) protocols that are to be followed for all aspects of construction.

6.2 Jetty

Construction of the continuous rock fill jetty will be carried out during the late summer open water season in Roberts Bay. Construction will however be ceased for a two week period in July whilst Arctic Char are migrating towards Little Roberts Creek to spawn. The basic components of the construction are as follows:

- Deployment of a silt fence around the entire jetty construction zone to ensure that any suspended sediments stirred up as a result of end-dumping quarry rock on the soft marine foundation can be contained.
- Two layers of geogrid will be placed on the seabed. These geogrids will extend at least 5 m beyond the outermost edge of the final jetty footprint and will be at least 5 m ahead of the current fill being placed. The geogrid overlap will not be less than 2 m. The placement of the geogrid will be done by qualified arctic divers.
- The jetty will be constructed from clean rock located in Quarry #1. The quarry rock will not be washed prior to placement. Since there will be some blast residue on this rock when it is placed in Roberts Bay, SRK modelled the water quality in the Bay to confirm that there would be no adverse environmental effects as a result of this practice. The results of this calculation are documented as an Appendix to SRK (2006f).

- Construction will consist of end-dumping the engineered fill from the shoreline towards the terminus of the jetty approximately 100 m offshore, directly onto the geogrid. After a few dump loads have been placed, a loader or dozer will be used to flatten the advancing front such that equipment can continue to end dump. In deeper water (more than 2 m depth) the initial rock fill be manually placed using an extended boom excavator. This will reduce the impact surcharge on the soft marine sediments and allow for more controlled placement of the fill.
- After completion of the bulk fill to the terminus of the jetty, the transition zone and jetty surfacing grade material will be placed once again moving from the shore advancing out towards the jetty terminus.
- Ancillary facilities such as the anchor blocks, mooring chains, shackles and blasting mats will be located and installed as construction commences.

6.3 Roads, Culverts, Turnouts and Caribou Crossings

Construction of all permanent roads will entail the following components:

- Clearing of the snow and ice off the road alignment immediately prior to fill placement.
- Construction fill will be placed by end-dumping along an advancing road surface. After end-dumping, the fill will be levelled with a dozer and subsequently compacted as per the Technical Specifications.
- The three types of fill making up the roads will be placed consecutively, with a new fill type only placed after the preceding layer has been completed to the design grade and level.
- Since the design road width is to narrow for duel lane traffic, the contractor will construct temporary rock fill road turnouts as construction progresses. These will be removed as construction advances.
- Culverts will be laid in place at designated locations and after selective placement of appropriate fill around the culverts, construction will advance normally. After road construction has been completed, the contractor will return to each culvert to install the steam pipes.
- Road turnouts and caribou crossings will be constructed using the same methodology as that used for the road construction.
- After completion of all road construction, road signs and guard rails will be installed as per the Technical Specifications.

6.4 Beach Laydown Area, Explosives Storage Facility and Pump House Pad

Construction of the 1 m thick pads for the beach laydown area, explosives storage facility and the pump house pad will be identical to that adopted for the roads. At the explosives storage facility there is a requirement to construct a containment berm around the AN/FO storage pad. This will be put in place after completion of the relevant pad using small shaping equipment such as a loader or excavator.

After completion of the pads, the ancillary facilities must be installed on the pads. These ancillary facilities include pre-fabricated magazines and buildings, which will be placed either directly onto the rock fill or onto timber blocks, as per the relevant manufacturer's recommendation.

6.5 Airstrip and Apron

Construction of the airstrip and apron will be similar to construction of the roads, with the only difference being that the fill thickness is twice as much. Upon completion of the airstrip and apron, airstrip lighting and instrumentation, as well as some other ancillary facilities will be installed according to the manufacturer's recommendations.

6.6 Camp Pad

Construction of the camp pad is identical to construction of the airstrip. On completion of the camp pad, ancillary facilities such as the camp complex and other portable buildings will be installed as per the manufacturer's recommendations.

6.7 Fuel Transfer Station

The construction components for the fuel transfer station are as follows:

- Preparation of the fill foundation will be similar to that used in road construction.
- The containment berms must be shaped and compacted using the appropriate small shaping equipment.
- Once the fuel transfer station foundation is completed, and liner tuck trenches have been excavated on the containment berms, the HDPE liner (sandwiched between to geotextile layers) that will form the primary containment will be installed as per the Technical Specifications.
- Finally, taking all the necessary precautions the liner protection fill will be put in place by end dumping and spreading with a loader.

6.8 Fuel Tank Farm

The fuel tank farm must be constructed on a bedrock foundation. The construction components are as follows:

- A level exposed bedrock bench will be prepared by drilling and blasting, taking due care that overbreak is reduced to a minimum.
- After the bedrock foundation has been prepared a nominal levelling layer of fill material will be placed.
- Containment berms, liner tuck trenches, liner installation and protective fill placement will be done using the same techniques as adopted for the fuel transfer station.

6.9 Mill Pad

The mill and crusher buildings must be founded on bedrock. Therefore the mill pad will be constructed by levelling a bedrock bench similar to the techniques mentioned for the fuel tank farm. There is however portions of the pad that does not require a bedrock foundation and those parts of the pad will be constructed as conventional rock fill, as per the procedures for the camp pad.

6.10 Temporary Waste Rock Pile Pad

Construction of the temporary waste rock pile pad is identical to that for the beach laydown area, with the exception that only run-of-quarry fill is required. Also, a nominal containment berm must be constructed along portions of the pad perimeter using small shaping equipment.

6.11 Bridge and Bridge Abutments

The components of the bridge construction are as follows:

- The abutments must be constructed using the same techniques as that used for the roads; however, the fill thickness is substantially greater, requiring more run-of-quarry fill material.
- Once the abutments have reached the bridge deck elevation, the pre-cast concrete sills and retaining walls for the bridge must be put in place.
- The bridge must be assembled and lowered in place onto the sills using a crane. The contractor may not have construction equipment in the stream bed, unless they are working on a dedicated ice bridge.
- The remainder of the abutment fill must be placed up to the road deck elevation, taking care to use hand-compacting techniques adjacent to the retaining walls.

6.12 Pollution Control and Sedimentation Ponds

Construction of the pollution control and sedimentation ponds will use the same techniques as used for general fill placement and liner installation previously discussed.

6.13 Float Plane Dock

The construction components for the float plane dock are as follows:

- Using the lake-ice as a working platform, drill and install the six bollards for the float plane dock.
- The access ramp and float plane dock laydown area will be constructed using the same basic fill construction techniques used for the roads.
- The dock will be assembled according to the supplier's specifications, and once the lake ice melts, the float plane dock will be lowered and anchored to the bollards.

6.14 Landfill

The landfill will be constructed in the developed Quarry #2. The final shape of the landfill will be determined once a quarry development plan has been prepared. The basic components of the landfill construction will however be as follows:

- The final quarry floor will be shaped and leveled such that any surface water will drain towards a single low point.
- Perimeter diversion and/or containment berms will be constructed around the effective area of the landfill using general fill placing techniques.
- A chain link fence will be erected on this berm according to the manufacturer's specifications.

6.15 Landfarm

Within the confines of the landfill, an area will be demarcated for construction of a landfarm. The landfarm construction will follow the same techniques as that used for the fuel tank farm.

7 Monitoring and Instrumentation

7.1 Monitoring Requirements

The surface infrastructure components discussed in this report will require two types of monitoring:

- Visual monitoring – physical inspection of all fill surfaces taking special care to identify any areas that may have undergone settlement.
- Thermal monitoring – to evaluate the depth of the active zone, such that advance warning of potential settlement can be determined.

7.2 Thermistor Locations

A total of 8 thermistors have been installed in locations where surface infrastructure has been installed, as illustrated in Dwg. G-04. Where possible, these installations must be retained. In addition, new thermistors should be installed at the following locations as part of the fill construction:

- Jetty; two strings
- Fuel transfer station; one string
- Airstrip; three strings
- Camp pad; two strings
- Pollution control pond; one string
- Sedimentation pond; one string
- Float plane dock laydown area; one string
- Roads; five strings
- Bridge abutments; two strings

Each of these stings should have at least three beads measuring between depths of 0.3 m and 3 m below natural ground surface. The thermistor strings need not have data loggers, but monitoring frequency of manual readings on all stings must be completed at least once a month. If warming trends are observed, this frequency should be increased as appropriate. This data should ideally be reviewed by a qualified geotechnical engineer, at least once a year to assist in making appropriate maintenance recommendations.

This report, "**Design of the Surface Infrastructure Components, Doris North Project, Hope Bay, Nunavut, Canada**", has been prepared by SRK Consulting (Canada) Inc.

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8 References

Adams, J. and Halchuk, S. 2003. *Fourth generation seismic hazard maps of Canada: Values for over 650 Canadian localities for the 2005 National Building Code of Canada*. Geological Survey of Canada, Open File 4459, 155 p.

AMEC. 2003. *Meteorology and Hydrology Baseline, Doris North Project, Nunavut, Canada*. Report submitted to Miramar Hope Bay Limited, August 2003.

AMEC. 2006. Landfarm Design and Management Manual, Doris North Gold Mine, Nunavut. Report submitted to Miramar Hope Bay Limited, October 2006.

British Columbia Mine Waste Rock Pile Research Committee. 1991. *Mined Rock and Overburden Piles – Investigation and design Manual*. Interim Guidelines. May 1991

EBA Engineering Consultants Ltd. 1996. *Boston Gold Project, Surficial Geology and Permafrost Features*. Report submitted to Rescan Environmental Services Ltd.

EBA Engineering Consultants Ltd. 1997. *Boston Gold Project Geotechnical Investigation on Proposed Roberts Bay Port.* Report submitted to BHP World Minerals, October 1997.

Golder. 2001. *Report on Thermistor Data Review – Hope Bay Project*. Letter-report submitted to Miramar Mining Corporation.

Natural resources Canada (NRCan) 1995. *Quantity-Distance Principles: Users's Manual*. Explosives Branch, Department of Natural Resources, Government of Canada. Ottawa, ON. 87 p.

Rescan. 2001. *Supplemental Environmental Baseline Data Report, Hope Bay Belt Project*. Report submitted to Hope Bay Joint Venture.

SRK Consulting Inc. 2005a. *Preliminary Tailings Dam Design, Doris North Project, Hope Bay, Nunavut, Canada*. Report submitted to Miramar Hope Bay Limited, October 2005.

SRK Consulting Inc. 2005b. *Groundwater Study, Doris North Project, Hope Bay, Nunavut, Canada*. Report submitted to Miramar Hope Bay Limited, October 2005.

SRK Consulting Inc. 2005c. *Preliminary Surface Infrastructure Design, Doris North Project, Hope Bay, Nunavut, Canada*. Report submitted to Miramar Hope Bay Limited, October 2005.

SRK Consulting Inc. 2005d. *Phase I Foundation Investigation, Proposed Roberts Bay Jetty Location, Doris North Project, Hope Bay, Nunavut, Canada*. Report submitted to Miramar Hope Bay Limited, April 2004.

SRK Consulting Inc. 2005e. *Phase II Foundation Investigation, Proposed Roberts Bay Jetty Location, Doris North Project, Hope Bay, Nunavut, Canada*. Report submitted to Miramar Hope Bay Limited, May 2005.

SRK Consulting Inc. 2006a. *Design of the Tailings Containment Area, Doris North Project, Hope Bay, Nunavut, Canada*. Report submitted to Miramar Hope Bay Limited, October 2006.

SRK Consulting Inc. 2006b. *Technical Specifications for Tailings Containment Area and Surface Infrastructure Components, Doris North Project, Hope Bay, Nunavut, Canada*. Report submitted to Miramar Hope Bay Limited, October 2006.

SRK Consulting Inc. 2006c. *Engineering Drawings for Tailings Containment Area and Surface Infrastructure Components, Doris North Project, Hope Bay, Nunavut, Canada*. Report submitted to Miramar Hope Bay Limited, October 2006.

SRK Consulting Inc. 2006d. *Phase III Foundation Investigation, Proposed Roberts Bay Jetty Location, Doris North Project, Hope Bay, Nunavut, Canada*. Report submitted to Miramar Hope Bay Limited, August 2006.

SRK Consulting Inc. 2006e. *Geochemical Characterization of Portal Development Rock, Doris North Project, Hope Bay, Nunavut, Canada*. Report submitted to Miramar Hope Bay Limited, October 2006.

SRK Consulting Inc. 2006f. *Water Quality Model, Doris North Project, Hope Bay, Nunavut, Canada*. Report submitted to Miramar Hope Bay Limited, October 2006.