Attachment B

Project Description Report

Water Licence Application

Project Description Report - Gunghi Creek Crossing Replacement

Project: EB193003

Prepared for:

Government of the Northwest Territories, Department of Infrastructure

Yellowknife, Northwest Territories

November 2019

Water Licence Application

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Prepared for:
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November 2019

Executive Summary

The Government of Northwest Territories is proposing the replacement of the existing watercourse crossing carrying the Inuvik to Tuktoyaktuk Highway (ITH) over Gunghi Creek, located at ITH km marker 131.2 (Zone 8W, 577222.00 m E, 7693944.00 m N), approximately 14 km south of Tuktoyaktuk. Wood Environment & Infrastructure Solutions (Wood) was retained to prepare the Project Description Report (PDR) and information requirements for a Water Licence Application.

The existing 2000 mm diameter by 38 m long corrugated steel pipe was built in April 2010 and requires replacement due to major sagging in the center of the existing structure. Gunghi Creek is located in a permafrost rich area prone to major icing that contributes to culvert ice plugging which additionally undermines and endangers the crossing embankments. The proposed replacement structure is a 7518 mm span by 3500 mm rise by 38.966 m long open bottom concrete arch bridge on a 40^{0} RHF skew. The new structure will be installed with a 0.0015 m/m streambed gradient to match average surveyed streambed gradients. The replacement design includes channel bed restoration through the new open bottom arch bridge, which will promote flow roughness, slow water velocities, restore habitat connectivity and fish passage through the watercourse crossing, and improve long-term productive capacity of available fish habitat at the Project site. Channel restoration will consist of a 0.45 m thick constructed channel bed of Class 1 rock riprap with over non-woven geotextile that will be embedded and graded to transition smoothly to the natural channel bed elevations upstream and downstream of the structure. The constructed channel bed will incorporate rock boulders (Class 2 [projecting 350 mm above the Class 1 riprap] spaced at 5.0 m intervals. The channel bed transitions will extend 5 m upstream and downstream from the new bridge structure. Armored bank transitions at the bridge inlet and outlet ends will have 3:1 to 1:1 slopes.

The project site is located on Inuvialuit-owned 7(1)(A) private lands within the Inuvialuit Settlement Region; however, the works will occur within the existing ITH right-of-way (RoW) obtained by the Government of the Northwest Territories, Department of Infrastructure from the Inuvialuit Regional Corporation. The Project construction is tentatively scheduled for February 15, 2020 - April 15, 2020, where works are expected to be completed during low/no flow and frozen surface water conditions. Instream works are planned to be completed by March 30, 2020, prior to the spring freshet and the restricted activity timing window for instream work of April 1 to July 15.

The project in located in a small number of harvesting and management areas for the Inuvik and Tuktoyaktuk communities, however the proposed development is not expected to impact traditional land use and management principles. At the time of writing community engagement with local Hunters and Trappers Committees (HTC) was planned for November 12, 2019. Comments received to date by the Inuvik HTC were in support of the replacement structure.

The PDR identified a number of potential environmental effects on soils, permafrost, vegetation, wildlife, and aquatic resources. In general, potential adverse environmental effects on the environmental components will be short-term and/or localized to the project site and can effectively be mitigated through technically and economically feasible mitigation methods described in this report. Adherence to design, construction and operation best practices, will also minimize or address the potential of malfunctions or accidental events. Adverse residual impacts therefore are predicted to be not significant for both construction and operation phases of the Project for all environmental components. Further, due to the project utilizing the existing ITH RoW, and mitigation that will be implemented to minimize the contribution of the Project to cumulative effects in the region, no significant adverse cumulative effects are predicted as a result of the Project.

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List of Acronyms

BMP	Best Management Practices
CEA	Cumulative Effects Assessment
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
DFO	Department of Fisheries and Oceans Canada
ECCC	Environment and Climate Change Canada
ECO	Environmental Construction Operations
EISC	Environmental Impact Screening Committee
ESC	Erosion and Sediment Control
ESCP	Erosion and Sediment Control Plan
EMP	Environmental Management Plan
GNWT	Government of Northwest Territories
IFA	Inuvialuit Final Agreement
IHTC	Inuvik Hunters and Trappers Committee
ITH	Inuvik to Tuktoyaktuk Highway
LSA	Local Study Area
NTS	National Topographic Series
NWT	Northwest Territories
PDA	Principal Disturbance Area
PDR	Project Description Report
RoW	Right-of-Way
RSA	Regional Study Area
THTC	Tuktoyaktuk Hunters and Trappers Committee
VEC	Valued Ecosystem Component
SARA	*Species at Risk Act*

1.0 Introduction

The Government of the Northwest Territories, Department of Infrastructure (GNWT) will be undertaking culvert replacement works at a crossing carrying the Inuvik to Tuktoyaktuk Highway (ITH) over Gunghi Creek, south of Tuktoyaktuk, Northwest Territories. Wood Environment & Infrastructure Solutions (Wood) was retained to prepare a Water Licence Application. It is intended this Project Description Report (PDR) meet the information requirements in support of the Water Licence Application.

2.0 Project Description and Location

The Gunghi Creek Crossing replacement or "the Project" is located at the north end of the Inuvik to Tuktoyaktuk Highway (ITH), at approximately km marker 131.2 (Zone 8W, 577222.00 m E, 7693944.00 m N), located 14 km south of Tuktoyaktuk (see Figure 1). The Project site is located on Inuvialuit-owned 7(1)(A) private lands within the Inuvialuit Settlement Region. The Project site occurs in the Tuktoyaktuk Coastal Plains Level IV ecoregion of the Level II Southern Arctic, Tundra Plains ecoregion (ECG 2012). Gunghi Creek is within the Southern Beaufort Sea – Eskimo Lakes Basin of the Arctic Ocean watershed (GNWT 2018a).

The existing 2000 mm diameter by 38 m long corrugated steel pipe was built in April 2010 and requires replacement due to major sagging in the center of the existing structure. Gunghi Creek is located in a permafrost rich area prone to major icing that contributes to culvert ice plugging which additionally undermines and endangers the crossing embankments. The proposed replacement structure will provide adequate flow capacity during a Q100 design flood and spring freshet over design ice events.

The proposed replacement structure is a 7518 mm span by 3500 mm rise by 38.966 m long open bottom concrete arch bridge on a 40^0 RHF skew. The new structure will be installed with a 0.0015 m/m streambed gradient to match average surveyed streambed gradients, incorporate channel enhancement, and accommodate fish passage. Design drawings are provided in Appendix A.

Channel bed restoration through the new open bottom arch bridge will promote flow roughness, slow water velocities, restore habitat connectivity and fish passage through the watercourse crossing, and improve long-term productive capacity of available fish habitat at the Project site. Channel restoration will consist of a 0.45 m thick constructed channel bed of Class 1 rock riprap with over non-woven geotextile that will be embedded and graded to transition smoothly to the natural channel bed elevations upstream and downstream of the structure. The constructed channel bed will incorporate rock boulders (Class 2 [projecting 350 mm above the Class 1 riprap] spaced at 5.0 m intervals. The channel bed transitions will extend 5 m upstream and downstream from the new bridge structure. Armored bank transitions at the bridge inlet and outlet ends will have 3:1 to 1:1 slopes.

The Project works will occur within the existing ITH right-of-way (RoW) obtained by the Government of the Northwest Territories, Department of Infrastructure from the Inuvialuit Regional Corporation. An onsite detour (ice road and snow fill) will be constructed within the existing ITH RoW to bypass traffic during construction.

Northwest Territories	DRAWN: JP/VA	Gunghi Creek Crossing Replacement Inuvialuit Water Board Water Act Application	DATE: October 2019
	CHECKED: PK		PROJECT #: EB193003
wood. Environment & Infrastructure Solutions 5681-70 STREET EDMONTON, AB, T6B 3P6 PHONE:780-436-2152, FAX:780-435-8425	SCALE: 1:15,000		MAP NAME: Fig1_Location.mxd
	DATUM & PROJECTION: NAD 1983 UTM Zone 8N	Location Plan	FIGURE 1

I:\GIS\Projects\EB\EB193003_GunghiCreek\Fig1_LocationPlanV3.mxd

2.1 Construction Schedule

The Project is tentatively scheduled for construction starting February 15, 2020 with completion April 15, 2020, where works are expected to be completed during low/no flow and frozen surface water conditions. Instream works are planned to be completed by March 30, 2020, prior to the spring freshet and the restricted activity timing window for instream work of April 1 to July 15.

2.2 Construction Access, Laydown, and Equipment

Construction crew will commute daily from an existing camp in Tuktoyaktuk using the existing ITH. A single trailer will be kept onsite for office and safety purposes. No onsite camp will be required. An onsite detour (ice road and snow fill) will be constructed to bypass traffic during construction. The detour will be constructed within the existing ITH RoW. It is understood that where water is required for construction of the temporary detour, it will be hauled in from Tuktoyaktuk. Construction laydown/staging area will also occur with the existing ITH RoW at the project site. The laydown is expected to be used for piling equipment and related materials. Typical construction primary and ancillary activities are summarized in Table 1.

Table 1. Typical Project Components Undertaken for Crossing Replacement Projects

Project Phase	Primary Project Activities	Ancillary Activities	Related Equipment
Construction	• Clearing and grading, stripping and stockpiling of topsoil and subsoil • Watercourse crossing structure removal and installation • Installation of signage • Waste disposal	• Staging areas • Traffic management • Related traffic signage • Erosion and Sediment Control Water Management	• loader, haul truck • backhoe • Auger • Dozers, excavators

3.0 Contact Names and Addresses

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4.0 Methodology

4.1 Spatial Boundaries

For the purpose of the PDR, the principal disturbance area (PDA), or Project footprint, was defined as the physical footprint of proposed disturbance.

The local study area (LSA) was defined by the PDA plus a 150 m buffer on either side of the existing roadway centreline at the Project crossing.

A regional study area (RSA) up to 5 km surrounding the LSA was used to identify and evaluate potential regional effects of the Project.

4.2 Background Information Review

A review of available maps, satellite imagery, photographs, and reports was conducted in reference to the Project area. Background information review was primarily limited to existing coarse-level (e.g., regional) information relating to valued ecosystem components (VECs). The information sources reviewed included:

- Project description, design and construction information from the Contractor (Allen Services & Contracting) and Wood Environment and Infrastructure Solutions;
- Satellite imagery, site photos and maps;
- Environmental databases: NWT Spatial Data Warehouse, Alaska Exotic Plants Information Clearinghouse (AKEPIC) data mapping tool, and Species at Risk Public Registry; and
- Review of documents prepared for either the proposed development or construction of the ITH:
  - *Fish Habitat Assessment for Crossing Structure Replacement: NWT Highway 10 at KM 7.5 (Gunghi Creek)* (Stantec 2018; provided in Appendix B);
  - *Detailed Hydrotechnical Report Gunghi Creek Culvert Replacement Km 131.2 Inuvik Tuktoyaktuk Highway (No. 10), Project # EB193003* (Wood 2019; provided in Appendix B); and
  - *Project Description Report for Construction of the Inuvik to Tuktoyaktuk Highway, Northwest Territories* (Kiggiak-EBA Consulting Ltd. 2010).
  - *Geological Evaluation for Crossing Remediation at Gunghi Creek Inuvik to Tuktoyaktuk Highway, NT* (Kiggiak-EBA Consulting Ltd. 2017).

4.3 Environmental Effects Assessment

Assessment of the anticipated residual effects of the project-related activities on environmental components was based on professional judgment and qualitative/quantitative evaluation based on Project-specific activities and their potential interactions with the environment during the construction and operation/maintenance phases. Residual effects were assessed by considering the potential effectiveness of proposed mitigation measures, followed by assessing any remaining post-mitigation effects. Assessment criteria used to rate potential residual effects and determine significance is provided in Table C1, Appendix C. Underlying assumptions included:

- Proposed works will be designed, constructed and operated with due care for safety and the environment, using current and technically feasible engineering and construction Best Management Practices (BMPs), PDR recommendations, Environmental Management Plan (provided in Appendix D), and Contractor's ECO Plan; and
- For residual effects, baseline condition includes effects of past and existing activities.

Assessment of cumulative environmental effects that are likely to result from the project follows directly from assessment of residual effects. If the project is anticipated to have measurable incremental effect on a given environmental component, and where these effects could act in an additive or cumulative manner with impacts from other projects or activities in the study area, then a cumulative effects assessment (CEA) was completed for the environmental component.

5.0 Other Environmental Assessments

Stantec (2018) completed a fish habitat assessment in support of the proposed Gunghi Creek crossing replacement (provided in Appendix B), which included a field-level assessment and review of technical studies for fish species presence in the area of the project site.

A number of other assessments have been completed for the Inuvik to Tuktoyaktuk Highway including studies completed since 1970s (Kiggiak-EBA Consulting Ltd. 2010), the *Proposed Inuvik to Tuktoyaktuk Road: Environmental/Socioeconomic Baseline Report* (Rescan 1999). Several volumes of information on the environmental aspects of potential industrial have also been prepared for petroleum exploration in the Mackenzie Delta and Beaufort Sea region (Kiggiak-EBA Consulting Ltd. 2010). Further, an *Environmental Impact Statement for the Mackenzie Gas Project* (IOL et al. 2004), was prepared and included biophysical baseline data, socio-economic, cultural, and community engagement with residents of Inuvik and Tuktoyaktuk.

6.0 Water Use

The proposed Gunghi Creek crossing replacement project will not result in the direct use/withdrawal of water. Any water required for the project will be transported to site from the Hamlet of Tuktoyaktuk and will not be locally sourced. The proposed development will involve:

- Instream water activities at a watercourse crossing where the watercourse is greater than five meters wide at the ordinary high-water mark;
- Watercourse training, including channel and bank alterations; and
- Where water is present during the proposed winter construction schedule, diversion of the watercourse around instream isolation facilities (see Section 11.4.2).

7.0 Deposit of Waste

Waste, as defined in the NWT *Waters Act* potentially generated during the project includes: sediment, sewage, solid, and hazardous waste (eg., fuels, oils, batteries and lubricants). A Waste Management Plan, provided in Appendix D has been developed for the collection, transportation, and disposal/treatment of waste potentially generated during the project. With the implementation of the best management practices and mitigation measures outlined herein, the proposed development is not expected to result in the deposit of waste.

Potentially for erosion and sediment mobilization from disturbed areas during construction is very low, as activities will be carried out in winter/frozen conditions. Sediment will be managed through implementation of the Erosion and Sediment Control Plan provided in Appendix D and where water is present during construction turbidity monitoring will be undertaken (see also Section 11.4.2).

For sewage waste generated on site, service will be provided by Allens in Inuvik, or a Tuktoyaktuk Municipal Contractor and will be disposed of according to the Hamlet of Tuktoyaktuk or Town of Inuvik regulation.

Solid and hazardous waste will be temporarily stored onsite in separate, designated covered containers and transported to an approved waste disposal/transfer facility for treatment/disposal in either the Tuktoyaktuk or Inuvik. Recyclable material will be stored separately onsite and disposed of at the recycling depot in either Tuktoyaktuk or Inuvik. Hazardous waste (e.g. fuels, oils, batteries and lubricants) will be separated from solid waste and stored in a clearly marked area (e.g. signs and/or flagging) more than 100m from the high-water mark of any water body.

8.0 Other Persons Affected by Undertaking

The project will occur within an existing right-of-way for the ITH. The closest dwelling or business occurs 10 km north of the project site. The Hamlet of Tuktoyaktuk and Town of Inuvik have licensed waste management facility. The contractor will be responsible to confirm acceptance of waste generated during construction with their selected facility.

9.0 Socio-Economic

9.1 Traditional and Other Land Uses

The proposed development occurs approximately 10 km south of the nearest business or dwelling. The project site is located on Inuvialuit-owned 7(1)(A) private lands within the Inuvialuit Settlement Region. Traditional land uses of the Inuvialuit peoples of the Tuktoyaktuk and Inuvik communities include subsistence hunting, trapping, gathering, and fishing (Ecological Stratification Working Group 1995).

The project site occurs within Inuvik and Tuktoyaktuk land use management categories C[1] and E[2]. Further, several important harvest, wildlife range and management areas overlap the Project. Table 2 outlines these community conservation management areas. The proposed construction timing window (Feb 15 - April 15, 2020) will occur during the Tuktoyaktuk and or Inuvik harvesting seasons for furbearers, muskrat, caribou, moose, polar bear, muskox, grizzly bear, ptarmigan, and lake trout (THTC et al 2016; and IHTC et al 2016). Although the Project occurs within important areas for land use and special management, the proposed development will be restricted to within the existing ITH RoW and is not expected to impact traditional land use and management principles.

1 Management Category C: Lands and waters where cultural or renewable resources are of particular significance and are sensitive during specific times of the year. These lands and waters shall be managed so as to eliminate, to the greatest extent possible, potential damage and disruption. (THTC et al 2016).

2 Management Category E: Lands and waters where cultural or renewable resources are of extreme significance and are sensitive. There shall be no development on these areas. These lands and waters shall be managed to eliminate, to the greatest extent possible, potential damage and disruption. This category recommends the highest degree of protection in this document (THTC et al 2016).

Table 2. Tuktoyaktuk and Inuvik Community Conservation and Management Areas[1]

Community	Designated Area	Site / Management No.
Tuktoyaktuk, Inuvik	Spring/summer/fall/winter caribou harvesting	302C, 306C, 309C, and 315C
Tuktoyaktuk	Spring goose harvesting	304C
Tuktoyaktuk	Spring/fall fishing	305C and 310C
Tuktoyaktuk	Winter wolverine harvesting	314C
Tuktoyaktuk	Grizzly bear denning	322C
Tuktoyaktuk, Inuvik	Caribou herds[2] winter range	701E
Tuktoyaktuk, Inuvik	Fish lakes and rivers	704C
Tuktoyaktuk, Inuvik	Tultoyaktuk-West grizzly bear management area	I/GB/04
Tuktoyaktuk, Inuvik	South Beaufort polar bear management area	I/PB/03

Notes. 1: THTC et al 2016; and IHTC et al 2016; 2: Tuktoyaktuk Peninsula, Cape Bathurst, and Bluenose-West Caribou herds.

9.2 Community Engagement and Consultation

Consultation with the Inuvik and Tuktoyaktuk Hunters and Trappers Committees (HTC) is scheduled for November 12, 2019. The Inuvik HTC met in Inuvik on October 30, 2019 to discuss the proposed development. The IHTC are in favor of the proposed development, as outlined in the letter provided in Appendix E.

10.0 Biophysical Environment

10.1 Geology, Permafrost and Soils

The geology and permafrost conditions in the LSA are described in the *Geological Evaluation for Crossing Remediation at Gunghi Creek Inuvik to Tuktoyaktuk Highway, NT* (Kiggiak-EBA Consulting Ltd. 2017), as summarized herein. The LSA occurs in an area mapped as ground moraine with a thin organic veneer (Rampton 1987). The till and glacial deposits are of the Buckland Glaciation, and till and associated gravel and sand deposited directly, or with minor reworking by glacier ice, are generally modified by cryoturbation (Kiggiak-EBA Consulting Ltd. 2017). The LSA is also within a continuous permafrost zone (Heginbottom et al. 1995) and was characterized by high ground ice content (greater than 20%) in the upper 10-20 m of the ground. Based on the geology and permafrost conditions, soils in the LSA are likely Turbic Cryosols that have developed primarily in mineral parent material and have marked evidence of cryoturbation (Ecological Stratification Working Group 1995; Soil Classification Working Group 1998).

10.2 Vegetation

The RSA is characterized by low shrub and erect dwarf shrub tundra (*Betula glandulosa, Vaccinium uliginosum, V. vitis-ideas, Ledum palustre, Salix glauca, Salix* spp., *Alnus* spp., *Empetrum nigrum,* mosses, lichens), no trees (ECG 2012). Moss-low-shrub wetlands are extensive (ECG 2012). Vegetation at the Project site was dominated by low and dwarf shrub species (dwarf birch [*Betula nana*] and willows) (Stantec 2018; Appendix F, Photos 1-2). A review of the Alaska Exotic Plant Information Clearinghouse (AKEPIC) data portal and NWT Spatial Data Warehouse, Geospatial Portal did not identify any occurrences of non-native or species at risk plants within the RSA, LSA or PDA (ACCS 2019; GNWT 2018a).

10.3 Wildlife and Wildlife Habitat

Expected Wildlife Species

There are 25 mammals potentially occurring in the LSA, as outlined in Table 3. Kiggiak-EBA Consulting Ltd. (2010) reported approximately 137 bird species in the region of the ITH including songbirds, upland birds, waterfowl, raptors and owls. Only 17 of these bird species are year-round residents, while the remaining 120 are migratory species with the majority only occupying the region in the summer (Kiggiak-EBA Consulting Ltd. 2010). The RSA does not overlap any amphibian ranges of species known to occur in the NWT (CMA 2017).

Table 3. Mammals potentially occurring within the LSA of the Gunghi Creek Crossing[1]

Common Name	Scientific Name
Barren-ground shrew	*Sorex ugyunak*
Tundra shrew	*Sorex tundrensis*
Masked shrew	*Sorex cinereus*
Northern red-backed vole	*Clethrionomys rutilus*
Tundra vole	*Microtus oeconomus*
Brown lemming	*Lemmus sibiricus*
Collared lemmings	*Dicrostonyx groenlandicus, D. kilangmiutak, D. richardsoni*
Arctic hare	*Lepus arcticus*
Snowshoe hare	*Lepus americanus*
Arctic Ground Squirrel	*Spermophilus parryii*
Beaver	*Castor canadensis*
Muskox	*Ovibos moschatus*
Barren-ground caribou (Tuktoyaktuk Peninsula, Cape Bathurst, and Bluenose-West herds)	*Rangifer tarandus groenlandicus*
Polar bear	*Ursus maritimus*
Moose	*Alces americanus*
Grizzly bear	*Ursus arctos*
Tundra wolf	*Canis lupus*
Red fox	*Vulpes vulpes*
Arctic fox	*Vulpes lagopus*
Lynx	*Lynx canadensis*
Wolverine	*Gulo gulo*
Ermine	*Mustela ermine*
Porcupine	*Erethizon dorsata*
Least weasel	*Mustela nivalis*
River otter	*Lontra canadensis*
Notes 1: GC 2019a; Kiggiak-EBA Consulting Ltd. 2010.	

Species of Conservation Concern

Of the 25 terrestrial mammals and 137 bird species that potentially occur in the LSA, 18 are federally listed as outlined in Table 4 (GC 2019a).

Table 4. Status of Federal and Territorial Listed Species Potentially Occurring in the LSA

Common Name	Scientific Name	Federal Status[1]		NWT Status		
		COSEWIC	SARA	NWT Species at Risk Listing[2]	Species at Risk Committee Assessment[2]	General Status[3]
Barren-ground Caribou	*Rangifer tarandus groenlandicus*	Threatened	No Status	Threatened	Threatened	At Risk
Grizzly bear	*Ursus arctos*	Special Concern	Special Concern	No Status	Special Concern	Sensitive
Polar Bear	*Ursus maritimus*	Special Concern	Special Concern	Special Concern	Special Concern	Sensitive
Wolverine	Gulo gulo	Special Concern	Special Concern	No Status	Not At Risk	Sensitive
Eskimo Curlew	*Numenius borealis*	Endangered	Endangered	Not Applicable	Not Applicable	At Risk
Rusty Blackbird	*Euphagus carolinus*	Special Concern	Special Concern	No Status	Not Assessed	Sensitive
Peregrine Falcon	*Falco peregrinus*	Not At Risk	Special Concern	No Status	Not Assessed	Sensitive
Short-eared Owl	*Asio flammeus*	Special Concern	Special Concern	No Status	Not Assessed	Sensitive
Bank Swallow	*Riparia riparia*	Threatened	Threatened	Not Applicable	Not Applicable	At Risk
Barn Swallow	*Hirundo rustica*	Threatened	Threatened	Not Applicable	Not Applicable	At Risk
Buff-breasted Sandpiper	*Calidris subruficollis*	Special Concern	Special Concern	Not Applicable	Not Applicable	Sensitive
Harris's Sparrow	*Zonotrichia querula*	Special Concern	No Status	Not Applicable	Not Applicable	Undetermined
Horned Grebe	*Podiceps auratus*	Special Concern	Special Concern	Not Applicable	Not Applicable	Sensitive
Red Knot	*Calidris canutus islandica*	Special Concern	Special Concern	Not Applicable	Not Applicable	At Risk
Red Knot (Rufa subspecies)	*Calidris canutus rufa*	Endangered	Endangered	Not Applicable	Not Applicable	At Risk
Red-necked Phalarope	*Phalaropus lobatus*	Special Concern	Special Concern	Not Applicable	Not Applicable	Sensitive

Notes 1. GC 2019a; GC 2016: **COSEWIC** – Committee on the Status of Endangered Wildlife in Canada; **SARA** – *Species at Risk Act*; **Threatened** - A wildlife species that is likely to become endangered if nothing is done to reverse the factors leading to its extirpation or extinction; **Special Concern** – A wildlife species that may become threatened or endangered because of a combination of biological characteristics and identified threats; **Endangered** – A wildlife species facing imminent extirpation or extinction; **Not At Risk** – A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances;
2. GNWTENR 2018; **Threatened** – a species likely to become an endangered species if nothing is done to reverse the factors leading to its extirpation or extinction; **Special Concern** – a species that may become threatened or endangered because of a combination of biological characteristics and identified threats; **No Status** – species was assessed and found to be not at risk of extinction given the current circumstances; **Not Assessed** – species has not been assessed; **Not Applicable** – Species at Risk (NWT) Act does not apply to this species;
3: WGNWT 2016. **At Risk -** species for which a detailed assessment has recently been completed and determined that the species is at high risk of extinction or extirpation.; **Sensitive** – species that are not at high risk of extinction or extirpation but may require some special attention or protection to prevent them from becoming at risk; **Undetermined** - . species for which insufficient information, knowledge, or data is available to reliably evaluate their general status rank.

Habitat Suitability

Habitat suitability for listed species potentially occurring in the LSA is presented below.

Barren-ground caribou

Caribou are generalist foragers that require large annual ranges (several hundred thousand square kilometres in size) in response annual variations in environmental conditions (eg., snow depth, insects, forage quality, plant growth, and predation) (COSEWIC 2016).

The Cape Bathurst are the primary herd potentially occurring in the LSA, while the Bluenose-west and Tuktoyaktuk Peninsula herds are only expected to sparsely overlap the LSA. Calving (late May or early June) and summer habitat for all three herds generally occurs north-northwest of the LSA; in the Brock, Hornaday and Horton River area for Cape Bathurst and Bluenose-west; and the north end of the Tuktoyaktuk peninsula for the Tuktoyaktuk Peninsula herd. The Cape Bathurst and Bluenose-west herds generally winter near or below the treeline, south of the LSA, although the LSA occurs within designated caribou winter range 701E, while the Tuktoyaktuk Peninsula herd generally winter north of the LSA (THTC et al 2016).

Grizzly Bear

Grizzly bear are omnivorous, but primarily herbivorous and require a wide variety of plant species. They are habitat generalists with strongly seasonal habitat associations (eg., dependent local plant communities, fish migrations, and ungulate calving) (COSEWIC 2012a; THTC et al 2016). Grizzly bear generally avoid areas of human activity, although some disturbed habitats, such as road allowances may attract bears (COSEWIC 2012a). Although the PDA occurs within Grizzly bear denning area 322C, no dens were identified near the ITH alignment (Rescan 1999; THTC et al 2016).

Polar Bear

The project occurs in the North Beaufort Polar Bear Management Area, established in 2006 to facilitate coordinated management of polar bear between the Inuit of the Kitikmeot West Region in Nunavut and the Inuvialuit in Northwest Territories (Kiggiak-EBA Consulting Ltd. 2010; Joint Secretariat 2017). Polar bear are dependent on sea ice distribution and conditions, which govern the availability of their primary prey species, the ringed seal (*Pusa hispida*) (Joint Secretariat 2017). Female polar bears typically den on land in early winter. The most commonly selected den sites are along coastal banks where snow accumulates on the leeward side of banks. However, den sites may be located further inland in ravines or depressions if conditions are suitable (Joint Secretariat 2017). The LSA provides poor denning habitat and does not support habitat for their primary prey or ideal foraging opportunities. As such, polar bear are expected to primarily occupy the coastal region north of the Project and unlikely to be observed in the LSA.

Wolverine

Wolverine inhabit a variety of habitats including forested and open areas, however historical accounts of aboriginal harvesters indicate wolverines are more common at higher elevation areas and uncommon in open tundra habitats found at the Project (COSEWIC 2014). Wolverine numbers are strongly associated with abundance and diversity of prey and other carnivore species. Den sites are typically built in areas with high security such as in talus boulders, deadfall piles, under logs in avalanche debris, along eskers or in snow tunnels on the tundra (COSEWIC 2014). Less preferred but historically reported den sites include snowbanks, along streams and under tree roots. Although the banks of Gunghi Creek may provide suitable denning habitat, wolverines are a reclusive species sensitive to disturbance, and it is unlikely that denning occurs in the LSA.

Birds of Prey

Although peregrine falcon are listed as Special Concern by SARA, they are considered a common raptor species in the Tundra Plains Ecoregion, and are the most globally widespread bird of prey (ECG 2012). Habitat requirements include abundant small prey (i.e., mammals and birds), and access to high quality nesting sites, which are typically cliffs adjacent to lakes or rivers. The absence of preferred nesting sites in proximity to the Project is considered a limiting factor and peregrine falcons are therefore not suspected to nest within the LSA.

The short-eared owl prefer low-arctic tundra, open areas, bogs and marshes, and in the northwest territories are most commonly found breeding on coastal tundra habitat (COSEWIC 2008). General habitat selection includes areas with abundant mammals (GNWT et al 2014). General habitat selection includes adequate nesting sites in dense grassland or small willows, and areas with abundant mammals (GNWT et al 2014). Habitat within the LSA was rated as moderate for short-eared owl.

Shorebirds and Waterfowl

Eskimo curlews and Buff-breasted sandpipers share similar preferences for breeding and feeding habitat. Preferred habitats of both species include primarily treeless areas of tundra with abundant dwarf shrubs and graminoids, or grassy meadows dominated by grasses, dwarf birch, sedges and mountain-avens such as along riparian areas associated with watercourses and wetlands (COSEWIC 2009a). Habitat within the LSA was rated as moderate for short-eared owl.

Horned Grebe generally nest in fresh water, occasionally in brackish water, along small bays bordering lakes, marshes, or open water wetlands (COSEWIC 2009b). Emergent vegetation is considered an important feature of preferred nesting sites. Habitat within the LSA was rated as poor for Horned Grebe due to lack of emergent vegetation in the LSA.

Red Knots in the arctic nest on barren habitats such as south-facing wind swept ridges, plateaus or ridges with less than 5% vegetation cover (COSEWIC 2007). Nest sites are typically located within 50 m of the coast, often near lakes or wetlands, and are constructed in dry, south-facing areas. Foraging can occur up to 10 km from the nest site, often in damp areas with little vegetation. Habitat within the LSA was rated as poor due to lack of preferred nesting habitat.

Red-necked phalarope are dependent on shallow freshwater ponds for forage during the nesting season, and commonly select nest sites in and around sedge meadows (ECG 2012). Outside of the nesting season, red-necked phalaropes spend up to nine months foraging on the open ocean. Habitat within the PDA/LSA was rated as poor due to lack of shallow ponds in the PDA/LSA.

Songbirds

Rusty blackbirds prefer to nest in treed wetland areas but occasionally nest in willow thickets in the southern arctic (ECG 2012). Due to lack of trees and low height of shrubbery observed around Gunghi Creek, nesting in the LSA or PDA is not suspected.

Bank swallows congregate in large colonies, burrowing out their nest sites in the face of steep sandy bluffs or riverbanks (ECG 2012). Barn swallows use natural crevices, caves, tree cavities or man-made structures such as roof eaves for nesting (ECG 2012). Both swallow are not expected to nest in the LSA due to lack of preferred habitat.

Harris's sparrows are common at the forest-tundra transition area but may be found in treeless habitats such as those found at the Project site (ECG 2012). Breeding/nesting sites are often associated with coniferous trees such as spruce and tamarack with shrub understories (COSEWIC 2017). Nests are seldom constructed in open tundra areas but may be located in dense shrub cover where trees are absent (COSEWIC 2017). Due to lack of trees this species not expected to nest in the LSA.

10.4 Surface Hydrology and Climate

Climate

Hydraulic regime is a result of climatic factors including temperature and precipitation in the region. In Tuktoyaktuk, the closest community where meteorological data is recorded average annual precipitation is 106.7 mm and ranges from 6.8 mm in May to 25.7 mm in August with the majority being snowfall, as shown in Figure 2 (Department of Natural Defence Station Tuktoyaktuk A; GC 2019b). The average annual temperature is -10.1°C and ranges from -26.6°C in January to 11.0°C in July (GC 2019b). Decreasing temperature in the fall result in a usual freeze over in the RSA between October 1st and October 9th and the first ice deterioration between May 13th and May 28th (Allan 1977).

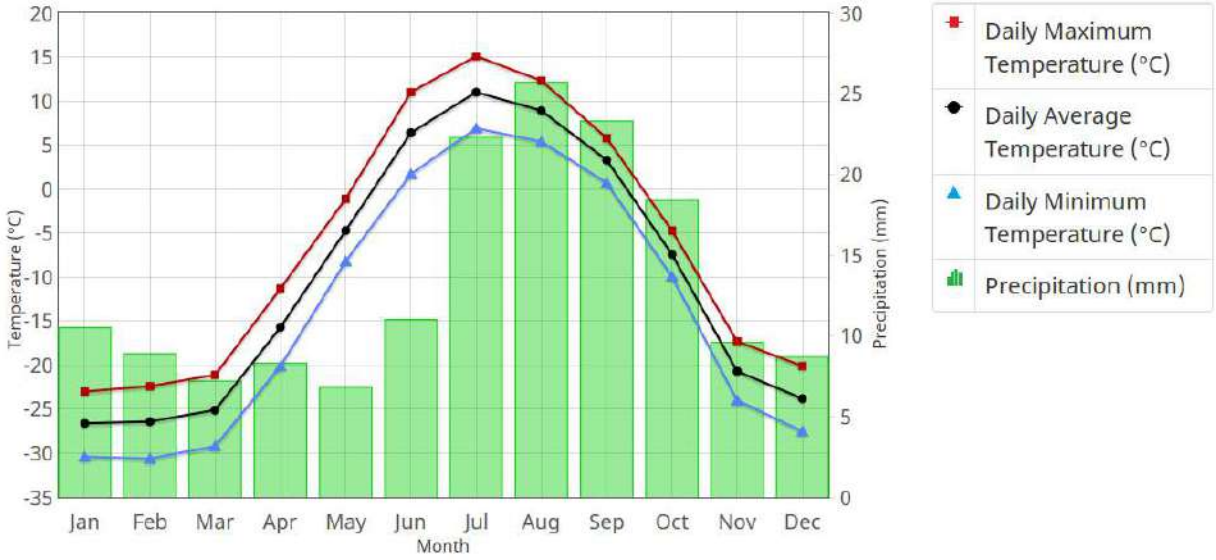

Figure 2. Temperature and Precipitation Graph for 1981 to 2010 Canadian Climate Normals for Tuktoyaktuk (Station Tuktoyaktuk A).

Surface Hydrology

There are numerous small ponds and lakes within the RSA; many are shallow, but some occupy deep thermokarst depressions in glaciofluvial deposits (ECG 2012). The project site occurs within the Southern Beaufort Sea – Eskimo Lakes Basin of the Arctic Ocean watershed (GNWT 2018a). The primary surface drainage in the LSA is Gunghi Creek and surface water runoff from adjacent lands, with open water lakes/ponds occurring upstream of approximately 200 m upstream and downstream of approximately 675 m downstream. Hydrometric data is not recorded for Gunghi Creek but is expected to exhibit a similar seasonal pattern at a slightly lesser magnitude than Trail Valley Creek, the closest and most similar watercourse where historical hydrometric data is available (GC 2019c; Water Survey of Canada Station 10ND002). The hydrograph shows that discharge increases in spring (May), with peaks typically reached in June from a combination of snow and ice melt and summer rainfall. Discharge decreases after June with

rainstorm generated peaks until it reaches base flows in the fall and winter (November-December onward), as shown in Figure 3.

Surface runoff varies throughout the year, but is typically highest in May-June, due to a thin active layer above the permafrost. As temperature and solar radiation increases the active layer increases in depth, resulting a lowered water table and decrease in surface water runoff.

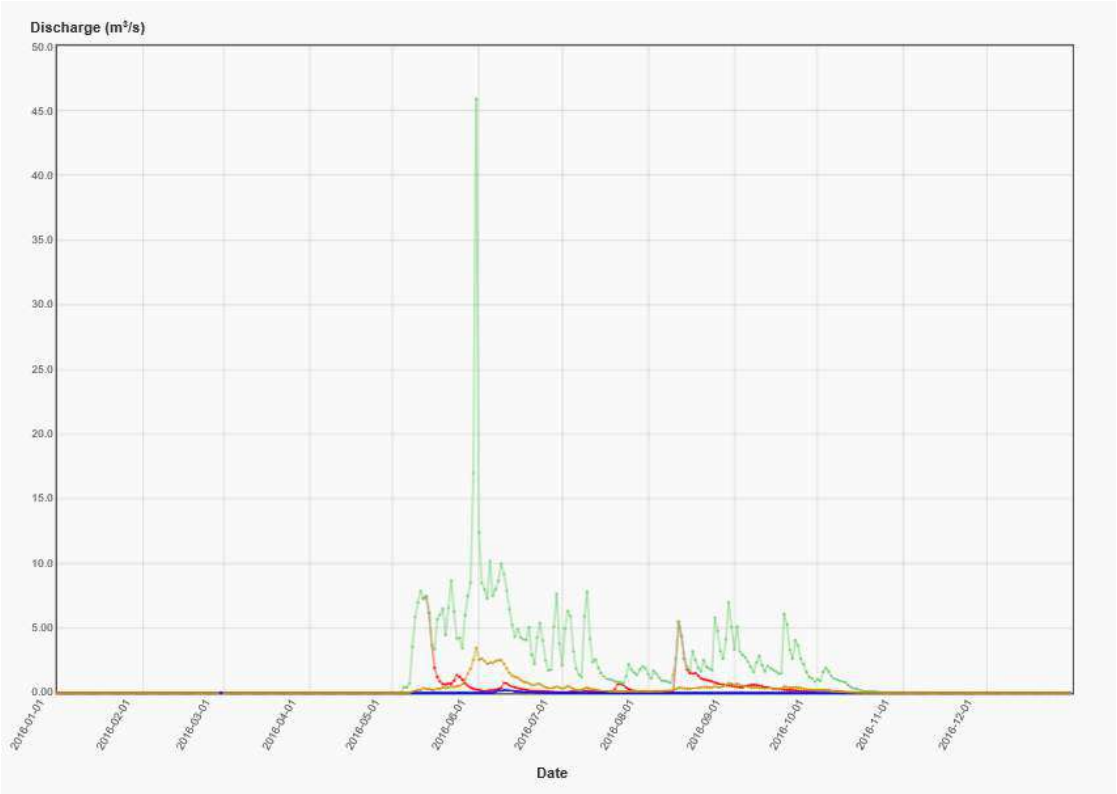

Figure 3. 1977–2016 Hydrograph for Trail Valley Creek near Inuvik at Water Survey Station 10ND002

10.5 Aquatic Resources

10.5.1 Wetlands

National Topographic Series (NTS) Map 107C identifies a wetland along the southwest margin of the footprint; however, based on photo documentation at the project site the southern margin of Gunghi Creek appears to be upland tundra (Appendix F, Photo 1). Kiggik-EBA Consulting Ltd. (2010) reported the number of wetlands along ITH corridor to be limited and surrounded by poorer habitat in the form of upland habitat, and where present were of poor quality.

10.5.2 Watercourse

Gunghi Creek originates from Tiktaliktuk Lake approximately 6.0 km upstream of the crossing and ultimately drains into Tuktoyaktuk Harbour approximately 4.0 km downstream. An assessment of Gunghi Creek at the project crossing was conducted by Stantec in 2018 (provided in Appendix B). Stantec (2018) classified Gunghi Creek as a permanent watercourse that likely freezes to the bottom in the winter.

Upstream and downstream of the existing culvert structure (within the PDA) the watercourse was characterized by pool habitat averaging 8.4 m and 15 m wide and 0.75 m and 1.0 m deep, respectively (Appendix F, Photos 3-4). Substrates in the vicinity of the crossing were composed primarily of fine material upstream and primarily organic and fine material, with some gravel, cobble and boulders downstream. Bankfull depth ranged from 1.0 m upstream to 1.7 m downstream of the crossing. Upstream and downstream of the pool habitat (outside of the PDA) at the crossing the watercourse was characterized primarily by run habitat with fine substrate material. Average channel and wetted widths were 10.2 m and 8.36 m, respectively, while average bankfull was 1.5m and average wetted depth was 0.5 m. A summary of channel morphology is provided in Table 5.

Table 5. Gunghi Creek Channel Characteristics

Characteristic	Measurement
Drainage area upstream of PDA (km^2)[1]	60
Stream length upstream of PDA (km)[1]	6.0
Downstream distance to nearest water body (km)[1,2]	4.0 to Tuktoyaktuk Harbour
Average upstream channel width (m)[2,3]	12.1
Average downstream channel width (m)[2,3]	9.5
1:2 year Calculated Discharge (m^3/s)[1]	4.8
Notes 1: Measurement obtained from Wood 2018; 2: Measurement obtained from Stantec 2018; 3: Average channel widths measured from the existing culvert inlet and 100 m upstream and the culvert outlet to 300 m downstream.	

10.5.2.1 Watercourse Classification

Restricted Activity Timing Window

According to the Department of Fisheries and Oceans *Northwest Territories Restricted Activity Timing Windows for the Protection of Fish and Fish Habitat* and potential spring spawning use of the watercourse, Gunghi Creek occurs within fish timing Zone 1 and has a restricted activity window from April 1 to July 15 (DFO 2013; Stantec 2018). Restricted activity timing windows are timing constraints intended to protect fish during spawning and incubation periods when spawning fish, eggs and fry are vulnerable to disturbance or sediment.

Navigable Waterway

Under the *Canadian Navigable Waters Act*, Gunghi Creek is not a scheduled navigable waterway. In this case, the proponent has opted deposit information on the online registry about the project and publish a notice inviting public comments. Where any concerns were put forth by the public and resolved by the proponent, the works may go ahead based on the timelines in subsection 10.2(1) of the *Act*.

10.5.3 Fish Community

Table 6 lists the known or expected fish species reported by Stantec (2018) in Gunghi Creek. Of the nine (9) fish species identified as potentially occurring in the creek, only three (3) species (broad whitefish, northern pike, and ninespine stickleback) were reported to inhabit the creek.

A review of DFO's aquatic species at risk map identified the downstream waters of Gunghi Creek (downstream of 1.2 km downstream of the crossing) as an area with potential occurrence of Dolly Varden (DFO 2019). However, Dolly Varden were not identified by Stantec (2018) as potentially occurring in Gunghi Creek or within the NWT range identified by Stewart et al (2010). Dolly Varden are federally listed as a species of 'special concern' (GC 2019a). None species identified by Stantec (2018) as potentially occurring in Gunghi Creek are listed federally as a species of special concern, extirpated, endangered or threatened and all species, except pond smelt (ranked as undetermined) were ranked as secure in the NWT. Gunghi Creek was not identified as containing critical habitat for any fish species (DFO 2019).

Table 6. Fish Species Known or Expectd to Occur Within Gunghi Creek

Species	Scientific Name	Presence	Sport Fish?	NWT GSRank[5]	SARA Status[6]
Lake whitefish	*Coregonus clupeaformis*	Potential[1]	Yes	Secure	None
Broad whitefish	*Coregonus nasus*	Known[2]	Yes	Secure	None
Least cisco	*Coregonus sadinella*	Potential[1,2]	No	Secure	None
Northern pike	*Esox lucius*	Known[2]	Yes	Secure	None
Pond smelt	*Hypomesus olidus*	Potential[1]	No	Undetermined	None
Burbot	*Lota lota*	Potential[1]	Yes	Secure	None
Ninespine stickleback	*Pungitius pungitius*	Known[2]	No	Secure	None
Lake trout	*Salvelinus namaycush*	Potential[1]	Yes	Secure	None
Inconnu	*Stenodus leucichthys*	Potential[3,4]	Yes	Sensitive	None

Notes:

1. Bond and Erickson (1985), Chang-Kue and Jessop (1992)
2. IMG-Golder (2009)
3. Sawatsky et al. (2007)
4. The use of Gunghi Creek by inconnu ("coney") was suggested by the local wildlife monitor
5. NWT GSRank = species General Status Rank in the Northwest Territories (GNWT 2016)
6. SARA Status = species status under the federal *Species at Risk Act* (ECCC 2018)

10.5.4 Fish Habitat Suitability

The pool habitats upstream and downstream of the Gunghi Creek crossing were rated by Stantec (2018) as 'moderate' for spawning of northern pike and small-bodied species. Spawning habitat was considered poor for whitefish (coregonid) species. Pools habitats along Gunghi Creek were considered to be too shallow to support overwintering habitat for any fish species. Rearing habitat was rated as moderate, due to available pool habitat and fish passage was rated as poor- moderate due the existing structure being undersized and suspected to impede fish passage during low flow conditions (Stantec 2018; Wood 2019) Overall, Gunghi Creek at the crossing was suspected to be utilized primarily as migratory corridor for northern pike, ninespine stickleback and coregonid specie (Stantec 2018).

10.6 Archaeology

10.6.1 NWT Archaeology Program

Archaeological resources, consisting of sites and artifacts within sites, are protected and managed in the NWT under the authority of several pieces of legislation, regulations and policies (Prince of Wales Northern Heritage Centre 2019a). These include the *Archaeological Sites Act* (GNWT 2014a) and the Archaeological Sites Regulations (GNWT 2014b) as well as the *Northwest Territories Lands Act* (GNWT 2014c), the Northwest Territories Land Use Regulations (GNWT 2014d), the Inuvialuit Land Administration Rules and Procedures (on Inuvialuit private lands) (Inuvialuit Land Administration 1986), the *Historical Resources Act* (GNWT 2010) and the *Access to Information and Protection of Privacy Act* (GNWT 2015).

In the Archaeological Sites Regulations, an archaeological artifact "means any tangible evidence of human activity that is more than 50 years old" (GNWT 2014b). The regulation of archaeology (NWT Archaeology Program) is part of the Cultural Places Program administered by the Prince of Wales Northern Heritage Centre (PWNHC). The PWNHC functions as the territorial regulator for archaeological resources, participating in the control of land use activities that may threaten archaeological sites and by overseeing archaeological investigations through their permitting process. All archaeological studies in the NWT require a permit issued by the PWNHC and the permit obligations include reporting on the methods and results of those studies.

10.6.2 Archaeological Overview

An archaeological overview of the Inuvik Tuyktoyaktuk Highway and associated borrow sources including a desktop study and preliminary field reconnaissance was completed in 2009 under Permit 2009-024 (Kiggiak-EBA Consulting Ltd. 2010). At the time, 103 archaeological sites had been recorded in the region between the Mackenzie River in the east and the Husky Lakes in the west and from the coast of Kugmallit Bay in the north to Inuvik in the south with 12 sites within 5 km of the proposed highway route.

The earliest archaeological evidence of human activity in the region is categorized by archaeologists as belonging to a technological manifestation known as the Northwest Microblade Tradition, dating to approximately 6,000 years ago (Morrison 1987). This tradition is defined by distinctive stone tool types thought to represent some of the first post-glacial inhabitants of the Western Canadian Arctic. Between 4,500 and 1,000 years ago, Arctic-adapted peoples, called Paleoeskimo or Paleo-Inuit by archaeologists, inhabited the region (Friesen 2015). Tracking their distinctive tool types and structural remains, archaeologists believe them to be descended from northeastern Asian ancestors who moved eastward (Friesen 2013). The Paleo-Inuit appeared to have been displaced by the Thule people, the ancestors of the modern Inuit and Inuvialuit.

The earliest historic documentation of the region was the result of the explorations of Alexander Mackenzie in 1789 (Mackenzie 2001) who visited the mouth of the Mackenzie River. John Franklin's overland expedition in 1825-27 recorded contacts with Inuvialuit residents of the Mackenzie Delta (Franklin 1971). Sustained contact between Inuvialuit and non-indigenous peoples began when whaling ships began to overwinter on the Beaufort Sea coast in the late 19th century (Bockstoce 1986), opening the region to trade, missionaries and settlement and resulting in significant social, cultural and health impacts to the local populations (Morrison and Arnold 1994).

Types of sites found in this region include stone tool scatters and quarry/ workshops; stone features such as tent rings, caches and cairns; hearths and fire cracked rock concentrations; cabin remains and semi-subterranean house remains, cache pits, refuse deposits, graves, and various types of wood features.

The primary goal of the 2009 overview was to identify lands that would be affected by the Project that displayed characteristics indicating potential to contain archaeological sites. Terrain with archaeological potential were defined as including: "level and dry banks, terraces or benches along major streams or lakes" (Kiggiak-EBA Consulting Ltd. 2010). This included areas with well-defined, elevated landforms adjacent to larger water bodies. Several areas of archaeological potential were mapped and the portions of the proposed highway route that crossed elevated landforms close to the Husky Lakes, as well as moraines, knolls, pingos, eskers, ridges and major creek banks were included in this category. Overlaps PDA and no archaeological sites found.

The types of sites that were expected in the Project area included structural remains, stone, bone and/or wood artifacts, mounds indicating semi-subterranean houses or refuse piles, driftwood piles representing houses or graves, depressions used as caches, and rock piles representing caches or cairns (Kiggiak-EBA Consulting Ltd. 2010). Overlaps PDA and no archaeological sites found.

Archaeological ground reconnaissance in areas of potential (estimated to consist of approximately one quarter of the proposed route) within a 100 m-wide corridor and including borrows, work staging areas and camps was recommended. Recommended survey methods included closely spaced pedestrian transects and intensive systematic subsurface testing.

Three additional archaeological field assessments of the Inuvik Tuyktoyaktuk Highway and associated borrow sources were conducted between 2011 and 2013 under Permits 2011-014, 2012-012 and 2013-010, (Prince of Wales Northern Heritage Centre 2019b).

Under Permit 2011, a team from IMG-Golder conducted a helicopter survey to confirm archaeological potential and then performed pedestrian surveys and shovel-testing at high potential locations. A total of 189 shovel tests were excavated and no new archaeological sites were discovered. One previously recorded site was revisited (IMG-Golder 2011).

Under Permit 2012-012, seven borrow source locations were assessed for archaeological resources. None were discovered (Kavic-Stantec 2012).

Another 17 borrow source locations were assessed under Permit 2013-010 resulting in the discovery of two archaeological sites. One previously recorded archaeological site was revisited (Prince of Wales Northern Heritage Centre 2019c).

11.0 Effects Assessment and Mitigation Measures

An important consideration when assessing effects of the proposed development is the existing level of public use and activities that have already affected the biophysical resources in the Project area. For example, current effects include the existing Inuvik to Tuktoyaktuk Highway, culvert crossing and associated vegetation alterations, 'edge' habitat, and wildlife behavioural changes, such as habituation to noise disturbance and human activity.

Environmental Management Plans for erosion and sediment control, hazardous materials, waste management, wildlife encounter management, spill contingency, aquatic effects and permafrost monitoring, and closure and reclamation and emergency response plans are provided in Appendix D. Any additional terms and conditions of Project approvals, licenses and permits will be outlined in the Contractors Environmental Construction Operations (ECO) Plan, to be prepared for the Project.

11.1 Geology, Permafrost and Soils

11.1.1 Potential Effects

Potential effects to geology, permafrost and soils occur during the construction related activities. These activities include site clearing, soil handling, excavation, grading and reclamation of the land surface. Potential effects of the Project on soil quality may include:

- Admixing, which results in a loss of soil profile integrity, dilution of organic matter and reduction of nutrient status, and possibly changes in water holding capacity (i.e., a reduction in soil quality);
- Permafrost exposure, which results in greater potential of permafrost melt and erosion;
- Compaction, which degrades soil structure, thus reducing permeability and aeration;
- Erosion, which results in loss of soil volume; and
- Contamination by spills or leaks.

These effects may lead to a reduction of soil suitability after restoration.

11.1.2 Mitigation Measures

M1. Construction activities should be scheduled to avoid periods of rapidly changing weather, including heavy rains or rapid snow melt, which could lead to surface run off and soil erosion. Construction should occur during frozen conditions.

M2. Construction area boundaries and areas of concern will be marked with barriers to ensure that construction personnel know they are working in or near sensitive areas that cannot be disturbed and to limit the area of disturbance to the PDA.

M3. Topsoil (the organic veneer) will be salvaged and stored separately from underlying mineral soils. Although color change between topsoil and subsoil is a good indicator of the soil profiles, care will be exercised to ensure proper topsoil salvage.

M4. Soil salvage operations will be conducted with qualified supervision and in a manner to maximize the quality of the soil for future use in reclamation. In particular, topsoil will be conserved, and measures will be implemented to reduce admixing (e.g., scheduling of topsoil stripping activities during daylight hours).

M5. Exposure of permafrost layers should be minimized to the extent possible and capped following construction activities in order to reduce the potential for future permafrost melt.

M6. During the construction, stabilization of soil stockpiles, and management of surface run-off (snow melt, rainfall) will reduce the erosion potential of runoff. Erosion and sediment control (ESC) measures will be used to reduce soil surface exposure, as required, in order to minimize both water and wind erosion.

M7. To minimize soil compaction, to the extent possible, the following will be implemented:
- schedule construction activities to avoid work on wet soils;
- minimize the number of repeated passes over areas prone to compaction; and
- use tracked vehicles rather than conventional tires and rig matting when warranted by soil moisture conditions.

M8. Temporary ESC measures during construction will be the responsibility of the construction Contractor. ESC measures will be implemented to prevent loss of soils and sedimentation of through erosion.

M9. A spill prevention and response plan will be designed and implemented as part of the Contractor's ECO Plan during construction to prevent contamination of any soil system, including soils stored for later use, and in the event of accidental contamination during operation, to immediately respond and mitigate the contamination. A *Guide to the Spill Contingency Planning and Reporting Regulations* (GNWT 2011) should be followed.

11.1.3 Residual Effects

Most potential effects on soil quality due to admixing, permafrost melt, compaction or erosion, can be successfully mitigated with the recommended mitigation measures and BMPs, including soil handling, implementation of ESC measures, and reclamation and revegetation as part of the Project design (Appendix A).

The primary mitigation for potential effects related to accidental spills and releases is prevention through BMPs for fuel storage, re-fueling and spill response. Accidental releases are anticipated to be localized and will be handled immediately as outlined in the spill response plan as part of the Contractor's ECO Plan during construction.

Overall, the residual effects resulting from the Project related to admixing, compaction/rutting, contamination and/or soil erosion, are all considered to be negative, low in magnitude, limited to the PDA in extent, long-term in duration, and reversible. The residual effect resulting from the Project related to permafrost melt is considered to be negative, low in magnitude, limited to the PDA in extent, long-term in duration, and irreversible. Mitigation measures identified to address potential effects on geology, permafrost and soils within the PDA are anticipated to mitigate potential negative environmental effects.

11.2 Vegetation

11.2.1 Potential Effects

Construction activities may result in minor clearing along existing disturbed RoW. Removal of native vegetation can result in exposed soil and create a potential source of sedimentation. Minimizing the spatial extent of vegetation clearing to reduce exposed soil in the PDA, and prompt implementation of ESC measures are anticipated to mitigate the effects on vegetation.

Non-native or invasive plant species (i.e., weeds) often colonize disturbed areas through the dispersal of seeds by wind, water, wildlife or human-related activity. Invasive species are often strong competitors with

native species in disturbed environments. Invasive plants can move into adjacent areas and displace or otherwise affect the post-disturbance recovery of native vegetation. Given the nature of the Project, there will be opportunities for weeds to invade disturbed areas. The spread of weeds into disturbed areas typically occurs over a medium time period (1-5 years). However, if native vegetation cover can be re-established in a timely manner, weed spread is predominantly eliminated.

No rare species (including Species at Risk), or unique vegetation communities have been identified in the PDA. The potential for loss of rare plant populations or unique plant communities due to the Project is considered low largely based on the small footprint of the PDA.

11.2.2 Mitigation Measures

The following measures will be implemented to address potential effects of the Project on the vegetation.

M10. The removal of vegetation will be restricted to the minimal acceptable requirements to avoid potential disturbance to native vegetation communities outside the PDA;
M11. Disturbed areas will be stabilized, vegetated and/or seeded as soon as possible after construction;
M12. Prompt implementation of ESC measures of all disturbed areas;
M13. Implementing measures to reduce the introduction and spread of weeds and invasive plant species, such as washing and inspecting vehicles/equipment prior to its arrival onsite to ensure that they have been cleaned and are free of dirt, mud, weeds and invasive species; utilizing seed weed-free seed mixtures; and monitoring to identify potential locations for control measures; is recommended.
M14. Post-construction monitoring following winter construction to identify areas of instability and/or erosion. Where vegetation establishment is inadequate, or erosion/instability is identified, remedial measures will be implemented;
M15. Post-construction monitoring to identify occurrences of weed establishment throughout disturbed areas. Follow-up (e.g., implementing weed control measures) may be required if and where monitoring identifies problem areas (e.g., infestations of weeds designated as prohibited noxious or noxious are identified);
M16. Weed control methods will be implemented during the construction, reclamation and maintenance phases of the Project in areas where weed problems are identified. The use of herbicides is not recommended within the Project site due to potential runoff into Gunghi Creek.
M17. Following winter construction, weed control measures, such as mowing, hand picking, seeding of a temporary vegetation cover (annuals) may be required on site until the desired vegetation becomes established.

11.2.3 Residual Effects

Minor clearing and grubbing will be required for the construction of the Project. In addition to clearing, indirect disturbances to native vegetation from dust effects in the spring and potential for spread of non-native plants/invasive weeds were considered. There is expected to be a nil-low potential for the Project to have an effect on rare species or unique vegetation communities. With implementation of recommended mitigation measures, residual effects on vegetation related to direct effects (vegetation clearing) and indirect effects (weeds/invasive species) are predicted to be negative, low in magnitude, limited to the PDA in extent, long-term in duration, and reversible.

11.3 Wildlife and Wildlife Habitat

11.3.1 Potential Effects

Construction related effects on wildlife are expected to be limited. Indirect effects from sensory disturbance is often associated with habitat clearing and construction activities and may discourage most species from using habitat adjacent to the Project. Most wildlife will avoid construction activities and habitats in the immediate vicinity of active work sites during the day and return during periods of inactivity (e.g., overnight). Most bird species are highly susceptible to noise disturbance; however, nesting activities are not expected during the proposed winter construction. Following construction, species are expected to return to adjacent habitats.

The movement patterns of animals, particularly mammals and ungulates, may be temporarily disrupted by construction activities. Construction activities are expected to occur during daylight hours, and animal movements may occur during periods of inactivity. Overall, substantial barriers to movement from construction activity are not expected to differ from current levels. As birds are highly mobile, construction and recreational activity not anticipated to cause significant barriers to movement.

Direct mortality of wildlife may occur if clearing is required, however nesting activities are not expected during the proposed winter construction, and any minor clearing involved is anticipated to be localized top the PDA. As the proposed works are scheduled for completion April 15 and only minor clearing will be required, the vegetation clearing timing constraint of May 20 to August 17 will be adhered to.

11.3.2 Mitigation Measures

M18. Prior to construction a survey will be conducted to ensure no active grizzly/ black bear, wolverine or lynx dens occur within 250 m of the project site. Where dens are identified the appropriate management agency will be identified to determine appropriate mitigation.
M19. Clearly delineate by staking or flagging any construction access routes, temporary workspaces and environmentally sensitive areas prior to disturbance to minimize clearing necessary for construction workspaces;
M20. Limit construction to daylight hours to allow animals to move through the project site overnight;
M21. Use noise reduction equipment to muffle or control noise levels and reduce sensory disturbance to wildlife;
M22. Ensure waste management plans are adhered to at all times to prevent attraction of wildlife to work site. Waste storage and accidental spill sites should be fenced to prevent wildlife access;
M23. Limit the size of permanent and temporary workspaces to the greatest extent possible, and reclaim work areas immediately following construction;
M24. Prohibit pets, firearms or recreational use of all-terrain vehicles in construction sites;
M25. Do not harass or feed wildlife;
M26. Record all wildlife observed within or near construction activities for submission to appropriate management agency;
M27. Store hazardous materials securely in an appropriate location to avoid interaction with wildlife; and
M28. Where caribou approach the construction site or active ungulate mineral/salt licks are observed a temporary suspension of construction may be required to adhere to recommended setback distances outlined in Table 7. Where caribou or active mineral/salt licks are observed appropriate the environmental management agencies should be contacted to determine appropriate mitigation.

Table 7. Recommended Wildlife Setback Distances[1]

Wildlife	Feature or Habitat	Setback Distance
Caribou	N/A	500 m
Ungulates (general)	Mineral/salt lick	1 km
Notes 1: AANDC et al 2012.		

11.3.3 Residual Effects

Residual habitat losses associated with the proposed development are very small and will effect an area that is occupied by the existing crossing structure and ITH roadway RoW. With the implementation of revegetation of the PDA residual effect related to habitat loss is considered to be negative in direction, local in extent, low in magnitude and reversible. Construction activities are anticipated to result in an increased amount of noise and traffic and will likely result in increased sensory disturbance. Due to the overall small scale of the Project and anticipated short construction timeframe, the residual effect related to sensory disturbance is considered to be negative in direction, local in extent, low in magnitude and reversible.

11.4 Aquatic Environment

11.4.1 Potential Effects

Potential direct or indirect construction-related effects to the aquatic environment of Gunghi Creek are discussed below.

Release of Deleterious Substances

There is the potential for the accidental release of contaminants during construction. Contaminants may include sediments, debris, hydrocarbons, and hydraulic fluids. These substances could affect fish health, reproductive success, behaviour or result in direct fish mortalities. These potential effects can be mitigated by avoiding instream construction to the extent possible (e.g., operating machinery from outside of the watercourse), instream worksite isolation techniques where required, implementation of appropriate erosion and sediment control measures, and proper storage and handling of hazardous materials. Residual impacts are expected to be negative, low in magnitude, local in geographic extent, short-term in duration, reversible and isolated.

Fish Passage

The replacement open bottom concrete arch culvert was designed to accommodate fish passage during peak flows for the weakest swimmer (northern pike) of species potentially occurring in Gunghi Creek. As per the DFO Swim Distance & Water Velocity Tool, at the design velocity 0.97 m/s (inlet velocity, Table 8), 50% of northern pike can swim a distance of 13 m, while 87.5% can swim 6 m. Accordingly, the arch culvert design will incorporate rock boulders (Class 2 [800 mm in diameter]) spaced at 5.0 m intervals along the arch culvert invert and reconstructed channel to provide rest areas for fish and promote fish passage. Katopodis and Gervais (2016) have identified that fish have the ability to detect and utilize zones of lower velocity, where the Class 1 riprap along the headslopes and bank margin and Class 2 rock boulders are expected to increase roughness and reduce local flow velocities through flow turbulence and provide resting areas for fish moving upstream. As such, fish passage is anticipated to be accommodated through the replacement structure.

Table 8. Hydraulic Summary for Open Bottom Concrete Arch Bridge

Flow	Natural Channel		Concrete Arch Bridge Opening		
	Depth (m)	Velocity (m/s)	Upstream Velocity (m/s)	Downstream Velocity (m/s)	Freeboard (m)
Q_{100} (16 m^3/s)	1.7	0.9	1.7	1.8	1.6
3Q10 (6.6 m^3/s)[1]	1.3	1.01	0.97	0.95	2.1
Q_2 (4.8 m^3/s)	1.1	0.98	0.87	0.84	2.3
Q_{check} (32 m^3/s)	2.3	1.1	2.5	2.6	0.7
Notes 1: Wood 2019, provided in Appendix B; 2: 3Q10 is fish passage flow.					

Fish Habitat and Channel Area Affected

The proposed works will affect an area that has previously been disturbed by the existing crossing. No critical habitats were identified at the Project site. The proposed works will affect pool habitat, used primarily by migratory fish and is considered to have moderate productive capacity.

Replacement of the existing twin 2000 mm diameter by 38.0 m long culvert with a new 7518 mm span by 3500 mm rise by 38.966 m long open bottom concrete arch bridge will result in a net-gain of 217 m^2[3] and alteration of approximately 562 m^2 of channel area [4] that will remain available to fish. Channel widening through the replacement structure will improve flow conveyance capacity and accommodate fish passage. The proposed replacement structure will provide adequate freeboard to facilitate debris passage over a range of floods. Channel enhancement will also be incorporated to maintain long-term instream habitat diversity and habitat connectivity through the Project site. Channel enhancement features will include Class 2 rock boulders spaced spaced 5 m apart and Class 1 rock riprap along the newly graded streambed, which will also transition smoothly into the natural channel bed and streambank upstream and downstream of the crossing. Overall, productive capacity of fish habitat through the crossing structure is anticipated to improve through the wider channel bed and increase in channel area and habitat diversity available to fish in the replacement crossing PDA.

11.4.2 Mitigation Measures

General

M29. Instream works will be avoided during the restricted activity timing window of April 1 to July 15.

M30. The construction limits will be conspicuously marked with flagging tape to ensure that construction personnel know the disturbance must remain within the proposed footprint and right-of-way.

M31. All work will be conducted from above the streambanks, wherever possible, to avoid disturbance to riparian vegetation. Disturbed areas will be stabilized, vegetated and/or seeded as soon as possible after construction.

M32. An Erosion and Sediment Control Plan (ESCP) will be prepared and implemented. Effective ESC measures will be in place prior to disturbance, during and after construction to prevent sediment from entering the watercourse and wetlands. All ESC measures will be inspected regularly to

3 Calculation based on available habitat through the proposed bridge opening at the design high water level (293 m^2) minus available habitat through the existing crossing structure (76 m^2).

4 Calculation based on alterations from the placement of riprap along the newly graded streambed below the ordinary high water level.

ensure that they are functioning properly and are maintained, cleaned and/or upgraded as required until complete revegetation of all disturbed areas is achieved.

M33. Minimize clearing of riparian vegetation (where possible, prune or top vegetation rather than uprooting/grubbing), minimize removal of any instream natural structures (e.g., woody debris, boulders; if removed, return to its original location), and use existing roads, cut lines and trails when accessing the work area to minimize further disturbance within the riparian area (soil compaction, clearing).

M34. Any excavated areas of the channel bed will be backfilled with material that is the same quality and gradation that was removed.

M35. Only clean rock, appropriately sized and free of deleterious substances will be used for riprap. These materials will be obtained off site and will not be taken from below the average high-water level of any watercourse.

M36. Construction will be halted during periods of heavy precipitation.

M37. All equipment and machinery will be assembled, cleaned and checked for proper mechanical operation prior to entering the work site. Regular inspections will be completed to ensure that hydraulic, fuel, and lubrication systems are in good condition and equipment is free of leaks.

M38. Biodegradable oils and lubricants (e.g., white lithium greases and vegetable oil hydraulic fluid) will be used in any equipment that will be working in the watercourse.

M39. Washing, refueling, servicing and staging of machinery and equipment will be conducted at least 100 m from a water body to prevent the entry of any deleterious substances.

M40. If fuel is to stored on site, it must be placed within a lined containment berm that is to be located at least 100 m from any water body. The berm is to have a capacity of 110% relative to the volume of fuel being stored.

M41. All equipment that is to be used will be free of weed species and aquatic invasive species.

M42. All spoil materials and debris will be removed from the site and properly disposed of above the high-water mark so that they do not enter any water body.

M43. The Contractor will prepare an emergency spill response plan and contingency measures as part of the Environmental Construction and Operation (ECO) Plan. Information provided in the EMP in Appendix D will also be included in the Contractor's ECO Plan.

Instream Isolation

Where the watercourse is dry or frozen to the channel bottom at the time of work the requirement to isolate does not apply.

M44. Any instream works in flowing water conditions will be isolated during construction. 100% of downstream flow should be maintained at all times. Where ice is present, the diverted water will be returned to the watercourse under the ice, wherever possible. All diverted or discharged water will meet the requirements of the federal water quality guidelines (CCME 2002).

M45. Any bypass pumping or water withdrawal will be conducted as follows:

- Must pass through a screen with openings that are no larger than 2.54 mm and at a velocity that does not result in the entrainment and entrapment of fish or fish fry.
- The fish screen must be constructed of materials that can withstand extreme winter temperatures.
- The screen should be: kept clean of ice and debris, be inspected for damage before each withdrawal, pump should be stopped if any sign of fish impingement or entrainment, and a secondary screen should be kept onsite in case the primary screen gets frozen or damaged.
- The inlet screen will not be placed directly on the bottom of the water body and will be placed in a manner that prevents disturbance on the channel bed material

- All openings for guides and seals will be smaller than the opening width of the screen material (2.54 mm) so fish cannot pass through.
- Protect large screens with trash racks fabricated of bar (150 mm spacing is typical) or grating in areas where there is debris loading (i.e. woody material, leaves or algae mats).
- Approach velocity directly in front of the screen will not exceed the designed approach velocity at any location.
- Ensure there is enough structural support to prevent sagging or collapsing of the screen panel.
- Where ice is present on the water body, the diverted water will be returned to the water body downstream of the instream worksite, under the ice.

M46. Materials in isolation berms will be made of non-earthen materials and not introduce clay or silt into any watercourse. Instream works will be confined to the isolated channel section. Accumulations of deposited sediment will be removed from within the isolated area prior to removing the isolation barrier.

M47. Should the need for dewatering arise, water will be released into a well vegetated area or settling basin and not directly into any water body. Water returning to the watercourse will be of equal or better quality than the water in the watercourse.

M48. If water, standing or flowing, is present in the isolated work zone at the time of construction, a fish rescue program will be completed prior to the start of instream work to ensure all fish are protected.

M49. Any fish will be rescued from the isolated area prior to construction and be relocated, unharmed, into an area containing sufficient flow and cover. Fish rescue may require a territorial licence. Rescue operations employing effective methods (e.g. electrofishing, seine netting, minnow trapping) carried out as stipulated in the research license.

Temporary Access Road -Snow Fill

M50. It is understood that construction of the temporary access will not require pumping of any water from any nearby water body.

M51. Construct approaches or access road crossings perpendicular to the watercourse where possible.

M52. Construct approaches using clean (ambient), compacted snow and ice to a sufficient depth to protect the stream banks or shoreline.

M53. Where logs are used to stabilize the approach the logs are to be clean and securely cabled together. No logs and woody debris are to be left in the river or on the banks or shoreline.

M54. The snow bridge should be V-notched once construction is completed to allow it to melt from the center.

M55. Remove compacted snow from snow fills prior to the spring freshet.

Turbidity Monitoring

Where water is present during construction the Contractors operations will be subject to the maximum allowable increase in Total Suspended Solids in the watercourse, as specified by the *Canadian Water Quality Guidelines* (CCME 2002). These guidelines provide threshold levels for water quality monitoring. It is expected the monitoring will support the implementation of recommended environmental protection measures to minimize impacts of construction and to provide a feedback mechanism so that mitigation measures can be adjusted where and when necessary.

11.4.3 Residual Effects

The proposed works will result in a net-gain of 217 m^2 and alteration of approximately 562 m^2 of channel area that will remain available to fish. Overall, productive capacity of fish habitat through the crossing structure is anticipated to improve and channel widening through the replacement structure will improve flow conveyance capacity and accommodate fish passage. It is anticipated that residual effects will be offset through the implementation of channel enhancement, which will maintain long-term instream habitat diversity and habitat connectivity through the Project site. Potential effects on aquatic resources will be mitigated through the implementation of construction BMPs and recommended mitigation measures, including the implementation of an ESC Plan. Residual effects are considered to be positive in direction, low in magnitude, local in extent, short-term in duration and irreversible.

11.5 Archaeology

11.5.1 Potential Effects

No archaeological sites have been recorded at or near the Gunghi Creek crossing. Also, the surrounding lands were not identified as having archaeological potential in the overview study (Kaggiak-EBA 2010). The Project will not affect recorded archaeological resources and is unlikely to affect unrecorded archaeological resources.

11.5.2 Mitigation Measures

Since the Project will not affect archaeological resources, no mitigation measures need to be implemented. The Project is, however, subject to reporting requirements should a previously unrecorded archaeological resource be discovered accidentally (see Prince of Wales Northern Heritage Centre 2019a).

11.5.3 Residual Effects

The Project will not result in residual effects with respect to archaeological resources.

12.0 Cumulative Effects Assessment

The cumulative effects assessment predicts the effects of the proposed Project plus existing, approved and planned developments within the RSA. The PDA has already been impacted by clearing of native vegetation along the existing ITH RoW. The proposed Project will result in only minor local changes to soils, vegetation, and wildlife in the area. In addition, anticipated effects resulting from the Project can be effectively mitigated. As a result, overall residual effects are expected to be neutral in direction, low in magnitude, local, short-term, reversible and are considered not to have a significant cumulative effect.

13.0 Conclusion and Supporting Information

The PDR for the Gunghi Creek crossing replacement Project identified a number of potential environmental effects resulting from the proposed works, and applicable mitigation measures. Based on available information, it is Woods' opinion that potential effects within the study area during construction can be mitigated by the implementation of construction BMPs and recommended mitigation measures. Key mitigation measures include the implementation of an erosion and sediment control plan, weed monitoring and control, timing restrictions for vegetation clearing and instream work, and

reclamation/revegetation of areas disturbed during construction. Long-term effects to the project area will be positive, with anticipated improvements being improved fish passage and habitat connectivity.

14.0 Closing

This report is based on and limited by the interpretation of data, circumstances, and conditions available at the time of completion of the work as referenced throughout the report. Wood has performed its services in a manner consistent with the standard of care and skill ordinarily exercised by members of the profession practicing under similar conditions in the geographic vicinity and at the time the services were performed. Wood believes that this information is accurate but cannot guarantee or warrant its accuracy or completeness including information provided by third parties.

This report has been prepared for the exclusive use of the Government of Northwest Territories and their agents for specific application to this project site. The work was conducted in accordance with the scope of work prepared for this project, verbal and written requests from the Government of Northwest Territories, and generally accepted biological work practices. No other warranty, expressed or implied, is made.

Wood does not accept any responsibility for the use of this report, in whole or in part, for any purpose other than that intended or to any third party for any use whatsoever. Wood requires that third parties wishing to rely on this report agree to the terms, conditions and limitations stipulated in Woods' Standard Contract and in the report.

We trust that the information contained within this report satisfies your requirements. Should you have any questions, please contact the undersigned at your earliest convenience.

Respectfully submitted,

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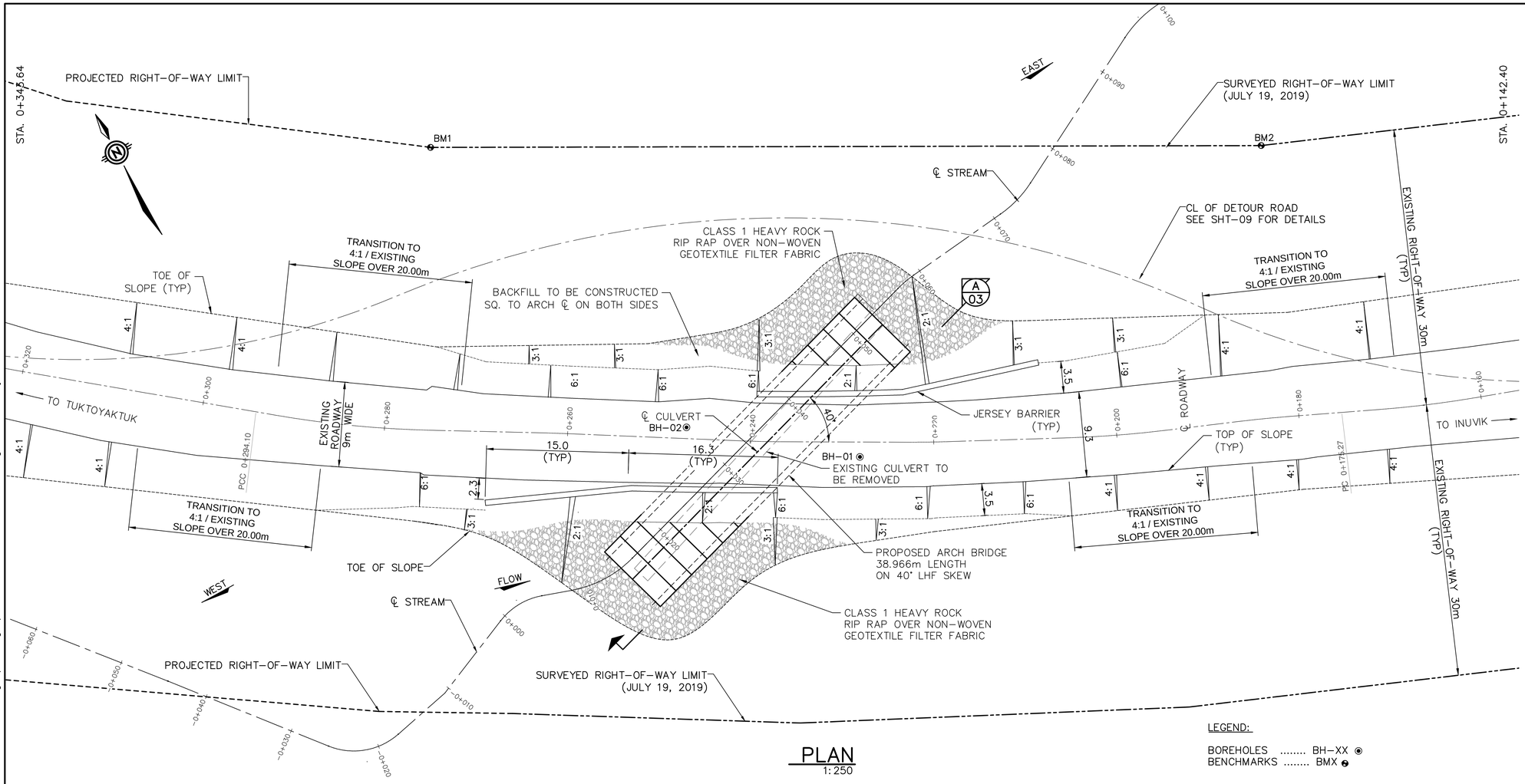
Appendix A

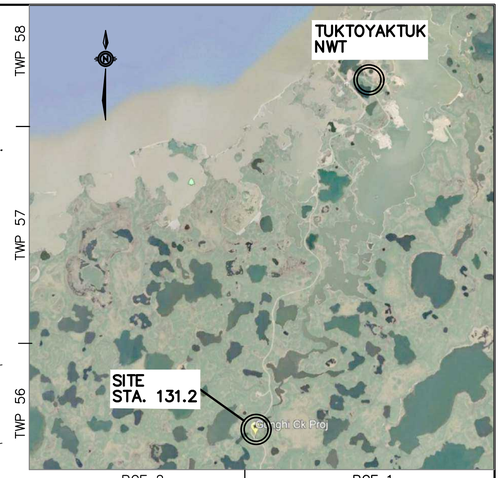
Design Drawings



PLAN
1:250

LEGEND:

BOREHOLES ..... BH-XX ◉
BENCHMARKS ..... BMX ❶



SITE MAP

INUVIK TO TUKTOYAKTUK HIGHWAY — N.T.S.
LOCAL ROAD

SURVEY AND BENCHMARK

- MACKENZIE DELTA GEOMATICS LIMITED UNDER THE DIRECTION OF CA, AUGUST 28, 2017
  BM1 : N 7693990.504 E 577210.810 EL. 4.261
  BM2 : N 7693947.488 E 577291.821 EL. 4.136

HYDROTECHNICAL DATA

- DRAINAGE AREA = 60 km²
- ESTIMATED AVERAGE CHANNEL SLOPE = 0.0015 m/m
- DESIGN DISCHARGE Q_{100} = 16.0 m³/s
- MEAN OUTLET VELOCITY AT PROPOSED ARCH STRUCTURE FOR DESIGN DISCHARGE = 1.8 m/s
- MEAN ANNUAL DISCHARGE (Q_a) = 4.80 m³/s
- MEAN OUTLET VELOCITY AT PROPOSED ARCH STRUCTURE DURING MEAN ANNUAL DISCHARGE = 0.84 m/s
- 3-DAY DELAY Q_{10} FLOW ($3Q_{10}$) = 6.6 m³/s
- MEAN OUTLET VELOCITY DURING $3Q_{10}$ FLOW = 0.95 m/s

PROPOSED STRUCTURE

- 1-7518mm SPAN x 3200mm RISE PRECAST CONCRETE ARCH BRIDGE 38.966 m LENGTH ON 40° LHF SKEW

GENERAL NOTES

- DIMENSIONS AND ELEVATIONS ARE GIVEN IN METRES UNLESS NOTED OTHERWISE
- ROADWAY DESIGN STANDARD RLU-80 GRAVEL SURFACE
- STRUCTURAL DESIGN IN ACCORDANCE WITH CAN/CSA S6-14 AND CL 800 DESIGN LIVE LOAD
- WORK FOR RIP RAP TO BE DONE IN CONFORMANCE WITH SECTION 10 OF STANDARD SPECIFICATIONS FOR BRIDGE CONSTRUCTION (EDITION 16), ALBERTA TRANSPORTATION CULVERT ASSEMBLY, BACKFILL AND OTHER TYPICAL DETAILS SHALL BE IN ACCORDANCE WITH THE DRAWINGS, DWG S-1418-17 AND SECTION 18 OF SPECIFICATIONS FOR BRIDGE CONSTRUCTION (EDITION 16), ALBERTA TRANSPORTATION

ITEM		UNIT	ESTIMATE AS CONST
SUPPLY 1-7316 SPAN x 3200 RISE ARCH BRIDGE		m	38.966
INSTALL 1-7316 SPAN x 3200 RISE ARCH BRIDGE		m	38.966
SUPPLY 900 x 900 x 12170 PRE-CAST PILE CAP		UNIT	4
INSTALL 900 x 900 x 12170 PRE-CAST PILE CAP		UNIT	4
SUPPLY 900 x 900 x 14606 PRE-CAST PILE CAP		UNIT	2
INSTALL 900 x 900 x 14606 PRE-CAST PILE CAP		UNIT	2
REMOVAL OF EXISTING CULVERT		LUMP	1
EXCAVATION - STRUCTURAL		m³	–
BACKFILL			–
CRUSHED AGGREGATE MATERIAL		m³	–
WOVEN GEOTEXTILE FILTER FABRIC		m²	–
324ø x 12.7 PLAIN STEEL PIPE PILE	SUPPLY	m	760
	SET-UP	PILE	40
	INSTALLATION	m	760
141ø X 6.4 PLAIN STEEL PIPE PILE	SUPPLY	m	228
	SET-UP	PILE	12
	INSTALLATION	m	228
BRIDGE IDENTIFICATION TAG		UNIT	–
ROLLED EROSION CONTROL PRODUCT TYPE C		m²	–
HEAVY ROCK RIPRAP - CLASS 2		m³	–
NON-WOVEN GEOTEXTILE FILTER FABRIC		m²	–
GEOTEXTILE FENCE BARRIER (SILT FENCE)		m	–
ROADWAY WORK		LUMP	1

QUANTITY ESTIMATE

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SCALES SHOWN ARE CORRECT FOR 22" x 34" SHEET SIZE

JOB No. EB193003

REV	DATE	REVISIONS	BY
6			
5			
4			
3			
2			
1	2019-10-10	ISSUED FOR 100% REVIEW	AM

DESIGNER

DATE

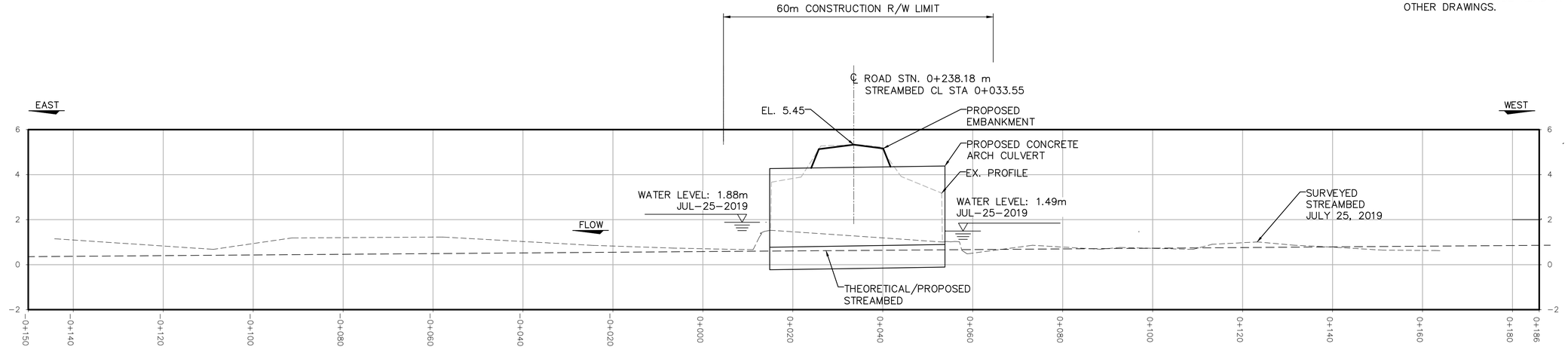
GOVERNMENT OF THE NWT
DEPARTMENT OF INFRASTRUCTURE

ITH 131.2
GENERAL LAYOUT

DEPARTMENT BAR CODE	DATE	STREAM	LOCATION	HIGHWAY	FILE	SHEET	DRAWING
	2019-08-30	GUNGHI CREEK	INUVIK TO TUKTOYAKTUK HIGHWAY	LOCAL	–	1 OF 9	SHEET-01

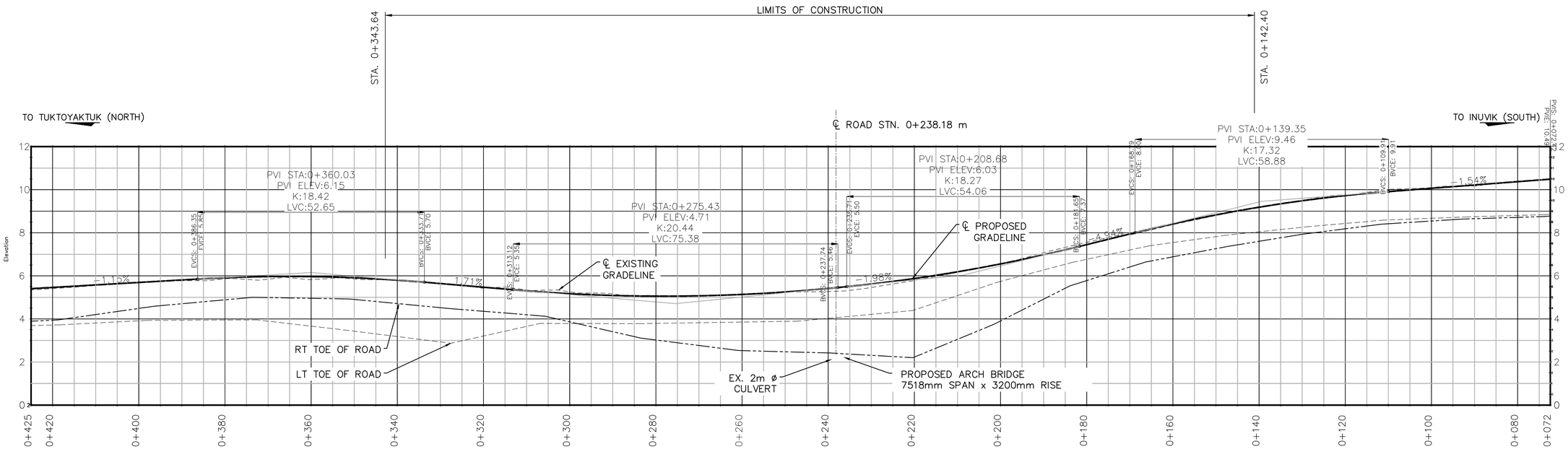
NOTE:

THIS DRAWING TO BE READ IN CONJUNCTION WITH OTHER DRAWINGS.



STREAMBED PROFILE

LOOKING NORTH H 1:500, V 1:100



ROAD PROFILE

LOOKING WEST H 1:500, V 1:100

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GOVERNMENT OF THE NWT
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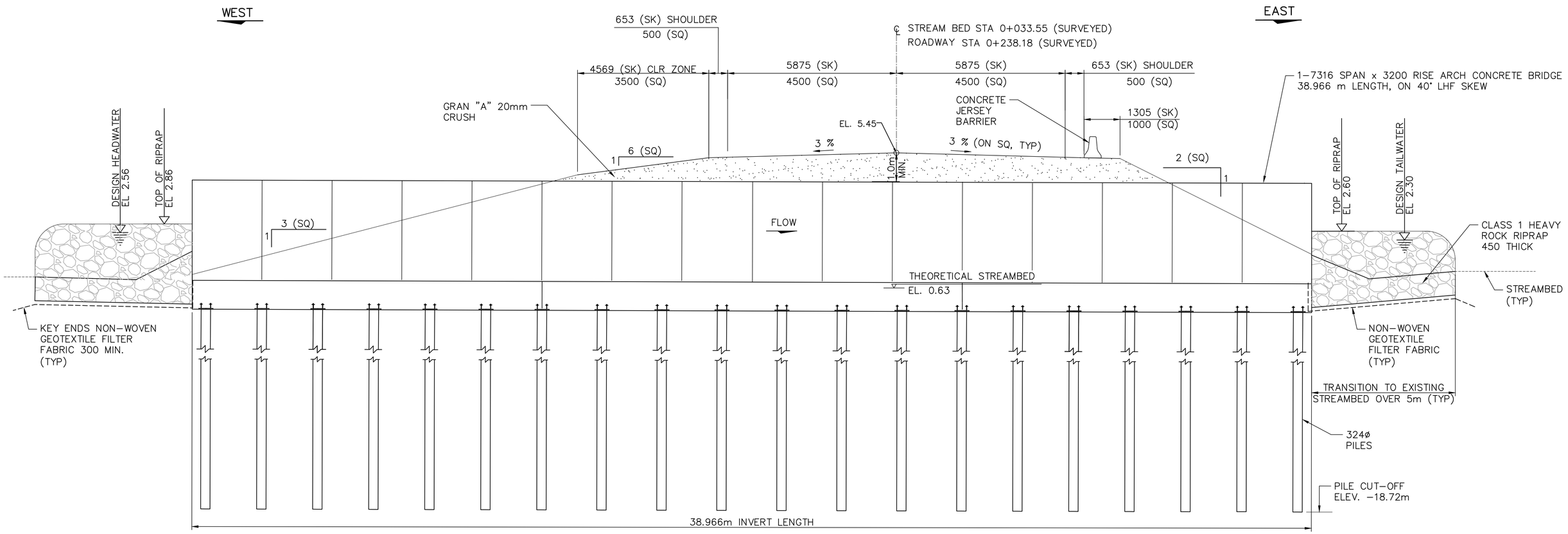
ITH 131.2
STREAMBED AND ROAD PROFILES

DEPARTMENT BAR CODE	DATE	STREAM	LOCATION	HIGHWAY	FILE	SHEET	DRAWING
	2019–08–30	GUNGHI CREEK	INUVIK TO TUKTOYAKTUK HIGHWAY	LOCAL	–	2 OF 9	SHEET–02



A 01 LONGITUDINAL SECTION
LOOKING NORTH 1:75

NOTE:

- THIS DRAWING TO BE READ IN CONJUNCTION WITH OTHER DRAWINGS.
- ALL DIMENSIONS ARE GIVEN IN MILLIMETRES UNLESS OTHERWISE NOTED.
- ELEVATIONS ARE GIVEN IN METRES.

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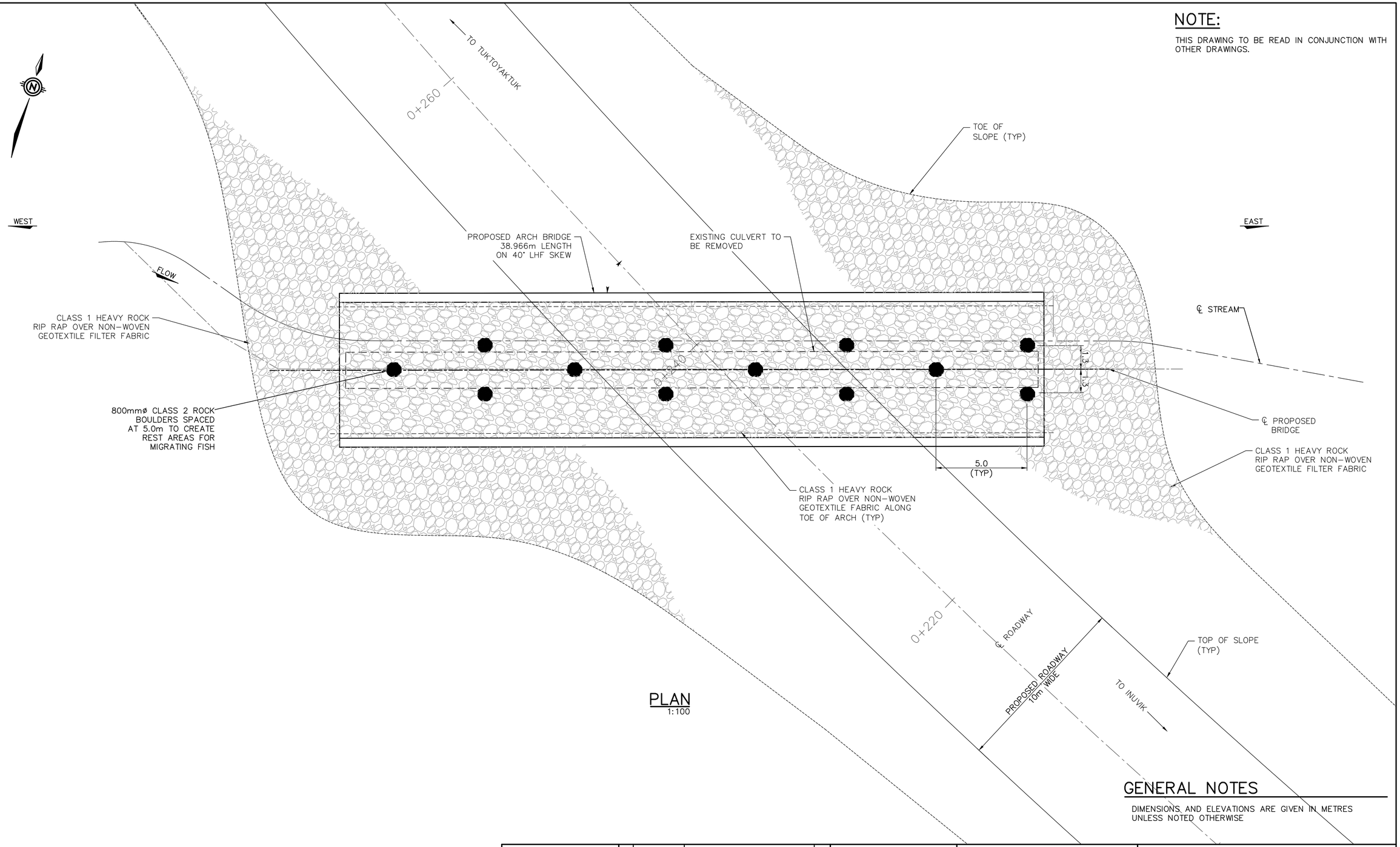
GOVERNMENT OF THE NWT
DEPARTMENT OF INFRASTRUCTURE

ITH 131.2
INFORMATION SHEET 1

DEPARTMENT BAR CODE	DATE	STREAM	LOCATION	HIGHWAY	FILE	SHEET	DRAWING
	2019–08–30	GUNGHI CREEK	INUVIK TO TUKTOYAKTUK HIGHWAY	LOCAL	–	3 OF 9	SHEET–03

NOTE:

THIS DRAWING TO BE READ IN CONJUNCTION WITH OTHER DRAWINGS.



PLAN
1:100

GENERAL NOTES

DIMENSIONS AND ELEVATIONS ARE GIVEN IN METRES UNLESS NOTED OTHERWISE

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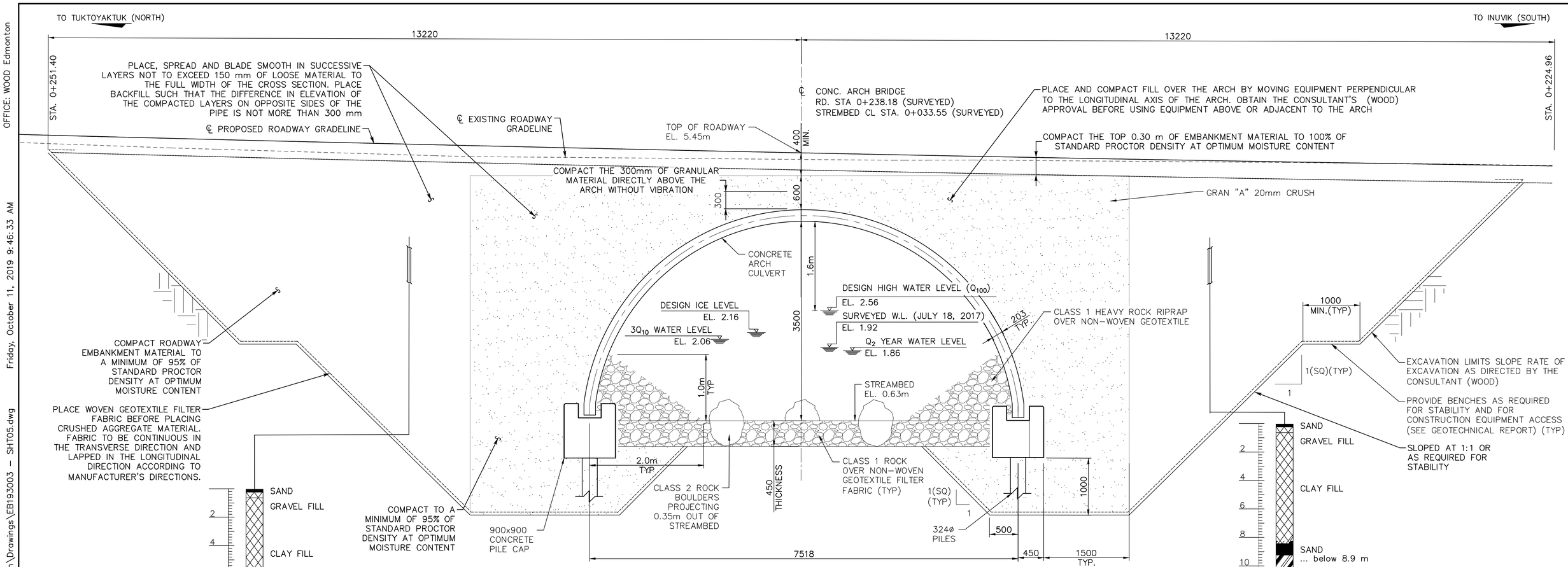
GOVERNMENT OF THE NWT
DEPARTMENT OF INFRASTRUCTURE

ITH 131.2
INFORMATION SHEET 2

DEPARTMENT BAR CODE	DATE	STREAM	LOCATION	HIGHWAY	FILE	SHEET	DRAWING
	2019-08-30	GUNGHI CREEK	INUVIK TO TUKTOYAKTUK HIGHWAY	LOCAL	-	4 OF 9	SHEET-04



A TYPICAL SECTION
1:150

AGGREGATE GRADATION (% PASSING) FOR GRAN "A" 20mm CRUSH													
SIEVE SIZE (um)	50000	40000	20000	16000	14000	12500	10000	5000	2500	1250	630	315	160	80
UPPER LIMIT		100		100			73	55		45		15		8
LOWER LIMIT		100		62			48	33	18	15		2		0

TEST HOLE: GUNGHI BH-02
STA: 0+246.99
N 7693951.0, E 577222.0
2017-02-23

END OF BOREHOLE AT 20.4 m
25mm ø PVC PIPE INSTALLED TO 20.4m
3 SINGLE BEAD THERMISTOR STRINGS INSTALLED AT 9.0, 13.0 AND 15.0m DEPTHS.

TEST HOLE: GUNGHI BH-01
STA: 0+228.03
N 7693939.0, E 577237
2017-02-23

END OF BOREHOLE AT 20.4 m
25mm ø PVC PIPE INSTALLED TO 20.4m
3 SINGLE BEAD THERMISTOR STRINGS INSTALLED AT 9.0, 13.0 AND 15.0m DEPTHS.

NOTE:

- THIS DRAWING TO BE READ IN CONJUNCTION WITH OTHER DRAWINGS.
- BACKFILLING OPERATIONS AT THE SIDES OF THE ARCH SHALL NOT COMMENCE BEFORE THE KEYWAY GROUT HAS ATTAINED 17.5 MPa.
- COMPACT BACKFILL MATERIAL BY MECHANICAL MEANS. FLOODING OR JETTING IS TO BE AVOIDED.
- EXCAVATION AND BACKFILLING TO BE DONE IN CONFORMANCE WITH SECTION 1 AND SECTION 2 OF STANDARD SPECIFICATION FOR BRIDGE CONSTRUCTION EDITION 16, ALBERTA TRANSPORTATION.
- ALL WATER LEVEL ELEVATIONS ARE AT INLET (HEAD WATER)
- ALL DIMENSIONS ARE GIVEN IN MILLIMETRES UNLESS OTHERWISE NOTED.
- ELEVATIONS ARE GIVEN IN METRES.

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SCALES SHOWN ARE CORRECT FOR 22" x 34" SHEET SIZE

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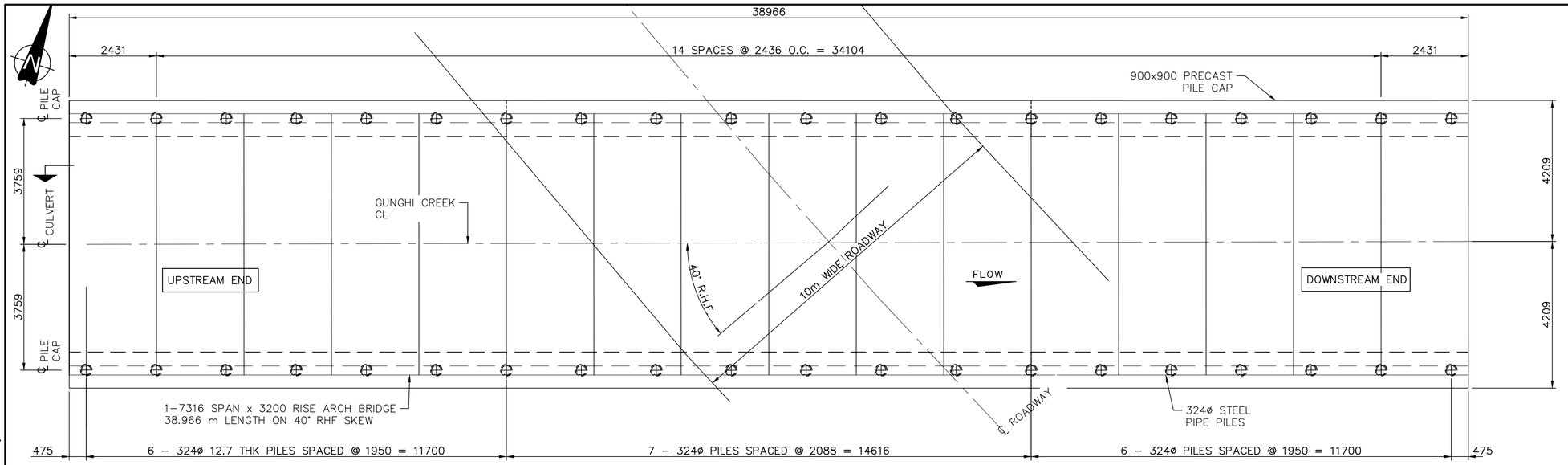
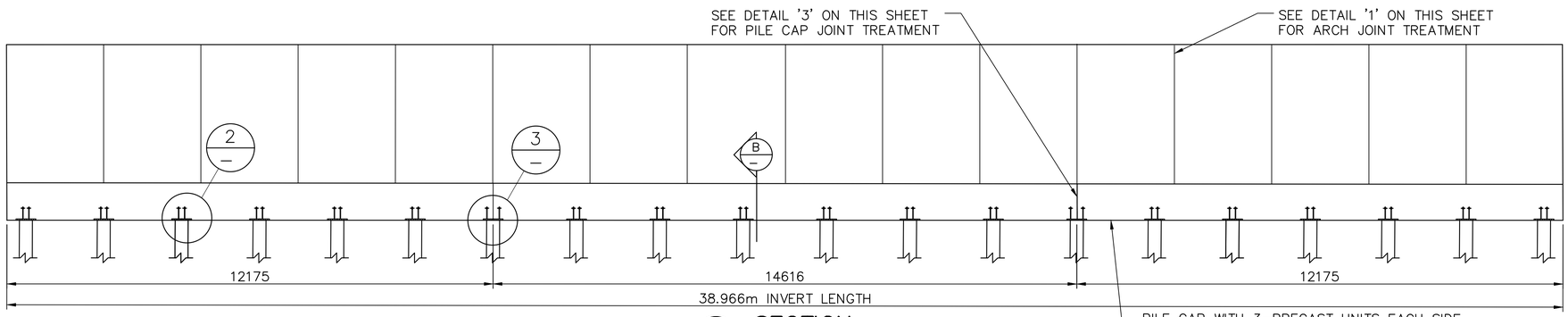
GOVERNMENT OF THE NWT
DEPARTMENT OF INFRASTRUCTURE

ITH 131.2
INFORMATION SHEET 3

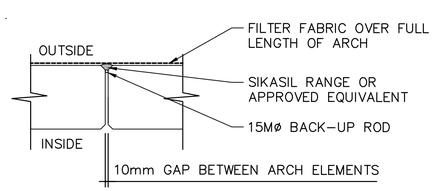
DEPARTMENT BAR CODE	DATE	STREAM	LOCATION	HIGHWAY	FILE	SHEET	DRAWING
	2019-08-30	GUNGHI CREEK	INUVIK TO TUKTOYAKTUK HIGHWAY	LOCAL	-	5 OF 9	SHEET-05



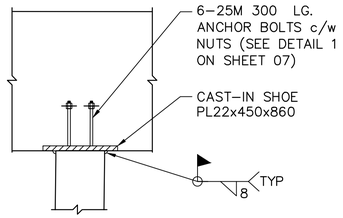
PLAN
1:150



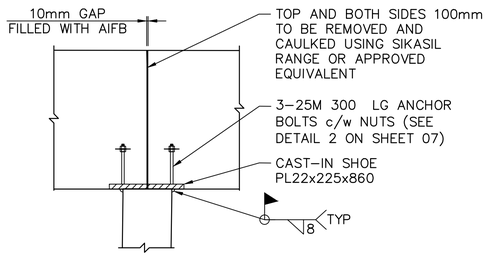
A SECTION
1:150



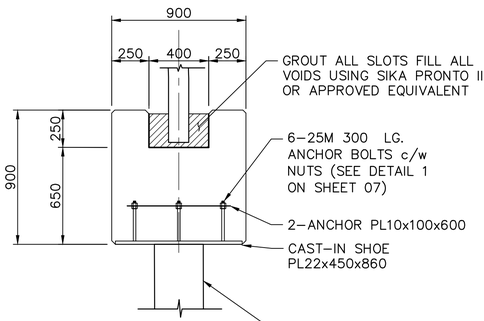
1 DETAIL – ARCH ELEMENT JOINT
1:10



2 DETAIL
1:20



3 DETAIL
1:20



B SECTION
1:10

GENERAL NOTES

- ALL DIMENSIONS SHOWN ARE IN MILLIMETERS UNLESS NOTED OTHERWISE
- THIS DRAWING IS TO BE READ IN CONJUNCTION WITH OTHER DRAWINGS
- ALL PRE–CAST CONCRETE SHALL BE IN CONFORMANCE WITH SECTION 7 OF STANDARD SPECIFICATIONS OF BRIDGE CONSTRUCTION OF ALBERTA TRANSPORTATION (EDITION 16).
- ALL EXPOSED CORNERS OF PRECAST CONCRETE UNITS TO HAVE 20 mm CHAMFER.
- THE MINIMUM COVER TO REINFORCING STEEL SHALL BE 50 mm UNLESS OTHERWISE NOTED.
- ALL WELDING TO CONFORM TO AWS SPECIFICATION D1.5

MATERIAL STRENGTH

- ARCH CONCRETE SHALL BE CLASS 'HPC' WITH 28–DAY COMPRESSIVE STRENGTH MINIMUM 45 MPa.
- PILE CAP CONCRETE SHALL BE CLASS "C" WITH 28–DAY COMPRESSIVE STRENGTH MINIMUM 35 MPa
- ALL REINFORCING STEEL SHALL CONFORM TO CAN/CSA G30.18 GRADE 400.
- CONCRETE GROUT SHALL HAVE A MINIMUM COMPRESSIVE STRENGTH SAME AS FOR PILE CAP CONCRETE. THE PROCEDURE OF APPLICATION SHALL BE IN ACCORDANCE WITH THE MANUFACTURER'S RECOMMENDATIONS THAT RESULT IN 100% CONTACT OVER GROUTED AREA.
- ALL STEEL PLATES SHALL CONFORM TO CAN/CSA G40.21–300WT OR EQUIVALENT.
- ALL ANCHOR BOLTS TO CONFORM TO ASTM A307 GRADE A. IT MUST MEET THE SUPPLEMENTARY REQUIREMENT S1 OF ASTM A307
- ALL NUTS TO CONFORM TO A194, GRADE 2H.

FABRICATION AND INSTALLATION

- PILES SHALL BE INSTALLED AS PER KIGGIAK EBA GEOTECHNICAL RECOMMENDATIONS AND IN CONFORMANCE WITH SECTION 3 OF STANDARD SPECIFICATIONS FOR BRIDGE CONSTRUCTION EDITION 16, ALBERTA TRANSPORTATION.
- BOTH ARCH AND PILE CAP SHALL BE PRECAST IN KNELSEN PLANT IN UNITS, AS SHOWN ON DRAWING, TO BE INSTALLED ON SITE.
- ARCH ELEMENTS SHALL BE INSTALLED AS PER BEBO ARCH SYSTEMS INSTALLATION GUIDE, BEBO ARCH INTERNATIONAL AG

CODES AND STANDARDS

WORK IS TO BE DONE IN CONFORMANCE WITH FOLLOWING STANDARDS.

- STANDARD SPECIFICATIONS OF BRIDGE CONSTRUCTION (EDITION 16) ALBERTA TRANSPORTATION (AT)
- CAN/CSA A23.1–14/A23.2–14 – CONCRETE MATERIALS AND METHODS OF CONCRETE CONSTRUCTION/TEST METHODS AND STANDARD PRACTICES FOR CONCRETE.
- CAN/CSA S6–14 – CANADIAN HIGHWAY BRIDGE DESIGN CODE.
- CSA W59 AND AWS D1.5

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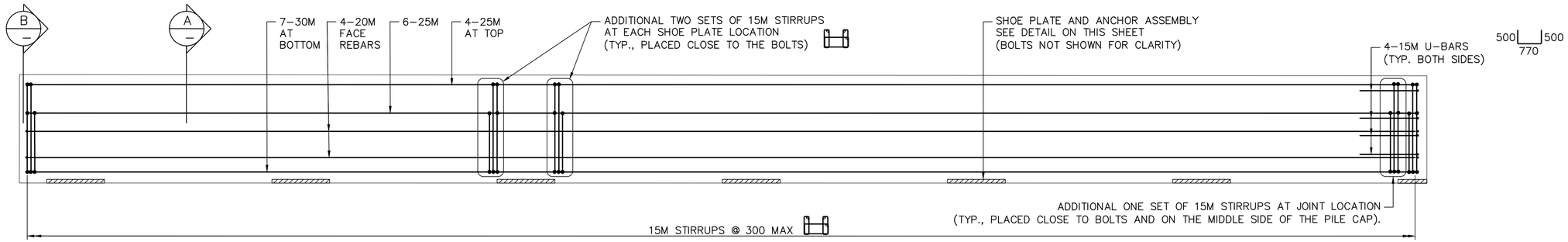
GOVERNMENT OF THE NWT
DEPARTMENT OF INFRASTRUCTURE

ITH 131.2
CONCRETE BRIDGE
PLAN, SECTIONS & DETAILS

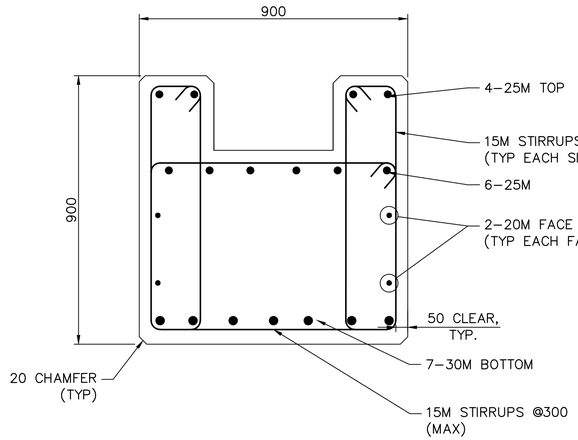
DEPARTMENT BAR CODE	DATE	STREAM	LOCATION	HIGHWAY	FILE	SHEET	DRAWING
	2019–09–20	GUNGHI CREEK	INUVIK TO TUKTOYAKTUK HIGHWAY	LOCAL	–	6 OF 9	SHEET–06

OFFICE: WOOD EDMONTON
Friday, October 11, 2019 8:44:54 AM
G:\BRIDGES\Projects\EB193003 – Gunghi Creek Culvert Replacement\30A – Calculations and Design\Drawings\EB193003 – SHT06_07.dwg



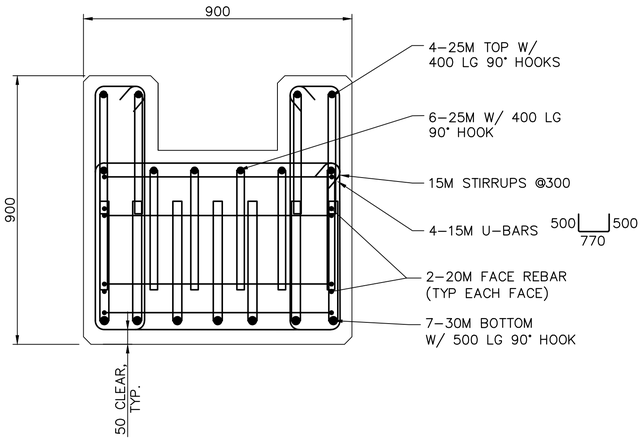
PRECAST PILE CAP UNIT – REINFORCEMENT DETAIL

(12175 LG. SHOWN, OTHERS WITH SIMILAR DETAILS) 1:20



A SECTION

1:10



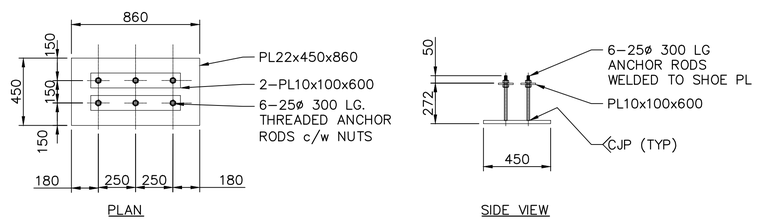
B PILE CAP END

(SAME FOR BOTH ENDS) 1:10

LAP LENGTHS

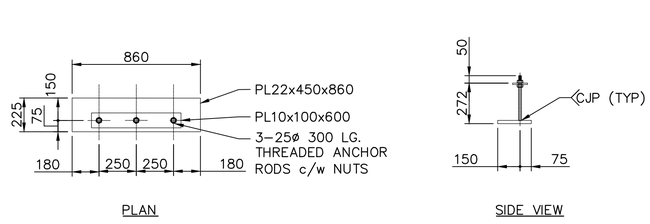
REINFORCEMENTS LAP LENGTHS AS FOLLOWS:

30M – 1500 LONG
25M – 1200 LONG
20M – 900 LONG



1 DETAIL – SHOE PLATE AND ANCHOR ASSEMBLY

1:20



2 DETAIL – SHOE PLATE AND ANCHOR ASSEMBLY

(AT JOINT LOCATION) 1:20

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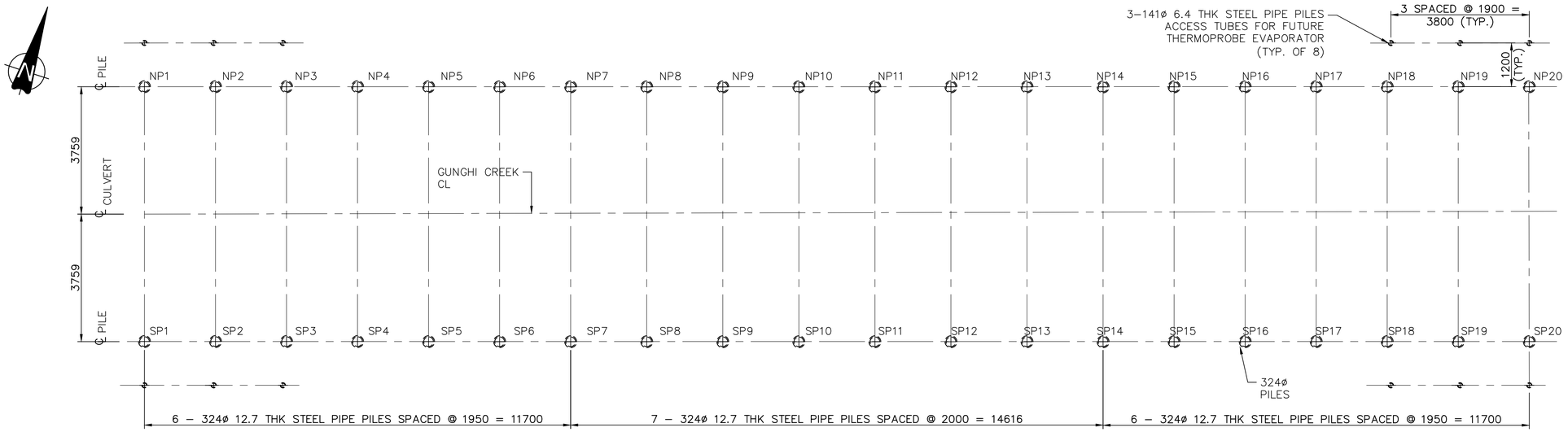
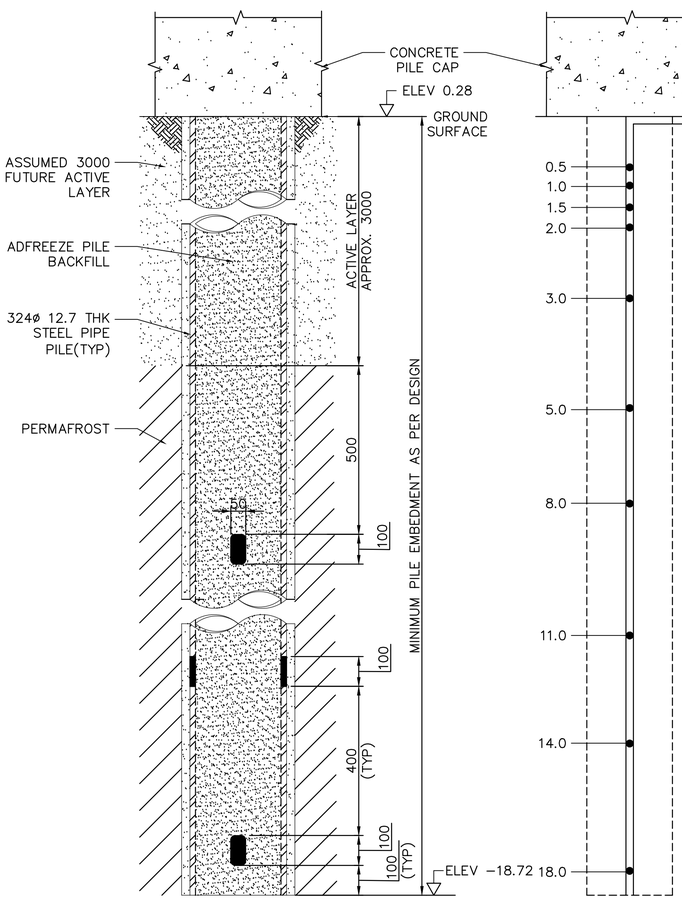
ITH 131.2
CONCRETE BRIDGE
PILE CAP REINFORCING DETAILS

DEPARTMENT BAR CODE	DATE	STREAM	LOCATION	HIGHWAY	FILE	SHEET	DRAWING
	2019-09-20	GUNGHI CREEK	INUVIK TO TUKTOYAKTUK HIGHWAY	LOCAL	–	7 OF 9	SHEET-07

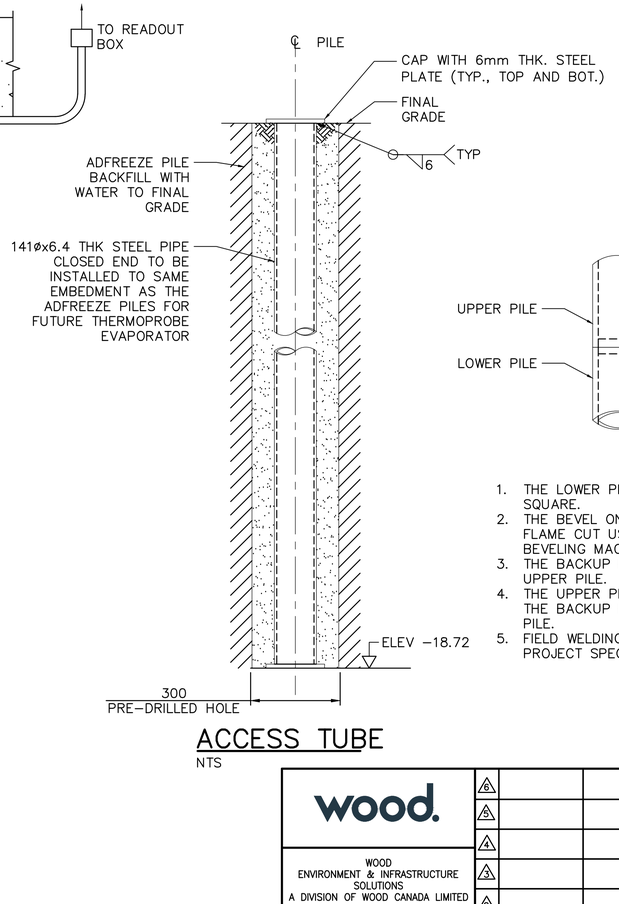


NOTES: INSTALL MULTI–BEAD THERMISTOR CABLE ON PILE NP1, NP9, SP14 AND SP20

PILING PLAN
1:150



PILE EMBEDMENT
NTS



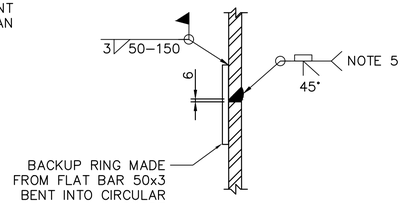
THERMISTOR CABLE DETAILS
NTS (TO BE INSTALLED INSIDE THE PILE)

ACCESS TUBE
NTS

FOUNDATION PILE DESIGN LOAD (kN)		
LOAD COMBINATION	VERTICAL	LATERAL
SLS 1 (PERMANENT)	400	10
SLS 1 (DEAD + LIVE)	550	40
ULS 1 (PERMANENT)	500	10
ULS 1 (DEAD + LIVE)	750	70

1. THE LOWER PILE SHALL BE TRIMMED TRUE AND SQUARE.
2. THE BEVEL ON THE UPPER PILE SHALL BE FLAME CUT USING A MECHANICAL PIPE BEVELING MACHINE.
3. THE BACKUP PLATE SHALL BE WELDED TO THE UPPER PILE.
4. THE UPPER PILE SHALL BE POSITIONED WITH THE BACKUP RING FITTED INTO THE LOWER PILE.
5. FIELD WELDING SHALL BE IN ACCORDANCE WITH PROJECT SPECIFICATION.

PILE SPLICE
NTS



P – DETAIL
NTS

GENERAL NOTES

- THE GEOTECHNICAL INVESTIGATION IS AVAILABLE FROM "ADFREEZE STEEL PIPE PILE RECOMMENDATIONS FOR PRECAST BRIDGE CULVERT GUNGHI CREEK, KM 131.2 INUVIK–TUKTOYAKTUK HIGHWAY REVISION 1" PROVIDED BY KIGGIAK–EBA. FILE: KE1077/ENG.YARCO3163, JULY 2019
- THE FOUNDATION PILES ARE ADFREEZE TYPE (SLOTTED). NUMBER OF PILES, LENGTHS AND TIP ELEVATIONS ARE BASED ON THE RECOMMENDATIONS MADE BY KIGGIAK–EBA CONSULTING LTD.
- ALL PILES SHALL BE INSTALLED PLUMB TO THE PILE TIP ELEVATIONS SHOWN ON THE GENERAL LAYOUT DRAWING OR LOWER TO PROVIDE THE REQUIRED DESIGN CAPACITY NOTED IN THE PILE LOAD TABLE.
- THE CONTRACTOR SHALL BE PREPARED TO USE AN AUGER OR OTHER MEANS OF PASSING PILES THROUGH FROST OR BOULDERS.
- USE A TEMPLATE FOR ACCURATE HORIZONTAL PLACEMENT OF PILES IS RECOMMENDED.
- PILES SHALL BE INSTALLED TO THE FOLLOWING TOLERANCES:
  –MAXIMUM TOLERANCE FOR PILE SPACING IN PLAN IS 50 mm
  –FINISHED PILE CUT–OFF ELEVATION TO BE WITHIN 3 mm OF REQUIRED ELEVATION.
  –MAX OFFSET FROM PILE CENTERLINE BY 25 mm.
- STEEL PIPE PILING SHALL MEET THE REQUIREMENTS OF SPECIFICATION ASTM 252 GRADE 2, EXCEPT THAT HYDROSTATIC TESTING IS NOT REQUIRED. IMPERIAL EQUIVALENT PILING IS ACCEPTABLE. MILL CERTIFICATES SHALL BE PROVIDED TO CONSULTANT FOR REVIEW PRIOR TO PILE SUPPLY.
- ALL WELDING SHALL CONFORM TO THE REQUIREMENTS OF CURRENT AWS SPECIFICATION D1.5.
- ANY VOIDS DEVELOPED IN THE VICINITY OF THE PILES FROM ADJACENT SOIL DURING INSTALLATION SHALL BE BACKFILLED WITH GRANULAR FILL OR GROUT TO MAINTAIN THE LATERAL GROUND RESISTANCE.
- PILES SHALL BE INSTALLED IN THE DRILLED HOLES OF DIAMETER 100 MM LARGER THAN THE PILE DIAMETER. THE VOIDS BETWEEN THE PILE AND THE DRILLED HOLE SHALL BE FILLED WITH ADFREEZE GRANULAR MATERIAL AND WATER.
- CONTRACTOR SHALL ENGAGE A QUALIFIED GEOTECHNICAL ENGINEER WHO SHALL MONITOR FOR DRILLING AND PILE INSTALLATIONS BASED ON THE EQUIPMENT CONTRACTOR PROPOSES TO USE. THE CONTRACTOR SHALL SUBMIT THE PROPOSED INSTALLATION FOR REVIEW BY THE ENGINEER.
- REFER TO GEOTECHNICAL INVESTIGATION REPORT BY KIGGIAK ENGINEERING CONSULTANT LTD FOR PREDICTED ADFREEZE PILE INTERVENTION TIMING AT THIS CROSSING.
- PILES SHALL BE 19m LONG.
- DELIVER PILES IN THE LONGEST LENGTHS POSSIBLE TO MINIMIZE FIELD SPLICES. HOWEVER IF REQUIRED, SPLICING SHALL BE DONE AS SHOWN ON DRAWING.
- GRADATION OF ADFREEZE PILE BACKFILL MATERIAL IS AS SHOWN IN THE TABLE. THE BACKFILL MATERIAL SHALL BE PLACED WITH WATER.
- TO CONTAIN A SATURATED, BUT CONSOLIDATED ADFREEZE BACKFILL, WATER SHOULD BE PLACED FIRST FOLLOWED BY AGGREGATE IN AN ALTERNATING SEQUENCE. MAINTAINING FREE WATER ABOVE THE LEVEL OF BACKFILL SHOULD ACHIEVE THE OBJECTIVES OF SATURATION AND ADEQUATE CONSOLIDATION.
- THE ADFREEZE AGGREGATE SHALL BE PLACED AT A CONTROLLED RATE TO AVOID THE POTENTIAL FOR ARCHING THE ANNULUS BETWEEN THE PIPE PILE AND THE WALL OF THE PILE HOLE.

ADFREEZE PILE BACKFILL MATERIAL	
SIEVE SIZE	% BY WEIGHT
20	100%
10	65–100
5	40–100
1.5	20–90
0.63	15–65
0.315	10–35
0.160	5–20
0.080	0–10
PLASTICITY INDEX	NP–6
POREWATER SALINITY	0–5 PPT

wood.

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A DIVISION OF WOOD CANADA LIMITED

SCALES SHOWN ARE CORRECT FOR 22" x 34" SHEET SIZE

JOB No. EB193003

REV	DATE	REVISIONS	BY
6			
5			
4			
3			
2			
1	2019–10–10	ISSUED FOR 100% REVIEW	JZ

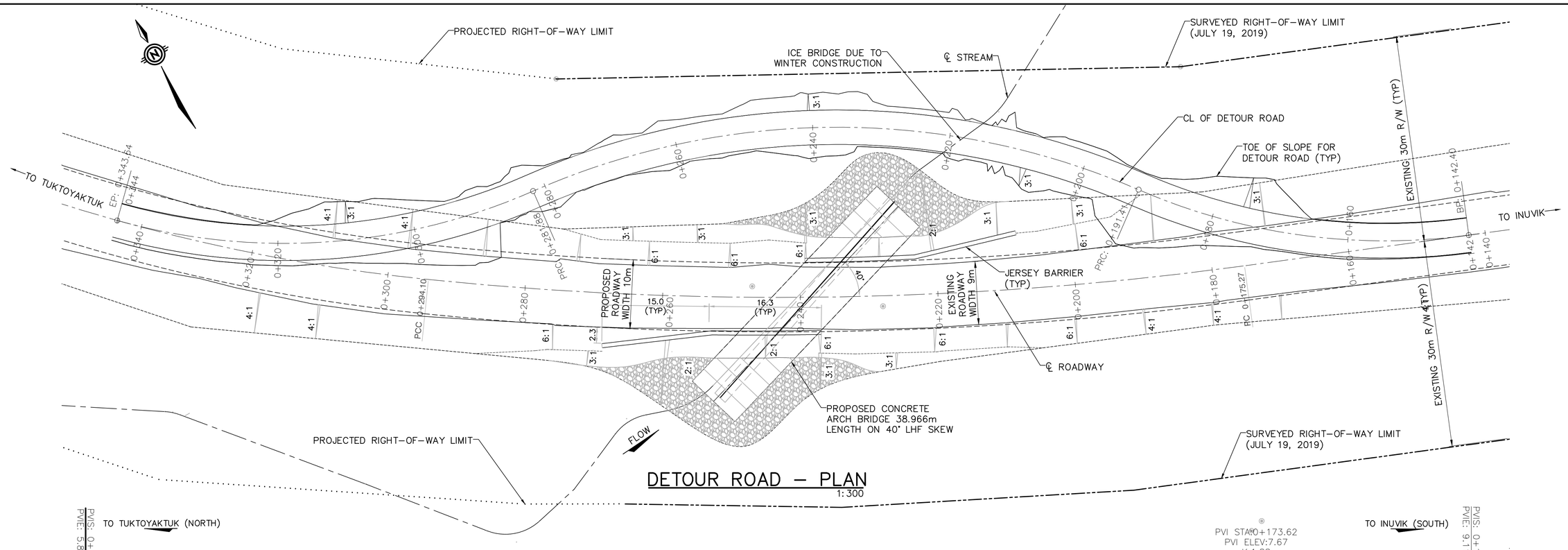
DESIGNER

DATE

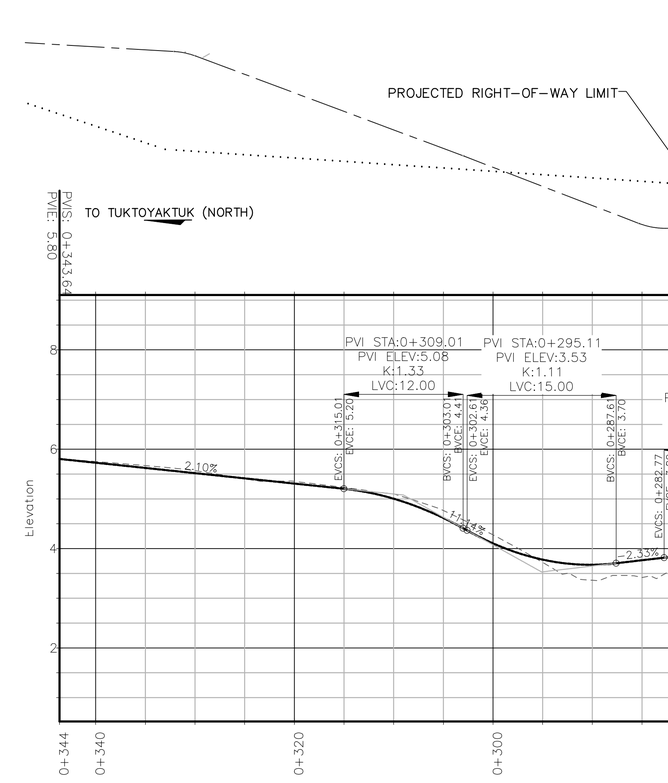
GOVERNMENT OF THE NWT
DEPARTMENT OF INFRASTRUCTURE

ITH 131.2 CONCRETE BRIDGE PILING PLAN, DETAILS AND NOTES

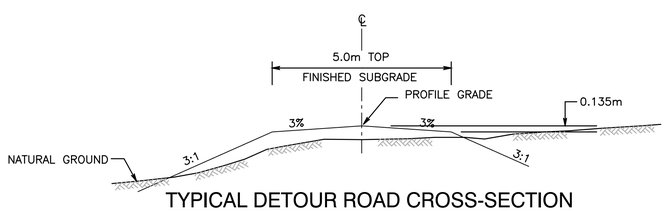
DEPARTMENT BAR CODE	DATE	STREAM	LOCATION	HIGHWAY	FILE	SHEET	DRAWING
	2019–08–30	GUNGHI CREEK	INUVIK TO TUKTOYAKTUK HIGHWAY	LOCAL	–	8 OF 9	SHEET–08



DETOUR ROAD – PLAN
1:300



DETOUR ROAD PROFILE
LOOKING NORTH 1:300



TYPICAL DETOUR ROAD CROSS-SECTION
N.T.S.

NOTE:
- THIS DRAWING TO BE READ IN CONJUNCTION WITH OTHER DRAWINGS.
- ALL DIMENSIONS ARE GIVEN IN MILLIMETRES UNLESS OTHERWISE NOTED.
- ELEVATIONS ARE GIVEN IN METRES.

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DEPARTMENT OF INFRASTRUCTURE

ITH 131.2
DETOUR ROAD
PLAN AND PROFILE

DEPARTMENT BAR CODE	DATE	STREAM	LOCATION	HIGHWAY	FILE	SHEET	DRAWING
	2019-08-30	GUNGHI CREEK	INUVIK TO TUKTOYAKTUK HIGHWAY	LOCAL	–	9 OF 9	SHEET-09