

Hydrotechnical Progress Report

Summary of Fieldwork

Tli Cho Alignment Hydrological
Study

Reference number: S051107



Prepared for:

Government of the Northwest
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1.0 Introduction

The Government of the Northwest Territories – Department of Transportation (DOT) has begun the pre-engineering work on the proposed Tli Cho Winter Road realignment. As a part of the pre-engineering studies, a hydrological analysis is required to provide design parameters for culvert and bridge sizing.

The following is a hydrotechnical memorandum which summarizes the 2014 field visit to Yellowknife, NWT completed by Stantec staff between the dates of July 1-4, 2014. This package includes:

- Summary of fieldwork and hydrologic observations
- Tabular summary of measurements and observations
- Photo inventory of each crossing

1.1 Objective

The purpose of the visit was to observe and collect data for the watercourse crossings along the proposed Tli Cho Highway which extends from Highway 3 near Yellowknife, north to the community at Lac La Martre. Where possible, the hydrologic survey included:

- Measurement of bankfull width and depth at the crossing
- Measurement of channel slope
- Depth and velocity readings of channel discharge at crossing and 50 m upstream and 50 m downstream of crossing
- Survey of channel substrate and floodplain composition
- Photo inventory of each crossing

All hydrologic observations and measurements will be used as input for the hydrologic and hydraulic model calibrations at the time of preliminary design.

1.2 Field Study Limitations

Specific field measurements (i.e., velocities, widths, depths) were limited to crossings where flowing water was present and where the helicopter was able to land. Of the 15 crossings that encompassed this program, all crossing locations were visited by helicopter, however the crew was only able to land at and obtain measurements for Sites 2, 8, 9, 12, 14 and 15.

2.0 Watercourse Crossing Descriptions and Fieldwork Overview

Five major crossings have been identified (8, 9, 12, 14, and 15) while the remaining crossings are all considered minor. The minor crossings are poorly defined and likely only provide conveyance during significant rainfall events and spring freshet (to be confirmed with hydrologic and hydraulic modelling). Flowing water was only observed at Crossings 8, 14, and 15 while all other crossings either contained stagnant water, or were dry at the time of the field visit.

The crossings are listed below from Crossing 1 (furthest southern crossing) to Crossing 15 (furthest northern crossing) with a brief hydrologic description for each location. See Appendix B for photographic records at each crossing location.

2.1 Crossing 1

Crossing 1 is a low area with a poorly defined channel and no defined floodplain. Banks are vegetated with low shrubs and some trees. The "channel" was dry but the area of flooding during a rainfall event could be wide due to the flat relief in the area. Stagnant water was observed downstream. Surficial soil appears sandy.

2.2 Crossing 2

Similar to Crossing 1, Crossing 2 is a low-lying area with a poorly defined channel and floodplain. Banks are vegetated with thick grasses and shrubs as well as a forested area downstream. A small marsh area lies upstream. A significant amount of water must pond prior to spilling at the crossing. The "channel" was dry but the estimated flow width is 3-5 m. Surficial soil is sandy.

2.3 Crossing 3

Crossing 3 is similar to both 1 and 2 and has a poorly defined channel with forested banks. Small shrubs and grasses are within the "channel". There is no defined floodplain. Surficial soil appears sandy.

2.4 Crossing 4

Crossing 4 is a defined, ephemeral channel. Channel bed characteristics are similar to the first three crossings with some shrubs and grasses. The depth of the channel is approximately 0.3 m. An open, marsh area is located upstream of the crossing (see photos). The floodplain is forested with the same grasses and shrubs as the channel. Surficial soil appears sandy.

2.5 Crossing 5

Crossing 5 is poorly defined but a change in vegetation was observed downstream where flooding occurs during rainfall events. The channel has shrubs, trees, and grasses within the channel bed. Further downstream the channel opens up and is not as thickly forested as at the crossing location. Surficial soil appears sandy.

2.6 Crossing 6

Crossing 6 is poorly defined, however a change in the vegetation and forest type within the crossing location shows the extent of flooding during rainfall events. The crossing is a low area with signs of recent flooding. The channel and floodplain are not defined and the channel bed is full of shrubs and grasses. Surficial soil appears sandy.

2.7 Crossing 7

Crossing 7 is a low-lying area where ponding occurs downstream of the road during rainfall events. Soil appears sandy with some organics.

2.8 Crossing 8

Crossing 8 is a major crossing and is located at a series of well-defined and braided meandering channels within a marsh. The area floods during high water levels following large rainfall events. As water levels recede during dry periods low areas remain wet and small, oxbow ponds are created adjacent to the channel. There is minimal vegetation within the channel while the floodplain is thickly grassed with some trees. The main channel is approximately 3.5 -5 m while the floodplain is between 50-75 m. Bankfull depth within the main channel is 1.5 m. The channel substrate is mainly organic with some fines. The field crew sank 0.5 m into the bed of the channel at the time of the field visit. Erosion of the braided channels is evident.

2.9 Crossing 9

Crossing 9 is a major crossing and is a large, well defined, ephemeral stream. The main channel is an outlet for an upstream lake which flows during large rainfall events when the lake begins to spill. Stagnant water within the channel was observed at the time of the visit. The bankfull width and depth are 11.5 m and 0.80 m, respectively. There is no defined floodplain but the banks are forested. The channel bed consists of cobbles and gravel with some silt and muskeg.

2.10 Crossing 10

Crossing 10 is a low-lying area where ponding occurs during large rainfall events. There is no defined channel. The area is mainly marsh with muskeg, organics, and grass at the crossing. The surrounding area and floodplain is forested and grassed. The ponding area is approximately 15-20 m wide. A second potential crossing with a small, well-defined, meandering channel was observed just south of the proposed crossing area (see photos).

2.11 Crossing 11

Crossing 11 is similar to 10 with a low-lying, ponding area at the crossing and no defined channel. The area is mainly marsh with muskeg, organics, and grass at the crossing. The area is bounded by two lakes approximately 100-200 m upstream and downstream of the crossing. The areas adjacent to the crossing are forested and grassed. Stagnant water was observed at the time of the field visit.

2.12 Crossing 12

Crossing 12 was a well-defined, wide, meandering channel. No flow was observed but stagnant water was 0.55 m deep. Bankfull depth and width is 1 m and 31 m, respectively. The main channel is un-vegetated while the floodplain is grassed. The substrate within the channel is mainly organic with some fine material. Due to small, natural dams, the depth of water must be approximately 1 m before continuous flow occurs.

2.13 Crossing 13

Crossing 13 is a low-lying marsh area bounded by small lakes. Stagnant water was observed at the crossing. Vegetation consists of small shrubs and grasses. Substrate appears organic.

2.14 Crossing 14

Crossing 14 is a major crossing and is a well-defined meandering channel with riffle-pool sequences. The distance between riffles is approximately 150-200 m. The proposed crossing is located at a pool. The bankfull depth and width at the crossing is estimated at 2.5-3 m and 10 m, respectively. Substrate in the channel is gravel and cobbles with some fine and organic material. The floodplain is grass with forest. The channel banks are undercut and erosion is evident. A higher waterline was observed approximately 0.3 m above the measured depth.

2.15 Crossing 15

Crossing 15 is a major crossing at a set of rapids on Rivière La Martre and originates from Lac La Martre to the west. The bankfull width is approximately 50-60 m while the bankfull depth is estimated at approximately 3-4 m. The river substrate consists of large boulders and cobbles with gravel. Sediment deposition is evident downstream of the rapids where discharge velocities are much smaller (see photos). A set of falls is located approximately 3-4 km downstream of the rapids. The floodplain consists of marsh areas with tall grasses immediately adjacent to the river which are bounded by thick forest.

3.0 Summary of Hydrological Characteristics

A total of 15 watercourse crossings were visited and surveyed from a hydrological perspective. As previously determined, there are five major crossings (8, 9, 12, 14, and 15) with significant discharge and large contributing watersheds. These streams and rivers are well-defined, meandering channels with visible floodplains. The remaining 11 crossings are considered minor crossings with relatively low discharge quantities. These minor crossings are poorly defined and only discharge during significant rainfall events and the spring freshet. Please see the attached table for a summary of field measurements.

4.0 Closure

This preliminary Hydrotechnical Progress Report – Summary of Fieldwork will be followed a hydrological analysis as per Stantec's proposal that will include:

1. Delineation of drainage area to each crossing location based on available topographic data.
2. Characterization of stream flow regimes using long-term regional hydrometric data located in the surrounding area. Ungauged streams will be assessed using the Regional Flood Frequency Analysis approach. This will provide estimates of stream flow for various return period events up to the 100-year return period.
3. Assessment of ice characteristics at each crossing location. Since this work will be completed in July, this assessment will be estimated based on historical climate data.
4. Assessment of hydraulic conditions at each crossing location, including open water velocity and elevation, breakup elevation (estimated), and guidance will be provided regarding bridge elevation and scour protection. The required hydraulic opening will be estimated at all 15 crossings for the 100-year flow. A conceptual hydraulic model will be developed for the four largest crossing locations.
5. Recommend appropriate slope protection in the vicinity of each crossing including rip rap diameter and top elevation.

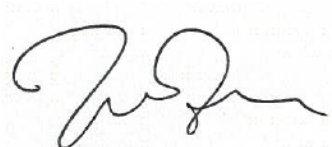
Sincerely,

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5.0 Appendices

APPENDIX A: HYDROLOGICAL SURVEY - COLLECTED DATA

APPENDIX B: PHOTOGRAPHIC RECORD

APPENDIX A

Hydrologic Survey – Collected Data

1449-02005 Tli Cho Winter Highway Realignment
Government of Northwest Territories - Department of Transportation
Hydrologic Survey - Collected Data

Conditions at Time of Survey

Crossing Number	Defined Channel? (Y/N)	Defined Floodplain? (Y/N)	Stagnant Water? (Y/N)	Evidence of Ponding (Y/N)	Flow Direction	Bankfull Width (m)	Bankfull Depth (m)	Average Velocity (m/s)	Measured Flow ¹ (m ³ /s)	Temperature (deg C)	pH	Conductivity (mS)	Hardness (mg/L)	Soil Conductivity (mS)	Substrate
1	N	N	Y	Y		-	-	-	NF	-	-	-	-	-	Sand
2*	N	N	N	N		-	-	-	NF	-	-	-	-	-	Sand
3	N	N	N	Y		-	-	-	NF	-	-	-	-	-	Sand
4	Y	N	N	Y		-	-	-	NF	-	-	-	-	-	Sand
5	N	N	N	Y		-	-	-	NF	-	-	-	-	-	Sand
6	N	N	Y	Y		-	-	-	NF	-	-	-	-	-	Sand
7	N	N	N	Y		-	-	-	NF	-	-	-	-	-	Sandy with some organics
8*	Y	Y	Y	Y	NE	3.5-5	1.5	0.29	0.079	19	7.56	0.02	1000	0.03	Organics with fine sediment
9*	Y	N	Y	Y	SE	11.5	0.8	-	NF	-	-	-	-	-	Boulders, cobbles, gravel with muskeg
10	Y	N	Y	Y	SW	-	-	-	NF	-	-	-	-	-	Muskeg, organics, grass
11	N	N	Y	Y	NE	-	-	-	NF	-	-	-	-	-	Muskeg, organics, grass
12*	Y	Y	Y	Y	NE	31.0	1-1.5	-	NF	-	-	-	-	-	Organics with fine sediment
13	N	N	Y	Y	E	-	-	-	NF	-	-	-	-	-	Organics and grass
14*	Y	Y	N	N	NE	10.0	2.5-3	0.14	0.385	21	8.11	0.42	250	0.02	Boulders, cobbles, gravel
15*	Y	Y	N	N	W	50-60	3-4	NM	NM	21	8.04	0.25	500	0.02	Boulders, cobbles, gravel

Notes:

¹Flow is an average of the 2-3 measurements taken at each crossing; where possible, measurements were taken upstream, downstream, and at the crossing

NF - no flow at crossing

NM - not measured due to conditions (depth, velocity)

*Able to land and document observations

APPENDIX B

Photographic Record



Photo 1: Crossing 1 looking northeast (downstream); note dry conditions and downstream marsh area (July 3, 2014)



Photo 2: Crossing 1 looking northwest (downstream); stagnant water observed upstream of crossing (July 3, 2014)



Photo 3: Crossing 2 looking northeast (downstream); note sandy surficial soil on roadway and dry conditions (July 3, 2014)



Photo 4: Crossing 2 looking south (upstream); tall grasses and small shrubs in marsh area upstream of crossing



Photo 5: Crossing 3 looking east; note sandy and dry conditions (July 3, 2014)



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Photo 6: Crossing 3 looking west; vegetation appears to change near crossing (July 3, 2014)



Photo 7: Crossing 4 looking southwest (upstream); some minor drainage through forest and a defined crossing at road (July 3, 2014)



Photo 8: Crossing 4 looking northeast (downstream); clearing/marsh located downstream (north) of crossing (July 3, 2014)



Photo 9: Crossing 5 looking southeast; downstream watercourse in background (July 3, 2014)



Photo 10: Crossing 5 looking northeast (downstream); note vegetation change showing extents of flooding downstream of crossing and width of flooding at crossing (July 3, 2014)



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Photo 11: Crossing 6 looking northeast (downstream); note low point in road and change of vegetation (July 3, 2014)



Photo 12: Crossing 6 looking north; extent of previous flooding at crossing approximately 20 m (July 3, 2014)



Photo 13: Crossing 7 looking northwest (upstream); low, ponding area on east side of road, no defined channel upstream (July 3, 2014)



Photo 14: Crossing 7 looking east (downstream); note ponding area and downstream marsh area past forest (July 3, 2014)



Photo 15: Crossing 8 looking south; note oxbows and meandering channel. Floodplain approximately 50-75 m wide (July 3, 2014)



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Photo 16: Crossing 8 looking west (upstream); grassed floodplain and organic substrate; note eroded banks with some undercutting (July 3, 2014)



Photo 17: Crossing 8 looking east (downstream) from braided channel; bankfull width = 3.5 m, bankfull depth = 1.5 m (July 3, 2014)



Photo 18: Crossing 8 looking west (upstream) at braided channel; floodplain is grassed with forest at edges, note high water level (July 3, 2014)



Photo 19: Crossing 8 looking east; meandering channel and oxbows and large floodplain downstream (July 3, 2014)



Photo 20: Crossing 9 looking southwest; upstream lake at right edge of photo (July 3, 2014)



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Photo 21: Crossing 9 looking east (downstream); well defined channel with no floodplain (July 3, 2014)



Photo 22: Crossing 9 looking west upstream from bed; note cobbles, gravel and muskeg substrate (July 3, 2014)



Photo 23: Crossing 9 looking east downstream; bankfull width = 11.5 m, bankfull depth = 0.8 m (July 3, 2014)

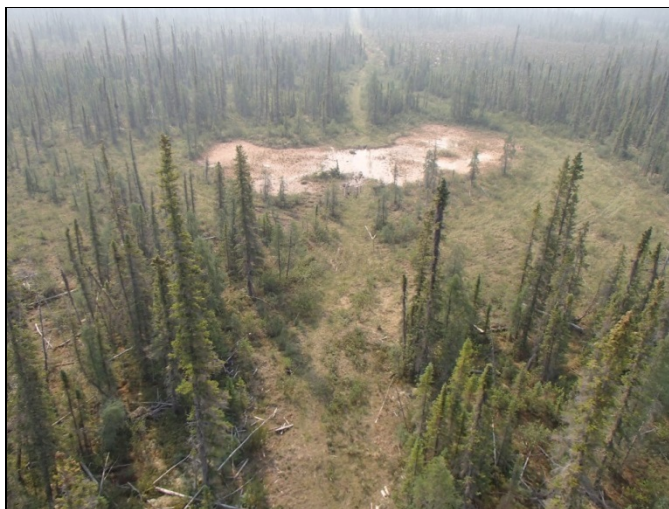


Photo 24: Crossing 10 looking north; ponding area with standing water (July 3, 2014)

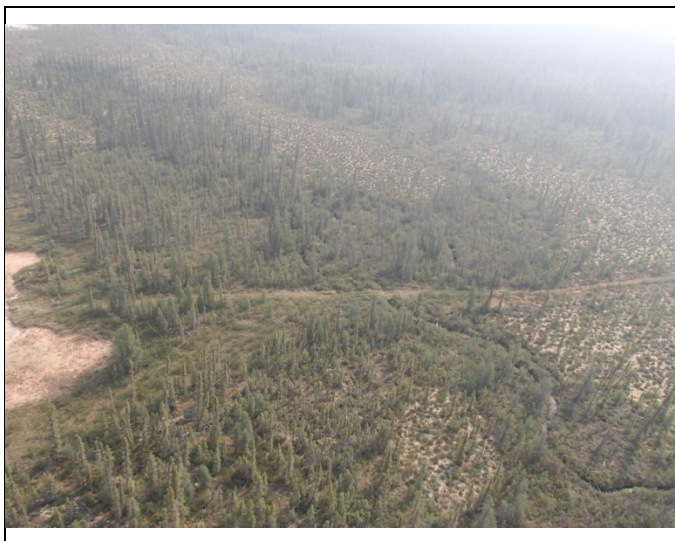


Photo 25: Crossing 10 looking southeast (downstream); crossing at left of photo with small channel crossing at right (July 3, 2014)



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Photo 26: Crossing 10 looking at small channel just south of crossing (July 3, 2014)



Photo 27: Crossing 11 looking southwest at upstream lakes; note extent of flooding around crossing with no trees (July 3, 2014)

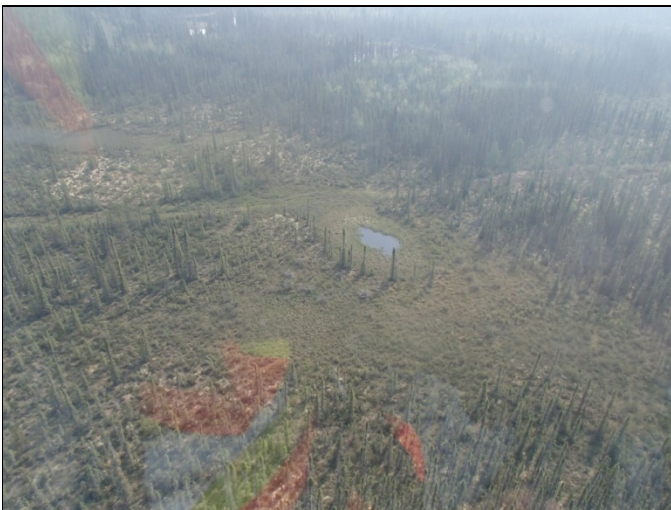


Photo 28: Crossing 11 looking southeast (downstream) (July 3, 2014)



Photo 29: Crossing 11 looking south; upstream lakes and downstream marsh areas (July 3, 2014)



Photo 30: Crossing 12 looking northeast (downstream); note wide floodplain (July 3, 2014)



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Photo 31: Crossing 12 looking northeast (downstream); bankfull width = 31 m, bankfull depth = 1-1.5 m (July 3, 2014)



Photo 32: Crossing 12 looking east (downstream); note organic substrate and grassed floodplain (July 3, 2014)



Photo 33: Crossing 13 looking south; upstream lake and stagnant water at crossing (July 3, 2014)



Photo 34: Crossing 13 looking southeast (downstream); no defined channel but wide, grassed area of flooding (July 3, 2014)



Photo 35: Crossing 14 looking north (downstream); deep pool at crossing with cobbles and gravel substrate, bankfull width = 10 m, bankfull depth = 2.5-3 m (July 2, 2014)



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Photo 36: Crossing 14 looking northeast (downstream); wide, meandering channel with grassed floodplain and forest (July 2, 2014)



Photo 38: Crossing 14 looking northeast (downstream); upstream riffle looking to pool and crossing downstream (July 2, 2014)



Photo 40: Crossing 15 looking north; upstream pool at river bend at left, crossing at rapids (July 2, 2014)



Photo 37: Crossing 14 looking west (upstream); riffle downstream of crossing with large boulders and cobbles (July 2, 2014)



Photo 39: Crossing 15 looking north; note sediment deposition past rapids (July 2, 2014)



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Photo 41: Crossing 15 looking east (downstream); grassed and forested floodplain (July 2, 2014)



Photo 42: Crossing 15 looking west (upstream); at narrowest point upstream of crossing and river bend (July 2, 2014)



Photo 43: Crossing 15 looking west (downstream); note high velocities and eddies in channel (July 2, 2014)



Photo 44: Crossing 15 looking northwest; rapids and downstream pool (July 2, 2014)



Photo 45: Crossing 15 looking northeast (upstream); grassed floodplain and pool at river bend (July 2, 2014)



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