



## **FINAL REPORT**

### **FOUNDATION INVESTIGATION AND DESIGN REPORT** **Crow River Bridge Replacement, Nort Road, District of Kenora**

**Agreement No. 6014-E-0017**  
**Assignment No. 5**  
**GWP 6322-11-00**  
**Geocres No. 52P-03**

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August 28, 2015

# Ontario Ministry of Transportation

## Foundation Investigation and Design Report

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Nort Road (Hwy 808), District of Kenora

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# **PART 1: FOUNDATION INVESTIGATION REPORT**

## **1.1 Introduction**

This foundation investigation report presents the results of a geotechnical investigation completed by **exp** Services Inc. for the replacement of the Crow River (July Falls) Bridge on Nort Road (Hwy 808), located approximately 27.4 km north of the Nort Road and Highway 599 junction in Central Patricia, the Ministry of Transportation (MTO) Northwestern Region. The work was undertaken under Agreement # 6014-E-0017, Assignment No. 5 (GWP 6322-11-00). The terms of reference (TOR) were as presented in the MTO letter dated April 28, 2015.

Based on preliminary information provided and site observations, the existing bridge is a rectangular bridge with longitudinal laminated wood decking and steel beams/girders, and is about 25 m in length and about 6.1 m in width. It is also understood that the existing bridge is intended to be replaced with a modular bridge, which is to be constructed on temporary abutments about 10 m east of the existing structure. The existing structure will then be removed and permanent abutments will be constructed on the existing alignment. The new modular bridge will then be moved onto the permanent abutments along the existing alignment.

The purpose of the investigation was to evaluate the subsurface conditions along the alignment, to permit detailed design for the bridge replacement. The site specific geotechnical investigation consisted of test pitting, soil sampling, test pit logging, and laboratory testing.

This foundation investigation report has been prepared specifically and solely for the project described herein. It contains the factual results of the investigation and the laboratory testing completed for this project.

## **1.2 Site Description and Geological Setting**

### **1.2.1 Site Description**

As shown on Drawing 1 (Appendix B), the Crow River Bridge replacement site is located approximately 27.4 km north of the Nort Road and Highway 599 junction in Central Patricia, north of Pickle Lake, Ontario. At the site, Nort Road is a relatively narrow two-way gravel roadway with a two lane bridge and has a speed limit of 80 km/h. The existing structure is a rectangular bridge with longitudinal laminated wood decking and steel beams/girders, and is about 25 m in length and about 6.1 m in width. It is understood that the bridge was constructed in 1964. At the time of the fieldwork, the water level at Crow River was about 2.8 m below the top of the bridge deck.

Based on a true north direction, the Crow River Bridge runs in generally a northeast and southwest direction, and Crow River flows from the southeast to the northwest. However, for simplicity and for the purposes of this report a “project north” has been established and project north is oriented to the centerline alignment of the Crow River Bridge (i.e. project north is in the same direction as true north’s northeast direction). The orientation of project north is presented on Drawing 1 in Appendix B. Hereinafter, the directions indicated in this report are in referenced to project north.

During the fieldwork on May 21, 2015, the general site conditions were assessed. Nort Road runs in a generally north-south direction, and Crow River flows from east to west, towards Badesdawa Lake, which is about 2.8 km west of the site. At the time of the fieldwork, the river level at the upstream side of the bridge was elevated to about 331 m elevation compared to about 330.25 m from the survey drawing provided by the MTO, dated July 2014. Rock fill was observed along the south river bank in the areas of the abutments, at both the upstream and downstream sides of the bridge, and vegetation including grass, trees and shrubs were noted at the banks further away from the bridge. Along the north river bank, likely due to the high water level, no rock fill was observed at the abutments at the upstream and downstream sides of the bridge. The river level extended beyond the north abutment and into the treed/forested area, resulting in localized flooding. The upstream and downstream sides of the bridge appeared to be clear of debris, and as such the flow does not appear to be impeded. In addition, bedrock outcrops were observed south of the bridge.

Select photographs are provided in Appendix A.

### 1.2.2 Geological Setting

According to the Ontario Ministry of Northern Development and Mines, Bedrock Geology of Ontario Map No. 2542, the bedrock geology of the site consists of Neo to Mesoarchean Era (2.5 to 3.4 Ga), supracrustal rock. The bedrock was described as mafic to intermediate metavolcanic rock containing basaltic and andesitic flows, tuffs and breccias, chert, iron formation, minor metasedimentary and intrusive rocks and related migmatites.

## 1.3 Investigation Procedures

### 1.3.1 Site Investigation and Field Testing

The field investigation was performed on May 21, 2015. The field program consisted of excavating five (5) sampled test pits (TP1 to TP5). All of the test pits were located off road and advanced as close as possible to the existing abutments and proposed temporary abutment locations. The test pit locations are shown on Drawing 1 in Appendix B.

All the test pits were advanced using a Link Belt 130 track excavator operated by Perron Contractor. The test pits were advanced to depths ranging between about 0.9 m and 4.3 m below ground surface and elevations ranging between about 326.8 m and 332.0 m. Test pits at the south bank (TP1, TP2 and TP5) were terminated due to refusal on bedrock, and test pits at the north bank (TP3 and TP4) were terminated due to maximum reach of excavator.

The test pit locations were referenced to the MTM ON-15 NAD83 coordinate system and their ground surface elevations were surveyed by **exp** personnel. The ground surface elevations, including top of bridge and top of water at the upgradient and downgradient sides of the bridge, were referenced to a geodetic benchmark (BM) provided by the client (spike in Balsam tree north of the existing bridge). The elevation of the BM is 333.740 m, and location of the BM is shown on Drawing 1, in Appendix B.

Soil samples were collected continuously from the sides of the test pits at shallower depths and from the bucket at greater depths. The recovered soil samples were examined and logged in the field by **exp** geotechnical personnel.

Upon completion of the test pits, groundwater level / seepage measurements were obtained prior to backfilling the test pits. The measured groundwater levels after completion of excavated test pits are shown on test pit log sheets in Appendix C. The test pits were backfilled using the excavated material and generally placed back in the excavation from the depth it was removed.

The fieldwork was supervised by a member of **exp**'s engineering staff who directed the excavating and sampling operation, logged test pit data in accordance with MTO and/or ASTM Standards for Soils Classification, and retrieved soil samples. All of the recovered soil samples were placed in labelled moisture-proof bags which, were brought to **exp**'s Thunder Bay laboratory for additional visual, textual and olfactory examination, and for subsequent examination by a geotechnical engineer and laboratory testing.

### 1.3.2 Laboratory Testing

All samples brought to the laboratory were subjected to visual examination and classification. The laboratory testing program included the determination of natural moisture content and particle size distribution for approximately 25% of the collected soil samples. Atterberg Limits tests were carried out on select cohesive soil samples. All of the laboratory tests were carried out in accordance with MTO and/or ASTM Standards, as appropriate, at the **exp** laboratory in Thunder Bay, ON.

The laboratory test results are provided on the attached test pit log sheets in Appendix C, as well as graphically in Appendix D.

In addition, chemical testing of two select soil samples was conducted. The soil samples were sent via courier, in a secure cooler under chain of custody, to Maxxam Analytics Inc., a CALA-certified and accredited laboratory in Mississauga, Ontario. Details of the chemical testing are discussed below and the lab results are included in Appendix E.

## 1.4 Subsurface Conditions

The detailed subsurface conditions encountered in the test pits advanced during this investigation are presented on the Test Pit Records in Appendix C. Laboratory test results are provided in Appendix D. The "Explanation of Terms Used on Borehole Records" preceding the test pit logs in Appendix C forms an integral part of and should be read in conjunction with this report.

A test pit location plan and stratigraphic sections are provided in Appendix B. It should be noted that the stratigraphic boundaries indicated on the test pit log and stratigraphic sections are inferred from observations made within in the test pit and those along the test pit walls. These boundaries typically represent transitions from one soil type to another and should not be interpreted as exact planes of geological change. Furthermore, subsurface conditions may vary between and beyond the test pit locations.

In general, the subsurface conditions encountered generally consist of silty sand fill, overlying peat, overlying silty sand with gravel to silt, overlying sandy silt till and overlying probable bedrock. A more detailed summary of the subsurface conditions encountered in the test pits is provided in the following sections.

#### 1.4.1 Rootmat / Topsoil

Rootmat / topsoil was encountered surfacing TP3 and TP4. The rootmat / topsoil was generally described as soft, brown, moist to wet. Trace gravel, trace sand, some peat and trace roots and rootlets were present at TP3. The rootmat / topsoil extended about 0.2 m below ground surface and to elevations of about 330.9 m (TP3) and 331.0 m (TP4).

Laboratory testing performed on a select sample consisted of a moisture content test. The test result is as follows:

Moisture content:

- 70.8%

The result of the moisture content test is provided on the record of test pit sheets in Appendix C.

#### 1.4.2 Silty Sand with Gravel Fill

Silty sand with gravel fill was generally encountered underlying the rootmat / topsoil and generally surfacing remaining the test pits. The fill was generally described as loose, brown, moist to wet, and containing occasional cobbles and some angular rock fill. At TP1 and TP2, trace peat and some roots were also observed, and at TP2 only, trace metal debris was noted. At TP4, clayey silt fill was encountered beneath the rootmat / topsoil and was described as soft to firm, light brown, moist and containing occasional cobbles. The fill extended to depths ranging between about 0.6 m and 0.9 m below ground surface, with elevations ranging between about 330.3 m and 332.3 m.

Laboratory testing performed on selected samples consisted of moisture content tests. The test results are as follows:

Moisture content:

- 6.6% to 21.9%

The results of the moisture content tests are provided on the record of test pit sheets in Appendix C.

#### 1.4.3 Peat

Peat was encountered beneath the fill and surfacing TP5. The peat was generally described as soft, brown to black, moist to wet, containing trace to some roots and rootlets, and trace wood debris. At TP4, trace gravel, trace sand and some silt to silty soils were noted. The peat stratum ranged in thickness between about 0.1 m and 0.9 m. The peat extended to depths ranging between about 0.3 m and 1.8 m below ground surface, and elevations ranging between about 329.3 m and 332.2 m.

Laboratory testing performed on selected samples consisted of moisture content tests. The test results are as follows:

Moisture content:

- 49.4% to 166.1%

The results of the moisture content tests are provided on the record of test pit sheets in Appendix C.

#### 1.4.4 Silty Sand with Gravel to Silt with Sand

Silty sand with gravel to silt with sand was generally encountered underlying the peat. The silty sand with gravel to silt with sand was generally described as loose to compact, brown to grey, moist to wet and containing occasional cobbles and boulders. At TP3, a layer of clayey silt, about 400 mm in thickness, was encountered within the silty sand and was described as soft, brown, moist to wet, containing some cobbles to cobble. The silty sand with gravel to silt with sand extended to depths ranging between about 0.9 m and 3.4 m below ground surface, with elevations ranging between about 327.7 m and 332.0 m.

Laboratory testing performed on selected samples of the silty sand with gravel to silt with sand and the clayey silt consisted of moisture content, grain size distribution and Atterberg Limits tests. The test results are as follows:

Moisture content:

- 8.2% to 41.2%

Grain size distribution:

- 0% to 32% gravel,
- 13% to 60% sand,
- 24% to 79% silt, and
- 4% to 19% clay size.

One (1) Atterberg Limits test was performed on a representative sample of the clayey silt, and indicated that the soil is of low plasticity. The data is shown on the plasticity chart, Figure 5. The liquid limit, plastic limit and plasticity index were about 26, 17, and 9, respectively.

Total saturated unit weights have been calculated based on the moisture contents and are estimated to range from about 17.7 to 23.5 kN/m<sup>3</sup>.

The results of the moisture content and grain size distribution tests are provided on the record of test pit sheets in Appendix C. The results of the grain size distribution are also provided on Figures 1, 2 and 3 in Appendix D, and the Atterberg Limit results are provided on Figure 5 in Appendix D.

#### 1.4.5 Sandy Silt Till

Sandy silt till was encountered underlying the silty sand with gravel to silt with sand at TP3 and TP4. The till was generally described as compact to dense, brown to grey, moist and containing

occasional cobbles and boulders. The till extended to about 4.3 m below ground surface (maximum reach of excavator), with elevations of about 326.8 m at TP3, and 326.9 m at TP4.

Laboratory testing performed on selected samples of the till consisted of moisture content and grain size distribution tests. The test results are as follows:

Moisture content:

- 8.6% to 12.2%

Grain size distribution:

- 1% to 16% gravel,
- 30% to 40% sand,
- 48% to 52% silt, and
- 6% to 7% clay size.

Total saturated unit weights have been calculated based on the moisture contents and are estimated to range from about 22.4 to 23.3 kN/m<sup>3</sup>.

The results of the moisture content and grain size distribution tests are provided on the record of test pit sheets in Appendix C. The results of the grain size distribution tests are also provided on Figure 4 in Appendix D.

#### 1.4.6 Bedrock

Refusal to further excavating due to bedrock was encountered underlying the silty sand with gravel to silt with sand at TP1, TP2 and TP5 (south of Crow River). The depth to refusal ranged between about 0.9 m and 1.8 m below ground surface, with elevations ranging between 329.8 m and 332.0 m. The bedrock was described as dark green, weathered, fine grained metasedimentary rock.

### 1.5 Groundwater and Surface Water Conditions

Information on groundwater levels at the site was obtained by measuring the water levels in the open test pits prior to backfilling. The groundwater levels encountered in the test pits are shown on the test pit records in Appendix C and presented below in Table 1.1.

Seasonal variations in the water table should be expected, or after periods of extended precipitation or drought, and, as such, may differ at other times.

**Table 1.1. Groundwater data**

Test Pit	Date Completed	Date Measured	Ground Surface Elevation <sup>2</sup>	Depth to Water <sup>3</sup>	Groundwater Elevation
TP1	May 21/15	May 21/15	333.21	-- <sup>4</sup>	--
TP2	May 21/15	May 21/15	331.58	0.6	330.98
TP3	May 21/15	May 21/15	331.09	0.0	331.09
TP4	May 21/15	May 21/15	331.17	0.9	330.27
TP5	May 21/15	May 21/15	331.83	0.6	331.23
Crow River WL Upstream (East) Side	--	May 21/15	--	--	330.95 <sup>5</sup>
Crow River WL Downstream (West) Side	--	May 21/15	--	--	330.49 <sup>5</sup>
Notes: 1) All units in metres. 2) Elevations surveyed are referenced to a geodetic benchmark (BM) provided by the client (spike in Balsam tree north of the existing bridge). The elevation of the BM is 333.740 m. 3) Depths are relative to ground surface. 4) Indicates no groundwater encountered. 5) Indicates top of water elevation at Crow River.					

## 1.6 Chemical Analysis of Soil

Two soil samples were selected for chemical analyses and were sent via courier, in a secure cooler under chain of custody, to Maxxam Analytics Inc., a CALA-certified and accredited laboratory in Mississauga, Ontario. The analytical laboratory results are presented in Appendix E, and are summarized in Table 1.2, below.

**Table 1.2. Corrosivity Chemical Analysis**

Borehole	pH (unitless)	Chloride (ppm)	Soluble Sulphate (ppm)	Resistivity (ohm-cm)	Conductivity (mS/cm)
TP1-S3	6.90	<20	<20	11,000	0.091
TP4-S8	7.71	<20	<20	11,000	0.089

Based on the chemical analysis, the data in Table 1.2 indicates high resistivity. Our experience in Northwestern Ontario is that the soils generally contain low to medium resistivity and are typically susceptible to corrosion, unlike the resistivity results presented above. The pH level presented in Table 1.2, is indicates low potential for corrosion. The chloride content is <20 ppm (µg/g) i.e.

<0.002% which indicates a low potential for additional corrosion. Based on our experience, buried metallic pipes and appurtenances would be susceptible to corrosion, unless protected.

The maximum water soluble sulphate content of the soils tested is <20 ppm ( $\mu\text{g/g}$ ), i.e. <0.002% and being less than 0.10%, does not require sulphate resistant cement. The data supports our experience in Northwestern Ontario.



## Part II FOUNDATION DESIGN REPORT

### 2.0 Introduction

This section of the report provides geotechnical design recommendations for replacement of the Crow River Bridge, located on Nort Road (Hwy. 808) approximately 27.4 km north of the Nort Road and Highway 599 junction in Central Patricia (Latitude 51.649478, Longitude -89.887536). The recommendations are based on interpretation of the factual data obtained from the test pits excavated during the current investigation at the site and presented in Part I - Foundation Investigation Report. The interpretation and recommendations provided are intended solely to permit designers to assess foundation alternatives and design the proposed bridge replacement. Comments on construction are only provided to highlight issues that could affect the design. Contractors bidding on the works should make their own assessments of the factual data and how it might affect construction means and methods, scheduling and the like.

Based on information provided and site observations, the existing bridge is a rectangular bridge with longitudinal laminated wood decking and steel beams/girders, and is about 25 m in length and about 6.1 m in width. It is also understood that the existing bridge is intended to be replaced with a modular bridge, which is to be constructed on temporary abutments about 10 m east of the existing structure. The existing structure will then be removed and permanent abutments will be constructed on the existing alignment. The new modular bridge will then be moved onto the permanent abutments along the existing alignment.

Given the remote location of the bridge, the temporary abutments would ideally be constructed using timber cribbing and the permanent abutments would be constructed using a shallow foundation. Likely alternative for the permanent abutments include a bin wall type structure, RSS abutment or precast concrete spread footings.

The modular bridge is anticipated to be a prefabricated deck on girder type structure with the following estimated unfactored vertical loads per abutment

- Dead Load = 550kN
- Live Load = 510kN (no DLA)

The conceptual drawings provided by MTO indicate crib or bin plan dimensions of 6 m by 6 m. Based on these values, the total applied bearing pressure would be about 30 kPa (Unfactored).

### 2.1 Foundations

The attached concept plan (see Appendix G) indicates that the new bridge would be about 30 m or about 5 m longer than the existing structure. This would allow for some set back of the new abutments relative to existing. It is assumed that no significant grade changes are planned. Actual siting of the abutment should consider constructability in addition to bridge length and hydraulics.

## 2.1.1 Geotechnical Resistance

### South Abutment Foundations

Foundation areas for the south abutments, both temporary and permanent, should be prepared by removing the fill, peat and other loose soils to expose the underlying till or other hard stratum, such as the probable bedrock, on which refusal to the excavator was encountered during the investigation. The crib or bin wall can be constructed on a levelling pad prepared with either crushed rockfill or other suitable compacted granular material, such as OPSS Granular A or B, placed and compacted to 100% standard Proctor maximum dry density. The pad should extend at least 1 m beyond the exterior limits of the proposed crib abutments and be at least 200 mm thick. For design, the factored geotechnical resistance at ULS may be taken as **225 kPa**. The geotechnical reaction at SLS, for a maximum settlement of 25 mm, may be taken as **150 kPa**. Any settlement should be completed soon after application of the full loads.

At the south abutment locations, the elevation of the refusing (probable bedrock) stratum is irregular, varying between about 330 m and 332 m. The design will need to consider this and potential sliding, due to bridge lateral forces and the backfill itself. Resistance to lateral loads is discussed in the next section.

### North Abutment Foundations

Foundation areas for the north abutments, both temporary and permanent, should be prepared by removing the fill, peat and other loose soils to expose the underlying silt to silty sand, encountered at elevations of between about 329 m and 329.5 m. The crib or bin wall can be constructed on a levelling pad prepared with either crushed rockfill or other suitable compacted granular material, such as OPSS Granular A or B, placed and compacted to 100% standard Proctor maximum dry density. The pad should extend at least 1 m beyond the exterior limits of the proposed crib abutments and be at least 200 mm thick. For design, the factored geotechnical resistance at ULS may be taken as **225 kPa**. The geotechnical reaction at SLS, for a maximum settlement of 25 mm, may be taken as **150 kPa**. Any settlement should be completed soon after application of the full loads.

## 2.1.2 Lateral Resistance

Resistance to lateral forces/ sliding should be calculated in accordance with Section 6.7.5 of the CHBDC. The unfactored coefficients of friction for concrete footings on bedrock, rockfill and Granular A or B can be taken as 0.7, 0.6 and 0.5, respectively. A factor of 0.8 should be applied in calculating the horizontal resistance.

## 2.1.3 Frost Penetration

The frost penetration depth at the Crow River Bridge site is about 2.9 m, according to OPSD 3090.100. Any temporary or permanent support system using shallow foundations should be provided with a minimum 2.9 m of soil cover or equivalent thermal insulation for frost protection.

## 2.1.4 Erosion Protection

Erosion protection should be provided to maintain the integrity of the abutments and adjacent embankment slopes. The actual scheme should be designed by a specialist river engineer/scientist and should consider the findings of this report and actual bridge length/abutment locations.

## 2.2 Lateral Earth Pressure

Temporary shoring that may be required for excavation and construction, as well as the crib or bin wall abutments should be designed to resist lateral earth pressure. The expression for calculating lateral earth pressure is given by:

$$P = K(\gamma h + q) \text{ for non-braced cut, or } K(0.65\gamma h + q) \text{ for braced cut}$$

Where,

$P$  = earth pressure intensity at depth  $h$ , kPa

$K$  = earth pressure coefficient

$\gamma$  = unit weight of retained soil, kN/m<sup>3</sup>

$q$  = surcharge near wall, kPa

$h$  = depth to point of interest, m

The above expression does not take into account hydrostatic pressure, which must be included for the groundwater levels measured on the site. Table 2.1 provides earth pressure parameters for given materials in a well compacted state.

Table 2.1 Material types and earth pressure properties

Material	Effective Friction Angle $\phi'$ (°)	Coefficient of Active Earth Pressure ( $K_a$ )	Coefficient of Passive Earth Pressure ( $K_p$ )	Coefficient of Earth Pressure at Rest ( $K_o$ )	Unit Weight $\gamma$ kN/m <sup>3</sup>
Granular B Fill	34	0.28	3.54	0.44	22
Rockfill	44	0.18	5.55	0.31	24
Existing Embankment Fill	32	0.31	3.25	0.47	20

The mobilization of full active or passive resistance requires a measurable and perhaps significant wall movement or rotation. Therefore, unless the structural element can tolerate these deflections, the at-rest earth pressure should be used in design.

The effect of compaction surcharge should be taken into account in the calculations of active and at- rest earth pressures. The lateral pressure due to compaction should be taken as at least 12 kPa at the surface, and its magnitude should be assumed to diminish linearly with depth to zero at the

depth where the active (or at rest) pressure is equal to 12 kPa. This pressure distribution should be added to the calculated active (or at rest) pressure. Notwithstanding, lighter compaction equipment and smaller lifts should be used adjacent to walls to prevent overstressing.

## 2.3 Embankment Slope Stability

A temporary road embankment will be required for the temporary bridge. The temporary embankment can be constructed directly on the existing ground surface after removal of the vegetation (trees, brush, etc.). Material can consist of a well compacted Granular B fill or compacted rockfill.

We have performed stability analyses for both of these materials and for various side slopes using the Rocscience software, SLIDE 5 (method of Morgenstern/Price). The soil properties shown below in Table 2.2 have been selected for use in the stability analyses. Both static and seismically loaded analyses have been performed. For seismic loading, the peak horizontal ground acceleration of 0.036g has been taken from the National Building Code for Sioux Lookout, which is the closest station to the Crow River bridge site. The peak vertical acceleration has been taken as two thirds of the peak horizontal value, as suggested in the Canadian Foundation Engineering Manual.

**Table 2.2 Material types and earth pressure properties**

Material	Unfactored Friction Angle $\phi'$ ( $^{\circ}$ )	Undrained Shear Strength (kPa)	Unit Weight $\gamma$ kN/m <sup>3</sup>
Existing Fill	32	0	20
New Compacted Granular B Fill	34	0	22
New Compacted Rockfill	44	0	24
Peat (organic soil)	0	20	12
Native Silt/Sand	30	0	19
Till	36	0	22

The critical section for the new temporary embankment is considered to be on the north side, represented by the area in the vicinity of Section C-C' on Drawing 1. The north side has thicker soil deposits, including a layer of peat, whereas the south side has bedrock (or at least a dense refusing stratum) close to surface. Notwithstanding, we have also performed limited analyses for the south temporary embankment.

The results of the various analyses are summarized below, in Table 2.3.

**Table 2.3 Summary of Slope Stability Analyses**

Slope	Condition	Minimum Desired Factor of Safety	Calculated Factor of Safety	Figure in Appendix F
Crib on North Side	Static	1.5	1.87	F1
	Seismic	1.3	1.77	F2
Existing North Side Embankment	Static	1.5	1.77	F3
	Seismic	1.3	1.75	F4
North Side Embankment Rockfill @ 1.5:1 slope	Static	1.5	1.47	F5
	Seismic	1.3	1.38	F6
North Side Embankment Granular B @ 2:1 slope	Static	1.5	1.50	F7
	Seismic	1.3	1.39	F8
South Side Embankment Rockfill @ 1.5:1 slope	Static	1.5	1.83	F9
	Seismic	1.3	1.69	F10
South Side Embankment Granular B @ 2:1 slope	Static	1.5	1.58	F11
	Seismic	1.3	1.46	F12

## 2.4 Excavations and Dewatering

All excavations for this project must be conducted in accordance with the Occupational Health and Safety Act (OHSA) and Regulations for Construction (O. Reg. 213/91). All fill and the native soils may be classified as a Type 3 soil above the groundwater table in conformance with the OHSA. The native soils below the groundwater table may be classified as a Type 4 soil. It is expected that most of excavations will be above the groundwater levels except those to remove the organics and deleterious materials beneath the crib foundations. In order to avoid disturbance of the founding subgrade and to allow placement of backfill in dry conditions, groundwater must be controlled to below the proposed invert excavation levels prior to digging to final levels. The ingress of surface water must be controlled using a suitable system as well.

Temporary excavations side slopes for Type 3 soil should not exceed 1H:1V in accordance with OHSA, and closer to 2H:1V is recommended and likely required for global stability of the cuts for construction of the cribs (i.e. to maintain a global factor of safety greater than 1.3) where excavation will be left open for some time. Temporary excavation side slopes for Type 4 soils should not exceed 3H:1V where applicable. There is a potential for sloughing to occur if the cut remains open for an extended period of time (i.e. > 24 hours) or during a rainfall event. In addition, some localized surficial sloughing may be experienced in areas of perched groundwater seepage (i.e. within the embankment fill).

The soils encountered below the groundwater table and within potential excavation depths consist of peat and native silt, sand and clayey silt. The materials are highly susceptible to disturbance from groundwater and mobilized equipment. The groundwater level needs to be controlled to 1 m below the excavation level to avoid disturbance, and any surface or groundwater seepage should

be removed from the excavation prior to the crib bedding material being placed. In general, pumping using properly filtered sumps, and/or filtered drains placed along the base of the excavation should provide sufficient groundwater control during foundation works. There will likely be a requirement for cofferdam(s) since excavation will be below water level.

It is the responsibility of the Contractor to propose a suitable dewatering system based on the time of construction and groundwater levels and surface water flow conditions for prior approval of the MTO. The method used should not undermine the existing road. Similarly, any related temporary works such as cofferdams should be suitably designed by the contractor and submitted for approval by MTO prior to execution.

Erosion and sediment control during construction should be as per the MTO Drainage Manual, Volume 2. Silt fences and other sediment control measures should be included to protect the downstream environment from the construction activities.

August 28, 2015

## 2.5 Closure

The comments given in this report are intended only for the guidance of design engineers. The number of boreholes or test pits required to determine the localized underground conditions between boreholes or test pits that may affect construction costs, techniques, sequencing, equipment, scheduling, etc. could be greater than has been carried out for design purposes. Contractors bidding on or undertaking the works should, in this light, decide on their own investigations, as well as their own interpretations of the factual borehole results, so that they may draw their own conclusions as to how the subsurface conditions may affect them.

Contractors bidding on or undertaking any proposed work at this site should, relative to the subsurface conditions, decide on their own investigations, if deemed necessary, as well as their own interpretations of the factual results provided herein, so they may draw their own conclusions as to how the subsurface conditions may affect them.

This Foundation Investigation and Design Report have been prepared by Ahileas Mitsopoulos, P.Eng., Demetri N. Georgiou, M.ASc. P.Eng., and Silvana Micic, Ph.D., P.Eng. It was reviewed by TaeChul Kim, M.E.Sc., P.Eng. and by Stan E. Gonsalves, M.Eng., P.Eng., Designated MTO Foundation Contact.

Yours truly,

**exp Services Inc.**



Demetri N. Georgiou, M.ASc., P.Eng.  
Senior Geotechnical Engineer  
Project Manager



Stan E. Gonsalves, M.Eng., P.Eng.  
Principal Engineer  
Designated MTO Foundation Contact

Encl.

## **Appendix A – Site Photographs**





Photo 1. Looking south from the north bank, east of bridge



Photo 2. Looking south from the north bank, west of bridge





Photo 3. Looking southeast at the south bank, from the bridge deck



Photo 4. Looking south at the south bank, from the bridge deck





Photo 5. Looking north at Nort Road



Photo 6. Looking south at Nort Road





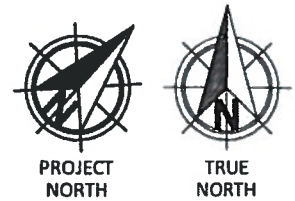
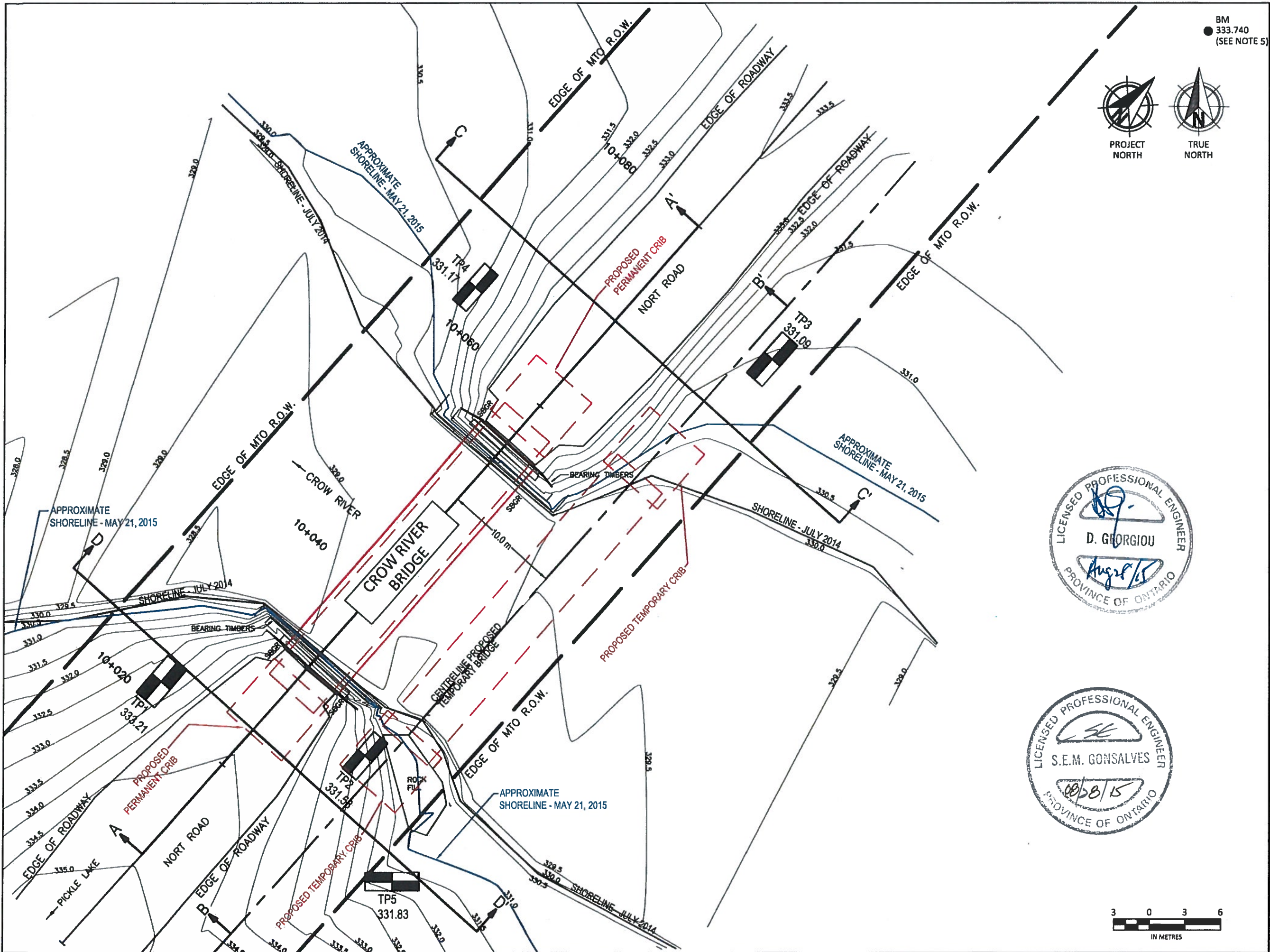
Photo 7. Water level at north shore and west of bridge



Photo 8. Water level at south shore and east of bridge

## **Appendix B – Drawings**





Agreement No. 6014-E-0017  
 Assignment No. 5  
 GWP 6322-11-00

**CROW RIVER BRIDGE**  
 (Nort Road, District of Kenora)  
**PLAN**

DWG 1

exp. **exp Services Inc.**  
**KEY PLAN**

**LEGEND**  

TP1  
 333.21

TEST PIT LOCATION  
 GROUND SURFACE ELEVATION IN METRES

BM  
 333.740

BENCHMARK LOCATION  
 GEODETIC ELEVATION IN METRES

BH No.	APPROX. ELEV. (m)	MTM COORDINATES	
		NORTH	EAST
TP1	333.21	5,723,758	312,579
TP2	331.58	5,723,764	312,562
TP3	331.09	5,723,791	312,613
TP4	331.17	5,723,797	312,588
TP5	331.83	5,723,748	312,581

**NOTES**  
 1. ALL DIMENSIONS ARE IN METRES.  
 2. BASE MAP PROVIDED BY CLIENT.  
 3. TEST HOLE LOCATIONS ARE BASED ON FIELD MEASUREMENTS FROM EXISTING BRIDGE AND/OR PROJECTED MTM COORDINATES FOR ZONE ON-15 AS PER PROVIDED FIGURE.  
 4. THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. THE PROPOSED STRUCTURE DETAILS/WORKS ARE SHOWN FOR ILLUSTRATION PURPOSES ONLY.  
 5. BENCHMARK IS A SPIKE LOCATED IN THE ROOT OF 0.3 m Ø BALSAM TREE AT MTM ON-15 COORDINATES 5723818.469 N 312649.799 E

REVISIONS		
DATE	BY	DESCRIPTION

GEORES No. 52P-03  
 Date: August 27, 2015  
 Drawn By: RM

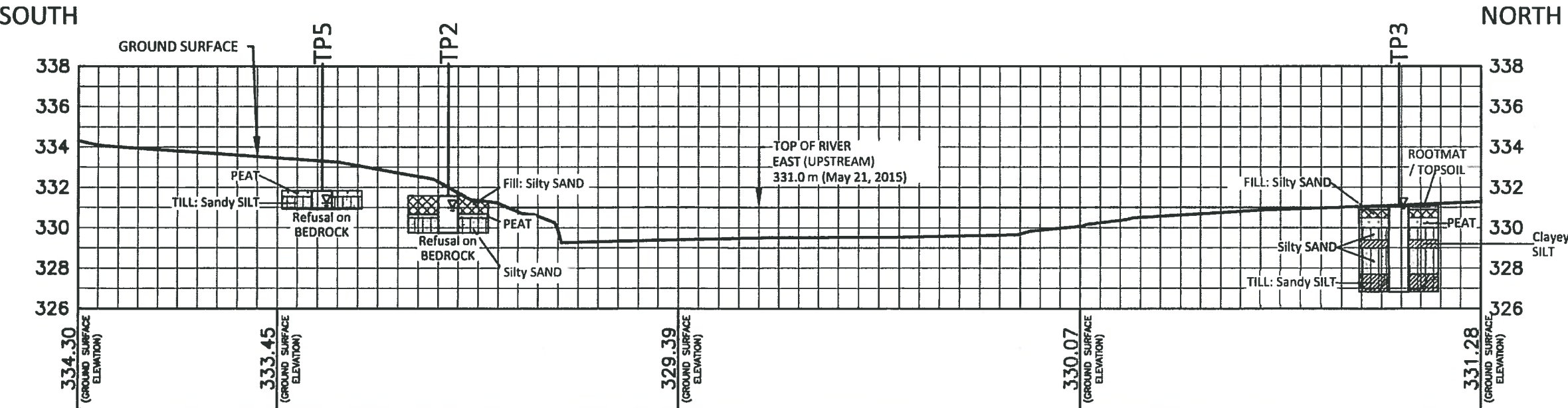
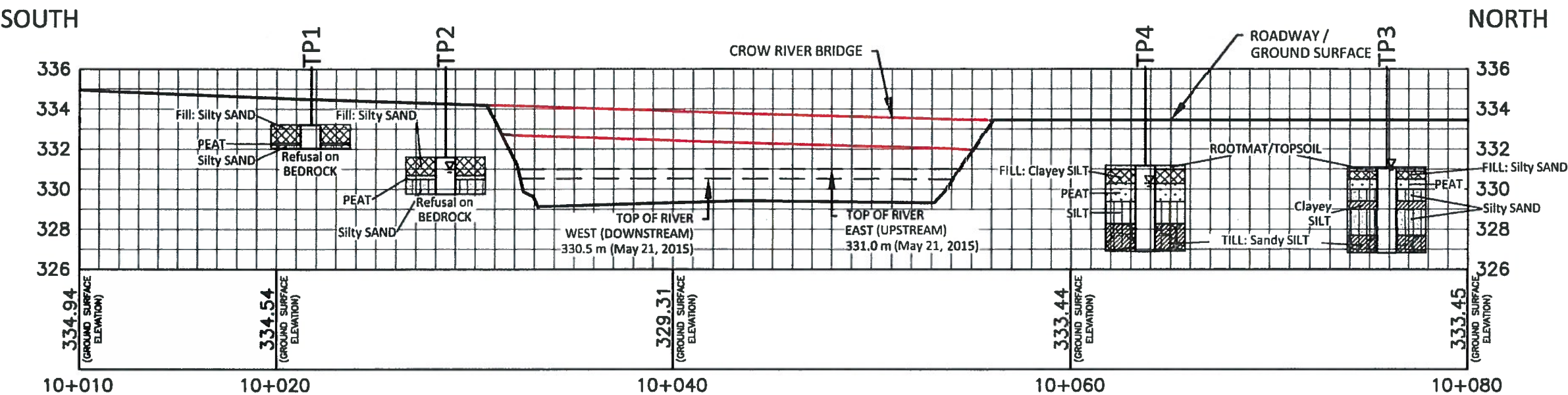
Project No. ADM-00223648-DO  
 Scale: 1:300  
 Checked By: AM  
 Checked By: DG

LICENSED PROFESSIONAL ENGINEER  
 D. GEORGIU  
 August 15  
 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER  
 S.E.M. GONSALVES  
 08/28/15  
 PROVINCE OF ONTARIO



A - A'  
PROFILE OF CROW RIVER BRIDGE  
(EXISTING ALIGNMENT)



B - B'  
PROFILE OF CROW RIVER BRIDGE  
(PROPOSED TEMPORARY ALIGNMENT)



Agreement No. 6014-E-0017  
Assignment No. 5  
GWP 6322-11-00

CROW RIVER BRIDGE  
(Nort Road/Highway 808, District of Kenora)  
CROSS SECTIONS 1 of 2

DWG  
2

exp Services Inc.

KEY PLAN

LEGEND

BH No.	APPROX. ELEV. (m)	MTM COORDINATES	
		NORTH	EAST
TP1	333.21	5,723,758	312,579
TP2	331.58	5,723,764	312,562
TP3	331.09	5,723,791	312,613
TP4	331.17	5,723,797	312,588
TP5	331.83	5,723,748	312,581

NOTES

- ALL DIMENSIONS ARE IN METRES.
- BASE MAP PROVIDED BY CLIENT.
- THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. THE PROPOSED STRUCTURE DETAILS/WORKS ARE SHOWN FOR ILLUSTRATION PURPOSES ONLY.

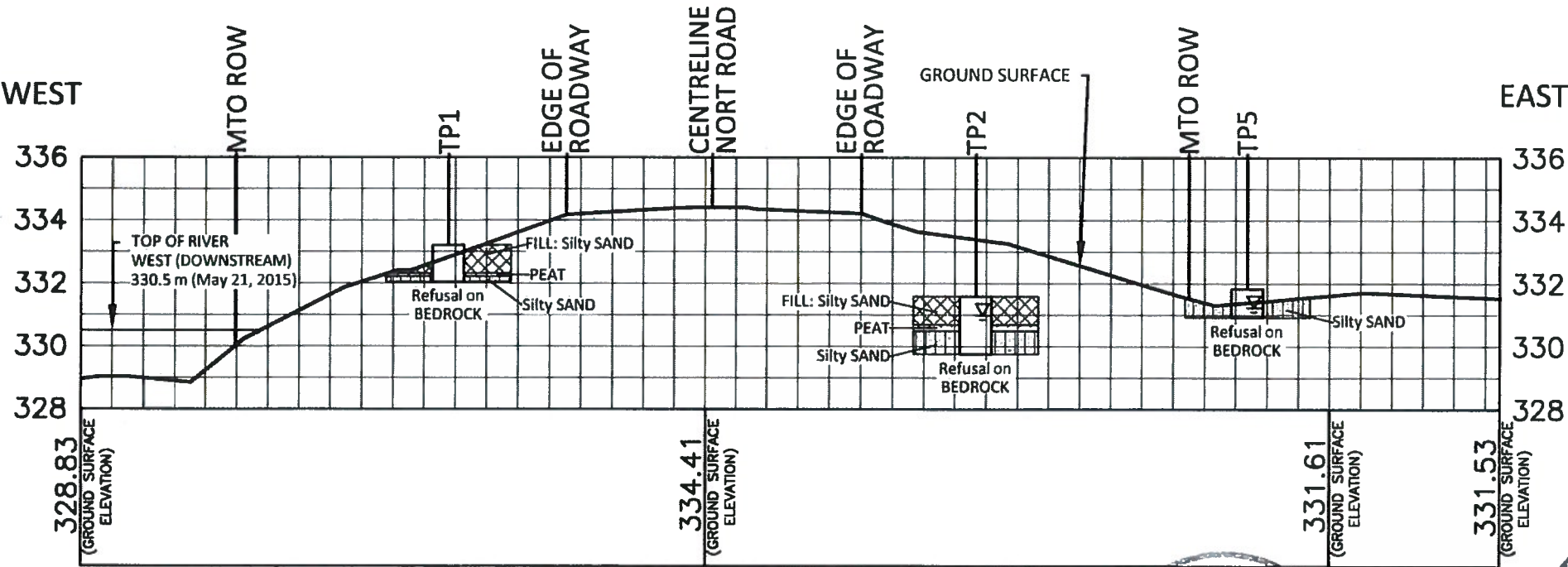
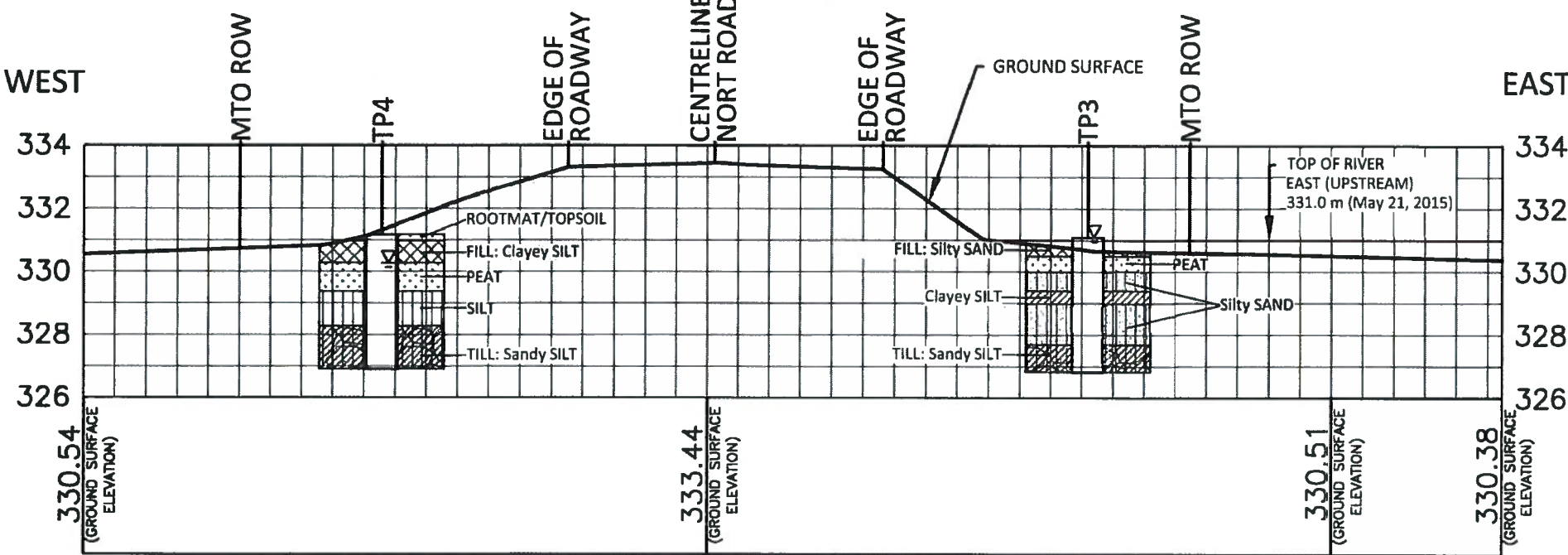
REVISIONS

DATE	BY	DESCRIPTION

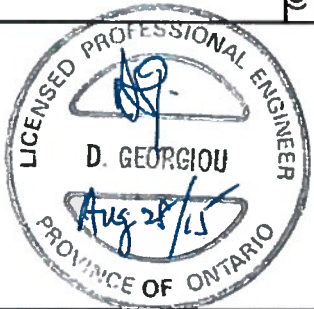
GEOCRES No. 52P-03  
Date: August 27, 2015  
Drawn By: RM  
Checked By: DG

Project No. ADM-00223648-D0  
Horizontal Scale : 1:250  
Vertical Scale: 1:250  
Checked By: AM

C - C'  
CROSS SECTION  
(NORTH BANK)



D - D'  
CROSS SECTION  
(SOUTH BANK)



Agreement No. 6014-E-0017  
Assignment No. 5  
GWP 6322-11-00

CROW RIVER BRIDGE  
(Nort Road/Highway 808, District of Kenora)  
CROSS SECTIONS 2 of 2

exp Services Inc.

DWG 3

KEY PLAN

LEGEND

MEASURED WATER LEVEL

BH No.	APPROX. ELEV. (m)	MTM COORDINATES	
		NORTH	EAST
TP1	333.21	5,723,758	312,579
TP2	331.58	5,723,764	312,562
TP3	331.09	5,723,791	312,613
TP4	331.17	5,723,797	312,588
TP5	331.83	5,723,748	312,581

NOTES

- ALL DIMENSIONS ARE IN METRES.
- BASE MAP PROVIDED BY CLIENT.
- THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. THE PROPOSED STRUCTURE DETAILS/WORKS ARE SHOWN FOR ILLUSTRATION PURPOSES ONLY.

REVISIONS		
DATE	BY	DESCRIPTION

GEOCRES No. 52-03  
Date: August 27, 2015  
Drawn By: RM  
Checked By: DG

Project No. ADM-0023648-00  
Horizontal Scale : 1:200  
Vertical Scale : 1:200  
Checked By: AM



## **Appendix C – Test Pit Records**

# RECORD OF TEST PIT No TP1

1 OF 1

**METRIC**

W. P. GWP No. 6322-11-00 LOCATION Crow River Bridge (Site No. 41S-95) MTM ON-15 5,723,758N 312,579E ORIGINATED BY EF  
 DIST/HWY 61 / Nort Road (Hwy 808) TEST PIT TYPE Link Belt 130 Track Excavator COMPILED BY AM  
 DATUM Geodetic DATE 2015/05/21 - 2015/05/21 CHECKED BY DG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
333.2	Sand																
0.0	<b>Silty SAND with Gravel (FILL)</b> - loose, brown, moist to wet, some angular rock fill, trace peat, some roots		S1	BS			333										
332.3																	
0.9	<b>PEAT</b> - frozen, black, trace roots and rootlets		S2	BS													
332.2																	
1.0	<b>Silty SAND</b> - frozen, brown, some cobbles, some roots		S3	BS													
332.0																	
1.2	<b>End of Test Pit</b> - refusal on bedrock																

MTO TEST PIT TEMPLATE F-15112-AG - ADM-00223648-D0 - MTO 5 - CROW RIVER BRIDGE - PICKLE LAKE.GPJ ONTARIO MOT.GDT 8/27/15

# RECORD OF TEST PIT No TP2

1 OF 1

METRIC

W. P. GWP No. 6322-11-00 LOCATION Crow River Bridge (Site No. 41S-95) MTM ON-15 5,723,764N 312,562E ORIGINATED BY EF  
DIST/HWY 61 / Nort Road (Hwy 808) TEST PIT TYPE Link Belt 130 Track Excavator COMPILED BY AM  
DATUM Geodetic DATE 2015/05/21 - 2015/05/21 CHECKED BY DG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
331.6 0.0	Sand <b>Silty SAND with Gravel (FILL)</b> - loose, brown, moist to wet, some angular rock fill, trace peat, some roots, trace metal debris		S1	BS			331										
330.7 0.9	<b>PEAT</b> - soft, black, wet, some roots, trace wood debris		S2	BS												98.6	
330.5 1.1	<b>Silty SAND with Gravel</b> - loose to compact, brown, moist, some cobbles, occasional boulders		S3	BS			330										29 41 25 5
329.8 1.8	<b>End of Test Pit</b> - refusal on bedrock																

MTD TEST PIT TEMPLATE F-15112-AG - ADM-00223648-D0 - MTD 5 - CROW RIVER BRIDGE - PICKLE LAKE.GPJ ONTARIO MOT.GDT 8/27/15



## RECORD OF TEST PIT No TP3

1 OF 1

METRIC

W. P. GWP No. 6322-11-00 LOCATION Crow River Bridge (Site No. 41S-95) MTM ON-15 5,723,791N 312,613E ORIGINATED BY EF  
DIST/HWY 61 / Nort Road (Hwy 808) TEST PIT TYPE Link Belt 130 Track Excavator COMPILED BY AM  
DATUM Geodetic DATE 2015/05/21 - 2015/05/21 CHECKED BY DG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
331.1	Rootmat																
0.0	ROOTMAT/TOPSOIL - soft, brown, wet, trace gravel, trace sand, some peat, trace roots and rootlets		S1	BS			331										
330.9																	
0.2	Silty SAND (FILL) - loose, brown, wet, occasional cobbles and boulders		S2	BS													
330.5																	
0.6	PEAT - soft, black, wet, trace roots, trace wood debris		S3	BS													
330.0							330										
1.1	Silty SAND - loose to compact, grey, moist, some cobbles and boulders		S4	BS													
329.4																	
1.7	Clayey SILT - soft, brown, moist to wet, some cobbles to cobbley		S5	BS													
329.0							329										0 13 68 19
2.1	Silty SAND with Gravel - loose, brown, wet, occasional cobbles and boulders		S6	BS													
327.7																	
3.4	Sandy SILT (TILL) - dense, brown to grey, moist, occasional cobbles and boulders		S7	BS			328										
326.8																	
4.3	End of Test Pit - maximum reach of excavator		S8	BS			327										1 40 52 7

+ 3, X 3: Numbers refer to  
Sensitivity

O 3% STRAIN AT FAILURE



MTO TEST PIT TEMPLATE F-15112-AG - ADM-00223648-D0 - MTO 5 - CROW RIVER BRIDGE - PICKLE LAKE GP J. ONTARIO MOT. GDT. 8/27/15

# RECORD OF TEST PIT No TP4

1 OF 1

METRIC

W. P. GWP No. 6322-11-00 LOCATION Crow River Bridge (Site No. 41S-95) MTM ON-15 5,723,797N 312,588E ORIGINATED BY EF  
 DIST/HWY 61 / Nort Road (Hwy 808) TEST PIT TYPE Link Belt 130 Track Excavator COMPILED BY AM  
 DATUM Geodetic DATE 2015/05/21 - 2015/05/21 CHECKED BY DG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
331.2	Rootmat																
0.0	ROOTMAT/TOPSOIL - soft, brown, moist to wet		S1	BS			331										
331.0																	
0.2	Clayey SILT (FILL) - soft to firm, light brown, moist, occasional cobbles		S2	BS													
			S3	BS													
330.3																	
0.9	PEAT - soft to firm, dark brown, moist to wet, trace gravel, trace sand, some silt to silty, some roots and rootlets, trace wood debris		S4	BS			330										
329.3																	
1.8	SILT with Sand - compact to dense, brown to grey, moist to wet, occasional cobbles		S5	BS			329										0 17 79 4
			S6	BS													
328.3																	
2.9	Sandy SILT with Gravel (TILL) - compact to dense, grey, moist, occasional cobbles and boulders		S7	BS			328										16 30 48 6
			S8	BS													
326.9							327										
4.3	End of Test Pit - maximum reach of excavator																




MTD TEST PIT TEMPLATE F-15112-AG - ADM-00223648-D0 - MTO 5 - CROW RIVER BRIDGE - PICKLE LAKE GPJ ONTARIO MOT. GDT 8/27/15

# RECORD OF TEST PIT No TP5

1 OF 1

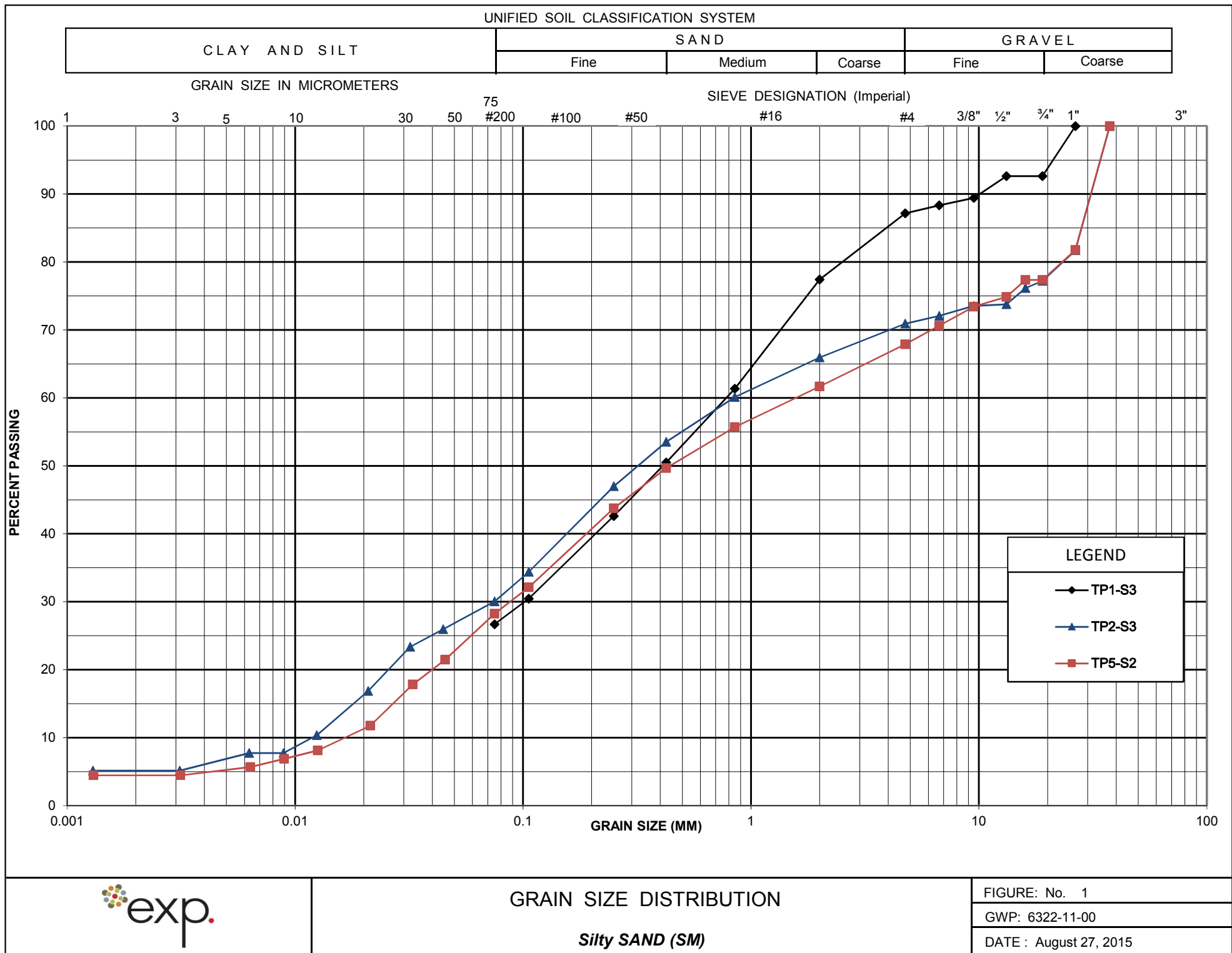
**METRIC**

W. P. GWP No. 6322-11-00 LOCATION Crow River Bridge (Site No. 41S-95) MTM ON-15 5,723,748N 312,581E ORIGINATED BY EF  
 DIST/HWY 61 / Nort Road (Hwy 808) TEST PIT TYPE Link Belt 130 Track Excavator COMPILED BY AM  
 DATUM Geodetic DATE 2015/05/21 - 2015/05/21 CHECKED BY DG

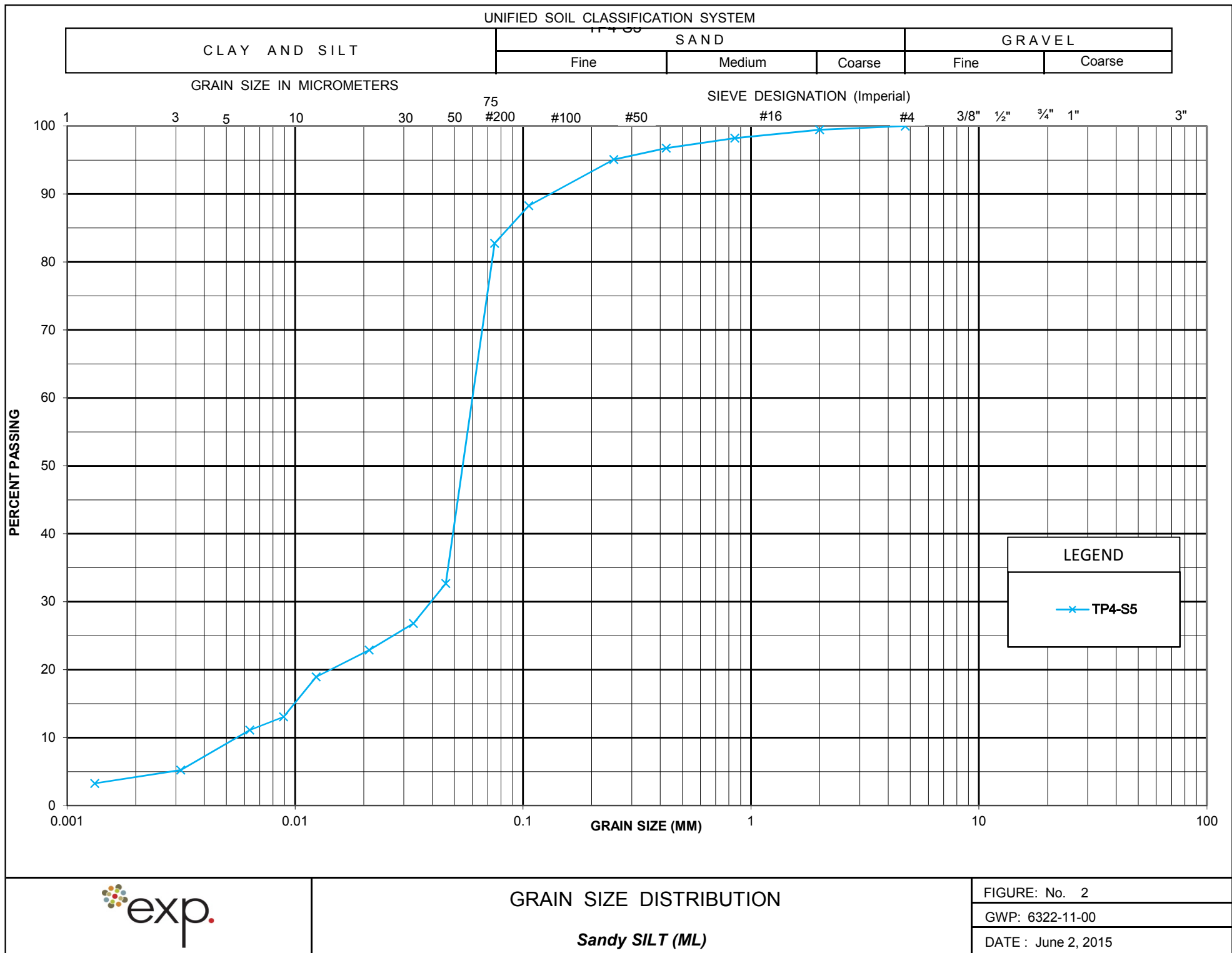
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
331.8	Peat		S1	BS													
331.5																	
0.3	Silty SAND with Gravel - loose, brown, wet, occasional cobbles and boulders		S2	BS													
			S3	BS													
330.9							331										
0.9	End of Test Pit - refusal on bedrock																

MTO TEST PIT TEMPLATE F-15112-AG - ADM-00223648-D0 - MTO 5 - CROW RIVER BRIDGE - PICKLE LAKE.GPJ ONTARIO MOT.GDT 8/27/15

## **Appendix D – Laboratory Data**





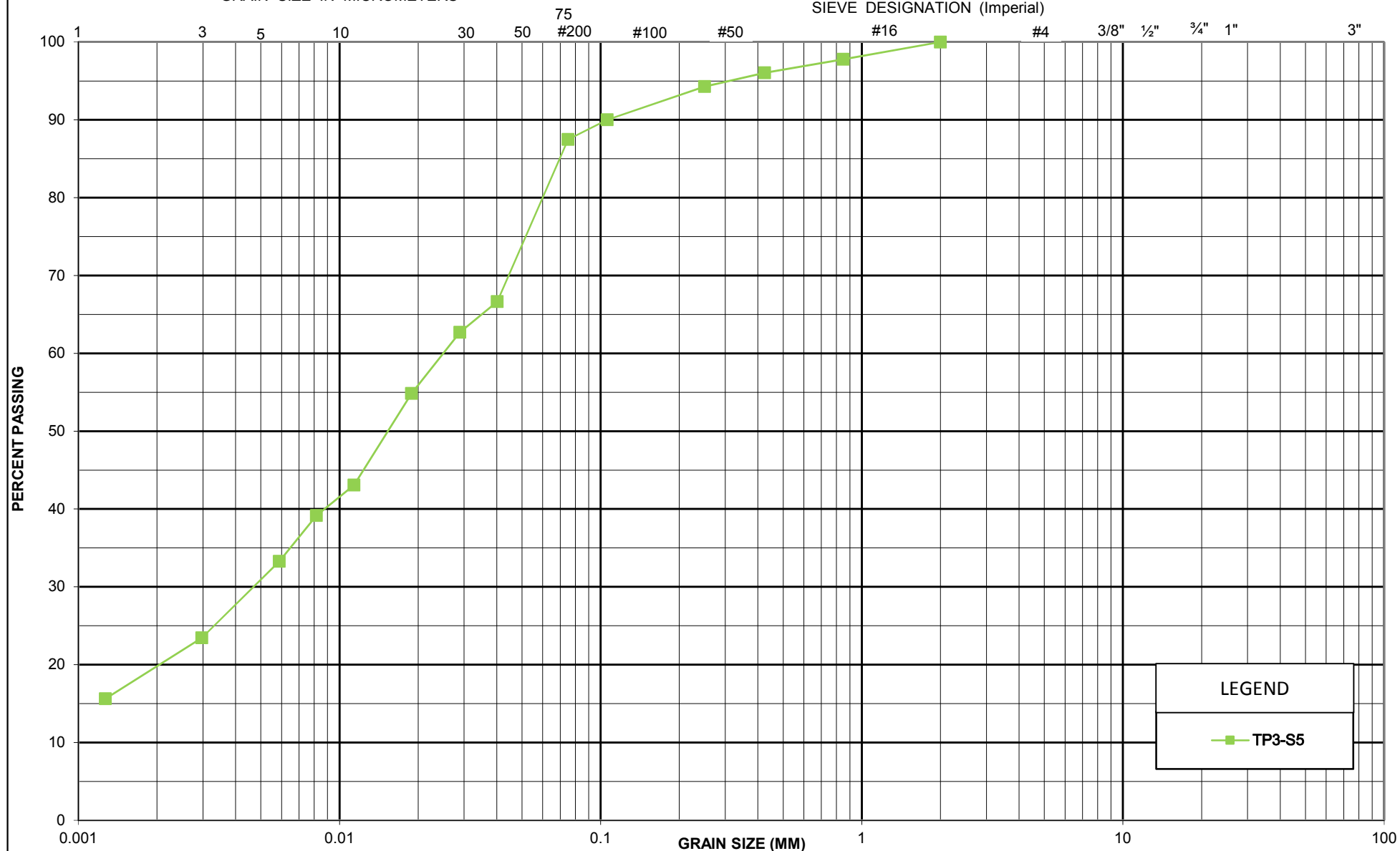


# UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse

GRAIN SIZE IN MICROMETERS

SIEVE DESIGNATION (Imperial)



## LEGEND

TP3-S5



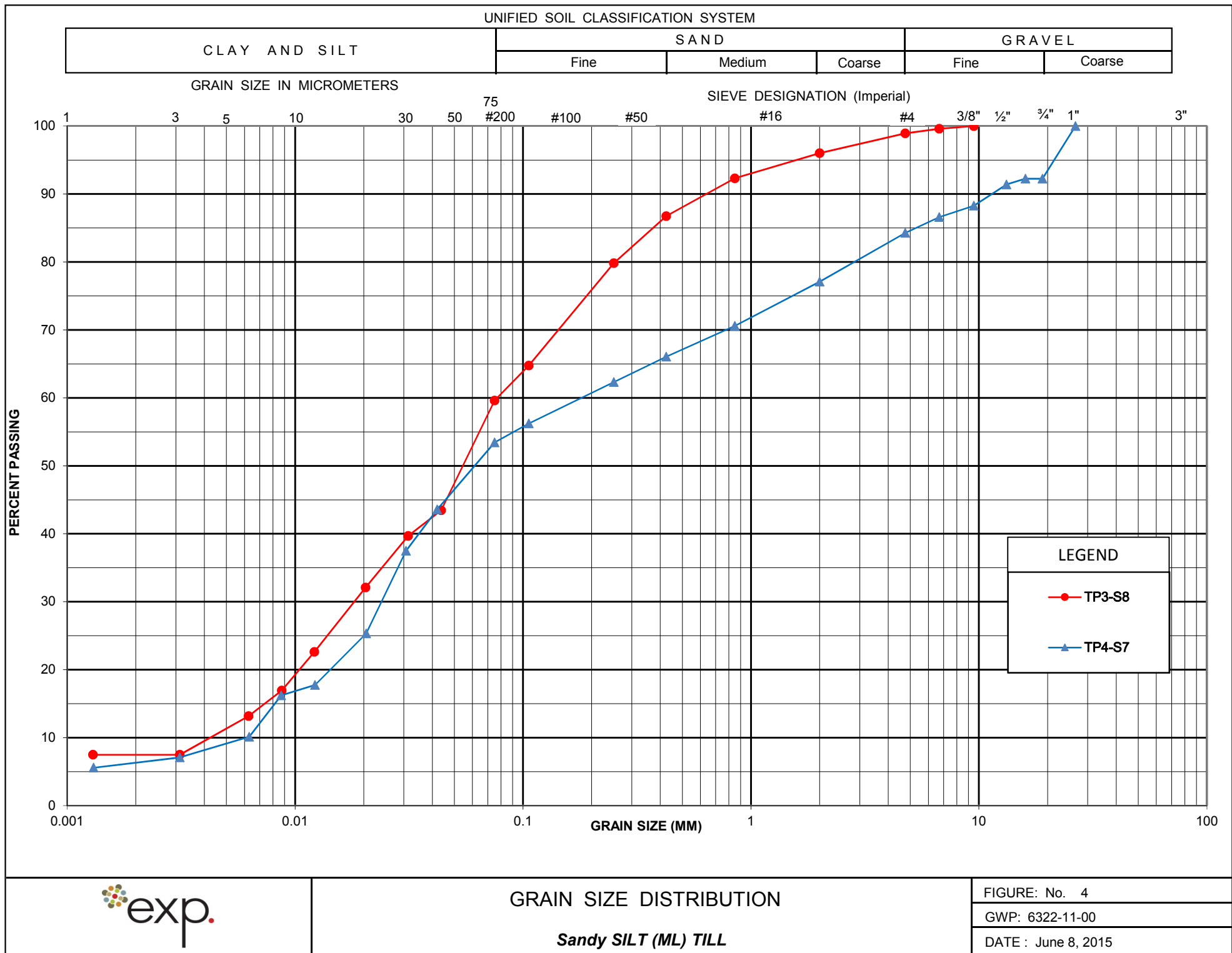
## GRAIN SIZE DISTRIBUTION

*Clayey SILT (CL)*

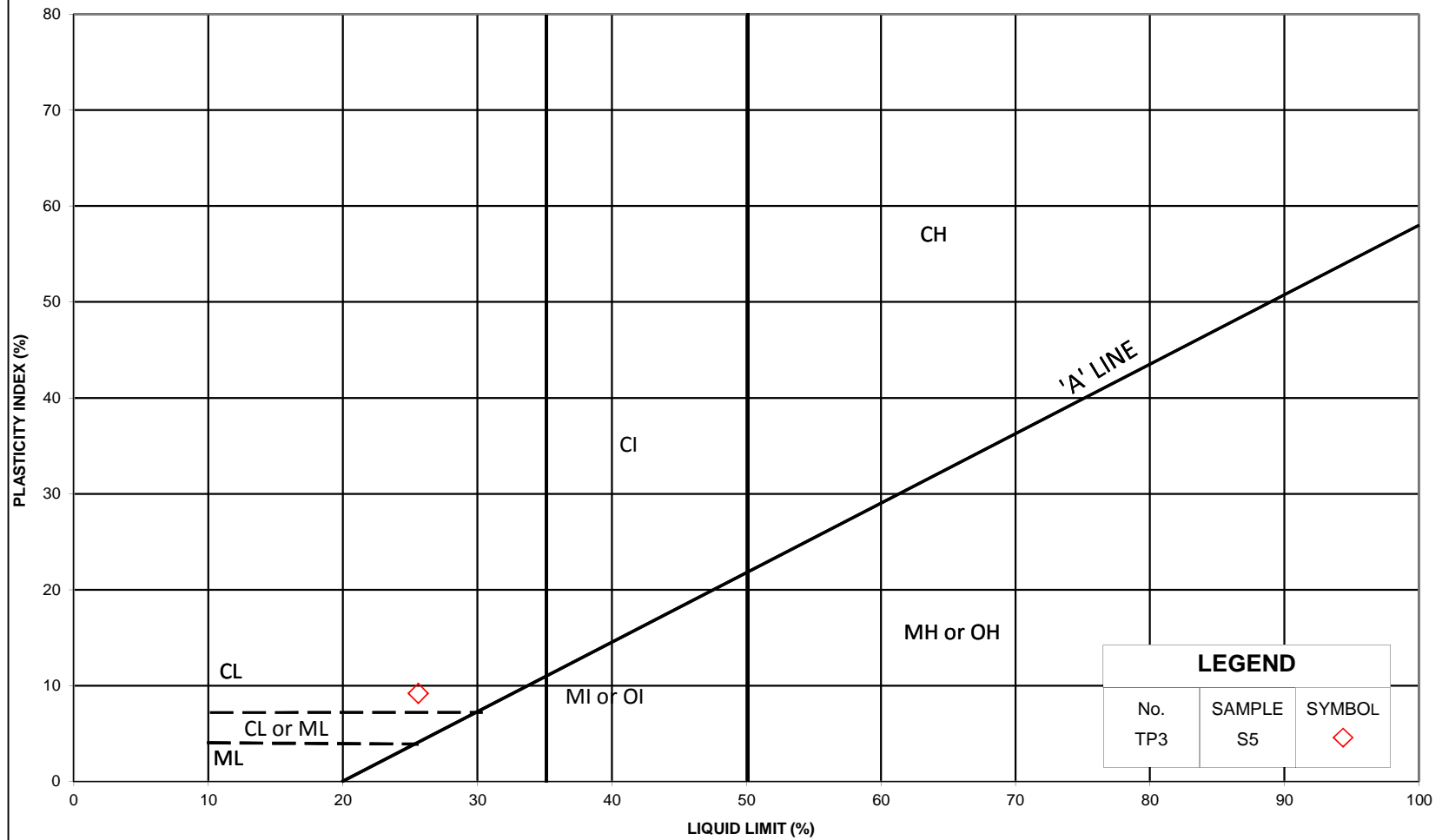
FIGURE: No. 3

GWP: 6322-11-00

DATE : May 29, 2015



**Crow River Bridge Replacement (Site No. 41S-095)**  
**GWP No. 6322-11-00, Nort Road, District of Kenora, Ontario**



**PLASTICITY CHART**  
**Clayey SILT (CL)**

FIGURE No. 5  
 ADM-00223648-D0  
 June 2, 2015

## **Appendix E – Chemical Analyses**

Your Project #: ADM-00223648-D0  
Site Location: CROW RIVER BRIDGE, ONTARIO  
Your C.O.C. #: na

**Attention: Michael Suslyk**

exp Services Inc  
Thunder Bay Branch  
1142 Roland St  
Thunder Bay, ON  
P7B 5M4

**Report Date: 2015/06/02**  
Report #: R3449807  
Version: 1 - Final

## **CERTIFICATE OF ANALYSIS**

**MAXXAM JOB #: B599159**

**Received: 2015/05/27, 09:00**

Sample Matrix: Soil  
# Samples Received: 2

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Chloride (20:1 extract)	2	N/A	2015/06/01	CAM SOP-00463	EPA 325.2 m
Conductivity	2	N/A	2015/06/01	CAM SOP-00414	OMOE E3138 v2 m
pH CaCl2 EXTRACT	2	2015/05/29	2015/05/29	CAM SOP-00413	EPA 9045 D m
Resistivity of Soil	2	2015/05/27	2015/06/01	CAM SOP-00414	SM 22 2510 m
Sulphate (20:1 Extract)	2	N/A	2015/06/01	CAM SOP-00464	EPA 375.4 m

**Remarks:**

Maxxam Analytics has performed all analytical testing herein in accordance with ISO 17025 and the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act. All methodologies comply with this document and are validated for use in the laboratory. The methods and techniques employed in this analysis conform to the performance criteria (detection limits, accuracy and precision) as outlined in the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act.

The CWS PHC methods employed by Maxxam conform to all prescribed elements of the reference method and performance based elements have been validated. All modifications have been validated and proven equivalent following the 'Alberta Environment Draft Addenda to the CWS-PHC, Appendix 6, Validation of Alternate Methods'. Documentation is available upon request. Maxxam has made the following improvements to the CWS-PHC reference benchmark method: (i) Headspace for F1; and, (ii) Mechanical extraction for F2-F4. Note: F4G cannot be added to the C6 to C50 hydrocarbons. The extraction date for samples field preserved with methanol for F1 and Volatile Organic Compounds is considered to be the date sampled.

Maxxam Analytics is accredited for all specific parameters as required by Ontario Regulation 153/04. Maxxam Analytics is limited in liability to the actual cost of analysis unless otherwise agreed in writing. There is no other warranty expressed or implied. Samples will be retained at Maxxam Analytics for three weeks from receipt of data or as per contract.

Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.

\* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

Your Project #: ADM-00223648-D0  
Site Location: CROW RIVER BRIDGE, ONTARIO  
Your C.O.C. #: na

**Attention: Michael Suslyk**

exp Services Inc  
Thunder Bay Branch  
1142 Roland St  
Thunder Bay, ON  
P7B 5M4

**Report Date: 2015/06/02**  
Report #: R3449807  
Version: 1 - Final

**CERTIFICATE OF ANALYSIS**

**MAXXAM JOB #: B599159**  
**Received: 2015/05/27, 09:00**

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.  
Hina Siddiqui, Project Manager –Environmental Customer Service  
Email: HSiddiqui@maxxam.ca  
Phone# (905) 817-5700

=====

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam Job #: B599159  
Report Date: 2015/06/02

exp Services Inc  
Client Project #: ADM-00223648-D0  
Site Location: CROW RIVER BRIDGE, ONTARIO

### RESULTS OF ANALYSES OF SOIL

Maxxam ID		AIN177	AIN177	AIN178		
Sampling Date		2015/05/21 17:00	2015/05/21 17:00	2015/05/21 12:00		
COC Number		na	na	na		
	<b>Units</b>	<b>TP4-S8</b>	<b>TP4-S8 Lab-Dup</b>	<b>TP1-S3</b>	<b>RDL</b>	<b>QC Batch</b>
<b>Calculated Parameters</b>						
Resistivity	ohm-cm	11000		11000		4039855
<b>Inorganics</b>						
Soluble (20:1) Chloride (Cl)	ug/g	<20	<20	<20	20	4042972
Conductivity	umho/cm	91	91	89	2	4043480
Available (CaCl2) pH	pH	7.71		6.90	N/A	4042884
Soluble (20:1) Sulphate (SO4)	ug/g	<20	<20	<20	20	4042974
RDL = Reportable Detection Limit QC Batch = Quality Control Batch Lab-Dup = Laboratory Initiated Duplicate N/A = Not Applicable						



Maxxam Job #: B599159  
Report Date: 2015/06/02

exp Services Inc  
Client Project #: ADM-00223648-D0  
Site Location: CROW RIVER BRIDGE, ONTARIO

## TEST SUMMARY

**Maxxam ID:** AIN177  
**Sample ID:** TP4-S8  
**Matrix:** Soil

**Collected:** 2015/05/21  
**Shipped:**  
**Received:** 2015/05/27

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	4042972	N/A	2015/06/01	Deonarine Ramnarine
Conductivity	AT	4043480	N/A	2015/06/01	Lemeneh Addis
pH CaCl2 EXTRACT	AT	4042884	2015/05/29	2015/05/29	Neil Dassanayake
Resistivity of Soil		4039855	2015/06/01	2015/06/01	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	4042974	N/A	2015/06/01	Deonarine Ramnarine

**Maxxam ID:** AIN177 Dup  
**Sample ID:** TP4-S8  
**Matrix:** Soil

**Collected:** 2015/05/21  
**Shipped:**  
**Received:** 2015/05/27

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	4042972	N/A	2015/06/01	Deonarine Ramnarine
Conductivity	AT	4043480	N/A	2015/06/01	Lemeneh Addis
Sulphate (20:1 Extract)	KONE/EC	4042974	N/A	2015/06/01	Deonarine Ramnarine

**Maxxam ID:** AIN178  
**Sample ID:** TP1-S3  
**Matrix:** Soil

**Collected:** 2015/05/21  
**Shipped:**  
**Received:** 2015/05/27

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	4042972	N/A	2015/06/01	Deonarine Ramnarine
Conductivity	AT	4043480	N/A	2015/06/01	Lemeneh Addis
pH CaCl2 EXTRACT	AT	4042884	2015/05/29	2015/05/29	Neil Dassanayake
Resistivity of Soil		4039855	2015/06/01	2015/06/01	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	4042974	N/A	2015/06/01	Deonarine Ramnarine

Maxxam Job #: B599159  
Report Date: 2015/06/02

exp Services Inc  
Client Project #: ADM-00223648-D0  
Site Location: CROW RIVER BRIDGE, ONTARIO

### GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	0.3°C
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**Results relate only to the items tested.**

Maxxam Job #: B599159  
Report Date: 2015/06/02

## QUALITY ASSURANCE REPORT

exp Services Inc  
Client Project #: ADM-00223648-D0  
Site Location: CROW RIVER BRIDGE, ONTARIO

QC Batch	Parameter	Date	Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits	% Recovery	QC Limits
4042884	Available (CaCl <sub>2</sub> ) pH	2015/05/29			100	97 - 103			0.62	N/A		
4042972	Soluble (20:1) Chloride (Cl)	2015/06/01	115	70 - 130	107	70 - 130	<20	ug/g	NC	35		
4042974	Soluble (20:1) Sulphate (SO <sub>4</sub> )	2015/06/01	105	70 - 130	105	70 - 130	<20	ug/g	NC	35		
4043480	Conductivity	2015/06/01			101	90 - 110	<2	umho/cm	0.22	10	118	75 - 125

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

QC Standard: A sample of known concentration prepared by an external agency under stringent conditions. Used as an independent check of method accuracy.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

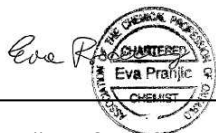
NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (one or both samples < 5x RDL).

Maxxam Job #: B599159  
Report Date: 2015/06/02

exp Services Inc  
Client Project #: ADM-00223648-D0  
Site Location: CROW RIVER BRIDGE, ONTARIO

### VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).






Ewa Pranjić, M.Sc., C.Chem, Scientific Specialist

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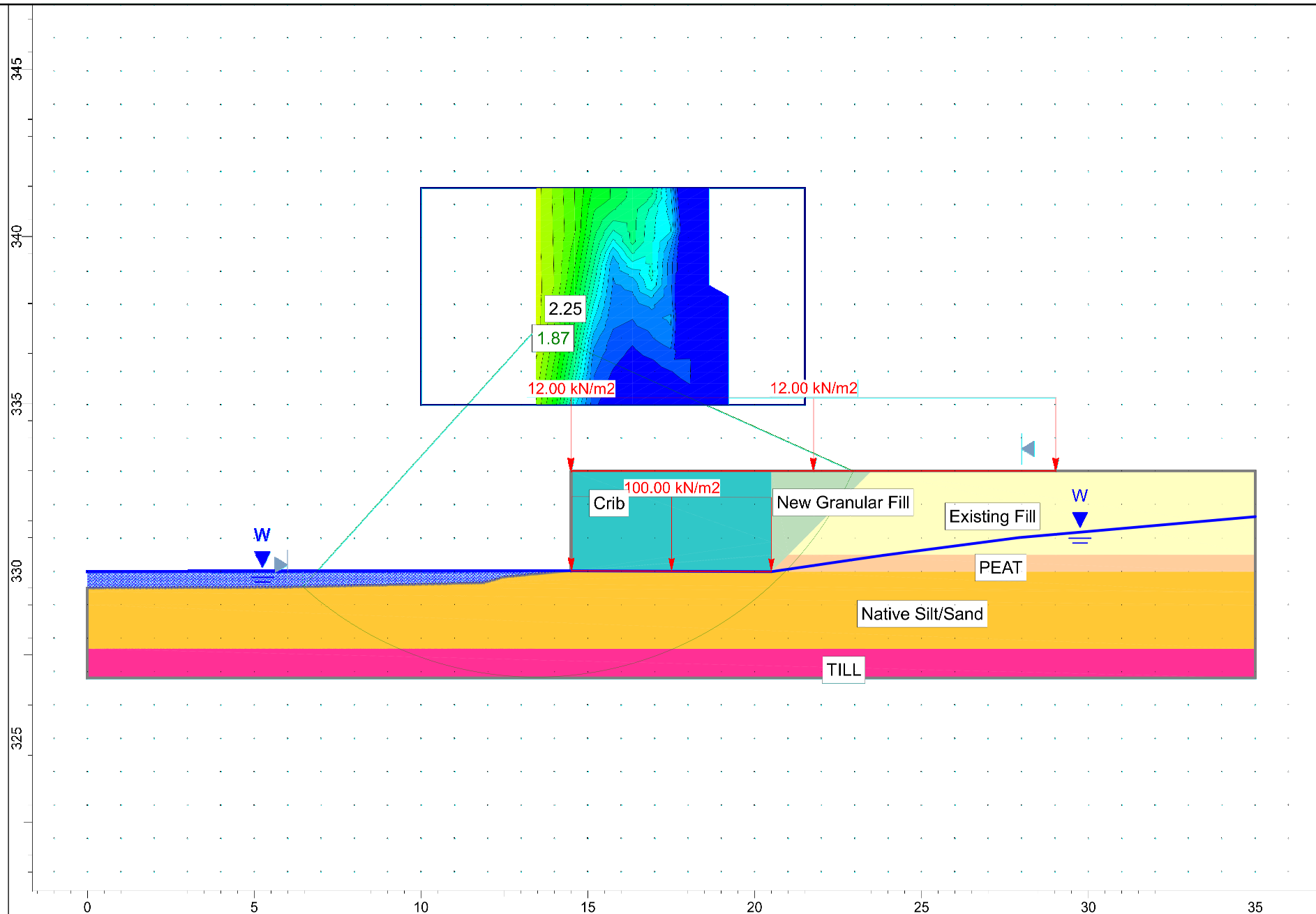
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

## CHAIN OF CUSTODY RECORD

Page 1 of 1

INVOICE INFORMATION		REPORT INFORMATION (if differs from invoice)		PROJECT INFORMATION		TURNAROUND TIME (TAT) REQUIRED																																																																																																																																																																																																					
Company Name: <b>exp Services Inc.</b>		Company Name: _____		Quotation #: _____		<input checked="" type="checkbox"/> Regular TAT (5-7 days) PLEASE PROVIDE ADVANCE NOTICE FOR RUSH PROJECTS																																																																																																																																																																																																					
Contact Name: <b>Michael Suslyk, Ahileas Mitsopoulos</b>		Contact Name: _____		P.O. #: _____		<input type="checkbox"/> Rush TAT (Applicable Surcharge) <input type="checkbox"/> 1 Day (100%) <input type="checkbox"/> 2 Days (50%) <input type="checkbox"/> 3-4 Days (25%)																																																																																																																																																																																																					
Address: <b>1142 Roland Street Thunder Bay, ON P7B 5M4</b>		Address: _____		Project #: <b>ADM-00223648-D0</b>																																																																																																																																																																																																							
Phone: <b>807.623.9495</b> Fax: <b>807.623.8070</b>		Phone: _____ Fax: _____		Site Location: <b>Crow River Bridge, Ontario</b>																																																																																																																																																																																																							
Email: <b>michael.suslyk@exp.com, ahileas.mitsopoulos@exp.com</b>		Email: _____		Site #: _____																																																																																																																																																																																																							
				Sampled By: <b>Elwin Farkas</b>																																																																																																																																																																																																							
<b>MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE MAXXAM DRINKING WATER CHAIN OF CUSTODY</b>				ANALYSIS REQUESTED				Rush Confirmation #:																																																																																																																																																																																																			
				<table border="1" style="width:100%; border-collapse: collapse;"> <tr> <td style="width: 10%;">pH</td> <td style="width: 10%;">Water Soluble Sulphate</td> <td style="width: 10%;">Resistivity</td> <td style="width: 10%;">Conductivity</td> <td style="width: 10%;">Chloride</td> <td style="width: 10%;"></td> <td style="width: 10%;"></td> <td style="width: 10%;"></td> <td style="width: 10%;"></td> <td style="width: 10%;"></td> </tr> <tr> <td colspan="10" style="text-align: center;">FIELD FILTERED (PLEASE CIRCLE) Metals / Hg / CrVI</td> </tr> </table>				pH	Water Soluble Sulphate	Resistivity	Conductivity	Chloride						FIELD FILTERED (PLEASE CIRCLE) Metals / Hg / CrVI										Date Required:																																																																																																																																																																															
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<u>Y</u></td> <td colspan="4"></td> <td colspan="2">LABORATORY USE ONLY</td> </tr> <tr> <td colspan="4" style="text-align: center;">SAMPLES MUST BE KEPT COOL (&lt; 10 °C) FROM TIME OF SAMPLING UNTIL DELIVERY TO MAXXAM</td> <td colspan="4"></td> <td colspan="2">                 CUSTODY SEAL (Y/N)                  Present <input checked="" type="checkbox"/>                  Intact <input checked="" type="checkbox"/>                  COOLING MEDIA PRESENT (Y/N)  <input checked="" type="checkbox"/> </td> </tr> <tr> <td colspan="2" style="text-align: center;">SAMPLE IDENTIFICATION</td> <td style="text-align: center;">DATE SAMPLED</td> <td style="text-align: center;">TIME SAMPLED</td> <td style="text-align: center;">MATRIX</td> <td style="text-align: center;"># OF CONT.</td> <td colspan="4"></td> <td colspan="2" style="text-align: center;">COMMENTS / TAT COMMENTS</td> </tr> <tr> <td colspan="2">1 TP4-S8</td> <td>21-May-15</td> <td>17:00</td> <td>Soil</td> <td>1</td> <td><input checked="" type="checkbox"/></td> <td><input checked="" type="checkbox"/></td> <td><input checked="" type="checkbox"/></td> <td><input checked="" type="checkbox"/></td> <td><input checked="" type="checkbox"/></td> <td colspan="2"></td> </tr> <tr> <td colspan="2">2 TP1-S3</td> <td>21-MAY-15</td> <td>12:00 PM</td> <td>Soil</td> <td>1</td> <td><input checked="" type="checkbox"/></td> <td><input checked="" type="checkbox"/></td> <td><input checked="" type="checkbox"/></td> <td><input checked="" type="checkbox"/></td> <td><input checked="" type="checkbox"/></td> <td colspan="2"></td> </tr> <tr><td colspan="2">3</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2"></td></tr> <tr><td colspan="2">4</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2"></td></tr> <tr><td colspan="2">5</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2"></td></tr> <tr><td colspan="2">6</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2"></td></tr> <tr><td colspan="2">7</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2"></td></tr> <tr><td colspan="2">8</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2"></td></tr> <tr><td colspan="2">9</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2"></td></tr> <tr><td colspan="2">10</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2"></td></tr> <tr> <td colspan="2">RELINQUISHED BY: (Signature/Print)</td> <td>DATE: (YYYY/MM/DD)</td> <td>TIME:</td> <td colspan="2">RECEIVED BY: (Signature/Print)</td> <td colspan="2">DATE: (YYYY/MM/DD)</td> <td colspan="2">TIME:</td> <td colspan="2" rowspan="2">         # JAI ANI SUBI           27-May-15 09:00          Hina Siddiqui            B599159       </td> </tr> <tr> <td colspan="2">Michael Suslyk</td> <td>26-May-15</td> <td>12:00</td> <td colspan="2">[Signature]</td> <td colspan="2">2015/05/27</td> <td colspan="2">09:40</td> </tr> </table>				REGULATION 153 (2011)		OTHER REGULATIONS		<input type="checkbox"/> Table 1 <input type="checkbox"/> Table 2 <input type="checkbox"/> Table 3 <input type="checkbox"/> Table _____	<input type="checkbox"/> Res/Park <input type="checkbox"/> Ind/Comm <input type="checkbox"/> Agri/Other	<input type="checkbox"/> Med/Fine <input type="checkbox"/> Coarse  <input type="checkbox"/> CCME <input type="checkbox"/> MISA <input type="checkbox"/> PWQO <input type="checkbox"/> Other (Specify): _____ <input type="checkbox"/> REG 558 (MINIMUM 3 DAY TAT REQUIRED)	<input type="checkbox"/> Sanitary Sewer Bylaw <input type="checkbox"/> Storm Sewer Bylaw Municipality: _____	FOR RSC (PLEASE CIRCLE) Yes / <input checked="" type="checkbox"/> No								Include Criteria on Certificate of Analysis (Y/N)? 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## **Appendix F – Slope Stability Analyses**



# F1 - CRIB ON NORTH SIDE STATIC

CROW RIVER BRIDGE  
(Nort Road, District of Kenora)

Agreement No. 6014-E-0017  
Assignment No. 5  
GWP 6322-11-00

exp

exp Services Inc.

GEOCRE No. 52P-03

Project No. ADM-00223648-D0

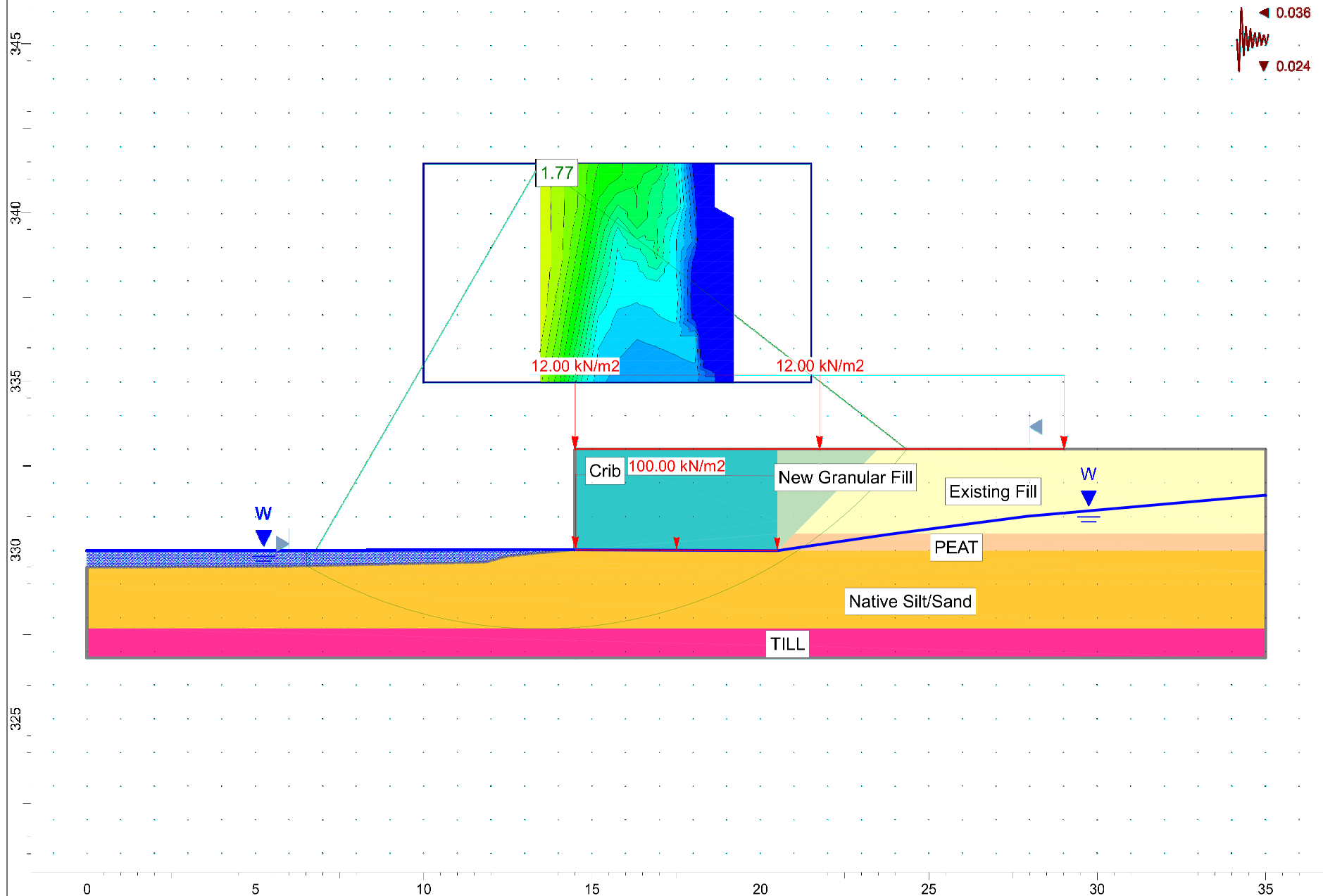
Date: August 27, 2015

Scale : AS SHOWN

Drawn By: RM

Checked By: AM

Checked By: DG



## F2 - CRIB ON NORTH SIDE SEISMIC

**CROW RIVER BRIDGE**  
(Nort Road, District of Kenora)

Agreement No. 6014-E-0017  
Assignment No. 5  
GWP 6322-11-00



**exp Services Inc.**

GEOCRE No. 52P-03

Project No. ADM-00223648-D0

Date: August 27, 2015

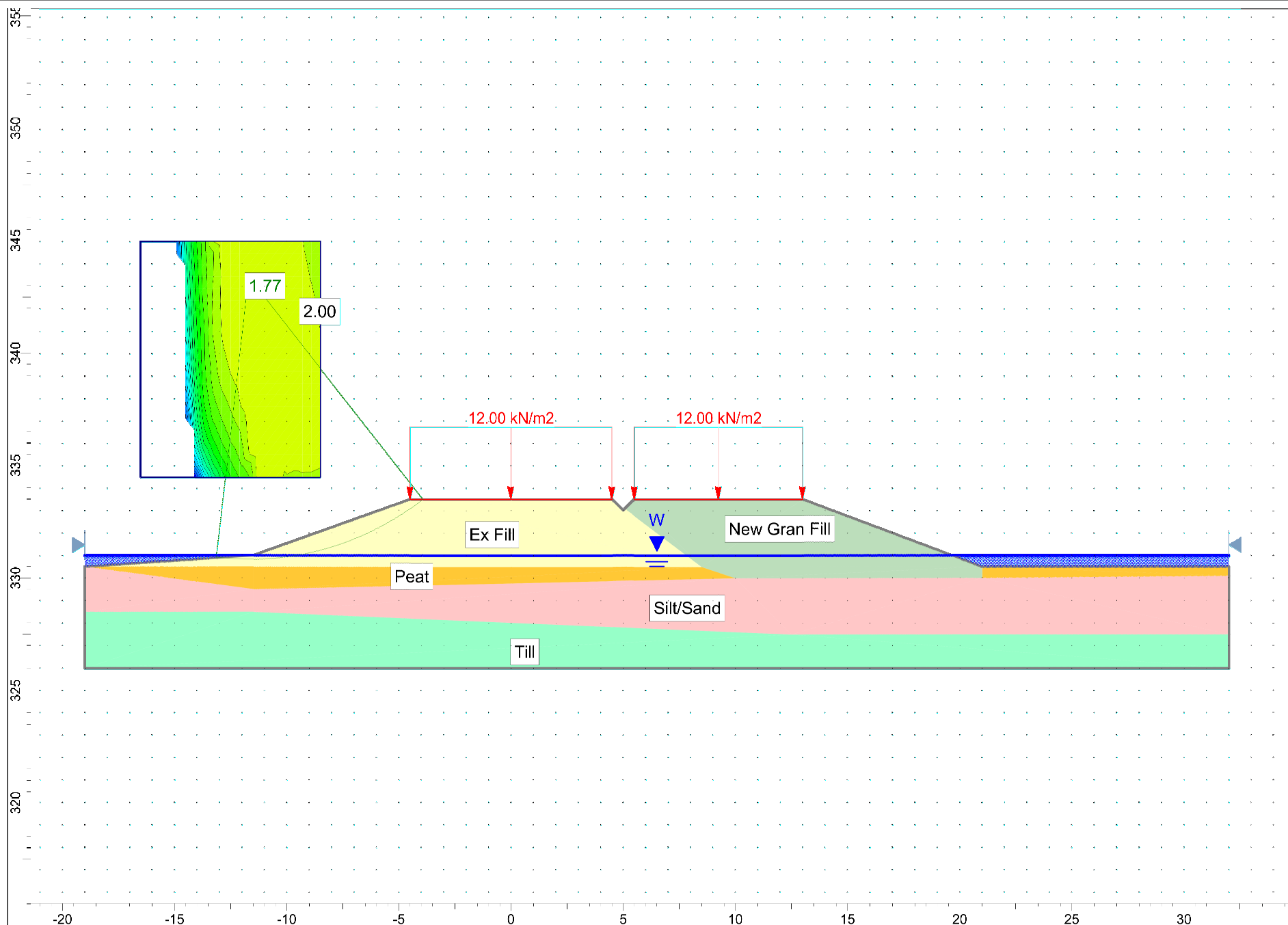
Scale : AS SHOWN

Drawn By: RM

Checked By: AM

Checked By: DG





## F3 - EXISTING NORTH SIDE EMBANKMENT STATIC

CROW RIVER BRIDGE  
(Nort Road, District of Kenora)

Agreement No. 6014-E-0017  
Assignment No. 5  
GWP 6322-11-00

exp

exp Services Inc.

GEOCRE No. 52P-03

Project No. ADM-00223648-D0

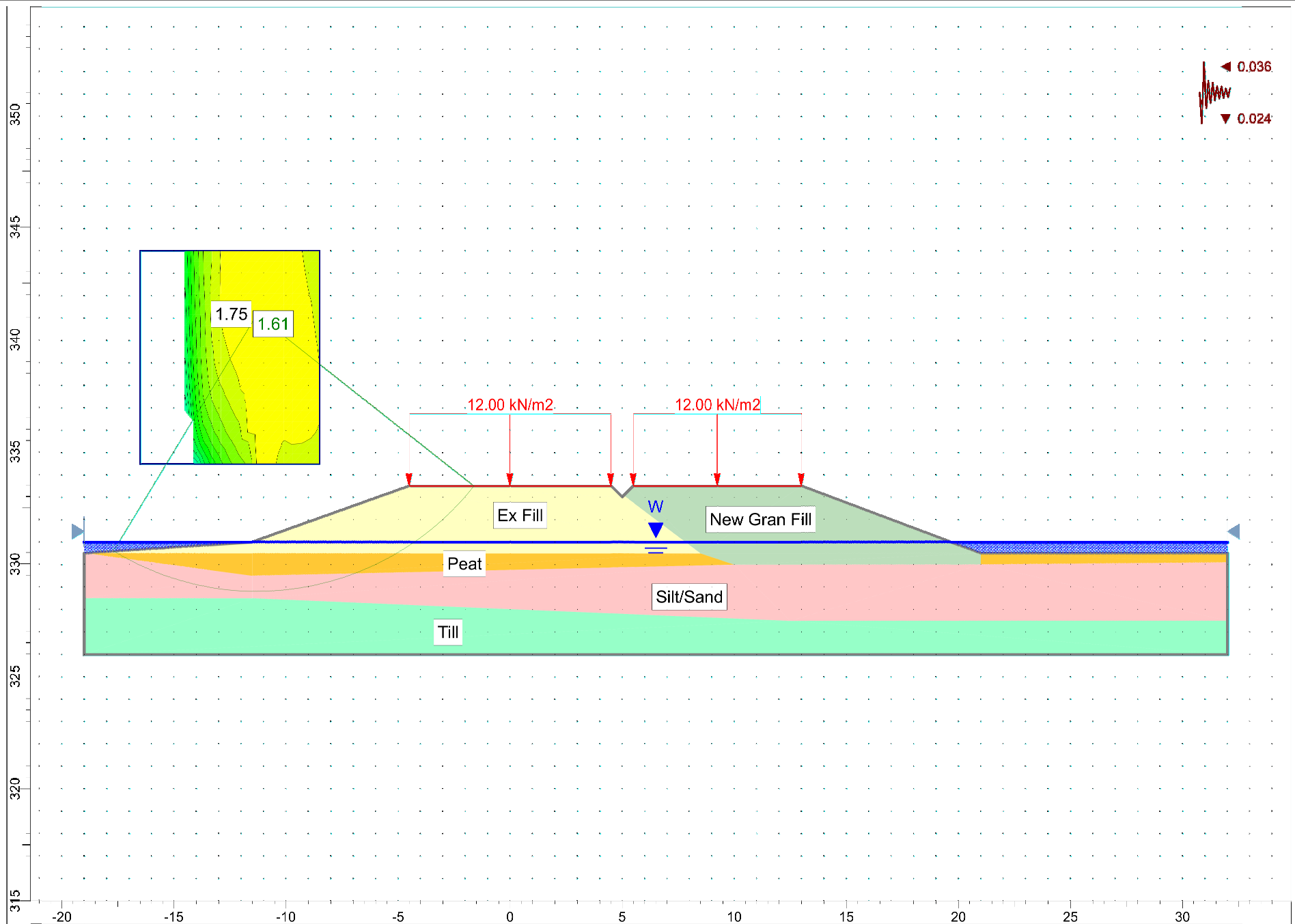
Date: August 27, 2015

Scale : AS SHOWN

Drawn By: RM

Checked By: AM

Checked By: DG



## F4 - EXISTING NORTH SIDE EMBANKMENT SEISMIC

CROW RIVER BRIDGE  
(Nort Road, District of Kenora)

Agreement No. 6014-E-0017  
Assignment No. 5  
GWP 6322-11-00

exp.

exp Services Inc.

GEOCRE No. 52P-03

Project No. ADM-00223648-D0

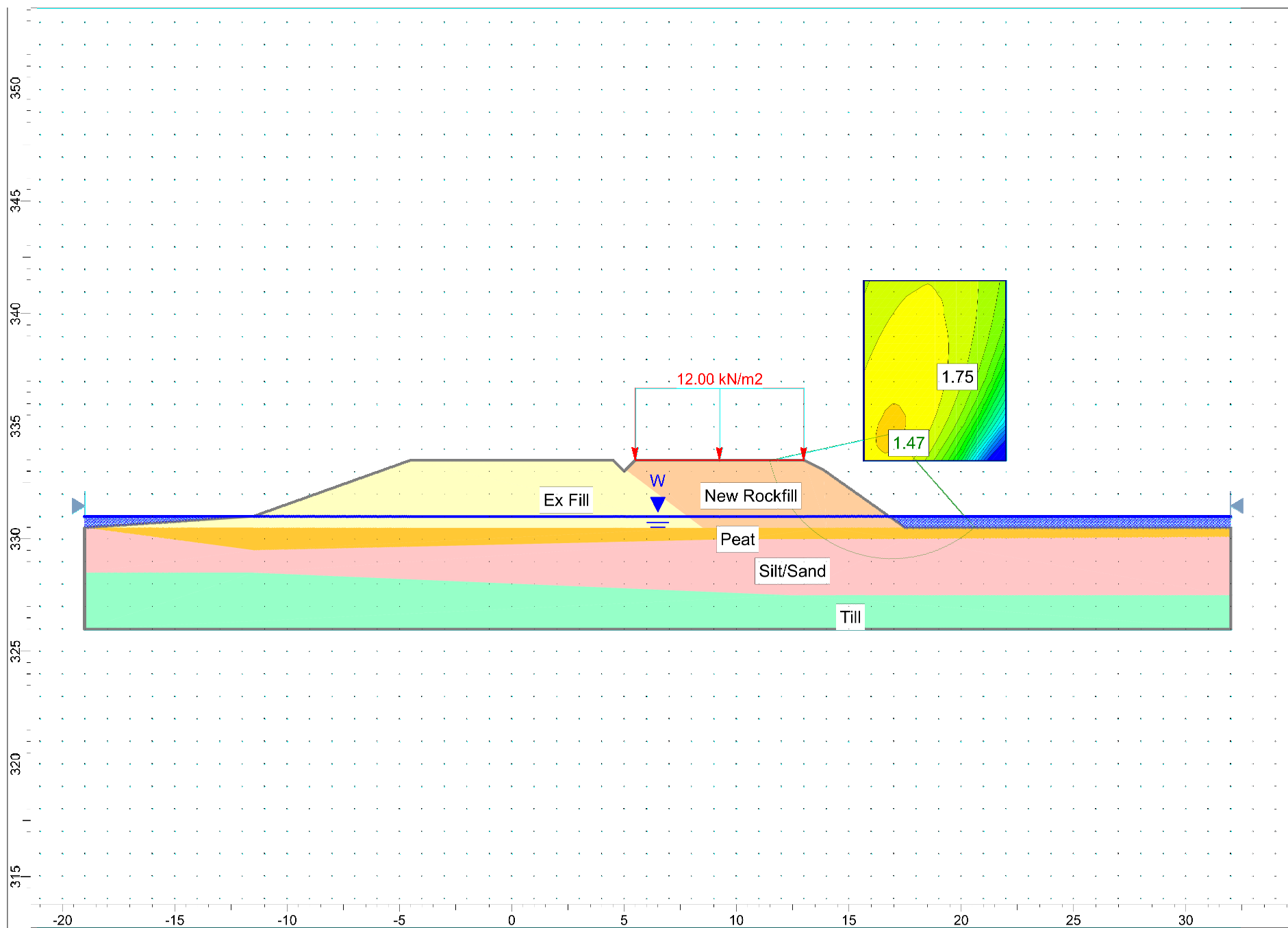
Date: August 27, 2015

Scale : AS SHOWN

Drawn By: RM

Checked By: AM

Checked By: DG



**F5 - TEMPORARY EMBANKMENT - NORTH SIDE**  
**ROCK FILL AT 1.5:1 SLOPE**  
**STATIC**

**CROW RIVER BRIDGE**  
 (Nort Road, District of Kenora)

Agreement No. 6014-E-0017  
 Assignment No. 5  
 GWP 6322-11-00



**exp Services Inc.**

GEOCRE No. 52P-03

Project No. ADM-00223648-D0

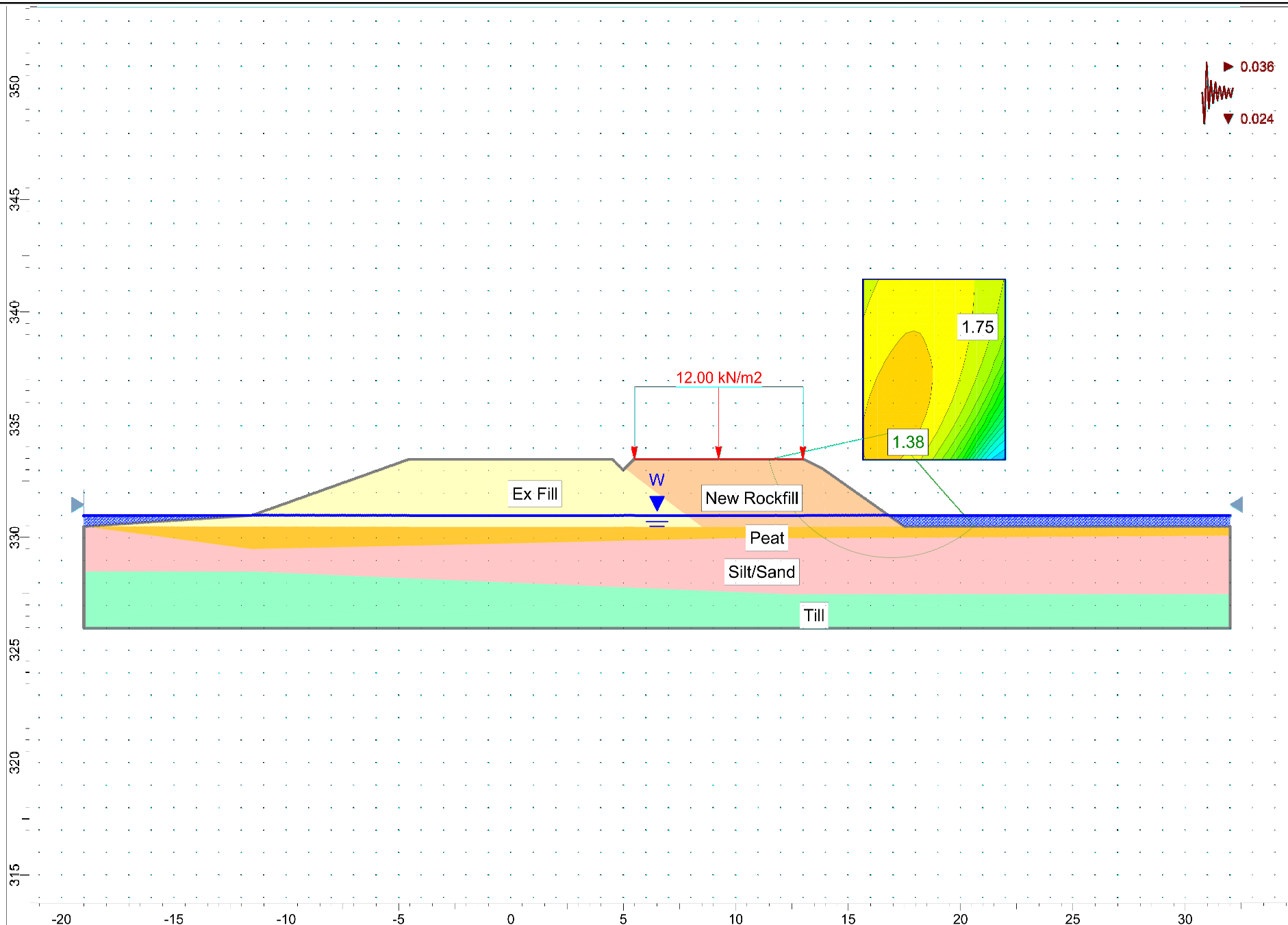
Date: August 27, 2015

Scale : AS SHOWN

Drawn By: RM

Checked By: AM

Checked By: DG



**F6 - TEMPORARY EMBANKMENT - NORTH SIDE  
ROCK FILL AT 1.5:1 SLOPE  
SEISMIC**

**CROW RIVER BRIDGE**  
(Nort Road, District of Kenora)

Agreement No. 6014-E-0017  
Assignment No. 5  
GWP 6322-11-00

**exp**

**exp Services Inc.**

GEOCRE No. 52P-03

Project No. ADM-00223648-D0

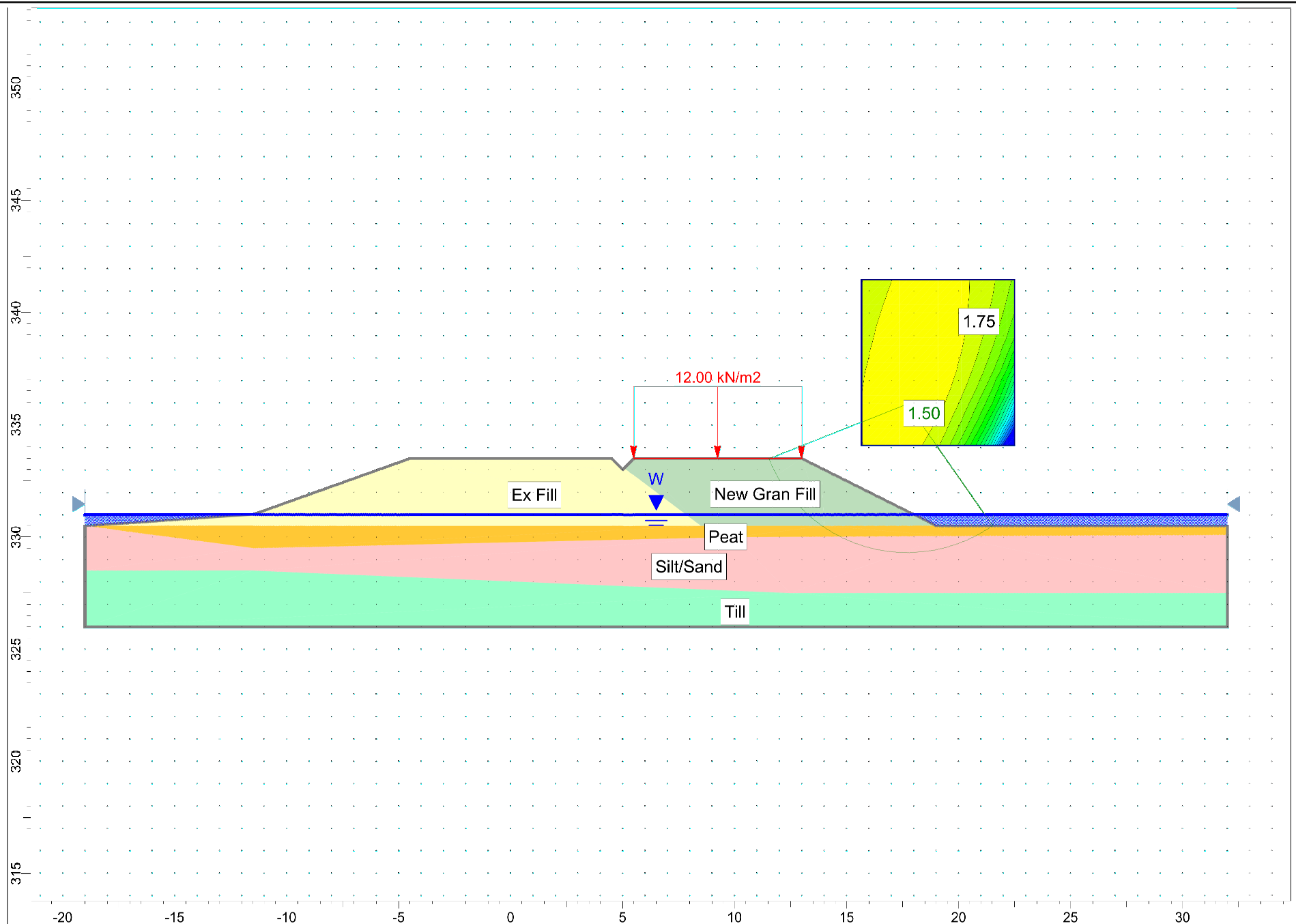
Date: August 27, 2015

Scale : AS SHOWN

Drawn By: RM

Checked By: AM

Checked By: DG



**F7 - TEMPORARY EMBANKMENT - NORTH SIDE  
GRANULAR "B" AT 2:1 SLOPE  
STATIC**

**CROW RIVER BRIDGE**  
(Nort Road, District of Kenora)

Agreement No. 6014-E-0017  
Assignment No. 5  
GWP 6322-11-00

**exp.**

**exp Services Inc.**

GEOCRE No. 52P-03

Project No. ADM-00223648-D0

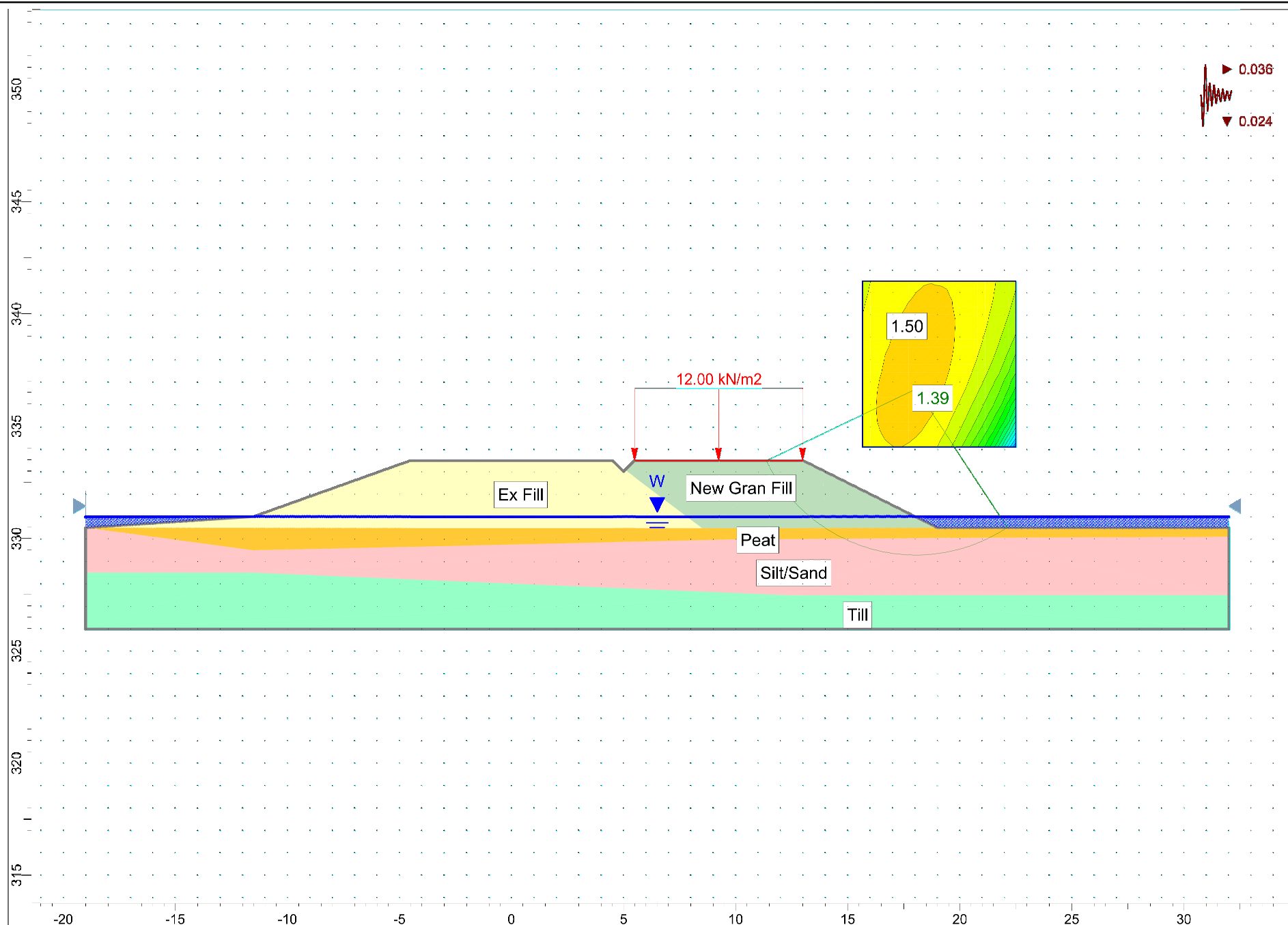
Date: August 27, 2015

Scale : AS SHOWN

Drawn By: RM

Checked By: AM

Checked By: DG



**F8 - TEMPORARY EMBANKMENT - NORTH SIDE  
GRANULAR "B" AT 2:1 SLOPE  
SEISMIC**

**CROW RIVER BRIDGE**  
(Nort Road, District of Kenora)

Agreement No. 6014-E-0017  
Assignment No. 5  
GWP 6322-11-00

**exp**

**exp Services Inc.**

GEOCRES No. 52P-03

Project No. ADM-00223648-D0

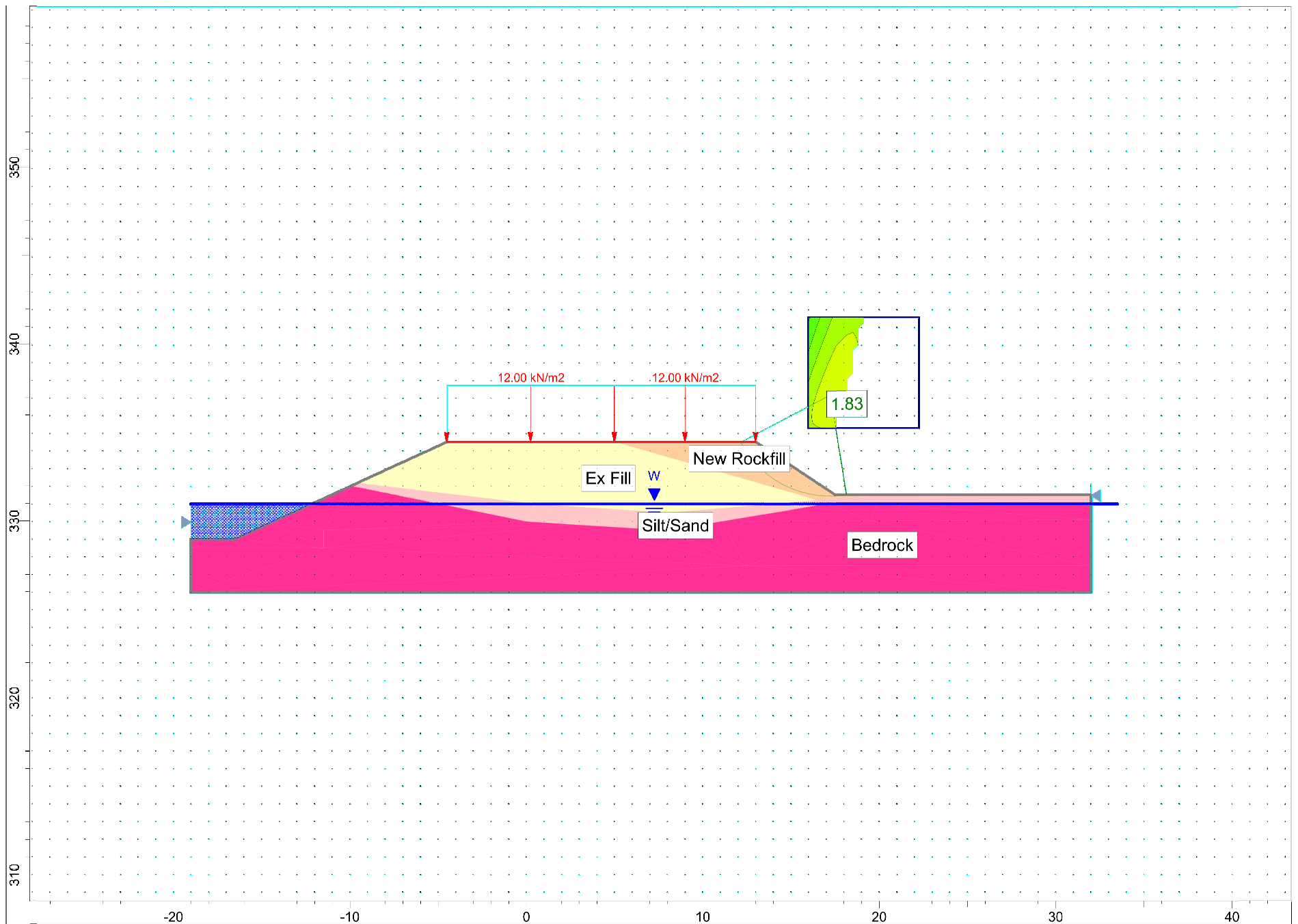
Date: August 27, 2015

Scale : AS SHOWN

Drawn By: RM

Checked By: AM

Checked By: DG



**F9 - TEMPORARY EMBANKMENT - SOUTH SIDE**  
**ROCK FILL AT 1.5:1 SLOPE**  
**STATIC**

**CROW RIVER BRIDGE**  
 (Nort Road, District of Kenora)

Agreement No. 6014-E-0017  
 Assignment No. 5  
 GWP 6322-11-00



**exp Services Inc.**

GEOCRE No. 52P-03

Project No. ADM-00223648-D0

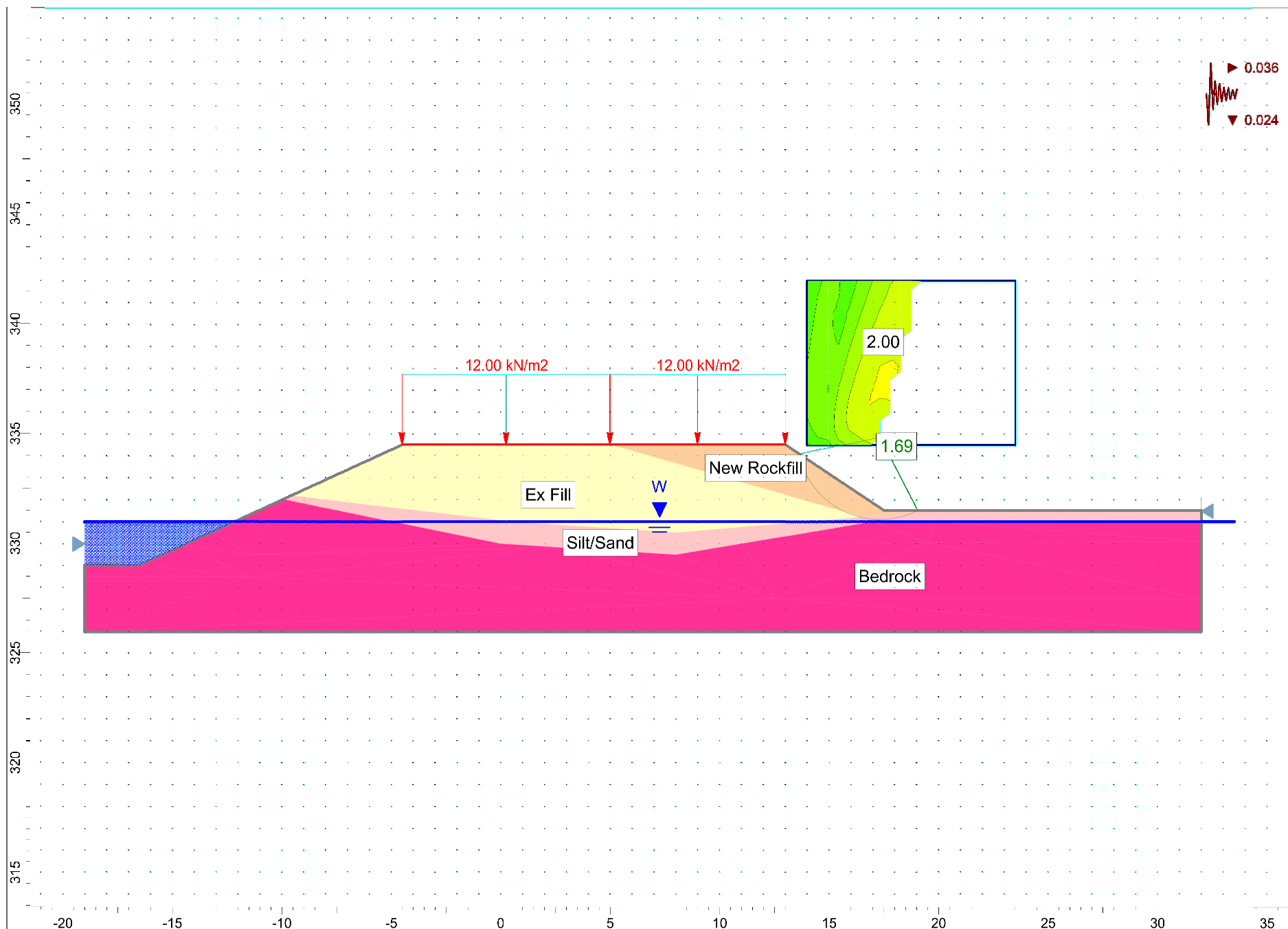
Date: August 27, 2015

Scale : AS SHOWN

Drawn By: RM

Checked By: AM

Checked By: DG



# F10 - TEMPORARY EMBANKMENT - SOUTH SIDE ROCK FILL AT 1.5:1 SLOPE SEISMIC

CROW RIVER BRIDGE  
(Nort Road, District of Kenora)

Agreement No. 6014-E-0017  
Assignment No. 5  
GWP 6322-11-00

exp

exp Services Inc.

GEOCRE No. 52P-03

Project No. ADM-00223648-D0

Date: August 27, 2015

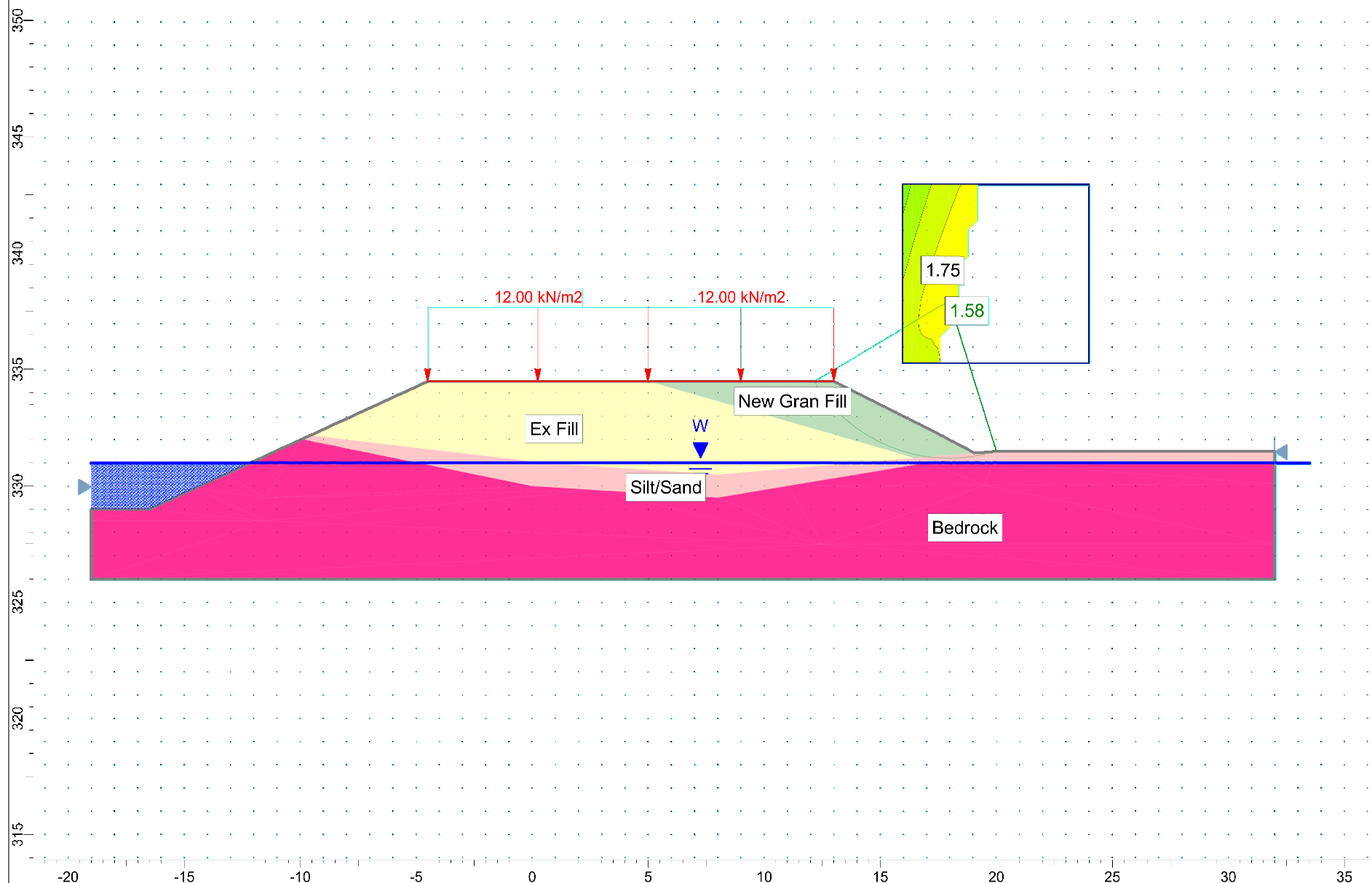
Scale : AS SHOWN

Drawn By: RM

Checked By: AM

Checked By: DG





**F11 - TEMPORARY EMBANKMENT - SOUTH SIDE  
GRANULAR "B" AT 2:1 SLOPE  
STATIC**

**CROW RIVER BRIDGE**  
(Nort Road, District of Kenora)

Agreement No. 6014-E-0017  
Assignment No. 5  
GWP 6322-11-00

**exp**

**exp Services Inc.**

GEOCRES No. 52P-03

Project No. ADM-00223648-D0

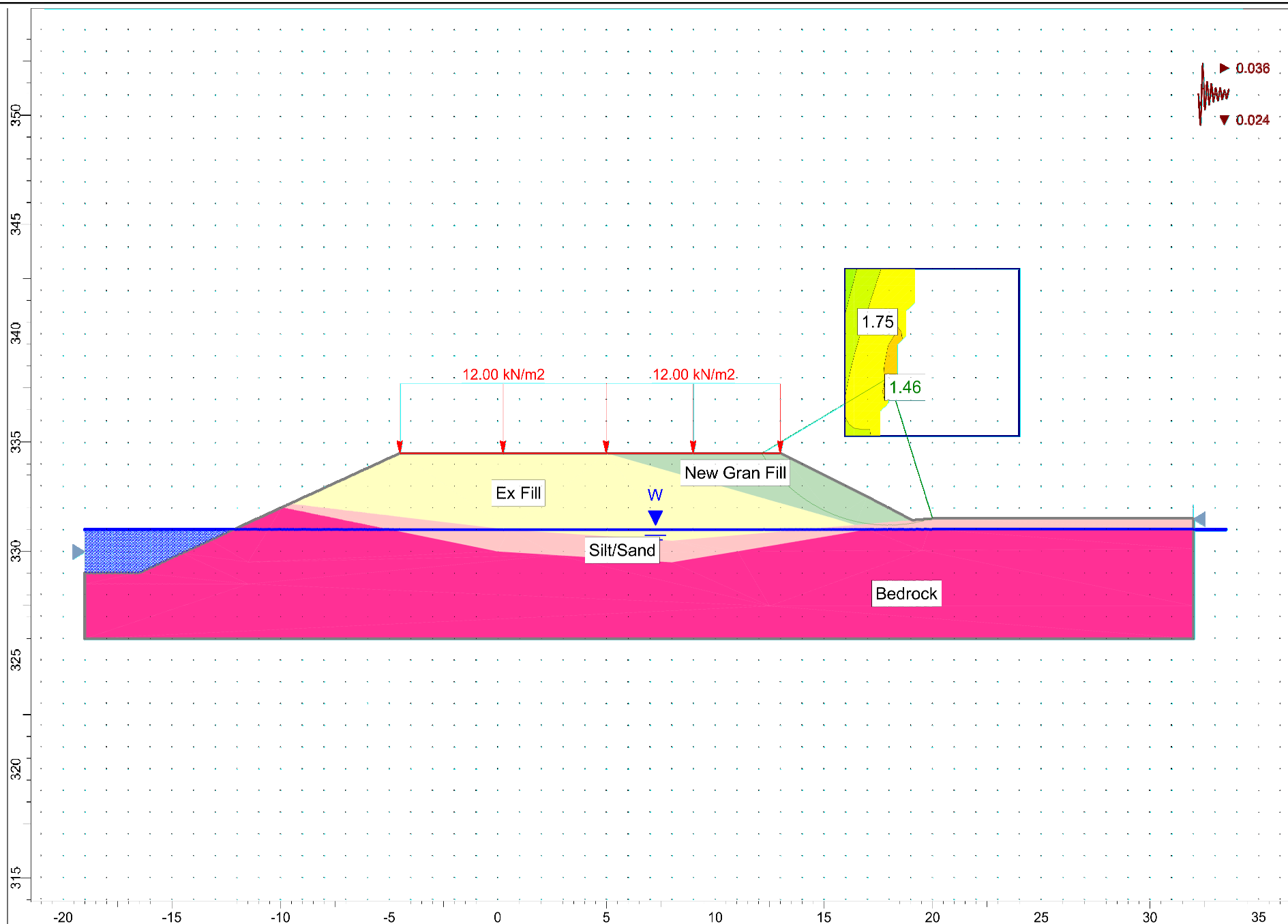
Date: August 27, 2015

Scale : AS SHOWN

Drawn By: RM

Checked By: AM

Checked By: DG



**F12 - TEMPORARY EMBANKMENT - SOUTH SIDE  
GRANULAR "B" AT 2:1 SLOPE  
SEISMIC**

**CROW RIVER BRIDGE**  
(Nort Road, District of Kenora)

Agreement No. 6014-E-0017  
Assignment No. 5  
GWP 6322-11-00

**exp**

**exp Services Inc.**

GEOCRE No. 52P-03

Project No. ADM-00223648-D0

Date: August 27, 2015

Scale : AS SHOWN

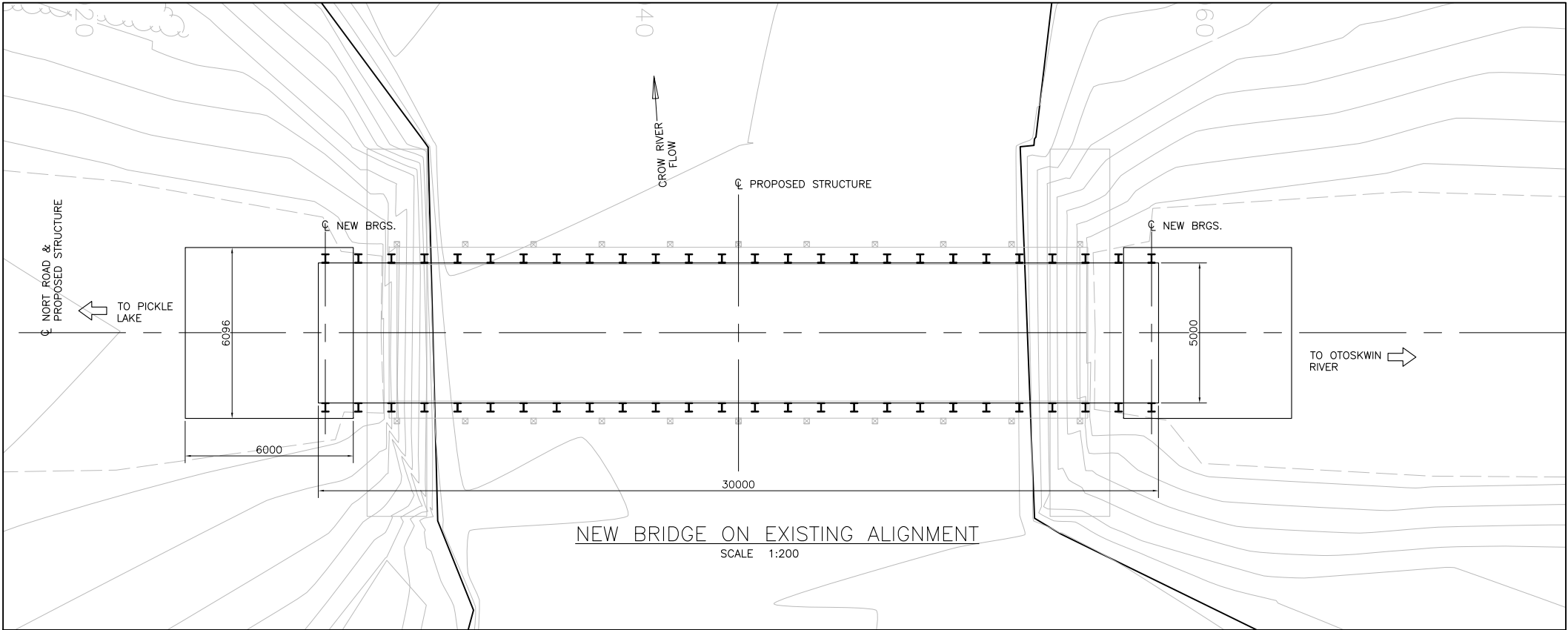
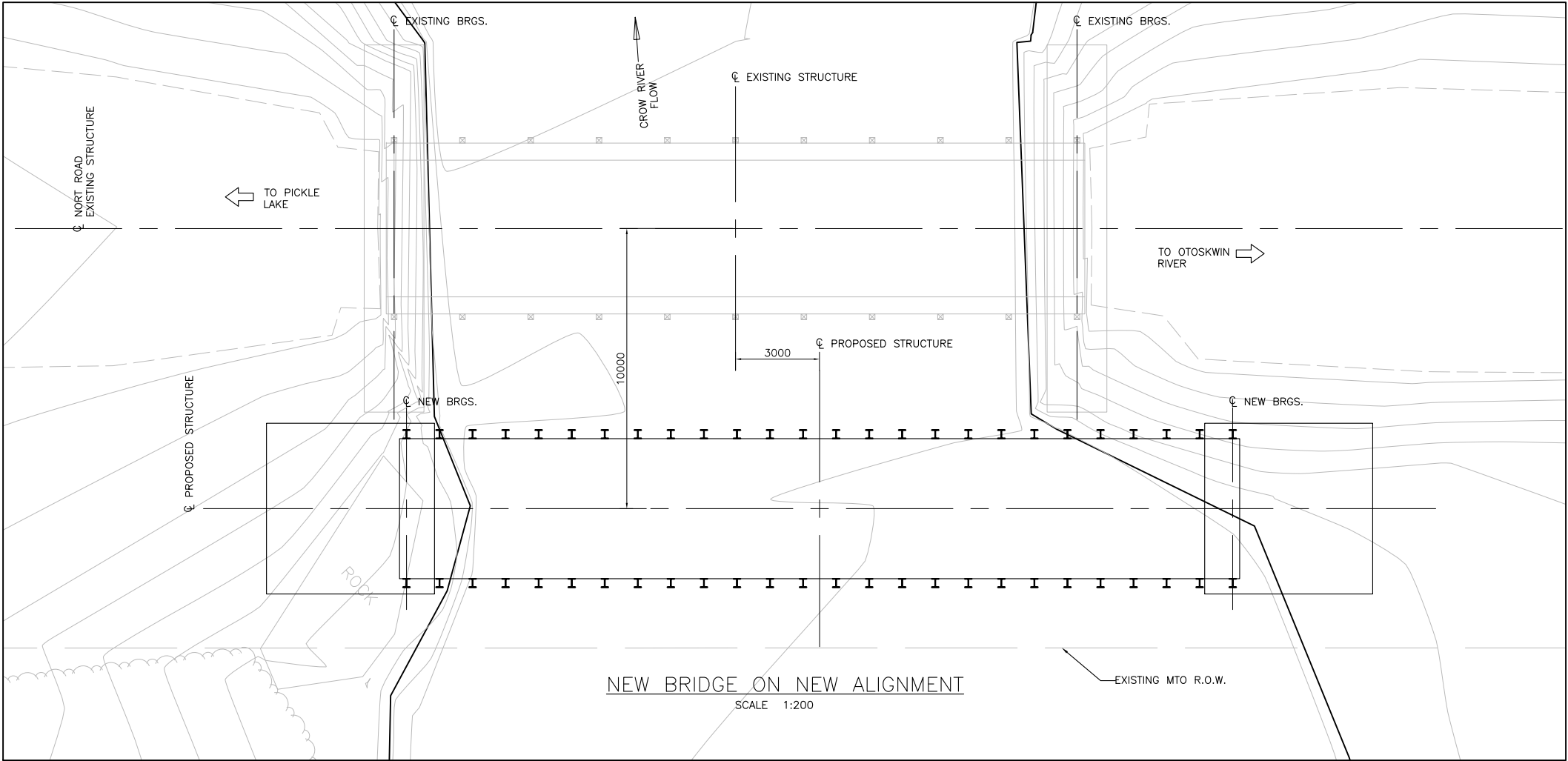
Drawn By: RM

Checked By: AM

Checked By: DG

## **Appendix G – Bridge Concept Plan**

DRAWING NAME:  
CREATED:  
MODIFIED:



METRIC  
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN

DIST  
CONT No  
WP No

CROW RV. BR. @ JULY FALLS  
STRUCTURE REPLACEMENT  
NORT ROAD  
PROPOSED ALIGNMENTS



SHEET

DRAWING NOT TO BE SCALED  
100mm ON ORIGINAL DRAWING

REVISIONS		DESCRIPTION			
DESIGN	CHK	CODE	CHBDC-00	CL	625-ONT
DRAWN	NST	CHK	SITE: 41S-095		DWG