TREK GEOTECHNICAL Quality Engineering | Valued Relationships

February 17, 2015 File No. 0015 010 00

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RE Geotechnical Investigation for Shoal lake Intake Fuel Storage and Delivery System Rehabilitation

Introduction

This letter provides design values and recommendations for the construction of shallow foundations for the Fuel Storage and Delivery System Rehabilitation works planned at the Shoal Lake Aqueduct Intake. The proposed facility consists of a concrete pad on the east and west side of the existing rail line to support above ground fuel storage tanks and ancillary equipment.

Field Investigation

Test holes 15-02 and 15-01 were drilled on the east and west sides of the track at the locations shown on Drawing 01. The holes were drilled by Maple Leaf Drilling using an Acker MP-5 track mounted drill rig under the supervision of TREK Geotechnical. Disturbed samples were collected and taken to TREK's soils laboratory in Winnipeg for additional visual classification and testing. Standard Penetration tests (SPT) were conducted in the non-cohesive soils. The test holes were backfilled with auger cuttings upon completion. The attached test hole logs provide a description of the soil units encountered, the results of field testing (Torvane, pocket penetrometer and SPT blow counts) and observations made during drilling. Additional interpretation on the engineering properties of the soil units, in particular the clay layer encountered at depth, were made based on other test holes drilled in the vicinity previously by UMA Engineering and in 2015 by TREK. All interpretations of soil stratigraphy for the purposes of design should refer to the detailed information provided on the attached test hole logs.

Subsurface Conditions

The soil stratigraphy west of the rail line (TH 15-01) consists of topsoil overlying sand (fill), peat, silt and highly plastic clay at a depth of 2.3 m. The soil stratigraphy east of the rail line (TH 15-02) consists of topsoil overlying compact sand, silt and sand and highly plastic clay. The absence of peat in this test hole suggests it has been removed previously and replaced with sand fill. A copy of the draft test hole logs are attached for reference. No seepage was encountered in either test hole.

Recommendations for Shallow Foundations

Shallow foundations should be placed on undisturbed clay soil or granular fill overlying undisturbed clay. In this regard, all unsuitable soil including topsoil, peat, silt, or any other deleterious material within the foundation footprint should be removed. Based on TH 15-01, the excavation of unsuitable soils to a depth of about 2.3 m below surface will be required on the west side of the rail line. A minimum of 0.5 m of compacted granular fill (as recommended below) should be placed below the slab, above the sand encountered on the east side of the rail line (TH 15-02). Additionally, the native sand should be compacted prior to placement of any fill materials. It is important to note that the lateral extent and depth of these soil units will vary and the final excavation limits (horizontal and vertical) need to be determined in the field during construction.

Recommendations provided herein for the design of shallow foundations are in accordance with the National Building Code of Canada (NBCC). Shallow footings founded on undisturbed clay can be designed using a Serviceability Limit State (SLS) bearing resistance of 100 kPa and an Ultimate Limit State (ULS) bearing resistance of 125 kPa, which is based on a resistance factor of 0.4. Shallow footings founded on undisturbed sand (for example east of the rail line) can be designed using an SLS bearing resistance of 130 kPa and a ULS bearing resistance of 160 kPa. If increased bearing capacity is required beneath the foundations, compacted granular fill used to replace unsuitable soils can be accounted for in distributing the contact load on the clay (or sand) to the design values. In this regard, the contact stress at depth should be made based on a 0.5 horizontal to 1 vertical (0.5H:1V) linear decreasing stress distribution. Furthermore, the distributed stresses below the sand east of the rail line should be calculated at depth to ensure the design values provided above for the clay are not exceeded.

The SLS values provided are intended to limit total settlement to 25 mm and differential settlement (for individual foundation units) to about 12 mm. Differential settlement between shallow foundations on either side of the track should be expected. Shallow foundations may also be subject to additional vertical movement associated with seasonal shrinkage and swelling of the clay subgrade.

The soil response (sub-grade reaction) to vertical loads can be modeled in a manner that assumes the soil beneath a shallow foundation can be simulated by a series of vertical springs. The soil behaviour can be estimated using an equivalent spring constant referred to as the vertical sub-grade reaction modulus (k_v). It is expected that the tributary stress area (below the base of the foundation) will extend into the clay layer, and therefore the k_v value for design should be largely reflective of this clay layer. A k_v value ranging between 12,000 and 24,000 kN/m^3 for clay is suggested for use as an estimated boundary condition for analysis.

Additional considerations for the design and construction of shallow footings are provided below:

1. The sub-grade should be protected from freezing, drying, or inundation with water. As such, it may be necessary for the contractor to sequence construction so that only a small portion of the subgrade remains open at a given time and that excavations are backfilled as soon as possible.
2. Excavations should be completed with a backhoe equipped with a smooth bladed bucket operating from the edge of the excavation. Care should be taken not to over-excavate and to minimize the subgrade disturbance at all times.
3. After excavation, the subgrade should be reviewed by qualified geotechnical personnel.
4. Where soft or weak areas are identified by the geotechnical personnel, these areas should be over-excavated and replaced with compacted granular fill or repaired as directed by the geotechnical engineer.
5. Fill required to raise grades or for levelling should consist of 20 mm down crushed limestone placed in maximum 150 mm thick lifts and compacted to 98% SPMDD.

Closure

The geotechnical information provided in this report is in accordance with current engineering principles and practices (Standard of Practice). The findings of this report were based on information provided (field inspections, photographs). If conditions are different than the conditions previously encountered on-site or those presented here, we should be notified to adjust our findings if necessary.

All information provided in this report is subject to our standard terms and conditions for engineering services, a copy of which is provided to each of our clients with the original scope of work, or a mutually executed standard engineering services agreement. If these conditions are not attached, and you are not already in possession of such terms and conditions, contact our office and you will be promptly provided with a copy.

This report has been prepared by TREK Geotechnical Inc. (the Consultant) for the exclusive use of The City of Winnipeg (the Client) and their agents for the work product presented in the report. Any findings or recommendations provided in this report are not to be used or relied upon by any third parties, except as agreed to in writing by the Client and Consultant prior to use.

Kind Regards,

TREK Geotechnical
Per:

Reviewed By:

APEGM
Certificate of Authorization
Trek Geotechnical Inc.
No. 4877 Date: Feb 17/2015

PROVINCE OF MANITOBA
B. S.
HAY
Member
32339
Feb 17/15
REGISTERED PROFESSIONAL ENGINEER

Michael Van Helden
for:

Brent Hay, P.Eng.
Geotechnical Engineer

Ken Skaftfeld, M.Sc., P.Eng.,
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BSH/ks
Attach.

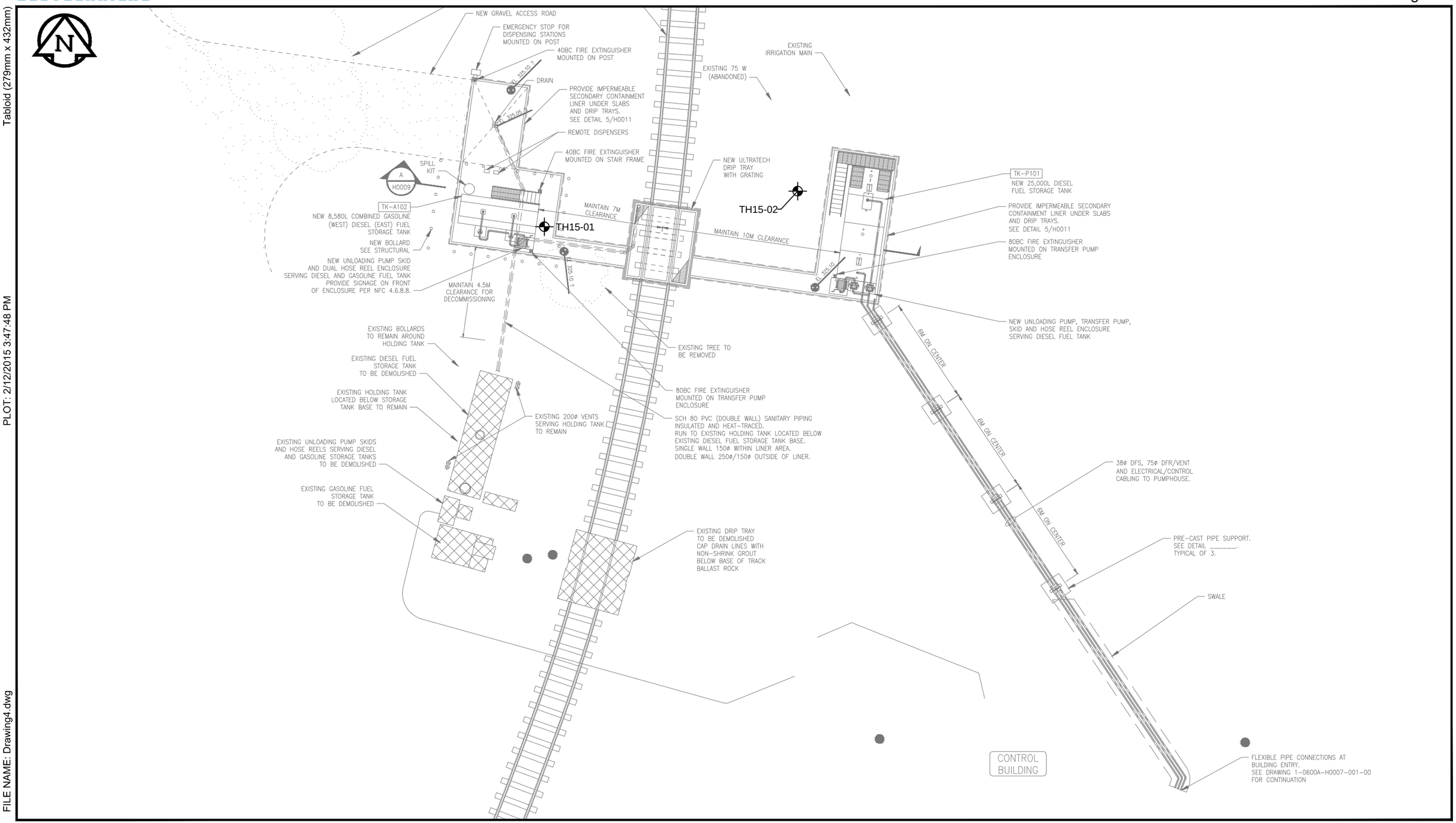
TREK GEOTECHNICAL

0015 010 00
City of Winnipeg
Shoal Lake Foundation Investigation

Tabloid (279mm x 432mm)

PLOT: 2/12/2015 3:47:48 PM

FILE NAME: Drawing4.dwg



0 2 4 6 8m
SCALE : 1:200 (279mm x 432mm)

LEGEND :

⊕ TEST HOLE (TREK, JANUARY 13, 2015)

NOTES :

1. DRAWING FROM CITY OF WINNIPEG, DRAWING NUMBER 1-0600A-H0008-001-00 A

Figure 01
Test Hole Site Plan

Sub-Surface Log

Test Hole TH15-01
1 of 1

Client:	City of Winnipeg	**Project Number:**	0015 010 00
Project Name:	Shoal Lake Intake Fuel Storage and Delivery System Rehabilitation	**Location:**	Fuel Storage - west of Rail Line (see DWG 01)
Contractor:	Maple Leaf Drilling	**Ground Elevation:**	324.91 m Existing Ground
Method:	125 mm Solid Stem Auger, Acker MP5-T Track Mount	**Date Drilled:**	January 13, 2015 - January 13, 2015

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) | Split Barrel (SB) | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	RQD (%)	SPT (N)
324.6	0		ORGANIC CLAY (Topsoil) - silty, trace sand, trace gravel, black, frozen, moist and firm when thawed, high plasticity		G01		
324.1	0.5		SAND (Fill) - trace clay, trace silt, trace gravel - brown, frozen, moist when thawed		G02		
323.4	1.0		ORGANIC SILT - trace fine sand - black, moist		G03		
322.6	1.5		SILT - some fine sand, trace clay - light brown - moist - soft, low plasticity		G04		
321.9	2.5		CLAY - silty, trace sand - brown - moist, firm to stiff, high plasticity		G05		
	3.0		END OF TESTHOLE @ 3.0 m in CLAY.				

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21

Particle Size (%): 0 20 40 60 80 100

PL MC LL: 0 20 40 60 80 100

Undrained Shear Strength (kPa)

Test Type: △ Torvane △ ✪ Pocket Pen. ✪ ☒ Qu ☒ ○ Field Vane ○

0 50 100 150 200 250

Notes:
1) No sloughing or seepage observed.
2) Test hole open to 3.0 m upon completion.
3) Test hole backfilled with bentonite to surface.

Logged By: Brent Hay **Reviewed By:** Ken Skaftfeld **Project Engineer:** Ken Skaftfeld

SUB-SURFACE LOG LOGS 2015-01-28 SHOAL LAKE FDN INV 0015-010-00 0_FINAL FUEL ONLY.GPJ TREK GEOTECHNICAL.GDT 2/12/15

Sub-Surface Log

Test Hole TH15-02
1 of 1

Client: City of Winnipeg
Project Number: 0015 010 00
Project Name: Shoal Lake Intake Fuel Storage and Delivery System Rehabilitation
Location: Fuel Storage - east of Rail Line (see DWG 01)
Contractor: Maple Leaf Drilling
Ground Elevation: 324.99 m Existing Ground
Method: 125 mm Solid Stem Auger, Acker MP5-T Track Mount
Date Drilled: January 13, 2015 - January 13, 2015

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) | Split Barrel (SB) | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	RQD (%)	SPT (N)
324.8	0		ORGANIC CLAY (Topsoil) - silty, trace sand, trace gravel, black, frozen, moist and firm when thawed, high plasticity				
			SAND - brown - frozen, moist when thawed - compact, poorly graded fine to medium grained sand				
	0.5		-non-frozen below 0.8 m		G06		
	1.0				G07		14
	1.5						
323.3			SILT and SAND - brown - moist to wet - compact, fine grained sand				18
	2.0				G08		
322.6							27
	2.5		CLAY - silty - brown - moist, firm to stiff, high plasticity				
321.9	3.0				G09		

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21
Particle Size (%): 0 20 40 60 80 100
PL MC LL: 0 20 40 60 80 100
Undrained Shear Strength (kPa): 0 50 100 150 200 250
Test Type: △ Torvane △ ✪ Pocket Pen. ✪ ☒ Qu ☒ ○ Field Vane ○

END OF TESTHOLE @ 3.0 m in CLAY.
Notes:
1) No sloughing or seepage observed.
2) Test hole open to 3.0 m upon completion.
3) Test hole backfilled with bentonite to surface.

Logged By: Brent Hay **Reviewed By:** Ken Skaftfeld **Project Engineer:** Ken Skaftfeld

SUB-SURFACE LOG LOGS 2015-01-28 SHOAL LAKE FDN INV 0015-010-00 0_FINAL FUEL ONLY.GPJ TREK GEOTECHNICAL.GDT 2/12/15