Nunavut Water Board Supplemental Technical Information for Water Crossings

PROPOSED NORTH POLE RIVER ACCESS ROAD, REPULSE BAY, NU

FINAL

Prepared for:
Hamlet of Repulse Bay
Repulse Bay, NU

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Abbreviations

ATV ..... All-Terrain Vehicle
CCME ..... Canadian Council of Ministers of the Environment
CSP ..... Corrogated Steel Pipe
DFO ..... Fisheries and Oceans Canada
HRIA ..... Heritage Resources Impact Assessment
NJWL ..... Nunami Jacques Whitford Ltd.
PSIR ..... Project Specific Information Requirements

1 Supplemental Technical Information for Water Crossings

1.1 Waterbody

Six streams will be crossed by the proposed 7.68 km access road. A small bouldery area which separates an unnamed freshwater lake and Tariuraq Inlet will also be crossed, resulting in a total of seven waterbody crossings. This small bouldery area naturally contained large rocks and boulders and separated the freshwater lake and the marine Tariuraq Inlet. To the knowledge of Nunami Jacques Whitford (NJWL), the six streams are unnamed. Project names and locations of crossings are provided in Table 1.1 below.

Table 1.1 Project name and location of each waterbody crossing along the North Pole River Access Road, Repulse Bay, NU

Waterbody	Project Name	Location		
		Road Kilometre	Latitude	Longitude
Area between freshwater lake and Tariuraq Inlet	CRS-1	0.0	66° 33’ 5” N	86° 17’ 4” W
Waterbody crossing #2	CRS-2	1.8	66° 33’ 31” N	86° 19’ 9” W
Waterbody crossing #3	CRS-3	3.5	66° 33’ 19” N	86° 20’ 17” W
Waterbody crossing #4	CRS-4	4.4	66° 33’ 22” N	86° 21’ 32” W
Waterbody crossing #5	CRS-5	5.0	66° 33’ 27” N	86° 22’ 13” W
Waterbody crossing #6	CRS-6	6.2	66° 33’ 7” N	86° 23’ 39” W
Waterbody crossing #2	CRS-7	7.2	66° 32’ 54” N	86° 24’ 39” W

The Hamlet of Repulse Bay began construction of the new access road in 2007 though stopped after only approximately 2.9 km was built. Crossing CRS-1 has been constructed with granular material; however, culverts were not installed and drainage flows under/through the road. The crossing at CRS-2 has also been constructed and a rudimentary culvert installed.

1.2 Photos & Maps

Figure 1 in **Appendix A** includes a map of the proposed road route and waterbody crossings. Culvert design detail is included on Figure 2 in **Appendix A**. Photographs of all waterbody crossings are provided in **Appendix B**.

1.3 Other Agencies

A Project Proposal and Project Specific Information Requirement (PSIR) have been submitted to the Nunavut Impact Review Board.

The Government of Nunavut Department of Culture, Language, Elders and Youth were also contacted for information and advice regarding heritage resources of the Repulse Bay area. A desktop heritage resource review of the Project area was completed by NJWL and a field-based heritage resource impact assessment (HRIA) is planned for early summer 2009, before construction commences. Additional information and recommendations arising from the HRIA will be forwarded to the appropriate agencies.

1.4 Project Alternatives

Alternatives to the Project, and viable technical and economic alternatives for carrying out the Project, have been considered. The alternative to the Project is to not construct the proposed road and not develop the identified granular resources in the future. This is not considered feasible; however, as the Hamlet requires these granular resources to support future municipal projects and community economic growth initiatives. Alternative means of carrying out the Project focused on constructing the proposed road in an alternate location to access the identified granular resources. This option is also not considered feasible as the cost of locating and designing a new route would be prohibitive as the Hamlet and the Government of Nunavut Community and Government Services have already completed route design, environmental survey and permit applications for the present routing. The proposed Project routing was developed by FSC in 2002 based on field study considering ease of construction, minimizing construction and maintenance costs and avoiding environmentally sensitive areas. An assessment of the environmental effects of project alternatives was not undertaken as there was not considered a practicable alternative to the proposed route.

1.5 General Conditions of the Site(s)

The following sections provide a description of each of the water crossings along the proposed route.

1.5.1 Area between the Freshwater Lake and Tariuraq Inlet (CRS-1)

This crossing is located near Km 0 of the proposed access road and is within the previously constructed portion of the road. The crossing has been constructed; however, no culverts were installed and the water from the freshwater lake drains into the marine Tariuraq Inlet through the large riprap of the constructed road. The slope between the two lakes is less than 5%.

Both the lake and inlet are bound to the east and west by large bedrock outcrops. The north end of the freshwater lake is also bound by bedrock outcrops. Substrate along the north shore of the road (within the lake) is primarily cobbles (64 – 256 mm) and gravel (2 – 64 mm; 80% combined) with some boulders (<256 mm) and fines (<2 mm; 5% each). Algae were observed on the shallow substrates of Tariuraq Inlet, though little aquatic or shoreline vegetation was present. Water depth along the north shore of the road was shallow (maximum of 30 cm) and flow rate was estimated at approximately 0.3 m/s during a period of high flow (spring freshet).

Substrate along the south shore of the road (within Tariuraq Inlet) is mainly fines (80%) with some cobble and boulders (10% each). Some submergent and emergent vegetation was observed near the south shore of the road on flooded flats and in-between riprap. This primarily included Alaska willow (*Salix alaxensis*), dwarf fireweed (*Chamerion latifolium*), unidentified grass and sedge species, and moss; algae covered rocks were also observed.

Future re-construction of this crossing will include the installation of several corrugated steel pipe (CSP) culverts, installed as per the typical culvert detail illustrated in Figure 2. No vegetation is anticipated to be removed in subsequent improvements of this crossing. Water flow is expected to be less than 0.3 m/s during any future construction activities at this crossing.

1.5.2 Waterbody Crossing #2 (CRS-2)

The CRS-2 crossing is located at Km 1.8 of the proposed access road. It is also within the previously constructed portion of the road and a crossing has been built. One culvert made of 205 L drums has been installed and water from the adjacent pond drains north through this culvert. Water may also seep through the large riprap of the constructed road as flow patterns on the downstream side were not confined to a channel. Slope between the upstream pond and downstream wet area is less than 5%.

The crossing at CRS-2 is located within a slight valley. The crossing area is vegetated with standing and flowing water on either side of the constructed road. Common plant species include Arctic white heather (*Cassiope tetragona*), common horsetail (*Equisetum arvense*), mountain avens (*Dryas integrifolia*), woolly lousewort (*Pedicularis lanata*), some willows (*Salix* spp.) and unidentified grass, sedge and moss.

The culvert currently installed at the CRS-2 crossing will be replaced with a CSP culvert during future construction of the access road, as per the typical culvert detail illustrated in Figure 2. Little vegetation will need to be removed during this operation. The adjacent pond was reported to be present throughout the ice-free season, however as construction will take place after freshet, water flow through the culvert is expected to be negligible.

1.5.3 Waterbody Crossing #3 (CRS-3)

Waterbody crossing CRS-3 is situated on a stream at the toe of an east facing hillside, within a valley bounded to the east and west by large bedrock hills and outcrops. The valley slopes south towards Repulse Bay. During the environmental survey, snow was still present on south and west facing slopes of the valley. CRS-3 is located at Km 3.5 of the proposed access road. This portion of the road has not been constructed however a frequently used ATV trail is present here and throughout the remainder of the proposed road route; this existing ATV trail is used to access the North Pole River by community members. The stream has been impacted by ATVs crossing across the streambed as bank and channel structure appeared altered at the crossing site. Substrate at the CRS-3 crossing site was primarily boulders and cobbles with some fines.

Upstream and downstream of CRS-3, the stream channel is natural and has slight undercut banks which were overflowed during the spring freshet; water depth upstream was 1 m while only 0.35 m at CRS-3. Channel width measurements were taken just above the impacted area; channel width was 3.4 m and wetted width was 2.74 m. The stream flows to the south and was observed to be relatively strong and turbulent during the survey (during the freshet). Stream flow was estimated at less than 1 m/s. Banks at the crossing site and upstream and downstream were primarily vegetated with grass and sedge; however, other common species included Arctic white heather, purple saxifrage (*Saxifraga oppositofolia*), bog rosemary (*Andromeda polifolia*), Arctic cotton-grass (*Eriophorum scheuchzeri*), and few, small willows including Alaska and net-veined willow (*S. reticulata*).

Future construction activities at this site would include the installation of a CSP culvert and the build up of the access road on to and over top of the culvert, as per the typical culvert detail illustrated in Figure 2. Vegetation will be lost as the road will be wider than the existing ATV trail and riprap will be placed overtop. The Hamlet Foreman and an Elder accompanied NJWL during the environmental survey and reported that the stream flows throughout the ice-free season (S. Kidlapik and R. Tungilik, *pers. comm.*);

therefore, some amount of flow will be present during construction. In-stream works will be completed after the freshet when flow is estimated at less than 0.5 m/s.

1.5.4 Waterbody Crossing #4 (CRS-4)

The CRS-4 crossing is located at Km 4.4 of the proposed access road. The stream flows to the south and is located in a gently sloping valley, bounded to the north, east and west by bedrock hills and outcrops. Boulders were present across the bedrock outcrops and valley slopes. Substrate within the valley was obscured as much of it was snow covered at the time of the survey. The banks of the stream were also snow covered by a 0.5 m to 2 m deep snowpack during the survey. Stream flow occurred through an open channel between and underneath the snowpack; wetted width of the channel ranged from 1 m to 6 m wide. This stream reportedly only flows during the spring freshet (S. Kidlapik, *pers. comm.*).

Visible banks of this stream appeared to be rocky with vegetation, typically lichen, grass and sedge species, occurring at (on the right bank) or 0.5 m above (on the left bank) the present water level. Substrate within the stream and at CRS-4 was primarily boulders with cobbles and few fines; water depth ranged from 0.2 m to 0.5 m. The CRS-4 crossing is staked upstream from the existing ATV trail crossing and did not appear to be greatly impacted by ATVs. However since the stream is expected to be ephemeral and flows were so wide during the freshet, impact from ATVs is expected to be much less than that observed in non-ephemeral streams (e.g. CRS-3).

Future construction activities at CRS-4 would include the installation of four side-by-side CSP culverts and the build up of the access road on to and over top of the culverts, as per the typical culvert detail illustrated in Figure 2. Little vegetation appeared to be present within the valley and along the visible stream banks, though what is present at the crossing beyond the existing ATV trail will be lost as construction material and riprap are placed overtop. As this stream is expected to be ephemeral and construction activities will begin after the spring freshet, flow rate is anticipated to be negligible during construction of the crossing. .

1.5.5 Waterbody Crossing #5 (CRS-5)

Waterbody crossing CRS-5 is located at Km 5.0 of the access road. The stream is situated along a gently south sloping vegetated valley bound to the east by large bedrock hills and outcrops and to the west by smaller bedrock hills. Snow was present on west facing valley slopes and along portions of the valley floor.

The channel at CRS-5 is natural and has not been impacted by ATV crossings as it is approximately 350 m upstream from the existing ATV trail. Substrates at CRS-5 were primarily fines and cobble with some boulders. Banks upstream, downstream and at CRS-5 were primarily vegetated by grass, sedge and moss; other species observed included Arctic white heather, purple saxifrage, moss campion (*Silene acaulis*), and willows. The stream flows towards the south and connects with the southward drainage of the CRS-4 stream. Water flows of CRS-5 appeared high due to the spring melt during the environmental survey and water flowed near the top of the banks in many places. Water depth at the CRS-5 crossing was approximately 0.5 m, while channel width was 2.0 m and wetted width was 1.18 m; flow was estimated to be less than 0.5 m/s.

Future construction activities at this crossing include the installation of a CSP culvert and the build up of the access road on to and over top of the culvert as per the typical culvert detail illustrated in Figure 2. Shoreline vegetation immediately within the road route will be lost and, as the crossing is sited in a natural area which hasn't been impact by the existing ATV trail, the vegetation loss may be slightly greater here than the other waterbody crossings. This stream was reported to flow throughout the ice-free

season (S. Kidlapik, *pers. comm.*) and some flow will likely be present during construction. In-stream works will be completed after the freshet when stream flow will be reduced.

1.5.6 Waterbody Crossing # 6 (CRS-6)

The CRS-6 crossing is located at Km 6.2 of the access road. No defined stream channel is present at the proposed crossing site though the terrain is saturated with water. One defined stream channel is present approximately 20 m upstream and 5 m downstream of the CRS-6 crossing site however. Water flows south from the upstream channel through a relatively flat area where the channel divides into several smaller channels and flows spread wide through a saturated vegetated area; the stream channel re-forms downstream of this flat area. The existing ATV trail is also present through this flat area and at the proposed crossing site. The previous ATV crossings through the several small channels and saturated area appear to have contributed to the lack of defined channel at this site; tracks running perpendicular to flow were noted upstream and downstream of the existing trail.

Between the upstream and downstream reaches, the terrain is hummocky with very soft, muddy conditions. The area is primarily vegetated with grass, sedge and moss; other species near the upstream and downstream channels include water sedge, mountain avens, purple saxifrage, Arctic cotton-grass and some willow species. Due to the lack of defined channel at the crossing site, channel measurements were taken at the upstream and downstream reaches. Channel width upstream of the CRS-6 crossing site was 1.3 m, while wetted width was 0.6 m and water depth was also 0.6 m. Downstream the channel width was 1.6 m, wetted width was 1.4 m and water depth was 0.1 m. Water flow at CRS-6 was difficult to estimate due to wide spread flows, however flow was estimated to be 0.5 m/s or less upstream and downstream of the crossing site.

Three CSP culverts will be installed within this area, approximately 40 m apart. The access road will be built up onto and overtop of the culverts as per the typical culvert detail illustrated in Figure 2. As the road route crosses this saturated area at the existing ATV trail, little vegetation will be lost since the existing trail is primarily muddy and unvegetated. This stream is expected to flow throughout the ice-free season. Construction will be completed after the spring melt and water at the CRS-6 crossing site is anticipated to be shallow (e.g. less than and with reduced flow.

1.5.7 Waterbody Crossing #7 (CRS-7)

The CRS-7 crossing is located at Km 7.2 of the access road. The stream is present within a shallow valley bounded to the east and west by bedrock hills and outcrops; snow was present along the east and west facing hillsides. The valley bottom slopes towards the south and the crossing is located in the north (upland) portion of the valley; terrain in this area was sandy with cobble and gravel. A separate, less used ATV trail crosses this stream approximately 7 m upstream from the crossing site. The stream has been impacted by ATV traffic as banks had been eroded and the stream channel widened.

Stream banks were primarily vegetated by grass, sedge and moss, however common horsetail, purple saxifrage, mountain avens, Arctic cotton-grass and net-veined willow were also observed. Stream substrates included fines, cobbles and gravels with boulders; boulders were present throughout the stream and in-stream along its banks. Upstream at the ATV crossing site, substrates were primarily fines and gravels. Water depth during the spring melt was 0.03 m at CRS-7 and ranged from 0.05 m upstream and 0.10 m downstream; wetted width at the crossing site was 0.98 m. Stream flow was estimated at less than 0.5 m/s and, due to the shallow depth and low flow during the freshet, this stream is expected to be ephemeral. This was confirmed by an Elder who reported that the stream only flows when it is raining (S. Kidlapik, *pers. comm.*)

A CSP culvert will be installed at the CRS-7 crossing and the access road will be built up on to and overtop of the culvert, as per the typical culvert detail illustrated in Figure 2. Shoreline vegetation immediately within the road route will be lost as granular materials will be placed on top. Since the stream is expected to be ephemeral, stream flow during culvert placement and in-stream construction is anticipated to be negligible as construction activities will take place after the spring melt.

1.6 Existing Habitat

No fish species were observed within the any of the waterbodies crossed by the proposed access road. The CRS-1 crossing traverses the drainage of a freshwater lake into the marine Tariuraq Inlet and it was reported that the lake may freeze to bottom in winter (S. Kidlapik and R. Tungilik, pers. comm.). Both the Elder and the Hamlet Foreman commented that Arctic char (*Salvelinus alpinus*) may have swum up the drainage area during the summer (before the crossing was constructed), however would have died in the winter when the lake froze. A comprehensive fisheries assessment was not completed during the environmental survey of the proposed access road and fish presence within both lakes could not be confirmed. However it is likely that Tariuraq Inlet contains fish as it is connected to the marine environment of Repulse Bay and is affected by tides in the summer when the current is strong (S. Kidlapik and R. Tungilik, pers. comm.). The freshwater lake also likely contained fish due to the connection with Tariuraq Inlet and may still contain fish if it does not freeze to bottom. Fish species present in Tariuraq Inlet may include Arctic char though this was not verified.

During the environmental survey, all six streams had higher flow than normal due to spring melt. Based on information received from the accompanying Elder and Hamlet Foreman, and the stream flow and water depth observed during the freshet, three of these six streams (CRS-2, CRS-4 and CRS-7) are expected to be ephemeral and flow during the freshet or significant precipitation events only. As a result these streams likely do not have suitable habitat for fish use in spawning, rearing, or food supply during the short freshet season. Furthermore, the shallow depth of CRS-4 and CRS-7 make them unlikely to be used for fish migration. A stickleback species was observed in the small pond from which CRS-2 flows and the fish may have used the CRS-2 stream prior to the construction of the access road and installation of the culvert at this site. However, stickleback are not considered a subsistence or economically important species and any other species of this nature (e.g. Arctic char, lake trout [*Salvelinus namaycush*]) are unlikely to use this stream due to the lack of suitable habitat for these species here.

The remaining three streams (CRS-3, CRS-5 and CRS-6) are expected to flow throughout the ice-free season. All three streams are not expected to contain resident fish species since they freeze to bottom during the winter but may have suitable habitat for fish spawning, rearing and food supply. The headwater lake of CRS-3 was reported to likely contain fish (S. Kidlapik, *pers. comm.*); the species was not provided though are possibly lake trout. The outlet of the CRS-3 stream is the marine environment of Repulse Bay, approximately 700 m downstream from the CRS-3 crossing site. The CRS-3 stream may be used as a migration route for smaller fish from the headwater lake however this could not be verified.

The headwater lakes of CRS-5 and CRS-6 may also contain fish (i.e. lake trout) though this could not be confirmed. If fish are present, the CRS-5 stream may be used as a southward migration route for fish into the marine environment of Repulse Bay during the freshet when depth is sufficient and the connection to Repulse Bay is best. However due to observed potential barriers (e.g. short waterfalls; Photo 19 in **Appendix B**), the crossing site at CRS-5 is likely not used for northward fish migration. The saturated area at the CRS-6 crossing site is also a potential barrier to fish migration due to the wide spread flow pattern and shallow depths. Because of this, fish are unlikely to migrate past the CRS-6 crossing site, though may use a downstream portion of this stream for migration. The outlet lake of CRS-6 may also contain fish (i.e. lake trout), though this was not verified during the environmental survey.

1.7 Construction Details

1.7.1 Access Road Construction & Mitigation

The proposed start date for all construction activities is July 15, 2009. Access road construction is expected to take place over two summers and the predicted completion date is September 2010. Construction will begin at the end of the previously constructed portion of the access road (approximately Km 2.9) and will move successively westward along the proposed route. As mentioned, culverts will be installed at all waterbody crossings.

A loader and a back hoe will be used for the installation of all culverts. Granular materials used for culvert installation will include 20 mm gravel, used at the bed of the culvert, and 150 mm to 300 mm riprap, hand placed around the culvert on the road shoulder.

As there is potential for fish presence in or downstream of waterbodies CRS-1, CRS-3, CRS-5, CRS-6 and CRS-7, in-stream construction will need to be restricted within a timing window to avoid sensitive life stages. The timing window recommended in the Fisheries and Oceans Canada (DFO) Nunavut Operational Statement for In-Water Construction Timing Windows (DFO 2008) will be adopted for in-stream construction activities at these sites. The recommended window for waterbodies in the Repulse Bay area containing Arctic char, lake trout or whitefish (fall spawning fish) is June 30th to August 15th, inclusive. This timing window has been applied as the presence of spring spawning fish (i.e. Arctic grayling [*Thymallus arcticus*] or northern pike [*Esox lucius*]) was not indicated by the accompanying Elder or Hamlet Foreman in waterbodies in or near the Project area. The June 30th to August 15th timing window is also best for in-stream construction on other non-fish bearing waterbodies as it occurs after the spring melt and stream flow will be at its lowest.

Restricting culvert installation to periods of low or no flow will also mitigate potential impacts to hydrology and water quality arising from culvert installation. Potential impacts may include altered stream hydrology, the release of and/or increase in downstream sediments, and the deposition of deleterious substances (e.g. fuel spills). Any effects to hydrology will be temporary and short-term: stream hydrology is unlikely to be negatively affected over the long-term. Installation of culverts may result in a minor positive effect on stream hydrology as traffic will be expected to use the constructed stream crossings rather than travelling within the streambeds. Removal of ongoing disturbance from ATV crossings may result in the restoration of natural or near natural stream flow patterns.

To reduce the potential for a release of a deleterious substance and protect water quality, clean equipment and clean granular material will be used during all in-stream construction work, and regular equipment inspection will be carried out to check for leaks, cracks and weak hoses. An emergency spill kit will be kept on-site with working equipment and, in the event of a spill, the Spill Prevention and Response Plan will be immediately initiated. This Spill Prevention and Response Plan was developed for the Naujaat Co-Op's fuel management and will be adopted by the Hamlet during the access road construction.

Stream flow is expected to be negligible in three of the six streams during construction activities (after the freshet) however low water flow is anticipated in the remaining three streams. A temporary dam to hold back water will be installed to provide sufficient time for culvert installation in these streams. However if a temporary dam will not work under the encountered flow conditions, a temporary channel diversion may need to be built. Permanent alteration of the stream channel is not required for the installation of culverts. At the CRS-1 crossing site, it would not be feasible to construct a temporary dam or diversion channel during culvert installation. In this case and during potential temporary flow diversion in other channels, the water body will be monitored downstream of culvert installations for sediment levels (turbidity/total

suspended solids) during all flow diversion and in-stream construction, and where some water flow is still present.

Culvert riprap (rock cobble 150 mm – 300 mm; FSC 2002) will be hand placed during culvert installation to reduce sediment suspension and dispersion and bank damage; where boulders are too large for hand placement, the slow and deliberate placement by machinery will be applied. This construction practice, along with monitoring downstream suspended sediments levels should be sufficient to ensure effects from sediment on fish populations and habitat are mitigated. If sediment values do exceed allowable criteria (as per CCME 2007 guidelines), boulders/riprap placement can be slowed down or temporarily halted to further reduce sediment suspension. If allowable criteria cannot be met by slowing rock placement, sedimentation control measures (e.g. silt curtains) will be utilised to further protect the downstream environment.

Silt fences will also be installed up-shore of the five small lakes adjacent to the Project route to protect water quality and potential fish habitat within. Two fish species were observed within a small lake adjacent to the existing ATV trail and proposed road route (see Figure 1 in **Appendix A**). One species is likely a ninespine stickleback (*Pungitius pungitius*) as they are reportedly the only stickleback species present in Nunavut (CESCC 2006). The unidentified juvenile fish species appeared to be a salmonid though could not be differentiated between an Arctic char or lake trout (*Salvelinus namaycush*) juvenile. As mentioned, fish may also be present in a second small lake which CRS-7 drains into (S. Kidlapik, *pers. comm.*); this was not confirmed during NJWL's environmental survey. With mitigation, sedimentation is not anticipated to have a significant or permanent effect on fish and aquatic life in waterbodies along the access road route.

Controlling downstream sedimentation and other mitigation measures outlined in the DFO Nunavut Operational Statements for Culvert Maintenance (DFO 2008) will be adopted for culvert installation. Though these measures are outlined for culvert maintenance, they are generally practical for installation as well. Mitigation measures include limiting the removal of shoreline vegetation, operating all heavy equipment and machinery on land, using clean equipment, materials and performing regular equipment inspections, and having an emergency spill kit available on-site. Any installed sediment control measures will also be inspected on a regular basis to ensure proper function.

Construction of the Project is expected to be completed over two summer seasons and any sedimentation effects on fish and aquatic life are expected to be temporary and short-term. With the identified mitigation measures, adverse environmental effects on fisheries from access road construction are anticipated to be not significant and temporary in duration.

1.7.2 Additional Mitigation

Other mitigation measures enacted during the access road construction manage potential impact to the terrestrial environment, such as permafrost, vegetation and wildlife. Effects to permafrost will be mitigated by utilizing the end dump construction method; minimizing the area of disturbance, including confining all site preparation and construction activities to the affected area (e.g. within the area of the existing ATV trail), minimizing the number of vehicles required, and restricting other pieces of heavy equipment (e.g. dump trucks, crew trucks) to the constructed portions of the road. Minimizing area of disturbance will also protect against loss of native vegetation and associated biodiversity; no revegetation of disturbed areas is planned however. Mitigation for the protection of wildlife will involve limiting the timing and duration of construction to non-critical periods (e.g. for nesting avifauna) and halting construction activities when an animal is encountered or if evidence of migrating caribou cows and/or calving is present within the area.

1.7.3 Cumulative Effects

There are no known previous or current developments which might produce a cumulative effect within the Project area, the Repulse Bay area or geographic region during access road construction or operation. However, cumulative effects in the Project area may arise from interaction of road operation effects and potential effects from future development of the granular resource sites (quarries). Potential cumulative effects to water quality and fisheries may include reduced water quality from increased dust and impacts to potential fish habitat within the quarries' footprints. An evaluation of potential fish and fish habitat should be completed within and adjacent to each quarry footprint prior to development. Quarry-specific mitigative strategies (e.g. additional dust management, fish habitat protection) could then be developed.

Other identified cumulative effects to the terrestrial environment include permafrost degradation within the quarries' footprints, loss of vegetative biodiversity and natural communities, prolonged wildlife avoidance of the access road and developed quarries, and increased vehicle-wildlife collisions. These potential cumulative effects could be mitigated with further evaluation of permafrost, vegetation and wildlife within each quarry footprint and subsequent development of mitigative strategies. Mitigation may include, but not be limited to, minimizing the area of disturbance, restriction on the timing of excavation and development of wildlife management plans. The economy of Repulse Bay may experience a positive cumulative effect from access road and quarry operation however, as employment opportunities would be created.

1.8 Culvert Installation

Culverts will be installed at all waterbody crossings along the proposed access road. The typical culvert construction detail is illustrated in Figure 2 in **Appendix A**. Corrugated steel pipe will be used for culvert material. Standard culvert dimension include a minimum diameter of 600 mm for all culverts and minimum 1% decreasing grade from inlet to outlet. Culvert length varies per culvert; these are provided in Table 1.2. Road thickness from the road surface to the top of the culvert will be a minimum of 300 mm or a maximum of 600 mm, and a 100 mm space between base riprap and culvert bottom will be installed at the culvert outlet. Culvert and supporting riprap will be 3 m wide on the road shoulder.

Table 1.2 Culvert diameter and length at each stream crossing along the North Pole River Access Road, Repulse Bay, NU

Waterbody Crossing	Minimum Diameter (mm)	Length (m)
CRS-1	600	Unknown
CRS-2	600	15.8
CRS-3	600	22.8
CRS-4	600	17.8
CRS-5	600	15.5
CRS-6	600	18.8
CRS-7	600	14.4

A backhoe will be used to prepare and grade the culvert bed. The stream channel will be dug twice the width of the culvert and will follow the natural slope and course of the stream channel at the crossing

sites. The culvert base will be compacted granular material (20 mm gravel). All culverts will be buried 100 mm into the stream channel as culvert diameter will generally be less than 1000 mm; if culvert diameter is greater than 1000 mm, the culvert will be buried 150 mm in the stream channel. Culvert bottoms will not purposely be covered with natural substrates however natural streambed material will eventually accumulate along the culvert bottom and provide representative streambed substrate. The embedded culverts will retain the stream substrates and provide unimpeded fish passage in streams with the potential for fish presence.

Culverts will be maintained in accordance with the DFO Nunavut Operational Statement for Culvert Maintenance (DFO 2008). Culverts will be inspected annually for indications of scour degradation, culvert blockage, diversion of stream flow, bank erosion and flooding. Culverts may eventually need to be cleaned of debris (e.g. woody debris, garbage, ice build-up) to enable unobstructed water passage. If it appears the culvert needs to be cleaned, any materials inside or lodged at the inlet of the culvert will be removed and disposed of away from the stream channel. If sediment accumulation becomes large (i.e. culvert greater than 50% full of sediment), some sediment will be cleared out. Sediment control measures (e.g. silt fences) will be installed prior to any sediment clearing to prevent a large influx of sediments in the downstream environment.

2 Summary

The assessment of the interactions of the Project with hydrology, water quality and fisheries concluded that, with mitigation, adverse environmental effects of the Project on these components in the Repulse Bay area will be not significant. Table 2.1 summarizes the potential effects associated with the Project and mitigation measures identified.

Table 2.1 Summary of Potential Environmental Effects for Hydrology, Water Quality and Fisheries

Valued Environmental Component	Potential Effect Positive (P) or Adverse (A)	Mitigation Measures	Cumulative Effect
Hydrology / Water Quality	• Change in surface water quantity and flow (A) • Changes to surface water quality in Project area (A)	• Compliance to DFO Operational Statements • Restriction of in-stream works to periods of low or no flow • Culvert installation may improve stream hydrology through removing direct disturbance from ATVs • Utilizing clean equipment and granular material to protect against deposition of deleterious substances • Regular inspection of all equipment for leaks • Installation of silt fences • Retention of vegetated banks • Monitoring and adaptive management during in-stream works	Not Significant
Fisheries	• Changes to surface water quality in Project area (A) • Introduction of deleterious substances (A)	• Compliance to DFO Operational Statements • Minimize spatial extent of granular material placement and activity • Limit duration of construction period • Restriction of in-stream works to periods of low or no flow • Installation of a temporary dam to hold back water • Slow and deliberate placement of boulders/riprap to reduce sediment suspension and dispersion • Hand placement of in-stream boulders during culvert installation to reduce sediment suspension and dispersion • Utilizing clean equipment and granular material to protect against deposition of deleterious substances	Not Significant

Valued Environmental Component	Potential Effect Positive (P) or Adverse (A)	Mitigation Measures	Cumulative Effect
		• Regular inspection of all equipment for leaks • Installation of silt fences up-shore of Project construction activities on all adjacent waterbodies • Water quality monitoring for turbidity/TSS; implementation of controls to augment construction activities if large changes are evident	

The Hamlet of Repulse Bay will be required to obtain permits and authorization from the Nunavut Water Board and Nunavut Impact Review Board to construct the Project. The approval of the Project will benefit the Hamlet of Repulse Bay by providing a granular material source for future municipal projects and support community development initiatives.

3 Closure

This report has been prepared by Nunami Jacques Whitford Limited for the sole benefit of the Hamlet of Repulse Bay for submission to the Nunavut Water Board. The report may not be relied upon by any other person or entity, other than for its intended purposes, without the express written consent of Nunami Jacques Whitford Limited and the Hamlet of Repulse Bay.

This report was undertaken exclusively for the purpose outlined herein and is limited to the scope and purpose specifically expressed in this report. This report cannot be used or applied under any circumstances to another location or situation or for any other purpose without further evaluation of the data and related limitations. Any use of this report by a third party, or any reliance on decisions made based upon it, are the responsibility of such third parties. Nunami Jacques Whitford Limited accepts no responsibility for damages, if any, suffered by any third party because of decisions made or actions taken based on this report.

Nunami Jacques Whitford Limited makes no representation or warranty with respect to this report, other than the work was undertaken by trained professional and technical staff in accordance with generally accepted engineering and scientific practices current at the time the work was performed. Any information or facts provided by others and referred to or used in the preparation of this report were assumed by Nunami Jacques Whitford Limited to be accurate. Conclusions presented in this report should not be construed as legal advice.

The information provided in this report was compiled from a field survey and existing documents and data provided by the Hamlet of Repulse Bay and by applying currently accepted industry standards and principles. This report represents the best professional judgment of Nunami Jacques Whitford Limited personnel available at the time of its preparation. Nunami Jacques Whitford Limited reserves the right to modify the contents of this report, in whole or in part, to reflect any new information that becomes available. If any conditions become apparent that differ substantially from our understanding of conditions as presented in this report, we request that we be notified immediately to reassess the conclusions provided herein.

This report has been prepared by a team of Nunami Jacques Whitford Limited professionals on behalf of the Hamlet of Repulse Bay. If representatives of the Hamlet of Repulse Bay have questions or concerns about this report, please contact the undersigned.

Respectfully submitted,

NUNAMI JACQUES WHITFORD LIMITED

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Environmental Scientist

Nick Lawson, B.Sc.
Project Manager & Senior Reviewer

4 References

Canadian Endangered Species Conservation Council (CESCC). 2006. Wild Species 2005: The General Status of Species in Canada. Available at: <http://www.wildspecies.ca/wildspecies2005/index.cfm?lang=e>.

Fisheries and Oceans Canada (DFO). Nunavut In-Water Construction Timing Windows for the Protection of Fish and Fish Habitat. Nunavut Operational Statement. March 31, 2008. Available at <http://www.dfo-mpo.gc.ca/regions/central/habitat/os-eo/provinces-territories-territoires/nu/os-eo21-eng.htm>.

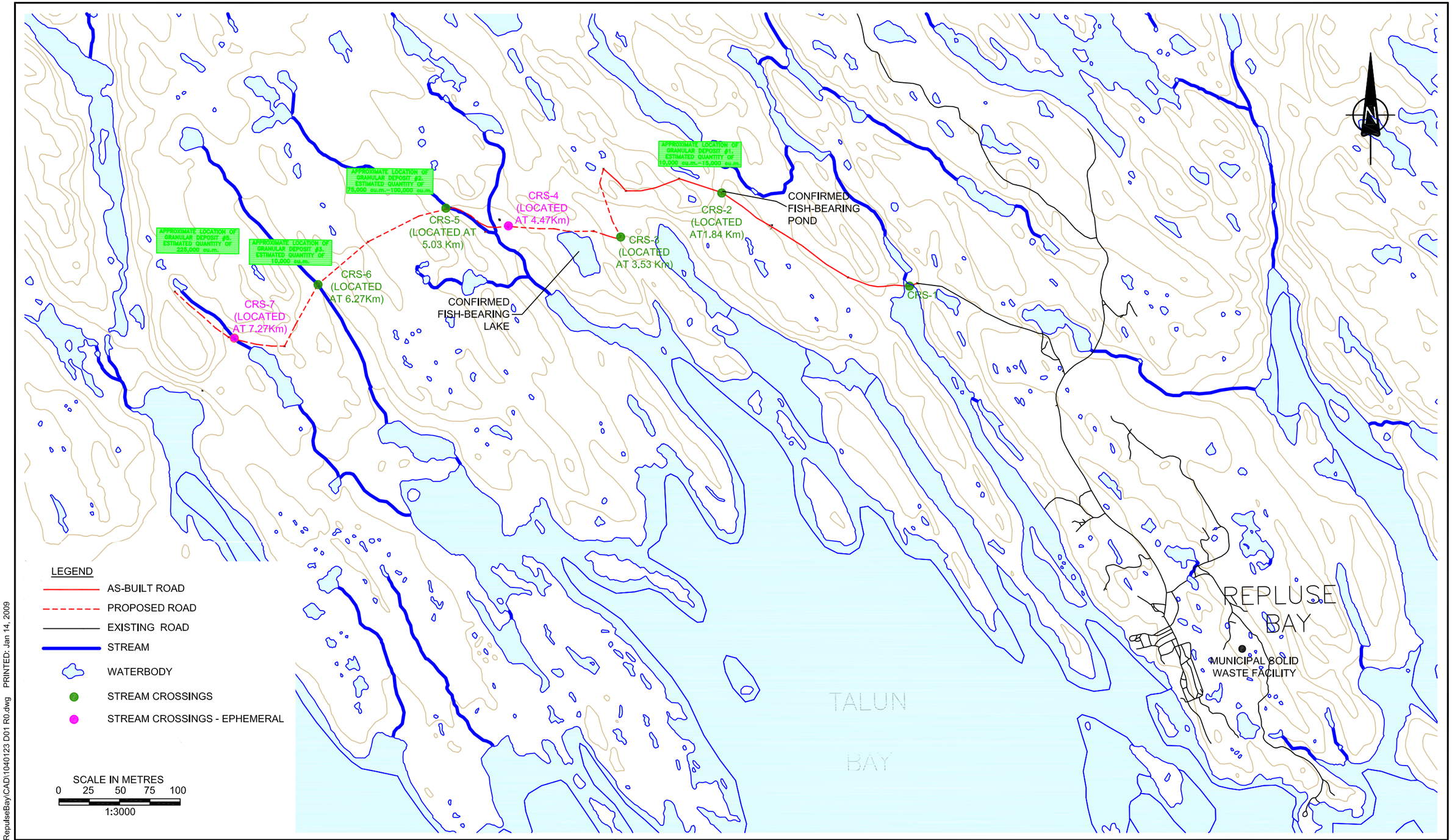
Fisheries and Oceans Canada (DFO). Culvert Maintenance. Nunavut Operational Statement. March 31, 2008. Available at <http://www.dfo-mpo.gc.ca/regions/central/habitat/os-eo/provinces-territories-territoires/nu/os-eo07-eng.htm>.

4.1 Personal Communications

Kidlapik, S. Repulse Bay Elder. Member of Naujaat Hunters and Trappers Organization. Conversations. 16 – 19 June 2008.

Tungilik, R. Hamlet of Repulse Bay Foreman. Conversations. 16 – 19 June 2008.

Appendix A Figures



Reference:	**Job No.:** 1040123 **Scale:** 1:3000 **Date:** 12-Jan-09 **Dwn. By:** SS **App'd By:**	**Client:** HAMLET OF REPULSE BAY **Site Address:** Repulse Bay, NU		NORTH POLE RIVER ACCESS ROAD PROPOSED ROUTE & WATERBODY CROSSINGS	**Dwg. No.:** 1	Jacques Whitford AXYS

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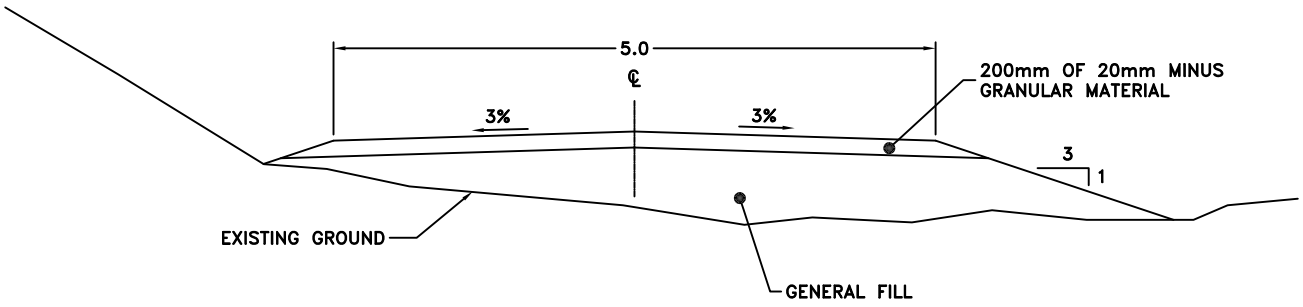
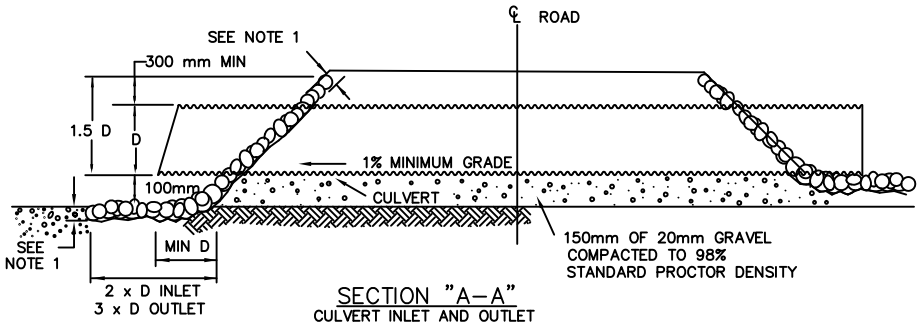


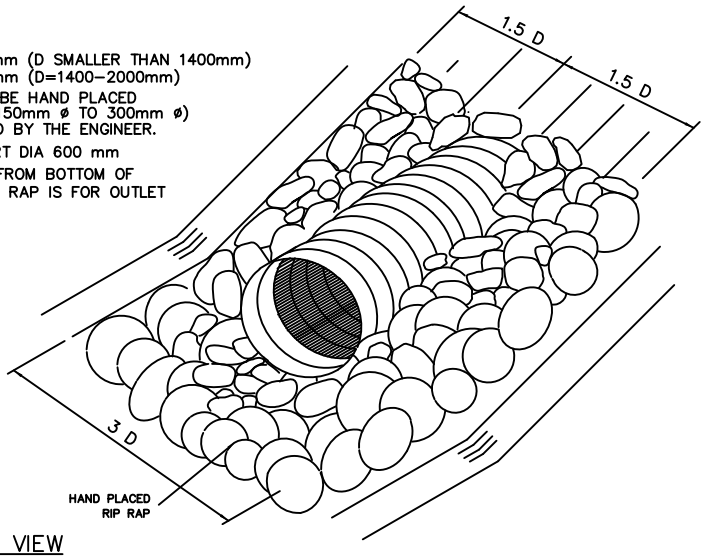
TYPICAL ROAD SECTION



SECTION "A–A"
CULVERT INLET AND OUTLET

NOTE:

1. THICKNESS 300mm (D SMALLER THAN 1400mm)
   THICKNESS 600mm (D=1400–2000mm)
2. RIP RAP SHALL BE HAND PLACED
   ROCK COBBLE (150mm ø TO 300mm ø)
   OR AS SPECIFIED BY THE ENGINEER.
3. MINIMUM CULVERT DIA 600 mm
4. 100 mm DROP FROM BOTTOM OF
   CULVERT TO RIP RAP IS FOR OUTLET
   END ONLY



ISOMETRIC VIEW
CULVERT INLET AND OUTLET

TYPICAL CULVERT DETAIL

ROAD CROSS SECTION AND CULVERT DETAIL REPULSE BAY, NU	Job No.: 1040123 Scale: N.T.S. Date: 07-Jan-09 Dwn. By: SS	Dwg. No.: 2	Jacques Whitford AXYS
Client: HAMLET OF REPULSE BAY	App'd By:		

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