January 4, 2018

Municipality of Temagami
7 Lakeshore Drive
Temagami, Ontario
P0H 2H0

Lake Temagami Access Road Improvement Study, 2017 – Project No. NWL-01701027

Re: Addendum No. 1

Please be advised that Page No. 26 of the **Lake Temagami Access Road Improvement Study, 2017** report, dated November 27, 2017**, Section 7: Construction Cost Estimate Table** is deleted in its entirety and replaced with the following for clarification purposes.

Engineering and Construction cost estimates for this project.

Construction Cost		$ 19,400,000.00
Construction Contingency	ie; adverse soil conditions, delays, etc. (25%)	$ 4,850,000.00
Engineering	ie; Geotechnical, Engineering Design, Environmental Assessment (5%)	$ 970,000.00
Utility Relocation	ie; Pole relocations due to road realignment.	$ 5,818,000.00
Project Management	ie; Construction Administration/Site Supervision (10%)	$ 1,940,000.00
Total		$32,978,000.00

Sincerely,

Brad Gilbert, A.Sc.T., rcsi
Project Manger
exp Services Inc.
cc: Nolan Dombroski, P. Eng.

Municipality of Temagami

Lake Temagami Access Road Improvement Study, 2017

Type of Document:
DRAFT

Project Number:
NWL-01701027

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Date Submitted:
2017-11-27

Legal Notification

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Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. **Exp** Services Inc. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this project.

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IMPROVEMENT STUDY

Lake Temagami Access Road, 2017

Lake Temagami Access Road

1 Site Location

The Municipality of Temagami has retained **exp** Services Inc. to review the Lake Temagami Access Road, located approximately 7km South of the Temagami town site on Highway 11. This study includes the review of approximately 17 km of the Lake Temagami Access Road from Highway 11 Westerly to the parking area(s) servicing the town docks on Lake Temagami.

Figure 1: Location Plan
N.T.S.

2 Authorization

The authorization for this assignment was provided by Mr. Patrick Cormier, CAO, Municipality of Temagami. by issuance of a signed Work Authorization form dated June 16, 2017.

3 Scope

This study included aerial (drone) and visual survey of 16.8km of the Lake Temagami Access Road, from Highway 11 Westerly to the parking area(s) serving the town docks on Lake Temagami.

The goal of this project was to identify the scope of construction work required to bring the entire 17 km of roadway up to MTO standards.

4 Deliverables

The deliverables of this project will be a written report presenting the following:

- Located infrastructure;
- Distressed areas requiring additional attention;
- Locations requiring horizontal realignments to meet MTO requirements;
- Locations requiring vertical realignment to meet MTO requirements;
- Budgetary construction cost estimates for the work(s) noted above.

5 Survey

The site was visited on the week of September 16, 2017 to perform the aerial UAV survey of the Lake Temagami Access Road.

The site was visited again on November 3, 2017 to locate infrastructure and identify distress areas.

All locations in the following report are recorded as a distance in kilometers from Highway 11 heading Westerly.

5.1 Located Infrastructure

Infrastructure along the Lake Temagami Access Road was identified. Locations and conditions were categorized as follows:

Poor	Requires replacement, no longer performing its intended function to an acceptable level.
Fair	Requires attention, cleanout of ditch, culvert, etc. Performing its intended function, but performance is reduced.
Good	Performing its intended function.
Unknown	Current state unknown as per site observations.

Table 1 on the following page lists the location and condition of the infrastructure located during the Nov. 3, 2017 site visit.

Table 1 – Culvert Information

Culvert #	Location (km)	Diameter (mm)	Material	Condition	Notes
1	1.1	N/A	N/A	N/A	Flow evident, could not locate.
2	1.4	N/A	N/A	N/A	Flow evident, could not locate.
3	1.75	450	CSP	Poor	Bottom perforated
4	2.7	450	CSP	Poor	Perforated and collapsing, right end heaved above water.
5	(Not Used)				
6	3.3	450	POLY	Good	Flowing south
7	3.6	300	POLY	Good	Flows south
8	3.8	70	POLY	Good	
9	4.2	450	CSP	Poor	Perforated and collapsing
10	4.6	450	CSP	Unknown	Nearly buried
11	5.3	750	CSP	Unknown	Half buried
12	5.5	750	CSP	Poor	Bottom heavily rusted, and top buckled under south shoulder
13	5.7	150	POLY	Good	Drains pocket in ditch
14	6.1	400	POLY	Good	Flowing north
15	6.3	750	CSP	Unknown	Nearly buried
16	6.6	250	CSP	Poor	Heaved above water, rusty and collapsing
17	6.8	600	CSP	Poor	Perforated and collapsing
18	7.1	450	CSP	Fair	Rusty
19	8.6	N/A	N/A	Good	
20	8.8	750	CSP	Unknown	Completely buried
21	9.8	450	POLY	Good	Flowing south
22	10.5	450	POLY	Good	Flowing south
23	10.95	450	POLY	Fair	Flowing south, heaved above water at north end
24	11.2	200	CSP	Good	Flows south
25	12.9	400	POLY	Good	Minimal cover, heaved both ends
26	13.15	300	POLY	Good	Minimal cover, both sides heaved above water
27	13.4	200	POLY	Good	Flows north
28	13.4	400	POLY	Good	Flows north
29	14.1	300	POLY	Good	Both ends heaved above water
30	14.6	900	CSP	Good	Flows south
31	15.8	600	POLY	Good	Flows south
32	15.95	1,200	POLY	Good	Flows towards lake
33	16.25	600	POLY	Good	Flows south

5.2 Distressed Areas

Distressed areas of the Lake Temagami Access Road were identified during the Nov. 3, 2017 site visit.

The Lake Temagami Access Road had been recently re-graded so it is likely that additional areas of concern may have been obscured by the recent work.

The figure below shows the location of the ten “Distressed Areas” identified.

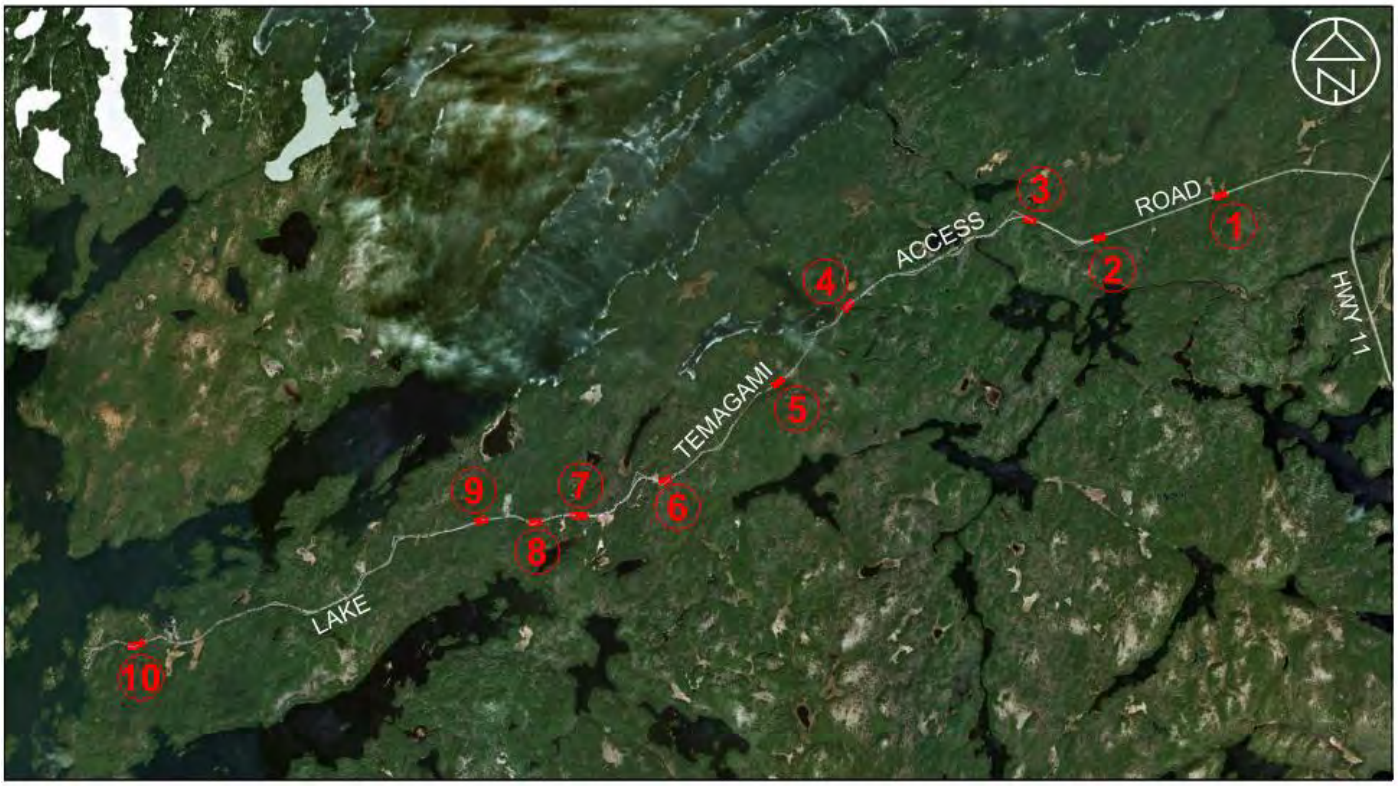


Figure 2: Distressed Areas Location Plan
N.T.S.

5.2.1 Distress Area #1

- 1.75 to 1.85 km
- Swampy area on both sides, road grade approximately 0.3m above water level.
- Roadway is wet, with shallow ruts and heavy potholing.
- Shoulders are very soft.

Picture 1 – Distress Area #1 (North on Right)

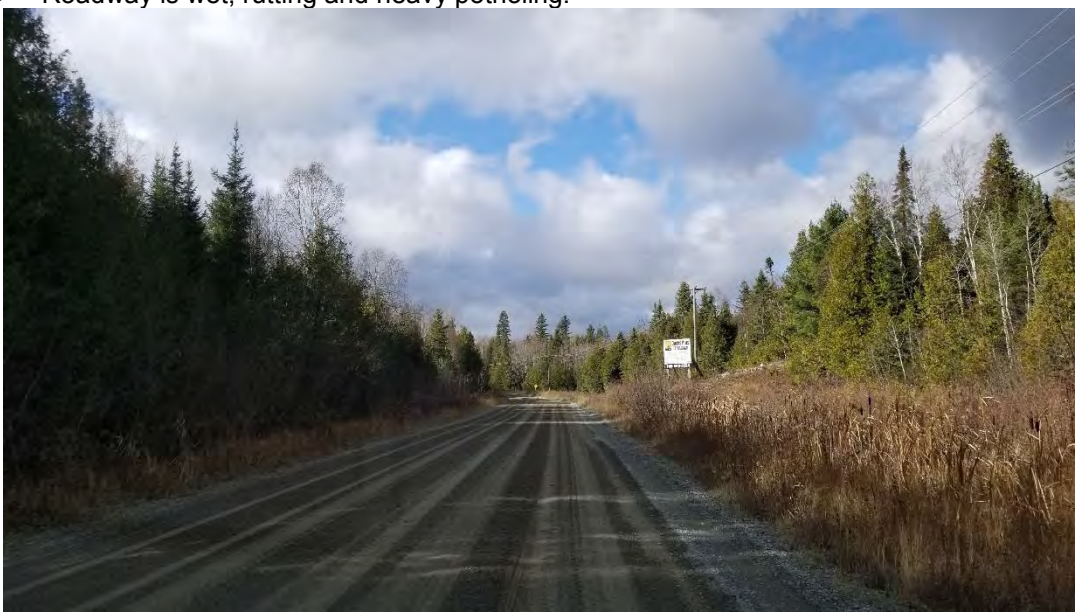
5.2.2 Distress Area #2

- 3.25 to 3.35 km
- Swampy area on North side, marshy area on South side.
- Roadway is wet, soft and heavy potholing.
- North Shoulder is soft.

Picture 2 – Distress Area #2 (North on Right)

5.2.3 Distress Area #3

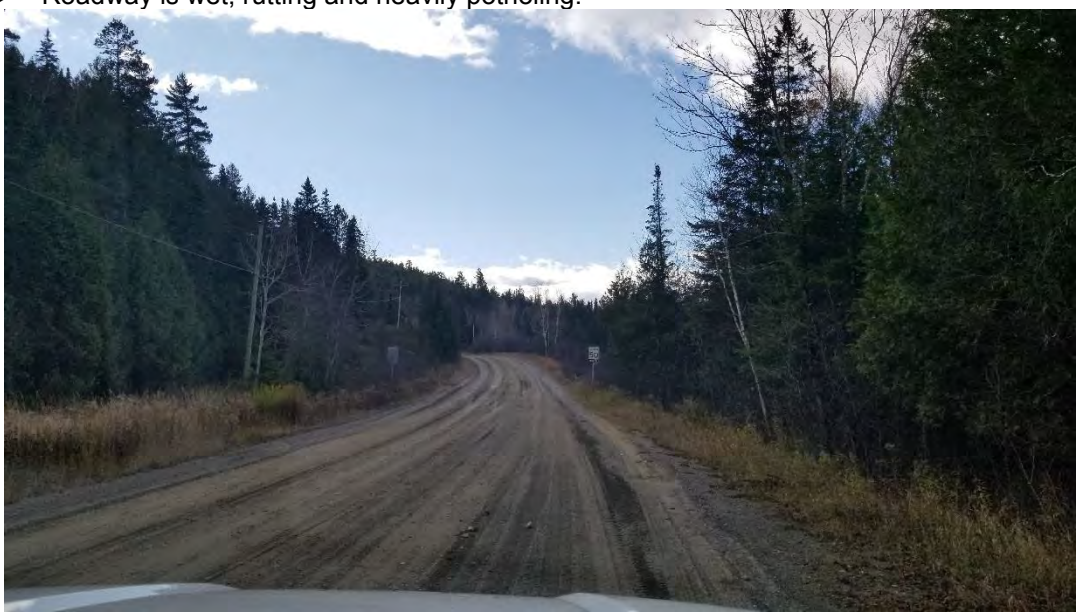
- 4.15 to 4.25 km
- Low point, ditches on both sides holding water.
- Culvert #9 in poor condition, heaved above bottom of ditch, collapsing.
- Roadway is wet, rutting and heavy potholing.



Picture 3 – Distress Area #3 (North on Right)

5.2.4 Distress Area #4

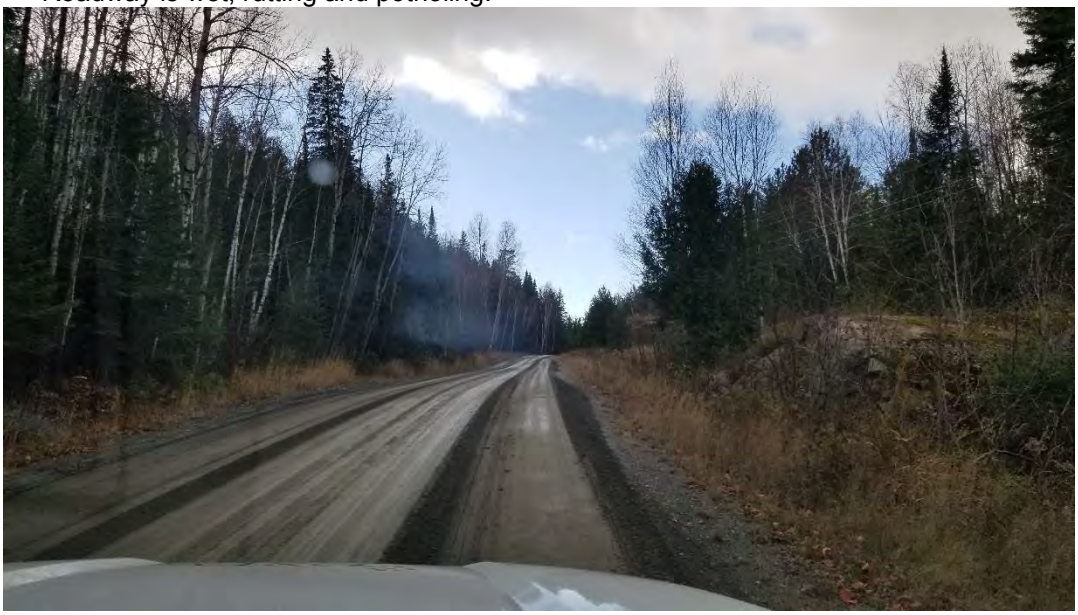
- 6.6 to 6.7 km
- Pond on North side, marshy area on South side, road grade approximately 0.3m above water level.
- Culvert #16 flowing to the South in poor condition, collapsing, and heaved.
- Roadway is wet, rutting and heavily potholing.



Picture 4 – Distress Area #4 (North on Right)

5.2.5 Distress Area #5

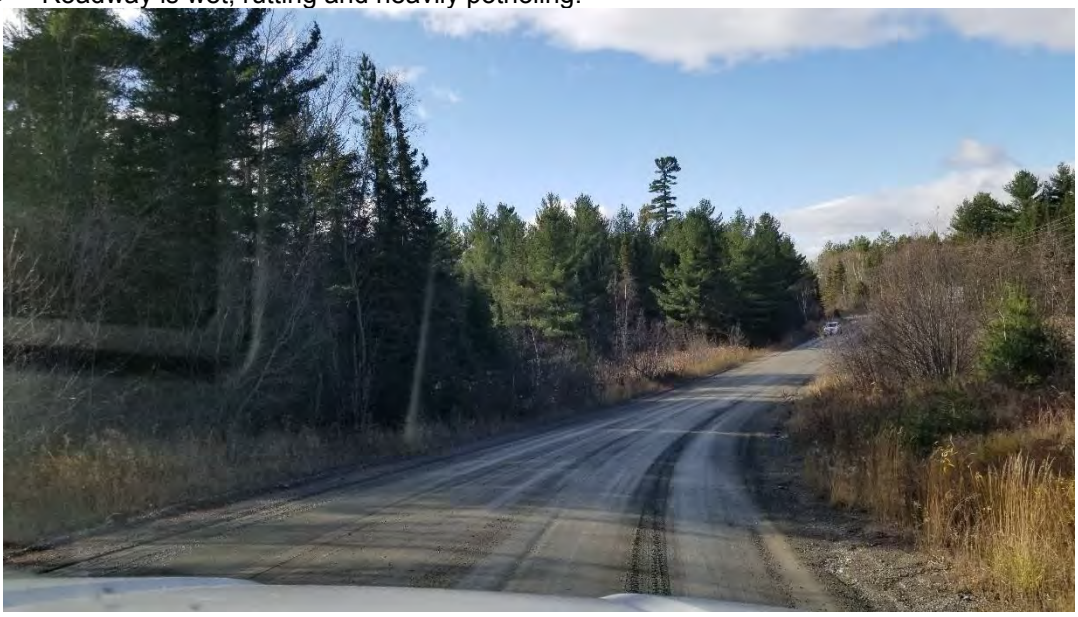
- 7.85 to 7.95 km
- Rock cut on both sides, minimal or non-existent ditches.
- Roadway is wet, rutting and potholing.



Picture 5 – Distress Area #5 (North on Right)

5.2.6 Distress Area #6

- 9.65 to 9.75 km
- Swampy area on both sides, road grade approximately 0.2m above water level.
- Roadway is wet, rutting and heavily potholing.



Picture 6 – Distress Area #6 (North on Right)

5.2.7 Distress Area #7

- 10.85 to 11.0 km
- Swampy area on both sides, North side holding water.
- Culvert #23 heaved above water level on North side.
- Roadway is wet, light rutting, and moderate potholing.

Picture 7 – Distress Area #7 (North on Right)

5.2.8 Distress Area #8

- 11.4 to 11.5 km
- Low point, swampy area on both sides, road grade approximately 0.6m above water level.
- Roadway is wet, rutting and potholing.

Picture 8 – Distress Area #8 (North on Right)

5.2.9 Distress Area #9

- 12.05 to 12.15 km
- Swampy area both sides, road grade approximately 0.5m above water level on South side and 0.3m on North side.
- Roadway is wet, rutting and potholing.

Picture 9 – Distress Area #9 (North on Right)

5.2.10 Distress Area #10

- 16.65 to 16.80km
- Swampy area on South side, North side recently ditched.
- Roadway widens to approximately 16 m wide, minimal crossfall on roadway.
- Roadway is wet, slight rutting and severe potholing.

Picture 10 – Distress Area #10 (North on Right)

5.3 Horizontal Curves

A horizontal alignment was generated using AutoCAD Civil3d based off of the roadway crown shots from the September 16, 2017 survey.

Table 2 below shows the location of the start of the curve and the radius.

Table 2 – Horizontal Curve Information

Curve #	Start Location (m from Hwy 11)	Radius (m)	Curve #	Start Location (m from Hwy 11)	Radius (m)
1	0	450	**26**	10,229	180*
2	823	180*	**27**	10,402	150*
3	3,451	250	**28**	10,489	170*
4	4,159	330	**29**	10,701	320
5	4,609	250	**30**	10,949	660
6	4,909	160*	**31**	11,160	530
7	5,093	250	**32**	11,414	200*
8	5,364	480	**33**	11,580	290
9	5,581	660	**34**	12,044	450
10	5,988	320	**35**	12,741	330
11	6,477	90*	**36**	13,011	160*
12	6,545	380	**37**	13,290	230*
13	6,843	240*	**38**	13,622	340
14	7,063	190*	**39**	13,894	220*
15	7,256	380	**40**	14,430	260
16	7,631	540	**41**	14,794	420
17	7,974	400	**42**	15,144	170*
18	8,108	260	**43**	15,233	330
19	8,613	510	**44**	15,587	410
20	8,802	310	**45**	15,947	310
21	9,100	180*	**46**	16,234	170*
22	9,436	220*	**47**	16,400	100*
23	9,530	140*	**48**	16,565	350
24	9,634	190*	**49**	16,697	160*
25	9,873	170*	**50**	16,933	150*

The horizontal alignment was reviewed for conformance with MTO standards. The posted speed limit on the Temagami Access Road is 60 km/h, a design speed of 80 km/h was selected to provide a factor of safety. Based upon the observations of surveyors on site, vehicles were travelling well in excess of the posted speed limit.

Per Table C3-5 of the *Geometric Design Standards for Ontario Highways, 2002* the minimum curve radius for a secondary highway with a design speed of 80 km/h is 250m. Based on this minimum radius, 22 of the 50 curves identified in **Table 2** are substandard*.

Eight areas requiring horizontal realignment were identified, they are shown in the figure below.

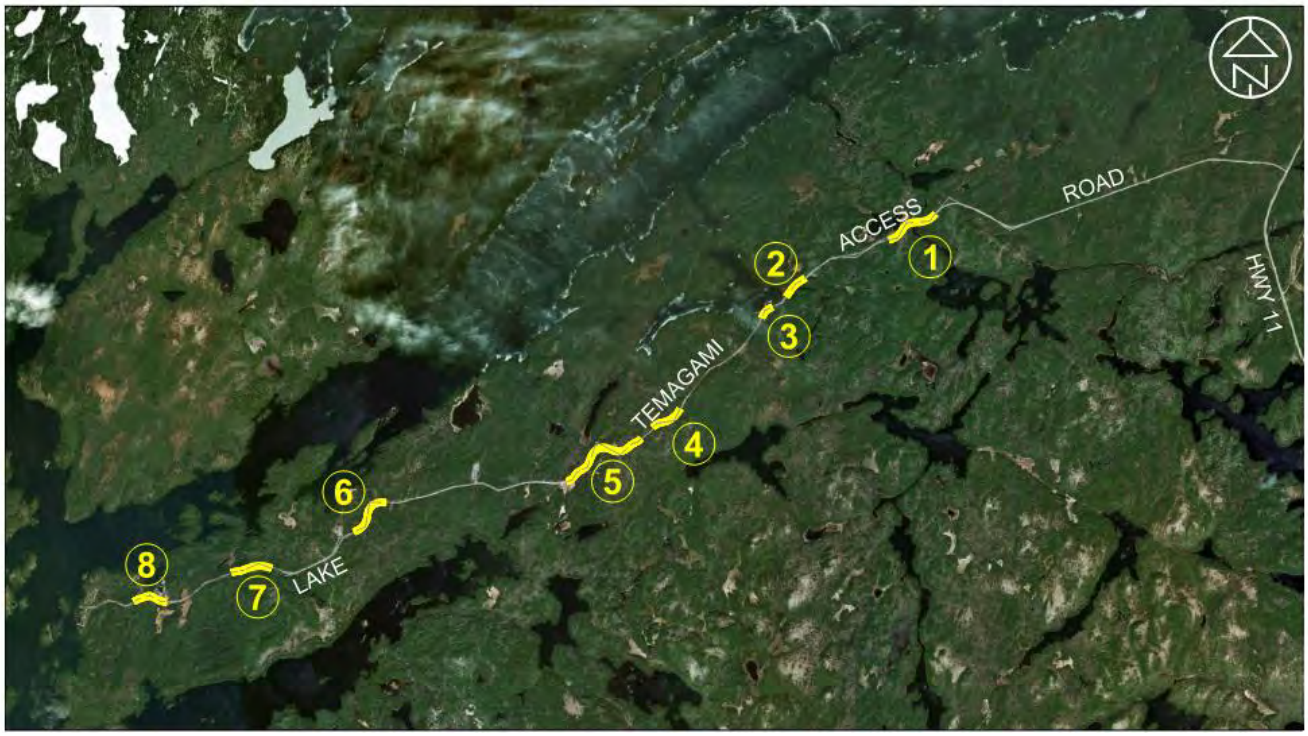


Figure 3 – Horizontal Realignment Area Location Plan
N.T.S.

5.3.1 Horizontal Realignment Area #1

- 4.60 to 5.29 km
- Curves 5, 6 and 7 require adjustment.

Picture 11 – Horizontal Realignment Area #1 – Curve 5 (North on Right)

Picture 12 – Horizontal Realignment Area #1 – Curve 6 (North on Right)

Picture 13 – Horizontal Realignment Area #1 – Curve 7 (North on Right)

5.3.2 Horizontal Realignment Area #2

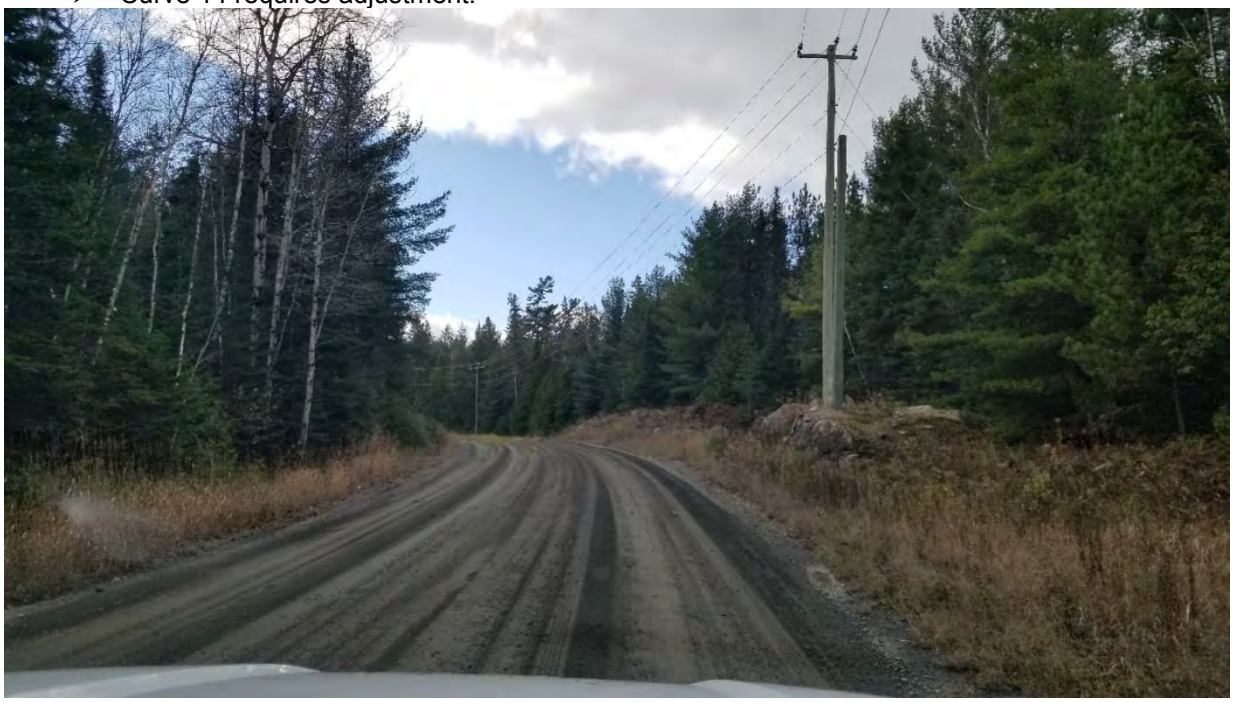
- 6.48 to 6.81 km
- Curves 11 and 12 require adjustment.

Picture 14 – Horizontal Realignment Area #2 – Curve 11 (North on Right)

Picture 15 – Horizontal Realignment Area #2 – Curve 12 (North on Right)

5.3.3 Horizontal Realignment Area #3

- 7.04 to 7.23 km
- Curve 14 requires adjustment.



Picture 16 – Horizontal Realignment Area #3 – Curve 14 (North on Right)

5.3.4 Horizontal Realignment Area #4

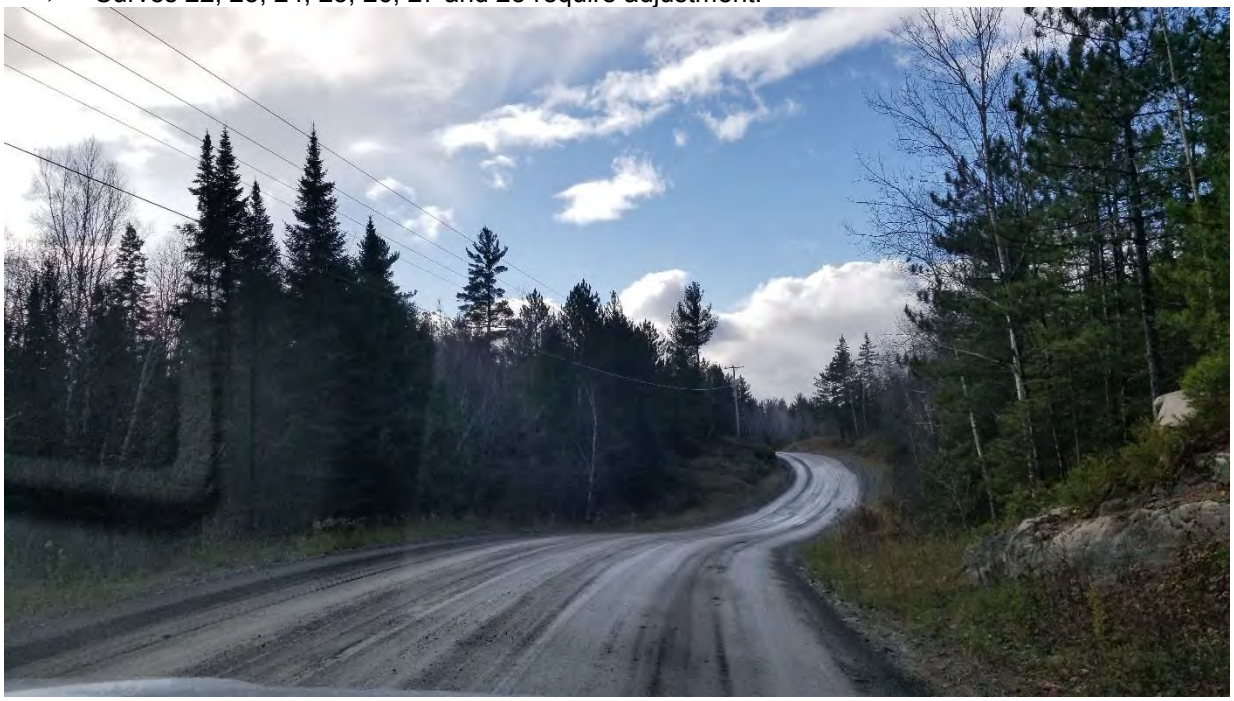
- 8.80 to 9.22 km
- Curves 20 and 21 require adjustment.

Picture 17 – Horizontal Alignment Area #4 – Curve 20 (North on Right)

Picture 18 – Horizontal Realignment Area #4 – Curve 21

5.3.5 Horizontal Realignment Area #5

- 9.43 to 10.61 km
- Curves 22, 23, 24, 25, 26, 27 and 28 require adjustment.



Picture 19 – Horizontal Realignment Area #5 – Curves 22 & 23 (North on Right)

Picture 20 – Horizontal Realignment Area #5 – Curve 24 (North on Right)

Picture 21 – Horizontal Realignment Area #5 – Curve 25 (North on Right)

Picture 22 – Horizontal Realignment Area #5 – Curves 26, 27 & 28 (North on Right)

5.3.6 Horizontal Realignment Area #6

- 12.95 to 13.55 km
- Curves 36 and 37 require adjustment.

Picture 23 – Horizontal Realignment Area #6 – Curve 36 (North on Right)

Picture 24 – Horizontal Realignment Area #6 – Curve 37 (North on Right)

5.3.7 Horizontal Realignment Area #7

- 14.79 to 15.30 km
- Curves 41, 42 and 43 require adjustment.

Picture 25 – Horizontal Realignment Area #7 – Curve 41 (North on Right)

Picture 26 – Horizontal Realignment Area #7 – Curve 42 (North on Right)

5.3.8 Horizontal Realignment Area #8

- 16.22 to 16.65 km
- Curves 46 and 47 require adjustment.

Picture 27 – Horizontal Realignment Area #8 – Curve 46 (North on Right)

Picture 28 – Horizontal Realignment Area #8 – Curve 47 (North on Right)

5.4 Vertical Curves

A vertical alignment was generated using AutoCAD Civil3d based off of the crown shots from the September 16, 2017 survey. The spacing of survey shots taken on September 16 were inadequate to provide enough surface definition for AutoCAD to generate a "best-fit" profile that reasonably represented the existing road. In order to provide a detailed curve-by-curve assessment a profile would have to be manually created for over 140 vertical curves. This level of detailed analysis is outside the scope of this project.

Per **Table C4-6 – Crest Curvature** of the *Geometric Design Standards for Ontario Highways, 2002* the minimum vertical curvature ("K") for a crest curve with a design speed of 80 km/h is 35.

Per **Table C4-7 – Sag Curvature, Headlight** of the *Geometric Design Standards for Ontario Highways, 2002* the minimum vertical curvature ("K") for a sag curve with a design speed of 80 km/h is 30.

Vertical Curvature (K) is a measure of the length of curve over which a 1% grade change occurs. For example, a crest curve connecting two tangents with a grade change of 3% would require a curve length of 105m to have a K value of 35.

To illustrate the magnitude of vertical correction required on the Lake Temagami Access Road, the vertical crest curve centered at approximately 5.7 km covers a grade change of 12% +/-. To satisfy the minimum K value of 35 the curve should be at least 420 m long, the existing curve is approximately 180 m long (K value of 15). To achieve this correction the crest of the hill would have to be lowered 3.5 meters. In practice, the preceding and succeeding vertical curves would also be adjusted to reduce the grade change and therefore require a shorter curve and less vertical correction.

In the case of the Lake Temagami Access road, the majority of the vertical curves appear to be substandard for an 80 km/h design speed. To compound the difficulty of bringing the vertical alignment up to standard, there appears to be many sub-standard curves located one-after-another, necessitating a substantial redesign of the vertical alignment.

A qualitative assessment of the vertical alignment was performed, areas were broadly classified as follows:

- No vertical realignment required.
- Moderate vertical realignment required, up to 1.5m.
- Major vertical realignment required, more than 1.5m.

Our qualitative assessment identified that the following percentages of the road require vertical realignment:

- No vertical realignment required 20%
- Moderate vertical realignment required 50%
- Major vertical realignment required 30%

6 Remediation

6.1 Infrastructure

We recommend the replacement of the culverts identified in **Table 1** in **Section 5.1** as being in Poor or Fair condition, or Unknown due to being obstructed or buried. This would include 14 culverts ranging in size from 200 mm to 750 mm.

The culverts should be installed according to Ontario Provincial Standard Drawing (OPSD) 802.010, 802.013 or 802.014 (See Appendix), as appropriate.

The installation of the culverts should include a frost taper to help mediate future frost action, the frost tapers should be constructed according to OPSD 803.030 or 803.031 (See Appendix) as appropriate.

6.2 Distress Areas

Distress Areas identified in **Section 5.2**, on the Lake Temagami Access Road, appear to be deteriorating due to excess water in the road base.

The likely cause(s) and proposed remedial actions are as listed below:

- Inadequate subsurface drainage, due to a lack of ditches or presence of rock obstructing existing ditches.
  - Rock excavation to establish positive drainage of both the subgrade and ditches.
    - Applies to Distress Area #5.
  - Granular A backfill to increase roadway crossfall and installation of subdrains.
    - Applies to Distress Area #10
- Differential water levels from one side of the road to the other.
  - Install or replace equalization culvert.
    - Applies to Distress Areas #3, 4, and 9
- Minimal grade separation between the water table and the road surface.
  - Grade raise using either select subgrade material (SSM) or rock fill as appropriate.
    - Applies to Distress Areas #1, 2, 3, 4, 6, 7, 8, and 9.

6.3 Horizontal Curves

We recommend the realignment of the substandard horizontal curves identified in **Section 5.3**.

Realigned portions of the road should be constructed according to OPSD 200.010, 201.010, 203.010, 203.020, 209.020 (See Appendix), as appropriate.

6.4 Vertical Curves

We recommend the identification and realignment of the substandard vertical curves discussed in **Section 5.4**.

Identification and assessment of the vertical curves composing the Lake Temagami Access Road would require further field work collecting additional topographical data of the existing roadway centerline at a short interval (approximately 10 to 25 m).

Realigned portions of the road should be constructed according to OPSD 200.010, 201.010, 203.010, 203.020, 209.020 (See Appendix), as appropriate.

7 Construction Cost Estimate

We have assembled budgetary engineering and construction cost estimates which are preliminary and only to be used for funding application purposes.

Major items identified for this project include, but are not limited to, the following:

- Rock Excavation
- Rock Face
- Rock Ditch Cleanout
- Granular 'A'
- Granular 'B'

In order to achieve MTO standards for the Lake Temagami Access Road improvements to Horizontal and vertical alignments must be made according to MTO standards for minimum stopping and sight distances. Along with the above mentioned items, this work shall also require, but not be limited to, the following:

- Clearing and Grubbing
- Earth Excavation
- Select Subgrade Material (SSM)
- Geogrid with Geotextile
- Cable and Steem Beam Guide Rail Systems

A major issue with the existing roadway is drainage. Significant improvements will be required to provide a dry and stable road base. In several areas, there is limited or non-existent potential for storm water offtake ditches, and the only remediation possible is to raise the grade of the road well above the existing water table. The items identified for this work include, but are not limited to, the following:

- Culverts
- Earth Ditching
- Rock Ditching
- Grade Raises (Earth Fill, Rock Fill, SSM)

Due to the location of the project (proximity to multiple waterways and wetlands), and the extent of realignment work, environmental protection, investigations and assessments will be required, along with utility relocations and geotechnical investigations.

Our engineering and construction cost estimates for this project are as follows:

Construction Cost		$ 19,400,000.00
Construction Contingency	ie; adverse soil conditions, delays, etc. 25%	$ 4,850,000.00
Engineering	ie; Geotechnical, Utility Relocation, Project Management, Engineering Design, Environmental Assessment	$ 8,728,000.00
Total		**$32,978,000.00**

8 Closing

The Lake Temagami Access Road requires extensive upgrades and realignments in order to meet MTO standards. We recommend moving forward with a more detailed feasibility study to further develop the scope of work required, and hopefully identify potential cost savings versus our cost estimates in **Section 7**.