BATHURST INLET PORT AND ROAD PROJECT
Updated Description of BIPR Project
Part 2

the BATHURST INLET PORT AND ROAD PROJECT

Rescan Engineers & Scientists

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UPDATED DESCRIPTION OF PROJECT (CONTINUED)

1.9.2.1.4 Construction

The process of installing an OPEN CELL structure through the ice in the winter is shown in Figure 1.9-5. Figures and photos illustrate the following four steps:

1. Rock-fill is pushed out from shore until the toe reaches the design water depth. Sea ice is removed as the fill progresses outward.
2. Face sheets are installed through the sea ice by cutting the ice along the template to match the sheet pile pattern.
3. Tailwall sheets are driven into the rock-fill through similar cuts in the ice. Once the tailwalls are in place, ice within the cells can be removed.
4. Fill is then placed and compacted in lifts up to design grade. Bollards, bullrails, and fenders (where specified) are installed. Dredging at the face (where specified) is completed.

Results from a future geotechnical investigation will be required to determine soil properties and the soil profile down to bedrock, which is expected to be 15 m to 20 m deep from the geophysical surveys. It appears that the esker deposited by the glaciers originally extended past the current day shoreline, then became submerged when the glaciers receded. The offshore esker sands and gravels will provide a much more suitable foundation for the wharf and causeway when compared to the soft marine sediments that dominate offshore bottom conditions prevalent around most of the peninsula.

The causeway fill material and the sheet pile cells backfill will consist of esker borrow material excavated upland to create the port laydown area and camp pad. Sheet pile will be installed first to create the face of the dock with tail walls that extend into the causeway fill section. Sheet pile will be backfilled after driving is completed. Backfill in the Arctic marine environment in the winter requires special methods to minimize the amount of snow and ice mixed in with the gravel fill. The winter backfill will trap some snow and ice and compaction will be difficult. Some settling the following next two summer seasons can be expected and will require placement of additional material to fill localized depressions back to grade. Any critical foundations for buildings and or large stationary equipment will be constructed on pile foundations to account for this settlement.

Where subjected to wave attack, the causeway will be reinforced with armor rock.

1.9.2.1.5 Dredging

Once the sheet piles have been installed and backfilled, a crane and clamshell bucket will be used to dredge less than 15,000 m^3 at the face of dock during the open water season. In the event the entire dredge area cannot be reached from the dock, a floating barge will be deployed and dredged material once removed will be deposited directly from the clamshell directly on top of the dock and used as fill behind the sheet pile.

1.9.2.2 Barge Landing

A barge landing will be an integral component of the port. During the construction period the barge landing will support the initial sealift of fuel and equipment for construction of the port. During the operating period the barge landing will serve multiple purposes including trans-shipment of fuel and supplies from the port to local communities and lightering cargo from larger vessels at anchor or moored at the port.

1.9.2.2.1 Construction Barge Ramp

A barge ramp will be provided during construction as a temporary facility inside the protected inlet (Plate 1.9-3 and Figure 1.9-6). Inside the inlet, the temporary barge ramp will be protected from the prevailing wind and will be located within the footprint of the permanent wharf and rock-fill structure to reduce the overall BIPR Project footprint. The selected site has a good approach and good sand and gravel bottom conditions. For most sealifts smaller 1500 or 2000 series barges will be able to ground on the beach and lower a ramp to roll off most of the equipment, containers and break bulk. If required, a short (< 20 m) rock jetty will be constructed from the beach to reach the ramp from deeper draft barges. The temporary rock jetty will be incorporated within the rock-fill of the final wharf configuration.

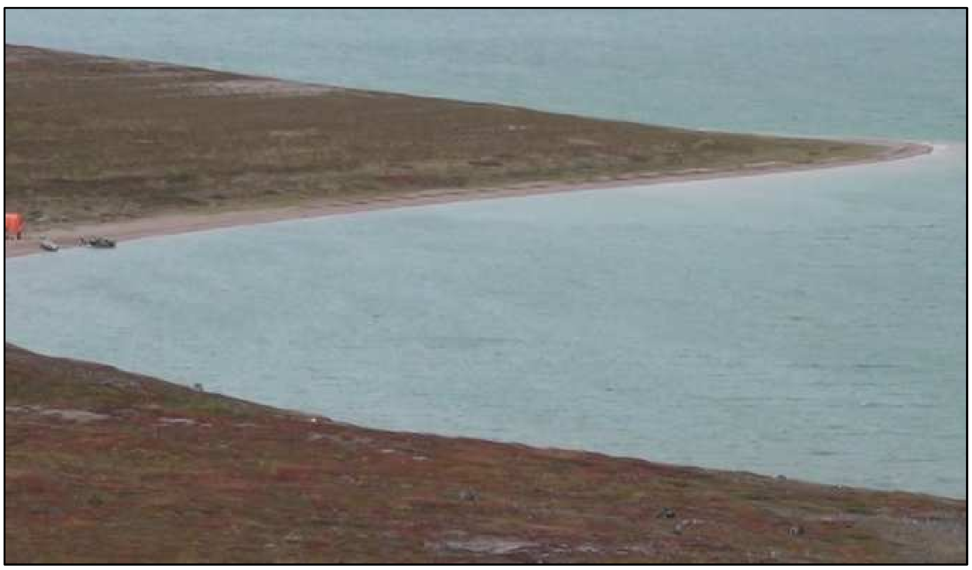
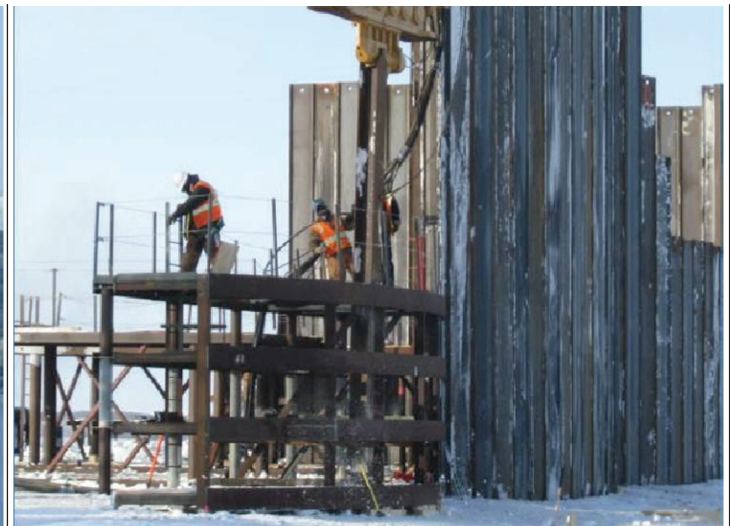


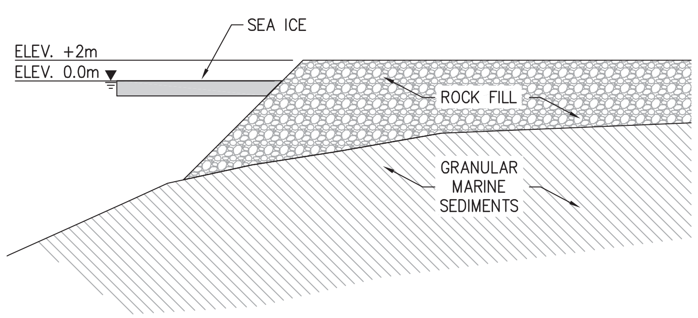
Plate 1.9-3. Barge landing site.

The construction barge landing will have an associated upland laydown pad for fuel bladders and containers.

1.9.2.2.2 Permanent Barge Berth

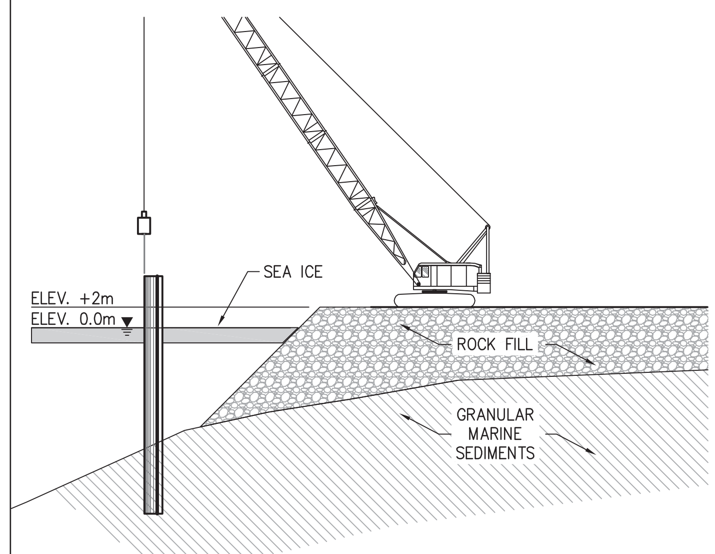
The permanent barge berth will be integrated into the marine wharf design (see Figure 1.9-3) to allow a larger bulk carrier to be berthed at the same time as a barge. The barge berth will be located at the south end of the wharf in approximately 10 m of water, and will accommodate a wide range of barges from the large 12,000 DWT ocean class 6 m draft to the small 1,500 DWT





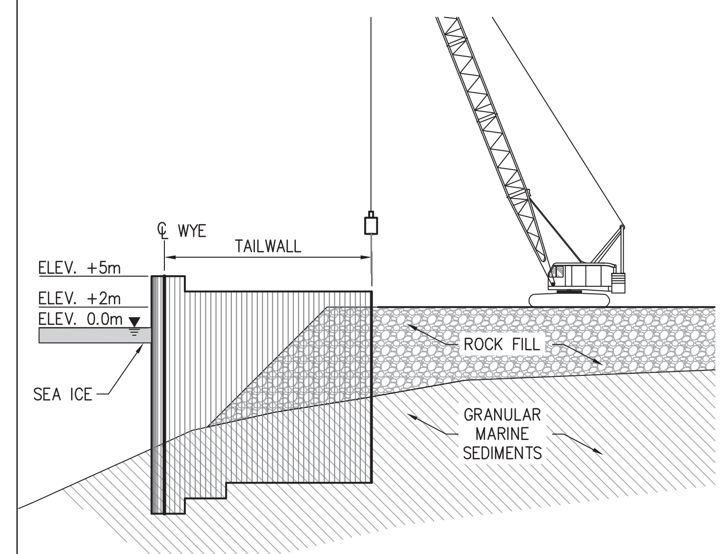
STEP 1

CONSTRUCT FILL SLOPE TO −15m
REMOVE ICE AS FILL PROGRESSES
(NOT TO SCALE)



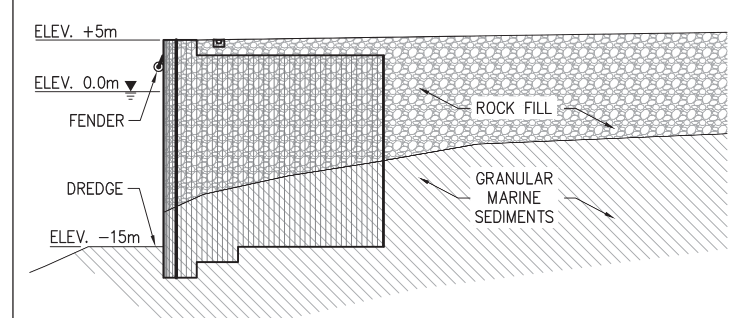
STEP 2

INSTALL FACE SHEETS FROM FILL SLOPE
CUT ICE WHERE SHEETS TO BE DRIVEN
(NOT TO SCALE)



STEP 3

INSTALL TAILWALL TO DESIGN DEPTH
REMOVE ICE INSIDE CELLS
(NOT TO SCALE)



STEP 4

FILL TO DESIGN ELEVATION AND CUT OFF FACE SHEETS.
INSTALL BOLLARDS, BULLRAILS AND FENDERS.
DREDGE TO −15m AT FACE AFTER ICE MELTS.
(NOT TO SCALE)

Figure 1.9-5

OPEN CELL SHEET PILE®
Bulkhead Installation Sequence

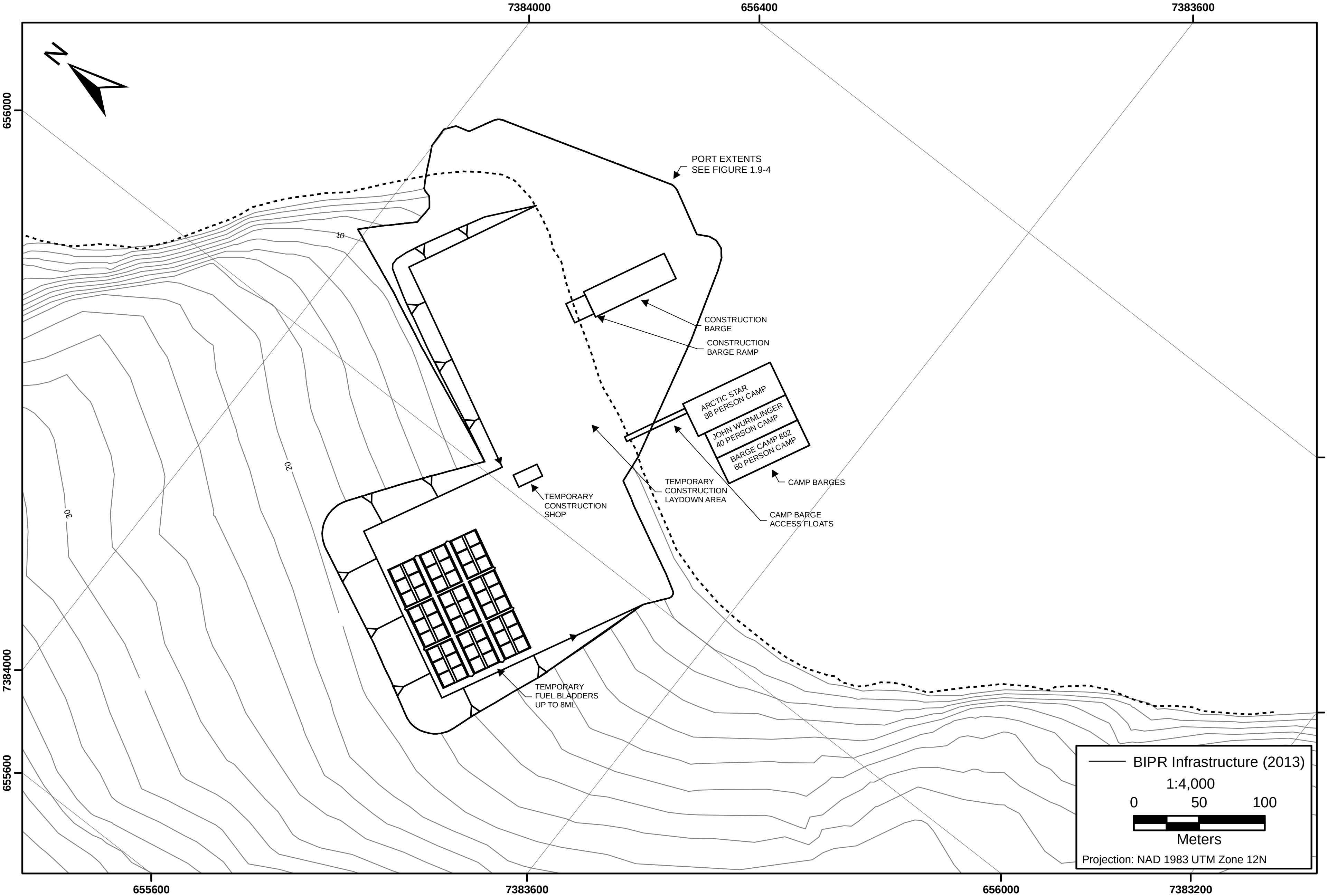


Figure 1.9-6

the BATHURST INLET PORT AND ROAD PROJECT

Constuction Barge Landing

Figure 1.9-6

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Hay River barge with only 1 m to 2 m of draft. Built in roll on and roll off capabilities and/or a crane will be used to load and offload the barges. The barge berth will have several functions as summarized below:

- Lightering facility to offload cargo from a freighter if the main wharf is being used;
- Roll on and roll off for large modules and/or mobile equipment; and
- Transshipment facility for fuel and general cargo to western Nunavut communities to take advantage of discounted bulk charter rates into BIPR.

1.9.2.3 Quarry

A quarry will be developed about 1.5 km north of the wharf to provide rock fill for construction of the wharf and material for constructing pads for other facilities such as the tank farm, camp, airstrip, and roads (Figure 1.9-7, Figure 1.9-8). About 800,000 m^3 of rock will be excavated.

Quarry rock will be excavated using conventional drill and blast techniques on benches, with air-track drills used to drill blasting holes, dozers to push blasted rock to a crusher, and loaders to feed the crusher and load haul trucks. Sampling conducted on the original port site in 2003 indicated that the rock at that location is not potentially acid generating, and similar rock is anticipated at the quarry site. Further sampling at the proposed quarry site will determine the acid generating potential of the rock to ensure that acid generating rock will not be used for construction purposes.

Blasting will be subject to conventional operational controls with drilling plans, blast patterns and protection berms designed to limit fly rock. The orientation of the quarry face will further limit the effects of fly rock on the tank farm and other site facilities, and work in adjacent areas will be suspended during planned blasting time windows.

Surface runoff will be directed away from the quarry by diversion ditches and runoff from the quarry will be directed overland to settle sediment before it reaches open water.

1.9.2.4 Excavated Material Storage Area

An excavated material stockpile area will be established west of the camp (Figure 1.9-9). It will have a surface footprint of approximately 14.5 ha., which will be used as a permanent stockpile facility for overburden material excavated during the construction of the quarry, tank farm, and other port site facilities. Setbacks from open water and perimeter berms along the downhill sides of the stockpile area are proposed to limit sediment transfer caused by stormwater runoff. The organic overburden material will be segregated from other waste material so that it can be used to re-contour the surfaces of port site facilities back to more natural formations during the reclamation phase of the BIPR Project.

1.9.2.5 Inert Waste Disposal Site

A disposal site will be established in the footprint of the port (Figure 1.9-4) for safe storage of inert wastes such as concrete and steel. If required, the inert waste disposal site will also include a bioremediation facility for hydrocarbon-contaminated soils.

1.9.2.6 Fuel Storage

A key function of the port site will be the storage of fuel that will be delivered in bulk by ships during the ice free season. The fuel will be stored in a tank farm and then be allocated over the rest of the year to BIPR Project clients such as mines or local communities. Communities will obtain fuel by barge during the ice free season and tanker trucks will be used to haul fuel to other clients such as mines on a year round basis. The effects of the use of the BIPR Project by client mines beyond the current estimates will be assessed for each mine in their respective Environmental Impact Statements.

The preferred tank farm location is atop the ridge northwest of the wharf, at an elevation of approximately 50 m (Figure 1.9-10). There will be twelve 18 ML tanks, for a total storage capacity of 216 ML. The vast majority of fuel will be arctic-grade diesel, but one tank will be dedicated to Jet A fuel.

1.9.2.6.1 Design

The tank farm will be founded on compacted gravel fill over bedrock, requiring that all overburden be excavated and a minimum 1-m-thick level base course be built up (Figure 1.9-10). The tank farm will be surrounded by a 2 m high containment berm sized to contain a volume equal to 100% of the largest tank plus 10% of all other tanks within the berm. A 60 mil high density polyethylene (HDPE) liner will be buried within the berm and base course. A layer of quarry rock will be placed around the perimeter of the tank farm excavation for thermal protection of the surrounding overburden. Sumps will be provided in the corner of each containment area for collection of runoff and any spills.

All fuel storage facilities will be designed in accordance with relevant CSA and API codes, as well as the National Fire Code, governing fuel storage, handling, and containment.

1.9.2.6.2 Fuel Delivery to Storage

Fuel will be offloaded from vessels directly to the tank farm using pumps on board the vessels. No booster pump is required on shore because vessels servicing the region come equipped with pumps capable of providing enough pressure to reach the tank farm. A module at the port will house a connection manifold, meter, filter, and a connection for inserting a cleaning pig. A single 200 mm pipeline will carry fuel to the tank farm from the port. The flow meter at the port will be closely monitored as well as the pump pressure during transfer of the fuel from the vessel to the tanks. Any sudden changes in volumes and/or pressure to predetermined thresholds could potentially indicate a problem in the system and the pumps will be immediately shut down. Pumping will not resume until after the system, including the pipeline, has been inspected and the problem is identified and rectified as appropriate. After all the fuel has been transferred to the tank farm by the last vessel at the end of the shipping season, the cleaning pig will be used to thoroughly evacuate the pipeline before it is shut down for the winter.

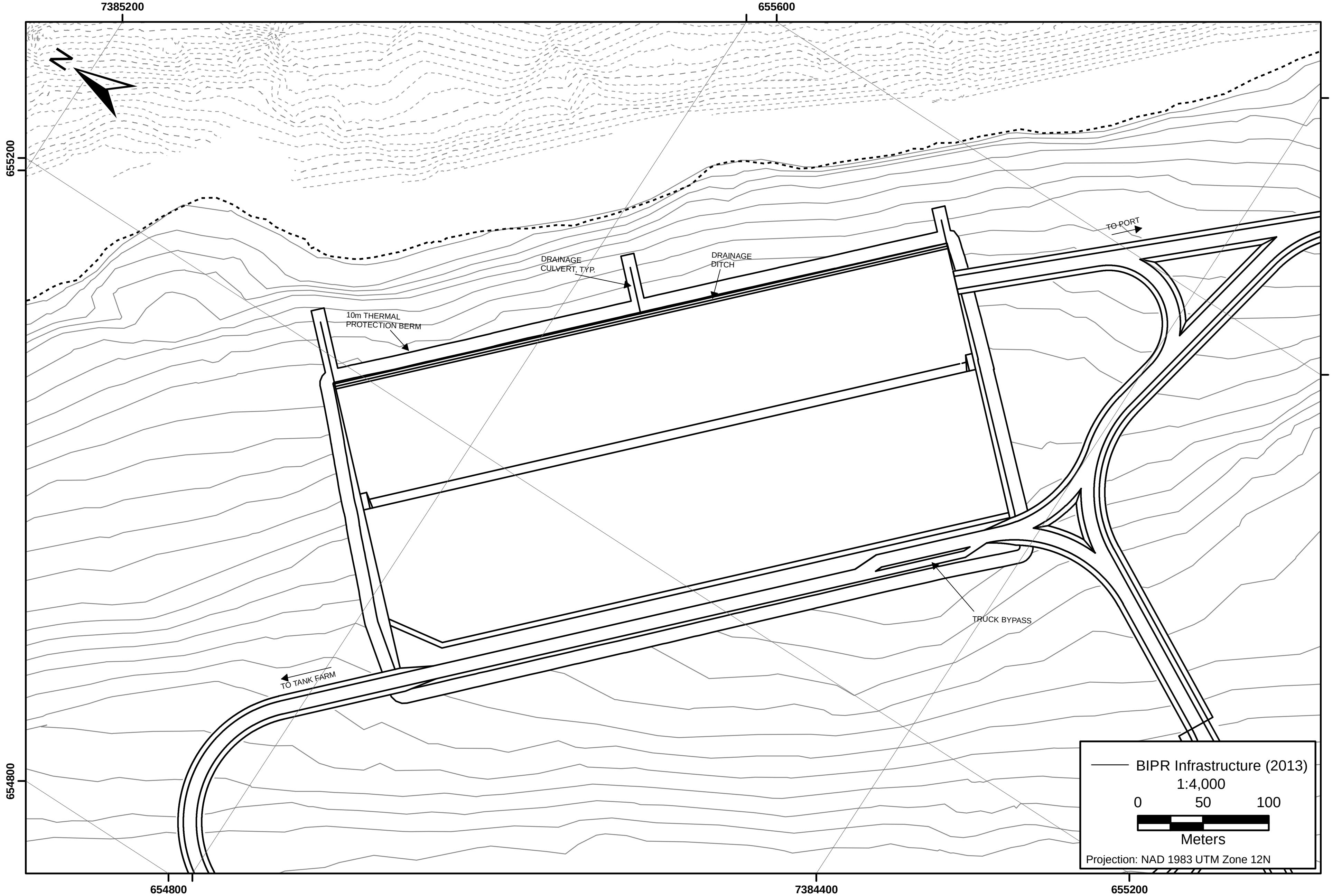

Figure 1.9-7

the Bathurst Inlet Port and Road Project

Quarry Layout

Figure 1.9-7

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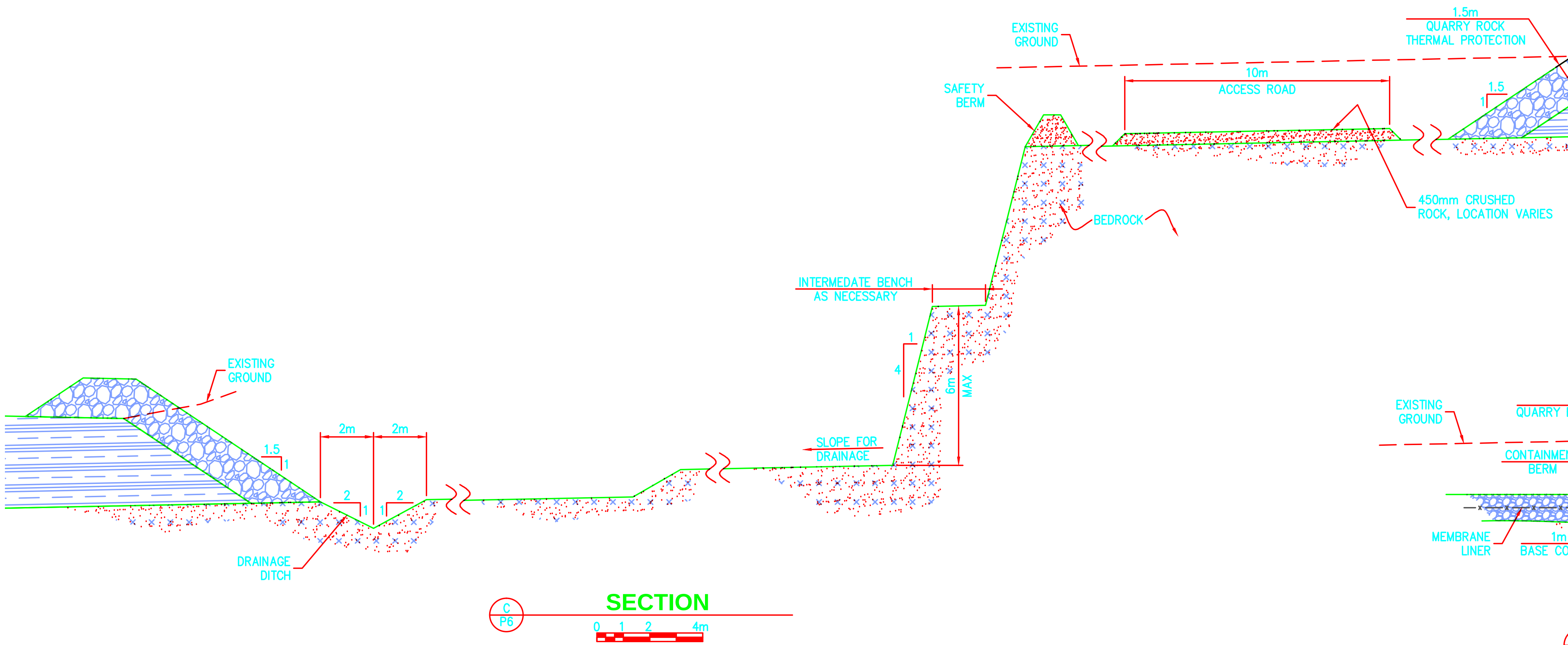

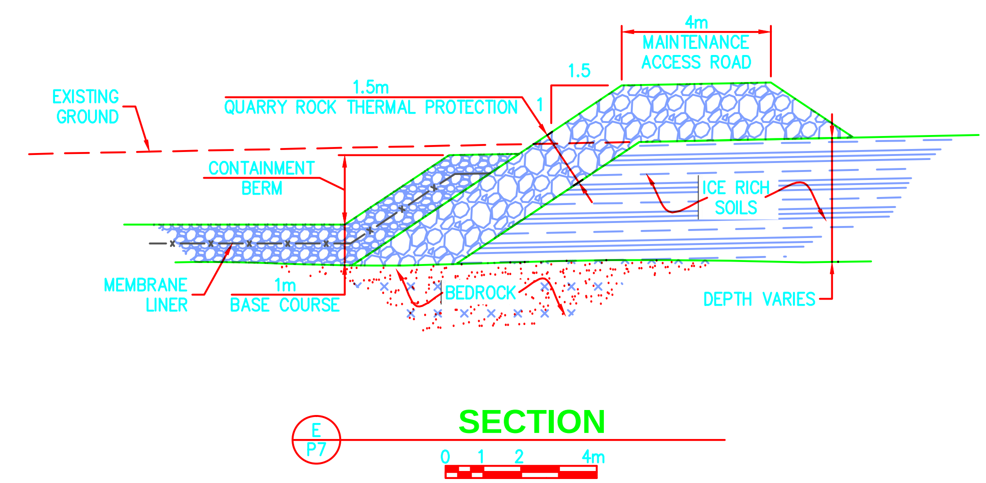

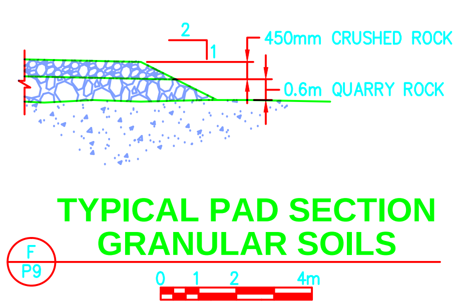

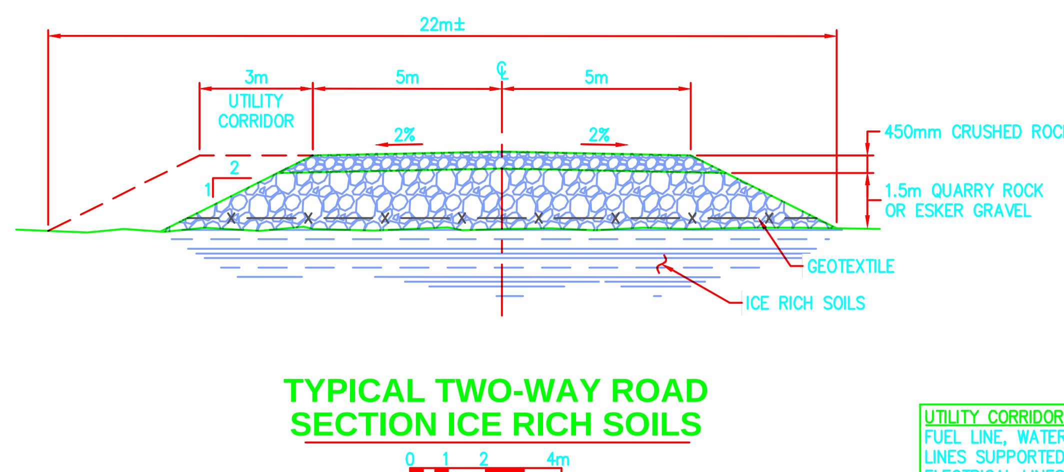

UTILITY CORRIDOR:
FUEL LINE, WATER AND SEWER LINES SUPPORTED ABOVE GROUND. ELECTRICAL LINES BURIED.

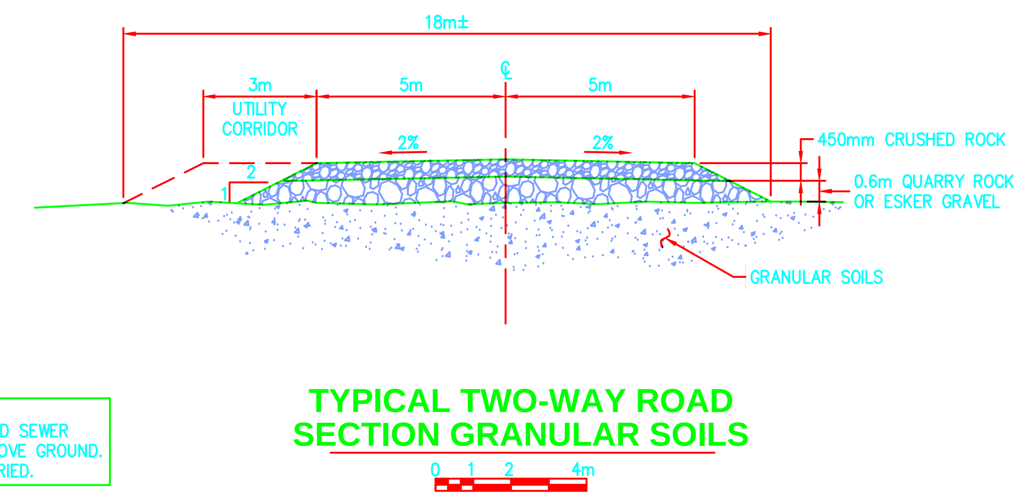

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Figure 1.9-8

Quarry Cross Section

PROJECT #1098-003-20 GIS # BPR-15-035a March 27, 2013

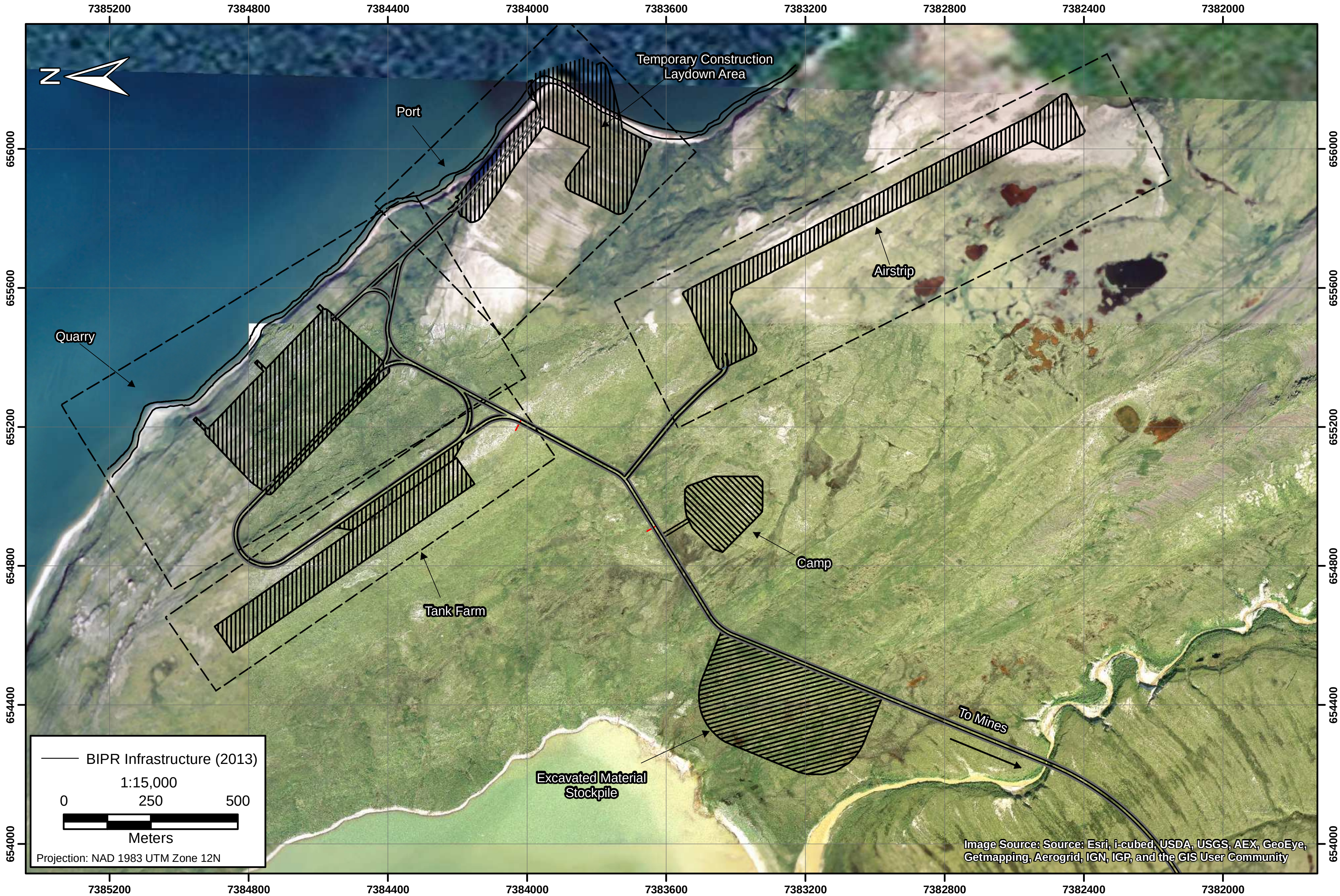

Figure 1.9-9

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Port Facilities Site Plan

Figure 1.9-9

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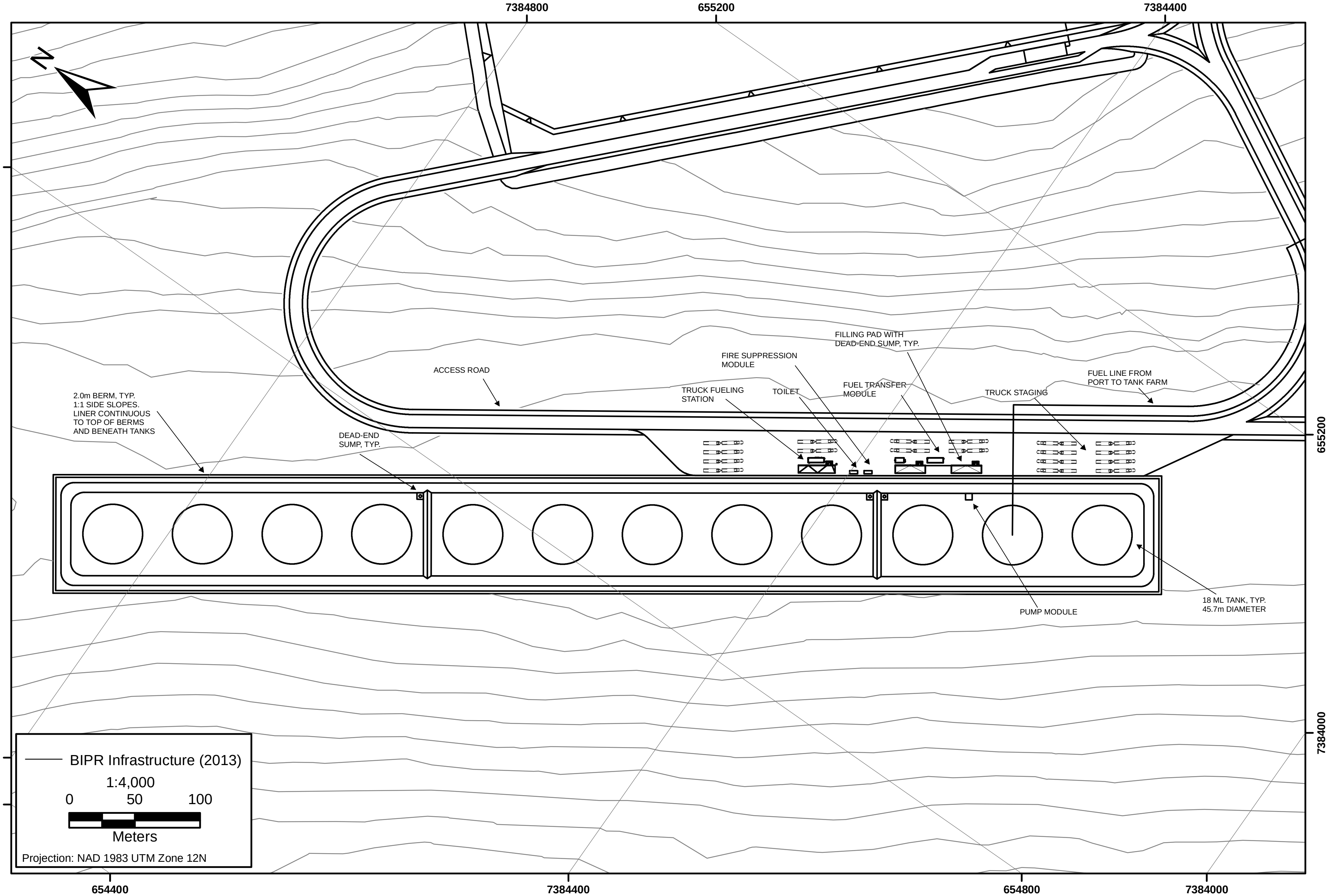

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Fuel Tank Farm Layout

Figure 1.9-10

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Spill control supplies including floatable booms, skiff and motor, absorbents and other equipment will be available at the port in case a spill occurs on land or in-water. Trained spill control crews will be available and ready to respond in case a spill occurs. A detailed spill response plan will be implemented in accordance with all regulations and corporate policy before any fuel transfer operations are allowed to proceed.

1.9.2.6.3 Fuel Loading and Dispensing

Individual trucks will be fueled at a fuel dispensing station and tank trucks will be loaded at a truck loading station. A 150 mm insulated, heat-traced pipeline will carry fuel to the truck loading station and fuel dispensing station, located adjacent to the tank farm. A pump and fuel transfer module will be housed in containers at the fuel dispensing station. A fire suppression module will also be located at this site.

Jet A fuel will be supplied to the airstrip via a 10,000 L skid-mounted tank with its own pump and meter attached.

1.9.2.6.4 Staging

A temporary fuel storage facility will be located at the temporary barge landing until the permanent tank farm is available (Figure 1.9-6). The temporary facility will use collapsible fabric tanks, or bladders, to contain 4 to 8 ML of fuel.

1.9.2.7 Camp

The construction/operation camp, dry and kitchen/diner complex will consist of prefabricated modules placed on a rockfill pad with a minimum thickness of 1 m. To prevent thawing of the underlying permafrost soil, a minimum 1 m air space will be maintained between the floor of the modules and the rockfill pad formed by a timber or steel sill.

The construction/operations camp will be located about a kilometre west of the proposed port site (Figure 1.9-9). It will be constructed in stages in order to accommodate the build-up of personnel from the early stage of construction activity to the estimated peak of 200 during construction. The camp accommodation units and services will be expanded, as additional beds are needed. The ultimate construction camp will include the following:

- three 64 person two storey management complex, accommodating one worker per room, shared washrooms between two rooms, showers and laundry facilities;
- heated and lighted modular corridor between all facilities;
- a kitchen/diner, with a seating capacity of 150 in the diner area. The kitchen will have the capacity to provide hot meals to all workers, plus lunch making facilities for workers required to eat their meals at their place of work. Separate washrooms for male and female personnel will be available; and
- a recreation building will be located in the second storey above the extension of the kitchen/diner, and will include a commissary, television room, games room, and gym. It will also include a meeting room and the camp manager’s office.

All major camp buildings will be prefabricated modular trailer units. The individual trailer units will be joined together to form weather tight facilities on timber blocking approximately 800 mm clear and open for drifting above grade. The trailer undersides will be totally enclosed with plywood skirting to the finished grade. Windows will be aluminum, sliding sash type, with insect screens. All buildings will be heated and ventilated. Air conditioning will be provided in the dining room, lunch preparation and recreation facilities only. Extraction fans will be installed in the kitchen, the washrooms and the wet areas of the buildings.

The camp area will have a fire protection system complete with surface piping isolation valves and fire hydrants strategically located around the camp. Camp areas will be equipped with sprinklers and portable fire extinguisher units as required by code. The system will be supplemented with smoke/heat detectors and manual alarm stations. A fire alarm signal will be activated by start-up of the fire pump, or activation of smoke/heat detector, or by manually turning on an alarm station. All alarm signals will be monitored at a central control station.

The construction camp developed to house construction personnel will gradually be turned over to operations as the construction activities wind down. On completion of the construction activities, surplus bunkhouse units, one management trailer and portions of the dining and recreation buildings may be dismantled and shipped off site if no suitable use can be found during the operating phase of the BIPR Project.

Workers from Cambridge Bay and other communities, who live too far away to commute each day to the BIPR Project site, will reside in the operations camp. The operations camp will be sized initially for 200 employees. The camp will be operated and maintained by an independent contractor.

1.9.2.8 Maintenance and Administration Facilities

A number of support facilities for the port will be grouped together for efficiency, including the camp, maintenance/truck shop building, emergency response facilities, mine dry, electricity generators, potable water pumphouse, and wastewater treatment plant. They are described in the following sections.

1.9.2.8.1 Maintenance/Truck Shop

The maintenance shop facilities in the service complex include a wash bay, three mobile equipment repair bays including lubrication facilities, machine shop and one welding bay. The equipment bays have been sized to accommodate the maintenance and ancillary mobile service equipment. The repair bays have been provided with vertical roll-up doors. These bays will be high enough to allow sufficient clearance for a 100 tonne truck with its box in the raised position.

The maintenance shop will be a pre-engineered, steel frame structure, with metal cladding and concrete slab floors. The metal clad roof and walls will be insulated. Interior metal liners will be installed on all walls for part of their height to protect the insulation. A low concrete exterior wall will extend from grade to the underside of cladding around the perimeter of the building to protect the cladding during snow removal. Elsewhere, the interior finish will be painted block walls, linoleum over concrete floor slabs, and panel drop ceilings.

Space has also been allocated for the machine shop, electrical/instrumentation shops, welding shop, hydraulic shop, and fabrication shop.

Air compressors and receivers will supply air for the air-operated lubrication distribution pumps from a compressor room at the far end of the complex. Welding outlets will be provided together with portable welding curtains and mobile welding fume filters. Heating and ventilation units will heat these areas, particularly near the outside doors. The units will have the capability of re-circulating air, or to bring in outdoor air, as will be dictated by the quantity of exhaust air being extracted from the area by truck exhaust fans, welding exhaust fans, or general exhaust fans. Hose reels fed from the lubricant storage area will dispense grease and various grades of lubricants to the shops.

The wash bay will be equipped with high-pressure water monitors and steam cleaning equipment. The concrete floor will be sloped towards a drain and an oil interceptor system plus waste oil tank will be included to store residual oils. A heating and ventilation unit will provide heating to this area, particularly near the outside doors. The unit will re-circulate air during periods that the truck wash is idle, but will supply heated outdoor air whenever the exhaust fan is energized. A summary of equipment that will be in the maintenance building is provided in Table 1.9-3. A sloping concrete apron will extend in front of the repair bays, and bollard sets will be provided to protect the building entrances from vehicular damage.

Table 1.9-3. Maintenance Building Equipment

Description	Quantity
35 Ton Vehicle Hoist	3
Heavy Duty Workbench	3
25 Ton Overhead Crane	1
Welding Machine	1
Heater, 1 Million BTU	1
Pressure Washer	1
Wash Bay with Sump Pump	1
Greywater Tank	1

Anticipated hazardous wastes include waste oil, used anti-freeze, miscellaneous chemicals and solvents that may be used in the shop. Waste oil will be burned on site in a specifically designed unit or waste oil heater for the shop. Used anti-freeze and other miscellaneous chemicals and solvents used in the shop will be stored in a designated storage area and hauled offsite on the annual sealift for disposal by a licensed handler.

1.9.2.8.2 Warehouse

The warehouse will be located in the same building as the shops, beside the repair bays. The upper section will house the compressor and electrical/communications rooms. A fire-rated wall will separate the warehouse from the other areas of the shop. A fenced outside storage area will provide yard storage.

1.9.2.8.3 Administration and Dry Facilities

The administration and dry facilities will be contained in a separate modular trailer complex. The dry will have an area containing individual (clean and dirty) lockers, washrooms and showers for the shop workers. A separate change room, locker facility, and washrooms for women will also be provided. The facility will be sized to accommodate 20 men and five women, including hourly employees, staff and visitors:

The dry will include the associated electrical/mechanical room, laundry, first aid and safety, offices, training/lunch rooms, and supervisory staff offices.

Office space will be allocated to the site manager, truck dispatcher, safety, and security. There will be a separate area for reception and clerical personnel. The balance of the space will house a records room, copy room, lunch room, conference/meeting room, storage and utility rooms, and washrooms.

1.9.2.8.4 Emergency Response Annex

The emergency response annex will house emergency response vehicles for deployment to port facilities and the all-weather road as necessary. It will include medical emergency response (ambulance), fire truck, emergency medical technician (EMT) services, and health and safety supply storage.

1.9.2.9 Airstrip

The permanent airstrip will be located and constructed on top of a large flat granular marine deposit. The foundation conditions consist of fine to medium sand that can readily be graded and compacted during the summer. The construction of the airstrip will require minor grading for leveling and drainage control, followed by placement of a compacted crushed gravel surface composed of non-acid generating rock.

The airstrip will be 1,200 m-long and 30 m-wide with aircraft turning areas at both ends (Figure 1.9-11). The airstrip will meet Code 3B (per Transport Canada Aviation Standards) and be capable of handling De Havilland Twin-Otter and Hawker-Siddley ATR 42 aircraft. The airstrip will be used year round for operating personnel and light/perishable (food) cargo movements.

1.9.3 Utilities

Utilities will be consolidated in the vicinity of the camp for efficiency and to limit the overall BIPR Project footprint.

1.9.3.1 Power Supply

Based on the operation of the port site facilities over a period of 20 years the power plant is designed to accommodate four diesel generator sets with a continuous rating of 890 KWe each. Three generators will be required to meet the anticipated average demand (2 mWe) with the fourth in operation to meet the maximum demand (3.5 mWe). Therefore, normally three generators will be sufficient to meet the average load.

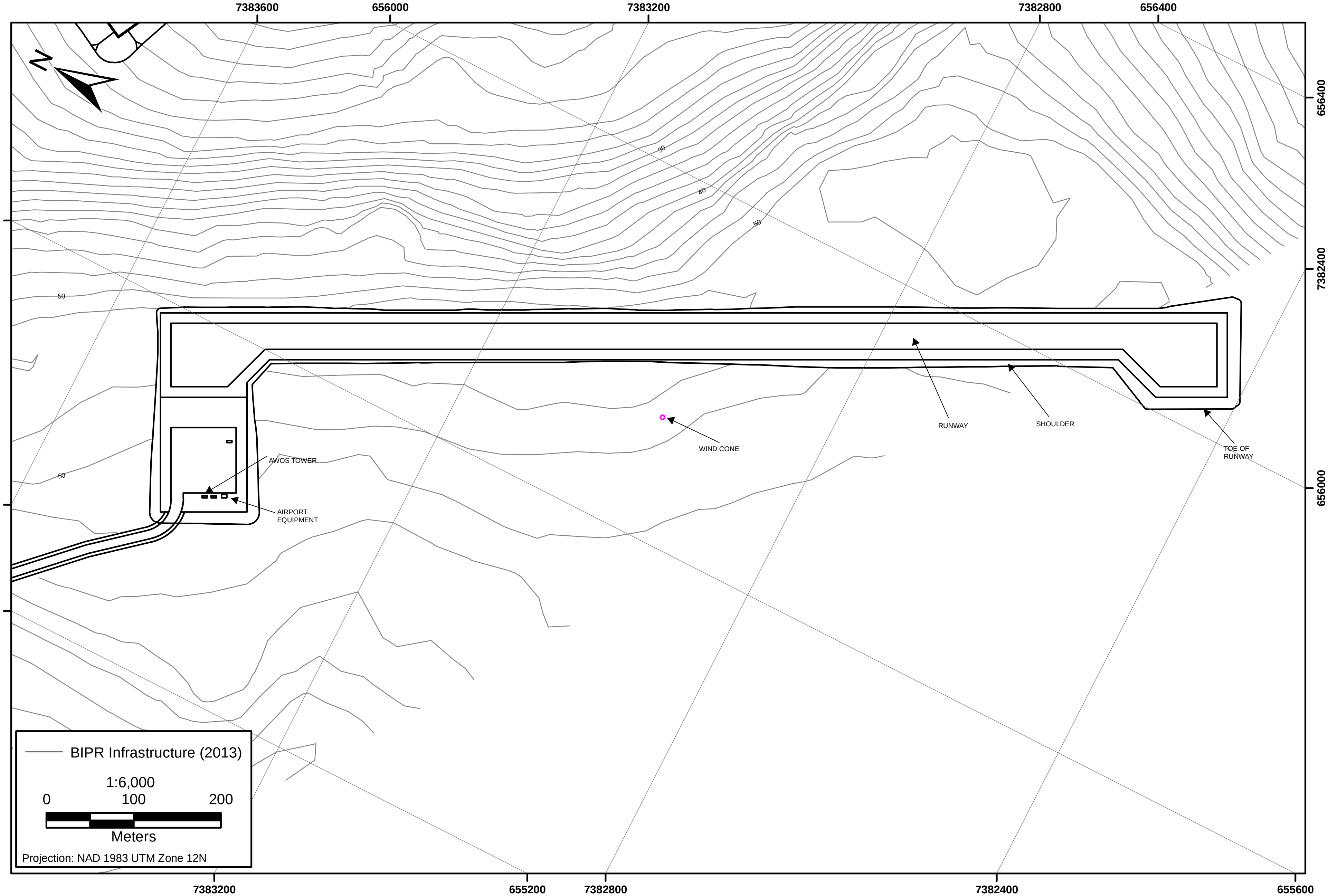

Figure 1.9-11

the BATHURST INLET PORT AND ROAD PROJECT

Bathurst Inlet Port Airstrip Layout

Figure 1.9-11

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The generated power will be 4.16 kV, 3-phase, 60 Hz at a power factor of 0.90. The generators will be medium speed operating at or below 1,200 rpm for longer life. The generators will have 10% overload capability for 1 hour in 12 hours. Power generators selected will have a built-in closed circuit, two stage heat recovery system. The recoverable heat from the normally running generators will be adequate to meet the total heat demand of all the camp and shop facilities. A properly sized boiler and glycol heating system will be provided to supplement the generator heat recovery system. The projected power requirements are shown in Table 1.9-4.

Table 1.9-4. Total Estimated Electrical Load

Electrical Loads	Connected Load (kW)	Maximum Demand (kW)	Average Demand (kW)
Dry Building	125.0	112.5	78.8
Maintenance/Truck shop	225.0	202.5	141.8
Office	60.0	54.0	37.8
Raw Water Pumphouse	167.9	151.1	105.8
Potable Water Pumphouse	162.3	146.1	102.3
Sewage Treatment Plant	59.9	53.8	37.7
Miscellaneous	146.1	131.4	13.2
Fuel Tank Farm	225.0	202.5	141.8
Truck Fuel Dispensing Station	75.0	67.5	47.3
Truck Fuel Loading Station	75.0	67.5	47.3
Ship Fuel Unloading & Metering	350.0	315.0	157.5
Power Plant	125.0	112.5	78.8
Camp Facilities	1,300.0	1,170.0	495.0
Total	4,131.9	3,718.0	2,137.2

Source: SNC-Lavalin 2007

Combustion air for the generators will be preheated as necessary, by using radiant heat from the exhaust piping or other intake air heating systems.

The external fuel day tank, with 8 hour fuel capacity, and supply lines will be heat traced to supply warm fuel to engines at +4ºC to maximize combustion efficiency of the diesel engine.

Generators will have external remote radiators and after coolers. The external radiators will serve as ‘heat dumps’ in the event the heat recovery system is not used.

A waste oil recovery and storage system will include a sump tank to collect the drains from generator engines and will be periodically pumped to an external bulk storage tank which will be heat traced.

A complete fire suppression and alarm system will be installed in the generator building.

The electrical systems for the truck shop, dry building and kitchen/diner/camp complex will be distributed by means of an internal cable and tray system and indoor dry type transformers.

The electrical systems for the fuel handling, water management and office facilities will be distributed by means of an overhead 4.16 kV power line distribution system.

Two loop feeders will extend from the power plant to the camp, tank farm, quarry, port, and airstrip. Each area will be equipped with 5kV switches to allow for isolation and cross-tie of each circuit. The loop configuration will allow for continued operations in the event of a failure in one of the circuits. Where possible the conductor loop will be physically separate for added reliability.

The 5kV feeders will be direct burial cable at or below grade depending on soil conditions. In locations over bedrock or permafrost, direct burial cables will be encapsulated in non-frost susceptible granular fill for cover and protection. Minimum cover over cables will be 1 m in all directions.

Transformers will be 4160-600Y347V pad mounted oil filled units. A minimum of two transformers will serve each area. Transformers of the same size will be used wherever practicable to simplify replacement in the event of a failure. Secondary containment will be provided for oil filled transformers.

1.9.3.2 Water

1.9.3.2.1 Raw Water

A suitable non-potable fresh water source is not available in the BIPR Project site area. Seawater will be relied upon for the raw water supply. The quality and average volume of water required will vary depending on its usage.

The water source that will be available to the BIPR Project is Bathurst Inlet, enough seawater to meet the demands can be drawn from Bathurst Inlet without any effect.

The raw water/sea fire water pumphouse will have an intake pipe in the surrounding rock fill connected into a wet well. The raw water/sea fire water pumphouse will contain the fire water pumps (electric, back-up diesel, and jockey pump), diesel fuel tank, raw water pumps. Two vertical turbine raw water pumps in parallel in the wet well will pump water through a 254 mm (10’’) diameter insulated, HDPE pipe, to the potable water pumphouse, located by the camp. The pipeline will be routed partly alongside roads. Air/vacuum valves will be provided at high points along the pipeline. Drain valves will be installed on the pipeline at the pumpstation and at the run-off collection ponds. This will enable the pipeline to be drained during any prolonged shutdown under freezing conditions.

The design capacity of the system will be 60 m^3/hr with one pump operating; a flow rate that exceeds the above flows plus the water makeup requirement. The demand will vary throughout the life of the BIPR Project. Only under extreme circumstances will it be necessary to operate all the pumps simultaneously.

1.9.3.2.2 Potable Water

Potable water will be supplied from desalinating seawater with an estimated capacity of 5 m^3/hr.

The estimated daily potable water demand during construction will be 54 m^3, which is based on a maximum work force of 200 people. During operations, the estimated daily consumption will be 45 m^3, which is based on an average camp capacity of 150 people that will include both port site personnel and contractors such as truck drivers.

For overall operations, a permanent potable water tank will be installed near the potable water pumphouse. The vertical, field-erected steel tank will have a nominal capacity of 115 m^3. Upon operation, the potable water supply pipeline will be re-directed from the camp and connected to the permanent tank. After discharge from the tank, the water will be treated by a calcium hypochlorite addition system with a small mix tank and a metering pump.

Potable water pumps will draw water from the tank for distribution:

- through a pipe loop in the camp; and
- through an insulated main to the other structures via a utilidor .

Some areas requiring potable water will not be connected to this site system because their demand is small and remote from any potable water main. They will have trucked potable water for drinking and seawater for the washroom facilities.

1.9.3.3 Waste Water

Sewage and grey water from the port site and camp areas will be collected by a gravity sewer system or pumped from holding tanks and will be conveyed to a sewage treatment plant. For the truck maintenance shop, a sewage lift station and forcemain will be required to pump its sewage to a gravity sewer main. The lift station will be a packaged pumpstation with a fibreglass chamber and the forcemain will be HDPE pipe. All sewer pipes will be surface run, insulated and heat traced to the minimum required for freeze protection.

A sewage treatment plant (STP) will be used to service the port site area during the construction phase and continue for operation. The maximum capacity of the plant will be 65 m^3 per day, which is based on a maximum workforce of 200 during construction. Sewage treatment will be by a packaged tertiary treatment, extended aeration plant that will include:

- flow equalization;
- primary settlement;
- sludge storage;
- aeration tank;
- final clarifier;
- disinfection; and
- sand filtration.

A packaged STP will be used because it is simple to fabricate off-site into modular components, suitable for remote applications, has a good reputation for low maintenance, good stability under fluctuating organic and hydraulic loads, low energy consumption, and simple to operate.

The treated effluent will be discharged into Bathurst Inlet with an effluent quality not exceeding permit limits. An insulated surface pipeline will discharge the effluent into the bay on the east side of the port site.

Sewage from the washroom facilities at the wharf area will be directed to nearby sewage holding tanks. These tanks will be emptied at regular intervals and their contents treated at the site STP.

Sludge from the STP will be stored or disposed of in a manner acceptable to regulatory authorities.

1.9.3.4 Incinerator

An approved diesel-fired incinerator unit will be provided to burn all kitchen waste.

1.9.3.5 Communications

Telephone and facsimile communications from the BIPR Project site will be via satellite to the Infosat or Polar Net distribution system. Associated equipment will be installed at the administration offices. Radio and an internal telephone communications system will be provided from the administration office area to all remote locations on the network. Mobile equipment will each have satellite phones and mobile automatic vehicular location (AVL) for operator communications and safety.

A similar satellite phone system will be installed at the Contwoyto Lake terminal camp.

1.9.4 Drainage Control

Site drainage will be addressed using planning, engineered containment, and operational protocols to limit exposure of stormwater and meltwater to contaminants.

1.9.4.1 Planning

The overall site plan is designed to limit the possibilities of runoff and meltwater reaching potential pollution generating surfaces. Pads will be built above surrounding terrain where possible to negate the chance that runoff from adjacent areas will run over pad surfaces. In granular soils where cut slopes are necessary, cutoff ditches will be located to route runoff around the pads, and where possible, to their natural flowpaths.

1.9.4.2 Engineered Containment

In locations where stormwater runoff may become contaminated, engineered containment structures will be in place to capture any incidental polluted runoff.

At the fueling station, a concrete fueling surface will be graded to dedicated sumps. This arrangement will ensure that any spills or drips from fueling operations are captured.

At the port, the grading is designed to drain runoff to the face of the dock. The possible source generating area is fuel pump module. While this system is enclosed and has internal containment, there remains a possibility that fuel may reach the ground and contaminate stormwater. A trench drain and sump designed to catch any polluted runoff from these areas will be installed at the face of the dock, downstream of flow coming from these two areas.

The water caught in sumps at the fuel dispensing area and the port sump will be visually checked for oil sheens. If deemed clean, it will be discharged over the face of the dock. Otherwise, the sump will be emptied either via piping system or vacuum truck and taken to the on-site sewage treatment plant, where it will be treated with other site grey and black water and discharged via the sewage outfall.

1.9.5 Phase 1 Operation Equipment

When in operation, Phase 1 will require the equipment listed in Table 1.9-5. This list is conceptual and the actual numbers and models of equipment may vary depending upon availability and further design work.

Table 1.9-5. Phase 1 Operation Equipment

Equipment	Number of Units	Equipment	Number of Units
Crew Bus	1	Fuel Truck, 3,000 gallon	1
Pickup	8	Man lift	4
Tracked Manhauler (6 person capacity)	1	Tele Handler	1
Kabota	6	Light Plant	6
Zodiac with motor	2	Heater, 1 Million BTU	4
Snow Machine	4	Godwin Pump	1
Cat 16M Motor Grader	1	Compressor 185 CFM	1
Cat 563 Compactor	1	Skid Steer loader	1
Water truck, 15,000 gallon	1	Welding machine	4
Loader 966 with QC forks	2	988 Loader	4
Snow Blower (fits 966 loader)	2	D7Dozer	1
Cat D5 Dozer	1	Skid Steer	1
Cat 320 Excavator	1	Crane 200 t Crawler	2
Rock Truck 30 ton (with snow removal)	2	Crane 60 t Rough Terrain	1
Fire Truck	1	Container Fork lift, 88 ton	4
Ambulance	1	Camp Incinerator	1
Mechanics' Truck	1	45 tonne B-train Truck (General Cargo)	15
Electrical Box Truck	1	35 tonne B-train Truck (Fuel)	60
Generator (7 to 890 KW)	9		

1.9.6 Explosives

Explosives will not be stored on site during operations. Explosive materials that arrive at the Port will be transported to the mine site(s) for storage. During construction of the BIPR Project, explosives storage and handling requirements will be in accordance with Explosives Regulatory Division, Natural Resources Canada. Explosives will be stored in separate detonator and powder magazines in approved storage units in accordance with the required separation distances from camps, active quarries, haul roads and other magazines. All explosives will be stored a minimum of 30 m from waterbodies. Any explosives left over from construction will be detonated on site in quarry in a controlled manner or relocated to the mine for storage and reuse.

1.9.7 Abandonment and Reclamation

All reclamation activities will be done in accordance with the final abandonment plan as approved by all land use authorities. The following objectives were developed with this goal in mind in compliance with Nunavut Land Use Regulations:

- protect the environment through sound reclamation practices;
- restore the land to its original state as closely as possible;
- restore land uses (e.g. creating wildlife habitat and/or promote habitat recovery);
- minimize effects to aquatic habitat and water quality with proper engineering;
- ensure that abandoned areas are safe and do not pose health and safety risks; and
- satisfy the requirements specified in permits and licences.

Reclamation activities will be carried out progressively, where possible. However, the greater portion of the abandonment and restoration activities will be undertaken upon final abandonment. Should operations be suspended temporarily, such as due to a rise in fuel costs to levels that would make all mining in remote regions uneconomic, temporary abandonment measures will be implemented.

Contingency plans for temporary abandonment will be developed and submitted in support of the BIPR Project EIS.

Abandonment and restoration activities of the port may include the following:

<u>During and Following Construction</u>

Areas that are disturbed for the construction of the BIPR Project which will not be required for the operation will be reclaimed as soon as possible. Quarries not required for maintaining the port and road during operations will be contoured and on completion of construction. Quarry layout and design will be such to prevent entrapment of wildlife.

<u>During Operation</u>

All earth structure, cuts or fill embankments will be designed as near as possible to the abandonment conditions. The outside slopes not used for operations will be progressively reclaimed as time and equipment permits. These earth structures and stream crossings will be continually maintained. If any active erosion is observed, the problem will be corrected and slopes reclaimed to final abandonment conditions.

Temporary Abandonment

Temporary abandonment activities would be dependent on a number of factors (e.g. anticipated duration of temporary abandonment, potential effects) and might include the following:

- enhance revegetation on specific disturbed or altered lands;
- contour all erosion-prone surfaces and slope the sides of excavations and embankments (except when in solid rock) to 2:1;
- implement an environmental monitoring program and maintain compliance with government environmental guidelines or permit/licence requirements; and
- treat and/or remove and dispose of all contaminated soils, if any, in accordance with land use regulations.

Final Abandonment

Non-renewable resources are finite and at some future time, the port and associated facilities may no longer be required. Final closure and abandonment would include the following activities to be carried out within the timeframe defined in the Final Abandonment Plan:

- remove, or dispose locally in an approved manner, all imported materials and structures;
- remove all buildings and any above ground foundations constructed at the port site;
- remove any liners and flatten berms
- treat and/or remove and dispose of all contaminated soils, if any, in accordance with the Final Abandonment Plan;
- commence and enhance revegetation on all parts of the land disturbed or altered, within a reasonable timeframe, as may be approved in the Final Abandonment Plan;
- contour all surfaces to reduce the potential for erosion, and slope the sides of excavation (e.g., quarries) and embankments to permanent stable conditions; and
- implement an environmental monitoring program in compliance with the Final Abandonment Plan.

Specifically it is envisioned that the following closure activities will be undertaken:

1.9.7.1 Fuel Storage

The tanks and all piping will be drained and cleaned, then dismantled. The tank steel will be shipped out. The liner within the tank enclosures will be removed and the area. The liner will be shipped out on a backhaul to Yellowknife or by ship. The pad will be ripped and reclaimed is there is sufficient topsoil (As much topsoil will be salvaged as practical).

1.9.7.2 Fuel Dispensing and Loading Area

All equipment will be drained, cleaned and then dismantled. All steel will be shipped out. Subject to obtaining the necessary permits, all combustible materials including wood will be burned, and inert material shipped out. Any fuel-contaminated soil will be cleaned by bioremediation using microorganisms suited to the climate and/or transported to a permitted facility if it cannot be remediated.

1.9.7.3 Infrastructure and Camp

All modular units, generators, buildings and equipment will be cleaned and dismantled and shipped out. Any wood or combustible materials from the camp will be burned, and inert material will be shipped out or disposed in an inert material disposal site at the port.

1.9.7.4 Wharf

Typical design life of the OPEN CELL bulkhead is in the range of thirty to fifty years. The BIPR Project life is estimated at twenty years. Upon completion of the BIPR Project, two options are available regarding the port. In the first, the port operations and maintenance responsibilities can be turned over to another organization for use and maintenance, if they choose to accept it. The second option would be to decommission and abandon the wharf.

This abandonment would involve excavating material behind the sheet pile wall down to ordinary high water, and cutting the sheet piles off at the water level. Cut off sheet piles will be shipped out. Upon completion of cutting the sheet pile, the foreshore will be recontoured to resemble the existing coastline topography.

1.9.7.5 Airstrip and Roads

The airstrip and roads will be ripped to improve surface drainage. Culverts and bridges will be removed and natural drainage will be restored. Topsoil will be spread on the surface where it is available. The areas will be re-vegetated using native plant species.

1.10 All Weather Road

1.10.1 Introduction

The proposed all-weather road will start at the proposed Bathurst Inlet port, and proceed southwest to the south end of Contwoyto Lake, a distance of 217 km. In addition to providing a supply route to the potential users in the area, the road will provide the option to create a new supply route for operating supplies and fuel to the existing diamond mines in the Lac de Gras area in Northwest Territories.

The all-weather road will be developed in two phases, with the first phase extending 85 km southwards to a point near the proposed Hackett River mine. It will support the development and operation of both the proposed Hackett River Project and the proposed Back River Project. Subsequent development of the Phase 2 all-weather road through to Contwoyto Lake will be dependent upon confirmation of potential future users.

The proposed route for the all-weather road and the quarry locations is shown in Figure 1.10-1.

1.10.2 Alignment

The proposed all-weather road alignment was selected using terrain analysis (SNC-Lavalin 2007) based on topographic maps (1:250,000 and 1:50,000 National Topographic System sheets), aerial photographs (1:60,000 black and white and 1:15,000 coloured) and coloured digital ortho-mosaic maps with Global Positioning System ground control with follow-up fixed wing and helicopter surveys.

The road right of way shown on the design drawings was selected because:

- it accommodates present and potential mine and mineral development in western Nunavut;
- it avoids lakes, seasonal creek crossings, and steep slopes of high relief bedrock topography;
- it follows a route alignment over predominantly smooth terrain with long tangents, moderate grades and low degree curves;
- anticipated road fill would typically range from 1 to 2 m, except for major valley crossings (of which there are few) and rare high eskers; and
- from a terrain standpoint in regionally rocky permafrost terrain along the Arctic Circle, it is considered mostly good and fair, avoiding many costly road construction constraints.

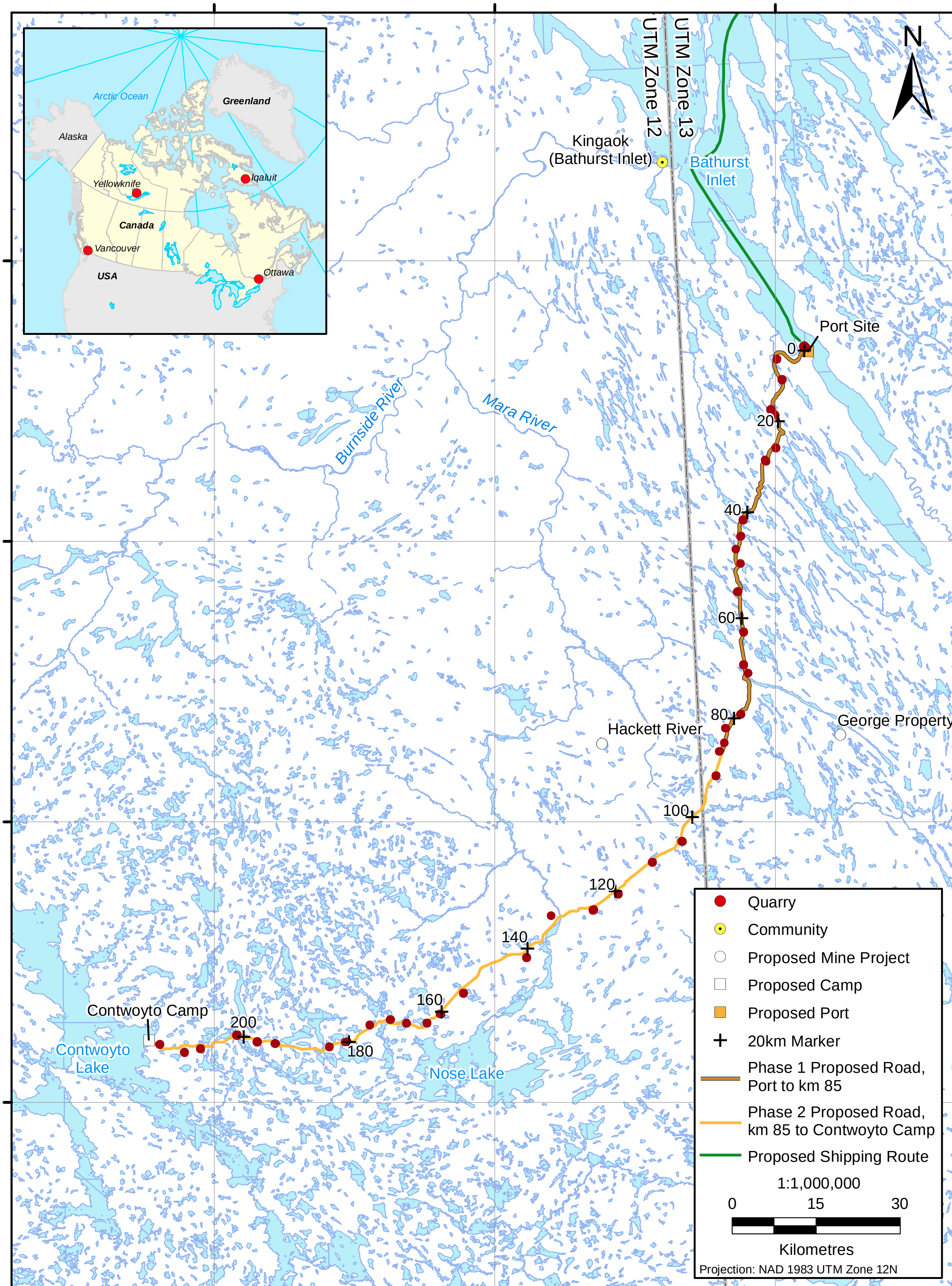
1.10.3 Design

The transport criteria selected for the roadway are based on an 8-axle B-train tractor/trailer design vehicle with a gross vehicle weight of 153 tonnes. The roadway will have a 10 m gravel running surface and no turnouts. Road design criteria are summarized in Table 1.10-1.

1.10.3.1 Physiography

The proposed road corridor and port site lie entirely within the SGP of the Precambrian Shield, a physiographic region generally characterized by low local relief typically less than 50 to 100 m, but rising from sea level to over 600 m over the entire region. Along the proposed route, the northern half of the all-weather road has the most topographic variability. For the first 20 km of the proposed route the terrain is interspersed with rocky ridges and broad plains and then climbs steadily to the south from sea level at the port site to over 200 m at Amagok Creek. In this area lake density is relatively low and drainage flows trend north and northwest.

For the next 20 km, the proposed route trends south as the land continues to rise to over 370 m in elevation. Numerous small linear-shaped lakes aligned with the southeast-northwest structural grain of the region cover the terrain. From 40 to 100 km the proposed route continues to run south and turns southwest. Terrain variability is less than in the first 40 km, lakes are similar in orientation, although fewer and generally larger and more varied in shape. The elevation varies from 360 to 470 m, being mostly around 390 to 400 m.



the Bathurst Inlet Port and Road Project

Figure 1.10-1

All-weather Road and Borrow Pit Locations

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Table 1.10-1. Road Design Criteria

Criterion	Value
Width	10.0 m
Design Speed – Loaded	60 km/h
Design Speed – Empty	80 km/h
Cross Fall	2%
Maximum Grade – Adverse	10%
Maximum Grade – Switchback	8%
Minimum Lateral Clearance	9.0 m
Minimum Vertical Clearance	5.5 m
Surface (-50 mm crushed rock)	150 mm
Base (-150 mm crushed rock)	300 mm
Sub-Base (-900 rock)	0.6 m to 1.6 m
Fills Side Slopes	1.5 horizontal: 1 vertical
Granular & Base Compaction	100%
Minimum Horizontal Radius	150 m
Minimum Stopping Distance	270 m
Minimum Crest Curve K Value	24
Minimum Sag Curve K Value	20
Bridges:	
Width	10.0 m
Design Load	153 tonnes

Source: 2007 SNC-Lavalin, as modified by PND

In the southern half (km 100 – 217) of the proposed road route, the topography is smoother with the elevation 400 to 510 m. The lowest elevation is located at the Mara River crossing and along drainages associated with the Mara River. The route continues in a southwest direction to about km 160, where it takes on a generally west direction towards Contwoyto Lake. From km 100 to 150, the terrain is dotted with small round lakes. Lake density, size and shape variability increases in the last 60 km to Contwoyto Lake.

1.10.3.2 Geology

1.10.3.2.1 Bedrock Geology

From Contwoyto Lake to the east for about 30 km, the route crosses Archean gneisses and migmatites, and from the Nose Lake area, across the Mara River drainage basin the route is underlain by Archaean granite and granodiorite. About midway between the port site and Contwoyto Lake, the route crosses metagraywacke-mudstone turbidites and intermediate to felsic metavolcanic rocks of the Yellowknife Supergroup. The remainder of the route and the port site are underlain by predominantly platform carbonates (i.e. limestone and dolomitic limestone) and deeper-water clastics (i.e. gritstone, mudstone, and shale) of the Great Slave Supergroup.

The bedrock type has a striking influence on the landscape, and ultimately habitat type, biodiversity and the location of culturally important sites due to the rocks' resistance to erosion and their structural grain. The presence/absence of glacial material and the thickness of ground moraine are likely due to erosion resistance. Where surficial material is minimal or lacking, frost-ravelled bedrock fields are common and drainage is poorly developed and controlled by structure. In these areas, vegetation is scarce and habitat diversity and density are low. For example, east of the Mara River between kilometre posts 80 and 100, the frost-ravelled bedrock is exposed over much of the terrain, which is sparely covered by an angular bouldery ground moraine. Lake and vegetation density is moderately low, and poorly defined drainages are evident, providing little habitat value.

In contrast, in the areas east of Nose Lake (near km 150), esker and kame deposits are more prevalent, ground moraine is thicker and more extensive, and alluvium is interspersed with ground moraine and bedrock exposures. Overall, patterned ground is better developed, and there is a higher landscape and habitat diversity.

Geological mapping and an assessment of acid rock drainage and metal leaching (ARD/ML) potential of the proposed road alignment was conducted in 2003. This assessment concluded that some areas of proposed rock cuts and quarry sites may be hosted by lithologies with a potential to generate ARD/ML. Proposed rock cuts and quarries will be further screened to allow road constructors to avoid or mitigate potential ARD/ML concerns.

1.10.3.2.2 Surficial Geology

Low relief ground moraine of sandy till, deposited during the Wisconsin glaciation, covers much of the proposed road alignment. The Wisconsinan ice sheet retreated from the study area as recently as 9,500 to 9,000 years ago (Dyke and Prest 1987). Generally, till cover is discontinuous and thin (< 2 m), although greater accumulations occur in pre- glacial valleys, in valleys where major Laurentide ice streams were receding and stagnating, along the base of major scarps, and along erosion-resistant dykes and outcrops. Glaciofluvial deposits (e.g. eskers and kames) are common, but widely dispersed. Geowest (1998) identified seven areas of drumlins, flutings, and crag and tail terrain, and eleven discontinuous esker chains along or within 10 km of the route. Significant volumes of glacially influenced deposits occur along the route in the vicinity of the port site and in the Amagok River Valley (i.e. between km 17 and 22).

Thin glaciolacustrine deposits occur throughout the study area, a result of glacial and post-glacial lakes and ice-dammed ponds. Beach deposits left by regressing seas and glacially influenced deposits are abundant in the vicinity of the proposed port site and over the first 4 km of the proposed road. In particular, fine-grained raised beach deposits occupy most of the valley along km 2 to 4 of the proposed road, and over an extensive area to the south of the port site.

Widespread permafrost combined with low topographic relief promotes the accumulation of organic material. Consequently, bogs and fens occur extensively along the route. This is particularly evident within the western half of the proposed alignment, where local relief is low and subdued, the soil mantle is relatively thick, cryogenic features such as patterned ground and gelifluction are well developed on slopes, and bogs and marshes are common in low-lying areas.

In general, terrain types are distinguished by thickness of ground moraine, structural grain, drainage/lake density, drainage pattern, relief, proportion of bedrock exposure, extent and type of patterned ground development, and the presence of taliks.

1.10.3.3 Permafrost

The depth to which permafrost extends along the proposed road alignment is about 500-525 m. The depth of active layer is predominantly governed by the thickness of the organic layer and water/ice content of the underlying material. The active layer can vary from as low as 0.5 m with thick organic layer to 4 m in ‘dry’ rock (SNC-Lavalin 2007).

Permafrost conditions are highly variable along the proposed right of way, ranging from dry, ice-free rock and coarse-grained sediments to ice-rich, thaw-sensitive fine-grained sediments.

1.10.3.4 Embankment Design

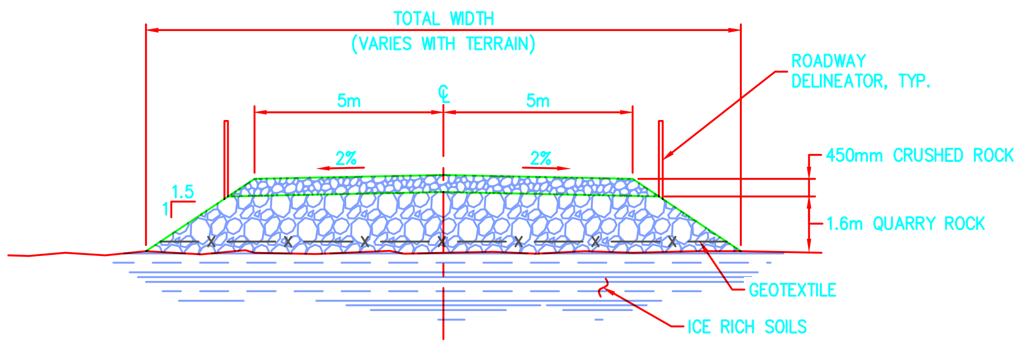
The road will cross variable soil and bedrock terrain covered with organics. The governing factors in designing the embankment road fill are:

- Providing a stable temporary road that can accommodate construction traffic without rutting.
- Designing the road section to accommodate the existing active layer and some thaw consolidation of road sections in relatively ice-free soil.
- Design the road section to maintain the active layer and prevent thaw consolidation of road sections in ice-rich soils.
- Design the road to account for structural stability for heavy truck transport under estimated traffic frequency.
- Minimize potential for roll overs for soft shoulders when vehicles are passing.

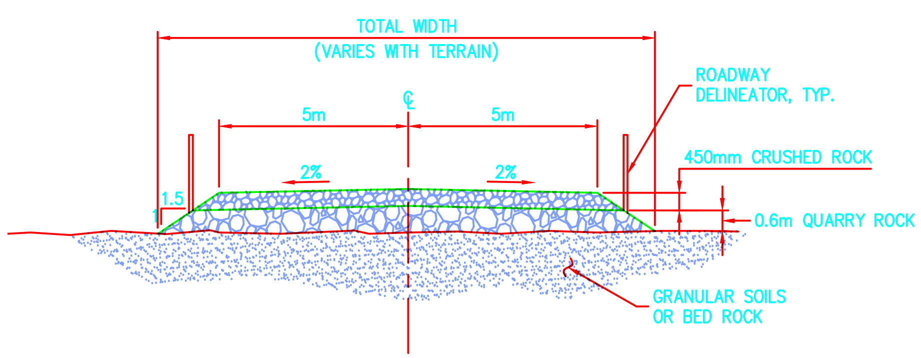
Two road embankment cross-sections have been developed: one for construction over ice-rich soils subject to compaction during thaw cycles (minimum 2 m thickness), and one for construction over bedrock or well-drained granular materials such as eskers (minimum 1 m thickness). These cross-sections are shown in Figure 1.10-2.

The road surface width will be 10 m to allow for two-way traffic with the anticipated vehicle widths. The total toe-to-toe width will vary (18 m to 22 m) with soil type and the terrain. Average total width values are shown in Figure 1.10-2.

The road design section traversing across fine grained ice-rich soils are subject to some subsidence. To minimize subsidence, the road will have a minimum fill section of 2 m to thermally isolate the underlying permafrost. General fill to construct the road section will be comprised of 1.6 m quarry rock and may require a high-strength woven geotextile depending on total fill height requirements. Additional analysis to assess soil gradation, moisture content, ice content, salinity, tundra insulating and separation characteristics among other factors will be needed to assess fill height versus use of geotextile. Additional thermal analysis and load carrying studies will be performed to assess the structural section and ability to minimize thaw consolidation where required.



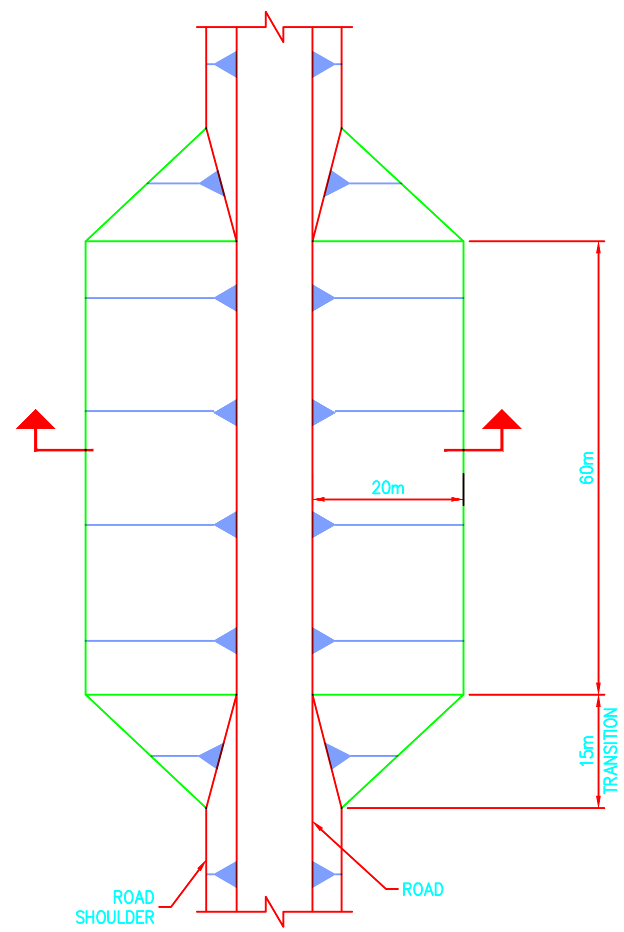
TYPICAL TWO-WAY ROAD SECTION ICE RICH SOILS



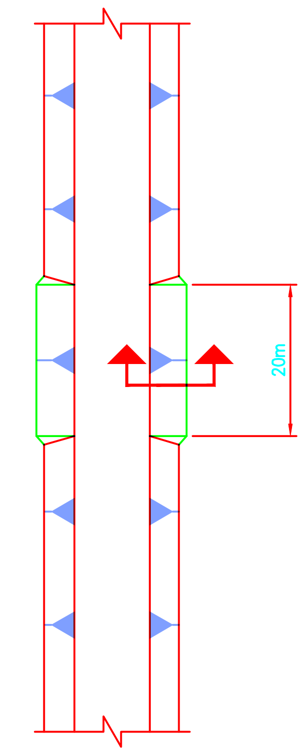
TYPICAL TWO-WAY ROAD SECTION GRANULAR SOILS OR BEDROCK

TOTAL WIDTH		
TERRAIN	ICE-RICH	GRANULAR/ BEDROCK
LEVEL/SMOOTH	16.0m	13.0m
CHOPPY/LUMPY	17.6m	14.3m
TERRACED/STEEP	20.8m	16.9m
ANOMALOUSLY STEEP/DIFFICULT	24.0m	19.5m

NOTE:
LOCATIONS OF CARIBOU CROSSING-LARGE TO BE DETERMINED BASED ON ADDITIONAL FIELD STUDY FINDINGS, 15 TOTAL.

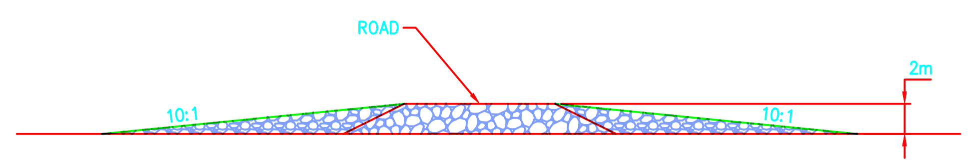


CARIBOU CROSSING LARGE-PLAN

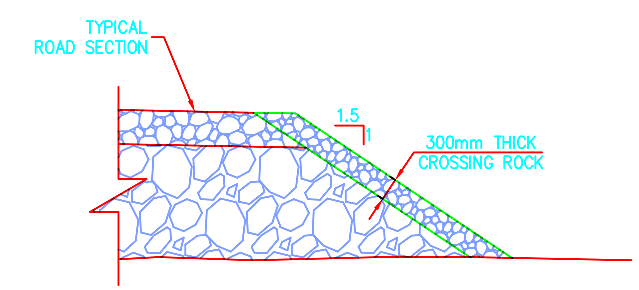


NOTE:
PROVIDE SMALL CROSSING EVERY 500m ON CENTER.

CARIBOU CROSSING SMALL-PLAN



CARIBOU CROSSING LARGE-SECTION



CARIBOU CROSSING SMALL-SECTION

CROSSING ROCK SHALL BE WELL GRADED, ANGULAR AND CONSIST OF THE FOLLOWING GRADATION:

SIZE	% PASSING
200mm	100
100mm	40-60
50mm	10-20

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Figure 1.10-2

Typical All-weather Road Sections

Factors such as ice content, salinity, soil gradation, thermal characteristics of compressed tundra, climatic factors and other factors will need to be considered as part of the detailed design. Often times it is desirable to cause the top of the permafrost to rise into the non-frost susceptible road section. Experience with other projects has demonstrated that a properly installed geotextile may add strength to the road section, protect the underlying tundra mat and reduce road failures. The geotextile may be omitted pending further permafrost field studies and a detailed trade off study evaluating the costs of geotextile vs. the cost of additional rock.

Settlement occurs in the road fill section during the summer thaw if it was placed the year previous under winter snow and ice conditions. It is very difficult to achieve any compaction in winter-placed fill so if constructed in the winter any additional 5 to 10% of extra fill section will be placed to make up for this allowance. Consolidation and settlement in bridge approaches may also occur and cause a break in grade because the adjacent bridge foundations have very little tolerance for settlement. These areas will require repairs after one to two years.

The road sections on granular soils are not subject to settling of the underlying soils when thawed. Road thickness can be reduced to 1 m total and design will be based on the bearing capacity of the granular soils. However this is partially dependent on groundwater conditions, percent silt content and the potential for “pumping” during construction.

1.10.4 Stream Crossings

The all-weather road will cross 105 drainages of which 62 are rivers and streams that will require bridges ranging in length from 20 to 150 m, and 43 will require the installation of culverts. Bridges are listed in Table 1.10-2. Figure 1.10-3 includes a listing of culverts.

1.10.4.1 Stream Hydrology

The BIPR Project is located in the continental Canadian Arctic, a region comprised of vegetated tundra slopes, scattered wetlands and lakes. Long, severe winters and short summers, in which temperatures will rise above freezing, result in short annual periods of surface water activity. This surface water flow is rapid, and generally begins with spring break-up events in late May or early June. Peak annual stream flows have been observed occurring in early to mid-June. The major contributor to these annual peak flows is the volume of accumulated snow during the winter season. Typically, stream flow will decrease during the summer season, reaching a seasonal low in August. Larger streams are generally sustained through the brief summer season by melting ice, snow pack, rainfall events, and lake and wetland discharge. During drier years, the stream flow may cease in the smaller drainages. Surface water runoff from rain events occurs during autumn months, generally in early October, prior to annual freeze-up. Detailed descriptions for BIPR Project hydrology are provided in the Surface Water Hydrology Baseline Study, 2010 and 2012 (Rescan 2012).

The proposed all-weather road alignment crosses 105 rivers and creeks including 58 fish bearing crossings. Approximately sixty-seven percent of the streams provide drainage for small watersheds with drainage areas less than 10 km^2. Three of the largest stream crossings have upstream drainage basins exceeding 100 km^2. Of the 104 streams, sixty-two will require the installation of bridges. Culvert batteries will be installed at smaller non-fish bearing streams and drainage crossings.

Table 1.10-2. Bridge Listing

No.	Road Marker	Bridge Length (m)	No. of Spans	Clear Span (m)	Notes
1	2.2	40	2	35	
2	2.8	12	1	6	
3	7.8	12	1	6	
4	14.1	12	1	6	
5	22.9	100	5	94	Amagok Creek
6	33.4	60	3	54	
7	33.8	20	1	14	
8	34.8	20	1	14	
9	35.9	60	3	54	
10	39.0	40	2	34	
11	42.3	40	2	34	
12	43.3	60	3	54	
13	44.5	80	4	74	
14	49.7	60	3	54	
15	52.0	40	2	34	
16	58.7	40	2	34	
17	68.6	12	1	6	
18	69.4A	12	1	6	
19	69.4B	12	1	6	
20	70.1	12	1	6	
21	70.15	12	1	6	
22	72.2	12	1	6	
23	74.1	12	1	6	
24	76.0	20	1	14	
2	84.2	20	1	14	
26	85.0	12	1	6	
27	97.2	160	8	154	
28	103.3	12	1	6	
29	106.7	20	1	14	
30	113.8	12	1	6	
31	115.2	40	2	34	
32	117.4	20	1	14	
33	123.8	12	1	6	
34	128.8	120	6	114	Mara River
35	134.6	40	2	34	
36	151.6A	20	1	14	

(continued)

Table 1.10-2. Bridge Listing (completed)

No.	Road Marker	Bridge Length (m)	No. of Spans	Clear Span (m)	Notes
37	151.6B	40	2	34	
38	159.7	100	5	94	
39	160.7	60	3	54	
40	167.6	12	1	6	
41	168.0	12	1	6	
42	168.3	80	4	74	
43	169.1	12	1	6	
44	169.4	40	2	34	
45	169.6	12	1	6	
46	170.8	40	2	34	
47	173.1A	20	1	14	
48	173.1B	20	1	14	
49	177.2	60	3	54	
50	181.4	80	4	74	
51	182.8	12	1	6	
52	183.6	12	1	6	
53	186.5	20	1	14	
54	189.6	12	1	6	
55	192.4	12	1	6	
56	196.7	12	1	6	
57	197.4	12	1	6	
58	201.9	20	1	14	
59	202.8	40	2	34	
60	204.3	40	2	34	
61	206.9	20	1	14	
62	208.2	12	1	6	

Steam measurements were performed by Rescan in 2001, 2007, and 2010 including expected bankfull wetted widths, typically measured at the visible high water mark. These measured stream widths, herein referred to as “bankfull width”, have been assumed as a conservative basis for preliminary bridge design.

Peak flood frequency analysis has been conducted using return period regression equations developed for the BIPR Project by utilizing data presented in the 2010 and 2012 BIPR surface water hydrology baseline (Rescan 2012). Additional hydrographic surveys will be completed prior to final bridge design.

Single span bridge sections of 12 m or 20 m will be installed across the smaller streams and drainages. The design 12 m bridge sections will be used to span drainages with bankfull widths 4 m or less and 20 m bridge sections will be used to span streams with bankfull widths of 5 m to 12 m. A preliminary hydraulic analysis has been performed to determine the maximum hydraulic capacity for a typical proposed bridge section assuming a maximum allowable depth of 1 m with a minimum 1.3 m freeboard. A summary of the maximum hydraulic capacity for a typical 12 m and 20 m bridge sections is presented in Table 1.10-3. The 12 m and 20 m single span bridge sections will have adequate capacity to convey the range of 100-year peak flood events present in these smaller drainage basins.

Table 1.10-3. Maximum Hydraulic Capacity for Typical Single Span Bridges

Bridge Span (m)	Maximum Clear Span (m)	Maximum Bankfull Width (m)	Minimum Vertical Clearance (m)	Depth (m)	Hydraulic Capacity (m^3/sec)
12	6	4	1.3	1.0	5.7 to 9.1
20	14	12	1.3	1.0	11.2 to 23.7

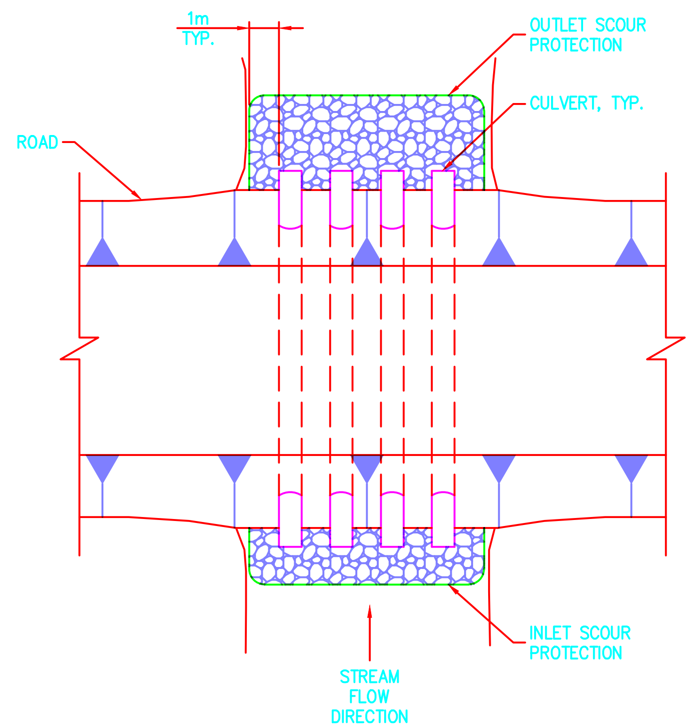
Design of the larger bridges is anticipated to be governed by the existing bankfull width rather than design hydraulic capacity. Multi-span bridges will utilize in-water piers to 20 m bridge sections. Detailed hydraulic analysis will be required during detailed design phases to verify the minimum span length and maximum hydraulic capacities for larger streams and rivers. A summary of maximum bankfull widths and effective clear spans for the various preliminary multi-span bridge sections is provided in Table 1.10-4.

Table 1.10-4. Multi-span (40 m to 160 m) Bridge Summary

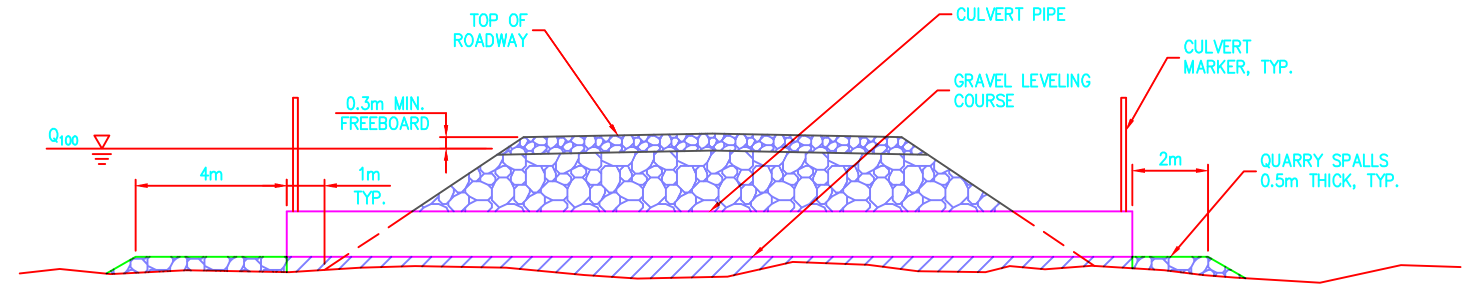
Bridge Span (m)	Maximum Clear Span (m)	Maximum Bankfull Width (m)
40	34	32
60	54	52
80	74	72
100	94	92
120	114	112
160	154	152

Preliminary performance criteria for culvert installations will be designed to convey the 50-year peak flood event with a maximum headwater/diameter (HW/D) ratio of 1.5; and will convey the 100-year peak flood event without overtopping the road with a minimum of 0.3 m freeboard.

Preliminary hydraulic analysis assuming a nominal culvert diameter of 1.2 m has been performed to estimate the maximum hydraulic capacity for culvert batteries with one to four pipes. A summary of typical culvert batteries hydraulic capacity providing a minimum 0.3 meter freeboard is presented in Table 1.10-5. The location and individual culvert battery capacity required will be determined during final design.

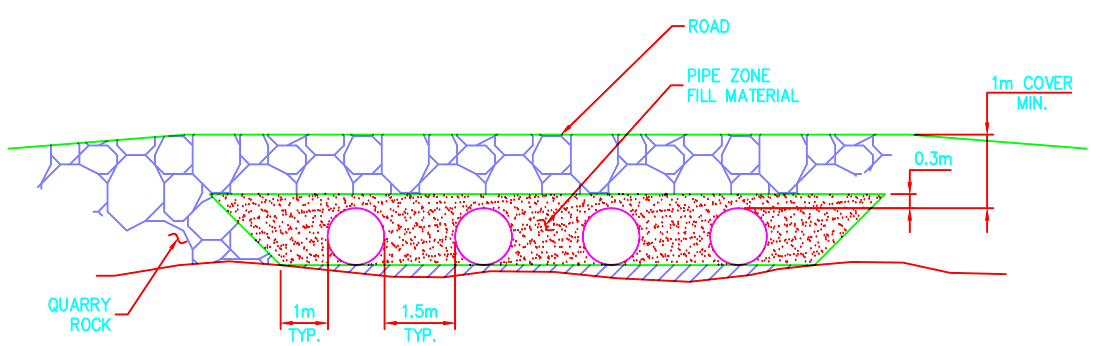


TYPICAL CULVERT PLAN



TYPICAL CULVERT PROFILE

QUARRY SPALLS	
SIZE	% PASSING
200mm	100
75mm	40 MAX
20mm	10 MAX



TYPICAL CULVERT SECTION

CULVERT LIST

Road Marker	Stream Width (m)	Crossing Structure Type
18.3	n/a	Pipe Battery
25.7	n/a	Pipe Battery
27.4	n/a	Pipe Battery
30.4	n/a	Pipe Battery
38.1	n/a	Pipe Battery
40.6	n/a	Pipe Battery
47.5	n/a	Pipe Battery
54.3	n/a	Pipe Battery
56.9	n/a	Pipe Battery
62.3	n/a	Pipe Battery
63.5	95	Pipe Battery
66.5	n/a	Pipe Battery
67.9	n/a	Pipe Battery
68.3	n/a	Pipe Battery
68.4	n/a	Pipe Battery
74.9	n/a	Pipe Battery
77.0	1.2	Pipe Battery
78.9	9	Pipe Battery
80.4	n/a	Pipe Battery
83.7	21	Pipe Battery
90.3	n/a	Pipe Battery
91.1	n/a	Pipe Battery
91.4	n/a	Pipe Battery
92.3	39	Pipe Battery
94.1	6,4	Pipe Battery
98.8	n/a	Pipe Battery

CULVERT LIST (Cont.)

Road Marker	Stream Width (m)	Crossing Structure Type
100.3	3	Pipe Battery
113.2	3	Pipe Battery
119.4	36	Pipe Battery
123.3	n/a	Pipe Battery
125.3	60	Pipe Battery
136.6	n/a	Pipe Battery
144.6	17	Pipe Battery
146.6	n/a	Pipe Battery
147.5	n/a	Pipe Battery
149.7	n/a	Pipe Battery
155.7	n/a	Pipe Battery
158.2	n/a	Pipe Battery
193.8	n/a	Pipe Battery
197	n/a	Pipe Battery
198.2	n/a	Pipe Battery
211	11	Pipe Battery

Table Notes:

1. Stream widths determined from SNC 2011 Engineering Report
2. n/a for stream width denotes no visible stream channel
3. Culvert batteries will consist of one to four culverts based on individual location hydrology
4. km Posts are based on the SNC 2011 report. Culverts are intended to replace all stream fords and non−fish bearing streams as identified in the SNC 2011 report.

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Figure 1.10-**3**

Typical Culvert Details and Culvert Listing

Table 1.10-5. Culvert Battery Hydraulic Capacity Summary

Number of Culverts	m^3/sec
1	3.5
2	7.1
3	10.7
4	14.3

1.10.4.2 Freeboard

Factors that are considered to establish the minimum freeboard distance applied to design high water are summarized in Table 1.10-6. The minimum recommended freeboard to the bottom chord of a bridge is no less than 1.3 m and is based on the limited site specific data as well as the possibility of some minor ice damming near the structures. Battered ice breaking piers will be used where ice damming is anticipated. Winter and spring break up studies that will be conducted prior to final design may provide a justification to raise the freeboard to include additional ice damming effects.

Table 1.10-6. Factors Considered to Establish Minimum Freeboard Distance

Factor	Issue	Comment
Peak flow	Structure needs to be designed to pass peak flow	Freeboard for culvert crossings will be a minimum of 0.3 m from the design high water to the road shoulder.
Transport Canada navigation requirements	Is the structure required to pass small craft such as canoe and/or kayaks?	Transport Canada requires a minimum freeboard of 1.7 m for designated navigable waters under the *Navigable Waters Protection Act* (NWPA 1985) however; this provision may not be required because of changes under the *Navigation Protection Act* (NPA 2012).
Accumulation of ice debris in channel	Does the structure encroach in the normal channel and cause blockage and accumulation of ice or debris?	Bridge will be set back a minimum of 1 m from normal bankfull conditions. Larger bridges with multiple spans and piers located inside of normal bankfull conditions will cause minimum accumulation of ice because the piers will be small diameter piles (<800 mm) and piers will be spaced to adequately pass the anticipated ice volumes. Upstream piles will also be equipped with a batter if significant ice flows are anticipated.
Winter conditions	Are there baseline data at the crossing sites regarding snow accumulation and thickness of ice build-up?	No data are currently available. Winter bridge crossing condition assessment field work will be conducted prior to final design to develop a basic understanding of winter conditions and freeboard may be further adjusted depending on findings.
Spring breakup characteristics	Does spring breakup result in a large amount of ice debris?	Break up studies will be performed on the major crossings before final design. Since most of these stream basins are relatively minor, with small channels and ponds at the time of freeze up, it is not anticipated there will be major ice flows at breakup as experienced in some arctic rivers.

(continued)

Table 1.10-6. Factors Considered to Establish Minimum Freeboard Distance (completed)

Factor	Issue	Comment
Road way approach	Does freeboard require an excessive amount of fill to construct the road way approach?	A higher freeboard results in a higher grade line and more fill to construct the road way approach. The amount of freeboard proposed does not require an excessive amount of fill to construct. Allowing overtopping of the road would allow the loss of material downstream during flood events, creating a much larger impacted area over time.

Freeboard for culvert crossings will be a minimum of 0.3 m from the design high water to the road shoulder. Any overtopping of the road surface is expected to require repairs prior to resuming trucking. The culvert crossings will have minimal exposure to significant ice floes and ice accumulation because their locations are within smaller seasonal drainages.

1.10.4.2.1 Navigable Waters

Transport Canada requirements under the *Navigable Waters Protection Act* necessitate additional freeboard for crossings over streams that may have boating traffic, including traffic by canoes and kayaks. The minimum freeboard requirements are 1.7 m for crossings over navigable water. Legislation pertaining to navigable waters is currently in transition from the *Navigable Waters Protection Ac*t (NWPA; 1985) to the *Navigation Protection Act* (NPA; 2012). The NWPA previously applied to all waterways in Canada, whereas the NPA will focus on a specific subset of waterbodies listed in Schedule 2 of the Act. The following potential navigable water crossings were identified under the previous act where freeboard will be designed to comply with the Act:

- 2.2 Km - Un-named Creek;
- 22.9 Km - Amagok Creek;
- 128.8 Km - Mara River; and
- 181.4 Km - Un-named Creek.

However, it may be that all streams along BIPR may not be subject to the new NPA legislation as none are listed on Schedule 2 of the new Act.

1.10.4.3 Bridges

1.10.4.3.1 Bridge Design

The currently estimated lengths of the individual bridge crossings are based on the bank width dimensions determined by field reconnaissance (SNC-Lavalin 2011). The total bridge crossing length for each site was determined by adding the fill slope limits to the 1 m set back from top of bank and total bankfull width. Bridge designs have been standardized in two sizes, 12 m and 20 m long. Where longer spans are required, multi-span bridges with in-stream piers will be used. Based on the 2011 field reconnaissance, 62 bridges will be required over the 217 km length of all-weather road.

Bridges will be designed to convey the 100 year peak flood event with a minimum of 1.3 m of freeboard. Piers will be designed for the 500 year peak flood scour. Abutments will be constructed outside the bankfull width with design clear span lengths to be a minimum of bankfull width plus one metre on each side. Spill through abutments will be used.

The bridges will utilize modular components to minimize in-field construction efforts and are designed to support Super B-Train heavy haul trucks. General bridge details and dimensions are provided in Figures 1.10-4 to 1.10-7.

A brief description of the various bridge components is provided below:

- **Deck –** The deck will be constructed using precast concrete deck panels grouted to the steel girders in the field. Deck panel design will be standardized and panels will be interchangeable among any of the bridges to reduce construction time in the field.
- **Girders –** The bridge girders will be constructed utilizing structural plate steel that will be fabricated off-site. For single-span bridges, the girder can be installed in the summer or winter from the roadway. Multi-span bridge girders will likely be installed from the ice during winter. Plate 1.10-1 shows installation of a box girder from grounded river ice. All girders will be at least 1.3 m above 100-year flood level to allow floating ice to pass without damaging bridge structures.
- **Abutments –** Abutments will vary depending on the depth of bedrock at each site. For shallow bedrock, 3 m to 4 m below the ground surface, an excavated hole with a concrete footing on bedrock with drilled anchor rods will be used to support steel piles, fit to length in the field. For deeper bedrock, piles will be placed in drilled shafts in the permafrost, which will be fixed in place with grout or frozen slurry. It is estimated that pile depths must be 8 m minimum to prevent frost jacking. Details of these designs are shown in Figure 1.10-5. For abutments with between 4 m and 8 m of soils over bedrock, deeper excavations will be designed for concrete footings, or rock anchor piles similar to those used for in-stream piers can be used. Abutments will be placed outside the wetted stream area.
- **In-Water Piers –** All crossings with more than one span will require an intermediate support (Figure 1.10-6). The support will consist of three 760 mm diameter steel piles and a steel or precast concrete cap. As an option, an inclined support may be added to the upstream pier where ice impact is anticipated (Plate 1.10-2). The inclined pier nose will force ice floes to fail in bending and reduce the load demand on the foundations. Typically, piles will be supported on bedrock by socketing the piles into the rock and anchoring using drilled and grouted rock anchors. In deeper bedrock applications, the piles will be installed in over-sized, drilled holes, and backfilled with a sand-slurry mixture.
- **Bridge Rails –** The crossings will utilize removable bridge rails to facilitate the movement of wide mine modules (Figure 1.10-7). The rails will be fabricated in segments and installed in rail pockets attached to the bridge deck. The pockets will be attached to the deck using cast-in-place embeds to allow attachment without requiring in-field welding separate from bridge rails. The construction methods described above have been extensively utilized the Arctic. These methods are proven and reliable. In addition, they minimize in-field construction time by utilizing modular components to the greatest extent practical.

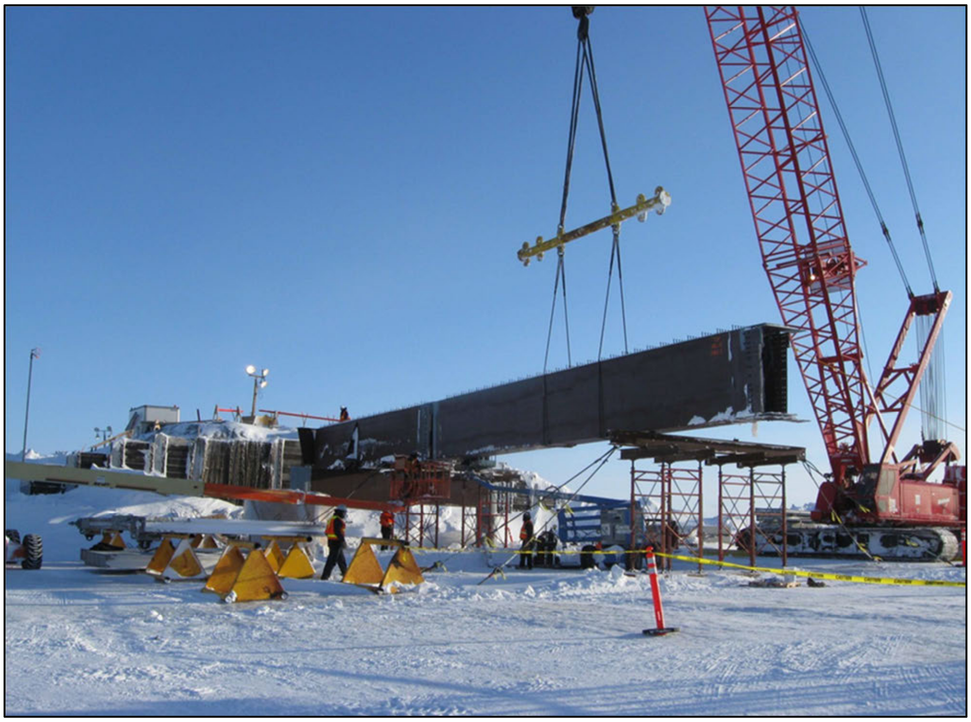
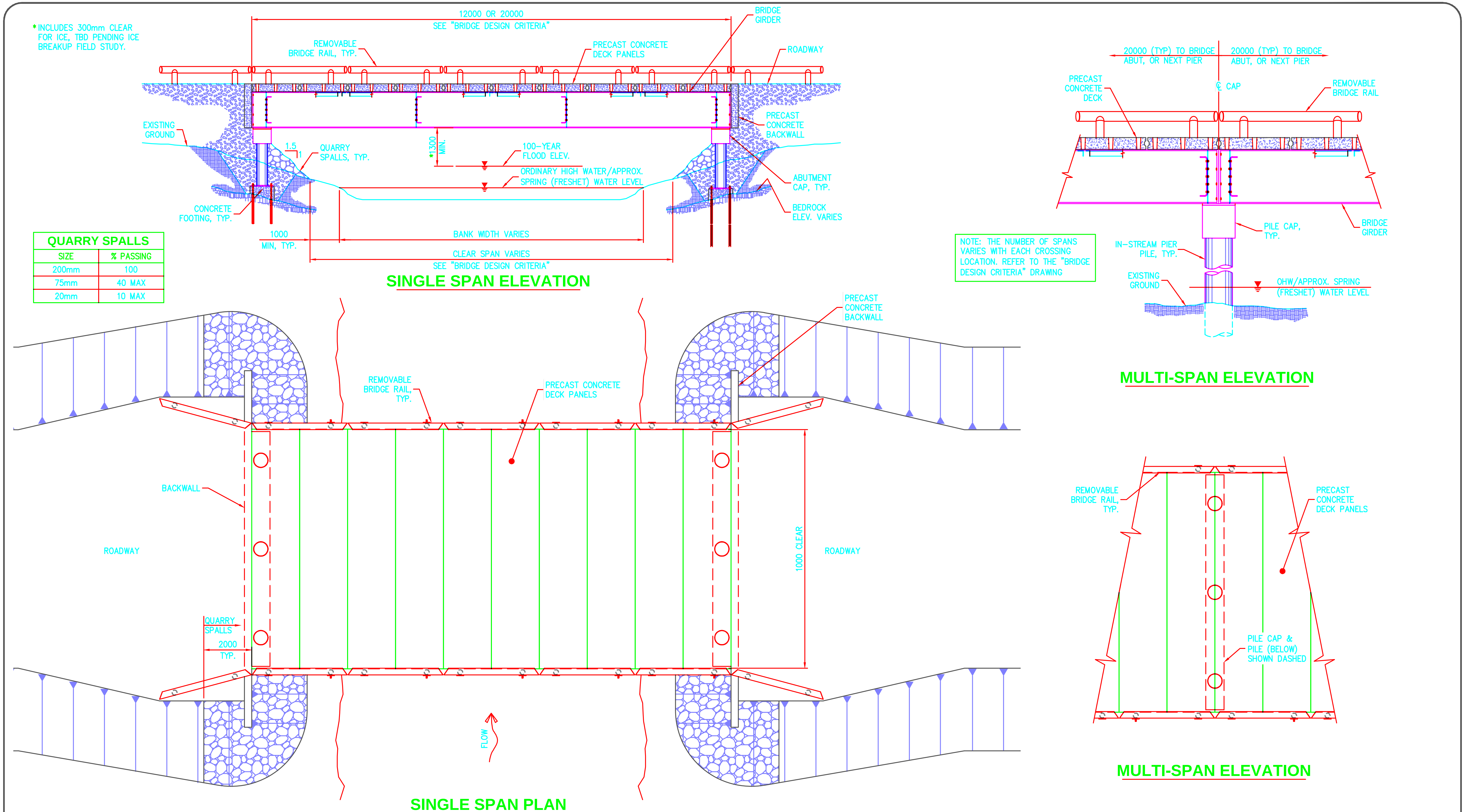


Plate 1.10-1. Box girder installation from grounded river ice, Tanna River, Alaska.

Plate 1.10-2. In-water piers, Kuparuk River, Alaska.



QUARRY SPALLS

SIZE	% PASSING
200mm	100
75mm	40 MAX
20mm	10 MAX

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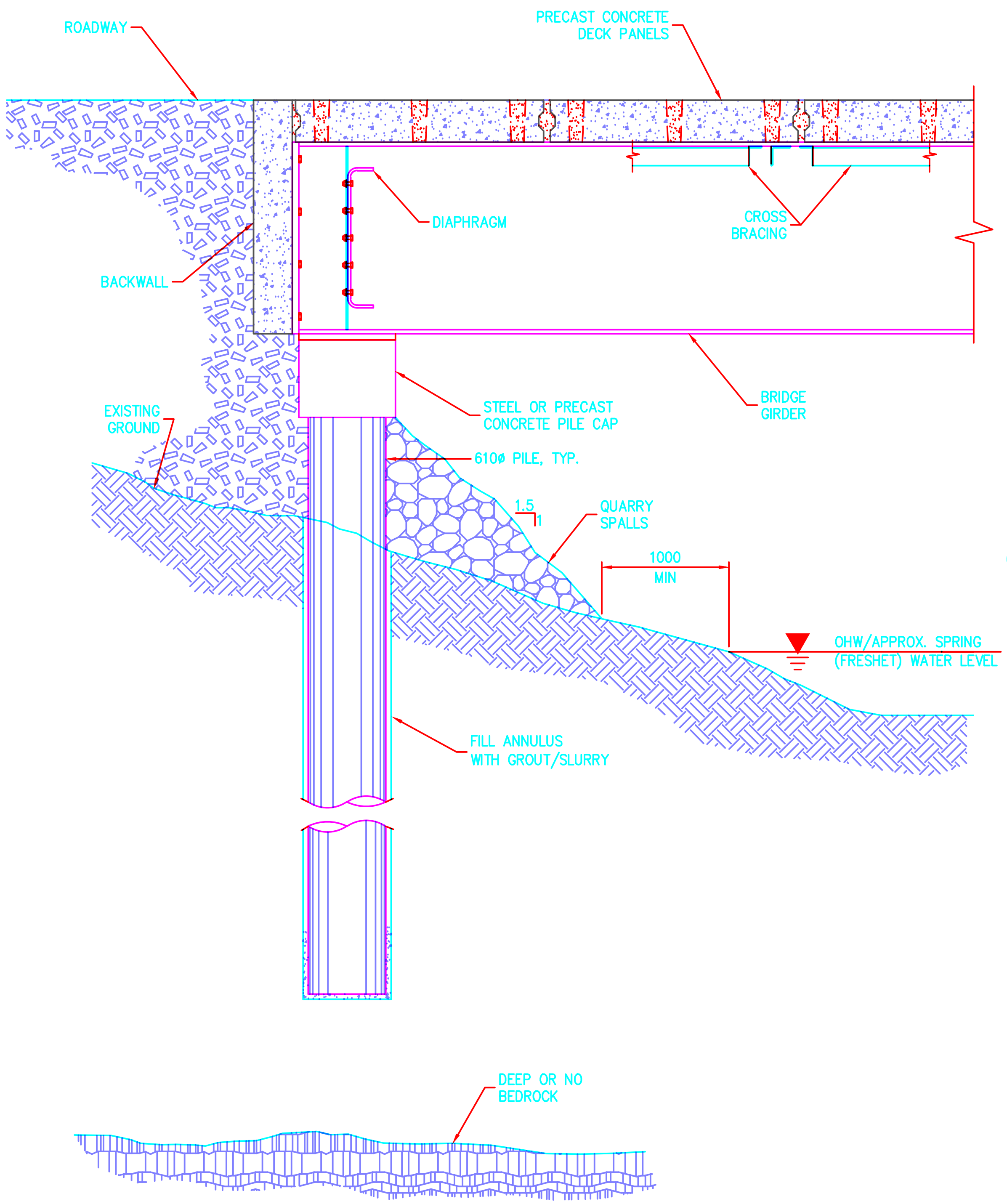
Figure 1.10-4

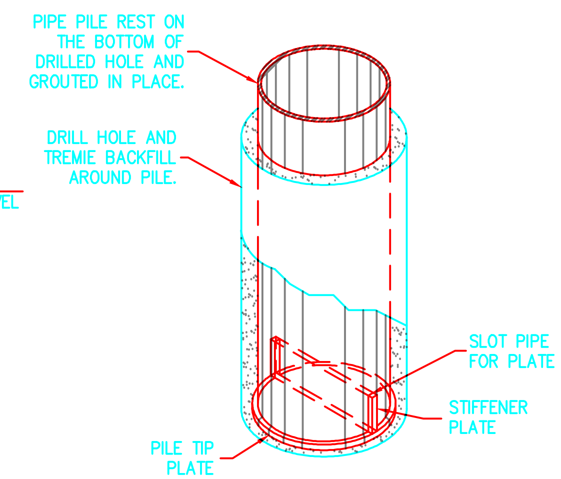
Typical Bridge Layout



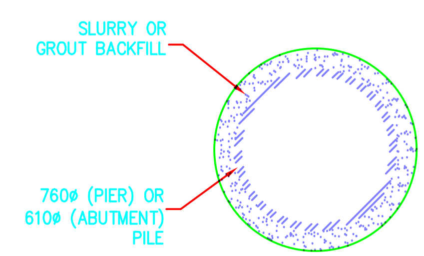
TYPICAL SECTION
DEEP BEDROCK ABUTMENT

NOTE: REMOVABLE BRIDGE RAILING NOT SHOWN

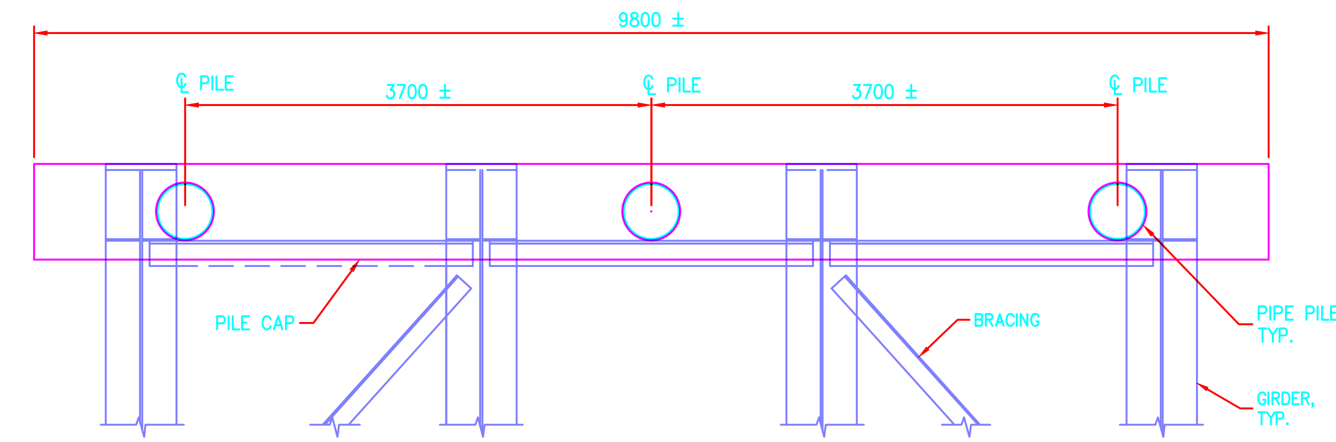
QUARRY SPALLS	
SIZE	% PASSING
200mm	100
75mm	40 MAX
20mm	10 MAX



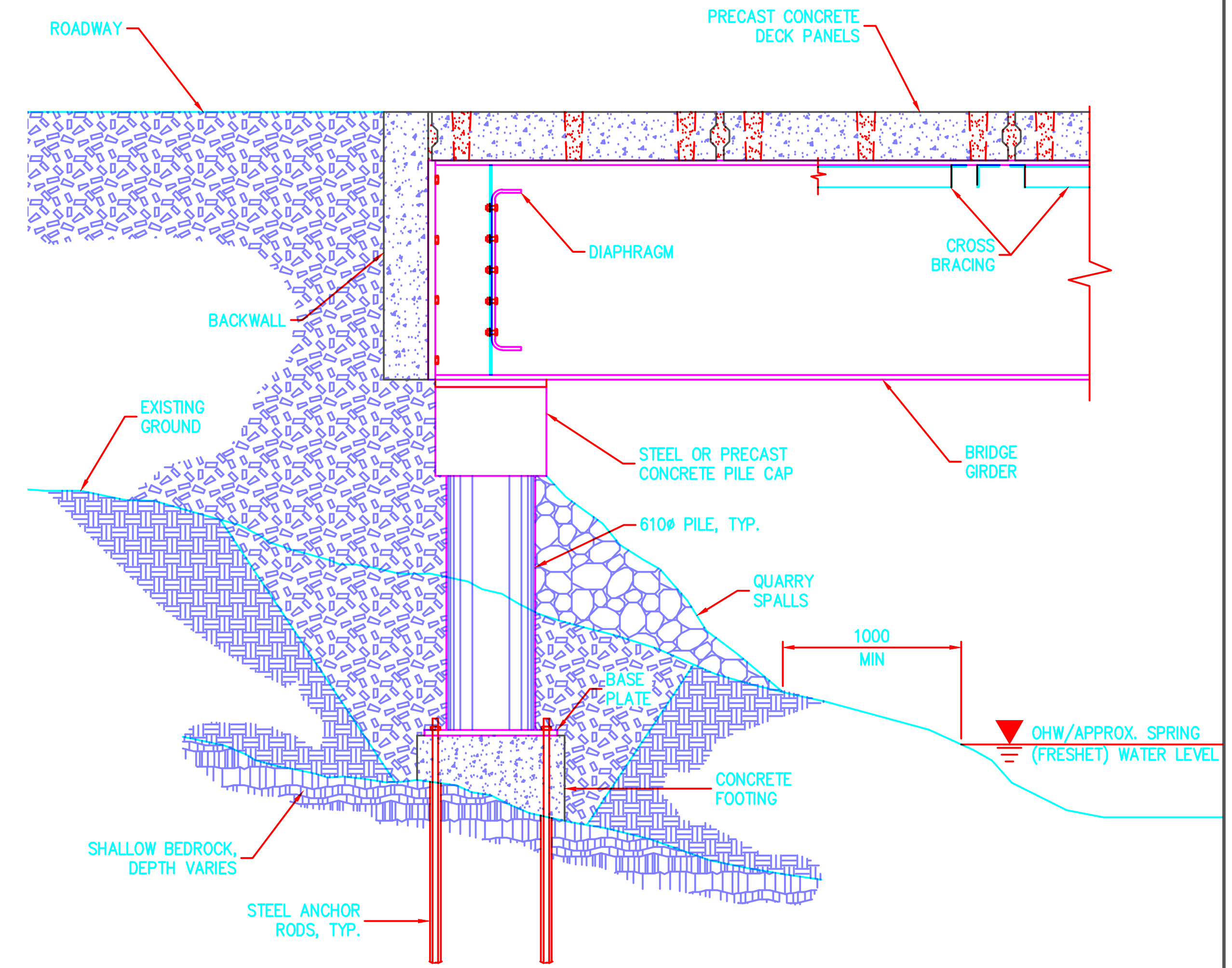
DRILL & SLURRY DETAIL



DRILL & SLURRY GROUT
TYPICAL SECTION

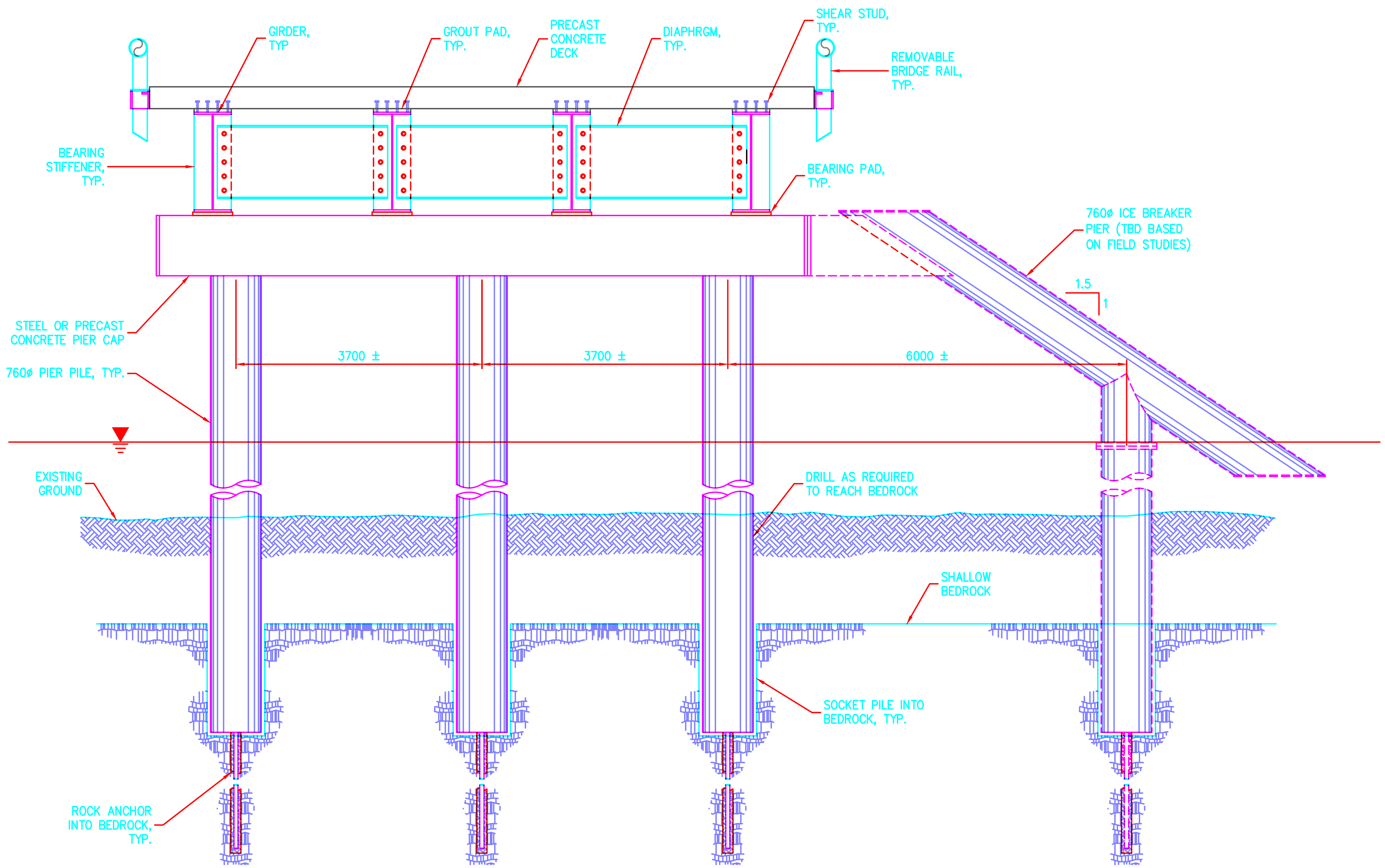


PLAN



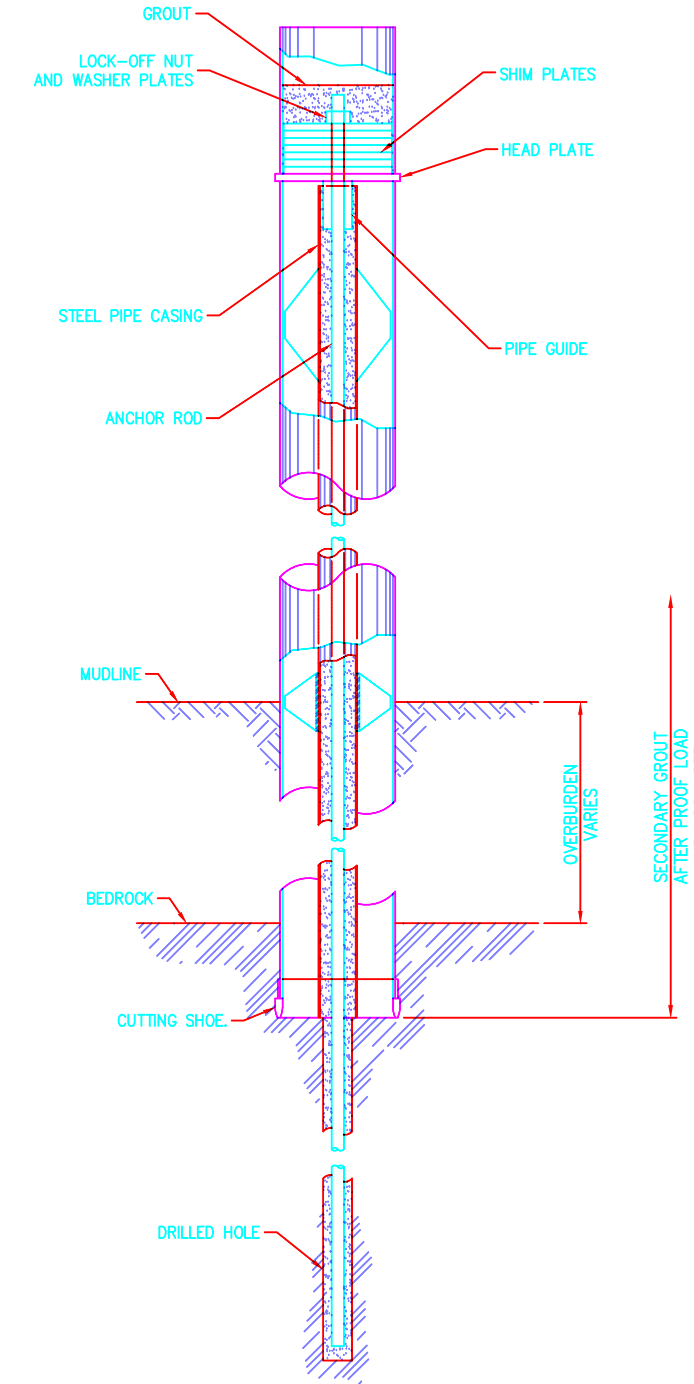
TYPICAL SECTION
SHALLOW BEDROCK ABUTMENT

NOTE: REMOVABLE BRIDGE RAILING NOT SHOWN



TYPICAL IN-STREAM PIER

NOTE:
WHERE BEDROCK IS DEEP, PILES WILL BE INSTALLED USING THE DRILL & SLURRY METHOD. SEE FIGURE 1.10-13 FOR DETAILS



ROCK ANCHOR DETAIL

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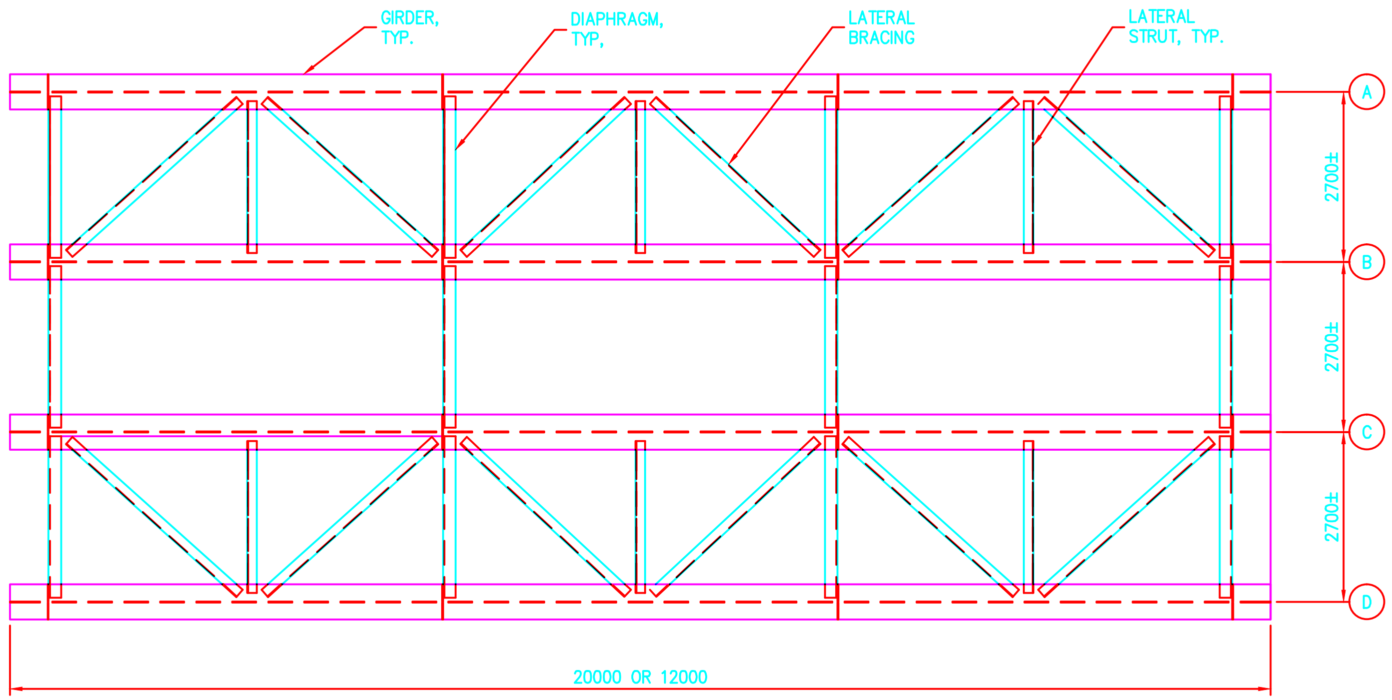
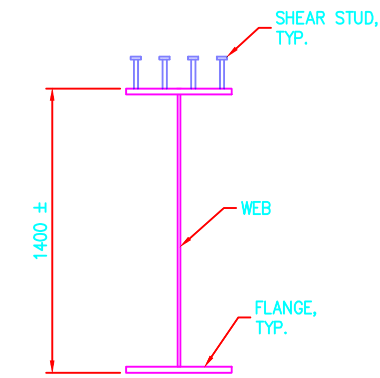
Figure 1.10-6

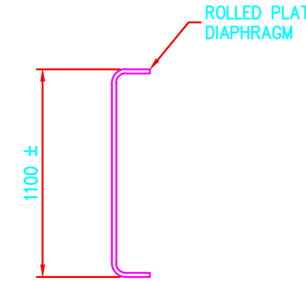
Typical Pier Details



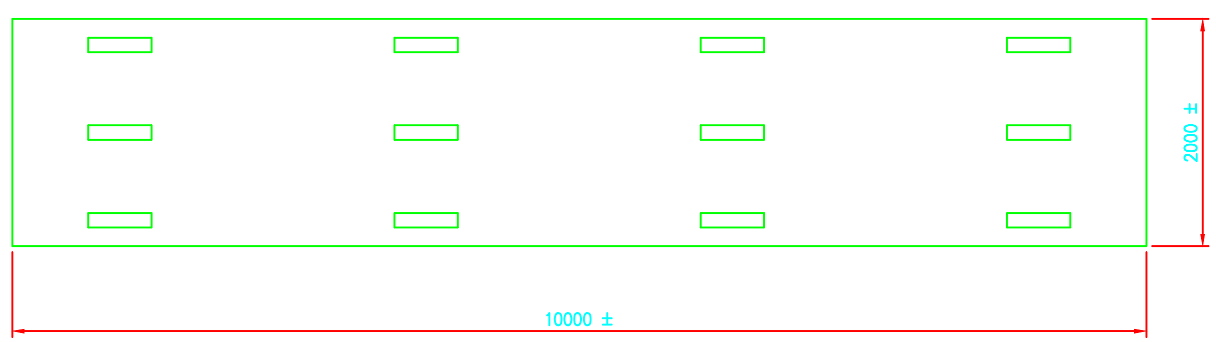
TYPICAL GIRDER FRAMING PLAN



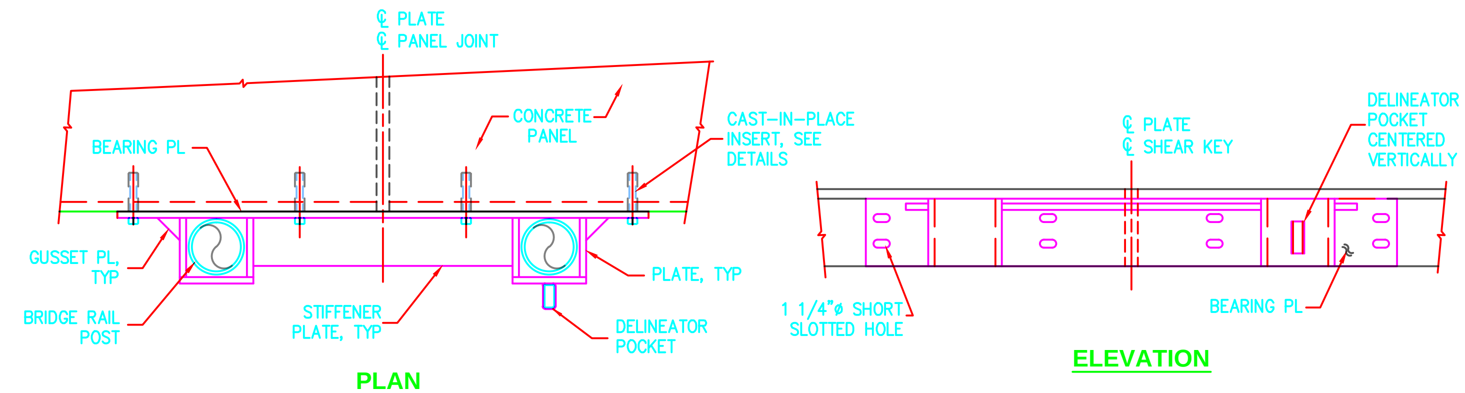
TYPICAL GIRDER SECTION



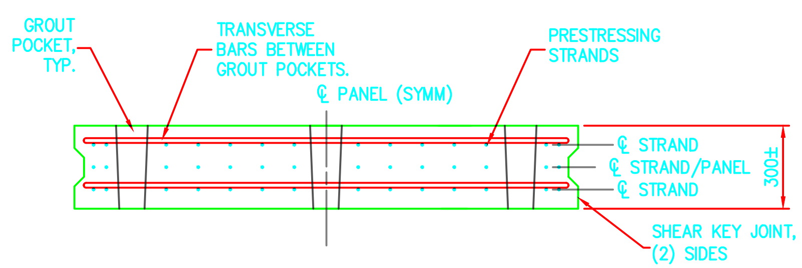
TYPICAL DIAPHRAGM SECTION



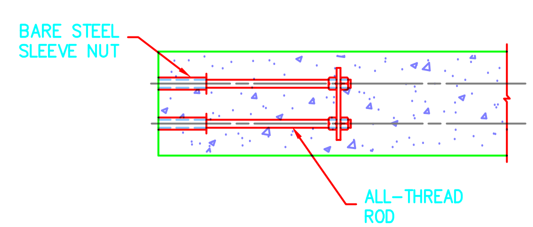
TYPICAL DECK PANEL PLAN



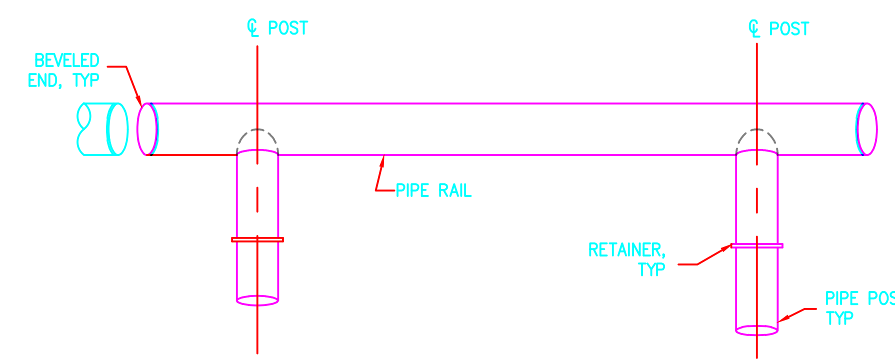
TYPICAL BRIDGE RAIL WELDMENT DETAILS



SECTION A-A



BRIDGE RAIL INSERT DETAIL



TYPICAL BRIDGE RAIL

Girder, Deck, and Bridge Rail Details

1.10.4.3.2 Bridge Construction

Bridge foundations for the abutments and the in-water piers are best constructed in the winter for ease of construction and to minimize impacts. Road construction will start in the winter and bridge foundations will proceed as soon as the pioneer road approaches each crossing site. In shallow bedrock situations, the bridge abutment foundations will require excavation of the overlying overburden and is best accomplished in the winter to avoid shoring and dewatering, and to minimize any disturbance to the stream riparian zone. In most situations, the overburden will be ripped and removed with an excavator. It may also be necessary to perform a minor amount of blasting to assist with frozen overburden removal.

In deep bedrock locations, a socket will be drilled through the finer grained frozen soil overburden in the winter using rotary drilling equipment and back filled with sand slurry to bond the pile to the frozen soils. Any excavated overburden and rotary drill cuttings will be incorporated into roadside fill embankments or disposed at a nearby quarry overburden stockpile site.

In-water piers will require socketing into bedrock. Removal of any stream boulders and/or finer grained substrate will be performed prior to the socket drilling. Heavy cranes and other necessary support equipment will only be allowed on the ice if it is ground-fast or has been reinforced with additional ice layers. Any cuttings and/or grout spills will be removed from the in-water drilling site and disposed of properly. Boulders and other stream substrate will be repositioned around the newly installed bridge piles restore a natural appearance and prevent blockage of fish passage.

Bridge girder erection and cap placement can be performed either in the winter or the summer. In the summer, most of the erection can be completed from one side of the stream. Any required crossings, with the exception of one initial crossing to set a temporary bridge, will be accomplished using the temporary bridge. Winter bridge girder erection can be performed when the stream is frozen. Ice thickness will be verified before any heavy equipment is allowed to mobilize on the ice.

1.10.4.4 Culverts

1.10.4.4.1 Culvert Design

Culvert batteries will typically consist of one to four culverts in a battery depending on crossing hydrology. Culvert battery locations are described in Figure 1.10-3.

Culvert batteries will be designed to convey the 100-year return period design event without overtopping the road. A minimum of 0.3 m freeboard shall be maintained between the maximum hydraulic gradient and the top of road during the design event. Culvert design will incorporate a small cross slope to facilitate drainage, assumed in preliminary design to be 0.2%. There is a potential to overtop and wash out the road in cases when higher than anticipated flows are experienced, and/or the culvert is unexpectedly plugged with ice, frozen snow, or rock debris. Experience at other Arctic locations, such as Red Dog Road near Kotzebue, Alaska, has demonstrated that through proper maintenance these types of washouts can be minimized.

Culverts will be constructed using continuous solid wall structural steel pipe, or steel corrugated multi-plate bolt together pipe.

The pipe will be laid on-grade, or slightly above, to provide for a thin layer of rock leveling course and possibly a geotextile directly on the tundra. If required, quarry spall scour protection will be laid on top of the tundra at the inlet and outlet of the pipe. No excavation into the existing tundra will occur. Due to time and construction constraints, temporary culverts may be installed to expedite the construction of the road. These temporary culverts, including the pipe zone bedding material, will be replaced with the design culvert batteries.

1.10.4.4.2 Culvert Inspection and Maintenance

Culvert crossings along the all-weather road will be inspected yearly, after break up. Items of importance are:

- structural damage to the culvert pipe and pipe zone;
- flow path between the culvert entrance and exit, inspection for obstructions;
- culvert delineators remain in place, and are structurally sound; and
- rip rap scour protection at the entrance and exit, inspection for signs of increased erosion, deterioration, or failures in the quarry spall scour protection.

Any damaged items or insufficiencies will be remedied during the same summer season to avoid exacerbation of any negative conditions.

Winter maintenance activities will occur just prior to spring break up to maximize their value. Snow removal at the entrance and exit of the culvert batteries using a dozer or excavator will remove banked snow or ice which obstructs flow within the culverts. If it appears that the culvert is completely blocked with ice, a steam lance or similar tool will be used to clear a flow path for runoff.

1.10.5 Construction Materials

Road surfacing material will be crushed rock from road embankment quarry sites. Drilling and sampling will be completed to confirm the limits of material available during detail design. Limited sampling and visual analysis has been done to confirm geological rock types and potential for acid rock drainage (Rescan 2007). More studies will be conducted in 2013. Road embankment material will be a nominal minus 900 mm hauled and placed with 90-tonne trucks. Portable crushers will move between quarries to optimize haul distances with crushing only taking place during the summer and autumn. The road base material will be a nominal minus 150 mm and the surfacing minus 50 mm crushed rock. It is proposed to haul and place all crushed granular material with 90 tonne trucks.

The use of esker material will be limited due their important habitat value and due to the intention to build a majority of the roadway embankments during the winter months when eskers will be frozen. A preliminary review of eskers found along the right of way indicates that most of the surficial materials are too fine for road surfacing or do not contain sufficient quantities of boulder material which could be cost effective to crush.

Eskers are frequently habitat for burrowing wildlife and sites of archaeological significance. Esker borrow material obtained from environmentally acceptable locations will be used for road maintenance sanding, fine bedding, and concrete aggregate production.

1.10.5.1 Pit and Quarry Locations

It is proposed that the roadway embankments will be constructed with rock from quarries developed along the ROW. The locations of the potential quarry sites were determined from air photo terrain analysis and field investigations (Table 1.10-7). The potential quarry sites have been identified on the roadway plan in Figure 1.10-1. Spacing of quarries was based on optimizing haul distances, the amount of material potentially available in the quarry and the proximity to the proposed road centreline to limit the length of quarry access roads.

Table 1.10-7. Borrow Pit Locations

Borrow Pit	Latitude	Longitude	Quantity (m^3)	Disturbed Area/ Quarry (Ha)
Port Site	66°32.514' N	107°30.185' W	800,000	13.4
Q-2	66°31.477' N	107°37.009' W	115,000	2.4
Q-4	66°29.500' N	107°36.009' W	148,000	3.1
G-5	66°26.677' N	107°39.132' W	130,000	2.7
Q-6	66°26.139' N	107°38.156' W	49,000	1.0
Q-7	66°23.003' N	107°38.385' W	105,000	2.2
Q-8	66°21.747' N	107°40.934' W	115,000	2.3
Q-9	66°16.248' N	107°47.086' W	110,000	2.3
Q-10	66°14.739' N	107°47.842' W	75,000	1.6
Q-11	66°13.534' N	107°49.239' W	50,000	1.0
Q-12	66°12.127' N	107°48.214' W	38,000	0.8
Q-13	66°9.437' N	107°49.281' W	109,000	2.3
Q-14	66°5.561' N	107°48.334' W	120,000	2.2
Q-15	66°2.402' N	107°48.710' W	115,000	2.4
G-16	66°1.589' N	107°47.783' W	57,000	1.2
Q-17	65°57.686' N	107°49.960' W	90,000	1.9
Q-18	65°56.416' N	107°53.756' W	78,000	1.6
Q-19	65°55.033' N	107°54.193' W	30,000	0.6
Q-20	65°54.217' N	107°55.436' W	85,000	1.8
Q-21	65°51.901' N	107°56.547' W	90,000	1.9
Q-22	65°45.746' N	108°5.168' W	135,000	2.8
Q-23	65°43.945' N	108°12.318' W	150,000	3.1
Q-24	65°41.039' N	108°20.556' W	120,000	2.5
Q-25	65°39.600' N	108°26.527' W	16 3000	3.4
Q-26	65°39.209' N	108°36.408' W	85,000	1.8
G-27	65°35.263' N	108°42.480' W	117,000	2.5
Q-28	65°32.049' N	108°57.363' W	150,000	3.1

(continued)

Table 1.10-7. Borrow Pit Locations (completed)

Borrow Pit	Latitude	Longitude	Quantity (m^3)	Disturbed Area/ Quarry (Ha)
Q-29	65°30.130' N	109°2.813' W	60,000	1.3
Q-30	65°29.307' N	109°6.004' W	90,000	1.9
Q-31	65°29.357' N	109°10.741' W	64,000	1.3
Q-32	65°29.738' N	109°14.457' W	42,000	0.9
Q-33	65°29.280' N	109°19.235' W	50,000	1.0
Q-34B	65°27.703' N	109°24.768' W	130,000	2.7
Q-34C	65°27.284' N	109°28.684' W	50,000	1.0
Q-35A	65°27.708' N	109°41.200' W	70,000	1.5
Q-35	65°27.912' N	109°45.353' W	150,000	3.1
Q-36	65°28.577' N	109°49.984' W	150,000	3.0
Q-37	65°27.340' N	109°58.444' W	117,000	2.5
Q-38	65°27.016' N	110°2.167' W	125,000	2.6
Q-39	65°27.814' N	110°7.858' W	45,000	0.9

Total Quantity (m^3): 4,409,000
Total Disturbed Area (Ha): 93.8

1.10.6 Road Maintenance

The roads at Bathurst Inlet are designed to withstand the wear and tear of large vehicles and heavy loads but wear such as washboarding, rutting, and potholing are likely to occur during the life of the BIPR Project, and maintenance will be necessary. Typical road wear results from factors such as erosion, the freeze/thaw cycle, and vehicle weight, speed and frequency of travel.

Corrective measures on an as-needed basis will alleviate encountering any major road issue requiring full section reconstruction. Grading is not practical once the road is frozen so maintenance will be scheduled to occur during the summer months.

Maintenance procedures to the structural road section such as blading or dragging using a motor grader will be used to restore the road crown and curve super-elevations as well as redistribute loose material from the sides of the road. The road maintenance crews will be staged at either end of the road or both ends depending on what is the most efficient.

Occasionally, reconstructive grading may be necessary to correct major surface defects such as washboarding, deep ruts, soft spots, or severe erosion. Cutting, redistributing, blending in additional surface material, and re-compacting will be performed as wear develops to keep the roads in good operating condition, extend the life of the roads, and save money by ultimately preventing large scale, costly repairs.

On occasion during excessive snow pack or ice accumulation during shoulder seasons, portions of roads or pads may become slick. The ice surface may be scarified to increase traction, using care to roughen only the ice surface, and not degrade the structural road or pad surface. Typically, salt will not be used as it does not bond with the road surface to melt ice.

Periodic snow removal from driving surfaces will be necessary. Care will be taken when operating snow removal machinery to trim only snow, and not blade or scrape portions of the structural section of the road. For both all-weather and port roads and pads, snow will be stockpiled/pushed to the downwind side of the road/pad, to minimize blow back and additional maintenance operations. Winter snow removal crews will be mobilized to areas of need as required along the road. In the event a major storm event is predicted for the area, crews may be staged in advanced on both ends of the road.

Normally snow will be removed by using snow blowers mounted on tractors for port and all-weather roads, with loaders with buckets utilized for pad clearance. Snow will be deposited in designated off-pad snow stockpile areas. For cases of excessive packed snow, a motor grader is preferred to a tractor and bucket to preserve the road crown, but care will be taken to remove only snow, and leave the structural gravel section intact.

1.10.7 Road Management

The all-weather road will be used eventually to provide access to the mine sites in western Nunavut and adjacent areas of Northwest Territories during construction of their facilities, and to provide a transportation route from the Bathurst Inlet port to the mine sites during their production periods. Inbound transportation of mine supplies (fuel, cement, grinding media, lubricants, spare parts, dry goods, and other general cargo) in conventional tractor trailers, will occur as required until the end of production and reclamation. The road will be used year round. However, the road will be closed on a short term basis for various reasons (bad weather, wildlife, etc.). Year-round road access will reduce the amount of infrastructure required at the mine sites by significantly reducing the volumes of fuel and other consumable supplies that must be stored at the mines in order to support ongoing operations.

The key haulage equipment operating on the road will be supported by radio controls. Weather will be monitored and hauling will cease for the duration of poor weather conditions and reduced visibilities. All vehicles using the road will be equipped with safety provisions and equipment so that major blizzards can be safely waited out at any point along the road, in the unlikely event that vehicles are caught enroute from either the port or one of the mines. The road will be maintained by Bathurst Inlet Port and Road Company or its contractors to ensure timely delivery of freight for mine operations.

It is anticipated that traffic will consist of about 18 B-train trucks per day over 10 to 12 months of the year, with operational restrictions during active caribou migration periods.

1.10.7.1 Safety

The BIPR Project all-weather road is designed to utilize the following safety features:

- flexible delineators at 100 m intervals each side to identify the road shoulders;
- kilometre markers each kilometre each side;
- two lane traffic;
- two lane bridges with guard rails;

- radio controlled traffic;
- dust control; and
- regular maintenance.

1.10.7.2 Access

No public access will be permitted. The road will be signed to indicate that it is a private road and that public access is prohibited. Controlled use access to the road will be important so as to ensure the safety of all users.

During the life of the mine, the transportation of freight and road maintenance operations will be conducted by an owner-operated fleet, or contracted motor carriers who are experienced in northern trucking operations.

All drivers will either be employees of the company or the contracted motor carrier, and must possess a valid driver's license from a Canadian province or territory, for the appropriate class of vehicle, in order for them to be allowed to operate vehicles on the access road.

1.10.7.3 Policies

In general, the operational policies for the road will be:

- All mine personnel using the road will be required to monitor and report unauthorized non-mine use of the road.
- Wildlife has the right of way.
- All vehicles will be insured.
- A policy on hunting and fishing will be developed for BIPR Project employees and contractors.
- All spills of any materials will be reported and cleaned up, as set out in the spill contingency plans. The trucking fleet will be required to have appropriate spill containment and clean-up equipment on hand or available on demand.

1.10.7.4 Mitigation

Mitigating procedures to limit potential effects of traffic during construction and operations of the mines will include:

- providing all road operators information regarding the potential for wildlife/vehicle collisions;
- restricting vehicles to designated roads and approved construction areas (i.e. no off road travel allowed);
- banning any use of off-road vehicles outside exploration to avoid damage to local vegetation (tundra);

- monitoring and reporting of significant numbers of wildlife observed in the vicinity of roads and immediately reporting to appropriate BIPR Project environmental staff who will issue notices to vehicle operators accordingly;
- posting appropriate and maintaining speed limits;
- giving wildlife the right of way and reducing traffic speeds when animals are detected near roads or other approved work areas; and
- reporting and disposing of accidental wildlife mortalities near the BIPR Project site.

Operation Timing Windows

The road will be closed to heavy truck traffic during the key life history periods of the local caribou populations.

The timing windows will be adjusted yearly, based on radio collar data and camera tracking, and are subject to change if the calving area and movement patterns of the caribou change.

Truck Management

There will be a Wildlife Management Plan for the road which will detail mitigation such as trucks will stop when groups of caribou are crossing the road. .

Road Design

Approximately, fifteen large caribou crossings, 60 m in length, will be constructed where known migration routes cross the road alignment. Small 20 m length caribou crossings will be constructed every 500 m along the full length of the road.

Road and quarry location will avoid carnivore dens and raptor nests where possible.

Construction Windows

Quarries will be located to occur more than one kilometre from known raptor nests as much as possible. If raptor nests are identified within a kilometre of a quarry, blasting will be prohibited during the nesting period.

Construction windows for road construction will follow caribou timing windows. Despite the timing windows, road building will be permitted in affected areas if caribou are not present.

1.10.7.5 Dust Control

The amount of dust generated by vehicle traffic is typically related to the road surface type and aggregate durability and, vehicle usage variables such as speed and number of tires per vehicle, and surface moisture.

To mitigate the amount of dust and minimize maintenance, a hard, durable aggregate surface course will be utilized. Part of the quarry site geotechnical program will include rock core samples for hardness and durability testing. Quarries with the best testing results and that can be crushed to produce the most durable aggregate will flagged as material sources for the surface course.

Several methods of dust suppression are commonly used including watering and chemical stabilization.

Watering is the most common method of reducing the amount of dust. Because the effectiveness of water as a dust suppressant is short lived it must be applied frequently. Over application of water can thermally degrade ice-rich permafrost. In addition to frequent application, suitable non-saline sources must be located and permitted. Water volumes will be permit and/or seasonally-limited.

Chemical stabilization options include: surfactant agents; hygroscopic and deliquescent chemicals such as calcium chloride and other proprietary chemicals; organic binders such as lignosulfonate compounds, and petroleum derived binders such as asphalt emulsion. The options being considered for BIPR include the following:

- Calcium chloride.
- Proprietary compounds, similar to calcium chloride but contain no chlorides, including proprietary dust control binders such as ENVIROBND RC and EK-35. These compounds are typically applied by tanker truck with a pressurized spray bar to recently graded roads that are subsequently rolled to bind the chemicals to the roadway material to limit runoff. Application is typically temperature sensitive and cannot be applied much below freezing.
- DL-10, an asphalt-based product currently approved in Nunavut. Application is limited to outside a 30 m setback from all stream crossings.

1.10.8 Abandonment and Reclamation

1.10.8.1 Objectives

The following objectives were developed for abandonment and reclamation in compliance with Nunavut Land Use Regulations:

- protect the environment through sound reclamation practices;
- restore the land as close as possible to its original condition;
- restore land uses (e.g. creating wildlife habitat and/or promote habitat recovery);
- minimize effects on aquatic habitat and water quality with proper engineering;
- ensure that abandoned areas are safe and do not pose health and safety risks; and
- satisfy the requirements specified in permits and licences.

Reclamation activities will be carried out progressively, where possible. The greater portion of the abandonment and restoration activities will commence upon final abandonment. Should operations be suspended temporarily, such as due to a rise in fuel costs to levels that would make all mining in remote regions uneconomic, temporary abandonment measures will be implemented. Contingency plans for temporary abandonment will be developed and submitted in support of the Project EIS.

Abandonment and restoration activities of the BIPR Project may typically include the following activities. These have been further described in the DEIS.

1.10.8.2 During and Following Construction

Areas that are disturbed for the construction of the BIPR Project which will not be required for the operation will be reclaimed as soon as possible. Quarries that are not required for maintaining the roadway during operations will be contoured and abandoned on completion of road construction.

At no time during the operation of the road will active erosion of terrain on or adjacent to the road, or on associated lands, be allowed to proceed unchecked or alter natural drainage patterns in adjacent lands.

1.10.8.3 Final Abandonment

It is expected that the road will be in use for many generations in the future. Nevertheless, non-renewable resources are finite and at some future time the road may no longer be required. Final closure and abandonment activities will include the following:

- remove all imported materials or securely store them in an approved manner;
- treat and/or remove and dispose of all contaminated soils, if any, in accordance with the Final Abandonment Plan;
- remove all bridges and culverts;
- contour all surfaces to reduce the possibility of erosion, and slope the sides of excavations (e.g. quarries) and embankments, except in solid rock, to a stable slope;
- contour the sides of excavations to provide escape terrain for wildlife;
- facilitate vegetation establishment on all areas stripped of vegetation during the land use operation; and
- implement an environmental monitoring program consistent with the Final Abandonment Plan.

1.11 Contwoyto Lake Camp

1.11.1 Introduction

Phase 2 of the BIPR Project's all-weather will terminate on the east shore of Contwoyto Lake at approximately 65º 28' N and 110º 11' W. A camp will be built at this location during the construction of Phase 2 to serve as the connecting point between the proposed all-weather road from Bathurst Inlet and the existing ice road to Yellowknife. During the ice road season, the tractors/trailers from the proposed Bathurst Inlet port will stop at the camp, and split or re-distribute the loads for travel on the ice road in order to potentially service client mining operations. Trucks delivering dry cargo and operating supplies may arrive at the camp up to one month in advance of the ice road opening such that these goods can be transported over the ice road as soon as it opens. A temporary trailer parking and material storage area will be provided at the camp, along with a maintenance shop, and rest/stop facilities for the truck drivers (Figure 1.11-1). A road maintenance crew will be based at the Contwoyto camp to supplement the road maintenance towards Bathurst Inlet as and when required. The camp may also be used by a maintenance crew servicing the ice road.

1.11.2 Location and Geotechnical Conditions

The shore facilities at the proposed Contwoyto camp will be located on a slightly raised small peninsula underlain by ice-rich soil covered with about a 300 to 500 mm thick organic mat. The soil is underlain by Yellowknife Supergroup bedrock consisting of generally hard competent rock. The soil cover is likely not more than 3 m thick.

The area will be prepared by constructing a rockfill platform generally more than 1.5 m thick. The camp will be an elevated structure placed directly on the rock fill. The utility building will be either an elevated structure with an air space, founded on compact granular fill; or the structure will be founded directly on the compact granular fill that extends to bedrock (after excavating the ice-rich soil).

The maintenance shop will be either constructed entirely on compacted fill that extends to bedrock, after ice-rich soil excavation, or founding the main structure on piles and the interior floor on about a 2 m thick granular fill. In the latter case, the maintenance shop floor will be independent of the structure as it can tolerate settlement due to thaw.

1.11.3 Camp

The camp building services (heating, ventilation, lighting, and kitchen equipment) will be electrically powered. A 20-person modular bunkhouse unit, accommodating one person per room, will be provided. The bunkhouse will have centrally located separate washrooms for male and female personnel, lounge and common laundry facilities. Basic furniture in each room will be provided.

A fully equipped kitchen/diner will be provided with seating capacity of 60. The kitchen will have the capacity to provide meals to all guests (truckers) and staff, with take-out service for those requiring it. Guests and kitchen staff will use separate washrooms during kitchen duty hours. There will be a small sitting and meeting lounge adjacent to the dining area. The kitchen/diner will have an Arctic entrance vestibule leading to an enclosed dry/mud/cloak room before entering the diner or the accommodation area. 10-vehicle plug-ins will be provided along the perimeter of the building.

A 2.4 m wide modular Arctic corridor will be provided between the Camp, the Maintenance Shop and the Utilities Trailers. The corridor will be heated and will have lighting.

The camp will have a fire protection system consisting of a diesel-powered fire pump and a fire reserve within the water storage tank. Fire water will be distributed by steel fire water pipelines to sprinklers throughout the area. Portable fire extinguisher units will be positioned at strategic locations. The system will be supplemented with smoke/heat detectors and manual alarm stations.

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Figure 1.11-1

the BATHURST INLET PORT AND ROAD PROJECT

BIPR Project - Contwoyto Camp

Figure 1.11-1

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1.11.4 Maintenance Shop

The Maintenance Shop building will be approximately 12-m-wide by 16-m-long. It will provide servicing and minor repairs for tractors, trailers, road maintenance equipment, and small vehicles.

The shop will be an open area plan with the capacity to service two vehicles or pieces of equipment at a time. The facilities will include; lubrication, tire repairs, electrical repairs, cooling systems repair, running gear/engine repairs, welding, brake and exhaust inspections/repairs, and safety checks.

1.11.5 Utilities

The camp utilities will be contained in three 3.7 m wide by 15 m long prefabricated modules which will abut up to and be interconnected to each other to form the camp utility complex.

1.11.5.1 Power Supply

A diesel-powered 500 kWe generator plant will be used to supply the primary electrical power. A diesel powered 300 kWe standby generator plant will be used to supply emergency power and can be used alternatively to supply electrical power.

1.11.5.2 Potable Water

Water supply will be by a submersible pump located at a depth of 5 m in Contwoyto Lake. Lake water will be pumped directly into a lined steel storage tank with a capacity of 25 m^3. Water will be drawn from this tank and treated by filtration and UV disinfection prior to distribution and use. The potable water will be distributed through a small piping network to the demand areas.

1.11.5.3 Waste Water

A 15 m^3/day tertiary sewage treatment plant will be provided to produce an effluent quality acceptable for direct discharge to tundra.

1.11.5.4 Communications

Telephone and facsimile communications from the camp to the outside will be via satellite. Associated equipment will be installed. Radio control (vehicles and personnel) and an internal telephone system will also be provided.

1.11.5.5 Diesel Fuel Storage and Distribution

A double walled, steel (spill-containment) fuel tank with a capacity of 45,000-litres will be installed adjacent to the camp utility complex. This tank will supply fuel to the generator(s) and the diesel fire pump, and provide vehicle fuelling. It is sized to provide fuel to the generators for minimum of 14 days and to have a dedicated fuel reservoir to supply the fire pump for a minimum of 9 hours.

1.11.5.6 Incinerator

An approved diesel-fired incinerator unit will be provided to burn all kitchen waste.

1.11.6 Abandonment and Reclamation

It is expected that the camp facilities will be in use for many generations in the future. Nevertheless, non-renewable resources are finite and at some future date the camp facilities may no longer be required. Final closure and abandonment activities would include the following:

- initiation and enhancement of revegetation on all parts of the land disturbed or altered, within a reasonable timeframe as may be directed the Final Abandonment Plan;
- establishment of vegetation on all areas stripped of vegetation during the land use operation;
- implementation of an environmental monitoring program and maintain compliance as required in the Final Abandonment Plan;
- treatment and/or removal and disposal of all contaminated soils as directed in the Final Abandonment Plan;
- removal of all imported materials and structures, or secure storage in an approved manner; and
- removal of all buildings and burial of foundations.

1.12 Environmental Management Plans

There are numerous management plans that will be prepared as part of the Environmental Impact Statement. Plans associated with the atmospheric, terrestrial, freshwater, and marine environments, as well as a socio-economic management plan and those specific to the infrastructure itself will be included. These plans will cover management of:

- air quality;
- waste;
- water;
- fish and fish habitat;
- quarries;
- road and port;
- emergency spill response and contingency;
- wildlife;
- wetlands;
- vegetation;
- heritage resources; and
- socio-economics.

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