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GEOTECHNICAL INVESTIGATION
PROPOSED RAILTRACK EXPANSION WITHIN SW-9-39-25-W4M JOFFRE, ALBERTA

PMEL FILE NO. 12332
NOVEMBER 7, 2016

PREPARED FOR:

HATCH CORPORATION
840 7 AVENUE SW, SUITE 340
CALGARY, ALBERTA
T2P 3G2

ATTENTION: MS. RHIAN ZWIERZCHOWSKI

TABLE OF CONTENTS

LIST OF TABLES

LIST OF DRAWINGS

LIST OF APPENDICES

1.0 INTRODUCTION

The following report has been prepared on the subsurface soil conditions existing at the site of the Proposed Rail Track Expansion to be constructed at the existing Procor site located within the SW-9-39-25-W4M, near Joffre, Alberta.

Authorization to proceed with this investigation was provided by Ms. Rhian Zwierzchowski of Hatch Corporation on September 23, 2016. The Terms of Reference for this investigation were presented in P. Machibroda Engineering Ltd (PMEL) Proposal No. 12332, dated September 20, 2016.

The field investigation was conducted on October 11, 2016. Groundwater monitoring was completed on October 25, 2016.

2.0 FIELD INVESTIGATION

Nine test holes, located as shown on the Site Plan, Drawing No. 12332-1, were dry drilled using a continuous flight, solid stem auger drill rigs. The test holes were 150 mm in diameter and extended to depths of between 3 and 6.5 metres below the existing ground surface.

Test hole drill logs were compiled during test drilling to record the soil stratification, the groundwater conditions, the position of unstable sloughing soils and the depths at which cobblestones and/or boulders were encountered.

Both disturbed and relatively undisturbed soil samples were recovered during test drilling. Relatively undisturbed soil samples were recovered by hydraulically pressing thin-walled Shelby tubes into the bottom of the test holes as test drilling progressed. The Shelby tube samples were sealed to minimize moisture loss. Disturbed samples of auger cuttings, collected during test drilling, were sealed in plastic bags to minimize moisture loss. The soil samples were taken to our laboratory for analysis.

Standard penetration tests (SPT), utilizing a safety hammer with automatic trip were performed during test drilling.

Standpipe piezometers (slotted, 50 mm diameter PVC pipe), were installed in Test Hole Nos. 16-7, 16-8 and 16-9 for groundwater monitoring purposes.

3.0 FIELD DRILL LOGS

The field drill logs recorded during test drilling have been shown plotted on Drawing Nos. 12332-2 to 10, inclusive.

The ground surface elevation at each Test Hole location was referenced to the top of the concrete floor slab of the existing shop building, located approximately as shown on Drawing No. 12332-1. A datum elevation of 100.000 was assumed for the concrete slab.

3.1 Soil Profile

The general subgrade soil conditions consisted of a thin layer of topsoil (0 to 300 mm) overlying glacial till extending to depths of between 3 and 6.5 metres below existing grade, the maximum depth drilled with our test holes at this site. The glacial till was initially firm in consistency and generally becoming stiffer with depth.

Asphalt (100 mm thick) overlying gravel fill (to a depth of approximately 400 mm) followed by clay fill (to a depth of approximately 1.2 metres) was encountered in Test Hole 16-5. The clay fill was underlain by glacial till to a depth of approximately 5 metres below existing grade.

In Test Hole Nos. 16-1, 16-2, 16-3, and 16-6 the upper 900 mm of glacial till soils were black in colour and contained trace amounts of organics. In Test Hole No. 16-4, trace organics were present between 500 and 900 mm below existing ground surface.

3.2 Groundwater Conditions, Sloughing

The Test Holes remained open during and immediately follow drilling. Groundwater seepage conditions were encountered during test drilling. The depths at which groundwater seepage conditions were encountered have been shown on Drawing Nos. 12332-2 to 10, inclusive.

The groundwater levels recorded in the piezometers installed during the field investigation have been summarized in Table I.

TABLE I. RECORDED GROUNDWATER LEVELS

Test Hole No.	Ground Surface Elevation (m)	Piezometer Rim Elevation (m)	Groundwater Elevation (m)	
			I.A.I.	October 25, 2016
16-7	99.3	100.1	Dry	97.9
16-8	100.8	101.9	Dry	99.5
16-9	100.1	101.1	Dry	98.7

I.A.I. - Immediately After Installation.

An examination of Table I revealed that the groundwater table was measured between approximately 1.3 and 1.4 metres below existing grade on October 25, 2016.

Higher groundwater conditions could be encountered, particularly during or following precipitation and/or spring thaw.

3.3 Cobblestones and/or Boulders

The glacial till consisted of a heterogeneous mixture of gravel, sand, silt and clay-sized particles. The glacial till strata also contained sorted deposits of the above particle sizes. In addition to the sorted deposits, a random distribution of larger particle sizes in the cobblestone range (60 to 200 mm) and boulder-sized range (larger than 200 mm) should be expected at the subject site.

It should be recognized that the statistical probability of encountering cobblestones and/or boulders in the nine small diameter test holes drilled at this large site was low. Intertill deposits of cobblestones, boulders and isolated deposits of saturated sand or gravel should be anticipated. The frequency of encountering such deposits will increase proportionately with the volume of soil excavated.

4.0 LABORATORY ANALYSIS

The soil classification and index tests consisted of a visual classification of the soil, water contents, Atterberg limits, unit weights, grain size distribution analysis, unconfined compressive strength and organic matter content.

The results of soil classification and index tests conducted on representative samples of soil recovered from this site have been shown on the drill logs alongside the corresponding depths at which the samples were recovered as shown on Drawing Nos. 12332-2 to 10, inclusive.

Unconfined compressive strength results conducted on recovered Shelby tube samples have been summarized in Table II.

TABLE II. SUMMARY OF COMPRESSIVE STRENGTH TEST RESULTS

Test Hole No.	Depth (m)	Moisture Content (%)	Unconfined Compressive Strength (kPa)	Undrained Shear Strength (kPa)
16-1	3.2	18.6	144	72
16-1	4.7	17.8	137	63
16-3	1.7	20.0	121	60
16-3	3.2	17.7	115	57
16-6	1.7	21.7	104	52
16-6	3.2	18.1	135	67
16-9	1.7	17.2	180	90
16-9	3.2	20.0	208	104

The results of the grain size distribution analysis have been shown plotted in Appendix B.

5.0 DESIGN RECOMMENDATIONS

Based on the foregoing outline of soil test results, the following design recommendations have been presented.

5.1 Design Considerations

It is understood that approximately one kilometre of new rail track is proposed. Reportedly only unloaded rail cars will be stored on the new tracks.

The subsurface soil conditions consisted predominantly of topsoil overlying glacial till. The subgrade soils are frost susceptible and the average depth of frost penetration for the Red Deer area is approximately 2 metres (1.5 metres for heated structure) based on the existing soil conditions and estimated freezing index for this region. The design air freezing index as described in the Canadian Foundation Manual of 2006 (4th Edition) is approximately 2,000 degree-Celsius days based on the estimated mean annual freezing index of 1,450 degree-Celsius days.

The groundwater table was measured between approximately 1.3 and 1.4 metres below existing grade on October 25, 2016. Higher groundwater conditions could be encountered, particularly during or following precipitation and/or spring thaw.

The glacial till soils are considered firm to stiff in consistency to 6 metres below existing grade. A spur track system based on the existing subgrade soils or with the reinforcement of geogrid should perform satisfactorily.

Design recommendations have been prepared for site preparation; excavations and de-watering and spur track.

5.2 Site Preparation

5.2.1 General

All organics, loose fill and deleterious materials should be removed from the spur track foot print. In Test Holes on the West side of the subject site (e.g. Test Hole Nos 16-1, 16-2, 16-3, 16-4 and 16-5) trace organics were encountered within the glacial till layer. Organic matter analysis determined approximately 2 to 3 percent organics were present in the select samples. The glacial till subgrade should perform satisfactorily, however, a member of the Geotechnical Consult should inspect and approve any subgrade soils where trace organics are present. The surface of the subgrade should be levelled and compacted to the following minimum density requirements. See Appendix C for further information in regards to topsoil composition and soil structure.

Spur Track - 96 percent of standard Proctor density at optimum moisture content.

Fill, required to bring the subgrade soil to the design elevation in the construction area, should preferably consist of granular material or non-expansive (i.e. low plastic) fine-grained soil. The on-site glacial till, free of organic or deleterious materials, is considered acceptable for use as subgrade fill.

The fill should be placed in thin lifts (maximum 150 mm loose) and compacted to 96 percent of standard Proctor density at optimum moisture content.

The site should be graded to ensure positive site drainage away from all structures.

5.2.2 Soft Subgrade Conditions

Where excess moisture exists in the subgrade and scarification and drying the soil is not an option, overexcavation and replacement of a minimum of 400 mm of the softened soil with suitable subgrade fill could be considered to provide stable subgrade support for additional fill lifts.

In areas where granular fill be placed directly on the subgrade soils, utilization of geogrid in tandem with geotextile may be required depending on the strength of the subgrade level and amount of fill being placed. In general, geogrid would be beneficial for subgrades that are soft in consistency and total fill thicknesses of approximately 500 mm or less. In this case, a combination geogrid/geotextile such as NAUE Combigrid or equivalent that combines both materials in one product could be a viable option.

Level the subgrade soil and ensure the geotextile/geogrid is laid flat with no bunching before placing any material, and, overlap the geotextile/geogrid at least 500 mm. The granular fill should be placed by end dump and spread methods in one lift using tracked construction equipment, ensuring all equipment travels on the placed fill and not on the exposed geotextile/geogrid.

The placed fill should be lightly compacted using static compaction equipment. Care should be taken not to over compact the lift to attain 96 percent standard Proctor density as the primary purpose of the initial 400 mm is to bridge the underlying soils and provide a strong bearing layer to build up from. Subsequent fill lifts to bring the subgrade up to design elevation should consist of granular fill (sub-base course) placed and compacted in accordance with Section 5.2.1.

If rolling subgrade conditions persist after placing the 400 mm stabilizing lift and it is anticipated that the required compaction will not be attained on subsequent fill lifts (i.e., 98 percent Proctor density), placement of geogrid reinforcement prior to placing additional fill lifts is recommended.

The geogrid (such as Tensar TX130 or equivalent) should be placed (by hand) over the leveled fill surface using an overlap of 500 mm on adjoining pieces. A minimum of 225 mm of granular fill should be placed over the geogrid in a single lift, ensuring equipment is working on top of the lift and not in contact with the geogrid.

Compact the granular fill material to 96 percent of standard Proctor density using static compaction equipment (no vibratory equipment). Construct the remaining structure in accordance with Section 5.2.1.

In areas where subgrade fill (on-site glacial till soils) will be placed to build up the subgrade and softened soils are encountered, it is recommended that the soft soils are overexcavated (a minimum of 400 mm) and replaced with a single lift of compacted subgrade fill. Additional special measures may be required to stabilize soft areas and should be subject to review by the Geotechnical Consultant during the field construction and based on the actual conditions, the required fill thickness, the proposed construction equipment and the intended use for the designated area.

The need for special measures (i.e., geogrid) and/or gravel fill in soft areas should be subject to review by the Geotechnical Consultant during the field construction and based on the actual conditions, the required fill thickness, the proposed construction equipment and the intended use for the designated area.

5.3 Excavations and De-Watering

It is understood that areas may require excavation to bring the existing ground surface elevation down to the design subgrade invert elevation. If the excavation required is below the existing groundwater table de-watering at the site may be required.

It is anticipated that any proposed excavations at this site will be completed with unbraced sloped side walls. The long term stability of the excavation walls will be affected by wetting and drying of the exposed excavation walls, the length of time that the excavation remains open, consistency and structure (degree of fracturing, slickensiding, etc.) of the subgrade soils.

Temporary excavations should be designed and excavated in strict compliance with rules and regulations of Alberta Occupational Health and Safety Act (OH & S). The contractor is solely responsible for protecting excavation by shoring, sloping, benching and/or other means as required to maintain the stability of both the excavation sides and the bottom.

The required conformance standards are detailed in Occupational Health and Safety Code 2009, Part 32, Sections 441 to 455, inclusive. The subsurface conditions at this site have been classified as per OH&S (Section 442) and have been presented in Table III.

TABLE III. OH&S SOIL CLASSIFICATION

Material Type	OH&S Soil Classification
Glacial Till	Likely to crack and crumble

The groundwater table measured in the piezometers installed varied between approximately 1.3 and 1.4 metres below existing grade on October 25, 2016. Higher groundwater levels should be expected during or following spring snowmelt and periods of precipitation. Slopes will need to be flattened where groundwater seepage and sloughing condition are encountered.

A sump (or multiple sumps, if required) should be set up at the deepest excavation points and the floor of the excavation sloped to the sump(s) to handle any potential groundwater seepage and precipitation runoff. A self-actuated sump pump(s) should be operated on a continuous basis and should be discharged well away (10 metres) from the excavations.

5.4 Spur Track

The subgrade soils encountered in the test holes drilled along the proposed rail track consisted primarily of glacial till ranging in strength from firm to stiff in consistency.

Glacial till that is in a stiff condition or greater will provide strong subgrade support for the tracks. Additional special measures may be required where soft subgrade conditions are encountered. General recommendations with regards to soft subgrade conditions have been presented in Section 5.2.2.

In areas where subgrade fill (on-site glacial till soils) will be placed to build up the subgrade, the fill should be placed in thin lifts (maximum 150 mm loose) and compacted to 96 percent of standard Proctor density at optimum moisture content.

Water retention alongside rail tracks is a common cause of subgrade softening and rail track distress. Providing positive drainage alongside the tracks is imperative in maintaining the strength of the subgrade soils. The design gravel section presented below is based on maintaining the existing strength of the subgrade soils going forward.

If site drainage is not ideal and retention of water will occur in the adjacent ditches during periods of the year, increasing the thickness of sub-ballast or placement of a geogrid at the base of the sub-ballast layer is recommended to provide additional strength to offset any subgrade strength loss.

The following recommendations have been provided to assist in the rail track subgrade design.

1. Overexcavate any organic and/or heterogeneous material from the footprint of the track.

2. Prior to placement of the fill, scarify the upper 150 mm of the subgrade, moisture condition and compact the exposed subgrade surface to 96 percent of standard Proctor density at optimum moisture content. Overexcavate softened soils and replace with suitable fill.

3. Subgrade fill, if required, may consist of suitable on-site glacial till soils or granular fill. The subgrade fill should be placed in thin lifts (maximum 150 mm loose) and compacted to 96 percent of standard Proctor density at optimum moisture content. If granular fill is used, the gradation fill should meet the aggregate gradation requirements presented in Table IV.

TABLE IV. GRANULAR FILL AGGREGATE GRADATION REQUIREMENTS

Grain Size (mm)	Percent Passing
	Granular Fill
80.0	100
50.0	55-100
25.0	38-100
20.0	
16.0	32-85
10.0	
5.0	20-65
1.25	
0.630	
0.315	6-30
0.160	
0.080	2-10
Plasticity Index (%)	0-8

4. Slope the subgrade surface to provide positive drainage. A minimum slope of 2% is recommended.

5. Based on the strength of the subgrade soils, the following railway structures have been presented in Table V.

TABLE V. THICKNESS DESIGN FOR RAILWAY STRUCTURES

Railway Structure	Non-reinforced (mm)	Reinforced (mm)
Ballast	225	225
Sub-Ballast	675	325
Geogrid	--	Required*
Prepared Subgrade	(150)	(150)
Total Thickness	**900**	**550**

*Tensar TX130 or equivalent

6. A non-woven geotextile such as Nilex 4551 or equivalent is recommended between the subgrade and sub-ballast to provide separation between the two materials. Place the geotextile over the prepared subgrade surface in accordance with the manufacturer's specifications. An overlap of 600 mm is recommended for adjoining pieces. Construction traffic should be kept off the placed geotextile to avoid damage.

7. The initial lift of granular sub-ballast should be placed in a 250 mm thick lift above the geotextile and spread using end-dump and spread methods utilizing tracked construction equipment (to avoid damage of the geotextile). Compact the sub-ballast to 98 percent of standard Proctor density at optimum moisture content. Subsequent lifts should be placed in a maximum of 150 mm loose lifts and compacted to 98 percent of standard Proctor density at optimum moisture content. The granular sub-ballast fill should meet the aggregate gradation requirements presented in Table VI.

TABLE VI. SUB-BALLAST AGGREGATE GRADATION REQUIREMENTS

Sieve Size (mm)	Percent Passing
	Sub-Ballast
31.5	100
18.0	75 - 90
12.5	65 - 83
5.0	40 - 69
2.0	26 - 47
0.900	17 - 32
0.400	12 - 22
0.160	7 - 14
0.071	2 - 6

8. Provide positive site drainage to reduce the potential for moisture infiltration through the railbed structure.

9. Water should not be allowed to collect in the adjacent ditch for long periods of time which would increase softening of the glacial till subgrade and subsidence of the tracks. Culverts should be installed, as required, to improve drainage alongside the spur tracks.

10. Embankment side slopes should be no steeper than 2.0 Horizontal to 1.0 Vertical (2H:1V).

6.0 LIMITATIONS

The presentation of the summary of the field drill logs and foundation design recommendations has been completed as authorized. Nine, 150 mm diameter test holes were dry drilled using our continuous flight, solid stem auger drilling equipment. Field drill logs were compiled for the Test Holes during test drilling which, we believe, were representative of the subsurface conditions at the Test Hole locations at the time of test drilling.

Variations in the subsurface conditions from that shown on the drill logs at locations other than the exact test locations should be anticipated. If conditions should differ from those reported here, then we should be notified immediately in order that we may examine the conditions in the field and reassess our recommendations in the light of any new findings.

The Terms of Reference for this geotechnical investigation did not include any environmental assessment of the site. No detectable evidence of environmentally sensitive materials such as hydrocarbon odour was detected during the actual time of the field test drilling program. If, on the basis of any knowledge, other than that formally communicated to us, there is reason to suspect that environmentally sensitive materials may exist, then additional test holes should be drilled and samples recovered for chemical analysis.

The subsurface investigation necessitated the drilling of deep test holes. The test holes were backfilled at the completion of test drilling. Please be advised that some settlement of the backfill materials will occur which may leave a depression or an open hole. It is the responsibility of the client to inspect the site and backfill, as required, to ensure that the ground surface at each Test Hole location is maintained level with the existing grade.

This report has been prepared for the exclusive use of Hatch Corporation and their agents for specific application to the Proposed Rail Track Expansion to be constructed at the existing Procor Site, located within SW-9-39-25-W4M, near Joffre, Alberta. It has been prepared in accordance with generally accepted geotechnical engineering practices and no other warranty, express or implied, is made.

Any use which a Third Party makes of this report, or any reliance on decisions to be made based on it, is the responsibility of such Third Parties. Governing Agencies such as municipal, provincial or federal agencies having jurisdiction with respect to this development and/or construction of the facilities described herein have full jurisdiction with respect to the described development. Any other unspecified subsequent development would be considered Third Party and would, therefore, require prior review by PMEL. P. Machibroda Engineering Ltd. (PMEL) accepts no responsibility for damages, if any, suffered by any Third Party as a result of decisions made or actions based on this report.

The acceptance of responsibility for the design/construction recommendations presented in this report is contingent on adequate and/or full time inspection (as required, based on site conditions at the time of construction) by a representative of the Geotechnical Consultant. PMEL will not accept any responsibility on this project for any unsatisfactory performance if adequate and/or full time inspection is not performed by a representative of PMEL.

If this report has been transmitted electronically, it has been digitally signed and secured with personal passwords to lock the document. Due to the possibility of digital modification, only originally signed reports and those reports sent directly by PMEL can be relied upon without fault.

We trust that this report fulfills your requirements for this project. Please contact our office if you should require additional information.

P. MACHIBRODA ENGINEERING LTD.

PERMIT TO PRACTICE
P. Machibroda Engineering Ltd.
Signature ______________
Date 2016-11-08
PERMIT NUMBER: P-5862
The Association of Professional Engineers and Geoscientists of Alberta

Matthew LaBrecque, E.I.T.

Nov. 7, 2016

Naser Farkhideh, M.Sc., E.I.T.

GRAHAM BAXTER
2016-11-08

Graham Baxter, P. Eng.

ML:NF/GB:zz

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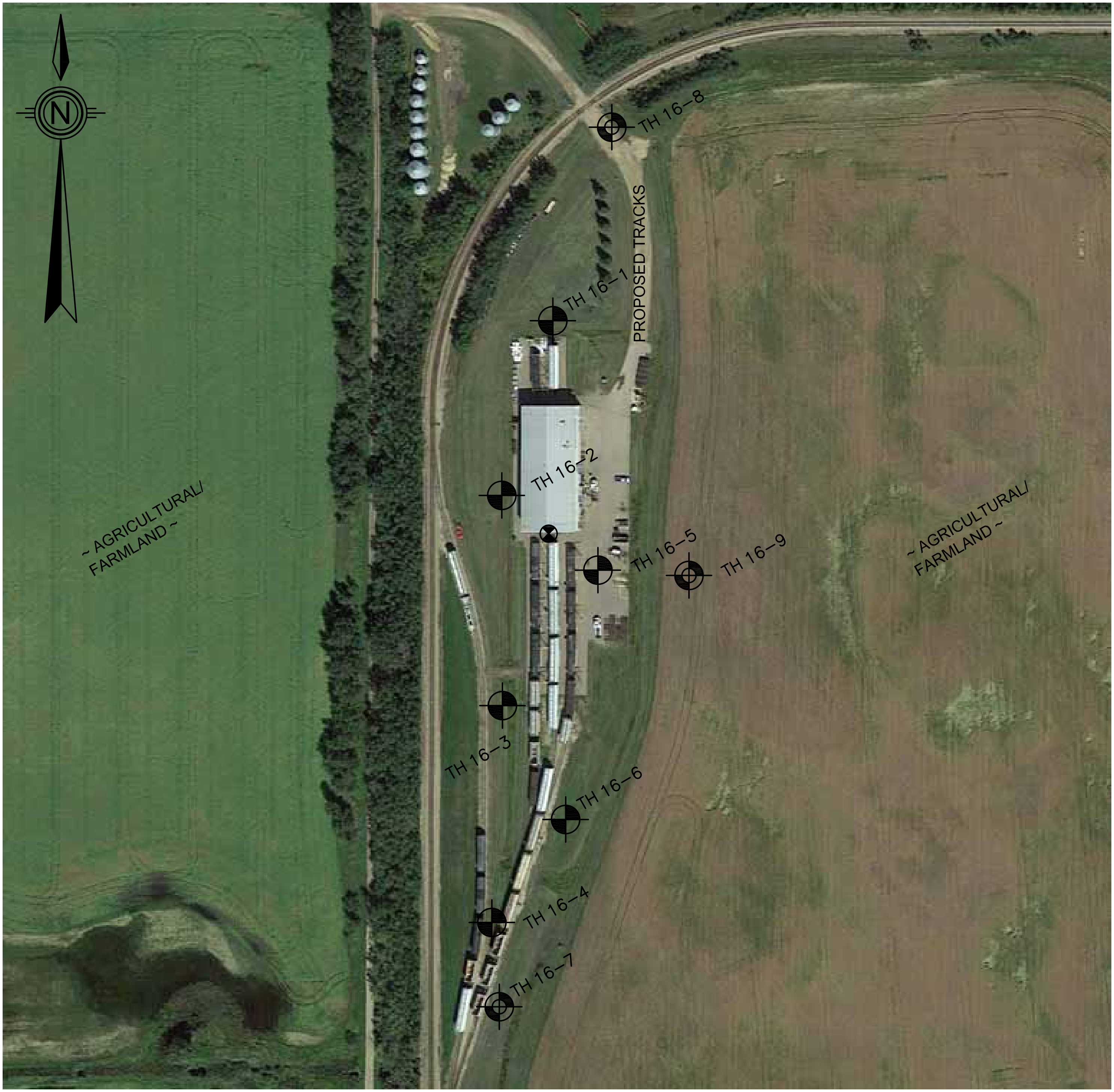
DRAWINGS



NOTE:
1. THIS DRAWING IS FOR CONCEPTUAL PURPOSES ONLY. ACTUAL LOCATIONS MAY VARY AND NOT ALL STRUCTURES ARE SHOWN.
2. THIS DRAWING WAS COMPILED FROM GOOGLE EARTH PRO ©2016, IMAGE ©2016 DIGITALGLOBE, (IMAGERY DATE: 8/22/15).
3. BENCHMARK: TOP OF MIDDLE BAY DOOR CONCRETE SLAB, ASSUMED DATUM ELEVATION = 100.000 m.

LEGEND

- ⊕ —PMEL TEST HOLE
- ⊕ —PMEL TEST HOLE (PIEZOMETER INSTALLED)
- ⊗ —BENCHMARK

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DRAWING TITLE:

SITE PLAN - TEST HOLE LOCATIONS

PROJECT:

PROPOSED RAIL TRACK EXPANSION
WITHIN SW-9-39-25-W4M, NEAR JOFFRE, AB

APPROVED BY: ML

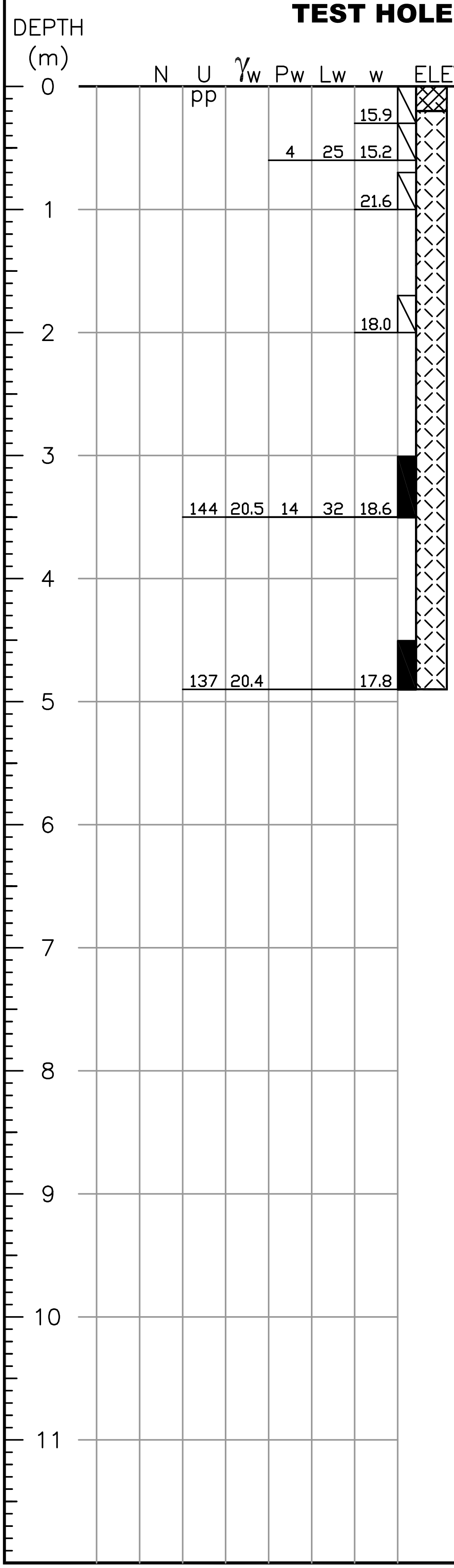
DRAWN BY: SD

DRAWING NUMBER: 12332-1

DATE: OCTOBER, 2015

SCALE: NOT TO SCALE

TEST HOLE 16-1



TOPSOIL, black, rootlets.

GLACIAL TILL, clay, some silt, some sand, trace gravel, firm, medium plastic, moist, black, coal chips, trace organics.
—brown, medium plastic, no organics below 900 mm.
—seepage below 1.5 m.

—stiff below 2.0 m.

—grey below 3.2 m.

NOTE:
1. Test Hole open and dry I.A.D.

LEGEND:

TOPSOIL
FILL
GRAVEL
SAND
SILT
CLAY
GLACIAL TILL

w.....WATER CONTENT (PERCENT OF DRY SOIL WEIGHT)

Lw...LIQUID LIMIT

Pw...PLASTIC LIMIT

γw...WET UNIT WEIGHT (kN/m³)

U.....UNCONFINED COMPRESSIVE STRENGTH (kPa)

pp...POCKET PENETROMETER (kg/cm²)

N.....STANDARD PENETRATION TEST (SAFETY HAMMER w/AUTOMATIC TRIP) (50/125 = BLOWS/SAMPLER PENETRATION [mm])

SO_4 .....SULPHATE CONTENT (PERCENT OF DRY SOIL WEIGHT)

P200...% PASSING No. 200 SIEVE

I.A.D.....IMMEDIATELY AFTER DRILLING

▽...RECORDED WATER LEVEL (TEST HOLE I.A.D.)

▼...RECORDED WATER LEVEL (PIEZO)

■ SHELBY TUBE
☒ SPLIT SPOON
⧅ CUTTINGS

LIMITATIONS: THE FIELD DRILL LOG IS A SUMMARY OF THE SUBSURFACE CONDITIONS ENCOUNTERED AT THE SPECIFIC TEST HOLE LOCATION AT THE TIME OF TEST DRILLING. SUBSURFACE CONDITIONS MAY VARY AT OTHER LOCATIONS OF THIS SITE AND, IN TIME, MAY CHANGE AT THIS SPECIFIC TEST HOLE LOCATION.

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FIELD DRILL LOG AND SOIL TEST RESULTS

PROJECT:
PROPOSED RAIL TRACK EXPANSION

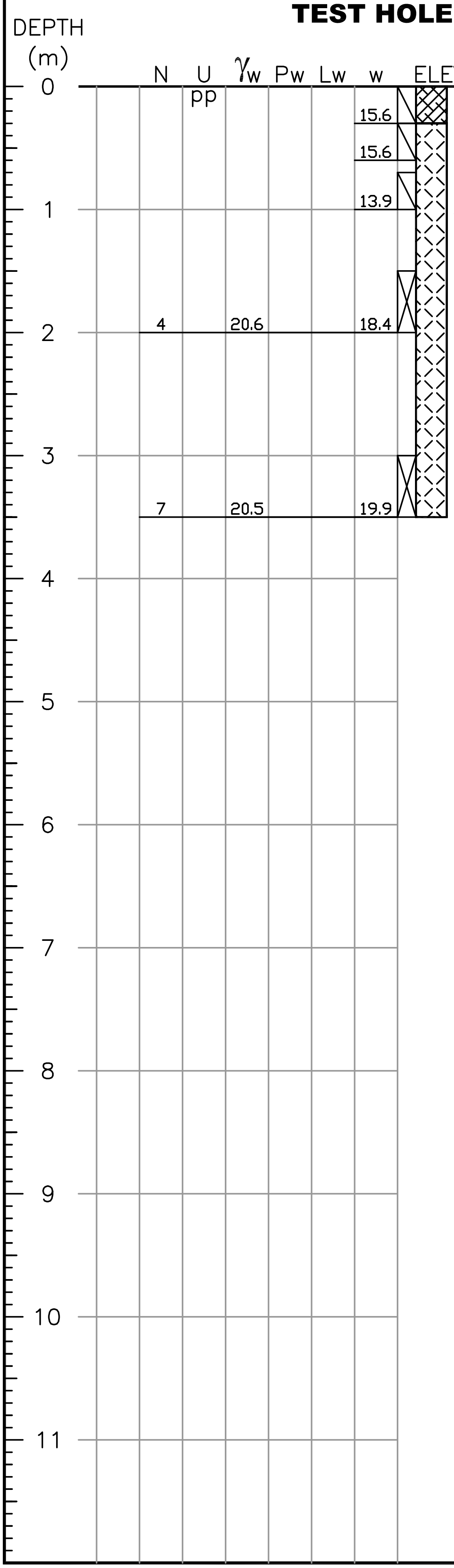
LOCATION:
WITHIN SW-9-39-25-W4M,
NEAR JOFFRE, AB

NORTHING: 5801700 **EASTING:** 0325975

DATE DRILLED: OCT 11/16

DRAWING NUMBER: 12332-2

TEST HOLE 16-2



TOPSOIL, black, rootlets.

GLACIAL TILL, clay, some silt, some sand, trace gravel, firm, medium plastic, moist, black, coal chips, gypsum crystals, trace organics.

—brown, no organics below 900 mm.

—seepage below 3.0 m.

NOTE:

1. Test Hole open and dry I.A.D.

LEGEND:

▨ TOPSOIL
▤ FILL
▩ GRAVEL
░ SAND
▥ SILT
▧ CLAY
▨ GLACIAL TILL

w.....WATER CONTENT (PERCENT OF DRY SOIL WEIGHT)

Lw...LIQUID LIMIT

Pw...PLASTIC LIMIT

γw...WET UNIT WEIGHT (kN/m³)

U.....UNCONFINED COMPRESSIVE STRENGTH (kPa)

pp...POCKET PENETROMETER (kg/cm²)

N.....STANDARD PENETRATION TEST (SAFETY HAMMER w/AUTOMATIC TRIP) (50/125 = BLOWS/SAMPLER PENETRATION [mm])

SO_4 .....SULPHATE CONTENT (PERCENT OF DRY SOIL WEIGHT)

P200...% PASSING No. 200 SIEVE

I.A.D.....IMMEDIATELY AFTER DRILLING

▽...RECORDED WATER LEVEL (TEST HOLE I.A.D.)

▼...RECORDED WATER LEVEL (PIEZO)

■ SHELBY TUBE
☒ SPLIT SPOON
⧄ CUTTINGS

LIMITATIONS: THE FIELD DRILL LOG IS A SUMMARY OF THE SUBSURFACE CONDITIONS ENCOUNTERED AT THE SPECIFIC TEST HOLE LOCATION AT THE TIME OF TEST DRILLING. SUBSURFACE CONDITIONS MAY VARY AT OTHER LOCATIONS OF THIS SITE AND, IN TIME, MAY CHANGE AT THIS SPECIFIC TEST HOLE LOCATION.

P. MACHIBRODA ENGINEERING LTD.

FIELD DRILL LOG AND SOIL TEST RESULTS

PROJECT:

PROPOSED RAIL TRACK EXPANSION

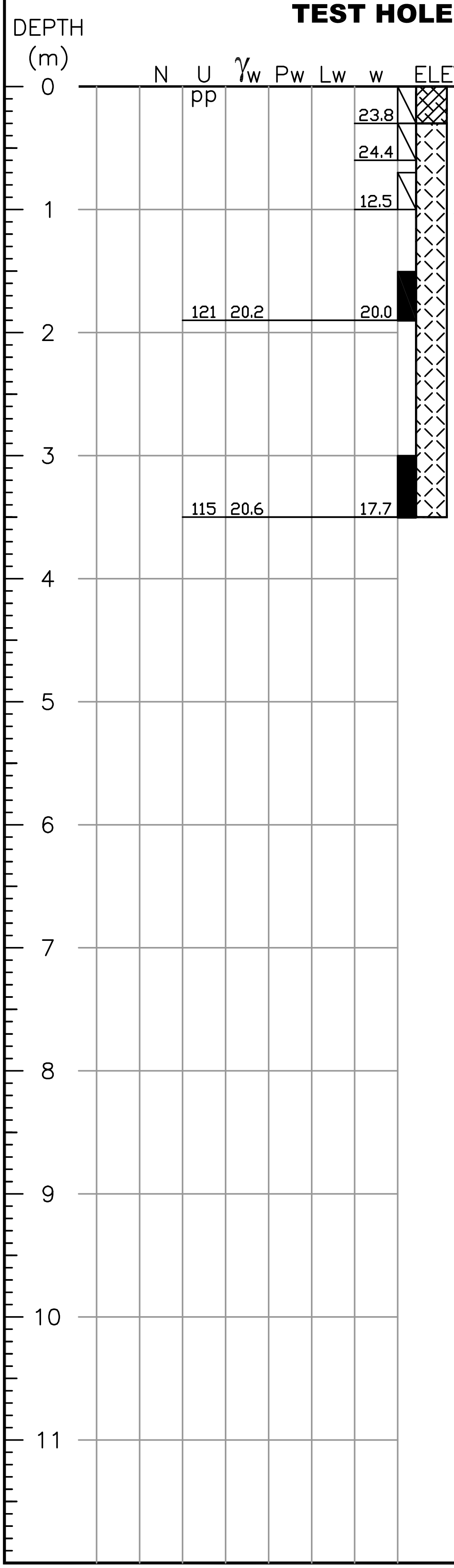
LOCATION:

WITHIN SW-9-39-25-W4M,
NEAR JOFFRE, AB

NORTHING: 5801624 **EASTING:** 0325950

DATE DRILLED:	**DRAWING NUMBER:**
OCT 11/16	12332-3

TEST HOLE 16-3



TOPSOIL, black, rootlets.

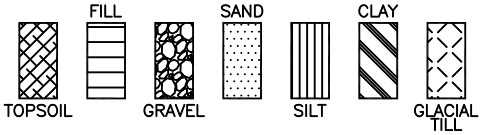
GLACIAL TILL, clay, some silt, some sand, trace gravel, stiff, medium plastic, moist, black, coal chips, gypsum crystals, trace organics.
–brown, no organics below 900 mm.

–firm below 1.7 m.

–seepage below 3.1 m.

NOTE:
1. Test Hole open and dry I.A.D.

LEGEND:



w.....WATER CONTENT (PERCENT OF DRY SOIL WEIGHT)

Lw...LIQUID LIMIT

Pw...PLASTIC LIMIT

γw...WET UNIT WEIGHT (kN/m³)

U.....UNCONFINED COMPRESSIVE STRENGTH (kPa)

pp...POCKET PENETROMETER (kg/cm²)

N.....STANDARD PENETRATION TEST (SAFETY HAMMER w/AUTOMATIC TRIP) (50/125 = BLOWS/SAMPLER PENETRATION [mm])

SO_4 .....SULPHATE CONTENT (PERCENT OF DRY SOIL WEIGHT)

P200...% PASSING No. 200 SIEVE

I.A.D.....IMMEDIATELY AFTER DRILLING

▽...RECORDED WATER LEVEL (TEST HOLE I.A.D.)

▼...RECORDED WATER LEVEL (PIEZO)

■ SHELBY TUBE ☒ SPLIT SPOON ⧅ CUTTINGS

LIMITATIONS: THE FIELD DRILL LOG IS A SUMMARY OF THE SUBSURFACE CONDITIONS ENCOUNTERED AT THE SPECIFIC TEST HOLE LOCATION AT THE TIME OF TEST DRILLING. SUBSURFACE CONDITIONS MAY VARY AT OTHER LOCATIONS OF THIS SITE AND, IN TIME, MAY CHANGE AT THIS SPECIFIC TEST HOLE LOCATION.

P. MACHIBRODA ENGINEERING LTD.

FIELD DRILL LOG AND SOIL TEST RESULTS

PROJECT:
PROPOSED RAIL TRACK EXPANSION

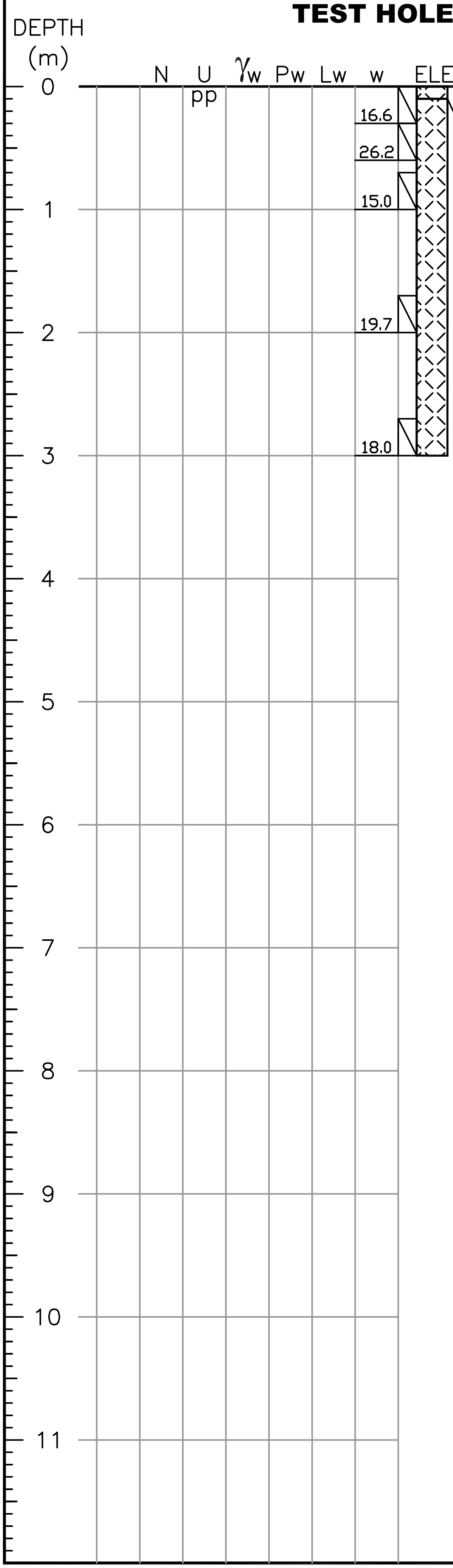
LOCATION:
WITHIN SW-9-39-25-W4M,
NEAR JOFFRE, AB

NORTHING: 5801532 **EASTING:** 0325947

DATE DRILLED: OCT 11/16

DRAWING NUMBER: 12332-4

TEST HOLE 16-4



ELEV: 99.2 m

TOPSOIL, black, rootlets.

GLACIAL TILL, clay, some silt, some sand, trace gravel, stiff, medium plastic, moist, brown, coal chips, oxide stained, gypsum crystals.
–trace organics 500 to 800 mm.

–firm below 1.6 m.

NOTE:
1. Test Hole open and dry I.A.D.

LEGEND:

▩ TOPSOIL
☰ FILL
⁘ GRAVEL
░ SAND
▥ SILT
▧ CLAY
⧅ GLACIAL TILL

w.....WATER CONTENT (PERCENT OF DRY SOIL WEIGHT)

Lw...LIQUID LIMIT

Pw...PLASTIC LIMIT

γw...WET UNIT WEIGHT (kN/m³)

U.....UNCONFINED COMPRESSIVE STRENGTH (kPa)

pp...POCKET PENETROMETER (kg/cm²)

N.....STANDARD PENETRATION TEST (SAFETY HAMMER w/AUTOMATIC TRIP) (50/125 = BLOWS/SAMPLER PENETRATION [mm])

SO_4.....SULPHATE CONTENT (PERCENT OF DRY SOIL WEIGHT)

P200...% PASSING No. 200 SIEVE

I.A.D.....IMMEDIATELY AFTER DRILLING

▽...RECORDED WATER LEVEL (TEST HOLE I.A.D.)

▼...RECORDED WATER LEVEL (PIEZO)

■ SHELBY TUBE
☒ SPLIT SPOON
⧄ CUTTINGS

LIMITATIONS: THE FIELD DRILL LOG IS A SUMMARY OF THE SUBSURFACE CONDITIONS ENCOUNTERED AT THE SPECIFIC TEST HOLE LOCATION AT THE TIME OF TEST DRILLING. SUBSURFACE CONDITIONS MAY VARY AT OTHER LOCATIONS OF THIS SITE AND, IN TIME, MAY CHANGE AT THIS SPECIFIC TEST HOLE LOCATION.

P. MACHIBRODA
ENGINEERING
LTD.

FIELD DRILL LOG AND SOIL TEST RESULTS

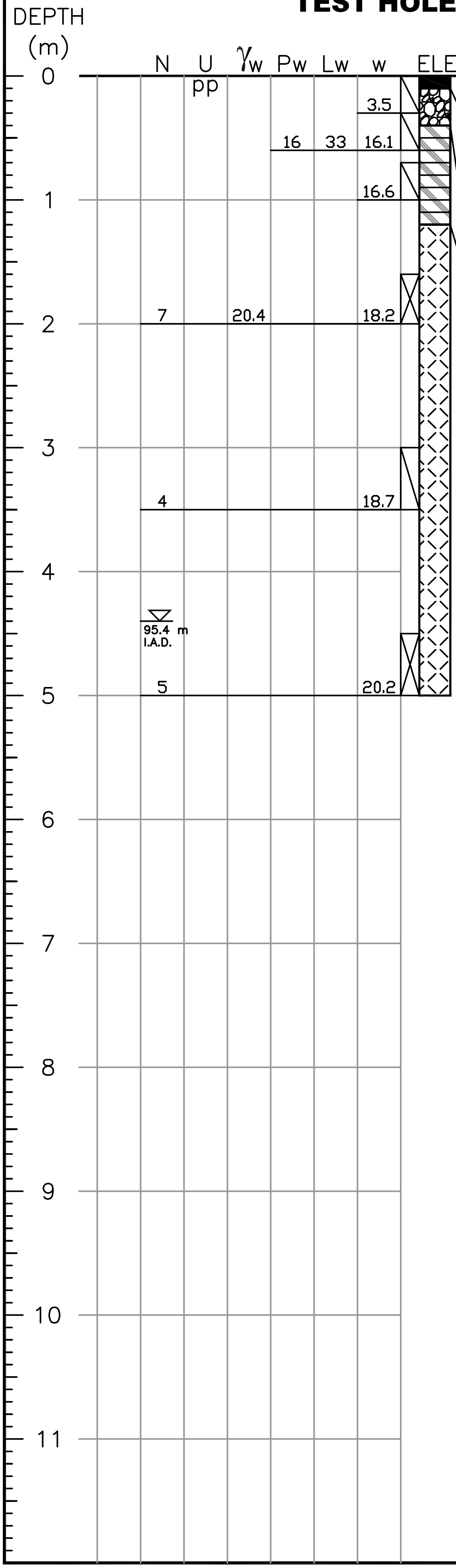
PROJECT:
PROPOSED RAIL
TRACK EXPANSION

LOCATION:
WITHIN SW-9-39-25-W4M,
NEAR JOFFRE, AB

NORTHING: 5801437 **EASTING:** 0325939

DATE DRILLED:	**DRAWING NUMBER:**
OCT 11/16	12332-5

TEST HOLE 16-5



ASPHALT.

GRAVEL, sandy, trace silt, compact, well graded, fine to coarse grained, moist, brown.

FILL, clay, some silt, trace sand, trace gravel, medium plastic, moist, grey, trace organics.

GLACIAL TILL, clay, some silt, some sand, trace gravel, firm, medium plastic, moist, brown, mottled grey, oxide stained.

—seepage below 3.2 m.

NOTE:
1. Test Hole open I.A.D.

LEGEND:

▨	▤	▩	░	▥	▧	▨
TOPSOIL	FILL	GRAVEL	SAND	SILT	CLAY	GLACIAL TILL

w.....WATER CONTENT
(PERCENT OF DRY SOIL WEIGHT)

Lw...LIQUID LIMIT

Pw...PLASTIC LIMIT

γw...WET UNIT WEIGHT (kN/m³)

U.....UNCONFINED COMPRESSIVE
STRENGTH (kPa)

pp...POCKET PENETROMETER (kg/cm²)

N.....STANDARD PENETRATION TEST
(SAFETY HAMMER w/AUTOMATIC TRIP)
(50/125 = BLOWS/SAMPLER
PENETRATION [mm])

SO_4 .....SULPHATE CONTENT
(PERCENT OF DRY SOIL WEIGHT)

P200...% PASSING No. 200 SIEVE

I.A.D.....IMMEDIATELY AFTER DRILLING

▽...RECORDED WATER LEVEL
(TEST HOLE I.A.D.)

▼...RECORDED WATER LEVEL (PIEZO)

■	☒	◪
SHELBY TUBE	SPLIT SPOON	CUTTINGS

LIMITATIONS: THE FIELD DRILL LOG IS A SUMMARY OF THE SUBSURFACE CONDITIONS ENCOUNTERED AT THE SPECIFIC TEST HOLE LOCATION AT THE TIME OF TEST DRILLING. SUBSURFACE CONDITIONS MAY VARY AT OTHER LOCATIONS OF THIS SITE AND, IN TIME, MAY CHANGE AT THIS SPECIFIC TEST HOLE LOCATION.

P. MACHIBRODA
ENGINEERING
LTD.

FIELD DRILL LOG AND SOIL TEST RESULTS

PROJECT:

PROPOSED RAIL
TRACK EXPANSION

LOCATION:

WITHIN SW-9-39-25-W4M,
NEAR JOFFRE, AB

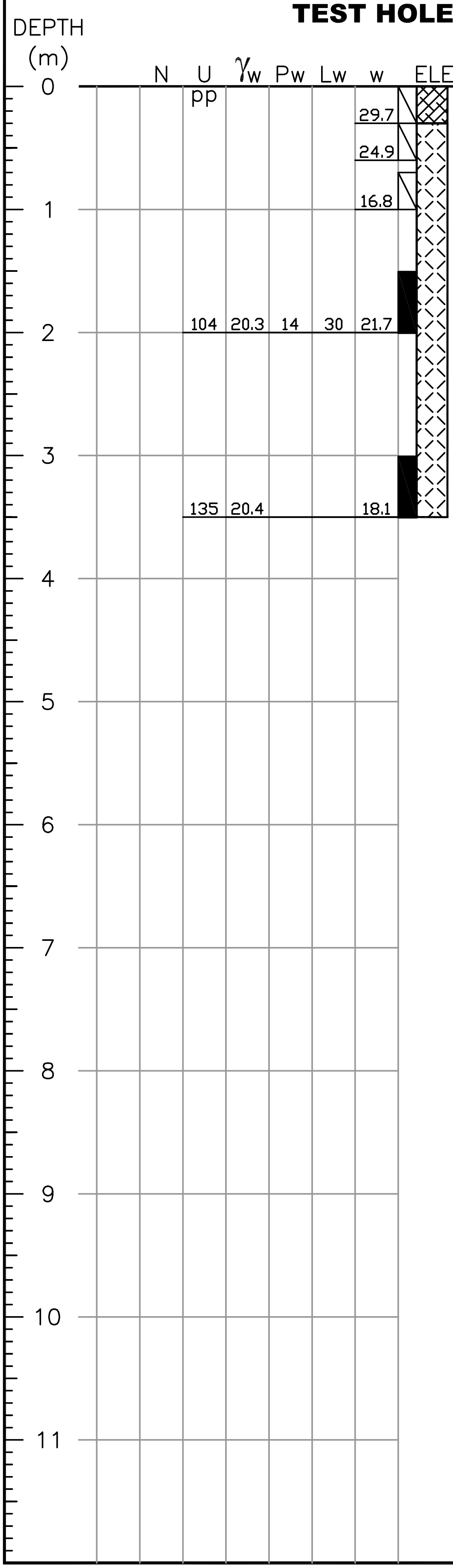
NORTHING: 5801590 **EASTING:** 0325991

DATE DRILLED: OCT 11/16

DRAWING NUMBER: 12332-6

TEST HOLE 16-6

ELEV: 99.7 m



TOPSOIL, black, rootlets.

GLACIAL TILL, clay, some silt, some sand, trace gravel, firm, medium plastic, moist, black, coal chips, gypsum crystals, trace organics.
—brown, no organics below 900 mm.

—seepage below 2.5 m.

—stiff below 2.9 m.

NOTE:
1. Test Hole open and dry I.A.D.

LEGEND:

TOPSOIL
FILL
GRAVEL
SAND
SILT
CLAY
GLACIAL TILL

w.....WATER CONTENT (PERCENT OF DRY SOIL WEIGHT)

Lw...LIQUID LIMIT

Pw...PLASTIC LIMIT

γ_w...WET UNIT WEIGHT (kN/m³)

U.....UNCONFINED COMPRESSIVE STRENGTH (kPa)

pp...POCKET PENETROMETER (kg/cm²)

N.....STANDARD PENETRATION TEST (SAFETY HAMMER w/AUTOMATIC TRIP) (50/125 = BLOWS/SAMPLER PENETRATION [mm])

SO_4 .....SULPHATE CONTENT (PERCENT OF DRY SOIL WEIGHT)

P200...% PASSING No. 200 SIEVE

I.A.D.....IMMEDIATELY AFTER DRILLING

▽...RECORDED WATER LEVEL (TEST HOLE I.A.D.)

▼...RECORDED WATER LEVEL (PIEZO)

■ SHELBY TUBE
☒ SPLIT SPOON
⧄ CUTTINGS

LIMITATIONS: THE FIELD DRILL LOG IS A SUMMARY OF THE SUBSURFACE CONDITIONS ENCOUNTERED AT THE SPECIFIC TEST HOLE LOCATION AT THE TIME OF TEST DRILLING. SUBSURFACE CONDITIONS MAY VARY AT OTHER LOCATIONS OF THIS SITE AND, IN TIME, MAY CHANGE AT THIS SPECIFIC TEST HOLE LOCATION.

P. MACHIBRODA ENGINEERING LTD.

FIELD DRILL LOG AND SOIL TEST RESULTS

PROJECT:
PROPOSED RAIL TRACK EXPANSION

LOCATION:
WITHIN SW-9-39-25-W4M,
NEAR JOFFRE, AB

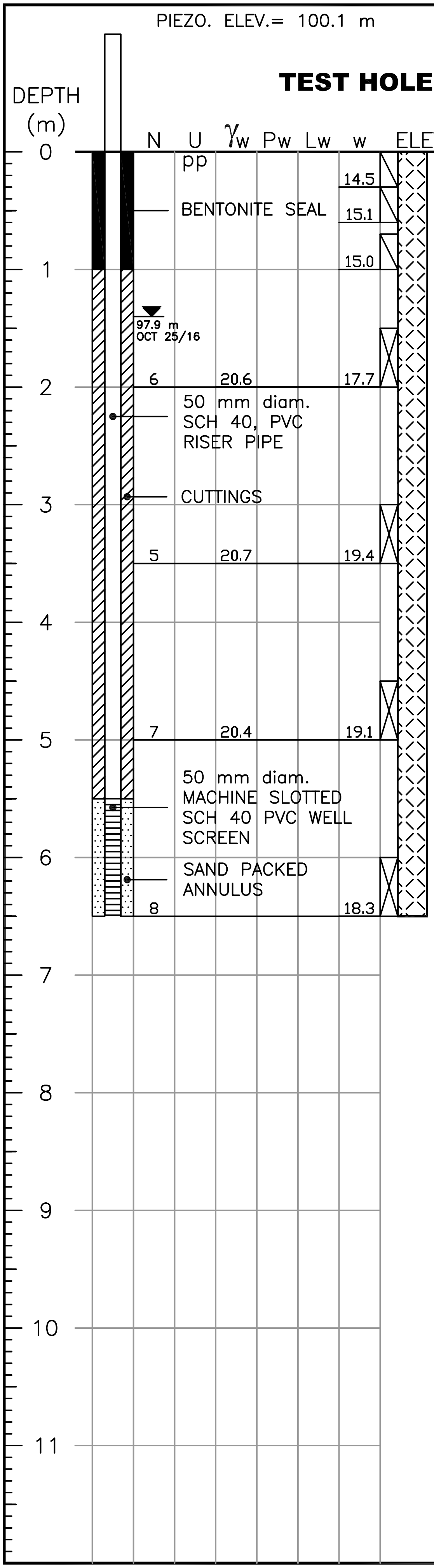
NORTHING: 5801481 **EASTING:** 0325973

DATE DRILLED: OCT 11/16

DRAWING NUMBER: 12332-7

PIEZO. ELEV.= 100.1 m

TEST HOLE 16-7



GLACIAL TILL, clay, some silt, some sand, trace gravel, firm, medium plastic, moist, brown, coal chips, oxide stained.

–seepage below 3.6 m.

–grey below 4.6 m.

–stiff below 6.0 m.

NOTE:
1. Test Hole open and dry I.A.D.

LEGEND:

TOPSOIL ▩ FILL ▤ GRAVEL SAND ▒ SILT ▥ CLAY ▧ GLACIAL TILL

w.....WATER CONTENT (PERCENT OF DRY SOIL WEIGHT)

Lw...LIQUID LIMIT

Pw...PLASTIC LIMIT

γw...WET UNIT WEIGHT (kN/m³)

U.....UNCONFINED COMPRESSIVE STRENGTH (kPa)

pp...POCKET PENETROMETER (kg/cm²)

N.....STANDARD PENETRATION TEST (SAFETY HAMMER w/AUTOMATIC TRIP) (50/125 = BLOWS/SAMPLER PENETRATION [mm])

SO_4 .....SULPHATE CONTENT (PERCENT OF DRY SOIL WEIGHT)

P200...% PASSING No. 200 SIEVE

I.A.D.....IMMEDIATELY AFTER DRILLING

▽...RECORDED WATER LEVEL (TEST HOLE I.A.D.)

▼...RECORDED WATER LEVEL (PIEZO)

■ SHELBY TUBE ☒ SPLIT SPOON ◸ CUTTINGS

LIMITATIONS: THE FIELD DRILL LOG IS A SUMMARY OF THE SUBSURFACE CONDITIONS ENCOUNTERED AT THE SPECIFIC TEST HOLE LOCATION AT THE TIME OF TEST DRILLING. SUBSURFACE CONDITIONS MAY VARY AT OTHER LOCATIONS OF THIS SITE AND, IN TIME, MAY CHANGE AT THIS SPECIFIC TEST HOLE LOCATION.

P. MACHIBRODA ENGINEERING LTD.

FIELD DRILL LOG AND SOIL TEST RESULTS

PROJECT:
PROPOSED RAIL
TRACK EXPANSION

LOCATION:
WITHIN SW-9-39-25-W4M,
NEAR JOFFRE, AB

NORTHING: 5801400 **EASTING:** 0325941

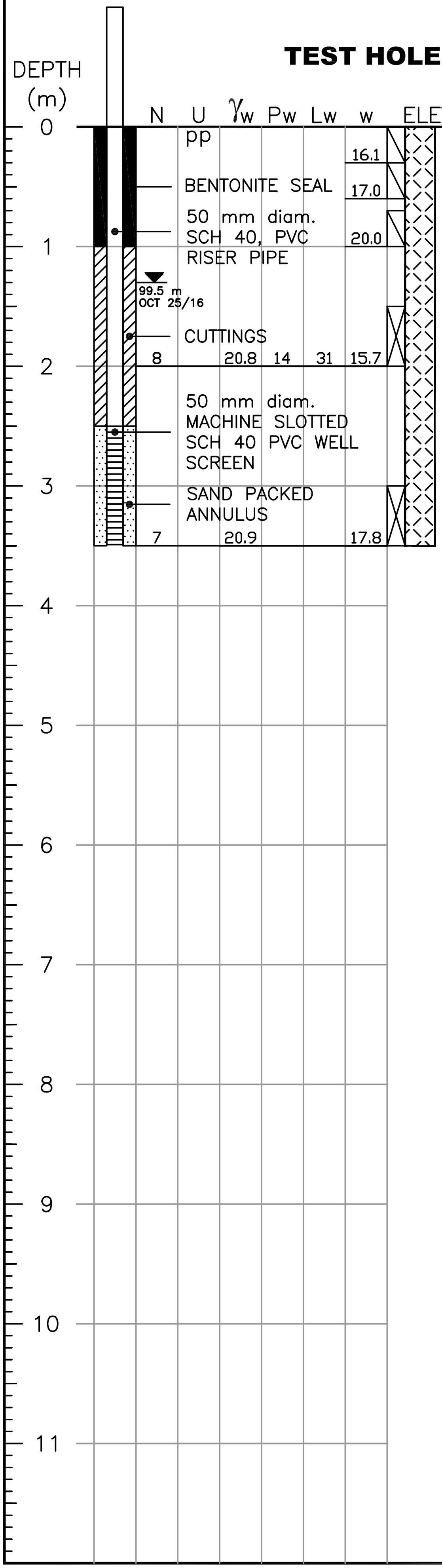
DATE DRILLED: OCT 11/16

DRAWING NUMBER: 12332-8

PIEZO. ELEV.= 101.9 m

TEST HOLE 16-8

ELEV: 100.8 m



N	U	γ_w	Pw	Lw	w
					16.1
					17.0
					20.0
8		20.8	14	31	15.7
7		20.9			17.8

GLACIAL TILL, clay, some silt, some sand, trace gravel, firm, medium plastic, moist, grey.

–brown below 1.4 m.

NOTE:
1. Test Hole open and dry I.A.D.

LEGEND:

TOPSOIL, FILL, GRAVEL, SAND, SILT, CLAY, GLACIAL TILL

w.....WATER CONTENT (PERCENT OF DRY SOIL WEIGHT)

Lw...LIQUID LIMIT

Pw...PLASTIC LIMIT

γw...WET UNIT WEIGHT (kN/m^3)

U.....UNCONFINED COMPRESSIVE STRENGTH (kPa)

pp...POCKET PENETROMETER (kg/cm^2)

N.....STANDARD PENETRATION TEST (SAFETY HAMMER w/AUTOMATIC TRIP) (50/125 = BLOWS/SAMPLER PENETRATION [mm])

SO$_4$ .....SULPHATE CONTENT (PERCENT OF DRY SOIL WEIGHT)

P200...% PASSING No. 200 SIEVE

I.A.D.....IMMEDIATELY AFTER DRILLING

▽...RECORDED WATER LEVEL (TEST HOLE I.A.D.)

▼...RECORDED WATER LEVEL (PIEZO)

■ SHELBY TUBE ☒ SPLIT SPOON ⧅ CUTTINGS

LIMITATIONS: THE FIELD DRILL LOG IS A SUMMARY OF THE SUBSURFACE CONDITIONS ENCOUNTERED AT THE SPECIFIC TEST HOLE LOCATION AT THE TIME OF TEST DRILLING. SUBSURFACE CONDITIONS MAY VARY AT OTHER LOCATIONS OF THIS SITE AND, IN TIME, MAY CHANGE AT THIS SPECIFIC TEST HOLE LOCATION.

P. MACHIBRODA ENGINEERING LTD.

FIELD DRILL LOG AND SOIL TEST RESULTS

PROJECT:
PROPOSED RAIL
TRACK EXPANSION

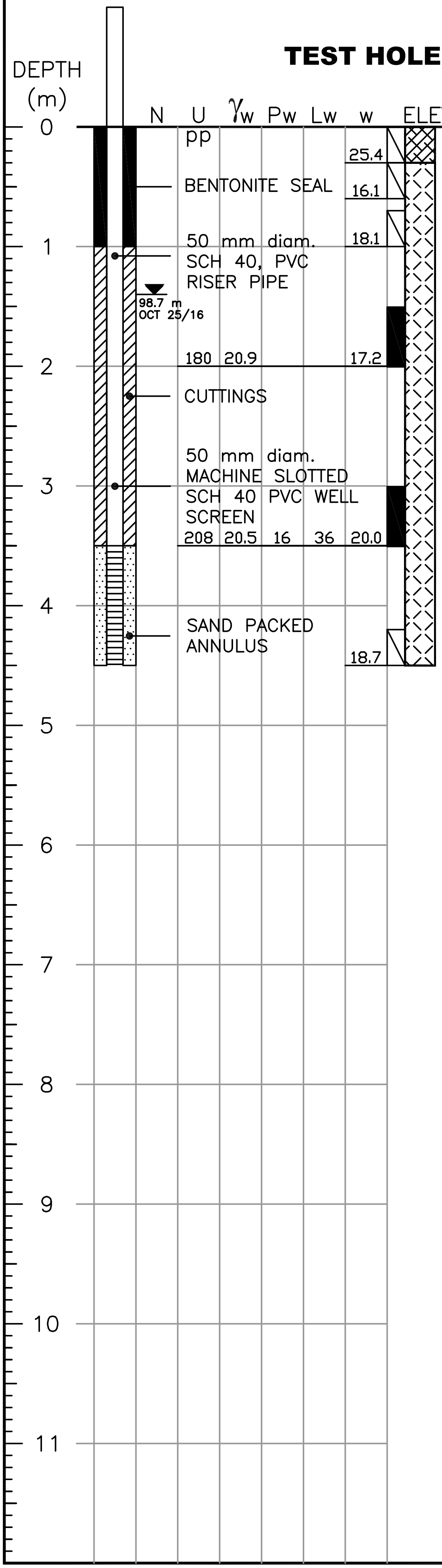
LOCATION:
WITHIN SW-9-39-25-W4M,
NEAR JOFFRE, AB

NORTHING: 5801784 **EASTING:** 0326004

DATE DRILLED:	DRAWING NUMBER:
OCT 11/16	12332-9

PIEZO. ELEV.= 101.1 m

TEST HOLE 16-9



TOPSOIL, black, rootlets.

GLACIAL TILL, clay, some silt, some sand, trace gravel, stiff, medium plastic, moist, brown, coal chips, gypsum crystals.

NOTE:
1. Test Hole open and dry I.A.D.

LEGEND:

TOPSOIL ▩ FILL ▤ GRAVEL SAND SILT ▥ CLAY ▧ GLACIAL TILL

w.....WATER CONTENT (PERCENT OF DRY SOIL WEIGHT)

Lw...LIQUID LIMIT

Pw...PLASTIC LIMIT

γw...WET UNIT WEIGHT (kN/m³)

U.....UNCONFINED COMPRESSIVE STRENGTH (kPa)

pp...POCKET PENETROMETER (kg/cm²)

N.....STANDARD PENETRATION TEST (SAFETY HAMMER w/AUTOMATIC TRIP) (50/125 = BLOWS/SAMPLER PENETRATION [mm])

SO_4.....SULPHATE CONTENT (PERCENT OF DRY SOIL WEIGHT)

P200...% PASSING No. 200 SIEVE

I.A.D.....IMMEDIATELY AFTER DRILLING

▽...RECORDED WATER LEVEL (TEST HOLE I.A.D.)

▼...RECORDED WATER LEVEL (PIEZO)

■ SHELBY TUBE ☒ SPLIT SPOON ⧅ CUTTINGS

LIMITATIONS: THE FIELD DRILL LOG IS A SUMMARY OF THE SUBSURFACE CONDITIONS ENCOUNTERED AT THE SPECIFIC TEST HOLE LOCATION AT THE TIME OF TEST DRILLING. SUBSURFACE CONDITIONS MAY VARY AT OTHER LOCATIONS OF THIS SITE AND, IN TIME, MAY CHANGE AT THIS SPECIFIC TEST HOLE LOCATION.

P. MACHIBRODA ENGINEERING LTD.

FIELD DRILL LOG AND SOIL TEST RESULTS

PROJECT:
PROPOSED RAIL
TRACK EXPANSION

LOCATION:
WITHIN SW-9-39-25-W4M,
NEAR JOFFRE, AB

NORTHING: 5801586 **EASTING:** 0326031

DATE DRILLED: OCT 11/16

DRAWING NUMBER: 12332-10

APPENDIX A

EXPLANATION OF TERMS ON TEST HOLE LOGS

CLASSIFICATION OF SOILS

Coarse-Grained Soils: Soils containing particles that are visible to the naked eye. They include gravels and sands and are generally referred to as cohesionless or non-cohesive soils. Coarse-grained soils are soils having more than 50 percent of the dry weight larger than particle size 0.080 mm.

Fine-Grained Soils: Soils containing particles that are not visible to the naked eye. They include silts and clays. Fine-grained soils are soils having more than 50 percent of the dry weight smaller than particle size 0.080 mm.

Organic Soils: Soils containing a high natural organic content.

Soil Classification By Particle Size

Clay – particles of size	< 0.002 mm
Silt – particles of size	0.002 – 0.060 mm
Sand – particles of size	0.06 – 2.0 mm
Gravel – particles of size	2.0 – 60 mm
Cobbles – particles of size	60 – 200 mm
Boulders – particles of size	>200 mm

TERMS DESCRIBING CONSISTENCY OR CONDITION

Coarse-grained soils: Described in terms of compactness condition and are often interpreted from the results of a Standard Penetration Test (SPT). The standard penetration test is described as the number of blows, N, required to drive a 51 mm outside diameter (O.D.) split barrel sampler into the soil a distance of 0.3 m (from 0.15 m to 0.45 m) with a 63.5 kg weight having a free fall of 0.76 m.

Compactness Condition	SPT N-Index (blows per 0.3 m)
Very loose	0-4
Loose	4-10
Compact	10-30
Dense	30-50
Very dense	Over 50

Fine-Grained Soils: Classified in relation to undrained shear strength.

Consistency	Undrained Shear Strength (kPa)	N Value (Approximate)	Field Identification
Very Soft	<12	0-2	Easily penetrated several centimetres by the fist.
Soft	12-25	2-4	Easily penetrated several centimetres by the thumb.
Firm	25-50	4-8	Can be penetrated several centimetres by the thumb with moderate effort.
Stiff	50-100	8-15	Readily indented by the thumb, but penetrated only with great effort.
Very Stiff	100-200	15-30	Readily indented by the thumb nail.
Hard	>200	>30	Indented with difficulty by the thumbnail.

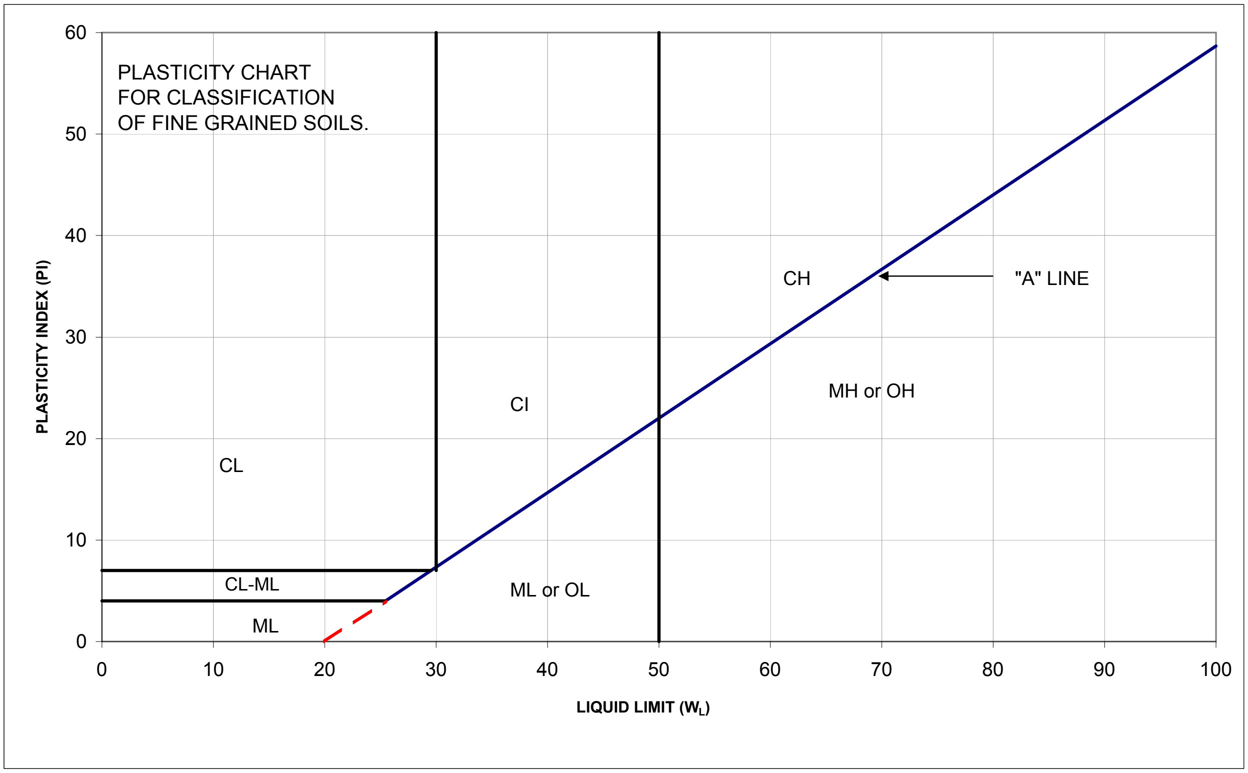
Organic Soils: Readily identified by colour, odour, spongy feel and frequently by fibrous texture.

DESCRIPTIVE TERMS COMMONLY USED TO CHARACTERIZE SOILS

Poorly Graded	- predominance of particles of one grain size.
Well Graded	- having no excess of particles in any size range with no intermediate sizes lacking.
Mottled	- marked with different coloured spots.
Nuggety	- structure consisting of small prismatic cubes.
Laminated	- structure consisting of thin layers of varying colour and texture.
Slickensided	- having inclined planes of weakness that are slick and glossy in appearance.
Fissured	- containing shrinkage cracks.
Fractured	- broken by randomly oriented interconnecting cracks in all 3 dimensions.

SOIL CLASSIFICATION SYSTEM (MODIFIED U.S.C.)

MAJOR DIVISION			GROUP SYMBOL	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA
HIGHLY ORGANIC SOILS			Pt	PEAT AND OTHER HIGHLY ORGANIC SOILS	STRONG COLOUR OR ODOUR AND OFTEN FIBROUS TEXTURE
COARSE-GRAINED SOILS (MORE THAN HALF BY WEIGHT LARGER THAN NO. 200 SIEVE SIZE)	GRAVELS More than half coarse fraction larger than No. 4 sieve size	CLEAN GRAVELS	GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES <5% FINES	$C_u = \frac{D_{60}}{D_{10}} > 4$ $C_c = \frac{(D_{30})^2}{D_{60} \times D_{10}} = 1$ to 3
			GP	POORLY-GRADED GRAVELS AND GRAVEL-SAND MIXTURES <5% FINES	NOT MEETING ALL ABOVE REQUIREMENTS FOR GW
		DIRTY GRAVELS	GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES >12% FINES	ATTERBERG LIMITS BELOW "A" LINE OR PI < 4
			GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES >12% FINES	ATTERBERG LIMITS ABOVE "A" LINE WITH PI > 7
	SANDS More than half coarse fraction smaller than No. 4 sieve size	CLEAN SANDS	SW	WELL-GRADED SANDS, GRAVELLY SANDS MIXTURES <5% FINES	$C_u = \frac{D_{60}}{D_{10}} > 6$ $C_c = \frac{(D_{30})^2}{D_{60} \times D_{10}} = 1$ to 3
			SP	POORLY-GRADED SANDS OR GRAVELLY SANDS <5% FINES	NOT MEETING ALL GRADATION REQUIREMENTS FOR SW
		DIRTY SANDS	SM	SILTY SANDS, SAND-SILT MIXTURES >12% FINES	ATTERBERG LIMITS BELOW "A" LINE OR PI < 4
			SC	CLAYEY SANDS, SAND-CLAY MIXTURES >12% FINES	ATTERBERG LIMITS ABOVE "A" LINE WITH PI >7
FINE-GRAINED SOILS (MORE THAN HALF BY WEIGHT PASSING NO. 200 SIEVE SIZE)	SILTS Below "A" line on plasticity chart; negligible organic content		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY SANDS OF SLIGHT PLASTICITY	$W_L < 50$
			MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS, FINE SANDY OR SILTY SOILS	$W_L > 50$
	CLAYS Above 'A" line on plasticity chart; negligible organic content		CL	INORGANIC CLAYS OF LOW PLASTICITY, GRAVELLY, SANDY, OR SILTY CLAYS, LEAN CLAYS	$W_L < 30$
			CI	INORGANIC CLAYS OF MEDIUM PLASTICITY, SILTY CLAYS	$W_L > 30 < 50$
			CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS	$W_L > 50$
	ORGANIC SILTS & ORGANIC CLAYS Below "A" line on plasticity chart		OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY	$W_L < 50$
			OH	ORGANIC CLAYS OF HIGH PLASTICITY	$W_L > 50$



APPENDIX B

LABORATORY TEST RESULTS

ASTM D422: GRAIN SIZE ANALYSIS OF SOIL

Project: PROPOSED RAIL TRACK EXPANSION
WITHIN SW-9-39-25-W4M, JOFFRE, ALBERTA

Project No.: 12332

Date Tested: OCTOBER 14, 2016

Test Hole No.: 16-1

Sample No.: 5

Depth (m): 3-3.5

Sieve Analysis:

Sieve	Diameter mm	% Finer
1.5"	38.1	100
1"	25.4	100
3/4"	19.1	100
1/2"	12.7	100
3/8"	9.5	100
# 4	4.75	100
# 10	2	99
# 20	0.85	97
# 40	0.425	92.7
#60	0.25	86.4
# 100	0.15	78.1
# 200	0.075	65.6

Hydrometer Analysis:

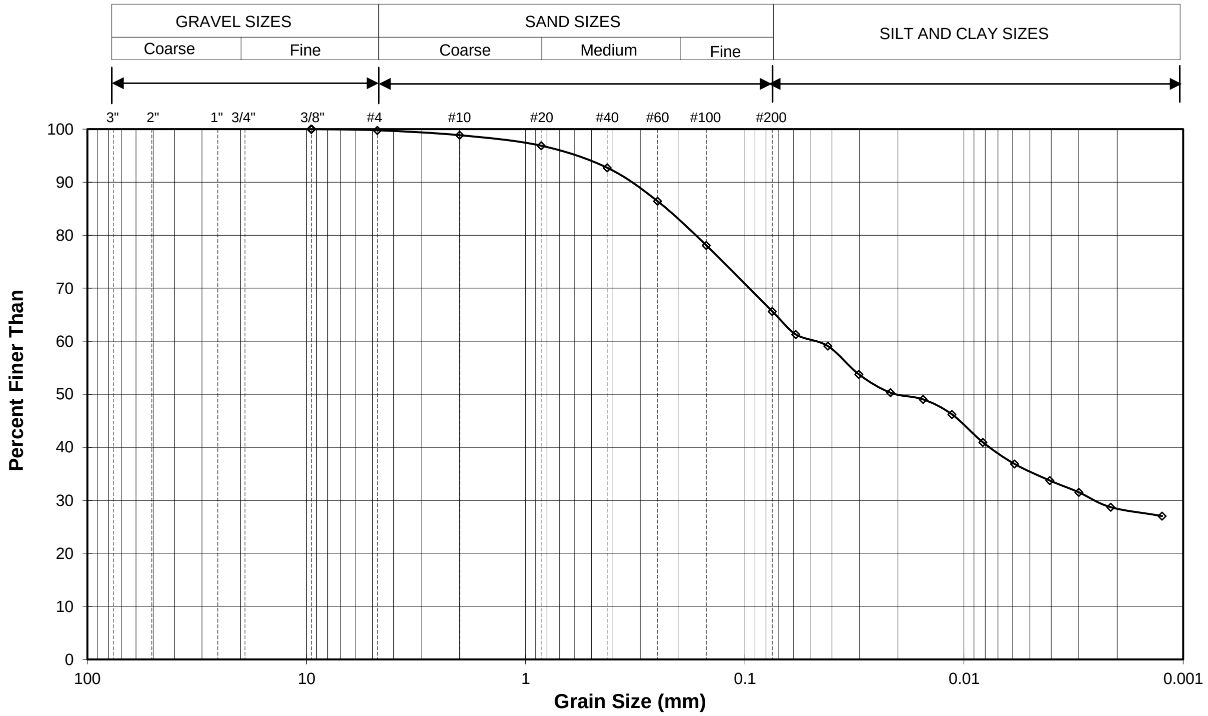
Dispersing Agent:
Sodium Hexametaphosphate

Diameter mm	% Finer
0.0585	61.3
0.0418	59.1
0.0302	53.8
0.0216	50.3
0.0154	49.0
0.0113	46.2
0.0082	41.0
0.0059	36.9
0.0041	33.7
0.0030	31.5
0.0021	28.7
0.0012	27.1

Material Description:

% Gravel Sizes	% Sand Sizes	% Silt Sizes	% Clay Sizes
0	34	37	29

Remarks:



P. MACHIBRODA ENGINEERING LTD.

DRAWING NO.

APPENDIX B-1

ASTM D422: GRAIN SIZE ANALYSIS OF SOIL

Project: PROPOSED RAIL TRACK EXPANSION
WITHIN SW-9-39-25-W4M, JOFFRE, ALBERTA

Project No.: 12332

Date Tested: OCTOBER 14, 2016

Test Hole No.: 16-6

Sample No.: 31

Depth (m): 1.5-2

Sieve Analysis:

Sieve	Diameter mm	% Finer
1.5"	38.1	100
1"	25.4	100
3/4"	19.1	100
1/2"	12.7	100
3/8"	9.5	100
# 4	4.75	100
# 10	2	99
# 20	0.85	98
# 40	0.425	94.6
#60	0.25	88.7
# 100	0.15	80.9
# 200	0.075	68.0

Hydrometer Analysis:

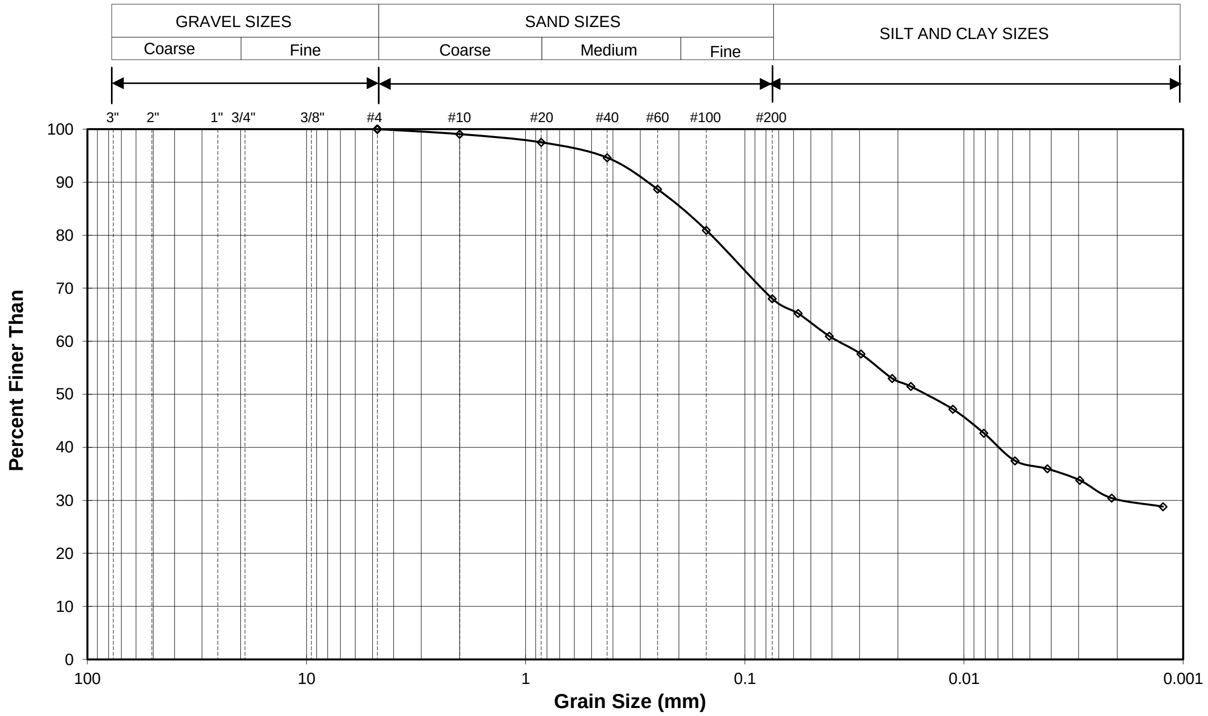
Dispersing Agent:
Sodium Hexametaphosphate

Diameter mm	% Finer
0.0571	65.3
0.0412	61.0
0.0295	57.6
0.0213	53.0
0.0175	51.5
0.0113	47.2
0.0081	42.7
0.0059	37.5
0.0042	35.9
0.0030	33.8
0.0021	30.4
0.0012	28.8

Material Description:

% Gravel Sizes	% Sand Sizes	% Silt Sizes	% Clay Sizes
0	32	38	30

Remarks:



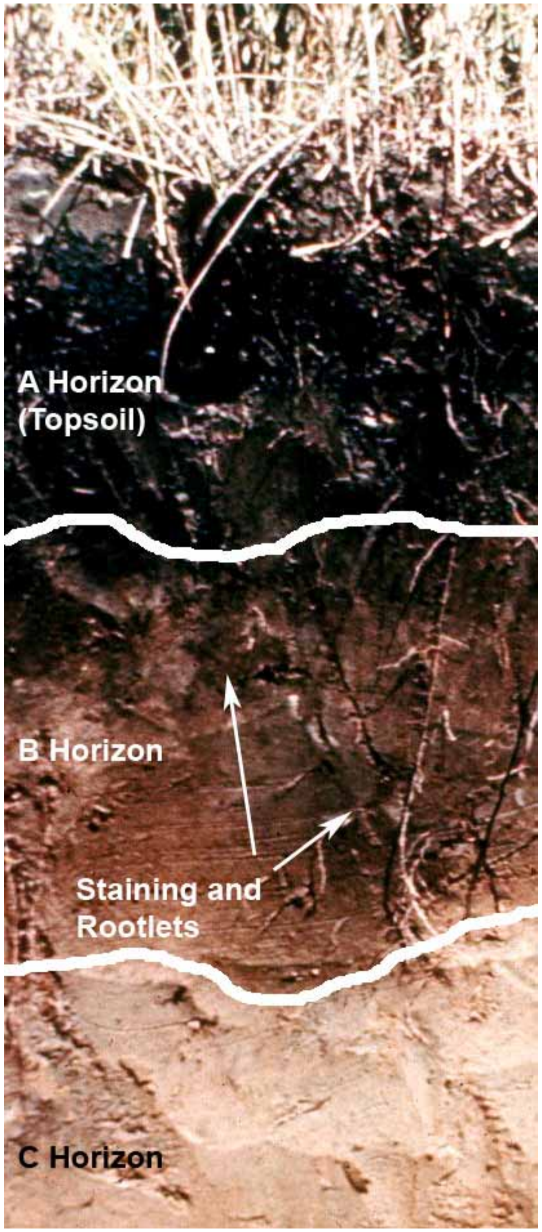
P. MACHIBRODA ENGINEERING LTD.

DRAWING NO.

APPENDIX B-2

APPENDIX C

TOPSOIL, ORGANIC MATTER AND ORGANICS



A Horizon

The A horizon is the topsoil layer of the soil strata. It is characterized by a build up of organic matter, and a lower unit weight than subsequent layers. The organic matter content of this layer is typically 4-10% by mass.

The colour of this horizon varies from dark black to brown, depending on surface vegetation and climatic conditions.

B Horizon

Typically reddish brown in colour and contains accumulations of matter that have been washed down from the A Horizon. The B horizon is generally composed of clay that has been washed out of the A Horizon, but can also contain iron, calcium and sodium deposits as well.

C Horizon

Unweathered parent soil.

Topsoil is a mixture of mineral soil and organic matter. The organic matter is developed from decaying biological material (leaves, grass, trees, animals, etc.) and contributes to the brown to black colour of the soil. Following the topsoil is the B horizon which is a transition layer, where staining from the overlying topsoil is common. This results in a darker colour of the soil immediately below the organic topsoil layer. Depending on the surface vegetation, rootlets may be present below the depth of topsoil. However it should be recognized that these rootlets are not the same as organic matter in topsoil.

Physically speaking in comparison to mineral soil, topsoil has a significantly lower bulk density and a lower unit weight as compared to the underlying parent soil. This is due to larger pore spaces and non mineral materials in the soil matrix. Along with lower density, topsoil is often spongy and colloidal/fibrous. The following figure is of a typical prairie soil. Each horizon is labelled accordingly to demonstrate a typical soil profile.

Reference

Henry L. 2003. Henry's Handbook of Soil and Water, Henry Perspectives, Saskatoon, SK.