Elias Consulting
Occupational Hygiene

108 Turnbull Drive Winnipeg MB R3V 1X2
T: 204-261-1770 www.eliasconsulting.ca
www.adjustingtlvs.com
C: 204-998-5710 alison@eliasconsulting.ca

October 16, 2019 Project # 15-A-167-82a

Trevor Blue
Winnipeg Transit
421 Osborne Street
Winnipeg MB R3L 2A2

Re: Asbestos Assessment – Drain pipe in Bus Hoist Pit

As part of the bus hoist replacement project, the horizontal pipe connecting the front jack to the drain channel was assessed for asbestos. The pipe from hoist H16 was sampled and analyzed for asbestos. The cementitious drain pipes are all considered asbestos containing.

Sample Details/Parameters		Result	Qualifier*	D.L.	Units	Extracted	Analyzed
L2364970-1	H16 DRAIN PIPE						
Sampled By:	CLIENT on 15-OCT-19						
Matrix:							
Bulk Asbestos Content							
Asbestos: Chrysotile (Serpentine)		10-25		1	%		15-OCT-19
Asbestos: Crocidolite (Amphibole)		10-25		1	%		15-OCT-19
Other Non Fibrous: Filler		50-75		1	%		15-OCT-19
Note: Sample contains asbestos							

After discussions with the Contractor, the cementitious pipes most likely cannot be removed intact (no further damage). All work that will result in the active damage of the pipe would need to occur inside the enclosure. Meaning that the jack hammering that will result in crushing the pipes will need to occur in a Type 2 enclosure in order to contain the silica dust and any asbestos fibers that may be released. An enclosure would need to be built over the area being jack hammered and the open pit. All workers inside the enclosure would be required to have appropriate asbestos abatement training.

Yours truly,
For Elias Occupational Hygiene Consulting Inc.

Alison Reineke, BHEc, BSc, CIH, ROH, CRSP
Occupational Hygienist

Elias Consulting
Occupational Hygiene

108 Turnbull Drive Winnipeg MB R3V 1X2
T: 204-261-1770 www.eliasconsulting.ca
www.adjustingtlvs.com
C: 204-998-5710 alison@eliasconsulting.ca

October 7, 2019 Project # 15-A-167-82

Trevor Blue
Winnipeg Transit
421 Osborne Street
Winnipeg MB R3L 2A2

Re: Asbestos Assessment – Pipe in Bus Hoist Pit

As part of the bus hoist replacement project, the horizontal pipe connecting the front and rear jack that houses the hydraulic hose was assessed for asbestos. Pipe H34 was sampled and analyzed for asbestos. The cementitious pipes are all considered asbestos containing.

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed
L2358326-1 H34 PIPE						
Sampled By: CLIENT on 02-OCT-19 @ 14:00						
Matrix: BULK						
Bulk Asbestos Content						
Asbestos: Chrysotile (Serpentine)	10-25		1	%		02-OCT-19
Asbestos: Crocidolite (Amphibole)	1-10		1	%		02-OCT-19
Other Non Fibrous: Filler	75-99		1	%		02-OCT-19
Note: Sample contains asbestos						

If each individual cementitious pipe can be removed without being actively damaged (removed intact, no further damage), each would be considered a Type 1 removal. No PPE would be required, and the waste would be treated as asbestos containing and double bagged.

If each individual cementitious pipe cannot be removed intact (no further damage), then each shall be removed under Type 2 abatement procedures. An enclosure would need to be built over the area and enclosing the open pit to some degree. All work that will result in the active damage of the pipe would need to occur inside the enclosure. All workers inside the enclosure would be required to have appropriate asbestos abatement training.

Yours truly,
For Elias Occupational Hygiene Consulting Inc.

Alison Reineke, BHEc, BSc, CIH, ROH, CRSP
Occupational Hygienist

Submitted to:

City of Winnipeg

EXCAVATION ASSESSMENT

WINNIPEG TRANSIT GARAGE BUILDING, 421 OSBORNE STREET
WINNIPEG, MANITOBA

FEBRUARY 2020

FILE NO.: 19-217-03

ENG-TECH CONSULTING LIMITED

"Engineering and Testing Solutions That Work for You"

420 Turenne Street
Winnipeg, Manitoba
Canada
R2J 3W8

1999 20 2019 YEARS OF EXCELLENCE

Phone: (204) 233-1694
Facsimile: (204) 235-1579
e-mail: engtech@mymts.net
www.eng-tech.ca

EXECUTIVE SUMMARY

ENG-TECH Consulting Limited (ENG-TECH) was retained by the City of Winnipeg (CoW) to assess the petroleum hydrocarbon (PHC) impact at the excavation for the hoist replacement at the Winnipeg Transit Garage Building at 421 Osborne Street in Winnipeg, Manitoba (in this report the property will subsequently be referred to as “the Site”).

The purpose of the current investigation was to assess the residual PHC impact in the soil resulting from the hydraulic hoists that were removed as part of the hoist replacement program. The purpose of the excavation was to facilitate the replacement of the hoists but not to remediate the site impact.

During the excavation/removal of the in-ground hoists and concrete pits, PHC impact in the soil was encountered. Parkwest Projects Ltd., the contractor conducting the hoist replacement, submitted several soil samples for analysis of benzene, toluene, ethylbenzene, xylenes (BTEX) and PHC fractions 1 to 4 (F1-F4). The analytical results indicated that PHC concentrations in the soil, especially PHC F3, were greater than the applicable regulatory guidelines. CoW subsequently decided to have the excavation assessed to determine the residual PHC concentrations at the limits (i.e. the base and walls) of the excavation.

ENG-TECH attended the Site on February 10, 2020 to conduct the excavation assessment. A total of 90 soil samples were collected from the base and walls of the excavation. A total of twelve (12) soil samples were submitted for analysis of BTEX and PHC F1-F4.

Three soil samples had PHC F3 concentrations greater than the applicable guidelines. Two of the samples (S66 and S72) were located on the south wall near the southwest corner (near Hoists 16 and 17); the other sample (S39) was located on the east wall of the excavation (to the east of Hoist 13).

Although only three (3) of the twelve (12) soil samples had PHC concentrations greater than the applicable guidelines, many soil samples from depths of 2 and 3 mbg appeared to be “oily”, indicating that hydraulic oil was present. At several locations, what appeared to be hydraulic oil was seeping from the walls of the excavation typically at the interface between the silt and clay layers.

None of the soils samples from the base of the excavation had PHC concentrations greater than the applicable guidelines. Based on the laboratory results and observations during the soil sampling, PHC impact in the soil did not appear to present at 3.5 metres below grade (i.e., the base of the excavation).

The CCME exposure pathway that governs the site would be “Management Limits”. According to the CCME CWS: “In addition to the chronic toxicity of PHC to human and ecological receptors, various effects of PHC contamination are also considered. These effects include:

- “Free phase formation;
- “Exposure of workers in trenches to PHC vapours;
- “Fire and explosive hazards;
- “Effects on buried infrastructure; and,
- “Aesthetic considerations.”

Since free phase hydraulic oil would not typically be considered an explosive hazard nor would it be expected to produce significant PHC vapours, the primary concerns would be the effects of the hydraulic oil on buried infrastructure and potential exposure of workers to hydraulic oil while working in trenches/excavations.

ENG-TECH concludes that residual concentrations of PHCs were present at the walls of the excavation at concentrations greater than the applicable guidelines.

TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 Terms of Reference

ENG-TECH Consulting Limited (ENG-TECH) was retained by the City of Winnipeg (CoW) to assess the petroleum hydrocarbon (PHC) impact at the excavation for the hoist replacement at the Winnipeg Transit Garage Building at 421 Osborne Street in Winnipeg, Manitoba (in this report the property will subsequently be referred to as "the Site").

ENG-TECH received authorization to proceed with the current assessment from Mr. Adolfo Laufer of the CoW Transit Department on February 3, 2020.

1.2 Objectives

The purpose of the current investigation was to assess the residual PHC impact in the soil resulting from the hydraulic hoists that were removed as part of the hoist replacement program. The purpose of the excavation was to facilitate the replacement of the hoists and not to remediate the site impact.

1.3 Scope of Work

The scope of work of the current investigation was as follows:

- Collected soil samples at regular intervals and depths representative of the soil layers and where PHC impact was suspected.
- Assess combustible vapour concentrations (CVCs) of the soil samples using an RKI Eagle portable gas detector.
- Submit samples to ALS Laboratories in Winnipeg for laboratory analysis.
- Prepare a report summarizing the field program and analytical results.

1.4 Methodology

The site remediation was conducted using guidelines and criteria outlined in publications from ASTM, the Canadian Council of Ministers of the Environment (CCME), Canadian Standards Association (CSA) and Manitoba Conservation and Climate (MCC). A bibliography/reference list of the publications referred to is attached to this report.

1.5 Background Information

During the excavation/removal of the in-ground hoists and concrete pits, PHC impact in the soil was encountered. Parkwest Projects Ltd., the contractor conducting the hoist replacement, submitted several soil samples for analysis of benzene, toluene, ethylbenzene, xylenes (BTEX) and PHC fractions 1 to 4 (F1-F4). The analytical results indicated that PHC concentrations in the soil, especially PHC F3, were greater than the applicable regulatory guidelines. The CoW subsequently decided to have the excavation assessed to determine the residual PHC concentrations at the limits (i.e. the base and walls) of the excavation.

2.0 SITE ASSESSMENT

2.1 Site Location and Description

The Site is located inside the Winnipeg Transit Garage Building at 421 Osborne Street in the City of Winnipeg, Manitoba. The Site and the majority of the surrounding property are zoned as C3 or “commercial corridor” by the CoW. Industrial property is located to the north and west; residential property is located farther east. The Site is currently used as a bus repair garage.

The site location is presented on Figure 1.

2.2 Field Activities

ENG-TECH attended the Site on February 10, 2020 to conduct the excavation assessment. A total of 90 soil samples were collected from the base and walls of the excavation. Each soil sample collected was analyzed for combustible vapour concentrations (CVCs) using an RKI Eagle calibrated to hexane and operated with methane response enabled. Briefly, the procedures used for CVC testing were as follows:

- Collect a soil sample and remove the perimeter edges. Cut the sample into small pieces and place them into a plastic sealable bag.
- Induce air into the bag such that the bag is taut and seal the bag.
- Allow the soil vapours to release from the soil to accumulate in the headspace of the bag at approximately 20°C.
- Measure the vapour concentration in the headspace of the bag by placing the probe of the RKI Eagle into the bag. Concentrations were recorded in parts per million (ppm) or the percent of the lower explosive limit for hexane (%LEL) and recorded on the test hole logs.

In addition to the above, each soil sample was visually assessed for the presence of obvious odours and/or staining. Soil samples for laboratory analysis were collected from the walls and base of the final excavation limits and were selected based on CVCs and visual observations. These soil samples were placed in laboratory-provided containers, sealed, and placed in a cooler with ice packs. Soil samples collected for analysis of BTEX and PHC F1 were collected using the Terra Core™ sampling device.

Upon completion of fieldwork, coolers were transported to ALS Laboratory Group (ALS) in Winnipeg, Manitoba. ALS is accredited with the Canadian Association for Laboratory Accreditation (CALA).

Table 1 summarizes the excavation soil sample details. Soil sample locations are presented on Figure 1. Photographs taken during the field activities are presented in Appendix A. The locations of the soil samples submitted for laboratory analysis including laboratory results are presented on Figure 2.

2.3 Laboratory Analyses

A total of twelve (12) soil samples were submitted for analysis of BTEX and PHC F1-F4.

The laboratory results are summarized in Table 2. Copies of the reports from ALS are attached in Appendix B.

2.4 Regulatory Guidelines

The results from the soil analyses will be compared to the guidelines outlined in the most recent Canadian Council of the Ministers of the Environment (CCME) publications including:

- CCME Canadian Environmental Quality (CEQ) Guidelines for Protection of Environmental and Human Health (most recent version) with 10^{-5} incremental risk guidelines used for benzene.
- CCME Canada-Wide Standards (CWS) for Petroleum Hydrocarbons (PHC) in Soil (most recent version).

The Site is currently used and zoned for commercial use therefore the commercial guidelines were applied.

The soil types encountered at the Site were primarily fine grained, therefore the fine-grained guidelines were used for comparison.

Groundwater at the Site is not used for drinking water, livestock watering or irrigation therefore guidelines for these pathways do not apply to the Site. Drinking water is provided via water pipeline by the CoW.

The closest body of water is the Red River located approximately 350 m to the east of the site therefore the protection of freshwater aquatic life pathway guidelines do not apply to the Site.

Since the PHC impact is located within a building, the vapour inhalation guidelines were used for comparison.

2.5 Findings

2.5.1 Stratigraphy

The stratigraphy at the Site consisted primarily of a thin layer of granular fill used as a base material for the hoists underlain by silt and clay, with clay being the primary material, especially after a depth of 2.0 metres below grade (mbg).

Groundwater was not observed in the excavation with the exception of a soft wet area in the northwest corner of the excavation where weeping tile was encountered.

2.5.2 CVC Results

The CVCs in the soil samples ranged from 15 to 80 ppm. CVC results are presented on Table 1.

2.5.3 Analytical Results

The PHC concentrations for soil samples were less than the CCME guidelines and/or the detection limits of the test performed, with the following exceptions:

- PHC F3 concentrations for samples 39, 66 and 72 were 7310, 8260 and 18300 mg/kg, respectively and were greater than the PHC F3 criterion of 5000 mg/kg.

2.6 Discussion

Three samples had PHC F3 concentrations greater than the applicable guidelines. Two of the samples (S66 and S72) were located on the south wall near the southwest corner (near Hoists 16 and 17); the other sample (S39) was located on the east wall of the excavation (to the east of Hoist 13).

Although only three (3) of the twelve (12) soil samples had PHC concentrations greater than the applicable guidelines, many soil samples from depths of 2 and 3 mbg appeared to be "oily", indicating that hydraulic oil was present. At several locations, what appeared to be hydraulic oil was seeping from the walls of the excavation typically at the interface between the silt and clay layers (see Photograph #2).

None of the soils samples from the base of the excavation had PHC concentrations greater than the applicable guidelines. Based on the laboratory results and observations during the soil sampling, PHC impact in the soil did not appear to present at 3.5 mbg (i.e., the base of the excavation).

The CCME exposure pathway that governs the site would be "Management Limits". According to the CCME CWS, "In addition to the chronic toxicity of PHC to human and ecological receptors, various effects of PHC contamination are also considered. These effects include:

- "Free phase formation;
- "Exposure of workers in trenches to PHC vapours;
- "Fire and explosive hazards;
- "Effects on buried infrastructure; and,
- "Aesthetic considerations."

Since free phase hydraulic oil would not typically be considered an explosive hazard nor would it be expected to produce significant PHC vapours, the primary concerns would be the effects of the hydraulic oil on buried infrastructure and the potential exposure of workers to hydraulic oil while working in trenches/excavations.

2.7 Conclusions

ENG-TECH concludes that residual concentrations of PHCs were present at the walls of the excavation at concentrations greater than the applicable guidelines.

3.0 THIRD PARTY USE AND STATEMENT OF LIMITATIONS

The content of this document is not intended for the use of, nor is it intended to be relied upon by any person, firm or corporation, other than the Client and ENG-TECH. ENG-TECH denies any liability whatsoever to other parties for damages or injury suffered by such third party arising from the use of this document by them, without the express written authority of ENG-TECH and our client. This document is subject to further restrictions imposed by the contract between the Client and ENG-TECH, and these parties' permission must be sought regarding this document in all other circumstances. ENG-TECH disclaims responsibility for consequential financial effects on transactions or property values, or requirements for follow-up actions and costs.

As with any environmental site assessment the intent is to identify and address, not eliminate, potential environmental concerns. The observations made at the Site do not apply to areas which could not be observed. In addition, other materials or compounds not investigated or addressed or beyond the scope of work could be present at the Site. If this occurs, ENG-TECH must be notified to determine whether modification to any part of this report should be conducted.

4.0 CLOSURE

The conclusions and recommendations presented in this report were based on the scope of work outlined for the purpose of the investigation, and were prepared in accordance with accepted professional engineering/geo-science principles and practices. If you have any questions or concerns, please contact the undersigned.

Sincerely,
ENG-TECH Consulting Limited

Walter Holowka, C.E.T., NCSO
Senior Geoenvironmental Technologist

Clark Hryhoruk, M.Sc., P. Eng.
Principal

PROVINCE OF MANITOBA
C. D.
HRYHORUK
Feb 28/20
REGISTERED PROFESSIONAL ENGINEER

CDH/wgh

ENGINEERS
GEOSCIENTISTS
MANITOBA
Certificate of Authorization
ENG-TECH Consulting Limited
No.2475

1999 20 2019
YEARS OF EXCELLENCE

BIBLIOGRAPHY/REFERENCES

BIBLIOGRAPHY/REFERENCES

Canadian Environmental Quality Guidelines, published by Canadian Council of Ministers of the Environment (CCME), http://st-ts.ccme.ca/en/index.html

Canada-Wide Standards (CSW) for Petroleum Hydrocarbons (PHC) in Soil, published by Canadian Council of Ministers of the Environment (CCME), Updated 2008

Google Maps, various years, www.google.ca/maps.

Guideline for Designation of Contaminated Sites in Manitoba, Guideline 97-01, published by Manitoba Sustainable Development in March 1997.

Guideline for Environmental Site Investigations in Manitoba, Guideline 98-01, published by Manitoba Sustainable Development, May 2002.

Standard Practice for Environmental Site Assessments: Transaction Screen Process, E 1528-06, published by American Society for Testing and Materials (ASTM).

TABLES

TABLE 1 - EXCAVATION SOIL SAMPLE SUMMARY

Project No.:	19-217-03						Site Location: 421 Osborne Street, Winnipeg, MB
Location of 0,0 (X,Y):	N/A						
Sample ID	Date/Time	Soil Type	Sample Location	Depth (m)	CVC (ppm)	Sent to Lab	Observations (staining, odour, etc.)
S1	2020-Feb-10 10:00	Clay	NW corner	1.0	25		Dark grey
S2	2020-Feb-10 10:00	Clayey silt	NW corner	2.0	15		Light grey
S3	2020-Feb-10 10:00	Clay	NW corner	3.0	15		Medium grey
S4	2020-Feb-10 10:05	Clay	E side of Hoist 18N	1.0	15		Medium grey
S5	2020-Feb-10 10:05	Clayey silt	E side of Hoist 18N	2.0	20		Light grey, staining
S6	2020-Feb-10 10:05	Clay	E side of Hoist 18N	3.0	60	✓	Medium grey, oily
S7	2020-Feb-10 10:15	Sandy clay fill	W side of Hoist 17N	1.0	20		Dark grey
S8	2020-Feb-10 10:15	Clay	W side of Hoist 17N	2.0	25		Dark grey
S9	2020-Feb-10 10:15	Clay	W side of Hoist 17N	3.0	35		Dark grey
S10	2020-Feb-10 10:20	Clay	E side of Hoist 17N	1.0	50		Medium grey
S11	2020-Feb-10 10:20	Clay	E side of Hoist 17N	2.0	45		Medium grey
S12	2020-Feb-10 10:20	Clay	E side of Hoist 17N	3.0	50		Medium brown, wet
S13	2020-Feb-10 10:40	Sandy clay fill	W side of Hoist 16N	1.0	40		Dark grey
S14	2020-Feb-10 10:40	Clay	W side of Hoist 16N	2.0	45	✓	Medium grey, oily
S15	2020-Feb-10 10:40	Clay	W side of Hoist 16N	3.0	45		Medium brown/grey, oily
S16	2020-Feb-10 10:45	Clay	E side of Hoist 16N	1.0	40		Dark grey
S17	2020-Feb-10 10:45	Clay	E side of Hoist 16N	2.0	45		Medium grey, oily
S18	2020-Feb-10 10:45	Clay	E side of Hoist 16N	3.0	50		Medium brown/grey, oily
S19	2020-Feb-10 11:00	Sandy clay fill	W side of Hoist 15N	1.0	50		Dark grey
S20	2020-Feb-10 11:00	Clay	W side of Hoist 15N	2.0	55	✓	Medium grey, oily
S21	2020-Feb-10 11:00	Clay	W side of Hoist 15N	3.0	45		Medium brown
S22	2020-Feb-10 11:10	Sandy clay fill	E side of Hoist 15N	1.0	55		Dark grey
S23	2020-Feb-10 11:10	Clay	E side of Hoist 15N	2.0	50		Medium/dark grey, oily
S24	2020-Feb-10 11:10	Clay	E side of Hoist 15N	3.0	45		Medium brown, oily
S25	2020-Feb-10 11:30	Sandy clay fill	W side of Hoist 14N	1.0	30		Dark grey
S26	2020-Feb-10 11:30	Clayey silt	W side of Hoist 14N	2.0	50		Light brown/grey
S27	2020-Feb-10 11:30	Clay	W side of Hoist 14N	3.0	60		Medium grey, oily
S28	2020-Feb-10 11:40	Clay	E side of Hoist 14N	1.0	30		Medium grey
S29	2020-Feb-10 11:40	Clay	E side of Hoist 14N	2.0	70	✓	Medium grey, oily
S30	2020-Feb-10 11:40	Clay	E side of Hoist 14N	3.0	55		Medium grey, oily

TABLE 1 - EXCAVATION SOIL SAMPLE SUMMARY

Project No.:		19-217-03			Site Location: 421 Osborne Street, Winnipeg, MB		
Location of 0,0 (X,Y):	N/A						
Sample ID	Date/Time	Soil Type	Sample Location	Depth (m)	CVC (ppm)	Sent to Lab	Observations (staining, odour, etc.)
S31	2020-Feb-10 12:00	Silt	W side of Hoist 13N	1.0	55		Light brown
S32	2020-Feb-10 12:00	Clay	W side of Hoist 13N	2.0	60		Medium grey
S33	2020-Feb-10 12:00	Clay	W side of Hoist 13N	3.0	60		Medium brown
S34	2020-Feb-10 12:10	Clay	E side of Hoist 13N	1.0	60		Dark grey
S35	2020-Feb-10 12:10	Sandy clay fill	E side of Hoist 13N	2.0	65		Light brown/grey, staining
S36	2020-Feb-10 12:10	Clayey sily	E side of Hoist 13N	3.0	80	✓	Medium grey, oily
S37	2020-Feb-10 12:30	Clay	E wall: 4 m from N side	1.0	35		Dark grey
S38	2020-Feb-10 12:30	Sandy clay fill	E wall: 4 m from N side	2.0	45		Medium grey, oily
S39	2020-Feb-10 12:30	Clay	E wall: 4 m from N side	3.0	55	✓	Medium grey/brown, oily
S40	2020-Feb-10 12:40	Clay	E wall: 4 m from S side	1.0	35		Dark grey
S41	2020-Feb-10 12:40	Clay	E wall: 4 m from S side	2.0	40		Medium grey, oily
S42	2020-Feb-10 12:40	Clay	E wall: 4 m from S side	3.0	50		Medium grey, oily
S43	2020-Feb-10 12:50	Clay	SE corner	1.0	35		Medium grey
S44	2020-Feb-10 12:50	Clayey silt	SE corner	2.0	45		Light grey, staining
S45	2020-Feb-10 12:50	Clay	SE corner	3.0	45		Light grey, staining
S46	2020-Feb-10 13:00	Clay	W side of Hoist 13S	1.0	35		Dark grey
S47	2020-Feb-10 13:00	Clayey silt	W side of Hoist 13S	2.0	40		Light grey, staining
S48	2020-Feb-10 13:00	Clay	W side of Hoist 13S	3.0	55	✓	Medium grey, oily
S49	2020-Feb-10 13:10	Clay	E side of Hoist 14S	1.0	35		Dark grey
S50	2020-Feb-10 13:10	Clayey silt	E side of Hoist 14S	2.0	35		Light grey, staining
S51	2020-Feb-10 13:10	Clay	E side of Hoist 14S	3.0	50		Medium grey, oily
S52	2020-Feb-10 13:15	Clay	W side of Hoist 14S	1.0	30		Dark grey
S53	2020-Feb-10 13:15	Silty clay	W side of Hoist 14S	2.0	40		Light grey, staining
S54	2020-Feb-10 13:15	Clay	W side of Hoist 14S	3.0	45		Medium grey, oily
S55	2020-Feb-10 13:20	Clay	E side of Hoist 15S	1.0	30		Medium grey
S56	2020-Feb-10 13:20	Clay	E side of Hoist 15S	2.0	35		Medium grey, oily
S57	2020-Feb-10 13:20	Clay	E side of Hoist 15S	3.0	30		Medium brown
S58	2020-Feb-10 13:25	Silty clay	W side of Hoist 15S	1.0	40		Light brown
S59	2020-Feb-10 13:25	Clay	W side of Hoist 15S	2.0	40		Medium grey, oily
S60	2020-Feb-10 13:25	Clay	W side of Hoist 15S	3.0	35		Medium grey, oily

TABLE 1 - EXCAVATION SOIL SAMPLE SUMMARY

Project No.:	19-217-03	Site Location: 421 Osborne Street, Winnipeg, MB
Location of 0,0 (X,Y):	N/A	

Sample ID	Date/Time	Soil Type	Sample Location	Depth (m)	CVC (ppm)	Sent to Lab	Observations (staining, odour, etc.)
S61	2020-Feb-10 13:30	Clay	E side of Hoist 16S	1.0	35		Dark grey
S62	2020-Feb-10 13:30	Clay	E side of Hoist 16S	2.0	60		Medium grey
S63	2020-Feb-10 13:30	Clay	E side of Hoist 16S	3.0	50		Medium grey/brown, oily
S64	2020-Feb-10 13:40	Clay	W side of Hoist 16S	1.0	60		Dark grey
S65	2020-Feb-10 13:40	Clay	W side of Hoist 16S	2.0	45		Medium grey, oily
S66	2020-Feb-10 13:40	Clay	W side of Hoist 16S	3.0	65	✓	Medium grey, oily
S67	2020-Feb-10 14:00	Sandy clay fill	E side of Hoist 17S	1.0	40		Dark grey
S68	2020-Feb-10 14:00	Clayey silt	E side of Hoist 17S	2.0	45		Light grey
S69	2020-Feb-10 14:00	Clay	E side of Hoist 17S	3.0	50		Medium grey, oily
S70	2020-Feb-10 14:10	Clay	W side of Hoist 17S	1.0	45		Dark grey
S71	2020-Feb-10 14:10	Clay	W side of Hoist 17S	2.0	55		Medium grey, oily
S72	2020-Feb-10 14:10	Clay	W side of Hoist 17S	3.0	55	✓	Medium grey/brown, oily
S73	2020-Feb-10 14:30	Sandy clay fill	E side of Hoist 18S	1.0	35		Dark grey
S74	2020-Feb-10 14:30	Clay	E side of Hoist 18S	2.0	40		Medium grey
S75	2020-Feb-10 14:30	Clay	E side of Hoist 18S	3.0	45		Medium grey/brown
S76	2020-Feb-10 14:35	Sandy clay fill	SW corner	1.0	35		Dark grey
S77	2020-Feb-10 14:35	Clay	SW corner	2.0	40		Medium grey, oily
S78	2020-Feb-10 14:35	Clay	SW corner	3.0	40		Medium grey/brown, oily
S79	2020-Feb-10 14:45	Clay	Floor: W of Hoist 18	3.5	45		Medium grey/brown, oily
S80	2020-Feb-10 14:45	Clay	Floor: W of Hoist 18	3.5	65	✓	Medium grey/brown, oily
S81	2020-Feb-10 14:45	Clay	Floor: b/w Hoist 17 &18	3.5	40		Medium grey/brown
S82	2020-Feb-10 14:50	Clay	Floor: b/w Hoist 17 &18	3.5	40		Medium grey/brown
S83	2020-Feb-10 14:50	Clay	Floor: b/w Hoist 16 &17	3.5	50		Medium grey/brown
S84	2020-Feb-10 14:50	Clay	Floor: b/w Hoist 16 &17	3.5	50		Medium grey/brown
S85	2020-Feb-10 15:00	Clay	Floor: b/w Hoist 15 &16	3.5	55	✓	Medium grey/brown, oily
S86	2020-Feb-10 15:00	Clay	Floor: b/w Hoist 15 &16	3.5	55		Medium grey/brown
S87	2020-Feb-10 15:00	Clay	Floor: b/w Hoist 14 &15	3.5	50		Medium grey/brown
S88	2020-Feb-10 15:15	Clay	Floor: b/w Hoist 14 &15	3.5	60	✓	Medium grey/brown, grey staining
S89	2020-Feb-10 15:15	Clay	Floor: b/w Hoist 13 &14	3.5	55		Medium grey/brown
S90	2020-Feb-10 15:15	Clay	Floor: b/w Hoist 13 &14	3.5	50		Medium grey/brown

TABLE 2
PETROLEUM HYDROCARBONS IN SOIL

Sample ID	Depth (m)	Sample Date	Parameters							
			BTEX				Hydrocarbon Fractions			
			Benzene[6]	Toluene	Ethylbenzene	Xylenes (total)	F1 (C_6-C_{10})	F2 (>C_{10}-C_{16})	F3 (>C_{16}-C_{34})	F4 (>C_{34})
S6	3.0 (subsoil)	2020-FEB-10	<0.0050	<0.050	<0.015	<0.071	<10	<25	<50	<50
S14	2.0 (subsoil)	2020-FEB-10	<0.0050	<0.050	<0.015	<0.071	<10	130	4350	590
S20	2.0 (subsoil)	2020-FEB-10	<0.0050	<0.050	<0.015	<0.071	<10	27	1730	241
S29	2.0 (subsoil)	2020-FEB-10	<0.0050	<0.050	<0.015	<0.071	<10	26	2020	280
S36	3.0 (subsoil)	2020-FEB-10	<0.0050	<0.050	<0.015	<0.071	<10	27	1350	171
S39	3.0 (subsoil)	2020-FEB-10	<0.0050	<0.050	<0.015	<0.071	<10	67	**[7310]**	809
S48	3.0 (subsoil)	2020-FEB-10	0.0269	0.116	0.016	0.091	<10	<25	244	57
S66	3.0 (subsoil)	2020-FEB-10	<0.0050	<0.050	<0.015	<0.071	<10	117	**[8260]**	1100
S72	3.0 (subsoil)	2020-FEB-10	<0.0050	<0.050	<0.015	<0.071	<10	182	**[18300]**	2370
S80	3.5 (subsoil)	2020-FEB-10	<0.0050	<0.050	<0.015	<0.071	<10	<25	<50	<50
S85	3.5 (subsoil)	2020-FEB-10	<0.0050	<0.050	<0.015	<0.071	<10	<25	130	<50
S88	3.5 (subsoil)	2020-FEB-10	<0.0050	<0.050	<0.015	<0.071	<10	<25	913	107
Regulatory Guidelines										
CCME Guidelines (surface)[4,5]			**2.8**	**330**	**430**	**230**	**800**	**1,000**	**5,000**	**10,000**
CCME Guidelines (subsoil)[4,5]			**2.9**	**660**	**860**	**460**	**800**	**1,000**	**5,000**	**10,000**

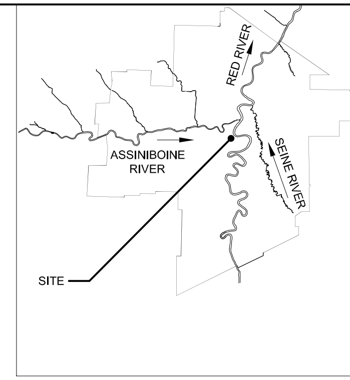
Notes:
1. All concentrations are in mg/kg (i.e., ppm).
2. The consistency of the soil samples was primarily fine-grained material therefore the fine-grained guidelines were used (fine-grained means soil having a median grain size of <75 µm).
3. “Surface” refers to soil samples from the surface to 1.5 m; “subsoil” refers to soil samples that are >1.5 m. All of the samples analyzed would be considered subsoil since they were from depths greater than 1.5 m.
4. CCME Guidelines include:
   - for BTEX: *Canadian Environmental Quality Guidelines for the Protection of Environment and Human Health,* commercial guidelines.
   - for hydrocarbon fractions: *Canada-Wide Standards (CWS) for Petroleum Hydrocarbons (PHCs) in Soil,* commercial guidelines.
5. Site specific guidelines exclude the pathways for the protection of potable groundwater and freshwater aquatic life.
6. CCME Guideline for benzene uses the 10^{-5} incremental risk of cancer.
7. **[#]** Concentrations greater than the CCME Guidelines are shown in **bold**.

ENG-TECH CONSULTING LIMITED

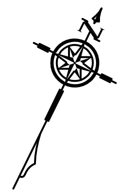
FIGURES

EXCAVATION LOCATION

SCALE 1:4000



KEYMAP

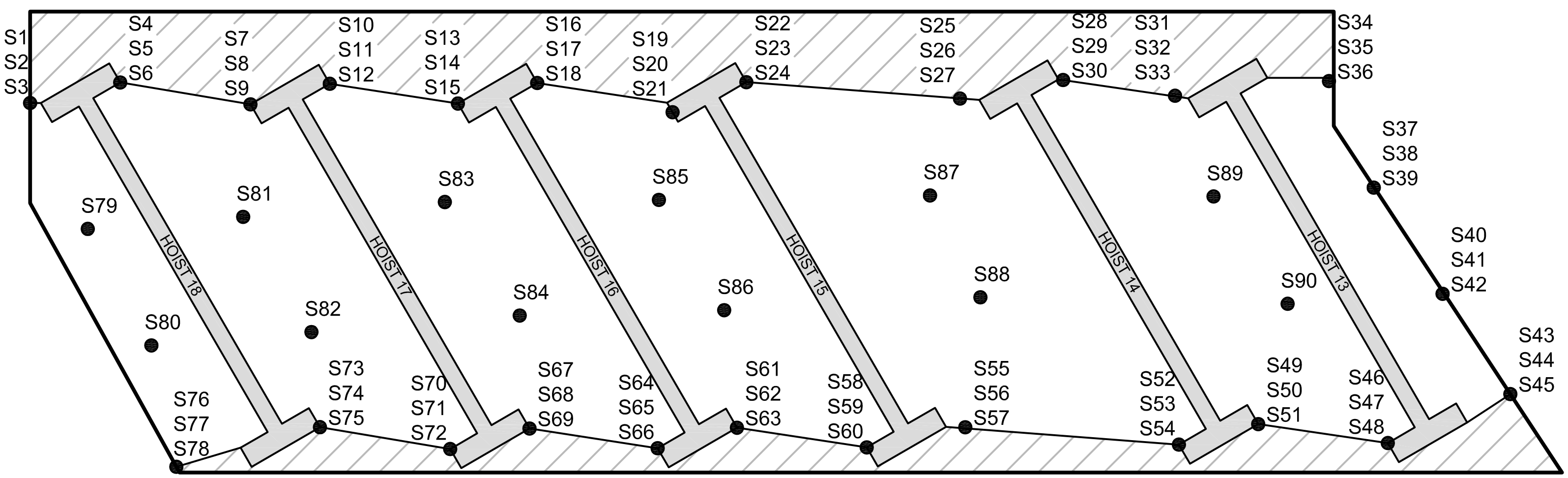


LEGEND

S17 SOIL SAMPLE LOCATION

EXCAVATION BOUNDARIES

UPPER SHELF (< 1.0 m BELOW CONCRETE)



SOIL SAMPLE LOCATIONS

SCALE 1:200

NO.	DATE	ISSUE / REVISION
0	FEB 2020	REPORT

ENG-TECH Consulting Limited
420 Turenne Street
Winnipeg, MB
R2J 3W8
Phone: (204) 233-1694
Fax: (204) 235-1579

ENG. STAMP:

ENGINEERS GEOSCIENTISTS MANITOBA
Certificate of Authorization
ENG-TECH Consulting Limited
No.2475

CLIENT:
CITY OF WINNIPEG

PROJECT:
EXCAVATION ASSESSMENT
421 OSBORNE STREET
WINNIPEG, MANITOBA

DWG DESCRIPTION:
SITE LOCATION AND EXCAVATION DETAILS

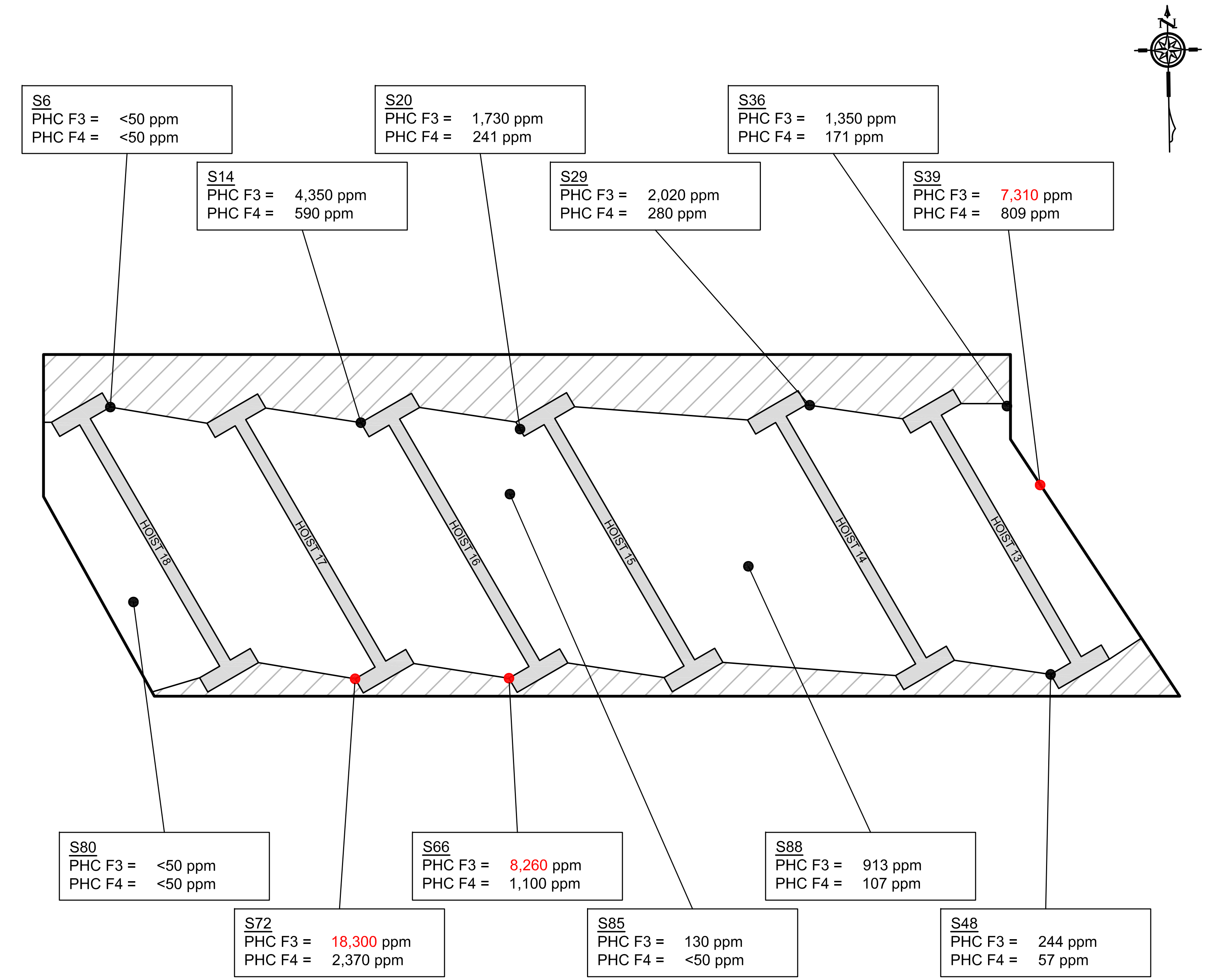
SCALE:
AS SHOWN

DRAWN BY:	DATE:
WGH	FEBRUARY 2020

FILE No.:	CLIENT DWG/FIG. No.:
19-217-03	

ENG-TECH DWG/FIG. No.:	NO.:
1	0

P:\2019\217(C.O.W)\03(Geo_Transit Garage Program; 421 Osborne)\Excavation Assessment\Report\Figures\19-217-03 Figure 1 Excavation Details.dwg



P:\2019\217(C.O.W)\03(Geo_Transit Garage Program; 421 Osborne)\Excavation Assessment\Report\Figures\19-217-03 Figure 2 Laboratory Results.dwg

LEGEND

S17 SOIL SAMPLE LOCATION

EXCAVATION BOUNDARIES

UPPER SHELF (<1.0 m BELOW CONCRETE)

PHC = PETROLEUM HYDROCARBON

F3 = FRACTION 3

F4 = FRACTION 4

SAMPLE CONCENTRATIONS SHOWN IN RED (I.E., 7,310 ppm) ARE GREATER THAN THE APPLICABLE CRITERIA.

NO.	DATE	ISSUE / REVISION
0	FEB 2020	REPORT

ENG-TECH Consulting Limited
420 Turenne Street
Winnipeg, MB
R2J 3W8
Phone: (204) 233-1694
Fax: (204) 235-1579

ENG. STAMP:

ENGINEERS GEOSCIENTISTS MANITOBA
Certificate of Authorization
ENG-TECH Consulting Limited
No.2475

CLIENT:
CITY OF WINNIPEG

PROJECT:
EXCAVATION ASSESSMENT
421 OSBORNE STREET
WINNIPEG, MANITOBA

DWG DESCRIPTION:
LABORATORY RESULTS

SCALE:
1:200

DRAWN BY:	DATE:
WGH	FEBRUARY 2020
FILE No.: 19-217-03	CLIENT DWG/FIG. No.:
ENG-TECH DWG/FIG. No.: 2	NO.: 0

APPENDICES

APPENDIX A

Site Photographs (2)

PHOTOGRAPH #1: Excavation as seen facing east from west side of excavation.

PHOTOGRAPH #2: Oily surface on the soil at S27 at approximately 2.0 metres below grade.

ENG-TECH CONSULTING LIMITED

APPENDIX B

Laboratory Reports (1)

ENG-TECH Consulting
ATTN: WALTER HOLOWKA
420 Turenne Street
Winnipeg MB R2J 3W8

Date Received: 11-FEB-20
Report Date: 18-FEB-20 14:06 (MT)
Version: FINAL

Client Phone: 204-233-1694

Certificate of Analysis

Lab Work Order #: L2415429

Project P.O. #: NOT SUBMITTED

Job Reference: 19-217-03

C of C Numbers:

Legal Site Desc:

Hua Wo
Chemistry Laboratory Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2415429-1 6							
Sampled By: CLIENT on 10-FEB-20 @ 16:00							
Matrix: SOIL							
BTEX and F1-F4 by Tumbler Method							
BTX plus F1 by GCMS							
Benzene	<0.0050		0.0050	mg/kg	10-FEB-20	12-FEB-20	R4997484
Toluene	<0.050		0.050	mg/kg	10-FEB-20	12-FEB-20	R4997484
Ethyl benzene	<0.015		0.015	mg/kg	10-FEB-20	12-FEB-20	R4997484
o-Xylene	<0.050		0.050	mg/kg	10-FEB-20	12-FEB-20	R4997484
m+p-Xylenes	<0.050		0.050	mg/kg	10-FEB-20	12-FEB-20	R4997484
F1 (C6-C10)	<10		10	mg/kg	10-FEB-20	12-FEB-20	R4997484
Surrogate: 4-Bromofluorobenzene (SS)	111.4		70-130	%	10-FEB-20	12-FEB-20	R4997484
CCME Total Extractable Hydrocarbons							
F2 (C10-C16)	<25		25	mg/kg	13-FEB-20	13-FEB-20	R4996480
F3 (C16-C34)	<50		50	mg/kg	13-FEB-20	13-FEB-20	R4996480
F4 (C34-C50)	<50		50	mg/kg	13-FEB-20	13-FEB-20	R4996480
Surrogate: 2-Bromobenzotrifluoride	88.9		60-140	%	13-FEB-20	13-FEB-20	R4996480
Chrom. to baseline at nC50	YES				13-FEB-20	13-FEB-20	R4996480
CCME Total Hydrocarbons							
F1-BTEX	<10		10	mg/kg		18-FEB-20	
Total Hydrocarbons (C6-C50)	<76		76	mg/kg		18-FEB-20	
Sum of Xylene Isomer Concentrations							
Xylenes (Total)	<0.071		0.071	mg/kg		18-FEB-20	
Miscellaneous Parameters							
Moisture	32.4		0.10	%		13-FEB-20	R4996418
L2415429-2 14							
Sampled By: CLIENT on 10-FEB-20 @ 16:05							
Matrix: SOIL							
BTEX and F1-F4 by Tumbler Method							
BTX plus F1 by GCMS							
Benzene	<0.0050		0.0050	mg/kg	10-FEB-20	12-FEB-20	R4997484
Toluene	<0.050		0.050	mg/kg	10-FEB-20	12-FEB-20	R4997484
Ethyl benzene	<0.015		0.015	mg/kg	10-FEB-20	12-FEB-20	R4997484
o-Xylene	<0.050		0.050	mg/kg	10-FEB-20	12-FEB-20	R4997484
m+p-Xylenes	<0.050		0.050	mg/kg	10-FEB-20	12-FEB-20	R4997484
F1 (C6-C10)	<10		10	mg/kg	10-FEB-20	12-FEB-20	R4997484
Surrogate: 4-Bromofluorobenzene (SS)	128.4		70-130	%	10-FEB-20	12-FEB-20	R4997484
CCME Total Extractable Hydrocarbons							
F2 (C10-C16)	130		25	mg/kg	13-FEB-20	13-FEB-20	R4996480
F3 (C16-C34)	4350		50	mg/kg	13-FEB-20	13-FEB-20	R4996480
F4 (C34-C50)	590		50	mg/kg	13-FEB-20	13-FEB-20	R4996480
Surrogate: 2-Bromobenzotrifluoride	87.4		60-140	%	13-FEB-20	13-FEB-20	R4996480
Chrom. to baseline at nC50	YES				13-FEB-20	13-FEB-20	R4996480
CCME Total Hydrocarbons							
F1-BTEX	<10		10	mg/kg		18-FEB-20	
Total Hydrocarbons (C6-C50)	5070		76	mg/kg		18-FEB-20	
Sum of Xylene Isomer Concentrations							
Xylenes (Total)	<0.071		0.071	mg/kg		18-FEB-20	
Miscellaneous Parameters							
Moisture	29.1		0.10	%		13-FEB-20	R4996418
L2415429-3 20							
Sampled By: CLIENT on 10-FEB-20 @ 16:10							
Matrix: SOIL							
BTEX and F1-F4 by Tumbler Method							
BTX plus F1 by GCMS							

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2415429-3 20							
Sampled By: CLIENT on 10-FEB-20 @ 16:10							
Matrix: SOIL							
BTX plus F1 by GCMS							
Benzene	<0.0050		0.0050	mg/kg	10-FEB-20	12-FEB-20	R4997484
Toluene	<0.050		0.050	mg/kg	10-FEB-20	12-FEB-20	R4997484
Ethyl benzene	<0.015		0.015	mg/kg	10-FEB-20	12-FEB-20	R4997484
o-Xylene	<0.050		0.050	mg/kg	10-FEB-20	12-FEB-20	R4997484
m+p-Xylenes	<0.050		0.050	mg/kg	10-FEB-20	12-FEB-20	R4997484
F1 (C6-C10)	<10		10	mg/kg	10-FEB-20	12-FEB-20	R4997484
Surrogate: 4-Bromofluorobenzene (SS)	113.6		70-130	%	10-FEB-20	12-FEB-20	R4997484
CCME Total Extractable Hydrocarbons							
F2 (C10-C16)	27		25	mg/kg	13-FEB-20	13-FEB-20	R4996480
F3 (C16-C34)	1730		50	mg/kg	13-FEB-20	13-FEB-20	R4996480
F4 (C34-C50)	241		50	mg/kg	13-FEB-20	13-FEB-20	R4996480
Surrogate: 2-Bromobenzotrifluoride	89.3		60-140	%	13-FEB-20	13-FEB-20	R4996480
Chrom. to baseline at nC50	YES				13-FEB-20	13-FEB-20	R4996480
CCME Total Hydrocarbons							
F1-BTEX	<10		10	mg/kg		18-FEB-20	
Total Hydrocarbons (C6-C50)	2000		76	mg/kg		18-FEB-20	
Sum of Xylene Isomer Concentrations							
Xylenes (Total)	<0.071		0.071	mg/kg		18-FEB-20	
Miscellaneous Parameters							
Moisture	30.9		0.10	%		13-FEB-20	R4996418
L2415429-4 29							
Sampled By: CLIENT on 10-FEB-20 @ 16:15							
Matrix: SOIL							
BTEX and F1-F4 by Tumbler Method							
BTX plus F1 by GCMS							
Benzene	<0.0050		0.0050	mg/kg	10-FEB-20	12-FEB-20	R4997484
Toluene	<0.050		0.050	mg/kg	10-FEB-20	12-FEB-20	R4997484
Ethyl benzene	<0.015		0.015	mg/kg	10-FEB-20	12-FEB-20	R4997484
o-Xylene	<0.050		0.050	mg/kg	10-FEB-20	12-FEB-20	R4997484
m+p-Xylenes	<0.050		0.050	mg/kg	10-FEB-20	12-FEB-20	R4997484
F1 (C6-C10)	<10		10	mg/kg	10-FEB-20	12-FEB-20	R4997484
Surrogate: 4-Bromofluorobenzene (SS)	124.6		70-130	%	10-FEB-20	12-FEB-20	R4997484
CCME Total Extractable Hydrocarbons							
F2 (C10-C16)	26		25	mg/kg	13-FEB-20	13-FEB-20	R4996480
F3 (C16-C34)	2020		50	mg/kg	13-FEB-20	13-FEB-20	R4996480
F4 (C34-C50)	280		50	mg/kg	13-FEB-20	13-FEB-20	R4996480
Surrogate: 2-Bromobenzotrifluoride	89.2		60-140	%	13-FEB-20	13-FEB-20	R4996480
Chrom. to baseline at nC50	YES				13-FEB-20	13-FEB-20	R4996480
CCME Total Hydrocarbons							
F1-BTEX	<10		10	mg/kg		18-FEB-20	
Total Hydrocarbons (C6-C50)	2330		76	mg/kg		18-FEB-20	
Sum of Xylene Isomer Concentrations							
Xylenes (Total)	<0.071		0.071	mg/kg		18-FEB-20	
Miscellaneous Parameters							
Moisture	29.6		0.10	%		13-FEB-20	R4996418
L2415429-5 36							
Sampled By: CLIENT on 10-FEB-20 @ 16:20							
Matrix: SOIL							
BTEX and F1-F4 by Tumbler Method							
BTX plus F1 by GCMS							
Benzene	<0.0050		0.0050	mg/kg	10-FEB-20	12-FEB-20	R4997484

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2415429-5 36							
Sampled By: CLIENT on 10-FEB-20 @ 16:20							
Matrix: SOIL							
BTX plus F1 by GCMS							
Toluene	<0.050		0.050	mg/kg	10-FEB-20	12-FEB-20	R4997484
Ethyl benzene	<0.015		0.015	mg/kg	10-FEB-20	12-FEB-20	R4997484
o-Xylene	<0.050		0.050	mg/kg	10-FEB-20	12-FEB-20	R4997484
m+p-Xylenes	<0.050		0.050	mg/kg	10-FEB-20	12-FEB-20	R4997484
F1 (C6-C10)	<10		10	mg/kg	10-FEB-20	12-FEB-20	R4997484
Surrogate: 4-Bromofluorobenzene (SS)	106.8		70-130	%	10-FEB-20	12-FEB-20	R4997484
CCME Total Extractable Hydrocarbons							
F2 (C10-C16)	27		25	mg/kg	13-FEB-20	13-FEB-20	R4996480
F3 (C16-C34)	1350		50	mg/kg	13-FEB-20	13-FEB-20	R4996480
F4 (C34-C50)	171		50	mg/kg	13-FEB-20	13-FEB-20	R4996480
Surrogate: 2-Bromobenzotrifluoride	89.7		60-140	%	13-FEB-20	13-FEB-20	R4996480
Chrom. to baseline at nC50	YES				13-FEB-20	13-FEB-20	R4996480
CCME Total Hydrocarbons							
F1-BTEX	<10		10	mg/kg		18-FEB-20	
Total Hydrocarbons (C6-C50)	1550		76	mg/kg		18-FEB-20	
Sum of Xylene Isomer Concentrations							
Xylenes (Total)	<0.071		0.071	mg/kg		18-FEB-20	
Miscellaneous Parameters							
Moisture	32.6		0.10	%		13-FEB-20	R4996418
L2415429-6 39							
Sampled By: CLIENT on 10-FEB-20 @ 16:25							
Matrix: SOIL							
BTEX and F1-F4 by Tumbler Method							
BTX plus F1 by GCMS							
Benzene	<0.0050		0.0050	mg/kg	10-FEB-20	12-FEB-20	R4997484
Toluene	<0.050		0.050	mg/kg	10-FEB-20	12-FEB-20	R4997484
Ethyl benzene	<0.015		0.015	mg/kg	10-FEB-20	12-FEB-20	R4997484
o-Xylene	<0.050		0.050	mg/kg	10-FEB-20	12-FEB-20	R4997484
m+p-Xylenes	<0.050		0.050	mg/kg	10-FEB-20	12-FEB-20	R4997484
F1 (C6-C10)	<10		10	mg/kg	10-FEB-20	12-FEB-20	R4997484
Surrogate: 4-Bromofluorobenzene (SS)	109.3		70-130	%	10-FEB-20	12-FEB-20	R4997484
CCME Total Extractable Hydrocarbons							
F2 (C10-C16)	67		25	mg/kg	13-FEB-20	13-FEB-20	R4996480
F3 (C16-C34)	7310		50	mg/kg	13-FEB-20	13-FEB-20	R4996480
F4 (C34-C50)	809		50	mg/kg	13-FEB-20	13-FEB-20	R4996480
Surrogate: 2-Bromobenzotrifluoride	87.6		60-140	%	13-FEB-20	13-FEB-20	R4996480
Chrom. to baseline at nC50	YES				13-FEB-20	13-FEB-20	R4996480
CCME Total Hydrocarbons							
F1-BTEX	<10		10	mg/kg		18-FEB-20	
Total Hydrocarbons (C6-C50)	8180		76	mg/kg		18-FEB-20	
Sum of Xylene Isomer Concentrations							
Xylenes (Total)	<0.071		0.071	mg/kg		18-FEB-20	
Miscellaneous Parameters							
Moisture	29.5		0.10	%		13-FEB-20	R4996418
L2415429-7 48							
Sampled By: CLIENT on 10-FEB-20 @ 16:35							
Matrix: SOIL							
BTEX and F1-F4 by Tumbler Method							
BTX plus F1 by GCMS							
Benzene	0.0269		0.0050	mg/kg	10-FEB-20	12-FEB-20	R4997484
Toluene	0.116		0.050	mg/kg	10-FEB-20	12-FEB-20	R4997484

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2415429-7 48							
Sampled By: CLIENT on 10-FEB-20 @ 16:35							
Matrix: SOIL							
BTX plus F1 by GCMS							
Ethyl benzene	0.016		0.015	mg/kg	10-FEB-20	12-FEB-20	R4997484
o-Xylene	<0.050		0.050	mg/kg	10-FEB-20	12-FEB-20	R4997484
m+p-Xylenes	0.091		0.050	mg/kg	10-FEB-20	12-FEB-20	R4997484
F1 (C6-C10)	<10		10	mg/kg	10-FEB-20	12-FEB-20	R4997484
Surrogate: 4-Bromofluorobenzene (SS)	115.0		70-130	%	10-FEB-20	12-FEB-20	R4997484
CCME Total Extractable Hydrocarbons							
F2 (C10-C16)	<25		25	mg/kg	13-FEB-20	13-FEB-20	R4996480
F3 (C16-C34)	244		50	mg/kg	13-FEB-20	13-FEB-20	R4996480
F4 (C34-C50)	57		50	mg/kg	13-FEB-20	13-FEB-20	R4996480
Surrogate: 2-Bromobenzotrifluoride	88.5		60-140	%	13-FEB-20	13-FEB-20	R4996480
Chrom. to baseline at nC50	YES				13-FEB-20	13-FEB-20	R4996480
CCME Total Hydrocarbons							
F1-BTEX	<10		10	mg/kg		18-FEB-20	
Total Hydrocarbons (C6-C50)	301		76	mg/kg		18-FEB-20	
Sum of Xylene Isomer Concentrations							
Xylenes (Total)	0.091		0.071	mg/kg		18-FEB-20	
Miscellaneous Parameters							
Moisture	28.6		0.10	%		13-FEB-20	R4996418
L2415429-8 66							
Sampled By: CLIENT on 10-FEB-20 @ 16:50							
Matrix: SOIL							
BTEX and F1-F4 by Tumbler Method							
BTX plus F1 by GCMS							
Benzene	<0.0050		0.0050	mg/kg	10-FEB-20	12-FEB-20	R4997484
Toluene	<0.050		0.050	mg/kg	10-FEB-20	12-FEB-20	R4997484
Ethyl benzene	<0.015		0.015	mg/kg	10-FEB-20	12-FEB-20	R4997484
o-Xylene	<0.050		0.050	mg/kg	10-FEB-20	12-FEB-20	R4997484
m+p-Xylenes	<0.050		0.050	mg/kg	10-FEB-20	12-FEB-20	R4997484
F1 (C6-C10)	<10		10	mg/kg	10-FEB-20	12-FEB-20	R4997484
Surrogate: 4-Bromofluorobenzene (SS)	124.2		70-130	%	10-FEB-20	12-FEB-20	R4997484
CCME Total Extractable Hydrocarbons							
F2 (C10-C16)	117		25	mg/kg	13-FEB-20	13-FEB-20	R4996480
F3 (C16-C34)	8260		50	mg/kg	13-FEB-20	13-FEB-20	R4996480
F4 (C34-C50)	1100		50	mg/kg	13-FEB-20	13-FEB-20	R4996480
Surrogate: 2-Bromobenzotrifluoride	92.0		60-140	%	13-FEB-20	13-FEB-20	R4996480
Chrom. to baseline at nC50	YES				13-FEB-20	13-FEB-20	R4996480
CCME Total Hydrocarbons							
F1-BTEX	<10		10	mg/kg		18-FEB-20	
Total Hydrocarbons (C6-C50)	9470		76	mg/kg		18-FEB-20	
Sum of Xylene Isomer Concentrations							
Xylenes (Total)	<0.071		0.071	mg/kg		18-FEB-20	
Miscellaneous Parameters							
Moisture	24.2		0.10	%		13-FEB-20	R4996418
L2415429-9 72							
Sampled By: CLIENT on 10-FEB-20 @ 16:45							
Matrix: SOIL							
BTEX and F1-F4 by Tumbler Method							
BTX plus F1 by GCMS							
Benzene	<0.0050		0.0050	mg/kg	10-FEB-20	12-FEB-20	R4997484
Toluene	<0.050		0.050	mg/kg	10-FEB-20	12-FEB-20	R4997484
Ethyl benzene	<0.015		0.015	mg/kg	10-FEB-20	12-FEB-20	R4997484

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2415429-9 72							
Sampled By: CLIENT on 10-FEB-20 @ 16:45							
Matrix: SOIL							
BTX plus F1 by GCMS							
o-Xylene	<0.050		0.050	mg/kg	10-FEB-20	12-FEB-20	R4997484
m+p-Xylenes	<0.050		0.050	mg/kg	10-FEB-20	12-FEB-20	R4997484
F1 (C6-C10)	<10		10	mg/kg	10-FEB-20	12-FEB-20	R4997484
Surrogate: 4-Bromofluorobenzene (SS)	119.2		70-130	%	10-FEB-20	12-FEB-20	R4997484
CCME Total Extractable Hydrocarbons							
F2 (C10-C16)	182		25	mg/kg	13-FEB-20	13-FEB-20	R4996480
F3 (C16-C34)	18300		50	mg/kg	13-FEB-20	13-FEB-20	R4996480
F4 (C34-C50)	2370		50	mg/kg	13-FEB-20	13-FEB-20	R4996480
Surrogate: 2-Bromobenzotrifluoride	87.3		60-140	%	13-FEB-20	13-FEB-20	R4996480
Chrom. to baseline at nC50	YES				13-FEB-20	13-FEB-20	R4996480
CCME Total Hydrocarbons							
F1-BTEX	<10		10	mg/kg		18-FEB-20	
Total Hydrocarbons (C6-C50)	20900		76	mg/kg		18-FEB-20	
Sum of Xylene Isomer Concentrations							
Xylenes (Total)	<0.071		0.071	mg/kg		18-FEB-20	
Miscellaneous Parameters							
Moisture	30.9		0.10	%		13-FEB-20	R4996418
L2415429-10 80							
Sampled By: CLIENT on 10-FEB-20 @ 16:50							
Matrix: SOIL							
BTEX and F1-F4 by Tumbler Method							
BTX plus F1 by GCMS							
Benzene	<0.0050		0.0050	mg/kg	10-FEB-20	12-FEB-20	R4997484
Toluene	<0.050		0.050	mg/kg	10-FEB-20	12-FEB-20	R4997484
Ethyl benzene	<0.015		0.015	mg/kg	10-FEB-20	12-FEB-20	R4997484
o-Xylene	<0.050		0.050	mg/kg	10-FEB-20	12-FEB-20	R4997484
m+p-Xylenes	<0.050		0.050	mg/kg	10-FEB-20	12-FEB-20	R4997484
F1 (C6-C10)	<10		10	mg/kg	10-FEB-20	12-FEB-20	R4997484
Surrogate: 4-Bromofluorobenzene (SS)	111.2		70-130	%	10-FEB-20	12-FEB-20	R4997484
CCME Total Extractable Hydrocarbons							
F2 (C10-C16)	<25		25	mg/kg	13-FEB-20	13-FEB-20	R4996480
F3 (C16-C34)	<50		50	mg/kg	13-FEB-20	13-FEB-20	R4996480
F4 (C34-C50)	<50		50	mg/kg	13-FEB-20	13-FEB-20	R4996480
Surrogate: 2-Bromobenzotrifluoride	91.3		60-140	%	13-FEB-20	13-FEB-20	R4996480
Chrom. to baseline at nC50	YES				13-FEB-20	13-FEB-20	R4996480
CCME Total Hydrocarbons							
F1-BTEX	<10		10	mg/kg		18-FEB-20	
Total Hydrocarbons (C6-C50)	<76		76	mg/kg		18-FEB-20	
Sum of Xylene Isomer Concentrations							
Xylenes (Total)	<0.071		0.071	mg/kg		18-FEB-20	
Miscellaneous Parameters							
Moisture	35.2		0.10	%		13-FEB-20	R4996418
L2415429-11 85							
Sampled By: CLIENT on 10-FEB-20 @ 16:55							
Matrix: SOIL							
BTEX and F1-F4 by Tumbler Method							
BTX plus F1 by GCMS							
Benzene	<0.0050		0.0050	mg/kg	10-FEB-20	12-FEB-20	R4997484
Toluene	<0.050		0.050	mg/kg	10-FEB-20	12-FEB-20	R4997484
Ethyl benzene	<0.015		0.015	mg/kg	10-FEB-20	12-FEB-20	R4997484
o-Xylene	<0.050		0.050	mg/kg	10-FEB-20	12-FEB-20	R4997484

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2415429-11 85							
Sampled By: CLIENT on 10-FEB-20 @ 16:55							
Matrix: SOIL							
BTX plus F1 by GCMS							
m+p-Xylenes	<0.050		0.050	mg/kg	10-FEB-20	12-FEB-20	R4997484
F1 (C6-C10)	<10		10	mg/kg	10-FEB-20	12-FEB-20	R4997484
Surrogate: 4-Bromofluorobenzene (SS)	107.4		70-130	%	10-FEB-20	12-FEB-20	R4997484
CCME Total Extractable Hydrocarbons							
F2 (C10-C16)	<25		25	mg/kg	13-FEB-20	13-FEB-20	R4996480
F3 (C16-C34)	130		50	mg/kg	13-FEB-20	13-FEB-20	R4996480
F4 (C34-C50)	<50		50	mg/kg	13-FEB-20	13-FEB-20	R4996480
Surrogate: 2-Bromobenzotrifluoride	90.6		60-140	%	13-FEB-20	13-FEB-20	R4996480
Chrom. to baseline at nC50	YES				13-FEB-20	13-FEB-20	R4996480
CCME Total Hydrocarbons							
F1-BTEX	<10		10	mg/kg		18-FEB-20	
Total Hydrocarbons (C6-C50)	130		76	mg/kg		18-FEB-20	
Sum of Xylene Isomer Concentrations							
Xylenes (Total)	<0.071		0.071	mg/kg		18-FEB-20	
Miscellaneous Parameters							
Moisture	31.8		0.10	%		13-FEB-20	R4996418
L2415429-12 88							
Sampled By: CLIENT on 10-FEB-20 @ 17:00							
Matrix: SOIL							
BTEX and F1-F4 by Tumbler Method							
BTX plus F1 by GCMS							
Benzene	<0.0050		0.0050	mg/kg	10-FEB-20	12-FEB-20	R4997484
Toluene	<0.050		0.050	mg/kg	10-FEB-20	12-FEB-20	R4997484
Ethyl benzene	<0.015		0.015	mg/kg	10-FEB-20	12-FEB-20	R4997484
o-Xylene	<0.050		0.050	mg/kg	10-FEB-20	12-FEB-20	R4997484
m+p-Xylenes	<0.050		0.050	mg/kg	10-FEB-20	12-FEB-20	R4997484
F1 (C6-C10)	<10		10	mg/kg	10-FEB-20	12-FEB-20	R4997484
Surrogate: 4-Bromofluorobenzene (SS)	104.4		70-130	%	10-FEB-20	12-FEB-20	R4997484
CCME Total Extractable Hydrocarbons							
F2 (C10-C16)	<25		25	mg/kg	13-FEB-20	13-FEB-20	R4996480
F3 (C16-C34)	913		50	mg/kg	13-FEB-20	13-FEB-20	R4996480
F4 (C34-C50)	107		50	mg/kg	13-FEB-20	13-FEB-20	R4996480
Surrogate: 2-Bromobenzotrifluoride	91.9		60-140	%	13-FEB-20	13-FEB-20	R4996480
Chrom. to baseline at nC50	YES				13-FEB-20	13-FEB-20	R4996480
CCME Total Hydrocarbons							
F1-BTEX	<10		10	mg/kg		18-FEB-20	
Total Hydrocarbons (C6-C50)	1020		76	mg/kg		18-FEB-20	
Sum of Xylene Isomer Concentrations							
Xylenes (Total)	<0.071		0.071	mg/kg		18-FEB-20	
Miscellaneous Parameters							
Moisture	30.8		0.10	%		13-FEB-20	R4996418

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
BTEXS+F1-HSMS-WP	Soil	BTX plus F1 by GCMS	EPA 8260C

The soil methanol extract is added to water and reagents, then heated in a sealed vial to equilibrium. The headspace from the vial is transferred into a gas chromatograph. Target compound concentrations are measured using mass spectrometry detection.

F1-F4-CALC-WP	Soil	CCME Total Hydrocarbons	CCME CWS-PHC, Pub #1310, Dec 2001-S

Analytical methods used for analysis of CCME Petroleum Hydrocarbons have been validated and comply with the Reference Method for the CWS PHC.

In cases where results for both F4 and F4G are reported, the greater of the two results must be used in any application of the CWS PHC guidelines and the gravimetric heavy hydrocarbons cannot be added to the C6 to C50 hydrocarbons.
In samples where BTEX and F1 were analyzed , F1-BTEX represents a value where the sum of Benzene, Toluene, Ethylbenzene and total Xylenes has been subtracted from F1.

In samples where PAHs, F2 and F3 were analyzed, F2-Naphth represents the result where Naphthalene has been subtracted from F2. F3-PAH represents a result where the sum of Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Dibenzo(a,h)anthracene, Fluoranthene, Indeno(1,2,3-cd)pyrene, Phenanthrene, and Pyrene has been subtracted from F3.

Unless otherwise qualified, the following quality control criteria have been met for the F1 hydrocarbon range:
1. All extraction and analysis holding times were met.
2. Instrument performance showing response factors for C6 and C10 within 30% of the response factor for toluene.
3. Linearity of gasoline response within 15% throughout the calibration range.

Unless otherwise qualified, the following quality control criteria have been met for the F2-F4 hydrocarbon ranges:
1. All extraction and analysis holding times were met.
2. Instrument performance showing C10, C16 and C34 response factors within 10% of their average.
3. Instrument performance showing the C50 response factor within 30% of the average of the C10, C16 and C34 response factors.
4. Linearity of diesel or motor oil response within 15% throughout the calibration range.

F2-F4-TMB-FID-WP	Soil	CCME Total Extractable Hydrocarbons	CCME CWS-PHC, Pub #1310, Dec 2001

A soil or sediment sample is extracted with 1:1 hexane/acetone in a tumbler, followed by a silica gel clean up to facilitate separation of the hydrocarbons from other polar extractions. An aliquot of the solvent is analyzed using a gas chromatograph equipped with a flame -ionization detector.

MOISTURE-WP	Soil	% Moisture	CCME PHC in Soil - Tier 1 (mod)

Moisture content in solid matrices is determined gravimetrically after drying to constant weight at 105°C.

XYLENES-SUM-CALC-WP	Soil	Sum of Xylene Isomer Concentrations	CALCULATED RESULT

Total xylenes represents the sum of o-xylene and m&p-xylene.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WP	ALS ENVIRONMENTAL - WINNIPEG, MANITOBA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS
Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Submitted To:

Winnipeg

TRANSIT DEPARTMENT

GEOTECHNICAL INVESTIGATION

WINNIPEG TRANSIT GARAGE HOIST REPLACEMENT PROGRAM
421 OSBORNE STREET, WINNIPEG, MANITOBA

AUGUST 2019

FILE NO. 19-217-03

ENG-TECH CONSULTING LIMITED

"Engineering and Testing Solutions That Work for You"

420 Turenne Street
Winnipeg, Manitoba
Canada
R2J 3W8

1999 20 2019 YEARS OF EXCELLENCE

Phone: (204) 233-1694
Facsimile: (204) 235-1579
e-mail: engtech@mymts.net
www.eng-tech.ca

TABLE OF CONTENTS

Attachments

1.0 INTRODUCTION

ENG-TECH Consulting Limited (ENG-TECH) completed the requested geotechnical investigation for the proposed Winnipeg Transit Garage Hoist Replacement Program at 421 Osborne Street in Winnipeg, Manitoba. ENG-TECH was informed that the Winnipeg Transit Garage had recently been expanded to the west. The hoist replacement program at the Winnipeg Transit Garage would be limited to the pre-expanded Winnipeg Transit Garage, which will include the replacement of 38 in-ground vehicle hoists with the associated in-ground reinforced concrete hoist pits, as well as the concrete floors (structural and slab-on-grade) in the vicinity these 38 hoists. The structures in the pre-expanded portion of the Winnipeg Transit Garage are supported by cast-in-place concrete friction piles, which are reportedly 25 feet in length with diameters of 30 inches, and are being considered for possible re-use. The maximum expected point load of the replacement program will be a factored load of 355 kN. The preferred type of foundation for the new structures would be cast-in-place concrete friction piles. The purpose of the investigation was to assess the soil conditions close to the footprints of the existing 38 hoists to be replaced in the pre-expanded portion of the Winnipeg Transit Garage in order to provide recommendations for the new replacement hoist foundations, concrete garage and hoist pit floors (slab-on-grade and structural), and concrete durability, as well as comments on lateral earth pressures for permanent and temporary below grade walls, and estimate the capacities of the existing cast-in-place concrete friction piles (based on the piles being 25 feet in length with diameters of 30 inches). Verification of depth and diameter of the existing piles was outside the scope of work.

1.1 Scope of Work

ENG-TECH completed the following scope of work:

- Clearance of underground utilities.
- Clearance of limited private services, which included the underground electrical lines of the City of Winnipeg light standards and vehicle plug-ins located south of the southwest corner of the pre-expanded Winnipeg Transit Garage by the east gate of the City of Winnipeg Brandon Street parking lot.
- A test hole drilling and soil sampling program.
- A laboratory testing program.
- An assessment and engineering report outlining the investigation and recommendations as outlined above.

2.0 TEST HOLE DRILLING, SOIL SAMPLING & LABORATORY TESTING

ENG-TECH supervised the drilling of two (2) test holes (TH1 and TH2) on July 17, 2019 at 421 Osborne Street in Winnipeg as shown in Figures 1 and 2. The Winnipeg Transit Garage has been recently expanded to the west, and all the hoists being replaced are located in the pre-expansion transit garage footprint (not including the expansion). Both test holes were drilled close to the locations of the 38 hoists to be replaced and outside the pre-expansion transit garage footprint. The test holes were drilled on the outside of the transit garage to avoid height limitations for the drilling activities associated with the transit garage ceiling.

TH1 was located close to the southeast corner of the pre-expansion transit garage as shown in Figure 1, while TH2 was located close to the southwest corner of the pre-expansion transit garage as shown in Figure 2. TH2 was drilled 15.2 m below existing grade, while TH1 was advanced to 12.2 m below existing grade. The test holes were drilled using a truck mounted Acker MP8 drill rig equipped with 125 mm diameter solid stem continuous flight augers, owned and operated by Paddock Drilling Ltd. All test holes were backfilled using the soil auger cuttings and bentonite upon completion of drilling.

The soil stratigraphy was visually classified at the time of drilling using the modified Unified Soil Classification System (USCS). Soil samples were collected off the auger flights, and by means of Shelby tubes at the depths of 4.6 m and 7.6 m in TH1. All soil samples collected were retained for testing in ENG-TECH's Winnipeg laboratory.

Moisture contents were determined on all collected soil samples (24), while two (2) Atterberg Limits and two (2) unconfined compressive strength tests were completed on selected soil samples. All laboratory results are shown on the test hole summary logs.

3.0 STRATIGRAPHY

The stratigraphy at the test holes consisted of 25 to 150 mm of topsoil over 575 mm to 1.675 m of clay fill followed by approximately 12 m of native clay underlain by silt till to the depth explored, except at the following:

- At TH1, where a 75 mm layer of crushed limestone fill was detected between the topsoil and clay fill.
- At TH1, where an additional 100 mm layer of topsoil was encountered between the clay fill and native clay.
- At TH2, where a 600 mm layer of native silt was detected between the clay fill and native clay.

The topsoil was dark brown, moist, soft and contained organics. The crushed limestone fill was tan, moist, poorly graded, fine to coarse grained, and up to 19 mm in diameter. The clay fill was dark to light brown, moist, firm to stiff, low plastic, and contained silt (trace to some) and gravel (trace to some). The silt was tan, moist to wet and low plastic. The clay was medium brown, moist, stiff to very stiff and contained silt (trace to some), and with depth became grey, soft, and additionally contained gravel (trace). The silt till was tan, moist, stiff, low plastic, and contained sand and gravel.

Seepage and sloughing was detected from the silt layer in TH2, while no seepage or sloughing was encountered at TH1 during the drilling.

Detailed stratigraphy descriptions are outlined on the test hole summary logs.

Since the test holes were outside the pre-expansion transit garage footprint, the upper soils under the present concrete floor in the area of the hoists to be replaced would likely consist of granular fill over native clay, with potentially clay fill between the granular fill and native clay.

4.0 RECOMMENDATIONS

4.1 General

Based on the soil conditions and the magnitude of the expected loads, deep foundations such as the cast-in-place concrete friction piles (the preferred foundation type) would be suitable to limit settlement and differential movements of the proposed replacement hoists, however construction difficulties during the pile installation would include seepage and sloughing from random saturated zones. Seepage and sloughing were detected from a moist to wet silt layer from 1.7 m to 2.3 m below existing grade in TH2 during the drilling program, and random saturated zones should be expected in some of the boreholes for the pile installation.

Other deep foundations, such as driven end bearing piles were not considered since auger refusal was not encountered during the drilling. Suitable foundations could be provided without auger refusal, and determination of auger refusal depth was outside the scope of work for this project.

Shallow foundations would not be practical option due to the size limit constraints associated with the replacement hoist foundations. The existing hoists are supported by cast-in-place concrete friction piles, which may be re-used. Therefore the replacement hoists will require a suitable deep foundation type for support.

Other foundation types could also be used to support the replacement hoists, although they were not considered as practical or economical as the above option. Therefore, only foundation recommendations for cast-in-place concrete friction piles will be presented in this report.

The most current City of Winnipeg grading specifications should be used for the base and sub-base materials specified in this report.

4.2 Foundations

4.2.1 Cast-in-Place Concrete Friction Piles

Cast-in-place concrete friction piles were assessed using a geotechnical resistance factor of 0.4 to obtain the Ultimate Limit State (ULS) and Serviceability Limit State (SLS) values that can be used in design for vertical resistance at the proposed replacement hoists as outlined in Table 1:

Table 1
ULS and SLS Skin Friction Static Resistances for Cast-In-Place Concrete Piles

Depth Range (m)	ULS Skin Friction Resistance	SLS Skin Friction Resistance
	kPa	
The greater of: 2.4 m below existing grade or 1.0 m below the underside of the grade beam	0	0
Between the above and 7.6 m below existing grade	18	15
Between 7.6 m and 15.0 m below existing grade	10	8

The following recommendations also apply to the use of cast-in-place concrete friction piles:

- The piles should be spaced at least 2.5 pile diameters apart, as measured from center to center in order to have the piles act individually. For a two (2) pile group, the capacity per pile as outlined above could be used to establish the capacity of the group.

- A minimum embedment depth of 7 m must be used for all piles supporting the replacement hoists located within the Winnipeg Transit Garage, and a minimum embedment depth 8 m must be used for all piles for the replacement hoists located on the perimeter of the Winnipeg Transit Garage and in unheated areas.

- The piles may be treated as supported columns throughout their depth below final grade.

- The weight of the embedded portion of the pile may be neglected in the design, when determining the load on a pile.

- Each pile must be steel reinforced to at least 6 m, with reinforcement to resist up-lift pressures due to structural forces as determined by the structural engineer. The design of piles to resist up-lift from soil swell pressure is not required for all piles since significant differential changes in moisture content are not expected around the piles with depth. Vertical reinforcement may also be required to resist breaking of the upper portion of the piles as a result of up-lift forces due to frost action against perimeter piles and piles in unheated areas. The use of a Sona tube wrapped with a layer of 4 mil poly and inserted in the upper 2.4 m of the bore holes prior to placement of concrete will aid to reduce the potential of uplift pressures on the piles due to frost for all piles supporting replacement hoists on the perimeter of the Winnipeg Transit Garage and in unheated areas.

- The piles should be poured immediately after the completion of drilling to reduce the potential for seepage in the boreholes, and sloughing, swelling and squeezing of the boreholes, and should be poured in accordance with Clause 7.2.7 of the Canadian Standards Association A23.1-14 (Concrete Materials and Methods of Concrete Construction). Seepage and sloughing were detected from a random wet silt layer in TH2 during the drilling program and should be randomly expected in at least some of the boreholes during the installation of the cast-in-place piles. Steel sleeving varying in length (including to full length) may be required for some of the boreholes, while pumping may be required to remove excess water from some of the boreholes prior to pouring the concrete. Sleeving and a pump of adequate capacity should be available on site and used on an as required basis.

- A minimum void space or compressible void form of 150 mm should be maintained under all non-bearing surfaces of the pile caps, grade beams, and structures supported on piles exposed to soil to prevent damage due to uplift pressures and potential swelling of the underlying soils, should it occur.

4.3 Replacement Concrete Slab-on-Grade Garage Floors

ENG-TECH cautions that some movement of the concrete slabs should be expected and is typical for all concrete slab-on-grade floors, and can be minimized with sub-grade preparation, and use of well graded compacted base and sub-base materials. The replacement concrete slab-on-grade floors must not be founded on topsoil or organic soils since there would be the potential of excessive settlement and differential movements. Also, the replacement concrete slab-on-grade floors must not be founded on soft and/or wet soils since there would be the potential for excessive settlement and differential movements, unless there is adequate bridging over the soft and/or wet soils.

Topsoil layers were detected as deep as 900 mm in TH1 and 25 mm in TH2, while a wet soft soil (moist to wet soft silt) layer was encountered between 1.7 m and 2.3 m below existing grade in TH2. Likely any topsoil in the upper 900 mm of the areas of the replacement concrete slab-on-grade floors has been removed previously during the construction present concrete slab-on-grade floors, however a silt layer like detected in TH1 or potentially additional silt layers of random thickness and/depths could be present in the stratigraphy, and should be expected in some areas of the replacement slab-on-grade floors.

Full removal of the soft and/or wet soils would be the best to limit settlement and differential movements, however would likely not be economical or practical across the footprints of the proposed replacement concrete slab-on-grade floors. Partial removal of the soft and/or wet soils encountered with adequate bridging over the remaining soft and wet soils could be used to reduce the potential of excessive movements (settlement and differential movements) to typical movements for the slab-on-grade floors. Adequate bridging of the soft and/or wet soil spots for the replacement garage concrete slab-on-grade floors should consist of at least 300 mm of firm to stiff medium to high plastic clay over a geotextile. Geotextile would provide separation barrier between the soils used for bridging, and the soft and/or wet soils.

If typical movements of a slab in the order of 50 mm are not acceptable to the owner, then a floor structurally supported on piles should be used.

Based on the above and providing the owner is willing to accept the possibility of typical movement of slabs in the order of 50 mm, the replacement concrete floor slabs after the removal of the existing concrete floor slabs could be constructed as follows:

- Removal all soft, wet and/or organic soils (as well as topsoil if encountered) from the surface to their full depth within the footprints of the replacement slab-on-grade floors, continue to excavate as required in order to achieve a minimum depth of 200 mm below the base of the replacement slabs design elevation. The exposed sub-grade soils at the sub-grade design elevation of the slabs should consist of inorganic firm to stiff clay fill and/or medium dense to dense granular fill.

- The exposed sub-grade should be inspected by ENG-TECH (and inspection must include supervising proof rolling with a smooth faced roller in non-vibratory mode), and the upper 300 mm of the exposed sub-grade should be uniformly compacted to 95% of its Maximum Dry Density (MDD) at ± 2% of optimum moisture content (ASTM D 698) prior to placement of any base materials. If soft or wet spots are encountered during the proof rolling or compaction activities and partial removal is preferred, these soft and/or wet spots should be sub-excavated an additional 300 mm (partial removal) followed by the placement of a geotextile (non-woven Nilex 4551 or equivalent), and then backfilled using medium to highly plastic inorganic clay in two lifts with each lift compacted to a minimum of 95% of its MDD at ± 2% of optimum moisture content. Alternatively if soft and /or wet spots are encountered during the proof rolling or compaction activities and full removal is preferred, these soft and/or wet soils should additionally be fully sub-excavated to their full depth (full removal) and then backfilled using medium to highly plastic inorganic clay in maximum 150 mm thick lifts or crushed sub-base (50 mm max) course in maximum 200 mm thick lifts with lift compacted to a minimum of 95% of its MDD at ± 2% of optimum moisture content.

- The excavated soils can be temporarily stockpiled a minimum of 3.0 m away from the excavations. Stockpiled excavated soil must be approved by ENG-TECH for re-use prior to placement.

- As required place medium to highly plastic inorganic clay in maximum 150 mm thick lifts or place crushed sub-base (50 mm max) course in maximum 200 mm lifts to 200 mm below the underside of the design elevation of the slabs, and uniformly compact each lift to 98% MDD at ± 2% optimum moisture content.

- Place a 200 mm thick lift of granular or limestone base course and uniformly compact it to 100% of MDD at ± 2% optimum moisture content immediately below the base of the slab.

- Place a minimum 6 mil poly layer on top of the granular base under the floor slab prior to pouring the concrete.

The floor slabs should be continuously reinforced and be provided with joints at regular intervals to control and reduce random cracking and to prevent faulting. All partition walls or equipment founded on the slabs must have a minimum 75 mm thick void space at the top to prevent damage if the slab should heave. The slabs should be structurally separated from the grade beams and columns.

4.4 Structurally Supported Replacement Concrete Garage Floor

ENG-TECH understood that the some of the replacement concrete garage floors will be structurally supported on piles over void spaces. With the replacement concrete garage floors supported on piles, compressible void form of 150 mm will suffice below the floors.

4.5 Replacement Concrete Slab-on-Grade Hoist Pit Floors

During the drilling program, topsoil was detected as deep as 900 mm from existing grade in TH1, and a soft and moist to wet silt layer was encountered from 1.7 to 2.3 m below existing grade in TH2. The tops of the replacement concrete pits floors are expected to be located at various depths ranging from approximately 1.5 m (5 feet) to 4.0 m (13 feet) below existing grade. The replacement concrete pit floors must not be founded on topsoil or organic soils since there would be the potential of excessive settlement and differential movements, however this should not be issue since topsoil was only detected to 900 mm in TH2 during the drilling program. Also, the replacement concrete slab-on-grade floors must not be founded on soft and/or wet soils since there would be the potential for excessive settlement and differential movements, unless there is adequate bridging over the soft and/or wet soils.

A soft and moist to wet silt layer was detected in TH2 from 1.7m to 2.3 m below grade during the drilling program and potentially additional silt layers of random thickness and/depths could be present in the stratigraphy, and should be expected in some areas of the replacement pit floors.

Full removal of the soft and/or wet soils would be the best to limit settlement and differential movements, however would likely not be economical or practical across the footprints of the proposed replacement concrete pit floors. Partial removal of the soft and/or wet soils encountered with adequate bridging over the remaining soft and wet soils could be used to reduce the potential of excessive movements (settlement and differential movements) to typical movements for the slab-on-grade floors. Adequate bridging of the soft and/wet soil spots for the replacement concrete slab-on-grade pit floors should consist of at least 300 mm of firm to stiff medium to high plastic clay over a geotextile. Geotextile would provide separation barrier between the soils used for bridging, and the soft and/or wet soils.

Native clay of high plasticity was detected in the both test holes below 900 mm in TH1 and 2.3 m in TH2. If the native clay was to swell in the presence of excess moisture, heave and associated movement of the slab can occur. Movement associated with shrinkage or swelling of the soils due to changing moisture content is expected, however this can be minimized with proper sub-grade preparation and the use of a free draining base material.

If potential typical movement of the replacement concrete pit floors are unacceptable to the owner, then replacement concrete pit floors structurally supported by piles over void spaces should be used.

Based on the above and providing the owner is willing to accept the possibility of typical movements of the concrete pit floor slabs, the replacement pit floor slabs after the removal of the existing floor slabs could be constructed as follows:

- Excavate all silt, and any soft and/or wet soils (as well as topsoil and organic soils if encountered) to their full depth from the surface, and continue as required to at least 150 mm below the underside of the replacement pit floor design elevation (which will vary from approximately between 1.5 m and 4.0 m below existing grade). During the drilling program, soft and moist to wet silt was detected between 1.7 m and 2.3 m below existing grade in TH2. The sub-grade soils should consist of inorganic firm to stiff native clay and/or firm to stiff clay fill and/or medium dense to dense granular fill, should be shaped such that it continuously slopes towards a sump pit(s).

- The excavated soils can be temporarily stockpiled a minimum of 3.0 m away from the excavations. Stockpiled excavated soil must be approved by ENG-TECH for re-use prior to placement.

- Uniformly compact the upper 300 mm of the sub-grade to 95% of its MDD at ± 2% of optimum moisture content in order to densify and decrease the voids created during excavating. If soft and/or wet spots are encountered during the compaction activities and partial removal is preferred, these soft and/or wet spots should be sub-excavated an additional 300 mm (partial removal) followed by the placement of a geotextile (non-woven Nilex 4551 or equivalent), and then backfilled using medium to highly plastic inorganic clay in two lifts with each lift compacted to a minimum of 95% of its MDD at ± 2% of optimum moisture content. Alternatively if soft and/or wet spots are encountered during the compaction activities and full removal is preferred, these soft and/or wet soils should additionally be fully sub-excavated to their full depth and then backfilled using medium to highly plastic inorganic clay in maximum 150 mm thick lifts or crushed sub-base (50 mm max) course in maximum 200 mm thick lifts with lift compacted to a minimum of 95% of its MDD at ± 2% of optimum moisture content. The sub-grade should be inspected by ENG-TECH prior to the placement of any base material.

- Place at least 150 mm of pea gravel and moderately vibrate it to reduce voids and future replacement pit floor movements.

- Place a vapour barrier consisting of a minimum of 10 mil poly directly below the underside of the replacement pit slab prior to pouring the concrete.

The replacement pit floor should be continuously reinforced and should be provided with joints at regular intervals to control and reduce random cracking and to prevent faulting. The replacement pit floor should be structurally separated from the foundation walls and columns.

4.6 Structurally Supported Replacement Concrete Hoist Pit Floors

ENG-TECH understood that the some of the replacement concrete pit floors will be structurally supported on piles over void spaces. With the replacement concrete pit floors supported on piles, compressible void form of 150 mm will suffice below the replacement pit floors. The exposed sub-grade soils of the void space should be shaped such that it continuously slopes towards a sump pit(s).

4.7 Lateral Earth Pressure on Below Grade Walls

ENG-TECH assumes that below grade walls will be rigid, and therefore, the coefficient of earth pressure at rest (K_o) can be used to determine the lateral earth pressure on the walls. The compaction effort of the backfill placed against the walls, backfill type and sub-drainage conditions will have an impact on the magnitude and shape of lateral earth pressures on the walls. Lateral earth pressures induced by compaction, surcharge loading and groundwater will have to be accounted for in the design of below grade walls.

Outlined below are recommendations for lateral earth pressures for lightly to moderately and well compacted backfill against rigid walls.

Lightly to Moderately Compacted Backfill

Backfill lightly to moderately compacted typically corresponds to 90 to 95% of MDD. Settlements under the self-weight of the backfill compacted to the above range usually does not exceed 4% of the fill height. The lateral earth pressures against below grade walls of lightly to moderately compacted backfill with no sub-drainage system installed can be determined as outlined below:

$$\sigma_h = K_o \cdot \gamma \cdot z_w + K_o \gamma'(z - z_w) + \gamma_w(z - z_w)$$

Where:

σ_h= lateral earth pressure (kN/m^2)
K_o = coefficient of earth pressure at rest
γ = total unit weight of the soil (kN/m^3)
γ' = buoyant unit weight of the soil (kN/m^3)
γ_w = unit weight of water (kN/m^3)
z = depth of wall below grade (m)
z_w = depth to the top of the water table (measured from top of final grade, m)

For cases where a sub-drainage system will be installed, the lateral earth pressures acting on the wall may be determined by:

$$\sigma_h = K_o \cdot \gamma \cdot z$$

The recommended values for the lateral earth pressure coefficient and total unit weight of the soil are outlined below:

Earth Pressure Coefficients and Total Unit Weights for Lightly to Moderately Compacted Backfill		
Soil Type	**K_o**	**Total Unit Weight (kN/m^3)**
Gravel Fill	0.45	21
Sand Fill	0.50	20
Silt	0.55	19
Clay Fill	0.60	21
Cohesive (Clay)	0.65	18

Well Compacted Backfill

For well compacted backfill against the upper portions of below grade walls, there will be a build-up of lateral compaction stresses acting on the wall. These compressive stresses depend on the force imposed by the compactor, which depends on the dead weight and centrifugal force of the compactor. Typical compactor forces can be provided by the manufacture of the compactor.

Well compacted backfill typically corresponds to 98% (plus) of MDD. Settlements of backfill compacted to at least 98% MDD usually does not exceed 1% of the fill height, providing no surcharge loads are added to the fill after compaction.

When backfill is well compacted against the upper portion of below grade walls, the lateral earth pressures in the upper portion along the walls can be determined as outlined below:

(1) From: 0 (top of wall) to z_1

$$\sigma_h = K_o \sqrt{(2 \cdot P \cdot \gamma \div \pi)}$$

Where: $z_1 = K_o \sqrt{(2 \cdot P \div (\pi\ \gamma))}$

$$P \text{ (Compactor Force, kN/m)} = \frac{\text{Compactor Weight (kN)} + \text{Centrifugal Force (kN)}}{\text{Width of Compactor (m)}}$$

(2) From: z_1 to z_2

$$\sigma_h = K_o \sqrt{(2 \cdot P \cdot \gamma \div \pi)}$$

Where: $z_2 = (1 \div K_o) \sqrt{(2 \cdot P \div (\pi \cdot \gamma))}$

(3) From: below z_2

$$\sigma_h = K_o \cdot \gamma \cdot z$$

Soil parameters descriptions have previously been outlined. The recommended values for the lateral earth pressure coefficient and total unit weight of well compacted soils are outlined below.

Earth Pressure Coefficients and Total Unit Weights for Well Compacted Backfill		
Soil Type	**K_o**	**Total Unit Weight (kN/m^3)**
Gravel Fill	0.40	22
Sand Fill	0.40	21
Silt	0.45	20
Clay Fill	0.50	22
Cohesive (Clay)	0.55	20

Surcharge Loading

If surcharge loads (other than light vehicle parking within 1.5 m from the pits) will be adjacent the pits, then they will have to be accounted for. We assume busses could park beside the pits, and these busses could generate additional non-uniform surcharge loading against the below grade walls and the order of magnitude dependent on the location of the busses to the below grade walls. Based on Boussinesq method and considering practicality, the horizontal surcharge load generated by the busses on below grade walls could be assumed to be 30 kPa for the upper 2 m of the below grade walls and 8 kPa on the remainder (deeper than 2 m). If other vehicles beside busses will be parked by the pits, we should be informed in order to provide design recommendations.

Lateral Earth Pressure on Temporary Below Grade Walls

Design details of a shoring system can be provided, if required, once more is known about the proposed construction scheduling. For preliminary (and conservative) design purposes the use of a design coefficient (K_d) is recommended rather than the lateral earth pressure coefficient at rest (K_o). For a level grade surface the design lateral earth pressures will increase linearly from zero at the top of grade to a maximum at the base as outlined below.

$$\sigma_h = K_d \cdot \gamma \cdot z$$

Where:

σ_h = lateral earth pressure for depth z (kN/m^2)
K_d = design coefficient of earth pressure (0.60)
γ = unit weight of soil (19 kN/m^3)
z = depth below soil surface (m)

4.8 Comments on Capacity of Piles Supporting Existing Hoists

There are 38 hoists in the pre-expansion section of the Winnipeg Transit Garage which will be replaced. These hoists are reportedly supported by cast-in-place concrete friction piles which are 25 feet (7.6 m) in length with a diameter of 30 inches (0.76 m). The capacity of each existing reported pile could be estimated by using the skin friction static resistances values provided in Table 1 of section 4.2.1 of this report.

In the case of the top an existing cast-in-place concrete friction pile at underside of garage floor, which was 25 foot in length with a diameter of 30 inches, the capacity based on table 1 would be 223 kN in ULS and 186 kN in SLS, where the estimation based on the following:

- Neglecting greater of upper 2.4 m below existing grade (underside of garage floor) or 1.0 m below the underside of the grade beam.
- A surface area (diameter multiplied by pi) of a 30 inch (0.76 m) diameter cast-in-place concrete friction pile multiplied by a length of 5.2 m (total length of 7.6 m subtracting the neglecting length of 2.4 m), and then multipled by the ULS value of 18 kPa or the SLS value of 15 kPa. For deeper estimations, note that below 7.6 m from existing grade, the ULS value was 10 kPa and the SLS value was 8 kPa.

The estimated capacity of the existing reported cast-in-place concrete friction piles would be dependent on where the top of the pile was located since all of these piles would have the same length (25 feet) and same diameter (30 inches), however the capacity of all could be calculated using table 1.

The actual top of pile location, length and diameter of the reportedly used cast-in-place concrete friction piles used to support the existing hoists was outside the scope of work.

If requested, ENG-TECH could attempt to use the Echo system to determine the length of the existing piles, which would require removal of any pile caps and grinding the top of the piles relativity flat. The success of Echo system testing is dependent of the integrity of the piles being tested.

4.9 Foundation Concrete

General

All concrete should be designed, specified, and constructed in accordance with CSA standard A23.1-14, Concrete Materials and Methods of Concrete Construction using the Performance Specification Alternative as outlined in Table 5 of CSA A23.1-14.

Under the performance alternative, the concrete supplier shall assume responsibility for the performance of the concrete as delivered and the contractor shall assume responsibility for the concrete in place. The owner shall specify performance requirements including; the required structural criteria and concrete strength at age, the concrete exposure class for durability, and any other properties that may be required to meet the owner's performance requirements such as colour, architectural requirements, and special surface finishes. The owner reserves the right to request the supplier provide satisfactory documentation that the proposed mix design will achieve the strength, durability, and performance requirements specified by the owner, and that the mix design satisfies the requirements of CSA A23.1-14. In addition, the owner may request the contractor to submit documentation demonstrating the owner's performance requirements have been met during construction and placement.

Based on Tables 1, 2, 3, and 4 of CSA A23.1-14, the concrete in contact with the local soils can be classified as a S-2 exposure class (severe sulphate exposure) for the piles and pile caps, a F-2 exposure class (exposure to freezing and thawing without chlorides) for the grade beams, a C-4 exposure class (exposure to chlorides without freezing or thawing) for a garage and pit floor slab areas where potentially buses and vehicles could be parking or being repaired which will be heated to maintain a continuous inside air temperature above freezing, a N-CF exposure class (not exposed to chlorides, freezing or thawing) for floor slab areas with a steel-towel finish which will be heated to maintain a continuous inside air temperature above freezing, and a N exposure class (not exposed to chlorides, freezing or thawing) for floor slab areas which will be heated to maintain a continuous inside air temperature above freezing. The concrete design can be selected as structurally required by design however the concrete should be designed to meet the minimum specifications outlined below for durability.

Piles and Caps (S-2)

56 day minimum compressive strength of 32 MPa
Maximum water/cementing materials ratio of 0.45
Maximum nominal aggregate size of 20 mm
Type HS or HSb cement
Air content of 4-7%

Grade Beams (F-2)

28 day minimum compressive strength of 25 MPa
Maximum water/cementing materials ratio of 0.55
Maximum nominal aggregate size of 20 mm
Type Gu or Gub cement
Air content of 4-7%

Heated Garage aand Pit Floors Slab Exposed to Chlorides (C-4)

28 day minimum compressive strength of 25 MPa
Maximum water/cementing materials ratio of 0.55
Maximum nominal aggregate size of 20 mm
Type Gu or Gub cement
Air content of 4-7%
Requirement for air-entrainment should be waived when a steel toweled finish is required

Heated Floor Slabs (Not Exposed to Chlorides) with Steel-Towel Finish (N-CF)

28 day minimum compressive strength of 25 MPa
Maximum water/cementing materials ratio of 0.55
Maximum nominal aggregate size of 20 mm
Type Gu or Gub cement
Air content – natural

Heated Floor Slabs Not Exposed to Chlorides (N)

Minimum compressive strength for structural design
Maximum water/cementing materials ratio as per the mix design for the strength required
Maximum nominal aggregate size of 20 mm
Type Gu or Gub cement
Air content – natural

4.10 Inspection and Testing

Documentation and inspection during installation cast-in-place concrete friction piles should be conducted by ENG-TECH.

Also, the sub-grades for the concrete slab-on-grade garage and pit floors should be inspected by ENG-TECH prior to the placement of any base and sub-bade materials. Instructions for dealing with sub-grade soft spots will be provided after inspection.

All material testing (both field and laboratory) of the concrete and base materials used at this site should be completed by ENG-TECH, which is certified with Canadian Council of Independent Laboratories (CCIL) for concrete category 2, asphalt type A and B, and aggregates type C.

5.0 CLOSURE

This report was based on the scope of work outlined for the purpose of the investigation, and was prepared in accordance with acceptable professional engineering principles and practices. If you have any questions, please contact the undersigned.

Sincerely,
ENG-TECH Consulting Limited

Rodney L Girouard

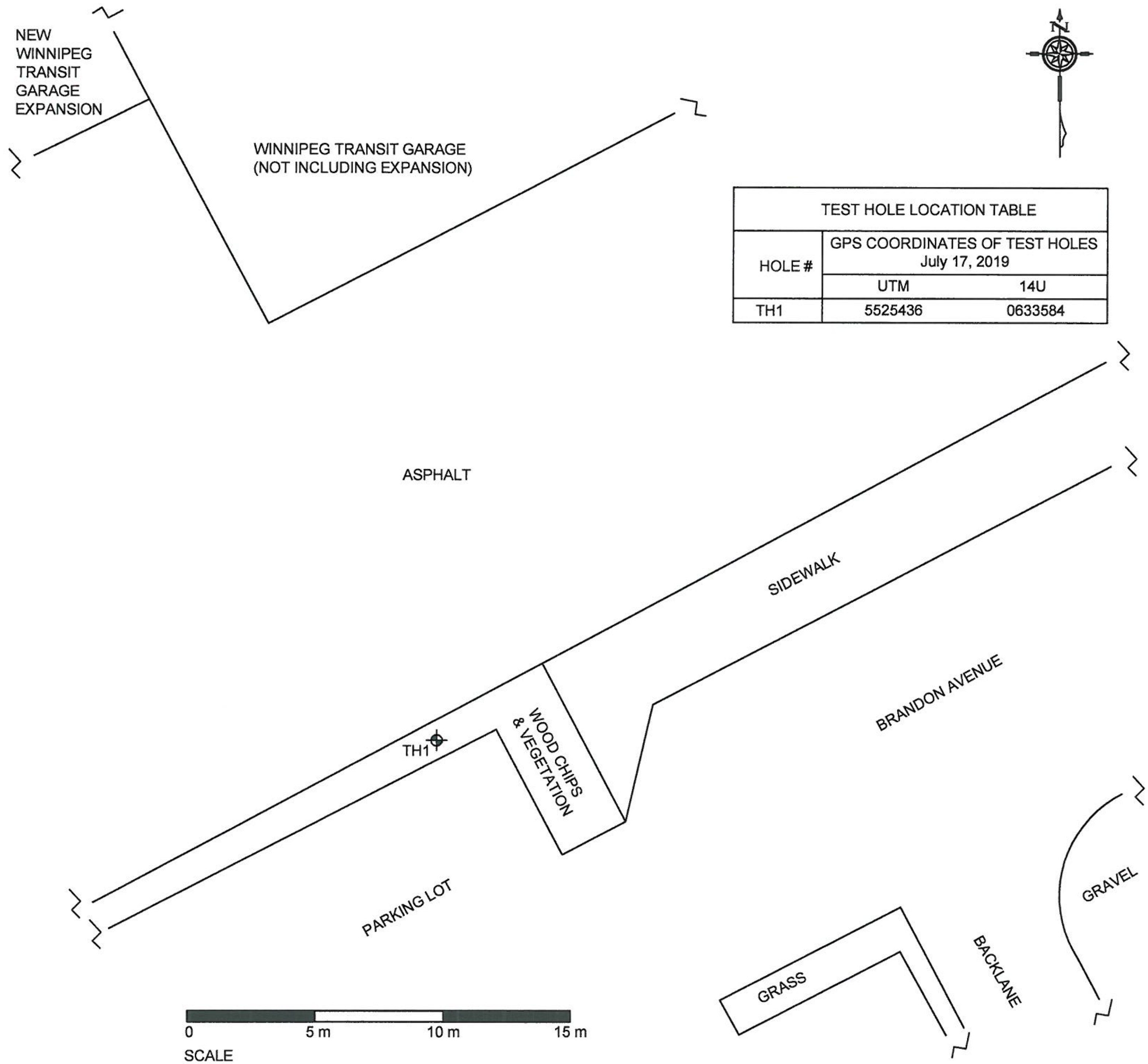
PROVINCE OF MANITOBA
R.L.J. GIROUARD
Member
21542
August 14, 2019
REGISTERED PROFESSIONAL ENGINEER

Rod Girouard, P.Eng.
Geotechnical Engineer

Clark Hryhoruk, M.Sc., P. Eng.
Principal, Geotechnical Engineer

CDH/rlg

ENGINEERS
GEOSCIENTISTS
MANITOBA
Certificate of Authorization
ENG-TECH Consulting Limited
No.2475



TEST HOLE LOCATION TABLE		
HOLE #	GPS COORDINATES OF TEST HOLES July 17, 2019	
	UTM	14U
TH1	5525436	0633584

LEGEND

⌖ TEST HOLE

NO.	DATE	ISSUE / REVISION
0	AUG. 2019	report

ENG-TECH CONSULTING LIMITED
420 Turenne Street
Winnipeg, MB
R2J 3W8
Phone: (204) 233-1694
Fax: (204) 235-1579

ENG. STAMP:

ENGINEERS GEOSCIENTISTS MANITOBA
Certificate of Authorization
ENG-TECH Consulting Limited
No.2475

CLIENT:
CITY OF WINNIPEG -
TRANSIT DEPARTMENT.

PROJECT:
GEOTECHNICAL INVESTIGATION -
WINNIPEG TRANSIT GARAGE
HOIST REPLACEMENT PROGRAM,
421 OSBORNE STREET,
WINNIPEG, MANITOBA

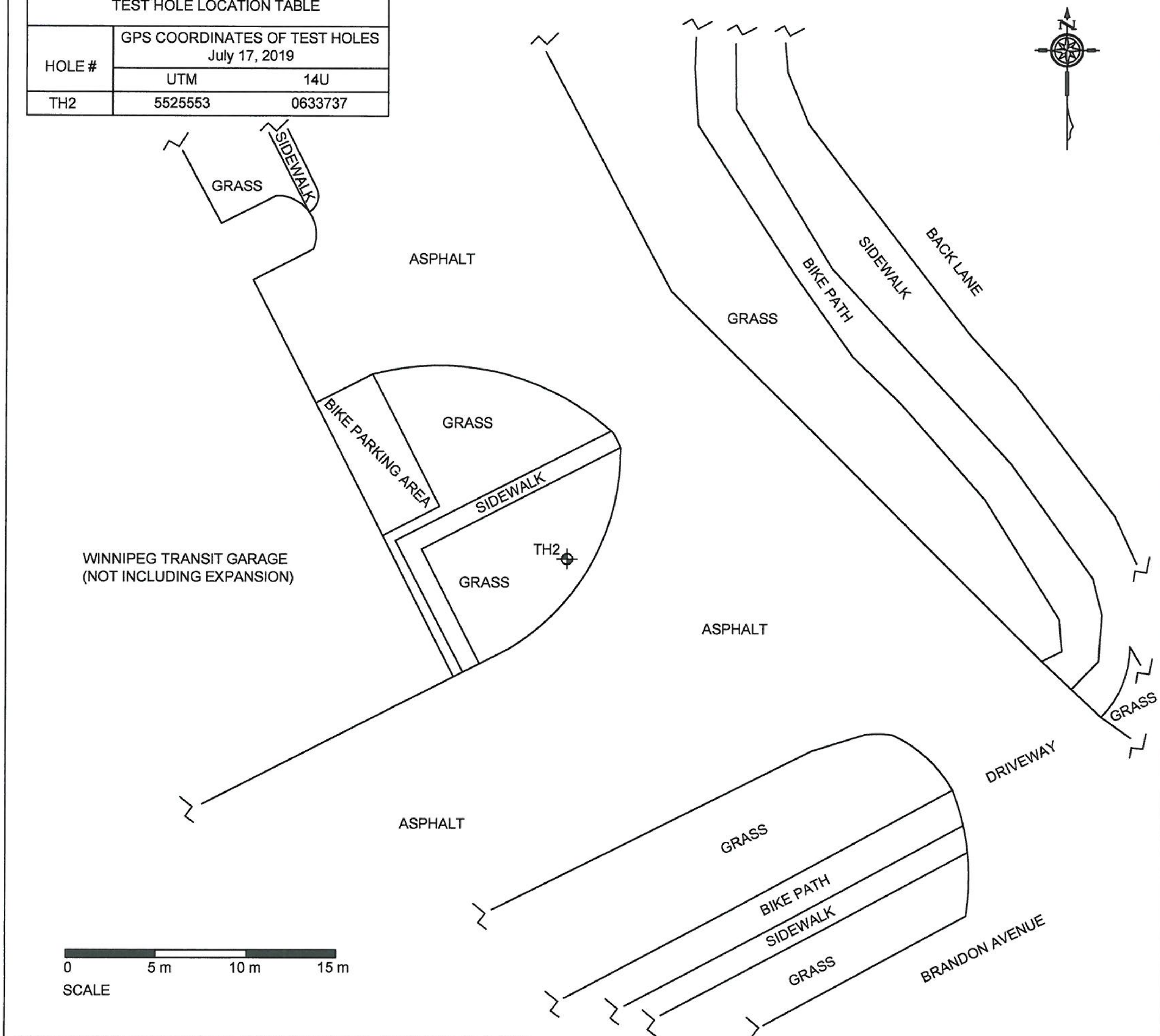
DWG DESCRIPTION:
TEST HOLE LOCATION PLAN FOR TH1

SCALE:
AS SHOWN

DRAWN BY: RLG
DATE: AUGUST 2019
FILE No.: 19-217-03
CLIENT DWG/FIG. No.:
ENG-TECH DWG/FIG. No.: 1
NO.:

P:\2019\217(C.O.W)\03(Geo_Transit Garage Program; 421 Osborne)\Figures\Figure 1 – Test Hole Location Plan for TH1.dwg

TEST HOLE LOCATION TABLE		
HOLE #	GPS COORDINATES OF TEST HOLES July 17, 2019	
	UTM	14U
TH2	5525553	0633737



LEGEND

⌖ TEST HOLE

NO.	DATE	ISSUE / REVISION
0	AUG. 2019	report

ENG-TECH CONSULTING LIMITED
420 Turenne Street
Winnipeg, MB
R2J 3W8
Phone: (204) 233-1694
Fax: (204) 235-1579

ENG. STAMP:

ENGINEERS GEOSCIENTISTS MANITOBA
Certificate of Authorization
ENG-TECH Consulting Limited
No.2475

CLIENT:
CITY OF WINNIPEG - TRANSIT DEPARTMENT.

PROJECT:
GEOTECHNICAL INVESTIGATION - WINNIPEG TRANSIT GARAGE HOIST REPLACEMENT PROGRAM, 421 OSBORNE STREET, WINNIPEG, MANITOBA

DWG DESCRIPTION:
TEST HOLE LOCATION PLAN FOR TH2

SCALE:
AS SHOWN

DRAWN BY:	DATE:
RLG	AUGUST 2019
FILE No.:	CLIENT DWG/FIG. No.:
19-217-03	
ENG-TECH DWG/FIG. No.:	NO.:
2	

P:\2019\217(C.O.W)\03(Geo_Transit Garage Program; 421 Osborne)\Figures\Figure 2 – Test Hole Location Plan for TH2.dwg

MODIFIED UNIFIED CLASSIFICATION SYSTEM FOR SOILS

MAJOR DIVISION			GROUP SYMBOL	GRAPH SYMBOL	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA
COARSE GRAINED SOILS (MORE THAN HALF BY WEIGHT LARGER THAN 75 µm)	GRAVELS MORE THAN HALF THE COARSE FRACTION LARGER THAN 4.75 mm	CLEAN GRAVELS (TRACE OR NO FINES)	GW		WELL GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	$C_U = \frac{D_{60}}{D_{10}} > 4$; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1$ TO 3
			GP		POORLY GRADED GRAVELS, GRAVEL- SAND MIXTURES, LITTLE OR NO FINES	NOT MEETING ABOVE REQUIREMENTS
		DIRTY GRAVELS (WITH SOME OR MORE FINES)	GM		SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES	ATTERBERG LIMITS BELOW "A" LINE OR P.I. LESS THAN 4
			GC		CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES	ATTERBERG LIMITS ABOVE "A" LINE AND P.I. MORE THAN 7
	SANDS MORE THAN HALF THE COARSE FRACTION SMALLER THAN 4.75 mm	CLEAN SANDS (TRACE OR NO FINES)	SW		WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES	$C_U = \frac{D_{60}}{D_{10}} > 6$; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1$ TO 3
			SP		POORLY GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES	NOT MEETING ABOVE REQUIREMENTS
		DIRTY SANDS (WITH SOME OR MORE FINES)	SM		SILTY SANDS, SAND-SILT MIXTURES	ATTERBERG LIMITS BELOW "A" LINE OR P.I. LESS THAN 4
			SC		CLAYEY SANDS, SAND-CLAY MIXTURES	ATTERBERG LIMITS ABOVE "A" LINE AND P.I. MORE THAN 7
FINE GRAINED SOILS (MORE THAN HALF BY WEIGHT SMALLER THAN 75 µm)	SILTS BELOW "A" LINE NEGLIGIBLE ORGANIC CONTENT	LL ≤ 50%	ML		INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY SANDS OF SLIGHTY PLASTICITY	CLASSIFICATION IS BASED UPON PLASTICITY CHART (SEE BELOW)
		LL > 50%	MH		INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS, FINE SANDY OR SILTY SOILS	
	CLAYS ABOVE "A" LINE NEGLIGIBLE ORGANIC CONTENT	LL ≤ 30%	CL		INORGANIC CLAYS OF LOW PLASTICITY, GRAVELLY, SANDY OR SILTY CLAYS, LEAN CLAYS	
		30% < LL ≤ 50%	CI		INORGANIC CLAYS OF MEDIUM PLASTICITY, SILTY CLAYS	
		LL > 50%	CH		INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS	
	ORGANIC SILTS & CLAYS BELOW "A" LINE	LL < 50%	OL		ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY	
		LL > 50%	OH		ORGANIC CLAYS OF HIGH PLASTICITY	
HIGHLY ORGANIC SOILS			Pt		PEAT AND OTHER HIGHLY ORGANIC SOILS	STRONG COLOUR OR ODOUR, AND OFTEN FIBROUS TEXTURE

ADDITIONAL SYMBOLS

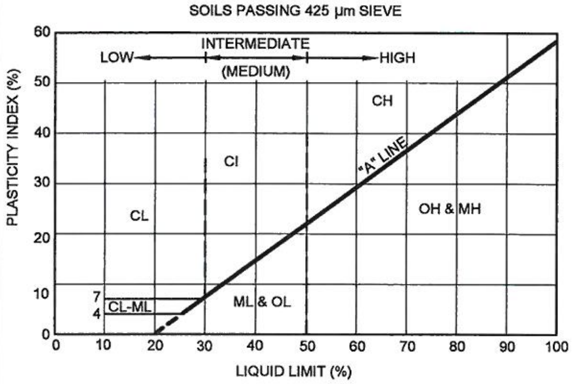
TILL	SANDSTONE
	GRANITE
FILL	
TOPSOIL	
CONCRETE	
SHALE	
LIMESTONE	

PLASTIC SOILS

MOISTURE	PLASTICITY	INTRUSIONS	CONSISTENCY	POCKET PEN (TSF)	(N)
DRY	LOW	ROOTLETS	VERY SOFT		< 2
DAMP	MEDIUM	OXIDES	SOFT	0 - 0.5	2 - 4
MOIST	HIGH	MICA	FIRM	0.5 - 1.0	4 - 8
WET		GYPSUM	STIFF	1.0 - 2.0	8 - 15
		ETC.	VERY STIFF	2.0 - 4.0	15 - 30
			HARD	> 4.0	> 30

TSF x 95.8 = kPa (q_U) $S_U = \frac{1}{2} \times q_U$

PLASTICITY CHART FOR SOILS PASSING 425 µm SIEVE



SOIL DESCRIPTIONS

TRACE:	0 - 10%	BOULDERS:	> 200 mm	COARSE SAND:	2 - 4.75 mm
SOME:	10 - 20%	COBBLES:	75 - 200 mm	MEDIUM SAND:	0.425 - 2 mm
WITH:	20 - 35%	COURSE GRAVEL:	19 - 75 mm	FINE SAND:	0.075 - 0.425 mm
AND:	35 - 50%	FINE GRAVEL	4.75 - 19 mm	FINES:	< 0.075 mm

GRANULAR SOILS

MOISTURE	DENSITY	GRADATION	INTRUSIONS	SPT (N)
DRY	VERY LOOSE	POORLY	ROOTLETS	0 - 4
DAMP	LOOSE	WELL	OXIDES	4 - 10
MOIST	MED. DENSE		MICA	10 - 30
WET	DENSE		FINES	30 - 50
	VERY DENSE		ETC.	> 50

DEFINITIONS

LL = LIQUID LIMIT

P.I. = PLASTICITY INDEX

C_U = COEFFICIENT OF UNIFORMITY

q_U = UNCONFINED COMPRESSIVE STRENGTH

S_U = UNDRAINED SHEAR STRENGTH

C_C = COMPRESSION INDEX

PL = PLASTIC LIMIT

ENG-TECH CONSULTING LIMITED

420 Turenne Street
Winnipeg, MB R2J 3W8
Phone: (204) 233-1694
Fax: (204) 235-1579

F:\Drafting\SOIL CLASSIFICATIONS\SOIL CLASSIFICATIONS.dwg

ENG-TECH Consulting Limited

Engineering And Testing Solutions That Work For You

Test Hole #: TH1

Client: City of Winnipeg - Transit Department

Site: 421 Osborne Street, Winnipeg, Manitoba

Location: Figure 1

Project: Winnipeg Transit Garage Hoist Replacement Program

File No.: 19-217-03

Date Drilled: July 17, 2019

Grade Elevation: ± 100.0 m

Water Elevation: --

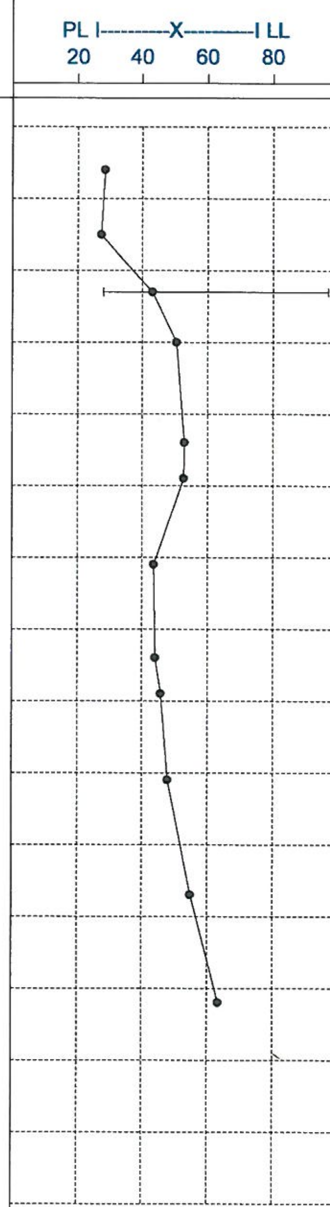
SUBSURFACE PROFILE

Depth (m)	Description	Elevation (m)
0.0	Ground Surface	100.0
	Topsoil (150 mm) - wood chip covered. - dark brown, moist, soft, organics.	
	Crushed Limestone Fill (PG)(75 mm) - tan, moist, poorly graded, fine to coarse grained & up to 19 mm in diameter.	
	Clay Fill (CL) - dark to light brown, moist, firm, low plastic, trace to some silt & gravel.	
	Topsoil (100 mm) dark brown, moist, soft, organics.	
	Clay (CH) - medium brown, moist, stiff, highly plastic, trace to some silt. - below 4.9 m, firm to stiff. - below 7.9 m, grey & firm. - below 9.4 m, soft.	
12.2	***End of Test Hole*** - end of test hole at 12.2 m below grade. - test hole was dry during drilling. - test hole backfilled with auger cuttings and bentonite upon completion of drilling.	

SAMPLE DATA

Sample No.	Sample Type	Moisture Content (%)	Blows/300 mm	P. Pen (kPa)	Torvane (kPa)	UC (kPa)
S1	Auger Cuttings	28.5		48		
S2	Auger Cuttings	27.3		96		
S3	Auger Cuttings	43.2		96		
S4	Auger Cuttings	50.5		72		
				72		
S5	Auger Cuttings	53.0		72		
S6	Shelby Tube	52.8				57
				48		
S7	Auger Cuttings	43.7		60		
				48		
S8	Auger Cuttings	44.2				
				60		
S9	Shelby Tube	45.8				31
				36		
S10	Auger Cuttings	48.0				
					24	
S11	Auger Cuttings	55.0			24	
					21	
S12	Auger Cuttings	63.5			21	

Moisture Content (%)



ENG- TECH Consulting Limited

Logged by: Rod G.

Reviewed by: [signature]

Drilled By: Paddock Drilling Ltd.

Drill Rig: Truck Mounted Acker MP8

Auger Size: 125 mm Solid Stem

Completion Depth: 12.2 m

Completion Elevation: ± 87.8 m

Sheet: 1 of 1

Sample Type: Core Barrel | Shelby Tube | Auger Cuttings | Split Spoon

ENG-TECH Consulting Limited

Engineering And Testing Solutions That Work For You

Test Hole #: TH2

Client: City of Winnipeg - Transit Department
Site: 421 Osborne Street, Winnipeg, Manitoba
Location: Figure 2
Project: Winnipeg Transit Garage Hoist Replacement Program

File No.: 19-217-03
Date Drilled: July 17, 2019
Grade Elevation: ± 100.0 m
Water Elevation: --

SUBSURFACE PROFILE

Ground Surface — Elevation 100.0 (Depth 0.0 m)

Topsoil (25 mm)
- weed covered.
- dark brown, moist, soft, organics.

Clay Fill (CL)
- dark brown, moist, stiff, low plastic, trace to some silt & gravel.
- below 1.2 m, very stiff.

Silt (ML)
- tan, moist to wet, soft, low plastic.

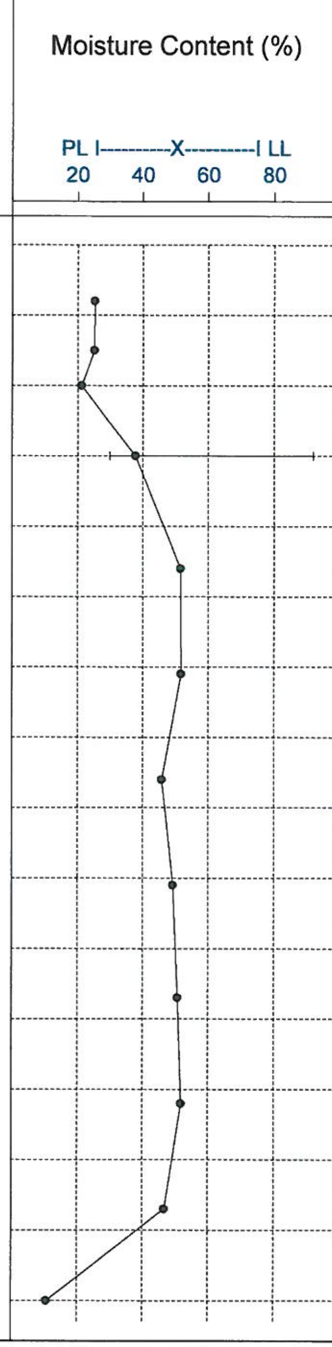
Clay (CH)
- medium brown, moist, very stiff, highly plastic, trace to some silt.
- below 6.4 m, firm.
- below 7.9 m, grey.
- below 9.4 m, soft.

below 13.0 m, trace gravel.

Silt Till (ML)
- tan, moist, stiff, low plastic, and sand & gravel.

SAMPLE DATA and SHEAR STRENGTH (kPa)

Sample No.	Sample Type	Moisture Content (%)	Blows/300 mm	P. Pen	Torvane	UC
S1	Auger Cuttings	25.2		72		
S2	Auger Cuttings	25.1		144		
S3	Auger Cuttings	21.2			10	
S4	Auger Cuttings	37.8		72		
				72		
S5	Auger Cuttings	51.6		72		
						57
				60		
S6	Auger Cuttings	51.8		72		
				48		
S7	Auger Cuttings	45.9		60		
						31
				48		
S8	Auger Cuttings	49.4		36		
					24	
S9	Auger Cuttings	50.8			24	
					21	
S10	Auger Cuttings	51.9			21	
					18	
S11	Auger Cuttings	46.8			18	
S12	Auger Cuttings	10.8		72		



Depth (m): 0.0 – 15.0; Elevation (m): 100.0 – 85.0

ENG- TECH Consulting Limited

Logged by: Rod G.
Reviewed by: CA

Drilled By: Paddock Drilling Ltd.
Drill Rig: Truck Mounted Acker MP8
Auger Size: 125 mm Solid Stem

Completion Depth: 15.2 m
Completion Elevation: ± 84.8 m
Sheet: 1 of 2

Sample Type — Core Barrel | Shelby Tube | Auger Cuttings | Split Spoon

ENG-TECH Consulting Limited

Engineering And Testing Solutions That Work For You

Test Hole #: TH2

Client: City of Winnipeg - Transit Department

Site: 421 Osborne Street, Winnipeg, Manitoba

Location: Figure 2

Project: Winnipeg Transit Garage Hoist Replacement Program

File No.: 19-217-03

Date Drilled: July 17, 2019

Grade Elevation: ± 100.0 m

Water Elevation: --

SUBSURFACE PROFILE				SAMPLE DATA				Moisture Content (%) PL I----X----I LL 20 40 60 80	SHEAR STRENGTH (kPa)		
Depth (m)	Soil Symbol	Description	Elevation (m)	Sample No.	Sample Type	Moisture Content (%)	Blows/300 mm		P. Pen	Torvane	UC
16.0 – 18.0		***End of Test Hole*** - end of test hole at 15.2 m below grade. - seepage and sloughing from silt layer during drilling. - test hole backfilled with auger cuttings and bentonite upon completion of drilling.	84.0 – 82.0								
19.0			81.0								
20.0			80.0								
21.0			79.0								
22.0			78.0								
23.0			77.0								
24.0			76.0								
25.0			75.0								
26.0			74.0								
27.0			73.0								
28.0			72.0								
29.0			71.0								
30.0			70.0								

ENG- TECH Consulting Limited

Logged by: Rod G.

Reviewed by: [signature]

Drilled By: Paddock Drilling Ltd.

Drill Rig: Truck Mounted Acker MP8

Auger Size: 125 mm Solid Stem

Completion Depth: 15.2 m

Completion Elevation: ± 84.8 m

SAMPLE TYPE: SPLIT BARREL | SHELBY TUBE | AUGER CUTTINGS | SPLIT SPOON