Submitted To AECOM Canada Ltd.
189 Wyld Street Suite 103, North Bay, Ontario P1B 1Z2
On Behalf of the Ontario Ministry of Transportation

Highway 654 Rehabilitation
Bridge Rehabilitation – Site No. 44-018
South River Bridge
GWP 5090-05-00

Highway 654
From Highway 534 Easterly 23.1 km to Highway 11

FINAL FOUNDATION INVESTIGATION AND DESIGN REPORT

Date: May 31, 2013
Ref. Nº: 12/03/12027-F3

Geocres No. 31L-171

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Bridge Rehabilitation – Site No. 44-018
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Final Foundation Investigation and Design Report

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Property and Confidentiality

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REVISION AND PUBLICATION REGISTER		
Revision N°	**Date**	**Modification And/Or Publication Details**
00	2013-01-31	DRAFT Report Issued
01	2013-05-31	Final FIDR Report Issued

REPORT DISTRIBUTION	
2 hard copy	AECOM
5 hard copy, 1 electronic copy	MTO Project Manager
1 hard copy, 1 electronic copy	MTO Pavements and Foundations Sections
1 hard copy	File

1 INTRODUCTION

LVM | MERLEX has been retained by AECOM Canada Ltd., on behalf of the Ministry of Transportation of Ontario (MTO), to carry out a foundation investigation to supply subsurface data for the design of a protection system to be implemented at the South River Bridge during the proposed rehabilitation. The bridge is located on Highway 654, some 1 km north of Highway 534, in the Township of Nipissing. The existing bridge is a three span concrete girder bridge some 55.3 m in length.

The foundation investigation location was specified by the MTO. The terms of reference for the scope of work are outlined in LVM | MERLEX's Proposal for additional foundation investigation 12/03/12027, dated August 23, 2012. The purpose of this investigation was to determine the subsurface conditions in the area of the bridge approaches in order to provide design recommendations for a protection system to be implemented during rehabilitation activities. LVM | MERLEX investigated the foundation area by the drilling of boreholes, carrying out in-situ tests, and performing laboratory testing on select samples.

2 SITE DESCRIPTION

The South River Bridge is located on Highway 654, between Stations 11+023 to 11+078, Township of Nipissing (Site No. 44-018). The topography at the site is generally of low relief. The existing highway embankment currently supports two undivided lanes of highway, running in a north south direction. South River flows from east to west at the bridge location. A visual review of the highway at the north and south approaches indicates that, in general, the approaches are in fair condition.

The existing 55.3 m three span concrete bridge was constructed in 1972 and rehabilitated in 1988 on the existing highway alignment. It is understood that the structure is in good condition.

Infrastructure at the bridge location consists of overhead wires on the left (west) side of the highway.

2.1 SITE PHYSIOGRAPHY AND SURFICIAL GEOLOGY

This project is located in the Geomorphic Sub-province known as the Muskoka Ridges and Pockets. The topography along this section of Highway 654 is generally slightly rolling. There are exposed bedrock ridges. At many locations, significant layers of earth overlay the bedrock. Organic terrain was also observed. Within the specific project area overburden consists primarily of silt and clay containing varying amounts of sand and gravel.

Bedrock in the area, as indicated on OGS Map 2506, is of the Late Precambrian Era. At the location of this culvert foundation investigation, the bedrock comprises of granitic to syenitic rocks and derived gneisses.

3 INVESTIGATION PROCEDURES

The field work for this investigation was carried out during the period of September 26th to 27th, during which four (4) sampled boreholes and DCPTs were advanced. Two boreholes were advanced at each end of the bridge: one through the existing approach slab and the second a short distance beyond the end of the approach slab.

The field investigation was carried out using a truck mounted CME drilling rig equipped with hollow stem augers, standard augers, and routine geotechnical sampling equipment. Prior to mobilizing the auger drill to the site, the concrete approach slabs were core drilled, where required, with an electric core drill. Soil samples were obtained at the borehole locations at regular intervals of depth using the standard 50 mm O.D. split spoon sampler advanced in accordance with the Standard Penetration Test (SPT) procedures (ASTM D-1586). The SPT method involves advancing a 50 mm O.D. split spoon sampler with the force of a 63.5 kg hammer freely dropping 760 mm mounted in a trip (automatic) hammer. The number of blows per 300 mm penetration was recorded as the “N” value. At the boreholes, a Dynamic Cone Penetration Test (DCPT) was carried out to give a continuous plot of the soil resistance with depth. When cohesive deposits were encountered, the in-situ strength was measured using an “N” size field vane, vane collar, and calibrated torque meter. All samples taken during this investigation were stored in labeled airtight containers for transport to our North Bay laboratory for visual examination and select laboratory testing.

Groundwater conditions in the open boreholes were observed during the advancement of and immediately following, completion of the individual boreholes. All open boreholes were backfilled upon completion with compacted auger cuttings in the general order they were removed and, where necessary, bentonite pellet backfill was added to the boreholes to bring them up to grade. At the borehole(s) through the embankment, the upper portion of the hole, where necessary, was backfilled with an asphalt cold patch to seal the existing asphalt surface.

The field work for this investigation was under the full time direction of a senior member of our engineering staff, who was responsible for locating the boreholes, clearing the borehole locations of underground services, in-situ sampling and testing operations, logging of the boreholes, labeling and preparation of samples for transport to our North Bay laboratory, plus overall drill supervision. All samples received a visual confirmatory inspection in our laboratory. Laboratory testing of select samples included routine testing for natural moisture content determination and particle size analysis, as well as specific gravity testing. The results of the laboratory testing are presented on the individual Record of Borehole Sheets (Appendix 2), with a summary of results presented on the laboratory sheets in Appendix C (Figures Nos. L-1 to L-7).

The location of the individual boreholes were determined in the field using highway chainage (established by others) and offset relative to highway centerline. The MTO co-ordinates, northing and easting, were then established for the boring locations. Elevations contained in this report are referenced to a geodetic datum.

4 SUBSURFACE CONDITIONS

Details of the subsurface conditions revealed by the investigation program are presented on the enclosed Record of Borehole Logs (Appendix 2) and on Figure No. 2 (Appendix 3). Please note that stratigraphic delineation presented on the borehole logs and soil strata plot are the results of non-continuous sampling, response to drilling progress, the results of SPT and Dynamic Cone Penetration Test (DCPT) plus field observations. Typically such boundaries represent transitions from one zone to another and are not an exact demarcation of specific geological unit. Additional consideration should be given to the fact that subsurface conditions may vary markedly between adjacent boreholes and beyond any specific boring location, and are shown on the drawings for illustration purposes only.

4.1 SOUTH RIVER BRIDGE

A plan and profile illustrating the borehole locations and stratigraphic sequences is shown on Drawing No. 2, Appendix 3. During the course of the exploration program, four (4) sampled boreholes were put down at this site, as follows;

- Borehole No. 1 was advanced to the south of the south approach slab right of centerline.
- Borehole No. 2 was advanced behind the south abutment right of centerline.
- Borehole No. 3 was advanced behind the north abutment to the left of centerline, and
- Borehole No. 4 was advanced to the north of the north approach slab, left of centerline.

At the time of the subsurface investigation, the ground surface elevations at Boreholes Nos. 1 to 4 were recorded at 206.4, 206.3, 205.3, and 205.1 m, respectively.

4.1.1 Pavement Structure

At surface at Borehole Nos. 1 and 2, a pavement structure consisting of 75 mm of asphalt and 100 mm crushed gravel underlain by a second layer of asphalt some 100 mm thick underlain by a layer of crushed gravel some 400 to 450 mm thick was penetrated. At Borehole Nos. 2 and 3, a pavement structure consisting of 100 to 125 mm of asphalt overlying a concrete slab some 250 to 275 mm thick was encountered. A layer of crushed gravel some 125 mm thick was encountered underlying the concrete approach slab at Borehole No. 2.

4.1.2 Embankment Fill

Underlying the pavement structure at Borehole Nos. 1 to 4, a deposit of fill consisting of brown sand trace silt, trace gravel was penetrated. The natural moisture content measured on samples of this deposit was in the order of 2 to 17%. Gradation analyses were carried out on four (4) samples of this deposit, the results of which indicated 0 to 6% gravel size particles, 90 to 96% sand size particles, and 2 to 6% silt and clay size particles (Figure No. L-1, Appendix 3). Based on SPT 'N' values of 7 to 42 blows per 300 mm penetration, the compactness of this deposit was described as loose to dense, generally compact. This deposit was encountered to depths of 2.1, 4.3, 5.5, and 5.5 m below grade at Borehole Nos. 1 to 4, respectively (elevations 204.3, 202.0, 199.8, and 199.6 m, respectively).

4.1.3 Sand and Silt

Underlying the embankment fill at Borehole Nos. 1, 2, and 3, a deposit of dark brown to grey sand and silt to sandy silt, trace to with organics was penetrated. The natural moisture content of measured on samples of this deposit was in the order of 19 to 104%. The elevated moisture content in the samples from this deposit is due to the organic content. Gradation analyses were carried out on two (2) sample of this deposit, the results of which indicated 0% gravel size particles, 33 to 55% sand size particles, 40 to 58% silt size particles, and 5 to 9% clay size particles (Figure No. L-2, Appendix 3). Based on SPT 'N' values of 4 to 6 blows per 300 mm penetration, the compactness of this deposit was described as loose. This deposit was encountered to depths of 4.9, 5.5, and 6.1 m below grade at Borehole Nos. 1 to 3, respectively (elevations 201.5, 200.8, and 199.2 m, respectively).

4.1.4 Sand

Underlying the sand and silt at Borehole No. 1, a deposit of grey sand trace silt was penetrated. The natural moisture content measured on a sample of this deposit was in the order of 11%. This deposit was encountered to a depth of 5.5 m below grade (elevation 200.9 m).

4.1.5 Silt

Underlying the sand at Borehole No. 1, and underlying the sand and silt at Borehole Nos. 2 and 3 and underlying the fill at Borehole No. 4, a deposit of grey silt some sand trace clay was penetrated. The natural moisture content measured on samples of this deposit was in the order of 25 to 31%. A gradation analysis was carried out on one (1) sample of this deposit, the results of which indicated 0% gravel size particles, 16% sand size particles, 78% silt size particles, and 6% clay size particles (Figure No. L-3, Appendix 3). Based on STP 'N' values of 0 (static weight of hammer) to 17 blows per 300 mm penetration, this deposit was described as very loose to compact, generally very loose. This deposit was encountered to a depth of 6.7 m below grade at Borehole No. 4 (elevation 198.4 m). Sampling was terminated in this deposit at depths of 8.1, 9.6, and 9.6 m below grade at Borehole Nos. 1 to 3, respectively (elevations 198.3, 196.7, and 195.7 m, respectively).

4.1.6 Sand

Underlying the silt at Borehole No. 4 a deposit of grey sand some silt trace gravel was penetrated. The natural moisture content measured on samples of this deposit was in the order of 19%. Based on STP 'N' values of 12 blows per 300 mm penetration, this deposit was described as compact. Sampling was terminated in this deposit at a depth of 8.1 m below grade (elevation 197.0 m).

4.1.7 DCPT

Dynamic Cone Penetration Tests (DCPT) were advanced at each borehole location. DCPT refusal was encountered at depths of 21.6, 20.4, 10.3, and 11.8 m below grade, respectively (elevations 184.8, 185.9, 194.9, and 193.3 m, respectively).

4.1.8 Previous Investigations

Based on a previous foundation investigation, Geocres 31L-9, carried out at this location in 1971, by the Department of Transportation and Communications, the native subsurface materials consisted of silty sand overlying silty clay at the south approach, and silty sand generally overlying sand and gravel at depth at the north approach. Refusal was encountered between elevations of some 184.4 to 191.4 m at the south approach, and between elevations 192.6 to 196.8 at the north approach (see Enclosure No. 6, Appendix 3). Based on Contract No. 88-233, the bridge was founded on deep foundations at the south abutment, south pier, and north abutment, and on a shallow foundation at the north pier (see Enclosure No. 7, Appendix 3).

4.2 GROUNDWATER DATA

Measurements of the groundwater table and cave-in levels were undertaken, where possible, in the open boreholes during the advance of the individual borings and upon completion. These levels are recorded on the individual Record of Borehole Log Sheets (Appendix B). The groundwater levels in Borehole Nos. 1 to 4 were measured at elevations between 198.3 to 200.1 m, upon completion. The water level in the South River was measured at elevation 197.8 m in July 2012.

The groundwater and river water levels will fluctuate seasonally/yearly.

5 DISCUSSION AND RECOMMENDATIONS

5.1 GENERAL

A foundation investigation was carried out for the design of a protection system for the proposed bridge rehabilitation and conversion to semi integral abutments, at the South River Bridge. The bridge is located between Stations 11+023 to 11+078, in the Township of Nipissing, and is identified as Site No. 44-018. The existing bridge is a 55.3 m three span, concrete I-girder structure with a reinforced concrete deck.

The existing highway, at the bridge location, supports two undivided lanes of traffic, running in a north-south direction. A visual review of the highway embankment at the north and south approaches indicates that, in general, the bridge approaches have performed well. Based on data from this foundation investigation, the embankment supporting the existing pavement structure at this site has been constructed with a granular fill overlying native sands and silts.

Based on Contract No. 88-233, the South River Bridge abutments and piers are founded on either shallow foundations supported on bedrock or on end bearing piles extending to bedrock (see Appendix 4). The conversion to semi-integral abutments will require the removal of the ballast walls. It is anticipated that, to carry out the bridge rehabilitation and convert the South River Bridge to a semi-integral abutment, an excavation some 1 m deep will be required behind the existing abutments. As such, a protection system will be required at the north and south abutments of the bridge to support an excavation some 1 m deep behind the abutments and maintain an active lane of traffic. Based on data from this foundation investigation, the fill behind the abutments supporting the approach slabs and pavement structure generally consist of granular fill.

5.2 EXCAVATION AND DEWATERING

The fill below the pavement structure and approach slabs is considered a Type 3 soil in accordance with the Occupational Health and Safety Act and Regulations for Construction Projects. As such, to remain stable above the water table, side walls of temporary open excavations would have to be cut back to an angle of 1H:1V. A 1 m deep excavation (i.e. to elevations 205.3 to 204.3 m) will be required to the rear of the abutments to allow the rehabilitation work to be carried out on the ballast wall. The existing width of the approach is insufficient to allow the construction of a 1H:1V slope parallel to the active traffic lane. As such, a vertical excavation adjacent to the active traffic lane will be required and a protection system, installed perpendicular to the abutments, will be needed to support the active traffic lane. Conceptual shoring locations are illustrated on Figure No. SK-4, Appendix 5.

Excavations must be maintained in a dewatered condition during excavation and foundation construction. The water level in the borehole was recorded at elevation 198.3 to 200.1 m. This level is below the anticipated depth of excavation (elevations 205.3 to 204.3 m), as such, it is not anticipated that the groundwater table will be encountered during the shallow excavations at the abutments. If a deeper excavation is required to be advanced below the prevailing groundwater table (estimated at elevation 200.1 m), then groundwater control in accordance with OPSS 517 will have to be carried out.

5.3 PROTECTION SYSTEM

The results of this investigation indicated that, underlying the pavement structure and approach slabs, a granular fill consisting of sands trace silt trace gravel was encountered, in a generally compact state of compactness, to native sands and silt at depths of 2.1 to 4.3 m below grade at the south approach (elevations 204.3 to 202.0 m) and a depth of 5.5 m below grade at the north approach (elevations 199.6 to 199.8 m).

The required depth of anticipated excavation, directly behind the abutments, will be relatively shallow, in the order of 1.0 m (elevations 204.3 at the north abutment and 205.3 m at the south abutment). In consideration of the anticipated soil conditions, the use of sheet piles of sufficiently robust cross section could be used for a protection system. In order to fix the sheet toe, the sheeting should be driven to a depth of a minimum of 0.5 m below the required depth of excavatin. This is in the granular fill deposit. Considering the limited depth of excavation and provided a sheet pile of sufficiently robust section is used, a whaler and raker may not be required if the top of the sheet pile wall is fixed to the existing approach slab. If fixing the sheet pile walls to the approach slab is not possible, a whaler with raker or a tieback system would have to be installed. If tiebacks are required, the resistance (R) for grouted anchors, located outside the active failure wedge, in cohesionless soils can be estimated from the following equation as supplied in the Canadian Foundation Manual (4^{th} Edition):

$R = \sigma z' \, As \, Ls \, \alpha g$ Where: $\sigma z'$ = effective vertical stress at the midpoint of the load carrying length

As = effective unit surface area of the anchor

Ls = effective embedment length of the anchor

αg = anchorage coefficient use 1.0 for granular backfill

Unless the pull-out resistance (capacity) of the anchor is proven with a load test program, the allowable anchor load (as suggested by the Canadian Foundation Engineering Manual, 4th Edition), is commonly obtained by dividing the computed capacity of the anchor by a factor of safety of 3. Alternatively, proprietary anchor systems can be used.

If excavation to a greater depth than the anticipated 1 m is required, then the shoring system would have to be advanced to a greater depth, dependant on the final depth of excavation below the top of pavement. Based on the results of this investigation, the embankment fill, and native materials do not contain obstructions. As obstruction were not encountered at the approach boreholes, sheet piles are also considered acceptable for use in deeper excavations.

Considering the cohesionless nature of the embankment fills (granular pavement structure over rock fill and granular fills) a rectangular apparent pressure distribution over the height of the cut would be appropriate for design of the temporary shoring. The width of the apparent rectangular pressure distribution, over the height of excavation, can be considered equal to 0.65*Ka*γ*H, where:

Ka = active earth pressure,

ɣ = unit weight, and

H = height of wall above the base of excavation.

The protection system can be designed using the lateral earth pressure parameters provided in section 5.4 Lateral Earth Pressures.

The temporary protection system should be designed and constructed to comply with OPSS 539. In consideration of the location of the protection system and traffic volume, a performance level 2 is considered appropriate.

5.4 LATERAL EARTH PRESSURES

Lateral earth pressures should be computed in accordance with the Canadian Highway Bridge Design Code (CHBDC). The design parameters for the fill and native materials are as follows:

PARAMETER	GRANULAR B TYPE I/ EXISTING FILL	NATIVE SAND AND SILT	NATIVE SILT	NATIVE SAND
Unit Weight (kN/m^3)	21.2	18.0	17.5	18.5
Angle of Internal Friction	31°	28°	27°	29°
Coefficient of Active Earth Pressure (Ka)	0.32	0.36	0.38	0.35
Coefficient of Passive Earth Pressure (Kp)	3.12	2.77	2.66	2.88
Coefficient of Earth Pressure at Rest (Ko)	0.48	0.53	0.55	0.52

For rigid structures, the “at-rest” condition (Ko) applies. For flexible structures the “active” condition (Ka) applies.

5.5 BACKFILL AND COMPACTION

The existing backfill at the abutments was generally in a compact condition. Prior to backfilling the excavation the existing subgrade should be proofrolled with a minimum of five overlapping passes of a hand operated vibratory compactor with a minimum weight of 400 kg (or a centrifugal force of 50 kN). Backfilling should be carried out in accordance with OPSS 902 and compaction should be carried out in accordance with OPSS 501.

5.6 CONSTRUCTION CONCERNS

Considering the relatively shallow depth of expected excavations and nature of the approach fill and native materials, no major construction concerns are anticipated if the works are carried out in general conformance to that discussed herein.

6 STATEMENT OF LIMITATIONS

The design recommendations given in this geotechnical report are applicable only to the project described in the text and only if constructed substantially in accordance with details of alignment and elevations stated in the report. Since all details of the design may not be known, in our analysis certain assumptions had to be made. The actual conditions may however, vary from those assumed, in which case changes and modifications may be required to our geotechnical recommendations. We recommend, therefore, that we be retained and provided the opportunity during the design stage to review the design drawings, site survey information, proposed elevations, etc. to verify that they are consistent with our recommendations or the assumptions made in our analysis. It is further recommended that we be retained to review the final design drawings and specifications relative to the geotechnical recommendations.

If, during construction, conditions in the field vary from those assumed at the design stage, an engineer from this office must be notified immediately.

Proper subgrade preparation, groundwater control, compaction, etc. are all critical aspects of the bearing capacity of native soils. It must be noted that different aspects of the geotechnical design are based on the assumption that LVM | MERLEX will be retained during site preparation and construction of the proposed works to ensure that both the geotechnical site characteristics and the construction operations/techniques are consistent with our recommendations. Should LVM | MERLEX not be involved during the full construction phase, our liability is strictly limited to the factual information contained herein only.

The comments in this report are intended solely for the guidance of the design engineer and address the geotechnical conditions only. The number of boreholes required to determine the localized conditions between boreholes directly affecting construction costs, equipment, scheduling, etc. would in fact be greater than what has been carried out for design purposes. Therefore, contractors bidding on this project or undertaking this work should make their own interpretations of the factual borehole results and carry out further work as they deem necessary to assess the scope of the project.

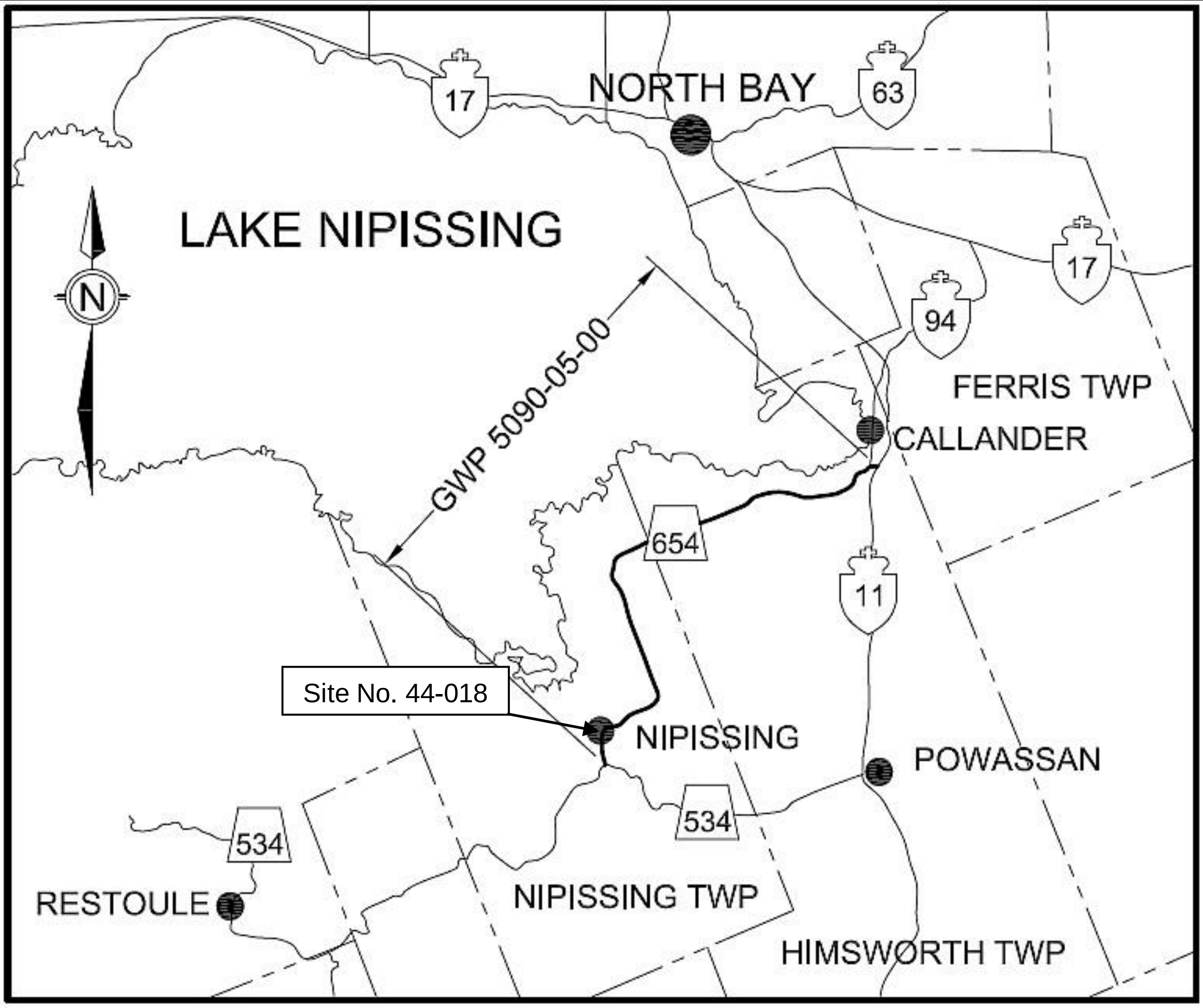
Section 5 of this reported is intended for the use of the client and the design team only and is not intended to be included in the tender documents. Inclusion of the factual information (Sections 1 to 5 inclusive) in the tender documents is furnished merely for the general information of bidders and is not in any way warranted or guaranteed by or on behalf of the owner or the owner's consultants and its subconsultants or the consultants' or subconsultants' employees, and neither the owner nor its consultants or its employees shall be liable for any representations negligent or otherwise contained in the documents.

Appendix 1 Key Plan

Drawing No. 1	Key Plan

KEY PLAN **Drawing No. 1**

NOT TO SCALE



FINAL
FOUNDATION INVESTIGATION
AND DESIGN REPORT
GWP 5090-05-00
Highway 654

From Highway 534
Easterly 23.1 km To Highway 11

Reference No: 12/03/12027-F3 May 2013

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Appendix 2 Subsurface Data

Enclosure No. 1	List of Abbreviations and Symbols
Enclosure Nos. 2 to 5	Record of Borehole Sheet

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LIST OF ABBREVIATIONS & DESCRIPTION OF TERMS

The abbreviations and terms, used to describe retrieved samples and commonly employed on the borehole logs, on the figures and in the report are as follows:

1. ABBREVIATIONS

AS Auger Sample
CS Chunk Sample
DS Denison type sample
FS Foil Sample
NFP No Further Progress
PH Sampler advanced by hydraulic pressure
PM Sampler advanced by manual pressure
RC Rock core with size & percentage of recovery
SS Split Spoon
ST Slotted Tube
TO Thin-walled, open
TP Thin-walled, piston
WS Wash Sample

2. PENETRATION RESISTANCE/"N"

Dynamic Cone Penetration Test (DCPT):

A continuous profile showing the number of blows for each 300 mm of penetration of a 50 mm diameter 60° cone attached to AW rod driven by a 63 kg hammer falling 760 mm.

Plotted as —•—•—•—•

Standard Penetration Test (SPT) or "N" Values

The number of blows of a 63 kg hammer falling 760 mm required to advance a 50 mm O.D. drive open sampler 300 mm.

3. SOIL DESCRIPTION

a) *Cohesionless Soils:*

"N" (blows/0.3 m)	*Relative Density*
0 to 4	very loose
4 to 10	loose
10 to 30	compact
30 to 50	dense
over 50	very dense

b) *Cohesive Soils:*

Undrained Shear Strength (kPa)	*Consistency*
Less than 12	very soft
12 to 25	soft
25 to 50	firm
50 to 100	stiff
100 to 200	very stiff
over 200	hard

3. SOIL DESCRIPTION (Cont'd)

c) *Method of Determination of Undrained Shear Strength of Cohesive Soils:*

+ 3.2 - Field Vane test in borehole. The number denotes the sensitivity to remoulding.

D - Laboratory Vane Test

¨ - Compression test in laboratory

For a saturated cohesive soil the undrained shear strength is taken as one-half of the undrained compressive strength.

4. TERMINOLOGY

Terminology used for describing soil strata is based on the proportion of individual particle sizes present in the samples (please note that, with the exception of those samples subject to a grain-size analysis, all samples were classified visually and the accuracy of visual examination is not sufficient to determine exact grain sizing):

Trace, or occasional	Less than 10%
Some	10 to 20%
With	20 to 30%
Adjective (i.e. silty or sandy)	30 to 40%
And (i.e. sand and gravel)	40 to 60%

Terminology for cobbles and/or boulders frequency is an estimate based on drill response and field observations:

Occasional	Obstructions encountered in borehole, however advance is not severely impeded
Numerous	Obstructions appear essentially continuous over drilled length

5. LABORATORY TESTS

P Standard Proctor Test
A Atterberg Limit Test
GS Grain Size Analysis
H Hydrometer Analysis
C Consolidation

SAMPLE DESCRIPTION NOTES:

1. **FILL:** The term fill is used to designate all man-made deposits of natural soil and/or waste materials. The reader is cautioned that fill materials can be very heterogeneous in nature and variable in depth, density and degree of compaction. Fill materials can be expected to contain organics, waste materials, construction materials, shot rock, rip-rap, and/or larger obstructions such as boulders, concrete foundations, slabs, abandoned tanks, etc.; none of which may have been encountered in the borehole. The description of the material penetrated in the borehole therefore may not be applicable as a general description of the fill material on the site as boreholes cannot accurately define the nature of fill material. During the boring and sampling process, retrieved samples may have certain characteristics that identify them as ‘fill’. Fill materials (or possible fill materials) will be designated on the Borehole Logs. If fill material is identified on the site, it is highly recommended that testpits be put down to delineate the nature of the fill material. However, even through the use of testpits defining the true nature and composition of the fill material cannot be guaranteed. Fill deposits often contain pockets or seams of organics, organically contaminated soils or other deleterious material that can cause settlement or result in the production of methane gas. It should be noted that the origins and history of fill material is frequently very vague or non-existent. Often fill material may be contaminated beyond environmental guidelines and the material will have to be disposed of at a designated site (i.e. registered landfill). Unless requested or stated otherwise in this report, fill material on this site has not been tested for contaminants however, environmental testing of the fill material can be carried out at your request. Detection of underground storage tanks cannot be determined with conventional geotechnical procedures.

2. **TILL:** The term till indicates a material that is an unstratified, glacial deposit, heterogeneous in nature and, as such, may consist of mixtures and pockets of clay, silt, sand, gravel, cobbles and/or boulders. These heterogeneous deposits originate from a geological process associated with glaciation. It must be noted that due to the highly heterogeneous nature of till deposits, the description of the deposit on the borehole log may only be applicable to a very limited area and therefore, caution must be exercised when dealing with a till deposit. When excavating in till, contractors may encounter cobbles/boulders or possibly bedrock even if they are not indicated on the borehole logs. It must be appreciated that conventional geotechnical sampling equipment does not identify the nature or size of any obstruction.

3. **BEDROCK:** Auger refusal may be due to the presence of bedrock, but possibly could also be due to the presence of very dense underlying deposits, boulders or other large obstructions. Auger refusal is defined as the point at which an auger can no longer be practically advanced. It must be appreciated that conventional geotechnical sampling equipment does not differentiate between nature and size of obstructions that prevent further penetration of the boring below grade. Bedrock indicated on the borehole logs will be labeled ‘possibly’ or ‘probable’ etc. based on the response of the boring and sampling equipment, surrounding topography, etc. Bedrock can be proven at individual borehole locations, at your request, by diamond core drilling operations or, possibly, by testpits. It must also be appreciated that bedrock surfaces can be, and most times are, very erratic in nature (i.e. sheer drops, isolated rock knobs, etc.) and caution must be used when interpreting subsurface conditions between boreholes. A bedrock profile can be more accurately estimated, at the clients’ request, through a series of closely positioned unsampled auger probes combined with core drilling.

4. **GROUNDWATER:** Although the groundwater table may have been encountered during this investigation and the elevation noted in the report and/or on the record of boreholes, it must be appreciated that the elevation of the groundwater table will fluctuate based upon seasonal conditions, localized changes, erratic changes in the underlying soil profile between boreholes, underlying soil layers with highly variable permeabilities, etc. These conditions may affect the design and type and nature of dewatering procedures. Cave-in levels recorded in borings give a general indication of the groundwater level in cohesionless soils however, it must be noted that cave-in levels may also be due to the relative density of the deposit, drilling operations etc.

ENCLOSURE NO.:2 (Pg. 1 of 3)

METRIC

RECORD OF BOREHOLE NO. 1

LVM

REFERENCE	12/03/12027-F3	DATUM	Geodetic	LOCATION	N 5106418.9 E 303646.8 - Nipissing Township
PROJECT	GWP 5090-05-00, Highway 654, Site No. 44-018	BOREHOLE TYPE	Truck Mounted CME 45B - Hollow Stem Augers		
CLIENT	AECOM	DATE (Started)	26 September 2012	DATE (Completed)	26 September 2012
TIME (Completed)	5:00:00 PM				

ORIGINATED BY: JL
COMPILED BY: AT
CHECKED BY: MAM

SOIL PROFILE

ELEV / DEPTH	DESCRIPTION
206.4	Ground Surface
0.0	75 mm Asphalt 100 mm Crushed Gravel 100 mm Asphalt 450 mm Crushed Gravel FILL - brown sand trace silt trace gravel (compact/dense)
204.3 / 2.1	SAND AND SILT - dark brown sand and silt with organics (loose) some to with organics
201.5 / 4.9	SAND - grey sand trace silt
200.9 / 5.5	SILT - grey silt some sand trace clay (very loose)
198.3 / 8.1	End of Sampling

Continued Next Page

SAMPLES AND TEST RESULTS

Number	Type	"N" Values	Natural Moisture Content	Remarks & Grain Size Distribution (%) GR SA (SI CL)
1	AS		○	
2	SS	32	○	
3	SS	25	○	6 90 (4)
4	SS	5	○	
5	SS	5	○	0 55 40 5
6	SS	4	○	
7	SS	7	104	
8	SS	2	○	0 16 78 6
9	SS	4	○	

GROUND WATER CONDITIONS: water level symbols at approx. elevation 200.0

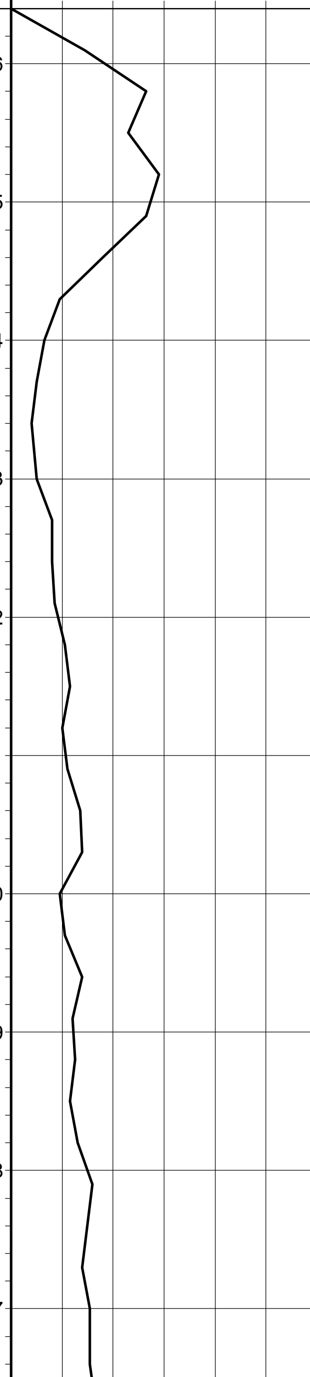
ELEVATION SCALE: 206, 205, 204, 203, 202, 201, 200, 199, 198, 197

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20, 40, 60, 80, 100)

SHEAR STRENGTH kPa: ○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE (20, 40, 60, 80, 100)

PLASTIC LIMIT W_P — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L; WATER CONTENT (%) 20 40 60

UNIT WEIGHT γ kN/m³



COMMENTS

+3, ×3 : Numbers on right refer to Sensitivity. Numbers on left refer to values greater than 120 kPa

○ 3% STRAIN AT FAILURE

The stratification lines represent approximate boundaries. The transition may be gradual.

WATER LEVEL RECORDS

Date (dd/mm/yy)/Time	Water Depth (m)	Cave In (m)
1) 26/9/12 4:45:00 PM	DRY	6.3
2) 27/9/12 12:00:00 PM	6.4	-
3) 2/10/12 9:30:00 AM	6.4	-

MEL-GEO 12027 - AREA 3 - BOREHOL LOGS.GPJ MEL-GEO.GDT 5/2/13

L|V|M
120 Progress Court, North Bay, On P1A 0C2 Phone: (705)476-2550 Fax: (705)476-8882 Email: northbay@lvm.ca

ENCLOSURE NO.:2 (Pg. 2 of 3)

METRIC

RECORD OF BOREHOLE NO. 1

LVM

REFERENCE	12/03/12027-F3	DATUM	Geodetic	LOCATION	N 5106418.9 E 303646.8 - Nipissing Township
PROJECT	GWP 5090-05-00, Highway 654, Site No. 44-018			BOREHOLE TYPE	Truck Mounted CME 45B - Hollow Stem Augers
CLIENT	AECOM			DATE (Started)	26 September 2012
				DATE (Completed)	26 September 2012

TIME (Completed) 5:00:00 PM

ORIGINATED BY JL

COMPILED BY AT

CHECKED BY MAM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE; 20 40 60 80 100)	PLASTIC LIMIT W_P / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA (SI CL)
ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES						
	Continued from Previous Page										
	Continued Next Page										

MEL-GEO 12027 - AREA 3 - BOREHOL LOGS.GPJ MEL-GEO.GDT 5/2/13

L|V|M

120 Progress Court, North Bay, On P1A 0C2 Phone: (705)476-2550 Fax: (705)476-8882 Email: northbay@lvm.ca

ENCLOSURE NO.:2 (Pg. 3 of 3)

METRIC

RECORD OF BOREHOLE NO. 1

L|V|M

REFERENCE 12/03/12027-F3 DATUM Geodetic LOCATION N 5106418.9 E 303646.8 - Nipissing Township ORIGINATED BY JL

PROJECT GWP 5090-05-00, Highway 654, Site No. 44-018 BOREHOLE TYPE Truck Mounted CME 45B - Hollow Stem Augers COMPILED BY AT

CLIENT AECOM DATE (Started) 26 September 2012 DATE (Completed) 26 September 2012 TIME (Completed) 5:00:00 PM CHECKED BY MAM

ELEV DEPTH	SOIL PROFILE: DESCRIPTION (Continued from Previous Page)	STRATA PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100); SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT W_P, NATURAL MOISTURE CONTENT W, LIQUID LIMIT W_L; WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA (SI CL)
184.8							185				
21.6	DCPT Refusal End of Borehole										

MEL-GEO 12027 - AREA 3 - BOREHOL LOGS.GPJ MEL-GEO.GDT 5/2/13

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120 Progress Court, North Bay, On P1A 0C2 Phone: (705)476-2550 Fax: (705)476-8882 Email: northbay@lvm.ca

ENCLOSURE NO.:3 (Pg. 1 of 2)

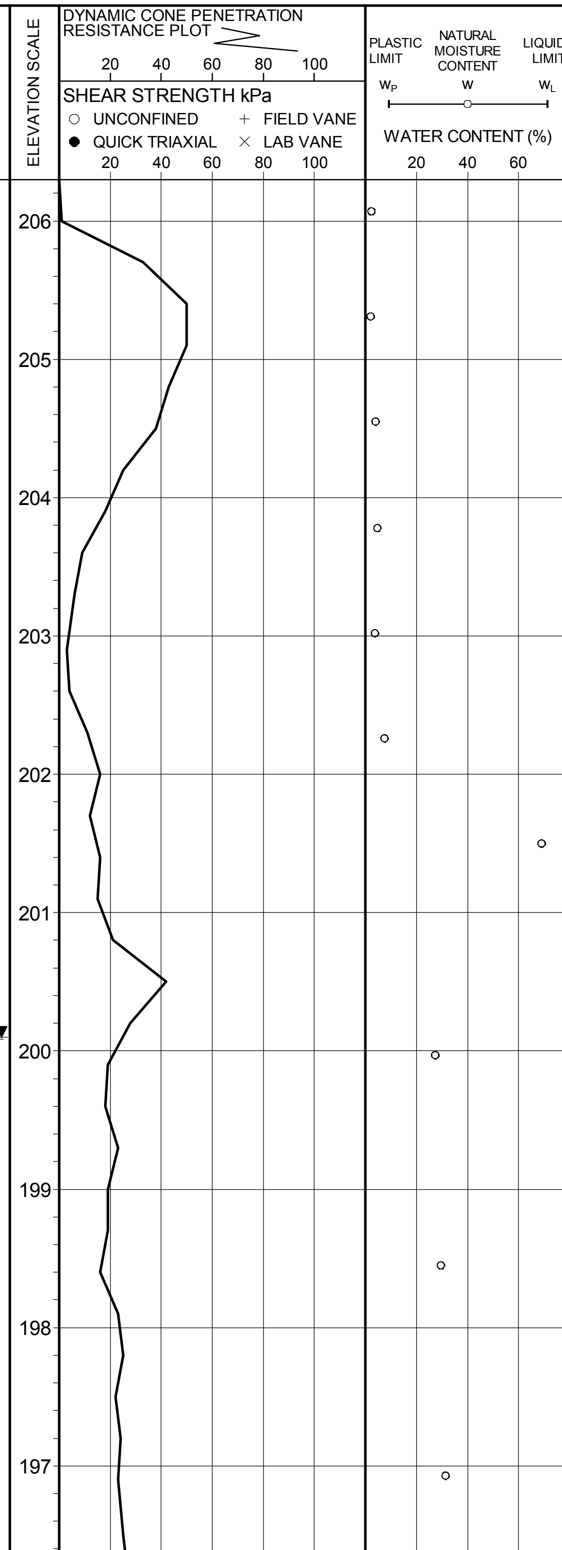
METRIC

RECORD OF BOREHOLE NO. 2

LVM

REFERENCE 12/03/12027-F3	DATUM Geodetic	LOCATION N 5106425.8 E 303647.8 - Nipissing Township	ORIGINATED BY JL
PROJECT GWP 5090-05-00, Highway 654, Site No. 44-018		BOREHOLE TYPE Truck Mounted CME 45B - Hollow Stem Augers	COMPILED BY AT
CLIENT AECOM		DATE (Started) 27 September 2012 / DATE (Completed) 27 September 2012 / TIME (Completed) 4:30:00 PM	CHECKED BY MAM

ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA (SI CL)
206.3	Ground Surface								
0.0	125 mm Asphalt 275 mm Concrete FILL - brown sand trace silt trace gravel (loose/compact)		1	AS					
			2	SS	25				5 91 (4)
			3	SS	22				
			4	SS	17				0 94 (6)
			5	SS	16				
			6	SS	7				2 96 (2)
202.0 4.3	SAND AND SILT - dark brown sand and silt with organics (loose)		7	SS	6				0 33 58 9
200.8 5.5	SILT - grey silt some sand trace clay (very loose)		8	SS	2				
			9	SS	4				
			10	SS	4				
196.7 9.6	End of Sampling Continued Next Page								



COMMENTS

+3, ×3 : Numbers on right refer to Sensitivity. Numbers on left refer to values greater than 120 kPa

○ 3% STRAIN AT FAILURE

The stratification lines represent approximate boundaries. The transition may be gradual.

WATER LEVEL RECORDS

Date (dd/mm/yy)/Time	Water Depth (m)	Cave In (m)
1) 27/9/12 4:15:00 PM	6.7	7.4
2) 28/9/12 8:59:00 AM	5.8	-
3) 2/10/12 6:02:00 AM	6.2	-

MEL-GEO 12027 - AREA 3 - BOREHOL LOGS.GPJ MEL-GEO.GDT 5/2/13

L|V|M
120 Progress Court, North Bay, On P1A 0C2 Phone: (705)476-2550 Fax: (705)476-8882 Email: northbay@lvm.ca

METRIC

RECORD OF BOREHOLE NO. 2

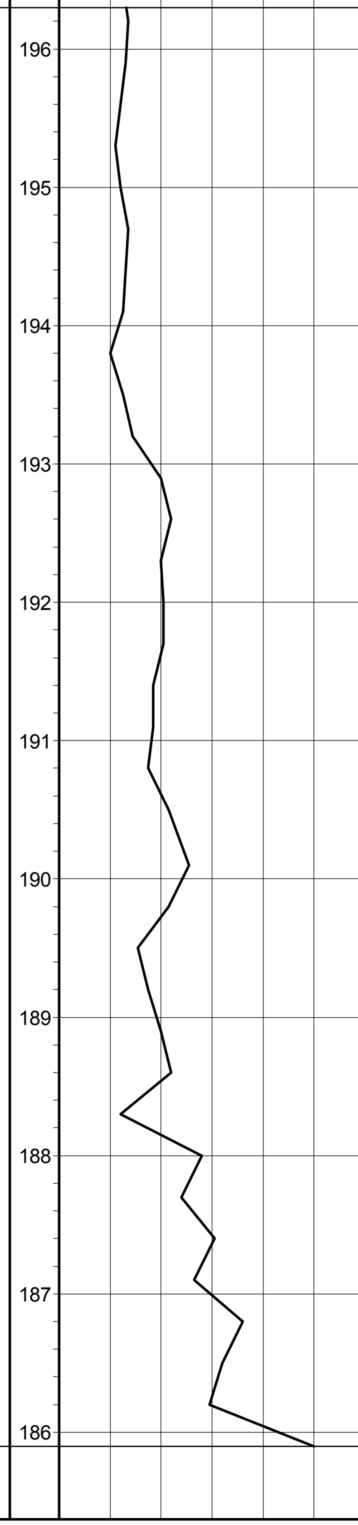
LVM

REFERENCE	12/03/12027-F3	DATUM	Geodetic	LOCATION	N 5106425.8 E 303647.8 - Nipissing Township
PROJECT	GWP 5090-05-00, Highway 654, Site No. 44-018			BOREHOLE TYPE	Truck Mounted CME 45B - Hollow Stem Augers
CLIENT	AECOM			DATE (Started)	27 September 2012
				DATE (Completed)	27 September 2012

TIME (Completed) 4:30:00 PM

ORIGINATED BY JL
COMPILED BY AT
CHECKED BY MAM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100); SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L; WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA (SI CL)
ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES						
	Continued from Previous Page										
185.9 20.4	DCPT Refusal End of Borehole										



MEL-GEO 12027 - AREA 3 - BOREHOL LOGS.GPJ MEL-GEO.GDT 5/2/13

ENCLOSURE NO.:4 (Pg. 1 of 2)

METRIC

RECORD OF BOREHOLE NO. 3

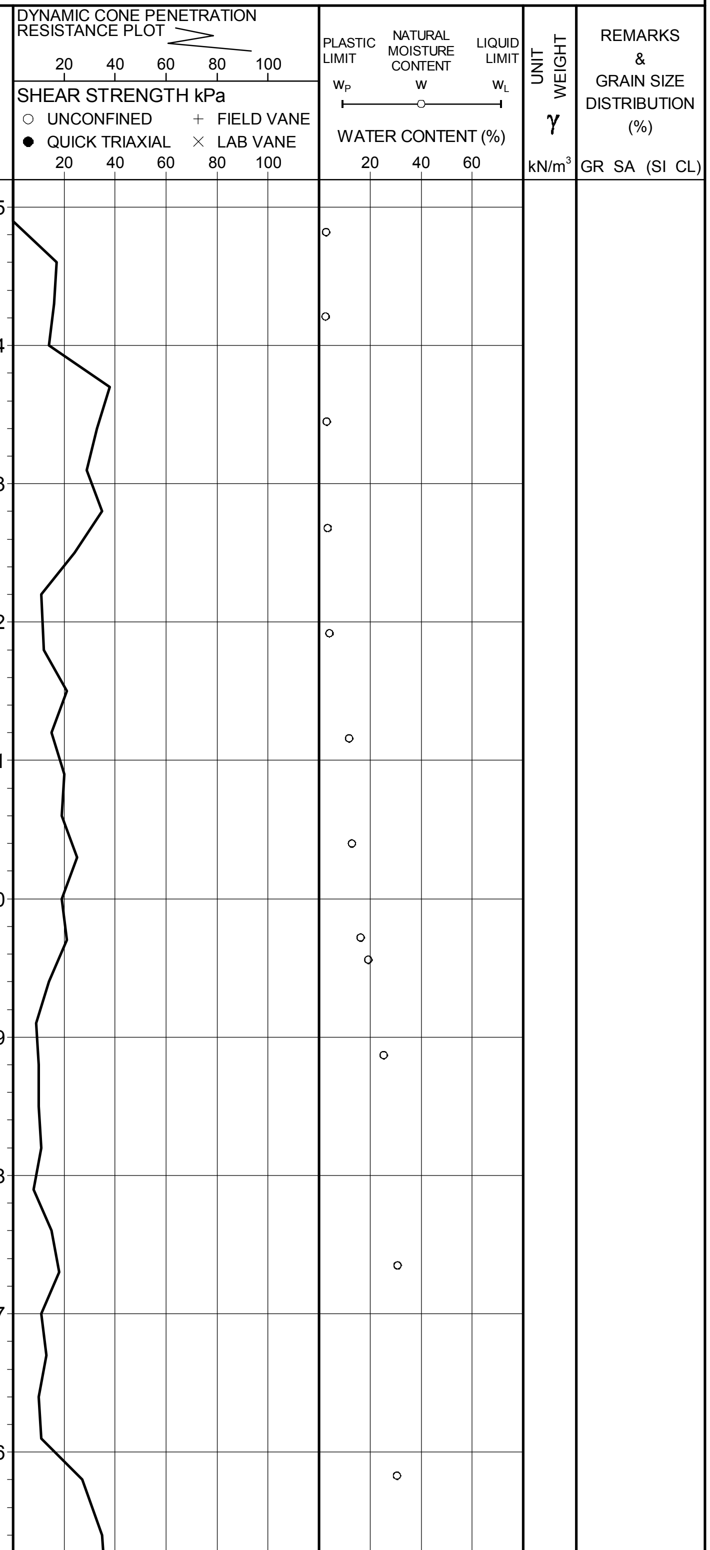
LVM

REFERENCE 12/03/12027-F3 DATUM Geodetic LOCATION N 5106484.0 E 303658.2 - Nipissing Township ORIGINATED BY JL

PROJECT GWP 5090-05-00, Highway 654, Site No. 44-018 BOREHOLE TYPE Truck Mounted CME 45B - Hollow Stem Augers COMPILED BY AT

CLIENT AECOM DATE (Started) 27 September 2012 DATE (Completed) 27 September 2012 TIME (Completed) 11:35:00 AM CHECKED BY MAM

ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRATA PLOT	SAMPLE NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
205.2	Ground Surface						
0.0	100 mm Asphalt 250 mm Concrete FILL - brown sand trace silt trace gravel (compact)		1	AS			205
			2	SS	15		204
			3	SS	10		
			4	SS	14		203
			5	SS	13		202
			6	SS	13		201
			7	SS	13		200
199.7 5.5	SAND AND SILT - grey sand and silt trace organics		8	SS	11		
199.1 6.1	SILT - grey silt some sand trace clay (loose/compact)		9	SS	2		199
							198
			10	SS	4		197
			11	SS	17		196
195.6 9.6	End of Sampling Continued Next Page						



COMMENTS

The stratification lines represent approximate boundaries. The transition may be gradual.

+3, ×3 : Numbers on right refer to Sensitivity. Numbers on left refer to values greater than 120 kPa

○ 3% STRAIN AT FAILURE

WATER LEVEL RECORDS

Date (dd/mm/yy)/Time	Water Depth (m)	Cave In (m)
1) 27/9/12 11:15:00 AM	7.4	9.1
2) 28/9/12 8:43:00 AM	6.9	-
3) 2/10/12 9:30:00 AM	6.9	-

MEL-GEO 12027 - AREA 3 - BOREHOL LOGS.GPJ MEL-GEO.GDT 5/2/13

L|V|M
120 Progress Court, North Bay, On P1A 0C2 Phone: (705)476-2550 Fax: (705)476-8882 Email: northbay@lvm.ca

ENCLOSURE NO.:4 (Pg. 2 of 2)

METRIC

RECORD OF BOREHOLE NO. 3

REFERENCE 12/03/12027-F3 DATUM Geodetic LOCATION N 5106484.0 E 303658.2 - Nipissing Township ORIGINATED BY JL

PROJECT GWP 5090-05-00, Highway 654, Site No. 44-018 BOREHOLE TYPE Truck Mounted CME 45B - Hollow Stem Augers COMPILED BY AT

CLIENT AECOM DATE (Started) 27 September 2012 DATE (Completed) 27 September 2012 TIME (Completed) 11:35:00 AM CHECKED BY MAM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100); SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT W_P, NATURAL MOISTURE CONTENT W, LIQUID LIMIT W_L; WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA (SI CL)
ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES						
	Continued from Previous Page										
194.9 10.3	DCPT Refusal End of Borehole						195				

MEL-GEO 12027 - AREA 3 - BOREHOL LOGS.GPJ MEL-GEO.GDT 5/2/13

ENCLOSURE NO.:5 (Pg. 1 of 2)

METRIC

RECORD OF BOREHOLE NO. 4

LVM

REFERENCE 12/03/12027-F3 DATUM Geodetic LOCATION N 5106490.5 E 303660.6 - Nipissing Township ORIGINATED BY JL

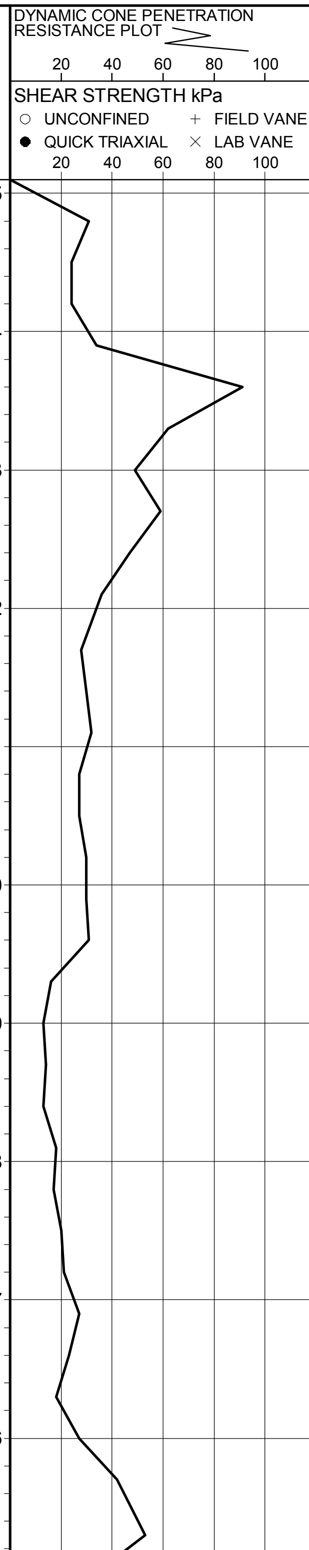
PROJECT GWP 5090-05-00, Highway 654, Site No. 44-018 BOREHOLE TYPE Truck Mounted CME 45B - Hollow Stem Augers COMPILED BY AT

CLIENT AECOM DATE (Started) 26 September 2012 DATE (Completed) 26 September 2012 TIME (Completed) CHECKED BY MAM

ELEV DEPTH	DESCRIPTION (SOIL PROFILE)	SAMPLE NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS
205.1	Ground Surface				
0.0	75 mm Asphalt 100 mm Crushed Gravel 100 mm Asphalt 400 mm Crushed Gravel FILL - brown sand trace silt trace gravel (compact/dense)	1	AS		
		2	SS	30	
		3	SS	42	
		4	SS	22	
		5	SS	15	
		6	SS	10	
		7	SS	15	
199.6 5.5	SILT - grey silt some sand (very loose)	8	SS	WH	
198.4 6.7	SAND - grey sand some silt trace gravel (compact)	9	SS	12	▽ (water level)
197.0 8.1	End of Sampling				

Continued Next Page

ELEVATION SCALE: 205, 204, 203, 202, 201, 200, 199, 198, 197, 196



PLASTIC LIMIT W_P — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L

WATER CONTENT (%) 20 40 60

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA (SI CL)

COMMENTS

The stratification lines represent approximate boundaries. The transition may be gradual.

+³, ×³ : Numbers on right refer to Sensitivity. Numbers on left refer to values greater than 120 kPa

○ 3% STRAIN AT FAILURE

WATER LEVEL RECORDS

Date (dd/mm/yy)/Time	Water Depth (m)	Cave In (m)
1) 26/9/12 1:40:00 PM	6.8	7
2)	-	-
3)	-	-

MEL-GEO 12027 - AREA 3 - BOREHOL LOGS.GPJ MEL-GEO.GDT 5/2/13

METRIC

RECORD OF BOREHOLE NO. 4

REFERENCE 12/03/12027-F3 DATUM Geodetic

LOCATION N 5106490.5 E 303660.6 - Nipissing Township

ORIGINATED BY JL

PROJECT GWP 5090-05-00, Highway 654, Site No. 44-018

BOREHOLE TYPE Truck Mounted CME 45B - Hollow Stem Augers

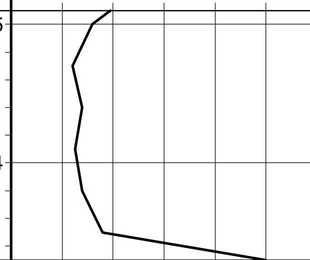
COMPILED BY AT

CLIENT AECOM

DATE (Started) 26 September 2012 TIME

DATE (Completed) 26 September 2012 (Completed)

CHECKED BY MAM

SOIL PROFILE			SAMPLES					DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100; SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P, NATURAL MOISTURE CONTENT w, LIQUID LIMIT w_L; WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA (SI CL)
ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE				
	Continued from Previous Page						195 194				
193.3 11.8	DCPT refusal End of Borehole										

MEL-GEO 12027 - AREA 3 - BOREHOL LOGS.GPJ MEL-GEO.GDT 5/2/13

Appendix 3 Lab Data

Drawing No. 2:	Borehole Location and Soil Strata
Figure Nos. L-1 to L-3:	Grain Size Distribution Curves
Figure No. L-4:	Lab Test Summary Sheet

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METRIC

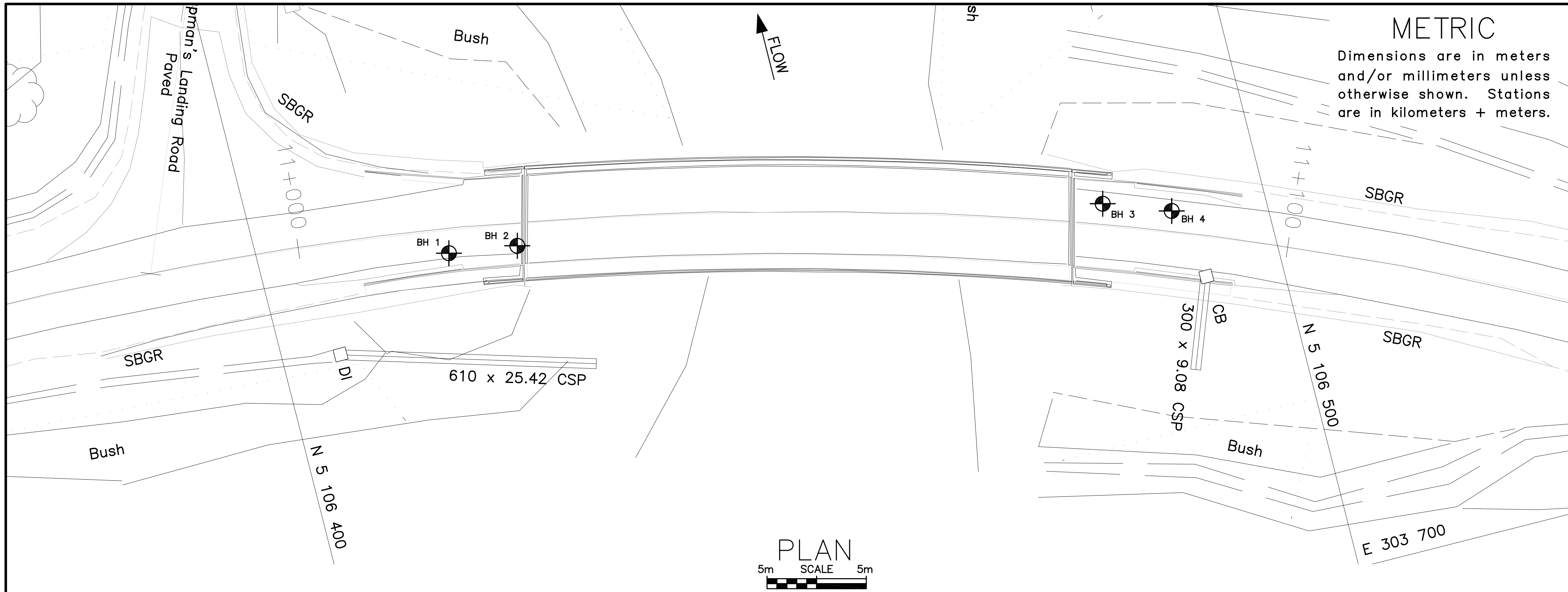
Dimensions are in meters and/or millimeters unless otherwise shown. Stations are in kilometers + meters.

CONT No
WP No 5090–05–00

HWY NO. 654 –
Township of Nipissing
South River Bridge
BOREHOLE LOCATIONS & SOIL STRATA

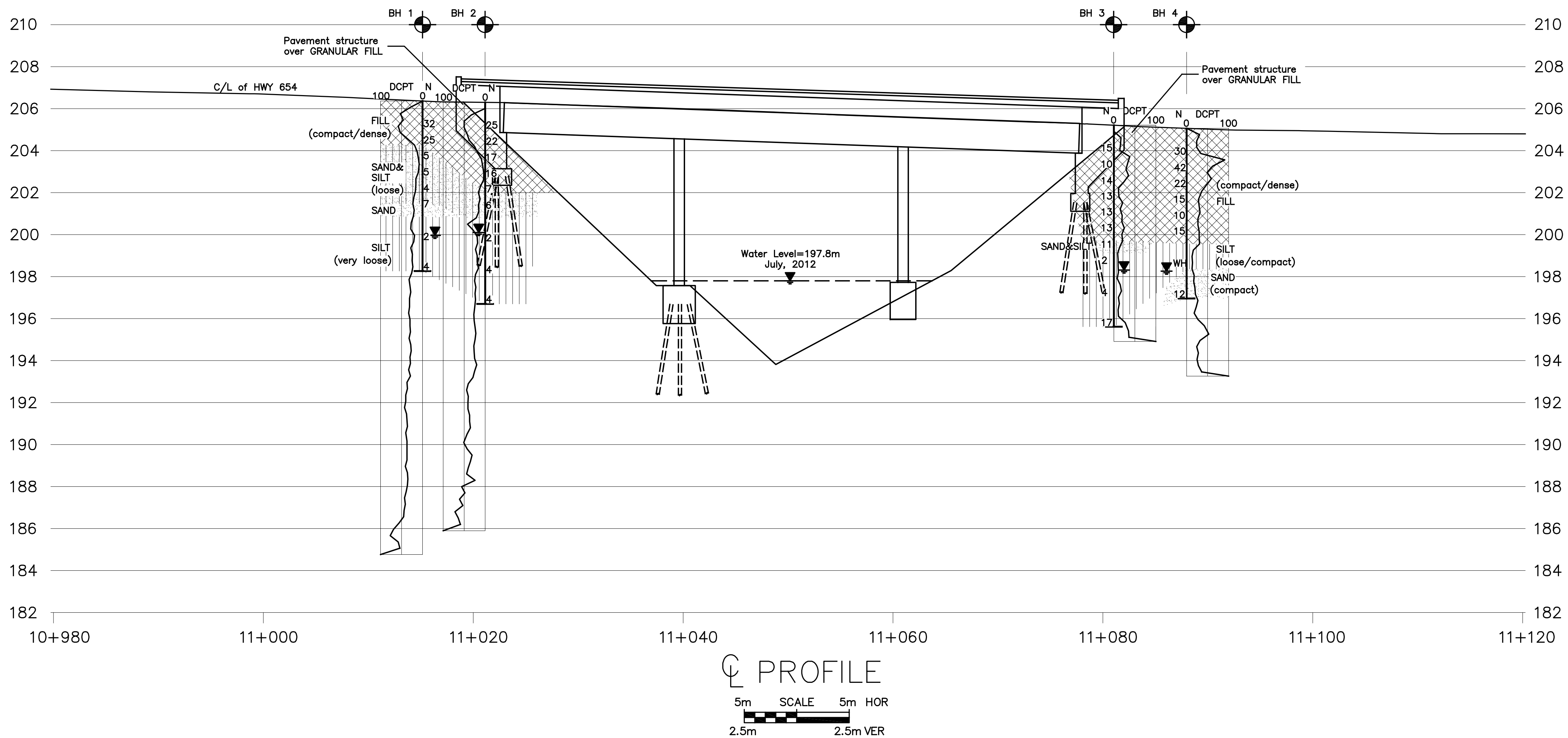
Drawing 2

LVM | MERLEX



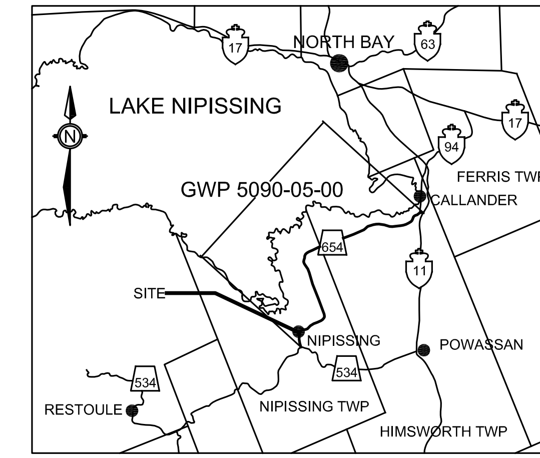
PLAN

5m SCALE 5m



℄ PROFILE

5m SCALE 5m HOR
2.5m 2.5m VER



KEY PLAN – NOT TO SCALE

LEGEND

- Borehole
- Dynamic Cone Penetration Test (DCPT)
- Borehole and DCPT
- N — Blows/0.3 m (Std Pen Test, 475 J/blow)
- DCPT — Blows/0.3 m (60° Cone, 475 J/blow)
- Water Level at Time of Investigation
- A/R — Auger Refusal at Elevation
- E/S — End of Sampling

Borehole No.	Elev.	O/S	Co–ordinates	
			Northerly	Easterly
Borehole No. 1	206.4	2.3m Rt	5106418.9	303646.8
Borehole No. 2	206.3	2.2m Rt	5106425.8	303647.8
Borehole No. 3	205.2	2.3m Lt	5106484.0	303658.2
Borehole No. 4	205.1	2.3m Lt	5106490.5	303660.6

NOTE 1: This drawing is for subsurface information only. Surface details and features are for conceptual illustration. The proposed structure location is shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contract Documents.

NOTE 2: The boundaries between soil strata have been established at the borehole locations only. The boundaries illustrated and stratigraphy between boreholes on this drawing are assumed based on borehole data and may vary. They are intended for design only.

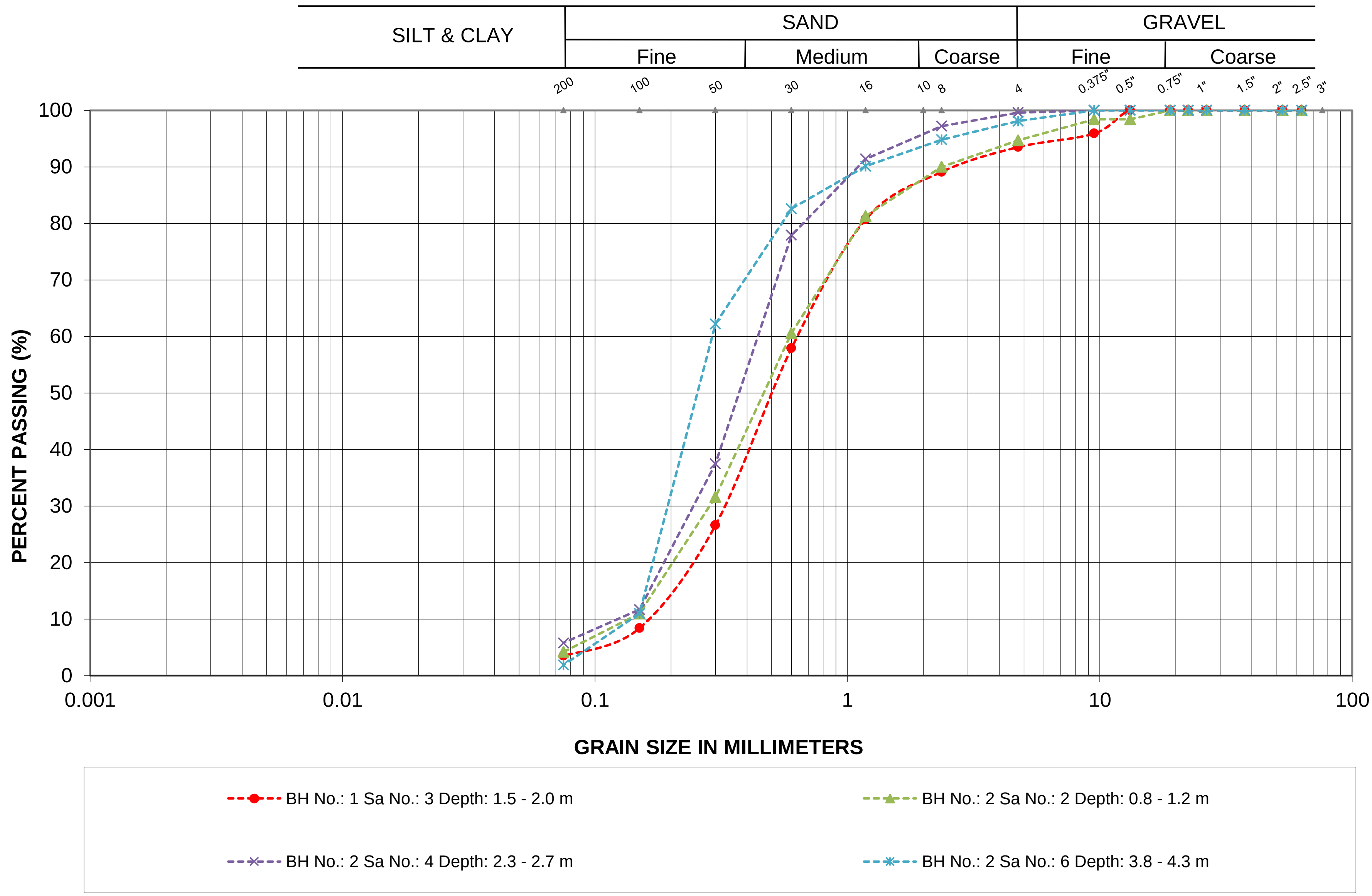
REVISIONS DATE	BY	DESCRIPTION
Jan 2013	MCM	DRAFT
May 2013	MCM	FINAL

HWY No. 654 – Nipissing Twp – South River Bridge			
SUBM'D	REF 12027–F3	GEOCRES 31L–171	SITE 44–018
DRAWN MCM	CHK MAM	DATE November 2012	DWG 2

Reference No.: 12/03/12027-F3
Date: May 2013

LVM | MERLEX

GRAIN SIZE ANALYSIS



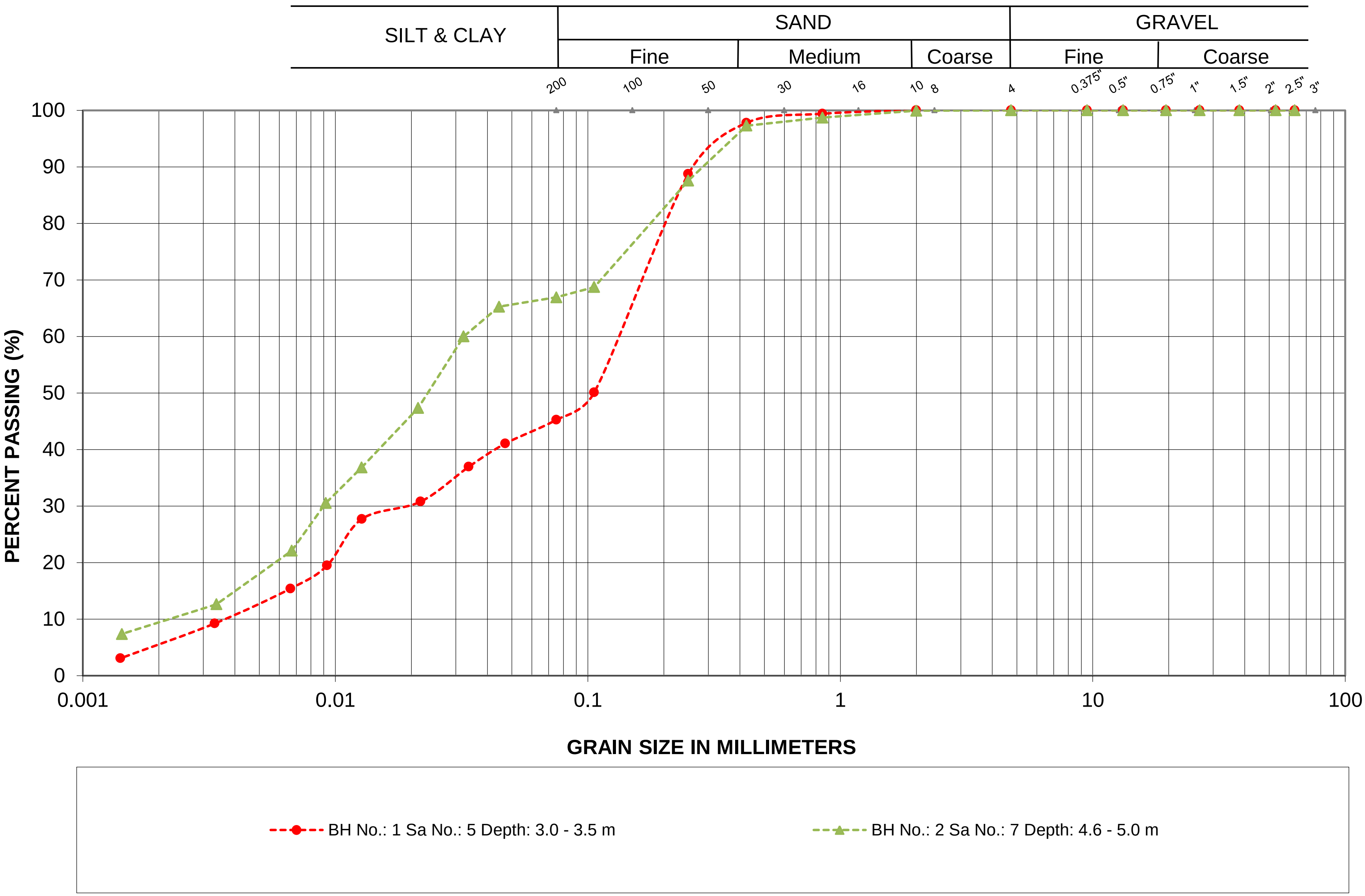
G.W.P.: 5090-05-00
LOCATION: Hwy 654

EMBANKMENT FILL
Sands, Trace Silt, Trace Gravel

Reference No.: 12/03/12027-F3
Date: May 2013

LVM | MERLEX

GRAIN SIZE ANALYSIS



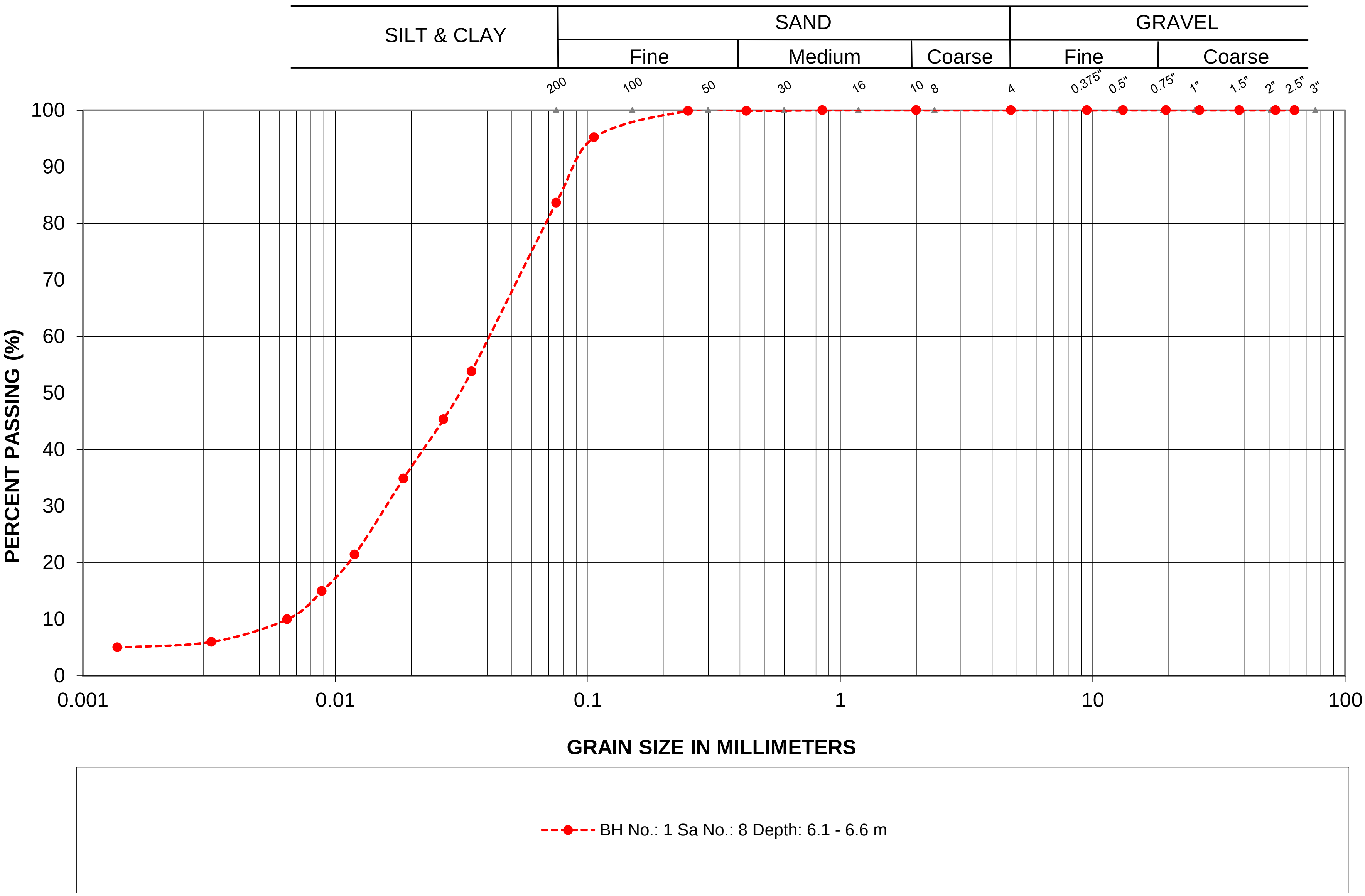
G.W.P.: 5090-05-00
LOCATION: Hwy 654

SAND AND SILT

Reference No.: 12/03/12027-F3
Date: May 2013

LVM | MERLEX

GRAIN SIZE ANALYSIS



G.W.P.: 5090-05-00
LOCATION: Hwy 654

SILT

Laboratory Tests - Summary Sheet

Borehole No.	Sample No.	Depth	Grain Size Analysis: Gravel Size (%)	Sand Size (%)	Silt Size (%)	Clay Size (%)	NMC	Atterberg Limits: LL (%)	PL (%)	IP (%)	SPT 'N'	USCS	Unit Weight (kN/m3)	Remarks
1	1	0.0					2.4				N/A			
	2	0.8					2.4				32			
	3	1.5	6	90	4		2.8				25			
	4	2.3					29.1				5			
	5	3.1	0	55	40	5	55.8				5			
	6	3.8					72.2				4			
	7A	4.6					104.0				7			
	7B	4.6					10.7				7			
	8	6.1	0	16	78	6	26.7				2			
	9	7.6					30.9				4			
2	1	0.0					2.3				N/A			
	2	0.8	5	91	4		2.0				25			
	3	1.5					3.9				22			
	4	2.3	0	94	6		4.6				17			
	5	3.1					3.7				16			
	6	3.8	2	96	2		7.4				7			
	7	4.6	0	33	58	9	68.9				6			
	8	6.1					27.3				2			
	9	7.6					29.5				4			
	10	9.1					31.4				4			
3	1	0.0					2.7				N/A			
	2	0.8					2.5				15			
	3	1.5					2.9				10			
	4	2.3					3.3				14			
	5	3.1					4.0				13			
	6	3.8					11.7				13			
	7	4.6					12.8				13			

LVM | MERLEX

Laboratory Tests - Summary Sheet

Borehole No.	Sample No.	Depth	Grain Size Analysis				NMC	Atterberg Limits			SPT 'N'	USCS	Unit Weight (kN/m3)	Remarks
			Gravel Size (%)	Sand Size (%)	Silt Size (%)	Clay Size (%)		LL (%)	PL (%)	IP (%)				
3	8A	5.3					16.2				11			
	8B	5.3					19.2				11			
	9	6.1					25.3				2			
	10	7.9					30.7				4			
	11	9.1					30.5				17			
4	1	0.0					2.3				N/A			
	2	0.8					3.3				30			
	3	1.5					3.5				42			
	4	2.3					5.7				22			
	5	3.1					4.7				15			
	6	3.8					11.6				10			
	7	4.6					16.9				15			
	8	6.1					25.5				WH			
	9	7.6					19.3				12			

Appendix 4 Historical Data

Enclosure Nos. 6 and 7: Historical Drawings

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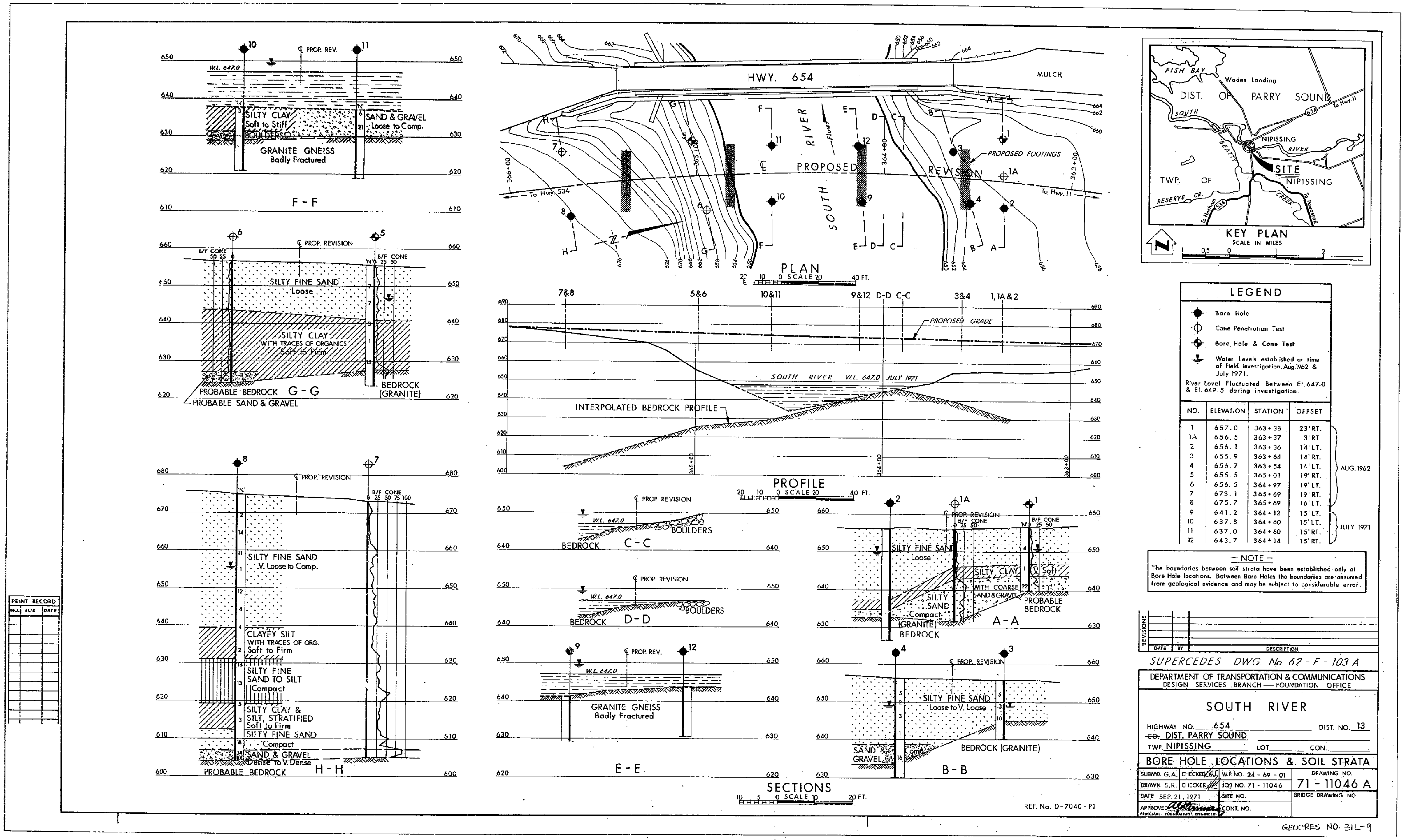
Enclosure No. 6



SOME DEFECTS IN NEGATIVE DUE
TO CONDITION OF ORIGINAL DOCUMENTS

Enclosure No. 7

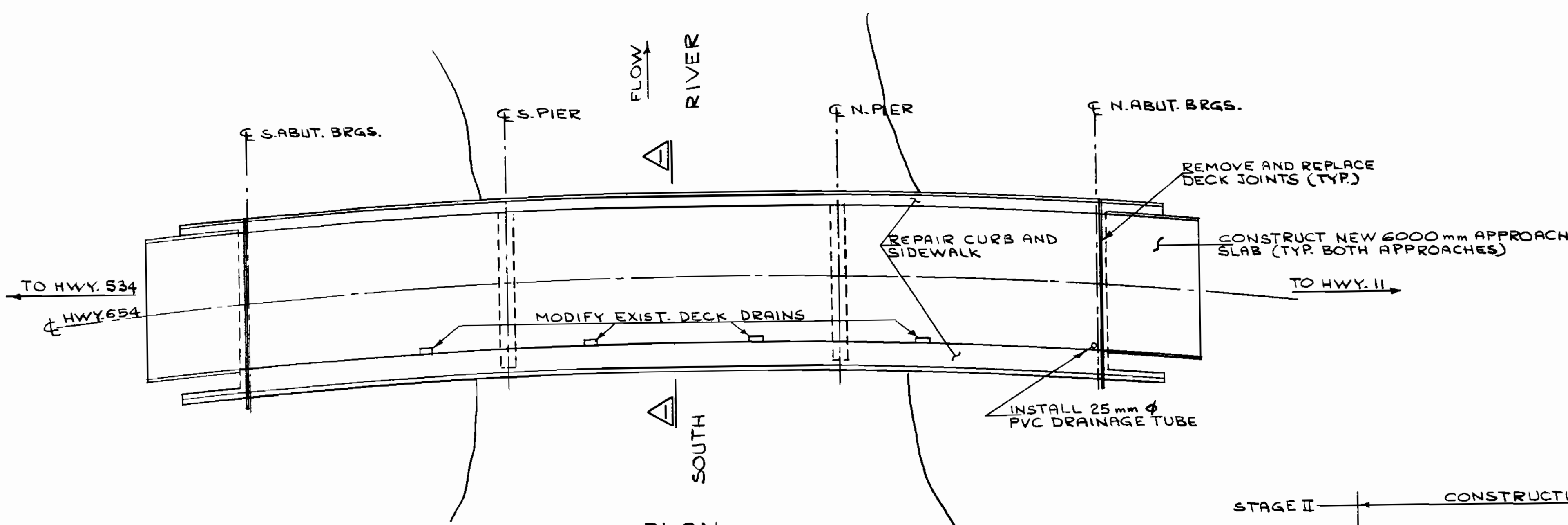
METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

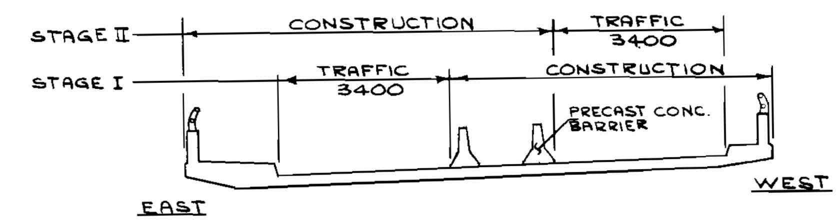
DIST. 13	HWY. 654
CONT No 88-233	
WP No 138-76-03	

SOUTH RIVER BRIDGE REHABILITATION
GENERAL ARRANGEMENT

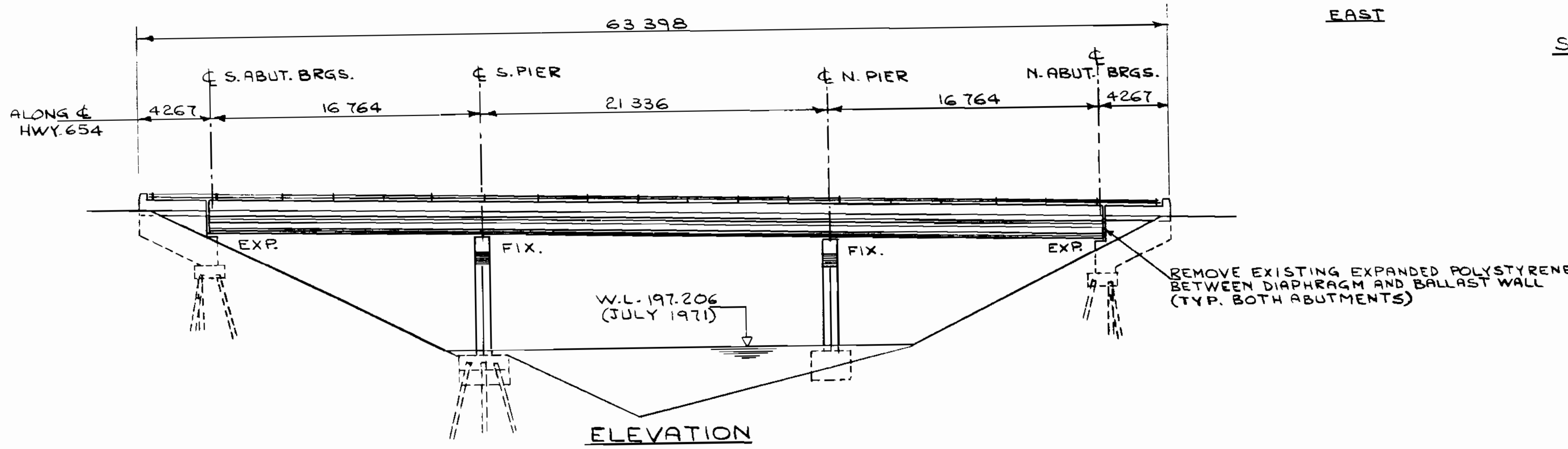
SHEET 75



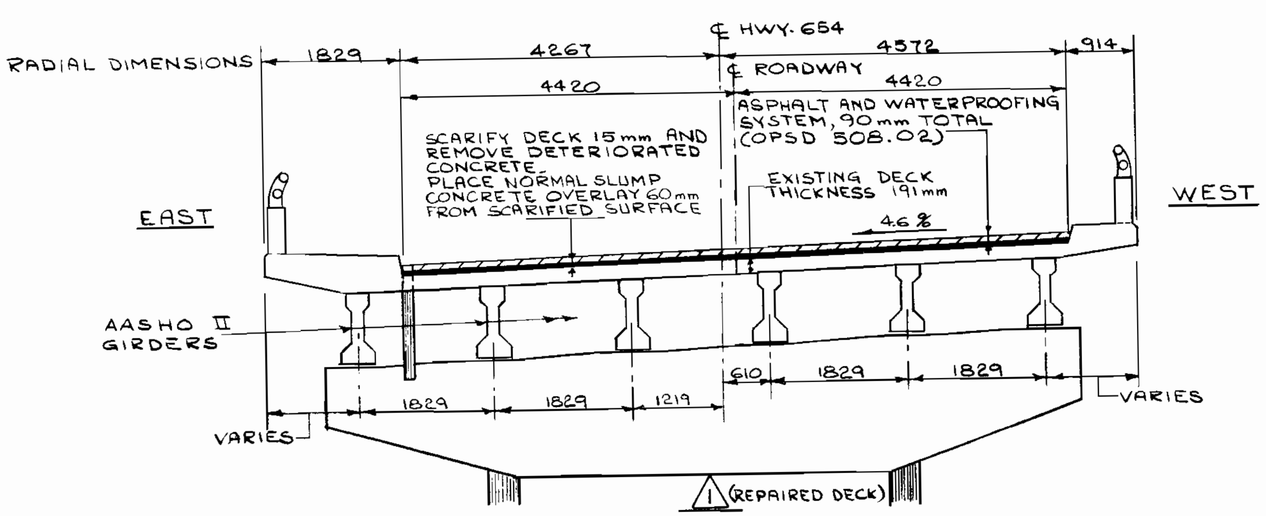
PLAN
1:200



STAGING
1:75



ELEVATION
1:200



1:50

GENERAL NOTES

1. CLASS OF CONCRETE SHALL BE 30 MPa.
2. REINFORCING STEEL SHALL BE GRADE 400. BARS MARKED WITH SUFFIX 'C' DENOTE COATED BARS.
3. CLEAR COVER TO REINFORCING STEEL SHALL BE 70 ± 20 UNLESS OTHERWISE NOTED.
4. THE CONTRACTOR SHALL VERIFY ALL DIMENSIONS OF THE EXISTING WORK AND ALL DETAILS ON SITE AND REPORT ANY DISCREPANCIES TO THE ENGINEER BEFORE PROCEEDING WITH THE REPAIR WORK.

SCOPE OF WORK AND SUGGESTED STAGING

STAGE 1

1. CLOSE WEST LANE; MAINTAIN TRAFFIC IN EAST LANE.
2. INSTALL TEMPORARY CONCRETE BARRIERS.
3. REMOVE EXISTING EXPANSION JOINTS, INCLUDING EXISTING CONCRETE AT ENDS OF DECK, TOP OF BALLAST WALLS AND CURBS.
4. SCARIFY DECK AND REMOVE DETERIORATED CONCRETE.
5. PLACE NORMAL SLUMP CONCRETE OVERLAY.
6. CONSTRUCT APPROACH SLABS.
7. BLOCK GAP BETWEEN END OF DECK AND BALLAST WALL AND INSTALL GRANULAR FILL IN EXPANSION JOINT BLOCKOUTS.
8. WATERPROOF DECK. PAVE BRIDGE DECK AND APPROACHES.
9. SAWCUT AND REMOVE ASPHALT PAVEMENT AND GRANULAR FILL IN EXPANSION JOINT BLOCKOUTS.
10. INSTALL EXPANSION JOINTS AND PLACE CONCRETE IN END DAMS.

STAGE 2

11. CLOSE EAST LANE; MAINTAIN TRAFFIC IN WEST LANE.
12. RELOCATE TEMPORARY CONCRETE BARRIERS.
13. REPEAT STEPS 3 AND 4 (EXCEPT REFERENCE TO "CURBS" SHALL BE REPLACED WITH "SIDEWALK").
14. MODIFY EXISTING DECK DRAINS.
15. REPEAT STEPS 5 TO 10.
16. INSTALL EXPANSION JOINT SEALS.
17. REMOVE TEMPORARY CONCRETE BARRIERS AND OPEN BRIDGE TO TWO LANE TRAFFIC.

LIST OF DRAWINGS

44-18-R1 GENERAL ARRANGEMENT
-R2 DECK JOINT DETAILS
-R3 MODIFICATION OF EXIST. DECK DRAINS AND JOINT INSTALLATION
-R4 JOINT ANCHORAGE AND ARMOURING
-R5 6000 mm APPROACH SLABS
-R6 QUANTITIES - STRUCTURE

APPLICABLE STANDARD DRAWINGS

OPSD-508.02, OPSD-920.01, OPSD-920.02

JULY/88

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN KSY	CHECK	LOADING	DATE FEB. 88
DRAWING V.Z.	CHECK	SITE No 44-629-18	DWG R1

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS ONTARIO

Appendix 5 Design Data

Table A: Comparison of Shoring Alternatives
Figure No. SK-4: Conceptual Shoring Locations

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Table A – Comparison of Shoring Alternatives

Method	Depth Range (m)	Advantages	Disadvantages	Remarks	Estimated Costs
Wood Sheeting	1.5 – 5	-Low cost, -Easily installed in good ground conditions	-Limited by soil conditions, -Limited depth of installation, -Low strength, -discontinuous	Considered for protection system.	$ 650/m^2
Steel Sheet Piles	5 – 21	-High strength, continuous, -Readily available	-Limited by soil conditions (i.e. obstructions)	Recommended for temporary protection.	$ 650/m^2
Pre-cast concrete panels	3 – 10	-Durable -Assists in minimizing seepage	-Limited depths -Can be damaged during installation -Limited by soil conditions (i.e. obstructions)	Not considered due to higher cost.	
Soldier piles	5 – 25	-Easy installation -Readily available -Adaptable to various ground conditions	-Pre-drilling may be required -Possible ground loss	Not considered due to depths required and higher costs	$ 725/m^2 Predrilling $ 1,500/m^2
Tangent/ Secant/ Staggered Drilled Piles	10 – 18	-Readily available -Adaptable to various ground conditions	-Possible ground loss and/or seepage -Poor alignment tolerance	Not Considered due to higher costs	
Concrete Diaphragm	10 – 30	-High Strength -Durable -Can be permanent	-High cost -Requires specialized equipment/control	Not Considered due to higher costs	
Micropiles with reinforced shotcrete face		-Can be installed in various ground conditions -High strength -Good tolerance	-High Cost -Requires specialized equipment	Not Considered due to higher costs	$ 1,200 – 1,500/m^2

REF.: 12027-F3

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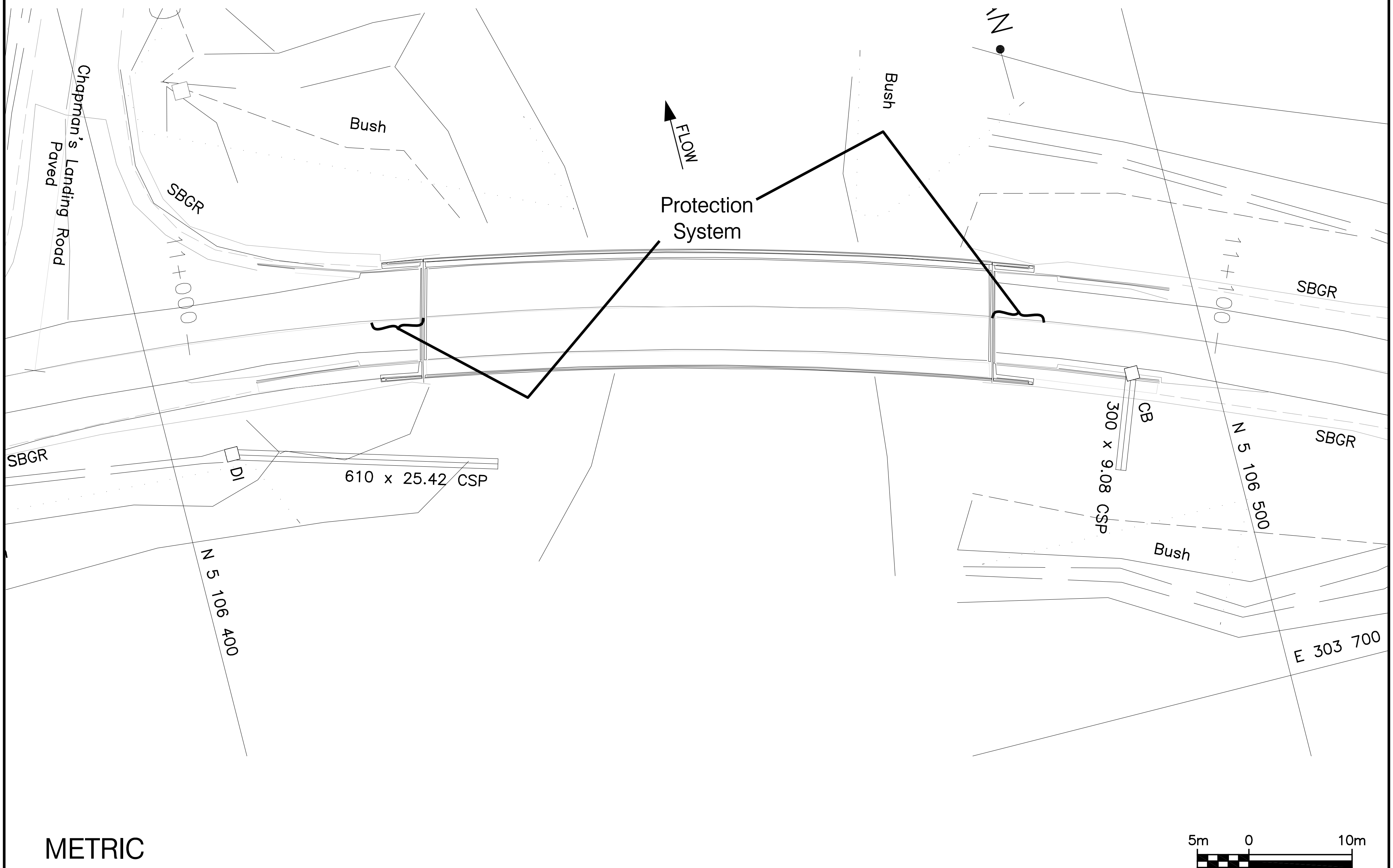

METRIC

Dimensions are in meters and/or millimeters unless otherwise shown. Stations are in kilometers + meters.

HWY 654- Township of Nipissing - South River Bridge
Conceptual Shoring Locations

FIGURE SK-4